

**Impacts of Upstream Watershed Management
Activities on Downstream Water Users and Users
Willingness to Pay by Contingent Valuation Method
(the Case of Gumera River Watershed, Ethiopia)**

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Abstract

A watershed is a naturally delineated unit of land that drains water, sediment, dissolved materials, heat, and biota to a common outlet along a stream channel. If watershed gives all these services, the various activities that are performed in the watershed area will certainly have impact on downstream water users. The activities that are carried out for watershed management cost the local administration and community. This research is, therefore, designed to investigate the impacts of upstream watershed area management activities on downstream water users, and downstream water user's willingness to pay for upstream watershed area protection taking the Gumera watershed as a case study.

The study analyses the impacts of watershed management activities on downstream water users and the determinants of households' willingness to pay for watershed area protection by using contingent valuation method (CVM). Samples of 110 households living in the downstream watershed area were selected by stratified sampling method and questionnaire survey with interviews was carried out to collect data on impacts and willingness to pay. Single bounded value elicitation formats with an open ended follow up question were used for the CVM. Eleven variables (income, age, marital status, household level of education, household size, female headed households, off-farm activities, respondents' market access, membership in environmental organization, ratio of dependency household members and bid value) were identified for the determination of the determinant of willingness to pay. The primary and secondary data that were collected were analysed both qualitatively and quantitatively. The quantitative information from the questionnaire was tabulated and analysed using SPSS. Probit model was used to analyse the factors influencing households' willingness to pay.

Results of the study showed that watershed management activities have both positive impacts (improves water quality, leads to good water management, provides more sustainable water supply etc...) and negative impacts (erosion problem, water pollution, destruction of homes and human lives due to flooding etc...) and households are willing to pay for the provision of watershed area protection. The important variables identified in this study to determine households' WTP for watershed area protection include, bid value, income of the household, participating in off farm activity, household size, ratio of dependent household members, and households' market access. The mean willingness to pay from the single bounded questions

were birr 291.2 per household per year. The expected aggregate willingness to pay amount is 4,066,260.9 birr per year. The mitigation measures to protect negative impacts are practicing land, water and biomass managements side by side.

An important policy implication drawn from the study is that farm households are willing to pay for watershed area protection. If government designs and implements a proper charge of watershed area protection in the area based on such studies it will avoid or at least reduce negative impacts of watershed activities and inefficient water use practices and there would be a more sustainable utilization of environmental resources.

Key words: Gumera watershed, watershed management activities, upstream-downstream linkage, watershed management impact, CVM, WTP.

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List of symbols

α = the intercept (constant)

β = regression parameters (coefficients)

μ = the mean of the explanatory variable

ε_i = standard error of explanatory variable

Abbreviations

BIDV = Bid value

CEM = Choice experiment method

CSAE = Central statistical agency of Ethiopia

CV = Contingent valuation

CVM = Contingent valuation method

ETB = Ethiopian Birr

EMA = Ethiopian map agency

FHHs = Female headed household

GMSSIP = Government managed small scale irrigation project

GWP = Global water partnership

HHS = Household size

HLEDU = Household level of education

HPM = Hedonic pricing method

IWRM = Integrated water resource management

MARKA = Market access

MENORG = Membership in environmental organization

MLE = Maximum likelihood estimation

MSTASUS = Marital status

OFA = Off-farm activities

OLS = Ordinary least squares

RDHM = Ratio of dependent household members

RWTP = Respondents willingness to pay

TCM = Travel cost method

UNEP = United Nations environment programme

WTA = Willingness to accept

WTP = Willingness to pay

CHAPTER ONE

1. INTRODUCTION

1.1. General

The starting point for watershed management is recognizing that watersheds are the fundamental hydrological unit and thus the basic land unit within a river basin that drains water, sediment, dissolved materials, heat, etc... to a common outlet along a stream channel, where biodiversity and ecosystem functions can be sustained and where livelihood opportunities are provided.

Watershed areas face a range of degradation challenges associated with human activities (deforestation, overgrazing, intensive cultivation, up and down ploughing, cropping without rotation etc...) and the way in which they are managed has a profound cascading effect on natural resources and communities in the wider basin. One of profound cascading effect is flooding. Flooding, as a natural phenomenon is not new to Ethiopia. It has been occurring at different places and times with varying magnitude. Gumara River is one of the rivers which cause flooding at Fogera-Dera flood plain. The Fogera flood plain is frequently affected by floods. There have been floods recorded in the years of 1996, 1998, 1999, 2000, 2001, 2003 and 2006. The 1996 flood set a new record for flooded area, while 2006 flood was recorded with its long duration and damage. In the year 2006, the heavy rain, caused rising of the Lake level, overtopping of Gumara river and high volume of water flow in the smaller catchments making thousands of people homeless, caused death of thousands cattle and led to large crop losses (Brhane Hagos, March 2011).

One of the expected causes of flooding is poor watershed area protection. Poor watershed area protection can be due to less understanding of upstream land users and downstream water users about watershed area protection and their impact. For unprotected watershed area the rainfall directly changes to runoff and then to flooding and its effect results in social and economic damage. To being free and save from these damages knowing the linkage of upstream land users and downstream water users, the impact of watershed area management activities, the mitigation measures for negative impacts and users willingness to pay for watershed area protection, are necessary.

This research is, therefore, designed to investigate impacts of upstream watershed area management activities on downstream water users and users' willingness to pay taking Gumera watershed as a case study.

1.2. Statement of the problem

Many watershed areas, which provide important freshwater resources, are facing serious threats. Upstream activities, such as agriculture, forestry, or urban development, may result in the loss of or reduced vegetation cover, pollution, soil erosion and increased or reduced runoff that can seriously affect water quality and quantity further downstream as well as the sustainability of the water resource in the long term.

The siltation in hydraulic structures and plots, water quantity and quality problems, flooding occurs (Brhane Hagos, March 2011) are the main issue on Gumera river basin projects. This can be due to poor watershed management and attempts to internalise watershed protection benefits and costs are few. This necessitates investigating the upstream watershed management activities and their impacts on downstream water users and analysing downstream water users willingness to pay for watershed area protection.

Proper pricing of watershed area protection in Ethiopia in general and the study area in particular are important because of the following benefits and problems. Firstly, water is scarce. Ethiopia is one of the countries projected to experience either water scarcity or water stress in 2025. It is projected to have an annual per capita availability of less than 1000 M³ (UNEP, 2002). Secondly, the common pool and public good nature of land and water or the old-age thinking of water as a free good makes it difficult to establish property right and costly to enforce and hence leads to inefficient utilization of watershed area and water (Ayleward et al., 2010). Thirdly, watershed area protection charges are means of cost recovery. The cost of watershed management activities are covered by either the federal government budget or from foreign loan/grant. In this regard the appropriate pricing of watershed area protection is important so that farmers are involving in assisting the development process of their country by paying the proper amount of money for the service of watershed area protection. Lastly, Ethiopia has one of the highest population growths, the majority of its population lives in the rural parts of the country; there is expansion of urbanization and increasing economic development and influence of climatic factors like

flooding and drought. All these imply the need for pricing of watershed area protection for appropriate utilization of water.

The detail research questions that are addressed in the study include:

- i. What is the knowledge of upstream land users and downstream water users about watershed and watershed management activities?
- ii. What are the impacts of upstream watershed management activities on downstream water users in Gumera watershed?
- iii. What are the successful watershed management mechanisms which would have the greatest benefits with little negative effect on downstream water users?
- iv. What is the downstream water users' willingness to pay for watershed area protection in upstream?
- v. What are the socio economic determinants of downstream water users WTP for upstream watershed area protection?

1.3. Objectives of the study

The general Objectives of the study are:

- ✚ To investigate the impacts of upstream watershed area management activities on downstream water users
- ✚ To investigate downstream users willingness to pay for watershed area protection

The specific Objectives of this study are:

- ✚ Identify major watershed management activities in upstream.
- ✚ Investigate the impacts of the upstream activities through questionnaire survey, field visit and interview
- ✚ Explore downstream water users knowledge of upstream watershed activities
- ✚ Employ contingent valuation method to assess downstream water users' willingness to pay
- ✚ Employ SPSS (probit model) to identify the major socio economic determinants of downstream water users' willingness to pay
- ✚ Selection of mitigation measures for the impact of upstream watershed management activities on downstream water users

1.4. Significance of the study

The study conducted to investigate the impact of watershed management activities on Gumera watershed has a significant contribution to the literature, and can be used as an input for different stakeholders for policy purpose and also as a basis for further studies. More particularly this study could contribute to upstream land users and downstream water users linkage policy in order to enhance efficiency and to promote sustainability in land and water use.

The research work is to elicit farmer's willingness to pay for different attributes of Gumera watershed area protection. It is expected to provide basic information for policy makers regarding the environmental issues and the significance of Gumera watershed area in particular.

Thus, this study, which uses CVM, will provide the basis for further empirical study in this area or serve as a literature for further study for researchers. Furthermore the outcomes of this study are expected to be interest to regional government officials and different stakeholders by providing information for guiding policy in relation to impacts of watershed management activities on downstream user and watershed area protection pricing.

The result of this study can thus be used as an input for informed decision making from a basin perspective which later could be developed to regional scale and used to prepare the community to have positive attitude for water projects construction. It also increases the initiation of willingness to pay for watershed area protection and creating an understanding of the way of analysing the non-market environmental goods.

1.5. Scope and limitation of the study

The scope of this study is limited to exploring the impact of upstream watershed management activities on downstream users and the analysis of watershed area protection pricing of one of the river basin which is found in South Gonder based on the information obtained from farmer's willingness to pay for watershed area protection. The study uses CVM. While this method is widely applied and it is very relevant for this study, like other valuation techniques this method has its own limitations. In addition because of the time and financial constraint the sample survey will be limited to 10 kebeles of fogera wereda with 110 households of

downstream water users. However, the data generated in the survey will be used with much care to minimize the small sample bias.

1.6. Structure of the research

The thesis consists of five chapters including this chapter, which provides general information in its introduction. This chapter also provides or describes the Statement of the problem, objective, significance and scope and limitation of the study. Chapter 2 is a review of the literature. Chapter 3 presents the description of the study Area, material and methods used while the fourth chapter is about the result and analysis of the survey data. The last chapter, chapter 5, describes the discussion and conclusions drawn from the results and recommendation.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Theoretical Concepts

2.1.1. Watershed Management Concept

Watershed management means different things to different people. It may entail soil conservation, reforestation, hydrological flow regimes, or natural resources management. The watershed management concept allows for the consideration of linkages that are usually ignored. In the first place, natural and human interactions are highlighted. In the second place, upstream-downstream effects are recognized. A watershed approach allows for the development of institutional frameworks that can effectively promote wise use and conservation of resources. In addition, there is a need to consider water and the hydrological services provided by a watershed from an economic perspective.

Attempts to internalise watershed protection benefits and costs are few. In general, there is a gap between economic theory and actual practice in regard to water resource appraisal, planning, conservation, management and use. Therefore, there is a need to innovate and promote policy and institutional changes in water resources management at local and national levels. Finally, the valuation of activities at a watershed level requires significant resources, since different kinds of information are needed and many actors are involved. (Marta Echavarría, *EcoDecisión*, Quito, Ecuador, 2000).

2.1.2. Mechanisms and instruments of watershed management

Mechanisms and instruments which may be applied to develop social, economic and institutional linkages between upstream land users and downstream water users can be structured into: regulatory instruments; economic instruments; educational and awareness-building measures; mechanisms to increase market access; the building of organisational structures; and participatory approaches. An essential prerequisite for the implementation of any mechanism or instrument linking upstream land users and downstream water users is the assessment of the downstream costs and benefits that arise from upstream land use. In practice, this assessment is a demanding task. There are many reasons for this, among others: Land use impacts may be difficult to distinguish from natural or other anthropogenic effects,

e.g. from mining and urbanisation. In comparison with other anthropogenic or natural effects, the land use impacts may be small. Some land use impacts, e.g. sedimentation, may occur over long time scales, making the present net value of the impact very small. With regard to some land use impacts, i.e. on the hydrologic regime and sediment transport, there seems to be an inverse relationship between the scale at which the impacts can be observed and the scale at which the redistribution of benefits might be important. The impacts can be most readily be felt in small spatial scales, while the number of water users increases with the size of the watershed. Due to the decreasing magnitude of impact at larger scales, the respective costs and benefits to the individual water user may be small.

Regulatory instruments

Regulatory instruments (command and control measures) are widely used in developed countries to protect water resources from agricultural land use practices, including pollution. Command and control measures are river basin management plan: - natural resources diagnosis, protected areas delineation, and investment plan; right to the use of water (concessions):- environmental authority: autonomous regional corporations or national park system; dumping authorizations:- regional environmental authority.

Economic instruments

Economic instruments to distribute benefits and costs resulting from land use impacts on water resources between upstream and downstream stakeholders include subsidies, taxes, and transferable property or use rights for land, water and emissions.

Subsidies: subsidies include direct and indirect payments, such as tax exemptions, price regulations and protective measures, by the state to achieve certain objectives. With regard to land use impacts on water resources, there are direct and indirect subsidy schemes in place aimed at compensating farmers for the costs arising from water protection.

Taxes: taxes are another instrument employed to curb negative impacts on water resources of land use practices. The economic incentive for the farmer is the same as in the case of the subsidy. There is an important difference, however: in the case of subsidies, the government pays the farmer for avoiding pollution, while with taxes, the farmer has to pay for activities which are increasing pollution, or the pollution itself. From a property rights viewpoint, the

subsidy approach implicitly gives the environmental property rights to the farmer, while in the case of taxes, the rights are allocated to society at large, and the farmer has to pay to use them.

Flexible property or use rights: one way of protecting water resources from land use impacts is through the acquisition of land or land use titles. The region can purchase land in sensitive areas (e.g. near watercourses, wetlands and reservoirs) in upland watersheds to protect its water supply. These lands are set aside from use or can only be used for certain recreational activities, like hiking or fishing with a special permit. Alternatively, the region can purchase the right to develop a property through a so-called conservation easement.

Education and awareness building measures

Educational programs are used to encourage farmers to switch to less polluting farming practices. Four key approaches are: - Campaigns, Participatory learning, Informal education and Formal school-based interventions.

Campaigns: the focus of campaigns is to provide uniform, large-scale impact with standard messages. There are many examples of large-scale national and international public awareness campaigns that have led to massive social change. Examples include childhood immunization, the wearing of seat belts in cars, and smoking restrictions.

Campaigns comprise a set of activities that may include: publications, including billboards, posters, newspaper or magazine coverage, information cards, flyers, bookmarks and brochures; curricula, modules and presentations, including slide presentations and oral presentations; e-learning; performing and cultural arts; games and competitions; audio and video materials; web pages and activities; social media and telecommunications.

Participatory learning: people are especially motivated by approaches in which they themselves participate in a solution, and especially when they believe it is their own idea. The focus of participatory learning is to engage people in discovery and problem solving for disaster risk reduction. At the heart of all of these activities is the community's own experience of empowerment

Informal education: the focus of informal education is taking advantage of brief moments and encounters to stimulate thinking and engage people in discovery of actions and

behaviours to increase safety and resilience. Informal education in communities and schools is the most flexible of all approaches with respect to setting, audience and timeframe

Formal school-based interventions: the focus of formal school-based interventions covers two areas: school disaster management and disaster risk reduction in school curricula. These are considered to be formal because accountability and responsibility for school safety and curricula belong exclusively to education authorities, so they require support for long-term planning and capacity building. Whether there is one such authority, many, or seemingly none, the same issues of caution remain.

Market support

The improved access of upstream farmers to downstream markets is another mechanism to improve cooperation between stakeholders: one that may increase farmers' income and, in the framework of a watershed agreement, can be used as an incentive to conserve the resources.

Organizations

Organizational development is a prerequisite for the successful implementation of instruments establishing linkages between upstream land users and downstream water users. Organizations have two important functions: first, they provide a forum of exchange between upstream and downstream stakeholders and second, organizations are vital as a forum to consolidate the interests and opinions of scattered groups of users, e.g. upstream farmers.

Participatory approaches

Participatory approaches to curb negative impacts of land use practices on water resources are frequently applied to improve the management of natural resources, for example through soil and water conservation, and to increase sustainability by including the local population in the planning and implementation process. In addition to the environmental benefits, the aim of the participatory approaches includes economic benefits such as improved farmer income and better livelihood security, as well as social benefits such as the establishment of organizations and decreased out-migration. (Benjamin Kiersch, land and water development division FAO, Rome, 2000).

2.1.3. Managing watersheds and river basins

The global water partnership (GWP) defines integrated water resources management (IWRM) as a “process which promotes the coordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” (GWP 2000).

The IWRM approach works best when it manages to take the different scales of the river basin into account, embedding watershed management in river basin management. Experiences with watershed and river basin management show that both top-down and bottom-up management approaches are needed and that institutional arrangements must provide for linkages between the local and the national or regional levels. Local communities are often the most affected by management decisions at higher scales and their participation in watershed management planning is essential. However, planning and management authorities at the basin level need to balance local community needs with those of the wider society and environment. Integration can be improved by the establishment of networks and communities of practice across all scales, disciplines, basins and countries, and new information sharing technologies should be used to share information at all levels.

The key to effective management of water resources is an understanding of the inextricable link between the hydrological cycle and the way land resources are managed. The impact of land use on the hydrological regime and water quality downstream varies with the type of land use, watershed size, climate, soil characteristics, topography and geology. Finding a way to incorporate the many diverse factors that influence the functionality and services provided by watersheds, such as economic development, population growth, land use change and climate change, requires integration across scales, sectors and communities — something that has so far eluded natural resource planners. While there are examples of successful small-scale local management efforts, these need more than local-level scaling-up policies if they are to restore and improve watershed goods and services.

Water economies in developing countries are largely informal with little contact between users and public institutions. To reflect this, reform efforts need to use indirect and incentive based approaches. Replicating models from developed economies is not the solution. The long-term success and sustainability of watershed and river basin management initiatives

depends on securing on-going funding and this has often been a problem. Exchange of knowledge and experience among countries that share a river basin can help to develop common policy frameworks and ensure long-term commitment and steady funding.

Success in managing competing interests in land and water resources relies on an understanding of the complexity of these systems. The functionality of watersheds to provide essential goods and services continues to decline. Balancing development, while maintaining ecosystem integrity, requires a concerted planning effort that is inclusive and transparent. An integrated management approach that guides overall planning from the watershed to the basin level recognises the importance of multi-stakeholder negotiations as a means of combining top-down policy implementation and bottom-up participatory processes. Good data is needed to inform watershed and river basin planning and decision makers need to see that this information is both meaningful and credible. There is a clear need to integrate climate change adaptation and mitigation and disaster risk reduction into the agenda of water and land management at all levels.

Land use has an impact on the hydrological regime and quality of water on downstream. The importance of this impact varies with the type of land use, the size of the watershed, climate, soil characteristics, topography and geology. The interactions between all these factors are complex and the specific characteristics of each situation need to be considered and the water movement through the basin calculated. While the adverse effect of sedimentation on reservoirs, waterways, irrigation systems and, sometimes, coastal zones are well known, the impact of land-use practices on the overall sediment yield of river basins is not. Most of a river's sediment load originates from specific locations within the watershed and arrives in the river during extreme climatic events. The delivery of sediment from upstream to downstream is relatively slow and, therefore, any impact from land-use practices will only be felt after several decades, making it very difficult to distinguish between natural and human-induced sediment load and also complicating management decisions.

Economics and financing

Economic forces and conditions underlie many of the activities that impact on watersheds and river basins. Pressing, and often competing, economic demands lead to watershed degradation and significant costs and losses have often been incurred, especially for poorer and more vulnerable groups. The search for adequate funding to undertake integrated

watershed and river basin management is a core concern among government agencies across the Basin.

A variety of economic and financial approaches for integrated watershed and river basin management are already being applied, including novel ways of analysing economic costs and benefits in decision making, introduction of new prices and markets for watershed goods and services and the development of innovative financing mechanisms. Decision makers tend to undervalue both the benefits of more sustainable water management and the costs of watershed degradation and loss.

Changes in sediment generation and vegetation cover, pollution and other forms of degradation caused by inappropriate land use within watersheds have a profound impact on the functionality of ecosystems and their provision of critical services. Furthermore, activities associated with extractive industries, such as mining and forestry, along with the development of water resources through the construction of storage structures and increasing extraction of groundwater all have implications for watershed functions.

The human-induced changes to watersheds are compounded with increased water scarcity. With its inextricable links to food security and economic development, water scarcity, which is driven by population growth, dietary change, urbanisation, globalisation, bio fuel production and climate change, is becoming one of the defining issues of the 21st century.

Watershed degradation, urbanisation and population increase are factors that decrease natural resilience to extreme weather events such as storms and torrential rains leading to flash floods in upland areas and extreme inundation of floodplains. These factors therefore reduce the ability of communities and systems to adapt to climate change.

Governance

Governance is about the way we share power, decisions, benefits and risks. –We” can be a local village community, the population of a watershed, of a nation, or even of a large trans-boundary river basin. Watershed governance includes the full spectrum of influences, from shaping agendas and deliberating options through the design of institutions and laws to the way these are implemented in the practices of day-to-day management of watersheds. As

everything becomes more interconnected, good governance becomes ever more vital, and ever more difficult.

The governance and institutional frameworks within which watershed and river basin management takes place have a strong influence on how IWRM should be approached and which tools are most effective. In turn, this is affected by the capacity of individuals and institutions to make the necessary changes to the established management regimes. These issues need to be assessed and taken into account when devising integrated management approaches. (Hanne Bach; Torkil Jønch Clausen, 2011)

Changes of use and occupation of land in the watershed generate increased occurrence of peak flow and sediment transport, but the inadequate management of the area (with removal of riparian vegetation and lack of energy sinks in outputs of drainage systems) potentiates the increasing the instability of water bodies morphology. In case of presence of reservoirs, the alterations are worst because they create siltation and erosion process at the same river. (Cristiano Poletto; Elissandro Voigt Beier, 2012)

Human anthropogenic activities like the burning of coal, deforestations and various agricultural activities like change in land use, mismanagement of land, grazing may also alter the composition of atmosphere contributing to climatic change. Integrated watershed management (IWM) is more a philosophy of comprehensive integrated approach to natural resources management. It aims at integration of social resources management with natural resource management. The approach is generally preventive, progressive, corrective and curative. Watershed management involves the judicious use of natural resource with active participation of institutions, organizations, in harmony with the ecosystem. The approaches also being developed as part of a strategy to achieve food security while protecting the environment through sustainable land use development, integrated watershed management (IWM) approaches are being developed. The major advantages of IWM approaches are involvement of those most affected by the decisions (i.e. the stakeholders) in all phases of the development of their watershed and holistic planning that addresses issues which extend across subject matter disciplines (biophysical, social, and economic sciences) and administrative boundaries (village, woreda etc) (Reid. et al, 2003).

2.1.4. Components of watershed management

The three main components in watershed management are land management, water management and biomass management.

Land management

Land characteristics like terrain, slope, and formation, depth, texture, moisture, and infiltration rate and soil capability are the major determinants of land management activities in a watershed. The broad category of land management interventions can be as follows: structural measures, vegetative measures, production measures, and protection measures.

Mechanical conservation measures may become necessary in watershed management in the initial stages. Structural measure include interventions like contour bunds, stone bunds, earthen bunds, graded bunds, compartmental bunds, contour terrace walls, contour trenches, bench terracing, broad based terraces, centripetal terraces, field bunds, channel walls, stream bank stabilization, check dams etc. Watersheds may contain natural ecosystems like grasslands, wetlands, mangroves, marshes, water bodies. All these ecosystems have a specific role in nature. Vegetative measures include vegetative cover, plant cover, mulching, vegetative hedges, grass land management, agro-forestry, etc. The production measures include interventions aimed at increasing the productivity of land like mixed cropping, strip cropping, cover cropping, crop rotations, cultivation of shrubs and herbs, contour cultivation conservation tillage, land levelling, use of improved variety of seeds, horticulture, etc. Protective measures like landslide control, gully plugging, runoff collection, etc. can also be adopted. Adoption of all the interventions mentioned above should be done strictly in accordance with the characteristics of the land taken for management.

Water management

Water characteristics like inflows (precipitation, surface water inflow, ground water inflow) water use (evaporation, transpiration irrigation, drinking water) outflows (surface water outflow, ground water out flow) storage (surface storage, ground water storage, root zone storage) are the principal factors to be taken care of in sustainable water management. The broad interventions for water management are rain water harvesting, ground water recharge, maintenance of water balance, preventing water pollution and economic use of water,

Biomass management

Major intervention areas for biomass management are eco-preservation, biomass regeneration, forest management & conservation, plant protection & social forestry, increased productivity of animals, income & employment generation activities, coordination of health & sanitation programs, better living standards for people, eco-friendly life style of people and formation of a learning community a sustained basis. (Jimma University and Population, Health and Environment, 2010)

2.1.5. Definition of economic valuation of environmental goods and its importance

Economists are striving in the valuation of environmental goods and services to give attention for the protection and wise use of environmental resources. A concise definition of valuation is “an attempt to put monetary values to environmental goods and services”. It is a key exercise in economic analysis and its results provide important information about values of environmental goods and services. The information can be used to influence decisions about wise use and conservation of the ecosystem.

The basic aim of valuation is to determine people’s preferences by gauging how much they are willing to pay (WTP) for given benefits or certain environmental attributes (Abila et al., no date). The fact that the environment was viewed as an open access resource implied a zero price for the environment. This perception of individuals on the environment leads to unwise use of the natural resources which leads to environmental degradation because of the over use of such resources. Hence with a zero price for environmental use, the economic system does not include control mechanisms to check over use of the environment. So environmental valuation is desirable to introduce a control mechanism in the wise use of environmental resources(Folmer et al. 1989). The other aim of environmental valuation is to incorporate the environmental impacts in to cost benefit analysis and to allocate the environmental resources efficiently on the various competing uses in a way that brings the highest possible benefit to the society once monetary value of the non-priced goods are known(Perman et. al, 2003).

2.1.6. Components of value of environmental resources

Economists have broadly decomposed the total economic value conferred by resources and the environment into use value and non-use value. Use values can be broken down into direct

and indirect use values. Direct use values are contributions that the assets make to current production/consumption or the value derived from directly consuming services provided by an environmental good and indirect use values are benefits derived basically from functional services that the environment provides to support current production/consumption or value derived from indirect consumption of an environmental good such as the aesthetic and functional services it provides.

In the environmental and resource economics literature, non-use values are hypothesized as having three separable components, namely option, bequest and existence values or demands. Option value refers to individuals' willingness to pay to retain the option of possible future use. It shows peoples willingness to pay to preserve an environmental resource to guarantee for future use but not actually using it currently, bequest value refers to the satisfaction that people gain from the knowledge that a natural resource endowment is being preserved for future generations. Bequest demand exists to the extent that the present generation is willing to pay for preserving natural resources for the use of future generations and existence value refers to the satisfaction that some people derive from the preservation of natural resources so that there remains a habitat for fish, plants, wildlife, and so on. In other words, it refers to what people are willing to pay (demand) for preserving the ecological integrity of the natural environment (Ahmed Hassen, 2004).

Thus the calculation of the total economic value of an environmental resource should contain all the above components of value. Since non-use values are derived from motivations other than direct personal use, they are obviously less tangible than the use values. The estimated non-use values can be quite large so ignoring either one or more components of the value will under estimate the total value of the resource or leads to resource misallocations (Tietenberg, 2003 and Freeman, 1999)

2.1.7. Environmental valuation techniques

There are two broad valuation techniques: indirect (revealed preference) valuation techniques and direct (stated preference) valuation techniques.

2.1.7.1. Revealed preference methods (indirect valuation methods)

Hedonic pricing method (HPM)

The hedonic pricing method is an indirect valuation method that is used to estimate economic values for environmental services that directly affect market prices. It is most commonly applied to variations in housing prices that reflect the value of local environmental attributes. It can be used to estimate economic benefits or costs associated with environmental quality, including air pollution, water pollution, or noise.” (Letson et al., 2002).

The hedonic price approach is based on the theory that value of a commodity is a bundle of valuable characteristics, one or more of which may be environmental. The basic premise of the hedonic pricing method is that the price of a marketed good is related to its characteristics, or the services it provides. It assumes that goods and services are defined by the attributes embodied in them, and the values of these goods and services are the sum of the values of the attributes which they contain.” When goods or services contain an environmental characteristic, the market value of the environmental characteristic is embedded” in the market price of the good or service which contains the characteristic (Abila et. al, no date)

The hedonic pricing method uses the prices of traded commodities to determine the value of environmental characteristics that are thought to affect the price of the item. The main disadvantage of this valuation method (HPM) it cannot be used to estimate non-use values of an environmental resource. In this regard the method has limited importance.

Travel cost method (TCM)

Travel cost methods have been used extensively to estimate the value of recreation. Using these methods, researchers can calculate the economic costs necessary to reach a recreational site as an estimate of user willingness to pay for recreation. That economic cost may include entry fees, monetary costs of travel, and foregone earnings. In effect, these travel expenses represent the price” of the recreational experience and are an indirect but observable indicator of user value. By comparing the number of visits that individuals make at different

levels of travel cost, economists are able to estimate economic value for site attributes, such as improved environmental quality (Letson et. al, 2002).

The travel cost method uses costs, such as travel costs, entrance fees and time, incurred in visiting a particular site for recreation or other purposes as a proxy of the value of that site for the purpose (Graves et. al, 2009). The travel cost method (TCM) is used to estimate economic use values associated with ecosystems or sites that are used for recreation. The method involves using travel costs as a proxy for the price of visiting outdoor recreational sites. The basic premise of this method is that the time and travel cost expenses that people incur to visit a site represent the “price” of access to the site. Thus, peoples’ willingness to pay to visit the site can be estimated based on the number of trips that they make at different travel costs. This is analogous to estimating peoples’ willingness to pay for a marketed good based on the quantity demanded at different prices (Abila et. al, no date).

The main benefit of travel cost approaches is their reliance on observable market behaviour. Individuals routinely spend their money and time to attend recreational sites, and easily obtained visitation records offer much of the data needed to deduce economic values. The main disadvantage of this method is it cannot be used to estimate non-use values.

2.1.7.2. Stated preference methods (direct valuation methods)

Two main stated preference methods are the contingent valuation method (CVM) and the choice experiment method (CEM). Both methods depend on a hypothetical market which is presented to the respondent in a questionnaire. A main advantage of stated preference methods over the revealed preference method is that we can ask respondents for their willingness to pay (WTP) regardless of whether they make use of the hypothetical commodity or not. In other words we can obtain use and non-use values whereas the revealed preference method only addresses the use value of the resource (Abila et al., no date). In the next section a detailed description of the two stated preference methods (CVM and CEM) is provided.

Contingent valuation method (CVM)

The contingent valuation method is the earliest technique of the stated preference method of non-market valuation approaches. The CVM involves asking people directly what they would

be willing to pay or willing to accept compensation for change in preferences. This method is called contingent valuation because the valuation is contingent on the hypothetical scenario put to respondents. The contingent valuation method has two major advantages over the indirect valuation methods. First, CVM deals with both the use and non-use values of the environmental resource while the indirect methods deal only with the use value. Second, survey responses to willingness to pay or willingness to accept hypothetical questions go directly to the monetary measures of utility change (Perman et al., 2003).

The CVM has proven the most popular of the available methods for monetary valuation of the environment. According to Spash (2008) this is because of the following three main reasons. The first thing is its simplicity. Secondly the application of CVM seems unlimited in the sense that questions could apparently be asked concerning the provision of any environmental goods and services. The last and obvious reason is the CVM deals with both the use and non-use values of these environmental goods and services.

Main steps in CVM

The major steps involved in a CVM exercise are described below. The first step is the design of a survey instrument for the elicitation of individuals' willingness to pay (WTP) /willingness to accept (WTA). The instrument includes a detailed description of the good being valued and the hypothetical circumstance under which the good is made available to the respondent, i.e., designing the hypothetical scenario, deciding whether to ask respondents WTP or WTA questions and creating a scenario about the means of payment or compensation.

The next step is defining the population of interest and administering the survey instrument to a sample. Different methods of survey administration can be used such as telephone, face-to-face, ordinary mail and e-mail etc. The third step is analysing the survey responses like estimating the average WTP/WTA for the population and assessing the survey result to ascertain the accuracy of these estimates. The fourth step of the CVM exercise is estimating and aggregating WTP/WTA for the population. Conducting sensitivity analysis is the final step (Perman et al., 2003, Carson and Hanemann, 2005 and Hanley et al., 1997).

Even though CVM is a good method in non-market valuation for environmental goods, it suffers from potential biases. Of these biases the following can be mentioned:

Starting point bias: the starting point can influence the respondents answer about WTP. For example if we start with inappropriate price (bid value) we may obtain inappropriate responses in the final bid. Most of the time starting point bias arises in the bidding game because the value selected has an impact on the final bid. To overcome this problem the payment card approach is advised even if this one is also not free of bias (Gundimeda, no date)

Payment (vehicle bias): payment (Vehicle bias) arises if the WTP/WTA varies depending on the mode of payment. The response of respondents on their WTP estimates may be different if the mode of payment available to them is different. For instance if an individual is asked how much he/she is willing to pay for an environmental improvement, WTP may be different depending on the mode of payment which could be in the form of tax, labour hour, user fees etc. This difference in WTP dependent on the mode of payment is called (payment) vehicle bias.

Hypothetical bias: in hypothetical market respondents may view the question as unrealistic, and may respond with an equally unrealistic estimate of WTP. Such kind of bias can be minimized by using different elicitation formats and by making the hypothetical situation as believable as possible and motivating the respondents well.

Strategic bias: sometimes especially in the case of public goods respondents under estimate their WTP to free ride if they know that bids are actually going to be collected. Even if respondents know the intention of the analyst because of human behaviour and to be free riders respondents may not give their true WTP. Referendum format may reduce strategic bias.

Compliance bias: this may happen when respondents decide not to fulfil the interest of the researcher, especially when they have been called upon frequently to answer questions without any benefit. They just provide responses which may be too low or too high which may actually affect the true value of the environmental resource. In order to minimize such kind of bias different incentive mechanisms have to be arranged for respondents.

Many other biases exist in CVM analyses which are not mentioned here. So, researchers have to give emphasis on the best way to minimize these biases by using different elicitation

formats and by attempting to create a common understanding on the good or service going to be valued between respondents and the researcher.

Choice experiment method (CEM)

The pioneer of this method is said to be Lancaster (1966) and the econometric model used for analysis is mainly due to McFaden (1974). The basic idea of this method is individual consumers derive utility/satisfaction from goods through the attributes the goods provide. The CEM is based on the idea that any environmental good can be described in terms of its attributes and the levels it take. For example irrigation water can be described in terms of the quality of water, the stock of fish, the size of cropping/grazing land/and its aquatic species etc. Respondents are presented with various alternative descriptions of a good, differentiated by their attributes and levels and are asked to rank the various alternatives to choose their most preferred attribute (Hanley et al., 2001).

Note that disadvantages of the choice experiment method include its complexity in the experimental design of the data compared to the CVM and its difficulty in the selection of attributes and its levels (Hanley et al., 1998).

2.2. EMPIRICAL LITERATURE REVIEW

2.2.1. Studies on valuation of water supply using CVM

Using CVM Dunfa Lemessa (1998) examined respondents WTP for improved rural water supply in the Ada'a Liben district as a case study in Ethiopia based on data collected from 228 households. The ordered probit model result indicates the coefficients of income, time, and status of water quality; education and credit availability were positive and statistically significant. Whereas the coefficients of women, children, domestic animals, sex of the respondent and corrugated iron sheet roof house were statistically insignificant.

Using Probit and Tobit regression models Medhin Fissaha (2006) conducted a CVM study in Addis Ababa for 250 randomly selected households. The study estimated WTP for sampled households for improved water supply services. Results of the study revealed that respondents' WTP is affected by a number of explanatory variables including sanitation facility, water related disease and socio –economic variables like income, age, sex, marital status, education level and family size of the respondent etc. Many of the variables had the

expected sign and significance except the variables years of stay in the area and marital status of the respondent have negative sign and are insignificant. The mean WTP for private connection is found to be 0.2 birr per Baldi and 0.1579 birr per Baldi from closed ended and open-ended question respectively, which are well above the current subsidized tariff.

Fissiha Aberra (1997) used a CV survey to estimate households' willingness to pay for piped water supply using 266 respondents in Meki town, Ethiopia. This study revealed that more than 50% of the selected households are willing to pay almost twice the existing tariff rates for improved water services.

Using a CVM study Gossaye Fanta (2007) tried to obtain households WTP for improved water service in Debre Zeit town, Ethiopia based on 234 randomly selected sampled households from all kebeles of Debre Zeit town. The survey result shows that 99.57% of the survey respondents use pipe water. However, only 10.26% of the respondents were satisfied with the status quo level. Using dichotomous choice and open ended elicitation formats the study result reveals that mean willingness to pay for one bucket or for 20 litter of improved water service are 10.2367 and 12.4786 cents respectively. The total willingness to pay for one bucket or 20 litters of improved water services is 262,781.45 cents or Birr 2,627.82 per day or Birr 959,159.30 per year. The Probit and OLS econometric models show that age, household size, reliability dummy and the income variables influences households' willingness to pay for the improved water services in the Debre Zeit town. Except the existence of significance between the probit and OLS estimation results are more or less the same. The study indicates all of the respondents were expressed their willingness to pay above the existing tariff structure and recommends the provision of improved water would increase the revenue of the study area.

Hala Abou-Ali (no date) used both CVM and CEM to analyse the impact of better water quality on health improvements in Cairo, Egypt. 1500 randomly sampled households in metropolitan Cairo were used to administer the survey. The valuation format used is dichotomous choice. The study result shows no considerable difference is found between the estimated values of the changes in health risk derived from both methods. However, it still could be concluded that households living in Metropolitan Cairo have positive WTP for reducing health risks owing to water quality.

Mahumani (2009) estimated the economic value of ground water by determining the utility value of ground water using contingent valuation method. The elicitation format used for contingent valuation of the ground water is open ended approach which is exposed to strategic bias and loose answers. The result of the study shows the overall mean WTP for satisfactory household ground water for the study area is R 2.28 (in domestic currency) per kiloliter of ground water.

Applying the Tobit and ordinary least squares (OLS) econometric models Ibrahim and Robert (2010) tried to measure the total economic value of domestic water in Ramallah, Palestine. The total number of sampled households in the study is about 525 and the elicitation format used to model WTP for respondents is dichotomous choice with follow up open ended questions. The study result shows the mean WTP for the total economic value of improved domestic water in Ramallah is about NIS 627(in domestic currency) per annum.

The results revealed that the variables age, water consumption, the use of water filters and income have significant impact on WTP. Water consumption has a negative effect on households WTP which is theoretically consistent while the other explanatory variables have a positive impact on WTP as expected. The variable gender, urban respondents, employment status, gainfully employed and education has positive but insignificant impact on WTP. This is inconsistent compared with results of many other studies.

2.2.2. Studies on valuation of irrigation water using CVM

Tsegabirhan W/Giorgis (1999) conducted a CVM study in Wikro, Tigray, Ethiopia for 82 randomly selected farmers using both OLS and ordered probit regression models. A contingent valuation method is used to elicit the valuation of small farmers' small scale irrigation schemes. The survey results are for the main irrigation seasons and the whole year, which depends on the 0.25 hectares of irrigable land. The average WTP for the main irrigation is birr 369 and for the supplementary irrigation is birr 217 which implies the average WTP for the whole year is birr 586. The variables identified in the study to determine WTP of the peasant are age, credit, education, experience with irrigation, total area cultivated, number of oxen owned by a house hold, family size, total revenue and quantity of fertilizers. The elicitation format used in the study is open ended elicitation approach which is vulnerable to different biases. The study also recommends the following variables to be included for further studies like existence of market outlets, agro-climatic factors and the type

of irrigation technology used by framers this study includes some of the suggested variables for analysis.

Using a CVM study Jonse Bane (2005) tried to obtain the valuation of peasants for non-agricultural uses of irrigation water using 260 randomly selected households in two peasant associations in Bure district of west Gojam, Ethiopia using probit and bivariate probit models. The study employed double-bounded referendum style elicitation format with open ended follow up questions. The study identified the following determinants of WTP: income, age, sex, family size, irrigation water management, choices of water use rights, quantity of irrigation water consumption, distance from current sources (in meters), wealth, land tenure, Peasant Associations (Sites), quality of water, location and starting point bid. The study also finds that using double bounded value elicitation technique does not improve statistical efficiency over single bounded format. The study therefore used the single bounded elicitation format to calculate values of households' WTP for domestic uses of irrigation water.

Habtamu Tilahun (2009) employed CVM to analyse irrigation beneficiary households' willingness to pay for watershed management to value irrigation water to enhance agricultural productivity using 210 randomly selected household heads in the Koga Watershed of the Upper Blue Nile Basin in Ethiopia. The study also analysed the magnitude and determinants of labour supply behaviour of farm households for the routine management and maintenance of irrigation infrastructure in the Upper Blue Nile basin of Ethiopia. For the total irrigable land area it is estimated that households could contribute an estimated 468,784 person labour days per year and the aggregate expected WTP for the total of 7,000 hectares of irrigable land was 964,320 birr per year. The logit model analysis based on single dichotomous elicitation format shows that households' willingness to contribute labour was influenced by education, age of the household head, expectations about yields in irrigated agriculture, wealth of the household, involvement in off-farm activities, time taken to walk to the nearest market, the household's dependency ratio and randomly assigned bid working days. The study proposes the following policy implication –Any plan for generation of financial resources from irrigation beneficiary households should also consider factors that influence the productivity of this system.”

Sonia Akter (no date) applied a contingent valuation technique (CVM) to value the economic benefit of government managed small scale irrigation project (GMSSIP) in Bangladesh using

single bounded closed ended WTP questions. The estimated WTP for use of irrigation water from government managed small scale irrigation project equals to Taka 1670 (US\$ 23.85) per 0.25hectars of land per cropping season, which is 12 percent of the average agricultural income of households per cropping season. Furthermore, the logit study reveals that bid level, respondents' age, education, family size, number of income sources, ownership of farm land, management system of current irrigation scheme and decision to change cropping patterns if a government managed irrigation scheme is provided, have significant influence on farmers' WTP for GMSSIP. It may be difficult to find the maximum willingness to pay of respondents as the study restricted to close ended WTP questions only.

Karthikeyan et al. (2009) used contingent valuation method in the form of close ended questions to determine the factors contributing to WTP for irrigation water in south India in the dry and wet seasons. Logit model results reveal that the mean WTP of farmers for irrigation water was INR (Indian currency) 218./Ha/Year and family size, age of the respondent, educational level of the head of the household, family labour force, area under cultivation, and water requirement at farm level as the main determinants of farmers' WTP for irrigation water.

Using logistic regression Latinopoulos (2005) used contingent valuation method and hedonic pricing method (HPM) to determine the factors contributing to WTP for irrigation water in Greece agricultural areas. The study result shows the value of irrigation water, as estimated either directly or indirectly by water users, is low because it relates to its use component and ignores the non-use value of water. The paper put the following concluding remark.

As a general rule, one can propose that properly designed water management policies that aim at environmental and economic goals should also take into account the social impacts to the main stakeholders, i.e. the farmers. Within this sense, the provision of water services can be best implemented by combining a water pricing structure that ensures equity at low price levels with a more strict and efficient administrative system that will safeguard the sustainability of water resources.

Using logistic regression model Bamidele et.al (2010) investigated factors influencing farmers' ability to pay for irrigation facilities by taking Oshin Irrigation scheme in Kwara state in Nigeria. The study used a one stage sampling procedure for selecting 60randomly farmers. The study is based on cross sectional farm data which was sourced mainly from

primary source. The primary data sources comprised the use of well-structured questionnaires to solicit response from farm household. The study result reveals that the age of farmers, the type of education acquired by the farmers, household income and the size of the farmers' household were revealed to determine farmers' ability to pay for irrigation facilities. The result indicates that farmers are able to pay a mean sum of N1077.64 (in Nigerian domestic currency) per hectare which is below the N1000 per hectare charged at the Oshin irrigation site. The main problem of this study is the study sample is too small and it does not explicitly put the elicitation format to survey farmers WTP for irrigation water service in Nigeria.

Tiwari (2005) provided the results of a case study on determining the economic value of irrigation water using both direct and indirect valuation techniques. The results indicated that the opportunity cost of irrigation water was considerably greater the maximum willingness to pay. The review concluded that there is unsustainable use of irrigation water at present. Tiwari used both the open and closed-ended questions elicitation methods. From the closed ended question the result found that WTP was related to respondents' gender, agricultural income, perceived water sufficiency, education, family size and landholding. On the other hand, the WTP from openended question was significantly varying with the farmers' attitude towards paying fee, sex, education, migrating family members, family size and access to credit.

Using the ordered probit model, Whittington et al., (1990) estimated individuals' WTP for improved water services in rural areas of southern Haiti. The authors concluded that household wealth, education level of respondents, distance of the household from the existing water sources, quality of water and sex of respondents (female) were the major factors influencing the WTP of the respondents.

Banda et al., (2007) used a tobit model to analyse factors affecting the probability that a household is willing to pay for both improved quantity and quality of water in rural area of South Africa. The study found that households' income, availability of water, households' access to a tap and water per capital, monthly water consumption were significant determinants of WTP. Besides, 62% of the households were willing to pay for improved water quantity.

Rogers et al. (1998) estimate agricultural and non-agricultural use values of irrigation water in arid zone of Haryana, India. The study defined agricultural use value and non-agricultural

use value in terms of net value of output per unit of water input (USD/m³). The study reported that the agricultural and non-agricultural use value was estimated \$0.019/m³ and \$0.01/m³, respectively.

Using the contingent valuation method Chandrasekaran, et al. (2009) estimated the economic value of tank irrigation water. The overall mean WTP value across seasons (wet and dry seasons) was 218.50/ha/year Indian Rupee. Besides, the study found that the area under rice cultivation and the water requirement were significant factors influencing farmers WTP in the wet and dry seasons, whereas, labour force was found to be insignificant impact on the farmers' WTP in the dry season.

Farolfi et al. (2006) employed contingent valuation method to estimate Swaziland households' willingness to pay (WTP) for an improvement in their water quantity and quality. The authors used the tobit regression models to analyse household willingness to pay for improvement domestic water quantity and quality. The study found that households in urban areas were less willing to pay for water quantity and quality compared to rural households. Besides, the study tried to analyze factors that affect WTP of households and found that the variables household income, water consumption, source of water, age of household head, gender of household head were significant determinants of household WTP.

We may note that water valuation studies conducted in Ethiopia are not on watershed area protection rather on the provision of potable water supply for urban people except a few. In this regard this research will have its own significant contribution on watershed area protection.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Conceptual framework

A conceptual framework serves to describe the overall research steps. The study used both primary and secondary data. For primary data a questionnaire survey, field survey and some interviews was conducted to assess farmers' opinion on the impacts of upstream watershed management on downstream water users and users' willingness to pay for watershed area protection. The samplers for the questionnaire survey were selected by cluster random sampling method and then, simple random sample method is used to select 110 respondents. The parametric technique estimates the preference function, which would allow the calculation of the mean of willingness-to-pay value given the estimated parameters. Finally the definition of variables (factors that affect willingness to pay) and their expected signs are described.

3.2. Description of the study area

3.2.1. Location and accessibility

Gumera watershed, drained by Gumara River, is located in south Gonder zone of the Amhara national regional state, at 624 km north of Addis Ababa. This watershed is part of the Abay basin and more particularly part of Lake Tana sub-basin which is situated on the north eastern side of Lake Tana. It drains Dera, Farta, Fogera and some part of Estie Weredas. The geographical location of the watershed is between $11^{\circ} 34. 41.41. N$ and $11^{\circ} 56 .36.95.N$ latitude to $37^{\circ} 29. 30.48. E$ and $38^{\circ} 10. 58.01. E$ longitude.

Gumera River originates from mount Guna on the high plateau to the east, which is characterized by mountainous, highly rugged and dissected topography with steep slopes and drains to the plain in the west, characterized by valley floor with flat to gentle slopes where the river overflows its bank during the rainy season. As the river flows to the low land area the gradient decreases and forms meander. The main Gumera River covers a total length of about 72 km up to the gauging station. It has diverse altitudinal difference which ranges from 1778 m to 3707 meters above sea level. It is situated in the south east of Lake Tana and eastern part of the Blue Nile and covers a drainage area of about 1464 km².

The main asphalted road from Bahir Dar to Gonder crosses the study area. The area is also accessed by other gravel roads which connect Wereta, Amed Ber, Debre Tabor, Gassay, Mekane Eyesus, Arb Gebeya, Anbesame and Wanzaye.

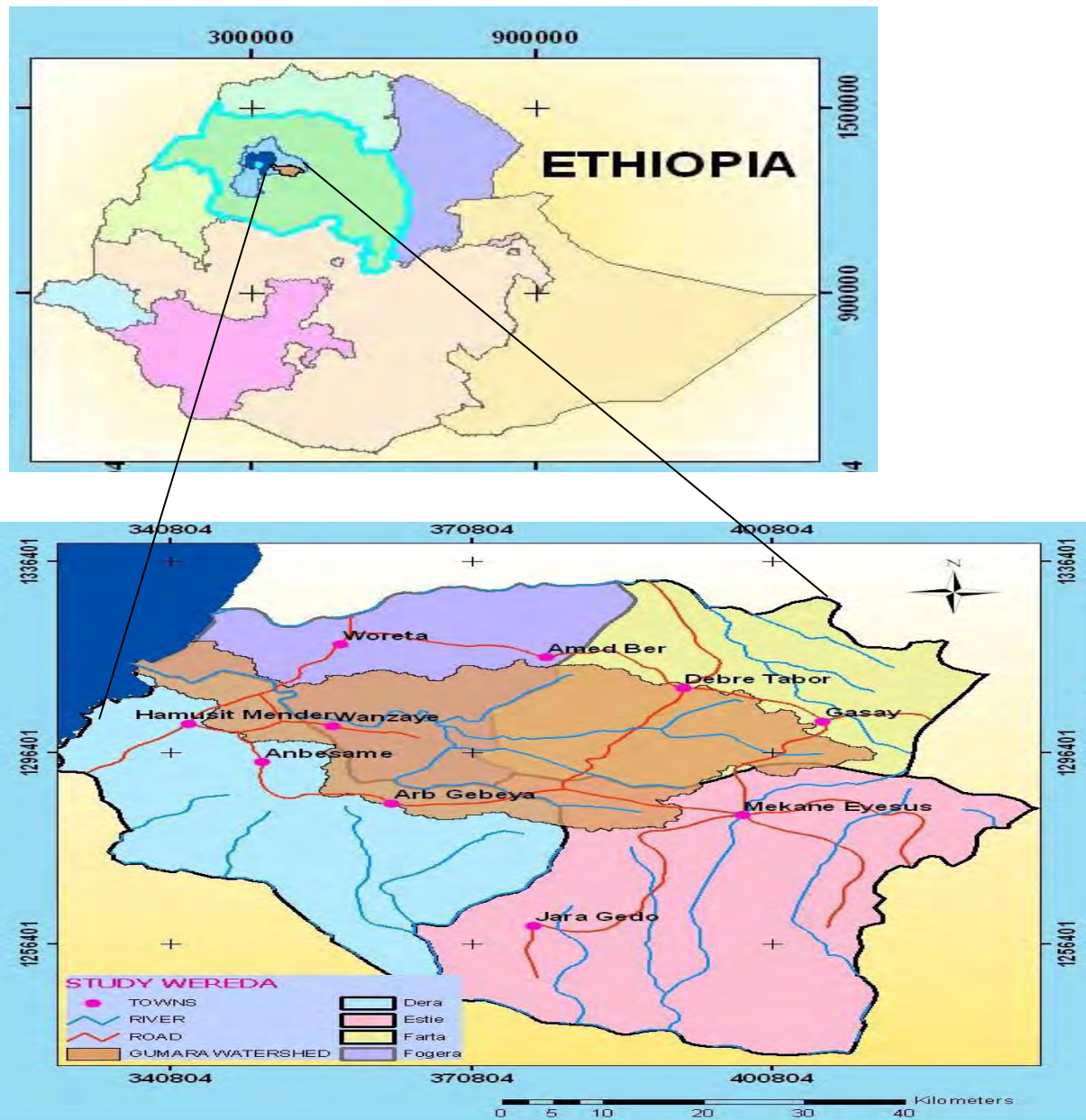


Figure 3.1 Map of the study area: Gumera river and its watershed area (Source: Ministry of Water and Energy)

3.2.2. Topography

Gumera watershed is a land with varying topography ranging from 1778 masl on the flood plain near to Lake Tana to 3707 masl (EMA, 1980) at the high plateau of Guna mountain. Tertiary volcanism and subsequent weathering and denudation processes are responsible for

the present day landscape of the area. The high to low relief dissected hills and mountains are the result of volcanism. Erosion and deposition by major rivers are forming relatively wide, flat and marshy flood plains. The topography of the area has an important contribution for surface runoff and soil erosion processes. Therefore, the topographic effect of the area has significant effect on generation of direct runoff from precipitation and can affect the upstream watershed and downstream users.

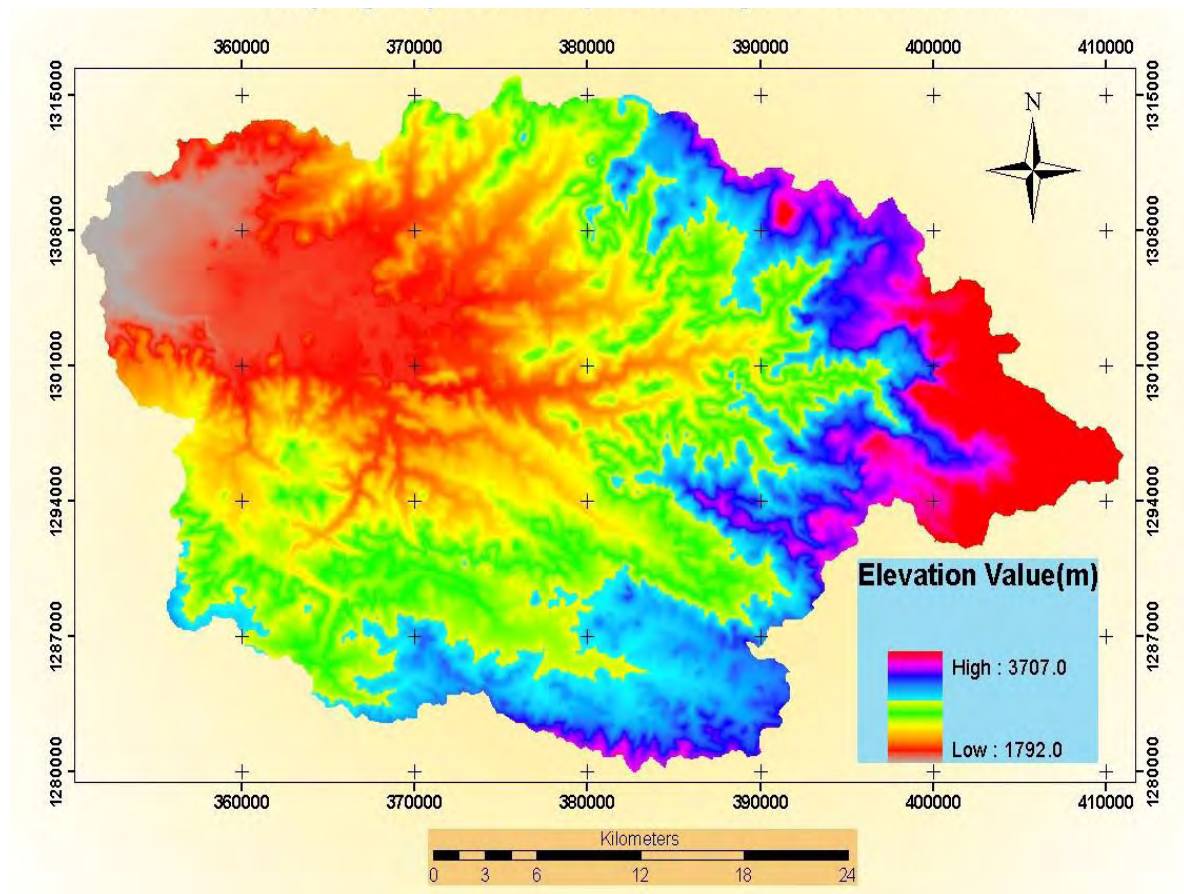


Figure 3.2 Map showing relief of the study area (Source: Ministry of Water and Energy)

3.2.3. Geology

The area is comprises of basaltic and acidic lava flows and falls such as ignimbrite and pyroclastic falls. It is also consists of lacustrine sediments of various sizes ranging from clay through sand and gravel to boulders, especially concentrated along rivers and streams as well as along the side of the lake as a result of recession.

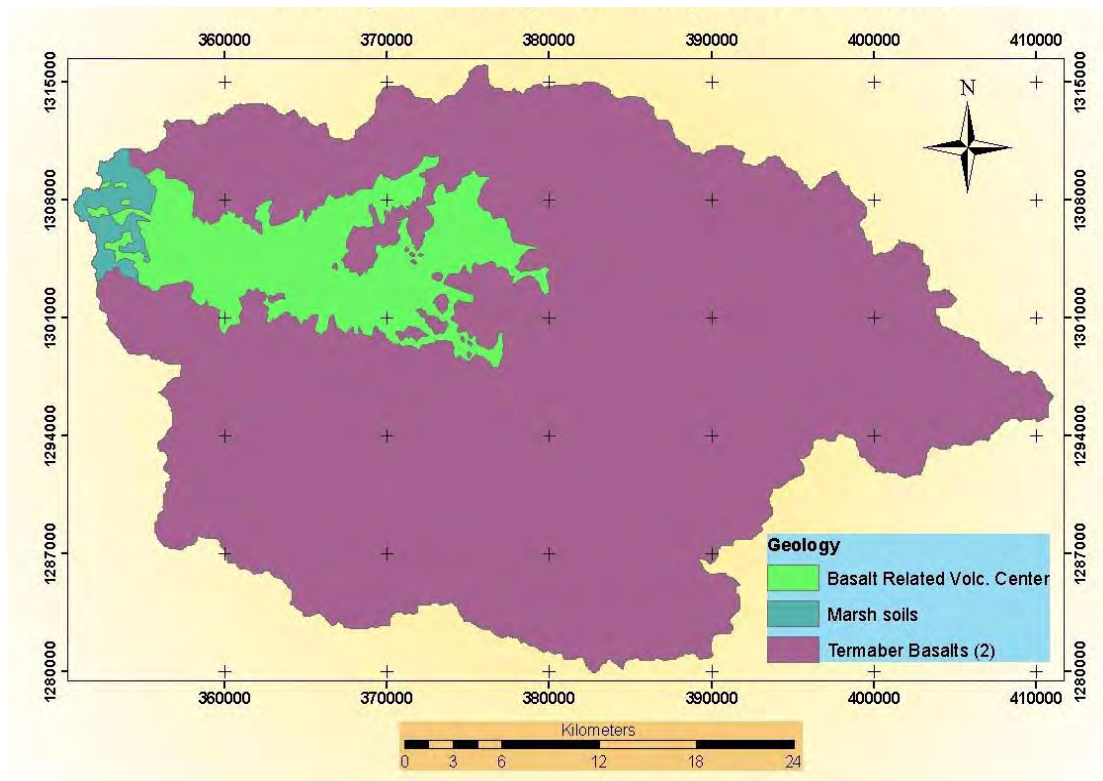


Figure 3.3 Geological map of Gumera watershed (Source: Ministry of Water and Energy)

3.2.4. Soil

The lowland flat plains of the watershed are dominated with Vertisols and Fluvisols which have a dominant textural class of sandy clay and sandy loam respectively. Shallow Leptisols are the dominant soil types found in the mountain and hills of the watershed. Based on FAO classification system, six soil types namely, Haplic luvisol, chromic luvisol, Lithic leptosol, Eutric vrtisol, Eutric Fluvisol and Chromic Cambisol are common soil types in Gumara Watershed (MoARD, 2004; WWDSE, 2007). The watershed is mainly characterized by four major dominant soil groups: Chromic Luvisols, Eutric Fluvisols, Haplic Luvisols and Eutric Leptosols.

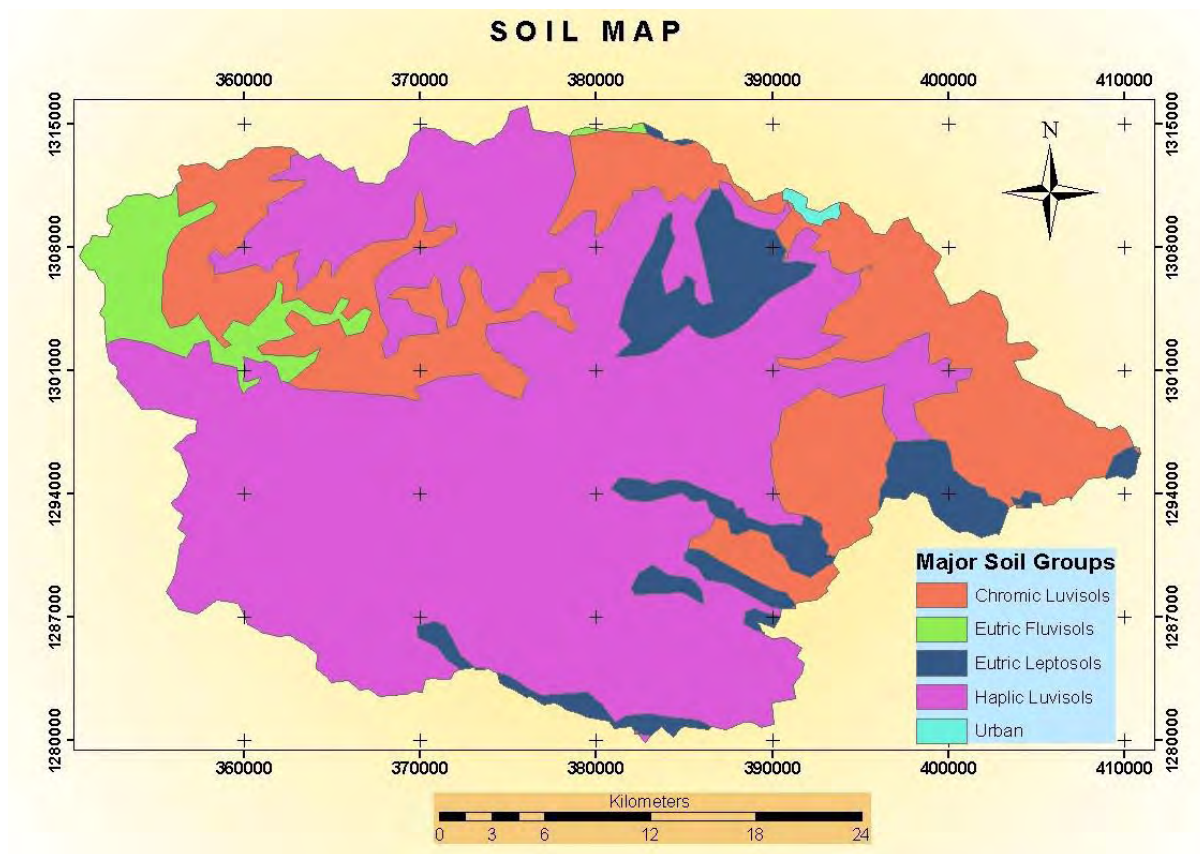


Figure 3.4 Soil map of Gumera Watershed (Source: Ministry of Water and Energy)

3.2.5. Climate

Rainfall: based on the rainfall pattern, the year is divided into two seasons: a rainy season mainly centred on the months of June to September, and a dry season from October to March. April and May are an intermediate season where minor rains often occur. Of the total annual rainfall, 70% to 90% occurs in the June to September rainy season. The mean annual rainfall of the area is 1279mm though there is slight spatial variation within the area (WWDSE, 2007)

Temperature: the mean monthly temperature at Bahir Dar is in the range 16.9 to 21.6° C. The monthly mean maximum temperature varies from 22° C in August to more than 33° C in April; the monthly mean minimum temperature varies from 3° C in January and December to 16.7° C in May. The highest mean temperatures were always in March or April.

3.2.6. Land use

The land use/cover types of Gumara watershed is classified as urban, agriculture, pasture and agro-pasture. In the entire watershed resource-intensive economic activities often precipitate environmental degradation. This is particularly the case when prevailing production and consumption patterns are unsustainable.

Agriculture is the main stay of livelihood in this study watershed. Crop and livestock production are fully integrated and thus the production system can be referred as crop livestock mixed system. Traditionally, rain fed production of cereals, dominated by barley and wheat in upstream area and teff, millet, noug, maize, rice and pulses such as chickpea and rough pea in the downstream, is the main livelihood strategy in the watershed. Bush or shrub land, grazing land, forest/wood land and wetland/swap are other land cover types in the watershed (WWDSE, 2007). Farmers usually have cattle, sheep, goat, horse, and donkey.

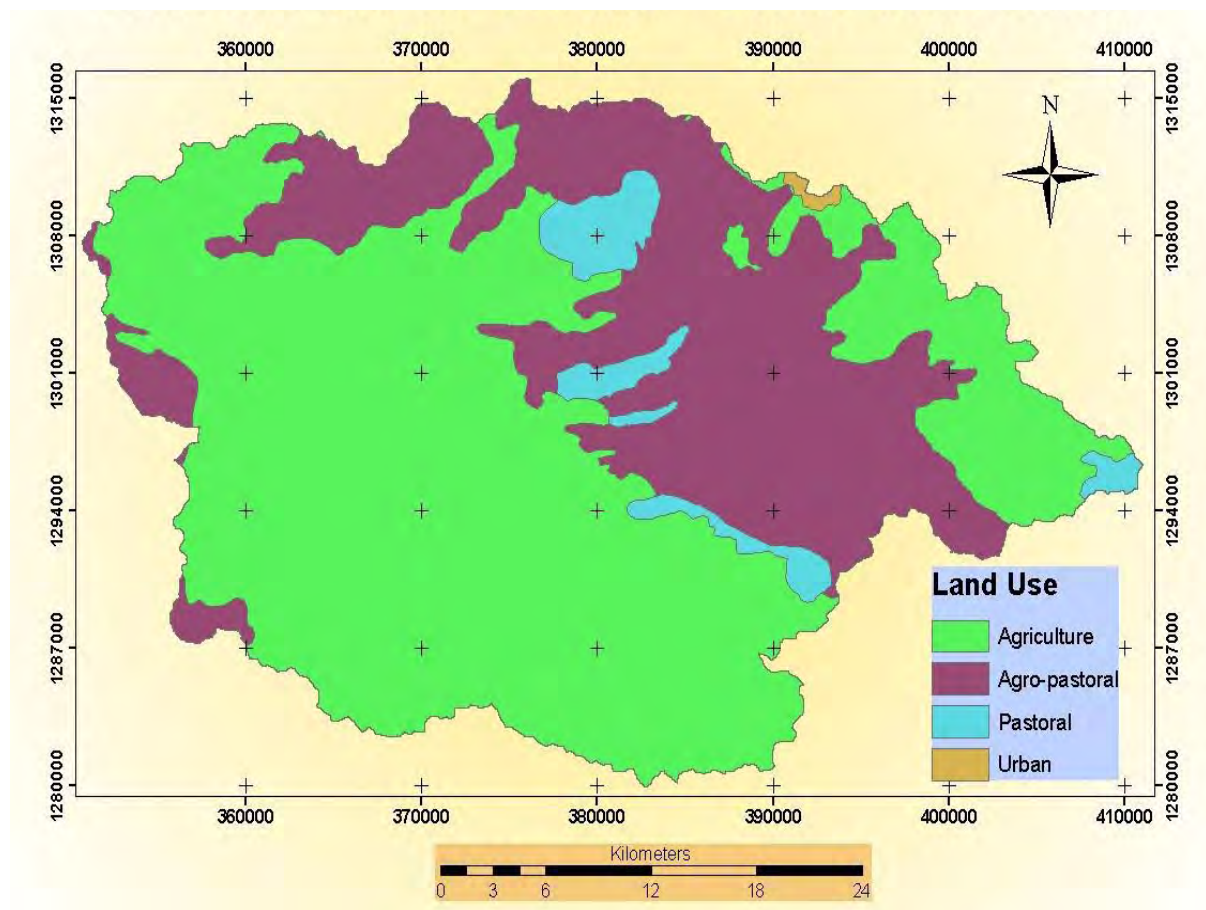


Figure 3.5 Land use map of the study area (Source: Ministry of Water and Energy)

3.2.7. Population distribution

The population in Gumera river watershed area is distributed in urban and rural areas. The population distribution in rural areas is scattered. Gumera watershed drains from Dera, Farta, Fogera and some parts of Este weredas. Areas in which water drains in to the river and having high elevation from other watershed areas with reference to selected watershed are considered as upstream part of the river. In Gumera watershed the planned dam site is located on Sendega River. Using dam site as reference the watershed area is divided as upstream which includes Farta and Misrak Este weredas and downstream which includes Fogera and some parts of Dera weredas. A numerical distribution of populations and households in urban and rural areas is as shown below in the table 3.1.

Table 3.1 Populations and households distribution in urban and rural areas

Geographical Area	Urban population		Rural population		Households	
	male	female	male	female	urban	rural
Dera Wereda	7946	8826	119015	112677	4949	52288
Farta Wereda	3443	3340	115070	110328	2008	49978
Fogera Wereda	12345	12845	104120	99139	7085	45820
Misrak Este Wereda	7013	6888	100542	96382	4028	42524

Source: CSA, 2007

3.2.8. Current watershed area management activities and structures

In Gumera river basin there are watershed management activities. But it is limited to part of land management system only. Activities that are practiced in the river basin are terracing, bounding by check dams and micro basin structures, drainage ditches and water ways, vegetative coverage, mulching, mixed cropping, cover cropping, crop rotation, contour cultivation conservation tillage and land levelling.

On Gumera river basin there is no huge hydraulic structures currently except bridges. But traditional structures like unlined and lined canals, check dams, micro basin, diversion weirs, division boxes and other measuring structures are available.

3.3. Research methods

3.3.1. Data sources

The study used both primary and secondary data. The secondary data were obtained from various sources of the governmental and the non-governmental organizations. Books, journals, internet sources, research reports, and archives were employed for acquiring the necessary information. The primary data were obtained through field survey, questionnaire survey and interview.

3.3.2. Questionnaire survey

3.3.2.1. Questionnaire structure

The questionnaire consisted of three parts. The first section of the questionnaire seeks to generate data on households' actual experience on watershed management concepts. The second section is on contingent valuation (CV) which included the scenario for the respondent and question on household's willingness to pay for watershed area protection. The third part of the questionnaire consists of the socio-economic characteristics of household respondents. In this section of the questionnaire information regarding the socio-economic characteristics (age, education, occupation, sex, income, and other wealth indicators etc...) is collected.

The survey questionnaire implemented consisted of three sections outlined below:

Section	Title
1	watershed management concepts
2	Assessment of willingness to pay for the Gumera watershed area protection
3	Socio-economic information

Section 1 is divided into two parts. The first part inquired on the watershed management and water usage information of the respondents while the second part asked about watershed management negative and positive impacts on downstream users and the main questions asked in this section are about meaning of watershed management, about watershed management activities on Gumera river basin, the importance of managing and protecting the Gumera river watershed area for the households, the impacts of upstream watershed area management activities on downstream water users etc.... The second section highlighted the

hypothetical scenario on the “good” to be valued and questions asked are the willingness to pay for watershed area management activities, the maximum amount (per month) they would be willing to pay, reasons for willing and non-willing etc... and For the last part, socio-economic questions such as age, gender, civil status, education, household’s size, household’s income, ratio of dependent household members and membership in environmental organizations were posed. This information would be necessary in determining the factors affecting WTP and would also allow estimation of population statistics (see all questions in appendix A)

3.3.2.2. Sampling methods

Sampling method determination

In order to meet Objective, a questionnaire survey, field survey and some interviews was conducted with the intention of assessing farmers’ opinions on the impacts of upstream watershed area management on downstream water users and willingness to pay for watershed area protection. The samplers for the questionnaire survey were selected by cluster random sampling method and then, simple random sample method is used to select the respondents. Considering the number of households residing in the study area (Gumera watershed area, some parts of Fogera wereda (ten kebeles)) the study consists a total of 13,964 households (CSA, 2007). Thus, the researcher selected 110 sampling households, which is 8.5% of degree of precision, through random sampling method.

Number of samples determination

Number of samples (sample size) is important for economic reasons: to avoid an undersized study, which can result a waste of resources for not having the capability to produce useful results, and an oversized one, which uses more resources that are not necessary.

The number of samples depends on many factors including:-

- Sampling method,
- Cost consideration
- Minimum acceptable level of precision and
- Confidence level
- Degree of precision

According to Watson, Jeff (2001) the smallest sample size n that gives the desired precision can be computed from the following equation.

$$n = \frac{\left[\frac{P*(1-P)}{(A^2/z^2) + P*(\frac{1-P}{N})} \right]}{R}$$

Where n: sample size required

N: number of households

A: degree of precision or the desired margin of error, expressed as a decimal: (i.e. 0.03, 0.05, 0.085, 0.1 for 3%, 5%, 8.5%, 10%)

Z: based on confidence level: 1.96 for 95% confidence, 1.6449 for 90% and 2.5758 for 99%

P: estimated variance in population as a decimal (0.5 for 50-50, 0.3 for 70-30)

R: estimated response rate, as a decimal

The total number of households considered in Gumera watershed for selected stratum is 13,964. Total numbers of male and female headed households in Fogera Wereda in 10 Kebeles are tabulated under appendix B. For degree of precision 0.085, z value 1.96, variance 0.3 and assuming the response rate is 100%, the total sample size becomes 110.

Cluster sampling

Cluster sampling is a frequently-used, and usually more practical, random sampling method. It is particularly useful in situations for which no list of the elements within a population is available and therefore cannot be selected directly, Well-defined clusters, which will often be geographic areas exist, a reasonable estimate of the number of elements in each level of clustering can be made, and often the total sample size must be fairly large to enable cluster sampling to be used effectively.. As this form of sampling is conducted by randomly

selecting subgroups of the population, possibly in several stages, it should produce results equivalent to a simple random sample.

The sample is generally done by first sampling at the higher level(s) e.g. randomly sampled kebeles, then sampling from subsequent levels in turn e.g. within the selected kebeles sample kebeles, then within these postcodes, the within these households, until the final stage is reached, at which point the sampling is done in a simple random manner e.g. sampling people within the selected households.

One approach for cluster sampling is proportionate clusters (Watson, Jeff, 2001). With proportionate clusters, the sample size of each cluster is proportionate to the population size of the cluster. The cluster expressed as Kebele.

Cluster sample sizes are then given by

$$n_h = \left(\frac{N_h}{N}\right) n$$

Where n_h : the sample size for stratum h

N_h : the household size for stratum h

N : total household size

n : total sample size

Table 3.2 Sample size for each kebeles for N=13,964 and n=110

Sr. No.	Kebeles	N_h	n_h		
			Total	Male	Female
1	Gayion	1439	11	9	2
2	Arida	1381	11	9	2
3	Delemo	891	7	6	1
4	Aba Bunda	1398	11	9	2
5	Guramba	1270	10	8	2
6	Aba Kiros	1242	10	8	2
7	Bebekes	1588	12	10	2

8	Kuhare Mikael	1242	10	8	2
9	Shina	2151	17	14	3
10	Kedest Hana	1362	11	9	2

Source: CSA, 2007

3.3.3. Methods of data analysis

There are a number of different research methods available and one should be selected which is most likely to meet the objective of the research and gather the correct type of information. In order to address the specified objectives and to answer the given research questions, the study analysed the data both qualitatively and quantitatively. The qualitative method was employed to analyse the opinions of farmers'. The quantitative data was analysed using tables, graphs and percentage. The quantitative information from the questionnaire was tabulated and analysed using SPSS. SPSS is a Windows based program that can be used to perform data entry and analysis and to create tables and graphs. Originally it is an acronym of –Statistical Package for the Social Sciences” but now it stands for –Statistical Product and Service Solutions”. It is one of the most popular statistical packages which can perform highly complex data manipulation and analysis with simple instruction.

3.3.3.1. Parametric estimation for CVM

Parametric models allow for the incorporation of respondent characteristics into the willingness to pay function (Haab and McConnell, 2002). This helps describe the behavioural or preference tendencies of the respondents. In effect, the parametric technique estimates the preference function, which would allow the calculation of the willingness-to-pay value given the estimated parameters.

Following Bateman et al., (2002) a bid function can be calculated explaining the variation in WTP response due to the change in the characteristics of the non-market good, in prices of market goods and differences in socio-economic characteristics of respondents such as income. Given the binary nature of the data a probit model is used to estimate farm households' WTP for the provision of watershed area protection. The main objective of estimating econometric model in WTP survey is to calculate mean WTP and to allow inclusion of respondents' socio-economic factors into WTP functions. Incorporation of

respondents' characteristics into the CV model helps the researcher to gain information on validity and reliability of the CV results (Habb and McConnell, 2002).

The basic model to analyse dichotomous responses based on the random utility theory is developed by Hanemann (1984). The central theme of this theory is that although the individual knows his/her utility certainly, it has some components which are unobservable from the view of the researcher. As a result, the researcher can only make probability statement about respondents "yes" or "no" responses to the proposed scenario.

The indirect utility for the jth respondent can be specified as follows

$$U_{ij} = U_i (Y_j, X_j, \varepsilon_{ij})$$

Where Y_j = jth respondents income

$i = 1$ denotes the final state and $i = 0$ the status quo (or the initial state)

X_j = vector of household characteristics and attributes of a given choice

ε_{ij} = random component of the given indirect utility

If a payment (also called the bid value, β_i^*) is introduced due to changes in measurable attributes like quality or quantity of environmental goods, the consumer accepts the proposed bid if and only if $U_{ij} (Y_j - \beta_i^*, X_j, \varepsilon_{ij}) > U_{0j} (Y_j, X_j, \varepsilon_{0j})$

For the researcher, however, the random components of preferences cannot be known and she/he can only make probability statement of "yes" or "no" responses. Thus, the probability that the respondent says "yes" is the probability that she/he thinks that she/he is better off in the proposed program. For individual j, the probability is:

$$P(\text{yes}) = [U_{ij} (Y_j - \beta_i^*, X_j, \varepsilon_{ij}) > U_{0j} (Y_j, X_j, \varepsilon_{0j})]$$

This probability statement provides an intuitive basis to analyse binary responses. Assuming the utility function is additively separable in deterministic and stochastic preferences:

$U_{ij} = (Y_j, X_j) + \varepsilon_{ij}$ Given the additive specification of the utility function the probability statement for respondent j becomes:

$$P(\text{yes}) = [U_{ij} (Y_j - \beta_i^*, X_j) + \varepsilon_{ij} > U_{0j} (Y_j, X_j) + \varepsilon_{0j}]$$

This probability statement is the point of departure for the linear utility function in income and covariates, which is assumed by our empirical models.

The probit model now can be defined as:

$$Y_i^* = \beta' X_i + \varepsilon_i$$

Where:- β' is vector of parameters of the model

X_i is vector of explanatory variables

ε_i (the error term) and is assumed to have random normal distribution with mean zero and common variance δ^2 (Greene, 2003).

Y_i^* is unobservable households' actual WTP for the provision of watershed area protection.

Y_i^* is simply a latent variable. What we observe is a dummy variable WTP_i , which is defined as:

$$Y_i = WTP_i = 1 \text{ if } Y_i^* \geq \beta_i^*$$

$$Y_i = WTP_i = 0 \text{ if } Y_i^* < \beta_i^*$$

In the single bounded elicitation format the j th respondent is asked if he/she is willing to pay the proposed bid value, to get say a given improvement in environmental quality, quantity or both.

Thus, for example, the probability that a household is willing to pay to assure the sustainability of a watershed area is given by:

$$\begin{aligned} \Pr(Y_i = \frac{1}{X_i}) &= \Pr(Y_i^* \geq \frac{\beta_i^*}{X_i}) \\ &= \Pr(X_i \beta' + \varepsilon_i \geq \frac{\beta_i^*}{X_i}) \\ &= \Pr(\varepsilon_i \geq -X_i \beta' + \frac{\beta_i^*}{X_i}) \end{aligned}$$

If we assume the distribution is symmetric

$$\Pr(Y_i = \frac{1}{X_i}) = \Pr(\varepsilon_i \geq -X_i \beta' + \frac{\beta_i^*}{X_i})$$

= F(X_i, β') Where F is a cumulative distribution function (Cdf). Depending on the assumption on the distribution of the error term we can estimate the probability either using logit or probit model. In this case the main assumption is the error has mean zero and constant variance δ² to have a probit model (Greene, 2003).

Note that the probability that the household is not willing to pay (0 values) for the proposed bid is given by:

$$\Pr(Y_i = \frac{0}{X_i}) = \Pr(Y_i^* < + \frac{\beta_i^*}{X_i}) = 1 - \Pr(Y_i = \frac{1}{X_i}) = 1 - F(X_i, \beta')$$

The standard approach to estimating binary choice models according to Greene (2003) is the MLE (maximum likelihood estimation).

The resulting log-likelihood function (n) for the responses to a CV survey for a sample of n observations is.

$$\ln L(Y, X, \beta) = \sum_{i=1}^n \{ Y_i \ln F(X_i' \beta) + (1 - Y_i) \ln [1 - F(X_i' \beta)] \}$$

$$\text{or } \ln L(Y, X, \beta) = \sum_{i=1}^n \{ Y_i \ln P_i + (1 - Y_i) \ln (1 - P_i) \}$$

Where: P_i is the probability of the respondents to choose the environmental improvement and

(1-P_i) is the respondents' probability of choosing no for the proposed bid.

Where p=1 if the ith response is yes and zero otherwise.

Based on the above justification, we specify the probit model for households' preferences for the watershed area protection services as follows:

$$WTP_i = \alpha + \beta_1 \text{INCOME} + \beta_2 \text{EDU} + \beta_3 \text{BIDV} + \beta_4 \text{OFA} + \beta_5 \text{MARKA} + \beta_6 \text{RDHM} +$$

$$\beta_7 \text{FHHS} + \beta_8 \text{HHS} + \beta_9 \text{AGE} + \beta_{10} \text{MStatus} + \beta_{11} \text{MENORG} + \varepsilon_i$$

Where WTP is response to the bid price =1 if the response is yes, = 0 if the response is no, α is the intercept (constant) term, β_i is regression parameters, ε_i is the error term and the explanatory variables will be defined under the variable description sections (3.4) latter. The regression parameters will be estimated by Maximum likelihood technique.

One of the main objectives of estimating empirical WTP model based on the CV survey response is to derive mean of the WTP distribution (Hanemann, Loomis and Kanninen, 1991). For the open ended contingent valuation survey responses the maximum willingness to pay figures reported by the respondents can be simply be averaged to produce an estimate of mean willingness to pay:

$$\text{Mean WTP } (\mu) = \sum_{i=1}^n \left(\frac{Y_i}{n} \right)$$

Where n is the sample size and each y is reported willingness to pay amount by surveyed households (Habb and McConnell, 2002).

3.4. Definition of variables and their expected signs

INCOME (annual income in birr) - household annual incomes impress positive effects on WTP since they indicate a higher ability to pay.

HLEDU (house hold level of education) - the hypothesis here is respondents with higher education are more aware of the benefit of watershed area protection. So a positive relationship is expected between the level of respondents' education and their willingness to pay for environmental improvements. A dummy variable 1 is specified for those who attended formal education and 0 otherwise.

BIDV (bid value)- there are two ways to fix the bid value for watershed area protection. The first one, by listing out the watershed area management activities and allocating the fund or by doing cost breakdown for each activities and then divide the total cost to the total household. In this case bid value is equally distributed for all households. But there are rich and poor households which cannot pay equally. The second way is fix the bid value randomly starting from zero and ending to an open ended value and asking households how much they are willing to pay. The second way considers the potential of the households and leads the households for participating for the watershed area protection fee. In this research the second

way is preferred and the bid value fixed are: - **0, 10, 20, 50, 100, 200, 250, 300, 400, 500**. The bid value (WTP Amount) is expected to negatively affect WTP. This is supported by the economic theory that as prices increase the demand for the good, or in this case willingness to pay for watershed protection services, decreases

OFA (off- farm activities) – this is a dummy variable OFA=1 if the respondent participates in off farm business and 0 otherwise. Participation of households in off-farm activities may have different effects depending on their returns. If households believe that irrigation agriculture has a lower expected return than the off-farm business, they may not place a high value on the sustainability of watershed area

MARKA (respondents market access) - access to markets is measured as the time required walking to the nearest market. As the time to travel to gain market access increases, this may decrease the probability that a household would be willing to pay for a sustainable watershed area. So a negative relationship is expected.

RDHM (ratio of dependency household members) – this is the ratio of dependent household members to the number of economically active family members. This variable is expected to have a negative effect on farmers' willingness to pay.

FHHs (female headed households) – this is a dummy variable where 1= the presence of a female-headed household, and 0 otherwise. The assumption is female headed households more often have access to different packages of agricultural training relative to their small number in the study area. This may contribute toward a positive attitude towards the sustainability of watershed area.

HHS (household size) - this is the family size measured as the total number of people in the respondent's household. A negative relationship is expected between family size and the probability of choosing an improved environment due to the fact that households' expenditure for consumption will be high. It is expected that the more people live with the respondent the less willing to pay due to more expenses for the household.

AGE (age of the respondent) - age could have both positive and negative effects depending on how they value future use. Older respondents may already be thinking of future generations' downstream water users and would like them to have a guaranteed positive

upstream watershed area impact on downstream users while younger ones may highly value it because of the longer life expectancy argument, which gives them more chances from benefiting from the good.

MSTASUS (marital status) - an effect is sometimes found; although a priori there is no expectation on the direction of the effect. The other socio-economic variables indicate respondents' ability/inability to pay. Those who can afford more would be willing to pay a higher amount. This is a dummy variable where 1= if the respondent married and 0 otherwise.

MENVTORG (Membership in environmental organizations) – it is expected to influence WTP in a positive direction because of more environmental concern or awareness of those who are part of such organizations. This is a dummy variable where 1= if the respondent are membership in environmental organizations and 0 otherwise

CHAPTER FOUR

4. RESULT AND ANALYSIS OF THE SURVEY DATA

This section of the study addresses the following main issues: The first section provides descriptive statistics of the socio-economic survey results. The second section presents Information about Watershed management and water. The third section presents description about Watershed management impacts. Section four presents willingness to pay (WTP). The final section of the chapter presents multivariate analysis of determinants of households WTP.

4.1. Socio-economic characteristics of the surveyed households

This study is conducted based on a sample of 110 farm household respondents in the downstream water users' area. The mean household size of respondents was 5.75 with a minimum of 1 and a maximum of 10. The total respondents (100%) were engaged in farming activity. The data on age tells a wide range of responses starting from 20 to 62 years and the average is found to be 38 years.

Table 4.1 Descriptive statistics of the socio economic characteristics of the respondents

variable	number	min	max	(%)	mean	Std. dev.
Age(yrs.)	110	20	62	100	37.93	10.61
Gender: Female headed HH	20	0	1	18.18	0.91	0.39
Marital status: Married	90	0	1	81.2.	0.82	0.39
Education attainment	88	0	1	80.00	0.80	0.40
Households size(No)	110	1	10	100.00	5.75	2.02
yearly income(ETB)	110	3400	554000	100.00	64023.64	97622.72
Membership of an environmental organization	69	0	1	62.70	0.63	0.49
Bid value payers(ETB)	100	0	2000	90.91	193.18	307.01
Off- farm activities	16	0	1	14.50	0.15	0.35
Ratio of dependent Households member	110	0	.71	100.00	0.46	0.21
respondents market access(hrs)	110	0.5	6	100.00	3.10	1.07

Of the total number of household heads, only 18.18% were female while the remaining 81.82 were male headed households. The average educational attainment of household respondents was 0.82. Out of the total number of household respondents 88(80%) are attending formal education. The observed average household yearly income is birr 64,023.64. The income level ranges from a minimum of birr 3,400 to a maximum of birr 554,000 per year. The survey data also shows 14.50% of the households are engaged in off farm activity to earn additional income. From the total number of household heads 69(62.70%) are membership of an environmental organization. household respondents takes an average time of 3 hours with a minimum of half an hour and a maximum of six hours to travel from their home to market .

4.2. Information about watershed management and water

Respondents were asked their understanding about watershed management. They understand that, 98.18% as land management, 23.64% as water management and 32.73% as biomass management (see table 4.2). Among the respondents, 94.54% knows the watershed activities which are done currently in the watershed area. But 5.46 % of them have no information about watershed management whether the activity is practicing or not. 94.54% respondents which know the current activity categorise the management as 98.18% as land management, 23.64% as water management and 32.73% as biomass management.

Table 4.2 Respondents understanding about watershed management

Activity	Frequency	Percentage (%)
land management	108	98.18
water management	26	23.64
biomass management	36	32.73
Total	-	-

Total may not add-up to 100% due to multiple responses

Those respondents who know about the watershed were also asked for their view regarding the importance of protecting it. An overwhelming majority of 102 out of the 110 sample respondents or around 92.73% agreed to the value of keeping it protected. The top two reasons why watershed protection is viewed as essential are (1) it minimizes floods during the rainy season (2) Its water absorption and makes this available for future use (see Table 4.3). Its role in improving water quality and providing a more sustainable water supply is

recognized by 61.82% and 29.10% of sample respondents, respectively. 21.82% are especially concerned about the destruction of forest and nature.

Table 4.3 Reasons for Watershed management importance's

Indicator	Frequency	Percentage
It provides a more sustainable water supply	32	29.1
It improves water quality	68	61.82
It minimizes floods during the rainy season	102	92.73
It absorbs water and makes this available for future use	70	63.64
Avoids forest/nature destruction	24	21.82
Total	-	-

Total may not add-up to 100% due to multiple responses

The downstream water users use 69.10% of the river water for their cattle's, 70.91% for Irrigation, 54.54% for drinking, 54.54% for food cooking and 58.18% for cloth washing. From the survey the respondents use the river water mainly for irrigation and for their cattle's.

Table 4.4 Purpose of Gumera river water for sampled households

Purpose of Gumera river water	Frequency	Percentage (%)
For Irrigation	78	70.91
for drinking	60	54.54
for their cattle's	76	69.1
for food cooking	60	54.54
for cloth washing	64	58.18
Total	-	-

Total may not add-up to 100% due to multiple responses

Less than half of the sampled households 47.27% get all ways polluted water and 56.36% get usually polluted water. The major causes of pollution is the characteristics of upstream watershed area(81.82%) like steepness of the area which causes erosion, heavy rainfall that produces runoff (76.36%) and activities performed by upstream land users like

deforestation(69.10%), overgrazing(16.36%), up and down ploughing, not practicing crop rotation(9.10%), intensive cultivation(30.91%). Wastes from homes, clinics and hospitals, schools and towns, which contain different chemicals that affect the water by changing its colour, Oder or tastes and solid materials, affected the quality of water by 14.54 (%). The contribution of construction activities and Industrial wastes in polluting the Gumera river water is negligible.

Table 4.5 Main causes of water pollution on Gumera river watershed area

Causes	Frequency	percent
Steepness of watershed area	90	81.82
Intensive cultivation of watershed area	34	30.91
Heavy rainfall	84	76.36
Deforestation	76	69.10
Overgrazing	18	16.36
up and down plugging and not Practicing crop rotation	10	9.10
wastes from homes, clinics, hospitals, schools and Towns	16	14.54
Industrial wastes	0	0
construction activities	0	0
Total	-	-

Total may not add-up to 100% due to multiple responses

Among the respondent households 76.36% can get sufficient water for their demand from Gumera River. The quantity of water evaluated by respondent households is shown below in table 4.6. 34.55% of respondents answer about the water amount as too excess, 23.64% of total says it is sufficient, 36.36% says satisfactory while 5.45% says less relative to users demand.

Table 4.6 Water quantity evaluation by respondent households

	Frequency	Percent
Too excess	38	34.55
The water is sufficient	28	23.64
satisfactory	40	36.36
Less relative to users demand	6	5.45
Too less	0	0
total	110	100

The water quantity problems are perceived by the respondents to be mainly caused by the increasing number of water users, water management problem and deforestation (Table 4.7). Water way structures blockage and water distribution scheduled has no effect on water quantity according to respondents. Very few (9.10%) associate it with insufficient or defective water facilities and low river outflow. Although the threat to water posed by the growing number of users recognized, the last two points suggest that more efforts must be exerted from both the water district and Governmental bodies.

Table 4.7 Reasons for water quantity problems in percent to total respondents

Cause	Frequency	percent
Water way structures blockage	0	0
Increasing number of water users	24	21.82
Water management problem	20	18.18
The water distribution scheduled problems	0	0
Deforestation	20	18.18
Insufficient or defective water facilities and low water outflow	10	9.1
Total	74	67.28

Above half of the respondents (74.54 %) state that everybody has responsibility to protect the watershed area to get good quality and quantity of water. Despite the fact that their environmental awareness is at the high level even if the percentage of getting training is below half(45.45%), it is observed that they participate in any organization (local /national) at the level of 62.7 %. In addition, only 67.27 % of the respondents participated in the meetings related Gumera river watershed problems.

4.3. Description about watershed management impacts

Even though knowing the impacts of upstream watershed management is vital, 5.45 percent of sampled households on downstream Gumera river water users have not knowledge about the impact of the activities. If the management activities are practiced the impact is positive otherwise negative. According to the sample households result the watershed management has a great positive impact (70.91%) on downstream users.

On Gumera river there is no huge hydraulic structures except bridges. But traditional structures like unlined canals, check dams, micro basin, ayibero basin, trench, diversion weirs and other measuring structures are available. Upstream watershed area management problem makes hydraulic and road structures useless, depositing silts in hydraulics structures, blocking of hydraulics structures and disposing of hydraulics structures by 43.65% and increasing of structures maintenances cost by 12.73% (see table 4.8). The cumulative effect results improper use of water and face water shortage which cause reduction in yield of the water users.

Table 4.8 Negative impacts on hydraulics structures if watershed management activities are not practiced

Impacts	Frequency	Percent
Making hydraulic and road structures useless	10	9.1
Depositing silts in hydraulics structures	16	14.55
Increasing of structures maintenances cost	14	12.73
Blocking of hydraulics structures	10	9.1
Disposing of hydraulics structures	12	10.9
Total	-	-

Total may not add-up to 100% due to multiple responses

According to the respondents response their land is affected by Erosion problem, adding of extra chemicals on the farm, dumping of silts on the tilling area and destruction of crops, productive lands, fences, and livestock due to flooding. This effect comes due to uncontrolled upstream watershed area.

Table 4.9 Negative impacts on downstream farms/plots if watershed management activities are not practiced

Impact	Frequency	%age
Destruction of crops, productive lands, fences, livestock due to flooding	32	29.1
Water quality disturbance (pollution)	54	49.1
Reduction of water quantity	68	61.82
Erosion problem	42	38.18
Adding of extra chemicals on the farm	26	23.64
Reduction in yield	48	43.64
Dumping of silts on the tilling area	30	27.27
Total	-	-

Total may not add-up to 100% due to multiple responses

Community conflicts are the main problem in which downstream communities' face (41.82%) due to shortage of food and water (40%) resulting from watershed management problem. This community conflicts form unsmooth relation with upstream community (27.72%) and blocking of marketing relation between up and downstream users (see table 4.10).

Table 4.10 Negative impacts on downstream communities' social and economical interaction if watershed management activities are not practiced

Impact	Frequency	percentage
Following of disease	44	40
Shortage of food and water	44	40
Community conflict	46	41.82
Disposing of population	18	16.36
Income from the tourists will reduce	0	0
Formation of unsmooth relation with upstream community	30	27.27
Blocking of marketing relation between up and downstream users	34	30.91
Destruction of homes and human lives due to flooding	12	10.91

Total	-	-
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Total may not add-up to 100% due to multiple responses

If there are watershed management activities on the upstream area positive impacts like leading to good water management, minimizing floods during the rainy season, provides more sustainable water supply, absorbing water and makes this available for future users, improving users income, occurs finally. Sampled households responses about the positive impacts shown in table 4.11 below.

Table 4.11 Positive impacts on downstream water users after watershed management activities practiced

Positive impact	Frequency	percentage
Leads to good water management	24	21.82
Links upstream land users and downstream water users politically, Economically, and by their social life.	36	32.73
It minimizes floods during the rainy season	84	76.36
It improves water quality	68	61.82
Provides more sustainable water supply	42	38.18
improve users income	36	32.73
It absorbs water and makes this available for future users	48	43.64
Total	-	-

Total may not add-up to 100% due to multiple responses

4.4. Willingness to pay (WTP)

In the CV questions, people were asked how much they are willing to pay for the improvement of the Gumera river watershed management to improve water quality, quantity and other uses. The data obtained was entered and analyzed using statistical technique SPSS which is appropriate for the type of the question. Comparing percentages of “yes” responses and “No” responses bids, the sample had 90.91percent saying “yes” and 9.09% saying “No” bid amount they bid while 6.4 percent of the respondent households are willing to pay the highest amount in the questioner which was 500 Birr.(table4.12).

Table 4.12 Frequency distribution of respondents bid amount they would pay

WTP amount (Birr per year)	Frequency	percentage
0	10	9.10
10	6	5.50
20	2	1.80
50	29	26.40
100	22	20.00
200	16	14.50
250	2	1.80
300	5	4.50
400	7	6.40
500	7	6.40
1000	2	1.80
2000	2	1.80
total	110	100

A large share of the respondents is willing to pay for the watershed protection even at the highest price level. The reason could have been that they want to use irrigation for their plot and needing a good quality and quantity of water for different purpose.

As the price of the good or service increases, the respondent is less willing to purchase the good. However, for the Ethiopia 50 birr per year, more people are willing to pay. Protest responses were also screened to isolate respondents with a “no” valuation for watershed protection. To allow protest screening, respondents with a “no” response to the referendum question were asked to give their reason for voting no. Bautista (2003) offers various conditions on why beneficiaries of watershed protection services would not be willing to pay. Non-willingness to pay may be associated with communities recognizing their rights to good water quality, quantity and that access to it has no constraints; users are already used to obtaining services for free; there is no existing law requiring them to pay; inability or lack of income to pay; and high resistance from powerful entities.

For the survey, the main motive given by those non-willing to pay is I am not irrigation beneficiary from the river, I do not have enough money and only the rich households should pay by the household which is considered to be a valid “no” response or zero bid (table 5.12). This is crucial to the study because otherwise, the sample would be dominated by protest responses. Should the results reveal protest response dominance, the study would fail and the derived WTP estimates would not be credible. Though the second and third main reasons cited, the “belief that it is the responsibility of the government to finance the activity” and the “mistrust of the institution who would manage the funds”, are both classified as protest responses, “no-voters” citing other protest reasons are minimal and total protest responses do not dominate.

Table 4.13 Sample household reasons for non-willingness to pay

Main Reason	Frequency	%age
I am not beneficiary from the river water	10	9.10
I am satisfied with the existing watershed management	0	0.00
I do not have enough money	8	7.27
Only the rich households should pay	10	9.10
Poor people will be affected	4	3.64
Those who consume more must pay	0	0.00
I know that the money will not be used properly	0	0.00
It is the responsibility of the government to finance	8	7.27
I do not believe that pay will result in improved watershed management	0	0.00
I cannot afford to pay any additional amount what I am currently paying as a tax	2	1.8
It is not our obligation	0	0.00
Total	-	-

Total may not add-up to 100% due to multiple responses

For the purpose of this study, the model, which adjusts “yes” responses with respect to certainty and considers “no” responses as legitimate zero valuation will be adopted. It can be argued that a referendum CV survey would be less concerned whether the zero response represents a true valuation and would be more focused on whether it reflects intended behavior (Lindsey, 1994 in Indab). Protest responses are said to be mostly legitimate influences on actual behavior.

To determine what motivates people to be willing to pay, respondents who were willing to pay the bid price were asked to identify their reasons for their willingness to pay for watershed protection. Bautista (2003) also provided possible explanations on willingness to pay of beneficiaries for watershed protection services. Beneficiaries would likely be willing to pay if there are threats to their present water usage; if future supplies are uncertain and they would like to guarantee their future needs; if there is an explicit policy mandating users to pay and the government is capable of enforcing such a rule, thus, discouraging free-riding; if utility of the service to their economic activities is clearly realized; and if there is confidence on the proper use of funds. For the study, 72.73% of respondents specified that they want the watershed to continue producing other environmental services like flood control, biodiversity conservation, recreation and carbon sequestration, 67.27 percent of respondents specified that they would like a more reliable water supply and 61.82 percent valued watershed protection for the sake of future generations (table 4.14). Other reasons cited include preventing downstream negative impacts (16.36%), believing that the administration will do a good job in administering the fund (21.82%), and acknowledging that it is their duty as water users (34.54%).

Table 4.14 Sample household reasons for willingness to pay

Main reason	Frequency	percentage
It is my duty as a water user	38	34.54
I want more reliable water	74	67.27
To prevent downstream negative impacts	18	16.36
I want the watershed to continue producing other environmental Services like flood control, biodiversity conservation, recreation And carbon sequestration	80	72.73
I would like the future generation to have reliable water	68	61.82
I believe that the administration will do a good job in administering the fund	24	21.82
Total	-	-

Total may not add-up to 100% due to multiple responses

The survey result indicates 61.82% respondents want practicing of terracing and bunding, 58.18 % needs drainage ditches and water ways constructions and thirdly they want constructions of gully erosion controllers and runoff collectors (47.27%). Other mitigation measures respondents want to practices are grass land management, vegetation covers, plant protection and forest management and conservation (23.64%), coordination of health and sanitation programs (21.82%), formation of learning community a sustained basis (18.18%), for cultivation of shrubs and herbs, contour cultivation and conservation tillage (14.45%), for land levelling and crop rotation forming system (12.73%) and for income and employment generation activities (18.18%).

Table 4.15 Mitigation measures in which sample respondents want to practice in %

mitigation measures	Frequency	percentage
Terracing and bunding	68	61.82
Stream bank stabilizers and land slide controller	14	12.73
For gully erosion controllers and runoff collectors	52	47.27
Drainage ditches and water ways constructions	64	58.18
For grass land management, vegetation covers, plant protection and forest management and conservation	26	23.64
For cultivation of shrubs and herbs, contour cultivation and Conservation tillage	16	14.45
For land leveling and crop rotation farming system	14	12.73
For income and employment generation activities	20	18.18
Coordination of health and sanitation programs	24	21.82
Formation of learning community a sustained basis	20	18.18

Total may not add-up to 100% due to multiple responses

Respondents' strongly recommend that negative impacts are reduced by the contributing money for the maintenance of conservation measures by beneficiary households(70.91%) and by covering all the costs incurred to watershed management by government (46.36%) and finally the people have to take the responsibility to manage it properly after finalization takes (22.73%). Watershed management should be provided (2.73%) for areas that has no watershed management.

Table 4.16 Respondents' recommendation to reduce negative impacts of Watershed management

Recommendations	Frequency	percentage
Government has to cover all the costs incurred to watershed management	51	46.36
The people have to take the responsibility to manage it Properly after finalization	25	22.73
Beneficiary households has to contributes money for the maintenance of conservation measures	78	70.91
Watershed management should be provided	3	2.73
Total	-	-

Total may not add-up to 100% due to multiple responses

The respondents argued that the collected money should managed by the commute which will be selected from the community (54.54%), the wereda administrator (32.73%), the kebele manager (likember) 18.18% and NGOs (12.73%). The study result shows that communities' initiation for development, i.e. watershed area protection, and there believes to each other because above half of them argued on their own commute.

4.4.1. Correlations between willingness to pay (WTP) and other variables

The average household size for willing and non-willing households is 5.59 and 6 respectively. The average dependency ratios for willing and non-willing households were about 0.4595 and 0.4294 respectively. This means in each household member on average there is one economically inactive individual dependent on an economically active member of the family. There is no significant difference between willing and non-willing households in household size and dependency ratio. The respective average age for willing and non-willing households is 37.89 and 38.7 years. The age difference is not significant. Of the sample of 110 respondents 90.91% were found to be willing to pay the proposed bid price for Gumera river watershed protection activities and other purposes, the remaining 9.09% not accepting the proposed bid price. The respective averages for willing and non-willing female headed households are 0.95(17.27%) and 0.05 (0.9091%) and the group difference is found to

be significant and similar with the expected value. The group comparison in terms of education between those willing to accept the proposed bid price and refused to accept the proposed bid price shows the mean educational attainment for willing and non-willing households is 0.60 and 0.16 respectively. Income was found to be significantly different between willing and non-willing respondents 70,062.50 and 36,350 respectively. It was also noted 16% of the willing households were engaged in off arm activity to enhance their income and no non-willing households engaged in off arm activity. From married respondents (90) 91.10% have willingness to pay while from unmarried respondent (20) 90% have willingness to pays. Therefor the difference in marital status is not significant. Respondents participated in environmental organizations have more willingness to pay (94.22%) than non-participated respondents in environmental organizations (85.36%). so being membership of environmental organizations influence in a positive direction as expected.

We also find that young household heads are equally willing to pay for the protection watershed area by downstream water users association. The average maximum willingness to pay for the total sampled households is about 193.18 birr per year /household. The maximum willingness to pay ranges from 0 birr to 2000 birr per household per year. (see table 4.1).

4.5. Multivariate regression analysis of determinants of households' WTP

Multivariate regression analysis helps analyze WTP responses by determining if WTP estimates are internally consistent or theoretically valid. This model would permit identification of the factors that influence respondents' WTP and checking if directions of effects are consistent with theoretical expectations. Table 4.17 contains the complete multivariate regression results.

In the multivariate regression analysis, only four explanatory variables were found to significantly influence willingness to pay for the Gumera river watershed area protection, the annual household income in birr, household size, respondents' market accesses and bid value per year (see table 4.17). This is consistent with the priori expectation that the bid value, household size and respondents market accesses would influence peoples' willingness to purchase the good. The bid value, household size and respondents market accesses are negatively influence WTP indicating that the higher the bid value, household size and the time to travel to gain market access increases, the less likely respondents would be willing to

pay in support of the Gumera river watershed area protection. On the other hand, household income affects WTP in the positive direction. The higher the household income, the more people will want to pay. Lastly, observing consistency of signs of coefficients of explanatory variables presents an indication of the theoretical validity of the model.

Table 4.17 Probit regression results for multivariate analyses, parametric coefficients

WTPi	Coefficients	Std. error	z	p>z	95.0%	
					Confidence Interval	
(Constant)	.725	.215	3.366	.001	-.297	1.152
Female headed household size	.064	.154	.311	.756	-.258	.353
Age of the respondent	.051	.004	.318	.751	-.007	.010
Marital status of the respondents	.080	.155	.388	.699	-.247	.367
Household level of education	.100	.087	.820	.414	-.102	.245
Household size	-.146	.025	-.834	.406	-.071	.029
Ratio of dependent household members	.166	.178	1.272	.207	-.127	.579
Annual household income in birr	.0045	.000	.422	.674	.000	.000
Off-farm activities	.113	.092	.996	.322	-.091	.275
Respondents market access in hours	-.052	.031	-.458	.648	-.075	.047
Membership in environmental organizations	.072	.067	.638	.525	-.091	.176
Bid value per year	-.158	.000	1.498	.137	.000	.000

Source: SPSS analysis of survey data

4.5.1. Calculating mean WTP using the probit model estimation results

One of the main objectives of estimating empirical WTP model based on the CV survey response is to derive central value (or mean) of the WTP distribution (Hanemann, Loomis and Kanninen, 1991). One objective of estimating the probit model is to calculate the mean willingness to pay for watershed area protection by running a regression of the binary choice variable on the bid values.

$$WTP_i = \alpha + \beta_1 INCOME + \beta_2 EDU + \beta_3 BIDV + \beta_4 OFA + \beta_5 MARKA + \beta_6 RDHM + \beta_7 FHHS + \beta_8 HHS + \beta_9 AGE + \beta_{10} MStatus + \beta_{11} MENORG + \epsilon_i$$

$$WTP = \mu = \alpha + \sum_{i=1}^m \beta_i \mu_i + \epsilon_i$$

Where β_i -are the coefficient of the i th explanatory variable

μ_i - are the mean of the i th explanatory variables

α -is the intercept (constant)

m - is number of variable and

ϵ_i - is the error term for the explanatory variables

Using the estimates in table 4.17 and the above equation the mean willingness to pay from single bounded elicitation were found to be birr 259.87 birr per household per year.

To determine the mean willingness to pay from the open ended follow up questions we simply averaged the maximum willingness to pay figures across respondents as follows:

$$\text{Mean WTP } (\mu) = \sum_{i=1}^n \left(\frac{Y_i}{n} \right)$$

Where n is the sample size and each y is a reported willingness to pay amount by surveyed households (Habb and McConnell, 2002). The mean willingness to pay estimated from the sampled households were reported as birr 193.18 per year per household. Clearly the mean

willingness to pay estimate from the single bounded elicitation is much higher than the open ended elicitation which is in line with results from other studies.

4.5.2. Estimating total WTP

The aggregate willingness to pay for watershed area protection can be estimated by taking the total number of beneficiary households in the command area. Based on environmental and social impact assessment report made on the basin (Gumera River) the total number of beneficiary households in Fogera woreda is estimated about 13,964. Based on this figures the expected aggregate willingness to pay amount for watershed area protection using the close ended and open ended is estimated birr 3,628,799.27 and 2,697,593.45 per year per household respectively.

CHAPTER FIVE

5. DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1. Discussion

5.1.1. Information about watershed management and water

The survey reveals that most respondents have limited knowledge about watershed management concept. Overall, a large percentage of the sampled households' was not familiar with the protection area and watershed concepts and has not heard about the water management and biomass management. The respondents' response for the meaning of watershed area management takes 98.18 % (table 4.2) for land management.

The upstream communities and downstream water users use land management system (i.e. structural measures, vegetative measures, and production measures) for runoff and erosion protection. But from the site observation and responses of respondents main causes of water pollution are the upstream area (watershed area) is highly steep (81.82%, table 4.5), exposed to heavy rainfall and deforestation which needs biomass management (i.e. forest management and conservation, plant protection and social forestry, biomass regeneration, eco-preservation etc...) and water management (i.e. rain water harvesting, ground water recharge, preventing water pollution and economic use of water etc...) to protect formation of runoff and then erosion. 54.5% of the respondent has not got formal and informal training about watershed management system. This indicates that the awareness level of the community about watershed management is limited.

Responses of households for the importance of managing and protection of watershed area takes 92.73% minimizing floods during rainy season, 63.64% for absorption of water and makes this available for future use and 62.82% for improvement of water quality. Minimizing of flood is done by land management system i.e. structural measures (table 4.3).

5.1.2. Impacts of upstream watershed management activities on downstream water users

Almost all the sampled households (94.55%) understand the impacts of upstream watershed management activities on downstream water users. 70.91% categorise the impact as positive while 69.1% as negative impact. This shows that the downstream users identify both positive

and negative impacts that occur on their hydraulic structures, farms/plots and on social and economic interaction.

If the watershed management activities are not practiced, the impact on the downstream is negative. The negative impact which face on the hydraulic structures are: - making hydraulics and road structures useless due to flooding, depositing silts in hydraulics structures that comes from watershed area due to erosion, disposing of structures due to high floods, blocking of hydraulic structures by silts and other coarser material that comes due to flooding, high costs for the maintenance of damaged, silted and blocked structures, etc.

On Gumera river basin there is no huge hydraulics structures currently except bridges. But traditional structures like unlined and lined canals, check dams, micro basin, diversion weirs, division boxes and other measuring structures are available. Those structures face the entire mentioned problem. Due to structures siltation problem, which is the result of poor watershed management, the water flow in the canals is less than the required/demand. So the downstream users cannot use their maximum production effort. Depositing silts in structures and increasing in maintenance cost are the series problems on the Gumera river water users (see table 4.8).

The negative impacts on downstream farms/plots are destruction of crops, production lands, and fences, live stokes due to flooding, getting disturbed (polluted) water, erosion problem, adding of extra chemicals, dumping of silts in the tilling area, facing shortage of water, reduction of yield etc. Those negative impacts on farms/plots are due to hydraulic structures problem. When the structures fail the water flow out of the way and cause erosion of farms, destruction of crops, productive land, fences, and live stocks, adding extra chemicals and dumping of silts. Those cumulative effects and when the plots are occupied by silt, the yield of farms reduce. The reduction of yield and water resulted to social and economic problems (see table 4.9).

The negative impact of absence of watershed management activities on social, and economic interaction are shortage of food and water, following of disease, formation of un smooth relation between up and down users, community conflict, destruction of homes and humans lives, disposing of population, flooding etc. When there is no water management, runoff pounds in different area. If this pound is not treated water borne diseases like malaria occurs. On the other hand, water shortage during winter season occurs if proper watershed

management is not present. By the entry of upstream area soils, trees and others in to the river and canals the water diverts its direction. This flow of water out of the way causes destruction of homes and human lives and led's to disposing of population. This is what is happened between Gumera river water users in different kebeles. Because of community conflict between kebeles peoples died in 2005 (see table 4.10 and survey interview).

On the other hand, if watershed management activities are practiced, it has positive impact on downstream water users. Negative impacts can be minimized as far removed and led to good watershed management. If those negative impacts are removed the users income will improved and can get sufficient water for their irrigation, drinking, cattle's, cloths and other purposes throughout the year. In Gumera River there is water potential which can perform all things. But there is watershed management problem. If the community and the Government give attention and removed the problem there are potentials for increment of economy for the community as well as the country (see table 4.11).

Terracing reduces runoff and soil loss due to water erosion by half (IAPAR, 1984). Terracing, check dams and micro basin has only an effect on water erosion (see figure 5.1), it does not stop or reduce the impact of wind erosion.

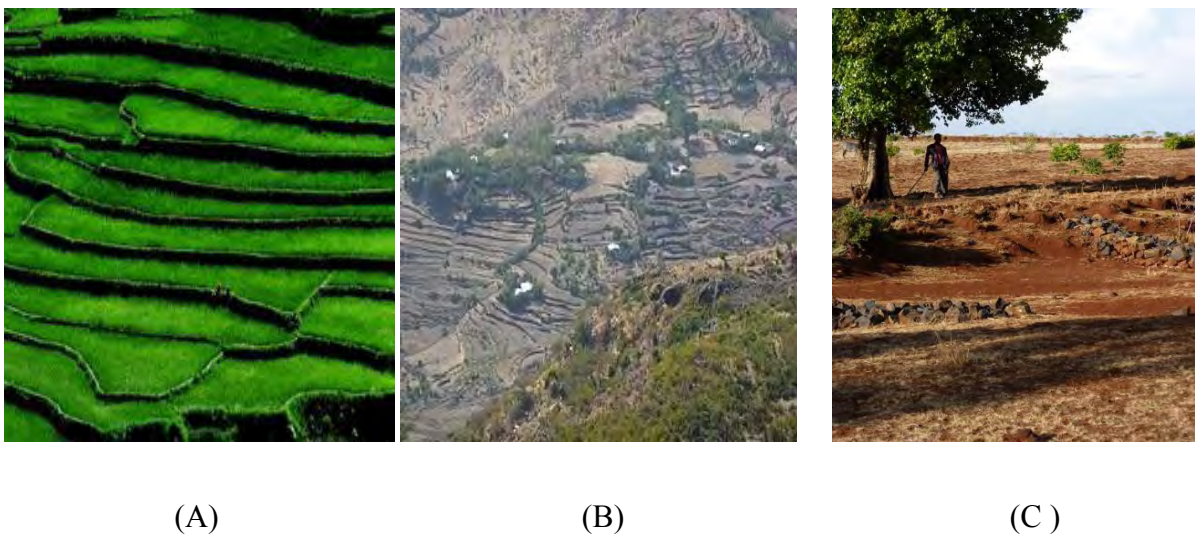


Figure 5.1 Terracing and check dam in Gumera watershed

Terracing is a prime example of how careful management of environmental resources can positively impact the capacity of rural communities to prevent and cope with natural disasters from landslides, to droughts, to the resulting devastation of food insecurity crises and famines. In the other way, terracing retain too much water leading to saturation and

consequently storm runoff (Gallart et.al, 1994). In Gumera river basin terracing with contour cultivation measures are used in some areas (see in figure 5.1 A and B).

When two and more conservation measures are used together the watershed area management is successful otherwise it is difficult. The observation in Gumera basin is as such. If all watershed management systems i.e. land management, water management and biomass management are used together good watershed management will be present. In figure 5.1 only land management activities were done. Based on the above discussion the communities/water users' initiation for development, willingness to pay for watershed area protection is necessary which is described under subtitle 5.1.3.

5.1.3. Respondents willing to pay

The study finds that 90.91% of the respondents are willing to pay the specified bid amount for watershed area protection. The main reason for their willing to pay are need of more reliable water for now and for future generation, their interest to continue producing other environmental services like flood control, biodiversity conservation, etc. This hope rises from what is observed from some farmers being productive and the land they have is suitable for irrigation purpose but not used for irrigation due to water shortage. This hope is correct because land is suitable for irrigation, there is water potential if it is properly managed and there is human/ labour power to perform the activity. The main problem is the way of applying their interest and planned management system. If Forgera wereda administration takes the management and gives the way of applying system; the communities hope will be tangible.

Respondent reasons for non-willing to pay are currently not beneficiary from the river water and have not enough money for payment. From the survey result their income is not less than others. But about half of the non-willing respondents are not a member of environmental organization and they are illiterates. If special training is given to them they will have willing to pay.

The main mitigation measure in which respondent want to practices for watershed area management activity problems are terracing and bounding, drainage ditches and water ways, gully erosion controller and runoff collectors. All mitigation measures are currently practicing except runoff collectors. So giving training for currently practicing management

activities and for practicing additional mitigation measures like water and biomass management activities should be the next step. Because the respondents recommend that the negative impact of watershed management activities will reduce and then stop if beneficiary households contributes money, take the responsibility to manage it properly after finalization and the government follow the general management.

Bid value, market access, ratio of dependent household members, household size and marital status were expected the negatively influence on the respondents willing to pay. But from the probit regression results bid value, household size and respondents market access influence negatively and others affect positively.

The bid value amount (0-500 birr per year/ household) in the questionnaire considers the communities power to pay and it is not under estimated because only four respondents explain their willing to pay above estimated bid value i.e. 1000 and 2000 birr per year/ household. The mean of the bid value which is calculated by probit model (259.87 birr per year/ household) is greater than the averaged maximum willingness to pay (193.18 birr per year/ household) which is in line with results from other studies.

From environmental and social impact assessment report made on the Gumera watershed area the total number of mainly beneficial households in 10 kebeles of Fogera woreda is estimated about 13,964. The expected aggregate willingness to pay amount is 3,628,799.27 birr per year. But for the total downstream watershed area community (i.e. 110,142 households), the expected aggregate willingness to pay amount 28,622,601.54 birr per year. This birr can do many additional protection activities like runoff collectors, stream bank stabilizers, land slide and gully erosion controllers, plant protection and forest management and conservation, coordination of health and sanitation activities, formation of a learning community a sustained basis.

The total service fee 28,622,601.54 can be used in two ways. First, the fund can pay directly for activities done on the watershed and secondly in the form of training cost. In the first way, fund or budget should allocate to pay for the activities after the activities done. As pointed out in the table 5.1 the activities which can be done in this way are: - terracing (like figure 5.1 and 5.2 A) about 500km which costs 15 birr/meter and a total of 7,500,000 birr; runoff collectors (like figure 5.2 B) 80 which costs 20,000 birr each and a total of 1,600,000 birr; gully erosion and land slid controller and stream bank stabilizers (like figures 5.2 C and D) at

Table 5.1 Cost breakdown for watershed management activities for the service fee

No.	Watershed management activities	unit	Length or amount	Unit price	Total cost in ETB
1	Terracing	km	500	15birr/m	7,500,000
2	Runoff collectors	No.	80	20,000	1,600,000
3	Gully erosion, land slid controller and stream bank stabilizer	No.	60	50,000	3,000,000
4	Drainage ditches and water way construction	km	200	30birr/m	6,000,000
5	Rain water harvesting	No.	30	50,000	1,500,000
6	Training	No.	360,000	25birr/person	9,000,000

60 places which costs 50,000 birr for each and a total of 3,000,0000 birr; drainage ditches and water way constructions(like figure 5.2 b) about 200km which costs 30 birr/meter and a total of 6,000,000 birr; and rain water harvesting 30 at different kebeles (like figure 5.2 E) by 50,000 birr for each and a total of 1,500,000 birr. All costs are based on current cost in the Amhara region.



(A) Terracing



(B) Runoff collector



(C₁) Active gully



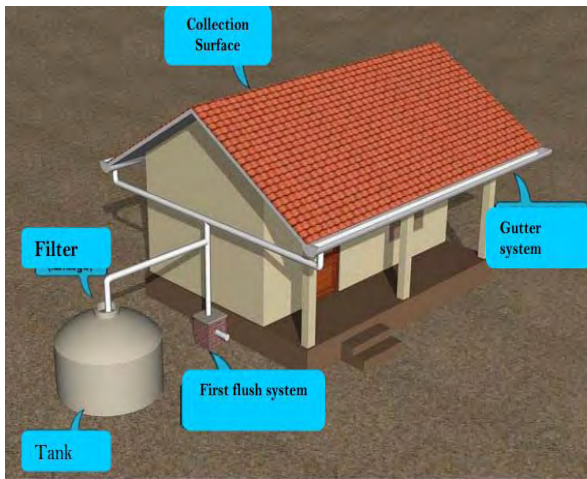
(C₂) Stabilized gully



(D₁) Stream bank



(D₂) Stabilized stream bank



(E₁) Rain water harvesting



(E₂) multiple use of harvested water

Figure 5.2 some watershed area management activities that can be done by the fund

In the second way the payment (9,022,601.54 service fee) is in the form of training cost. It is better if the training include forest management and conservation, plant protection, vegetation covers, grassland management, contour cultivation, conservation tillage, cultivation of shrub's and herbs, land levelling and crop rotation farming systems income and employment generation activities, coordination of health and sanitation programs and formation of learning community by budgeting 9,022,601.54 birr for running the training. The training should include 9.10% non-willing downstream households and all upstream households included in the watershed area.

5.2. Conclusion

The purposes of this study were to promote sustainability in water use by managing watershed area. The study attempts to exploring the impact of upstream watershed management activities on downstream users and determine the price of watershed area protection by eliciting farmers' willingness to pay (WTP) on Gumera watershed using contingent valuation method (CVM).

The impacts of upstream watershed management activities on downstream water users are both negative and positive. Negative impacts are face on structures (making hydraulics and road structures useless due to flooding, depositing silts in hydraulics structures, disposing of structures due to high floods, blocking of hydraulic by silts and other coarser material, high costs for the maintenance of damaged, silted and blocked structures, etc.), on farm plots (destruction of crops, production lands, and fences, live stokes, getting disturbed (polluted) water, erosion problem, adding of extra chemicals, dumping of silts in the tilling area, facing shortage of water, reduction of yield etc.), and on social and economic interaction (shortage of food and water, following of disease, formation of un smooth relation between up and down users, community conflicts, destruction of homes and humans lives, disposing of population, flooding etc.). Positive impacts are the inverse of those negative impacts.

The mitigation measures to protect negative impacts are practicing land, water and biomass managements side by side and if practicing those activities is not started early the watershed area will degraded highly and the negative impacts will increase.

The survey responses of 110 randomly selected farm households in the study area were analysed by regression for this study. The sample households were asked a closed ended question with follow up open ended question to elicit households' willingness to pay for watershed area protection for the contingent valuation analysis. .

The contingent valuation method used a probit model to estimate the key factors that affect households' willingness to pay for watershed area protection. The important variables identified in this study to determine household's WTP for watershed area protection are, bid value, income of the household, participating in off farm activity, household size, ratio of dependent household members, and households market access.

Regarding the sign and the significance of these variables, bid value, household size, households market access, income of the household, and participating in off farm activity has a significant impact on the probability of households WTP for watershed area protection. The mean of the bid value which is calculated by probit model (259.87 birr per year/ household) is greater than the averaged maximum willingness to pay (193.182 birr per year/ household) which is in line with results from other studies.

An important policy implication drawn from the study is that farm households are willing to pay for watershed area protection. If government designs and implements a proper charge of watershed area protection in the area based on such studies it will avoid or at least reduce inefficient water use practices and other water related damages and there would be a more sustainable utilization of environmental resources.

5.3. Recommendation

The survey showed that there is limited understanding about various aspects of watershed management activities. The Fogera wereda should give training about watershed management activities mainly about water and biomass management activities for the communities for good mitigation of the negative impacts.

The study strongly recommend that the Gumera river downstream areas are suitable for irrigation purpose (Gumera irrigation project feasibility study report, February, 2008) and the downstream users have very initiation to cultivate their land by irrigation, and also above 90% of the users have willing to pay for watershed area management, so that the government should designs and implements a proper charge of watershed area protection and start the Gumera dam early.

Since, the water users' number is highly increasing and lower communities face water shortage, there is conflict between successive kebele. So that the, Amhara region, and the government should give tentative solution like, using of water by schedule, Ground water exploring etc., for the users until the dam will construct.

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APPENDIX A

QUESTIONNAIRE FOR HOUSEHOLD HEADS

This questionnaire is prepared for two reasons:

- To explore farmers' opinions about impacts of upstream watershed management on downstream users and to know willingness to pay for watershed management protection activities.
- To prepare thesis for the partial fulfilment of the requirements for Master of Science in Hydraulics Engineering Studies.

Hence, taking the above objectives into consideration, you are kindly asked to provide the appropriate answer for the following questions.

Date of Interview _____

I. Watershed management Concept questions

A. Watershed management and water usage information questions

Components of Watershed Management

The three main components in watershed management are land management, water management and biomass management.

Land Management: land characteristics like terrain, slope, and formation, depth, texture, moisture, and infiltration rate and soil capability are the major determinants of land management activities in a watershed. The broad category of land management interventions can be as follows: Structural Measures, Vegetative Measures, Production Measures, and Protection Measures. Structural measure include interventions like contour bunds, stone bunds, earthen bunds, graded bunds, compartmental bunds, contour terrace walls, contour trenches, bench terracing, broad based terraces, centripetal terraces, field bunds, channel walls, stream bank stabilization, check dams etc. Watersheds may contain natural ecosystems like grasslands, wetlands, mangroves, marshes, water bodies. All these ecosystems have a

specific role in nature. Vegetative measures include vegetative cover, plant cover, mulching, vegetative hedges, grass land management, agro-forestry, etc. The production measures include interventions aimed at increasing the productivity of land like mixed cropping, strip cropping, cover cropping, crop rotations, cultivation of shrubs and herbs, contour cultivation conservation tillage, land levelling, use of improved variety of seeds, horticulture, etc. Protective measures like landslide control, gully plugging, runoff collection, etc can also be adopted. Adoption of all the interventions mentioned above should be done strictly in accordance with the characteristics of the land taken for management.

Water Management: water characteristics like inflows (precipitation, surface water inflow, ground water inflow) water use (evaporation, transpiration irrigation, drinking water) outflows (surface water outflow, ground water out flow) storage (surface storage, ground water storage, root zone storage) are the principal factors to be taken care of in sustainable water management. The broad interventions for water management are rain water harvesting, ground water recharge, maintenance of water balance, preventing water pollution and economic use of water,

Biomass management: major intervention areas for biomass management are eco-preservation, biomass regeneration, forest management & conservation, plant protection & social forestry, increased productivity of animals, income & employment generation activities, coordination of health & sanitation programs, better living standards for people, eco-friendly life style of people and formation of a learning community a sustained basis. (Proceeding of the national workshop in integrated watershed management on gibe-omo basin Jimma University and gilgel gibe site)

1. What is watershed management mean for you?
B. Land management B. water management C. Biomass management

D. If any other, please write _____
2. Are there watershed management activities on Gumera river basin?
A. Yes B. No C. I don't have any information
3. If your answer in question no. 2 is ~~yes~~ what type is it?
A. Land management B. water management C. Biomass management D. All

4. Is it important to manage and protect the Gumera river watershed for the households?
- A. Yes B. No
5. If your answer in question no. 4 is ~~yes~~ why is it important?
- A. It absorbs water and make this available for future use
- B. It minimizes floods during the rainy season
- C. It improves water quality
- D. Provides more sustainable water supply
- E. To avoid forest/nature destruction
- F. Others, please specify: _____
6. For what purpose do you use the Gumera River water?
- A. For Irrigation E. For cattle's
- B. For drinking F. For fishery
- C. Cloth Washing G. others please specify it _____
- D. For food cocking _____
7. What looks like the quality of the Gumera river water which uses you?
- A. Pure
- B. polluted
- C. Usually polluted
- D. Other, please write it _____
8. If your answer in question No.7 is out of pure, what is the cause of pollution of Gumera river water?
- A. Steepness of watershed area F. Overgrazing of the watershed area
- B. Intensive cultivation of watershed area G. up and down ploughing and not
Practicing crop rotation
- C. Heavy rainfall H. construction activities
- D. Deforestation I. Industrial wastes
- E. Wastes from homes, clinics and hospitals, schools and towns
- F. Other (please specify) _____
9. Can you get sufficient water for your demand from Gumera River for different purpose?
- A. Yes B. No

10. How is the quantity of gumera River water for your demand?
- A. Too excess C. satisfactory
 B. It is sufficient D. less relative to users demand E. too less
11. If your answer in question No.9 is 'NO', what is your reason?
- A. Water way structures blockage
 B. Water management problem
 C. Increasing number of water users
 D. deforestation
 E. the water distribution scheduled problems
 F. insufficient or defective water facilities and low river outflow
 G. Other please specify it _____
12. Have you get training about watershed management systems?
- A. Yes B. No
13. Is there any meeting between governmental body and community concerning watershed management systems?
- A. Yes B. No If not, why? _____
14. Have you discussed with upstream land users about impact of watershed management?
- A. Yes B. No
15. Do you know watershed management activity which fails currently? _____

B. Questions About Watershed management impacts

16. Do you think that an upstream watershed management activity has an impact on downstream water users?
- A. Yes B. No

17. If your answer for question no. 16 is yes, what type of impact has it?
- A. Negative impact B. positive impact
18. If your answer for question no. 17 is Negative impact, which negative impact on hydraulics structures occur?
- A. Making hydraulic and road structures useless
- B. Depositing Silts in hydraulics structures
- C. Increasing of structures maintenances cost
- D. Blocking of hydraulic structures
- E. Disposing of hydraulic structures
- F. All
- G. Other please specify _____
19. If your answer for question no. 17 is Negative impact, which negative impact the lake face?
- A. Siltation
- B. Adding/supplying of extra chemicals
- C. Reduction of fish numbers
- D. Water quantity reduction
- E. Water quality disturbance(pollution)
- F. Reduction of lakes attractively
- G. Number of lake visitors will reduce
- H. All I. Other please specify _____
20. If your answer for question no.17 is Negative impact, which negative impacts face on the downstream farms/plots?
- A. Destruction of crops, productive land, fences, livestock due to flooding
- B. Water quality disturbance(pollution)
- C. Reduction of water amount
- D. Erosion problem
- E. Adding of extra chemicals on the farm
- F. Reduction in yield
- G. Dumping of silts on the tilling area
- H. All

I. Other please specify _____

21. If your answer for question no. 17 is Negative impact, which negative impact face on communities' social, political and economic interaction?

A. Following of disease

B. Shortage of food and water

C. Political instability

D. Disposing of population

E. income from tourists will reduce

F. Formation of unsmooth relation with upstream community

G. Blocking of marketing relation between up and down users

H. Destruction of homes and human lives due to flooding

I. All J. Other (please specify) _____

22. If your answer for question no. 17 is positive impact, what type of impact is it?

A. Leads to good water management

B. Links upstream land users and downstream water users politically, economically and by their social life

C. It minimizes floods during the rainy season

D. It improves water quality

E. Provides more sustainable water supply

F. Improve users income

G. It absorbs water and make this available for future use

H. Providing work for peoples living around the lake

I. All

J. Other(please specify) _____

23. List any additional purpose which you/the community get due to the presence of watershed management? _____

II. Willingness to pay (WTP) questions

24. Do you want to pay, for watershed area management activities?

A. Yes

B. No

25. What is the maximum amount (per year) you would be willing to pay for this purpose in Birr?
- A. 0 B. 10 C. 20 D. 50 E. 100 F. 200 G. 250 H. 300 I. 400 J. 500
 K. other please writes it _____
26. If your answer in question no. 24 is NO, what is your reason?
- A. I am not beneficiary from the river
 B. I am satisfied with the existing watershed management
 C. I do not have enough money
 D. Only the rich households should pay
 E. Poor people will be affected
 F. Those who consume more must pay
 G. I know that the money will not be used properly
 H. It is the responsibility of the government to finance
 I. I do not believe that paying will result in improved watershed management
 J. I cannot afford to pay any additional amount to what I am currently paying as a tax
 K. It is not our obligation
 L. Other(please specify) _____
27. If your answer in question no. 24 is ~~yes~~ please indicate your reason?
- A. I want more reliable water
 B. It is my duty as a water user
 C. To prevent downstream negative impacts
 D. I want the watersheds to continue producing other environmental services like flood control, biodiversity conservation, recreation and carbon sequestration
 E. I would like the future generation to have reliable water
 F. I believe that the Administration will do a good job in Administering the found
 G. Others, please specify: _____
28. For which watershed management problem mitigation measure activities you want to pay as fund?
- A. Terracing and Bounding
 B. stream bank stabilizers and Land slide controller
 C. for gully erosion controller and Runoff collectors
 D. drainage ditches and water ways constructions

- E. For grassland management, Vegetative cover, Plant protection and Forest management and conservation
- F. For cultivation of shrubs and herbs, contour cultivation and conservation tillage
- G. For land levelling and Crop rotation farming system
- H. For Income and employment generation activities
- I. Coordination of health and sanitation programs
- J. Formation of a learning community a sustained basis
- K. Other(please specify)_____

29. What do you recommend to reduce the negative impact of upstream watershed management on downstream users?

- A. Government has to cover all the costs incurred to watershed management
- B. The people have to take the responsibility to manage it properly after finalization
- C. Beneficiary households has to contribute money for the proper maintenance of conservation measures
- D. Watershed management should be provided
- E. Others, please specify_____

30. By whom do you want to manage the collected birr?

- A. The commute which will be selected
- B. The kebele manager (likember)
- C. The wereda Administrator
- D. NGOs
- E. Other, please write it _____

III. Socio economic characteristics of the respondent

31. Gender? A. Male B. Female

32. Age? _____years

33. Marital status (please tick one) A. Single B. Married C. Separated/divorced

34. What is your highest educational attainment? (please check and give the highest level)

- | | |
|------------------------|--------------------------------|
| A. No formal schooling | E. College |
| B. Elementary | F. Master's |
| C. High school | G. Higher than Master's degree |
| D. Vocational | |

35. What is your occupation? (Multiple response possible)

- A. Unemployed/housewife
- B. Self-employed
- C. Government employee
- D. Private employee
- E. Labourer/mechanic/tailor/skilled worker
- F. Overseas Filipino Worker
- G. Farmer
- H. fisherman
- I. Others, please specify: _____

36. House hold size _____ (No. of family members)

No. of children (those less than 15 years) _____

No. of adults (15-65 years) _____

No. of elders (those higher than 65 years) _____

37. What is your average yearly income (farm income)? _____ in birr (use the following table)

Crop type	Output in Kg	Average price in Kg	Revenue
Rice			
Wheat			
Teff			
Finger millet			
Sorghum			
Maize			
Pea			
Horse bean			
Barely			
Noug			
Tomato			
Potato			
Carrot			
Onion			
Garlic			

Cabbage			
Paper			
Other income			
Total			

38. Do you have other business (you or your family) other than agriculture (off-farm activity) to support your livelihood?

A. Yes B. No

39. How many in your household, including yourself, if there are any, earn cash income?

a. Number of male earners	
b. Number of female earners	

40. How much is the total monthly income of all household members including you?

- A. 300 – 1000 E. 4001 – 5000
 B. 1001 – 2000 F. 5001 – 6500
 C. 2001 – 3000 G. 6501 – 10000
 D. 3001 – 4000 H. above 10000

41. How much time do you take to travel the nearest market to sell your agricultural Products? _____ Hours.

42. Ownership of House: (Choose ONE)

- A. Owned D. Provided by employer
 B. Rented E. Using for free
 C. Living with relatives F. Others, please specify: _____

43. Are you a member of any environmental organization?

A. Yes B. No

44. Would you like to add any comments about the survey or do you have any questions?

Thank you very much for your cooperation and help.

APPENDIX B

Total number of male and female headed households in Fogera wereda Kebeles

Sr. No.	Kebeles	No. of Males headed	No. of Female headed	total
1	Gayion	1267	172	1439
2	Arida	1246	135	1381
3	Delemo	793	98	891
4	Aba Bunda	1206	192	1398
5	Guramba	1027	243	1270
6	Aba Kiros	1093	149	1242
7	Bebekes	1299	289	1588
8	Kuhare Mikael	1058	184	1242
9	Shina	1850	301	2151
10	Kedest Hana	1229	133	1362

Source: Fogera Wereda Development Beuro

APPENDIX C

Distribution of bid value per year Responses

Bid value	Frequency	Percent	Valid Percent	Cumulative Percent
.00	10	9.1	9.1	9.1
10.00	6	5.5	5.5	14.5
20.00	2	1.8	1.8	16.4
50.00	29	26.4	26.4	42.7
100.00	22	20.0	20.0	62.7
200.00	16	14.5	14.5	77.3
250.00	2	1.8	1.8	79.1
300.00	5	4.5	4.5	83.6
400.00	7	6.4	6.4	90.0
500.00	7	6.4	6.4	96.4
1000.00	2	1.8	1.8	98.2
2000.00	2	1.8	1.8	100.0
Total	110	100.0	100.0	