

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

**VALUING THE ECONOMIC BENEFITS OF
CONTROLLING OFF-SITE EFFECTS OF SOIL EROSION:
EMPIRICAL EVIDENCE FROM THE EASTERN
HIGHLANDS OF ETHIOPIA**

BY
BINIYAM TILAHUN

JULY, 2013
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BINIYAM TILAHUN

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ADDIS ABABA

Addis Ababa University
School of Graduate Studies

This is to certify that the thesis prepared by Biniyam Tilahun, entitled: *Valuing the Economic Benefits of Controlling Off-Site Effects of Soil Erosion: Empirical Evidence from the Eastern Highlands of Ethiopia* and submitted in partial fulfillment of the requirements for the degree of Degree of Master of science in economics (Environmental and Natural Resource) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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ABSTRACT

Valuing the Economic Benefits of Controlling Off-Site Effects of Soil Erosion: Empirical Evidence from the Eastern Highlands of Ethiopia

Biniyam Tilahun

Addis Ababa University, 2013

This study seeks to estimate the economic benefits of controlling off-site effects of soil erosion and identify determinants of WTP in Kufanzik area of eastern highlands, Ethiopia. A DB CVM survey was conducted on 134 randomly selected rural households to elicit preferences for controlling the off-site effects. Using a Pooled Probit model we have estimated the mean WTP & identified the determinant factors. The result indicates that controlling the off-site effects of soil erosion offers a welfare gain of 84.41 ETB. Income, level of education and off-site damage experience are the significant factors affecting WTP. The estimated values are indicative of the WTP potentials of the local community and hence designing a bottom-up approach of intervention might work better. In line with this the study considers the possibilities of implementing a market based mechanism of payment for environmental services (PES) and recommend further studies on WTA.

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ACRONYMS & ABBREVIATIONS

BVN-	Bivariate Normal
CA -	Conjoint Analysis
CBA-	Cost Benefit Analysis
CFW-	Cash for Work
CVM-	Contingent Valuation Method
DBDC-	Double Bounded Dichotomous Choice
EEPFE-	Environmental Economics policy forum for Ethiopia
ETB-	Ethiopian Birr
FAO-	Food and Agriculture Organization
FFW-	Food for Work
GDP-	Gross Domestic Product
GTP-	Growth and Transformation Plan
HPM-	Hedonic Price Method
LR-	Likelihood Ratio
NGO-	Non-Governmental Organization
NOAA-	National Oceanic and Atmospheric Administration
PASDEP-	Plan for Accelerated and Sustained Development to End Poverty
RBP-	Recursive Bivariate Probit
REP -	Random Effect Probit
SBDC-	Single Bounded Dichotomous Choice
SUBVP-	Seemingly Unrelated Bivariate Probit
WTA-	Willingness to Accept
WTP-	Willingness to Pay

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Climate change is a major problem facing the planet, Earth. Land degradation has been identified as one factor that contributes to climate change and loss of biodiversity (FAO, 2007). Land degradation in the form of soil erosion and soil nutrient depletion is the main challenge confronting many east African nations including Ethiopia (Gebremedhin B., 2004).

Ethiopia is a country where soil erosion is prevalent and most serious environmental problem. Soil erosion poses an ominous threat to the food security and development of the country (Bekele, 2003). The highland of Ethiopia loses its soil by water at alarming rate ranging from 3.4 to 84.5 tons per hectare a year with a mean of 32.0 ton per hectare a year (Berry L., 2003). A study by EEPFE reported that in 1995 the net amount of soil eroded was 130 million metric tons and this had increased to 182 million metric tons by 2005. The nutrient loss from this soil in terms of phosphorous and nitrogen had increased from 1.1 million metric tons in 1995 to 1.3 million metric tons in 2005. Moreover estimates of monetary value of productivity loss due to erosion show that Ethiopia lost 639 million birr (ETB) in 1995 and 766 million birr in 2005.

Looking at the conventional measure of economic growth, GDP, Ethiopia has experienced a strong economic growth in recent years. With real GDP growth at or near double digit levels since 2003/04, the country has consistently outperformed most other nations in Africa and expanded faster than the continental average (Peter M., 2010). But this measure of economic growth is questionable if environmental

and natural resource depletion like soil erosion is considered. The standard measure of growth does not reflect what is happening to natural resource and environment and this implies the standard measure of growth, GDP, gives an over estimated result. For the measure to show sustainability it has to be adjusted for the depletion of environment and natural resources or monetary resource accounting needs to be included in national accounts.

Gully erosion and the removal of fertile topsoil are the major forms of land degradation that lead to the reduction in land productivity and sedimentation related problem. The economics of erosion classifies the effect of erosion as on-site and off-site effects. The on-site effects are those occurring on the properties where erosion takes place and the off-site impacts are mainly downstream effects resulting from gully erosion. As Hayden et, al (2008) pointed out that the onsite effects of erosion constitute loss of crop yield induced by erosion, increased cost of remedial measure like cost of fertilizer to replace lost nutrient and the loss of soil carbon. While the offsite effects are the proximate property damage; run off and sedimentation; impact on landscape; habitat degradation; visual detracting and deterioration of recreation and amenity values.

Various studies estimated the onsite effects of soil erosion in Ethiopia. As cited in Emily and Fanaye (2012) the cost is estimated between 2 to 6.75% of agricultural GDP per year (Yesuf,et,al., 2005,Hurni(1988),Sutcliffe(1993),Bojo&Caselle(1995) and Sonnevel(2002)). Moreover the country losses more than 30000 hectare annually due to water erosion and an estimated 1 billion tons of top soil lost per year (Berry L.,2003) An estimate of the severity of soil erosion in Ethiopia varies similar to the cost estimate. But the estimate and valuation does not include the whole range

of effects of erosion. Many studies estimated either the gross impact or the onsite impacts separately. Study on the economic and environmental impacts or valuation of the offsite impacts are scarce in Ethiopia, though the problem is significant. Colacicio,et al(1989) and Crosson(1997) noted that a number of researches support the implication that the offsite impacts of soil erosion have greater economic cost than the onsite impacts.

Given the known and potential negative effects of soil erosion governments in Ethiopia had been undertaking different policies and strategies to address soil degradation as part of poverty reduction and environmental conservation effort. It was after 1970's that national effort for soil conservation expanded greatly in Ethiopia (Gebremedhin B., 2004). Various projects and programs are implemented for soil conservation including the direct economic incentive like food for work (FFW) and cash for work (CFW). But the problem of erosion remains critical challenge to the developmental effort of the country. The various programs/projects were mainly top-down, with little participation of the local communities, thus posing challenge to the success of soil conservation programs. In those projects that consider participatory approach to conservation, the extent of participation and impact of the approach on conservation were limited since real participation of community is not achieved (Gebremedhin B., 2004).

The current government of Ethiopia has invested in a series of land and water shed development activities under the past 5 year development plan i.e. PASDEP (Emily & Fanaye, 2012). In 2011 the government has launched an ambitious 5 year growth and transformation plan (GTP) and it outlines the need to invest in soil conservation activities taking into account the conditions of different agro ecological zone (GTP,

2011).But generally the effort made to promote the technologies so far had insignificant impacts in increasing the adoption of different soil conservation practices. Moreover the practices were dismantled since farmers act in anticipation of cash or expect to have incentive (Alemu, 2002). As a result soil erosion still remains an intractable challenge to the country.

The limited success stories of various conservation practices suggest the need to dig problem areas in implementing conservation activities. Most studies focus on the on farm effects of soil erosion but for public policy to address the challenge of soil erosion a comprehensive assessment of offsite impact is needed. This research aims at tackling this problem by assessing the offsite impacts and values of avoiding this effect from society's point of view. Hence provides the necessary inputs in designing possible intervention strategies.

The eastern highlands of Ethiopia is one of the most vulnerable areas for the offsite impacts of soil erosion. The damage on crop due to sedimentation, the loss of amenity services and the destruction of landscape & rural road are the main manifestation of the effects. The needs to control the problem through appropriate mechanism that involve real community participation require assessment of the value of the resource.

Non-market valuation can be used to quantify the benefits of different conservation practices with respect to the offsite effects. The total economic value of a resource can be measured using either stated or revealed preference approaches. Given the objectives of this study, stated preference techniques will be used to value the benefits of avoiding off site impacts. The techniques uses contingent valuation method(CVM), in which a hypothetical setting is constructed and the respondents

are asked to state their willingness to pay for controlling the offsite effects of soil erosion. CVM is best suited to assess the offsite effects of erosion . But such studies are not found or are scarce in Ethiopia (Yesuf, et,al, 2005).

1.2. STATEMENT OF THE PROBLEM

Land degradation in the form of soil erosion is one of the major environmental problems of developing countries (de Graaf, 1996). Ethiopia is one of those countries that suffer from wide spread and serious erosion induced by water. The problem is strong mainly in the highland area and the eastern Ethiopia highland is not exceptional to this. The cost of soil degradation is believed to be far reaching as it is difficult to quantify some of the impacts of erosion. It induces on site costs to individual farmers and off site cost to the community (Bekele, 2003).

The economics of soil erosion classifies the effects as on site and off site effects. The on-site/on farm effects which are mainly the loss of crop yield and associated effect at farm level has less externality effects than the off-site effects. The off-site effects like proximate property damage, run-off and sedimentation, habitat degradation, deterioration of recreational and amenity values, impact on rural road safety and other have costs on society at large. Eaton D. (1996) noted that the off-site effects are likely to be excessive since it consists of external costs borne by other agents.

The presence of off-site costs/benefits leads to market failure or externalities. These impacts are not reflected in market price since they affect other agent in the community who does not cause the action. The failures of the market to take account of this cost encourage actions that are not economically optimal for society as whole. Bekele (2003) noted that this externality has implication for soil problem especially in developing countries i.e. farmers lack sufficient incentive to consider the off-site

impacts of their practice. This aggravates the problem further and leads to non-optimal resource use and allocation.

When externality problem exist individual farmers cost and benefits deviates from the social cost and benefit, since the private agent consider only the on-farm costs and benefits, while from the societies point of view all impacts i.e. on-farm and off-farm need to be taken into account. Economic theory suggests for appropriate intervention when market fail to provide incentive for controlling the off-site impacts, assuming that such intervention improves resource allocation efficiency and close the gap between private and social cost/benefits.

The governments of Ethiopia and other developmental partners have been undertaking various programs and projects to address the problem. Food for work (FFW) and Cash for work (CFW) are the major intervention approach used. But evidence shows the result of such action is ineffective and the problem is still Aggravating. The effort made to increase adoption practices had insignificant impact. Moreover the practices were dismantled since farmers act in anticipation of incentives (Alemu, 2002). The various programs were top-down approach and involve limited participation of local community (Gebremedhin B., 2004)

Many studies were conducted in estimating the cost and benefits of soil erosion conservation. But the focus tended to be only on subset of effects such as on-farm/on-site effects rather than the off-site/external impacts. To address the problem of land degradation mainly soil erosion, a comprehensive assessment of cost and benefit is crucial. In Ethiopia the various efforts were mainly directed to solve the on-site impacts by attempting to increase adoption of conservation practices at farm/individual level. But economic theory/premise suggests that public

policy/intervention is best directed to address the externality effects than dealing with private decision. Accordingly appropriate intervention is most needed to manage the off-site effects than assisting private farmers to adopt practice that benefit them mostly. Crosson(1997) argues that individual farmers have the right incentive to make sound, long term decision on the use of their farm plot and protection of values in their assets. The externalities implicit here is land owners fail to take account of the off-site effects. Thus it is logical to intervene systematically to correct such failures.

For an intervention to have real impact in solving the problem of soil erosion active community involvement is important. The participation need not be limited, it must go beyond acting in expectation of incentives rather the society by itself must feel the challenge and contribute to solve the problem of erosion. The local community must be a leader in conservation activities and the first step in designing such activities need to be understanding the value of the resource for the community. The value will be reflected in their willingness to pay to avoid/control the off-site effects of soil erosion.

Due to various problems in Ethiopia, research and development focus has been on the valuation and analysis of the on-site effects of soil erosion. Even if there are no empirical/quantitative studies that reflect the off-site effects; there are noticeable and significant off site effects of erosion (Bekele, 2003). The scarcity of the cost estimates does not imply the impacts are small.

In this study a non-market valuation technique in the form of a stated preference approach is used to value the benefits of controlling the off-site effects of erosion in the eastern highlands of Ethiopia. The study area chosen for this study named *Kufanziq* is located in Tulo Woreda of west Harerghe, Ethiopia. Though quantified

information of the economic and environmental impact is scarce, there are clear and noticeable negative externalities of erosion. Landscape degradation, damage or impact on rural road safety, crop burial by sediment and deterioration of recreation & amenity values are the main manifestation of the off-site effects in the study area.

As to Yesuf,et,al., (2005)studies that asses the off-site cost and benefits of land degradation using contingent valuation method (CVM) are rare or scarce in Ethiopia, although such approach could be used. By valuing the benefits of avoided/controlled effects of soil erosion using CVM, the study will identify the socio-economic, demographic and institutional factors that will determine the success of technical solutions.

To define what the government, NGO, local community and other stakeholders' role should be, it is important to value the benefit of avoiding the problem from the local society's point of view. Moreover any intervention to correct either an externality or biased incentive must take into account farmers' own perception or valuation if such intervention is to have the desired effect (Barbier & Bishop, 1992 as cited in Derek Eaton, 1996). Identification and valuation of the off-site costs and benefits of soil erosion allows for the design of land use policies and assessment of implementation costs and priorities (Barbier, 1996; Pretty et al, 2000; Hein, 2007)

(Alemu, 2002) reported that Ethiopia is entering into the dangerous stage in which people are unwilling to do anything to better their living condition without incentive or without being rewarded food or cash. Hence one motive for this study is to investigate this situation or the quest to know whether people value the environment or not, which is reflected in their willingness to pay (WTP).

In approaching the offsite impacts of erosion both from individual and social perspective the role of research is significant. Bekele (2003) suggests that to address the problem intra-disciplinary and inter-disciplinary intervention is important. Consequently, the off-site effects of soil erosion require the attention of environmental economists and this research is such type of intervention.

The purpose of this study is, therefore, to value the economic benefit of controlling the offsite effects of soil erosion as it applies to farmers in *Kufanziq* area of the eastern highlands of Ethiopia. The research questions of the study are:

- ♥ *Do rural households value the environment?*
- ♥ *How much is the benefits of controlling off-site effects of erosion?*
- ♥ *What are the factors that influence farmers' willingness to pay (WTP)?*

1.3. OBJECTIVE OF THE STUDY

General Objective

The main objective of this study is to value the total economic benefits of controlling the offsite effects of soil erosion using data from rural households of the eastern highlands of Ethiopia.

Specific Objective

Specifically the study aims to:

- Estimate households' willingness to pay for controlling off-site effects of soil erosion.
- Identify the determinants of WTP
- Draw concluding remarks and policy implications relevant to the existing challenge.

1.4. SIGNIFICANCE OF THE STUDY

The threat of soil erosion calls for both intra and inter disciplinary research intervention, consequently addressing the off-site effects of erosion requires the attention of environmental economists. The output of this research is expected to be important for the development effort of the country. To define what the government, NGO, local community and other stakeholders' role should be, it is important to value the benefit of avoiding the problem from the local society's point of view. Identification and valuation of the off-site costs and benefits of soil erosion allows for the design of land use policies and assessment of implementation costs and priorities. Moreover any intervention to correct either an externality or biased incentive must take into account farmers' own perception or valuation if such intervention is to have the desired effect. Thus, the successful completion of this study is expected to provide significant information in dealing with the problem of erosion

In addition this research adds to the limited number of studies in environmental and resource fields using non-market valuation methods. Moreover studies on offsite effects of erosion using CVM are scarce in Ethiopia and hence this research contributes a lot to such limited literatures in Ethiopia.

1.5. SCOPE OF THE STUDY

This study is limited to valuing the economic benefits of controlling the offsite effects of erosion in the Kufanziq area, Western Harerghe Zone of Oromia Regional State, Ethiopia. The findings could be extrapolated to other areas with similar agro-ecological and socio-economic settings with a certain level of adjustment. But

generalization to wider areas and larger scales, however, requires precaution and further studies.

Soil erosion has both on-site and off-site effects. Only the off-site economic aspect is dealt in this study. In addition the study is limited to valuing only the benefit derived from controlling off-site impacts and did not estimate the cost of controlling the impacts i.e. no cost benefit analysis is made and there will not be policy decision/recommendations to be made with regard to cost-benefit analysis.

1.6 ORGANIZATION OF THE THESIS

The thesis is organized in five chapters. In the following section (chapter two), theoretical and empirical literature in the area of economics of soil erosion and non-market valuation techniques is reviewed. Chapter three provides a brief description of the survey design and methodology of the study. Results of descriptive and econometric analysis are discussed in chapter four. Finally, the contributions of the thesis and suggestions for future research are discussed in the conclusion part provided in chapter five.

CHAPTER TWO

LITERATURE REVIEW

2.1 THEORETICAL REVIEW

I. The Economics of Soil Erosion

The history of soil erosion dates back to the history of agriculture. Continuous erosion has led some country to be beneficiaries and others to be in poverty. For example, the loss of soil nutrient from Ethiopia enriched the soils of Egypt since early civilization (Blaikie & Brookfield, 1987 as cited in Bekele, 2003).

As to Hayden et al, (2008) soil erosion can be identified from its various physical manifestation and effects on landscape. But in economics soil erosion makes sense if it has appreciable impact on welfare of human beyond the mere physical movement. The normal rate of erosion under natural condition is approximately in equilibrium with the rate of soil formation (Troeh et, al., 1999). The problem is that human activities accelerate soil erosion than the natural rate.

Human activities that expose soil to erosion induce both immediate and long term negative impacts. The economics of erosion classifies these effects of erosion into two broad categories; the on-site effects and the off-site effects. The on-site effects can be valued in terms of the impacts on soil properties or the impacts on crop production. The off-site effects of soil erosion are numerous but are excluded from many studies. Valuation is generally limited to the effects of sedimentation on hydro-electricity generation and water supplies (Clark R., 1996.)

The offsite effects of erosion are so vast that a literature doesn't present a comprehensive assignment of effects. The following table taken from Hayden et.al.(2008) presents framework for categorizing the negative impacts of soil erosion.

Table 2.1 On-site and off-site effects of erosion

<i>On site effects</i>	<i>Off site effects</i>
*loss of crop yield -measure of physical Dimension/ erosion -measure of net productive value loss *increased cost of remedial -increased use of fertilizer -adoption of costly land management practices -repair to damaged structures -disruption of site operation *loss of soil carbon	*proximate property damage *Run-off, sedimentation & nitrification -deterioration of water quality -Treatment cost for downstream users -impact of flow modulation & flood frequency -impact on navigation -habitat degradation *visual detraction *dust nuisance *impact on road safety and maintenance *habitat change, coastal deposition and nitrification, etc

These are some of the known and potential impacts of soil erosion. The general argument is that the off-site impacts are excessive than the on-site one. Colacicio,et al(1989) & Crosson(1997) noted that various studies support the implication that the off-site impacts of soil erosion have greater economic cost than the on-site impacts.

Off-Site Effects of Soil Erosion

The offsite effects of erosion can be negative as well as positive, but generally the net social impact is believed to negative. The valuation off the off farm effect of erosion and conservation is problematic in many cases. This is mainly because of the difficulties encountered in quantifying the effects and it is hard to isolate sometimes the off and on site effects (Clark R., 1996). As a result many studies examine the effects focusing primarily on certain types of the problem like impact on hydro-electricity generation, irrigation & water quality. Some are restricted to the tangible

effects such as damage to infrastructure and increasing sediment load in water ways, but the impacts could be extended to less tangible effects like impacts on landscape and amenity or biodiversity (Hayden J. et al., 2008).

The external or off site impacts of erosion are numerous and can be both positive and negative effects. Clark R. (1996) presents some of the off-site effects that can be experienced as a result of soil erosion including:

- .Increase in risk of reduced crop yields due to soil salinisation and toxicity, caused by the ground water rise and sedimentation that result from increased run off*
- The smothering of crops by sediment*
- Reduction in crop yields due to water logging of low lying land caused by increased runoff,*
- Provision of fertile sediment on flood plains which may increase yields or may smother crops,*
- Damage to structures such as roads, bridges, terraces, and the foundations of buildings,*
- Provision of sand for use as a building material,*
- Reduction in the navigability of waterways and harbors,*
- Reduction in reservoir storage volume which results in:*
 - Reduction in water supplies for irrigation,*
 - Reduction in hydro-electricity generation capacity,*
 - Damage to the equipment used for hydro-electricity generation,*
 - Reduction in flood control,*
 - Reduction in dry season flows for drinking water and industrial use,*
- Reduction in the efficiency of irrigation systems,*
- Damage to the equipment used in irrigation systems,*
- increased costs of drainage system maintenance,*
- Reductions in the quality of water supplies for drinking water and industrial use as a result of:*
 - Increased concentrations of agrochemicals, metals and salts in the Water,*
 - Increased water turbidity due to its sediment content,*
 - Increased risk of algal blooms as a result of water nutrient enrichment;*
- algal blooms reduce the quality of water for consumption and reduce the aesthetic and recreational value of water resources.*
- Reduction in the diversity and size of biological populations in rivers, lakes and reservoirs,*
- Reduction in the recreation and amenity value of water resources,*
- Damage to fisheries, inland and coastal,*
- Damage to coral reef.*

The presence of off-site cost of erosion in developing countries results in market failures and affects farmers' incentive to practice conservation activities (Bekele, 2003). The minimal test for any socially optimal economic outcome to pass is Pareto optimality (Mas-Colell, et al, 1995). An outcome is said to be optimal if it is impossible to make some one better off without making others worse off. It is often said that given certain assumptions, a competitive market results in Pareto optimal. This is an ideal concept, the assumption of Pareto optimal outcome are often violated in real world, which in turn leads to market failure. This holds true especially for developing countries like Ethiopia (Bekele, 2003).

Market failure occurs when the market prices fail to reflect scarcity of resources and hence leads to non-optimal resource utilization. Market failure can be linked to soil erosion through its effect on incentive for conservation i.e. farmers lack sufficient incentive to take into account the off farm costs and benefits resulted from farmers decision on land use (*Ibid*, 2003). The consequences of market failure on incentive encourage further soil erosion practices. The offsite effect is an externality. Externality problem exists when the action of an agent affects the welfare of other agents in the economy (Mas-Colell et al., 1995). The market price fails to reflect these externality effects of soil erosion, since these impacts of erosion affect other economic agent, not the one who causes the problem.

In the presence of externalities individual who cause the erosion problem gains all benefits of his action but do not bear all the costs, while farmers who decide to control off site erosion problem bears all costs but do not gain all benefits (Bekele, 2003). This implies the individual cost and benefit deviates from societies cost and benefits or private decision to soil resource utilization is non-optimal from societies

perspective. Hence, the off-site effect of erosion leads to market failure for conserving soil resource. In addition to the off-site effects market also fails for many reasons in developing nations. Kerr (1998) noted that market fails due to various factors including: lack of information, risk and uncertainty, poor specification of property rights, under developed credit & insurance market and other institutional factors.

Soil management decision and off-site costs

Conceptualizing of soil erosion requires understanding of the economics of erosion. This means that the economic definition of erosion is somewhat more fluid than the physical definition: minor soil movements are still erosion in a physical sense, but if they have no appreciable impact on human activities then there is no economic value in their mitigation. The economic literature talks of an 'economically optimal' level of erosion, where the cost of an extra unit of mitigation is equal to the value of additional erosion costs avoided (Crosson, 1997). But in reality there is a deviation in the optimal soil resources stock of an individual farmer compared to the socially optimal stock. Soil resources management decision and outcomes from society and individual land user perspectives are different.

Social planner on behalf society considers all the costs and benefits related to soil management decisions whereas individual (private) land user will take into account only those costs and benefits that accrues to him/her i.e. individual farmers cost and benefits deviates from the social cost and benefit, since the private agent consider only the on-farm costs and benefits, while from the societies point of view all impacts i.e. on-farm and off-farm need to be taken into account. This means that the rate of depleting or replenishing soil stock by private land user differ from that

of social planner. Such differentials results in different level of soil stock compared to that expected under social planner management. These propositions can be demonstrated by a dynamic optimization of soil management decision for social planner and individual farmer.

Suppose that the land user face the following production technology: $y = f(q, u, z)$ and maximizes the following constrained objective functional;

$$\begin{aligned} \text{Max}_{u,z} J & \int_0^{\infty} E[\pi(q, u, z)] e^{-\rho t} dt \\ \text{s.t} \quad \dot{q}_r & = h(u, z) \end{aligned}$$

Where q, u, and z stand for land quality (fertility), land improving investment, vector of productivity increasing but fertility degrading inputs such as labor used and E is expectation operator.

The equation of motion for Land quality:

$$\dot{q} = h(u, z) \dots\dots\dots$$

$$\begin{aligned} h_u > 0 \quad h_z < 0, \quad h_{uu} < 0 \quad h_{zz} < 0 \\ h_{uz} = h_{zu} < 0 \end{aligned}$$

Here the land use decision results in off-site costs that are related to land improving investment input vector, u and productivity increasing but fertility degrading of vector inputs, z given as;

$$\begin{aligned} D & = D(u, z) \quad \text{and} \\ D_u & < 0 \quad , \quad D_z > 0 \end{aligned}$$

The land user profit is given by: $= E[pf(q, u, z) - ru - wz]$

A. Soil management decision by social planner

The criteria for social planner in deciding the investment on land will be formulated as follows:

$$\begin{aligned}
 H &= pf(q, u, z) - ru - wz - D(u, z) + \eta e^{-\alpha t} (h(u, z)) \\
 H_u &= pf_u - r - D_u + h_u \eta e^{-\alpha t} = 0 \\
 \Rightarrow pf_u + h_u \eta e^{-\alpha t} - D_u &= r
 \end{aligned}$$

This condition stipulates that social planner will continue to invest until a point where marginal benefit (sum of right hand side terms) of investment equals marginal cost (left hand side term of the equation) of investment. The right hand side of the equation comprises of marginal value product of the investment input, discounted future benefit of increased soil stock due one more unit of investment input, and reduced off-site cost due one more unit of investment input. The sum of these terms is equated to the unit cost of soil investment input

B. Soil management by private peasant farmer under land tenure insecurity

A peasant farmer operating in the environment of insecure land tenure will face the following optimization problem:

$$\begin{aligned}
 \text{Max}_{u, z} J &= \int_0^T \pi(q, u, z) e^{-(\alpha+\theta)t} dt \\
 \text{s.t } \dot{q} &= h(u, z)
 \end{aligned}$$

Where, θ captures the probability of losing a land at each period. The associated Hamiltonian function will be:

$$H = pf(q, u, z) - ru - wz + \eta e^{-(\alpha+\theta)t} (h(u, z))$$

The F.O.C will be

$$\begin{aligned}
 H_u &= pf_u - r + h_u \eta e^{-(\alpha+\theta)t} = 0 \\
 \Rightarrow pf_u + h_u \eta e^{-(\alpha+\theta)t} &= r
 \end{aligned}$$

This equation implies that peasant farmer continue to invest in soil management until the point where the marginal benefit of investment equals marginal cost of the same. The difference from condition 1 results from two reasons. *First*, looking at the right hand side of the above equation, the term D_U which represents marginal reduction of Off-site cost due to investment on soil is missing. That is the peasant farmer doesn't account for this cost. *Second*, the second term in right hand side is modified due to the presence of δ . It shows that the discount rate of future benefit of increased soil fertility due to one more unit of soil investment input is higher compared to that of society's discount rate.

From these two results it follow that the level of soil investment by peasant farmers is lower compared with the level required by social optimality. This will in turn result in different soil resources stock compared to socially optimal stock. It is this differences that we regard as soil erosion in economics rather than mere physical reduction of soil quantity and quality.

The deviation of private soil investment path from that of socially optimal path due to off-site impacts can be avoided by environmental regulators which regulates the behaviors of private land user to internalize these externalities through different policy instruments or interventions. To maximize social welfare and bring Pareto-optimality environmental regulators need to identify the cost and benefits of controlling the problem.

Economic and environmental impacts of soil erosion

Identifying and estimating the economic impact of soil erosion is crucial for designing and implementing sustainable land management practices and policies. Literature on the economic analysis of soil erosion discusses various impacts of soil erosion.

Erosion adversely affect soil fertility and productivity as it reduces organic matter, nutrients, soil biota, infiltration rate, water holding capacities and soil depth (Gregorich et.al., 1998; pimental et al., 1995). Soil erosion negatively affects the actual and potential productivity of land and hence crop yield and income. But quantifying the effects on crop yield is difficult and complex task as it involves the assessment of soil properties, crop characteristics, climate condition and the management system (Stocking, 1987; Lal, 1988; Lal&okigob ,1990;clark,1996 as cited in Bekele,2003).

Various field based and modeling studies have attempted to assess the erosion productivity relationship (Hayden,et al.,2008). Erosion and productivity are dependent and do not change discretely in isolation of other factors and erosion rates are not good indicator of the loss in productivity (Stocking, 1987). Different techniques are used to evaluate the economic costs and benefits of soil erosion and conservation. The hedonic pricing the replacement cost and change in productivity are among those approach (Bishop, 1995; Clark, 1996). But the quantification made using these methods focused mainly on the analysis of the on-site effects

A number empirical study established the relationship between soil loss and crop yield. For example Lal (1988) found that yield to maize and cowpeas have an exponentially declining relationship with loss of top soil in Nigeria. Studies by Bishop (1995) & Bishop and Allan (1989) also found the same relationship in Malawi and

Mali. Again a non linear relationship between productivity loss and soil loss was found in Kenya (Ekbon, 1995).

The quantification of the effects of soil erosion on productivity will lay the ground for valuation of costs of erosion and estimation of the benefits from soil conservation practices. But the analysis of the relationship between soil erosion and productivity loss is complicated by the masking of erosion effect with increased productivity due to fertilizer, pesticides, irrigation and improved cultivars (Pimental et al., 1995).

Erosion by water has greater impacts on the environment as well. Soil erosion damages the ecological services of soil that are important for society. The economic impact on productivity is due to direct on-site and off-site effects; while the environmental consequences are primarily off-site (Taylor & Francis, 2010).

II. Conceptual Framework for Valuation of the Benefits of Controlling Off-Site Effects of Soil Erosion

Decision regarding optimal utilization and conservation of resources require the need to understand economic value. The excessive depletion of soil resource is partially attributable to the failure of the market to account for non-marketable values. Applying a non market valuation helps to measure and compare the benefits of various conservation programs.

The Need for Economic Valuation

The word value caused much confusion between economists and ecologists.¹ For economists values are considered as equivalence measure. Valuation is simply an

¹ *Ecologists consider value as ethical measure and for economists value means the price individual are willing to pay to obtain a good or service*

attempt to assign monetary (quantitative) value to environmental goods and services or natural resource. The economic value of a resource is measured in terms of peoples WTP for the good less the cost of supply. The main objective of valuation is thus to gauge people WTP for an environmental benefit thereby their preferences.

Valuation does not imply determining the true value of a resources rather its valuing the change and comparing with alternatives. Economic valuation refers to the change, not the stock of a resource or ecosystem. Thus, the value of avoided/controlled soil erosion effect measured in monetary terms shows the importance of the given conservation plan for the society and the societies ability to pay to control the off-site effects of soil erosion. But in this case market price cannot indicate the importance of conservation activities, due to the externality effects of soil erosion. Thus in dealing with the valuation of soil resource conservation, environmental economists have developed various non-market valuation methods economic. Valuation of non-marketable goods and services means finding some measure of WTP when market fails to reveal that information directly (D.letson J.Walter, 2002).

Economics as a study of choice can contribute to resource and environmental management by identifying possible solution and comparing their cost and benefit. And economic valuation provide information that are important to policy formulation

Various authors demonstrated the potential uses and policy relevance of economic valuation which include:

- Cost-benefit analysis(CBA) of projects and policies
- Design of pricing policies
- Designing economic instruments for saving biodiversity like environmental taxes

- Revising National economic accounts; adjustment for depletion of resources
- Demonstrating the value of biodiversity; awareness raising
- Land use decision
- Setting priorities for conservation
- Limiting biodiversity invasion
- As a management tool
- As a participatory exercise

These are some of the relevance of economic valuation. Valuation is a useful tool in the environmental assessment and planning of soil conservation by providing answer to many critical questions about soil resource. For example what is the value of conserving or controlling soil erosion, how can conservation be efficiently and equitably financed, how can people take into account the benefits and costs of soil erosion due to their activity, who gains and losses when soil resource is conserved or degraded, etc.

If there is a need to value the benefits of conserving resource or controlling off-site effects of soil erosion and take into account when making decisions that affect soil resources, then a framework for identifying these values is important.

Typology of Values

Classifying and defining value is not as such easy deal. Philosophers dispute over the meaning of the word itself.² Broadly value can be classified as instrumental (anthropocentric) and intrinsic (eco-centric). Instrumental values are those that derived from some objective function or goal being sought. Economic value is such

² *There is a conflict among philosophers in the meaning of the word value i.e. whether value reside 'in' the object of interest(objective) valuation or is conferred upon the object by an agent(subjective) valuation.*

type (anthropocentric) and is preference based. While intrinsic values are non-instrumental and reside in the asset in question. It is independent of human preference and often it is divided into absolute & moral values. Environmental value is an example.

Choices involving unpriced goods and services can be troubling for policy maker and for public as well (D. Letson & J. Walter, 2002). Economists usually measure value using WTP and/or WTA for a change in the state of soil resources. WTP Shows the maximum amount of money that an individual is willing to give up to get one more of a good or an additional benefit. WTA reflects the minimum amount of money that one is willing to accept to get less state of the resource. WTP is the usual measure of benefit, where money is the standard measure. Environmental economists evaluate individual preferences for change in the state of environment, rather than the environment in its entirety (*Ibid*, 2002). The economic loss from off-site effects of erosion is the maximum amount of money that an individual is willing to pay in order to control the off-site effects of erosion.

The different uses of soil resource imply a wide range of values exist. The total economic value (TEV) of a change in well being due to intervention is usually divided into use and non-use values. Use values typically involve human interaction with the resource and are related to actual use of the good in question. Use values are divided into direct, indirect and option values. Direct use values are derived from direct utilization of a resource; it includes both consumptive and non consumptive uses. The indirect use values of an environment is related to a change in the value of the property that is supporting or are derived from indirect utilization of ecosystem function and regulation services. While the option use values are those expressed for

preserving a resource use for alternative, currently no use is made only individual wishes to preserve for the option of using in future.

Non-use values or passive use value are unrelated to any current or potential active use. It refers to the WTP to maintain some good in existence although there is no actual, planned or possible use. Non-use values are often classified as existence and bequest values. The former refers to WTP to keep the resource in existence, though there is no actual or planned use. Existence values are related to stewardship or human concern or for the welfare of non-humans. The latter (bequest value) refers to WTP to preserve the resource for future generation. Thus the total economic value is the sum of active use values and passive use values.

Overview of Valuation Methods

Different methods have been used to estimate the total economic value of natural resources and environmental goods. Broadly the valuation approaches can be divided into two. Revealed preference (indirect) and stated preference (direct) approach. The revealed preference method is used where conventional or proxy market prices exist while the stated preference method is used by constructing hypothetical market scenarios.

Stated Preference Approach

Stated preference methods are based on a hypothetically constructed market. That is, under this approach people are asked to state the value they attach to an avoided problem of erosion. The direct method of valuation include: Contingent Valuation Method (CVM), Contingent Ranking (CR) and Conjoint Analysis (CA)

- ***Contingent Valuation Method (CVM)***: Is a widely applied monetary valuation method for valuing environmental and natural resource related good (Jakobsson&Dragon, 1996). It uses survey question to elicit respondents true WTP/WTA for a change in the level of environmental good or service in a well constructed hypothetical market. An appealing aspect of CVM is that it estimates the total economic value of any resources in question (Pote&Loomis, 1997). Mitchell &Carson (1995) acknowledged Robert K.Davis (1963) to be the first to use CVM to estimate the benefits of outdoor recreation. A number of methodological issues need to be addressed while using CVM in a hypothetical market
- ***Contingent Ranking***: This method is closely related to CVM except that respondents are to rank various combinations or state of environmental good with their costs simultaneously (Georgion, pearce&moron, 1997; Heinemann&Kannnen, 1998).
- ***Conjoint Analysis***: In this method each respondent should rank a number of tasks that has a number of alternatives. A representative random utility model will be estimated for the population after estimating a utility index model for each individual.

Revealed Preference Methods

This method is indirect because preference revelation is indirect via a market. The method is used to study individuals' averting behavior. WTP can be estimated either by observing the prices that people pay for goods in various markets or by observing individual expenditure of money to avoid damage and inferring WTP amounts

(Abelson, 1996). This method includes surrogate market and conventional market approach.

A. Surrogate Market Approach

- *Defensive/Averting method*: - this method estimate expenditure involved in avoiding damage caused by a change in the state of environmental good or service.
- *Travel cost method*: - the idea of this method is to collect information about preference from people's behavior i.e. people do not buy the commodity (visit area) unless they find it worth its price (travel cost).But this technique captures only use values, it does not value future planned visits (Freeman, 1998).
- *Hedonic pricing method (HPM)*:- this method assumes that any difference in wage or property value among and between degraded and normal land is due to the value of environmental resources or it is attributable to the state of the resource (Khandke et.al, 2001). The HPM identifies environmental service flows as elements of a vector of characteristics describing a marketed good typically housing. HPM is the most common indirect valuation method.

B. Conventional Market Approach

Doze response and replacement cost method are the two most important techniques here. The former tries to establish a relationship between a known cause and environmental impact while the latter estimate the benefits of replacing lost natural resources through costs of replacing the resource.

Generally, the total economic value of a resource can be valued by employing one or a combination of different methods discussed above. Each approach has its own merit and demerit. Moreover choice of methods is based on the objective of valuation.

Given the relative merit and objective of this research, a Contingent Valuation Method (CVM) will be used in this study.

Contingent Valuation Method (CVM)

Contingent valuation method is a stated non-market valuation techniques and it estimates the economic value of a resource by constructing a hypothetical market and asking respondents to directly state their WTP/WTA to obtain the good or to give up the good, respectively.

The history of CVM goes back to the work of Ciriary-Wintrup (1947), he proposed that prevention/control of soil erosion generates some extra market benefits that have a nature of public good and the value could be estimated by eliciting individual WTP for the benefits through a survey method (portney,1994; Hanemann, 1994). But it was Davis (1963) who uses CVM empirically for the first time to value the benefits of Goose hunting. Now a day CVM has been widely used for valuing environmental goods and services that are not exchanged in the regular market of the world. This is mainly because of its merit in valuing use and non use values of environmental good and services. Desvousges et al., (1993) noted that CVM is the only method identified to estimate non-use values.

A considerable amount of studies on CVM, both theoretical and empirical, have emerged in economic valuation literature (L.vankatachalom, 2004). A number of points have been discussed regarding the methodological issues of CVM including its applicability in developing countries and limitation.

The fact that CV study is based on what people state to do is the source of both its strength and weakness. An appealing aspect of CVM is its ability to estimate the total

economic value of any environmental amenity (Pote & Loomis, 1997).CVM is one of the only ways to assign dollar value to non-use or passive use values. Moreover contingent valuation is more flexible in that it can estimate the economic value of virtually anything, even if there is no observable behavior. In addition the nature and results of CV Studies are not difficult to analyze and describe, though it requires a competent survey analyst to estimate.

The fact that CV study is based on what people says or state, brought enormous controversy and criticism. The results of CV studies by various authors show that the major criticism of CVM result revolves mainly around two aspect i.e. validity and reliability (Smith, 1993; Freeman, 1993; NOAA, 1993 as cited in L.Venkatachalom, 2004). Validity refers to the degree to which CVM measures the true economic values of a non- marketed good to individual(Freeman,1993) while reliability refers to the extent to which WTP amount varies due to random sources (Mitchel & Carson,1989).

L.Venkatachalom (2004) discussed the various errors/biases that affect reliability and validity of contingent valuation studies. The first problem relates to the disparity between WTP and WTA estimates. In principle both estimate can elicit preferences interchangeably, but theoretical and empirical finding proved that WTA is always greater than WTP (*ibid*). The reasons for this are many including income effect, substitution, transaction costs, broad based preferences, elicitation aspects and others. The CVM is also influenced by factors like the design of scenario which affects the nature of embedding problem; and biases including starting point bias, hypothetical bias, strategic bias, payment vehicle bias, non-response bias and information bias.³

³ *Embedding problem refers to the range of variation in WTP amount estimated for some good depending on whether the good is valued on its own or valued as part of a more inclusive package (Kahneman & Knetsch, 1992).*

Regarding the application of CVM in developing countries various methodological issues are raised. Whittington (2002) presents reasons that contribute to the low quality of CV studies in developing countries including poorly crafted scenario, poor administration & execution of survey, absence of pre-testing and assumption about how local people think the environmental amenity. A number of researches were also done and methodological solutions were proposed to overcome these issues and consequently the method has been used widely in developing countries

Generally, although Contingent valuation method has had many critiques in the past, it is now widely accepted by both the academic and policy making communities (Arrow, K. et al., 1993; HM Treasury, 2003) and there are guidelines for best practice (Arrow, K. et al., 1993).The method is still an effective way to value non-marketed environmental good and services if carefully designed and implemented. Moreover, in less developed countries where there is wide spread market failure reliance on stated preference technique provides a better solution for environmental valuation. Holden and Shiferaw (2002) noted that using CVM is a solution in developing countries where preference cannot be revealed through market mechanisms. Thus given other approaches capability to measure values comprehensively, Contingent Valuation Method (CVM) provides useful and meaningful results for policy (Nijkamp,p.et al, 2006).

2.2 REVIEW OF EMPIRICAL LITERATURE

Many studies were conducted in estimating the cost and benefits of soil erosion conservation. But the focus tended to be only on subset of effects such as on-farm/on-site effects rather than the off-site/external impacts. A lot of attention has been paid to the factors that determine the adoption of soil conservation practices by farmers

(Ervin C.A and Ervin E.D 1982). Conventional adoption analysis use probit or logit models to try to determine those factors that determine the decision process of whether to adopt or not, and to which extent, conservation practices (related to farm and operator characteristics or even variables of the perception of soil erosion by farmers). Some examples as cited in Bekele (2003) are the studies by Ervin and Ervin (1982), Norris and Batie (1987), Gould et al. (1989), Lohr and Park (1995), Shively (1997), Shiferaw and Holden (1998), Lucila et al. (1999), and Patta Nayak and Mercer (1998).

The quantification of the effect of soil loss on crop yield has laid the grounds for valuation of costs of erosion as well as estimation of benefits from soil and water conservation efforts. However, most of the empirical studies in this category of literature focused on the analysis of the on-site effect due to the farm level perspective of the studies and also due to difficulties of getting reliable information on off-farm effects (Bekele, 2003)

Despite the complexity of valuing the off-site impacts an attempt has been made to place monetary value to the off-site costs of erosion and the benefits of conservation especially in developed countries. As cited in Colombo et al (2003) relative to the on-site effects few studies exist for the off-site impacts, & most that do exist consider only a subset of impacts. To mention some, an early study by Clarke et al.(1985) accounted for several off farm impacts of soil erosion relating to water. The authors estimated a total annual off-farm cost due to all agricultural erosion sources of \$3-\$13 billion for the United States. Hitzhusen(1991) summarizes a number of studies that evaluate the downstream costs of erosion. Hansen et al.(2002) estimated the cost of erosion to downstream navigation and found that the dredging cost imposed by

erosion was about \$257 million per year and reduction in soil erosion would generate benefits proportional to these costs.

Different techniques can be used to quantify the economic value of the change environmental resources, like soil. But here the focus is on non-market valuation methods mainly the contingent valuation method. CVM has been applied in many research areas involving non market valuation. The method is used widely in environmental economics and resource related researches. Numerous authors have found the CVM as appropriate tool in valuing environmental goods and it can be used to value a range of environmental goods/services in both developed and developing countries. To mention few, Shultz et al. (1998) used contingent valuation to determine the WTP of visitors of national parks in Costa Rica (Poas National Park and Miguel Antonio National Park). They found that the mean WTP (using entrance fees as payment vehicle) to Poas National Park was US\$11 for residents and US\$23 for foreigners and that for Miguel Antonio National Park was US\$13 for residents and US\$14 for foreigners. Loomis and Gonzalez-Caban (1998) also used a CV survey to estimate the economic value of implementing a fire management plans to reduce acres of old growth forest that burn in California and Oregon; they found that California and New England residents were willing to pay US\$56 per household. Reaves et al. (1999), studying valuing endangered species (red cockaded woodpecker) and the restoration of its habitat following a natural disaster, found that mean WTP values for restoration of a red cockaded woodpecker population in South Carolina ranged from a low of US\$7.57 per person per year (payment card, protesters included) to a high of US\$13.25 per person per year (double-bounded dichotomous choice, protesters deleted).

Local studies using CVM has been increasing recently to list some for example, Zewdu & yemesrach (2003) tried to measure WTP to protect endangered environments & its determinants using dichotomous choice CVM in Netchsar national park, Ethiopia. By employing a bivariate probit model they found that the local people were willing to pay 57 birr per year per household and dependency ratio, primary economic activities & distance from the park were found to be the significant determinants of WTP. Mekonnen et al,(2004) used CVM to examine the determinants of peasants WTP for community woodlots in the highlands of Ethiopia that would be financed by the local community themselves. Using a random effect probit model the mean WTP is estimated to be 10 birr for closed-ended responses and the annual aggregate village WTP per hectare of community plantation ranges from 1301 birr to 8285 birr. Despite WTP estimate the study found that applying a closed ended elicitation format in the context of their study is problematic, it creates yea saying and compliance bias. Moreover the common preference assumption between male and female is also rejected by this study. Holloway& Ehui (2001) looked at the impact of extension services on participation of dairy producers in Ethiopia's milk market & the amount households are willing to pay for extension services. Based on WTP estimates & per unit cost estimates of extension visits, they suggest that privatization of extension service is a possibility in the context of milk market development. A Study by Jebessa S.(2004) on contingent valuation of multi-purpose tree resources in Arsi zone Ethiopia used a Probit and bivariate probit models to calculate the mean willingness to pay (WTP) and to identify factors affecting WTP from the responses to the dichotomous choice question format, the net benefit of the society from two hectares of Eucalyptus tree plantation was estimated at 41,000ETB per year. The

study revealed that age, access to credit, type of ownership for the proposed tree plantation, size of land holding and site specific factors significantly affect the willingness to pay for eucalyptus trees plantations in the same Community ownership was also preferred to government ownership for the establishment of multi-purpose tree plantation project and has got a higher WTP amount than government ownership.

In addition Tegegne (1999) also applied CVM to elicit people's valuation for environmental protection in terms of both cash requirement and labor contribution. Fisseha (1997) and Dunffa (1998) also applied the CVM studies for measuring the willingness to pay for improved water quality in Meki town and Ada'a Liben districts respectively. Moges (1999) used CVM to estimate the willingness to pay for the Tana recreation site. Essey (2000) applied CVM to estimate the benefits of reduction in air pollution in Wonji town and to identify the variables which determine the WTP for air pollution reduction. Solomon (2007) founds a positive household willingness to pay for the solid waste management options: the case of Yeka sub city, Addis Ababa. Using the contingent valuation method Yalemzewd (2007) also conducted a study on the valuation of urban green spaces. The result of the study confirms household's positive willingness to pay for urban green environment policies and using probit model the estimated mean WTP of the respondents is found to be Birr 16,682,574. The CVM is not limited to those studies, here a little is said.

There are also empirical studies on soil and water conservation related areas. For example on watershed protection in the Philippines, four CV studies have been implemented which found that Filipinos benefit from this service. These studies valued watershed protection services in Mt. Makiling Forest Reserve (Francisco *et al.*, 2000), Angat, Ipo, Umiray and La Mesa Watersheds (Calderon *et al.*, 2005), Mt.

Isarog Natural Park (Calderon, unpublished) and Peñablanca Protected Landscape and Seascape (Bennagen *et al.*, forthcoming). All employing CV, these studies found there was a positive willingness to pay for watershed protection services from various water users.

Using data from a 2000 survey of 500 Maryland landowners in US, Lynch L. et al, (2002) examined what level of financial incentives (WTA) they would require to install buffers for 15 years on a voluntary basis to improve water quality. Using a random utility model, higher incentive payments, part-time farming, education, and a Lower Shore location positively influence the respondent's willingness to install a buffer. Length of the farming horizon, age, and a Southern Maryland location negatively influence the respondent's willingness to accept (WTA). Purvis et al (1989) adopted CVM for valuation of the on-site effects of filter strips under a soil conservation program in Michigan, US. The study estimates farmers WTA for the establishment of filter strips on their farm land using Tobit model.

CVM as a research tool is also applied in valuing the economic benefits of avoiding erosion problem. As a chance this research coincides with the objectives set while the CVM was proposed for the first time by Ciriary-Wintrup (1947). He proposed that prevention/control of soil erosion generates some extra market benefits that have a nature of public good and the value could be estimated by eliciting individual WTP for the benefits through a survey method (portney, 1994; Hanemann, 1994)

Colombo et al.(2003) mentioned previous studies on off-farm impacts using CVM like Sinden(1988) that tested the existence of hypothetical bias in CV survey using

soil conservation study and Dragowic (1991) evaluated community support for government and personal expenditure on soil conservation

Asrat, Belay & Hamito (2004) examined the determinants of farmers WTP for soil conservation practices in southeastern highlands of Ethiopia & reported that the majority of the farmers in the study area were less willing to pay cash. However, they are willing to spend substantial amount of labor time on soil conservation. Here they found that the size of non-crop land is significant determinants of WTP.

Moreover, Colombo et al. (2003) used the Contingent Valuation method to estimate the benefits of a soil erosion control program for the local people in the Alto Genil catchment in southern Spain. The result shows the majority of survey respondents (97%) were aware that soil erosion was a problem and were willing to pay for a publicly-funded program to reduce erosion by creating Vegetation strips. Similarly Colombo et al. (2005) expanded this study to refine the willingness to pay (WTP) estimate and compare the Contingent Valuation and Choice Modeling approach in the same catchment. Both methods were found to be suitable to evaluate the off-site effect of soil erosion and produced similar WTP value estimates.

To the best knowledge of the researcher there is no study previously conducted on valuing the economic benefits of controlling off-site effects of erosion using CVM in Ethiopia, if not, in the study area. In line with this situation the research will try to fill an important knowledge gap.

CHAPTER THREE

DATA, SURVEY DESIGN AND ESTIMATION METHODOLOGY

3.1 Data

3.1.1 Data Source

The main data used in this research is primary data collected from rural households of selected peasant association (PA) named *Kufanzik*, in Tullo Woreda of west harerghe zone, Ethiopia. A CV questionnaire with a face to face survey method was used to collect the data. The main reason for the selection of the study area is that, first it is located in the severely eroded part of the eastern highlands and second it is convenient to deal with off-site impacts of erosion. Secondary data was also used, collected from Tullo Woreda agricultural bureau and from the selected kebele administrative for sampling frame and socio-economic related information.

3.1.2 The Study Area and Sample Design

To value the economic benefits of controlling off-site effects of soil erosion a contingent valuation (CV) survey was conducted in the highly degraded areas of eastern highlands of Ethiopia. The study area, kufanzik is located in Tullo woreda (District) of west harerghe zone at about 386 K.M east of the capital city of Ethiopia, Addis Ababa and 13 K.M from the nearest town, Hirna. With a total coverage of 511 hectare, the area is characterized by Woynadega (85%) and Dega (15%) climate type. And have an altitude ranging from 1900m to 2700m A.S.L. It receives a bimodal type of rain ranging from 900-1200mm. The major types of soils are sandy loam and black soil (vertisols)

The total population of the area is 5612, living under the umbrella of 1246 households. Of the total population 2745(49%) are male and the rest 2867 (51) are females. The age structure is dominated by adult age group (18-60) accounting for 3869 (69%), while people under the age of 18 and above 60, constitute 27.6% & 3.4%, respectively.

As in most of the highlands, the main economic activity in the area is a mixed agriculture, characterized by crop production, cash crop production (mainly 'Chat') and livestock production. Relative to some other kebeles in the district, the economic status of Kufanzik is somehow better, there are more than 200 households selected as role model farmer and almost all farmers have a corrugated roof.

Even though, the area has a potential for cash crop and livestock production, it suffers from a series of environmental problems. The major environmental problems are: erratic rainfall, soil erosion (both on-site & off-site effects), loss of farm land due to massive gully formation, damage on crop due to sedimentation & flooding, and decline in fertility of farm land. Particularly, soil erosion which has an off-site effect is a serious challenge. The rural road is almost out of use due to sedimentation related effects; downstream sedimentation of reservoirs and water channels is prevalent; runoff & flooding is frequent and many others. The off-site impacts require interdisciplinary intervention including environmental economists. As part of intervention we have investigated the benefits of controlling the off-site negative impacts using a CVM.

The study area, Kufanzik was purposely selected; this is because of the severity of the problem in this area and partially due to its convenience to deal with offsite effects.

Time and money limits our study from expanding to include more sights for investigation. After purposely identifying the study area, households were selected using a simple random sampling technique. The sampling list was obtained from the local kebele administration and a total sample size of 142 was used in this study.⁴

3.2 Survey Design

There are several techniques that can be used to value the benefits from controlled/avoided soil erosion problem. The total social cost of erosion is quite large and if it is controlled it will provide both use and non-use/passive use values. The only method identified to estimate both the use and non-use value is a contingent valuation method. CVM creates a hypothetical but realistic market/scenario using questionnaire, which allows respondents to indicate their preferences or WTP (Desvousges et.al, 1993; Mitchell and Carson, 1989). This study used a contingent valuation technique to estimate the benefit of controlling off-site effects of soil erosion. Currently in the study area erosion problem is serious that it requires immediate intervention by both the local community and other stakeholders. A bottom-up approach and active real participation of local community is believed to work effectively in addressing the problem. The study proposed the local people to contribute towards controlling off-site effects of erosion or to indicate their WTP. To obtain accurate benefit estimate from CV, a great deal of effort was expended to define and clearly display the current situation of off-site effects and the proposed outcome from controlled erosion to the respondent.

⁴ *Often the budget for a study will dictate how large the sample can be. The criterion for the sample size of 142 is mainly due to the costly nature of CV survey and due to the advantage that the DBDC format provides with respect to sample size.*

3.2.1 Questionnaire Design and Value Elicitation Format

The questionnaire which was administered personally is the most important part in CV studies. In order to answer the research questions and objectives of the study, a questionnaire that has five parts was developed and implemented. The first part states the purpose of CV study to the respondents. The enumerator explained why the study is conducted; who is conducting and assured that their response is confidential. The objective of this part was to show the context of the study i.e. hypothetical but realistic, to the respondent so that they participate being motivated and informed. The second part seeks to record the attitude of the respondent towards soil erosion problem and conservation related issues. The third section of the questioner tried to determine the use of the environmental good or service in question. The next part presents the valuation scenario which defines the good in question and the nature of the change in the provision of that good. This information make up a scenario and it is this scenario that respondents valued. Following a clear description of the scenario including the institution that is responsible for the provision of the good and the payment vehicle, the value elicitation question with follow-up was asked. The details in this part like payment vehicle, bid amount & others were determined priory when pilot survey was made. The final part of the survey constitutes questions on the socio-economic, demographic and other characteristics of households. The information collected here is used to test whether the WTP answers conform to theoretical expectations or not.

In order to model the true willingness-to-pay for the proposed scenario, the double-bounded, dichotomous-choice contingent valuation model was used, which is more information-intensive and asymptotically more efficient than the single-bounded

method (Hanemann et al., 1991). In the DBDC or take-it-or-leave-it with follow-up bid, an individual will be asked a different random initial bid to accept or reject and depending on the response to the first bid a follow-up bid will be asked.⁵ This follow-up amount was twice the initial sum if the respondents had replied affirmatively to the previous question and half the initial sum if they had replied negatively. The reasons given for the affirmative or negative answers were also noted for the purpose of identifying protest responses. In an effort to capture additional inconsistencies, a final open-ended question, regarding the maximum willingness to pay per year over the next five years for the realization of the proposed scenario was asked following the follow-up bid. In cases where the open-ended value was lower than the approved bid in the follow-up question, respondents were asked to explain their decision. The function of this question was to establish the range and anchoring effects. Respondents were also asked to state what their preferred method (vehicle) of payment is in an open-ended question,

The double bounded CV Survey which is proposed by Carson, Hanemann and Mitchel (1986) has a better merit in that, it simplifies the cognitive task faced by respondents & it improves the efficiency of the model. Moreover the dichotomous choice format is proven to reduce strategic bias, wherein a respondent might have the tendency to overstate or understate the bid amount if he/she acts strategically. The use of carefully constructed dichotomous choice WTP questions will address strategic bias and reduce the number of protest responses (Arrow et al., 1993; Hoehn and

⁵ *In double bounded dichotomous choice approach the follow up bid will be higher if the WTP response to the initial bid is 'Yes' and lower if the response to the first bid is 'No'. The reverse holds in case of WTA.*

Randal, 1987). This study has also used the Double-Bounded Dichotomous Choice (DBDC) value elicitation format.

3.2.2 Focus Group

Before starting the actual survey a focus group discussion was conducted with the type of people who are involved in the final survey.⁶ To test the validity of the scenario and questionnaire to convey the desired concepts to respondents, a focus group discussion/interview is important. First the focus group responded to general questions like their understanding of the offsite effects of erosion, the benefits if it is controlled and whether & how they value the soil resource. Then to develop specific questions for the survey, the focus group was presented with detailed and specific questions. The results from focus group discussion provide an idea of describing the scenario and presenting the background information in the actual survey. Moreover at this stage different payment mechanisms was also tested and questions that can identify protest bids and response that do not show preference were deeply scrutinized and tested. The main questions rose in FGD and the insights obtained from FGD are discussed in the next chapter.

3.2.3 Pre-testing and Bid level

Following the focus groups, an entire survey script is be prepared and a pretest was conducted on a sample of 20 randomly chosen households to design bid level for the final survey and test the questionnaire. We have made the pilot survey/ pre-test before conducting the actual survey and this ensures the content validity of CVM. Different authors suggested a number of methods for designing the bid levels .This study will

⁶ *Focus group discussion involves a way of knowing about views, opinions, attitude and experience (in-depth information) of selected group of individuals about off site effects of soil erosion and related issues.*

employ a method suggested by Boyle et al.(1988) in which an open-ended questions on WTP amount in the pre-test survey are used to set the initial bid amount and the follow-up bid will be determined by doubling and halving the initial bid amount.

The result showed that, the range of response varied between birr 0 and 105. Consequently, for the final survey four bid amounts (30, 50, 60 & 70) were used as initial values and each respondent faced a random initial bid and the follow-up bid was determined depending on the response for the initial question. Thus, there are four possible outcomes: (1) both answers are “yes”; (2) both answers are “no”; (3) a “yes” followed by a “no”; and (4) a “no” followed by a “yes”. The DBDC bid schemes used in final CV survey is presented below.

Table 3.1 Random bid scheme used in the CV survey

<i>Initial bid (in birr/year)</i>	<i>Follow-up bid (decreased) (if, ‘No’ for initial bid)</i>	<i>Follow-bid (increased) (if, ‘Yes’ for initial bid)</i>
30	15	60
50	25	100
60	30	120
70	35	140

Source: own computation from pilot study

The finding of the pre-test was then incorporated in the final document for CV Survey questionnaire. Before the actual survey, enumerators were selected and training is given and the final face-to-face survey was conducted in March 2013.

3.3 Method of Analysis and Model Specification

In order to meet the objective and research questions of the study data from contingent valuation survey is analyzed using econometric models. The main goal pursued in CV studies is to estimate WTP measures, determinants of WTP and precision of those estimates. In doing so the analysis is done using parametric estimation framework.

3.3.1 Modeling Framework

The parametric analysis of response from discrete choice question is based on Random Utility Model (McFadden, 1974; Hanemann, 1984)⁷. In the RUM the observed discrete choice response of each individual is assumed to reflect a utility Maximization process. The utility arising from a ‘yes’ or ‘no’ response to the CV scenario of controlling off-site erosion problem is comprised of a deterministic component (V_j) and a random (ϵ_j) component:

$$U_j = V_j + \epsilon_j \quad (1)$$

Utility is assumed to arise from income, the absence (controlled) off-site effects of erosion and other socio-economic and demographic factors. If the household accept the offered bid its income is reduced by the bid amount & this holds only under the following condition (Hanemann, 1984):

$$V_{1j}(M_j - B_j; S_j; T_1) + \epsilon_{1j} \geq V_{0j}(M_j; S_j; T_0) + \epsilon_{0j} \quad (2)$$

Where V_{1j} is the indirect utility in a state of controlled erosion T_1 , and V_{0j} is the indirect utility to the household in the presence of off-site erosion effects or in the status quo T_0 . Here $T_1 > T_0$ which shows the fact that the proposed scenario/controlled erosion has a higher non market benefit than the status quo. M_j is the income of the household; B_j is the bid amount; S_j captures the other socio-economic and demographic factors; and the error terms, ϵ_{1j} & ϵ_{0j} are the identically and independently distributed with a mean of zero.

Our dependent variable is dichotomous, and equals 1 if the j^{th} household is willing to pay money to support soil erosion control program and 0 otherwise.

⁷ In the random utility formulation a consumer chooses between alternatives 0 and 1 according to which has the higher satisfaction or utility. The discrete variable y then takes value 1 if alternative 1 has higher utility, and it takes value 0 if alternative 0 has higher utility.

The general form is represented as:

$Y_j^* = X_j \beta_j + \epsilon_j$, where, Y_j^* is the dependent variable, X_j is the vector of independent variables that include M and S of the above specification, β_j is the parameter to be estimated and the random error term is $\epsilon_j \sim (0, \sigma^2)$. Y_j^* is a continuous latent variable & it is not observable. The observed variable is the answers ‘YES’ or ‘NO’, which can be given by a dummy variable $Y_j = 1$ if YES and $Y_j = 0$ otherwise, to the question regarding whether or not the respondent would be willing to pay or willing to contribute a given bid amount. The j th respondent will say yes if $Y_j^* > 0$ and this will be true if the condition in equation (2) is satisfied.

$$Y_j = \begin{cases} 1 & \text{if } Y_j^* > 0 \text{ or } V_{1j}(M_j - B_j; S_j; T_1) + \epsilon_{1j} > V_{0j}(M_j; S_j; T_0) + \epsilon_{0j} \\ 0 & \text{if otherwise} \end{cases} \quad (3)$$

In the random utility framework, the maximum willingness to pay, Y_j is a random variable. While individuals are assumed to know their maximum willingness to pay with certainty, these values are revealed only through observed choices or elicited preferences, and determinants of these values often are unobservable, observable with error or measurable only through proxies. Thus, an observer cannot infer Y_j with certainty. Thus we can incorporate this uncertainty by specifying a cumulative distribution function $F(\cdot)$ for the maximum random willingness to pay.

The probability that a household j is willing to pay for controlling the off-site effects of soil erosion can be expressed as the difference of his/her utility functions with and without erosion problem. i.e.

$$\begin{aligned} \Pr_j(\text{Yes}) &= \Pr_j(Y_j = 1) = \Pr(V_{1j}(M_j - B_j; S_j; T_1) + \epsilon_{1j} > V_{0j}(M_j; S_j; T_0) + \epsilon_{0j}) \\ &= \Pr(V_{1j}(M_j - B_j; S_j; T_1) - V_{0j}(M_j; S_j; T_0) > \epsilon_{0j} - \epsilon_{1j}) \\ &= F(V), \text{ where } V = \epsilon_{0j} - \epsilon_{1j}, \quad V = V_{1j} - V_{0j} \text{ and} \\ &F(V) \text{ is the cumulative distribution function (cdf).} \end{aligned} \quad (4)$$

3.3.2 Econometric Model

The above cumulative distribution function in equation (4) provides an underlying structural model for estimating various econometric models from the discrete choice responses. In order to model the true willingness-to-pay, the double-bounded, dichotomous-choice contingent valuation model is used, which is more information-intensive and asymptotically more efficient than the single bounded method (Hanemann et al., 1991). To estimate WTP, the Bivariate Probit Model, the interval regression (see Cameron and Quiggin, 1994; Hanemann *et al.*, 1991)⁸, Recursive Probit, Pooled Probit and Random Effect Probit models were used that follows directly from our Double Bounded Dichotomous Choice (DBDC) survey design. The final WTP estimate is reported from the model that best explain our DBDC CV survey. Comparison will be made among models of single bounded dichotomous choice (SBDC) and double bounded dichotomous choice (DBDC), with respect to different criteria.

The improved statistical efficiency of the double-bounded model reported in literatures is also tested after estimating variants of SB & DB models.

I. Single-Bounded Model

Here responses to the initial bid (DC1) and follow-up bid (DC2) will be analyzed separately, as though they were elicited from two separate independent dichotomous choice experiments. In this case there is no correlation between the responses thus assuming $\rho = 0$. By estimating a separate single bounded dichotomous choice (SBDC)

⁸ *The bivariate probit model can be specified as if the two discrete responses are from the same valuation function, allowing for correlation in the error terms of the two responses. A restricted version of the bivariate probit model (i.e., if initial and follow-up responses are assumed to be motivated by same latent WTP value, observed differences are due to randomness in the WTP distribution, and the correlation coefficient $\rho = 1$) leads to a DB interval data probit model (Hanemann et al., 1991).*

models for initial bid (*MODEL I*) & follow-up bid (*MODEL II*) an attempt will be made to compare & consider the well documented results from environmental economics that DBDC results in better welfare estimates than single bounded.

The probability of obtaining a “yes” or “no” response for a given payment amount, Bid_i , to control the effects of erosion can be represented as:

$$Y_j^* = X_j + \epsilon_j$$

$$Y_{j1} = \begin{cases} 1 & \text{if } Y_{j1}^* > Bid_1 \\ 0 & \text{otherwise} \end{cases} \quad \text{and} \quad Y_{j2} = \begin{cases} 1 & \text{if } Y_{j2}^* > Bid_2 \\ 0 & \text{otherwise} \end{cases}$$

$$\begin{aligned} P(\text{yes}) &= P(Y_j=1) = Pr(X_j + \epsilon_j > bid_i) \\ &= Pr[\epsilon_j > (bid_i - X_j)] \\ &= 1 - F[(bid_i - X_j)/\sigma] = 1 - F(Bid_i; z_j) \\ &= 1 - F(z_j) \end{aligned} \tag{5}$$

Where, $F(\cdot)$ is the cumulative distribution function (cdf). For this study normality in the error term is assumed which results in a Probit Model and the log-likelihood function for $j=1, \dots, N$ observation will be:

$$\text{Log } L = \sum_{j=0}^N \{Y_j \log [1 - F((bid_i - X_j)/\sigma)] + (1 - Y_j) \log [F((bid_i - X_j)/\sigma)]\} \tag{6}$$

By adapting Haneman et al. (1991) a Probit model can be estimated for both the initial and follow-up responses (*MODEL I* & *MODEL II*) separately using maximum likelihood estimation.

II. Double-Bounded Model

In the double bounded dichotomous choice model for each person we have an initial bid and one follow-up bids. Thus, there are four possible outcomes: (1) both answers are “yes”; (2) both answers are “no”; (3) a “yes” followed by a “no”; and (4) a “no” followed by a “yes”.

Let the model be: ⁹ $WTP_{ij} = \beta' X_{ij} + \varepsilon_{ij}$, where $\varepsilon_{ij} \sim N(0, \sigma^2)$ and from equation (5)

$$P(\text{yes}) = 1 - F(z_j)$$

For each respondent we have an initial bid B_j^I and one of the follow-up bids ,lower bid (B_j^L) and higher bid (B_j^U), where $B_j^L < B_j^I < B_j^U$. Each respondent will be asked a random initial bid and the follow-up is dependent on the initial bid amount.

Following Hanemann et al. (1991), the Probabilities associated with the four possible likelihood outcomes of DBDC denoted by $P(yy); P(nn); P(yn)$ and $P(ny)$ for “yes, yes”, “no, no”, “yes, no”, and “no, yes” outcomes, respectively can be presented as:

A. The probabilities for “yes,yes” outcome will be:

$$\begin{aligned} P_{yy}(B_j^I, B_j^U) &= P(B_j^I \leq \text{Max.WTP} \& B_j^U \leq \text{Max.WTP}) \\ &= 1 - F(B_j^U; \sigma) \end{aligned} \quad (7)$$

B. The probabilities for “no,no” outcome will be:

$$\begin{aligned} P_{nn}(B_j^I, B_j^L) &= P(B_j^L > \text{Max.WTP} \& B_j^I > \text{Max.WTP}) \\ &= F(B_j^L; \sigma) \end{aligned} \quad (8)$$

C. The probabilities when a “yes” is followed by “no”, with $B_j^I < B_j^U$ will be:

$$\begin{aligned} P_{yn}(B_j^I, B_j^U) &= P(B_j^I < \text{Max.WTP} \& B_j^U > \text{Max.WTP}) \\ &= F(B_j^U; \sigma) - F(B_j^I; \sigma) \end{aligned} \quad (9)$$

⁹ WTP_{ij} is the willingness to pay of individual j , it represents a vector of values of the dummy response variable and $i = 1, 2$ represents DC1 and DC2, respectively; x_{ij} ($i = 1, 2$) is a vector of explanatory variables, including bids; β is a corresponding vector of coefficients. The error term, ε_{ij} incorporates both individual and question specific error.

D. For a “yes” answer following a ‘no’ response, the probabilities can be

$$\begin{aligned}
 \text{represented as: } P_{ny}(B_j^I, B_j^L) &= P(B_j^L > \text{Max.WTP } B_j^L) \\
 &= F(B_j^I; \cdot) - F(B_j^L; \cdot) \quad (10)
 \end{aligned}$$

The likelihood function for $j=1, \dots, N$ observation will be:

$$L(\cdot) = \prod_{j=0}^N d_i^{yy} \cdot P_{yy}(B_j^I, B_j^U) + d_i^{nn} \cdot P_{nn}(B_j^I, B_j^L) + d_i^{yn} \cdot P_{yn}(B_j^I, B_j^U) + d_i^{ny} \cdot P_{ny}(B_j^I, B_j^L) \quad (11)$$

Where d_i^{yy} , d_i^{nn} , d_i^{yn} & d_i^{ny} are the binary valued indicator variables with their probability represented above. In dealing with data from DBDC we estimate several versions of this model with maximum likelihood procedures.

A. *Bivariate probit model*

When DBDC survey is used it is important to consider that the answer to the follow-up bid is endogenous to the initial bid offered randomly. The second bid will take a predetermined value or it is not random and hence a model of joint distribution function is needed.

The *bivariate probit* model introduced by Cameron and Quiggin (1994) has become a general parametric modeling approach for double-bounded CV survey. It is argued that the responses to the two DC questions may not be independent, but rather path dependent i.e. the response to DC2 may be related to the response to DC1. Sequential presentation of WTP questions (DBDC) suggests that responses to these questions might not be independent if unobserved factors influence both responses. To deal with these issues, we use a bivariate probit model to estimate preference parameters and identify correlation in the unobserved factors influencing responses across the two WTP equations. In general, a *Bivariate Probit Model* is specified as:

$$Y_{j1}^* = \beta_1' X_{j1} + \epsilon_{j1} \text{-----} 12(a)$$

$$Y_{j2}^* = \beta_2' X_{j2} + \epsilon_{j2} \text{-----} 12(b)$$

In the data Y_{j1} & Y_{j2} are only observable through the two discrete choice responses

such that:

$$Y_{j1} = \begin{cases} 1 & \text{if } Y_{j1}^* > Bid_1 \\ 0 & \text{otherwise} \end{cases} \quad \text{and} \quad Y_{j2} = \begin{cases} 1 & \text{if } Y_{j2}^* > Bid_2 \\ 0 & \text{otherwise} \end{cases}$$

$$E[Y_{j1}] = E[Y_{j2}] = 0$$

$$Var[Y_{j1}] = Var[Y_{j2}] = 1$$

$$Cov[Y_{j1}, Y_{j2}] =$$

As the second equation is based on the first question response, the error terms are correlated and hence the two equations can be estimated jointly using a model developed by Cameron and Quiggin (1994), which assumes Bivariate Normal distribution for the two valuations, $BVN(\beta_1 X_1', \beta_2 X_2', \sigma_1^2, \sigma_2^2, \rho)$ or $BVN(0,0,1,1, \rho)$. The two questions have four possible pairs of response: $(Y_{j1}, Y_{j2}) = (1,1), (1,0), (0, 1)$ and $(0, 0)$. Combining the associated probabilities of all possible responses in the likelihood function, equation (11) can be estimated using the Bivariate Probit or the seemingly unrelated bivariate probit Model (*MODEL III*).

B. Recursive Probit Model

It is believed that response to the second question is likely to suffer from anchoring bias due to the initial bid question.¹⁰ To take account of the possible anchoring effect, a Recursive Probit model needs to be estimated. In modeling the follow up response, WTP estimated from the first equation is included in the second equation. Thus, the recursive system can be derived from (13) below where the first equation is the usual reduced form equation:

¹⁰ Anchoring bias refers to the situation in which the respondent is assumed to take the cue from the first bid while forming his WTP for the second question and creating a noise in the second equation parameters.

$$Y_{j1} = \beta_1 X_{j1} + \epsilon_{j1} \text{-----13(a)}$$

but the second equation is replaced by the structural equation

$$Y_{j2}^* = \beta_2 X_{j2} + \beta_3 \hat{wtp}_{j1} + \epsilon_{j2} \text{-----13(b)}$$

Where \hat{wtp}_{j1} is the WTP estimated from the first response equation for the j th respondent.

Following Maddala (1983) the system of equations defined by 13(a&b) can be estimated by a two-stage maximum likelihood procedure. The estimated recursive model will be compared with others models by constructing interval estimates around the mean WTP using Krinsky Robb procedure.

C. Interval Regression

In addition to the above model the data from double-bounded contingent valuation survey can also be analyzed using an *interval data* model. Interval regression developed by Hanemann et al., (1991) is a restricted version of the bivariate probit model. Here it is assumed that responses to both the initial and follow-up questions, $wtp1$ and $wtp2$, are motivated by the same latent WTP values, differences are due to randomness in the WTP distribution. Thus, the covariates and the errors for analyzing both dichotomous choice questions are identical i.e. $X_{i1}=X_{i2}$, $\epsilon_{i1}=\epsilon_{i2}$ and $\rho=1$ implying that there is perfect correlation between responses to $wtp1$ and $wtp2$. The model has some merits for example simulation results in Alberini (1995) suggest that this model is fairly robust with respect to misspecifications, especially in terms of estimated mean WTP.

Double-bounded CV data can be organized in left-censored, right-censored and interval-censored dataset format. Respondents who answer ‘yes, yes’ are right

censored, those with ‘no, no’ are left censored and those with ‘yes, no’ or ‘no, yes’ fall within an interval. Using interval regression the bids can be explicitly modeled and the mean WTP can be obtained by post-estimation prediction.

Table 3.2 Structure of WTP Bid Data for Interval Regression

Response to DBDC questions	Bounds on WTP implied by responses	
	Lower bound	Upper bound
<i>Yes-Yes(Right censored)</i>	B_j^U	<i>Disposable income()</i>
<i>Yes-No (Interval data)</i>	B_j^I	B_j^U
<i>No-Yes (Interval data)</i>	B_j^L	B_j^I
<i>No-No (Left censored)</i>	$0(or-)$	B_j^L

The censored observation are represented by infinity, but since WTP cannot exceed the disposable income of individual or cannot be negative we have asked a final open ended question on the maximum willingness to pay, thus the end points of the censored observation are constructed by incorporating the maximum WTP.

As to Cameron and Huppert (1989) in the interval data approach the probability of WTP falling between the lower and upper bounds can be specified as:

$$Pr(WTP_i \subseteq [lower\ bound, Upper\ bound]) =$$

$$Pr((lower\ bound - WTP_i) < z < (upper\ bound - WTP_i)) \text{ where } z \text{ is the}$$

standard normal random variable.

Accordingly, in this study the double bounded interval data model (interval regression) (*MODEL IV*) is estimated and comparison was made with other models.

D. Pooled Probit and Random Effect Probit Model

Response from the DBDC CV Survey can also be modeled by transforming the data into Pseudo-panal data format i.e. we can pool the data by splitting into two sub-samples, for first and second bid questions. From the combined (Pseudo-panal) data sets, we can estimate two models namely; the pooled data probit and Random effect probit models.

By pooling the two responses, the interdependence between the first and second question can be obviated and in the pooled probit model, data sets of the second response is considered as an additional observation generated on the same valuation function. Thus the pooled probit is a simple independent probit model with more observation.

Consider the following model,

$$y_{it}^* = x_{it}'\beta + v_{it} \quad i=1,2,\dots,n \text{ and } t=1,2,\dots,T \quad \text{-----}(14a)$$

$$v_{it} = \alpha_i + u_{it} \quad \text{-----}(14b)$$

and $y_{it} = 1$ if $y_{it}^* > \text{bid}$ and $y_{it} = 0$ else,

Where, y^* denotes the unobservable variable, y is the observed outcome, x is observable time varying and time vector of strictly exogenous characteristics which influence y^* , β is the vector of coefficients associated with the x_i , α_i denotes the individual specific unobservable effect and the u_{it} is a random error. Assume that $u_{it} \sim i.i.d.N(0, 1)$ and $\alpha_i \sim N(0, \sigma^2)$, thus $Var(v_{it}) = 1 + \sigma^2$ If we assume that the unit effects are all equivalent that is $\alpha_i = \alpha_j$ for all i and j then the above equation reduces to the pooled probit model: $y_i^* = \beta x_i + u_i$

Assuming the various realizations of Y_{it} for each i 's were independent and the variance of individual specific unobservable effect is zero ($\sigma^2 = 0$) and running the above pooled probit model (MODEL VI), gives consistent parameter estimates of the coefficients.

The “pooled” estimator which is the standard, single equation probit model, is the most restrictive estimation approach it assumes away all the cross period correlation and treats the panel essentially as a cross section.

The pseudo panel data can also be modeled using a random effects probit estimation approach. The random effects probit model extends the pooled probit model by allowing cross period correlation. The standard random effects probit model in which the random effect results from a group specific error term can be specified as:

$$y_{it}^* = x_{it}'\beta + \mu_i + u_{it} \text{ -----(15)}$$

The random effects, μ_i s are assumed to be independent of the covariates x_{it} and the remainder error term u_{it} . The sign of the latent variable determines the observed binary outcome variable, i.e.

$$Y_{it} = \begin{cases} 1 & \text{if } Y_{it}^* > Bid \\ 0 & \text{otherwise} \end{cases}$$

We assume that both μ_i and u_{it} are independent, identical & normally distributed i.e. $u_{it} \sim N(0, \sigma_u^2)$ and $\mu_i \sim N(0, \sigma_\mu^2)$ and for the standard random effects probit, we set $\sigma_u^2 = 1$ thus the $Var(v_{it}) = 1 + \sigma_\mu^2$. The constant through time error term, μ_i , which is the random effect for respondent i , allows variation across individuals that cannot be explained by the independent variables but is fixed for each respondents. But the random error term, u_{it} , varies across time period and individual. This implies within units, the v_{it} s will be correlated. The magnitude of correlation coefficient between the

responses, ρ , which is a measure of the ratio of the variance in the random effects component of the model to the total variance in the model, is given by:

$$\text{corr}(v_{i1}, v_{i2}) = \rho = (\sigma_u^2) / (\sigma_u^2 + \sigma_e^2)$$

The larger the correlation coefficient, the more likely the random effects model is appropriate (Greene, 1997; as cited in Whitehead, 2000). Moreover when this correlation coefficient is high, all else equal, the willingness to pay estimates between interval data and random effects models should be similar (Alberini, Kanninen, and Carson, 1997).

The parameters of the REP model are easily estimated by noting that the distribution of y_{it}^* conditional on u_i are independent normal (Heckman, 1981).

$$\text{Prob}(y_{it} = 1 | u_i, x_{it}) = \text{Prob}\left(\frac{y_{it}}{\sigma_u} > \frac{-x_{it}'\beta - u_i}{\sigma_u}\right) = \Phi(z_{it}) \text{-----16}$$

Where $Z_{it} = -(X_{it}'\beta + u_i) / (\sigma_u)$ and Φ is the distribution function of the standard normal variate. Thus from the above specification we can fit random-effects probit regression via maximum likelihood (MODEL VII). The random effects probit model is a generalization of the interval data model in which the mean WTP values are allowed to vary across valuation question (Haab, 1997).

3.4 Description of variables (covariates)

The main objective of this study is to estimate individual willingness to pay for changes in quantity or quality of environmental goods or services i.e. for controlled off-site erosion effects. Additionally, the study also aims to assess the effect of explanatory variables (covariates) on individual willingness to pay. Below are the descriptions of dependant and explanatory variables.

Dependent variables

Willingness to pay: The dependent variable in our WTP analysis was households' willingness to pay to community based conservation practices for the purpose of controlling the off-site effects of soil erosion. The variable is dichotomous which is expressed as 0 and 1. Whenever the *i*th household is willing to pay money and answers "yes" to a randomly assigned bid price, the value will be 1 and 0 otherwise.

Explanatory Variables and Hypotheses

In addition to estimation the mean willingness this CV study also aims to assess the effect of explanatory variables (covariates) on households' willingness to pay. Covariates relevant to this study were identified and selected based on the findings of past studies, existing theoretical explanations, and during the process of questionnaire design including pretest and FGD. Below are potential explanatory variables that are expected to influence households' decision to pay.

Bid value: the randomly assigned bid price is expected to influence the likelihood of accepting that bid and the maximum willingness to pay. Four bid levels were determined through pilot survey. And it is expected that higher bid values have a negative effect on households willingness to pay for controlling the offsite effects of

soil erosion i.e. households are expected to be rational in the face of increasing costs and hence the law of demand holds.

Income: the total annual income of the households including income from off-farm activities, was used to proximate the economic power of the households. It is expected that those households with higher annual incomes are more likely to answer yes to the given valuation question and subsequently to express a higher WTP.

Farm size: refers to total area of land a household cultivates measured in ha. Households who own large areas of land are expected to cultivate and earn more. So a positive relation is expected.

Off-Farm Income: Households' participation in off-farm income generating activities will influence the Likelihood of accepting a randomly assigned bid values in both ways. First households who have off-farm income have more purchasing power so that they seek to obtain a better state of an environment i.e. a state of controlled erosion and hence are more willing to pay. In contrast households who participate in off-farm income generating activities might be less concerned about the effect of erosion as they have more non-farm income & hence negative impact on willingness to pay might hold.

Access to credit: households who have access to credit service can enhance their farm activities and improve their livelihood given efficient utilization of the loan and hence are expected to have positive willingness to pay.

Livestock: Per capita livestock holding, measured by Tropical Livestock Unit (TLU) is expected to have a positive impact on households' decision to pay. One TLU is equal to 250 kg and the TLU conversion factor is: 1=for cow/oxen/, 0.75=bulls/heifer,

0.25= calf, 0.13=sheep/goats, 0.7= mule/horse, 0.7=donkey. Ownership of livestock can be an indicator of wealth so that a positive effect on WTP is expected.

Gender: This is a dummy variable where 1= the presence of a male-headed household, and 0 otherwise. And the sign is not hypothesized priori.

Age: Can have either positive or negative relationship with households WTP. As an individual's age increases, his/her attitude toward controlling the off-site effect will be higher, as experience in life is a great asset. In the other way as older people have a shorter planning horizon and they are less willing to pay

Household size: the larger the household size the higher might be the dependency ratio if the composition is dominated by child and old age people and consequently the higher the opportunity cost of paying for conservation activities. In contrast if the composition of the family is dominated by working class, the better will be their purchasing power so that more willingness to pay is expected from the household.

Education: is expected to have positive impact on an individual's willingness-to-pay, as it increases farmers' ability to process information and use it. The higher the level of education, the better will be the awareness and concern for the off-site effects of soil erosion. The highest level of education achieved by the household head is taken because is that education level of the decision maker can have a "spillover effect". Three level of education attainment by the head were identified (no education=0; primary=1; secondary & above=2)

Location: it is hypothesized that the downstream farmers bear the largest burden due to off-site effects of erosion relative to the upstream residents. But the off-site effects are so vast that it affects both parties in our case so its sign is indeterminate priori.

Damage: households who have experience any kind of off-site effects of erosion

previously will have greater tendency to avoid such damages and hence are more willing to pay relative to the non-affected one.

The table below summarizes dependent variables and independent variables that are hypothesized to influence (explain) WTP with their expected sign.

Table 3.3 Variables used in this study

Variable	Description	Expected sign
Dependant variables		
<i>wtp1</i>	<i>Respondent's answer to the initial question, 1=yes, 0=no</i>	
<i>wtp2</i>	<i>Respondent's answer to the second question, 1=yes, 0=no</i>	
Independent variables		
<i>bid1</i>	<i>The initial/base bid at the initial dichotomous choice question</i>	-
<i>bid2</i>	<i>The follow up bid at the second dichotomous choice question</i>	-
<i>farm size</i>	<i>Parcel/pieces of farm land in hectare</i>	+
<i>income</i>	<i>Total household income per year</i>	+
<i>access to credit</i>	<i>Availability of credit services</i>	+
<i>Off-farm income</i>	<i>Off-farm income including salaried and casual on-farm & off-farm labor</i>	+
<i>Livestock</i>	<i>ownership of Livestock in TLU</i>	+
<i>Age</i>	<i>Age of the respondent (in years)</i>	+/-
<i>Sex</i>	<i>Sex of the respondent (male=1; female=0)</i>	?
<i>Family size</i>	<i>Number of family members (dependency ratio)</i>	-/+
<i>Education</i>	<i>Education level of the household head (0=illiterate, 1=attained primary school & 2=high school and above)</i>	+
<i>Location</i>	<i>Location of respondents farm land (upstream=1, downstream=0)</i>	-
<i>Damage</i>	<i>Has the household faced any kind of off-site negative effects of erosion previously? (yes=1; No=0)</i>	+

CHAPTER FOUR

DESCRIPTIVE ANALYSIS, ESTIMATION RESULTS AND DISCUSSIONS

4.1 DESCRIPTIVE ANALYSIS

This section provides the summary of the socio-economic characteristics of the sample respondents and descriptive statistics of responses to willingness to pay questions & key variables. It also includes information on the severity of the offsite impacts as perceived by the sample respondents and their attitude towards controlling the off-site effects of erosion.

4.1.1 Socio-Economic Profile

Of the total 142 respondents a valid sample size of 134 farm households was used to collect relevant data pertaining to the objectives of this research. Responses are collected from the household head and of the total households 113(84.3%) were male headed and females constitute 21(15.6%). The average age of respondent was 43.3 years with a minimum of 21 year and maximum of 82 years. Interviewed households had total population of 763 out of which 416 (54.5%) were males and 347 (45.5%) were females. Table 4.1 presents the age-sex composition of the sample households. The young age group accounted for 31.2 % of the total sample population while population aging above 65 accounted only for 1.44%.

Table 4.1 Demographic composition of sample households by age and sex

Age group	Frequency by gender		Total	Percentage
	Male	Female		
0-18	103	135	238	31.2
18-65	304	210	514	76.3
>65	9	2	11	1.44
Total	416	347	763	100

Source: Own computation from Field survey

The average family size of the sample is 5.6 which is greater than the kebeles' average of 4.5, the minimum and maximum size of households being 2 & 10 respectively.

Table 4.2 Household size of the sample households

<i>Household size</i>	<i>Frequency</i>	<i>Percent (%)</i>
2-4	29	21.64
5-7	89	66.41
8-9	15	11.19
> 9	1	0.74

Source: Own computation from Field survey

Of the total household heads in the survey 84(62.69%) were illiterates (have never been to school), 35(26.12%) attended elementary or primary school and the remaining 15(11.19%) household heads attended high school. This implies that the agricultural sector of the study area is still dominated by illiterate farmers.

Table 4.3 Educational attainment of household heads by age

<i>Educational attainment</i>	<i>Age of the household head</i>				<i>Total</i>	
	<i>< 35 years</i>		<i>> 35 years</i>			
	<i>Frequency</i>	<i>%</i>	<i>Frequency</i>	<i>%</i>	<i>Frequency</i>	<i>%</i>
<i>Illiterates (has never been to school)</i>	15	17.86	69	82.14	84	62.69
<i>Attended primary school</i>	20	57.14	15	42.86	35	26.12
<i>Attended high school or above</i>	10	66.67	5	33.33	15	11.19
<i>Total</i>	45	33.58	89	66.42	134	100

Source: Own computation from Field survey

The majority of farmers aging above 35 have never been to school. This is because it is in recent time that education coverage especially in rural area has expanded, so that majority of the people who attended school are young household heads.

The observed average household annual income was 13294.78 ETB, ranging from a minimum of 2000 ETB to a maximum of 35000 ETB. The main source of income or

livelihood is farming activities. Only 33(24.63%) of the household participate in off-farm activities in addition to farming. Households that have access to credit service account for 33.58%. Measured in tropical livestock unit the average livestock ownership of the sample respondents was 1.78. Moreover respondents were asked to rank their economic status relative to residents of their area i.e. subjective measure of poverty. Accordingly, 4%, 26%, 44% & 26% of the respondents feel that they are rich, average, poor and very poor, respectively

With respect to landholding, as in most of the highlands of the country, the landholding of farmers in the study area is very small. The size of land holding varies from 0.125 hectare to 1 hectare, the average being 0.4hectare. The Majority of farmers (97.76%) own & cultivate less than 1ha of land, only 2.24% of the sample respondents own and cultivate more than 1hectare. In addition 13% of the sample respondent owns a parcel of land in more than one site.

Table 4.4 Landholding size of the sample households

<i>Land Size (in hectare)</i>	<i>Frequency</i>	<i>Percent</i>	<i>Cumulative</i>
<i><=0.25</i>	<i>54</i>	<i>40.2</i>	<i>40.24</i>
<i>0.26-0.5</i>	<i>46</i>	<i>34.3</i>	<i>74.56</i>
<i>0.56-0.75</i>	<i>25</i>	<i>18.6</i>	<i>93.21</i>
<i>0.76-1</i>	<i>9</i>	<i>6.7</i>	<i>100</i>
<i>>1</i>	<i>0</i>	<i>0</i>	<i>100</i>

Source: Own computation from Field survey

Looking at the location (topography) of farm land, of the total 134 respondents covered in this survey 46(34.33%) were downstream farmers and the rest 88(65.67%) were located in the upstream.

4.1.2 Perception and Attitude of Respondents towards the Off-Site Effects of Soil Erosion

Examination of respondents perception of soil erosion, both onsite & offsite effects, as a challenge either in their farm or in their area revealed that all respondents identified soil erosion to be a problem. There was no respondent who rate the challenge as low or does not exist and most of the respondents (81.34%) perceive soil erosion as severe problem.

Table 4.5 Farmers' perception of soil erosion as problem

Magnitude of erosion	frequency	%
<i>Severe</i>	<i>109</i>	<i>81.34</i>
<i>Moderate</i>	<i>23</i>	<i>17.16</i>
<i>Minor</i>	<i>2</i>	<i>1.49</i>
<i>Total</i>	<i>134</i>	<i>100</i>

Source: Own computation from Field survey

With respect to the specific off-site impacts of erosion respondents were asked to rate and rank the major off-site negative effects in their area. Accordingly, the following off-site negative effects of erosion were considered to be a challenge in the study area.

Table 4.6 Perceived major off-site effects of erosion and magnitude severity

Off-Site Effects	Severity				Total
	Severe	Moderate	Minor	Not Exist	
<i>Downstream sedimentation of reservoirs and water channels</i>	<i>98 (73.13%)</i>	<i>21 (15.67%)</i>	<i>15 (11.2%)</i>	<i>NA</i>	<i>134 (100%)</i>
<i>Damage on rural road</i>	<i>123 (91.79%)</i>	<i>11 (8.2%)</i>	<i>NA</i>	<i>NA</i>	<i>134 (100%)</i>
<i>Damage to irrigation channels</i>	<i>88 (65.67%)</i>	<i>36 (26.86%)</i>	<i>10 (7.46%)</i>	<i>NA</i>	<i>134 (100%)</i>
<i>Run-off & sedimentation</i>	<i>119 (88.8%)</i>	<i>9 (6.71%)</i>	<i>6 (4.47%)</i>	<i>NA</i>	<i>134 (100%)</i>
<i>Landscape degradation</i>	<i>98 (73.13%)</i>	<i>32 (23.88%)</i>	<i>4 (2.98%)</i>	<i>NA</i>	<i>134 (100%)</i>
<i>Proximate Property Damage</i>	<i>46 (34.32%)</i>	<i>55 (41.04%)</i>	<i>20 (14.92%)</i>	<i>13 (9.7%)</i>	<i>134 (100%)</i>
<i>Crop burial by sediment</i>	<i>33 (24.62%)</i>	<i>48 (35.82%)</i>	<i>22 (16.41%)</i>	<i>31 (23%)</i>	<i>134 (100%)</i>
<i>Visual Detraction</i>	<i>46 (34.32%)</i>	<i>76 (56.71%)</i>	<i>9 (6.71%)</i>	<i>3 (2.2%)</i>	<i>134 (100%)</i>

Source: Own computation from Field survey

It can be seen from the above table that the major off-site negative effects of soil erosion as perceived by the respondents are: Downstream sedimentation of reservoirs and water channels, Damage on rural road, Run-off & sedimentation, Damage to irrigation channels and Landscape degradation. To depict the identified off-site effects a picture showing various observed impacts were included in the appendix part. Moreover, respondents were asked to describe the Perceived trend in severity of those impacts and 93.5% of respondents reported the change in severity of the off-site effects to be large and the rest noted this change to be moderate.

Identified causes of off-site effects of erosion

In an attempt to know respondents awareness about offsite erosion effects as one of environmental challenge we have asked to state the possible reason for the cause of the off-site effects of erosion. From the survey questionnaire and Focus Group Discussion various possible causes of the off-site impacts were identified. Table below lists the main causes of the problem as frequently identified by the respondent.

Table 4.7 Perceived Main causes of off-site erosion problems.

<i>Main causes of off-site erosion</i>	<i>Number of responses (n=134)</i>	
	<i>frequency</i>	<i>%</i>
<i>Steep land without conservation structure</i>	109	81.34
<i>Deforestation and low vegetation cover of the soil</i>	97	72.4
<i>cultivation of steep slopes and erodible soils</i>	82	61.2
<i>Damaged conservation structures</i>	79	59
<i>Weak soil and water conservation practices</i>	71	53
<i>Erratic excessive rainfall</i>	42	31.35
<i>overgrazing</i>	33	24.62

Source: Own computation from Field survey and FGD

An attempt was also made to know their attitude towards controlling the off-site effects of erosion and we have posed question about their belief towards the possibilities of controlling the impacts and what needs to be done. The result shows that 76.1% of the respondent believes that the off-site effects of erosion can be controlled, while 23.8% do not see any possibilities to do so mainly because they feel the problem was deep routed.

As in most of the highlands of Ethiopia, various soil and water related conservation activities had been undertaken in the study area both by government and NGOs'. The conservation activities (programs) were mainly of incentive based and the observed result of such scheme was of little significance in tackling the challenge of soil erosion compared to the severity of erosion effects. Moreover such incentive mechanisms created a wrong attitude towards conservation activities. (Alemu, 2002) noted that Ethiopia is entering into the dangerous stage in which people are unwilling to do anything to better their living condition without incentive or without being rewarded food or cash. The finding of this paper also conforms to this conclusion. Respondents were asked their reason to decide to participate in soil and water conservation activities and their willingness to participate if the current payment scheme is absent. And we found that they are reluctant to participate and of the 22 current participant in such kind of incentive based scheme like safety net program included in our sample, 72.72% of the respondent noted that they decide to participate because they need the reward (cash) most. In addition 65.6% of the sample respondent indicated/agree that the responsible body to undertake activities that will help to control the off-site negative effects of erosion is Government or/and NGOs'.

4.1.3 Willingness to pay and summary of key covariates

In order to model willingness to pay for controlling the off-site effects of soil erosion a double bounded Contingent valuation method was used. Before the conducting the actual survey, a pilot study was made to design the bid vectors. Consequently, for the final survey four bid amounts (30, 50, 60 & 70 in ETB/year) were used as initial values and each respondent faced a random initial bid and the follow-up bid was determined depending on the response for the initial question. Finally respondents are asked to state their maximum willingness to pay to control the off-site effects of erosion so that any inconsistencies are dealt with.

Adjustment to uncertainty and protest responses

To use data for further statistical analysis, we calibrated it by dropping protest responses and adjusting WTP responses with certainty and consistency using respondents' answers to debriefing questions. Initially a total of 142 households were considered in this survey but only 134 responses are found to be valid

Protest responses are those that are indicative of the undue influence of the contextual elements of the CV (e.g., payment vehicle, information constraints, etc) (Jorgensen et al. 1999). According to Labao et al.,(2008) as cited in Mesfin T et al.,(2011) reasons other than financial constraint and the good having no value to the respondent are considered as protest responses. In the WTP bidding, out of 142 respondents 21 (14.78%) answered no/no. From No/No respondents 5 or (23.8%) reported that it is not their responsibility rather they point to government and they do not want to pay. In addition 3 or 14.2 % also reported a zero bid with a reason saying “only the downstream farmers have to pay”. Both of these reasons could be classified as protest

responses and adjustment was made. Initially a total of 142 survey questioners were administered and after adjustment to protest responses 8(5.6%) answers are excluded, only 134 respondents were retained for statistical analysis.

Due to a one-time nature of a hypothetical market valuation practices, individual preferences may be highly uncertain. Thus the data need to be calibrated for certainty. Such adjustment helps to mitigate a bias in CV studies, named hypothetical bias. Respondents who replied yes/yes, yes/no and no/yes to initial and follow-up bids were allowed to express the degree of uncertainty of their valuation responses. A ten point scale was used with 1 as 'Very uncertain' and 10 as 'Very certain'. All yes/yes, yes/no and no/yes responses were classified as no/no responses if the respondent chooses certainty scores 1 to 9. The result of such adjustment classified 4 responses as No/No responses. In addition the data was also tested for any inconsistencies in response to the DBDC questions using a debriefing final open-ended question of their maximum willingness to pay. When the final open-ended value was lower than the accepted bid in the follow-up question, we asked the reason for such inconsistencies. The situation was dealt with by recoding the inconsistent responses as a "No" response for the follow-up bid (Carlsson et al. 2004). In our case we have found 6 responses to the final open ended question to be inconsistent with the approved follow-up bid and hence converted (recoded) such 'yes' responses into 'no'.

The Summary of responses to the DBDC willingness to pay question adjusted for certainty, consistency and protest responses is given in Table below.

Table 4.8 Bid Vectors and Responses to the DBDC questions

<i>Bids (ETB/year)</i>	<i>Yes-Yes</i>	<i>Yes-No</i>	<i>No-Yes</i>	<i>No-No</i>	<i>Total</i>
<i>30 (15/60)</i>	16	10	4	2	32
<i>50 (25/100)</i>	13	13	5	4	35
<i>60 (30/120)</i>	12	12	5	5	34
<i>70 (35/140)</i>	6	13	12	2	33
<i>Total</i>	47	48	26	13	134

Source: *Own computation from Field survey*

N.B: *Initially a randomly assigned bid price will be asked and following the response to the initial bid, one of the two bids in bracket of the first column was asked as a follow up bid price.*

As shown, 35% of the respondents provide two positive responses and 9.7% gave two negative responses, whereas about 35.8% and 19.4%, fell in the “yes, no” and “no, yes” response categories respectively. The table further shows significant variation in WTP of respondents within each initial bid category. For instance, within the left censored, i.e., ‘no, no’ response category, about 15.3% of the respondents rejected the follow-up bid with minimum payment amount designed in the survey i.e. Birr15/year. This implies that these respondents are not willing to pay even birr 15 per year. On the other hand, among the right censored observations, i.e., in response category ‘yes, yes’, 12.7% of respondents stated that they are willing to pay birr 140/year, which implies their WTP is equal to or more than Birr 140/year. Moreover the table below presents the proportion of yes responses in both initial and follow-up bids.

Table 4.9 Bid vectors and Acceptance in Double-Bounded CVM

<i>“No” bid follow-up</i>	<i>Proportion accepting</i>	<i>Initial bid</i>	<i>Proportion accepting</i>	<i>“Yes” bid follow-up</i>	<i>Proportion accepting</i>
15	0.8	30	0.81	60	0.59
25	0.56	50	0.75	100	0.5
30	0.5	60	0.7	120	0.5
35	0.8	70	0.58	140	0.34

Source: *Own computation from Field survey*

Looking at the proportion of yes responses in all bid values we found this share to decline as the bid price rises, which is in line with the economic theory.

Reasons for WTP and Not WTP

To distinguish the components or rationale for positive WTP, those who responded “yes” both or either of the two WTP question were asked to state their motives to do so. Moreover Respondents who are not willing to pay were also asked to indicate their reasons. Table 4.10 below presents the values or motives for willingness to pay and the reason for not willing to pay.

Table 4.10 Reasons for WTP & Non-WTP

<i>Reasons for WTP</i>	<i>frequency</i>	<i>%</i>
<i>I am being affected by the off-site effects & I want to avoid this</i>	94	77.6
<i>We should protect the area for the future</i>	66	54.5
<i>I would like to contribute because I am concerned about the people who are being affected from off-site effects of erosion</i>	53	43.8
<i>I want to contribute to preserve and inherit a better environment(area) for the future generation</i>	51	42.1
<i>It is my duty as residents of this area</i>	43	35.5
<i>It is a good cause & a right thing to do & I like contributing to good causes like this projects</i>	21	17.3
<i>Reasons for Non- WTP</i>	<i>frequency</i>	<i>%</i>
<i>I cannot afford to pay</i>	11	84.6
<i>Not applicable</i>	2	15.3

Source: Own computation from Field survey

From those who are not willing to pay, we have distinguished the protest votes, looking at the reason for their decision and were removed from the data set. Of the total 134 valid responses 121 respondents are willing to pay and say ‘Yes’ to both or either of the two bids, while the rest 13 are a valid ‘No’ responses.

Finally, the descriptive statistics of variables used in the study are summarized in the table 4.11(see appendix).

4.2. ECONOMETRIC ANALYSIS

Econometric analysis helps a lot in meeting the main objectives of the study which is estimation of per capita willingness to pay and hence the implied economic values of controlling off-site effects of soil erosion. Moreover, it provides insights about the factors that determine willingness to pay of households.¹¹

The econometric models used here are based on the econometric theory and specifications developed in the previous chapter. In order to model the true willingness to pay from DBDC CV survey we have estimated variants of both the single bounded and double bounded model.

4.2.1 Single-Bounded Models

Here responses to the initial bid (wtp1) and follow-up bid (wtp2) was analyzed separately, as though they were elicited from two separate independent dichotomous choice experiments. In this case there is no correlation between the responses thus assuming $\rho=0$. A separate single bounded (SBDC) probit model was estimated for both the initial bid (*MODEL I*) & follow-up bid (*MODEL II*) responses to identify factors affecting the WTP of households for controlling the off-site effects of soil erosion. The summary results of conventional probit model estimates for the initial and follow-up bid responses are reported in table 4.12.

The probit model estimated for the two bids separately shows that, model I (for initial bid) performs better than model II. The overall significance test shows that for model I, the null hypothesis of all variables are jointly zero is rejected at 99.5% level of

¹¹ *All models of this study were analyzed using Stata version 11 econometric software.*

significance [LR (2)= 60.44 ; $P > X^2=0.0000$] while for model II we reject the hypothesis only at 95% level of significance [LR(2)=23.44 ; $P > 2=0.0242$]. Moreover, the Mcfadden Pseudo R^2 , a measure of goodness of fit, is 0.37 and 0.12 for model I & model II respectively. That means model I explains about 37% of the variation in the dependent variable & for model II only about 12% of the variation wtp is attributable to variables in the model. According to Mitchell and Carson (1993), if a CV study failed to show an R^2 greater than 0.15 the result is open to question. Hence, the measure of goodness of fit is adequate for model I relative to model II.

Most of the relevant explanatory variables like income, turned out to be insignificant in model II than model I. with respect to the measure of welfare (mean WTP) model I is efficient than model II, as it has tighter confidence interval. It is also evident that in DBDC CV survey response to the follow-up bid can be affected by the initial bid responses i.e. there is an expected bias in bidding game, called Anchoring effect. Hence model II two suffers from noise.

Thus, from the above comparison and other indicators (see appendix), we prefer probit estimate from the initial bid responses to be the relevant model for estimation and inference from the SBDC CV survey.

As indicated under the column of probit model I, most of the explanatory variables hypothesized to affect WTP are as expected in sign, except credit, which are of course insignificant. Variables that have a negative impact on respondents WTP for controlling the off-site effects of erosion are the proposed bid (significant & expected), gender (male=1, but insignificant), age (insignificant), credit (insignificant & unexpected) and location of the respondent (upstream=1, but insignificant).

The size of the farm and participation in off-farm income generating activities are as expected positive, but insignificant.

Other relevant variables such as level of education, income(log transformed), livestock ownership and off-site erosion damage experience are positively related to the likelihood of saying ‘Yes’ and are significant.

4.2.2 Double Bounded Models

To Model Responses from the DBDC CV survey we have estimated variants of double bounded models including: The Seemingly Unrelated Bivariate Probit(MODEL III), Recursive Bivariate Probit(MODEL IV) and Interval Data Model(MODEL V). Moreover, by pooling (transforming) the CV survey data into Pseudo-Panal Data Format, a Pooled Probit(MODEL VI) and Random Effect Probit(MODEL VII) models were estimated.

I. Bivariate Probit

The *bivariate probit* model introduced by Cameron and Quiggin (1994) has become a general parametric modeling approach for double-bounded CV survey. The argument here is Sequential presentation of WTP questions (DBDC) suggests that responses to these questions might not be independent if unobserved factors influence both responses. Formally the model is specified as:

$$\begin{aligned}
 y_1 &= \beta_1 x_1 + \epsilon_1, & y_1 &= 1 \text{ if } WTP1 \geq B^1, 0 \text{ otherwise.} \\
 y_2 &= \beta_2 x_2 + \epsilon_2, & y_2 &= 1 \text{ if } WTP2 \geq B^2, 0 \text{ otherwise} \\
 Var[\epsilon_1] &= \sigma_1^2, Var[\epsilon_2] = \sigma_2^2 \\
 Cov[\epsilon_1, \epsilon_2] &= \rho\sigma_1\sigma_2
 \end{aligned}$$

To deal with these issues, we have used a seemingly unrelated bivariate probit (SUBVP) model and estimated preference parameters and correlation coefficient of the unobserved factors influencing responses across the two WTP equations. The results of SUBVP model (MODEL III) with covariates included shows that the Wald test of goodness-of-fit under the null hypothesis that all parameters are zero can be rejected. The model is jointly significant at 99% level of confidence [Wald $\chi^2(24)=46.79$; Prob > $\chi^2=0.0036$] or at least one of the variable included in the model is different from zero. The correlation coefficient implies, error terms of the two responses are negatively correlated but insignificant ($\rho = -.3549411$). The LR test for $\rho=0$ [$\chi^2(1)= 1.2136$ and Pr.> $\chi^2=0.2706$] suggests that the two disturbances are insignificantly correlated.

Of the variables expected to influence WTP, only level of education, income, livestock ownership and damage were significant and has the expected sign in the first equation. While in the second equation all variables turn out to be insignificant even the second bid price.

The welfare estimates constructed using the Krinsky-Robb procedure reveals that the SUBVP model gives a better mean WTP (71.79ETB) estimates than the SBDC Probit model, as it has a tighter confidence interval (A range of 31.31ETB).

II. Recursive Bivariate Probit

In case of the above seemingly unrelated bivariate probit model, it is the parameter estimates of the first equation that enters in the computation of mean willingness to pay in general. This is because the follow-up question response is likely to suffer from anchoring bias due to the initial question. To take account of the possible anchoring effect, a Recursive Bivariate Probit (RP) model is estimated. In modeling the follow up response equation, the estimated WTP from the first response equation is included i.e. $y_1 = \beta_1 x_1 + \epsilon_1$ but the second equation is replaced by the structural equation

$$y_2 = \beta_2 x_2 + \beta_3 WTP_1 + \epsilon_2$$

The RBP Model estimation in table 4.13 shows that the error terms of the two responses are negatively related, though insignificant. The possible anchoring impact of initial bid turn out to be insignificant and the likelihood ratio test [$LR = \chi^2(1) = 0.22$; Prob > $\chi^2 = 0.6363$] for the SUBVP and the RP model shows that the null hypothesis of SUBVP is Nested in RP is not rejected. Moreover, the predicted WTP_1 that enter the second response equation to capture anchoring effect turn out to be insignificant to affect WTP_2 .

Similar to the seemingly unrelated bivariate model above all variables have insignificant coefficients in the second structural equation of RP model while in the first equation only variables like bid1, level of education, income, livestock ownership and damage were significant. The coefficients and standard errors of the RP model also converge with the estimates from the SUBVP model.

The point estimates of welfare (mean WTP) from the Recursive model has a tighter CI relative to the SUBVP model [Range=30.64]. But the ratio of CI to mean WTP is

identical for both models; hence improvement of Recursive Bivariate Probit over The Seemingly Unrelated Bivariate Probit is not conclusive.

III. Interval Regression

Interval regression developed by Hanemann et al., (1991) is a restricted version of the bivariate probit model. Here it is assumed that responses to both the initial and follow-up questions, WTP_1 and WTP_2 , are motivated by the same latent WTP values, differences are due to randomness in the WTP distribution. Thus, the covariates and the errors for analyzing both dichotomous choice questions are identical i.e. $X_{i1}=X_{i2}$, $\epsilon_{i1} = \epsilon_{i2}$, $\sigma_1 = \sigma_2$ and $\rho = 1$. The interval regression result of our CV survey shows that the variables included in the model are jointly significant and the two most important variables that explain variation in WTP of a household in interval data model are total annual income and previous damage due to off-site effects of erosion. Both are significant at 1 % level of significance and positive as expected.

To estimate the mean willingness to pay with its standard deviation we have used three different post estimation prediction methods. The three prediction methods yields identical mean WTP. But, estimates of standard errors vary significantly. For the interval regression the mean willingness to pay estimated from the linear average prediction is preferred as it has less variation relatively.

Prediction method ¹²	#Obsr.	Mean (in ETB)	Std.Dev.	Min.	Max.
Linear prediction	134	75.78069	26.79192	7.41423	138.1988
Conditional expected value prediction method: $e(a,b)$	134	75.78069	36.34803	8.098581	158.6082
Truncated method: $y^*(a,b)$	134	75.78069	36.34803	8.098581	158.6082

¹² $e(a,b)$ calculates $E(x\beta + u \mid a < x\beta + u < b)$, the expected value of $y \mid x$ conditional on $y \mid x$ being in the interval (a,b) , meaning that $y \mid x$ is censored. 'a' and 'b' are specified as they are for $pr(\cdot)$. $y^*(a,b)$ calculates $E(y^*)$, where $y^* = a$ if $x\beta + u < a$, $y^* = b$ if $x\beta + u > b$, and $y^* = x\beta + u$ otherwise, meaning that y^* is truncated. 'a' and 'b' are specified as they are for $pr(\cdot)$.

Accordingly, the per capita willingness of pay of a household for controlling the off-site effects of soil erosion is estimated to be 75.78 ETB/year for five consecutive years.

IV. Pooled Probit and Random Effect Probit Model

The interdependence between the first and second question can also be obviated by pooling the data into a Pseudo-panel data format and from the combined (Pseudo-panel) data sets we have estimated two models namely; the pooled data probit and Random effect probit models.

Table 4.15 reports estimation results of pooled probit and random effect probit models. The measure of overall significance of the model, namely, likelihood ratio (LR), which assumes the chi-square (2) distribution, is 63.85 for the pooled probit model with 12 degree of freedom (df) to estimate WTP for controlling the off-site effects of erosion. The critical value of chi-square statistic from the chi-square table is 3.07382 with 12 degree of freedom at 99.5% level of significant. This implies that the joint null hypothesis of coefficients of all explanatory variables included in the models are zero is firmly rejected. Thus, the overall significance of the pooled probit model is good.

The McFadden Pseudo R^2 , which is equivalent to coefficient of determination (R^2) in conventional regression model, is about 0.21. That means the variables in the pooled probit model explains about 21% of the variation in WTP and this value of Pseudo- R^2 is greater than the threshold value of $R^2=0.15$ for CV studies suggested by Mitchell and Carson (1993) and hence our model fits adequately.

The most important variable that explain variation in the likelihood of WTP of a household for controlling the off-site effects of soil erosion are: bid price, significant & negatively; level of education, significant & positively; total annual income (log form), significant & positively; and damage experience due to off-site negative effects of soil erosion, significant & positively. Bid price and income are significant at 99% while damage and education level were significant at 95% & 90%, respectively. The sign of the coefficients of those significant variables is as expected.

The estimated mean WTP of the sampled household is found to be 88.41.ETB/year, with a tighter CI and better level of achieved significance, showing an improvement over SBDC & DBDC models estimated till now.

The other variants of model estimated from the transformed pseudo panel data was a random effect probit model (MODEL VII). The REP model imposes the restriction that the correlation between successive error terms of the same observation is constant. The REP Model is an application of the restricted SUBVP model, whereby the estimated parameters are not statistically significant but the correlation is statistically significant (Haab & McConnell, 2002). But from earlier estimation of the SUBVP model we found that the correlation was not statistically significant.

The RE probit model estimation reveal that, the parameter estimates are identical to the pooled probit model. The log-likelihood of the model is equal to that of the pooled probit. Moreover, the point and interval estimate of mean WTP is similar. This

implies that the variance of individual specific unobservable effect in REP model is zero ($\sigma^2 = 0$).¹³

The coefficients of rho, which captures the magnitude of correlation within units, is insignificant as shown by the *LR test of rho=0* [*chibar2(01) = 0.00; Prob > chibar2 = 1.000*].

4.2.3 Single Bounded and Double Bounded Models: A Welfare and Efficiency Comparison

To estimate the economic benefits of controlling off-site effects of erosion we have compared results of the SBDC & DBDC models. A probit model from the first response equation is selected as a SBDC model for reason discussed before. For a direct comparison with the SB result, the SUBVP, RBP, REP & Pooled Probit models are selected as DBDC models.

All models provide evidence that respondents are rational when faced with increasing cost as the coefficient of bid amount is negative and statistically significant, except for bid2 in SUBVP & RBP, which was negative but insignificant. The income coefficient is positive and statistically significant all models except in Model II.

The comparison can be made from the perspective of efficiency in estimating welfare. The precision estimates of welfare measures computed from Krinsky-Robb procedure can serve as main criteria for judging efficiency of models.

¹³ If the null hypothesis of $\rho = 0$ is not rejected, we get a magnitude of correlation $= \text{corr}(v_{i_1}, v_{i_2}) = \frac{\sigma_r^2}{\sigma_r^2 + \sigma_e^2} = 0$ & when $\rho = 0$ the REP model is equal to the pooled probit model (Model VI) estimated before.

The precision of estimates from DBDC can be compared directly by constructing confidence interval around the mean using Krinsky-Robb procedures. The SB probit, REP, Interval data probit and pooled probit models are all nested in the seemingly unrelated bivariate probit model, so that a direct comparison is possible by means of Krinsky-Robb procedure. The point and interval estimates of SBDC (model I), SUBVP, RBP, REP & Pooled probit are reported in table 4.16 below.

We see that the point and interval estimates of mean WTP from the SBDC model approaches well to that of SUBVP & RP models, but have wider confidence interval. Comparing the achieved level of significance and the interval estimates of DB models, we found that the random effect and pooled probit models are more efficient than the SUBVP & RP models.

The comparison criteria revealed that in all cases estimates from the DBDC models are more efficient than the SB one. Hence, the claim for improved efficiency of DB CV survey over single bounded is confirmed in this study.

Table 4.16 Comparison of Alternative Estimates of Mean WTP

<i>Models</i>	<i>Mean Wtp</i>	<i>Confidence Interval 95%</i>		<i>Asl*</i>	<i>Range (UB-LB)</i>	<i>CI/ Mean</i>
		<i>Krinsky Robb</i>				
		<i>LB</i>	<i>UB</i>			
<i>SBDC</i>	72.08	63.77	95.43	0.0002	31.66	0.44
<i>Bivariate Probit (SUBVP)</i>	71.79	63.59	94.90	0.0002	31.31	0.44
<i>Recursive Probit (RP)</i>	71.50	63.46	94.10	0.0002	30.64	0.43
<i>Random Effects Probit (RE)</i>	88.41	78.45	103.72	0.0000	25.27	0.29
<i>Pooled Probit</i>	88.41	78.45	103.72	0.0000	25.27	0.29

**: Achieved Significance Level for testing H0: WTP ≤ 0 vs. H1: WTP > 0
LB: Lower bound; UB: Upper bound*

From the table it is clear that the last two models, namely, the pooled probit and RE Probit are relatively efficient. The result from the two Pseudo-Panal data model is

identical with respect to the point and interval estimates of mean WTP. Thus we need to choose between the REP & pooled probit models for further welfare aggregation and analysis.

Result of model VII implies that the variance of individual specific unobservable random effect is zero ($\sigma^2 = 0$). Which is equivalent to saying the pooled probit and REP are the same.

Random effect is used when there is a problem of different willingness to pay distribution across the first and the follow-up questions. REP is especially appropriate if respondents do not use the same decision model when answering the first and subsequent valuation questions. And the indicator of this is; when the single bound probit model gives larger willingness to pay estimates than the double bound interval data model (Whitehead, 2000). But in our case the WTP from interval regression is greater than the SB probit model ($75.78 > 72.08$). This further implies that respondents use the same decision model when answering the first and follow-up valuation questions and hence no need to account for differences using REP model.

Finally because the null hypothesis of $\rho=0$, which is the proportion of variance due to the random effect, is not rejected in REP model, we preferred results from the pooled Probit model for welfare aggregation and identification of welfare determinants.

4.3 Welfare Determinants

In addition to estimating the mean willingness, as indicator of welfare, the determinants of willingness to pay were also identified from the selected value

function. The pooled probit model as specified in previous section has been employed to identify the determinants of household willingness to pay for controlling the off-site effects of soil erosion.

In order to control a potential bias in CV study due to non-normality and outliers, the robust estimator was advocated (Mitchel&Carson, 1989; Haneman et.al., 1991). The table below reports the robust pooled probit model along with the marginal effects of explanatory variable on the probability of households' willingness to accept a bid.

The result revealed that among the variables expected to influence the WTP of a household to control the off-site effects of soil erosion, only bid price, level of education, income & damage were significant at an acceptable level of significance.

Table 4.17 Results of Pooled Probit Model Estimation

MODEL VI POOLED PROBIT MODEL					
Variables	Willingness to pay		Marginal Effects¹⁴		
	Coefficients	Robust Std. Err.	dy/dx	Std Err.	X-bar
<i>Bid</i>	-.0191594	.0031514***	-.0069107	.00113***	64.9784
<i>hhsiz</i>	.0582827	.0707224	.0210222	.02551	5.81897
<i>headsex†</i>	-.2557502	.2989903	-.0880471	.0971	.853448
<i>headage</i>	-.0014772	.0100113	-.0005328	.00361	43.8793
<i>heduc</i>	.3137341	.1598557**	.1131617	.05748**	.465517
<i>logincome</i>	.6796155	.2053789***	.2451326	.07415***	9.32364
<i>farmsize</i>	.5059519	.470207	.1824934	.16862	.405591
<i>Credit†</i>	-.1650937	.2453966	-.0601612	.09024	.344828
<i>offfarminc†</i>	.4029549	.281113	.1373029	.08877	.241379
<i>livestock</i>	.1024714	.0649945	.0369607	.02332	1.76839
<i>location†</i>	.3151884	.2034252	.1156691	.07573	.655172
<i>damage†</i>	.4507802	.1935748**	.1649355	.07157**	.612069
<i>constant</i>	-5.753839	1.789939***			
Wald chi2(12)= 63.59 Prob > chi2 = 0.0000 Log pseudo-likelihood = -120.49689 Pseudo R²=0.2095			y = Pr(wtp) (predict) = .6732751		

***, ** & * indicate level of significance at 1%, 5% and 10%, respectively based on robust standard error.

† dy/dx is for discrete change of dummy variable from 0 to 1

¹⁴ The marginal effect indicates the change in probability of an event due to a unit change in continuous explanatory variable and the change of dummy variable from 0 to 1 for discrete variables.

As expected the coefficient of bid is negative and significant at 99%. This indicates that the higher the bid price for the proposed erosion control program, the less likely the household would be willing to pay, which makes a sense and support the claim that respondents are rational. The variable income (Log transformed) has the expected positive sign and is significant in all models. This implies the probability of accepting a higher bid increases with income or controlled off site erosion effect if like a normal good to the rural households for which their demand increases with an increase in annual income. Specifically, holding other things constant a 1% increase in total annual income increases the probability of accepting a bid by 0.25%.

Level of education is found to affect households decision to say 'Yes' for a given bid, positively and significantly at 95% level of significance. The implication is that the higher the level of education, the greater the awareness about the multi-benefits of controlling off-site effects. It could also be that more literate individuals are concerned about environmental goods including soil. This covariate has a marginal effect of 0.31%, indicating for each level of additional education, the probability accepting a given bid rises by 0.31%, *ceteris paribus*.

The variable damage which captures the occurrence of any kind of any kind of off-site effects of erosion previously, is positive as expected and significant at 95%.The implication is that relative to households that doesn't encounter off-site impacts of erosion , the affected one are more willing to pay to avoid the problem. The reason could be they are actually affected before and have the awareness of its impact and are concerned more, so that they want to avoid the damage. The marginal effect indicates that households affected by off-site negative impacts of erosion previously

are 0.16% more willing to pay than the non-affected one, holding other things constant.

With respect to gender there is no difference in WTP between male and female, as shown by the insignificant coefficients of a dummy variable headsex(male=1). It is also unexpected and unusual to have statistically insignificant impact of location(upstream=1) on the likelihood of WTP. The parameter estimates of location shows that there is no difference between upstream and downstream farmers in willing to pay for avoiding the off-site effects of erosion. This could be because of the nature of some major types of off-site impacts. For example damage on rural road due to sedimentation & flooding hurts both the upstream and downstream farmers as they all use this road to reach the nearest market, though there is a difference in contribution to the cause, and it could be rational if all want to pay to avoid this challenge.

The policy implication of those determinants of WTP is that, first policies or programs that improves the cover and quality of education also promotes communities awareness and real participation in activities that aim to control the off-site effects of erosion. Similarly any kind of attempt to improve the livelihood of rural households will increase the per capita financial contribution of a household for a community based soil conservation programs. In addition raising the level of awareness about the cause and consequences (damage) of off-site negative effects of erosion plays a great role in the success of conservation programs that involve real participation of the local community.

4.4 The Aggregate Benefit

The main objective of this research was to estimate the mean willingness to pay thereby the aggregate benefits of controlling off-site effects of soil erosion from the DB CV survey. The pooled probit model is found to be the appropriate model for welfare estimation. Accordingly estimation of mean WTP (Compensated variation) as a measure of economic benefit showed that the community based off-site erosion control program offers a welfare gain of 88.41 ETB/ annum/household. This WTP value estimated from the pooled probit model using krinsky robb procedure is significant at 1%, with a tighter confidence interval ranging from 78.45 to 103.72 ETB.

In aggregating the benefits the mean value is used as an average value of individual WTP. This is because the good being valued is not a pure public good; there are private gains from off-site erosion control practices. Issues that need to be considered in aggregation like population choice bias, sampling frame bias, none response bias and selection bias (Mitchel & Carson, 1989) were properly addressed in this study. Face to face surveys on randomly selected households were used. Protest responses are excluded from analysis and expected protest zeros were accounted in aggregation of benefits.

The total number of households in the study area is 1246 and after accounting for expected protest zeros a total of 1176 households were retained for benefit aggregation. Using the mean WTP of 88.41 ETB, we estimated that the total annual WTP of the populations i.e. residents in Kufanzik area is about ***103,952.72 ETB*** per year. Then based on the aggregation result one can state that, the total economic

benefits of controlling off-site effects of soil erosion, for rural households in Kufanzik area of eastern highlands of Ethiopia, is approximately **103,952** Birr per year.

4.5 Reliability and validity of CV estimates

Contingent valuation method is a stated non-market valuation techniques Contingent valuation (CV) method is one of the most popular survey-based non market valuation techniques and it estimates the economic value of a resource by constructing a hypothetical market and asking respondents to directly state their WTP to obtain a good. Due to the hypothetical nature of the study, the method is prone to numerous different biases. As a result, testing reliability and validity of survey responses is an important component of CV study

I. Reliability

Reliability refers to how stable and reproducible the measure is. Reliability of a CV survey can be explained in terms of consistency in responses (Kealy et al. 1990). The test of such reliability is based on the magnitude of explanatory power model used in the study and if a higher proportion of the variation in stated WTP from the open ended question is explained by the variation in theoretically expected variables, we can say our CV result is reliable. According to Mitchell & Carson (1989), the simplest way of testing reliability of WTP values is to obtain a respectable R^2 value ($R^2 > 0.15$) from regressing the hypothesized covariates against the stated willingness to pay. The results from linear regression of the maximum stated willingness to pay on variables expected to influence WTP is reported in the appendix. The R^2 value of 0.33 implies our CV result achieves the threshold value of $R^2 = 0.15$. Moreover the F-test rejects the hypothesis that all variables are jointly zero. So that our CV result is

reliable at least from the simplest criteria of coefficient of determination, R^2 . Reliability is also defined as, 'the extent to which the variance of a response or estimate is a result of random sources of noise' (Mitchell and Carson, 1989) and hence the standard error of the mean WTP estimate can measure reliability and the confidence intervals can describe the reliability of calculated estimates as a measure of the true value. In our case the mean WTP estimated from the relatively efficient model is 88.41 ETB with a lower bound and upper bound of 78.45 & 103.72 ETB, respectively with more than 99% achieved level of significance.

II. Validity

Validity refers to the degree to which the CVM evaluation correctly indicates the true value of the asset under investigation (Bateman & Turner, 1992). We have tested validity of the study using the approaches of validating CV estimates described by (Mitchell and Carson, 1989).

Content validity: - Refers to the extent to which the survey design and content is suited to the task. Content validity assesses whether or not the CVM questionnaire asks the 'right questions in an appropriate manner' and whether the WTP measure is 'what respondents would actually pay for a public good if a market *for* it existed' (Turner, 1993). Accordingly to address/reduce such problem we have conducted a pilot survey prior to the actual survey and the entire survey script was pre-tested. It is also the case that this survey encountered low protest zeros. Hence, the researcher believes that the design & content of this survey is valid.

Construct validity: - It is related with the extent to which economic theory explains empirical behavior /choice. More specifically, construct validity refers to how well the signs and value of the explanatory variables fits in to the theoretical expectation on which the model is based. All the SB & DB probit regression analyses revealed that the probability of a ‘Yes’ response to the willingness to pay vary with a number of covariates in a reasonable manner and this offers some support for the construct validity of our contingent valuation application. As Turner (1993) noted, two types of construct validity exist: theoretical and convergent validity.

Theoretical validity: - Refers to testing the extent to which WTP values are consistent with economic theory (such as transitivity, stability, etc.) of preferences. Following Mitchell and Carson (1989) we run a linear regression of stated willingness to pay amount on variables expected to be theoretical determinants of willingness to pay, in order to asses theoretical validity of our estimates. The multivariate linear regression result (see appendix) demonstrate evidence of theoretical validity as the coefficients of the explanatory variables have theoretically expected sign although not all of them are statistically significant. In case of discrete choice data the probability of a yes response will decrease with increases in bid if the respondent behaves rationally. Hence, a test of theoretical validity of is if $Pr (wtp)/ bid < 0$. And in our case for all models this result holds, confirming the theoretical validity of our CV exercises.

Moreover Forsythe (2001) and Whittington et al (1992) argue that if people overbid without giving enough thought to their economic status, the correlation between income and WTP would be very small or non-existent. In this study the

correlation coefficient between income and WTP shows that the variables are significantly correlated.

Convergent validity: -Refers to the degree of correspondence between different values for the same good estimated using different methods. Considering convergent validity, the study restricted to use estimates only from CVM.

Criterion validity: - Criterion validity is the definitive test of validity. A comparison of the CVM estimates with the true value of controlling the off-site effects of erosion would test for criterion validity. Mitchell and Carson (1993) noted that if a created market exists for the public good being valued, it is possible to compare the resulting prices with values obtained from the CVM analysis. But implementing this is difficult and requires huge finance, so that we didn't undertake here.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Land degradation in the form of soil erosion is a major problem threatening the livelihood of many farmers in the highlands of Ethiopia. Soil erosion has both on-site and off-site effects. But the focus of various soil conservation programs and studies were mainly on the on-site effects, with little focus on the off-site impacts. Though there is no quantified information on the costs of off-site effects, there are noticeable and significant problems in the eastern highlands, particularly in the study area, reflected in the form of downstream sedimentation of reservoirs and water channels, rural road destruction, runoff, sedimentation and many others.

In this study we applied a DB CVM to estimate the benefits of controlling the off-site effects of erosion, as it applies to Kufanzik area of eastern highlands. A top-down incentive based conservation programs were proved to be ineffective. As such we have designed a bottom-up off-site erosion control program involving real participation of the local communities in our Contingent Valuation Survey Scenario.

The DB CV analysis using a pooled probit model revealed that the community based off-site erosion control program offers an average benefit of 88.41 ETB/year for the sample households and a total welfare gain of 103,952 ETB per year for communities in Kufanzik area of eastern highlands. The welfare indicator estimated from the DB CV is proved to be efficient than the SB one.

Moreover, results from the CV model exercise shows that a household annual income, level of education and respondents experience of off-site effects are the three most

important variables that explain variation in WTP. The implication is that human capital development or expansion in the cover and quality of education plays important role in the success of community based soil conservation programs. Off-site erosion control program was found to be a normal good & hence any policy/projects aimed at alleviating poverty (improving livelihood) also promotes soil conservation activities. In addition it is also important to raise awareness of rural farm households towards the cause and consequences of off-site effects of erosion.

The study also tested the reliability and validity of CV results. The various regression model tests support the reliability of estimation results. Moreover, our CV exercise fulfilled most of the relevant condition for validity.

5.2 RECOMMENDATIONS

Finally, based on the analysis and findings the following suggestions/policy implications are forwarded:

- The off-site effects of erosion are so serious and vast in the study area & hence immediate intervention involving real participation of the local community is needed.
- The result provides support for the establishment of community based off-site erosion control program because it offers a significant welfare benefit.
- Estimates from CV are *indicative, but not definitive*, of the existence of a substantial WTP potential (Demand side) for creating a market based mechanisms like PES. In line with this, further study on WTA (Supply side) is recommended.
- Any projects/programs that aim to tackle the challenges of soil erosion need to consider (focus) the off-site effects explicitly, as there is huge market failure

and externalities relative to the on-site effects. Moreover, active real participation of the local community is important in the design and success of soil conservation programs.

- Raising awareness of the local community about the cause and consequences of off-site effects of erosion plays a great role for the success of community based conservation programs. Hence before trying to mobilize the community in any kind of soil conservation schemes, awareness creation activities has to be done.

References

- Abelson, P.W. 1996. *Project appraisal and valuation of the environment*. New York, NY: St. Martin's Press.
- Alberini, A., 1995. "Efficiency Vs Bias of Willingness to Pay Estimates: Bivariate and Interval data Models." *Journal of Environmental Economics and Management* 29, 169–180.
- Alberini, Anna, Barbara Kanninen, and Richard T. Carson. 1997. "Modeling Response Incidence Effects in Dichotomous Choice Contingent Valuation Data," *Land Economics*, 73, 309-324.
- Alemu, M. 2002. "Erosion control in agricultural areas: an Ethiopian perspective." GTZ-integrated food security program, Ethiopia.
- Arrow, K.J., R. Solow, P.R. Portney, E.E. Leamer, R. Radner and H. Schuman (1993), "Report on the National Oceanic and Atmospheric Administration (NOAA) Panel on Contingent Valuation", *Federal Register*, Vol. 58, No. 10, pp. 4601-14.
- Asrat, P., K. Belay, and D. Hamito. 2004. "Determinants of farmers' willingness to pay for Soil Conservation Practices in the Southeastern Highlands of Ethiopia." *Land Degradation and Development* 15: 423–438. Assessment Review, 24, 89–124.
- Barbier, E.B. 1996. "The economics of soil erosion: theory, methodology and examples." Discussion Papers in Environmental Economics and Environmental Management. Heslington, UK, University of York.
- Bateman, I.J. & Turner, R.K. 1992. "Evaluation of the environment: the contingent valuation method." CSERGE Working paper GEC 92-18, University of East Anglia and University College London.
- Bateman, I.J., Carson, R.T., Day B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Ozdemigorlu, E., Pearce, D.W., Sugden, R. & Swanson, J. 2002. "Economic Valuation with Stated Preference Techniques: A Manual." Edward Elgar Publishing, USA.
- Bekele, W. 2003. Economics of Soil and Water Conservation: theory and Empirical Application to Subsistence Farming in the Eastern Ethiopian Highlands. Doctoral thesis Swedish University of Agricultural Sciences. Uppsala University.
- Bennagen, M.E., Indab, A., Amponin, J.A., Cruz, R.V.O., Folledo, R., Beukering, P.J.H. van, Brander, L., Hess, S., Soesbergen, A. van, Leeuw, K. van der, Jong, J. de (forthcoming). *Designing Payments for Environmental Services of Upland Dwellers: Two Philippine Case Studies*. Poverty Reduction and Environmental Management Program (PREM), Amsterdam.

- Bishop, J., & Allen, J., 1989. The on-site costs of soil erosion in Mali. *The World Bank, Environment Working Paper No. 21*.
- Bishop, J., 1995. "The economics of soil degradation: An illustration of the change in productivity approach to valuation in Mali and Malawi." IIED, LEEC paper DP 95-02.
- Bojo, J. & D. Cassells. 1995. *Land Degradation & Rehabilitation in Ethiopia. A re assessment*. AFTES working paper 17. Washington,DC:World Bank.
- Boyle, K. J., Welsh, M. P., Bishop, R. C. 1988. "Validation of empirical measures of welfare change: Comment." *Land Economics* 64, 94-98.
- Calderon, M.M., Camacho, L.D., Carandang, M.G., Dizon, J.T., Rebugio, L.L. & Tolentino, N.L. 2005. "Willingness to pay for Improved Watershed Management." Economy and Environment Program for Southeast Asia.
- Cameron TA, Quiggin J. 1994. Estimation using contingent valuation data from a 'dichotomous choice with follow-up' questionnaire. *Journal of Environmental Economics and management*; 27:218– 34.
- Cameron, Trudy Ann, and Daniel D. Huppert. 1989. "OLS versus ML Estimation of Nonmarket Resource Values with Payment Card Interval Data," *Journal of Environmental Economics and Management*, 17, 230-246.
- Carlsson, F., Köhlin, G., Mekonnen, A. 2004. Contingent valuation of community plantations in Ethiopia: A look into value elicitation formats and intra-household preference variations, Working Papers in Economics, No. 151.
- Ciriacy-Wantrup SV.1947. Capital returns from soil conservation practices. *Journal of farm Economics*; 29:1181– 96.
- Clark, R. 1996. Methodologies for the economic analysis of soil erosion and conservation. CSERGE Working Paper GEC 96-13. UK, *Economic and Social Research Council*.
- Colacicco, D., Osborn, T., and Alt, K. 1989. Economic damage from soil erosion. *Journal of Soil & Water Conservation*, 44(1): 35-39.
- Colombo, S., Hanley, N & Calatrava-Requena, J. 2005. Designing Policy for reducing the off-farm effects of Soil Erosion Using Choice Experiments. *Journal of Agric.Econ.*56, 81-95.
- Colombo, S. J. Calatrava-Requena, and N. Hanley. 2003. The economic benefits of soil erosion control: An application of the contingent valuation method in the Alto Genil basin of southern Spain. *Journal of Soil and Water Conservation*, 58(6): 367-371.
- Crosson, P., (1997). The on-farm economic costs of erosion. In: R. Lal, W.H. Blum, C.

- Davis, R.K. 1963. "The Value of Outdoor Recreation: An Economic Study of the Maine Woods." Ph.D. dissertation. Harvard University.
- De Graaff, J. 1996. The price of soil erosion: an economic evaluation of soil conservation and watershed development. *Ph. D. thesis Wageningen Agricultural University*, the Netherlands.
- Desvousges WH, Johnson FR, Dunford RW, Boyle KJ, Hudson SP, Wilson N. 1993. Measuring natural resource damages with contingent valuation: tests of validity and reliability. In Hausman JA, editor. *Contingent valuation: a critical assessment*. Amsterdam North Holland; 1993. p. 91– 159.
- Dunfa, L.1998. "Estimating Willingness to Pay for Rural Water Supply: The Case of Ada`a-Liben District (Ethiopia)", M.Sc Thesis, Dept. of Economics, Addis Ababa University.
- Eaton, D. 1996. The economics of soil erosion: a model of farm decision-making. Environmental Economics Program. London: *International Economics Perspectives*, 8, 19-44,(1994).
- Ekbom, A. 1995. The economics of soil conservation: A case study of the economic and agro ecological implications of soil conservation on maize cultivation in Muranga District, Kenya. *Environmental Economics Unit at Department of Economics, Working*
- Emily, S. and Fanaye, T. 2012. Household and plot level impact of sustainable land and watershed management practices in Blue Nile. *Ethiopian strategy support program II (ESSP II) Working paper 42*.
- Environmental Economics policy forum for Ethiopia (EPPFE). 2012. "Green accounting puts price on Ethiopian soil erosion and deforestation". <http://www.efdinitiative.org>
- Ervin, C.A., & Ervin, E.D.1982. Factors affecting the use of soil conservation practices: Hypothesis, evidence, and policy implications. *Land Economics* 58(3), 277-292.
- Essey, T. 2000. The Valuation of Improved Air Quality: A Contingent Valuation Study on Wonji Town (Ethiopia).M.Sc Thesis, Dept. of Economics, Addis Ababa University.
- Fisseha, A. 2007. Estimating Willingness to pay for Water: A contingent valuation study on Meki town. MSc. Thesis. Addis Ababa University, Ethiopia.
- Francisco, H.A., Dizon, J.T. & Torres, C.S. eds. 2002. Market Based Instruments for Water Resources in Mt. Makiling. In *Economic Instruments for the Makiling Forest Reserve*. REECS and College of Forestry and Natural Resources UP Los Banos, Laguna.

- Freeman III MA. 1993. The measurement of environmental and resource values. Washington, DC: *Resource for the Future*.
- Greene, William H. 1997. *Econometric Analysis*, 3rd Edition, Prentice Hall.
- Gregorich, E.G., Greer, K.J., Anderson, D.W., and Liang, B.C. 1998. Carbon distribution and losses: Erosion and deposition effects. *Soil and Tillage Research*, 47(3-4): 291-302.
- Guide to economic valuation and impact analysis, 2002. Edited by David Ietson & j-walter milor. *Florida coastal environmental resources*.
- Haab, Timothy C. 1997. "Analyzing Multiple Question Contingent Valuation Surveys: A Reconsideration of the Bivariate Probit," Department of Economics Working Paper #9711. East Carolina University.
- Haab, Timothy C. and Kenneth E. McConnell 2002. "Valuing Environmental and Natural Resources, The Econometrics of Non Market Valuation", Edward Elgar , Cheltenham U.K.
- Hanemann W.M.1994. Valuing the environment through contingent valuation. *Journal of Economic Perspectives* 8:19– 43.
- Hanemann, W.M. 1984. Welfare evaluations in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics*, 66, 332-341.
- Hanemann, W.M., Loomis, J., Kanninen, B. 1991. Statistical efficiency of double bounded dichotomous choice contingent valuation. *American Journal of Agricultural Economics* 73, 1255-1263.
- Haydon, J., Peter, C., Barbara, H., and Chris, P. 2008. Economic costs of hill country erosion and benefits of mitigation in New Zealand: Review and recommendation of approach. *Scion Forest Research Institute Ltd*.
- Hein, L. 2007. Assessing the costs of land degradation: A case study for the Puentes catchment, southeast Spain. *Land Degradation and Development*, 18(6): 631-642
- Hoehn, J. and A. Randall. 1987. "A Satisfactory Benefit-Cost Indicator from Contingent Valuation." *Journal of Environmental Economics and Management* 14:226-247.
- Hoevenagel, R., 1994. An assessment of the contingent valuation. In: Pething, E. (ed.). *Valuing the environment: methodological and measurement issues*. Kluwer academic publishers. The Netherlands.
- Holloway, G. J., and S. K. Ehui. 2001. "Demand, Supply, and Willingness-to-Pay for Extension Services in an Emerging-Market Setting." *American Journal of Agricultural Economics* 83: 764–768.

- Hurni, H., 1988. Degradation and conservation of the resources in the Ethiopian highlands. *Mountain Research and Development* 8(2/3), 123-130.
- Jakobsson, K. M. and Dragun, A: K. 1996. *Contingent Valuation and Endangered Species. Methodological Issues and Applications*. Edward Elgar Publishing Limited. pp. 77-115
- Jorgensen, B. S., G. Syme, B. Bishop and B. Nancarrow. 1999. Protest responses in contingent valuation. *Environmental & Resource Economics* 14(1) 131-150.
- Kahneman D, Knetsch JL. 1992. Valuing public goods: the purchase of moral satisfaction. *Journal of Environmental Economics and Management*; 22:57 – 70.
- Kealy, M.J., Montgomery, M. and Dovidio, J.F. 1990. Reliability and Predictive Validity of Contingent Values: Does the Nature of the Good Matter? *Journal of Environmental Economics and Management* 19: 244-263.
- Kerr, J., 1998. The economics of soil degradation: From National policy farmers' fields. In: Penning de Vries, F. W. T., Agus F., and Kerr, J., (Eds). *Soil erosion at multiple scales, Principles and methods for assessing causes and impacts*. CABI Publishing in association with IBSRAM, Bangkok, Thailand.
- Khandke K., K. Peterson, B. Booth, and S. Holladay. 2001. *Contingent valuation and land use patterns: An application to the Enore River Watershed in Upstate South Carolina*. A paper presented at the Southern Regional Science Association in Austin, Texas.
- L.Venkatachalam, 2003. The contingent valuation method: a review. *Journal of Environmental Impact Assessment Review* 24 (2004) 89–12.
- Labao, R., Francisco, H., Harder, D., Santos, F. I. 2008. Do colored photographs affect willingness to pay responses for endangered species conservation? *Environmental and Resource Economics* 40, 251-264
- Lal, R. 1988. Monitoring soil erosion's impact on crop productivity. In: Lal. R. (Ed). *Soil Erosion research methods*. Soil and Water Conservation Society, Wageningen, The Netherlands.
- Loomis, J. B., and A. Gonzalez-Caban. 1998. A willingness-to-pay function for protecting acres of spotted owl habitat from fire. *Ecological Economics*. 25(3) 315-322.
- Lori Lynch, Ian Hardie, and Doug Parker, 2002. Analyzing Agricultural Landowners' Willingness to Install Streamside Buffers. Department of Agricultural and Resource Economics University of Maryland.
- Mas-Colell, A., M.D. Whinston, and J.R. Green. 1995. *Microeconomic Theory*. New York:Oxford University Press.

- McFadden, D.1974. Conditional logit analysis of qualitative choice behavior, *Frontiers in econometrics*, P. Zarembka (ed.) New York: Academic Press, 105-142.
- Mesfin, T., Liesbet, V., Bart, M., Jozef, D., Kidanemariam, G., Kindeya, G., Hans, B., Erik, M. 2012. Rural Households' Demand for Frankincense Forest Conservation in Tigray: A Contingent Valuation Analysis. Bio-economics Working Paper Series: Working Paper 2012/2. Department of Earth and Environmental Sciences University of Leuven, Belgium.
- Ministry of Finance and Economic Development (MoFED).2011. Growth and Transformation Plan (GTP). Volume I and Volume II, Addis Ababa. Federal democratic republic of Ethiopia.
- Mitchell RC, Carson RT. 1989. Using surveys to value public goods: the contingent valuation method. Washington, DC: Resource for the Future. *Mountain Research and Development* 8(2/3), 123-130. Netherlands.
- Moges, S. 1999. "Economic Valuation of Environmental Goods as Outdoor Recreation. A contingent Valuation Approach: A Case Study of Lake Tana (Ethiopia)", M.Sc Thesis, Dept. of Economics, Addis Ababa University, Ethiopia.
- Nijkamp, P., Vindigni, G., & Nunes, P. A. L. D. 2006. Economic Valuation of Biodiversity: A Comparative Study. Paper presented at the 3rd World Conference of Environmental and Resource Economists, 3-7 July 2006. Kyoto International Conference Hall, Kyoto, Japan.
- Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, D., McNair, M., Crist, S., Shpritz, L., Fitton, L., Saffouri, R., and Blair, R. 1995. Environmental and economic costs of soil erosion and conservation benefits. *Science*, 267(5201): 1117-1123.
- Portney PR. 1994. The contingent valuation debate: why economists should care. *Journal of Economic Perspectives* 1994; 8:3– 17.
- Pretty, J.N., Brett, C., Gee, D., Hine, R.E., Mason, C.F., Morison, J.I.L., Raven, H., Rayment, M.D., and van der Bijl, G. 2000. An assessment of the total external costs of UK agriculture. *Agricultural Systems*, 65(2): 113-136.
- Purvis, Amy, John P. Hoehn, Vernon L. Sorenson, and Francis J. Pierce.1989. "Farmers' response to a filter strip program: Results from a contingent valuation survey," *Journal of Soil and Water Conservation*, (1989):501-504.
- Reaves, D.W., R.A. Kramer, and T. P. Holmes. 1999. Does question format matter? Valuing an endangered species. *Environmental and Resource Economics*. 14(3) 365-383.

- Shiferaw, B. & S. T. Holden. 1998. Resource Degradation & Adoption of Land Conservation Technologies in the Ethiopian Highlands. *Journal of the international association of Agricultural Economics*. 18. pp 233-247.
- Shultz, Steven; J. Pinazzo, M. Cifuentes. 1998. Opportunities and Limitations of Contingent Valuation Surveys to Determine National Park Entrance Fees: Evidence from Costa Rica. *Environment and Development Economics*; 3(1), pages 131-49
- Solomon, J. 2004. Contingent Valuation Of Multi-Purpose Tree Resources: The Case Of Arsi Zone, Ethiopia A thesis submitted to the School of Graduate Studies of Addis Ababa University, Ethiopia.
- Solomon, T. 2007. Household Willingness to Pay for Solid West Management Options: the case of Yeka sub city, Addis Ababa. MSc. Thesis, A.A.U, Ethiopia.
- Sonneveld, B. G. J. S. 2002. Land Under pressure: *The Impact of Water Erosion on Food Production in Ethiopia*. Shaker Publishing. Netherlands.
- Stocking, M., 1987. Measuring land degradation. In Blaikie, P., and Brookfield, H., *Land degradation and society*, pp. 49-63. Methuen, London and New York.
- Sutcliffe, J.P. 1993. Economic Assessment of Land Degradation in the Ethiopia Highlands. National Conservation Strategy Secretariat Ministry of Planning and Economic Development., transitional government of Ethiopia, Addis Ababa.
- Tadesse, M., and K. Belay. 2004. Factors Influencing Adoption of Soil Conservation Measures in Southern Ethiopia: The Case of the Gununo Area. *Journal of Agriculture and Rural Development in the Tropics and Subtropics* 105(1): 49–62.
- Taylor & Francis, 2010. Soil erosion impact on agronomic productivity & environmental quality. Ohio state university school of natural resource.
- Tegege, G. 1999. “Willingness to Pay for Environmental Protection: An Application of Contingent Valuation Method (CVM) in Sekota District, Northern Ethiopia”, *Ethiopian Journal of Agricultural Economics*, V.3 No.1
- Troeh, F. R., Hobbs, J. A., & Donahue, R. L., 1999. *Soil and water conservation: Productivity and environmental protection*, Third edition. Prentice Hall, New Jersey.
- Valentin, and B.A. Stewart (Editors), *Methods for assessment of soil degradation*. CRC Press, Boca Raton, pp. 495-511.
- Whitehead, John C. 2000. “Anchoring and Shift in Multiple Bound Contingent Valuation”: Department of Economics, East Carolina University.

- Whittington, D. 2002. Improving the Performance of Contingent Valuation Surveys in Developing Countries', *Environmental and Resource Economics*:22(1-2), 323-367.
- Yalemzewd Molla. 2007. Economic Valuation of Urban Green, Open Spaces: Evidence from Addis Ababa. MSc. Thesis, A.A.U., Ethiopia.
- Yesuf, M., A. Mekonnen, M. Kassie and J. Pender. 2005. Cost of Land Degradation in Ethiopia: A Critical review of Past Studies. Addis Ababa, Ethiopia: EDRI/EEPFE.
- Zewdu, B. & yemesrach, A. 2003. Willingness-to-pay for protecting endangered environments: the case of nechsar national park, Ethiopia. *Organization for social science research in eastern and southern Africa*. Issue 31, report series.

Appendices

Appendix I

Table 4.11 Descriptive statistics of key variables

Variables	Description	Mean	Std. Dev.	Min.	Max.
wtp1	Response to initial bid price (1=if 'yes' 0 otherwise)	.7089552	.4559486	0	1
wtp2	Response to follow up bid price (1=if 'yes' 0 otherwise)	.5447761	.4998597	0	1
bid1	Initial bid	52.68657	14.62124	30	70
bid2	Follow up bid	80.18657	41.41486	15	140
mwtp	Maximum stated WTP	75	48.89378	0	200
hhsiz	house hold size	5.69403	1.646265	2	10
headsex	Gender of the household head(1=if male & 0 if female)	.8432836	.3648973	0	1
headage	Respondents age in years	43.33582	12.20375	21	82
heduc	Respondents level of education (0=illiterate, 1=primary & 2=high school and above)	.4850746	.6908105	0	2
totalinc	Total annual income of the household	13294.78	6789.967	2000	35000
farmsize	Size of farm land in hectare	.4074291	.226905	.12	1
Credit	Access to credit services(1= 'yes', 0 otherwise)	.3358209	.4740488	0	1
offfarminc	Off-farm income generating activities(1 if 'yes' & 0 if 'No')	.2462687	.4324535	0	1
livestock	Ownership of livestock measured in tropical livestock unit(TLU)	1.785694	1.753813	0	10
location	Location of farm land(1=if downstream & 0 for upstream)	.6567164	.4765868	0	1
damage	previous damage due to off- site effects of soil erosion(1=if yes, 0 otherwise)	.6119403	.4891368	0	1

Table 4.12 probit model estimation for the initial and follow-up bid

MODEL I PROBIT MODEL FOR INITIAL BID RESPONSE				MODEL II PROBIT MODEL FOR FOLLOW-UP BID RESPONSE		
<i>Dependant variable(wtp1) is discrete response (yes=1/no=0) to initial bid</i>				<i>Dependant variable(wtp2) is discrete response (yes=1/no=0) to follow-up bid</i>		
<i>Variables</i>	<i>Coefficient</i>	<i>Std. Err.</i>	<i>Z-value</i>	<i>Coefficient</i>	<i>Std. Err.</i>	<i>Z-value</i>
<i>constant</i>	-10.08265	2.992614	-3.37***	-4.117592	2.402765	-1.71*
<i>bid1</i>	-.0465914	.0133029	-3.50***			
<i>bid2</i>				-.0125479	.0037071	-3.38***
<i>hhsz</i>	.0137092	.1134716	0.12	.1205874	.091722	1.31
<i>headsex</i>	-.3691873	.3837679	-0.96	-.171224	.3364151	-0.51
<i>headage</i>	-.0045318	.015288	-0.30	-.001762	.012643	-0.14
<i>heduc</i>	.5558569	.3015553	1.84	.2969865	.2137116	1.39
<i>logincome</i>	1.326902	.3645251	3.64***	.4219049	.2747875	1.54
<i>farmsize</i>	1.138379	.7642981	1.49	.2185982	.5876091	0.37
<i>Credit</i>	-.4637599	.3620169	-1.28	.13904	.2839315	0.49
<i>offfarminc</i>	.4482986	.4514281	0.99	.2987704	.3157164	0.95
<i>livestock</i>	.2296641	.1264973	1.82*	.003749	.082156	0.05
<i>location</i>	-.0165884	.3162093	-0.05	.418177	.2569423	1.63
<i>damage</i>	.6193138	.2928279	2.11**	.3189723	.2533316	1.26
<i>Number of obs = 134</i> <i>LR chi2(12) = 60.44</i> <i>Prob > chi2 (2) = 0.0000</i> <i>Log likelihood = -50.595291</i> <i>Pseudo R2 = 0.3739</i>				<i>Number of obs = 134</i> <i>LR chi2(12) = 23.44</i> <i>Prob > chi2 (2) = 0.0242</i> <i>Log likelihood = -80.626026</i> <i>Pseudo R2 = 0.1269</i>		

*Level of significance: * p<0 .1; ** p<0 .05; *** p<0 .01*

Table 4.13 Result of the Seemingly Unrelated & Recursive Bivariate Probit Models

MODEL III ESTIMATION RESULTS THE SEEMINGLY UNRELATED BIVARIATE PROBIT MOEL				MODEL IV ESTIMATION RESULTS OF RECURSIVE BIVARIATE PROBIT MODEL		
Dependant variable(wtp1)				Dependant variable(wtp1)		
Variables	Coefficient	Std. Err.	Z-value	Coefficient	Std. Err.	Z-value
Constant	-9.90261	2.95144	-3.36***	-9.940112	2.953175	-3.37***
bid1	-.0469164	.0133913	-3.50***	-.0478456	.0135904	-3.52***
Hhsize	.0144152	.1134317	0.13	.0132718	.1134978	0.12
Headsex	-.4055994	.3887043	-1.04	-.410201	.3893575	-1.05
Headage	-.0049371	.015245	-0.32	-.0050563	.0152504	-0.33
Heduc	.5592492	.3031651	1.84*	.5603785	.30333	1.85*
Logincome	1.304427	.3584507	3.64***	1.315259	.3592013	3.66***
Farmsize	1.236165	.7832155	1.58	1.23928	.7837828	1.58
Credit	-.5050359	.3652878	-1.38	-.508249	.3659137	-1.39
Offarminc	.4094592	.4428377	0.92	.4116133	.4429673	0.93
Livestock	.2508665	.1322416	1.90*	.25343	.1328737	1.91*
Location	-.0230185	.3158838	-0.07	-.0275279	.3162156	-0.09
Damage	.6727302	.2947196	2.28**	.6754647	.295296	2.29**
Dependant variable(wtp2)				Dependant variable(wtp2)		
Variables	Coefficient	Std. Err.	Z-value	Coefficient	Std. Err.	Z-value
Constant	-3.030657	2.581905	-1.17	-3.721063	2.983759	-1.25
bid2	-.0071524	.0059913	-1.19	-.0071516	.0060547	-1.18
Hhsize	.1279512	.0912505	1.40	.1324934	.0918388	1.44
Headsex	-.1827779	.3375138	-0.54	-.1866894	.3385114	-0.55
Headage	-.0011732	.012601	-0.09	-.001112	.0125976	-0.09
Heduc	.264992	.2127605	1.25	.3116708	.2363548	1.32
Logincome	.2666825	.3056444	0.87	.3519248	.3567657	0.99
Farmsize	.1377474	.5867047	0.23	.2144802	.6091077	0.35
Credit	.206845	.2874524	0.72	.1777032	.2949796	0.60
Offarminc	.2505241	.3154705	0.79	.2647759	.3163413	0.84
Livestock	-.0179371	.0830545	-0.22	-.0087668	.0858321	-0.10
Location	.4216781	.2551565	1.65*	.4427029	.2590397	1.71*
Damage	.2343057	.2633262	0.89	.2848887	.2852063	1.00
Wtp1				-.3368418	.713987	-0.47
/athrho	-.3710858	.3380775	-1.10	-.3678564	.3420469	-1.08
Rho	-.3549411	.2954854		-.3521153	.2996382	
Number of obs = 134 Wald chi2(24) = 46.79 Prob > chi2 = 0.0036 Log likelihood = -130.61452 LR test of rho=0 chi2(1) = 1.2136 Prob > chi2 = 0.2706				Number of obs = 134 Wald chi2(25) = 47.20 Prob > chi2 = 0.0046 Log likelihood = -130.50273 LR test of rho=0 chi2(1) = 1.17486 Prob > chi2 = 0.2784		

Legend: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 4.14 Results of Interval Regression

MODEL V INTERVAL REGRESSION						
<i>Explanatory variables</i>	<i>Coefficient</i>	<i>Std. Err.</i>	<i>Z-value</i>	<i>P> z </i>	<i>[95% Conf. Interval]</i>	
<i>hhsz</i>	.6353738	2.077614	0.31	0.760	-3.436674	4.707422
<i>headsex</i>	-8.087257	7.566411	-1.07	0.285	-22.91715	6.742637
<i>headage</i>	-.126622	.2935295	-0.43	0.666	-.7019293	.4486853
<i>heduc</i>	5.409935	4.608462	1.17	0.240	-3.622486	14.44236
<i>logincome</i>	29.65499	5.685953	5.22***	0.000	18.51072	40.79925
<i>farmsize</i>	20.63167	13.59169	1.52	0.129	-6.007556	47.2709
<i>Credit</i>	-8.962234	6.419293	-1.40	0.163	-21.54382	3.619349
<i>offarminc</i>	8.03142	7.214648	1.11	0.266	-6.10903	22.17187
<i>livestock</i>	2.648409	1.879298	1.41	0.159	-1.034948	6.331765
<i>location</i>	3.712615	5.921453	0.63	0.531	-7.893219	15.31845
<i>damage</i>	13.57732	5.665096	2.40	0.017	2.473934	24.6807
<i>constant</i>	-218.6024	51.11859	-4.28***	0.000	-318.793	-118.4119
<i>/lnsigma</i>	3.344568	.0692178 48	.32***	0.000	3.208904	3.480232
<i>sigma</i>	28.34833	1.962208			24.75194	32.46727
<i>Number of obs = 134</i> <i>LR chi2(11) =68.59</i> <i>Prob > chi2 (2) = 0.0000</i> <i>Log likelihood = -223.72275</i>			<i>Observation summary:</i> <i>0 left censored observation</i> <i>0 uncensored observation</i> <i>0 right- censored observation</i> <i>134 interval observation</i>			

Legend: * $p < .0.1$; ** $p < .0.05$; *** $p < .0.01$

Table 4.15 Results of Pooled Probit and Random Effect Probit Models

MODEL VI POOLED PROBIT MODEL				MODEL VII RANDOM EFFECT PROBIT MODEL		
<i>WTP</i>	<i>Coefficient</i>	<i>Std. Err.</i>	<i>Z-value</i>	<i>Coefficient</i>	<i>Std. Err.</i>	<i>Z-value</i>
<i>Bid</i>	-.0191594	.0033569	-5.71***	-.0191598	.0033569	-5.71***
<i>Hhsz</i>	.0582827	.0723295	0.81	.0582817	.0723293	0.81
<i>Headsex</i>	-.2557502	.2806033	-0.91	-.2557512	.2806029	-0.91
<i>Headage</i>	-.0014772	.0098745	-0.15	-.0014772	.0098745	-0.15
<i>Heduc</i>	.3137341	.1802521	1.74*	.3137309	.1802514	1.74*
<i>logincome</i>	.6796155	.2104201	3.23***	.6796205	.2104198	3.23***
<i>Farmsize</i>	.5059519	.4744207	1.07	.5059479	.4744199	1.07
<i>Credit</i>	-.1650937	.2338119	-0.71	-.1651023	.2338114	-0.71
<i>Offarminc</i>	.4029549	.2694062	1.50	.4029521	.269405	1.50
<i>Livestock</i>	.1024714	.0695195	1.47	.1024719	.0695194	1.47
<i>Location</i>	.3151884	.2049473	1.54	.3151861	.2049472	1.54
<i>Damage</i>	.4507802	.1992127	2.26**	.4507826	.1992123	2.26**
<i>Constant</i>	-5.753839	1.852293	-3.11***	-5.753879	1.85229	-3.11***
<i>/lnsig2u</i>				-15.86586	127.4298	

sigma_u				.0003587	.0228567	
Rho				1.29e-07	.0000164	
<i>Number of obs.</i> = 232 <i>LR chi2(12)</i> = 63.85 <i>Prob > chi2</i> = 0.0000 <i>Log likelihood</i> = -120.49689 <i>Pseudo R2</i> = 0.2095			<i>Number of obs.</i> = 232 <i>No. of groups</i> =2 <i>Wald chi2(12)</i> = 48.53 <i>Prob > chi2</i> = 0.0000 <i>Log likelihood</i> = -120.49689 <i>LR test of rho=0</i> <i>chibar2(01)</i> = 0.00 <i>Prob > chibar2</i> = 1.000			

Legend: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 4.18 Estimation of Total Aggregate Benefits of controlling the off-site effects of Soil Conservation

Total Population	Expected HHs to have protest zeros	Expected HHs to have valid responses	Mean WTP in ETB	Total benefit
1246	70	1176	88.41	103,952.72

Table 4.19 OLS regression of maximum stated willingness to pay

Linear regression

Number of obs = 134
F(13, 120) = 19.21
Prob > F = 0.0000
R-squared = 0.6044
ROOT MSE = 33.062

mwtp	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
bid1	-.0720754	.1760795	-0.41	0.683	-.4207007	.2765498
bid2	.7840819	.0790956	9.91	0.000	.627478	.9406857
hhsz	2.390078	2.231351	1.07	0.286	-2.027842	6.807999
headsex	-14.24608	8.366007	-1.70	0.091	-30.8102	2.318028
headage	-.0790653	.3414151	-0.23	0.817	-.7550434	.5969128
heduc	1.394366	4.285104	0.33	0.745	-7.089843	9.878574
logincome	9.508859	6.185552	1.54	0.127	-2.738104	21.75582
farmsize	23.38653	17.44362	1.34	0.183	-11.15459	57.92765
credit	14.06834	7.56927	1.86	0.066	-.9182923	29.05496
offfarminc	-.6301554	7.443622	-0.08	0.933	-15.36801	14.1077
livestock	-1.326233	1.669296	-0.79	0.428	-4.631323	1.978858
location	7.957964	6.021296	1.32	0.189	-3.963782	19.87971
damage	4.335456	6.366084	0.68	0.497	-8.267948	16.94086
_cons	-90.93483	52.17463	-1.74	0.084	-194.237	12.36731

Appendix II

SURVEY QUESTIONNAIRE

A Contingent Valuation Survey questionnaire for eliciting the economic benefits of controlling off-site effects of soil erosion in Kufanzik area of Eastern Highlands of Ethiopia.

Survey ID _____

Location: woreda _____

Kebele _____ Village/Got _____

Altitude _____ (meters above sea level)

Date of enumeration ____/____/____ (date/month/yr)

Enumerator _____

Supervisor _____

PART I. INTRODUCTION

The aim of this survey is to assess the households' per capita contribution to a project and hence the economic benefits of controlling the off-site effects of erosion through various measures that involve real participation of local community in the Kufanzik area of Tullo Wereda Oromia region, Ethiopia. As we see this area is being seriously affected from soil erosion that have immense off-site effects. We observed that Landscape degradation, damage or impact on rural road safety, crop burial by sediment and deterioration of recreation & amenity values are the main manifestation of the off-site effects in this area.

Designing and implementing appropriate action to avoid the problem requires realistic information from the local community. This is a purely academic research conducted by a student from Addis Ababa University and has nothing to do with governmental or non- governmental organization. You are selected randomly from people living in your area so that we could get some information which will help us for our research. Therefore I kindly request you to give me a genuine answer for the questions that I will forward. ***The information collected in this survey will be treated confidentially and used only for academic purpose. Therefore you are sincerely requested to provide me as much as possible accurate and true responses. In answering my questions, please remember that there are no correct or wrong answers. I am just after your honest opinion.***

THANKS IN ADVANCE!!!

Deterioration of Recreation & Amenity Values					
Damage to irrigation channels					
Visual Detraction					

10. Have you ever experienced (affected) by the off-site erosion problem? A) Yes
 B) No

If yes, what damage did you face? _____

11. What do you think is the main causes of off-site soil erosion problem in your area?

- A) Lack of conservation structures
- B) Steep land without conservation structures
- C) Damaged conservation structures
- D) Lack of diversion ditch
- E) The land is under steep ridges
- F) Deforestation and other in appropriate farming practices especially, by the upstream farmers
- G) Others _____

12. What do you think is the benefits of controlling off-site effects of erosion for you and for the society as a whole?

13. Do you believe that off-site erosion problems can be controlled? A) Yes

B) No

14. In your opinion, what should be done to control the off-site effects of soil erosion in your area? _____

15. Have you ever adopt/undertake conservation measures to avoid the off-site effects of erosion in your farm or in your area? If yes, what? _____

16. Do you participate in conservation programs like FFW/ CFW or others that undertake soil conservation activities? A) Yes B) No

17. If yes what is the reason for deciding to participate?

- A/ because I know that soil erosion is a serious environmental threat
- B/ I need the reward (money or food) that I get from participation in such program
- C/ it is because others in my area participated so that I have to participate
- D/ it is the governments plan so that I have to undertake it
- E/ others _____

18. Will you participate in soil conservation programs/activities in your area without reward or if the current reward schemes in the form of money/ cash were absent?

A) Yes B) No

19. Do you agree that the government or any other organization has to pay you to adopt soil conservation technologies or undertake soil erosion control practices in your farm plot which will benefit you and others in your area?

(1) Strongly agree; (2) Agree; (3) Disagree; (4) strongly disagree; (5) I do not know

20. Why you say this? (Put answer from#18)

21. It is observed that despite the efforts of governmental and Non-governmental organization the problem of erosion remain serious especially in your area. Why do

you think is the reason for the failures of such programs? _____

22. Who do you think is the responsible body to undertake activities that will help to control the off-site effects of soil erosion?

- A) Individual farmer
B) Local community
C) Government
D) NGO's
E) others, specify _____

23. Do you believe that the local community has to contribute money to undertake measures that will control the off-site effects of erosion? A) Yes B) No

24. If yes/No (to Q#23), would you please tell me your reason? _____

25. How would you characterize your own concern in soil degradation and environmental issues in general?

1. Very much concerned
2. Relatively
3. Average
4. Indifferent
5. Not concerned
-

26. Are you (or anyone in the family) a member of any environmental protection or related organization? A) Yes B) No

PART IV VALUATION SECTION

BACKGROUND INFORMATION AND VALUATION SCENARIO

A. PRESENTATION OF THE CURRENT OFF-SITE EFFECTS OF SOIL EROSION

ENUMERATOR: *Now, we will be talking about the present condition of the off-site soil erosion problem in your area.*

Kufanzik area is currently facing off-site soil erosion problems. The significantly observed off-site negative effects in this area are: *Landscape degradation, Damage on rural roads due to sedimentation and gully erosion, downstream sedimentation of reservoirs and water channels, Crop burial by sediment, Proximate Property Damage, damage to irrigation channels, and Deterioration of Recreation & Amenity Values. This are the major one, there can be many others as it is sometimes difficult to identify some of the off-site effects.*

The causes of the problem are many which include extensive deforestation (loss of vegetative cover), dissected nature of the terrain, poor land management activities, etc. The government and various NGO's had been undertaking various conservation activities which is mainly characterized by a top down approach that involve limited (absence of real) participation of the local community, using cash/food as an incentive to mobilize the local community. The soil conservation programs focused mainly in solving erosion problems at individual farm level by promoting to increase adoption of soil conservation technologies i.e. their focus was on the on-site erosion problems. Despite the effort made to control erosion, the problem remains a serious threat to the country and your area is not exceptional to this.

Your area, Kufanzik is under threat due to erosion problem that are mainly off-site in nature. If the current status of erosion is not controlled it is not difficult to imagine what will happen in the coming few years. As you see it is almost impossible to use the rural road during rainy season due sedimentation and

destruction of road structures; you can see that the landscape of your area is now being degraded; the proximate damage on property of farmers due to frequent flood is immense; crop burial due to sedimentation is a significantly observable problem especially for the downstream farmers; and due to the mass removal of soil resource & sedimentation the area is losing a great deal of recreational and amenity values. The problem is significant that it requires immediate intervention by the local community. The effort made so far imply that soil conservation programs that does not involve real participation of the local community will not be successful in addressing the challenge of soil erosion. In line with this creating a community owned off-site erosion control program could provide greater net benefits.

B. THE PROPOSED OFF-SITE EROSION CONTROL PROGRAM

ENUMERATOR: At this point, let us now talk about the control of the off-site negative impacts and the creation of a possible erosion control Program managed and funded by the local community.

If there will be a ***Kufanzik area off-site erosion control program (KOECP)*** that would be established by the active participation of the local communities in terms of financing, it would provide solutions by implementing various measures that can control the off-site effects of erosion in the area. The community funded program will undertake measures such as:

- A. Reforestation and afforestation of steep slopes.
- B. Regular patrolling and monitoring activities in the forest;
- C. Employment of sustainable upland farming technology and installation of soil erosion Control structures (vegetative and engineering activities) like contour strips, Hedgerow, soil bunds, and *fanya juu*, terraces, etc
- D It will design and implement a payment for environmental services (PES) scheme, in which a selected farmers in the upstream would be paid for undertaking conservation measures that can avoid the off-site effects of erosion in their farm land;
- E. Creation of closed areas for natural regeneration, and many other activities of land Rehabilitation;
- F. Awareness creation in order to trigger widespread voluntary adoption of the practices by farmers in a sustainable manner or in solving problems related to soil erosion
- G. Construction of various kinds of check-dams to rehabilitate Gullies;
- H. Extension services on the adoption and practice of appropriate land management technologies, technical assistant at farm level, etc.

The measures are not only these; the situation here is that if the community provides enough finance, the proposed program will effectively address the off-site erosion problem using various measures. The work of totally controlling erosion is not a onetime activity and the proposed program will generate benefit on both sort run and long run. In short run the proposed program will undertake various control measure that will reduce the current off-site negative damages like reduced sedimentation impact on rural road, proximate property damage will also be avoided, damage to irrigation channels will be reduced and others. While in long run you are more assured to have a state of controlled off-site erosion problems

because of the establishment and operation of the proposed program. The proposed community owned erosion control program (KOECP) will provide a whole package of benefits to you and to society as a whole compared to the status quo.

! Enumerator: clearly describe the statements in the box below so that the respondent will have a clear picture of the scenario.

<i>SCENARIO 'A' With the present state of affairs (status quo):</i>
<ul style="list-style-type: none"> • Damage to the rural road structure due to sedimentation and hence difficulty, if not impossibility of movement. • Continuous damage to proximate properties • Crop burial due to sediments mainly on downstream farmers • Damage on the landscape because of massive soil erosion and formation of gullies • No protection to forest areas i.e. vulnerable to illegal encroachment & deforestation • Damage to water channels and downstream sedimentation of reservoirs • Deterioration of Recreational & Amenity Values
<i>SCENARIO 'B' With the Proposed off-site erosion control program (change):</i>
<ul style="list-style-type: none"> • Avoided sediment on rural road and unhindered movement of people and animal • Avoided damage on proximate properties of the local community • Avoided damage on - Water (irrigation) channels <ul style="list-style-type: none"> - Crops of downstream farmers • Reduced downstream sedimentation of reservoirs, rivers and water channels • Occurrence of floods will also be minimized • Improved scenery of the entire landscape than now.

C. THE COMMUNITY OWNED OFF-SITE EROSION CONTROL TRUST FUND

Background on the Kufanzik area off-site erosion control fund

Given the current status of the off-site effects of erosion, successful implementation of the proposed program will generate greater benefits for both of you and the local community at large. However, it is not easy to implement the off-site effects control program; it needs funds (money). At present the conservation related investment by government and others does not able to bring the required changes in the states of the problem. Moreover, various observations show that such conservation activities are dismantled due to the nature of incentive they use and their intervention approach are mainly of top-down, with little or absence of real participation of the local community.

Thus, it is proposed that soil conservation (control) program that involve real participation of the local community (Kufanzik area) will work better in addressing the off-site effects of soil erosion. Participation of the local community spans contribution of money, as this is not spared from other sources such as governmental organizations and NGOs as well as control and management of the entire project activities.

The social benefits of implementing the program that aims to avoid the offsite negative effects of erosion are numerous as mentioned above (*scenario 'B'*). But, if there is a lack of enough funds raised from the community, the program will not be effectively implemented and you will continue with the status quo of the off-site effects of soil erosion. Do you have any questions about the community trust fund? If you do, I can try to answer them now.

THE CONTINGENT VALUATION (CV) QUESTION

I am now going to ask you a hypothetical question. Suppose you were told that the off-site effects of erosion you have been experiencing in your area would be brought to an end by establishing and implementing a community based conservation program. Further assume that the kebele unit extension will undertake the task of implementing proposed plan for controlling the off-site impacts of erosion, so that you can attain scenario '*B*' mentioned above. But, for the kebele unit extension to implement the proposed program (KOECP) a considerable resources need to be mobilized. As it is the local people in this area who bear the burden of the current off-site problems of erosion and also the ultimate beneficiaries from controlled off-site impacts, it is proposed that the local community to be the target population to cover the cost of the program.

We are undertaking this survey to find out the household per capita contribution to the proposed project. The decision to pay for the proposed program is on voluntary basis. All funds raised from the community would go to the KOECP and would be used various activities that can control the off-site effects. Under no circumstances will the fund be used for any other purpose. The local society will play a major role in management of the funds.

The decision to implement the proposed community based program will be made after the community agrees to cover the necessary expenses. For the time being, the cost of the program is not known in advance. However, we want to know if you are willing or not willing to contribute money for the program.

In responding to my question please consider the advantage and disadvantage of the program. Remember that you are paying to avoid the off-site effects of soil erosion in your area and if enough people are willing to pay enough money the plan will be implemented so that you will enjoy scenario '*B*'; otherwise the current situation will remain unchanged, or even may get worse. Although this work of controlling off-site effects continues over the years, the set of questions I will ask needs you to consider only the next five years. The money will be collected after the main harvest time. But, bear in mind that when you pay to control the off-site effects of erosion, that money is not available for other alternative uses *i.e.* an extra expense will affect your household's budget in terms of lower disposable income for other consumption like for instance food, clothes, transportation, saving etc

1. Do you want to contribute for the proposed community fund?

Yes No

To enumerator: If ‘yes’ is the answer go to Q#2 and If “NO” go to Q#8. Choose any bid value randomly from the given list as starting point except the highest and lowest bid values and then for the follow-up question increase/decrease the bid values on the basis of the first response.

****If YES; ask the respondent ONE LEVEL HIGHER value than the starting value and if NO; ask the***

respondent ONE LEVEL LOWEER value than the starting value

Bids values: [], [], [], [], [], [], []

2. As we have stated earlier, the cost required is not known in advance. However, if you are a decision maker in your household and are asked to contribute Birr _____ annually for five consecutive years to control the off-site effects of erosion, would your household be willing to pay the money?
Yes No
3. What if you are asked, instead, to contribute Birr _____ annually for five consecutive years, would your household be willing to contribute that amount?
Yes No
4. What would be the maximum amount your household would be willing to pay per annum for the five consecutive years? _____ Birr
5. ***If yes in 2 and yes in 3 and If the respondent maximum willingness to pay in Q.3 is greater than in Q.4, then ask***
You said that you are willing to pay -----\$(in Q.3) but when I ask you your maximum willingness to pay you said-----\$(inQ.4) which is less than the amount you already agreed to pay previously
Why? _____
6. ***If yes in 2 and no in 3 and If the respondent maximum willingness to pay Q.2 is greater than in Q.4, then ask***
You said that you are willing to pay -----\$(in Q.2) but when I ask you your maximum willingness to pay you said-----\$(inQ.4) which is less than the amount you already agreed to pay previously.
Why? _____
7. ***If no in 2 and yes in 3 and If the respondent maximum willingness to pay Q.3 is greater than in Q.4, then ask***
You said that you are willing to pay -----\$(in Q.3) but when I ask you your maximum willingness to pay you said-----\$(inQ.4) which is less than the amount you already agreed to pay previously.
Why? _____
8. ***[If no WTP is reported, then ask this]→*** If you are not willing to contribute any amount to the proposed community trust fund for controlling the off-site effects of erosion, would you please state your reason/s?
A) I cannot afford to pay.
B) I think it should be the government that should finance the proposed control activities.
C) I do not believe the control measure could actually able to control the off-site effects of erosion.
D) Only the rich households should pay
E) I don't have faith in the kebele unit extension (i.e. proposed body to undertake the program)
F) I don't believe controlling off-site effects is important (i.e. the scheme

is not important to me)

G) I do not fully understand the question

H) Other reasons, please specify: _____

9. If you voted "YES" and are willing to pay for controlling the off-site effects of erosion, would you please indicate your reason?

I want to avoid the effects because am being hurt.

It is my duty as a resident of this area

I want the soil of area to continue producing other environmental services like flood control, biodiversity conservation, carbon sequestration, etc.

I would like the future generations to have reliable water supply

I believe that the community trust fund will do a good job in administering the fund for the proposed activities

I take personal pleasure in knowing that the landscape and other feature of the will continue to exist

I would like to contribute because I am concerned about the people who are being affected by the off-site effects of erosion.

It is a good cause and I enjoy contributing to good causes in general.

Others _____

10. Before this interview, did you think that there were real existing environmental problems/threats to your area? A. Yes No

11. When you decided to contribute to the fund, did you agree that there are threats/effects to your welfare because of the off-site erosion?. A. Yes
B. No

12. If NO to Q#13, why not?

I see no serious threat in my farm land, property or any other assets

The off-site effects are already very far from my location

As far as I know, the area is still in a good condition or there is no such kind of threat

The government could very well control the challenge.

Others, please specify: _____

13. When you decided on your vote, did you believe that the proposed community trust fund would actually be effective in controlling the off-site effects of soil erosion?

A. Yes B. No

14. If NO to Q#15, why is that?

The funds may not be used to support the program activities due to graft and corruption

The funds may not be used in compensating the upstream communities.

The upstream communities may not adhere to what was agreed on in the Program

The off-site erosion problem in the area is already very big and can no longer be solved

Others, please specify: _____

15. When you decided on your vote, did you like the proposed payment mechanism i.e. to collect people's payment after the main harvest period?

A. Yes B. No

16. If NO, why? Please specify _____

17. How certain are you that you would be willing to, as well as capable of, paying the agreed amount, if this scenario was carried out in reality?

Very certain

Certain

Don't know

Uncertain

Very uncertain

18. If your answer in Item #17 is UNCERTAIN or VERY UNCERTAIN, why do you have some doubts about your response?

PART V. DEMOGRAPHIC, SOCIO-ECONOMIC & OTHER CHARACTERISTICS OF THE RESPONDENT

ENUMERATOR: *Now, we would like to get information on you and your family to help us in our study, please continue with your cooperation*

1. Age (yr.) _____
2. Gender: Male Female
3. Marital status: Married unmarried others
4. Household size including the respondent _____
5. Household Size _____
Adult (≥ 15 yr.) _____ Old age (>65) _____
Children (<15 yr.) _____ Disabled individuals in the family _____
6. What is your (Household head) highest educational attainment? _____
7. The largest level Educational attainment within the household (children, wife, husband, relatives or other persons living in the household).
0. No Formal Education at All 4. College/University Degree And Above
1. Elementary School 5. Others _____
2. High School
3. Technical/vocational
8. What is your occupation or main economic activity?
 1. Farmer 4. Private sector employee
2. Off-farm self-employed 5. Disable/unable to work
3. Public sector employee 6. Other, Specify _____
9. How Much Is The Total Annual Income Of The Household (Include The Earnings Of All Members Of The Family Who Are Working Or Gainfully Employed? _____ birr

ENUMERATOR: *Please be assured that the information you will give us will be held strictly confidential and it is only for pure academic research purpose.*

10. Do you have other business (you or your family) other than agriculture (off-farm activities) to support your livelihood? A) Yes B) No

11. If yes, which type of businesses? _____
12. How much money do you earn per year from this off-farm activity? ____ birr
13. Do you own livestock? A) Yes B) No

If *yes*, please describe the livestock you own.

<i>Livestock type</i>	<i>Total number</i>
Calves	
Cows	
Heifers	
Horses	
Oxen	
Sheep	
Goats	
Donkeys	
Young bulls	
Poultry	
Other specify _____	

14. What is the source of animal feed (rank the source of animal feed according to their importance?)

1. Communal land 3. Crop residue 5. Others _____
 2. Private grazing land 4. Hay

15. How do you describe the trend of animal feed?

1. Declining 3. Increasing
2. The same 4. I do not know

16. Do you have Access to credit services? Yes No

17. How would you classify the economic status of your household relative to others in this area?

1. Rich 3. Average 5. Much worse than average
 2. Relatively well-off 4. Below average

18. What is your farm size? Parcel/pieces of farm land/plot in hectare or in local unit _____

19. Do you own more than one plot of land? If yes how many _____?

20. Location of the household? 1 Upland farmer
2 Downstream farmers

21. How do you characterize the topography of your farm land/plots (slope classes of plot/s)?

Topo-sequence: 1= steep 3=plain 5=mixed
2=gentle 4=swampy

22. Do you have land certificate? Yes No

23. Have you ever adopted soil conservation practices in your farmland? _____

Yes = 1 if the household adopt & practicing improved type of soil conservation methods.

No=0 if the household didn't apply or practice any soil conservation measures.

24. Do you receives any extension service or technology support for soil and water conservation related activities? yes No

25. If yes, ~From whom? _____ (Government, NGO, Farmers Union ,others)

~In what form? __ A. Knowledge /Training C. Cash
B. In-kind (food, seeds, tools, etc) D. others__

~How often? (The most dominant frequency)
1 Weekly 3 Quarterly
2. Monthly 4. Annually

26. How long have you been stayed in this area? (in years)_____

27. *Finally, would you like to add any comments about the survey or do you have any questions?*

Thank you for your time!!

DECLARATION

This thesis is my original work, has not been presented for a degree in any university and all sources of material used for the thesis have been dully acknowledged.

The examiners' comments have been dully incorporated.

Declared by: Biniyam Tilahun Bogale

Signature: _____

Date: _____

Confirmed by: Dambala Gelo (Ph.D.)

Signature: _____

Date: _____