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THE ROLE OF COMMUNITY BASED WATERSHED MANAGEMENT FOR RURAL LIVELIHOOD IN WEREDA ADWA, CENTRAL TIGRAY ZONE

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ABSTRACT: *Currently, climate change and its impacts is a key issue in Ethiopia. Adaptation to climate change is making a system suitable to moderate the impact of climate change or deal with the consequence or to take advantage of new opportunities. In line with this, the research has assessed the role of watershed management for climate change adaptation in Adwa in the case of mariamshewito Watershed. To address the above objective, the study used both qualitative and quantitative data type. In order to collect valuable information, semi structured questionnaire, focus group discussion, key informant guide checklist and observation tools from both primary and secondary data sources were applied. Similarly, different statistical methods such as percentage of frequencies, bar graphs, X^2 test, independent and paired sample T-Test and one way ANOVAs were used. The key finding of the research presents that due to different interventions the livelihood of the community was diversified and enhanced especially; income, soil fertility, crop productivity, forest, water and food availability become improved. Even if it has some gaps in the process of implementation such as lack of linkage between sectors, lack of targeting on the poor, young and women participation, weak stakeholder linkage. It is concluded that the watershed management can play a significant role to enhance household's livelihood and cope with climate change impacts. Then, to fill the gap and go along the sustainability of the watershed, the study recommended based on the findings.*

KEYWORDS: Climate Change /variability/, Climate change Adaptation, Community based Watershed Management, Livelihood Diversification Index

INTRODUCTION

Ethiopia is one of the most vulnerable country to the adverse effects of climate change due to its geographical location, topography and heavily dependent on rain-fed agriculture, under-development of water resources, high population growth rate, low economic development level, inadequate road infrastructure in drought prone areas, weak institutions in combination with low adaptive capacity(NAPA, 2007).

Climate change is, unquestionably inducing changes to natural and social systems. The effects of these changes are already grave, and are growing further currently. The ongoing changes highly threaten human development for the world of poor and spreading to the entire world becoming long term dangers for all human beings (UNDP, 2007/2008).

Climate change influences the growth and development of Ethiopia through changes in agricultural productivity, water availability, road infrastructure maintenance and extreme events. To the amount that climate change reduces agricultural or hydropower output in a given year, it also reduces income and hence savings (EDRI, 2013).

Climate change causes an enormous challenge to Ethiopia's government and people. It has faced with increasingly erratic rains, and sometimes the complete failure of seasonal rains – problems linked to climate change. Consequently, millions of Ethiopians often face severe food scarcity (Kaur , 2013).

Statement of the problem

The application of community based watershed management (CBWM) is the most modern and recently developed method of land rehabilitation and climate change adaptation (Darghouth and others 2008). Watershed development planning in Ethiopia was started in the 1980's. Since then the government, nongovernmental organizations and local community efforts on rural development have been based on watershed development program.

Few complete studies however, examined the extent to which Community Based Watershed management interventions have resulted in the desired effects (e.g.P Pathak and others, 2007, Assefa,2011). Impact studies have showed that investments in watershed management in the developing world do pay off in economic terms (e.g., Holden and others 2005). However, such impact studies do not typically include detailed socio-economical components. Similarly, watershed management in Eastern Tigray has grown in recent years from more technical interventions to restore degraded lands. Monitoring of such interventions is critical since existing evaluation techniques do not represent realistic and local specific scenario.

The rationales for selection of the wereda: Firstly, the woreda was severely degraded woina dega (middle altitude) zone prone to frequent rain failure and unsuitable for crop cultivation. As a result the residents were vulnerable to climatic and market shocks. Despite of this, Community Based Watershed management (CBWM) is a widely implemented in the wereda. Yet, these management activities have not been documented. Moreover, impacts of these activities on climate change adaptation are also not evaluated.

Secondly, some necessary data were readily available.

Hence, this study was tried to fill the research gap by focusing on the assessment of watershed management contribution on climate change adaptation in Adwa wereda.

Objectives of the study

The primary objective of the research is to assess the role of community based watershed management for climate change adaptation, in the case of *Mariamshewito* watershed in Adwa. The specific objectives are to:

1. Assess climate variability in the study area
2. Assess household participation and management practices in the study area.
3. To analyze the contribution of watershed management for economic and social values of household.
4. To examine the contribution of watershed management for physical and hydrological environment.
5. To assess the impact of watershed management on female and marginal farmers.
6. Identify the major challenges in the implementation of the watershed management.

Description of the study Area

The scope of this paper has been limited to study the role of watershed management on climate change adaptation in Adwa, in the case of Mariamshewito watershed.

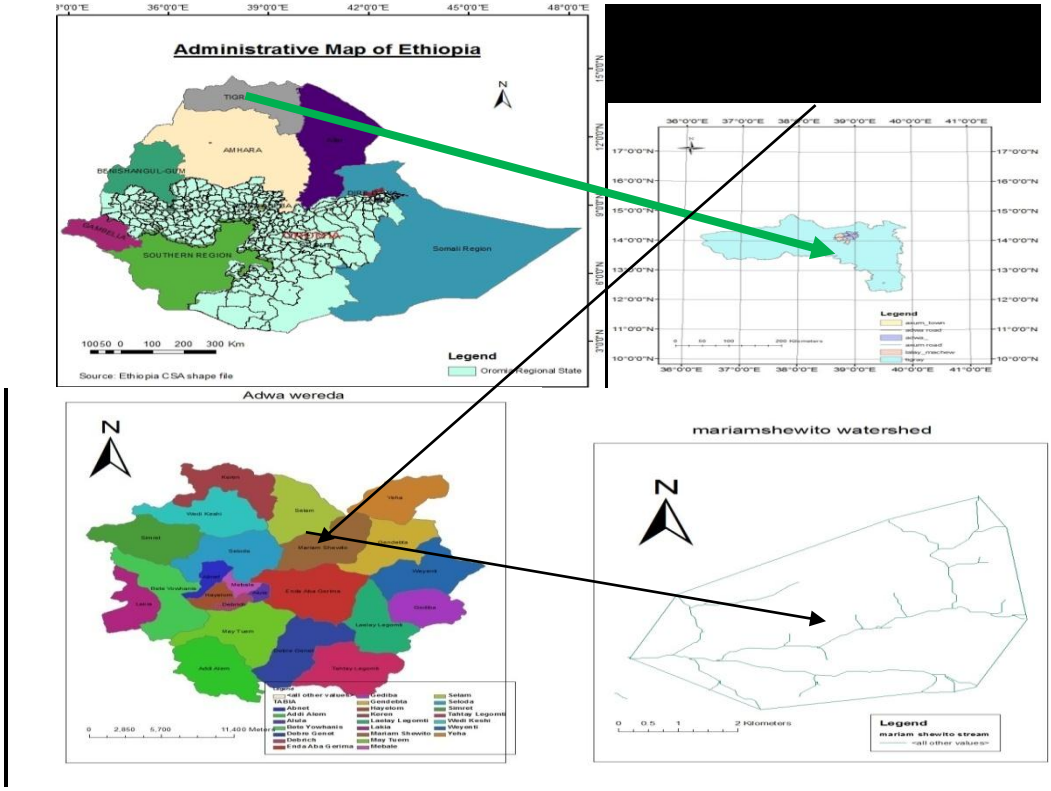


Fig.1. Map of the study area

Mariamshewito watershed is located in Adwa district, which is found in the Central Zone of the Tigray regional administration. Adwa is located some 1006kms away from Addis Ababa via Woldia-Mekelle road, in the extreme northern Ethiopia, within 14^0 15'N and 38^0 52'E geographically. Topographically, the woreda lies in midland with temperature 27, rainfall 600-850 and altitude 1890 m.a.s. The agro ecological zone of the woredais Weina-dega (Midland), and qola 63% and37% respectively.These altitudinal agro ecological belts are generallyaccepted as having land use forms suitable for crop cultivation of barley, Wheat, pulses, teff,maize and sorghum, as well as horticulture production of vegetables and fruits in the vast riverside valleys of the fertile low lands (Adwa wereda Agricultural office, 2014) .

METHODS AND MATERIAL

Research Design and sample frame

According to Dawson (2002) research design is the conceptual structure within which research would be conducted. Therefore, the researcher was used **cross sectional survey.** It assesses the overall activities at one shot.

Sample Frame

The sample frame of the study was peasant association list of households' roster.

Sampling Techniques and Sample Size

The study involved different sampling techniques. In order to select the study area and respondents for interview the researcher used purposive sampling method. Stratified sampling also used to categorize households to make comparative analyses among different groups in the community. First, categorical division is based on their wealth while the second extended category is within wealth category; there is also a need to address the gender balance in order to understand how both groups are contribute to and benefit from the management practices. After accomplishing the strata and having to the sampling frame, simple random sampling was implemented in each stratum to accomplish the whole process.

Sample Size

Care must be given to make the sample size of the study to be as representative as possible in accordance with the time and budget allocated. The rationale for deciding this sample size is based on factors like the homogeneity of population, cost of the survey, shortage of time, number of factors to be analyzed and the precision level required. The household number of the study area (mariamshewitokebele) is 1676, of which 1169 male, 507 female. Therefore, researcher was decided to select about 5% of each stratum that is 85. The sample size from each stratum was determined by using the disproportional sample selection.

Data Sources and Methods of Data Collection

The study was used both qualitative and quantitative data based on both primary and secondary data sources collected from different households, government offices and publications through survey, interview, Focus group discussion and reviewed documents. Besides, Maps and Satellite images were used to delineate the watershed using GIS tools.

Methods of Data Analysis and Presentation

Both quantitative and qualitative methods were used in analyzing the information collected using different instruments.

Qualitative data obtained using semi-structured questionnaire, interview, observations, FGD and document analysis were analyzed qualitatively using appropriate words. For quantitative data, descriptive statistics such as mean, percentages and frequency were employed to analyze the data gather. This study also follows a kind of comparative analysis among the different gender and wealth of the sample households using IBM-SPSS 20 package program. Statistical tests and measures of variation were also used to analyze the involvement of different groups of the local community on the watershed management practices.

RESULTS AND DISCUSSION

Watershed Management Practices in the Study Area

Since 1980, the government of Ethiopia was initiated watershed development to supported rural land rehabilitation, through well utilization and conservation natural resource (MOARD, 2005).

In Tigray, since the 1966, Farmers were familiar with traditional soil and water conservation practices in their day to day activities such as locally we call "Deret" that synonymous with 'grass strip' or 'soil bund'. But, their activities were not supported technically. However, currently technically supported physical and biological conservation measures were widely implemented to prevent soil erosion, land degradation and climatic hazards in the study area. The main purposes of mechanical/structural/physical soil and water conservation measures were to control the movement of water over the soil surface and limit its erosive capacity.

As the data from the farmers, the main physical conservation measures implemented in the study area were soil bund, deep trench, terraces, hill side terrace, haring bounce, half moon, gabion, gully cutting and stone bund.

Table 4.Types of physical soil and water conservations in the study area from 1997 -2005

Year	Type of SWC practices or activities										
	Stone bund in KM	Trench in KM	Trench bund	Hill side terraces in KM	Deep trench in KM	Bench terraces in M^3	Haring bonce in no	Half-moon in no	Eye borrow basin in no	Gabion	Gully cutting
1997	3	8	1	10.7	-	326	-	-	-	-	-
1998	11.26	15.4	1	17.58		4985	-	-	-	-	-
1999	16	29	17	11		2169	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-	-	-	-	-
2002	5.5	-	43.2	91.9	-	1063	4269	3229	-	-	-
2003	-	8.5	23	-	18.6	1464.5	-	8000	-	-	-
2004		17.0	28			1544		3009	2778	455	3250

Source: Natural resource development office, Adwa

Moreover, plantation of indigenous forest species is widely implemented in the study area. The number of indigenous forest species planted in the study area were increased from 8801 in 1996 to 344, 451 in 2004 and 65% of the area closure was cover by forest (Natural resource development office, Adwa, 2014).

Similarly, the various water harvesting structures constructed at mariamshewito watershed are check dam, shallow well Shallow excavation for household consumption, river diversion, motor pumping, tanker(vaska), percolation diet and spring development(see table5).

Table5. Water harvesting structures in the study area

No	Type of structure	No of structures
1	Check dam	24
2	Shallow well	430
3	River diversion	9
4	Motor pumping	60
5	Spring development	6
6	Vasca(Tanker)	2
7	Percolation diet (Horeye)	624

Source: Water resource development office, Adwa, 2014.

According to the data from the group discussants and interviewees, the above physical and biological soil and water conservation were implemented in private and communal land.

According to IPCC, 2001; IUCN, 2009; Kurukulasuriya and Mendelssohn 2008 as cited in Assefa, 2011, these above practices were considered as climate change adaptation mechanisms. Based on the data generated from the survey and different sources the local communities, the watershed communities were implemented the above adaptation mechanisms.

Watershed management cannot be achieved without the willingness of local people to participate (Pretty and Ward, 2001 as cited in Tadesse). According to the group discussants, the households were participated in the implementation of the conservation measures. They were contributing free labor yearly (20-40 days) on communal land management. In the survey, an effort was made to see the participation of households in soil and water conservation. According to the survey data, 78.8%, 60%, 65.9%, 76.5%, 72.6%, 83.5%, 70.6%, 82.4%, 56.5%, 35.3% and 83.5% of the households were implemented construction of soil bund and stone trace, using fuel saving stove, crop rotation, check dam construction, planting and protection of forest, gully reshaping, cut and carry system, grazing land rehabilitation, irrigation practices, using improved agricultural input, compost preparation and water development practices respectively.

Impact of Watershed Management on Economic, social and Environmental development

Considering the potential impacts of watershed management are indicates the watershed contribution to cope with climate change risks and hazards. Watershed management contributes to all sectors (agriculture such as crop production and livestock, water availability and quality, health, ecosystem service, socio economic and all human livelihood activities) directly or indirectly through chain reaction available between sectors (MOARD, 2005).

Impact on Crop Production and diversification

Crop is the most important source of household income in the study area. The main crops in the study area were teff, barely, wheat, maize and millet. 60%, 20% and 20% of the respondents revealed that crop was contributes 70%, 50%and 40% of their incomes respectively. This indicates that most of the households were dependent on crop production as primary source of their income. Due to the different watershed interventions the productivity of most of the crops were increased and in turn increased the household's income (see table 7).

Table7. Status of Crop production and income of sample households before and after watershed management

Before watershed management (1987)			**After watershed management(2005)**		
Crops	Average production in tone per year	Average Income	Crops	Average production in tone per year	Average income
Teff	0.08	1160	Teff	0.15	2175
Wheet	0.15	1200	Wheet	o.297	2376
Maize	0.10	570	Maize	0.05	285
Mustard(dagusha)	0.05	410	Mustard (dagusha)	0.075	615
Barly	0.025	250	Barly	0.045	450
Millet	-		Millet	0.055	412.5
Vegetable	-	400	Vegetables	-	1000
Total		3990		-	7313.5

Source: - survey, 2014

Note: - In all cases income is calculated by current price to avoid inflation effect.

Due to the different water harvesting structures, increased water availability and its proper utilization and other improved interventions during watershed program have increased growth rate of productivity resulting similar increase in area and production of important crops. The cropped area, productivity and production of important crops during the period of watershed development programs (1997 to 2006) in the village were increased. To examine the relevance of growth rate of variables the exponential trend, which is approximately best uniform rate of growth is used.

The survey indicates crop production were much higher after the intervention compared to before the intervention in the study area and average crop production and income of sampled households from crop production increased from 0.41 to 0.673 tone and 990 to 7313.5 birr respectively. According to the group discussants and interviews, the increasing in crop production and income were attributed to the watershed management activities like physical soil and water conservation which contributes to increased surface and groundwater availability, improved crop management practices like integrated nutrient and water management, integrated pest management and improved crop varieties adopted by the farmers in the watershed.

Crop diversification

Crop diversification not only provides a wider choice in production of various crops but also minimizes risk and increases profitability besides harnessing the maximum potential of land, water, human and climate. Most of the small and medium farmers are moving towards cash crops and short duration remunerative crops such as pigeonpea, groundnut, green gram, soybean and fodder sorghum. Various factors like increased availability of irrigation water, institutional and infrastructural development, adoption of Soil and water management technology, availability of improved varieties, availability of micro-financing and improved channel of rural marketing etc., are responsible for changes in crops and cropping pattern. Improved skills and awareness also aided to diversification of high value crops like vegetables,

etc. During watershed program about 45 ha was planted with various horticulture plants viz. mango, guava, lemon, sapota, orange and custard apple.

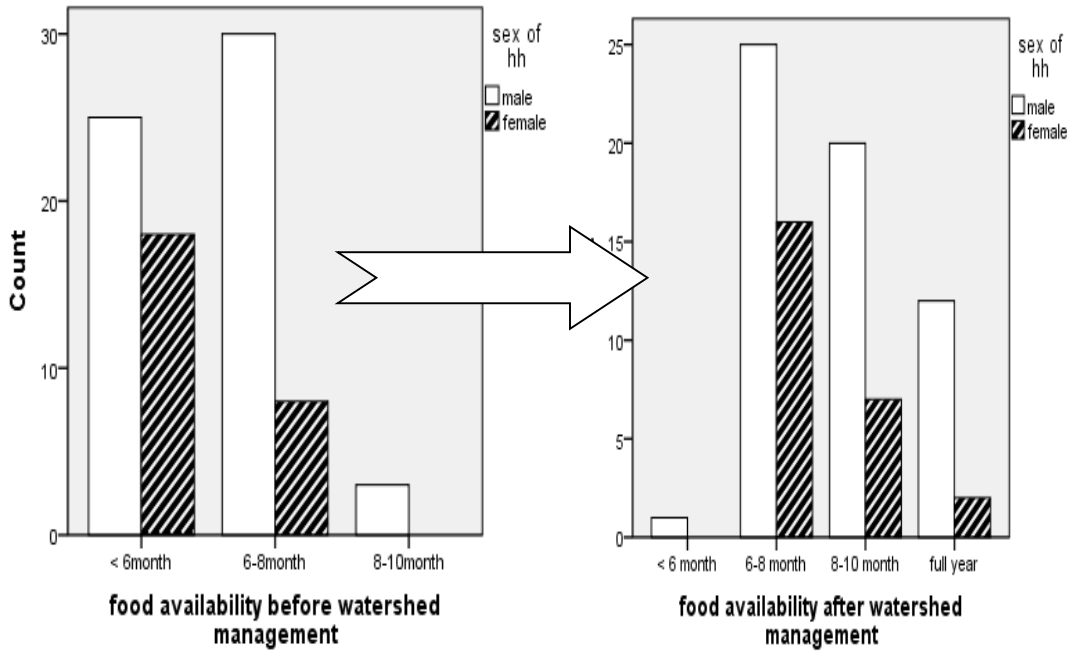
The crop diversification over period of time was measured using Simpson Index (1-ΣPi2), where Pi is the proportion of area under i^{th} crop. The higher diversity index indicates greater crop diversity in production pattern.

In the watershed, maize was the most diversified crop followed by wheat. The diversification index value of wheat has increased from 0.890 to 0.912 whereas for mustard it has gone up 0.854 to 0.923. The diversification index value of maize declined from 0.964 to 0.921. Other crops in the watershed show mixed influence of diversification and concentration.

Fig3. Crop diversification in the study area

Likewise, food availability of the households was improved due to the different conservation measures and application of improved agricultural inputs. As the survey data revealed, before the intervention 38.8%, 44.7%, 5.88% of the households harvest was able to cover the household's food demand for < 6, 6-8, 8-10 months respectively. This indicates that more than 80% of the households were covered their food demand for less than 10 months from their harvest.

However, after the intervention 3.5%, 48.2%, 31.8% and 28.2% of the households harvest was able to cover the household's food demand for < 6, 6-8, 8-10 months and full year respectively. This indicates that more than 60% of the households were covered their food demand for greater than 8 months from their harvesting.



Figer16. Food availability of sampled households before and after watershed management.

Source- household survey, 2014

Table16. Paired sample T-Test on household's food availability before and after watershed management.

Food availability before and after watershed		Paired Differences			t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean			
Pair 1	food availability before and after watershed	-1.131	.617	.067	-16.810	83	.000

Source: Own computation from household survey, 2014

This indicates that the difference in food availability from harvesting before and after watershed management is significant (p=.000).

From all these data, it is concluded that the implementation of watershed management enhanced the application of improved Agricultural inputs and in turn increased household's productivity, income and food availability. This finding was consistent with the study by the Global theme on Agriculture (2007) reported that watershed management in Gokulpura-Goverdhanpura, india, enhanced the productivity of most of the crops and provided more food, fodder and fuel security to the community. Due to watershed interventions, the per capita availability of cereals, pulses and vegetables increased per annum.

Impact on Livestock and Ruminant Production

Livestock is an integral part of the farming systems and they are particularly important for increasing the resilience of vulnerable poor people subjected to climatic and income shocks. This is possible through spreading risk and increasing assets. The loss of livestock, especially ox (bullock) is critical as it not only ruins the asset base, but also deprives the general productive capacity of the households.

Thus, the ownership of livestock is often used as an indicator for wealth and food security. The majority of sample households have different types of livestock. The major Livestock's inthe study area includes cattle, sheep, goats, donkeys, horses and poultry. Households' livestock ownership is measured by the average amount of Tropical Livestock Unit (TLU) (see table 17).

Table17. Distribution of the livestock population of sampled households

Before watershed management				**After watershed management**		
Livestock Species	No of livestock	TLU Conversion factor	Total TLU	No of livestock	TLU Conversion factor	Total TLU
Cow	85	1	85	76	1	76
Oxen	176	1	176	136	1	136
Sheep	300	0.13	39	248.3	0.13	32.28
Goats	270	0.13	35.1	189.93	0.13	24.7
Donkey	50	0.7	35	33	0.7	23
Horses	1	1.1	1.1	-	1.1	-
chicken	601	0.01	6	564	0.01	5.6
Total	-	-	377.2	-	-	297.58

Source: - Survey result, 2014

Watershed management has an impact on livestock size and type. From the survey, household size and type were decreased after watershed management. The total livestock of sampled households before and after intervention were 377.2 and 297.58 respectively. As the discussants and interviewees revealed, there were deceasing in livestock size and type due to food shortage as a result of the zero grazing. Almost all households have not own grazing land in the study area. The availability of communal grazing land after watershed management was decreased. Even though carry and cut system were used it is not sufficient. Many animals were died due to food shortage.

Saving

Saving is an assurance that households have to deal with, the difference in saving income and asset owned by household heads determine how far households can cope with the risk of climatic shocks. The amount of reserve that households have for the uncertain future reflect how much they have insurance in time of hazards, capacity to overcome adaptation barriers and degree of resilience. In view of that, average saving capability of households residing in the study area before and after watershed management is 1600 and 2001birr respectively. Even though, there had been some changes in saving capability of households residing in the study area before and after watershed management, the amount of saving is low. As households

replied low saving is due to large family size, small land size, low average income and frequent drought.

Total asset (money reserve, food and other equipment) owned by household heads also in a position of reducing vulnerability to climatic extremes as households are equipped with a means to cope with the expected or imminent climate related impacts. Large asset owners are not generally the most resilient but also the most susceptible to wider impact as compared to small asset owners. For example a household heads those keep large herds of cattle are being hardly vulnerable to the death of animal during prolonged drought which is frequent in current years.

Livelihood Diversification

Surface and groundwater availability increased due to the various water storage structures and biological and physical soil conservation resulted in increased cropping intensity and helped households to find new ways to raise incomes and reduce environmental risk. The watershed management helped households to diversify their livelihood activity.

Income or livelihood diversity is important to cope with climatic risks. If one income source were lost then still have other sources of income which make households and communities better able to cope during hazards and therefore make them resilient (Adger, 1998).

Livelihood diversification index in this research is based on the Simpson index of diversity (Nicholas et al., 2006) modified by researcher in a way to fit for data available.

$SID = 1 - \sum_{n=1}^{n} Pi^2$ ~Where, Pi is proportionate contribution of i-th activity to income of household. In this research data available is regarding a number of livelihood activities that households practice. For this reason the proportionate is the inverse of the number of livelihood activities reported by a household heads.

$$LDI = 1 - \frac{1}{\sum_{i=1}^{n} ki}$$ LDI- Livelihood diversification index

Ki- is the number of livelihood activities practiced by household head the value of LDI always falls between 0 and 1. As the number of livelihood activities increases, the inverse of livelihood activities practiced by households' decreases so that LDI approaches to 1. Accordingly, households with most diversified incomes will have the largest diversification index, and the less diversified incomes are associated with the smallest index.

The livelihood diversity index for each household heads before and after watershed intervention is calculated to see the intervention effect. It indicates that livelihood diversification is the highest after watershed intervention than before.

Table19. Mean and Standard deviation of households' livelihood diversification before and after watershed management

Sex of household	Livelihood diversification before WM			Livelihood diversification after WM		
	Mean	N	Std. Deviation	Mean	N	Std. Deviation
Male	.6629	59	.7573	.7573	59	.07448
Female	.6458	26	.7004	.7004	26	.09910
Total	.6576	85	.7399	.7399	85	.08631

Source: Own computation from household survey, 2014

The mean livelihood diversification of household heads before and after watershed management was 0.66 and 0.74 respectively. The researcher was nullified the hypotheses that there is difference in livelihood diversification of households before and after watershed management using the paired sample T-Test.

Table20. Paired sample T-Test on livelihood diversification of households before and after watershed management.

Crop diversification	**Mean**	**Std. Deviation**	**t**	**df**	**Sig (2-tailed)**
before and after WM	-.08224	.06992	-10.843	84	.000

Source: Own computation from household survey, 2014

The test result indicates that there is a significant difference in livelihood diversification of households before and after watershed management. The livelihood diversifications of household's were higher after watershed management than before the intervention.

According to the group discussants and interview, the different soil and water conservation practices were contributes farmers to engage in different activities such as bee-keeping, trade due the access of credit and irrigation etc. Accordingly, the changes in livelihood diversification were accredited to the soil and water conservation practices and application of improved agricultural inputs.

Even though there were improvements in livelihood diversification, it is different within the different wealth status. The researcher nullified the hypothesis that, there is a difference in livelihood diversification among the different wealth groups using one way ANOVA (see table.21)

Table21. One way ANOVA analysis of livelihood diversification by wealth status

Crop diversification before and after watershed management with different wealth status		Sum of Squares	df	Mean Square	F	Sig.
crop diversification after watershed management	Between Groups	.247	2	.124	26.81	.000
	Within Groups	.378	82	.005		
	Total	.626	84			
crop diversification before WM	Between Groups	.440	2	.220	42.06	.000
	Within Groups	.429	82	.005		
	Total	.870	84			

Source: Own computation from household survey, 2014

The difference of mean before and after intervention between wealth status is statistically significant at, *p*=.000 (F=42.061, df =2) and p=.000(F=26.809, df=2) respectively.This indicates an overall significant mean difference in livelihood diversification by wealth status before and after intervention. Therefore, needs to look the pair wise (Post Hoc) mean difference between dependent variable contrasting to each wealth status (poor, medium and better off).

As given in table 4.10 a significant difference were obtained between all wealth groups, between better off and poor, better-off and medium(p= 0.000) and poor and medium (p= 0.001).

Table 22. LSD Pair wise Post Hoc analysis livelihood diversification before and after intervention as dependent variable and wealth status as independent variable

Dependent Variable	(I) wealth status of household	(J) wealth status of household	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
crop diversification after watershed management	poor	medium	-.06536*	.01817	.001	-.1015	-.0292
		Better-off	-.13295*	.01817	.000	-.1691	-.0968
	medium	poor	.06536*	.01817	.001	.0292	.1015
		Better-off	-.06759*	.01784	.000	-.1031	-.0321
	Better-off	poor	.13295*	.01817	.000	.0968	.1691
		medium	.06759*	.01784	.000	.0321	.1031
crop diversification before WM	poor	medium	-.09802*	.01935	.000	-.1365	-.0595
		Better-off	-.17733*	.01935	.000	-.2158	-.1388
	medium	poor	.09802*	.01935	.000	.0595	.1365
		Better-off	-.07931*	.01900	.000	-.1171	-.0415
	Better-off	poor	.17733*	.01935	.000	.1388	.2158
		medium	.07931*	.01900	.000	.0415	.1171

*. The mean difference is significant at the 0.05 level.

Source: Own computation from household survey, 2014

Likewise, livelihood diversification was also different within the different gender households. The mean livelihood diversification for male and female households was .66 and .64 before intervention and .75 and .70 after intervention respectively. The livelihood diversification for male and female were increased by 0.9 and 0.6 respectively. The increasing in livelihood diversification was higher for male household heads than female household heads.

Likewise, the researcher nullified the hypothesis that, there is a difference in the livelihood diversification among the different gender groups using independent T-Test (see table23).

Table23. Independent T-Test analysis of fertilizer distribution by Gender group

Levene's Test for Equality of Variances between gender groups		t-test for Equality of Means								
		F	Sig.	t	df	Sig. (2-tailed	M D	SED	95% CID Lower	Upper
crop diversification before WM	Equal variances assumed	.272	.603	.615	82	.540	.01475	.0239	-.0329	.0624
	Equal variances not assumed			.630	50.992	.531	.01475	.0234	-.0323	.0617
crop diversification after watershed management	Equal variances assumed	4.758	.032	2.91	82	.005	.05703	.0196	.0180	.0960
	Equal variances not assumed			2.62	38.423	.013	.05703	.0217	.0129	.1011

Source: Own computation from household survey, 2014

The independent T-test result shows that there is no significant difference in mean between the groups before intervention, p=.603. But difference is significant after intervention p=.032.

Therefore, even though the different watershed intervention enhanced the livelihood diversification of the household in the study area, but not all households were benefited equally, especially poor and female households were less beneficiaries of the watershed. This is consistent with the study by Assefa(2011) reported that poor and female households in the Choke Mountain upper muga watershed in East Gojam of Ethiopia were less participant and beneficiary of the watershed.

Impact on Employment Opportunity and Migration

The different watershed management practices were provokes households with different employment opportunity. The farmers in the watershed are well organized and increased working duration as far as they are confluent to get good return. Households were involved in irrigation, trade and bee keeping activities and to start-up new businesses. Working culture of households was changed. For example, before the intervention households were harvest their land ones only before sowing but after intervention most of the households were harvesting minimum 3 times before sowing as a result the impact of pesticide were reduced. The involvement of households in different activities reduced household's migration in the study area.

The relationship between watershed management and migration were complex. The implementation of watershed management can affect migration through an increase in short-term employment as well as long-term productivity gains. Due to the different activities in the watershed management migration was reduced in the study area.

'tabia' which were justified that there had been an overall decrease in migration. Before the watershed management, due to the different environmental hazards, there were large migrations from the area.

QeshiTeferi is a farmer in mariamshewito
According to his view, from all his ten family members, 6 of them are males and he leave the area with 5 of his boy children, and went to the western Tigray such as humera, dansha and Adwa town for 11 years to lead their livelihoods by engaging in daily laborer.

But after the intervention migration was reduced and none of his family was migrated out due to livelihood diversification. He engaged in irrigation and bee keeping activities with his family and his livelihood were increased. This is consistent with the Study by the Global theme on Agriculture, 2007, reported that watershed Management in Gokulpura-Goverdhanpura, india were enabled to achieved high success in reducing the seasonal migration rates by providing better employment opportunities to the farmers in the village itself with satisfactory remunerative work.

Impact in Social Interaction

Enhancing Social network of households was also main objective of the watershed. The government introduced 1 to 5 household's network which have a great contribution to enhance household's social interaction and adoption of new technologies. This was worked on the assumption that if one farmer adopts a technology successfully, other farmers may learn the improvement from him/her, and share with others, thereby developing a multiplier effect Social network was from key farmers who acted as teachers or advisers to the other farmers. Likewise, the discussant and interviewees affirmed that this network improves household's participation in different activities by making competition each other.

Similarly, the female household discussants confirmed that the introduction of such networks provided us an opportunity to access information and exchange ideas and experience. Therefore, households and communities were better able to cope with climate hazards.

Climatic Hazards in the Watershed area after intervention

The data from the group discussion and interview indicates that due to the different interventions implemented, there had been improvements in resource management and utilization in the study area and in turn reduced the impacts of climatic hazards.

The survey indicates that 63.5% and 25.8%, of households consider drought as moderate and less severe in the study area after the intervention. Whereas, 5.5 and 5.2% of households as very severe and severe respectively. About 75.6% of households perceived the trend of drought decreased. Almost all households ranked the flood hazards after intervention as less severe and not severe and also perceived its trend as decreased almost all. 90% of respondents also perceive that the crop damage due to erratic rainfall is moderate to less severe. About frost and human disease about half of households reported as moderate and less severe (see table 2)

The survey indicates almost all households perceived the climatic hazards in the study area after intervention as moderate and less severe. As discussed earlier households perceived the impacts of climatic hazards before intervention as very sever and sever but after intervention seeming as moderate and less severe. From this it understood that the watershed management was great contribution to reduce impacts of climatic hazards.

Regarding to the status of main climate related hazards before and after the intervention was discussed by group discussants; all focus group discussions held assured that the impacts of main climate related disasters occurring in the study area i.e, drought due to longer dry spell, frost /cold/, hailstorm, land slide/erosion, spreading of alien weed species, rise in temperature, human disease, animal diseases, crop pests, flood were reduced due to the watershed interventions. This finding is consistent with Study by Assefa A., (2011), reported that the status of climate hazards like flood, drought, frost, soil erosion and landslide in Choke Mountain in East Gojjam of Ethiopia were reduced and in decreasing trend due to the various watershed management practices.

The physical soil and water conservation techniques were a greater contribution to increase fertility of cultivating land and crop production. Moreover, Marginal gully were changed into productive land. From the total 29.5km tributaries in the watershed 17.1 km were treated and become source of forage and food for both animals and human.

Before watershed management

After watershed management

Before watershed management

After watershed management

Figer20. Gully area changed in to productive land in mariamshewito watershed

Source- NR development office,Adwa,2014 *Source- Field photo, 2014*

Soil conservation practices can be effective in offsetting soil erosion and increasing productivity by reducing nutrient losses and conserving moisture when appropriately implemented.

From all discussions so far, it is generalized that there has been a significant improvement in crop productivity, food availability, water status, livelihood diversification, income, employment opportunity, social relationship, rehabilitation of degraded lands and reduction in migration and climatic hazards in the study area. These improvements were consistent with the Study for Ethiopia conducted by Assefa A. (2011) examined the role of watershed management for climate change adaptation which were found that as a result of the watershed management livelihood resources especially; income, soil fertility, land productivity, forest, water and food supply become improved. These all developments enable households to cope with climate change impacts.

Impact on Water Availability and Qualities

The major impact of watershed interventions was seen in improving the surface and groundwater availability. Increased water availability resulted in increased cropping intensity and diversification to more remunerative land use systems involving livestock, horticultural and vegetable production (ICRISAT, 2007).

In 1997, there were 227 open wells with low water yield, while in 2004 there were 430 open wells. In spite of 8% increase in the number of wells over the period of time; still there is a significant improvement both in terms of duration of water availability and the water yield from the wells. Before watershed interventions, only 88 wells used to have water for 8 to 12 months in a year whereas after the watershed interventions the well numbers increased to 187. Before the watershed interventions, 52 wells out of 227 were functional only for 1-4 months mainly during rainy season, whereas after the watershed interventions particularly due to the construction of WHS, majority of the seasonally functional wells have become functional throughout the year. Similarly, the mean depth of water column in the wells before the

watershed interventions was 4.5 m, compared to 9.5m after interventions (Fig. 10). There is a big increase (more than 100%) in mean depth of water column in wells after the watershed interventions. Particularly during post-rainy season, the depth of water column in wells increased substantially.

Moreover, according to the discussants and interviewees, the biological and physical soil and water management practices were great contribution to surface and ground water availability. There were problems of drinking water scarcity in the study area before watershed management. As a result, conflicts among the individuals were apparent for a long time in fetching water. Moreover, peoples were walk too long distance to fetch drinking water since the unimproved supplies often fail in the dry season. One of the most time consuming tasks of the households is the trip to reach the water source. According to the data from surveyed households before the intervention 70% of the respondent was required 50-60 minute to reach the nearest drinking water. On the other hand, 30% of the households were required 20-30 minutes to reach the nearest drinking water. However, after the intervention 75% and 25% of the households were required 10-15 minute and 20-25 minute to fetch drinking water respectively. Accordingly, the implementation of water harvesting structures were helped them to save their time and reduce their workload and water borne diseases. Communities were also affected with water borne diseases since they reliant on unimproved water sources such as ponds, small dugouts, streams and commonly shallow hand-dug wells before the intervention. The use of water from unprotected springs decreased greatly in the watershed as a consequence of the management activities. 70% of the surveyed households had access to tap water during project implementation. The source of the drinking water is the water that is pumped up from a well; this means that the water is filtered before entering the drinking water system. However, the usage decreased in the post implementation period because of poor construction, site selection and lack of follow-up.

Likewise, revealed that before intervention most of the households used drinking water from unprotected springs and rivers. Nevertheless, almost all households used from protected sources like tap water and in turn increased the household's health.

The existences of run-off for the construction of run-off harvesting structures at the hillsides and downstream of the water shed is enhanced. Since water harvesting structures at the watershed strongly design and implemented the ground water and surface water have developed. As a result that farmers implement supplementary irrigation practices by hand dug wells and others structures.

Irrigation together with adequate technological access makes households more resilient to climate change. According to group discussant and interviewee farmers, the implementation of soil conservation and water harvesting structures were significant contribution to increase access to irrigation. The irrigated land for vegetables doubled from 45 hectares to 524 hectares between 1997 and 2005 (See table 18).

Table18. Change in irrigated land size due to watershed management in mariamshewito

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Irrigated land in hectare	45	48	60.75	117.5	131	335.75	501.75	521	524

Source: - Adwa water development office, 2014

The data from the survey revealed that 56.5% of the households were practiced irrigation. Irrigation and the introduced packages led farmers to grow diverse spices, crops (like maize, and vegetables like cabbage, potatoes, onion and tomatoes during the dry season. Farmers' income from this activity tripled from 19,200 ETB to 48,000 ETB. This is income in addition to their traditional rain-fed farming during the rainy season. This change was consistent with the study by Kapse and Shinde (1999) indicated that various treatments carried out in the Nannaj villages of north Solapurtahsil helped to bring remarkable changes in the household's livelihood. The proportion of area under irrigation was increased by two and half times as a result beneficiaries could diversify their crop activity which resulted in increase in high value crop including fruits and vegetables.

Fig18. An irrigated plot in Mariamshewito watershed

Source: - Field photo, 2014

Water sources used for irrigation purpose were shallow well, ponds, check dam, vaska, tanker, percolation diet and small streams privately and communally owned, which have not constant flow. The method of irrigation practiced by most of the farmers was shallow well by means of motor pumping to irrigate their plot and the water is distributed to the users on a rotation basis. The households used to irrigate their parcel turn by turn in early morning after it collected tonight.

Besides, 64.7% of the households were used water lifting technologies for irrigation like motor pumping, Cama, sanbardino, rovan, lawinton and cangaro. Water lifting technologies utilization is considered as an advantage to boost food security in the area. The youth now transferred in to irrigation practice and they have motor pump through credit. The more the use of irrigation the more food secures likely and thus resilient households.

Impact on Female and Marginal Households

Enhancing female and marginal farmers were one of the objectives of watershed management. As discussed earlier the participation of female and marginal farmers in the implementation of climate change adaptation mechanisms and benefits from the different interventions were lower in the study area.

The discussion with the female households revealed that the main reason that female households were not participate well in the implementation of watershed were due to workload since they have internal (home) and external responsibilities and lower economic performance. Says that "***hade edi mis kiltie edi maere kiserih aykielin***" means one hand were not able to work with two hand.

Similarly, as discussed earlier, female households and marginal farmers were lower access to Agricultural access like fertilizer, improved seeds and other technologies like motor pumping in the study area. The provisions of these agricultural inputs in the study area were not considered the poor and female households rather focus on the general household interest.

As discussants from poor households, revealed the provisions of agricultural inputs were not consistent with the economic background of the households. For instant for the landless households forced to borrow bees or begait. So it is difficult to borrow begait for landless households due to zero grazing land. Instead, it is better when they provided with cash to introduce their own business.

Generally, the watershed performance in enhancing female and marginal farmer's livelihood were low even if some efforts were made.

Challenges in the Watershed management

According to the data from the group discussants and interviewees, the implementations of watershed management practices were faced with social, economic and natural limitations/ challenges. Accordingly, the major challenges in the watershed management were shortage of land, lack of awareness in resource management, disagreement between the households and local leaders, unwillingness of youngsters to participate in conservation practices due to landlessness, climate variability, lack of follow up, lack of knowledge and means of utilizing the available resource, water scarcity, low skill of using agricultural technologies and inputs, lack of integration between sectors.

A substantial proportion of farmers indicated that shortage of land and erodible nature of the soil, bare and steeply topography are the major challenges in the area. The rate of soil loss is very high and averagely 437.23 t/ha/year was lost. Farmers were not volunteers to implement soil and water conservation in their farmland since their farmland size was too small. Likewise, the farmers were also not interested to adapt improved seeds and fertilizers. Suggest that the distribution of fertilizers were not matched to the land size of households and in turn affects productivity.

Similarly, climate variability is also a major challenge in the study area. Shortage of natural rain fall strongly affects the successes of watershed management practices. For instant, some of the shallow wells (water tabs) were dried during the dry season and non-functional due to shortage of natural rain fall.

Another challenge in the implementation of the watershed was lack of awareness of households in the intervention. For instance, the communities were conflict with the guard hired to accessing the area closure. They tried to access the area closure at night time by hitting the guard. Trees planted in the area closure were cut illegally.

Similarly, lack of integration between sectors is also main challenge in watershed management. Sometimes programs are overlapped. Moreover, lack of technology, information and skills, infrastructure were also affects the watershed management implementation.

CONCLUSIONS AND RECOMMENDATIONS

The focus of this research was analyzing the role of community based watershed management to climate change adaptation in Adwa wereda mariamshewito watershed utilizing the data collected from 85 households randomly selected from mariamshewito kebeles.

The government together with NGOs and local communities perform many activities in the study area to support the local communities to cope with climate change, such as; Physical soil and water conservation measures such as soil bund, deep trench, terraces, hill side terrace, check dams, and water diversions, compost preparation (organic fertilizer compost and manure), dissemination of chemical fertilizer, aforestation, area closure protection and management, water management (water harvesting and groundwater recharging structures such as check dam, Shallow excavation for house hold consumption and irrigation, percolation tank, spring development, irrigation practices, cut and carry system as discussed in the above. Moreover, conserving and promoting of high yield local crop varieties, not only yield but also disease resistance, crop rotation, changing planting date, conserving indigenous forests species and awareness rising to conserve natural resources.

The different interventions were enabled to improve crop productivity, food availability, water status, livelihood diversification, income, employment opportunity, rehabilitation of degraded lands and reduction in migration and climatic hazards and in turn improved household's resilience to climate change in the study area. Moreover, the impacts of main climate related disasters occurring in the study area i.e, drought due to longer dry spell, flood, frost /cold/, hailstorm, land slide/erosion, spreading of alien weed species, rise in temperature, human disease, animal diseases and crop pests were generalized as less sever and not severe after the intervention. However in the implementation of such activities some challenges were facing such as shortage of land and natural rainfall variability, lack of follow up, lack of knowledge and means of utilizing the available resource, water scarcity, and low skill of using agricultural technologies and inputs, lack of integration between sectors.

Based on the finding of the study the following practical recommendations are pinpointed to overcome some of the constraints and maximize the benefits of the intervention following suggestions are provided on the basis of the finding.

- ☞ Marginal and female household's participation in the watershed management, access to different agricultural inputs as well as livelihood diversification was lower in the study area. Therefore, while watershed intervention implemented attention should be given to female and marginal farmers.

- ☞ Even though many interventions were implemented. Ones the interventions implemented cannot check whether these intervention are well functional or not, especially water harvesting structures. Many water harvesting structures (water tape) were poisoned and malfunctioned in the area which in turn affects the household's health. Therefore, investment in monitoring, follow up and continuous impact assessment of such interventions should be necessary.

- ☞ The communities were implemented the different management activities by afraid of penalty and conflict with the guard hired to accessing the area closure indirectly at night time by hitting the guard. Trees planted in the area closure were cut illegally. Therefore, the community participation should be based on consultative manner. This can be possible through community based training and awareness raising or providing tangible private economic benefits to individuals.

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