

**ADDIS ABABA UNIVERSITY  
COLLEGE OF DEVELOPMENT STUDIES  
CENTER FOR ENVIRONMENT AND DEVELOPMENT STUDIES**

**WATERSHED MANAGEMENT PRACTICES IN ENHANCING  
RESILIENCE CAPACITY OF FARMERS TO PERCEIVED CLIMATE  
CHANGE: THE CASE OF EMBA HSATY AND MEHAN WATERSHEDS,  
MICHEW ,TIGRAY REAGON**

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ADDIS ABABA, ETHIOPIA  
NOVEMBER, 2018**

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This is to certify that the thesis entitled “*Watershed Management Practices in Enhancing Resilience Capacity of Farmers to Perceived Climate Change: The Case of Emba Hsaty and Mehan Watersheds, Michew ,Tigray Reagon.*” submitted in partial fulfillment of the requirement for the degree of Master of Art in Environment and Sustainable Development from Addis Ababa University, and is a record of original research carried out by Bethelhem Habtom Id. N<sup>o</sup>. GSR/5258/09, under my supervision, and no part of the thesis has been submitted for any other Degree or Diploma. The assistance and help received during the courses of this investigation have been duly acknowledged. Therefore, I recommended that it be accepted as fulfilling the thesis requirement.

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## ***Abstract***

*Watershed Management Practices in Enhancing Resilience Capacity of farmers to Perceived Climate Change: the case of Emba Hasty and Mehan Watersheds, Tigray Region* this thesis identified how watershed management improves the livelihood of the households and also benefits the ecosystem for the changing climate. Using both probability and non-probability and simple random sampling method the data for the study was collected through a survey of 290 households, two focus group discussions, and 12 key informant interviews. Binary logistic model is used to examine communities' perception towards climate change, climate variability, to investigate watershed management practices in enhancing household resilience capacities in the face of changing climate, to evaluate the socio-economic outcome of watershed management practices. The finding shows that the overall temperature and over all rainfall has change. There is low rainfall, temperature has increased, early cessation of rainfall has increased, floods and drought have become more frequent owing to a number of factors that derive from both climatic and topographic conditions. Access and use of livelihood resources such as family size, total income, training, off farm activity, saving and experience in natural shock were found to be the most important factors that determine the community's resilience capacity of households. Economic instruments are likely to be more effective if they are combined with education and awareness building activities, and participation by affected people, for example through watershed management. Successful mechanisms have evolved from a narrow to a comprehensive focus or from management of a water source to the whole catchment area. This implies that policy should focus more on addressing the factors that expose people to climate change impacts and shape their resilience capacity, rather than focusing on short-term emergency responses.

*Key words: Climate Change Impact, Watershed Management, Resilience Capacity, Binary logistic model and Emba Hasy and Mehan watershed*

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Appendix I: Qualitative tools

## **List of Abbreviations**

EPA	Environmental Protection Agency
EPCC	Ethiopian Panel on Climate Change
FAO	Food and Agricultural Organization
IPCC	Intergovernmental; Panel on Climate Change
MOARD	Ministry of Agriculture and Rural Development
PWDP	Participatory watershed development plan
SEM	Socio Ecological Model
UNDP	United Nations development program
WFF	Work for Food
WMO	World Meteorological Organization
OLS	Ordinal Least Square

## **CHAPTER ONE: INTRODUCTION**

### **1.1. Background of the study**

Climate change is real, and its first impacts are already being felt. Global surface temperature has increased 0.8 °C during the past century; three-fourth of this increase occurred in the last three decades (IPCC, 2007; Hansen et al., 2008). In this regard, Bates et al. (2008) describes the best estimate linear trend in global surface temperature from 1906 to 2005 is a warming of 0.74°C (likely range 0.56 to 0.92°C), with a more rapid warming trend over the past 50 years. The recent IPCC projection states that changing climatic variability will possibly result in more extreme events including, flooding and drought (IPCC, 2014), which indicates to the negative impacts of climate trends have been more common than positive ones (IPCC, 2013).

Reviews from various climate models and emissions forecasts predicted warming of 1.2 °C in 2020s in all four seasons across the country (Conway et al., 2007). It is projected that Ethiopia's mean temperature will increase 1.7–2.1 °C by 2050 (EPA, 2012). Ethiopia is mostly vulnerable to climate change and variability events and suffers from associated risks (EPCC, 2015). These frequent rainfall failures resulted in loss of crops and livestock, which in turn contributed to food insecurity in various parts of the country (EPCC, 2015; Savage et al., 2015). It is projected that Ethiopia will face serious and negative impacts resulting from changing climate patterns in the future (Savage et al., 2015).

Similarly, Tigray Regional State is one of the most vulnerable regions in Ethiopia. In this regard, it has been observed that rainfall trend in Ethiopia during the last half a century significantly reduced towards North (NMSA, 2001; Gebrehiwot et al., 2011; Gebrehiwot and van der Veen, 2013). Ethiopia has a history of watershed management scheme dating back to the 1970s. Evidence suggests that Ethiopia has not yet achieved the full potential of its surface and groundwater resources. Watershed management programs based on lessons learned over the past several decades offer new opportunities to reduce farmers' dependence on rain-fed, low-productivity subsistence agriculture, reverse land degradation and increase the level of water use and local participation in water management. In view of this, recurrent humanitarian crises in parts of Africa together with accentuated climatic shocks resulting from climate change and increased geopolitical instability changed the conventional wisdom on humanitarian assistance (Hoddinott, 2014).

Although different definitions exist, in the context of climate change, the concept of resilience is viewed as the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner (IPCC, 2012).

Vis-à-vis the causes of climate change, most of the smallholder farmers perceived supernatural forces as cause of climate change farmers often referred to the Bible arguing that disobedience of humankind to God's principles and/or lack of respect to ancestral spirits and other customs caused climate change. The second most common set of causes was associated with environmental explanations that identified deforestation, pollution from industries and modernization as causes of climate change. Watershed planning and development is a vigorous necessity in complex landscapes. Interactions, between and within, communities depend on what happens at different levels of the watershed. Watershed moved away from conventional land use-planning exercise to a logical interpretation of the potentials of the land as a function of the needs, demands for and aims of the people living in the watersheds, including the interactions between people's activities and the natural resources. watershed planning is thus the key to understand what is needed to be done at various levels to sustain, improve and diversify production while developing and managing the natural resource base, promote income generation opportunities, increase access to basic social services and make livelihood systems resilient to shocks (Desta et al., 2005). Watershed management benefits to households are improved water availability, improved soil quality and better drainage, increased access to biomass for multipurpose use and higher profits, increased resilience to shocks and improved livelihoods and increased participation in income generation activities (MoARD, 2005).

Watershed management benefit the local community through the reduction of erosion, deforestation, flooding and waterlogging, increased the overall agricultural productivity and access to markets and basic services improved livelihood options, including for the poorest households, a more dependable, clean water supply for domestic and industrial use. Watershed management benefits to the society at large is the better conservation of natural resources and biodiversity, less danger from floods to downstream farmlands and protection of major infrastructure, increased water supply and improved health, reduced occurrence of drought and stable production (MoARD, 2005).

Resilience capacity depends on time and event. The outcome that resilience capacities have on well-being in the face of shocks can be found by computing well-being previously and after a shock. Factors such as the location of a population or the type of livelihood group affect both the probability of being exposed to a shock and the capacities a population has available to absorb, adapt, or transform in the face of shocks. In response to this, these study explored watershed management practices enhancing resilience capacity to perceived climate change: the case of watersheds, Miychew Wereda, Northern Ethiopia.

## **1.2. Statement of the problem**

Ethiopia is a country of an agrarian economy characterized by high population growth, huge dependence on erratic rainfall, low agricultural productivity, structural bottlenecks, and land-locked-ness (MoFED, 2013). In Ethiopia, over 80% of the population lives in rural areas, where most of the households earn merger income from the subsistence agriculture, which is again highly susceptible to shocks such as drought, flooding and disease outbreaks (MoFED, 2014). More recently, Ethiopia faced a severe food insecurity problem, due to El Niño-induced severe drought, which is the highest on record and affected an estimated 10.2 million people (FAO, 2016).

Climate change could cause serious deterioration to rural livelihoods and increase food insecurity. This is mainly due to climate change threatens to exacerbate existing threats to food security and livelihoods due to a combination of factors that include the increasing frequency and intensity of climate hazards, diminishing agricultural yields and reduced production in vulnerable regions, rising health and sanitation risks, increasing water scarcity, and intensifying conflicts over scarce resources, which would lead to new humanitarian crises as well as increasing displacement (IPCC, 2007; Ringer et al, 2010).

In Ethiopia, agriculture is heavily dependent on rain. Its geographical location and topography, plus a low adaptive capacity, make the country highly vulnerable to the adverse impacts of climate change. For Ethiopia climate change generates various kinds of risks that would affect all sectors in the country. For instance, agriculture, water supply, hydropower production, economic and social infrastructure, health and biodiversity are the sectors primarily affected with stronger secondary downstream impact to all sectors of the economy and the society (UNDP, 2011). In Tigray, regional state, the livelihood is dominated by small-scale mixed crop-livestock production with very low

productivity. Farmer's understanding of the climate change experience demonstrates that small-scale farmers are not so much bothered by questions related to cause and effect, but rely more on their own perception and awareness of changes, specifically of the season to season variations.

So far, some attempts have been made to document on the climate change and variability related issues in Tigray Regional State. These studies include Maxwell et al., (2013) resilience, food security dynamics, and poverty traps in Northern Ethiopia and evidence of climate variability; Gebrehiwot (2013) investigated the impact of climate change on crop production and productivity in Tigray, Gebre (2014) analyzed the observed changes and future adaptation options; and recently Kiros et al., (2017) analyzed the extreme rainfall signatures under changing climate in semi-arid of northern Ethiopia. Even through the empirical studies were comprehensive in terms of methodology applied, data used and level of analysis, the available studies focus more on regional and sub-regional scales with emphasis on livelihood resilience, food security, poverty, and rainfall and temperature variability.

However, findings from these studies may not explain the reality in the study area context. Moreover, the earlier studies have not looked into the interconnections between climate change resilience and watershed management, which is the focus on this study. This is because; climate change is a global phenomenon while adaptation is largely site-specific. A common disadvantage for local coping strategies is that they are often not documented, but rather handed down through oral history and local expertise. To this end, research on various climate resilience and adaptation strategies need to be undertaken because as site-specific issues require site-specific knowledge. Therefore, this study considers the micro level reality by combining the climate change resilience and watersheds management, which may help to develop context specific adaptation strategies for resource dependent and vulnerable farming communities in watersheds, Miychew *Wereda*, Northern Ethiopia.

### **1.3. Objective of the study**

#### **1.3.1. General objective**

The general objective of this study is to explore watershed management practices in enhancing resilience capacity to perceived climate change: The Case of Watershed Management on, Miychew *Wereda* Northern Ethiopia.

#### **1.3.2. Specific objectives**

The study aims to meet the following specific objectives:

- To detect/examine climate change in the area
- examine communities' perception towards climate change, climate variability and watershed management in the study area;
- To investigate watershed management practices in enhancing household resilience capacities in the face of changing climate;
- To evaluate the socio-economic benefits of watershed management practices.

### **1.4. Significance of the study**

The study result shows how watershed management helps the community in building resilience to climate change impacts. The study outputs may suggest to design community resilience building schemes, help the local level institutions on various strategies that can be adapted to help the community and the wider environment to anticipate, adapt and transform from the impacts of climate change and variability. It will serve as a reference document for some other similar studies to be carried out in the study area context and others.

### **1.5. Scope and limitation of the study**

The study was conducted with the focus on watershed management practices in enhancing resilience capacity to perceived climate change, particularly Watersheds in Miychew woreda. It also emphasised on the socio-economic outcome of watershed management in the study area context. On the other hand, one of the major limitation of this study was lack of adequate climate data on maximum, minimum and total rainfall over three decades to complement farmers' perception to climate change and variability through trend analysis, however, the data was full of missing values and forced to capture the first objective only through the household survey. The other limitation was the time and financial challenge, which remain a major bottleneck to undertake the household

survey among the selected kebeles. Regardless of this, the researcher tried all her level best to achieve the study objectives employing different strategies.

### **1.6. Ethical consideration**

The research was conducted using delicate research ethics. To request permission from concerned body, official letter from the College of Development Studies, Centre for Environment and Sustainable Development, Addis Ababa University was used. After receiving the permission, the study was conducted by taking the participants consent by explaining the objective of the study and the data gathered from them was kept confidential.

### **1.7 Organization of the paper**

This paper is organized into five sections. The first section is given to present the introduction where, it highlights on background to the study, statement of the problem, objectives of the study, scope and organization of the study. Part two emphasis on review of relevant literature, basic concepts related to the topic of study, and conceptual framework upon which the study is embedded. Part three emphasizes mainly on the broader methodological approaches, focusing on description of the study area, research design and justifications, sampling techniques and sample size, sources and types of data, instruments of data collection, and methods of data analysis. Section four presents result and discussion and the last section focusses on conclusions and recommendations.

## **CHAPTER TWO: REVIEW OF RELATED LITERATURE**

### **2.1. Concepts and definitions**

Although there is no clear-cut definition for concepts such as climate change and climate variability exist, WMO define climate as the “average weather” or more rigorously as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period is 30 years (WMO, 2007). IPCC defines climate change as a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (IPCC, 2007). The same source indicated that the changes in the climate are attributed to natural internal processes or external forcing or to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2007). Similarly, climate variability is defined as the variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events (IPCC, 2007). In this study, the definitions given by WMO and IPCC to climate change and climate variability are adopted as the operational definitions.

The concept of watershed viewed differently in different contexts such as, Watershed (USA) and drainage basin (USA), catchments (British) and drainage area in other settings. Hence, the concept can be stated that watershed/drainage basin/is an area drained by a stream of/or a system of connecting streams in such a way that all flow originating in that area. As Chow cited by Nigussie (2008) noted that watershed is a divide distinguishing one drainage basin from another. It is also seen a geographical unit in which the hydrological cycle is complete and its components can be characterized. Thus, the geographical unit is one of the possible intervention points for sustainable land management where monitoring and impact assessment for sustainable land management can be addressed. The same source indicated that watersheds can be further classified based on size into three categories, namely, major watersheds, medium watersheds, and sub-watersheds (Nigussie, 2008). The major watersheds are the tributaries to river basins and these may cover an area of land which range from 20,000 to 500,000 hectares of land. The medium watersheds are areas of land which shows a similar ecological setting with in it and the size that ranges from 5000-20,000 hectares. The last category, the sub-watersheds consists of the land area with the size less than <5000 hectares of land (Nigussie, 2008). The last watershed group can simply be applied for a

detailed development plan that may include a very detailed work plan thereby soil and water conservation measures, afforestation programs, forage and pasture management plans can be implemented.

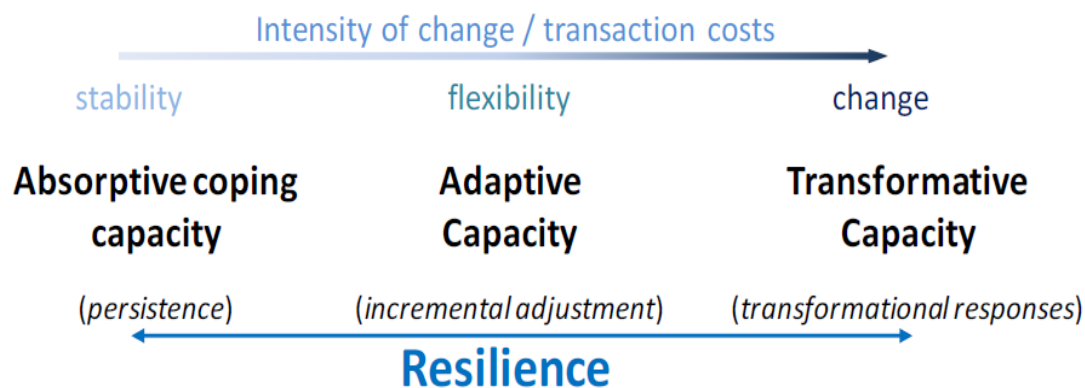
The term resilience is derived from the Latin word *resilire*, which means “to rebound or recoil.” (Hoddinott, 2014). Even though the concept of resilience has been applied in various fields such as, engineering, ecology, and psychology, very recently resilience has become widely used by humanitarian and development actors working across diverse thematic areas such as, disaster risk reduction, climate change, urban planning, ecosystem management, peace-building, and food and nutrition security (Béné et al., 2012; Frankenberg, 2012; Constan and Barrett, 2013; Hoddinott, 2014). Due to its diversified roots of origin, several definitions exist and each organization tends to understand and interpret resilience differently, sometimes to fit their own purposes. However, Holling, the founding father of "ecological resilience" defined resilience as " *a measure of the persistency of systems and of their ability to absorb change and disturbance and still maintain the same relationship between populations or state variables*" (Holling, 1973: 14 cited in Gall, 2013). Walker *et al.*, (2004) conceptualized resilience from the ecological perspectives as: "*Resilience is the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks in other words, stay in the same basin of attraction.*" (p.6). IPCC in its recent report on managing the risks of extreme events and disasters defines resilience, "*as the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner.*" (IPCC, 2012 p. 5). Therefore, the IPCC definition will serve as the operational definition of resilience in this study. On the other hand, resilience is a very broad concept that entails three interlinked capacities: absorptive, adaptive, and transformative capacities (UNDP, 2014). It is argued that resilience capacities largely depend on subjective or empiric characteristics and a certain set of assumptions about resilience.

**Absorptive capacity:** The ability of a system to prepare for, mitigate or prevent the impacts of negative events using predetermined coping responses in order to preserve and restore essential basic structures and functions (Béné et al., 2012). Frankenberg and Nelson (2013) highlighted absorptive capacity as the ability to minimize exposure to shocks and stresses (ex- ante) where

possible and to recover quickly when exposed (ex-post) and this capacity is considered as a key measure of resilience.

**Adaptive capacity:** The ability of a system to adjust, modify or change its characteristics and actions to moderate potential, future damage, and to take advantage of opportunities, all in order to continue functioning without major qualitative changes in function or structural identity (Béné et al., 2012; IPCC, 2012). Frankenberger & Nelson (2013) noted that, adaptive capacity deals with the ability to quickly and effectively respond to changing environmental, climatic, social, political, and economic conditions and thus it is a central factor in achieving resilience at all levels.

**Transformative capacity:** The ability to create a fundamentally new system this is when ecological, economic, or social structures make the existing system untenable (Walker *et al.*, 2004). For Mercy Corps (2013), transformative capacity is a factor of the enabling conditions that consists of the governance mechanisms, policies/regulations, gender norms, infrastructure, market systems, community networks, and formal and informal social protection mechanisms. It is further mentioned that this capacity facilitates the systemic change needed to address structural issues that contribute to food and livelihood insecurity (Mercy Corps, 2013). Therefore, the analysis of resilience focus on the three different yet interrelated forms of capacity, and offering different pathways towards the components making up a resilient system, as summarized in Figure 1. In the framework, absorptive capacity basis as the stability and structure of the system, otherwise termed ‘resistance’. The other dimension of resilience, adaptive capacity links flexibility in the system leading to incremental changes, otherwise termed ‘persistence’. This is commonly associated with climate change adaptation (IPPC, 2012).



**Figure 1 Core capacities for achieving and maintaining resilience**

**Source: Adapted from Béné et al., (2012) cited in Mercy Corps (2013, p.3)**

## 2.2. Theories of resilience

Carpenter *et al.*, (2001) indicated that most of the resilience-studies considered resilience as a theoretical construct. However, very few studies considered resilience as a model of a system. Using resilience as a theoretical construct can encourage important analyses of socio-ecological systems, and more information that is useful could be achieved by making more empirical analyses, which requires measurable concept of resilience. In all cases, it is important to emphasis on which state of system is considered ('resilience *of* what ') and which disturbances are of interest ('resilience *to* what '). Despite the historical development of resilience theory goes back to 1970s; the proliferation of scholarly works in development is very recent phenomenon. For example, best initiative was the introduction of the theory behind resilience is to report a few lines of a 2010 article by Folke *et al.*, (2010) that clearly indicated the most important characteristics of resilience. In their words, "resilience thinking addresses the dynamics and development of complex social–ecological systems (SES). Three aspects are therefore central: resilience, adaptability, and transformability. These aspects interrelate across multiple scales:

- *Resilience* in this context is the capacity of a social–ecological systems to continually change and adapt yet remain within critical thresholds;
- *Adaptability* is part of resilience. It represents the capacity to adjust responses to changing external drivers and internal processes, and thereby allow for development along the current trajectory (stability domain);
- *Transformability* is the capacity to cross thresholds into new development trajectories.

Thus, it is important to consider that transformational change at smaller scales enables resilience at larger scales. The ability to transform at smaller scales draws on resilience from multiple scales, making use of crises as windows of opportunity for novelty and innovation, and recombining sources of experience and knowledge to navigate social–ecological transitions." (Pisano, 2012). As for this study, the socio-ecological theory of resilience will be used as a theoretical framework to understand the multifaceted and interactive effects of climate change and variability in the context of watershed management.

### **2.3. Factors affecting livelihood resilience capacities**

Resilience capacity is necessarily multidimensional. It must encompass a range of indicators including economic assets and supply chains, social capital and social networks, technological agricultural practices, environmental natural resource management practices, infrastructure-related, safety and institutional resources and capabilities. The environmental conditions in which people live enable or limit their risk exposure and the opportunity to absorb, adapt and transform in the face of shocks. Thus a range of environmental factors are considered, such as climate and climate change, the state and management of natural resources, agro-ecological zones and changes in the risk landscape associated with the environment and ecological systems.

Within the Semi-Arid Tropical Sub-Saharan Africa, communities' livelihoods depend critically on fragile and poorly endowed natural resources, and poverty and environmental degradation are extensive. People in these regions depend largely on rain-fed agriculture, and their livelihoods are vulnerable to environmental variability. Environmental resources such as vegetation and soil are also vulnerable to human activities. To transcend these environmental challenges, human society and ecosystems must be resilient to recover quickly from environmental shocks.

### **2.4. Farmers' perception to climate change and variability**

Studies have shown that farmers perceive that the climate is changing and also adapt to reduce the negative impacts of climate change (Deressa et al., 2010). Also, Hadege's study shows that regardless of agro ecological settings, most farmers perceive an increasing trend of mean annual and *kiremt* season temperatures. Nevertheless, there was a significant difference among farmer's perception to temperature change. In this regard, farmers' living in *weyna dega* had perceived more than those living in *kola*. The difference is most farmers believed that temperature during the *belg* season has decreased in the last 30 years. (Hadgu et al., 2014) as described above we can understand that farmers are aware of the change in climate.

Perception of climate change among rural communities is determined by multiple forces. Different household influence whether and to what extent farmers perceive climate change and its impact on agriculture (Deressa et al., 2011). The age of a subsistence farmer is closely related to farming experience and their knowledge of the environment including changes in climatic conditions (Patt and Schröter 2008; Deressa et al. 2011; Juana et al. 2013).

Studies conducted in African smallholder farming systems have indicated that the level of formal education attained by farmers influences their ability to perceive climate change and its impact (Maddison 2007; Mustapha et al. 2012). Households who are less likely to perceive climate change are those with many members because they are more likely to engage in non-farm income generating activities, non-farm income safeguards financial losses from farming (Ndambiri et al., 2012). Access to extension services and climate information is claimed to increase farmer perception of climate change and its related risks (Maddison, 2007, ATPS, 2013).

Sadly, the stressed Ethiopian small holder farmers and pastoralists have already been hit hard by climate variability, losing harvests and livestock to drought, floods and struggling to survive amid changing rainfall patterns. Sub-Saharan Africa's considered one of the Most vulnerable regions to climate change, because of the high exposure and the low adaptive capacity of agriculture which is the most important livelihood. Mean annual temperature of Ethiopia has already increased by 1.3°C between 1960 and 2006, also daily temperature data indicate significantly increasing Trends in the frequency of hot days, and much larger increasing trends in the Frequency of hot nights. The changing patterns has continued and intensities of rainfall with increasing temperatures expected to have dire consequences for all Ethiopians, but especially more than 70 million poor rural people whose survival depended on rain fed agriculture in 2005, 39% of Ethiopia's population lay below the national poverty line. As the impacts of climate hazards and change occur alongside other trends, for example population growth, land degradation, poor infrastructure, and low opportunities for markets, indicating the compounded nature of the problems faced by the rural community (Nega et al., 2015)

## **2.5. Watershed management practices in Ethiopia**

In Ethiopia Watershed management was simply considered as a practice of soil and water conservation. Early watershed project stories are the bases for major watershed scheme in Ethiopia. Throughout time the Ethiopian government has acknowledged the serious implication of ongoing soil erosion to mitigate environmental degradation and as an outcome large national programs were implemented in the 1970s and 1980s. Though, the efforts of this initiative were seen to be insufficient in managing the rapid rate of demographic growth within the country, extensive and increasing land degradation, and high risks of low rainfall and drought. Since 1980, the government

has supported rural land rehabilitation, these intended to implement natural resource conservation and development programs in Ethiopia through watershed development (MOARD, 2005).

Since Planning the development of watersheds for Ethiopia started. A planning unit for developing large watersheds encompassed 30-40 thousand hectares. The plan was mostly for implementing natural resource conservation and development programs. Large-scale efforts persisted unsatisfactory due to lack of effective community participation, limited sense of responsibility over assets created, and uncontrollable planning units. The lessons learned from this experience encouraged MoA and support agencies like FAO to initiate pilot watershed planning approaches on a bottom-up basis, using smaller units and following community-based approaches. as a consequence, the minimum planning and sub watershed approaches were introduced. Minimum planning at the initial stage involved shifting from larger watersheds to smaller sub-watersheds. (MoARD 2005)

Watershed development becomes problematic when applied in inflexible and predictable way. This is true when applied without community participation and using only hydrological planning units, where a range of interventions remained limited and post rehabilitation management aspects were neglected. This resulted in various failures or serious short comings difficult to correct. (Desta et al 2005) if the dam is constructed before insufficient conservation measures were in place Where runoff and sedimentation rates are seriously underestimated. It will result in the filling with silt and coarse materials of the dam within one rainy season. large-scale watershed planning using top-down approaches and inflexible technical packages during the 80's that resulted in unsatisfactory performance of several conservation efforts. A poorly planned watershed approach might result in complete failure (Desta et al., 2005).

The inclusive goal of Participatory Watershed Development is to improve the livelihood of community in rural Ethiopia through wide-ranging and integrated natural resource development. It aims at productivity enhancement measures for improved income generation opportunities, enhanced livelihood support systems and high resilience to shocks (Desta et al., 2005). The other goal is to optimize the use of existing natural resources and untapped potentials in both already degraded areas and in the remaining potential areas in the country. More specific objectives include:

- Conserving soil, rainwater and vegetation effectively for productive uses;
- Harvesting surplus water to create water sources in addition to ground water recharge;
- Promoting sustainable farming and stabilize crop yields by adopting suitable soil, water, Nutrient and crop management practices;
- . Rehabilitating and reclaim marginal lands through appropriate conservation measures and mix of trees, shrubs and grasses, based on land potential;
- Enhancing the income of individuals by the diversified agriculture produce, increased Employment opportunities and cottage enterprises, particularly for the most vulnerable, Linked to the sustained use of natural resources.

## **2.6. Relationship between livelihoods and watersheds in rural Ethiopia**

All over Ethiopia, watershed logic governs water regimes, erosion levels, biomass availability, productivity levels, the quality of infrastructure and countless other activities. In degraded watersheds, opportunities for water harvesting and management are few and of limited use that is access roads are continuously damaged or they are not suited for construction, access to clean water for domestic use are very difficult and incidence of water-borne diseases is very high. Unstable watersheds induce unstable production systems and inefficiency of input utilization as erosion also erodes efforts to enhance productivity. Moreover, income generation opportunities linked to introduction of cash crops, bee-keeping, livestock fattening or dairy, and others, largely depend on the conditions or “health” of the watersheds. They depend as well on the interactions between communities and the different levels of the watershed units. Increased vulnerability to drought and food insecurity is directly linked to the conditions of the watershed and its limited capacity to support local livelihoods. The opposite occurs with protected and developed watershed systems, which generate multiple positive effects on people’s livelihoods, the environment and for the overall economy of the area. Potentials and opportunities linked to PWDP. The potential for community-based watershed development in Ethiopia are huge. This applies both for already severely degraded and food insecure areas as well as for those areas classified as food-secure and surplus-producing. (Desta et al., 2005). The latter definition should not be misleading as these areas are also subject to high erosion and deforestation rates, gradually losing their potential. These areas should rapidly undertake corrective actions to reverse degradation trends and retain as well as improve their potential.

The amount and type of activities, including technological interventions, may differ but the same principles and recommendations apply. In other words, participatory watershed planning should be considered as an instrument to “bring rural households back to business” in food-insecure and degraded contexts and “keep rural households in business” in other areas. Besides, watershed development also enables new opportunities to emerge, linked to water development, diversified crops, and access to markets, reclaimed land, fertility improvement, off-farm activities, and others. Thus, the watershed, or catchment area, is the natural framework for resource development in relation to crop production systems as well as resource conservation and utilization (Desta et al., 2005).

### **2.7. Socio-economic factors affecting resilience**

Resilience is the ability of an individual, a household, a community or an institution to withstand a shock or setback of some type and recover, or “bounce back,” after a setback. As such, it implies the ability to cope with adversity by adapting, learning and innovating. Livelihood outcomes such as food security and health as the objectives that people are trying to achieve. Measures such as food security or health status reflect current conditions. Other measures such as education capture longer-term outcomes. In most countries the frequent shock experienced is an increase in food prices, Livestock and crop disease, drought, poor harvests, and increased prices of agricultural or livestock inputs. (Lisa et al 2015) Since the farmers are occupied in this current conditions and the focus is on survival due to the above mentioned forcing factors most people who live in the rural area do not place their value in resilience.

### **2.8. Empirical studies in Ethiopia**

Among all other studies Hadigu (2014) in his study assessed farmer’s perception and adaptation to climate variability/change in three districts situated at different agro-ecological zones of Tigray region, Ethiopia. Data for the study were collected from 253 respondents selected through the multi-stage sampling technique. Descriptive statistics were employed to assess perception among gender and social groups about climate change and their adaptation methods. The results revealed that annual (0.18-0.71 °C per decade) and seasonal (0.37-0.6 °C per decade) temperatures of all stations have increased and the rate was higher in the highland areas. Similarly, 60-97% of the interviewed farmers were aware of change in temperature and their perception appears to be in accordance with the statistical record of these areas. Similar, Belachew and Muhammad (2015)

assessed on farmers' perception of climate change and their response was documented in Maruf Kebele of Central Oromia, Ethiopia with questionnaire survey, focus group discussion and field observation. Over hundred randomly selected households were included; the community typically includes a large proportion of small holder farmers from poorly equipped, land scarce households with low education and economic status. The results indicated that farmers had a good understanding and perception of the impacts of climate change at the local level; many negative impacts of the climate irregularity had been identified by the community, like reduced crop yield, heating/drying up of environment and soil loss affecting natural plant regeneration from the forest soil seed bank, drying up of streams and springs, disappearance of trees and plants, rarity of wild animals and increasing pests/disease. The results indicate the importance of understanding of community perception in designing policies and projects for effective adaptation strategies allowing local participation to cope with the impacts of climate change.

Niemistö (2011) he examined the resilience and sustainability of rural Ethiopian livelihoods. Preventing, coping and recovering from the shocks and stresses, in this case from drought and food insecurity, form an essential part of resilience and sustainability and therefore preventing and coping strategies were emphasized in the study. The empirical data was gathered by interviewing people living in six rural villages in Hararghe zone, Eastern Ethiopia. Semi-structured group interviews were used as the main data collection method and the findings were analyzed with qualitative methods; coding and finding themes from the data. The villagers were selected to be the key informants because the study is based on sustainable livelihoods thinking which emphasizes bottom-up approach and gives voice to local people. The results showed that resilience and sustainability in studied villages were low and fragile because of the severe shortage of water and lack of financial support. Difficult climatic conditions caused negative relations between ecological and economic sustainability. The villages have not been able to recover from the drought and are currently using the coping and preventing strategies to survive.

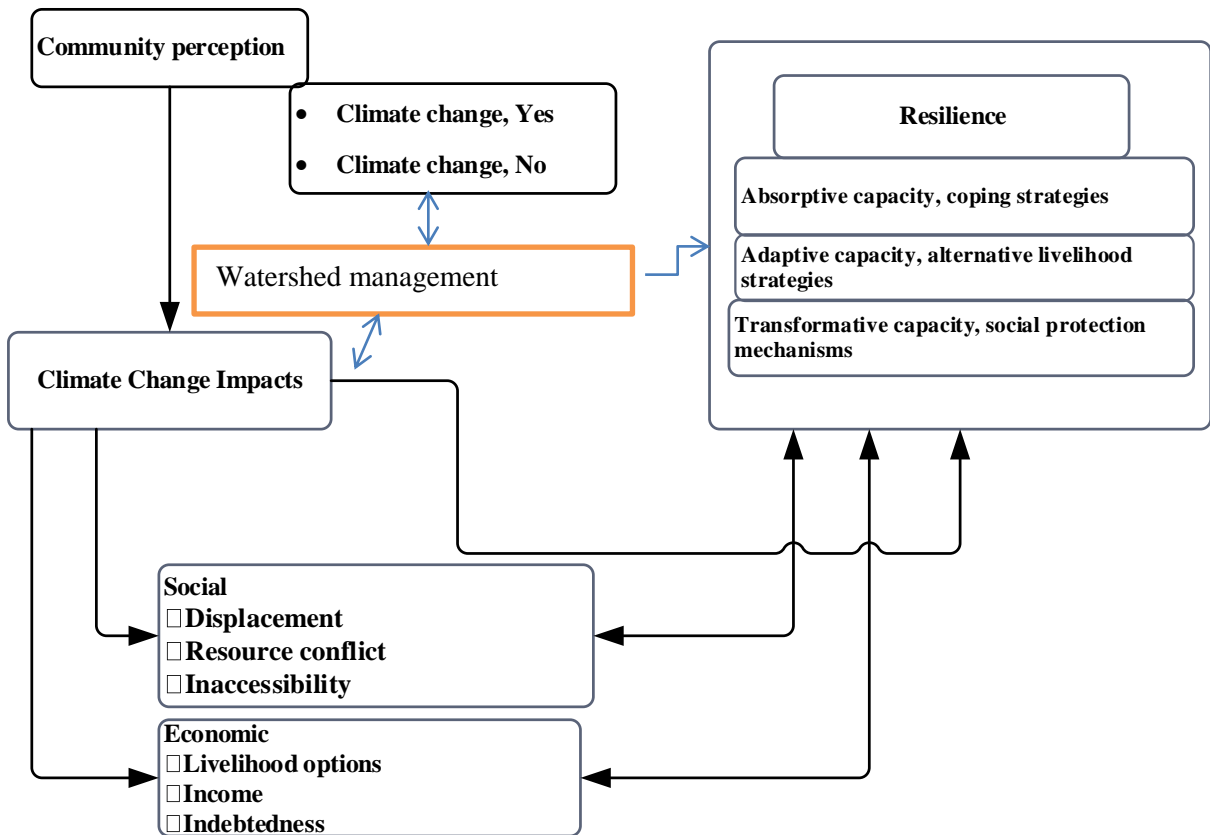
A study done by Gebru 2014 in Adwa woreda assessed factors that influence farmers' choice of adaptation measures and identifies adaptation methods to climate change in Ethiopia the study explains the basic barriers to climate change adaptation on the farmers' side are lack of knowledge, lack of capital, lack of sufficient land and lack of information. This studies mostly focused Some researchers have done climate related issues in on adaptation and mitigation strategies.

Tesfaye (2011) has studied explores the prospects, approaches and barriers of integrated and sustainable watershed management of Dijjil, Tsegur Eyesus and Lenche Dima watersheds, by examining the existing complex set of biophysical and socio-economic conditions, stakeholders' attitudes and perceptions, arrangements for participation of communities, available institutional structures and recent policy of land certification. Information was gathered from official documents, direct observations, semi-structured interviews with experts, watershed committees and households of the three watersheds. The result indicates that effective and sustainable watershed management can take place through participation of watershed community from the beginning, ownership of communal lands into private or association holdings, integration of multidisciplinary team, demand driven, changing the livelihood of the community within the short run by generating income from on farm and off farm activities, establishing community watershed management institution, and giving legislative support. Many studies have been done on farmers' perception, resilience and watershed management this paper may have similar methodology but the content is different due to the reason, the paper will see the relation within the three concepts. This paper is all about what the role of watershed management practice is in building community resilience capacity to climate change impacts.

## **2.9. Conceptual framework of the study**

The conceptual framework indicates the cause and effect or two-way interactions between and among the components of the framework. In this case, the first component, community perception to climate change and variability, this could be either changing or not changing over time. The change in climate is considered when there are changes both in the temperature (minimum and maximum) and the total rainfall over time in a given geographic location. Thus, the change in climatic components, temperature and precipitation will result in impacts that could be social, economic, and environmental. However, climate variables also have an impact on physical/human capital such as roads, storage and marketing infrastructure, houses, productive assets, electricity grids, and human health which indirectly changes the economic and socio-political factors that govern food access and utilization and can threaten the stability of food systems (FAO, 2008). The households perception on climate change can be positively or negatively related with Watershed management. Moreover, it is argued that more frequent and more intense extreme weather events and droughts, rising sea levels, and increasing irregularities in rainy season patterns are already having immediate impacts on food production, food distribution infrastructure, incidence of food

emergencies, livelihood assets and opportunities, human health, both in rural and urban areas (FAO, 2008). However, for the purpose of the study, only social and economic impacts of climate impacts will be measured. Depending on the dynamic interaction between and among the major components of the framework, the outcome will be resilience that can be measured as absorptive capacity (coping strategies), adaptive capacity (alternative livelihood strategies), and resilience capacity (social protection mechanisms). Therefore, this conceptual framework serves as the building block upon of the study.



**Figure 2 Conceptual framework of the study**

**Source: Own construction (2018)**

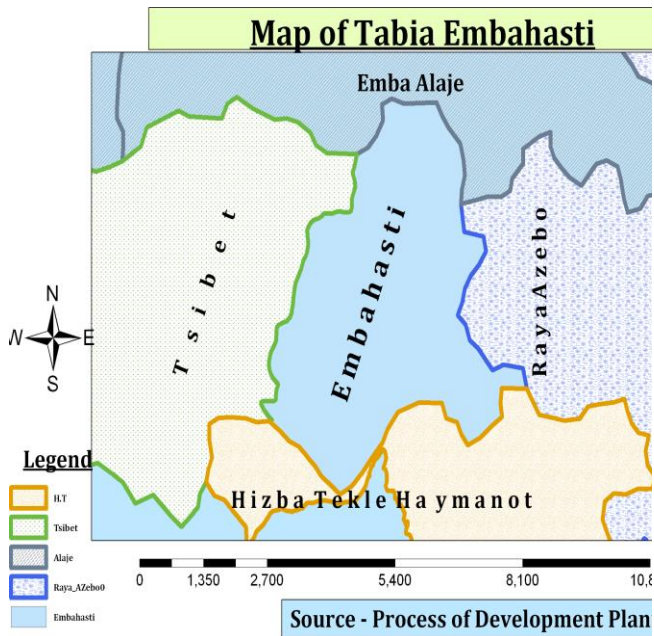
## **CHAPTER THREE: RESEARCH METHODOLOGY**

### **3.1. Study area description**

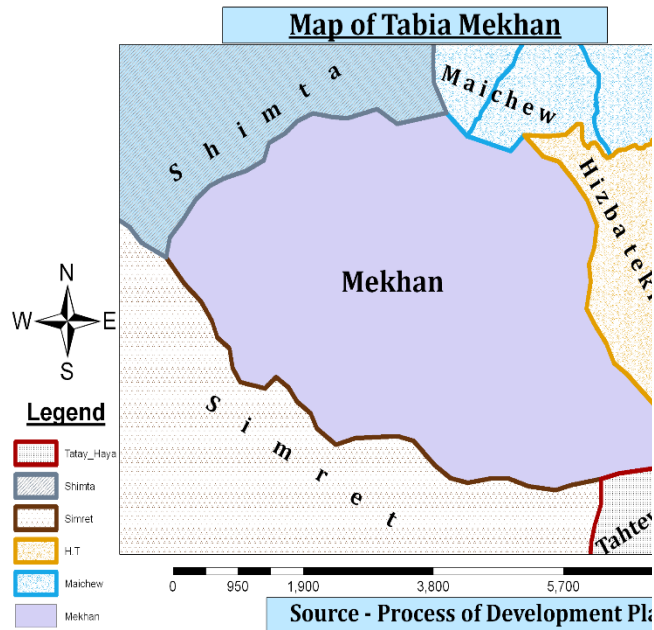
Endamehoni wereda is topographically mountainous, undulated and ragged area and has suitable weather condition. Its Geographic location is 554279-564869 East- 1404290-1422780 North. The wereda/district is located 120 km away from Mekelle capital city of Tigray region as for Addis Ababa the capital city of Ethiopia is found 679 km away. It has Altitude Range of 1653 masl-3909 masl, 0-25<sup>0</sup>C temperature and Annual Rainfall of 600-900mm. Population size is composed of 42,048 male, 4267 females. 17,105 Male headed Households and 4,363 Female headed Households. The agro ecology of the study area is humid 5% sub humid 65 % semi-arid 30%. the wereda has two major type of soil, including Eutric Cambisols and Lithosoil.

The total land holding is constituted of 16,940 ha of forest land, 17,434 ha of cultivated land, 14,463 ha of grazing land, 3,155 ha of residence, 7,884 ha area closure, and 1354.33 ha Miscellaneous a Total of 61,230.33 ha. In the wereda there are 19 kebele Administration. The district's primary or staple crops are wheat, barley, and pulses. The main rivers in the wereda are Gereb Ayni, Hara, Nai Muq, Awdey and Mai Chumachil. Agriculture is the mainstay of the economy in the wereda.

Emba Hasti is 10 km north of Maichew. In the kebele there are 823 households. There are four villages (kushet or got) called Adi Tsegba, Bolenta, Degua and Kola. It receives a mean annual rainfall of 825 mm. The mean annual maximum temperature is 15<sup>0</sup>C and the mean minimum is 6<sup>0</sup>C. Mehan is 8 km east of michew. In the kebele there are 1327 households within this households there are four villages (kushet or got) named Hadish Adi, Agamat, Adi Agam and Adi Demsash it receives a mean annual rainfall of 678 mm and the annual maximum temperature of 17<sup>0</sup> c and minimum temperature of 8<sup>0</sup> c.



**Figure 3 Map of Emba Hasty watershed**



**Figure 4 Map of Mehan watershed**

Source: Adapted from Endamahony woreda's socio economic profile 2009

### **3.2. Study design**

The study was based on a mixed research design, which integrated both quantitative and qualitative research methods. The former was used to generate numeric data on the topic under study and help to develop community resilience capacity index that was considered to create a dependent variable for further analysis. While the latter, was used to complement findings from the quantitative study and to arrive at valid conclusions. This was primarily chosen to strengthen results from one method and fill the gaps where the qualitative study was not able address the study objectives. Hence, using a cross-sectional survey both qualitative and quantitative data was generated from respondents.

### **3.3. Study population and selection**

The study population is the communities which are the main beneficiaries of Emba hasty and Mehan watersheds. The respondents were selected as the study population because their livelihood was directly related to the watersheds. Community members who lived in that place for at least 20 years were selected as the study population. Experts who have been working on those watersheds in guiding the community were also included. In the selection process, households who have lived in that area for 20 years and experts who worked on the watersheds were included.

### **3.4. Data types and sources**

Both primary and secondary sources of data were used to gather all the relevant information. The primary data of the study was collected from eligible respondents (community members who lived there for 20 years) using survey questionnaire, key informant interviews, focus group discussion and field observation. Whereas secondary data was collected through review of documents, books, journals, reports from workshops and different websites etc. was used to collect the intended information.

### **3.5. Sample size determination and sampling techniques**

The target population of this study was selected using both probability and non-probability sampling techniques. The study area was selected purposively from Maichew district watersheds. The two watersheds were selected for comparison purpose and see the watershed management practices and the role for community resilience capacities building in the face of changing

climate. Then the calculated sample size was distributed based on probability proportional to size for each watershed, finally, the households was selected using simple random sampling using the list of households in the area. The overall sample size was determined by using the using Kothari (2004) sample size determination formula.

$$n = \frac{Z^2 p * q}{e^2}$$

Where:  $n$  is the required sample size.  $Z = Z$  value (e.g. 1.96 for 95% confidence level);  $p =$  percentage picking a choice, expressed as decimal (0.5 used for sample size needed);  $q$  the percentage of not picking a choice (1- $q$ );  $e =$  error margin, expressed as decimal (e.g., 0.06 =  $\pm 4.0$ ) due to homogeneity in the socioeconomic, demographic and livelihood activities. Hence, the precision level is taken at 4 %, making it 0.06 for the determination of the same size. Accordingly, a total of 266 sample households and 10 % non-response rate, totaling 293 households. Accordingly, 144 was selected from Emba hasty kebele and 146 was selected from Mehan with three not completed households.

### **3.6. Data collection tools**

In this study, qualitative and quantitative methods were applied. Qualitative information of the study was obtained through key informant interviews (10 key informants, five from each Watershed) and Focus Group Discussions (FGD) (two FGDs, one in each Watershed) using interview and FGD guidelines as well as personal observation was made in the selected watersheds. Quantitative data was collected directly from eligible respondents (households who lived in that are for 20 years) using structured survey questionnaire. The questionnaires consisted of both open and close ended question that helped to answer the study objectives.

### **3.7. Study Variables**

Variables in Table were used in the construction of Binary Logistic Regression model that help to identify factors that contribute for community resilience. The dependent variable was household resilience capacity index (*HRCI*) index, which was developed and the threshold was obtained from the resilience index ( $HRCI \geq 0.5$  was coded as 1 or resilient category while  $HRCI < 0.5$  was coded as 0, representing the non-resilient category).

**Table 1 Explanatory variables proposed to measure determinants of households' resilience status**

<b>Variable Code</b>	<b>Definition</b>	<b>Measurement/Unit</b>	<b>Type</b>	<b>Expected sign</b>
SEX ( $X_1$ )	Sex of household head	1 if male, 0 otherwise	Dummy	-
AGE ( $X_2$ )	Age of household head	In years	Continuous	+
FAMLSZ ( $X_3$ )	Family size	In number	Continuous	-
EDUCTN ( $X_4$ )	Education of household head	In years	Continuous	+
LAND ( $X_5$ )	Total farm size	In hectare	Continuous	+
CREDIT ( $X_6$ )	Access to credit	1 if yes, 0 otherwise	Dummy	+
LIVESTOCK ( $X_7$ )	Livestock owned	In TLU	Continuous	+
MARKET ( $X_8$ )	Distance to market	In km	Continuous	-
INCOME ( $X_9$ )	Total annual cash income	In <i>Birr</i>	Continuous	+
EXT.VIST( $X_{10}$ )	Extension agent visited	1 if yes, 0 otherwise	Dummy	+
COOP ( $X_{11}$ )	Household membership in cooperative	1 if yes, 0 otherwise	Dummy	+

<i>WTER</i> ( $X_{12}$ )	Households involvement in	1 if yes, 0 otherwise	Dummy	+
<i>IRRG</i> ( $X_{13}$ )	Household access to irrigation	1 if yes, 0 otherwise	Dummy	+
<i>OFFRM</i> ( $X_{14}$ )	Household involvement in off-farm activities	1 if yes, 0 otherwise	Dummy	+
<i>SAVING</i> ( $X_{15}$ )	Household has saving	1 if yes, 0 otherwise	Dummy	+
<i>INFO</i> ( $X_{16}$ )	Access to early warning information	1 if yes, 0 otherwise	Dummy	+
<i>EXPR</i> ( $X_{17}$ )	Farming experience	In years	Continuous	+
<i>SHOCK</i> ( $X_{18}$ )	Experience of Natural shock	Number/year	Continuous	-

### 3.8. Method of data analysis

Quantitative data to be obtained through structured questionnaire was entered into computer for analysis using Statistical Packages for Social Science (SPSS) (version 23), XLSTAT (version 16), OPEN CODE (version 4.02), the latter one was used for coding qualitative data generated from text information such as interviews, observations or field notes. Accordingly, the data was edited, coded, and cleaned where some consistency checks was verified by running frequencies and cross-tab. The analysis part was done using both descriptive and econometric analysis.

#### 3.8.1. Model estimation

The binary logistic regression model was planned to estimate the relationship between dependent and independent variables of the study. According to Gujarat (2004) binary logistic regression model was used when the dependent variable was articulated in two categories in applying the explanatory variables. Logistic regression model becomes appropriate when the dependent

variable 'Y' has either dichotomous (i.e. two) or trichotomous (i.e. three) or polychotomous (i.e. multiple-category) responses. According to Gujarati (2004), linear probability, logit, and probit are approaches to develop a probability model for binary response variable. However, linear probability model (LPM), has limitations, such as generation of predicted values outside the 0-1 intervals (which violets the basic principles of probability). With such drawbacks of a linear probability model, non-linear probability models (i.e. logit and probit), are suggested to satisfy its limitations. Both logit and probit, models are quite similar, except that the logistic distribution has slightly fatter tails. Therefore, there is no compelling reason to choose one over the other. In practice, many researchers choose logit model because of its comparative mathematical simplicity (Gujarati, 2004). In doing so, the household resilience capacity index (HRCI) index was developed and the threshold was obtained from the resilience index (HRCI $\geq$ 0.5 was coded as 1 or resilient category while HRCI  $\leq$ 0.5 was coded as 0, representing the non-resilient category). Once the HRCI index was constructed and the dependent variable was created, binary logistic regression model was applied to identify factors that make community members to be resilient or not resilient in the face of the changing climate. In this study, the dependent variable was "household or community resilience" where a household falls into one of the two categories: a household is either "resilient, coded 1" or "not resilient, coded 0". Gujarati (2004) noted that the functional form of logit model is specified as follows and the logistic model (the log-odds ratio) takes the form:

$$P_i = E \left( \frac{Y_i}{X_i} \right) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X_i)}} \quad (1)$$

$$P_i = E \left( \frac{Y_i}{X_i} \right) = \frac{1}{1 + e^{-Z_i}}$$

Where  $P_i$  is a probability of a  $i^{th}$  household being resilient, which ranges from 0 to 1;  $Z_i$  is a functional form of  $m$  explanatory variables ( $X$ ) which is expressed as

$$Z_i = \beta_0 + \sum_{i=1}^m \beta_i X_i, \quad 1, 2, 3 \dots \dots \dots m \quad (2)$$

Where  $\beta_0$  is an intercept and  $\beta_i$  are slope parameters of the model or slopes of the equation. It indicates that how the log-odds are in favor of a given household resilient status change as independent variables change. If  $P_i$  shows the probability of a given household is resilient, and then  $1 - P_i$  shows the probability of a given household is not resilient, which is expressed as:

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \quad (3)$$

When equation (1) is divided by equation (3), the simplified form is stated as:

$$e^{Z_i} = \frac{P_i}{1 - P_i} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} \quad (4)$$

It explains a ratio of the probability that a household is resilient to the probability of household with not resilient. Finally, the logit model is obtained by taking the natural log of equation of 5 as follows:

$$L_i = \ln \left( \frac{P_i}{1 - P_i} \right) = \beta_0 + \beta_i X_i \quad (5)$$

Including an error term ( $U_i$ ) into the model is expressed as:

$$L_i = \beta_0 + \beta_i X_i + U_i \quad (6)$$

## **CHAPTER FOUR: RESULT AND DISCUSSION**

This chapter presents the discussion and interpretation of the study findings. It includes both descriptive statistical analyses under section 4.1 and econometric estimation results and discussion under section 4.2. The data employed for the analysis of this study was collected from 290 sample household from the two watersheds Emba Hasty and Mehan.

### **4.1. Descriptive Statistics and Discussion**

#### **4.1.1. Demographic and socio-economic characteristics of sampled households**

The sample household was selected from the two watersheds i.e., Emba Hasty and Mehan watershed each watershed has four kebeles /Got in total 290 households was selected as a sample size. The responds of sampled households' have been categorized as continuous and dummy/categorical variable and summarized in Table 2. The maximum and minimum age of respondents was 22 and 78 with mean age of 42.28. The average family size of respondents was 5.52 with a maximum and minimum family size of 10 and 2 respectively. And, from the total of 290 sampled households, 76.6% households were male headed households and the remaining 23.4% is found to be female headed households. The maximum land holding is 2 hectares' minimum land holding is 0.5 hectares. The maximum no of the respondents is male which are 76.6% and females 23.4%.

The maximum marital category is married with one spouse 70%, married with more than one spouse 1.0%, divorced 9.0%, and widowed 4.1% and separated 4.1 % respectively. The maximum Educational background of the respondents, which is Illiterate 57.6% and those able to read and wright are 42. 4%. The respondents who participated in off farm activities are 74.1% and those who do not participate are 28.6%. Farmers who participate in non-farm activities are 9.7% and those who do not participate in non-farm activities 90.3%. crop and livestock production is the primary occupation by 96.6% of the community members, 4.2% of the respondents participate in trade of commodities, 0.7% of the partake on trade of crop and livestock and last 0.3% of the respondents take part on charcoal production and trade.

**Table 2 Simple descriptive statistics**

<b>Continuous Variables</b>			
<b>Explanatory variables</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>
<b>Age</b>	22	78	42.29
<b>Family Size</b>	1	10	4.31
<b>Aggregate income</b>	1200.00	130000.00	26664.7241
<b>Total land holding</b>	0	2	.43
<b>Dummy/Categorical Variables</b>			
<b>Explanatory variables</b>	<b>Category</b>	<b>Total Number</b>	<b>Percentage</b>
<b>Sex</b>	Female	68	23.4%
	Male	222	76.6%
<b>Marital Status</b>	Single	34	11.7%
	Married with 1 spouse	203	70.0%
	Married with more than 1 spouse	3	1.0%
	Divorced	26	9.0%
	Widowed	12	4.1%
	Separated	12	4.1%
<b>Education Level (1-12) grades</b>	Illiterate	167	57.6%
	Read and write	123	42.4%
<b>Off Farm activities</b>	No	83	28.6%
	Yes	207	71.4%
<b>Non-farm activities</b>	No	262	90.3%
	Yes	28	9.7%
<b>Primary Occupation</b>	Crop and livestock production	280	96.6%
	Trade of	7	2.4%

	commodities		
	Trade of Crops & livestock	2	0.7%
	Charcoal production & sell	1	0.3%

Source: own survey data (2018)

#### 4.1.2. Communities' perception towards climate change and climate variability

Human perceptions of climate, its variability and its potential change have become an important challenge in understanding climate–society interactions, as more attention is given to studies of human adaptation to climate change (Lindskog,1994; Dahlberg & Blaikie 1996; Rebetez 1996, Ovuka & Lindqvist, 2000).

**Table 3 Overall temperature perception**

Overall temperature	Emba Has	Mehan
Increased	129 (89.58)	100(68.49)
no change	12 (8.33)	40(27.40)
Decreased	3(2.08 )	6(4.11)
Pearson chi2(2) = 19.7366 Pr = 0.000		

Source: own survey data (2018)

As can be seen from the Table 4, 89.58% of HHs in Emba Has kebele have perceived an increase in the overall temperature while it was 68.49% in Mehan kebele perceived the same change. The difference between the perceived and not perceived the change in the overall temperature was found to be statistically significant ( $X^2 = 19.7366$ ,  $p < .000$ ). The households' perception signifies that the overall temperature has been changing as perceived by the surveyed farmers in two of the studied watersheds. As two of the respondents clarified that

*“Before 5-10 years it used to be very cold there was a frost that damages almost everything (destroys crops, kills animals and turns the water to ice) but now a day no more because there is a temperature increase.” another person also said “It used to be really cold to the point you don’t want to go out but now it is getting warmer.”*

**Table 5 Dry season (Bega) Temperature**

<b>Dry season (Bega) Temperature</b>	<b>Emba Hasty</b>	<b>Mehan</b>
Increased	131 (90.97%)	101 (69.18%)
No change	9 (6.25%)	35 (23.97%)
Decreased	4 (2.78%)	10 (6.85%)
Pearson chi2(2) = 21.8016 Pr = 0.000		

**Source: own survey data (2018)**

As Table 6 indicates, 90.97% of HHs in Emba Hasty kebele have perceived an increase in the Dry season (Bega) Temperature while it was 69.18% in Mehan kebele perceived the matching change. The difference between the perceived and not perceived the change in the Dry season (Bega) Temperature was found to be statistically significant ( $X^2 = 21.8016$ ,  $p < .000$ ). The HHs farmer’s perception in the two studied watersheds observation signifies that the Dry Season Temperature has been changing.

**Table 7 Summer season (Kirmet) Temperature**

<b>Summer season (Kirmet) Temperature</b>	<b>Emba Has</b>	<b>Mehan</b>
Increased	106 (73.61%)	76 (52.05%)
no change	23(15.97%)	35 (23.97%)
Decreased	15 (10.42%)	47(32.19%)
Pearson chi2(2) = 21.4484 Pr = 0.000		

**Source: own survey data (2018)**

Table 8 shows, 73.61% of HHs in Emba Hasty kebele have perceived an increase in the Summer season (Kirmet) Temperature while it was 52.05% in Mehan kebele perceived the alike change. The difference between the perceived and not perceived the change in the summer season (Kirmet) Temperature was found to be statistically significant ( $X^2 = 21.4484$ ,  $p < .000$ ). The HHs farmer's perception in the two studied watersheds signifies that the summer season (Kirmet) Temperature has been changing.

**Table 9 Belg season Temperature**

<b>Belg season Temperature</b>	<b>Emba Has</b>	<b>Mehan</b>
Increased	94 (65.28%)	55 (37.67%)
No change	30 (20.83%)	72 (49.32%)
Decreased	20 (13.89%)	19 (13.01%)
Pearson chi2(2) = 27.5153 Pr = 0.000		

Source: own survey data (2018)

For instance, seeing the table 6, 65.28% of HHs in Emba Hasty kebele have perceived an increase in the Belg season Temperature while it was 37.67% in Mehan kebele perceived the matching change. The difference between the perceived and not perceived the change in the Belg season Temperature was found to be statistically significant ( $X^2 = 27.5153$ ,  $p < .000$ ). The HHs farmer's perception in the two studied watersheds observation signifies that the Belg season Temperature has been changing.

**Table 10 Number of hot days in a year**

Number of hot days in a year	Emba Has	Mehan
Increased	101(70.14)	95 (65.07)
no change	25 (17.36)	29 (19.86)
Decreased	18 (12.50)	22 (15.07)
Pearson chi2(2) = 0.8662 Pr = 0.648		

**Source: own survey data (2018)**

Table 7 shows, 70.14% of HHs in Emba Hasty kebele have perceived an increase in the Number of hot days in a year while it was 65.07% in Mehan kebele perceived the identical change. The difference between the perceived and not perceived the change in the Number of hot days in a year was found to be statistically non-significant.

**Table 11 Number of cold days in a year**

Number of cold days in a year	Emba Has	Mehan
Increased	40 (27.78%)	39 (26.71%)
No change	49(34.03%)	38 (26.03%)
Decreased	55 (38.19%)	69 (47.26%)
Pearson chi2(2) = 2.9705 Pr = 0.226		

Source: own survey data (2018)

As can be seen from Table 8, 27.78% of HHs in Emba Hasty kebele have perceived an increase in the Number of cold days in a year while it was 26.71% in Mehan kebele perceived the

matching change. The difference between the perceived and not perceived the change in the number of cold days in a year was found to be statistically non-significant. The HHs farmer's perception in the two studied watersheds observation signifies that the Belg season temperature has not been changing.

**Table 12 Number of cold/hot nights in a year**

<b>Number of cold nights in a year</b>	<b>Emba Has</b>	<b>Mehan</b>	<b>Pearson chi2</b>
Increased	52 (36.11%)	41 (28.08%)	Pearson chi2(2) = 5.9521 Pr = 0.051
no change	46 (31.94%)	38 (26.03%)	
Decreased	46 (31.94%)	67 (45.89%)	
<b>Number of hot nights in a year</b>	<b>Emba Has</b>	<b>Mehan</b>	<b>Pearson chi2</b>
Increased	102 (70.83%)	73 (50.00%)	Pearson chi2(2) = 13.6087 Pr = 0.001
no change	19 (13.19%)	38(26.03%)	
Decreased	23(15.97%)	35 (23.97%)	

Source: own survey data (2018)

As indicated in Table 9, 36.11% of HHs in Emba Has kebele have perceived an increase in the number of cold days in a year although it was 45.89% in Mehan kebele perceived the decrease in no of cold days in a year. The difference between the perceived and not perceived the change in the Number of hot days in a year was found to be statistically significant at 10 % significant level ( $X^2 = 5.9521$  Pr = 0.051). The HHs farmers' perception in the two studied watersheds indicates

that the number of hot days in a year has been changing. As for number of hot nights in a year 102 (70.83 of HHs in Emba Has kebele have perceived an increase in the number of cold days in a year although it was 73 (50.00) in Mehan kebele perceived same change. The difference between the perceived and not perceived the change in the Number of hot days in a year was found to be statistically significant ( $X^2 = 13.6087$  Pr = 0.001). The HHs farmer's perception in the two studied watersheds observation pinpoints that the number of hot days in a year has been changing.

**Table 13 Overall rainfall amount**

Overall rainfall amount	Emba Hasty	Mehan
Increased	67(46.53%)	20(13.70%)
No change	15(10.43%)	37(25.34%)
Decreased	62(43.06%)	89(60.96%)
Pearson chi2(2) = 39.5144 Pr = 0.000		

Source: own survey data (2018)

In table 10 , 46.53% of HHs in Emba Has kebele have perceived an Overall rainfall amount while 60.96% in Mehan kebele perceived the decrease in overall rainfall. The difference between the perceived and not perceived the change in the overall rainfall amount was found to be statistically significant ( $X^2 = 39.5144$  Pr = 0.000). The HHs farmer's perception in the two studied watersheds observation reveals that the overall rainfall amount has been changing.

**Table 14 Dry season rainfall**

<b>Dry season rainfall</b>	<b>Embahasty</b>	<b>Mehan</b>
Increased	66(45.33)	22(15.07)
No change	33(22.92)	29(19.86)
Decreased	45(31.25)	95(65.07)
Pearson chi2(2) = 40.1033 Pr =0.001		

Source: own survey data (2018)

The above table 11 shows, 45.33% of HHs in Emba Has kebele have perceived an increase in the Dry season rainfall while it was 65.07% in Mehan kebele perceived the distinct change. The difference between the perceived and not perceived the change in the Dry season rainfall was found to be statistically significant ( $X^2 = 40.1033$  Pr =0.000). The HHs farmers' perception in the two studied watersheds denotes that the dry season rainfall has been changing.

**Table 15 Summer season rainfall**

<b>Summer season rainfall</b>	<b>Embahasty</b>	<b>Mehan</b>
Increased	44(30.56%)	59(40.41%)
No change	32(22.22%)	11(7.53%)
Decreased	68(47.22%)	76(52.05%)
Pearson chi2(2) = 12.8715 Pr = 0.002		

Source: own survey data (2018)

In table 12 shows, 47.22% of HHs in Emba Has kebele have perceived a decrease in the summer season rainfall while it was 52.05% in Mehan kebele perceived the equivalent change. The difference between the perceived and not perceived the change in the summer season rainfall was

found to be statistically significant ( $X^2 = 12.8715$  Pr = 0.002). The HHs farmers' perception in the two studied watersheds signifies that summer season rainfall in a year has been changing.

**Table 16 Belg season rainfall**

<b>Belg season rainfall</b>	<b>Embahasty</b>	<b>Mehan</b>
Increased	39(27.08%)	23(15.75%)
No change	39(27.08%)	40(27.40%)
Decreased	66(45.83%)	83(56.83%)
Pearson chi2(2) = 6.0678 Pr = 0.048		

Source: own survey data (2018)

For example, as evidenced in Table 13, 45.83% of HHs in Emba Has kebele have perceived an decrease in the Belg season rainfall while 56.83% in Mehan kebele perceived the same change. The difference between the perceived and not perceived the change in the Belg season rainfall was found to be statistically significant ( $X^2 = 6.0678$  Pr = 0.048). The HHs farmers' perception in the two studied watersheds observation signifies that the Belg season rainfall has been changing. As one of the responded said *"In the old days we used to have belg rain but this day even that in no more"*

**Table 17 Rainfall starts lately**

<b>Rainfall starts lately</b>	<b>Embahasty</b>	<b>Mehan</b>
Increased	144(79.17%)	100(68.49%)
No change	12(8.33%)	17(11.64%)
Decreased	18(12.50%)	29(19.86%)
Pearson chi2(2) = 4.3388 Pr = 0.114		

Source: own survey data (2018)

The above table 14 shows 79.17% of HHs in Emba Has kebele have perceived an increase in the Rainfall starts lately while 68.49% in Mehan kebele perceived the alike change. The difference

between the perceived and not perceived the change in the Rainfall starts lately was found to be statistically non-significant ( $X^2 = 4.3388$  Pr = 0.114). The HHs farmer's perception in the two studied watersheds signifies that Rainfall starts lately was not supported by the survey data.

**Table 18 Early cessation of rainfall**

<b>Early cessation of rainfall</b>	<b>Embahasty</b>	<b>Mehan</b>
Increased	120(83.33%)	106(72.60%)
No change	9(6.25%)	13(8.90%)
Decreased	15(10.42%)	22(18.49%)
Pearson chi2(2) = 5.0095 Pr = 0.082		

Source: own survey data (2018)

Table 15 shows 83.33% of HHs in Emba Has kebele have perceived an increase in the Early cessation of rainfall while 72.60% in Mehan kebele perceived the alike change. The difference between the perceived and not perceived the change in the Early cessation of rainfall was found to be statistically significant at 10 % significant level ( $X^2 = 5.0095$  Pr = 0.082), suggesting that early cessation of rainfall was perceived by the farm households.

**Table 19 Flood due to extensive rainfall**

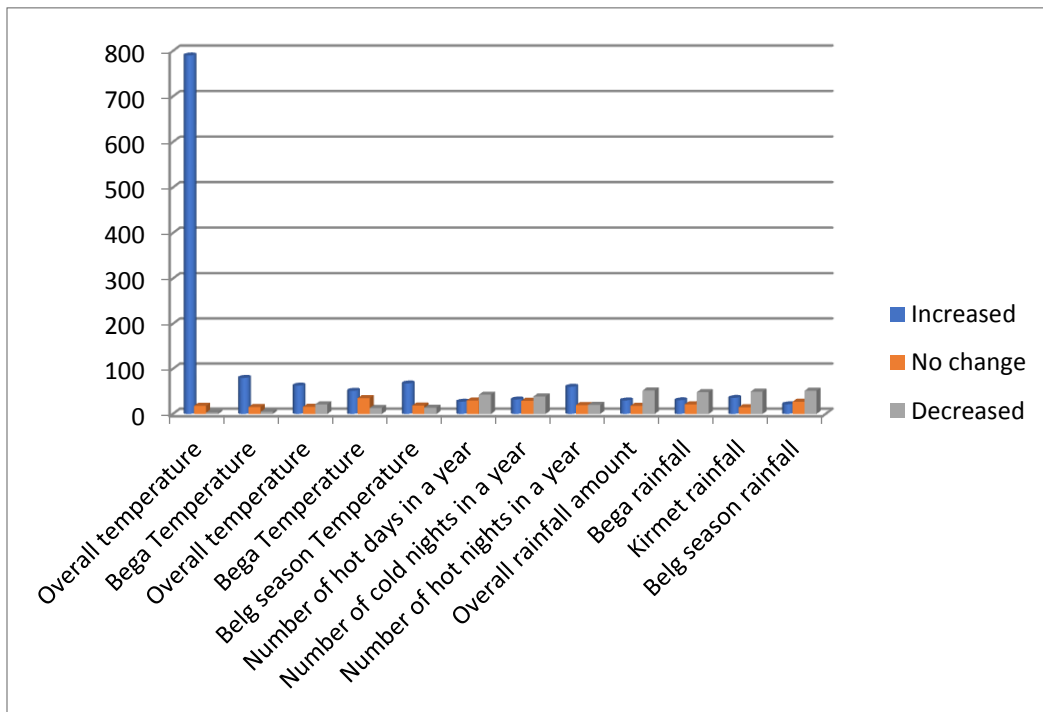
<b>Flood due to extensive rain fall</b>	<b>Embahasty</b>	<b>Mehan</b>
No	22(15.28%)	82(56.16%)
Yes	22(15.28%)	82(56.16%)
Pearson chi2(1) = 52.6901 Pr = 0.000		

Source: own survey data (2018)

For instance, seeing the table16 , 15.28% of HHs in Emba Hasty kebele have perceived an decrease and increase in the Flood due to extensive rain fall while 56.16% in Mehan kebele perceived the same change. The difference between the perceived and not perceived the change in the Flood due to extensive rain fall was found to be statistically significant ( $X^2 = 6.0678$  Pr = 0.048). The HHs farmer's perception in the two studied watersheds observation signifies that they have experienced Flood due to extensive rainfall. KKI also perceive the change in the weather condition they implied that temperature increased it has gotten hotter '*In the old times*

there used to be no mosquitos but this day there are mosquitos in spring and ponds’, Erratic rainfall, short duration of rainfall, late rainfall, No belg season rain and irradiation of some plants.

Over all respondents had perceived a reduction in the level of the rainfall and increment of temperature. From the blow graph we can conclude majority of the farmers in the study area perceived a decrease in the level of the rainfall but an increase in the level of temperature.



Source: own survey data (2018)

As seen on the above table 17, 83.33% of HHs in Emba Hasty have experienced crop failure during while 95.21% in Mehan kebele perceived the similar experience. The difference between those experienced and not experienced Crop failure was found to be statistically non-significant ( $X^2 = 2.3333$  Pr = 0.127. as shown in Table 17, 53.47% of HHs in Emba Hasty have not experienced Erratic rainfall while 62.33% in Mehan kebele experienced the similar change. The difference between those experienced and not experienced Crop failure was found to be statistically non-significant ( $X^2 = 2.3333$  Pr = 0.127). The HHs farmers have not experienced in the two studied watersheds.

As can be seen from Table 17, 92.36% of HHs in Emba Hasty have not experienced Lack of improved seed while 59.59% in Mehan kebele experienced Lack of improved seed. The difference between those experienced and did not experience crop failure was found to be statistically significant ( $X^2 = \text{Pearson chi2}(1) = 87.4500$  Pr = 0.000). The HHs farmers have experience Lack of improved seed in the two studied watersheds. On the above table 97.92% of HHs in Emba Hasty have not experienced unaffordable price of inputs while 99.32% in Mehan experienced the same. The difference between the experienced and not experienced Unaffordable price of inputs was found to be statistically non-significant ( $X^2 = \text{Pearson chi2 } 1.0422$  Pr = 0.307). The HHs farmers have not experience Unaffordable price of inputs in the two studied watersheds.

Climate induced shocks	Emba hasty		Mehan		P value
	No	Yes	No	Yes	
Crop failure during the last 10-20years?	24 (16.67%)	120 (83.33%)	7(4.79%)	139(95.21%)	Pearson chi2(1) = 2.3333 Pr = 0.127
Erratic rainfall	77(53.47%)	67(46.53%)	91(62.33%)	55(37.67%)	Pearson chi2(1) = 2.3333 Pr = 0.127
Lack of improved seed	133(92.36%)	71(7.64%)	59(40.41%)	87(59.59%)	Pearson chi2(1) = 87.4500 Pr = 0.000
Unaffordable price of inputs	141(97.92%)	3(2.08%)	145(99.32%)	1(0.68%)	Pearson chi2(1) = 1.0422 Pr = 0.307
Low level of soil fertility	108(75.00%)	36(25.00%)	94(64.38%)	52(35.62%)	Pearson chi2(1) = 20.7844 Pr = 0.000
Pest and disease	120(83.33%)	24(16.67%)	144(98.63%)	2(1.37%)	Pearson chi2(1) = 20.7844 Pr = 0.000
Shortage of farm oxen	143(99.31%)	1(0.69%)	145(99.32%)	0(0.00%)	Pearson chi2(2) = 2.0002 Pr = 0.368

Livelihood resilience capacity indicators	Emba Has		Mehan		P value
	No	Yes	Yes	No	
Crop productivity decline	14(9.72%)	130(90.28%)	16(10.96%)	130(89.04%)	Pearson chi2(1) = 0.1195 Pr = 0.730
Shortage of water for irrigation	18(12.50%)	126(86.50%)	8(5.48%)	138(94.52%)	Pearson chi2(1) = 4.3780 Pr = 0.036
Shortage of water for home	46(31.94%)	98(68.06%)	12(8.22%)	134(91.78%)	Pearson chi2(1) = 25.5047 Pr = 0.000
Emergence of new pests (weed)	15(10.42%)	129(89.58%)	27((18.49%)	119(8.51%)	Pearson chi2(1) = 3.8182 Pr = 0.051
Increased level of temperature	694.17%)	138(95.83%)	11(7.53%)	135(92.47%)	Pearson chi2(1) = 1.4898 Pr = 0.222
Increased level of drought	37(25.69%)	107(74.31%)	41(28.08%)	105(71.92%)	Pearson chi2(1) = 0.2102 Pr = 0.647
Increased level of flood	59(40.97%)	85(59.03%)	18(12.33%)	128(87.67%)	Pearson chi2(1) = 30.4996 Pr = 0.000
Geographic isolation	25(17.36%)	119(82.64%)	8(5.48%)	138(94.52%)	Pearson chi2(1) = 10.1489 Pr = 0.001
Livestock disease	13(9.03%)	131(90.97%)	10(6.85%)	136(93.15%)	Pearson chi2(1) = 0.4712 Pr = 0.492
Crop pest disease	11(7.64%)	133(92.36%)	1(0.68%)	145(99.32%)	Pearson chi2(1) = 8.8379 Pr = 0.003
Local conflict over diminishing resource	64(44.44%)	80(55.56%)	21(14.38%)	125(85.62%)	Pearson chi2(1) = 31.6187 Pr = 0.000
Price inflation	7(4.86%)	137(95.14%)	18(12.33%)	128(87.67%)	Pearson chi2(1) = 5.1321 Pr = 0.023

As seen on the above table 17, 75.00% of HHs in Emba Hasty have not experienced Low level of soil fertility while 64.38% in Mehan have experienced the same. The difference between the experienced and not experienced low level of soil fertility was found to be statistically non-significant ( $X^2 = \text{Pearson chi2 } 1.0422 \text{ Pr} = 0.307$ ). It was evident that 120(83.33) of HHs in Emba Hasty have not experienced pest and disease while 98.63% in Mehan have experienced the same. The difference between the experienced and not experienced Pest and disease was found

to be statistically significant ( $X^2 = \text{Pearson chi}^2 20.7844$  Pr = 0.000). The HHs farmers have not experience pest and disease in the two studied watersheds. From the same table, 99.31% of HHs in Emba Hasty have not experienced Shortage of farm oxen while 99.32% in Mehan they have experienced the same. The difference between the experienced and not experienced Shortage of farm oxen was found to be statistically significant ( $X^2 = \text{Pearson chi}^2 2.0002$  Pr = 0.368). The HHs farmers have not experience shortage of farm oxen in the two studied watersheds.

#### **Table 20 Livelihood resilience capacity indicators**

As seen on the above table 18, 90.28% of HHs in Emba Hasty kebele have experienced crop productivity decline while 89.04% in Mehan kebele have experienced the equivalent. The difference between the experienced and not experienced Crop productivity decline was found to be statistically not significant ( $X^2 = \text{Pearson chi}^2 0.1195$  Pr = 0.730).this explains that both watersheds have experienced crop productivity decline.

On table 18, 86.50% HHs in Emba Hasty kebele have experienced Shortage of water for irrigation while 94.52% in Mehan kebele have experienced similar thing. The difference between the experienced and not experienced in Shortage of water for irrigation was found to be statistically significant ( $X^2 = \text{Pearson chi}^2 =4.3780$ Pr = 0.036). The HHs farmers have experience Shortage of water for irrigation in the two studied watersheds.

From the above table 68.06% of HHs in Emba Hasty kebele have experienced Shortage of water for home while 91.78% in Mehan kebele have experienced the same. The difference between the experienced and not experienced Shortage of water for home was found to be statistically significant ( $X^2 = \text{Pearson chi}^2 =25.5047$  Pr = 0.000). The HHs farmers have experience shortage of water for home in the two studied watersheds.

Seen from the above table 89.58% of HHs in Emba Hasty kebele have experienced emergence of new pests (weed) while 80.51% in Mehan kebele have experienced the same. The difference between the experienced and not experienced Emergence of new pests (weed) was found to be statistically significant at 10 % significance level ( $X^2 = \text{Pearson chi}^2 =3.8182$  Pr = 0.051). The HHs farmers have experience emergence of new pests (weed)in the two studied watersheds. 138(95.83) of HHs in Emba Has kebele have experienced Increased level of temperature while

135(92.47) in Mehan kebele have experienced the same. The difference between the experienced and not experienced Increased level of temperature was found to be statistically non-significant ( $X^2 = \text{Pearson chi}^2 = 1.4898$  Pr = 0.222). The HHs farmers have experience Increased level of temperature in the two studied watersheds.

Followed by 74.3% of HHs in Emba Has kebele have experienced Increased level of drought while 71.92% in Mehan kebele have experienced the same. The difference between the experienced and not experienced Increased level of drought was found to be statistically not significant ( $X^2 = \text{Pearson chi}^2 = 0.2102$  Pr = 0.647). The HHs farmers have experience Increased level of drought in the two studied watersheds. 59.03% of HHs in Emba Has kebele have experienced Increased level of flood while 87.67% in Mehan kebele have experienced the same. The difference between the experienced and not experienced Increased level of flood was found to be statistically significant ( $X^2 = \text{Pearson chi}^2 = 30.4996$  Pr = 0.000). The HHs farmers have experience Increased level of flood in the two studied watersheds. 68.06%, 82.64% of HHs in Emba Hasty kebele have experienced Geographic isolation while 94.52% in Mehan kebele have experienced the same. The difference between the experienced and not experienced Geographic isolation was found to be statistically significant ( $X^2 = \text{Pearson chi}^2 = 10.1489$  Pr = 0.001). The HHs farmers have experience geographic isolation in the two studied watersheds.

Trailed by 90.97% of HHs in Emba Hasty kebele have experienced Livestock disease while 93.15% in Mehan kebele have experienced the same. The difference between the experienced and not experienced Livestock disease was found to be statistically significant ( $X^2 = \text{Pearson chi}^2 = 0.4712$  Pr = 0.492). The HHs farmers have experience Livestock disease in the two studied watersheds. 92.36% of HHs in Emba Hasty kebel have experienced Crop pest disease while 99.32% in Mehan kebele have experienced the same. The difference between the experienced and not experienced Crop pest disease was found to be statistically significant ( $X^2 = \text{Pearson chi}^2 = 8.8379$  Pr = 0.003). The HHs farmers have experience Crop pest disease in the two studied watersheds.

Again 55.56% of HHs in Emba Hasty kebele have experienced Local conflict over diminishing resource while 85.62% in Mehan kebele have experienced the same. The difference between the experienced and not experienced Local conflict over diminishing resource was found to be

statistically significant ( $X^2 = \text{Pearson chi}^2 = 31.6187$  Pr = 0.000). The HHs farmers experience Local conflict over diminishing resource in the two studied watersheds.

Last but not list 95.14% of HHs in Emba Hasty kebele have experienced Price inflation while 87.67% in Mehan kebele have experienced the same. The difference between the experienced and not experienced Price inflation was found to be statistically significant ( $X^2 = \text{Pearson chi}^2 = 5.1321$  Pr = 0.023). The HHs farmers have experienced Price inflation in the two studied watersheds.

**Table 21 Access to and use of publicly owned resources**

Access to resources	Yes	No	Pearson chi2(1), p-value
	Count (%)	Count (%)	
Own grazing land	203 (70)	87 (30)	54.4814 Pr = 0.000
Publicly owned grazing land	229 (78.97)	61 (21.03)	4.9370 Pr = 0.026
Publicly owned water for livestock	201 (69.31)	89 (30.69)	13.0631 Pr = 0.000
Publicly owned firewood	96 (33.10)	194 (66.90)	33.9058 Pr = 0.000

Source: own gathered data

As seen on the above table 70% of HHs in both watersheds have their own grazing land. The difference between the those who have grazing land and those who do not have was found to be statistically significant ( $X^2 = 54.4814$  Pr = 0.000). Similarly, 78.97% of HHs in both watersheds have publicly owned grazing land those who do not have was found to be statistically significant ( $X^2 = 4.9370$  Pr = 0.026). 69.31% household in both water shade have Publicly owned water for livestock The difference between the those who have grazing land and those who do not have was found to be statistically significant ( $X^2 = 13.0631$  Pr = 0.000). lastly as the table shows 66.90% of the households do not have Publicly owned firewood. The difference between those who have grazing land and those who do not have was found to be statistically significant ( $X^2 = 33.9058$  Pr = 0.000). The HHs farmers experience 86.50% in the two studied watersheds signifies that they have Access to and use of publicly owned resources.

**Table 22 Main constraints to your farmlands**

Farm land constraints	Yes	No	Pearson chi2(1), p-value
	Count (%)	Count (%)	
Erosion	181 (62.41)	109 (37.59)	14.8200 Pr = 0.000
Waterlogging	127 (43.79)	163 (56.21)	4.4767 Pr = 0.034
Poor soil fertility	128 (44.14)	162 (55.86)	63.0031 Pr = 0.000
Susceptibility to frost	13 (4.48)	277 (95.52)	6.6541 Pr = 0.010
High concentration of stones on the topsoil	272 (93.79)	18 (6.2)	3.9096 Pr = 0.048
Highly sandy	289 (99.66)	1 (0.34)	1.0174 Pr = 0.313
Water scarcity-inaccessibility to water or drought	281 (96.90)	9 (3.10)	2.9385 Pr = 0.086

Source: own data gathered 2018

First as seen on the above table states the main farmland constraints the farmers face as 62.41% of HHs in both watersheds have stated that erosion as farm land constraint. The difference between those who have grazing land and those who do not have was found to be statistically significant ( $X^2 = 14.8200$  Pr = 0.000).this shows that the HHs mainfarm land constraints include erosion. Secondly on the above table states the main farmland constraints the farmers face as 56.21% of HHs have stated that Waterlogging is not one of the farm land constraint. The difference between the those who have Waterlogging and those who do not have was found to be statistically significant ( $X^2 = 4.4767$  Pr = 0.034).this shows that the HHs main farm land constraints do not include waterlogging. Third the table states the main farmland constraints the farmers face as 55.86% of HHs have stated that Poor soil fertility is not one of the farm land constraint. The difference between the those who have Poor soil fertility and those who do not have was found to be statistically significant ( $X^2 = 63.0031$  Pr = 0.000).this shows that the HHs main farm land constraints do not include Poor soil fertility.

Forth the main farmland constraints, the farmers face as 95.52% of HHs have stated that is Susceptibility to frost is not one of the farm land constraint. The difference between the those who say Susceptibility to frost and those who do not say was found to be statistically significant

( $X^2 = 6.6541$  Pr = 0.010) this shows that the HHs main farm land constraints do not include Susceptibility to frost. Fifth main farmland constraints the farmers face as 93.79 % of HHs have stated that High concentration of stones on the topsoil is one of the farm land constraint. The difference between those who have High concentration of stones on the topsoil and those who do not have was found to be statistically significant ( $X^2 = 3.9096$  Pr = 0.048). This shows that the HHs main farm land constraints include High concentration of stones on the topsoil. Sixth the main farmland constraints the farmers face as 99.66% of HHs have stated that Highly sandy is one of the farm land constraint. The difference between those who say highly sandy and those who do not was found to be statistically significant ( $X^2 = 1.0174$  Pr = 0.313). This shows that the HHs main farm land constraints include highly sandy. Seventh the main farmland constraints the farmers face as 96.90% of HHs have stated that Water scarcity-inaccessibility to water or drought is one of the farm land constraint. The difference between the those who have Water scarcity-inaccessibility to water or drought and those who do not have was found to be statistically significant ( $X^2 = 2.9385$  Pr = 0.086). This shows that the HHs main farm land constraints include Water scarcity-inaccessibility to water or drought.

**Table 23 Practice to minimize soil erosion**

Practice to minimize soil erosion	Yes	No	Pearson chi2(1), p-value
	Count (%)	Count (%)	
Terracing	194 (66.90)	96 (33.10)	0.6911 Pr = 0.406
Crop rotation	126(43.45)	164 (56.55)	8.6800 Pr = 0.003
Using compost	125 (43.10)	165 (56.90)	0.0488 Pr = 0.825
Soil or stone bunds	154 (53.10)	136 (46.90)	209.2815 Pr = 0.000
Contour ploughing	74 (25.52)	216 (74.48)	4.3533 Pr = 0.037
Furrowing	94 (32.41)	196 (67.59)	63.1759 Pr = 0.000
Strip cultivation	6 (2.07)	284 (97.93)	6.0428 Pr = 0.014
Tree planting	59 (20.34)	231 (79.66)	3.3746 Pr = 0.066

Source: own data gathered

As seen on the above table the measure(s) HHs practice to minimize soil erosion 66.90% of HHs have stated that Terracing is one of the measure(s) HHs use to minimize erosion. The difference

between those who use terracing and those who do not use was found to be statistically non-significant ( $X^2 = 0.6911$  Pr = 0.406). As seen on the above table the measure(s) HHs practice to minimize soil erosion 56.55% of HHs have stated that crop rotation is not one of the measure(s) HHs use to minimize erosion. The difference between those who use crop rotation and those who do not use was found to be statistically significant ( $X^2 = 8.6800$  Pr = 0.003), which shows that the HHs measure(s) HHs practice to minimize soil erosion do not include Crop rotation.

It is evident that the measure(s) HHs practice to minimize soil erosion 56.90% of HHs have stated that Using compost is not one of the measure(s) HHs use to minimize erosion. The difference between those who use compost and those who do not use was found to be statistically not significant ( $X^2 = 0.0488$  Pr = 0.825). As seen on the above table the measure(s) HHs practice to minimize soil erosion 53.10% of HHs have stated that Soil or stone bunds is one of the measure(s) HHs use to minimize erosion. The difference between those who use Soil or stone bunds and those who do not use was found to be statistically significant ( $X^2 = 209.2815$  Pr = 0.000) that signify the HHs measure(s) HHs practice to minimize soil erosion include Soil or stone bunds.

As seen on the above table 18 the measure(s) HHs practice to minimize soil erosion 74.48% of HHs have stated that Contour ploughing is not one of the measure(s) HHs use to minimize erosion. The difference between those who Contour ploughing and those who do not use was found to be statistically significant ( $X^2 = 4.3533$  Pr = 0.037).this shows that the HHs measure(s) HHs practice to minimize soil erosion do not include Contour ploughing.

As can be seen from the above table, the measure(s) HHs practice to minimize soil erosion 67.59% of HHs have stated that Furrowing is not one of the measure(s) HHs use to minimize erosion. The difference between those who Furrowing and those who do not use was found to be statistically significant ( $X^2 = 63.1759$  Pr = 0.000).this shows that the HHs measure(s) HHs practice to minimize soil erosion do not include Furrowing. As seen on the above table the measure(s) HHs practice to minimize soil erosion 97.93% of HHs have stated that Strip cultivation is not one of the measure(s) HHs use to minimize erosion. The difference between those who Strip cultivation and those who do not use was found to be statistically significant

( $X^2 = 6.0428$  Pr = 0.014).this shows that the HHs measure(s) HHs practice to minimize soil erosion do not include Strip cultivation.

As seen on the above table the measure(s) HHs practice to minimize soil erosion 79.66% of HHs have stated that Tree planting is not one of the measure(s) HHs use to minimize erosion. The difference between those who use Tree planting and those who do not use was found to be statistically significant ( $X^2 = 3.3746$  Pr = 0.066).this shows that the HHs measure(s) HHs practice to minimize soil erosion do not include Tree planting.

**Table 24 Land management practice**

Land management practice	Yes	No	Pearson chi2(1), p-value
	Count (%)	Count (%)	
Fallowing (field rotation)	61 (21.03)	229 (78.97)	27.7795 Pr = 0.000
Crop rotation	178 (61.38)	112 (38.62)	24.1832 Pr = 0.000
Manuring	193 (66.55)	97 (33.45)	58.9146 Pr = 0.000
Use of fertilizers (e.g., Dap, Urea)	237 (81.72)	53( 18.28)	51.7987 Pr = 0.000
Inter-cropping	72 (24.83)	218 (75.17)	28.8337 Pr = 0.000

Source: own data gathered 2018

As seen on the above table 22, 78.97% HHs do not carry out Fallowing (field rotation) as land management practice. The difference between the those who use Fallowing and those who do not use was found to be statistically significant ( $X^2 = 27.7795$  Pr = 0.000).this shows that the HHs measure(s) HHs practice to maintain and replenish the soil fertility do not include Fallowing.

As seen on the above table22, 61.38% HHs carry out crop rotation as land management practice. The difference between the those who use Crop rotation and those who do not use was found to be statistically significant ( $X^2 = 24.1832$  Pr = 0.000), which shows that the HHs measure(s) HHs practice to maintain and replenish the soil fertility include Crop rotation. As seen on the above table 66.55% HHs carry out Manuring as land management practice. The difference between the those who use Manuring and those who do not use was found to be statistically

significant ( $X^2 = 58.9146$  Pr = 0.000).this shows that the HHs measure(s) HHs practice to maintain and replenish the soil fertility include Manuring. As seen on the above table 81.72% HHs carry out use of fertilizers as land management practice. The difference between the those who use of fertilizers and those who do not use was found to be statistically significant ( $X^2 = 51.7987$  Pr = 0.000).this shows that the HHs measure(s) HHs practice to maintain and replenish the soil fertility include Use of fertilizers.

It is evident that, 75.17% HHs do not carry out Inter-cropping land management practice. The difference between the those who use Inter-cropping and those who do not use was found to be statistically significant ( $X^2 = 28.8337$  Pr = 0.000).this shows that the HHs measure(s) HHs practice to to maintain and replenish the soil fertility do not include Inter-cropping.

**Table 25 Agricultural inputs usage**

Agricultural inputs usage	Yes	No	Pearson chi2(1), p-value
	Count (%)	Count (%)	
DAP	259 (89.31)	31 (10.69)	10.7031 Pr = 0.001
Urea	255 (87.93)	35 (12.07)	14.6614 Pr = 0.000
Improved seeds	131 (45.17)	159 (54.83)	0.5175 Pr = 0.472

Source: own data gathered 2018

On the above table 23,89.31% HHs Use DAP as land management practice. The difference between the those who use of DAP and those who do not use was found to be statistically significant ( $X^2 = 10.7031$  Pr = 0.001).this shows that the HHs measure(s) HHs practice to maintain and replenish the soil fertility include Use of DAP. As seen on the above table 87.93% HHs Use DAP as land management practice. The difference between the those who use of Urea and those who do not use was found to be statistically significant ( $X^2 = 14.6614$  Pr = 0.000).this shows that the HHs measure(s) HHs practice to maintain and replenish the soil fertility include Use of Urea.

On the above table 54.83% HHs do not Use Improved seeds as land management practice. The difference between the those who use of Improved seeds and those who do not use was found to

be statistically non-significant ( $X^2 = 0.5175$  Pr = 0.472).this shows that the HHs measure(s) HHs practice to maintain and replenish the soil fertility do not include Use of Improved seeds.

**Table 26 Amount used during the 2009/2010 production season**

Agricultural inputs usage	Emba Has	Mehan	Pr( T  >  t ), p-value
	Mean (SE)	Mean (SE)	
DAP total amount used in (KG)	0.2639706 (0.1607597)	0.334314 (0.1497287)	t = -3.6359, df =256, p=0.0003
Urea total amount used in (KG)	0.2475603 (0.152434 )	0.3403777 (0.1548822)	t=-4.7997, df=253, p= 0.0000
Improved seeds total amount used in (KG)	.4305556 (.4968823)	.4726027 (.5009674)	t=4.1409, df=p=0.0001

Source: own data gathered 2018

On the above table 0.1497287% HHs in mehan watershed DAP total amount used in (KG) increased than that of Emba hasty 0.1607597%. A t-test between Emba hasty and Mehan on the DAP total amount used in (KG) suggest that there is statistically significant difference between the two project sites (t = -3.6359, df =256, p=0.0003). On the above table 23, 0.1548822% HHs in mehan watershed Urea total amount used in (KG) increased than that of Emba hasty 0.152434%. A t-test between Emba hasty and Mehan on the Urea total amount used in (KG) suggest that there is statistically significant difference between the two project sites (t=-4.7997, df=253, p= 0.0000).

On the above table23,.5009674% HHs in mehan watershed Improved seeds total amount used in (KG)increased than that of Emba hasty .4968823%. A t-test between Emba hasty and Mehan on the Improved seeds total amount used in (KG)suggest that there is statistically significant difference between the two project sites (t=4.1409, df=p=0.0001).

**Table 27 Total amount of cost incurred (birr) during the 2009/2010 production season**

<b>Agricultural inputs cost</b>	<b>Emba Has</b>	<b>Mehan</b>	<b>Pr( T  &gt;  t ), p-value</b>
	Mean (SE)	Mean (SE)	
DAP amount of costs incurred (birr)	450.8697 (321.1006)	494.1223 (251.8199)	t=-1.2116, df=256, p= 0.2268
Urea amount of costs incurred (birr)	354.4353 (167.1135)	433.9281 (207.7771)	t= -3.3204, df=253, p=0.0010
Improved seeds amount of costs incurred (birr)	606.5645 (271.0375)	466.2319 (223.9919)	t=3.2421, df=129, p=0.0015

Source: own data gathered 2018

On the above table 24, 251.8199% HHs in Mehan spent cash on DAP increased than that of Emba hasty 321.1006%. A t-test between Emba hasty and Mehan on the DAP amount of costs incurred (birr) suggest that there is statistically significant difference between the two project sites (t=-1.2116, df=256, p= 0.2268). It is evident that 207.7771% HHs in Mehan spent cash on Urea increased than that of Emba hasty 167.1135%. A t-test between Emba hasty and Mehan on the Urea amount of costs incurred (birr) suggest that there is statistically significant difference between the two project sites ( t= -3.3204, df=253, p=0.0010). As shown in Table 25, 271.0375% HHs in Emba Hasty spent more cost in Improved seeds than that of Mehan. 223.9919% A t-test between Emba hasty and Mehan on the Improved seeds amount of costs incurred (birr) suggest that there is statistically significant difference between the two project sites (t=3.2421, df=129, p=0.0015).

**Table 28 Total land area covered by the agricultural input (ha) during the 2009/2010 production season**

<b>Agricultural inputs covered area (ha)</b>	<b>Emba Has</b>	<b>Mehan</b>	<b>Pr( T  &gt;  t ), p-value</b>
	Mean (SE)	Mean (SE)	
DAP total area covered using inputs (in ha)	0.2578571 (0.1711982)	2.893435 (30.29605)	t=-0.9487, df=256, p= 0.3437
Urea total area covered using inputs (in ha)	0.2296552 (0.1433117)	0.3235612 (.2224039)	t=-3.9184, df=253, p=0.0001
Improved seeds total area covered using inputs (in ha)	0 .4375 (0.2535607)	0.3378623 (0.2034623)	t= 2.4916, df=129, p=0.0140

Source: own data gathered 2018

On the above table 26 30.29605% HHs in Mehan total area covered by DAP increased than that of Emba hasty 0.1711982%. A t-test between Emba hasty and Mehan on the DAP total area covered using inputs (in ha) suggest that there is statistically significant difference between the two project sites ( $t=-0.9487$ ,  $df=256$ ,  $p= 0.3437$ ). On the above table 26, 207.7771% HHs in Mehan total area covered by Urea increased than that of Emba hasty 0.1433117% A t-test between Emba hasty and Mehan on Urea total area covered using inputs (in ha) suggests that there is statistically significant difference between the two project sites ( $t=-3.9184$ ,  $df=253$ ,  $p=0.0001$ ).

From the same table 26, 0.2535607% HHs in Emba Hasty spent more cost in improved seeds than that of Mehan. 0.2034623% A t-test between Emba Hasty and Mehan on Improved seeds total area covered using inputs (in ha) pinpoints that there is statistically significant difference between the two project sites ( $t= 2.4916$ ,  $df=129$ ,  $p=0.0140$ ).

## **4.2. Econometric Model Results**

### **4.2.1. Binary Logistic Model**

In this section, binary logistic model was employed to estimate the effect of each hypothesized variables on the resilience capacity of sampled households. The household resilience capacity index (HRCI) index was developed and the threshold was obtained from the resilience index (HRCI  $\geq 0.5$  was coded as 1 or resilient category while HRCI  $\leq 0.5$  was coded as 0, representing the non-resilient category). Table 4 below shows the odds ratio, the p-value and the marginal effects of explanatory variables on the dependent variable household or community resilience.

**Table 29 Explanatory variables on the dependent variable household or community resilience**

Resilience	Odds Ratio	Robust Std. Err.	Z	P>z	Marginal Effect dy/dx
_Iqn2_2_Sex_1	.8499923	.406516	-0.34	0.734	-.0399367
qn2_1_Age	1.032768	.0221421	1.50	0.133	.0079616
qn2_3_Family	.8044909	.0937982	-1.87	0.062*	-.0537173
_Iqn2_6_1_E_14	1.571112	.7715355	0.92	0.358	.1106618
Aggrigate_income	1.000028	.0000112	2.51	0.012**	6.91e-06
qn7_11_traning	3.432919	1.977349	2.14	0.032**	.2988646
_Iqn3_5_of_1	7.924879	4.46552	3.67	0.000***	.4657535
qn5_4_6_total_land	1.048701	1.212451	0.04	0.967	.0117418
_Iqn7_15_ca_1	.2213688	.1140985	-2.93	0.003***	-.3450699
_Iqn7_6_ear_1	.5017238	.3319519	-1.04	0.297	-.160815
_Iqn7_26_sm_1	.1275617	.0757838	-3.47	0.001***	-.4730991
_Iqn7_20_sa_1	9.922615	26.02229	0.88	0.382	.449153
qn10_1_cropfaliur	3.593674	4.126966	1.11	0.265	.3000615
qn10_4_floodfrq	.9446081	.162696	-0.33	0.741	-.014071
qn10_5_drought	.2367833	.145677	-2.34	0.019**	-.3070323
qn10_7_cropdisease	.32845	.3102221	-1.18	0.238	-.2485627
qn10_9_livestockdis	.082155	.0632349	-3.25	0.001***	-.4749146
qn10_11_humandisease	2.452983	1.852417	1.19	0.235	.2203253
_cons	.2869091	.9103395	-0.39	0.694	

Source: Computed from own survey data (2018),

\*, \*\* and \*\*\* = significant at 10%, 5% and 1% level of significance, respectively

The Binary logit model result indicates that Sex (X<sub>1</sub>) Age (X<sub>2</sub>), Famlsz (X<sub>3</sub>), Eductn (X<sub>4</sub>), Land (X<sub>5</sub>), Credit (X<sub>6</sub>), Livestock (X<sub>7</sub>), Market (X<sub>8</sub>), Income (X<sub>9</sub>), Ext.Vist [(X<sub>10</sub>)C, Oop (X<sub>11</sub>), Wter (X<sub>12</sub>), Irrg (X<sub>13</sub>), Offrm (X<sub>14</sub>), Saving (X<sub>15</sub>), Info (X<sub>16</sub>),

Expr (X\_17), Shock (X\_18) were determining farmer's choice of livelihood strategies (Table 27). Therefore, binary logit analysis results indicate selection of each type of livelihood strategy is affected by different factors and at different levels of significance by the same factor (Table 27) however, the magnitude fact of some significant variables is not similar. From the total of eighteen (18) explanatory variables, eight (8) of them were found to be statistically significant at 1 and 5 and 10% level of significance; and the remaining ten (10) variables become insignificant in predicting the likelihood of resilience capacity of the sampled households. The variables stated below show how they influence the resilience capacity of the households.

**Family Size:** It affects household's resilience in a negative and significant way with p-value, odds ratio and marginal effect of 0.062, 0.080 and -0.053 respectively. The odds ratio for family size indicates that the probability of household's resilience decreases by 0.062 times for one family member increment in the household. The marginal effect indicates that, keeping other factors constant, as a family size increases by one unit the probability of household's resilience decreases by 5.3 percent. As it was hypothesized, family size and households' resilience capacity has shown an inverse relationship. This may be due to households with large family size are vulnerable to poverty related with large family size which makes them vulnerable and incapable to cope up with the climate changes. Large family size drags down the household's ability to strive among those who have small families. There will be imbalance between the income and expenditure of the household. This indicated that family size had a negative influence on the household's resilience capacity in the FGD the group has emphasized on how having large family difficult till at least all the children grow. AS 2016 Fentaw stated in his study Determinants of income inequality in urban Ethiopia The most important factor to explain inequality is family size. Hence it is expected that educated households are likely to have fewer children. Hence, the expansion of education, especially female education, and intensification of family planning programme at grass root level are amongst areas deserving prime attention to mitigate problem of large family size as a means of aggravating urban poverty. This requires the provision of modern birth control methods and expansion of health centers.

**Total Income:** As estimated, total income of households and their resilience capacity has shown a significant and positive relationship with p-value of 0.012. The odds ratio value of 1.00 indicates that the probability of households' resilience capacity is increases by 2.651 times for

one-birr increment in annual income of households. Households with high annual income found to be more resilient to climate change than those households with lower annual income. The marginal effect of income has a value of  $6.91e-06$ . This implies that, assuming everything is constant, as income level of a household increases by one birr their probability to be resilient for a given climate change increases by 0.000691 percent. This result implies that households having large cash income are more likely to be resilient by diversifying the livelihood strategies into non-farm, off farm activities and saving. On other word, this result shows that those farmers with low income are less likely to be resilient than those who have high income. The possible reason is that those farmers who have adequate income sources can overcome financial constraints to engage alternative livelihood strategies and be resilient. Hence, higher income can encourage them to invest in other income generating activities especially non-farm activities. Similar finding was reported by Babatunde, Olagunju and Fakayode, Isaac and Woinishet (2010) show that the significant determinants of income on livelihood diversification into non-farm and/or off-farm activities wick can be said the household is resilient.

**Training:** households' resilience capacity was positively and significantly related with training provided with p-value and odds ratio of 0.032 and 3.43 respectively. The odds ratio result indicates that, the likelihood of being resilient for a given climate change for trained households is 3.43 times higher than the untrained one. The marginal effect of this variable is 0.298 implying that, keeping other factors constant, the probability of resilience capacity for trained households' increases by 29.8% as compared to untrained households.

This implies that households' participation in agricultural training most likely increases the likelihood of livelihood resilience. The probable reason is that the training enhances agricultural production skills, knowledge and experiences of farmers. This situation helps farmers to get better production, and then this most likely leads to obtain more income to fulfill their family requirements This is because the community members benefit they get from the trainings the respondents have stated that the gather new information from the trainings regarding new technologies, health and the environment. This arms the households with effective and new ways to do their activities. The FGD discussed with the informants itemized that the how different trainings the respondents participate on gives them a wider perspective on their daily activities

and how they transfer that knowledge to the others. The result of this study Dilruba and Roy (2011) indicates the positive association of training and livelihood diversification.

**Off farm activity engagement:** As it was hypothesized, households' engagement in off-farm activity and their resilience capacity has shown a positive and significant relationship with p-value of 0.000. The odds ratio result indicates that, the likelihood of being resilient for a given climate change for those households who engage themselves in off-farm activity is 7.92 times higher than that of those who don't. When we look at the marginal value of the variable, assuming everything constant, the probability for households to cope up with the given climate change increased by 46.5% for households who make a living based on off-farm activity compared to those households who only depend of farming activity. This may be due to diversifying the means livelihood is one way of mitigating the impact of climate change. More resilient households have the capacity to engage both on-farm and off-farm diversification activities. The study finding is in goes in harmony with that of Apata (2010) in that households with increased number of non/off-farm activities can make more money from non/off-farm sources. Very few households were engaged in off-farm/non-farm activities 2013as Bazezew stated in his study Lack of access to non-farm and off-farm activities is perhaps a major cause for the low coping and adaptive capacities of households in times of food security crises.

Agriculture is the dominant economic activity and the primary source of livelihoods for rural households in the study area. However, due to small farm size, uncontrolled population growth, recurrent drought, the agricultural production has been deteriorating over time, and has forced people to look for alternative employment option other than agriculture. A significant number of rural households engage in diverse livelihood strategies away from purely crop and livestock production towards non-farm and off farm activities that are undertaken to broaden and generate additional income for survival and livelihood improvement. The result of this study Dilruba and Roy indicates the positive association of training and livelihood diversification.in similar idea Zerihun and Befikadu (2017) in their study they highlighted that households are able to engage in both on-farm and off-farm activities and maintain their household income during times of climate change shocks.

**Saving:** saving was the other form of financial capital, identified by household heads participated in the study, as having effect on the resilience of households. Household's resilience capacity is inversely related with the households saving with P-value of 0.003. The odds ratio result indicates that, the likelihood of being resilient for a given climate change impact for those households who does not have a saving is 0.221 times lower than that of who have a saving. The marginal effect with the value of -0.345 indicates that, keeping other factors constant, resilience capacity of those households who don't have saving decreases by 34.5% as compared to households who have a saving. This might be due to savings crucially in helping households to quickly recover from the effects of climate change induced shocks to replace lost assets and income. During the interview with the informants they emphasized that, those who save were in a better position to withstand the aftermath shocks of flooding and/or any other related shocks as they can replace their lost assets. In general saving contributes to their resilience through creating more opportunities for livelihood diversification that enable households to manage and cope with climate change impacts in more sustainable ways. Among those who do not save, their resilience level is found to be very low.

**Experience of Natural shock:** it was hypothesized that, as if there will be an inverse relationship between households' experience in natural shock and their reliance capacity. To capture their experience in natural shock, households were asked about their experience regarding crop failure, flood, drought, crop disease, livestock disease and human diseases. From the above mentioned six indicators for natural shock, drought and livestock disease have shown an inverse and significant association with the independent variable. Drought with odds ratio value of 0.236, indicates that, households with drought experience is tend to be less resilient for a given climate change by the value of 0.236 times. And, the marginal effect value implies that, assuming everything is constant, households' resilience capacity decreased by 30.7% if they are experienced with drought. The other indicator was livestock disease which have shown a negative and significant relationship with the dependent variable with a p-value, odds ratio and marginal effect of 0.001, 0.082 and -0.474 respectively. The odds ratio result indicates that, the likelihood of being resilient for a given climate change for households who have faced with livestock disease is 0.082 times lower than that of households' who did not have faced the livestock disease. The marginal effect of the variable implies that, keeping other factors constant,

the probability of resilience capacity for those households' who have faced with livestock disease is decreased by 47.4% when we compare it to households' who did not face livestock disease. This can be due to different reasons but one thing that can certain is that because they have been exposed to the shock it is difficult for them to get back on their feet this makes it difficult for them.

## **CHAPTER FIVE: CONCLUSION AND RECOMMENDATION**

### **5.1 CONCLUSION**

The study was conducted to see watershed management in enhancing communities' resilience to climate change induced impacts focusing on community's perception regarding climate change and variability, watershed management practices in enhancing household resilience capacities in the face of changing climate and watersheds socio economic outcome. Focusing mainly on the resilience capacity enhanced by watershed management of rural households in Michew area Emba Hasty and Mehan watershed. The study attempted to show that the change in climate in the study area has clearly changed over the past two decade. Starting when we see the community's perception on climate change and variability the households are aware of the changing climate their misconception is that the respondents take climate change caused not by human action but supernatural. The study shows that the overall temperature and over all rainfall has change. There is low rainfall, temperature has increased, early cessation of rainfall has increased, floods and drought have become more frequent owing to a number of factors that derive from both climatic and topographic conditions. Such as, periodic changes in the amount of rainfall, the nature of watershed system and high concentration of stone in topsoil. In addition, certain human activities including deforestation, increased in plantation of eucalyptus tree, and traditional systems of cultivation were found to intensify the hardships on the households. The findings of the study highpoint that watershed management has positive impact on the community different agricultural extension services like natural resource management, soil and water conservation program, agronomy production, livestock production, irrigation expansion and climate resilience (it has been two years since it started) helped the community to bring a change despite its harsh climate. Households family size, total to income, participating in off farm activities, saving, training and experience in natural shock has big role in terms of determining the resilience of households.

### **5.2 RECOMMENDATION**

Some recommendations are Context specific institutional interventions such as the integrated safety nets may off-set livelihood predicaments. The safety nets can be implemented in the form of public works that are relevant to minimizing exposure to the recurring climate change impacts. Watershed management practices should work on strengthen both the absorptive and

adaptive capacities of households and communities in short-term while enhancing their transformative capacity in the long-term.

These imply that policy should focus more on addressing the factors that expose the community in strengthening their resilience capacities (adaptive, absorptive and transformative) to the long term, rather than focusing on short-term emergency responses, which seems to be a trend in Ethiopia.

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Module 1: Preliminary information

Zone _____	Household Code _____	
Woreda _____	Survey Date _____	Enumerator's Name _____
Kebele _____	Survey _____	Time _____
		Signature _____
Agro-ecology type: 1=Highland 2= Midland 3=Lowland		

MODULE 2: DEMOGRAPHIC AND SOCIO-ECONOMIC DATA OF THE HOUSEHOLD

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
relati o n to head (code 1)	Age (years)	Sex (Code 1 <sup>2</sup> )	Famil y Size (num ber)	Mari tal Stat us (Code 2 <sup>3</sup> )	Relig ion (Code 3 <sup>4</sup> )	Educat ion Level (Code 4 <sup>5</sup> )	Primary Occupat ion (Code 5 <sup>67</sup> )	Second Occupat ion (Code 5)	Lengt h of years in the curren t reside nce [write years]	Estima ted monthl y incom e (Birr)	Estima ted annual incom e (Birr)

<sup>1</sup> 1= Head 2= Wife/Husband/Partner 3= Son/daughter 4= Grandchild 5= Father/Mother 6= Sister/Brother 7= Niece/nephew 8= Uncle/Aunt 9= Son/Daughter-in-law 10= Father/Mother-in-law 11= Brother/Sister-in-law 12= Grandparent 13= Other relative of head or of his/her spouses 14= Servant (farm worker, herder, maid) 15= other (specify) \_\_\_\_\_

<sup>2</sup> Male = 1 Female = 2

<sup>3</sup> Single = 1 Married with 1 spouse = 2 Married with more than 1 spouse = 3 Divorced = 4 Widowed = 5 Separated = 6

<sup>4</sup> Orthodox = 1 Muslim = 2 Protestant = 3 Catholic = 4 Traditional = 5 Pagan = 6

<sup>5</sup> Cannot read & write = 13 Read & write = 14 Diploma = 15 Bachelor Degree = 16 Master Degree = 17 PhD = 18

<sup>6</sup> Crop and livestock production = 1 Trade of commodities = 2 Trade of Crops & livestock = 3 Local beverage production & sell =

<sup>7</sup> Charcoal production & sell = 5 Broker = 6 Other (Specify) \_\_\_\_\_


**MODULE 3: HOUSEHOLD SOURCES OF INCOME (ON-FARM, OFF-FARM AND NON-FARM ACTIVITIES)**

What are the sources of livelihoods and estimated earnings for all members in the household?  
(Answer all that apply)

Farming activities	Codes (1=Yes;2=No)		Estimated yearly income
3.1 Crop production			
3.2 Livestock rearing			
3.3 Fruit production			
3.4 Bee keeping			
Type	Codes (1=Yes;2=No)	# of months	Estimated yearly income
3.5 Off-farm activities			
3.6 Non-farm activities			
3.7 Other (specify)			

MODULE 4: FOOD SECURITY INDICATORS

4.1. Indicate the months of not enough food, enough food and surplus food you have experienced during the last 12 months?

0=Not enough food/food insecure											
1= Just enough food/food sufficient											
2= Plenty of food/surplus or food secure											
2008/2016											
Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Total # of food needs met (all months with the score of 1 or 2)											
Total # of food gaps (all months with the score of 0)											

MODULE 5: LIVELIHOOD RESILIENCE CAPACITY INDICATORS

5.1 Do you have access to land for agricultural use? 1=Yes; 2= No

5.2 If yes for QN #5.1, how did you get it?

1=through land redistribution 2=Shared with the family/relatives 3=Inherited from parents

4=Rented

6=Other (specify) \_\_\_\_\_

5.3 Do you have land use right/ownership certificate? 1= Yes 2=No

5.4 What are the total sizes of the following land types that you use?

Land type	Land owned in hectare/local unit
5.1 Cultivated land	
5.2 Fallow land	
5.3 Grass and woodland	
5.4 Forest land/wood lot	
5.5 Irrigated land out of cultivated	
5.6 Total land holding	

5.5 What type of soil is your cultivated land? 1=Black 2=Brown 3=Red; 4= Other (specify)

\_\_\_\_\_

5.6 How did you plough your land? 1=Using pair of oxen/horses; 2=Using hand hoe; 3=Using machine or tractor; 4=Others specify\_\_\_\_\_

5.7 Indicate your access to other publicly owned land resources

Indicator questions	Code definition	Response
1. Do you have own grazing land?	1=Yes 2= No	
2. Do you have access to open or publicly owned grazing land?	1=Yes 2= No	
3. Do you have access to open or publicly owned water source for livestock?	1=Yes 2= No	

4. Do you have access to get firewood from open or publicly owned forested land?	1=Yes 2= No	
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5.8 What are the main constraints to your farmlands? [Multiple response is possible]

1= Erosion; 2= Waterlogging; 3= Poor soil fertility; 4=Susceptibility to frost; 5= High concentration of stones on the topsoil; 6= Salinity; 7= Highly sandy; 8=Water scarcity-inaccessibility to water or drought; 9=Other (specify) \_\_\_\_\_

5.9 Which measure(s) do you practice to minimize soil erosion on your own farm, and in your community at large? [Multiple response is possible]

1= Terracing; 2= Crop rotation; 3= Using compost; 4= Tree planting; 5= Soil or stone bunds; 6=Contour ploughing; 7=Furrowing; 8= Strip cultivation; 9= Other (specify) \_\_\_\_\_

5.10 Which of the following land management practice do you carry out in order to maintain and replenish the soil fertility of your farmlands? [Multiple response is possible]

1= Fallowing (field rotation); 2= Crop rotation; 3= Manuring; 4= Use of fertilizers (e.g., Dap, Urea, and blended fertilizer); 5= Inter-cropping; 6= Other (specify) \_\_\_\_\_

5.11 Would you list the type and amount of agricultural inputs you used in the 2009/2010 cropping year?

Type of agricultural inputs		Responses 1=Yes 2=No	Total amount used in Kg.	Total amount of costs incurred	Total area covered using inputs (in Ha)
Chemical fertilizers	DAP				
	Urea				

	Blended fertilizer				
Improved seeds					

**PART II: LIVELIHOOD RESILIENCE CAPACITY INDICATORS**

No.	Indicator questions	Response code	Response
1.	Is there any institution in your locality where people can receive food assistance in time of shock or emergencies?	1= Yes 2= No	
2.	Is there any institution in your locality where people can receive non-food assistance in time of shock or emergencies?	1= Yes 2= No	
3.	Is there any institution in your locality where people can receive assistance due to losses of livestock?	1= Yes 2= No	
4.	Is there any institution working on disaster response program from government or NGOs?	1= Yes 2= No	

5.	Do you have access to climate related information?	1= Yes 2= No	
6.	Do you have access to early warning information system?	1= Yes 2= No	
7.	Do you have access to agricultural extension	1= Yes 2= No	

	services?		
8.	Do you or your family own a house?	1=Yes 2= No	
9.	Do you have access to health extension services in your locality?	1=Yes 2= No	
10.	Do you send your children to school?	1=Yes 2= No	
11.	Have you received any training over the last 12 months?	1=Yes 2= No	
12.	If your answer is yes for QN # 11, could you state the number of trainings you have attended over the last 12 _____months?		
13.	Do you have access to clean and safe [drinking] water supply? 1=Yes 2= No		
14.	What is the main drinking water for your household? 1=Piped in 2=Tube well/borehole with pump 3=Protected dug well 4=Open/unprotected well 5=Protected spring 6=River/stream		
15.	Do you use a toilet [does not include outdoors defecation]? 1=Yes 2= No		
16.	Do any of the household members have cash saving? 1=Yes 2=No		
17.	If yes for qn # 16, the total amount of money saved? _____		
18.	Do any of the household members have existing debt from any one? 1=Yes 2=No		
19.	If yes for QN # 18, what is the total amount of credit to be paid? _____		
20.	Has anyone from your family participate in	1=Yes 2= No	

	informal association ( <i>Iddir, equib, mahaber etc</i> )		
21.	Has anyone of your family member involved in hazard insurance schemes?	1=Yes 2= No	
22.	Do you have access to savings and credit institutions within 5 km?	1=Yes 2= No	
23.	Do you have access to primary school within 5 km?	1=Yes 2= No	
24.	Do you have access to health post within 5 km?	1=Yes 2= No	
25.	Do you have access to secondary school?	1=Yes 2= No	
26.	Do you have access to police station within 5 km?	1=Yes 2= No	
27.	Do you have access to veterinary service within 5 km?	1=Yes 2= No	
28.	Do you have access to small market within 5 km?	1=Yes 2= No	

MODULE 6: FARMERS' PERCEPTION TO CLIMATE VARIABILITY OR CHANGE

6.1. How do you perceive the change in the temperature and rainfall over the last 10-20 years' trend in perspectives (Changes of temperature and precipitation)

Change in temperature		Increased (1)	No change (2)	Decreased (3)	Do not know (4)
1	Overall temperature				
2	Dry season (Bega Temperature)				
3	Summer season (Kirmet Temperature)				
4	Belg season Temperature				
5	Number of hot days in a year				
6	Number of cold days in a year				
7	Number of cold nights in a year				
8	Number of hot nights in a year				
Change in Amount rainfall					
1	Overall rainfall amount				
2	Dry season (Bega rainfall)				
3	Summer season (Kirmet rainfall)				
4	Belg season rainfall				
5	Rainfall starts lately				
6	Early cessation of rainfall				

## MODULE 7: CLIMATE INDUCED SHOCKS INDICATORS

7.1 Have you ever faced crop failure during the last 10-20 years?

1=Yes      2=No

7.2 If yes for QN# 7.1, what are the main reason for the crop failure? [Multiple response is possible] 1=Erratic rainfall; 2=Lack of improved seeds; 3=Unaffordable price of inputs; 4=Low level of soil fertility; 5=Pest and disease; 6=Shortage of farm oxen; 7=Other (specify)\_\_\_\_\_ 7.3 Have you ever experienced flooding due to excessive rainfall over the last 10-20 years?

1=Yes      2=No

7.4 If yes for QN# 7.3, how do you rate the frequency of flooding in your locality over the last 10-20 years?

1= Highly decreased; 2= Decreased; 3= No change; 4= Increased; 5=Highly increased

7.5 Have you ever experienced drought due to climate variability/change over the last 10-20 years?

1=Yes      2=No

7.6 If yes for QN # 7.5, how do you rate the frequency of drought in your locality over the last 10-20 years?

1= Highly decreased; 2= Decreased; 3= No change; 4= Increased; 5=Highly increased

7.7 Have you ever experienced disease (crop) outbreak due to climate variability/change over the last 10-20 years?

1=Yes      2=No

7.8 If yes for QN# 7.7, how do you rate the frequency of disease outbreak in your locality over the last 10-20 years?

1= Highly decreased; 2= Decreased; 3= No change; 4= Increased; 5=Highly increased

7.9 Have you ever experienced (livestock) disease outbreak due to climate variability/change over the last 10-20 years?

1=Yes      2=No

7.10 If yes for QN# 7.9, how do you rate the frequency of disease outbreak in your locality over the last 10-20 years?

1= Highly decreased; 2= Decreased; 3= No change; 4= Increased; 5=Highly increased

7.11 Have you ever experienced disease (human) outbreak due to climate variability/change over the last 10-20 years?

1=Yes      2=No

7.12 If yes for QN# 7.10, how do you rate the frequency of disease outbreak in your locality over the last 10-20 years?

1= Highly decreased; 2= Decreased; 3= No change; 4= Increased; 5=Highly increased

## MODULE 8: PERCEIVED CLIMATE IMPACTS OF CLIAMTE CHANGE AND VARIABILITY

8.1. Would you please indicate the type of impacts that climate change has brought to you or your household?

No.	Indicators questions	Dummy	Response
1.	Crop productivity decline	1= Yes   2= No	
2.	Shortage of water for irrigation	1= Yes   2= No	
3.	Shortage of water for home/animal consumption	1= Yes   2= No	

4.	Emergence/resurgence of new pests (weeds) and	1= Yes 2= No	
5.	<sup>insects)</sup> Increased level of temperature	1= Yes 2= No	
6.	Increased frequency of drought	1= Yes 2= No	
7.	Increased frequency of flooding	1= Yes 2= No	
8.	Geographic isolation/inaccessibility	1= Yes 2= No	
9.	Livestock disease	1= Yes 2= No	
10.	Crop pests and diseases	1= Yes 2= No	
11.	Local conflict over diminishing resources	1= Yes 2= No	
12.	Food price inflation	1= Yes 2= No	