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The Role of Clean Development Mechanism on Social-Ecological Resilience, Humbo, Southern Ethiopia

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ABSTRACT

The study was conducted at Humbo district to assess the role of community assisted natural regeneration CDM project on for the social-ecological resilience. Total of 139 households were randomly selected from three representative kebeles. For this study, integrated qualitative and quantitative approach method was used that include key informant interviews, focus group discussion, and household survey. The quantitative data was subjected to SPSS v.20 for statistical analysis. Accordingly, major income sources for the surveyed households could be categorized into livestock production (29.1%), crop (42.9%), off-farm (17%) and non-farm (42.6%) such as petty trade, labour, and aid from safety-net program as income strategies. The results showed that majority of households (52.3%) depend on forest before the initiation of the A/R CDM project for firewood consumption, fodder for livestock as free grazing, timber for construction, and for charcoal making. Now days, majority of households (50%) shifted to manage private land as source of fodder and 15% of households forced to purchase from local suppliers that detrimentally affects the financial capital of those households. In contrast, A/R CDM project promoted tree plantations on own farms since 45.9% of households shifted to own woodlots for demand of firewood and supply of timber for the construction purposes. In turn, increased vegetation cover improved local microclimate against climate extremes.

Keywords: *CDM; climate variability; Humbo; livelihood strategies*

INTRODUCTION

In Ethiopia, forest resources play a significant role in the country's economy, particularly in the livelihood of rural people, as important sources of energy, food, employment, medicine, fodder and income (Alemayehu 2010; Yemiru et al. 2010; Aynalem 2012). For instance, according to a recent report by Hilawe et al. (2011), biomass energy (consisting of wood, charcoal and agricultural residues) provides 87.9% of the total energy consumed in the country. Apart from depending on forests and woodlands for domestic energy, studies (Kasahun 2008; Alemayehu 2010; Yemiru et al. 2010) undertaken in various parts of the country indicated that rural households engage in commercial supply of wood, charcoal, and other timber and non-timber forest products to urban areas to generate cash income thereby to support their livelihood.

Therefore, this informs that any conservation measure on forests need to take into account the undeniable linkage between forest resources and the livelihoods of poor people living in and around forests. Besides the significant role forests play as livelihood assets to rural people, currently their importance is further emphasized due to their key role in controlling and maintaining the stability, functioning, and sustainability of global ecosystems (Streck et al. 2008; World Bank 2008) in the face of frighteningly changing global climate. Forests serve as the world's most important terrestrial storehouses of carbon. However, in order to serve this function, the mature forests should be left intact (Streck et al. 2008). Therefore, these competing livelihood and conservational demands to forest resources have recently underlined the need to manage the forest resources sustainably in order to balance their utilization for both of the demands. Most of the developed countries have now committed to increased funding for carbon sequestration and protection of forest biodiversity in order to reduce emissions of greenhouse gases (World Bank 2008). Particularly, under Clean Development Mechanism (CDM) of Kyoto protocol on Green House Gas emission, investing in land and forest resources of

developing countries has received the attention of industrialized countries. Having twin objectives of reducing greenhouse gasses and promoting sustainable development in host countries, the CDM projects are being implemented in non-industrialized countries since 2005 (Maraseni, Cockfield and Apan 2005, Streck et al. 2008; UNFCCC 2010). In line with this, in 2006, Afforestation and Reforestation (A/R CDM) project has started its implementation in Humbo Woreda of Southern Ethiopia (WVE 2006; Brown et al. 2010). Initiated by World Vision Australia and World Vision Ethiopia, the initiative introduced a farmer-managed natural regeneration technique to restore the degraded natural forest and thereby to generate carbon credits. Consequently, the forestland that had long been an open access resource has become enclosed and protected (Aynalem 2012). Since the time of its introduction, the project managed to restore 2,728 hectare of degraded forest and thereby contributed to the reduction of greenhouse gases from the atmosphere (Brown et al. 2010). However, the project initiators hesitated a lot to investigate and disclose about another equally important goal of the initiative (i.e. its impact on the livelihoods of surrounding communities who used to depend on the forestland). In line with this, therefore, the current study was conducted to investigate the impact of A/R CDM the project on the livelihoods of local people socio-ecological resilience.

In spite of the widespread debate over the potential of CDM projects to achieve their sustainable development goals, as CDM pipeline shows, the number of A/R CDM project is rapidly increasing. The available scanty study on potential benefit of A/R CDM projects in Africa (Jindal et al. 2008) indicates that, in short run, the projects are less likely to benefit local communities and may even harm them by restricting access to natural resources and competing for scarce groundwater. In Ethiopia, too, studies on A/R CDM projects are very scanty. The available published study (Brown et al. 2010) indicated that Humbo A/R CDM project has managed to restore degraded forest through strategic replanting and protection and thereby managed to generate revenues from carbon sale. However, it did not touch the impact of the intervention on the livelihoods of households.

In a midterm evaluation report of the Humbo A/R CDM project, World Vision Australia (2011) reported protection and enhancement of biodiversity, reduced water and wind erosion, increased water supply, and returning of wild animals as major outcomes of the project. The report claims the establishment of local cooperatives, securing of user rights to cooperatives, and financial inflows from the sale of carbon stocks as social and economic benefits of the regeneration and protection of the degraded forest. However, the midterm evaluation report did not disclose how the surrounding communities cope with the loss of forest products caused by the sudden restrictions imposed by the project. Neither did it assess the impacts of the benefits claimed to be associated with the project on the livelihood assets of the households and communities participating in it.

Aynalem (2012) comprehensively revealed various factors influencing local people's access to the forest products and their bargaining power over the carbon revenue. In the study, Aynalem (2012) indicated that the decision to bring Humbo forestland under protection was made by political elites called up on by the project initiators. However, the impacts of the protection of the forestland and of the benefits claimed to be associated with the project on the livelihood assets of the surrounding households, their livelihood strategies and livelihood outcomes were not investigated in this study too. Decisions taken far from the site of local rural resources can have major impacts on the associated rural livelihoods (Dev et al. 2003, Homewood 2005). The costs incurred or the benefits enjoyed by a given community in turn significantly influences the way that community views and manages the natural resource under consideration. If the A/R project is perceived as being a barrier to local livelihoods, it may create an incentive for illegal harvesting and clearing of the forest and thereby threatening the sustainability of the forest and the permanence of carbon sequestration. Although the livelihood of local people affected by Humbo A/R project is an issue deserving investigation, the existing published studies overlooked it. Therefore, this study was conducted to fill the identified knowledge gap concerning the role of A/R CDM carbon sequestration project on social-ecological resilience.

Materials and Methods

Study Site Description

Humbo is located 397km southwest of the capital city Addis Ababa and one of the 12 rural districts in Wolaita Zone , southern Ethiopia

(Fekadu 2014). The Humbo town, capital of the district geographically located in approximate coordinates of 6°46'48.47" to 6°41'04.28"N latitude and 37°48'35.44" to 37°55'14.51"E longitude (Figure 1). The study site covers a total of 2,728 ha which is dominated by naturally regenerated vegetation (Negewo et al. 2016). The district has 36 kebeles out of which 35 is rural and 1 urban Administration covering a total land area of 97,363 ha (Gurmu 2006). Forest development cooperatives encompass seven rural kebeles namely Abela Gefeta, Abela Longena, Abela Shoya, Bola Wanche, Bosa Wanche, Hobicha Bada and Hobicha Bongota (Negewo et al. 2016). When considered in terms of agro climatic zones, 11.11% of the Woreda falls under highland (Dega), 28% falls under mid-highland (Woina-Dega) and the remaining 61% falls under lowland (Kolla). Mean annual temperature of the Woreda is 22ºC and mean annual rainfall is 1123.15mm. With regard to altitude, the largest mountain in the district is Solko Mountain which has a height of 2335m.a.s.l and the lowest area in the district is found in the south east along Lake Abaya, the largest rift valley lake, where altitude is less than 1100m.a.s.l (Fekadu 2014). The vegetation can be classified as the dry woodland forest type. It had been covered by dense broad-leaved vegetation types and montane forests before they were cleared around fifty years ago. Besides, Fabaceae and Combretaceae and Oleaceae were found to be the most species rich families in the area (Markos and Simon 2015).

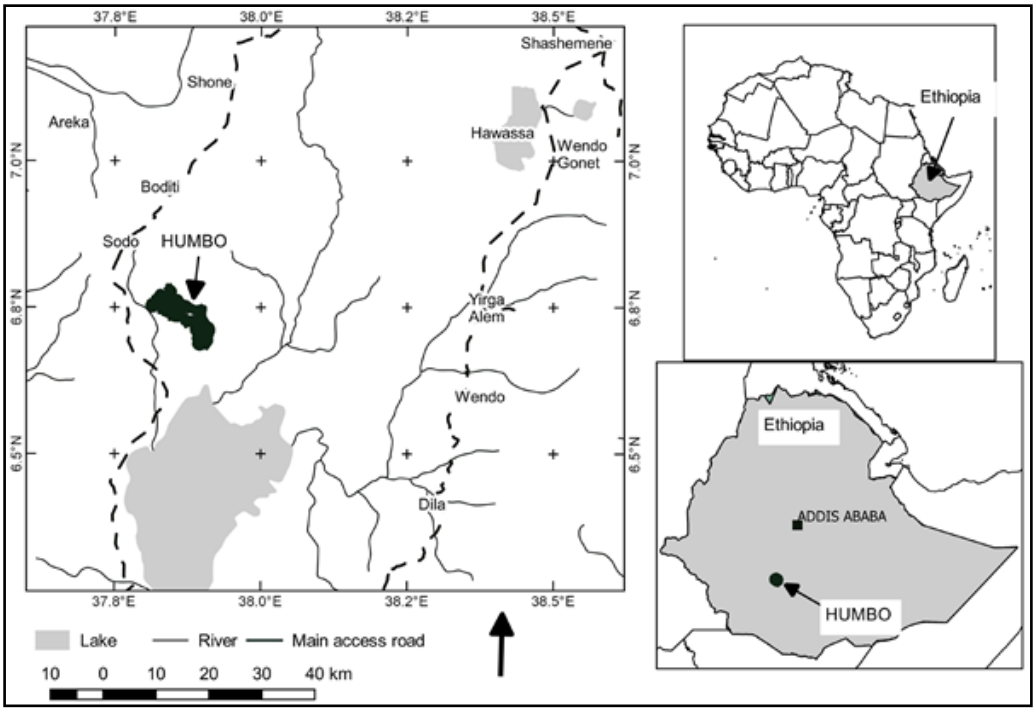

Figure1. *Map of study area (Negewo et al. 2016)*

Research Design and Sampling

This research has employed both quantitative and qualitative approaches based on primary and secondary sources by using household survey, key informant interview, focus group discussion, observation, case study and review of secondary sources. By considering time and logistic constraints into account, this study was employed a cross-sectional research design in order to get in-depth insight of the issues under consideration including quantitative and qualitative approaches of data collection. A cross sectional design entails a collection of data at a single point in time from a sample selected to describe some large population at that time (Bryman 2004). Since the aim of this study was a single-time description of the issue under investigation, cross sectional design was the most appropriate one (Fikedu 2014).

The sampling frame for survey included those households that are legally organized as forest development cooperatives to manage the forest of interest. A two stage sampling procedures was employed to select the sample households in the study area. In the first stage, three representative cooperatives out of seven was purposively selected on the basis of their accessibility and representativeness; Abela Longena, Hobicha Bada and Bosa Wanche. In the second stage, proportional sampling

technique was applied to draw samples from the population. Thus, 10 % of the households from each cooperative were included in the sample i.e. 51, 46 & 42 household heads were selected, respectively, from each cooperatives using systematic random sampling technique irrespective of their sex, social and economic status. This, thus, gave a total of 139 sample household heads for the survey (Negewo et al. 2016).

Data Collection Tools

Household survey was conducted to generate empirical data (qualitative and quantitative data) from randomly selected individual respondents. By this particular method 139 household heads were considered and interviewed as research subject from December 11-25, 2017 for the 10 days. A structured questionnaire that includes both close and open-ended was designed and employed to generate quantitative data from selected respondents. Pre-testing of questionnaire was conducted to see about inclusiveness, its validity, relevance and comprehensiveness. Based on the pre-testing feedback, final questionnaire was prepared and administered accordingly. Key informants are knowledgeable people who know about the study area. This data collection method was used to generate data from key informants concerning the impact of regeneration and other benefits associated with the project on community level assets. The key informants were selected purposively. Due to time and logistic constraints, three key informants were contacted from each executive committee of each Forest Development and Protection Cooperative (FDPC) and community elders. Nine key informants selected for the whole study.Focus group discussion is one of the most important research methods to get varieties of information from different segments of the community for qualitative data. Hence, a group interview was employed to generate qualitative data to supplement and substantiate data obtained from key informants.

In this particular research, due to time and logistic constraints, total of three focus group discussion was conducted with knowledgeable community members. Six persons was purposively/ systematic selected from each FDPC for group discussion that consisting of elders, youth, and women.

Data Analysis

Data that obtained through quantitative method; i.e., household data, was coded and entered into a Statistical Package for Social Science (SPSS ver. 20.0) for appropriate statistical analysis. Pearson's correlation also made to measure the association between independent and dependent variables. On other hands, the simple linear regression on the explanatory variables was run to identify the main factors that influenced household vulnerability to climate variability. Finally, the qualitative data gathered through key informant interviews and focus group discussions was narrated and interpreted on spot.

Results and Discussion

Demographic and Socio-Economic Characteristics

The socio-demographic information showed that majority of the sampled households (92.6%) were male-headed, while the rest were female-headed. This shows that male-headed households highly dominated the female-headed households in the surveyed area. The age distribution showed that the age of respondents ranged from 25-86 with more than half (52.5%) of the respondents falling in the age category of less than 18 years, about 19.9% in the age range of 19-29 years, about 17.3% in the age range of 30-40 years and the remaining 10.2% were 41 and above.

This shows that there is large age gap among the respondent household heads. However, on average respondents are in the productive age group. The mean family size of the surveyed households was 7.2±2.3 with minimum and maximum of 2 and 16, respectively. Educational status of individuals is an important component of human capital that influence the way people live and the world view of people concerning the surrounding environment. In this regard, the results showed that household heads have better penetration of formal education system. More than 35.8%, 38.8% and 11.9% of household heads in the studied community have access to attend the primary, secondary and tertiary level of education, respectively. The rest (13.4%) of interviewed household heads were not attended formal education. Regarding the context of the agricultural system, respondents mainly practice mixed agriculture incorporating crop production and livestock rearing. The results indicated that farmers grew diversity of cereal and perennial crops on their farmlands mainly maize, sorghum, teff, horicon beans, pigeon pea, coffee, inset and other root crops. On average, four types of crops (4.4±1.7) were cultivated per sampled households with maximum of eight. A

considerable proportion of the households are managing diverse livestock composition that have great role as a means of livelihood to households through provision of direct services. The mean livestock holding of the surveyed households was about 1.93±1.29 TLU with maximum of 5.02. Cattle, goat, sheep, and donkey were the major livestock species in the study areas. However, due to severe soil erosion, fragmented land size, and erratic rainfall, crop production has been negatively affected (WVE 2006; Bisrat 2011; Aynalem 2012).Both farm and grazing land are undeniably the most important assets of the households as overwhelming majority of the respondents reported farming as the main livelihood activity of their households. The results indicated that mean land holding size of the household was 0.89±0.7 with maximum of five hectare of land. This indicates that there is a severe shortage of agricultural land in the area though majorities of the respondents reported that their main livelihood activity is farming. The results indicated that major livelihood strategies include sole crop farming (21.5%); mixed agriculture (34.1%); crop, livestock and fuel (23.7%); labour (6.7%) and the other combination (12.5%) in the studied community (Figure 1).

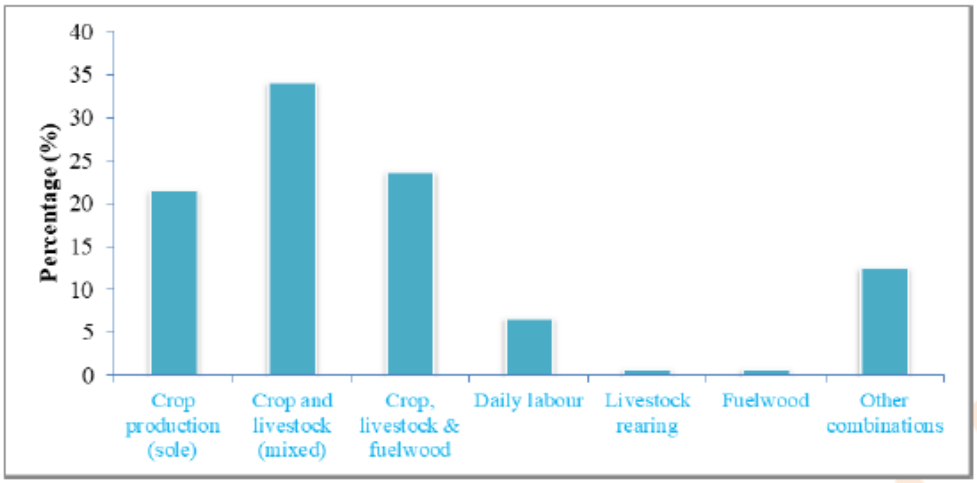

Figure2. *Livelihood characteristics of sampled respondents in study area*

According to the results, the main income sources for the surveyed households in the study area that could be categorized under livestock production (29.1%), crop production (42.9%), off-farm (17%) that mainly includes firewood sell, and non-farm (42.6%) such as petty trade, labour, and aid from safety-net program as income strategies. The average total annual income of sample households was 8,243.81 ETB (Figure 3). According to respondents' response (Figure 4), cost encored to satisfy the demand of household food consumption and purchase of livestock took lion-share with 4,056.8 (58.4 %) and 1,996.2 (28.7 %), respectively.

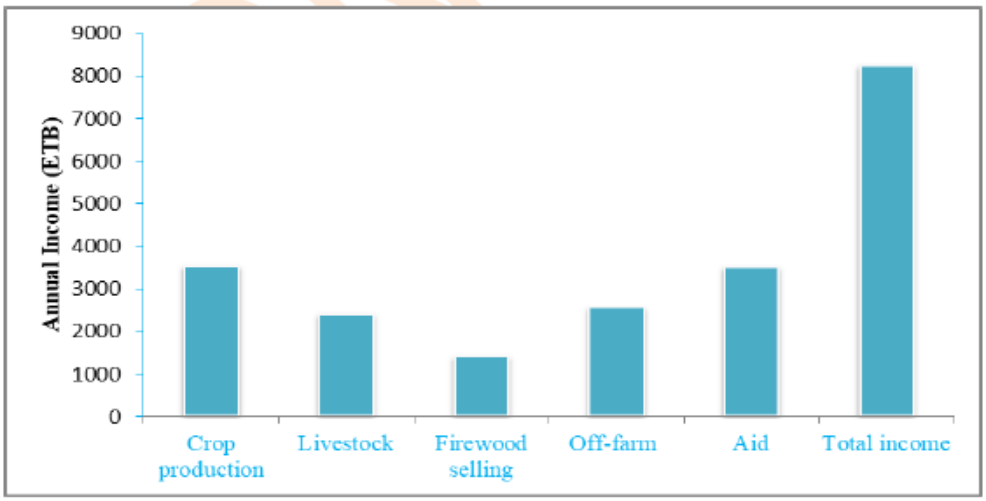

Figure3. *Major income sources of the sampled households in the study area*

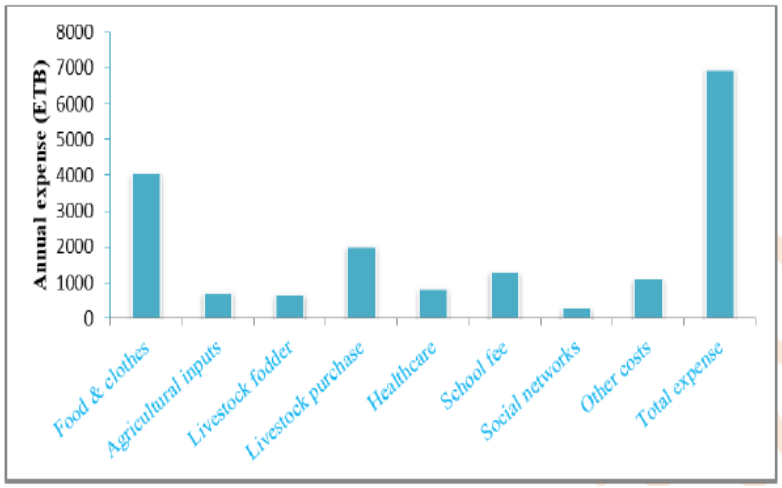

Figure4. *Major expenditure items of the sampled respondents in the study area*

Households' Perception on Climate Variability

The results indicated that almost all sampled households perceived the change on the climate variables in the area that challenged communities' livelihood in past three decades (Figure 8). About 72% of the surveyed farmers perceived decreasing local temperature due to A/R CDM project that contributed to increment of forest cover in the area, and 28% perceived increasing temperature over the past 20 years. About 74% of the farmers who claimed to have observed erratic nature of rainfall and 60% of the respondents experienced the shorter rainfall seasons over the past 20 years indicated that they need to have diversified adaptation measures.

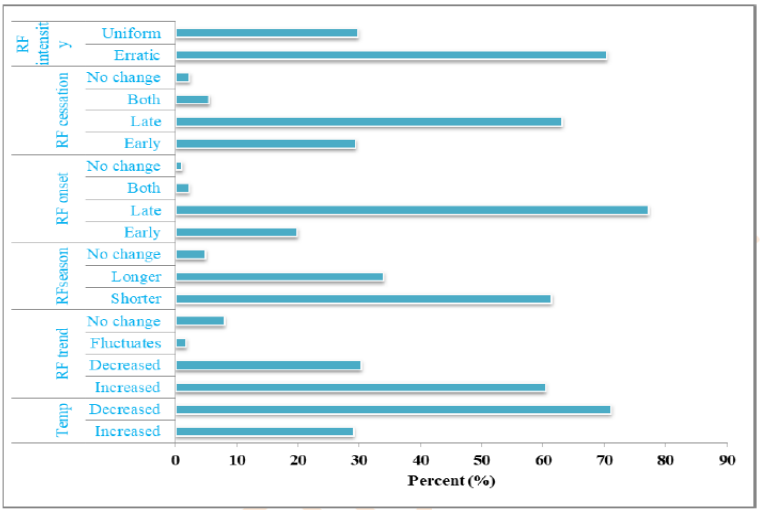

Figure5. *Households perception on trend of climate variables in study area*

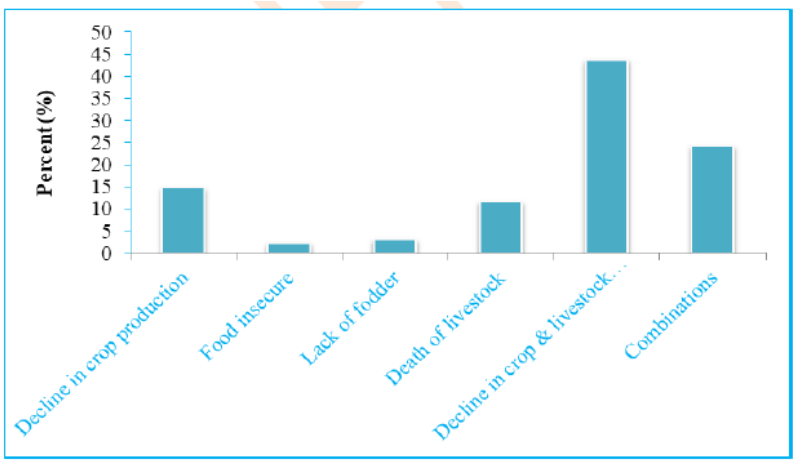

Figure6. *Impacts related to climate change and variability on livelihoods*

Humbo Woreda recurrently experiences food shortages. Poverty, hunger and increasing demand for agricultural land have driven local communities to over-exploit forest resources. Consequently, tree cutting for fuel-wood, charcoal making and construction material supply are livelihood activities of last resort that some people rely on to compensate periodical food shortages created by decline in agricultural production in the area over long period of time. Before the introduction of the A/R CDM project by World Vision Ethiopia, resource poor households in the area significantly relied on the forest in order to get some forest products for the aforementioned livelihood activities. In addition, such dependence on forest have aggravated by recurrent food insecurity that affects the inhabitants of the area (Elias 2006; WVE 2006; Fekadu 2014). Studies indicated that farmers perceive climate change and adapt to reduce the negative impacts (Mertz et al. 2009; Deressa et al. 2011). Further, the perception of climate change and taking adaptive measures are influenced by different socio-economic and environmental factors (Semenza et al. 2008; Deressa et al. 2011).

Impact of A/R CDM Project on Communities' Livelihoods

The results indicated that majorities (48.5%) of the respondents' homestead was located between 1 and 2 kilometre distance from the forest. On other hands, more than 27.6% of the households located within a kilometre distance from the forest and the remaining, 23.8% of them located 3 kilometres far from the forest. This shows that the overwhelming majority of the sample households were located in the close proximity of the forest under consideration. Before the introduction of A/R CDM project, majorities of the respondent households (71.3%) indicated that households' access to forest resources was limited so as to rehabilitate the degraded forest land. The results showed that more than half of the community (52.3%) depend on forestland as source of firewood, fodder for livestock as free grazing, timber for construction, and for charcoal making (Figure 5). This indicates that there existed a noticeable dependence of the surrounding households on the forestland.

Considerable change has been noticed in the households' dependence on the forestland after the introduction of the A/R CDM project to the area. The respondent households shift towards extraction of dead woods (40%), grass through cut-carry system (28%), medicinal plants (5.7%) and the rest (25.7%) of the community utilize the forest for combined products.

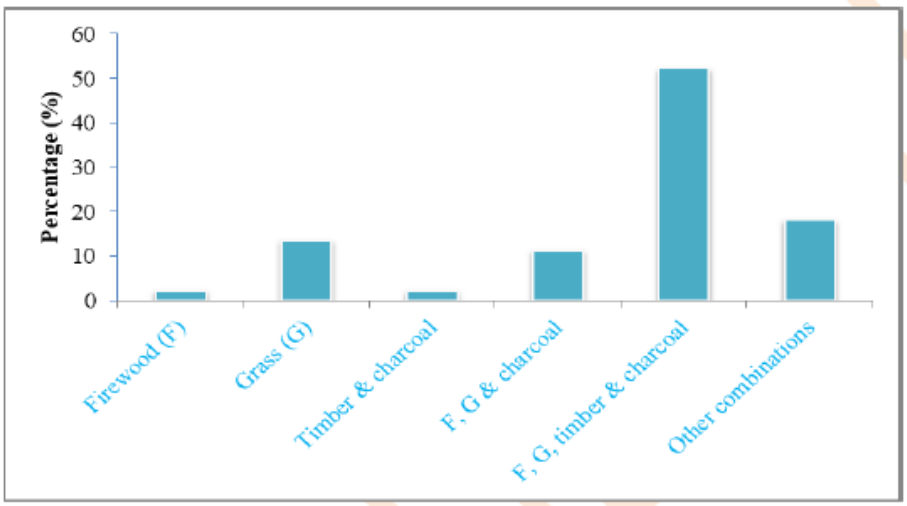

Figure7. *Types of forest products utilized before the CDM project establishment*

The results also showed that the nearby households and communities those have been extracting forest to support their livelihood shifted to other alternative sources (Figure 6). As a source of fodder for the livestock, 50% and 14.9% of the sampled households hold private grazing land and purchase from nearby farmers, respectively. Thus, the lack of own grazing land for noticeable number of households is perhaps one of the factors making the forestland important communal resource as livestock production is an important component of the main livelihood activity. On other hands, it made some households to incur additional cost in order to purchase fodder from local suppliers. This, in turn, detrimentally affects the financial capital of those households.

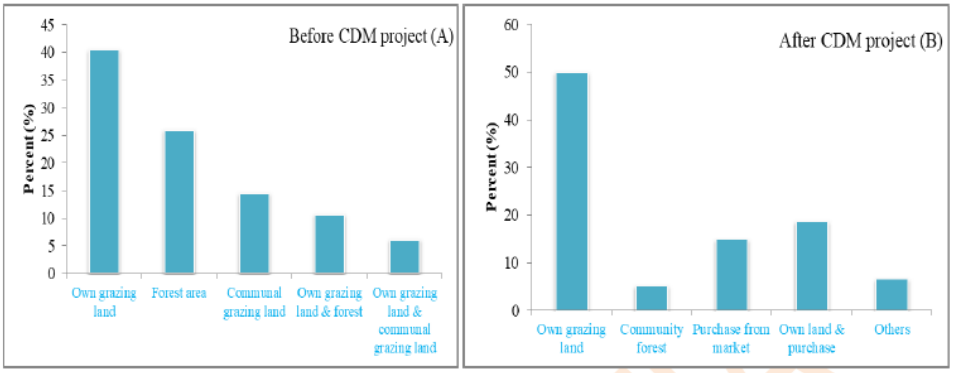

Figure8. *Households alternative sources of fodder before (A) and after (B) CDM project*

Majorities of the households (91.5%) indicated that A/R CDM project didn't improved access to satisfy the demand and supply of firewood. The reults showed that 45.9% of the sampled respondents depend on their own woodlots that encouraged the community to establish woodlots and plant trees around the farmlands (Figure 7). This could increased the vegetation cover of the area and contributed to improve the local microclimate against the climate extremes.

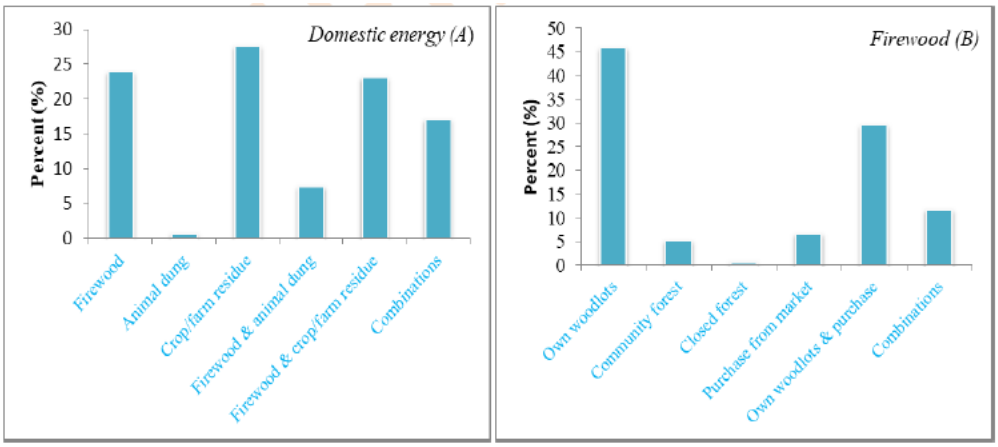

Figure9. *Households sources for the domestic energy (A) and firewood (B) demand*

The A/R CDM project created means of composation for income loss due to closure of the forest. The results showed that 10.7 % of the sampled households engaged on job opportunities created by the project including direct employement as coordinator, and guarding forest. In addition, more than 23.2% of interviewed households shifted their livelihood to labour sell and petty trade as source of alternative income source and 12.5% of respondents were supported by Safety net program. The rest 28.5% engaged in other income sources.

Households' Perception towards A/R CDM Project

The results indicated that majorities of the respondents (77.4%) have developed sense of forest ownership and reflected provision of continuous support in protection of regenerated forest with strong willingness to report any damage on the forest area. In other hands, more than 60% of the households showed that they support punishment imposed on illegal poachers and have willingness to protect the forest if supervision ceased in future (Table 4).

Table1. *Households' perception towards A/R CDM project in the study area*

Perception on A/R CDM project	Respondents (%)			
	Strong disagree	Disagree	Agree	Strongly agree
Sense of forest ownership	0.8	2.3	19.5	77.4
Providing continuous support in protection of forest land	0.7	2.2	19.4	77.6
Willingness to report damage on forest area	0.7	2.2	21.6	75.4
Supporting punishment imposed on illegal poachers	0.7	18.7	17.9	62.7
Looking for open access as it had been before the project	53.4	33.8	4.5	8.3
Willingness to protect the forest without supervision	0.8	2.5	34.7	61.9

On other hands, key informants and focus group discussion confirmed that due to Humbo community-based natural regeneration project, the rapid restoration of trees to hillsides reportedly contributed organic matter and mulch to the soils and the trees slowed rainwater runoff, helping water to percolate into the soil. Consequently, soil moisture retention increased and evapotranspiration decreased – increasing crop resistance to drought (Table 3).

Table2. *Social, environmental and economic benefits of A/R CDM project in the study area*

Social benefits	Environmental benefits	Economic benefits
- Builds collaboration, networks and partnerships - Fosters tree ownership and land tenure security for farmers - Increases empowerment for women - Increases food security, health and resilience - Improves the environmental comfort of rural communities	- Increases biodiversity - Reduces erosion - Enriches soils - Increases water availability - Reduces wind speed and extreme temperatures - Increases climate change adaptation and mitigation	- Increases incomes through improved crop yields - Increases incomes through sale of tree products - Offers new income opportunities via carbon credit revenues

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The environment is the foundation for food security. Rural populations in developing countries are heavily reliant on ecological resources from forests and savannah lands for food (in the form of tree products, wild animals and honey), medicinal resources and inputs (firewood, fodder and construction materials) (UNDP 2011). In Humbo, southern Ethiopia, during a project evaluation of a community-managed FMNR reforestation project, community members reported that, on hillsides where erosion was once a major problem, FMNR tree greening had reduced water and wind erosion and increased soil moisture as water percolated through the soils onto agricultural fields during heavy rainfall, instead of flooding down the hillsides (Kabore 2010).

Research by Brechears et al (2009) demonstrated that bare soils with little or no tree cover (commonly associated with conventional agriculture) have the highest vulnerability to topsoil loss from wind at 300 grams per square metre per day. Vulnerability decreases directly in proportion to the density of woody plant canopy cover and soil loss on farmed woodland is only 0.4 grams per square metre per day (Brenner 1996). Brennan (2006) found that the presence of trees in fields contributes to reducing wind speed, raising humidity and reducing leaf temperature of crops.

In terms of mitigation and economic regards, the Humbo community reforestation project in Ethiopia demonstrates the results that can be achieved from FMNR as a low-cost technique for carbon abatement. Between 2006 and 2011, 73,138 tonnes of CO2 was sequestered across 2,728 hectares, which is equal to an annual sequestration rate of 5.4 tonnes of CO2-e per year (UNFCC 2012). Over the 30 year life of the project, it is estimated that 880,296 tonnes of CO2-e will be sequestered by the project which is equal to 10.8 tonnes of CO2-e per year. Based on current growth rates the project is expected to achieve this level of abatement by 2036. The estimated abatement per hectare from this project compares well with figures quoted in the literature. Trees in forests (including plantations), if well stocked, typically sequester between 6.7 and 17.3 tonnes of CO2-e per hectare over a 30-year growth cycle (Australian Greenhouse Office 2001). The cost per tonne of CO2-e sequestered between 2006 and 2011 was calculated to be US$15.25. However, as the project will continue until 2036 and only around eight percent of total estimated abatement has been achieved to date, the cost is expected to decrease to approximately US$1.30 per tonne of CO2-e sequestered by the end of the project (Thomson 2014).

CONCLUSIONS

The finding of the study will have important policy relevance that could enable smallholder farmers in similar agro-ecology to better adapt to the effects of climate change and variability and to develop programs to strengthen the most vulnerable sectors. Therefore, integrating rural development schemes aimed at increasing adaptive capacity to climate variability and change is recommended to the range of climate extremes that they experience.

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