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Demirew Getachew

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FOREWORD

The Ethiopian Economic Association (EEA) and its Dire Dawa , Haramaya and Jigjiga Chapters are happy to issue the proceeding of the Second Annual Regional Conference on the Eastern Ethiopia Economic Development which was organized on November 30, 2013 at the Haramaya University Conference Hall. EEA, in collaboration with its Chapters, organized this important regional conference as one of its objectives of broadening its activities and coverage at regional level so as to contribute to the economic advancement of regional state through enhancing economic policy formulation capability; the dissemination of economic research findings; promotion of dialogue on critical socio-economic issues; promotion of education in economics in higher learning institutions; enhancing national, continental and global networks of professionals and institutions; and advancement of the professional interests of its members.

The Annual Regional Conferences that the Association has organized in collaboration with its Chapters have created important forums for presenting and discussing development issues that are highly relevant to the Regional Socio-economy. These forums have also provided incentives for researchers to conduct research and present their findings on regular basis. Indeed, the Annual Regional conferences were organized in an interdisciplinary fashion, thereby widening the interactive coverage involving both economists living here in the region and those living outside the region and non- economists who are working and experiences on the region. The 2nd Annual Regional Conference on the Eastern Ethiopia Economic Development has contributed towards a deeper understanding of economy of this part of the country and the complex challenges it faces.

The conference attracted about 150 participants including members of Regional Parliament, higher officials and expertise from Dire Dawa City Administration, Somalie Regional State and Harrari Regional State, Universities of Dire Dawa, Jigjiga and Haramaya, NGOs, private sector representative and EEA members in the Eastern Ethiopia. The participants

of the conference expressed their satisfaction on the organization of the conference and the content of the papers presented. They reflected that the papers largely focused on local issue that can contribute to the development of the Eastern part of Ethiopia. They also recommended that the issues raised in the discussion are critical that need to be taken by policy makers and implementing organs of the respective offices of the regions.

All papers which were presented at the Second Annual Conference were reviewed by external reviewers and comments and suggestions including editorial comments were communicated to authors for improvement. Finally, those papers which passed all the review and editorial process published in the Proceeding of the Second Annual Conference on the Eastern Ethiopia Economic Development.

I would like to take this opportunity to express my heartfelt gratitude, on my own behalf and on behalf of the Ethiopian Economic Association, to the many people and organizations that made the conference resounding success. First and foremost, I thank the authors of the papers and the audience whose active participations made the Conference meaningful. The staffs of the Economics Department of the Dire Dawa University, Haramaya University and Jigjiga University and the staff of EEA Secretariat deserve a special recognition for their passion and perseverance in managing the conference from inception to completion.

Our special thanks go to our partners who have shared our vision and provided us with generous financial support to materialize the activities of EEA. These include; The Friedrich Ebert Stiftung of Germany, The African Capacity Building Foundation (ACBF), The Think Tank Initiative of International Development Research Center (IDRC) of Canada; and Civil Society Support Program (CSSP).

Finally, I would like to extend my sincere gratitude to senior regional government officials from Dire Dawa City Administration, Somalie Regional

State and Harrari Regional State, who spared their busy schedule and participated in the conference.

Alemayehu Seyoum Taffesse (DPhil)
President of the Ethiopian Economics Association

TABLE OF CONTENTS

FOOD SECURITY AND ADAPTATION STRATEGY TO CLIMATE CHANGE IN EASTERN ETHIOPIA

Adugna Tafesse[1], Gazahgne Ayele, Mengistu Ketema and Endrias Geta

Abstract

Agriculture is believed to be a base and key driver for Ethiopia's long-term growth. Give the fact that the sector is mainly dependent on rainfall; it has been affected by climate change. Hence, to adapt the impact of climate change, employing adaptation strategies within the agricultural sector is vital to ensure food security and sustainable livelihood for farmers. Food insecurity and adaptation are among of the options to abate the negative impact of climate changes. This study has analyzed the negative impact of climate change on food security and adaptation choices by farm households in eastern Ethiopia. The study mainly used data obtained from 330 household heads from two agroecologies in highland of Eastern Hararghe Zone of Oromiya Region and Dire Dawa Administration, Ethiopia. The study used a univariate probit model and multinomial logistic regression model to identify factors affecting food security and the choice of adaptation strategies to climate change. The result indicated that farmers in the study area are food insecurity has aggravated by climate change. Factors determining the choice of climate change adaptation options were sex of household head, family size, education status of household head, social participations, fertilizer usage, training to climate change, credit access, farm experience and off-farm income. The positive impact of training on climate change sends a good signal to justify its intensification. It is also necessary to take into account farmers' adaptation strategies and determinant factors while designing policies related to household food security enhancement.

Keywords: food security, climate change, adaptation strategies, univariate probit, multinomial logit model

[1] Email of the corresponding author: adugnat2000@yahoo.com

1. Introduction

There are increasing concerns globally regarding changes in climate that are threatening to transform the livelihood of the vulnerable population segments (Watson, 2010). Climate change (long-term continuous change to average weather conditions or the range of weather) and climate variability (the way climate fluctuates yearly above or below a long-term average value) are posing the greatest challenge to mankind at global as well as local levels (Slingo *et al*., 2005).

Climate is an important factor for agricultural productivity. Its change affects all dimensions of food security (*i.e*. food availability, food accessibility, food utilization and food systems stability). It has an impact on human health, livelihood assets, food production and distribution channels, as well as changing purchasing power and market flows. The climate change effects are already being felt in global food markets, and are likely to be particularly significant in specific rural locations where agricultural product is decline. Its impact are felt in both rural and urban locations where supply chains are disrupted, market prices increase, assets and livelihood opportunities are lost, purchasing power falls, human health is endangered, and affected people are unable to cope (FAO, 2007).

The effects of climate change are expected to be more severe for some segments of society than others because of geographic location, the degree of association with climate-sensitive environments, and unique cultural, economic, or political characteristics of particular landscapes and human populations (Rosenzweig *et al*., 2008). Social vulnerability and equity in the context of climate change are important because some populations may have less capacity to prepare for, respond to, and recover from climate-related hazards and effects. Such populations may be disproportionately affected by climate change.

Ethiopia's economy is based mainly on agriculture, including crop and livestock production, which contributes about 43% of the national Gross

Domestic Product (GDP), more than 85% of employment opportunities and over 90% of the foreign exchange earnings of the country (MoFED, 2013). However, the Ethiopian economy, particularly agricultural development, is extremely vulnerable to external shocks like climate change, global price fluctuations of exports and imports and other external factors. Due to climate change which is manifested in terms of drought, rainfall irregularities, and long-term increase in the average temperature, there is increased risk of drought. Climate change poses substantial impact on agricultural production and hence on the scope for reducing food insecurity.

Recently, there are some attempts by various stakeholders to design short-run and long-run climate change adaptation strategies so as to enable sustainability of agricultural practices in Ethiopia. These include on crop diversification, mixed crops and livestock production, and keeping multiple species of livestock and also attempt by community or household level had been taken like migration, changing planting date, soil and water conservation etc.

Development of strategies for supporting adaptation and responding to the consequences of climate change will require collaboration at local, regional and global level, across disciplinary boundaries and between different sectors of the economy. Enhancing the ability of communities to adapt to climate change or manage climate change risks requires addressing pertinent locally identified vulnerabilities, to involve stakeholders and to ensure that adaptation initiatives are compatible with existing decision processes (Brooks *et al*., 2005).

This study focused on two of the *Woredas* found in the highlands of East Hararghe Zone (EHZ) and the lowland of Dire Dawa Administration (DDA) to analyze the effect of climate change on food security and to assess major adaptation strategies of smallholder farmers.

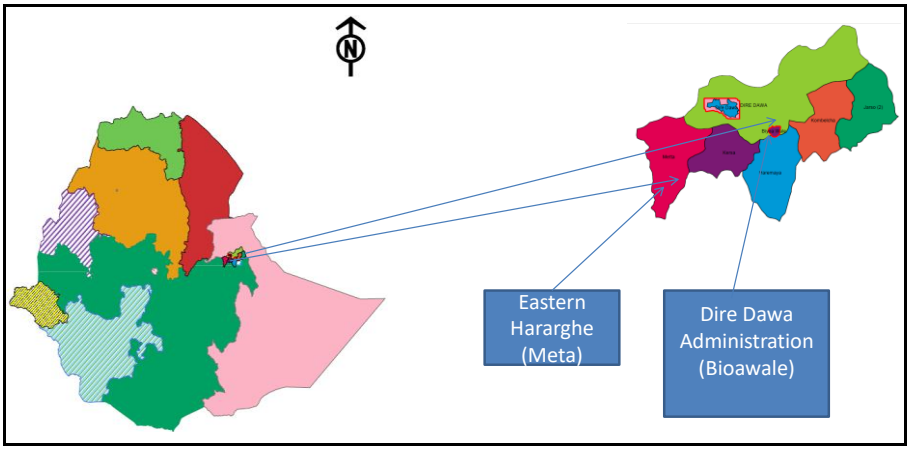
2. Research Methodology

2.1 The Study Area

The highlands of EHZ are normally extensively cultivated with high pressure on land and there is severe erosion. The lowlands of DDA are partly cultivated and partly used for pasture (Klingele and Yesus, 2004). Both highlands and lowlands are prone to chronic food insecurity. This study was designed to analyze climate change adaptation strategies used by smallholder farmers and their effects on food security in the highlands of EHZ of Oromiya Regional State and the lowlands of DDA in Ethiopia.

EHZ have six woredas. Meta is one of the woredas in the Oromiya Region of Ethiopia and DDA have four clusters rural *Woredas* have more or less homogenous characteristics in terms of agroecology and have similar agricultural practices. EHZ and DDA are situated in the eastern part of Ethiopia, at 520 and 515 kilometers, respectively, east of Addis Ababa, the capital city of the country (CSA, 2011).

Geographical location of the study areas



Source: Adapted from Ethio Geographic Information Systems (GIS).

Sorghum, maize, barley and wheat are the major crops in the Meta Woreda and *Khat* and coffee are the major cash crops. DDA is characterized by relatively high temperature throughout the year with minor seasonal variations and located in lowland agroecology. The farming system of the

Administration consists of crop production (4.1%), livestock production (7.9%) and mixed crop and livestock production (88.0%) (CSA, 2007).

2.2. Sampling Technique

In this study, a multi-stage sampling method was used to select respondents. In the first stage, eastern Ethiopia was stratified into two major agroecologies that are highland and lowland areas. Then the highland EHZ and DDA were selected purposively. The largest part EHZ falls under highland agroecology and DDA is under lowland agroecology. In the second stage, all *Woredas* in each study agroecology were listed. One *Woreda* from each agroecology was selected using a simple random sampling technique. In the third stage, sample *Kebeles* and sample households were selected using simple random sampling method. Sample households were selected from each *Kebele* by preparing a comprehensive list of households.

2.3. Analytical Methods

2.3.1. Measurement of food security

Measuring the food security is a question to be addressed in under food security section of the study. However, there is no single indicator to measure it. For this purpose, different indicators are needed to acquire the various dimensions of food security, such as the household calorie requirement, including daily calorie intake per adult equivalent per day to determine food availability and status of food security situation. Daily calorie availability can be measured based on consumption per adult equivalent. In this study, food balance sheet and aggregate household calorie consumption were constructed for the purpose of the food security analysis. Food security conditions were calculated based on calorie requirement, according to sex, age, and activity level of household members, as recommended by WHO and FAO (1985).

To identify food insecure households, a minimum calorie requirement was used as food security threshold. Among the most commonly used procedures for setting the security threshold, direct calorie intake method

was used by this study. The net weekly calorie availability was divided for seven days to get the household daily calorie intake. Family size of each household was converted into adult equivalent family size which considers age, sex, and dependency ratio of each family member in the household. The daily net calorie consumption of the household was divided by the adult equivalent family size to obtain the daily calorie availability per adult equivalent of the household. Households with daily calorie consumption greater than or equal to 2200 kcal per day were categorized as food secure, and those households whose calorie intake fallen below this food security threshold as food insecure.

Food insecurity was captured by measuring the head count and food insecurity gap which enable to capture successively more detailed aspects of food insecurity at household level, which is also known as the Foster-Greer-Thorbecke (FGT) decomposable indices (Foster *et al*., 1984). The FGT was used in the computation of incidence, depth and severity of food insecurity. The FGT measure is given as:

$$FGT(\alpha)=\left(\frac{1}{n}\right)\sum_{i+1}^{q}\left[\frac{(Z-y_i)}{Z}\right]^{\alpha} \qquad \textbf{(1)}$$

where FGT is food insecurity index; *n* is the number of sample households; y_i is the measure of per adult equivalent food calorie intake of the i^{th} household; Z represents the cut off between food security and food insecurity households (expressed here in terms of caloric requirements of 2200kcal); *q* is the number of food-insecure households; and α is the weight attached to the severity of food insecurity.

Within this FGT index, we compute the three most commonly employed indices: head count ratio, food insecurity gap and squared food insecurity gap (Hoddinott, 2001). Head count ratio describes the percentage of sampled households whose consumption is below the predetermined subsistence level of energy (2200 kcal), means FGT (α = 0) = q/n. The food insecurity gap, FGT (α=1), measure how far the food insecure of

households, on average, are below subsistence level of energy. Here, it means that, giving equal weight to severity of food insecurity among all the food insecure households will be equivalent to assuming that α = 1. This index characterizes the amount of resources that will be required to bring all the food insecure households to this subsistence level. To put it differently, it will provide the possibility to estimate resources required to eliminate food insecurity through proper targeting. Finally, squared food insecurity gap, FGT (α=2), is a measure closely related to severity of food insecurity gap but giving those further away from the subsistence level a higher weight in aggregation than those closer to the subsistence level (Hoddinott, 2001).

From food security measurement in terms of income or consumption, a Gini coefficient is calculated from a Lorenz curve to indicate the level of inequality (Todaro and Smith, 2009). The Gini coefficient measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line of perfect equality.

$$G = \frac{2}{n^2 \mu} \sum_{i=1}^{n} \left(r_i - \frac{n+1}{2} \right) Y_i \qquad \textbf{(2)}$$

where *G* is the Gini coefficient; Y_i is the per capita calorie intake of household *i;* is the mean per capita calorie intake; r_i is the rank of household *i* in the *y* and *n* is the total number of sample households. For the purpose of this study, the Gini coefficient income calculates from agricultural production.

2.3.2. Determinants of food security

Household and community level determinants of the household food security status and their likely effects were analyzed by a univariate probit model. The latent variable is specified by the following structural equation (Maddala, 1983; Long, 1997; Cameron and Trivedi, 2009; Greene, 2012).

$$Y^* = X'\beta + \varepsilon_i \quad \textbf{(3)}$$

Where *Y** is a latent variable for food security status (observed if *Y*>0*, 0 otherwise); X' is a vector of household specific and other socioeconomic factors determining food security status; β is a vector of parameters of interest, and ε_i random error.

Equation 4 is identical to those for the linear regression model with the important difference that the dependent variable is unobserved. The link between the observed binary *Y* and the latent Y* is made with a simple measurement equation:

$$Y_i = \begin{cases} 1 \; if \quad Y_i^* = X'\beta + \varepsilon_i > 0 \\ 0 \; if \quad Y_i^* \le 0 \end{cases} \quad \textbf{(4)}$$

Assuming $y_i = 0$ if food insecure, $y_i = 1$ if food secure and distribution of ε_i to be with mean 0 and variance 1 leads to the univariate probit model, in which

$$\Pr(Y_i = 1/X) = X'\beta = \int_{-\infty}^{X_1'\beta} \frac{1}{\sqrt{2\pi}} \exp\left(\frac{t^2}{2}\right) dt \quad \textbf{(5)}$$

The probability of the event occurring is the cumulative density function of ε_i evaluated at given values of the independent variables:

$$\Pr(Y_i = 1/X) = \Phi(X'\beta) \quad \textbf{(6)}$$

Where Φ (.) is the standard normal cumulative distribution function for the Univariate probit model.

2.3.3. Adaptation strategies

The analytical approach which is commonly used in decision studies involving multiple choices is the multinomial logit (MNL) model (Kurukulasuriya and Mendelsohn, 2006). This approach is appropriate for evaluating alternative combinations of adaptation strategies, including individual strategies (Hausman and Wise, 1978; Wu and Babcock, 1998).

Considering the multiple adaptation options available to the households, the study used the multinomial logit (MNL) model to analyze the determinants of household adaptation decisions to climate change. This model was similarly applied to analyze crop choices selection (Kurukulasuriya and Mendelsohn, 2006; Temesgen *et al*., 2008) and livestock (Seo and Mendelsohn, 2008) choices as methods to adapt to the negative impacts of climate change. The advantage of the MNL model is that it permits the analysis of decisions across more than two categories, allowing the determination of choice probabilities for different categories (Madalla, 1983; Wooldridge, 2002). Also, the estimates obtained from this model are easy to interpret which is another advantage (Green, 2012). This model provides a convenient closed form for underlying choice probabilities, with no need of multivariate integration, making it simple to compute choice situations characterized by many alternatives. In addition, the computational burden of the MNL specification is made easier by its likelihood function, which is globally concave (Hausman and McFadden, 1984).

Let Yi be a random variable representing the adaptation measure chosen by any farm household. We assume that each farmer faces a set of discrete, mutually exclusive choices of adaptation measures. These measures are assumed to depend on a number of climate attributes, socioeconomic characteristics and other factors X. The MNL model for adaptation choice specifies the following relationship between the probability of choosing option Y_i and the set of explanatory variables X (Greene, 2012).

$$\Pr(Y_i = j) = \frac{e^{\beta'_j X_i}}{\sum_{k=0}^{j} e^{\beta'_k x_i}}, \quad j = \quad 0,1,2,...5 \qquad \textbf{(7)}$$

Where j represents the alternative adaptation strategies used by farmers including: 0 is no adaptation strategy
1 is changing planting date
2 is irrigation water use
3 is soil and water conservation
4 is crop variety selection and
5 is more than one adaptation strategies

β_j is a vector of coefficients on each of the independent variables X. Equation (7) can be normalized to remove indeterminacy in the model by assuming that $\beta_0 = 0$ and the probabilities can be estimated as:

$$\Pr\left(Yi = {}^{j}\!/_{Xi}\right) = \frac{e^{\beta'_j Xi}}{1+\sum_{k=1}^{J} e^{\beta'_k X_i}}, \quad j = 0,1,2\ldots\ldots,J, \quad \beta_0 = 0 \qquad \textbf{(8)}$$

Estimating equation (8) yields the J log-odds ratios

$$\ln\left({}^{P_{ij}}\!/_{P_{ik}}\right) = X'_i\left(\beta_j - \beta_k\right) = X'_i\,\beta_j, if \;\; K = 0$$

The MNL coefficients are difficult to interpret, and associating the β_j with the j^{th} outcome is tempting and misleading. To interpret the effects of explanatory variables on the probabilities, marginal effects are usually derived (Greene, 2012):

$$\frac{\partial P_j}{\partial X_i} = P_j\left[\beta_j - \sum_{k=0}^{J} P_k \beta_k\right] = P_j\left(\beta_j - \overline{\beta}\right) \qquad \textbf{(9)}$$

The marginal effects measure the expected change in probability (the log odds) of a particular choice being made with respect to a unit change in an explanatory variable (Long, 1997; Greene, 2012). The signs of the marginal effects and respective coefficients may be different, as the former depend on the sign and magnitude of all other coefficients.

Finally, the model was run and tested for the validity of the independence of the irrelevant alternatives (IIA) assumptions by using both Hausman test

for IIA. The IIA assumption is that the ratio of probabilities between outcomes that does not change with the introduction of another choice. In other words, the relative probability of one alternative does not depend on the existence of other alternatives.

3. Results and Discussion

3.1. Institutional, and Households Characteristics

Households in developing countries are frequently hit by severe idiosyncratic (i.e. household-level) and covariate (i.e. community) shocks resulting in high consumption volatility. The result showed that the rural households in the two agro-ecologies of the study area basically differed in their major institutional characteristics (Table 1). Households in the highland areas were significantly better off in their food security status, calorie intake and distance to the nearest market and town from household residence. On the other hand, the lowland households were significantly better off in credit access, distance to office of agricultural extension station and visited farmers by the developmental agents.

Table 1: Mean value of institutional characteristics and food security status of the sample households by agro-ecology

Variable	Highland	Lowland	All	Mean/ proportion difference test (t-value)
Kilocalorie intake (Kcal)	2229.020	2168.260	2198.640	2.27**
Food security (%)	0.230	0.220	0.225	1.72*
Distance to the nearest market (Km)	5.900	12.590	9.245	11.36***
Distance to the nearest town (Km)	7.330	15.340	11.335	-13.37***
Distance to the extension station (Km)	3.960	3.160	3.560	4.35***
Contact extension agent (%)	0.350	0.420	0.385	4.72*
Access to credit (%)	0.710	0.840	0.775	-2.90***

Note: ***, **, and *, respectively signify significance levels of 1%, 5% and 10%.

Source: Author's computation

Table 1 also indicated the results of respondents' calorie intake per adult equivalent per day. Households in the highlands and lowlands had on average 2229.02 and 2168.26 kilocalories food intake, respectively. This indicates that households in the study areas were not better off in calorie intake as compared to the required average kilocalorie intake for a healthy adult. However, this result cannot tell us the problem of food insecurity. Farmers in highland were better calorie intake, because have practiced mixed crop production and generate off-farm income and also adopt high yielding crop varieties.

3.2. Farmers' Perception of Climate Change

Extensive literature reviews have revealed that a number of different socio-economic and natural factors have contributed to the increasing perception level of farmers about climate change variables like temperature, precipitation, etc. However, there were a significant proportion of the respondents who did not recognize climate change.

Climate change is expected to influence crop and livestock production and other components of agricultural systems. In this study, farmers were asked if they had noticed any significant climate changes from the past ten to twenty years. Results shown in Table 2 indicate that almost more than 50% of the sample farmers had noticed significant changes in both agroecologies and they ascribed reduction in farm production. About 71% of the sample households have perceived changes of precipitation, 55% understood increasing temperature and 63% recognized the occurring of untimely rain. In addition, farmers perceived that climate change affected direct crop production and livestock health, and resulted in land degradation and hence had negative impact on livelihoods.

Farmers noticed that over the last ten to twenty years, rainfall variability has been increasing substantially, as rains fail to come more frequently or come suddenly at abnormal times of the year. All farmers have also noticed more frequent droughts in the last ten years as compared to twenty years ago.

Table 2: Farmers' perception of changes in climate indicators and its effects

Variable	Frequency	Percentage
Reduction in precipitation	234	71
Increase in temperature	182	55
Untimely rain	209	63
Frequent drought	141	43
Flood	151	46
Livestock disease	265	80
Land degradation	144	44
Decreasing crop yield	212	64

Source: Author's computation

Flooding had a significant impact on the long-term productivity of their land as well. Much of the fertile topsoil was washed away and only hard-panned soil remains. The degraded land has hardly been supplying sufficient soil nutrient which improves farm productivity and requires more time for recovery.

From the farmers perception and supported by the literature, it is the climate-related hazards that significantly increased household vulnerability to climate change through reduced farm productivity and household food security. Although farmers have been able to deal with past drought and floods, the increasing frequency and intensity of climate-related hazards is forcing farmers to engage more frequently in emergency coping strategies such as consuming seeds reserved for planting and selling farm implements to smooth their consumption.

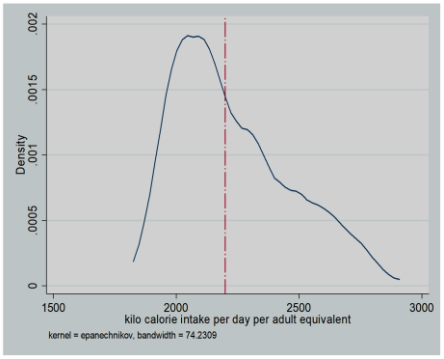
3.3. Food Security Status and its Determinants

Food security at a household level is analyzed and best measured by direct survey of income, expenditure, and consumption and comparing it with the minimum subsistence requirement (Von Braun *et al*., 1992. This study used daily calorie availability per adult equivalent (kilocalorie) as a measurement for food security. Accordingly, food security status was measured by

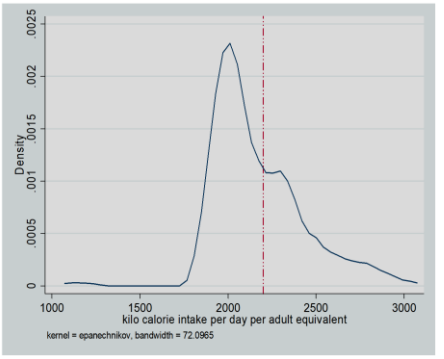
comparing the level of the daily calorie availability per adult equivalent with the minimum acceptable weighted average food requirement per person per day for Ethiopia which has been set at 2200 kcal (Kifle and Yoseph, 1999). In the highland and lowland areas, the estimated calorie intake indicated in Figures 1A and 1B. Figure 1B which is more right-skewed from the mean of the lowland indicates that there is more number of food insecure households.

Figure 1: Kernel density estimation of daily calorie intake per adult equivalent of the sample households by agroecology

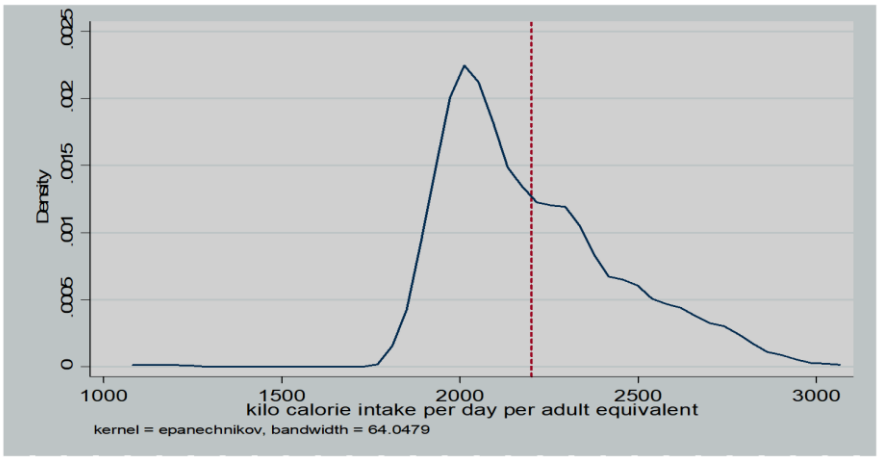
A. Highland agro-ecology



B. Lowland agro-ecology



C. Combined highland and lowland agro-ecologies



Source: Author's computation

The combined highland and lowland calorie availability graph as indicated by Figure 1C also shows the distribution of the estimated daily calorie availability per adult equivalent for all households which is right-skewed indicating higher number of food insecure households falling below the mean value of 2200 kcal.

The result indicated that about 44 percent of the respondents were food secure while the rest indicated as food insecure. About 31% of the sample households had a low daily calorie intake per adult equivalent (Table 3). About 56% of the sample households had a daily calorie intake of less than the minimum calorie requirement per adult equivalent (food insecure). About 35% of the sample households faced more than four months of food shortage period.

Table 3: Food security status and shortage period of the sample households

Food security indicator	Value	Status	Highland (%)	Lowland (%)	Total (%)
Daily calorie intake per adult	2500+	High	14.40	12.50	13.47
equivalent (Kcal)	2200-2500	Low	31.80	29.10	30.49
	<2200	Insecure	53.80	58.40	56.04
All sample			100.00	100.00	100.00
	0		15.40	14.50	14.96
Food shortage	1		10.10	13.90	11.94
Period (number of months)	2		12.10	13.80	12.92
	3		24.20	25.60	24.88
	>4		38.20	32.20	35.29
All sample			100.00	100.00	100.00

Source: Author's computation

The percent of values of the two agro-ecologies measures of food insecurity was about 54% for households in the highland and 58% for those in the lowland. Therefore, food insecurity was serious problem in both agroecologies, and more problems in the lowland (Table 3).

The daily calorie availability per adult equivalent was low in the lowland than in the highland. The two agroecologies had a significant difference in terms of the deviation from the food security threshold. The mean of households in highland were relatively better-off to escape from the food security threshold by 250 kcal whereas the lowland rural households had 145 kcal deficits from the minimum daily calorie requirement of 2200kcal (Table 4).

Agricultural production is the source of rural households' income in Ethiopia and is mainly generated from crop production. In this regard, it was found that 63% and 37% of the households in the highland and lowland, respectively, with mean difference of 50 % income, generated gross income inequality from crop production, which is higher than the national rural income inequality estimated at about 30% percent in the year 2010/2011(FDRE, 2012).

Table 1: The households' food security status and climate change

Variables	Highland	Lowland	All sample
Food insecure households (%)	58	69	63.50
Head count index (%)	34.12	43.13	38.63
Mean Food insecurity gap (kcal)	250	145	52.50
Squared food insecurity gap (%)	0.15	0.19	0.17
Mean income inequality (Gini coefficient)	0.63	0.37	0.50

Source: Author's computation

As the head count index measures the incidence of food insecurity, the mean food insecurity gap and the squared food insecurity gap measure the depth and severity of food insecurity, respectively. The incidence of the food insecurity in highland was 34.12% compared to the incidence in lowland (43.13%). Intensity of mean food insecurity gap or calorie measured by calorie adequacy also follows the same scenario. The mean of households in highlands faced food insecurity (250 Kcal) while their counterparts in lowland had relatively deeper calorie deficit (145 Kcal) and

also the severity food insecurity gap was 15% and 19% in highland and lowland, respectively.

Table 5 also shows the proxy measures of climate change such as flood, drought, change of moisture, disaster of crop production, and decrease of livestock production indicated by 42%, 41%, 65%, 66%, and 66% of the households in the highland, respectively. On the other hand, 23%, 68%, 44%, 64%, and 72% of the households in the lowland were affected by flood, drought, change of moisture, disaster on crop production, and decrease of livestock production, respectively.

Table 5: The proxy measurement of climate change

Variables	Highland	Lowland	All sample
Flood (%)	42	23	32.500
Drought (%)	41	68	54.500
Change of moisture (%)	65	44	54.500
Disaster of crop production (%)	66	64	65
Decrease of livestock production (%)	66	72	69

Source: Author's computation

Table 6 indicates that by randomly taking all significant explanatory variables, the predicted probability of the sample households of being food secure was about 0.374. The predicted probability of the households in highland to be food secure was about 0.609 which was higher as compared to that of predicted probability of the lowland which was about 0.409. The likelihood of food security in different parts of rural Ethiopia is different; because the food insecurity prevalence is different. For instance, it was about 36% in Shashemene Southern-Ethiopia (Amsalu *et al*., 2012). Others estimated food security status of households to be 39% in Eastern Shewa Zone of Central Highlands of Ethiopia (Hailu, 2012), 55% in Wollo area of Northern Ethiopia (Samuel, 2004), and 65% in rural Ethiopia (FDRE, 2012). It is, therefore, difficult to obtain comparable and representative empirical evidences on this subject for the fact that there is significant difference in measurement and estimation biases in food security indicators, sample coverage, and depth of food insecurity in different locations.

The probability of households to be food secure with social participation was 0.58 which is greater than that without participation (0.45). The predicted probability of households to be food secure with irrigation water use (33.7%) compared with the without irrigation situations (60.8%). Irrigation is considered an effective way of increasing agricultural production. It can supply the water needed for crop growth when rainfall is limited or, in more humid climates, it can bridge dry spells and reduce agricultural risks and use of irrigation technologies need to be accompanied by other crop management practices such as use of crops that can use water more efficiently. Important management practices that can be used include: efficient management of irrigation systems, growing crops that require less water, and optimizing irrigation scheduling and other management techniques that help reduce wastage (Loë *et al*., 2001). However, the negative sign shows that the study sites with access to safe irrigation water are rare; cultivated land is fragmented, smallholding and particularly up and downstream. In areas where groundwater is not adequately accessible, they have not any other means to get water.

Additionally, the mass production of irrigation products such as cash crop and perishable vegetables ignoring the infrastructural facilities such as lack of refrigerated transportation and storage, distance to the nearest market, town, road, transport, processing industries and information access leads to reduced profitability of the sector even though there are sufficient resources such as water, labor and land. In the study areas households have been planting cash crops *(like khat, cabbage, tomato)* and supply to the market in addition to cereal crop production. Therefore, it is advisable for policy makers to address production, consumption, distribution, trade constraints and to provide marketing infrastructures and other services before implementation of irrigation schemes to foster production profitability and reduce perishability.

Table 6: Univariate probit estimation of determinants of household food security status

Food security	Coefficient	Robust Std. Err.	Marginal	
			Coefficient	Std. Err
Education	0.526*	0.295	0.207*	0.113
Social participation	0.329*	0.138	0.231*	0.113
Training	0.424*	0.216	0.168*	0.013
Flood incidence	-2.792***	0.331	-0.836***	0.049
Family size	-0.249***	0.060	-0.099***	0.024
Credit access	0.205*	0.180	0.082	0.111
Sex of household head	0.986**	0.501	0.352**	0.142
Irrigation	-0.693**	0.289	-0.270**	0.107
Farming experience	0.174***	0.025	0.070***	0.010
Tropical livestock unit (tlu)	0.116	0.088	0.046	0.035
Fertilizer usage	0.040**	0.017	0.016**	0.007
Off-farm income	0.155*	0.029	0.052*	0.019
Agro-ecologies	0.507*	0.122	0.200	0.124
Constant	-2.351***	0.271		
Predicted probability (all)			0.374	
Pr(highland agroecology)			0.609	
Pr(lowland agroecology)			0.409	
Pr(with Social participation)			0.583	
Pr(without Social participation)			0.453	
Pr(with credit)			0.631	
Pr(without credit)			0.415	
Pr(with irrigation)			0.337	
Pr(without irrigation)			0.608	
Pr(with off-farm income)			0.534	
Pr(without off-farm income)			0.473	
Pr(with irrigation)			0.337	
Pr(with off-farm income)			0.534	
Pr(without off-farm income)			0.473	
Pr (without irrigation)			0.608	
Log pseudo likelihood			-54.078	
Wald χ^2 (13)			124.790	
Pseudo R^2			0.762	
Pr > χ^2			0.0000	
Goodness-of-fit test, Pr > χ^2 (318)			0.983	
Food security			0.450	
Food insecurity			0.550	
r(k <= 148 or k >= 182) = 0.069 (two-sided test)				

Note: ***, **, and *, respectively signify significance levels of 1%, 5% and 10%.
Source: Author's computation

Credit is an important factor for food security status. Therefore, the probability that households are food secure with credit access in the study area was 63.1% and it was 41.5% for those who do not have access to credit. Access to credit enables to increase per capita incomes and food security status of households. The probability of univariate probit estimation output of the food security status is 45% for food secure household and 55% for food insecure household in the study areas.

Strategies	Highland	Lowland	Total
Selection of crop variety (%)	0.162	0.240	0.201
Changing planting date (%)	0.220	0.148	0.180
Irrigation water use (%)	0.220	0.148	0.184
Soil and water conservation (%)	0.248	0.280	0.263
Combined more than one adaptation strategies (%)	0.006	0.000	0.003
No adaptation strategy (%)	0.160	0.184	0.170
All sample	100.000	100.000	100.000

Off-farm income activity is an additional work engaged in by household aside farming to supplement household income. Level of off-farm activity can influence households' food security but this can either be positive or negative depending on the level and gains from the activity (Babatunde *et al.,* 2007). This is because engagement in an activity can bring in money there by corroborating the food security situation of the household. In the study areas, off-farm income contribute has a positive and significant effect to food security at 10% significant level and also the probability the households are food security with off-farm income in the study area was 53.4% and it was 47.3% for those who do not participate on off-farm income activities.

3.4. Adaptation Strategies

The adaptation strategies adopted and practiced by farmers in the study area is applied more than ten different strategies, from those strategies the most frequently applicable include choice of crop variety selection,

changing the planting and harvesting dates of different crops, using irrigation, and increasing the use of soil and water conservation techniques. Table 7 shows these adaptation options and other strategies that serve as important mechanisms to cope with drought and temperature stress.

Table 7: Adaptation strategies used by farmers

Strategies	Highland	Lowland	Total
Selection of crop variety (%)	0.162	0.240	0.201
Changing planting date (%)	0.220	0.148	0.180
Irrigation water use (%)	0.220	0.148	0.184
Soil and water conservation (%)	0.248	0.280	0.263
Combined more than one adaptation strategies (%)	0.006	0.000	0.003
No adaptation strategy (%)	0.160	0.184	0.170
All sample	100.000	100.000	100.000

Source: Author's computation

As shown in Table 7, 16.2% and 24% of the farmers in the highland and lowland agro-ecologies used crop variety selection strategy, and about 22% and 14.8% of the farmers in the highland and lowland areas used changing planting date strategy, respectively. Proportion of households participating in soil and water conservation in the highland and lowland areas were 24.8% and 28%. Irrigation was used by 22% and 14.8% of the sample households of highland and lowland, respectively. The lowlanders were relatively better off on adoption of crop variety and soil and water conservation, but the highlanders were better in changing planting date and irrigation water use. Adoptions of more than one adaptation strategies applied in the study areas were 0.6% which is insignificant. However, the adoption of climate change adaptation strategies in both agro-ecologies was generally very low (less than 50%). The great majority of households were not yet using these very common agricultural technologies which have been introduced to the rural Ethiopian farmers since many years.

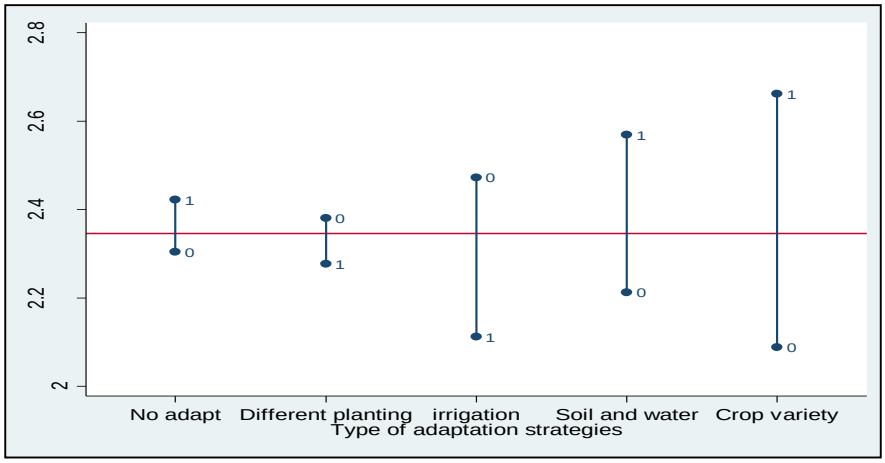
Adaptation measures help farmers guard against losses due to increasing temperatures, decreasing precipitation and frequently happening drought

and flood. Therefore, the dependent variable in the empirical model for this study is the choice of an adaptation option from the set of adaptation measures. In the study area, more than ten different adaptation strategies to climate change were identified. Such adaptation strategies were categorized and identified by the works of Bradshaw *et al*. (2004); Maddison (2006) and Nhemachena and Hassan (2007). From different categories of adaptation strategies this study focused on those strategies indicated by farmers as most important such as selection of crop variety, changing crop calendar, adoption of soil and water conservation, irrigation water usage, and no adaptation.

Farmers have considered the main adaptation choices to mitigate the exposure to climate change. However, this study has taken those who do not adopt any adaptation strategy as the base category. More than 37% of respondents did not adopt any adaptation strategies.

The adoption status of the five adaptation strategies to climate change is graphed to capture their possible relationships (Figure 2). Adopters of soil and water conservation and crop variety selection were more than those who adopted the remaining strategies. The adoption statuses of most adopters were below the mean value indicated by the horizontal reference line.

Figure 2: Adaptation strategies to climate change



Source: Author's computation

The empirical study on factors affecting adaptation strategies to climate change was done using MNL model. The parameter estimates of the MNL model provide only the direction of the effect of the independent variables on the dependent variable. Thus, the marginal effects measure the expected change in probability of a particular choice being made with respect to unit change in an explanatory variable (Long, 1997; Green, 2012).

Table 2: The marginal effects of explanatory variables from multinomial logit model

Variables	Changing planting date	Irrigation water use	Soil and water conservation	Crop variety selection
Agro-ecology	0.189***	-0.103	0.113	-0.338***
Training	0.005*	0.006*	0.016**	-0.008
Distance to market	-0.014	0.016**	-0.013**	-0.019**
Fertilizer usage	-0.006	-0.037	-0.343***	0.288***
Sex of household head	0.021	0.150	-0.142	0.011
Family size	-0.078	-0.023	-0.006	-0.032**
Education of household head	0.007	-0.056	0.187**	-0.066
Cultivated land	-0.005	0.994	-0.480**	0.363***
Off-farm income	0.053*	-0.054	0.244*	-0.015
Credit access	0.008*	0.470*	0.038**	0.028***
Social participation	0.009	-0.009*	0.077	0.135***
Farming experience	-0.085	-0.002	-0.009	0.009
Untimely rain	-0.055	-0.378	-0.039	0.080
Precipitation	0.009	0.002	0.137	-0.305**
Temperature change	-0.004	-0.035	-0.126	0.247***
Pr(predicted)	0.009	0.284	0.383	0.185

Note: ***, **, and *, respectively signify significance levels of 1%, 5% and 10%.

For lack of space, the standard errors of estimates are not reported.
Source: Author's computation

Table 8 presents results of the estimates of the marginal effects for each outcome in the MNL model. This analysis used the no adaptation strategy as the base category and evaluated the other choices as alternative options. The general interpretation of a marginal effect of a given estimate shows

how the probability of the outcome changes when the corresponding variable changes by one unit from its mean while the rest of the variables are held constant at their means.

The result suggested that agro-ecology promotes crop variety selection and changing of planting date. The highland agro-ecology was related with strongest adaptation measure which results in a 33.8% decrease in the probability of crop variety selection and 18.9% increase in the probability of changing planting date to adapt to climate change. This means, the lowland farmers practiced crop variety selection as an adaptation strategy more than their highland counterparts.

Training to climate change is to create the awareness to climate change forecasting, adaptation options, and other agricultural production activities remains an important factor affecting use of various adaptation measures for most farmers. Lack of training and/or limitations in information increases high downside risks from failure associated with uptake of new technologies and adaptation measures (Jones, 2003; Kandlinkar and Risbey, 2000). Availability of better climate and agricultural training helps farmers make comparative decisions among alternative agricultural productive management practices and this allows them to better choose strategies that make them cope well with changes in climatic conditions (Baethgen *et al*., 2003). In the study areas training to climate change was promoted changing planting date, irrigation water use and soil and water conservation the choice of adaptation strategies in different significant level.

The distance to market center is an important factor affecting adoption of agricultural technologies (Feder *et al*., 1985). Input markets allow farmers to acquire the inputs they need such as improved seed varieties, fertilizers and irrigation technologies. On the other hand, access to output markets provides farmers with positive incentives to produce and adopt alternative strategies. The longer the distance to the market, the lower will be the probability that farmers adopt improved technologies. In this study, distance to markets positively affected the use of irrigation and negatively and significantly affected soil and water conservation and crop variety

selection. That is, one kilometer increase in distance to market center would reduce the probability of adoption of soil and water conservation and crop variety selection strategies by 1.3% and 1.9%, respectively; but increase use of irrigation by 1.6%. Therefore, proximity to market is an important determinant of adaptation, presumably because the market serves as a means of exchanging information with other farmers (Maddison, 2006).

Family size as a proxy to labor availability may influence the adaptation of new technology positively as its availability reduces the labor constraints (Legesse *et al*., 2006). However, in this study it was found that household's family size is negatively and significantly related to the probability of crop variety selection as an adaptation strategy. This could be because households with large families may be forced to divert part of the labor force to off farm activities in an attempt to earn income in order to ease the consumption pressure imposed by a large family rather than adopting crop variety selection. On the other hand, it was inferred from the result that more educated households were more likely to implement soil and water conservation adaptation strategies than the less educated households.

Cultivated land had significant effect on some of the farmer's choice of adaptation strategies. The marginal probability of the multinomial logit model indicates that increasing cultivated land by 1 unit decreases the probability of adopting soil and water conservation by 48%, but the probability of crop variety selection as adaptation to climate change increases by 36.3%. However, the cultivated land size determines the land allocated to adopt suitable strategies.

Access to credit service had a strong positive influence on the probability of adopting all adaptation strategies. Access to affordable credit increases financial resource of farmers and their ability to meet transaction cost associated with various adaptation options they might want to take (Nhemachena and Hassan, 2008). This result implies that access to credit is critical in helping farmers to adapt to climate change.

Social participation (a proxy of economic independence and organizational membership and participation in collective action) was found to significantly influence some of the households' adaptation decisions. Social participation increases the probability of farmers' adoption of crop variety selection strategy by 13.5% while it decreases the probability of irrigation water use by 0.9 percent. Thus, social participation and social network are increasing awareness and forecasting use of climate change adaptation options.

The household perceptions about long term change of precipitation, as well as various adaptation strategies activity are adopted. However, in this study it was found that precipitation decrease the probability of using crop variety selection by 30.5% while a unit increase in temperature increased the probability of using crop variety selection by 24.7%. This exerts more pressure on the livelihood activities to sustain households' life.

The predicted probabilities of adaptation strategies suggested that the likelihood of the sample households to adopt the strategies of changing planting date, irrigation water use, soil and water conservation and crop variety selection in reference to the base category of no adaptation strategy were 0.9%, 28.4%, 38% and 18.5%, respectively.

3. Conclusions and Policy Implications

This study analyzed factors affecting food security and adaptation strategy to climate change based on a cross-sectional data collected from 330 farm households in Eastern Ethiopia during the 2011/2012 agricultural production year.

The food security and adaptation strategies options which are believed to adapt climate change impacts on agricultural production and implemented by farmers are considered in this study. A Univariate probit model and MNL model were used to analyze the determinants of farmers' household food security and choice of adapting strategies. Results from the model showed

that there are different socio-economic and environmental factors that affect farmers' food security and adaptation strategies to climate extreme events. These include the educational status of household head, credit access, social participation, size of cultivated land, use of chemical fertilizer, access to nearest market, off-farm income, agroecology and training to climate change.

Farmers in the study area have adopted four types of strategies among from different adaptive strategy alternatives, namely changing of planting date, use of irrigation, soil and water conservation and crop variety selection. The model results indicated that adaptation strategies, food security states will be better-off due to the decreased impact of climate change. The current food insecurity status is 55% and food security is 45% and adopted changing planting date, irrigation water use, soil and water conservation and crop variety selection were in 0.9%, 28.4%, 38% and 18.5%, respectively, indicating a decrease in negative impact of climate change as a result of the likelihood of food insecurity and adopting the strategies.

The issue of climate change has gone beyond effort alone. Government policy and investment strategies should also work to support the provision of access to education, access to credit, and awareness creation on climate change, off-farm income and adaptation mechanisms. In addition, policy interventions that encourage social network participation which can promote group and community discussions and enhance better information flows, ultimately enhancing the ability to adapt to climate change.

References

Amsalu Mitiku, Bekabil Fufa and Beyene Tadese. 2012. Empirical analysis of the determinants of rural households' food security in Southern Ethiopia: The case of Shashemene District. *Basic Research Journal of Agricultural Science and Review,* 1(6): 132-138.

Babatunde, R. O., O. A. Omotosho, and O. S. Sholotan. 2007. Factors influencing food security status of rural farming households in North Central Nigeria. *Agric. J.,* 2(3): 351 – 357.

Baethgen W. E., H. Meinke, and A. Gimene. 2003. Adaptation of agricultural production systems to climate variability and climate change: lessons learned and proposed research approach. Paper presented at climate adaptation.net conference "Insights and Tools for adaptation: learning from climate variability," 18-20 November, 2003, Washington, DC.

Bradshaw B., H. Dolan, and B. Smit. 2004. Farm level adaptation to climatic variability and change: Crop diversification in the Canadian prairies. *Climatic Change* 67: 119-141.

Brooks, N., W. N. Adger, P. M. Kelly. 2005. The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global environmental change* 15: 51-163.

Cameron, C., and P. Trivedi. 2009. *Micro econometrics using stata*. College Station: Stata Press.

CSA. 2007. The Federal Democratic Republic of Ethiopia statistical abstract. Addis Ababa, Ethiopia.

CSA. 2011. Analytical report on the 2011 urban employment unemployment survey. Analytical Bulletin, Addis Ababa, Ethiopia.

FAO. 2007. Climate change and food security: a framework for action. FAO Inter-departmental working group on climate change. Rome.

Feder, G. Just, R. E and D. Zilberman. 1985. Adoption of agricultural innovations in developing countries: A Survey. *Economic Development and Cultural Change,* 33(2): 255-298.

FDRE. 2012. Ethiopia's Progress towards Eradicating Poverty: An Interim Report on Poverty Analysis Study (2010/11). Addis Ababa, Ethiopia.

Foster, J., J. Greere, and E. Thorbecke. 1984. A class of decomposable poverty measures. Econometrical 52 (3): 761-766.

Greene, W. 2012. *Econometric Analysis* 7th ed. New Jersey: Pearson Hall, USA.

Hailu M. 2012. Causes of household food insecurity in rural Boset Woreda: Causes, extent and coping mechanisms to food insecurity. Germany: Lap Lambert Academic Publishing.

Hausman, J. and D. McFadden. 1984. Specification tests for the multinomial logit model. Econometrica 52 (5), 1219-40.

Hausman, J. and D. Wise. 1978. A conditional probit model for qualitative choice: Discrete decisions recognizing interdependence and heterogeneous preferences. Econometrical 46, 403-26.

Hoddinott J., 2001. Method for Rural Development projects: Food Security in practice, IFPRI, Washington D.C. 1: 80-100.

Jones, J. W. 2003. Agricultural responses to climate variability and climate change. Paper presented at climate adaptation.net conference "Insights and Tools for Adaptation: Learning from Climate Variability," November 18-20, 2003. Washington, DC.

Kandlinkar, M. and J. Risbey. 2000. Agricultural impacts of climate change: if adaptation is the answer, what is the question? *Climatic Change,* 45: 529-539.

Kifle Lemma and Yosef Gebrehiwot. 1999. The food security situation in Ethiopia. Concepts, status and Trends. In Taye Assefa (ed.): Food security through sustainable land use. Proceeding of the first National workshop of NOVIN partners. Forum on sustainable land use. NOVIN, Addis Ababa.

Klingele R, A. H. Yesus. 2004. Field trip report highland and lowland Hararghe zones region, UN-EUE, 22 - 31 August, Addis Ababa.

Kurukulasuriya, P., and R. Mendelsohn. 2006 . A Ricardian analysis of the impact of climate change on African crop land. CEEPA Discussion Paper No. 8. Centre for environmental economics and policy in Africa. Pretoria, South Africa: University of Pretoria.

Legesse Dadi, H. Teklewold, and N. Dana. 2006. Determinant of adoption of poultry technology: A double hurdle approach, Debre Zeit Agricultural Research Center, Debre Zeit, Ethiopia.

Loë de, R., R. Kreutzwiser, and L. Moraru. 2001. Adaptation options for the near term: climate change and the Canadian water sector. *Global Environmental Change,* 11: 231-245.

Long, J. S. 1997. Regression Models for Categorical and Limited Dependent Variables (RMCLDV). Thousand Oaks, CA: Sage Press.

Maddalla, G. S.. 1983. Limited-dependent and qualitative variables in econometrics. Cambridge: Cambridge University press.

Maddison, D. 2006. The perception of an adaptation to climate change in Africa. CEEPA. Discussion Paper No.10. Center for environmental economics and policy in Africa. Pretoria: University of Pretoria.

MoFED. 2013. Growth and Transformation Plan (available at http://www.ethiopians.com/Ethiopia_GTP_2015).

Nhemachena, C. and R. Hassan. 2007. Micro-Level Analysis of Farmers' Adaptation to Climate Change in Southern Africa. IFPRI Discussion Paper No. 00714. International Food Policy Research Institute. Washington DC.

Nhemachena, C. and R. Hassan. 2008. Determinants of African farmers' strategies for adapting to climate change: multinomial choice analysis. *African Journal of Agricultural and Resource Economics,* 2(1): 83-104.

Rosenzweig, C., D. Karoly, M. Vicarelli, P. Neofotis, Q. Wu, G. Casassa, A. Menzel, T.L. Root, N. Estrella, B. Seguin, P. Tryjanowski, C. Liu, S. Rawlins, A. Imeson. 2008. Attributing physical and biological impacts to anthropogenic climate change. *Nature,* 453(7193): 353–357.

Seo, N., and R. Mendelsohn. 2008. Climate change adaptation in Africa*:* a microeconomic analysis of livestock choice. CEEPA Discussion Paper No. 19. Centre for Environmental Economics and Policy in Africa. Pretoria, South Africa: University of Pretoria.

Slingo, J. M., A. J. Challinor, B. J. Hiskins, T. R. Wheeler. 2005. Introduction: food crops in a changing climate. *Philosophical transactions of the Royal society*, Series B360: 1983–1989.

Temesgen Deressa., R. Hassen, Tekie Alemu, Mahmud *Yesuf* and C. Ringler. 2008. Analyzing the determinants of farmers' choice of adaptation measures and perceptions of climate change in the Nile Basin of Ethiopia. International Food policy research institute (IFPRI) Discussion Paper No. 00798. Washington, DC: IFPRI.

Todaro, M. P and Smith, S. C. 2009. Economic Development. Tenth edition. Addison-Wesley.

Von Braun, J., H. Bouis, S. Kumar and R. Pandya-Lorch. 1992. Improving food security of the poor: Concept, Policy, and Programs. International food policy research institute. Washington, D.C, U.S.A.

Watson, B. 2010. Climate change*:* An environmental, development and security issue. Livestock and global climate change international conference proceedings, Tunisia, 17-20 May2008, 6-7.

WHO (World Health Organization) and FAO. 1985. Energy and protein requirements: Report of a joint FAO/WHO/UNU expert consultation. WHO Technical Report Series No. 724. Geneva.

Wooldridge, J. M. 2002. Econometric analysis of cross section and panel data. Cambridge, Mass.: MIT Press.

Wu, J. and B. A. Babcock. 1998. The choice of tillage, rotation, and soil testing practices: economic and environmental implications. *American Journal of Agricultural Economics*, 80:494-511.

FARMERS' WILLINGNESS TO PAY FOR IRRIGATION WATER USE: THE CASE OF HARAMAYA DISTRICT, EAST HARERGHE ZONE, OROMIA REGIONAL STATE

Anteneh Melake[1] and Endrias Geta[2]

Abstract

The value of irrigation water is a measure of the net economic contribution of water to the value of agricultural production. The economic value of irrigation water was determined through Contingency Valuation Method by analyzing farmers' willingness to pay for irrigation water under hypothetical market constructed in the study area. The objectives of the study were to analyze determinants of willingness to pay for irrigation water use by individual households and to evaluate their WTP for irrigation water use per ha of irrigable land per year. Ordered Logit Model was used to identify and analyze the factors that determine farmers' WTP for irrigation water. In addition, Binarylogit model was used to calculate the mean WTP for irrigation water use per ha per year. The result of ordered logit model showed that six explanatory variables were found to be significant at different probability levels. On the other hand, the result of the Binarylogit model showed that household head mean annual WTP amount was Birr 7,402.32 per ha per year. The result show that practical intervention measures for constructing, managing and maintaining irrigation infrastructure with community participation should consider the value they give for the resource. Policy directions for sustainable use of irrigation water and management in Ethiopia were also suggested.

Keywords: contingent valuation; economic value; irrigation water; sustainability; willingness to pay

Exchange rate at the time data collection 1USD= 18. 50138 ETB (Ethiopian Birr)

[1] Department of Agricultural Economics, Haramaya University, Ethiopia: antenehmelake@gmail.com Mob: +251911751546

[2] Department of Agricultural Economics, Haramaya University, Ethiopia: geta.endrias@gmail.comMob: +251916868202/

1. Introduction

The science of Economic has always had something to say about the relation between economic welfare and the stock of natural assets (Pearce and Warford 1993). Water markets are increasingly being relied upon by international institutions and national governments to facilitate allocation of the scarce water from inefficient low value users to efficient high value users. Sustainable growth can be achieved if developmental activities fall within the ambit of the carrying capacity of the environment. However, environmental resources are getting depleted from time to time.

In the sixteenth century, the famous Renaissance scholar Leonardo Da Vinci said that water is the driver of nature. During his lifetime, some may have considered this to be an overstatement, but some half a millennium later, Leonardo's understanding of the role, relevance and importance of water to society and nature can be considered to have been prophetic (Biswas *et al.*, 2009). Now, in the 21st century one of the development challenges facing the world is meeting the rising demand for food while maintaining the sustainability of the natural resource, especially water (FAO, 2004). Limited availability, declining quality and the growing demand for fresh water have now emerged as a major worldwide challenge, and climate change is expected to make matters worse (EC, 2012).

Water resources remain poorly developed and the utilization of the existing agricultural water management schemes is inefficient. The signs of water shortage and the need for demand management in situations where supply growth is no longer feasible in addition to current high levels of subsidy to irrigation, in parallel with underfunding of maintenance and deterioration of infrastructure are among factors towards irrigation water charging. However, in some irrigation projects water is provided as a free service. Elsewhere, even the low charges, supposed to be collected are, in fact, not collected (Cai *et al.*, 2001). Ainsworth and Jehn (2005) noted that adequate protection and routine maintenance enhance the sustainability of water supply systems. Thus, collaboration and integration of the government and beneficiary households are required, and such development activities

should consider the value those beneficiary households given to water resource for irrigation purpose.

The value of irrigation water is a measure of the net economic contribution of water to the value of agricultural production. As a consequence, the valuation of water used in agricultural activities is a prerequisite in the implementation of almost every pricing method. On the other hand, it is a difficult task mainly because irrigation water is a classic non-marketed resource (Dinar *et al*., 1997; Ward and Michelsen, 2002). The contingent valuation method is a survey-based approach to the valuation of nonmarket goods and services and widely applied to measure economic value of water. It relies on people's hypothetical WTP rather than actual market-information on their behavior (Hanemann *et al.*, 1991).

2. Background

About 85% of Sub-Saharan Africa's poor live in the rural areas and depend largely on agriculture for their livelihoods which depends on rainfall (Peacock *et al.,* 2007). However, there has been less agricultural water development to date in Sub-Saharan Africa than in any other region though the sector is the backbone of the region's economy. From 1962-2002, only 4 million ha (Mha) of new irrigation has been developed in the region, far and away the smallest expansion of any region. Yet the region has an immense potential for irrigation. Over the same period, China added 25 Mha, and India added 32 Mha and between 1994 and 2004 it was only 0.85 Mha (FAO, 2005).

Rain fed agriculture dominates in Ethiopia. Rainfall also varies temporally resulting in incidents of drought every 4-5 years (Osman and Sauerborn, 2008). These rainfall patterns affect crop and livestock production and contribute to volatility in food prices, which ultimately affects overall economic development (FAO, 2005). However, according to Seleshi (2010) the country has about 5.3 Mha potential irrigable lands. Yet, only about 640,000 ha is irrigated, of which about 241,000 ha from small scale, 315,000 ha from medium scale and 84,000 ha from large scale schemes. The per

capita irrigated area was about 30 meters square (m^2) which was very small compared to 450 m^2 globally (Seleshi *et al.*, 2007).

Some of the existing irrigation schemes are not operating at their full potential, while others are not functioning because of problems related to infrastructure, management and water shortages. A performance assessment conducted on six selected irrigation schemes (five small scales, one large-scale) confirmed they are performing poor (FAO, 2011). According to AgWater Solutions (2010) unsustainable use of irrigation, mainly due to excessive use of water and poor infrastructure maintenance, is one of the problems facing the agriculture sector of the country. In the past, the most common ways of constructing and maintaining irrigation schemes in countries was through government or donor expenditures with little or no community participation. Yet improving and protecting irrigation water always require joint action of stakeholders because absolute dependence on government or donor funds without community involvement is likely to be unsustainable. One example in Ethiopia from the 1980s is the large Borkena dam in South Wello (Desta *et al.,* 2005 as cited in Habtamu, 2009). But water pricing policy aiming at cost recovery enables to cover the costs of providing the service – ranging from O&M costs to full supply cost, including capital expenses, besides regulating water demand for production purpose as it signals water is scares.

3. Study Area

Oromia regional state of Ethiopia, which is the largest state in terms of both population and land area, has been involved in irrigation development. Currently, there are 199 irrigation schemes in the region. These irrigation schemes covered 33,765.19 ha of irrigated area, of which 4,627.29 ha are from small-scale, 2,800.01 ha from medium-scale and 26,338 ha from large-scale (Seleshi, 2010). In the regional state, motorized pumps are often used to lift water from rivers, lakes, ponds or hand-dug wells when gravity irrigation is difficult. Traditional ponds (*birka*) and sand-water are often used for livestock in dry land areas such as Borena. In addition, rainwater harvesting has been implemented by the government, particularly in

drought-prone areas, since 2002. Pond technology for small-scale irrigation is widely adopted in the region. In addition to this, drip irrigation, treadle pumps, rope-and-washer, and wind mills are just in the adoption process in some zone of the region. There are also ample groundwater resources in Oromia Region.

The study was conducted in Haramaya District, Eastern Hararghe Zone, Oromia National Regional State of Ethiopia. East Hararghe is one of the 180 zones in Oromia Regional State and located in the eastern part of Ethiopia between 41^0 12' E - 42^0 53' E and 7^0 32' N - 9^0 44' N, bordering Somali and Harari Region as well as Dire Dawa Administration. Haramaya District is one of the 18 Districts in the Eastern Haraghie Zone with an area of 561.64 km^2 (HDOA, 2012). According to CSA (2008), Haramaya District has a population of 271,394 out of which 50,986 (about 16%) live in urban and the remaining 220,408 (about 84%) live in rural in 2007. The District is situated in the semi-arid tropical belt of Eastern Ethiopia and characterized by a sub-humid climate with an average annual rainfall of about 790 mm, annual mean temperatures of 17^o C with mean minimum and maximum temperatures of 9.4 and 24^o C, respectively. The area experiences biannual type of rainfall classified as short and long rainy seasons. The short rainy season usually occurs from end of February to mid-May while the long rainy season is from July to end of September. The altitude of the District ranges from 1400 to 2340 meter above sea level. About 36.1% of the District's land is arable, 2.3% used for pasture, 1.5% covered by forest and the remaining 60.1% is considered degraded or unusable (HDOA, 2012).

The district is well known for its high production and center for commercial exchange of *Chat,* which is exported to Djibouti, Yemen, Oman, and Saudi Arabia. Other crops including sorghum, maize, coffee, and a variety of vegetables such as potato, onion, tomato, pepper, and cabbages are produced in the District. Livestock also plays an important role in the farming system of the area, providing income, food and fertilizer. Livestock production is largely dependent on crop residues and grazing on hillsides, field borders and roadsides.

Small-scale irrigation farms using engine driven pumps is the most prevalent system in the area. It is widely used to lift water from rivers, lakes, or ponds for producing *chat* and vegetables. According to the districts' Agriculture Office (2012), motorized irrigation is widely practiced in the district. Underground water, Lake Adellei and harvested rain water are the main sources of irrigation water in the study area in their respective order. More than 600 functional ponds were found in the district. The District Agriculture Office was providing motor pumps by 25% credit and 75% on hand payment while Water, Mineral and Energy Office was providing the same by 50% credit and 50% on hand payment. However, over-abstraction of the water puts the sustainability of resource under question. For example, Lake Haramaya of the district was dried out, mainly due to sedimentation and excessive pumping, which is endangering the biodiversity of the ecosystem (AgWater Solutions, 2010). In addition, the level of groundwater is dropping down further from year to year, and Lake Adellei, which might be suitable for irrigation purpose, is under risk.

Lake Adellei has salinity problems. However, farmers use the upper level of the water after pumping and storing in ponds allowing for the saltto precipitate. Regarding the distribution of the resource in question, no legal frameworks were established. This lack of legal framework in water usage created conflicts among users and also puts the sustainability of the resource under question. There is no well-constructed irrigation scheme and regulation to use Lake Adellei for irrigation, which was the focus area of the study. In addition, no attempt had been made to quantify farmers' willingness to pay (WTP) for irrigation water use in order to develop sound interventions aimed at developing irrigation scheme. This motivated the study to investigate the farmers' WTP for the non-marketed good, irrigation water use, in the hypothetical market constructed in the study area.

4. Methodology

4.1 Environmental Resource Valuation

Environmental resources are nonmarketable resource for which the existing market failed to value them. Due to market imperfection for water-related

goods and services, nonmarket economic valuation is an essential component of economic assessment of public water allocation and other policy choices. Nonmarket economic valuation can be defined as the analysis of actual and hypothetical human behavior to derive estimates of the economic value of goods and services in situations where market prices are absent or distorted. It is used to compute the total economic value of all the benefits provided by environmental resources. This value is derived from both use value and non-use value of the resource. The use value refers to the value that individuals drive from using environmental resource, while non-use values are the values derived from environmental resources even if individuals themselves do not use them. Environmental valuation methods are classified into two broad categories based on the elicitation techniques used. These are Revealed Preference or Indirect Valuation Method and Stated Preference or Direct Method.

4.2 Revealed Preference Method

When a valuation technique considers related or surrogate markets in which the environmental good is implicitly traded, it is referred as a revealed preference method or indirect valuation method. Travel cost method, the hedonic pricing method, the production function method, the net factor income method, the replacement cost method, the market prices method, and the cost-of-illness method are some examples revealed preference valuation method. However, these methods cannot consider the non-use value of the resource. Thus, it is not used in valuation of water resource for irrigation purpose (Birol *et al.,* 2006).

4.3 Stated Preference Method

This is survey-based methods that can be used either for those environmental goods that are not traded in any market or for assessing individuals' stated behavior in a hypothetical setting. The method includes a number of different approaches such as choice experiment method, and contingent valuation method (Birol *et al.,* 2006). In choice experiment method individuals are given a hypothetical setting and asked to choose

their preferred alternative among several alternatives in a choice set. Each alternative is described by a number of attributes or characteristics by incorporating price as one of the attributes along with other attributes of importance. According to Alpizar *et al*. (2001) and Colombo *et al.* (2005), it is appropriate when environmental attributes are easily identified and differentiated to assess the relative impacts of different environmental management options. Yet, this study was focused in measuring the value of sustainable irrigation water flows under a single management option. Thus, price is the only attribute that randomly varies. Therefore, another stated preference method known as the contingent valuation method was applied to measure economic value.

CVM relies on people's hypothetical WTP rather than actual market-information on their behavior: hence, the term contingent valuation. It is a survey-based approach to the valuation of nonmarket goods and services. It enables economic values to be estimated for a wide range of commodities which is not traded or practiced in the market before (Hanemann *et al.*, 1991). In the absence of organized markets, an intuitively appealing approach to revealing the preference of individual is the use of CVM. This technique uses a hypothetical market situation to obtain bids from individuals indicating their WTP for a commodity which is the amount that must be taken away from the person's income while keeping his utility constant. The approach is also used for valuation of wilderness as well as of common environmental facilities like forests, common lands, national parks and common water bodies, *etc*. (Kadekodi, 2001).

A particular advantage of CVM is that the method can be designed specifically to capture the total value of a good: Both use and non-use values such as valuing the continued existence of entities such as certain species of flora or fauna or even whole ecosystems. Its flexibility facilitates valuation of a wide range of non-marketed goods (Knife and Brehanu, 2007). However, the method has a number of biases that are:1) Strategic bias: the incentive to "free ride" - the respondent's answer is influenced by what they foresee may eventually happen with regards to the project or the study results; 2) Design bias: a) Starting point bias - where the interviewer

may bias the respondent's valuation by suggesting an approximate value; b) Vehicle or instrument bias - where the respondent is prejudiced by the proposed means of payment collection, or is unwilling to pay for services presumed to require public provision; and c) Informational bias -where there is inadequate detail on the effects discussed within the questionnaire or experiment and/or misleading statements by interviewer 3) Hypothetical bias- where the decision posed in the question does not involve real market behavior and consequently there is no real incentive to think about and give answers which truly reflect the individual's valuation. However the gain in efficiency largely prevails over the loss in bias, which, furthermore, tends to be moderate (Albertini and Cooper, 2000).

The method uses questionnaires to elicit a respondent's WTP or WTA for the preference-related value of the natural resource in question. The value is said to be contingent upon the existence of a hypothetical market as described in the survey put to respondents. Each respondent is given information about a particular problem. Each is then presented with a hypothetical occurrence or a policy action that ensures against the disaster. Each respondent is asked how much he/she would be willing to pay either to avoid the negative occurrence or bring about the positive occurrence. The means of payment (i.e., the payment vehicle) can take on any number of different forms, including a direct tax, an income tax, or an access fee. The price that people are willing to pay (a weighted average is computed) is taken as the price, and valuation of the asset or the resource is done using this price (Ulibarri and Wellman, 1997).

CVM uses a number of different elicitation methods. These elicitation methods may include open-ended and/or close-ended questions. Single-bounded and double-bounded dichotomous choices or Bidding Game are the two widely-used bidding methods in CVM for assessing market products or non-market resources. The open ended question asks the respondent how much he or she is willing to pay for given change in the status quo, i.e. individuals are asked for their maximum WTP with no value being suggested to them. This method has high degree of individual impreciseness, and sometimes systematic bias, may be a problem. On the

other hand, the double-bounded method is an extension of the single-bounded method and improves statistical efficiency over the single-bounded method by engaging respondents in two bids instead of one. A second question associated with higher or lower value is asked based on responses from the first question. If the initial offer is accepted, a premium will be asked; while if the initial offer is rejected, a discount will be offered. Using two sequential bidding questions, boundaries of WTP are therefore observed. However, the method may suffer from lack of incentive compatibility and starting point bias (Bateman *et al.,* 1997).

More specifically, in this study, the double-bounded dichotomous choice approach with an open-ended follow-up question was applied. The follow-up open ended question helped to identify inconsistencies in answering closed-ended questions as well as to observe those individuals who had positive WTP but below the proposed bid price range. Furthermore, it enabled assessment of whether a starting point bias exists or not in randomly assigned bid values.

4.4 Pricing of Irrigation Water

The effectiveness of the financial and economic roles of water pricing policies depends on the pricing method and its objective. Volumetric water pricing is used where the objective is to reduce water demand in the agricultural sector. It is the most favored pricing mechanism among economists and environmentalists, by which water is charged according to directly measured volumes of consumed water (Latinopoulos, 2004).

However, there is little practical evidence from the field to support the view that volumetric pricing changes farmers' water demand patterns. Even in countries facing extreme water scarcity, Jordan, Israel and Morocco, the aim of water pricing is to recover service delivery costs. In all of these countries water is priced on a volumetric or approximate volumetric basis to indicate its value to users and discourage wasteful use (Berbel *et al.,* 2007).

In most cases, it is difficult and expensive to enforce installment of measurement devices and to monitor legal and/or illegal users. If agricultural income is low water costs may outweigh the revenues of many farmers. In addition, in developing countries, given the poor level of "aggregated" service now observed the challenge to administration and management volumetric pricing would be unrealistic (Perry, 2001).

Moreover, shift to metered systems may be difficult, especially in specific situations with area-based systems, or no history of metering (as water has simply been available for agriculture), or other circumstances. Further, such price increases are mostly not accepted by any water user and might result in social problems, with improvements in the environment therefore being highly uncertain.

On the other hand, area-based charges could serve as a starting point to reduce opposition. It is also the most widely used and the most popular pricing method, which is adequate where the sole objective is cost recovery. Supply cost recovery includes investments cost in infrastructure, O&M costs and administrative costs *etc*. Farmers are charged a fixed price per unit of irrigated land. In some cases this may vary according to crop type, with higher charges for more water demanding crops (EC, 2012).

The prevailing water policy of Ethiopia for both urban water and irrigation investment is cost recovery (UNESCO, 2004). Thus, because of problems related with volumetric pricing coupled with the country's prevailing policy, area based pricing method is advisable for Ethiopia.

5. Theoretical Framework

The WTP decision made by farmers for irrigation water use depend on the expected level of satisfaction they could attain both from productive and non-productive uses. Here, WTP is defined as the amount that must be taken away from his/her income while keeping his/her utility constant. In this study farmers were expected to reasonably show their WTP or not decision for irrigation water they would use in line with the objective of

improving their yield or income and other benefits they could derive from the water supplied.

According to Hanemann (1989), in the dichotomous choice method, individuals are assumed to have utility functions (U), income (Y), and a set of conditioning factors (S):

$$U (Y; S) \quad \textbf{(1)}$$

If a farmer is willing to pay for irrigation water use, the farmer's utility is given by

$$U_1 = U (1, Y, S) \quad \textbf{(2)}$$

Whereas, if the farmer is not willing to pay for irrigation water, the farmers' utility will be given by

$$U_0 = U (0, Y, S) \quad \textbf{(3)}$$

With the introduction of a proposed irrigation water use, each farmer is confronted with a specified bid amount, VWTP, i.e. initial bid (B_I), discounted bid (B_D), and premium bid (B_P), which he/she could contribute toward assuring of a year-round irrigation water supply.

It is assumed that the individual would accept a suggested VWTP to maximize his/her utility under the following condition and reject it otherwise (Hanemann, 1989):

$$U (1, Y- VWTP; S) + \varepsilon_1 \geq U (0, Y; S) + \varepsilon_0 \quad \textbf{(4)}$$

Here, ε_0 and ε_1 are identically and independently distributed random variables with zero means.
U is the indirect utility function
Y is households' income
WTP is willingness to pay bid values, i.e. B_I, B_D, and B_P.

5.1 Data and Sample

The study used data that were gathered from both primary and secondary sources. The primary data were collected through face to face interview of the sample household heads using structured questionnaire consisting of questions related to socio-economic, demographic and institutional characteristics of the households, and contingent valuation. A draft questionnaire for these purposes was first presented for six households to generate information that was used to refine the survey instrument for the contingent valuation study. Feedback from the pre-tests was used to revise the questionnaire, especially in determining acceptable starting points and ranges of bids to minimize the effect of starting point bias. Additional primary data were generated from personal observation during focus group discussion and interview of the District Agriculture, and Water, mineral and Energy Offices workers.

Secondary data were also collected from the District Water, Mineral and Energy Office. Six enumerators who are fluent speakers of the local language were recruited and trained for a day on the objectives of the study, in data collection techniques, in the questionnaire, and how to approach the farmers during the interview for the purpose of data collection.

There are several approaches to determine the sample size. These include using a census for small populations, imitating a sample size of similar studies using published tables, and applying formulas to calculate a sample size. In this study a simplified formula provided by Yemane (1967) were used to determine the required sample size at 95% confidence level, 0.5 degree of variability and 9% level of precision.

$$n = \frac{N}{1 + N\,(e)^2} \qquad \textbf{(5)}$$

Where n is the sample size, N is the population size (total household size), and e is the level of precision. The District has 31 rural and 2 urban kebeles with total of 33,978 household (CSA, 2008). Hence, the sample size equals

$$n = \frac{33978}{1 + 33978\ (0.09)^2} \qquad \textbf{(6)}$$

$$= 123.0098 \approx 123$$

Regarding the sampling procedure, multi-stage sampling procedures were employed to select the sample irrigation water users' households as follow.
Stage 1: In the first stage, two kebeles were purposively selected on the basis of the availability of irrigation water use schemes. Currently, only two kebeles have an access to the water resource.

Stage 2: In the second stage, households in sample kebeles were categorized into two strata based on whether or not individual household uses irrigation water.

Stage 3: In the third stage, a total of 123 farm households were selected randomly from each stratum in each sample kebeles using probability proportion sampling method. Accordingly, 64 samples from Ifa Oromia and 59 from Biftu Geda were selected from the list accessed from respective kebeles.

Table 1: Distribution of sample households in kebeles

Kebele	Non users	Users	Total	Sample size		
				Non users	Users	Total
Ifa Oromia	1029	1012	2041	32	32	64
Biftu Geda	878	978	1856	28	31	59
Total	1907	1990	3897	60	63	123

Source: Own survey result (2012)

User households are using ground water for irrigation use but they are not using Lake Adellei water for the same purpose. However, households in the sampled kebeles were divided into two strata of users and non-users to

minimize sampling bias of the either stratum in the valuation non-marketed resource under question *i.e.,* lake Adellei for irrigation purpose.

Method of Data Analysis

Descriptive and inferential statistics such as means, ratios, standard deviations, variances and percentages were computed to explain the different socio-economic characteristics of the sample households. The mean WTP for open ended question was calculated by using descriptive statistics. In addition, inferential statistics to test statistical significance such as F-test and chi-square test were employed to analyze continuous and dummy variables, respectively.

Binarylogit and ordered logit models were used. The purpose of the binarylogit was to calculate the mean WTP for the closed-ended format while the ordered logit model was used to identify socioeconomic factors that affect the dichotomous choice WTP of households.

Binary logit model

The binary probit and logit models give generally similar result. In this study the binary logit model was adopted to calculate the mean WTP for the closed-ended format as stated by Langford and Bateman (1994). A suitable functional form for modeling WTP from the dichotomous choice format is given by:

$$\pi^{y} = G(B; \theta); \pi^{n} = 1 - G(B; \theta) \quad \textbf{(7)}$$

where π^{y} is the probabilities of saying "yes'' and π^{n} is the probabilities of saying "no'' at any particular bid level, B represents the bid levels and θ is a parameter vector which links the probability of saying "yes" to a statistical distribution.

The probability of any household saying "yes" to a particular bid level is a binary with two possible outcomes, zero and one. The functional form restricts the possible values of π , there being several choices for:

$$G(\pi_i) = a - b(B_i) \quad \textbf{(8)}$$

where (8) is commonly taken to be logit function, it becomes

$$G(\pi_i) = \ln\left[\frac{\pi}{1-\pi}\right] \quad \textbf{(9)}$$

For the logit model (8), the estimate of the mean WTP is given by

$$E(WTP) = \frac{a}{b} \quad \textbf{(10)}$$

where *a* is constant and b is the coefficient of the bid.

Ordered logit model

Amani (2009) and Muluken (2011) employed ordered logit model in studying water allocation and WTP for reused water and factors affecting farmers' WTP for municipal solid waste *chat* residual compost, respectively. In another study, Zelalem (2010) employed ordered probit model in studying determinants of WTP for improved rural water supply. Although the two methods are actually interrelated as one is the mirror image of the other and may give the same result, this study used ordered logit model to analyze the effect of socio-economic characteristics of the farmers on their choice of WTP for irrigation water use. The parameters of the model were estimated using the iterative maximum likelihood estimation procedure. The ordered logit model was used to analayze the factors that are responsible for farmers being willing or unwilling to pay for irrigation water because it is simpler to work with and the interpretation of parameter estimates is straight forward.

In this study, the outcomes of the bidding procedure are categorized into the following indices for WTP bids:

$$Y = \begin{cases} 1(no-no), if\ WTP < B_D \\ 2(no-yes), if\ B_D \leq WTP < B_I \\ 3(yes-no), if\ B_I \leq WTP < B_P \\ 4(yes-yes), if\ WTP \geq B_P \end{cases} \quad \textbf{(11)}$$

Consequently, probabilities for the above choice indices can be specified as:

$$P\ (Y=j) = \begin{cases} P(Y=1) = F(\alpha - \beta B_D + \lambda X) \\ P(Y=2) = F(\alpha - \beta B_I + \lambda X) - F(\alpha - \beta B_D + \lambda X) \\ P(Y=3) = F(\alpha - \beta B_P + \lambda X) - F(\alpha - \beta B_I + \lambda X) \\ P(Y=4) = 1 - F(\alpha - \beta B_P + \lambda X) \end{cases} \quad \textbf{(12)}$$

The probabilities of WTP indices can be expressed as:

$$\begin{cases} P(Y=1) = \frac{e^{\alpha - \beta B_D + \lambda X}}{1+e^{\alpha - \beta B_D + \lambda X}} \\ P(Y=2) = \frac{e^{\alpha - \beta B_I + \lambda X}}{1+e^{\alpha - \beta B_I + \lambda X}} - \frac{e^{\alpha - \beta B_D + \lambda X}}{1+e^{\alpha - \beta B_D + \lambda X}} \\ P(Y=3) = \frac{e^{\alpha - \beta B_P + \lambda X}}{1+e^{\alpha - \beta B_P + \lambda X}} - \frac{e^{\alpha - \beta B_I + \lambda X}}{1+e^{\alpha - \beta B_I + \lambda X}} \\ P(Y=4) = 1 - \frac{e^{\alpha - \beta B_P + \lambda X}}{1+e^{\alpha - \beta B_P + \lambda X}} \end{cases} \quad \textbf{(13)}$$

In a case where there are N respondents, the log-likelihood form for the above sets of responses, following Hanemann *et al.* (1991) can be written as:

$$\text{LnL} = \sum \left\{ I_{Y_{i-1}} lnP(Y=1) + I_{Y_{i-2}} lnP(Y=2) + I_{Y_{i-3}} lnP(Y=3) + I_{Y_{i-4}} lnP(Y=4) \right\} \quad \textbf{(14)}$$

Where $I_{Y_{i=j}}$ is an indicator function for the occurrence of *Yi = j* (*j* =1, 2, 3, 4), and the subscript *i* denotes the *i*th individual observation.

Maximum likelihood parameters were used to obtain the parameter values that maximize the probability of observing the WTP. In reality, the significant explanatory variables do not have the same level of impact on the dependent variable. Maximizing and then taking the first derivative of the log likelihood function produces the parameters for each explanatory variable. This produces the marginal effects or marginal probabilities, which measure the change in the probabilities resulting from a unit change in one of the regressors while holding other regressors constant.

Predicted marginal probabilities were used to assess the influence of the independent variables on the dependent variable. Mathematically this can be expressed as:

$$\frac{\partial(E(WT))}{\partial x_i} \qquad \textbf{(15)}$$

6. Result and Discussion

6.1 The Evaluation Scenario

Assumption: There is a project to develop and maintain irrigation scheme on Lake Adellei, which is found in Haramaya district around Adellei. The project resolves the dependency on rain fed agriculture. To optimize long- and short-run benefits from irrigation water, irrigation beneficiary households often contribute money to sustain the project's dam and channels.

During pretest of the questionnaire, three respondents of different income group from each kebeles were provided with open ended question on how much they would be willing to pay for irrigation water they use. The mean bid was calculated for individual two kebeles and the aggregate of the two kebeles. The aggregate mean bid amount was taken as initial bid for the double-bounded dichotomous question after it was checked for initial bid bias. The individual mean bid of the two kebeles were used in checking initial bid bias associated with the aggregate mean which was taken as initial bid. The result showed that there were no statistically significant

difference in the final WTP bid amount for three different mean of the two kebeles and their aggregate taken as initial bids. Therefore, the aggregate mean of the two sampled kebeles was taken as initial bid.

The households' willingness to pay for irrigation water: This represents a household's WTP decision for irrigation water. Thus, the households' WTP decision for irrigation water use is the dependent variable. It has four bid categories first bid depending on the bid levels. (No-No), second bid (No-Yes), third bid (Yes-No) and fourth bid (Yes-Yes) for those who were WTP (Birr 0-2,792),(Birr 2,800-5,592),(Birr 5,600-11,192), and above Birr 11,200 per ha per year, respectively.

Since households' WTP is a latent variable and not subject to direct observation, the sequential questions served to place upper and lower bounds on the true WTP. As a result, the WTP bid were categorized into four: 1 (No-No) for those who said No for both the initial bid and for the discount, 2 (No-Yes) for those who were not WTP for the initial bid, but WTP for the discount, 3 (Yes-No) for those who were WTP for the initial bid but not willing to the premium bid and 4 (Yes-Yes) in this category included those who were WTP for the premium and above it.

Farmers in the study area used *kindi* (1/8ha) to measure their farm size. Hence, WTP bid was provided for them per *kindi* of irrigable land per year. During the pretest of the questionnaire, three farmers from each kebeles from different income groups were asked an open ended question on how much they would be WTP for irrigation water use per *kindi* of irrigable land. Accordingly, their mean WTP was Birr 700 per *kindi* of irrigable land per year. In addition, the discounted and the premium WTP bid were Birr 350 and 1,400 per *kindi* of irrigable land per year. As a result, the WTP bid was ordered into four: 1 (No-No) for those who said No to both the initial bid and the discount (i.e. Birr 0-349 per *kindi* per year), 2 (No-Yes) for those who were not willing to the initial bid, but willing to the discount (i.e. Birr 350-699 per *kindi* per year), 3 (Yes-No) for those who were WTP the initial bid but not the premium (i.e. Birr 700-1,399 per *kindi* per year) and 4 (Yes-Yes) for those who were WTP the premium and above it (i.e. $\geq$ Birr 1,400

per *kindi* per year) were included. However, for convenience the result was presented per ha of irrigable land per year.

6.2 Results of Descriptive Statistics

Sex of Sample Household Head

The study included a total of 123 respondents. Out of these 103 (83.7%) were male and the rest 20 (16.3%) were female headed households. On average, 90% of female and 17.5% male headed households were not WTP for the initial and discounted bids. The chi-square test show that there was significant relation between sex of household head and WTP bid levels at less than 1% probability level.

Table 2: Summary of respondents WTP decision

	Sex				
WTP order	Male	Female	Total	Percent	Cumulative Percent
1	18	18	36	29.3	29.3
2	24	0	24	19.5	48.8
3	22	1	23	18.7	67.5
4	39	1	40	32.5	100
Total sample	103	20	123	100	
χ^2	42.7751***				

*** shows significance at less than 1%

Source: Own survey result (2012)

Age, education level, and family size

The result presented in Table 3 shows that the mean age of sample respondents was 33.92 years. Those respondents who were WTP for irrigation water the bids Birr 0-2,792 and 2,800-5,592 per ha per year had mean age of 38.86 and 37.29 years, respectively, which were greater than the mean age of the whole sample. The mean comparison showed that mean age difference among the four groups was statistically significant at less than 1% probability level.

Table 3: Age, education and family size of respondents

	Age		Education		Family size	
WTP order	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
1	38.86	0.89	0.28	0.14	8.56	0.36
2	37.29	2.14	0.33	0.33	6.54	0.47
3	33.7	1.11	2.48	0.58	6.52	0.55
4	33.85	0.96	1.28	0.41	5.25	0.36
Total sample	35.92	1.275	1.1	0.365	6.72	0.435
F value	4.03***		0.63		17.55**	

*** Shows significance at less than 1%

Source: Own survey result (2012)

The mean comparisons for education level of the household head show that mean difference among the four groups was not statistically significant. However, the mean comparison of the family size of the four groups was statistically significant at less than 1% probability level.

Total farm size, percentage of irrigated farm and dominant crop on the farm

The mean farm size of the respondents was 0.44 ha. Out of this irrigated area covered about 26.55%. The mean farm size of the respondents who were WTP Birr 2,800-5,592 per ha per year was 0.33 ha which was below the sample mean. However, respondents who were WTP the higher bids of farm greater than the mean as presented in Table 4.

Table 4: Farm size (in hectare) and percentage of irrigated area

WTP order	Total farm size		Total irrigated area		Irrigated area (%)
	Mean	**SD**	**Mean**	**SD**	**Mean**
1	0.44	0.28	0.1	0.16	22.72
2	0.33	0.31	0.05	0.13	15.15
3	0.51	0.45	0.15	0.27	29.41
4	0.49	0.29	0.17	0.14	34.49
Total sample	0.44	0.33	0.12	0.18	26.55

Source: Own survey result (2012)

The study revealed also those respondents who were WTP for the higher two bid levels have irrigated farm with mean above mean of the total irrigated area. However, the percentage of irrigated area of those WTP the premium and beyond it was less than the mean of the total respondent and of those not WTP the initial and the discount. Yet, the mean of total irrigated areas was relatively larger (Table 4).

Cash crops are dominantly produced by 59.3% of respondents while the rest 41.7% dominantly produced non-cash crops. Out of those produced cash crop dominantly 46.6% were WTP Birr 11,200 per ha per year and above it. In addition respondents WTP Birr 5,600-11,192 per ha per year accounted for 26% of cash crop produced. The chi-square test indicated that there was no significant relationship between the type of dominant crop grown and WTP bid levels.

Agricultural experience of sample household heads

Respondents of the survey had a mean of 21.45 years of experience in farming activities. Those who were WTP the two higher bids had a mean experience which was lower than the sample mean. The mean irrigated farming experience of the entire sample was 5.32 years. The mean comparison showed that irrigation experience mean difference among the four groups was statistically significant at less than 1% probability level (Table 5).

Table 5: Sample household's experience of farming and irrigation use

WTP Order	Total farming experience		Irrigation Experience	
	Mean	SD	Mean	SD
1	21.36	1.23	1.28	0.23
2	24.75	1.23	2.08	0.28
3	20.43	1.54	9.09	0.76
4	19.25	1.52	8.85	0.59
Total sample	21.45	1.38	5.32	0.47
F value			15.88***	

*** shows significance at less than 1%

Source: Own survey result (2012)

Livestock holding and distance from the nearest market center

The types of livestock kept on farm were cattle, sheep, goats, donkeys, camel and poultry. The average livestock holding of sample household was 2.49 TLU (Table 6). The average number of livestock owned by respondents who were not WTP the initial and the discounted bids was 1.97 TLU while the rest were above the average i.e. 2.83, 2.89 and 2.51 TLU in their respective order.

Table 6: Livestock holding and distance of respondent's residence from the nearest market

WTP order	Livestock (TLU)		Time (in hour)	
	Mean	SD	Mean	SD
1	1.97	0.15	1.89	0.13
2	2.83	0.19	1.48	0.10
3	2.89	0.23	1.18	0.12
4	2.51	0.20	0.97	0.10
Total sample	2.49	0.19	1.38	0.11

Source: Own survey result (2012)

In addition, the result show that sample households were found at mean distance that take 1 hour and 12 minutes from their residence to the nearest market they used to purchase agricultural inputs and other materials, and sell their farm outputs.

Income source

The result shows that sales of livestock and their products, annual crops, perennial crops, nonfarm and off-farming activities are the source of income for the respondents. The mean annual income of the respondents was Birr 15,494.10. Only those household who were not WTP for initial and the discounted bid earned income below the average annual income. The mean comparison showed that total annual income mean difference among the four groups is statistically significant at less than 1% probability level.

Table 7: Income distribution

WTP order	Source of Income							
	livestock		Annual crop		Perennial crop		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	2174.3	1096.9	2340.7	1049	2758.3	1263.9	8495	1048.54
2	4508.4	866.54	1934.1	1125	8551.5	2756.5	15840.7	1125.03
3	3024.2	897.51	3626.1	2108	9431.8	1755.5	16785.4	2107.92
4	3681.2	695.24	4612.3	2336	11240.8	1233.2	20855.2	2336.31
Total	3347	889	3128.3	1654	7995.6	1752.3	15494.1	1654.45
Percentage	21.6		20.19		51.6		100.00	
F-value							9.12***	

*** shows significance at less than 1%

Source: Own survey result (2012)

Additionally, the income generated from sale of livestock and their products and non-farm activities was highest for those who were WTP Birr 2,800-11,192 per ha per year while that from off-farm activities was highest for those who were WTP Birr 0-2,792 per ha per year. Nonetheless, the income earned from sale of crops was highest among respondents who were WTP above the premium. Chat is the dominant perennial crop contributing higher income for the respondents while vegetables dominate the income from annual crops. Sorghum and maize also contributed to the income of respondents in their respective order.

6.3 Results of Econometric Models

Mean WTP: Binary logit model result

The mean annual bid that households were WTP was estimated at Birr 7,402.32 per ha of irrigable land per year. This was higher than the result reported by Dagne (2008) that farmers in Jibrat District were WTP Birr 453.82 per ha per year. On the other side, Habtamu (2009), in Nile Basin, reported Birr 192 per ha of irrigable land per year. This shows that users in this study area value irrigation water at higher level. In addition to macroeconomic phenomena such as currency devaluation, the type of

crops farmers are producing affects the value farmers gave to resource. The study area is well-known for its export crop *chat.*

Determinants of WTP: Ordered logit model result

The result of the model revealed that six variables were significantly affecting farmers' WTP for irrigation water uses bid categories at different probability level. Irrigation experience of the household head (irrig_exp) and income of the household (income) positively and significantly affected WTP at probability level of less than 1%, and sex of household head (sex) and access to extension services (ext_acc) positively and significantly affected at 5% probability level whereas age of household head (age) and family size of the household (f_size) negatively and significantly affected at probability less than 1%.

Table 8: Estimates of ordered logit model and marginal effect of explanatory variable on WTP probabilities

Variables	Coefficients					
Age	-0.0886***	0.0030	0.01	0.01	-0.01	-0.01
Sex	1.9497**	0.0100	-0.25	-0.24	0.22	0.26
Educ	0.1820	0.3250	-0.02	-0.02	0.02	0.02
f_size	-0.4074***	0.0000	0.05	0.05	-0.05	-0.05
dom_crop	0.1968	0.6460	-0.03	-0.02	0.02	0.03
irrig_exp	0.2083***	0.0000	-0.03	-0.02	0.02	0.03
TLU	0.1541	0.2880	-0.02	-0.02	0.02	0.02
Income	0.0001***	0.0000	0.00	0.00	0.00	0.00
cred_acc	0.6261	0.1750	-0.08	-0.07	0.07	0.08
ext_acc	1.0034**	0.0210	-0.13	-0.12	0.11	0.14
mkt_dist	-0.3797	0.3400	0.05	0.05	-0.04	-0.05
lab_avail	0.2977	0.4870	-0.04	-0.04	0.03	0.04
Trend	0.5797	0.1830	-0.07	-0.07	0.06	0.08

*** and ** show significance at 1% and 5% probability level, respectively

Log likelihood = -108.21093 Number of observation = 123, LR chi^2 (13) = 117.47, Prob> chi^2 = 0.0000, Pseudo R^2 = 0.3518

Source: Own survey result (2012)

The marginal values provide the probability that a unit change in the individual continuous independent variables and being the household head male and having an access to extension service individually has on different WTP bid categories when all other variables are held at their means. The result in Table 8 is interpreted as follows.

Age of the household head (age): This variable was significant at 1% probability level and negatively related with the WTP bid levels. A unit year increase in the households head's age increases the probability to accept the lower bid categories by 1%. In contrast it decreases his/her WTP the higher bids by the same 1%. The possible reason is that, older household heads are more likely to reject new ideas and approaches. They may not be WTP or to pay more since they are traditionally used for free services and may have low preference for a new source that will require fees. The result is consistent with the hypothesis and the findings of Simret (2009) and Zelalem (2010).

Sex of the household head (sex): This variable was significant at 5% probability level and positively related with the WTP bid levels. Being male decreases the WTP probability to the first and second bid categories by 25% and 24%, respectively. Yet it increases the probability to pay the higher bids i.e. the probability to pay for the third and the fourth categories increases by 22% and 26%, respectively. As possible reason is that as Seleshi (2010) stated, irrigation can have potentially negative consequences for women, such as increasing the burden of labor on women, as irrigation is a labor - intensive form of agriculture, and allowing men to capture an unfair share of farm profits. The result was consistent with expectation and the findings of Habtamu (2009) and Eden (2010).

Household family size (f_size): This variable was significant at 1% probability level and negatively related with the WTP bid levels. A unit increases in household member increases the WTP probability to the first and second bid levels by 5%. However, the WTP probability to the third and fourth bid levels decrease by the same percent. This can be justified by the fact that an increase in family size decreases the per capita income of the

member and, hence it will decrease the payment for irrigation water. The result was consistent with the hypothesis and the findings of Dagne (2008) and Simret (2009).

Irrigation Experience of household head (irrig_exp): This variable was significant at 1% probability level and positively related with WTP bid levels. A unit year increase in the household head irrigation experience decreases the probability of WTP decision to the first and the second bid levels by 3% and 2% respectively while it increases the probability to pay the third and fourth bid levels by 2% and 3%, respectively. The possible reason is that farmers who have longer experience in irrigated farming know the benefits of irrigation. The result was consistent with the hypothesis and the studies of Chandrasekaran *et al*., (2009) and Habtamu (2009).

Household income (income): This variable was significant at 1% probability level and positively related with WTP bid levels. An increase in total annual income of the household increases his/her financial position and affects the willingness of the farmer to pay for irrigation positively. However, it is difficult to see the effect of one Birr on probability level. The result was supported by the studies of Chandrasekaran *et al.* (2009), Habtamu (2009), and Eden (2010).

Access to extension service (ext_acc): This variable was significant at 5% probability level and positively related with WTP bid levels. An access to extension service decreases the probability of WTP of farmers to the first and second bid levels by 13% and 12%, respectively. However, it increases the probability to pay the third and the fourth bid levels by 11% and 14%, respectively. This might be because extension services enhance farmers' awareness in improved and modern agricultural technologies. The findings of Dagne (2008) and Eden (2010) supported the result.

7. Conclusion and Recommendations

This study explored the household valuation of irrigation water as an initial step towards the development of a payment for the resource they use that

might estimate the economic contribution of the resource and reduce the negative impact of free use of the resource on its sustainability and analyzed factors determining their WTP decision. Based on the findings of the study, the following recommendations were listed for further consideration in particular in the study area and in general in similar situations in the country.

The result of the binary logit model estimated the mean WTP amount to be about Birr 7,402.32 per ha of irrigable land per year. This shows users in the study area value irrigation water at higher level. Since the government alone cannot address every development demands, NGOs, local communities and other concerned bodies need to participate in provision, operation and maintenance of irrigation scheme. Hence, on the side of local community, development planners should consider this value the households given to the resource.

On the other hand, the result of ordered logit model indicated that the sex of the household head and WTP bid levels were positively related. That is, being male headed household increases the probability of WTP. The reason might be labor demanding nature of irrigation activity. Thus, the policy implication of this result is introduction of labor saving technologies such as less labor demanding crop type could improve female headed household' WTP bid levels.

The age of a household head negatively and significantly influenced the WTP of the households for irrigation water. The reason for this might be older household heads are more likely to reject new ideas and approaches. In addition, since they had been traditionally used for free they may have low preference for a new source that will require fees. Thus, awareness creation about financial limitation of the government for investment, operation and maintenance to use the resource sustainably would increase farmers' WTP bid levels.

Family size and WTP were negatively related. Controlling the increase in the family size should be of priority to enhance farmer's WTP bid levels. Policy

related to family planning such as strengthening the existing education by health extension agents and awareness creation through mass media and *etc.* helps to control the family size and in effect it enhance WTP bid levels through increase in the per capita income.

Farmers' experience in irrigated farming showed a positive influence on farmers' WTP bid levels. Therefore, the policy implication of the result might be that building farmers' awareness about benefits of irrigation and its profitable use by strengthening the existing farmers' training centers, arranging field visits, and *etc.* improve their experience and bid levels in effect.

Total income of farmers determines their WTP decisions. Activities that could improve farmers return such as improving provision of improved and cost minimizing technologies, diversifying source of income, *etc.* increase their WTP bid levels through its effect on income.

Access to extension service is important to increase the WTP bid levels of the farmers. A well-organized extension service focused on what, how and when to produce by irrigation and *etc.* uplifts farmers' knowledge and skill and hence increase their WTP bid levels. Therefore, the quality and coverage of the service should be improved and updated.

References

Agwater Solutions. 2010. Agricultural water management national situation analysis brief: summary of the situation analysis conducted in Ethiopia in 2009. http://awm-solutions.iwmi.org.Accessed on May 03, 2012.

Ainsworth, S. and P. Jehn. 2005. Source water protection: What's in it for you? *Ground water monitoring and remediation,* 25(2): 44-51.

Alberini, A. and J. Cooper. 2000. Application of contingent valuation method in developing countries. Economic and social development paper. FAO, No.146, Rome.

Alpizar, F., Carlsson, F., Martinsson, P. 2001. Using Choice Experiments for Non-Market Valuation. Working Papers in Economics no. 52, Department of Economics, Göteborg University.

Bateman, I. J., Munro, A., Rhodes, B., Starmer, C., Sugden, R. 1997. Does part-whole bias exist? An experimental investigation. *Economic Journal,* 107: 322–332.

Berbel, J., J. Calatrava and A. Garrido. 2007. Water pricing and irrigation: a review of the European experience. In: F. Molle and J. Berkoff (eds.). Irrigation Water Pricing.CAB International.

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

Biswas, A .K., C. Tortajada and R. Izquierdo (eds.). 2009. Water management in 2020 and beyond; Berlin, Germany. 268p.

Cai, X., D. C. Mckinney, and M. W. Rosegrant. 2001. Sustainability analysis for irrigation water management: concepts, methodology, and application to the Aral Sea Region: environment and production technology division International Food Policy Research Institute. EPTD Discussion Paper No. 86. 48p.

Chandrasekaran, K., S. Devarajulu, and P. Kuppannan. 2009. Farmers' willingness to pay for irrigation water: a case of tank irrigation systems in South India. *Journal Article Water 2009, 1: 5-18*

Colombo, S., Hanley, N and Calatrava-Requena, J. 2005. Designing Policy for Reducing the Off-farm Effects of Soil Erosion Using Choice Experiments. *Journal of Agricultural. Economics* 56: 81-95.

CSA (Central Statistical Agency). 2008.Summary and statistical report of the 2007 population and housing census result. Federal Democratic Republic of Ethiopia Central Statistical Agency. Addis Ababa, Ethiopia.

Dagne Minalu. 2008. Determinants of farmers' willingness to pay for irrigation water in Jabitehinan District of Amhara Region. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University. 124p.

Dinar, A., M. W, Rosegrant and R. Meinzen-Dick. 1997. Water allocation mechanisms principles and examples, the World Bank, Washington, D.C.

EC (European Commission). 2012. The role of water pricing and water allocation in agriculture in delivering sustainable water use in Europe final report. WWW.Arcadisbelgium.Be. Accessed on May 07, 2012. 152p.

Eden Dagnachew. 2010. Willingness to pay for improving and protecting multiple use water resources: the case of Kersa District, Eastern Hararghe. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University. 73p.

FAO. 1997. Irrigation potential in Africa: a basin approach. FAO Land and Water Bulletin 4. Rome, Italy.

FAO. 2004. Economic valuation of water resources in agriculture, Water Report 27.

FAO. 2011. Monitoring agricultural water use at country level: experiences of a pilot project in Benin and Ethiopia. Land and Water Discussion Paper N0. 9. Rome. 47p.

FAO. 2005. Irrigation in Africa in figures: AQUASTAT survey 2005. FAO Water Report 29.

Habtamu Tilahun. 2009. Payment for environmental service to enhance resource use efficiency and labor force participation in managing and maintaining irrigation infrastructure, the case of Upper Blue Nile Basin. An MSc Thesis Presented to Cornell University. 105p

Hanemann W. M. 1989. Welfare evaluations in contingent valuation experiments with discrete response. *American Journal of Agricultural Economics,* 71: 1057-1061.

Hanemann, M., J. Loomis, and B. Kanninen. 1991. Statistical efficiency of double-bounded dichotomous choice contingent valuation. *American Journal of Agricultural Economics. Eco,* 969: 1255 – 1263.

Hanemann, W. M. 1991. Willingness to pay and willingness to accept: how much can they differ? *American Economic Review*, 81(3): 635-647.

HDOA (Haramaya District Office of Agriculture). 2012. Annual report of the Haramaya District Office of Agriculture, Haramaya.

Kadekodi, G. K. 2001. Valuation of natural resources: what have we learnt from Indian experience? *Indian Journal of Agricultural Economics*, 56(3): 286-312.

Kinfe GebreEgziabeher and Brehanu Adinew. 2007. Valuing water supply service improvement in Addis Ababa. Working Paper. Addis Ababa.

Latinopoulos, P. 2004. Valuation and pricing of irrigation water: an analysis in Greek agricultural areas. *Global Nest Journal*, 7(3): 323-335.

Muluken Fisseha. 2011. Factors affecting farmers' willingness to pay for municipal solid waste *chat* residual compost, Aweday, Eastern Hararghe, Ethiopia. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University. 86p.

Osman, Mahdi, and Petra Sauerborn. 2002. Rainfall variability and its influence on surface flow regimes examples from the central highlands of Ethiopia. *Journal of Soils and Sediments.* 2 (2):100-102.

Peacock, T., C. Ward and G. Gambarelli. 2007. Investment in agricultural water for poverty reduction and economic growth in Sub-Saharan Africa: a collaborative programme of ADB, FAO, IFAD, IWMI and World Bank .Synthesis Report. 71p.

Pearce, D. W., and J. J. Warford. 1993. World without End: Economics, Environment and Sustainable development. The World Bank, New York: Oxford University Press.

Perry C. J. 2001. Charging for irrigation water: the issues and options, with a case study from Iran. Research report 52. Colombo, Sri Lanka: International Water Management Institute. 17p.

Seleshi Bekele. 2010. Irrigation potential in Ethiopia: constraints and opportunities for enhancing the system. Colombo, Sri Lanka: International Water Management Institute. 59p.

Seleshi Bekele, Aster Denekew, Makonnen Loulseged, W. Loiskandl, Mekonnen Ayana and Tena Alamirew. 2007. Water resources and irrigation development in Ethiopia. Colombo, Sri Lanka: International Water Management Institute (IWMI) 78p. (IWMI Working Paper 123). 66p.

Simret Wondimu. 2009. Determinants of individual willingness to pay for quality water supply: a contingent valuation study, the case of Wonji Shoa Sugar Estate. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University. 81p.

Ulibarri, C. A. and K. F. Wellman. 1997. Natural resource valuation: a primer on concepts and techniques. Memorandum. USA.

UNESCO (United Nations Educational, Scientific and Cultural Organization). 2004. World water assessment program. National water development report for Ethiopia (final), Addis Ababa. 273p.

Ward, F.A. and A. Michelsen. 2002. The economic value of water in agriculture: c*oncepts and policy applications, water policy*, 4: 423-446.

Yemane Taru. 1967. *Statistics, an introductory analysis*. 2nd edition.Harper and Row Inc., New York. 345p.

Zelalem Lema. 2010. Determinants of willingness to pay for improved rural water supply in Gorogutu District, East Hararghe Zone of Oromia Region. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University. 85p.

FACTORS AFFECTING THE GROWTH OF MICRO AND SMALL ENTERPRISES: THE CASE OF HARAR TOWN

Reta Endale[1], Lemma Zemedu[2] and Endrias Geta[2]

Abstract

The Government of Ethiopia is focusing on micro and small enterprise for mainly its role of job creation. The objective of this study was, therefore, to identify factors that contribute to the growth of micro and small enterprises in Harar town. The study used survey data obtained from 184 micro and small enterprises. The samples were drawn randomly from formally registered micro and small enterprises by the Harari Micro and Small Enterprises Agency. Among the registered micro and small enterprises, construction, manufacturing, agriculture and services like hair fashioning, drink and food preparation enterprises were selected using proportional sampling method. The majority of enterprises were motivated to start their business due to lack of their own permanent jobs. The sources of finance for the startup were mainly personal saving and family assistance. The econometric result showed that the startup size of enterprises is negatively related with the growth of enterprises. Managers' experience, access to formal credit and the availability of continuous on job training were positively related with growth of enterprises. Accesses to market and the availability of own premises were also significant factors of growth of micro and small enterprises. Business type is also another factor that affects growth of micro and small enterprises. The findings of the study have verified the importance of micro and small enterprises in employment creation. The Regional Government has to promote the growth of micro and small enterprises by facilitating necessary credit services, working premises, market, continuous on job training to update their knowledge and bridge their gap. In this regard creation of awareness of the entrepreneurs to follow a product diversification strategy through training, mass media, experience exchange arrangements are vital. Promotion of their products and facilitation of micro and small enterprises market integration as well as business selections are very important areas of intervention by regional micro and small enterprise development agency.

[1] Education bureau. E-mail: reta_endale@yahoo.com,
[2] Haramaya University Instructor

1. Introduction

The role of micro and small enterprises in employment and income generation is increasingly recognized and has become a major playing field for policy makers and donors with dual objective of enhancing growth and alleviating poverty (Mulu, 2007). In Ethiopia, along with the overall policies and strategies of economic development, small enterprise and business development has been recognized as a key element to promote the development of the country. To this effect, the Government of Ethiopia has taken a number of specific policy measures aimed at the creation of enabling environment for the revival and expansion of the private sector. Micro and Small Enterprise Development Strategy and the Industrial Development Strategy which was issued in 1997 underscore the role and relevance of private sector for income and employment generation. The promotion of small enterprises and business development basically entails the facilitation of the start-ups, growth, and expansion of small scale enterprises (Minilek and Chinnan, 20012).

Micro and small enterprises are acknowledged to have huge potential for employment generation and wealth creation in any economy and are expected to play a significant role for national growth and development as well as minimize unemployment and related social problems in Ethiopia. The sector is claimed to be a breeding ground for development of industrial skill and entrepreneurships. In addition, it upgrades indigenous technologies, including exploitation of locally available raw materials with lower capital, flexible to local market conditions and with fewer requirements of infrastructure (Eshetu and Zeleke, 2008).

The efficacy of such interventions, however, depends on identifying the key problems and targeting the potentially successful entrepreneurs. An examination of the factors that affect the growth of micro and small enterprises is therefore essential. In this regard, only few studies are available in Ethiopia. The commonly cited studies in relation to Micro and Small Enterprises (MSEs) in Ethiopia are Mulu, (2007), Eshetu and Mammo (2009).

The general objective of this study is to assess factors affecting the performance of Micro and small enterprises. The study examines the effect of financial constraints, initial employment size, age of MSEs, sector, access to working place, sex, experience and education of the MSEs manager, access to trained human power, infrastructure and continuous training, market and product diversification on the performance MSEs.

The remaining part of the study is organized as follows. The first section presents theoretical literature review on micro and small enterprises. The second section discusses empirical literatures and methods of data analysis. The third section presents the results of the study. Finally, the last section presents the summary and conclusion of the study.

2. Review of Literatures

2.1. Definition of micro and small enterprise

There are different ways of defining the term small and micro enterprises in different countries. The base for defining is deepened on the number of employees hired, the capital invested and the total balance sheet (asset, liability and capital). Ethiopian micro and small enterprises development agency has given definition in 2002. It defines micro enterprises which employ up to five people and 50,000 capital for service and 100,000 for industry. It also defines small enterprises which employ 6-30 people and 1.5 million birr for industry sectors and 50,000 for service sectors (MTI, 2003).

2.2. Growth Measurement of Micro and Small Enterprises

Various theoretical models have been developed which describe the growth of micro and enterprises. One class of theoretical models focus on the learning process, either active or passive, and the other models refer to the stochastic and deterministic approaches.

In the passive learning model, MSEs improve their performance through time as a result smaller and younger firms should have higher and more viable growth rates (Solomon, 2004, Mulu, 2007 Aspasia and Ourania , 2008

and Goedhuys 2002)[3]. According to active learning model, owners or managers could raise their efficiency through formal education and training that increases their endowments. Entrepreneurs or managers with higher formal education, work experience, and training would, therefore be expected to grow faster (Minilek and Chinnan, 20012).

The other set of growth theories of firms include the Stochastic and Deterministic approaches. The stochastic model, which is also known as the Gibrat's Law, argues that all changes in size are due to chance. Thus, the size and age of firms has no effect on the growth of small enterprises (Pier et al 2002).

According to Michael *et a*l. (2010), the growth of micro and small enterprises can be measured using the financial or stock market value, the number of employees, the sales and revenue, the productive capacity, the value of production and the added value of production. Measuring firm growth in terms of sales, profits or fixed asset other than employment might be appealing, but susceptible to measurement errors. First, the dataset used in this study rely on a recall basis. Therefore firms would be unable to accurately report their sales or profits, since most of Micro and small enterprises do not keep records. Moreover, unlike to sales or fixed assets employment is not affected by inflation and relatively easy for respondents to remember and does not need to be deflated (Mulu , 2007). Therefore, the standard measure of growth used in studies of small firms is the change in the number of workers since start up.

2.3. Empirical Studies

Studies such as Michael *et al*(2010), Stranova (2001) and Mulu (2007), find a significant role of size and age on firm growth and concluded that younger and small sized firms tend to grow faster than old and large size firms and consistent with the learning hypothesis but contrary to the

[3] The terms such as firm, enterprise, business or MSEs are used synonymously in this study.

Gibrat's law. There exists an inverse relationship between these variables and enterprise growth.

Access to financial resources raises employment growth in small manufacturing firms (Mulu, 2007, Eshetu et al. 2008 and Cunningham and Maloney, 2001). According to Okoh and Song (2000), access to financial service and the amount of paid up capital during start up have positive relationship to growth of micro and small enterprises.

According to Hart and Guinness (2000), another variable likely to affect the growth of enterprises is availability of demand or accessibility of market for their products. They argued that complementary enterprises grouped close together or firms located close to the final demand sources grow more rapidly than their counterparts who are not. Product diversification also affects the growth process of manufacturing firms positively. It helps firms to cope with demand constraints on the specific product line and creates new opportunities for growth (Harabi, 2003).

According to Mohammad et al. (2009), increases in the experience or education of the entrepreneur and access to training lead to increases in enterprise growth. MSEs which are managed by a manager who has related business experience or who completed high school education or with some college educations and access to continuous on job training grew faster (Mulu, 2009, Mohammad et al, 2009, Atsede, 2008). The provision of training opportunities and various advisory services have been viewed as more important and have positive impact especially for firms which have survived the start up stage (Goedhuys, 2002). Enterprises which are run by men grow more rapidly than those run by women, even after controlling for the effects of all the other variables (liedholm, 2001, Mulu, 2007). However, Astede (2008) found insignificant effect of gender on enterprise growth.

The sector in which an enterprise operates helps explain growth as well. At the most aggregate level, it would appear from that enterprises in the manufacturing and service sectors are more likely to experience higher

rates of growth than trade (liedholm, 2001). Firms in manufacturing grow faster than those in service and trade (Mulu, 2007). Moreover, infrastructures like road, telephone, water, electric power, utilities and transports have impact on the growth of MSEs have positive impact which means Micro and small enterprises who have good and enough infrastructures grow fast (Solomon, 2004). According to Fred (2003), availability of own working place has positive impact on growth of micro and small enterprises.

3. Methodology

In this study because of heterogeneity among micro enterprises groups, stratification was needed. Accordingly, the total numbers of micro and small enterprise which took license from Harari micro and small enterprise agency were stratified into eleven groups/strata by using the type of their business. Then a total of 184 sample sizes were drawn from each stratum using probability proportional to size sampling technique. Then both primary and secondary data which are both qualitative and quantitative in nature were collected using structured questionnaire and interview. The analysis was done using descriptive statistic and econometric model.

Specification of model

Various theoretical models have been developed which describe the growth of small businesses. One class of theoretical models focus on the learning process, either active or passive, and the other models refer to the stochastic and deterministic approaches. In the passive learning model (Jovanic, 1982 cited in Liedholm, 2001), a firm enters a market without knowing its own potential growth. Only after entry does the firm start to learn about the distribution of its own profitability based on information from realized profits. The implication of this theoretical model is that smaller and younger firms should have higher and more viable growth rates (Cunningham and Maloney, 2001; Goedhuys, 2002).

In the active learning model a firm explores its economic environment actively and invests to enhance its growth under competitive pressure from both within and outside the firm. According to this model of learning, owners or managers could raise their efficiency through formal education and training that increases their endowments. Entrepreneurs or managers with higher formal education, work experience, and training would therefore be expected to grow faster (Goedhuys, 2002).

The other set of growth theories of firms include the Stochastic and Deterministic Approaches. The deterministic approach assumes, on the contrary, that differences in the rates of growth across firms depend on a set of observable industry and firm specific characteristics like access to credit, access to work premise, startup capitals, etc (Pier, 2002). Finally Evans (1987) by considering the entire three firm growth model formulated the below firm growth model.

Previous studies such as Mulu (2009), Eshetu and Mammo (2009), and Alessandra *et al.* (2011) used the Evans (1987) firm growth model to analyze factor which determine the growth of MSEs. Similarly, the current study used Evans's firm growth model to analyze the determinants of MSEs growth. The Evans's firm growth equation that relates firm growth to its initial size, age and other control variables can be specified as;

$$G = \beta_0 + \beta_i X_i + u \qquad \textbf{(1)}$$

Where $G = \frac{\text{Ln Et} - \text{Ln Eo}}{t}$

$\ln E_t$ = Current employment size of MSEs (log)

$\ln E_0$ = Initial employment size of MSEs (log)

X = A vector of explanatory variables determine MSEs growth

t = age of MSEs

β = vectors of parameters to be estimated

u_i = is the error term

The dependent variable: According to Michael *et al*. (2010), the growth of MSEs can be measured using the financial or stock market value, the number of employees, the sales and revenue, the productive capacity, the value of production and the added value of production. However, the standard measure of growth used in studies of small firms is the change in the number of workers since start up.

Employment growth (EGTH): is the dependent variable which refers to average annual growth rate (AAGR) in employment for MSEs. It is defined as the change in employment between the time the enterprise started and the time of the survey divided by age of MSEs(Evans, 1987).
It is calculated as:

$$\left(\frac{\mathbf{CE-IE}}{\mathbf{A}}\right) \qquad \textbf{(2)}$$

Where CE = Current employment
IE = Initial employment
A = Age of MSEs

The independent variables

Initial employment size of MSEs (SIZE); it is the initial size of the enterprise measured in the number of employed workers during start up. According to Liedholm (2001), initial size of the enterprise is the determinant of micro and small enterprise's employment growth. It is stated that smaller size firms grow faster than their counterparts that are larger.

Age (AGE); it is the age of the MSEs and is defined as the number of years of existence since start-up. According to Solomon (2004), it is expected that younger firms grow faster than those that are relatively older ones.

Sex (SEX); it is sex of manager or owner of MSEs. According to Astede *et al.* (2008), there is significant relationship between the gender of the

owner/manager and firm growth; male owned/managed firms exhibit higher growth than female-owned/managed firms.

Education (EDU); it is an independent variable which refers to level of education of the MSE's manager at the time of start up. According to Eshetu and Zeleke. (2008), manager with higher level of formal education would be more likely to grow than those with lower levels of education.

Related work experience (EXPR); it shows availability of related work experience of the manager before start up. According to Michael *et al.* (2010), the availability of related work experience is positively related to firm's growth.

Startup capital (STACAPT); it is the amount of paid up capital in Birr during start up. According to Astede *et al.* (2010), the amount of paid up capital to start the business is positively related with growth in small manufacturing enterprises.

Availability of credit (CRED); it refers to availability of credit from formal sources like micro financing institutions and banks. According to Eshetu and Mamo (2009), those MSEs that have access to formal and informal credit are expected to grow than those that have not.

Own working place (OWP); it shows availability of own working place or industrial land. According to Fred (2003), access to industrial land has been major factors in firm growth and has a positive impact to MSEs growth.

On job technical training assistance (OJTTA); it shows training, advisory and other technical assistance for workers and managers of MSEs since start up to the time of study. According to Goedhuys (2002), Continuous training of the workforce enhances the growth of MSEs.

Diversification of the product (DIVR); Refers to diversification of the firm's products and services. According to Michael *et al*. (2010), product diversification or production of various products is associated with the

growth of manufacturing firms because it helps firms to cope with demand constraints.

Infrastructure (INFR); it is availability of infrastructural facilities like power, water; road, telecommunications, and so forth enhance growth of manufacturing enterprises. According to Hart and Guinness (2000), availability of enough infrastructures has positive impact to firm growth.

Labor (LAB); it shows availability of workers with related vocational training to the functions of the enterprise. According to Liedholm (2001), firms with vocational trained workers are expected to grow faster than those who have not.

Access to adequate market (ACCMKT); it refers to availability of market or demand to all service or products of MSEs. Esther and Kappel (2008), showed that access to market plays a significant role in promoting MSEs as result, in this study, access to adequate market is expected to positively correlate with enterprises growth.

Type of businesses (BUSTYPE); they are independent variables which refer to the type of business that the MSEs engaged in and included as four independent discrete variables. BTYPE (AGRI), BTYP (MANUF) for manufacturing and, BTYP (SERV) service and BTYP (CONS) for construction. According to Atsede *et al. (*2008*),* MSEs that are engaged in manufacturing grow better than the other business type.

4. Results and Discussion

4.1. Socio economic characteristics of the respondents

At the time of survey 72.3% of business operators were males and 27.7 % were females. About 48.4 percent of the managers of the enterprises completed seiner secondary school and only 7.1% and 14.7% of the respondent were TVT and higher education completed respectively. The rest 29.9% of the manager of the enterprise are primary school completed and below. Regarding experience of the MSEs managers, 57.6% of them

have relevant experience in the business they are running now. Whereas 42.4% of Micro and small enterprises have no experience in the field they are running now. 65.2% of the MSEs have shortage of capital and no adequate access to capital through credit or other means. Regarding business type 45.1 % of the enterprises are engaged in services and 31.5% and 14.7% of the enterprises are engaged in construction and manufacturing sector. However, only 8.7 % of the enterprises are engaged in agriculture. The mean age of Micro and small enterprises is 4.58 years.

Regarding access to own working place 61.4% of MSEs have no suitable working place and only 26.6% of micro and small enterprises managers or owners have got continuous training. 53.3% of the MSEs have access to the infrastructure like water, electricity and road and 54.3% of the MSEs have market problem. 61.4% of micro and small enterprises have faced a problem of input and 62% of the enterprises produce only one type of product and the rest 38% of the enterprises produce at least more than two products.

It is clear that 66.8% of MSE's most important motive to start a business was to create job since they had no permanent jobs and 10.3% of Micro and small enterprises started the new business to be their own bosses. The rest 10.3 % and 8.7 % of MSEs indicated that their desire to get additional income and previous experience pushed them to become business operators, respectively. 52.7% of startup capital came from internal source of finance, especially, personal savings of entrepreneurs, followed by that of contribution of the members of the share holders of the enterprises (15.8%). Families' contribution for starting the business also reached about 18.5%. The other source of capital for starting the business was micro financial institutions which contributed about 12.5 %.

Initially, all 184 MSEs employed 1187 workers and at the time of study this number was grown to 1305 and it only increased by 118 on average year of 4.58. However, MSE's growth is different in different business sectors and the highest growth is seen in the manufacturing sector. At start up the manufacturing sector employed 130 people and at the time of study

reached 183 people with the average annual growth rate of 0.36. The service sector which employed initially 531 and grew to 654 people and the average annual growth is 0.299 and 1.48 job increase for each firm. The highest growth is also registered in the agriculture sector which initially employed 54 and grown to 95 employments and increased with 21 employments with average annual growth of 0.16 and each MSEs is increased employment by 1.17 employee. The negatively grown sector is the construction sector which initially employed 452 employers and at the time of study reduced to 373 and decreased with 79.

4.2 The determinants of firm growth

The multiple linear regression analysis was used to examine the relationship between the growth of MSEs in terms of employment using average annual employment growth rate as a measure and several explanatory variables such as gender, level of education of operators at the times of startup, availability of related work experience, firm age, number of employees at startup, startup capital, access to capital or credit, access to continuous training for workers and managers, availability of qualified workers, diversification of products, availability of own premise, infrastructure , access to market and business type.

The model identified six significant variables. These variables are experience of the manager, access to capital or credit, having own premises or working place, access to continuous on job training, access to market, type of business the enterprise engaged agriculture, construction, manufacturing and initial employment size

The overall prediction of the model is found to be significant at 1% significant level and with F=25.988. The adjusted R^{2} = 0.68 which means 68% of the variance in growth is due to the variables included in the model. Variance Inflation Factors (VIF) fall within the acceptance range (VIF = 1-10). Similarly, contingency coefficients were computed to check the existence of multicolinearity problem among the discrete explanatory variables. From

the contingency coefficients there is no multicolinearity between the discrete variables.

Table 1: The multiple linear estimates of the model

Model	Coefficients	Std. Error
(Constant)	-0.021	0.028
sex of MSEs managers	-0.008	0.004
Educational	0.002	0.002
Experience of owner	0.014***	0.004
Access to capital	0.012***	0.004
Own working place	0.013***	0.004
Access to continuous training	0.010**	0.004
Product diversification	0.003	0.004
Access to trained manpower	0.006	0.004
Access to market	0.014***	0.005
Access to infrastructure	0.0005	0.002
Age of MSEs(log)	-0.007	0.010
Startup capital(log)	0.005	0.007
Initial size(log)	-0.032***	0.006
Business type in reference to constructions		
Service	0.012***	0.004
Manufacturing	0.019***	0.006
Agriculture	0.016**	0.007
$R = 0.845$ $R^2 = 0.713$	R^2djusted = 0.686	F = 25.988 p = 000

Dependent variable: Average annual employment growth

* **Significant at 1% significance level ** Significant at 5% significance level

Source: Model result

The presence of heteroscedasticity is tested using Breusch-Pagan and Koenker test and the result shows that there is no heteroscedasticity . This concludes that the regression model used in this study is adequate or in other words, the model was fit. The independent variables that are significant from the model are discussed below.

Experience of the MSEs manager (EXP): Manager's experience is statistically significant at 1% significant level. Thus, enterprises which are managed by experienced person have high probability of growing than those which led by inexperienced managers. MSEs which are owned or managed by experienced person grow with average annual growth of 0.014 employment compared to MSEs owned or managed by inexperienced person. Parallel findings have been reported by other Researchers (Mulu, 2007, Astede *et al*, 2008, Mohammad *et al.*, 2009). Therefore, to increase the experience of MSEs' managers, they should be provided with continuous on job training and experience sharing.

Access to capital or credit (CRED): Access to capital or credit is also statistically significant at 1% significant level and Enterprises which have access to capital grew with 0.012 of AAGR which is better than those which have no access to capital or credit. According to Solomon (2004), MSEs which have access to credit grew better than those which have shortage of capital or credit and Solving this problem leads to solution of unemployment and MSEs growth. Again parallel findings have been reported by other Researchers (Mulu, 2007, Astede *et al.*, 2008, Eshetu , 2008, Cunningham & Maloney, 2001). Therefore, the regional and federal government should provide enough and easily accessible finance to MSEs.

Having suitable own working place (OWP): The availability of own premise is found to be a significant variable at 1% significance level and grow with 0.013 of AAGR. This shows that business operators that secure own working place and buildings are in a better position to plan with greater certainty and stand a better chance of accessing the needed infrastructure and this enhance the growth of such enterprises. Similar results have been found by other researchers (Solomon, 2004, Fred, 2003). As we all know there is industry zone in many towns of the country to provide land and other infrastructure for the industrial sector. Similarly to the most prominent and significant sector MSEs, there must be unique zone which provide land and other infrastructure easily and fast.

Access to market (ACCMKT): Access to market is statistically significant at 1% significant level. Thus, firms with access to market have grown significantly with 0.014 of AAGR but firms with market problem or limited access to market have less chance of growth or their growth potential is likely to decrease. Similar result was reported by researchers like (Ishengoma *et al*, 2008; Esher *et al*, 2008). Thus, access to market is an important factor for MSEs to perform better and to grow and promoting and constructing marketing channels, creating market integrations is vital to the sector growth.

Access to on job training: Access to on job training is statistically significant at 5% significant level. Providing on job training and advisory service contribute a lot to growth of MSEs. Researchers like Goedhuys (2002), also proved that the provision of training opportunities and various advisory services have positive impact especially for firms which have survived the start up stage.

The type of business the enterprise engaged: It is clearly seen from the model that types of business the firm engaged is statistically significant. Manufacturing and service sectors are significant at 1% significant level and MSEs which engaged in agriculture sector are significant at 5% and have a positive relation to growth. The sector in which a MSEs operates helps to explain its growth, controlling for the influence of other factors. MSEs involved in manufacturing, services and agriculture have growth rates higher than those in the reference category, constructions. However, MSEs engaged in constructions have negative impact to growth. This is because in Harar town the numbers of MSEs that were organized in constructions sectors especially in coble stone were more than the demand and they failed to Survive. According to Mulu (2007), the growth of firms is affected by the sector in which the business operates and in his research he found out that firms in manufacturing and service are growing faster than those in trade. From the theoretical perspective, it is likely that firms in different sectors would face different product demands and encounter different cost structures on the supply side and different evidence of differences in growth rates is quite extensive (liedholm, 2001). Therefore, before allowing

MSEs to engage in different sectors, there must be a feasibility study and this should be evaluated thoroughly to identify the sector which has a potential to grow.

Initial employment size (SIZ): Initial size of a firm is also found to be important in explaining growth. The variable is statistically significant at 1% level and negative, revealing strong inverse relationship between initial size and growth. The decrement of the initial size of enterprises by one increases the growth rate of enterprises by 0.032%. The smaller enterprises at start up thus register high growth rates than their larger counterparts. Similar findings are reported by other researchers (Michael *et al.,* 2010; Stranova, 2001; Solomon, 2004; Mulu, 2007). Smaller firms grow faster than large size firms can theoretically be explained by the existence of diminishing returns to scale. This is because younger firms need to rapidly achieve the minimum efficient size (Atsede, 2008). From this we can understand that smaller size MSEs should be encouraged and finance should not be provided based on the employment size as it is functioning now.

5. Summary, Conclusion and Recommendations

The interest for MSEs in developing countries stems largely from the widespread concern over unemployment. Governments in most developing countries are currently interested in the effects of the small enterprise sector on job creation. Practically all reports on MSEs in recent years appeal to the greater labor intensity of these enterprises and the importance of shifting a greater share of investment towards them. Before promoting structural shifts to MSEs, however, policy makers should know the factors that influence the start up, growth and closure of these enterprises.

The objective of this study was to identify factors that contribute to the start up, growth of small manufacturing enterprises in Harar town. The study was used on the data obtained from 184 small manufacturing enterprises to come to a better understanding on the factors that influence the start up experience and growth of these enterprises. Analysis was done using both descriptive statistics including tools such as frequency

distribution and T- test and a multiple linear regression analysis to identify the determinants of employment growth of small enterprises.

The results showed that most MSEs in Harar town started with an average paid capital of birr 28,457 and with an average of 6.45 employees. At the time of the study, enterprises included in the study had an average of approximately 7.09 employees. The majority of entrepreneurs had no related experience before they started their businesses and were motivated to start MSEs since they had no permanent work. The sources of finance for the start up of their business were personal saving and family assistance. Their constraints at the time of startup were lack of sufficient capital and working space. For most small manufacturing enterprises, the formal financial markets are not accessible because of limited collateral and lack of business record of accomplishment.

The econometric results showed that initial size of enterprises is negatively and significantly related with growth of enterprises. Similarly smaller initial employment size MSEs grow better than large initial employment size MSEs. Moreover, access to own working place, experience of MSEs manager and access to capital are significant at 1% significance level. Business type the MSEs engaged (service) was found to influence employment growth of enterprises positively. Manufacturing and agriculture are also significant and affect growth positively in comparison with construction sectors. The access to continuous on job training and access to market are positively related with growth of enterprises in Harar town.

The study result shows that MSEs growth is affected by, experience of MSEs managers, access to credit, access to own working place, access to continuous on job training, access to market, business type that the MSEs engaged, and initial employment size of MSEs.

The findings of this study have important implications for interventions designed to enhance the start up, growth and expansion of MSEs in Harar town and in similar cities within Ethiopia. Since the creation of new jobs

depends on the new entry rates and growth of enterprises, a special attention should be given to those factors that influence start up and growth of enterprises.

Experience is the most important factor which increases the growth of enterprises and MSEs managed by experienced managers grew more than MSEs managers who have no experience. Therefore, the government should continue to promote the culture of apprenticeship and experience sharing for the young new MSEs operators as a possible area of intervention in employment generation schemes.

Continuous on job training has a significant impact to firm's growth and MSEs managers who have got continuous on job training have grown more because the training were used to fill their knowledge and skill gap and designed based on their practical problem. Therefore by assessing the gap of MSEs managers and worker then filling their gap has a significant impact to the growth of MSEs and the concerned body should continue to give continuous on job training to MSEs' managers and workers.

Access to formal source of credit affects firm growth positively and significantly. Finance is always a challenge to MSEs growth. In the absence of formal source of credit informal networks appear more appealing for MSEs. Hence, supporting alternative channels like saving and credit associations and others that do not involve collateral requirements and difficult procedures might help businesses to grow. Therefore, to create easy and fast credit access the government and formal financial institutions should design different methods of lending.

The other factor that should be given great emphasis is for preparation and allocation of suitable and enough working premises to MSEs wherever possible. The study has indicated that serving businesses with industrial land or working space is one feasible area of intervention to sustain the growth of the enterprises.

Market problem is the other factors that hinder growth of MSEs. Therefore the concerned body should first give training to MSEs to produce quality, marketable goods and help them in promoting their products. Secondly specific market place should be given to MSEs which have market problem. Moreover market integration should be created by regional government through promotion.

Regarding business type, Regional Micro and small Enterprise Development Agency (RMSEDA) should perform feasibility study and identify the sectors that are not saturated and have access to input and market and guide MSEs towards feasible sectors. In Harar, the construction is more of saturated and are not growing and rather reducing their employment numbers. However the numbers of MSEs that are engaged in manufacturing, service and agriculture sector which have highest growth rate are very small in number. Therefore the RMSEDA should give more attentions towards organizing MSEs in manufacturing, service and agriculture sectors.

The other factor that hinders growth of MSEs was initial size of MSEs. Smaller firms grew faster than larger firms. For this reason, RMSEDA should not organize MSEs in large member. Most of the time MSEs agency encouraged those who want to form MSEs to have large numbers of people. This trend should be changed and small number of initial MSEs employment size should be advised and encouraged.

Policies and support programs need to consider the heterogeneous nature of the MSEs. Different categories of MSEs have different contributions and different potential for growth. For the large number of MSEs that do not expand in terms of employment and concentrate on survival type of activities, survival might be their main objective. This by itself should not be discouraged as it supports a large number of very poor families but the type of required assistance might be different from others. The enterprises with high potential to grow might require additional support beyond working capital that might include access to finance for long-term investment, marketing service, and targeted training among others.

References

Alessandra, C., N. Hanedb and C. Le Bas. 2011. Firm growth and innovation Some new empirical perspectives, International Centre for Economic Research. Working Paper (7)

Aregash, A. 2005. Public Private Partnership Projects of the GTZ in Ethiopia: International trade and the protection of natural resources in Ethiopia. Bonn: Eschoborn.

Aspasia, V. and O. Notta. 2008. Firm growth, size and age in Greek firms. Presented at International Conference on Applied Economics, 23 - 27 Oct, Macedonia, Greek

Atsede Woldie, P. Leighton and A. Adesua. 2008. Factors influencing small and medium enterprises (MSEs): an exploratory study of owner/manager and firm characteristics. Banks and Bank Systems, Volume 3, Issue 3.

Belay File. 2012. Determinants of MSEs success in urban informal sector of Addis Ababa. PhD thesis presented to University of Rotterdam.

BoFED (Bureau of Finance and Economic Development). 2006. Household Income and Expenditure Survey, the Harari People Regional State, Harar Ethiopia

CSA (Central Statistical Authority). 2000. Analyzed report on the 1999 national labor force Survey. Statistical Bulletin, 234, Addis Ababa.

CSA (Central Statistical Authority). 2003. Report on small scale manufacturing industries survey, volume 321, Addis Ababa

CSA (Central Statistical Authority). 2004. Report on Large and Medium scale Manufacturing and Electricity Industries Survey, Vol. 321. Addis Ababa: Ethiopian Central Statistical Authority.

CSA (Central Statistical Agency). 2008. Summary and statistical Report of the 2007 population and housing censes: population size by age and sex Addis Ababa.

Cunningham, V. W. and M. F. William. 2001. Heterogeneity among Mexico's micro enterprises, an application of factor and cluster analysis. University of Illinois and World Bank, Washington DC.

Endalkachew Mulugeta. (2008). Underlying causes of micro and small business enterprises failure in Addis Ketema sub city. An thesis submitted to the department of Regional and local Development studies, Addis Ababa University, pp100-106.

Eshetu Bekele and Mammo Muchie. 2009. Promoting micro, small and medium enterprises (MMSEs) for sustainable rural livelihood development,

innovation and international political economy research Aalborg University Denmark. DIIPER research series working paper (11)

Eshetu Bekele and Zeleke Worku. 2008. Women entrepreneurship in micro, small and medium enterprises: the case of Ethiopia. *Journal of International Women's Studies* 10(2): 234-270.

Esther, K. I. and R. Kappel. 2008. Business constraints and growth potential of micro and small manufacturing enterprises in Uganda. GIG Working paper (78)

EU (European Union). 2003. Definition of micro, small and medium-sized enterprises adopted by the commission, Brussels

Evans, D. E. 1987. The relationship between firm growth, size and age: estimates for 100 manufacturing industries'. *The journal of industrial economics*, 35: 567–582.

FDRE (Federal Democratic Republic Of Ethiopia). 2002. Industrial development strategy (Amharic). Department of press and audiovisuals, Addis Ababa.

FDRE (Federal Democratic Republic of Ethiopia). 1996. Proclamation No. 37/1996. Addis Ababa, Ethiopia.

Fred N. U. 2003. Survey of small and medium scale industries and their potentials in Nigeria. Central bank of Nigeria.

RMSEA (Harare region micro and small enterprise agency). 2013. Report on regional micro and small enterprises, Harar.

Goedhuys, M. 2002. Employment creation and employment quality in African manufacturing firms. International labor organization, Geneva, international labor office.

Gujarati. 2003. *Basic Econometric*, 4th International ed., Mc Graw Hill. New York, USA.

Harabi, N. 2003. Determinants of firm growth: an empirical analysis from morocco.

Hart, M. and M. Guinness. 2000. Exploring small firm growth in the UK regions 1994 –97. Kingston University. Small business research center, Kingston Hill.

ILO (International Labor Organization). 2000. Profile of employment and poverty in Africa: report on Ethiopia, Nigeria, Ghana, Tanzania, Kenya, and Uganda. ILO publications, Geneva.

Kawai, H. and U. Shujiro. 2001. Entry of small and medium enterprises and economic dynamism in Japan. The international bank for reconstruction and development, the World Bank institute, New York.

Liedholm, C. 2001. Small firm dynamics: evidence from Africa and Latin America, the international bank for reconstruction and development. The World Bank institute, New York.

Maddala, G. S. 1997. Limited Dependent and Qualitative Variables in Econometrics. Cambridge University press.

MoFED (Ministry of Finance and Economic Development). 2002. Ethiopia's sustainable development and poverty reduction program (SDPRP), Addis Ababa.

Michael, A. M., D. J. Molina, and R. T. Jewell. 2010. The determinants of the growth of microenterprises in central Mexico: Evidence from a survey in Toluca. *Canadian journal of development studies* 3(2): 223–252.

Minilek. K. and K. P. M. Chinnan. 2012. Employment growth and challenges in small and micro enterprises Woldiya, North East Amhara region, Ethiopia. Educational Research and Essays, Vol. 1(2), pp. 21 -26

Mohammad, A. F. and R. Jamali. 2009. MSEs employees gender composition and firm growth. Evidence from manufacturing industry in co-operative sector during the second development plan in Iran from 1995 to 1999. Journal *International Review of Business Research Papers* 5(3) :311-332

MTI (Ministry of Trade and Industry). 1997. Micro and small enterprises development strategy. Federal democratic republic of Ethiopia, MTI, Addis Ababa.

MTI (Ministry of Trade and Industry). 2003. Micro and small enterprises development strategy Federal democratic republic of Ethiopia, ministry of trade and industry, Addis Ababa.

Mulu Gebreeyesus. 2007. Growth of micro-enterprises: empirical evidence from Ethiopia Ethiopian development research institute (EDRI).

Mulu Gebreeyesus. 2009. Innovation and microenterprises growth in Ethiopia, presented at the research workshop on entrepreneurship, technological innovation, and development, held in Maastricht, the Netherlands, 30–31 October .United Nations University.

NBE (National Bank of Ethiopia). 2010. Ethiopian national bank annual report 2008-2010. Economic research department, National Bank of Ethiopia, Addis Ababa.

Okoh, G. A. and S. G. Ping. 2000. Financing small scale manufacturing firms in Ghana. Gothenburg University, school of economics and commercial law.

Serneels P. (2004). The Nature of Unemployment in Urban Ethiopia. Centre for the Study in African Economics Working Paper Working Series. CSAE: Berkeley Electronic Press.

Pier, G. R. 2002. Gibrat's Law and the firm size/ firm growth relationship in Italian services. Tinbergen Institute Discussion Paper 080(3).

Simeon, N. and L. Goldmark. 2009. Small firm growth in developing Countries university of California, Berkeley. *Journal of World Development* 37(9) :1453–1464 Solothum University of applied sciences, Northwestern Switzerland.

Stel .V A. 2002. Start up activity and employment growth in regions. Research center for advanced small businesses economics (CASBEC), University Rotterdam, Report (0108)

Wolday Amha and Gebrehiwot Agaba. 2004. Status, prospects, and challenges in the micro and small enterprise sector. A paper presented in the international conference on micro finance development in Ethiopia, 21-25 Jan 2004, Awassa, Ethiopia.

Zewde Shibiru. 2002. Women Entrepreneurs in Ethiopia, jobs gender, and small enterprises in Africa. Women entrepreneurs in Ethiopia ILO office, Addis Ababa.

DIMENSIONS AND DETERMINANTS OF AGRO-PASTORAL HOUSEHOLDS' POVERTY IN DEMBEL DISTRICT OF SOMALI REGIONAL STATE, ETHIOPIA

Shibru Tessema Muktar[1] Jema Haji Mohamad[2] and Yohannes Mengesha Woldemichael[3]

Abstract

This study investigates the dimensions and determinants of agro-pastoral households' poverty in Shinille zone of Somali regional state. It is based on information gathered from 240 randomly selected households in Dembel district. The Foster, Greer and Thorbecke (FGT) Poverty Indices are employed to examine the extent and severity of the agro-pastoralists' poverty in the study area (4). The survey outcome revealed that 67% of the sample households in the district live below the poverty line. In identifying the determinants of poverty, a binary logistic regression model was employed. Results show that access to irrigation, distance from market center, farm land size, non-farm activities, educational status, livestock holding, and herd diversification had a significant effect on the probability of a household to be poor or not.

Key words: FGT Poverty Indices, Somali Regional State, Binary Logistic Regression Model, agro-pastoral households' poverty.

[1] PhD Fellow at Haramaya University; shebe.tes@gmail.com;
[2] Associate Professor of Agricultural Economics at Haramaya University, jemahaji@gmail.com;
[3] [3]PhD Fellow at Haramaya University; fev_eris@yahoo.com

1. Introduction

1.1. Background of the Study

Agriculture is the backbone of the Ethiopia's economy it contributes about 50% to overall GDP, generates 90% of export earnings and supplies about 70% of the country's raw materials to the secondary activities (6). Although the contribution of the sector to the national economy is high, its performance is not that satisfactory. Due to poor performance of the Sector, poverty, inequality and food insecurity are the most crucial and persistent problems in Ethiopia (10). Accordingly, Human development indicators of the United Nations Development Programme (UNDP) also attest to the seriousness and extent of poverty in the country. For instance, the multidimensional poverty index (MPI) of Ethiopia is the second lowest out of 104 countries in the world (9).

The MoFED report using a consumption-based measure of poverty, estimated that 29.6 percent of the population were poor in 2010/11, living below the poverty line. This means that they are unable to lead a life fulfilling the minimum livelihood standard. Economic development in Ethiopia has unsatisfactorily over years and as a result the country has been caught in a ''vicious circle'' of poverty. The situation leads to low savings and investment capacity as a result of low level of income comes from low productivity that in turn leads to poverty. Poverty stills a major problem in most of developing countries, especially in sub-Saharan Africa.

Millions of poor people in Ethiopia living in semi-arid, agro-pastoral and pastoral areas have suffered extreme marginalization and food insecurity because of reduced access to pastureland, and in some places steadily extending croplands. (2).

According to (3), recurrent drought is a major concern in the Somali regional state, resulting in reduced forage supply, herd mortality, food insecurity and poverty. Furthermore, due to intensive grazing, over the carrying capacity of the land, there is a disappearance of most palatable,

digestible and high yielding species, which in turn results in a loss of potential grazing land. Generally poverty has become the picture of Dembel district for the last two decades. Even though food aids have been donated frequently, systematic attempts have not yet been made in the district so far. Therefore, even if, poverty reduction is not a simple task, a meaningful formulation and implementation of poverty reduction strategies require an area-focused research.

In this context, this study is initiated to identify and characterize the dimensions of poverty in the district, by using the household level of consumption expenditures and constructing poverty profile using method of cost of basic needs. In addition, identifying the determinants of poverty in the study area is the primary concern of the study.

1.2. Objectives of the Study

The general objective of the study is to assess the dimensions and determinants of agro-pastoralist households' poverty in Denbel district of Shinile Zone, Somali Regional State.

The specific objectives of the study are:

- To examine the dimensions of poverty in agro-pastoral community in the study area and
- To identify factors affecting poverty among agro-pastoralist households in the district.

2. Methods

2.1. Description of the Study Area

The Somali regional state of Ethiopia is located between 4-11^{0}N and 40-48^{0}E, within the eastern and southeastern lowlands of Ethiopia. It borders the Republic of Djibouti in the north, the Somali republic in the east, Oromiya region from south to northwest, and the Afar region in the north and northeast of the country. The total land area is about 327,000 km^2,

equivalent to 30% of the national land area (1). According to the 2007censusby the Central Statistical Agency CSA, the population of the region was estimated to be 4,439,147 out of which 621,210 live in the urban areas while the remaining 3,817,937 live in the rural parts. This indicates only 14 % of the population live in urban areas.

Shinile Zone is situated in the North Western part of Somali National Regional State (SNRS). Agro-pastoralism predominantly inhabits the region whereas Pastoralists have also been noted to some degree. The zone is divided into six districts namely, Mieso, Afdem, Erer, Shinile, Aysha and Denbel. The altitude of the Zone ranges between 530-1350 meters above sea level (1).

Denbel is one of the six districts of the Shinile zone .The district has 28 kebeles (lower administrative units) under it. And it is boarded by Aysha to the North, Awbare to the East, Shinile to the West, Jijiga to the South and Oromia and Dire Dawa council to the southwest (8).

2.2 Method of Sampling

In this study, a two-stage sampling procedure was adopted for the selection of the desired sample respondents.Among the 28 kebeles in the district, 12 of them belong to pure pastoralists and the rest are agro-pastoralists kebeles. Thus, in the first stage, four kebeles were selected purposively, from the agro-pastoral kebeles, based on accessibility, security situation and representativeness of the kebeles for the study. In the second stage, a total of 240sample households were randomly selected from the four kebeles using probability proportional to sample size technique.

2.3. Methods of Data Analysis

2.3.1. Determination of Poverty Line

To measure households' poverty status, this study adopted the cost of basic needs (CBN) approach which is widely used for setting the poverty line,

based on the estimated cost of the bundle of goods adequate to ensure that basic needs are met.

Steps to determine the poverty line

$$S_i = \alpha + \beta \log\left(\frac{Y_i}{Z^f}\right) + \varepsilon_i \quad \textbf{(1)}$$

Where S_i = food share

Y_i = total expenditure

Z^f = food poverty line

For those households whose total expenditure is approximately equal to the food poverty line ($Y_i \approx Z^f$), the food share is α, and consequently the non-food share of expenditure is (1-α). Thus the poverty line is

$$Z=Z^f + Z^{nf} \quad \textbf{(2)}$$

Where: Z^{nf} non-food poverty line

$$Z= Z^f + (1- \alpha) Z^f \quad \textbf{(3)}$$

$$Z= Z^f (2-\alpha) \quad \textbf{(4)}$$

This line enables us to identify sample households as poor or non-poor.

On the other hand, to examine the dimension of poverty, the FGT poverty measures were employed. These include the Headcount index, Poverty Gap index, and Poverty Severity index.

As indicated on (3), the mathematical expression of the model is given by:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{q}\left(\frac{Z - I}{Z}\right)^\alpha \quad \textbf{(5)}$$

Where; P_α = the measure of poverty index

z = the poverty line

I = the mean income of the poor found below the poverty line

N = population size

q = the number of poor households

α = Poverty aversion parameter

The weight given or attached to the severity and sensitivity of the poor where $\alpha \geq$ o, and the commonly used values of α are 0, 1 and 2. For α = 0, all poor are given equal weight and P_0 = Head Count index; for α = 1, each household is weighted by its distance to the poverty line and P_1 is Poverty Gap that measures the distance to the poverty line; and for α = 2, the weight given to each household is more than proportional to the shortfall from the poverty line and it is squared poverty gap index.

In addressing the second objective of the study, which is to identify the determinants of household poverty status in the study area, the binary logistic regression model was employed. In the model, the dependent variable takes a value of 1 if the household is below poverty line, i.e. poor with the probability of P_i and otherwise takes a value of 0, i.e. non-poor with the probability of 1-P_i.

As indicated on (7), specification of the model is as follows.

$$P_i = F(Z_i) = F(\alpha + \sum_{i=1}^{m} \beta_i X_i) = \frac{1}{1 + e^{-Z_i}} \quad \textbf{(6)}$$

$$Z_i = \alpha + \sum_{i=1}^{m} \beta_i X_i \quad \textbf{(7)}$$

Where; P_i = the probability that a household is poor

i = 1, 2, 3 …m

e = base of natural logarithms (2.718)

X_i = explanatory variables

m = number of explanatory variables

α = intercept

β_i= coefficient of explanatory variables.

Thus $1 - P_i$ is the probability of the household being non-poor, that is given by

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \quad \textbf{(8)}$$

It is pointed out in (5) that the logistic model could be written in terms of the odds and log of odds, which enables one to understand and interpret of the coefficients.

Therefore

$$\left(\frac{\mathrm{P}_i}{1-\mathrm{P}_i}\right)=\left(\frac{1+e^{\mathrm{Z}_i}}{1+e^{-\mathrm{Z}_i}}\right)=e^{\mathrm{Z}_i} \quad \textbf{(9)}$$

This implies

$$\left(\frac{\mathrm{P}_i}{1-\mathrm{P}_i}\right)=\left(\frac{1+e^{\mathrm{Z}_i}}{1+e^{-\mathrm{Z}_i}}\right)=e^{\mathrm{Z}_i}=e^{\left(\alpha+\sum_{i=1}^{m}\beta_i\chi_i\right)} \quad \textbf{(10)}$$

The above model can be represented in terms of logarithms as follows:

$$\ln(e^{Z_i})=Z_i=\alpha+\beta_1X_1+\beta_2X_2+\cdots+\beta_mX_m \quad \textbf{(11)}$$

If the disturbance term, (U_i) is taken into account, the logit model becomes

$$Z_i=\alpha+\sum_{i=1}^{m}\beta_iX_i+\mu_i \quad \textbf{(12)}$$

The coefficient of the logit model represents the change in the log of the odds associated with a unit change in the explanatory variable.

Table 1: Definition of explanatory variables and units of measurement

Code	Type	Definition of Variables
HHSEX	Dummy	Sex of the household head: 1 if the head of the household is male; 0, otherwise.
HHAGE	Continuous	Age of the household head in years
HHEDU	Dummy	Household head education status; 1 for literate HH head; 0, otherwise
FSIZE	Discrete	Family size in the household
DEPRAT	Continuous	Dependency ratio in percent
LIVSOWN	Continuous	Livestock ownership in TLU
OXENOWN	Discrete	Number of oxen owned
NONFARIN	Dummy	Non-farm income; 1 if member of the household participate in non-farm activity; 0, otherwise
DISTMKT	Continuous	Distance from market centers in hours
ACCI	Dummy	Access to irrigation; 1 if the household participate in irrigation scheme and 0, otherwise

DIVHERD	Discrete	Number of breeds owned by the HH
LSIZE	Continuous	Household land size in *qodi* (1 *Qodi* = 1/5 Ha).

Source: Own definition, 2011

3. Findings

3.1. Estimation of Poverty Line

As already been discussed above, the cost of basic needs approach (Ravallion, 1994) was used to construct households' poverty levels. This involves a series of steps. First, the researchers used the collected data to construct a typical diet for the poorest half of the sample as a reference group to determine the quantities of their basic food items that made up the reference food basket using expenditure share. These expenditure shares were then converted into calorie shares, using standard calorie conversion factors. The resulting diet is recalculated to obtain 2200 Kcal per day per adult which is the recommended minimum requirement according to WHO.

To obtain the minimum level consumption, the quantities of each food item in their diet were valued in terms of birr. The total value of the food basket constitutes the food poverty line. Based on the cost of 2,200 Kcal per day per adult for the food poverty line calculated from the data available is found to be 1522 birr per adult per year (about $84.56 per year). Table 2 gives details on the diet implied by the data and the resulting food poverty line. It was found that about 84 percent of the HH calories come from cereals. In terms of expenditure, cereals are more than 60 percent of the value of consumption in the study area.

Table 2: Typical diets and contribution to the food poverty line

Food item	Mean Kcal/Kg (per Li)	Calorie share (percent)	Amount of Kcal/day/AE	Value of poverty line	Value of poverty line/AE/day	Expenditure share
Cereals	3646	84	1848	2.53	925	60.8
Oil	8964	10	220	0.69	250	16.4
Sugar	3850	5	110	0.57	208	13.7
Salt	231	1	22	0.38	139	9.1
Total		100	2200	4.17	1522	100

Source: Own survey result, 2011

Using equation 2, the non-food share of the poverty line was estimated by regressing the food share of those households whose total consumption expenditure is between 80 and 120 percent of the food poverty line on the log of the ratio of consumption expenditures to the food poverty line. This is in order to give more weight to those households closer to 100 percent of the food poverty line.

From the regression analysis the food share $\alpha = 0.69$ implies that the households' pattern of expenditure is 69% for food and 31% for their non-food need. This means that poverty line for non-food need is 31% of the total expenditure. It is known that mean expenditure of these households approximately equal to the food poverty line ($Y \approx Z^f$). Thus, the non-food need is equivalent to 31% of the food poverty line. Based on this the non-food allowance for the poverty line is given by birr 472.

Here α and $1-\alpha$ are food share and non-food share of those households which spent in the neighbourhood of food poverty line (1522 birr). The basic assumption here is that mean total expenditure approximately equal to the food poverty line.

Based on the CBN approach, the researcher estimated the district's poverty line as follows:

$$Z = Z^f (2 - 0.69)$$

$$Z = Z^f (1.31) = 1522 * 1.31 = 1994 \text{ Ethiopian birr}$$

Finally, the poverty line in the Denbel district is birr 1994 which enable us to identify a sample household as poor or not.

3.2. Dimensions of Poverty

Once the above poverty line is established, the next step was to calculate poverty indices, which help to see the incidence and severity of poverty in the study area. Accordingly, the poverty indices were calculated using the FGT measures of poverty. Table 3 shows estimated poverty indices which are poverty head count, poverty gap and poverty severity in the study area.

Table 3: Absolute poverty indices based on sample agro-pastoralist households

Poverty indices	Index values
Head count index $(\alpha = 0)$	*0.67*
Poverty gap $(\alpha = 1)$	*0.34*
Poverty severity $(\alpha = 2)$	*0.17*

Source: Own survey result, 2010

The resulting poverty estimate for the study area (Table 3) shows that the percentage of poor people measured in absolute head count index (α = 0) is about 67%. This figure indicates that the proportion of the sampled agro-pastoral households in Denbel district live below absolute poverty line. This implies that 67% of the population are unable to get the minimum calorie required (2200 kcal per day per adult) and essential non-food expenditure. Putting differently, these much proportions of agro-pastoralists are unable to fulfill the minimum amount of consumption expenditure that is, Birr 1994 per adult equivalent per year.

The poverty gap index (α=1), a measure that captures the mean aggregate consumption shortfall relative to the poverty line across the sample households is found to be 0.34 which means that the percentage of total consumption needed to bring the entire population to the poverty line is 34%. This indicates if the district mobilizes resources that can meet 34 percent of caloric need of food insecure households and distribute to each household, then theoretically food insecurity can be eliminated.

Similarly, the FGT severity index (the squared poverty gap, α=2) in consumption expenditure shows that 17% fall below the threshold line

implying severe inequality. It means that there is a high degree of inequality among the lowest quartile HHs.

3.3 Determinants of Poverty

In identifying factors that determine the households' poverty status, a set of 12 explanatory variables were included in the binary logistic regression analysis. These variables were selected on the basis of theoretical explanations and the results of various empirical studies.

To determine the best subset of explanatory variables that best predicts the dependent variable, multicollinearity problems were checked for all explanatory variables prior to running the model.

As can be seen in the Table 5, out of the twelve explanatory variables, eight variables were found to have significant effect in determining the status of the household poverty. These variables are education, land size, access to irrigation, livestock ownership, number of oxen owned, non-farm income, distance from market center and diversification of herd. According to the model results, the remaining four variables, namely age, sex, family size and dependency ratio were found to have no significant influence on poverty status of the households in the study area.

Table 5: Estimation of the binary logit model

Variables	Odds ratio	Z-value
Sex	0.294	-0.79
Age	1.104	1.09
education	0.533*	-1.68
Family size	1.256	1.11
Dependency ratio	10.629	1.38
Livestock ownership	0.085*	-1.65
Number of oxen	0.292*	-1.84
Non-farm income	0.028**	-2.52
Distance from market centers	3.193***	2.90
Access to irrigation	0.032***	-3.21
Number of breeds owned	0.152*	
Household land size	0.166**	

-2 Log Likelihood

Pseudo R^2
LR chi2(12)
Prob> chi2
Note: *, ** and *** are statistically significant at 10%, 5% and 1% level respectively.
Source: Own survey result, 2011.

For instance, the odds of 0.533 for education status of the household head imply that, other variables being constant, the probability of being poor decreases by a factor of 0.533.The odds ratio of 0.166 for total land holding implies that, other things kept constant, the odds of being poor decreases by a factor of 0.166 when land size increase by one *qodi*.Participation in irrigation scheme resulted a decrease (by a factor of 0.032) in the odds of being non-poor. The odds ratio of livestock ownership show that, the odds in favour of poor decreases by a factor of 0.085 as TLU increase by one unit.

Similarly, the odds ratio of the number of oxen owned shows that, other variables being constant, the odds ratio in favour of poor decreases by a factor of 0.292 as the number of oxen owned increases by one. Regarding the variable, non-farm income, the odds ratio indicates that, other things being constant, the odds of being poor decreases by a factor of 0.028 if one of the members of the household participates in non-farm income generating activity. Furthermore results also indicate that the odds ratio in favour of poor increases by 3.193, if market distance increases by one hour, *citrus paribus.* The odds ratio of herd diversification shows that, other variables being constant, the odds in favour of poor decreases by a factor of 0.152 as the number of herd diversification or breed increases by one.

4. Conclusion and Recommendation

Overall, the study concluded that poverty in the study area is deep-rooted and widespread. The level and nature of poverty is also directly related to the poor agricultural performance which is highly dependent on unreliable weather conditions. The households' poverty status could be affected by households' characteristics such as distance from market center and participation in irrigation schemes. Access to irrigation helps the household to secure food and income for their basic need. In fact irrigation scheme is

not well practiced activity in the area despite high availability of potentially irrigable land and water resources.

In addition, household's livestock holding is also found to have ability in escaping poverty by providing food and cash for the household. The study findings on non-farm income activities also have become helpful income source and able to determine household poverty status. This indicates that a household could secure the income for basic necessities by participating in alternative options of non-farm income generating activities.

Hence, introduction of alternative income generating activities will have paramount importance in ensuring food security in the study area. Organizations intervening on projects like woman's petty trading activities should be encouraged to target poor on their interests of non-farm activities.

Even though livestock production is impeded by various constraints including food supply, disease, and institutional and policy factors, due emphasis should also be given to improve production and productivity of livestock sector. Thus, to increase feed availability and quality, some package activities such as rehabilitation of available natural feed (rangeland) through area closure and rotational grazing are need to be introduced. Appropriate feeding practice such as supplementary feeding (for instance multi nutrient block) could be suitable and also need to be introduced for agro-pastoralists. Policies on introduction of improved animals (which could highly productive, cope with the existing environment and tropical diseases), on livestock market, to the agro-pastoral areas are also very essential and need to be designed.

Improving school enrolment through implementing different integrated practice are possible policy alternatives. International development agencies and Governments should commit financial and other resources to education for agro-pastoral communities to develop their capacities to achieve their sustainable development and poverty reduction strategies.

References

Amaha, K. (2006). *Characterization of Rangeland Resources and Dynamics of the Pastoral Production Systems in the Somali Region of Eastern Ethiopia.*(PhD Thesis, University of the Free State, Bloemfontein, South Africa).

Ayalneh, B., Benedikt, K., & Konrad, H. (2006). *Peaceful Co-existence? What Role for Personal Wealth and Entitlement in Conflict Mitigation in Unfavorable Areas of Eastern Ethiopia*. Gold Coast, Australia.

Fikirte, H. (2008). *Rangeland Resource Utilization and Condition Assessment in Afdem District of Shinile Zone, Eastern Ethiopia. (*M.Sc. Thesis Research, Haramaya University). Retrieved from HU/SGS database.

Foster, J., Greer, J., & Thorbecke, E. (1984). A Class of Decomposable Poverty Measures. *Econometrica*, Vol. 52, No. 3, 61- 65. Hosmer, D. & Lemeshow, S. (1989). Applied Logistic Regression. *A Wiley Inter-Science Publication*, New York.

Ministry of Finance and Economic Development. (2008). Ethiopia's Progress towards Eradicating Poverty: An Interim Report on Poverty Analysis Study (2010/11). Development Planning and Research Directorate, Ministry of Finance and Economic Development, March 2012, Addis Ababa, Ethiopia.

Ravallion, M. (1994). *Poverty comparisons with non-compatible data: Theory and Illustrations. Hardwood Academic Publishers*. Save the Children United Kingdom. (2009). *Shinile Pastoral Livelihood Zone*. *An HEA Baseline Study. By SC-UK, DPPB and Partners.*

United Nations Development Program. (2010). *Human Development Reports Research Paper*. *Acute Multidimensional Poverty: A New Index for Developing Countries.*

Yilma, M. (2005). *Measuring Rural Household Food Security Status and It is Determinants in the Benishangul Gumuz Region, Ethiopia: The Case of Assosa Woreda.(*M.Sc. Thesis Research, Haramaya University). Retrieved from HU/SGS database.

SOCIOECONOMIC IMPACT OF THE UNDP/GEF-SGP FUNDED COMMUNITY-BASED CLIMATE CHANGE MITIGATION PROJECTS IN ETHIOPIA: A CASE FROM DIRE DAWA ADMINISTRATION

Yohannes Mengesha[1], Jema Haji and Yonas Abera

Abstract

Since July 2006, UNDP/GEF-SGP has supported 75 projects in Ethiopia, out of which, 13 of them were being implemented in Dire Dawa Administration. Taking the already phased out four community projects as a reference, this study examines the socioeconomic impacts of the program in the Administration. A cross sectional survey of 160 households (80 from the project beneficiaries and 80 from non-beneficiaries) was undertaken to examine and evaluate the impacts of the program on households' livelihood. Descriptive statistics coupled with an econometric model was used to analyze the data collected from different sources. The descriptive analysis of this study indicates that the societies are becoming better off in

[1] fev_eris@yahoo.com

their livelihood due to the existence of the project despite the fact that it is associated with many challenges. Applying a propensity score matching technique, the study has figured out that the level of monthly income, asset and monthly consumption expenditure of the program beneficiaries are higher than that of non-beneficiaries. Generally, the major findings of the study proved that the average effect of the program is positive and statistically significant; suggesting that the program has achieved its stated objectives of improving the socio economic conditions of the local community thereby the environment. It is also suggested that the project would have the capacity to improve the livelihood of the beneficiaries further if corrective measures are taken to tackle the challenges facing the project.

1. Introduction

Dire Dawa Administration is situated in the eastern part of Ethiopia. The region is known to be a low land with much of its land lying in semi-arid and arid lands with series of escarpments at the southern, south eastern and south western directions. Within the region, there is high altitudinal variation consisting of mountain ranges with slopes, hills, valley bottoms, river terraces and flat plains and most of the series of barren hills and mountains seen with their natural vegetation depleted and bed rocks exposed (DDEPA, 2012).

The region is also characterized dominantly with warm and dry climatic situations associated with arid and semi- arid in nature. Rainfall deficiency and absence of surface water, highly eroded and shallow soil depth, and significant decline in the overall forest resources and bio- mass cover mainly due to unregulated deforestation process are common features observed in the region (DDEPA, 2012).

Dire Dawa Administration is organized under 9 urban and 38 rural local Kebeles. Accordingly, in the region, there are two distinct, rural and urban, economic activities both of which are faced with very serious food insecurity problem due to a combination of socio-economic factors and increasing fragility of the ecosystem (ibid).

Environmental degradation in its different forms, erosion and deforestation in particular together with increasing population pressure has led to a decline in productivity and serious disturbance on the natural ecosystem. The situation has resulted in significant natural disasters due mainly to flash flood hazards in the rainy seasons. In addition to the flash flood hazards, the unsustainable utilization of natural resources and the absence of appropriate policy measures contributed towards increasing vulnerability of the community (DDEPA, 2013).

Land degradation coupled with vegetation cover loss is being the most serious problem facing the rural communities of Dire Dawa Administration which is aggravating the consequence of climate change disaster and biological diversity loss. The areas are vulnerable to the impacts of climate change because of factors such as wide spread poverty, recurrent drought and over–dependence on rain–fed agriculture and other socio economic factors (DDEPA, 2013).

The recurrent drought and associated absence of alternative source of income has forced the local communities to clear more vegetation to generate income through the selling of fuel wood and charcoal. Hence, this forced the area to become heavily reliant on massive food aid and a front line victim of drought and continuous famine that has jeopardizing development interventions in the area. These all, directly or indirectly lead towards over exploitation of natural resources contributing to the problem of climate change and poverty (ibid).

The Local Government is making efforts to address these adverse conditions and has designed coping mechanisms. In fact, some of these efforts have been promising and have brought about strategies that have induced changes in the attitude of the affected local communities. Some strategic measures include the development and implementation of national environmental initiatives, as well as policy/program and project initiatives that directly and/or indirectly address climate change and adaptation mechanisms. These initiatives could be capitalized for mitigating the undesirable consequences of climate related hazards, while lobbying for

and seeking international solidarity and assistance in the form of financial, technical and technological resources (NAPA, 2007, as cited in DDEPA, 2013).

With some assistance from non-governmental organizations and the government, small-scale farmers and pastoralists are adopting a variety of coping mechanisms. In the farming areas, many are shifting to more drought tolerant crops and varieties, improved forest management practices, diversified energy sources, and alternative means of income from off-farm activities (DDEPA, 2013).

The UNDP funded Global Environment Facility Small Grants Program (GEF-SGP) is one of the projects which was established to address these problems, in December 2009. During the implementation period of the project, (from December 2009 until November 2011) various planned activities have been accomplished by each CBO (Community Based Organizations) in collaboration with other partners in order to achieve the expected and desired outcomes and results of the projects. Most of the activities are, of course, related to combating land degradation, mitigation of climate change and livelihood improvements which include one or more of the following activities (DDEPA, 2013):

- Construction of physical soil and water conservation activities such as terrace, check dam and drainage on closed areas;
- Raising and planting of agroforestry, fruits and forage seedlings respectively;
- Procurement and distribution of nursery and SWC equipments to beneficiary groups;
- Provision of agroforestry, fruits and forage seeds;
- Provision and distribution of seedlings;
- Popularization and familiarization of fuel efficient stoves;
- Spring developments to improve the irrigable capacity;
- Construction of water wells for use in vegetables production;
- Preparation and transferring of compost on selected farm lands;

- Training on fuel efficient technologies, compost making, fodder development bee keeping and other activities;
- Capacity building for administrative bodies on financial and human resource management;
- Undertaking community travel workshops for community representatives; and
- Conducting continuous community discussion to empower sense of ownership during the implementation of the project and etc.

Given the activities implemented by the project, it is expected that the societies in reach of the project benefit from the activities performed by the project thereby enjoy improvement in their livelihood. However, the significance of the impact of the project on the livelihood of the beneficiaries has to be empirically justified.

2. Objectives of the Study

The general objective of this inquiry is to figure out the significance of the impact of the project on livelihood of the society. Specifically, the study was undertaken;

- To show the extent to which livelihood of the beneficiaries has changed due to the existence of the project, and
- To identify the major challenges facing the project.

3. Methodology

A. Data Sources and Methods of Data Collection

For this study, both primary and secondary data were used. The primary data was collected using a survey method. This survey constitutes sampled households from the project participants as well as from non-participants. In addition, existing project documents, including annual and periodic progress reports (from DDEPA & CBOs offices) and other related written and audiovisual documents were also reviewed to gather secondary data.

B. Sampling Design

This study has focused on four city and rural kebeles of the Administration including Gorro, Gendegara Gendegola, Koriso, and Halole – Iffa based on the terms of reference as requested by the Environmental Protection Authority Office of Dire Dawa (DDEPA). Using the probability proportional to size (PPS) sampling, 80 beneficiary households were randomly selected from a list of all the beneficiary households in the four kebeles. Similarly, 80 non-beneficiary households were selected using the same approach from a list of all non-beneficiary households in the four kebeles. In other words, using this method, a total of 160 households were sampled; of which, 80 are direct participants of the project and 80 are non-participant households. The detail is stated in Table 1 as shown below.

Table 1: Population and sample size of each kebele

No	Name of Village/Kebele	Number of Households				
		Total	CBO members	Non members	Sampled members	Sampled non members
1	Gorro	2100	380	1720	13	29
2	Gendegara Gendegola	1600	680	920	23	15
3	Koriso	2250	760	1490	25	25
4	Halole-Iffa	1250	565	685	19	11
Total		7200	2385	4815	80	80

Source: Own compile, 2013

C. Methods of Data Analysis

Descriptive and inferential statistics as well as econometric impact evaluation technique was applied to analyze the quantitative data. The study has employed an econometric model called Propensity Score Matching (PSM) method in assessing the impact of the program on the livelihood of the society.

Propensity Score Matching Method

The central aim of the study is to identify the causal effect of participation in the program. To examine the casual effect of the program, the difference

in the community's net wealth, income per capita and expenditure per capita, due to participation in the program, was considered. This was analyzed using the P-score Matching method. This method is preferred to the traditional regression methods in several ways. Matching involves pairing treatment and comparison units that are similar in terms of observable characteristics. Matching can yield unbiased estimates of the treatment impact, (Sadek and Wahba, 2001). Moreover, the PSM method is used to correct sample selection bias due to the observable difference between the treatment and comparison group.

This method involves three steps

i. Estimation of the propensity score for each household
ii. Matching the households in common support values using the value of the propensity score
iii. Test of overlapping and unconfoundedness assumptions
iv. Estimating the average treatment effect on the treated

i. Estimation of P-scores

In technical terms, suppose there are two types of individuals: those that are beneficiaries of the program (Di =1) and those that do not (Di=0). Individuals with program (treated group) are matched to those without (comparison group) on the basis of the propensity score. The propensity score for individual *i is* defined as:

$$P(Xi) = P(Di = 1 \mid Xi)\ (0 < P(Xi) < 1) \qquad \textbf{(1)}$$

Where, Xi is a vector of pre-treated explanatory variables such as (age of schooling, age of respondent, access to alternative credit service, etc.).

Rosenbaum and Rubin (1983) show that if the Di's are independent over all i, and outcomes are independent of program participation given Xi (i.e. unobserved differences across the treated and the comparison groups do not influence being in a specific group), then outcomes are also independent of program participation given $P(Xi)$, just as they would be if participation is assigned randomly.

A logit model was used to estimate the p-score using composite pre-intervention characteristics of the sample households (Rosenbaum and Robin, 1983). In the specification of the Logistic model, the dependent variable is the probability to participate in the program by the households whereas the independent variables are of both types that are continuous or categorical. The cumulative logistic probability model is econometrically specified as follows:

$$p_i = f(Z_i) = f(\alpha + \sum \beta_i X_i) \frac{1}{1+\varepsilon^{-Z_i}} \quad \textbf{(2)}$$

Where: p_i is the probability that an individual is a beneficiary of GEF-SGP given X_i, $\varepsilon -$ Denotes the base of natural logarithms, which is approximately equal to 2.718; X_i represents the i^{th} explanatory variables; and α and β_i are parameters to be estimated.

ii. Choice of Matching Algorithm

After estimation of the propensity scores, seeking an appropriate matching estimator is the major task of a program evaluator. There are different matching estimators in theory. However, the most commonly applied matching estimators are Nearest Neighbor matching (NN), Caliper matching, and Kernel matching. In this study, we have made comparisons among these matching estimators to select the best fitted one.

The question here is how and which method to select. Clearly, there is no single answer to this question. The choice of a given matching estimator depends on the nature of the available dataset (Bryson et al., 2002). In other words, it should be clear that there is no `winner' for all situations and that the choice of a matching estimator crucially depends on the situation at hand. The choice of a specific method depends on the data in question, and in particular on the degree of overlap between the treatment and comparison groups in terms of the propensity score. When there is substantial overlap in the distribution of the propensity score between the comparison and treatment groups, most of the matching algorithms will yield similar results (Dehejia and Wahba, 2002).

The matching quality depends on the ability of the matching procedure to balance the relevant covariates. Rosenbaum and Rubin (1983) proposed standardized bias that is commonly used method to quantify the bias between treated and control groups. According to Dehejia and Wahba (2002), choice of a matching estimator can be tested by different criteria, such as, balancing test, pseudo-R^2 and matched sample size.

Balancing test is a test conducted to know whether there is statistically significant difference in mean value of per-treatment characteristics of the treatment and the control group of the households. After matching the treatment and the control group should have similar household characteristics; to check whether this is the case, two types of balancing test were employed to check the matching quality. A simple t-test is used to examine whether the mean of each covariate differs between the treatment and the control group after matching and to supplement the simple t-test, the Hotel ling's T-squared test is performed to jointly test the equality of the mean between the two groups for all covariates and preferred when there is no significant difference.

Additionally, Sianesi (2004) suggests re-estimating the propensity score on the matched sample, i.e. only on participants and matched nonparticipants, and comparing the pseudo-R^2s before and after matching. The pseudo-R^2 indicates how well the regressors X explain the participation probability. After matching there should be no systematic differences in the distribution of covariates between both groups and therefore the pseudo-R^2 should be fairly low. Furthermore, one can also perform a likelihood ratio test on the joint significance of all regressors in the probit or logit model. The test should not be rejected before, and should be rejected after matching. Pseudo-R^2 before and after matching is used as comparison to ensure that there is no systematic differences in the distribution of the covariates between both groups, and the pseudo-R^2 should be fairly low after matching (Sianesi 2004).

Common support: The common support region is the area which contains the minimum and maximum propensity scores of treatment and control

group households, respectively. It requires deleting of all observations whose propensity scores is smaller than the minimum and larger than the maximum of treatment and control, respectively (Caliendo and Kopeinig, 2005). Only the subset of the comparison group that is comparable to the treatment group should be used in the analysis. Hence, an important step is to check the overlap and the region of common support between treatment and comparison group. Observations which lie outside common support region are discarded from analysis (Caliendo and Kopeinig, 2005). No matches can be made to estimate the average treatment effects on the ATT parameter when there is no overlap between the treatment and non-treatment groups.

Failure of Common Support: We have presented possible approaches to implement the common support restriction. Those individuals that fall outside the region of common support have to be disregarded. But, deleting such observations yields an estimate that is only consistent for the subpopulation within the common support. However, information from those outside the common support could be useful and informative especially if treatment effects are heterogeneous (Lechner, 2001b).

iii. Testing the Overlap and Unconfoundedness Assumptions

The first method to detect lack of overlap is to plot distributions of covariates by treatment groups (Imbens and Wooldridge, 2008). A more direct method is to inspect the distribution of the propensity score in both treatment groups, which can reveal lack of overlap in the multivariate covariate distributions.

The unconfoundedness assumption implies that beyond the observed covariates, there are no unobserved characteristics of the individual associated both with the potential outcome and the treatment (Imbens and Wooldridge, 2008). Although the unconfoundedness assumption is not directly testable, this study assesses its plausibility by estimating a pseudo causal effect that is known to be zero.

iv. Average Treatment Effect on the Treated

The parameter of interest in the estimation of propensity score is the Average Treatment Effect on the Treated (ATT) which can be estimated as follow:

Let D_{i1} be a dummy variable indicating individual i's beneficial of the program. The outcome variable, an indicator of economy of an individual i is denoted by $Y_{i\,1}$ which depends on whether or not the individual participated in the program. Then effect of the program participation in year t on the outcome in t + s is given by;

$$Y_{i,t+s}(1) - Y_{i,t+s}(0) \qquad \textbf{(3)}$$

The major difficulty in examining this effect is that $Y_{i,t+s}(0)$ is not observable if individual i participated in the program or if it is in treatment group, while $Y_{i,t+s}(1)$ is not observable if individual i does not participate in the program or if it is in the control group. Therefore, existing studies on impact evaluation often estimates the average effect of the treatment on the treated (ATT), defined as:

$$\begin{aligned} ATT &= E\left(Y_{i,t+s}(1) - Y_{i,t+s}(0) / D_{it} = 1, P(X_i)_i, _{t-1}\right) \\ &= E\left(Y_{i,t+s}(1) / D_{it} = 1, P(X_i), _{t-1}\right) - E\left(Y_{t,t+s}(0) / D_{it} = 1, P(X_i)_{i,t-1}\right) \end{aligned} \qquad \textbf{(4)}$$

Where:

X_i denotes pre- program characteristics of individual i in year t-1

$P(X_i)$ is the *p*-score

Y_i^1 and Y_i^0 are the potential outcomes in the two counterfactual situations of receiving treatment and no treatment.

D. Variable Definitions and Working Hypothesis

The literature on the impact of a program on poverty reduction makes it clear that the choice of dependent and independent variables had been identified by the researchers. This section describes the variables used in the econometric analysis.

Dependent variables

Participation in the program, which is the dependent variable for the logit analysis, is a dichotomous/dummy/ variable which was represented in the model by 1 for beneficiaries of the program and 0 for non-beneficiaries. There are three outcome variables which were used in the analysis of Average Treatment Effect on the Treated.

Asset: a number of measures of household worth including refrigerator, housing condition, TV, etc.

Income: this includes various categories of income including selling of goods and services, etc

Expenditure: this measures the total amount of expenditure on food and non-food items of a household per month.

Independent variables

The independent (explanatory) variables that were expected to have relationship with participation in the GEF-SGP were selected based on available literature and scientific research. The following explanatory variables are hypothesized to explain the dependent variable. These are: Households' socio-economic characteristics which include family size; age of schooling; age; amount saved, marital status; training and experience in credit use were selected for the logit analysis.

Family size: This is the total number of adult equivalent to represent total family sizes that live together under the same household. An increase in household size implies more expenditure from limited resources which intern results in higher tendency of these households to participate in such programs to finance their increased household expenditure. Hence, it is expected to have a positive relationship with the probability of the participation in the GEF-SGP.

Age of schooling: It refers to the educational level of the head of the household and is measured in years of formal schooling. The hypothesis is

based on the assumption that education has a direct relationship with the utilization of information that could help for adapting to climate change impacts which makes this variable to be positively related with the outcome variables.

Marital status: it is a dummy variable which takes value 1 if a household head is married and 0 other wise. Marriage is biological and social engagement to support each other both socially and economically. It is established with a view of helping each other and married people pool their resources together and reduce cost that would be spent separately. Hence, in this study, married household heads are assumed to have a positive relationship with the probability of participating in the program.

Age: It is defined as the period from the respondent birth to the time of the survey and is measured in years. Empirical evidence shows that with increase in age, household's motivation to engage in such programs decreases and hence it was hypothesized in the study that age of household heads has negative relationship with program participation.

Amount saved: This variable is a continuous variable that measures in Birr. According to Cohen (2001) savings can help households deal with income shocks; it provides a basic indicator of household security. The more they save the less they tend to be engaged in environmental protection activities. Therefore, it is expected that this variable would have negative influence on participation in the program.

Training taken: This is a dummy variable showing whether the individual has taken trainings related to the program. Hence, it is expected that taking related training will created access for the individual as well as motivate him/her to participate in the program.

Credit use experience: This is a dummy variable showing that whether the individual has access to credit service or not. It is expected that the possibility of individual's participation in the program increases as the

individual has access to credit use; for the reason that he is expected to have more experience to participate in such things.

4. Findings of the Study

A. Descriptive Analysis of Impact of the Program

Table 2 presents descriptive statistics results of sample households on outcome variables, such as, income, asset and expenditure. The survey results show that participant and nonparticipant households have average monthly income of 1765 and 1391.54 respectively. In terms of average asset value of the respondents, average asset of participants is 21319.47 while that of nonparticipants is 10171.52; and the estimated average monthly expenditure results indicate that it is 1494.69 for participants and 1184.2 for nonparticipants.

As indicated in the table, the difference in mean of monthly income, asset and expenditure of the two groups was found to be significant at 10% , 5% and 10% level of significance, respectively, as revealed by the t-statistic result. Result of the t-statistics for the variables was found to be 1.7942, 2.5895, and 1.7710, respectively. This means that households in the program are better off in all these variables.

Table 2: Descriptive results of outcome variables

Outcome variable	Program		Non-program		T-value
	Mean	SD	Mean	SD	
Income	1765 .69	1608.54	1391.54	932.3	-1.7942*
Asset	21319.47	37406.45	10171.52	8141.66	-2.5895**
Expenditure	1494.69	1328.15	1184.2	825.07	-1.7710*

Source: own computation result, 2013

***, ** and * Significant at 1%, 5% and 10% level of significance respectively

According to the explanation of DDEPA officials, The GEF-SGP is playing a major role in Poverty Alleviation by creating new business activities which generates alterative income for poor rural households. It has made a significant positive impact on the economic and social conditions of the beneficiaries. The project activities have resulted in increased personal

income, creating employment opportunity, and permit personal spending on children's education, health, nutrition and improved housing. The program has helped very poor households meet basic needs and protect against risks. Generally, the use of the program by low-income households is associated with improvements in household economic welfare. The program is said to help to smooth their consumption levels and significantly reduce the need to sell assets to meet basic needs.

B. Econometric model results

This section discusses the results of Propensity Score Matching in detail. To measure the average treatment effect on the treated (ATT) for intended outcome variables, a logit model was estimated in order to get the propensity scores. Next a matching estimator that best fit to the data was selected. Then based on those scores estimated and matching estimator selected, matching between participants and non-participants was done to find out the impact of the program on the mean values of the outcome variables. Therefore, this section illustrates all the required algorithms to calculate the average treatment effect on the treated, which helps us to identify the impact of the program.

i. Propensity scores

In Table 3 the estimation results of the logit model. The estimated model appears to perform well for our intended matching exercise. The pseudo-R^2 value is 0.8341. Looking into the estimated coefficients (Table 3), the results indicate that program participation is significantly influenced by five explanatory variables. Age, family size, experience in credit use, training and marital status were found to be significant variables to affect the participation of the household to the program, at 5%, 5%, 5%, 1%, and 10%, level of significance, respectively.

As indicated by sign of the coefficients, as age of the household head is getting older, the possibility of participation in the program is higher; households who have larger family size are less likely to participate in the program; access to credit increases the possibility of participation; training

in related activities increases the possibility of participation, and marital status of being married reduces the possibility of participation.

Table 3: Logit results of household program participation

Covariate	Coefficient	St. error	Z-value
Age	.1906755	.068377	2.79 **
Family size	-.7453037	.3388641	-2.20 **
Age of schooling	.1626885	.1371936	1.19
Amount saved	.0005103	.0008589	0.005
Experience in credit use	.2798052	.12721	2.20**
Training	0.121953	0.534323	3.99***
Marital status	-.9969225	.622401	-1.60*
_cons	-8.787451	3.279208	-2.68**
NN	160		
LR chi2(9)	184.99		
Prob > chi2	0.0000		
Pseudo R2	0.8341		
Log likelihood	-18.394881		

Source: own survey result, 2013

***, ** and * Significant at 1%, 5% and 10% level of significance, respectively

Here, our interest is to estimate predicted values of program participation (propensity score) for all households in the program and outside the program, before launching the matching. Then, a common support condition should be imposed on the propensity score distributions of household with and without the program and finally drop observations whose predicted propensity scores fall outside the range of the common support region. The data set resulted in good matches in the case of minima and maxima approach. Therefore, this approach was employed to identify the common support region.

As shown in Table 4 below, the estimated propensity scores vary between 0.087 and 0.992 (Mean=0.936) for program or treatment households and between 0.00021 and 0.978 (mean = 0.0655) for non-program (control) households. The common support region would then lie between 0.087 and 0.978. In other words, households whose estimated propensity score is less

than 0.087 and larger than 0.978 are not considered for the matching exercise.

Table 4: Distribution of estimated Propensity Score

Group	Obs.	Mean	S.D	Min	Max
Treated	80	0.936	0.174	0.087	0.992
Control	80	0.0655	0.164	0.00021	0.978
Total	160	0.506	0.468	0.000	0.992

Source: own estimation data, 2013

ii. Matching of participant and non-participant households

Alternative matching estimators were tried in matching the treatment program and control households in the common support region. The final choice of a matching estimator was guided by different criteria such as equal mean test referred to as the balancing test (Dehejia and Wahba, 2002), pseudo-R^2 and matched sample size. Specifically, a matching estimator which balances all explanatory variables (i.e. results in insignificant mean differences between the two groups), bears a low R^2 value and also results in large matched sample size is preferable.

In line with the above indicators of matching quality, caliper matching with radius 0.5 is resulted in relatively low pseudo R^2, with relatively better balancing test (with insignificant mean difference of 7 explanatory variables) and large matched sample size, as compared to other alternative matching estimators (indicated in Table 5). Then it was selected as a best fit matching estimator for data at hand.

Table 5: performance criteria

Matching criteria	Match sample size	Balancing test	Pseudo R2	
			Before matching	After matching
NN Matching				
Without replacement	83	7	0.836	0.342
With replacement	101	4	0.836	0.443
Radius Caliper				
0.1	88	4	0.836	0.443
0.25	108	4	0.836	0.374
0.5	108	7	0.836	0.342
Kernel				
0.1	106	4	0.836	0.342
0.25	108	4	0.836	0.443
0.5	108	6	0.836	0.496

Source: own estimation data, 2013

Testing the balance of propensity score and covariates

After choosing the best performing matching algorithm, the next task is to check the balancing of propensity score and covariate using different procedures by applying the selected matching algorithm (in our case Caliper matching). As indicated earlier, the main purpose of the propensity score estimation is not to obtain a precise prediction of selection into treatment, but rather to balance the distributions of relevant variables in both groups. The balancing powers of the estimations are determined by considering different test methods such as the reduction in the mean standardized bias between the matched and unmatched households, equality of means using t-test and chi-square test for joint significance for the variables used.

The process of matching thus creates a high degree of covariate balance between the treatment and control samples that are ready to use in the estimation procedure. t-values in Tables 6 show that before matching half of chosen variables exhibited statistically significant differences while after matching all of the covariates are balanced.

Table 6: Propensity score and covariate balance

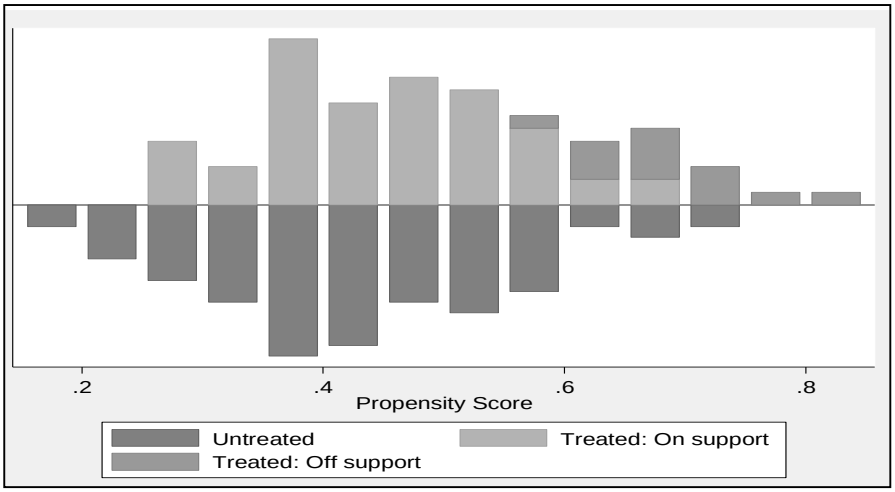
Variable	Mean			Bias	t-test
	Sample	Treated	Control		
Age	unmatched	49.704	35.114	61.4	3.88***
	Matched	37.345	40.624	-30.6	-1.07
Family size	Unmatched	4.4691	4.3165	8.2	0.52
	Matched	4.7241	5.1908	-25.0	-0.82
Age of schooling	unmatched	6.1605	6.3797	-5.0	-0.32
	Matched	5.0345	4.829	4.7	0.20
Marital	unmatched	1.6296	1.3418	30.7	1.94*
	Matched	1.6552	1.9597	-32.5	-1.18
Experience	Unmatched	3.8765	0.56962	137.1	8.68***
	Matched	2.931	4.1981	-52.5	-1.09
Training	Unmatched	0.8888	0.2532	345.4	11.76***
	Matched	0.75862	0.44456	125.6	1.61
Amount saved	Unmatched	185.1	99.57	16.9	1.07
	Matched	95.825	62.555	6.6	0.04
PesudoR^2	0.283				

Source: own estimation data, 2013

iii. Testing the Overlap Assumption and Unconfoundedness

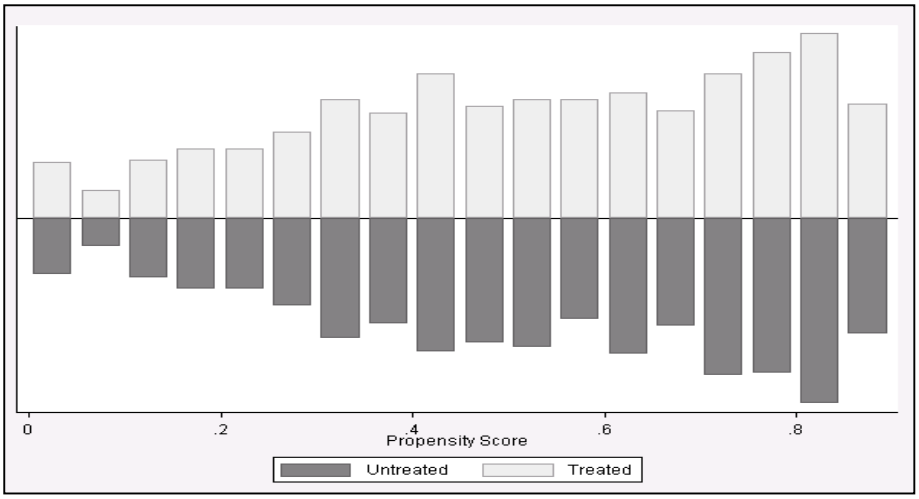
As can be seen from the Table 5, the value of pseudo R^2 is fairly low after matching, denoting that the unconfoundedness assumption is plausible. Moreover, the study uses p-score graph to test the plausibility of the overlap assumption. The following figure shows the distribution of propensity scores of both treatment and control observations before the common support condition. The figure showed that there were unmatched observations in both of the treated and untreated groups before the common support condition is imposed.

Figure 1: Distribution of propensity scores of treated and untreated households before common support



However, as can be seen from Figure 2, after matching the data using the Radius Caliper matching with 0.5 Caliper, the common support condition has trimmed out some observations from the model. The figure shows that there is great tendency of overlapping. Hence we can conclude that the overlap assumption is plausible for this estimator.

Figure 2: Distribution of propensity scores of treated and untreated households after common support



iv. Treatment effect on the treated

In this section, the research provides evidence as to whether or not the GEF/SGP has brought significant impact on household's living condition. The estimation result presented in Table 7 provides a supportive evidence of statistically significant effect of the program on the livelihood of the households. On average, the program has increased income of the participating households by 312.18 birr per month, assets by 3710.71; and expenditure by 249.358, at 1%, 5%, and 10%, level of significance.

Table 7: Average Treatment effect on Treated (ATT)

Variable	Treated	Control	Difference	S.E	T-test
Asset	16593.65	12882.94	3710.71	5984.32	2.05**
Income	1634	1321.8193	312.18	419.96	3.74***
Expenditure	1265.034	1015.676	249.358	37751	1.66*

Source: own estimation data, 2013

C. Challenges of the Project

As acquired from the secondary information, problems faced by the project, specifically by Community Based Organizations can be classified into four major areas: These include gaps in project management skills, gaps in logistics management, gaps in administration and governance, and threats from poor infrastructure.

i. Gaps in project management skills

Project Management is the process that provides a framework for information gathering, analysis, planning, implementation, monitoring and evaluation of a project. It is a dynamic process using the appropriate resources of the organization in a controlled and structured manner, employed to achieve a change clearly defined within specific objectives identified as strategic needs. Project management is therefore a powerful tool for improving the effectiveness and efficiency of a project by helping an organization to set project goals and objectives; and to guide implementation, monitoring and evaluation of a project.

Project management provides a framework within which projects are implemented and ensure that scarce resources are used for project activities that address the defined objectives. It also helps to establish a link between proposal preparation, review and approval mechanism, and ensures that the project is completed within defined scope, quality, time and cost limits.

For an organization to implement its programs in an effective and efficient manner as well as to keep its self sustainability, the staff implementing the project needs to have knowledge and skills in various elements of project management. However, project staffs of the largest majority of CBOs say that they lack such skills, a factor that has been an impediment in the ability of CBOs to mobilize resources and fill the existing gap in their environment and livelihoods.

ii. Gaps in logistics management

Logistics entails planning on availability and utilization of resources and commodities in order to achieve the set targets effectively. Logistics involves the integration of information, transportation, inventory, warehousing, material-handling, and packaging, and occasionally security. Logistics is a channel of the supply chain which adds the value of time and place utility". Community Based Organizations lack the training in logistics management to control the in-flow and out-flow of resources placed at their disposal, and to produce supportive documentation to assist their groups to effectively run their projects.

iii. Gaps in administration and governance

Administration and governance issues have been stumbling blocks in the running of community organizations. The roles of various office holders in the organization are often muddled and unclear, which ultimately affects the performance of the CBO. Furthermore communication channels within the organization are often lacking and internal conflicts are frequent.

Administration and governance were not covered in this survey, but it was clear that, with a skeleton staff, the CBOs often have one person playing

dual roles. For example on the question on who provides financial services in the organization, it was clear that most CBO Leaders/ Chairpersons were also involved in keeping project accounts and reporting on project activities. Such multiple roles often lead to a lack of transparency, for example in reporting on project finances.

iv. Threats from poor infrastructure

Rural Dire Dawa is known for its poor infrastructure, for a lack of roads, a lack of appropriate communication for information and education technologies, a lack of electricity, low levels of telephone lines and very long distances to be travelled by project coordinators to get to the project areas. This was the main problem lying under the poor and infrequent monitoring and evaluation practices done by the project coordinating bodies.

5. Concluding Remarks

Dire Dawa Administration is among those regions which are affected by natural catastrophes such as frequent damaging floods, desertification, and frequent drought, as the result of the climate change. Consequently, households living in the region, particularly rural households are expected to be impoverished which has the tendency to exacerbate the environmental destruction.

In cognizant of this, both the government and concerned non-governmental organizations are striving to combat the situation through implementation of different projects. The UNDP – GEF/SGP Project is among these projects working in the region through establishment of community based organizations. The primary goal of this project is changing the living standard of particularly the poor societies thereby mitigating environmental problems, through provision of different services to the society.

This study was undertaken to figure out the socio-economic impact of this project on the livelihood of the society. The study found out that the program intervention leads to change that is different from that would have happened without the intervention. The program increases the probability

of improvement in income, asset and expenditure of the clients. The changes more likely occur with program participation than without program participation. The program has enabled the participants to generate income that could be spent on better facilities, which could improve their living standard. This implies these households are expected to be enabled to mitigate or to take adaptation strategies for the existing environmental problems.

However, different challenges were identified which may retard the impact of the project. These problems include gaps in project management skills, gaps in logistics management, gaps in administration and governance, and threats from poor infrastructure. It is expected that the impact of the project would have even been much higher than its current impact had these problems not exist. With the existence of these problems, self sustainability of the impact/output of the project by the Community Based Organization is in question, in the future. Therefore, emphasis should be given to bring about solutions for these problems.

References

Bryson , Jennie and Halaby, Charles. 2002. "*Propensity Score Matching to Estimate the Effects of Elite College Attendance on Career Outcomes".* Paper presented at the annual meeting of the American Sociological Association, Atlanta Hilton Hotel, Atlanta, GA, http://www.allacademic.com/meta/p105891_index.html

Caliendo and Kopeining. 2005. *"Child Labor Response to Household Participation in Credit Schemes and Households, Income-Generating Activities in Peru"*. Master thesis. Washington D.C.

Dehejia, R., and S. Wahba. 2002. *"Causal effects in non-experimental studies: re-evaluating the evaluation of training programs".* Journal of the American Statistical Association, 94: 1053–1062.

Dire Dawa Environmental Protection Authority (DDEPA). 2012. *"Regional State of the Environment and Outlook".* Supporting the Delivery of MDG. A Preliminary Report.

Dire Dawa Environmental Protection Authority (DDEPA). 2013. *"Terminal Evaluation Report of the UNDP/GEF SGP Funded Community-Based Sustainable Environmental Management Program in Dire Dawa".*

Imbens, G. and J. Wooldridge. 2008. *"Recent developments in the econometrics of program evaluation".* The Institute for Fiscal Studies Department of Economics, UCL, cemmap working paper CWP24/08

Lechne, G. D., J. S. 2001b. *"Attitudes and Farmer Conservation Behavior"*. American Journal of Agricultural Economics 70:12-19

Rosembaum, P. R. and Robin, D. B. 1983. *"The Central Role of the Propensity Score in Observational Studies for Causal effects". Biometrika*, Vol.70, No.1, pp. 41–55.

Sadek, M. and W. Nagarjan. 2007. "*Predicting Creditworthiness: Evidence from ASCRAs and ROSCAs in the Gambia".* Saving and Development, Quarterly review. 22(4): 399-413.

Sianesi, K. 2004. *"Microfinance and Women's Economic Empowerment: Bridging the Gap, Redesigning the Future"*, Working Paper Series No. 1, WCCN (Wisconsin Coordinating Council on Nicaragua).

MEASURING SMALL FARMERS' VULNERABILITY TO CLIMATE CHANGE ACROSS VILLAGES OF GENDE RIGIE RURAL KEBELE, DIRE DAWA ADMINISTRATION

Yohannes Mengesha[1] , Zerihun Ashebir[2], Yonas Abera[3] and Teshale Delelegn[4]

Abstract

This study analyzes the climate change vulnerability of small holder farmers in Genderighe kebele of Dire Dawa Administration. The purpose of the study was to generate a baseline data on the overall vulnerability of HHs in the kebele and rank/prioritize villages based on their respective level of vulnerability. In so-doing, data was collected from a total of 69 households in the 8 villages of Genderighe kebele, employing a proportionate random sampling technique. Evidently, vulnerability to climate change in Ethiopia is highly related to poverty. Hence, the Head Count Ratio (HCR) method of poverty analysis was used in measuring the absolute level of HHs' vulnerability to climate change in the study area. Results from this analysis revealed that 48%of the sample households in the kebele live below the poverty line implying that about 574 households were estimated to be poor and/or vulnerable to climate change. The HCR indices were also estimated for each of the 8 villages in the study kebele and were used as relative measure of vulnerability based on which villages were ranked. Thus, out of the 8 villages in Genderighe kebele, Halele, Eyidu Arba and Kiyero villages have shown an HCR value of 0.78, 0.75 and 0.75 respectively. On the other hand, Haloli, Goro Guda and Dieyno villages have shown a relatively smaller value of HCR (0.50, 0.43 and 0.33 respectively), while Wechali and Genderighe proper villages had the smallest value, that was 0.25 and 0.23 respectively. However, since these rankings are based on the relative value

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Cordaid (The Netherlands) and Jerusalem Children and Community Development Organization JeCCDO

[1] MSc., fev_eris@yahoo.com
[2] MSc., zedhil@yahoo.com
[3] MSc., yonasabera09@yahoo.com
[4] BSc., teshaledelelegn@gmail.com

of HCR indices, which relied only on HHs' level of consumption, the research team has employed a more inclusive method of vulnerability ranking, by applying a Multi-Criteria Analysis (MCA) that enables controlling for other socioeconomic and biophysical factors. Hence, applying a simeltaneous analysis of different vulnerability indicators classified into five classes (availability of technology, wealth, Infrastructure, Irrigation potential and frequency of drought and flood), the MCA has constructed vulnerability indices for each village, based on which villages were prioritized once again. Comparing the outcomes from the two ranking methods employed, it appears that some villages keep the same positions or successive positions, which shows almost the same output in both methods. Thus, investing in the development of the relatively underdeveloped villages, irrigation for villages with high potential and production of drought-tolerant varieties of crops and species of livestock can all reduce the vulnerability of small farmers to climate change in the study areas.

Keywords: *climate change, vulnerability, Head Count Ratio, Multi-Criteria Analysis*

1. Background and Purpose of the Study

Agriculture is the dominant sector in the Ethiopian economy. It contributes about 46 percent of gross domestic product (GDP) and 85% of total employment (CIA World Fact book, 2013).The contribution of the agricultural sector to the total economy, however, is challenged by its vulnerability to climate change.

Environmental degradation in its different forms, erosion and deforestation in particular together with increasing population pressure has led the rural kebeles of Dire Dawa Administration, to a decline in productivity and serious disturbance on the natural ecosystem. The situation has resulted in significant natural disasters due mainly to recurrent drought and flash flood hazards. In addition, the unsustainable utilization natural resources and the absence of appropriate policy measures contributed towards increasing vulnerability of the community.

Dire Dawa being one of the regions in the country, that is prone to disasters related to climate change, environmental degradation and/or geological factors, is targeted by different International NGOs working in the area. Hence, with the funding from Comic Relief (United Kingdom), Cordaid (The Netherlands), Ethiopia Aid (United Kingdom), SMCF (United Kingdom), Jerusalem Children and Community Development Organization (JeCCDO) in collaboration with other local NGO partners has planned to implement a five years project entitled Community Managed Disaster Risk Reduction (CMDRR, 2012-2016) in Genderighe Keblle.

The project aims at increasing resilience of vulnerable communities to address increased disaster risks, effects of climate change and environmental degradation. The baseline survey was, therefore, aimed at collecting, analyzing and documenting pre- project information on the above mentioned project components as a benchmark for monitoring and evaluation of the project.

To this effect, this vulnerability assessment was undertaken with a major purpose of establishing a baseline data prior to the implementation of the project.

Scholars from different fields of specialization have been conceptualizing vulnerability differently based on the objectives to be achieved and the methodologies employed. These differences limit the possibility of having a universally accepted definition and methodological approach to assessing vulnerability against which the appropriateness of a given concept or method can be judged.

However, according to Temesgen et al., (2008), the level of vulnerability of different social groups to climate change is determined by both socioeconomic and environmental factors. The socioeconomic factors most cited in the literature include the level of technological development, infrastructure, institutions, and political setups. The environmental attributes mainly include climatic conditions, quality of soil, and availability of water for irrigation. The variations of these socioeconomic and

environmental factors across different social groups are responsible for the differences in their levels of vulnerability to climate change.

2. Objectives

Collect information on the local existing hazards, disaster situation, community copping capacities and vulnerabilities.

Rank villages based on their vulnerability to climate change, identify areas which are highly vulnerable and recommend appropriate interventions accordingly.

3. The Survey Area

Genderighe Kebele is located South West and West of the City of Dire Dawa. This area is known to be the hardest hit by flash flood hazards-the biggest cause of the disaster under consideration followed by recurrent drought. The settlement is located along the highly degraded hillside, which is almost entirely covered with stones. The soil is very sandy. Hence, both livestock and crop production in the kebele, are characterized by very low productivity.

4. Approaches and Methodology

In conducting the overall baseline survey, the study team employed participatory approach in which local community members and all concerned stakeholders (NGOs/CBOs, communities, key staff of relevant Government organizations at kebeles and City administration level etc) had high degree of involvement as sources of data. However, the household survey was the major source of data for this vulnerability assessment.

4.1 Sample Size Determination

Sample size had to be determined in such a way that the population characteristics which are interested of the survey are best represented by the sample at reasonable cost. To this end, the sample size was determined

by using the following formula which is recommendable in case of stratified and simple random sampling.

Sample Size = n / [1 + (n/population)]
In which n = Z * Z [P (1-P)/(D*D)]

P = True proportion of factor in the population, or the expected frequency value or prevalence rate;

D = Maximum difference between the sample mean and the population mean, or margin of error term;
Or Expected Frequency Value minus (-) Worst Acceptable Value;

Z = Area under normal curve corresponding to the desired confidence level

Confidence Level/ Value for Z
90% / 1.645
95% / 1.960
99% / 2.575
99.9% / 3.29

Using the above formula, the sample size is calculated by taking the following assumption.

Population Value/ Household Number = 1200
Expected Frequency or Occurrence of disaster risk =95%
Margin of error = 5%
P = Expected Frequency Value = 95%
D = (Expected Frequency - Worst Acceptable) = 95%- 90% = 5%
Z = 1.960 with a Confidence Level of 95%

First, calculate the value for "n".
N = Z * Z [P (1-P)/(D*D)]
N = 1.960 * 1.960 [0.95(1 - 0.95) / (0.05 * 0.05)
N = 1.960 * 1.960 [0.95(0.05) / (0.0025)
N = 1.960 * 1.960 [.0475 / .0025]
N = 1.960 * 1.960 [19]
N = 1.960 * 37.24
N = 72.99=73

Next, Calculate the Sample Size. (S = Sample Size)
S = n / [1 + (n / population)
S = 73 / [1 + (73 / 1200)]
S = 73 / [1 + 0.060]
S = 73 / 1.060
S = 68.867 or 69

4.2. Sampling Technique

Once the appropriate sample size was determined statistically, a two stage sampling technique was employed to select sample households for our study. At the first stage, stratified sampling technique was employed, in which, each of the total 8 villages in the kebele, were considered as a single strata. The second stage involved a proportional random sampling technique which enabled us to select sample households proportional to the population of each strata/village (Table 1).

Table 1: Sample Household Distribution

S. No	Genderighe Kebele/ Villages	HH population of Villages	Proportionally represented Households of Sample Village
1	Halele village	163	9
2	Genderighe proper	212	12
3	Haloli village	60	4
4	Goro gada village	119	7
5	Kiyro village	134	8
6	Wechali village	221	13
7	Dieynole village	151	9
8	Eydu village	140	8
	Total	1200	69

Source: Genderighe Kebele Office

4.3. Data Analysis

The study assessed village level vulnerability of households to climate change using quantitative and qualitative methods. First, assuming vulnerability as expected poverty, the quantitative method measured

absolute level of HHs' vulnerability to climate using the Head Count Ratio (HCR) method of poverty analysis. Using this method, the HCR indices were estimated for each of the 8 villages in the study kebele based on which villages were ranked.

Secondly, the research team has employed a more inclusive method of vulnerability by applying a qualitative analysis of different village level indicators classified into five classes which included: availability of technology; wealth; Infrastructure; Irrigation potential and frequency of drought & flood). Applying a Multi-Criteria Analysis (MCA), vulnerability indices were constructed for each village, based on which villages were prioritized once again. Finally, results from the two methods were compared.

5. Results

5.1 Dimensions of Poverty

In examining the dimension of poverty, the FGT poverty measures were employed. Since this method necessitates setting poverty line for the study area, the study team adopted the poverty line for rural Dire Dawa from Household Income and Consumption Expenditure Surveys (HICES) conducted by Central Statistical Agency (CSA) of Ethiopia in 2010/11. From this, the FGT measures of poverty were calculated. These include the Headcount index, Poverty Gap index, and Poverty Severity index

Table 2: Absolute poverty indices based on sample agro-pastoralist households

Poverty indices	Index values
Head count index	0.48
Poverty gap	0.22
Poverty severity	0.10

Source: Own survey result, 2013

The resulting poverty estimate for the study area (Table 1) shows that the percentage of poor people measured in absolute head count index (α = 0) is about 48%. This figure indicates that the proportion of the sample households in Genderighe kebele live below absolute poverty line. This implies that 48% of the population are unable to get the minimum calorie required (2200 kcal per day per adult) and essential non-food expenditure. Putting differently, these much proportions of households are unable to fulfill the minimum amount of consumption expenditure that is, Birr 2658.31 per adult equivalent per year.

The poverty gap index (α=1), a measure that captures the mean aggregate consumption shortfall relative to the poverty line across the sample households is found to be 0.22 which implying that the percentage of total consumption needed to bring the entire population to the poverty line is 22%. This indicates if the district mobilizes resources that can meet 22 percent of caloric need of food insecure households and distribute to each household, then theoretically food insecurity can be eliminated.

Similarly, the FGT severity index (the squared poverty gap, α=2) in consumption expenditure shows that 10% fall below the threshold line implying severe inequality. It means that there is a high degree of inequality among the lowest quartile HHs.

5.2. Vulnerability Across Villages

Given the different disciplines involved in vulnerability study, there are many conceptual and methodological approaches to vulnerability analysis. Hence, two methods of vulnerability analysis were used to assess the climate change vulnerability of households across the 8 villages of Genderighe kebele.

5.2.1. The Head Count Index

Vulnerability to climate change in Ethiopia is highly related to poverty (loss of copying or adaptive capacity) in most of the regions that were indicated

as vulnerable (Temesgen et al., 2008). Hence, the Head Count Ratio (HCR) method of poverty analysis was used as a proxy for measuring the absolute level of HHs' vulnerability to climate change in the study area. The HCR indices were calculated for each of the 8 villages in the study kebele and were used as relative measure of vulnerability based on which villages were ranked.

Table 3: Estimated poor households in Genderhighe by village

Village	Total no. of HHs	Sample HHs	No. of poor	Head Count Ratio of village	Estimated poor HHs	
					Freq.	Percent
Wechali	221	13	3	0.24	52	9.07
Genderighe proper	212	12	3	0.25	52	9.43
Dieyno	163	9	3	0.32	52	9.66
Goro gudo	119	7	3	0.44	52	9.07
Haloli	60	3	2	0.58	35	5.34
Kiyro	134	8	6	0.78	104	17.87
Eyidu arba	140	8	6	0.75	104	18.67
Halele	151	9	7	0.81	122	20.89
Total	1200	69	33	0.48	574	100

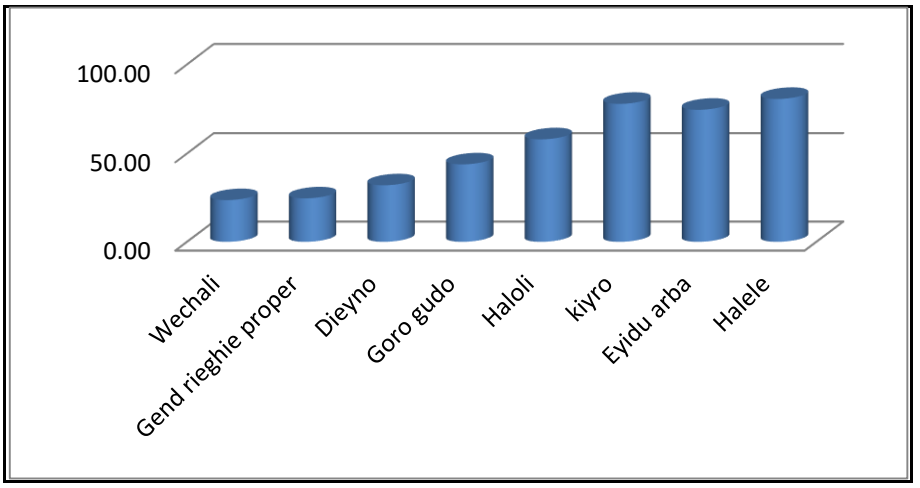
Source: Own survey result, 2013

As it is portrayed on Table 2, in terms of absolute number of poor households, approximately 574 households were estimated to be poor. Thus, out of the 8 villages in Genderighe kebele, Halele, Eyidu arba and Kiyero villages have shown an HCR value of 0.78, 0.75 and 0.75 respectively. On the other hand, Haloli, Goro guda and Dieyno villages have shown a relatively smaller value of HCR (0.50, 0.43 and 0.33 respectively), while Wechali and Genderighie proper villages had the smallest value, that was 0.25 and 0.23 respectively.

The possible reason for the former three *villages* to contribute to a relatively larger number of poor households is due to the fact that they are located deep into the rural kebele where flash flood and recurrent droughts

are frequent, making households' income source, limited to drought prone subsistent agricultural production.

Figure 1: Proportion of poor HHs by village



Source: Own survey result, 2013

By the same token, the relatively lower contribution of poor households in the rest of villages attributes to the fact that most of them involve in off-farm activities and daily labor. In contrast, these villages are also found in the part of the kebele located closer to the urban villages of Dire Dawa City. Hence the HCR results indicate that Halele, Eyidu Arba and Kiyero villages, which are located deep in to the remote area, are highly vulnerable to climate change followed by Haloli, Goro guda, Dieyno, Wechali and Genderighie proper villages.

However, since these rankings are based on the relative value of HCR indices, which relied only on HHs' level of consumption, there was a need for a more inclusive method of vulnerability ranking that enables controlling for other socioeconomic and biophysical factors other than poverty. Hence, another method of vulnerability analysis was employed.

5.2.2. MCA Vulnerability Index

The level of vulnerability of different social groups to climate change is determined by both socioeconomic and environmental factors. Hence, vulnerability across villages was ranked once again by making use of mca vulnerability index, which is constructed for each village based on the integrated vulnerability assessment approach.

The vulnerability indicators consist of the different socioeconomic and biophysical attributes of the study area. Thus, in an attempt to compute the indices and prioritize villages based on their level of vulnerability, the research team applied, a qualitative analytical model known as Multi-Criteria Analysis (MCA).

A. Setting up Vulnerability Indicators

The different socioeconomic and biophysical indicators collected at villages level, have been classified into five classes of indicators. Thus, the integrated vulnerability assessment approaches were adopted to combine these biophysical and socioeconomic indicators. The socioeconomic factors include wealth, literacy rate, technology, institutions, and infrastructure. The biophysical factors include irrigation potential, frequency of climate extremes, and future changes in temperature and rainfall.

Table 4 gives the socioeconomic and biophysical indicators classified into five classes. The research Team members endorsed the indicators proposed before the analysis was started.

The indicators are:

I.1. Technology, which refers to availability and use of Insecticides and pesticides, Fertilizer and improved seeds by the community of the villages

I.2. Indicator of wealth, which refers to quality of house, Livestock and Non-agricultural income of households in the village

I.3. Infrastructure and institutions: This refers to the presence of Health services, all weather roads, Food Market, Primary and secondary school, Telephone services and Microfinance services

I.4. Irrigation potential and literacy rate refers to the availability of Irrigation potential and Literacy rate in the villages

I.5. Frequency of drought and flood refers to the relative occurrences of drought and flood in the villages

B. Assigning Values/Scores to each Indicator

Once the indicators are identified the next step was to assign values/scores for each indicator. The scores could be quantitative or qualitative or binary depending on the nature of the indicators. Either way, for the purpose of MCA analysis, the scores need to be described in number.

Table 4: Description of Indicators along with value weights

Indicators	Proxy variables	Description	Range of Values
Indicator-1	Technology	Availability of Insecticides and pesticides, Fertilizer supply and improved seeds in the villages	Scale from 1 to 2
Indicator-2	Indicator of wealth	Quality of house, Livestock and Nonagricultural income of HHs in the villages	Scale from 1 to 3
Indicator-3	Infrastructure and institutions	Presence of Health services, all weather roads, Food Market, Primary and secondary school, Telephone services and Microfinance services	Scale from 1 to 5
Indicator-4	Irrigation potential and literacy rate	Availability of Irrigation potential and Literacy rate in the villages	Scale from 1 to 5
Indicator-5	Frequency of drought and flood	Village's exposure to drought and flood	Scale from 1 to 5

Each village needs to be assigned scores across each indicator. Accordingly, each of the eight villages were assigned scores across the five indicators. These indicators have been analyzed simultaneously in the table below.

Table 5: Evaluation of indicators for each village

N°	Villages	INDICATORS (Proxy variables)				
		Technology	Indicator of wealth	Infrastructure and institutions	Irrigation potential and literacy rate	Frequency of drought and flood
		Scale from 1 to 2	Scale from 1 to 3	Scale From 1 to 10	Scale from 1 to 5	Scale from 1 to 10
1	Halele	2	2	4	5	3
2	Kiyro	2	2	1	5	4
3	Haloli	2	3	2	5	3
4	Dieyno	1	2	2	2	4
5	Genderighie proper	2	2	5	5	3
6	Eyidu arba	2	2	2	4	3
7	Wechali	2	3	4	4	3
8	Goro gudo	1	3	4	5	4

C. Standardizing scores

Once each village is assigned with their respective scores, the scores need to be standardized for each indicator so that they could easily be aggregated horizontally for each village for the purpose of constructing vulnerability index.

To be able to compare the different indicators, the values must now be standardized; that is, expressed in one common unit, according to one common scale. This would enable add the values of each indicator horizontally for a given village to be able to establish a single aggregated standardized value (vulnerability index) based on which villages will be ranked.

All indictors have been standardized on a scale from 0 to 1 with increasing values for advantages and decreasing values for disadvantages (exposure). This has allowed calculating average notes for all indicators and realizing a first classification MCA1: Multicriteria Analysis 1 which gives us the vulnerability indices for each village.

Table 6: Standardized notes and 1st classification MCA1

No	Option	Standardized Option Notes/Indicators All indicators are noted on a scale of 0 to 1						
		Technology	Indicator of wealth	Infrastructure and institutions	Irrigation potential and literacy rate	Frequency of drought and flood	Vulnerability index	Rank
1	Halele	1	0.5	0.625	1	0.5	0.725	(5)
2	Kiyro	1	0.5	0	1	0.625	0.625	(3)
3	Haloli	1	1	0.25	1	0.5	0.75	(6)
4	Dieyno	0	0.5	0.25	0.33	0.75	0.366	(1)
5	Genderighe proper	1	0.5	1	1	0.5	0.8	(8)
6	Eyidu arba	1	0.5	0.25	0.66	0.5	0.582	(2)
7	Wechali	1	1	0.625	0.66	0.5	0.757	(7)
8	Goro gudo	0	1	0.75	1	0.75	0.7	(4)

As higher values of the vulnerability index show less vulnerability and vice versa, our results suggest that Dieyno, Kiyro and Eyidu arba are the most vulnerable villages in the study area, while Goro gudo, Genderighie proper and Haloli are relatively less vulnerable.

Comparing the formerly discussed analysis of poverty with this one, it appears that some villages keep the same positions or successive positions, which shows almost the same output in both of the vulnerability assessment methods.

Table 7: Comparative results of the Vulnerability index and Head count ratio of villages

Villages	Vulnerability index (rank)	Head count ratio(rank)
Halele	0.68 (5)	0.33 (6)
Kiyro	**0.63 (3)**	**0.75 (2)**
Haloli	0.82 (6)	0.5 (4)
Dieyno	**0.49 (1)**	**0.78 (1)**
Genderighie proper	0.76 (8)	0.25 (7)
Eyidu arba	**0.67 (2)**	**0.75 (3)**
Wechali	0.71 (7)	0.23 (8)
Goro gudo	0.74 (4)	0.43 (5)

6. Conclusion and Recommendation

Genderighe area is repeatedly affected by disaster due to draught and flood hazards. Even though, the damage caused by disaster affects nearly most residents of the locality, it is more severe in poor and low income groups located deep into the remote areas of the kebele. Household and community coping mechanisms are very minimal due to lack of adequate resource and lack of improved techniques and skills. In general, from survey results, it can be concluded that the households in the survey area are vulnerable to the impacts of climate change.

As part of a baseline survey for CMDRR project, this vulnerability analysis was conducted in order to target areas that are highly vulnerable and to recommend appropriate interventions. Although the results of this study indicate the general features of each village, future research should focus on administration and regional levels.

Based on the analysis, a few project options for decreasing the vulnerability of farmers to climate change can be presented. In line with the findings of Temeegen, et al., (2008), vulnerability to climate change in the study area was found to be highly related to poverty. Hence integrated rural development schemes aimed at alleviating poverty can play the double role of reducing poverty and increasing adaptive capacity to climate change. Special emphasis on the relatively less-developed remote villages of the kebele (i.e., Halele, Eyidu arba and Kiyero villages), in terms of investment in technology, institutions, and infrastructure can also play a significant role.

In addition, investment in irrigation in places with high potential for irrigation can increase the kebele's food supply. Strengthening the ongoing micro-level adaptation methods of governmental and nongovernmental organizations, such as water harvesting and other natural resource conservation programs, can also boost the adaptive capacities of farmers in the kebele.

The focus of integrating the environment and local livelihood improvement strategy should be in place. The basic focus of the initiative should be directed towards addressing the restoration works of degraded and depleted environment through integrating with livelihood improvement of the community. Therefore, the green coverage development, proper water and soil conservation and land management activities, improved agriculture development and practices, income generation and human development initiatives should be given consideration in program design process. Therefore, the local productive and carrying capacity and livelihood improvement and adaptation to adverse situation can be achieved as per the desire.

It is also important for local organizations to adapt the concept of how to prepare for a disaster to their own geographical and emergency related context. There are several aspects that should be considered by local organizations while dealing with disaster mitigation and management efforts. The prime focus should be made on mobilizing and organizing self-

initiated community organizations. Then it needs building and strengthening the capacity of the organizations and providing technical and administrative supports. This has basic importance to manage local situation, generate appropriate information, establishing functional networks, mobilize local resources and facilitate the improvement of local copping techniques and mechanisms.

Increasing the awareness of the community members on the importance of conservation agriculture for food security, climate change adaptation, productivity improvement, ecologically balanced system of production methods and the like will yield better for improved local individual and community initiatives.

References

Bocconfuso, D. 2004.Conceptual Framework for Approaches to Poverty. A Paper Prepared for the Workshop. Organized by CRD1and IDRC, Dakar, Senegal. p15.

CIA (Central Intelligence Agency). 2013. The World Fact Book. https://www.cia.gov/library/publications/the-world-factbook/

Foster, J., J. Greer, and E. Thorbecke. 1984. A class of decomposable poverty measures. *Econometrica* 52: 761-766.

HICES (Household Income and Consumption Expenditure Surveys). 2012. Conducted by Central Statistical Agency (CSA) of Ethiopia in 1995/96, 1999/00, 2004/05 and 2010/11 have been used to analyze poverty.

MoFED. (2008). Dynamics of growth and poverty in Ethiopia (1995/96-2004/05). Development Planning and Research Department, Ministry of Finance and Economic Development. April, 2008, Addis Ababa, Ethiopia.

Temesgen Deressa, Rashid M. Hassan and Claudia Ringler, 2008. Measuring Ethiopian Farmers' Vulnerability to Climate Change across Regional States. Environment and Production Technology Division. IFPRI Discussion Paper 00806, October 2008.

CAUSES AND SOCIO-ECONOMIC IMPACTS OF FLOODING IN DIRE DAWA, ETHIOPIA

Yonas Tadesse Alemu[1]

Abstract

Dire Dawa, the second largest city of Ethiopia, has been suffering from disastrous floods in its history. The flooding of 6 August, 2006 was unprecedented aftermath caused severe impacts on human lives; property; and infrastructure sector of Dire Dawa. This study focuses on finding the major flood causative factors and the resulting socio-economic impacts. The daily rainfall data analysis shows that, during the last decades, the highest values of rainfall intensity (Ip) have been increasing in the Dechatu catchment. The increase in rainfall intensity in the Dechatu catchment is constant since 1970. The mean peak rainfall intensity, Ipm (mm/24h), calculated from averaging the annual highest values (Ip) recorded in the study meteo-stations shows a marked increase in the Dechatu catchment. This result is considered as one main factor responsible for the increase in the frequency of high flash floods in the town of Dire Dawa. One of the major causes for the high magnitude flood that hit the city in August 6, 2006 was the high intensity of rain that fell in all the upland areas in the previous day. Similarly land-use change in the catchment particularly high rate of shrink of natural forest in the upland has aggravated flood incidences in the downstream area. The results of land use change between 1985 and 2006 showed that there is considerable expansion of urbanized area from 39% to 56.33% and farmlands from 11.04% to 12.77%. On the contrary shrub lands decreased from 17.77% to 3.96% and woodland from 0.37% to 0.23%. Such Expansions of urbanized area and farmlands on the expenses of woodland and shrub land areas has a direct correlation with the potential for surface runoff generation. The land use change in the catchment is one of the major flood triggering factors in Dire Dawa. Similar result was found by Dagnachew et al. (2003) in Awash basin.

[1] Lecturer at Dire Dawa University, Department of Geography & Environmental Studies, E-mail: tadesse.yonas@gmail.com Cell phone:+ 251911301797

The socio-economic impact of flooding in Dire Dawa in 2006 was so severe that it caused the death of 256 people, 244 missing and more than 9956 people displaced. Flood in 2006 hit the city in the middle of the night while people were in deep sleep. One of the reasons for such high death toll in the city was absence of early warning system in the city that could alert the people before floods hit the city. Flood in 2006 also hit the business centers severely and the total loss of properties for 882 small scale traders and 123 licensed traders was estimated at 17146493 ET. Birr. The flood had also an enormous impact on the economic foundation of the city administration due to the expenditure for rehabilitation and reconstruction. The recurrent expenditure of the city increased by 43% for reconstruction and rehabilitation whereas the capital expenditure was kept static or even decreased. Overall direct and indirect damages inflicted by the flood on agricultural; trade and infrastructural sectors of the city is estimated to be about 97,368,634.36 ET birr.

Enactment of land-use policy is important for future disaster mitigation. With Land-use policy it is possible to protect the river morphology and the catchment from abusive utilization which is one of the causes of flood generation. Moreover, promoting early warning system in the city is important in order to evacuate people before flood disaster occur.

1. Introduction

1.1. Background

During recent years, records of loss of life and damage caused by floods worldwide show a steady rising trend. While being beneficial to the flood plains and their productivity, floods do have great damage potential and affect ever-increasing number of people. On a global scale, there is evidence that the number of people affected and economic damages resulting from flooding are on the rise. All water related disaster events increased between 1980 and the end of the twentieth century. The estimated water-related economic losses globally show an increasing trend. The trend had a trough during the period 2001 to 2003, and then increased sharply until 2006 (WMO & GWP, 2005; Adikari and Yoshitani, 2009).

Disasters leave large numbers of people ill, disabled, widowed, orphaned, displaced, or suffering from post-traumatic stress disorder (ADB, 2004).

In Africa floods and flash floods cause loss of life, damage to property, and promote the spread of diseases such as malaria, dengue fever, and cholera. From 1900 to 2006, floods in Africa killed nearly 20 000 people and affected nearly 40 million more, and caused damage estimated at about US$4 billion (ICSU-Africa, 2007). Water related disasters increased more than four folds in Africa (Adikari et al., 2008). According to World Bank (2003), in most developing countries flood disasters still claim tens of thousands of lives each year and destroy livelihoods in an instant.

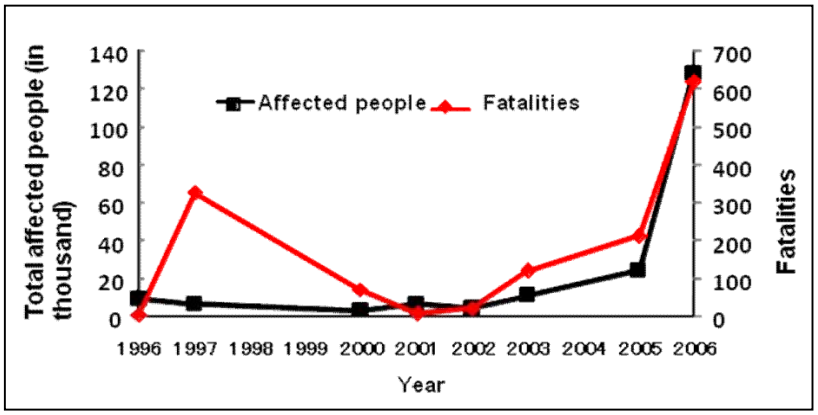
Ethiopia's topographic characteristics has made the country pretty vulnerable to floods and resulting destruction and loss to life, economic, livelihoods, infrastructure, services and health system (DPPC, 2007). Several factors could be mention as causes of flooding by different writers. Deforestation can impact hydrological processes, leading to localized declines in rainfall, and more rapid runoff of precipitation, causing flooding and soil erosion, a common phenomenon in most parts of Ethiopia (Dagnachew et *al.,* 2003). On the other hand, the high infiltration rates under natural forests serve to reduce surface runoff and flood response. From the theoretical considerations it would be expected that interception of rainfall by forests would reduce floods by removing the proportion of the storm rainfall and by allowing the buildup of the soil moisture deficits (Calder, 1999).

According to Dagnachew *et al.* (2003), Land-use change due to the expansion of urban areas also affects the ground infiltration rate which in turn gives the way flooding to occur. Land-cover change has one of the causes of flooding phenomenon of the Awash basin, which resulted in millions worth of resources lost nearly every main rainy season. Low level vegetative cover could also affect infiltration and could lead to reduced groundwater levels and the base flow of streams. It is obvious that land-cover can affect both the degree of infiltration and increases runoff following rainfall events (Dagnachew *et al.,* 2003). Sometimes as a result of

the extended and widespread heavy rainfall since the beginning of the rainy season, many areas in the country have experienced devastating damages of floods. For instance in the year 2006 altogether, the floods have killed 620 people and affected more than 128,000 people. Thousands have lost their property and means of livelihood in the same flooding disaster (UNCEF, 2006). In Ethiopia flood disasters and the damage it cause on properties and human lives have an increasing trend (see Figure 1.1).

The increasing flood damages in many parts of Ethiopia over years in general and the serious damages occurred recently in Dire Dawa in particular should remind us the urgent need in change of paradigm in order to reduce the human vulnerability and to guarantee sustainable development.

Figure 1.1: Flood disaster events in Ethiopia (adapted from EM-DAT)



1.2 Statement of the problem and objectives

Dire Dawa, which was established in 1910 and located at the foot hills of eastern *Harerghie* highlands, has been repeatedly hit by powerful flood disasters. Flooding at different time destroyed homes, public institutions, market places with their properties, infrastructures, crops in the field, livestock, etc. In Dire Dawa, flood in August 1981 which killed about 80 people was previously considered the worst in the town's history. However, the unprecedented August 6, 2006 flooding was worst of all cases; it

surpassed all flood disasters that occurred in the past in loss of human life, and property damages.

Owing to the recently witnessed unprecedented damage caused on one hand and the lesser amount of concrete actions to mitigate the flood hazards on the other, things continued unchanged, we can say, other developmental efforts would bear no fruits, this is because, floods could destroy them all, as we have experienced.

In such a situation it is important to consider major factors that contributed most in the past flood hazard calamities. It has of paramount importance to take notice of these factors to arrive at a wise and comprehensive solution towards mitigating the challenge (that is flooding) which is unpredictable.

In Dire Dawa, recently the city administration has given due attention to mitigate the challenges of flooding and the disaster it causes. However, still more has to be done because the recently occurred (2010) flooding witnessed that flood disaster is still so severe and requires rigorous research to identify the root causes of the problem and generate policy relevant recommendations. Studies in this regard are not sufficient to give adequate information of the impacts of flood disasters in the economic, social and infrastructural aspects of the city. In light of the problems discussed above, the specific objectives of this study are to:

1) Identify and assess the major flood-triggering factors and vulnerability of the community to flood hazards;
2) Generate maps of urban flood inundation by using data from peak runoff events;
3) Carry out a socio – economic impact survey and examine the extent of the disaster in individual and public property. And to generate policy relevant recommendations

2. Materials and Methods

2.1 General description of the study area

2.1.1 Location

Dire Dawa city is located between $9^0$27'N and $9^0$49'N latitude and $41^0$38`Eand $42^0$19`E longitude, and in the eastern marginal catchment of Awash basin

(Figure 2.1). East Hararghie Administrative zone of Oromiya Regional State borders it in the south and southeast and *Shinele* zone of Somalia Regional State in the north, east and west. Dire Dawa has a total area of about 66,017ha of which the south and south-eastern part of the city which is characterized by a chain of mountains and upland covering 45%; low lying flat land accounting for 40% of the land area; and the remaining 15% is covered by gorges, valley and River terraces (MoWR Ethiopia, 2006).

2.1.2 Population

The total population of Dire Dawa city is estimated to be 400,000 people (IDP, 2006). According to the 1994 Central Statistical Agency census result, Dire Dawa city had a total population of 252,000 during the census period and in the year 2005; the population of the city has reached 389,851 which exceeded the census period population by 137,851. More than half of this increase is due to migrants from nearby rural areas and other part of Ethiopia. Since Dire Dawa is one of the industrial and business cities in Ethiopia, people from rural areas perceived that job can easily be secured in the city. The increment within a decade accounts for more than half of the size of the 1994 population, which is tremendous in magnitude. On the other hand, the average annual growth rate of the population was 4% for the region during the years 1995-2000. The growth rate declined to 3.8% for the years between 2000 and 2005 and expected to further go down to 3.5% for the years between 2005 and 2010 (IDP, 2006).

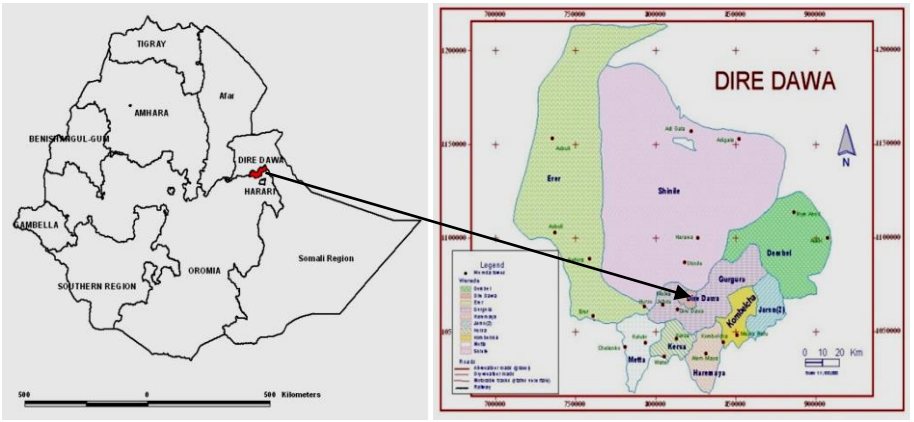
2.1.3 Climate

Because of its tropical location Dire Dawa is experiencing high temperature throughout the year with minor seasonal variations. Temperature progressively increases northward from somewhat temperate type along the mountain side of the city in its southern most point.

The seasonal rainfall has a bimodal distribution with peak in April and August. The two rainy seasons are spring and summer locally called 'Belg' and ‘Kiremt’ respectively, separated by a short dry spell in June. The mean

annual rainfall is about 730mm. The mean annual average air temperature is 29c^0 and June is the warmest month of the year while December and January are the coldest. Dire Dawa enjoy a sunny climate with mean annual daily value of bright sunshine equal to 8hours (IDP 2006).

Figure 2.1: location map of Dire Dawa Administrative Council



2.2. Data Source and Methods of Analysis

2.2.1 Data and Sources

Based on the nature and type of data, the data required for this study are categorized as physical and socio-economic data. Physical data includes climatic and land use related data. Data about social, economic and infrastructural sectors are categorized as socio-economic data.

Physical Data

The main data sources for this data encompass a topo map with scale 1:50,000, land sat multispectral scanner satellite image (MSS image) from 1975, Land sat TM of 30m × 30m resolution satellite image form 1985 and Spot 5m x 5m satellite image from 2006 (Yonas et al., 2013).

Climatic data, rainfall on a daily basis for the study area was obtained from National meteorological Agency by taking in to account the following four metrological stations which all are located within and around the

catchment. These include Dire Dawa, Haramaya , Dengego, Kersa and Kulubi stations.

Socio-Economic Data

In order to analyze the socio-economic impacts of flooding, flood damages on social, economic and infrastructure sector has been collected from Disaster Prevention & Preparedness Bureau (DPPB), Dire Dawa Agriculture and Rural Development Office. In addition population data of affected *Kebeles* collected from *kebele* administration. This study has also employed primary data sources. Focus group discussion, interview with key informants and direct observation in the field, are the most intensively used methods for primary data collection.

2.2.2 Data analysis

Meteorological data analysis

Extreme rainfall data for the meteorological stations in the study area have been systematically arranged for the main and minor rainy seasons (*Kiremt* and *Belg*). According to World Meteorological Organization (2009), extreme rainfall is greater than or equals to one (1) mm of rainfall. Then trend analysis of the daily rainfall data has been carried out for the Meteorological stations in the study area**.**

Land use analysis

Land use/cover change of Dechatu catchment was analyzed using multi-temporal satellite images: 1975 MSS image, 1985 Landsat TM image and 2006 spot image. Satellite images were geometrically corrected by using ground-truth points and enhanced using linear stretch technique. The classification of land use/cover was done first by unsupervised classification and after fieldwork supervised image classification which is a widely used classification technique was applied. From six major land use/cover types (Open Wood land, Shrub land, cultivated land, Bare land, Sand deposit and Built up area), 180 ground truth points were collected from the field. Each point was marked with GPS which was later integrated with the image. Half of this data was used as input for supervised image classification and the remaining for accuracy assessment. Finally the extent of land use/cover change was computed by using change detection statistics technique in

ENVI.4.2 software. Similarly, ENVI 4.2 software was used in a study conducted by Yonas et al., 2013.

Inundation analysis:

As no runoff data are available for Dechatu River, The Curve Number (CN) Method has been used to derive flood discharges from the rainfall excess. The SCS-CN method was selected as it is adapted for daily rainfall data and related to catchment characteristics such as soil and land-use.

The runoff curve Number (also called a curve Number or simply CN) is an empirical parameter used in hydrology for predicting direct runoff or infiltration from rainfall excess. The runoff curve number was developed from an empirical analysis of runoff from small catchments and hill slope plots, like Dechatu Catchment. It is an efficient method of determining the approximate amount of direct runoff from a rainfall event in a particular area.

To analyze the inundation area of Dechatu River, this study has been utilized Arc GIS 9.2 software package and Hydrologic Engineering Center-River Analysis System (HEC-RAS**)**. Then accurate topographic survey of the river cross-section was conducted at selected representative points across the Detchatu River using Total station. In addition, a survey of river bed roughness to calculate Manning's n value have been conducted which finally exported to HEC-RAS so as to make inundation analysis. Then the TIN of the catchment was produced from DEM of the catchment by using the 3D Analyst extension of Arc GIS.

Arc GIS data was imported to HEC-RAS on GIS format and cross section filtering was performed by taking a number of points to trim on cross sections. Flow data for boundary condition and initial condition such as flow hydrograph and slope has been defined. Finally, flow simulation was performed and the result is exported to GIS to process the inundation map.

Socio-economic Impact Analysis

Flood impact on the socio-economic and infrastructure sector has been analyzed by using both the ECLAC result and descriptive method of analysis.

In addition, tables, figures that show the disaster impact has been employed in the analysis.

3. Result and Discussion

3.1 Rainfall Trend in the Dechatu catchment

The daily rainfall data analysis shows that, during the last decades, the highest values of rainfall intensity (I_p) have been increasing in the Dechatu catchment. The increase in rainfall intensity in the Dechatu catchment is constant since 1970 (Figure 3.5).

An increase in rainfall intensity, in association with other factors such as land-use change, increased population settlement along the river bank in the downstream area have contributed to raise the risk level of flash floods in the town of Dire Dawa to the point that floods caused severe socio-economic impacts in the town and rural *kebeles*. In the very recent years of course the local administrations have constructed high flood retaining walls, that have contained the last floods occurred in 2010 with discharges around 1000 m^3s^{-1} preventing the town from further inundation.

On the basis of the rainfall data of the meteo-stations located within or close to the Dechatu River catchment, recoded the day before the devastating flood of 6 August 2006, that ranged from 100 to 150 mm in 24 hours, a rainfall intensity of 100 mm/24h was taken as a reference value capable to set conditions for a flash flood (Table 3.1). The mean peak rainfall intensity, I_{pm} (mm/24h), calculated from averaging the annual highest values (I_p) recorded in the study meteo-stations shows a marked increase in the Dechatu catchment. This result is considered as one main factor responsible for the increase in the frequency of high flash floods in the town of Dire Dawa.

The results of climate data analysis have been similarly expressed by focus group discussants. The focus group discussion revealed that rainy season's duration is shortened and rain falls with its highest intensity for short duration. According to the discussants, as the result of change in the

duration of rainy season they are forced to abandoned crops that require water for longer time during their growing period.

As it has been indicated in Figure 3.1; 3.2; 3.3; and 3.4, summer rainfall intensity in all upland meteo-stations has showed an increasing trend, and this is the season when most devastating floods occurred in Dire Dawa.

Table 3.1: Rainfall intensity measured at Rain Gauge stations in the Dechatu Catchment

Date	*Dire Dawa*	*Kersa*	*Alemaya*	*Kulubi*
Aug 1, 2006	0	0	0	0
Aug 2, 2006	0	0	0	0
Aug 3, 2006	4.3	7.9	18.9	26.7
Aug 4, 2006	10.2	0	24.5	4.7
Aug 5, 2006	36.9	159	118	100.5
Aug 6,2006	1	0	7.3	0

Figure 3.1: Summer daily average rainfall, Kersa station

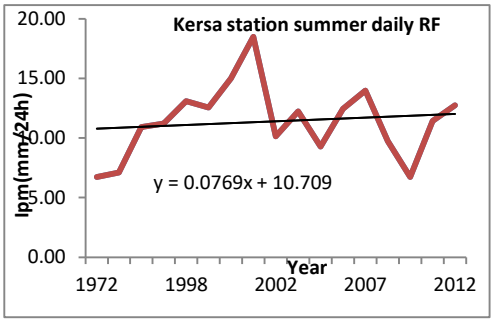
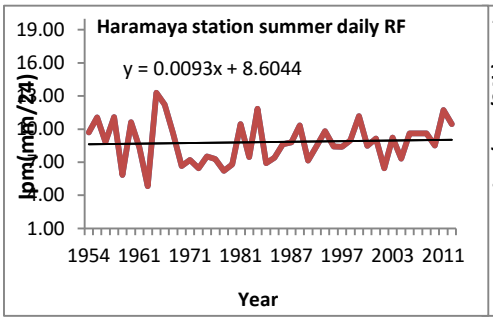


Figure 3.2: Summer daily average rainfall, Haramaya station

Figure 3.3: Summer daily average rainfall, Dengego station



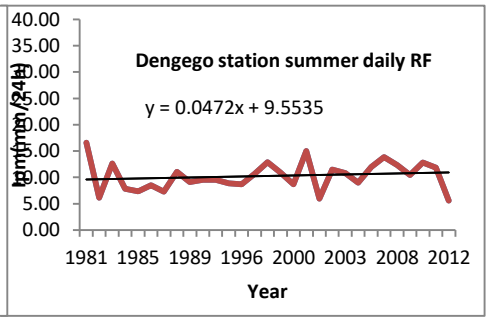
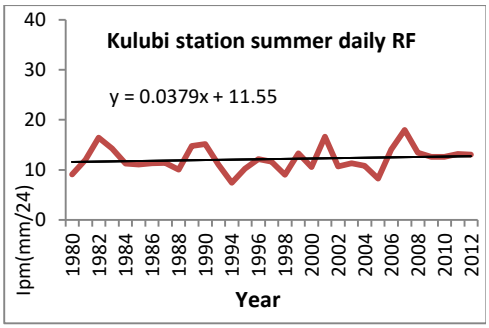
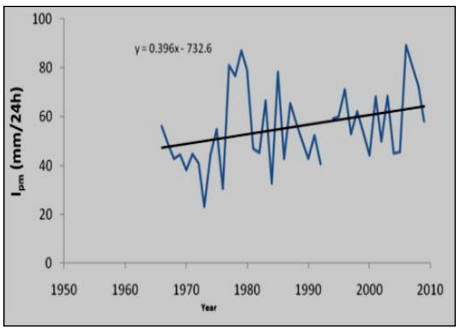


Figure 3.4: Summer daily average rainfall, Kulubi station

Figure 3.5: Daily average rainfall for all stations in the Dechatu Catchment





3.2 Land use/cover change analysis

Land use/cover change as one of the most prominent component in the hydrological processes of a given area it is important to evaluate the changes that undergone in a given catchment so as to understand the hydrological behavior of the catchment. Accordingly, the major land use/cover changes that observed in Dechatu catchment between the year 1975 and 2006 was studied based on the thematic land use/cover map that produced from 1975 Land Sat Mss and 2006 Spot satellite images. In doing so the change detection statistics method was implemented.

The change detection statistics of the area coverage of the six land use/cover classes of Dechatu catchment was cross-tabulated using ENVI 4.2 software package. ENVI 4.2 display change detection statistics result in three Ways (Number of Pixel, percentage and in area terms). For the sake of easy and better explanation this study implements the percentage option.
The change detection statistics of the catchment was done by considering the 1975 Land use/cover map as initial state map and 2006 land use/cover map as final state map (see Figure 3.6, 3.7 & 3.8) and the change observed in each land use/cover class is summarized in Table 3.2.

Figure 3.6: Land use/cover map of Dechatu catchment for the year 1975

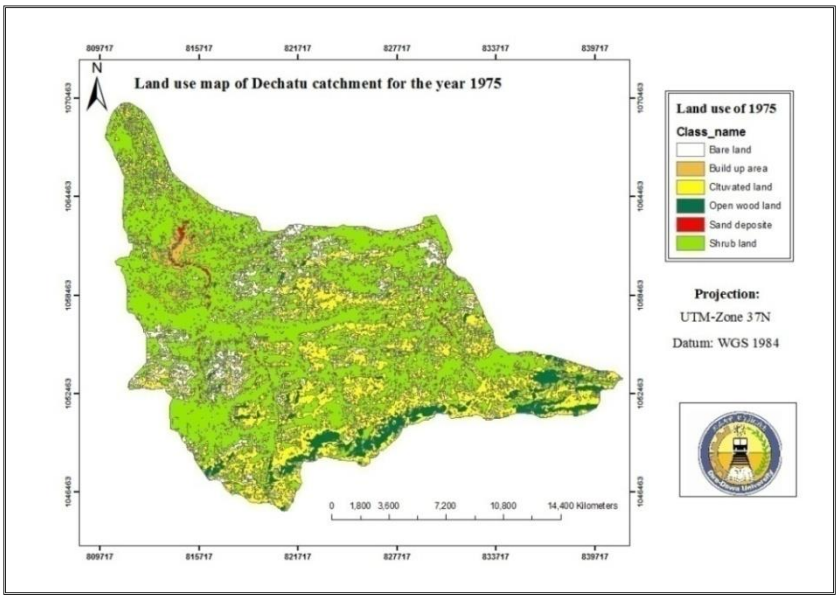


Figure 3.7: Land use/cover map of Dechatu catchment for the year 1985

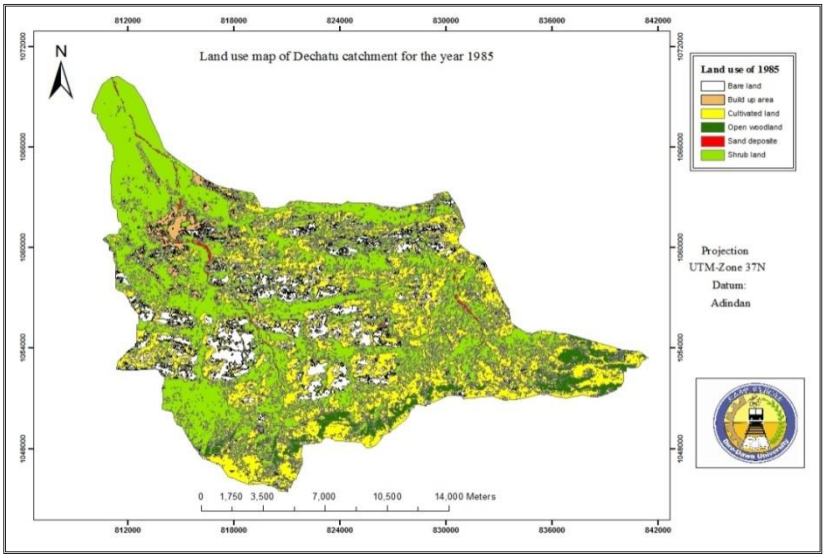


Figure 3.8: Land use/cover map of Dechatu catchment for the year 2006

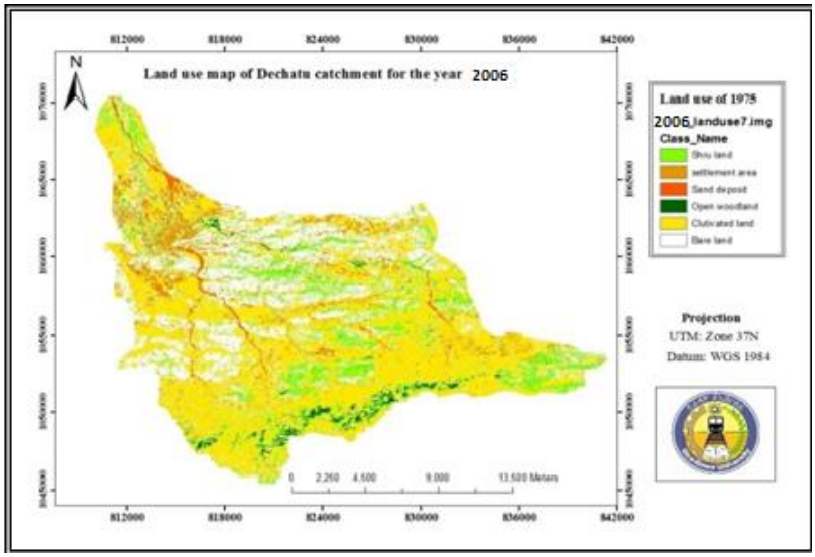

Land use map of Dechatu catchment for the year 2006
N
812000
818000
824000
830000
836000
842000
0 2,250 4,500 9,000 13,500 Meters
Land use of 1975
2006_landuse7.img
Class_Name
Shru land
settlement area
Sand deposit
Open woodland
Cultivated land
Bare land
Projection
UTM: Zone 37N
Datum: WGS 1984

Table 3.2: The land use/cover of Dechatu catchment change detection statistical summary

2006 and Use/cover	Percentage (%)	1975 Land Use/cover							
		Built-up area	Shrub land	Bare land	Open wood land	Sand deposit	Cultivated land	Row Total	Class total
	Unclassified	0.562	0.875	1.059	1.716	0.000	1.027	0.757	100.0
	Cultivated land	15.97	43.281	41.083	55.000	29.726	63.214	99.22	100.0
	Built-up area	44.61	9.993	4.880	2.306	22.877	2.579	99.11	100.0
	Shrub land	28.44	24.245	13.921	5.443	32.466	9.811	99.21	100.0
	Bare land	4.452	18.456	37.043	7.085	12.192	17.722	99.12	100.0
	Open wood land	0.234	1.833	1.407	28.303	0.822	5.247	99.78	100.0
	Sand deposit	5.717	1.318	0.605	0.148	1.918	0.401	99.35	100.0
	Class total	100.0	100.00	100.00	100.00	100.00	100.00	0.000	0.00
	Class change	55.38	75.755	62.957	71.697	98.082	36.786	0.000	0.00
	Image difference	117.18	-64.84	98.32	-72.96	59.68	67.87	0.00	0.00

Table 3.2 clearly states that, the most positive change 117.18 %, 98.32% and 67.87% is observed in the expansion of built-up areas, bare land and cultivated land respectively in the catchment. A number of factors have been identified as major causes for the highest change in the above two land use classes. Among these factors rapid urbanization, expansion of agricultural lands and deforestation are the major one.

3.3 Inundation Analysis

Since no runoff data are available for Dechatu River, The Curve Number (CN) Method has been used to derive flood discharges from the rainfall excess. Therefore, before the inundation analysis have been performed peak discharge, main input for the analysis, has to be derived by using curve Number (CN) method. Accordingly, peak discharge was calculated and

1400m3/s was found from the rainfall excess. With this discharge amount areas of inundated was analyzed.

Based on the result of the inundation map (Figure 3.9), the analysis shows that about 55% of the total inundation area is covered by 1m inundation depth; 30% of the total inundated area is covered by 2m inundation depth. Generally, about 86% of the total inundated area is covered by 2m or less than 2m inundation depth. Since all of the houses in the inundated area are one storey houses, this depth of inundation is very big to damage houses; damage property and cause human casualty.

The inundation depth of 4 to 6m is about 4.6% of the total inundation area which is less significant in terms of its area coverage. As it is shown in Figure 4.14; large residential areas are inundated by about 1 to 2meter inundation depth which implies that flood inflicted severe damages on property and human life on this inundated areas. Though the total inundated area is about 1km^2 of the total area of the city, due to dense settlements within the flooding zone human vulnerability and property damage to the disaster was high. More than 3m inundation depth is located within the river channel where the River passes through narrow hill before it reaches the city. The details of inundation results are shown in Table 3.3.

Table 3.3: Inundation area of Dechatu River

Inundation Depth	Inundated Area(m^2)	Percentage of total Inundated Area
1m	544400	55.9%
2m	291600	30%
3m	92800	9.52%
4m	25600	2.63%
5m to 6m	20400	2.1%

Figure 3.9: Inundation map of Dechatu catchment. The symbol in the map shows the location of residential areas inundated and cut-off road in the 2006 flooding.

The inundation of residential areas; business center by the river has inflicted considerable damages on the economy; infrastructure; and left with large number of human casualty.

3.4 Socio-economic impact of flooding in Dire Dawa

Introduction: In the analysis data of affected population, damaged houses, Infrastructural damages, damages on agricultural sector, trading sector and data on environmental damages were considered. In addition, the study tried to focus the socio-economic damages on the 2006 floods. This is due to the fact that the 2006 flood is the most disastrous flood damages on the socio-economic sectors in the flooding history of the city. Moreover, flood damages in the socio-economic sector are separated as direct and indirect damages.

3.4.1 Direct damage

The amounts of damages caused directly by flood related factors are categorized under direct damages. Direct damages during the 2006 flooding in Dire Dawa includes human casualty; property damages (both private and public property); damages on infrastructure which restricts communication, and damage on power sector which prevents use of electricity for production and light. Moreover, direct damages on the economic sector such as, agricultural and trade and industry were also so severe during the 2006 flooding year. The results of all the direct and indirect damages caused by the 2006 flooding are summarized in the following tables.

A. Flood affected population

Flood disaster damaged portions of the city located along either sides of the Dechatu river channel. Of the total nine kebeles, the most severely affected kebeles were four *(Kebele* 09, 06,05and 03) with the total population of 117,315 (Table 3.4).

Most of the flood affected people were poor people who used to live in flood prone areas. There are at least15 000 dwellers living in high-risk flooding areas in the city of Dire Dawa (UN-HABITAT, 2008). Poor people build houses made from inappropriate materials in flood-prone areas. Poor living condition makes this people most vulnerable to flood disaster.

Table 3.4: Flood affected population and affected *kebeles* in 2006 in Dire Dawa

Affected Kebeles	Dead	Missing	Population of Affected *Kebeles*
03	134	176	26363
05	39	-	30662
06	83	68	29492
09			30798
Total	256	244	117315

Moreover, as shown on Table 3.4, the 2006 flood also affected all age groups in the affected areas of the city. This is mainly due to the fact that the flood occurred in the middle of the night while people were in deep sleep. The residential areas which were hit by the ravaged flood in the middle of the night in August, 2006 had experienced the disastrous flood that left many fatalities and missing people. This shows us the city has no flood early warning system that alert the people to evacuate before floods occurred and cause disastrous damage like the 2006 flooding. Due to poor early warning systems, limited preparedness and weak rescue capacity in the city, the impact of flood hazards can be very big that it kills large number of people and causes severe damages on property in every flooding year.

A. Flood damages on market places

Unemployment in the city of Dire Dawa is estimated to be 16.7% (MWUD of Ethiopia, 2008). In order to alleviate this serious problem of the city of Dire Dawa, the government widely introduced micro-enterprise aimed to establish a sustainable saving and credit scheme to the poor and build the capacity of the poor by giving necessary credit and technical support.

Micro-enterprises have created job opportunity for large number of people especially for young groups (most of which are women) and helped them to live better life. However, flood disaster like the 2006 flooding ravaged the properties of these small scale traders and affected about 882 people.

Floods which devastate properties with a total amount 6,697,992 Birr of these small scale traders resulted in loss of own business or job, and income and forced them to seek others support. The 882 people once running their own business and supporting themselves and their families' now lost everything. Flood has taken all their properties and exposed them for suffering. This disaster impact on one hand has impoverished individuals whose vision was for better prospects.

Similarly, flood disaster in 2006 has inflicted severe damages on licensed traders' property (Table; 3.5). 123 individuals in three flood affected *kebeles* have lost an estimated amount of 10,448,501 Ethiopian birr

saleable commodities. If we roughly calculate the loss to the affected 123 people, each trader by an average has lost about 85,525 Ethiopian Birr. This is very big loss from the point of view of the contribution of these people to the growth of the city's business sector. A striking fact is that the number of people in each family (5 people for each household in Dire Dawa) supported by each trader is large. These numbers of people are therefore indirectly victims of the flood disaster.

The destructive flood that ravaged business centers of both small scale micro-enterprise and licensed traders have left about 1005 people without business and wait for handouts and rehabilitation from government and/or non-governmental organizations. The flood damages in different economic sectors of the city have also its own contribution in increasing the poverty rate of the city. Because of their poverty they were rendered more vulnerable to the flood, which in turn deepened their impoverishment.

Table 3.5: Estimated Economic losses of individuals who are licensed traders in the city of Dire Dawa.

No.	Kebeles	Affected traders	Estimated Loss (Birr)
1	Kebele 05	93	8,742,100
2	Kebele 09	15	1,527,342
3	Kebele 03	7	74,000
4	Kebele 02	1	14,360
4	House Cart Association	7	90,700
	Total	123	**10,448,501**

Source: Federal Multi-Agency Assessment Mission, 2006.

The 2006 flood also appears to be having a long term impact in the economy of Dire Dawa Administration due to the divergence of the government budget to reconstruction and rehabilitation. Due to flood disaster the city's recurrent expenditure for relief and reconstruction purpose was rose up. The capital budget which is used for developmental activity such as infrastructural development was partly diverted to recurrent expenditure. This implies floods have negatively impacted on the city's economic development.

In 2005/06 budget year due to sharp rose up of recurrent expenditure for flood affected people rehabilitation and reconstruction of damaged infrastructure, capital expenditure for the city was static. Due to flood disaster the city recurrent expenditure increased by 43%, if there was not flood it was only increased by 16%. The public sectors loss a total of 53.88 million Birr, 29.55 million Birr in emergency relief and the remaining 24.33 million Birr was estimated increase in recurrent expenditure for reconstruction (DPPB, 2006). If there was no flood this amount of capital used for development of the public sectors.

B. Flood affected Housing and Infrastructure in Dire Dawa

Floods at different time have inflicted severe impacts on the housing and infrastructure sectors. For instance flooding in 2006 has impacted severe damages in infrastructure (see Figure 3.10, 3.11, 3.12, 3.13) and housing. In the housing section, a total of 2685 houses were totally or partially damaged and as a result total population of 9,956 has been displaced. Most of these damaged houses were found within the flooding plain. To further worsen the disaster in the area, more than 55% of the damaged houses were made of poor materials such as mud and wood, which were not in a position to resist the force of the flood.

In the infrastructure sector the total direct damages inflicted on energy; water and sanitation; and transport and communication sector in the 2006 flood is estimated about 7,703,198.36 (Table 3.6). As a result of major damages on power and telecommunication transmission lines and water sector, affected areas of the city were suffered from shortage of potable water; absences of electricity and telecommunication services until the structures were maintained.

Moreover, due to the damage of main road that connects the city with other regions including the capital city and some roads within the city, transportation to the city and from the city was interrupted until the damaged roads maintained. Since Dire Dawa is located in a strategic position connecting Djibouti and central parts of Ethiopia, the road

damage created considerable impact by delaying goods that should be transported to the neighboring Djibouti and to the center of the country.

Table 3.6: Summary of flood affected infrastructure sector in Dire Dawa in 2006

No.	Infrastructure	Cost of damage
1	The rehabilitation of partially damaged Dechatu main bridge,	3,000,000.00
2	Taiwan Irish crossing that joins Taiwan with Number-1 area.	900,000.00
3	Halfkat Irish crossing which connects Halfkat and Vera pasta areas	500,000.00
4	Dechatu retaining wall in two parts (60m)	400,000.00
5	Kefira guide wall about 120m has been destroyed	950,000.00
6	About 100m retaining wall along Goro River in GTZ settlement ar	930,000.00
7	Road damaged and covered by silt	517,100.00
8	Electric poles and lines	500,000.00
9	Telephone poles and lines	6,098.36
	Total	**7,703,198.36**

Source: *Federal Multi-Agency Assessment Mission, 2006*

Figure 3.10: Flood damage on potable water pipe lines

Figure 3.11: Water level around *Kezira* main Bridge & Damages on gabion

Figure 3.12: Damage on Sediment Storage Dams(SSDs) or damage on infrastructure

Figure 3.13: Flood Damage on *Hafkat* ford and Damage on Railway Bridge

Source: All the pictures source is DD, Rural Development Office, Flood Impact Assessment Report, May 3, 2010

C. Flood disaster on Agriculture; Trade and Industry

Floods in 2006 affected the agriculture sector seriously that it damaged standing crops, drowned domestic animals and damaged irrigation facilities. Floods in Dire Dawa usually occur at the vegetative growth stage of major food crops (mostly in August). Crop fields in the low-lying areas of the watershed can be washed away by the flash flood that descends down from the upland. In rural places more than 1,827 households (10,809 persons) were affected by the same flood in 17 *kebeles*. The flood in rural areas left 21 livestock dead, 6 houses washed away, 257.6 hectares of farm lands with crops, and rural infrastructures were damaged. The total damages in the rural infrastructure sector were estimated 1,738,630.00 Eth. Birr. The rural

infrastructural damages in the 2006 flooding have been summarized in Table 3.7 below.

Table 3.7: Rural infrastructure damage

No	Description	Unit	Total Damage
1.	**Infrastructure damaged**		
	Soil bund	Km	224.2
	Stone bund	Km	62.3
	Stone check dam	M^3	8600
	Water harvesting ponds	No	2
	Cut off drain	Km	43.85
2	**Damage on farms**	**Ha**	**230.64**
	Sorghum	Ha	203.36
	Maize	Ha	25.9
	Haricot bean	Ha	0.75
	Sesame	Ha	0.63
3	**Fruits and Vegetables**	**Ha**	**17.21**
	Fruit	Ha	15
	Vegetables	Ha	2.21
4	**Cash crops**	**Ha**	**9.72**
5	**Different farm tools**	**Ha**	**399**
6	**Livestock killed**	**No**	**21**
7	**Water Schemes**	**No**	**10**
8	**Small scale irrigation schemes**	**No**	**5**
9	**Houses**	**No**	**6**

Source: Federal Multi-Agency Assessment Mission, 2006

In the trade sector in addition to traders lost their properties shown in Table 3.5, investors involved in coffee processing, dairy product processing industries also lost huge sum of money. As per Dire Dawa Investment Office Assessment Report in *Federal Multi-Agency Assessment Mission (2006)*, 10 investors have lost 13,162,981 Birr due to property damage by flood.

This has a negative implication on the city's future development in the investment sector on one hand and also it affects the investor's interest to invest their capital in the city on the other hand. Moreover, the shopping center which was constructed within the flood plain with a cost of

1,998,700.00 Birr is totally damaged by the 2006 flood. This was the big mistake committed by the city administration at the then period investing such huge sum of money for construction of building in a vulnerable place without considering protection.

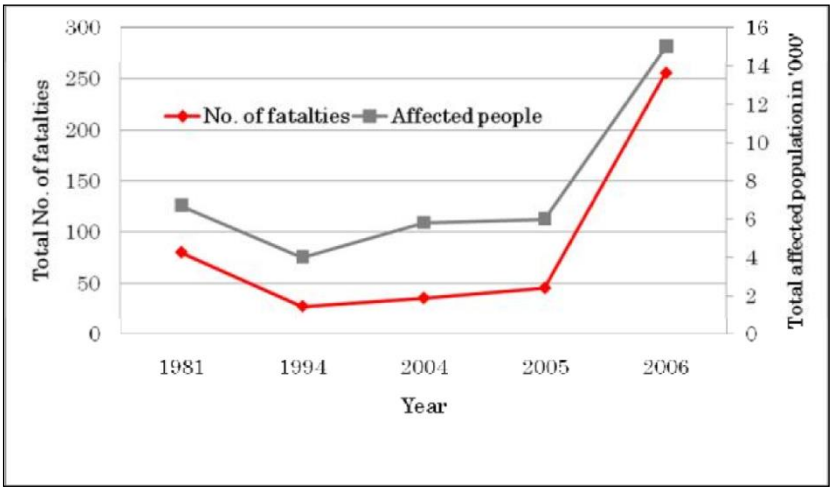
3.4.2 Indirect Damage

Indirect damage from floods includes the long term effects on the economy of disrupted businesses, interrupted savings and expenditure patterns and psychological damage to households and the work force. These effects were clearly demonstrated by the Survey, which showed the unbearable impact of being displaced, resulted in waiting handouts and/or remittances from family elsewhere. For instance, in 2006 flood, 9,956 people were displaced, of which 40% of households lost their business or jobs (as suggested by the Survey) resulting in the family having to survive on remittances from elsewhere or from handouts of the Dire Dawa Administration or other aiding organizations.

In agricultural sector the indirect loss include the amount of income foregone which farmers expect from the sale of by-product production of their animals (cows) and also the amount of money they expend until the next cropping season for the purchase of food crops. Farmers usually consume at home part of their product which they produce on their plots of land; the amount farmers expend for the purchase of farm tools which was damaged by floods; and government subsidies for the purchase of seeds are included in the indirect impact, which accounts the loss of 1738632 Birr (*Federal Multi-Agency Assessment Mission, 2006*). This is the amount incurred for reconstruction of SWC structures, purchase of seeds and farm tools. The field survey reveals that the amount incurred for indirect damage is beyond the cost mentioned above however; due to poor recordings of data it is difficult to portray the exact figures of damages. Cost of demolition and the removal of debris brought by the flood is also another indirect cost incurred by the city administration.

Generally, due to shortage of data availability and poor data recording practices the indirect impact assessment is not deep as expected, however, the overall socio-economic impact in the 2006 flooding compared to other flooding periods is exceptional high and severely affected both the rural and urban socio-economic sectors. From the records the last four flood events occurred during 1981, 1994, 2004 and in 2005 (Figure 3.14), are the major flood disasters that caused significant human casualty. Moreover, the casualties the flood caused have shown an increasing trend. The latest flood in the year 2006 is exceptionally high in its magnitude and the damage it caused as compared to the flooding event in the preceding years. Therefore, the most devastating flood in the history of Dire Dawa occurred on the 6th of August, 2006. This flood is the worst of its kind which resulted in the loss of more than 250 human lives; and property damages is also more than ever before.

Figure 3.14: Trends of flood affected people and fatalities in Dire Dawa city from 1981-2006 flooding periods (source: adapted from DPPC, 2006).



7. Conclusions

The increasing intensity of rainfall mainly due to climate change accompanied by land use change, particularly the expansion of urbanized areas and cultivation land at the expense of wood and shrub lands are the causes of potential generation of flash floods in the catchment. The

increased trend of sand deposition in the impact area and the conversion of marginal wood land areas to farmlands witnessed the increased rate of sediment transportation to downstream and this in turn has been responsible for rising of the river bed and also causing Dechatu River to burst its bank and flooded the residential areas.

Increasing population growth in the city especially as a result of high rate of migration; and lack of settlement space for the migrants has pushed them to occupy flood plain areas where increasing vulnerability to flood disaster is imminent. The migrants residing within the flooding zone accompanied by mushrooming of informal settlements are increased flood disaster vulnerability in the city.

Ethiopia lacks a comprehensive land use policy other than the water laws proclaimed in 1994. There is lack of land use policy in Ethiopia that prohibits farmers from using marginal land that are not suited for farming. Sustainable land use must be planned according to the land capability classification in order to realize the full productive potential of agricultural land. The current land use system results in deforestation, cultivation of steep slopes and intensification into flood plains which exacerbate flooding with its serious impacts.

The 2006 flood impact on the socio-economic sector of Dire Dawa was so severe that the extent of its impact is incomparable with other flood disasters occurred in the flooding history of Dire Dawa city. In the infrastructural sector floods caused severe damages on roads power and telephone transmission lines, and blocked the city's communication to other regions in the country. In the economic sector flooding impact was so severe that it damaged business centers; small market places with their properties which left property owners impoverish; damaged standing crops; drowned cattle.

The overall impact of the 2006 flood on the socio-economic sector of the city was exceptionally high compared to other periods of flood impact. Loss of more than 100 million Eth. Birr worth of property, of which individuals'

property is also significantly high and will take many years to recover. Moreover, the flood also appears to be having a long term impact on the Dire Dawa Administration economy due to the divergence of the government budget to reconstruction and rehabilitation.

Very poor and/or absence of flood early warning system is one of the major constraint of flood disaster mitigating effort in the city of Dire Dawa. The 2006 severe disaster is partly caused due to lack of warning alert that could awaken the community to evacuate to safer places.

The increasing trend of flooding impact on one hand particularly what has happened in the year 2006 and the lesser attention given particularly for non-structural measures indicates that floods and its massive disasters will continue to occur in the future and will cause even higher damages.

Generally, the 2006 flooding impact was so severe that it caused unprecedented damages on the socio-economic and infrastructural sectors of the city. The severity of the destruction is mainly due to:

- High intensity of rain that fell in the upland areas of the catchment in the 5th of August, 2006 - the flood hit the city in the middle of the night while people were in deep sleep
- Absence of early warning system in the city has hardly affected flood information transfer to the community, which is one of the major causes of increased death toll and property damages in the 2006 flooding.

Recommendations

Flood is a serious obstacle of the socio-economic development of the city of Dire Dawa. Every year large amount of property has been damaged by floods. One of the major causes of flooding in the city is related to land-use change. Therefore, Policy makers should give due consideration to the issue and ratify land-use policy. Land-use policy that regulates the allocation of land for appropriate activities is needed to minimize and avert abusive use of land and land based resources. Moreover, the land-use policy protects flood plains from being occupied by illegal settlers which affects the

morphology of the river and resulted in the occurrence of floods. Therefore, enactment of land-use policy will help to delineate the flooding zone and enables to create normal relationship between the River and the community.

A modality would need to be established to ensure communication linkages between *woreda* officials in highland areas receiving heavy rainfall and those downstream that are at risk of flooding. When intense flood-bearing rains fall in highland areas, concerned *woreda* officials would alert their downstream counterparts who in turn would alert the communities at risk. This method has proven successful in the case of limited number of people in the upland who used to alert their relatives in Dire Dawa during heavy rainfall in the upland (Kersa, Dengego, Kulubi and Alemaya) and able to save lives.

So as to apply this approach more effectively and widely, the MoWR should be involved and instruct and ensure that its river gauge observers or workers assigned especially in flood prone areas generate and provide high risk real time information on river levels and possible flooding threats to the local administrative authorities. Information to the people could be disseminated through electronic media. Moreover, the early warning information should also be equipped with placement of siren at essential corner of the city so as to alert the people in order to take necessary precaution when there is instance of flooding risk. To coordinate this activity and other issues related to flood disaster mitigation, there should be specifically setup body responsible for coordination of flood disaster mitigation task in Dire Dawa city.

Promote the implementation of community-based integrated watershed management between the upland part of neighboring regional states and Dire Dawa city administration. The Integrated Watershed Management minimizes soil loss through run-off and increases the ground water potential through increased infiltration and rehabilitates the degraded environment through reafforestation program. This in turn protects the potential risk of flooding in the downstream area.

References

Adikari Y., Yoshitani J., Takemoto N., and Chavoshian A., 2008, Technical Report on the Trends of Global Water-related Disasters, A revised and updated version of 2005 report. Public Work Research Institute. Tsukuba, Japan.

Adikari Y. and Yoshitani J., 2009, Global Trends in Water-Related Disasters: an insight for policy makers. UNESCO, 7place de Fontenoy, 75352 Paris, France.

Asian Development Bank, 2004, Disaster and Emergency
Assistance Policy.
http://www.adb.org/Documents/Policies/Disaster_Emergency/default.asp

Calder, Ian R. 1999. *The Blue Revolution, Land Use and Integrated Water Resources Management.* London: Earthscan publications Ltd.)

Dagnachew Legesse, Vallet-Coulomb, C. and Gasse, F. 2003. Hydrological response of a catchment and land use change in tropical Africa: Case study south central Ethiopia. *Journal of Hydrology* 275: 67-85.

Dire Dawa Administrative Council Rural Development Bureau, 2010. April 2010 Flood Impact assessment Report (un published document).

Disaster Prevention and Preparedness Commission, 2006, Dire Dawa flood Crisis, Consolidated appeal process.

Federal Disaster Prevention and Preparedness Agency, 2007, Regional summary of Multi-Agency Flood Impact assessment of 2006. Addis Ababa, Ethiopia

ICSU-Africa, 2007, Natural and human –induced hazard and disasters in Sub-Saharan Africa. http://www.icsu-africa.org/docs/DocSP03.1 .pdf

Integrated Development Plan(IDP), 2006, Integrated development plan of Dire Dawa Administration, 2006/7- 2010/ 2011. Berhanena Selam Printing Press, Addis Ababa, Ethiopia.

Ministry of Water Resources, Ethiopia, 2006, Oda-Gunufeta-Cherecha-Dechatu Watershed in Dire Dawa administration and East *Harerghie* zone-*Oromiya,* Integrated Watershed management. Term of Reference Draft.

UN-HABITAT, 2008, Dire Dawa Urban Profile, UNON, Publishing Services Section, Nairobi, Kenya.

UNCEF, 2006, UNICEF Humanitarian action ETHIOPIA Doners Update. http://www.unicef.org/videoaudio/PDFs/Ethiopia_DU_22_Dec_06_-rev.pdf

WMO and GWP, 2005, Associated program on Flood Management: Overview situation paper on flood management practices, edited by Technical Support Unit.

World Bank, 2003, *Building Safer Cities, the future of disaster risk.* Alcira, Margaret Arnold, and Anne Carlin (ed.). World Bank, 1818 H street NW, Washington, DC 20433, USA.

World Meteorological Organization, 2009, Guidelines on Analysis of Extremes in a changing climate in support of informed decisions for adaptation. Chairperson publications Board, Switzerland.

Yonas Tadesse; Derese Kumsa; W A Khan, 2013, Causes and Socio-Economic Impacts of Ephemeral Rivers Flooding, the Case of Dechatu River Flooding in Dire Dawa, Ethiopia (Un published document).