



**FACTORS THAT DETERMINES PARTICIPATORY FOREST  
MANAGEMENT PRACTICES AND EFFECTS OF CLIMATE CHANGE:  
IN CASE OF MAREKA WOREDA, DAWURO ZONE, SOUTHWEST  
ETHIOPIA**

**M.Sc. THESIS**

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**HAWASSA, ETHIOPIA**

**JANUARY, 2024**

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ETHIOPIA**

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**A THESIS SUBMITTED TO THE DEPARTMENT OF CLIMATE  
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**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE  
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**HAWASSA UNIVERSITY**  
**SCHOOL OF GRADUATE STUDEN**  
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This is to certify that the research entitled "Factors that Determines Participatory Forest Management Practices and Effects of Climate Change: The Case of Mareka woreda, Dawuro Zone, South West Ethiopia" submitted in partial fulfillment of the requirement for degree of **Master's** with a specialization in Climate Change and Sustainable Agriculture Graduate Program, School of Environment, Gender, and Development Studies and has been carried out by **TILAHUN BELAYENEH BALA ID. No GPCCSA/0012/14** under my supervision. Therefore, I recommend that the student has fulfilled the requirements, and hence hereby can submit the thesis to the department for defense.

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We, the undersigned, members of the Board of Examiners of the final open defense by TILAHUN BELAYENEH BALA have read and evaluated his/her thesis entitled "**Factors that Determines Participatory Forest Management Practices and Effects of Climate Change: The Case of Mareka District Dawuro Zone, South West Ethiopia**", and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree.

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## **DEDICATION**

Thanks to my Lord Jesus Christ creator of the universe, I dedicated for my wife Mherite Mega, my mother Logenesh W/Yes, and my sister and brothers for their continuous, support and encouragement in all the ways since the beginning of my studies and for teaching me that education is the key and power to a successful future.

## STATEMENT OF THE AUTHOR

I declare that this M.Sc. thesis entitled: "Factor that Determines Participatory Forest Management Practices and Effects of Climate Change: The Case of Mareka Woreda Dawuro Zone, South West Ethiopia". This thesis is submitted in partial fulfillment of the requirement for a M.Sc. Degree in Climate Change and Sustainable Agriculture at Hawassa University College of Agriculture. My original work has not been submitted for any degree at this or another University. All source or material used in this thesis has been properly acknowledged. The comments of my advisors have also been duly incorporated.

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Date of submission\_\_\_\_\_

Department: Climate change and sustainable agriculture

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## ACRONYMS

AR	Assessment Report
CBFM	Community based Forest Management
CDM	Clean Development Mechanism
FAO	Food and Agriculture Organization of the United Nations
FDRE	Federal Democratic Republic of Ethiopia
FGD	Focus Group Discussion
FUG	Forest User Group
GDP	Gross Domestic Product
GHG	Green House Gas
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
NGOs	Non -Governmental Organizations
NTFP	Non-Timber Forest Product
PFM	Participatory Forest Management
SFM	Sustainable Forest Management
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
CBFM	Community-Based Forest Management
HH	Household
MoA	Ministry of Agriculture
WMO	World Meteorological Organization
ENMA	Ethiopian National Meteorology Agency
UNEP	United Nation Environment Protection

## DESCRIPTION OF LOCAL TERMS

Bega	Dry season from October to January.
Belg	Short rainy season from February to May.
Dega	Agro-climatic zone that are located at high altitudes, often above 2,300 meters. Dega areas are characterized by cooler temperatures and have a distinct ecology and vegetation adapted to the altitude.
Kermit	Long rainy season from June to September.
Kolla	Agro-climatic zone that are often located at lower altitudes and are known for their dry, desert-like landscapes with an altitudinal range of 500 to 1500 m.a.s.l.
Woina Dega	Agro-climatic zone that have moderate temperatures and are located at higher altitudes.  Woina Dega areas are usually characterized by cooler climates and abundant rainfall. It lies between 1500-2,300 m.a.s.l.
Kebele	Smallest administrative unit in Ethiopia.

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# FACTORS THAT DETERMINES PARTICIPATORY FOREST MANAGEMENT PRACTICES AND EFFECTS OF CLIMATE CHANGE: THE CASE OF MAREKA DISTRICT DAWURO ZONE, SOUTH WEST ETHIOPIA

By: TILAHUN BELAYENEH BALA

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## ABSTRACT

*Forests provide multiple ranges of ecosystem services, moderate extreme weather events, and enhance the adaptive capacity of communities to support sustainable agriculture and human wellbeing. However, the heavy dependence of local communities on forest resources has caused deforestation and degradation in Ethiopia. Participatory forest management (PFM) is a solution to the current challenges of forest degradation and deforestation. The objective of this study was to investigate the factors that determine community participation in participatory forest management, as well as the effects of climate change in Gozo Bamushe and Bala Yoyo kebeles Mareka District, Dawuro Zone, and Southwest Ethiopia. Following, a multi-stage sampling technique were used. 272 sample households were systematically selected and used to collect the primary data. Secondary data were collected from different documents. The results of the descriptive statistical analysis of basic data showed that 69 (25.6%) respondents were from female and the remaining 201 (74.4%) were male. In general, there were 173 participants and 97 non-participating respondents. Among the 270 respondents, 56 (20.7%) were female participant and 117 (43.3%) were male participant. The community's acceptance of existing forest management practices varied, with the highest participation rate of 51.5% observed in the participatory forest management practices, compared to 25.2% for traditionally governed practices and 23.3% for state-governed practices. The binary logistic regression model analysis showed that total land holdings negatively affected participation in forest management, gender, educational level, family size, TLU, access to credit, training, and the enforcement of the law all had a positive and significant ( $P < 0.05$ ) effect on PFM practices. The results of this study suggest that the trend of climate variability in the study area is generally variable. The results indicate that 96.6% of participants and 90% of non-participants observed an increasing trend in temperature, while 95% of participants and 94% of non-participants perceived a decrease in rainfall and considered it unpredictable. Secondary data were obtained from the Ethiopian National Metrology Agency (ENMA) (1998–2022), showing that annual and Kermit rainfall are decreasing, Belg rainfall is increasing, and the average maximum and minimum temperatures are increasing. The results of this study lead to the conclusion that active participation in participatory forest management (PFM) is a crucial solution for improving effective forest management practices, reducing deforestation, mitigating the adverse effects of climate change, and enhancing rural livelihoods. Based on the current findings, it is recommended to improve the level of perception of the community and expand the practice by enhancing collaboration and coordination among stakeholders, including governmental and non-governmental organizations, in order to provide strong technical, financial, and legal support.*

**Key Words:** Forest; participatory forest management; community participation; and climate change

## **CHAPTER ONE**

### **1. INTRODUCTION**

#### **1.1. Background of the Study**

Forests provide multiple ranges of ecosystem services: provision (food, fodder, materials, water, and energy sources), regulation (climate, disease, floods, wastes, and water quality), and cultural (recreational, aesthetic, and spiritual benefits), and support (soil formation, photosynthesis, and nutrient cycling) (Range *et al.*, 2014; Balancer *et al.*, 2015). Forests moderate extreme weather events and enhance the adaptive capacity of communities by regulating water flow, providing food, wood energy, shelter, fodder, medicine, and fiber, generating income and employment, and conserving biodiversity. Furthermore, forests support sustainable agriculture and human well-being by stabilizing soils and mitigating climate change (FAO, 2018).

However, nowadays, this type of forest conservation practice has not minimized the problems of deforestation and degradation. The bottom-up approach of PFM has empowered local communities or villagers to gain rights and responsibilities to own, manage, and use forest resources. The primary management goals of the PFM system are to conserve biodiversity, mitigate forest degradation, promote sustainable forest management, and guarantee sustainable socioeconomic livelihood improvement and environmental benefits for local communities (Gashu, 2019; Demissew and Huajing, 2021).

This community-based forest management approach is a solution to Ethiopia's current challenges of forest degradation and deforestation. This approach was implemented in Ethiopia by different actors such as FARM Africa in Chilimo and Bonga forests, at Borana by FARM

Africa and SOS Sahel, at Adaba-Dodola by the GTZ (German Agency for Technical Cooperation), and the Belete Gera forest by the Japan International Cooperation Agency (JICA) (Lemenih *et al.*, 2015). Currently, the Federal Government of Ethiopia formally recognizes the PFM and includes it in the Forest Proclamation No.1068 (2010) provision for the development, conservation, and utilization of forests. As a result, the management system has expanded significantly, and now covers approximately 40% of the country's forest resources.

The overall policy provisions of Ethiopia in the implementation of the PFM deeply acknowledge the participation of the local people. The active involvement of the local community is vital for addressing environmental, economic, and social goals in rural areas, because local communities are comparatively more advantageous than the government during monitoring, implementation activities, conservation costs, and familiarity with local situations (Agrawal and Chhatre, 2006; Dash and Behera, 2015; Rahut *et al.*, 2015). Several studies have explained that local community forest user cooperatives can efficiently manage natural resources collectively (Dash and Behera, 2015; Walle and Nayak, 2019).

The role of forests in climate change is twofold. They act as both a cause and solution for greenhouse gas emissions. Approximately 25% of global emissions come from the land sector, which is the second-largest source of greenhouse gas emissions after the energy sector. Approximately half of these (5–10 GtCO<sub>2</sub>e annually) come from deforestation and forest degradation. Forests are one of the most important solutions for addressing the effects of climate change. Approximately 2.6 billion tons of carbon dioxide, or one-third of the CO<sub>2</sub> released from burning fossil fuels, are absorbed by forests every year. (Nature, 2020; FOA, 2020)

A gradual increase in temperature alters the regeneration and growth of some species. Temperature rise, low soil moisture, and competition with other species during the seedling stage have an impact on tree regeneration. Climatic variability and changes result from the degradation of forest resources and the emission of carbon dioxide into the atmosphere, affecting the forest (Marshet and Fekadu, 2019), and forests are viable tools for combating the impacts of climate change, as they can sequester atmospheric carbon and store it in different pools. Halting the loss and degradation of forest ecosystems and promoting their restoration has the potential to contribute to over one-third of the total climate change mitigation by 2030 to meet the objectives of the Paris Agreement (Rijal *et al.*, 2022).

The newly formed Southwest National Regional State has the highest forest coverage, especially in the Keffa, Sheka, Bench Shako, Dawuro, and Konta Zones. However, according to the annual report of the Dawuro Zone Forest and Environment Protection Department office, forestland in our study area is degraded due to agricultural expansion, population pressure, farmers' smaller landholding sizes, and other causes (DZFEPD, 2023).

Therefore, this thesis aimed to discover the factors that determine community participation in PFM practices in Mareka District, Dawuro Zone, and Southwest Ethiopia. The output of this study is essential for private, governmental, and non-governmental organizations.

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

In Ethiopia, a large proportion of the rural population depends on forests for various livelihoods and poverty alleviation. However, the government, stockholders, and development partners have paid little attention to the governance challenges that limit the contributions of community-managed forests to food security and the livelihoods of forest-adjacent communities (Mastewal and Wolde, 2022).

Participatory Forest Management (PFM) is vital for effective forest management and to improve the livelihood of local communities. However, local people's involvement in PFM is directly affected by socioeconomic, biophysical, demographic, and institutional factors. Participatory forest management (PFM) has gained prominence as a sustainable approach for mitigating the adverse effects of climate change and promoting community involvement in forest conservation. However, the factors determining the adoption and success of PFM practices, particularly in the context of climate change, remain poorly understood.

This study aimed to fill this research gap by investigating the factors that determine participatory forest management practices and the effects of climate change resilience in the Dawuro Zone of Mareka District, located in southwest Ethiopia.

### **1.3. Objectives of the study**

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

- The overall objective of this study was to investigate the factors that determine community participation in participatory forest management as well as effect of climate change in Mareka District Dawuro Zone, South West Ethiopia.

#### **1.3.2. Specific Objectives of the Study**

The specific objectives of the study were:

1. To assess the existing forest management practices in the study area.
2. To identify the determinants factors that affect community participation in PFM in the study area.
3. To analyze the temporal trends of rainfall and temperature from 1998–2022 in the study area.

4. To assess how climate change and variability affect forest management practices in the study.

#### **1.4. Research Question**

The specific objectives of the study are:

1. What are the existing forest management practices in the of study area?
2. What are the determinants factors that affect community participation in PFM in the study area?
5. How was the trend and pattern of rainfall and temperature in last 25 years from 1998–2022 in the study area?
3. How do climate change and variability affect forest management practices in the study area?

#### **1.5. Significance of the study**

This study contributes to the existing knowledge of participatory forest management practices and their relationships with climate change. Focusing on the specific case of the Mareka District Dawuro Zone in Southwest Ethiopia, it provides valuable insights that can help enhance conservation efforts and sustainable forest management practices in similar contexts.

The findings of this study have practical implications for policymakers, forest managers, and community stakeholders involved in participatory forest management, climate change adaptation, and mitigation. The results can guide the formulation of policies and interventions that address the identified factors influencing participatory forest management practices, and effectively respond to the impacts of climate change. In summary, the significance of this study

lies in its contribution to the field, local relevance, conservation implications, climate change adaptation, mitigation focus, and policy implications. These findings can inform decision-making processes and the development of targeted strategies to enhance participatory forest management practices and effectively respond to the challenges posed by climate change in similar contexts.

### **1.5. Scope and Limitation of the Study**

This research study is limited to the Mareka Woreda, Dawuro Zone, and Southwest Ethiopia Regional State. This study aimed to investigate the factors that determine participatory forest management practices and the effects of climate change. The study also selected two Keble's limited to Gozo Bamushe and Bala Yoyo from 15 Kebeles in Lili and Ali Forest. The study was also limited to a total population of 846 households; only 272 sample households with respondents were selected. The researcher was unable to address all issues in this study due to time, financial constraints, limited Internet access, and a lack of organized secondary data. To overcome the challenge working with different partners and governmental organization.

### **1.6. Organization of the paper**

This paper is organized into five sections. The chapters deal with the introduction, including the background of the study, statement of the problem, objectives of the study, research questions, significance of the study, scope of the study, and limitations of the study. The second chapter reviews the related literature, including definitions and concepts, empirical literature, theoretical literature, and the conceptual framework. Chapter three of this paper contains the methodology of the study, including a description of the study area, methods of data collection, research design that guides the researcher, and methods of data analysis.

Chapter four of the study addresses the results and discussions, and presents the analysis and interpretation. The last part of study chapter five contains the conclusion and recommendation.

## **CHAPTER: TWO**

### **LITERATURE REVIEW**

#### **2.1. Theory on Participatory Forest Management**

##### **2.1.1. Basic Concepts and definitions**

Participatory forest management has emerged as a potential framework for collaborative forest management between local communities and government forestry agencies Tessema Kassa, (2017). Participatory Forest Management (PFM) is a forest management system introduced as a balancing mechanism that safeguards forests and involves communities through benefit sharing while respecting traditional users and including them in the process. The designs, names, and ideas of PFM are as varied as the number of implementers all over the world (Alemayehu, 2020). The main objective of participatory forest management between local communities and government agencies is to conserve forest resources based on a trust-and-friendship approach (Islam *et al.*, 2015). According to Maier *et al.* (2014), this type of approach is necessary to achieve both long-term development and sustainability of forest resources and increase forest coverage.

Participatory forest management refers to the absolute involvement of the local community in any specific forestry program, from planning, implementation, monitoring, evaluation, utilization, etc. While efforts can be made to protect the health of ecosystems and meet economic needs at the same time, since ecological, social, and economic conditions vary from place to place, there must be a wide range of participatory approaches to sustainable forest management. In particular, forest decentralization, or PFM, is aimed at enhancing people's

participation in the management and utilization of forest resources, leading to the preservation of forest resources, poverty alleviation, and improvement in the livelihoods of the local people. In addition to balancing environmental, economic, and social sustainability through the active involvement of the community in forest management and solving serious problems in the supply of forest products and their utilization (FAO, 2015),.

Participatory Forest Management approach; The PFM is a legally binding contract between a defined community-based institution (Forest Management Group) and the government (represented by the Forest Services). Participatory forest management is used as a broad term to describe systems in which communities (forest users) and government services work together to define rights of forest use, develop ways of sharing management responsibilities, and agrees on how to divide forest benefits, Siraj *et al.*, (2018).

### **What is participation?**

Participation in this study refers to the active involvement of the forest user group (FUG) members in the forest management decision-making process at each stage of PFM program development. The term “FUG” means individuals who live in and around the forests and who organize themselves to manage the forests collectively through a formal agreement with the forest department.

A different study defines participation as the effective and active involvement of primary stakeholders in the decision-making and implementation of development efforts (Nelson and Wright, 1995). Others have argued that participation means empowering local communities (Eilola *et al.*, 2015).

### **What is community participation?**

Shukor *et al.* (2011), defines, the involvement of people in the community in a project to solve their problem. They come to know their situation better and are motivated to solve their common problems. According to him, community members share varying degrees of political, economic, social, and cultural characteristics as well as interests. Community Participation is the process by which individuals and families assume responsibility for their health and welfare and for those of the community and develop the capacity to contribute to their and the community's development.

### **What is sustainable development?**

Sustainable Development (SD) is thus maintaining a balance between the human need to improve lifestyles and a feeling of well-being (economic growth and equity) on the one hand and conserving the natural resources and ecosystems on which the present and future generations rely. The World Nature Conservation Union's (WNCU) (1991) Sustainable Development: "improves the quality of life while living within the carrying capacity of ecosystems." According to the World Conservation Union report, poor people, pressured by natural resources for their survival, are forced to overuse environmental resources. The overuse of natural resources leads to environmental degradation, which further impoverishes the poor, completing the vicious cycle and leading to a downward spiral of poverty and environmental degradation. On the one hand, it is understood that the poor are more dependent on natural resources and also more vulnerable to the impacts of environmental degradation and related climate change hazards.

**Forest:** “Forest land spanning more than 0.5 ha covered by trees (including bamboo) (with a minimum width of 20m or not more than two-thirds of its length) attaining a height of more than 2m and a canopy cover of more than 20% or trees with the potential to reach these thresholds in” according to FAO (2020).

**Climate change** refers to significant changes in global temperature, precipitation, wind patterns, and other measures of climate that occur over several decades or longer (IPCC, 2018).

**Adaptation:** The Intergovernmental Panel on Climate Change defines adaptation as “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.”

**Climate adaptation:** refers to the actions taken to manage the impacts of climate change by reducing vulnerability and exposure to its harmful effects and exploiting any potential benefits (IPCC, 2018).

**Climate change mitigation:** is action to limit Climate change by reducing the emission of greenhouse gas or removing those gases from the atmosphere (IPCC, 2022).

### **2.1.2. General motives behind introducing PFM**

The forest is one of the crucial resources that determine the livelihood, environmental stability, and socio-cultural value of forest-dependent people. However, this resource is being deteriorated by different drivers; it is becoming a global agenda with deep-rooted massive forest clearance and deterioration (Aklilu *et al.*, 2020). Forests are viable tools for combating the impacts of climate change, as they are capable of sequestering atmospheric carbon and storing it in different pools.(Sushila *et al.*, 2022).

Forest resources in Ethiopia have experienced so much pressure due to the increasing need for wood products and the conversion to agriculture. Conversely, it is now experiencing continuous destruction of forest resources due to overexploitation, deforestation, land degradation, climate change, and pollution due to a lack of coordination among the various sectors. The world's forests and woodlands are increasingly under pressure from the growing human population, and many are shrinking as a result of human-induced deforestation (Moyo, *et al.*, 2020; Rotter *et al.*, 2021; Cheṭan *et al.*, 2021).

There are many reasons for introducing PFM. A key challenge to establishing PFM is to put in place a system of management that works in the present-day context of increasing resource demand and land use competition. The main two objectives are to address social and environmental issues; one emphasizes mitigation of biodiversity loss, forest degradation, and deforestation, while the other views a concern for livelihoods in forest neighboring areas as well as the right to legally utilize forest resources. The PFM bottom-up approach has the principle of empowering local communities or villagers to gain rights and responsibilities to own, manage, and use forest resources. It involves giving communities and individuals authority along with accountability. Keshawn & Omer Aminu, (2019), Participatory forest management takes on the challenge of preventing environmental degradation while maintaining benefits to people's livelihoods related to forests. The twin challenges of sustainable development are preventing environmental degradation and eradicating poverty (Tadesse *et al.*, 2017).

PFM methodologies require that community-level groups, like cooperatives, receive legal status. These community-level groups must have committees that control and keep an eye on

forest management and exploitation operations. Individuals who are a part of community-based organizations are permitted to use forest products (Milkessa *et al.*, 2021).

### **2.1.3. Global overview of community-based participatory forest management**

Over 2.4 billion people rely directly or indirectly on forests for their livelihoods to provide both monetary and non-monetary revenue, which benefits local communities in terms of social, economic, cultural, spiritual, and environmental factors. Maintaining the multifunctional role of those forests and ensuring their resilience and the sustainable use of resources remains a key challenge (FAO, 2016). The world's forests and woods are coming under increasing strain from the expanding human population, and many are diminishing as a result of human-caused deforestation. Forests are recognized as protected areas that house game parks and forest reserves and contribute to the national economy by delivering renewable energy sources in the form of wood fuel and charcoal (Chiwaya *et al.*, 2021). The majority of community-based organizations are founded on a shared desire to protect forests while also enhancing the lives of their members (Mussa *et al.*, 2021; Song *et al.*, 2021; Agnoletti *et al.*, 2022).

Drigo *et al.*, (2013) mentioned the following different terms that can be used interchangeably with participatory forest management: For example, village forests (Malawi, Mali, Benin), social forestry (Philippines, India), community forests (Nepal, Mexico, Thailand, Gambia, Uganda, Namibia, Cameroon, Guinea, Nigeria, Senegal, Ethiopia, Chad, South Africa, Sudan, Togo, and Burkina Faso), and joint forest management (India). All these words above have the same objective of forest management through the active participation of the local people. The Philippines also officially adopted community-based forest management in 1995 as its strategy for sustainable forest management to improve the community's socioeconomic status and decentralize and devolve forest and forestland management (Gregorio *et al.*, 2020). According

to the Drigo *et al.*, (2013) study, in Latin America, Brazil has had a good experience as several community-based participatory forest management projects emerged in the 1990s.

#### **2.1.4. Participatory forest management in Sub-Saharan African countries**

In Sub-Saharan Africa, PFM is widely practiced. Findings regarding the role of the participatory forest management approach in sustaining the forest commons and improving the income of the people are mixed; meaning that in some cases there is a positive outcome in improving forest sustenance.

A community-based forest management approach has been implemented in Africa since the 1980s, when a lot of forests and woodlands had been destroyed (Moyo *et al.*, 2021; Axelsson & Grady, 2022). This enhances community engagement in forest management, reduces rural poverty, and promotes forest resource conservation. In Kenya, PFM refers to "a forest management approach that deliberately involves the forest adjacent communities and other stakeholders in forest management within a framework that contributes to a community's livelihoods" "(Kenya Forest Service 2015, as cited in Duguma *et al.*, 2018). Various studies were conducted on the impact of participatory forest management on local community livelihoods in the Arabuko-Sokoke Forest areas of Kenya, which showed PFM has improved forest coverage and income for the people (Matiku *et al.*, 2013).

In Malawi, forests and woodlands have been destroyed rapidly, like in other countries around the world. Malawi's government has been making strides to stop the further destruction of forests by communities by imposing some policies, but without success. The government later embarked on participatory forest management, a shift from the conventional management system (Gondwe *et al.*, 2021; Song *et al.*, 2021). In South Africa, under the National Forests

Act of 1998, PFM was implemented to realize the socioeconomic benefits of forest conservation. In Malawi, PFM was initiated following policy changes in 1996 to allow for people's involvement in the conservation of trees, forests, and protected forest areas (Senganimalunje *et al.*, 2016).

In Ethiopia, participatory forest management is used as a strategy to engage local communities to achieve a sustainable forest management objective while also generating livelihood benefits Tadesse and Teketay, (2017). Participatory Forest Management was introduced to reduce the extent of deforestation and to engage the community in managing and protecting the forests. In Ethiopia, where PFM has been practiced for a long time, the study by Gobeze *et al.* (2009) showed that the system has enabled diversifying income sources, increasing household income levels, and building household assets in forest-dependent communities. In Ethiopia, the adoption of PFM decreased the pressure on forests for forest product extraction and conversion to other farming activities (Duguma *et al.*, 2018). In Cameroon, PFM was launched to reduce deforestation, generate livelihood benefits for the local communities, and engage communities in managing their resources (Oyono *et al.*, (2013).

In Tanzania, the study indicated that forest cover increased by 95% and the number of trees on private farms increased by 89.2%. In Sub-Saharan-Saharan states, in general, compared to the state-controlled management approach, the PFM approach has contributed to the improvement of the rights and ownership of resources and hence contributed to local resource governance by communities in the region, (Gobeze *et al.*, 2009; Persha and Meshack, 2016; defere 2022).

### **2.1.5. Participatory forest management (PFM) in Ethiopia**

Ethiopia owns diverse vegetation resources that include high forests, woodlands, bush lands, plantations and trees outside forests. Each of these vegetation resources variously contributes to production, protection, and conservation functions and plays a significant role in the national and local economies. Today, lack of awareness, negative attitudes, exclusion of local people in the economic benefit-sharing mechanism, lack of incentives, conflict of interest, weak legal actions taken against illegal forest users, agricultural expansion, overgrazing, an unspecified boundary, and a lack of skills and professional knowledge in the local community have exacerbated the loss of forests in Ethiopia (Demissew *et al.*, 2022).

PFM was first implemented in Ethiopia in the middle of the 1990s, and the government has since acknowledged it as a tool for halting deforestation and enhancing the management of the nation's natural forests and woodland resources (Kassa, L. (2017). PFM is acknowledged as a tool to strengthen the participation of communities in sharing the responsibilities and benefits of managing forests through an agreed-upon management plan by the country's 2018 Forest Proclamation 1065/2018. PFM has a significant potential to help Ethiopia meet its commitment to reduce emissions from deforestation and forest degradation and improve ecosystem services (Ethiopia Revised NDC, 2021; Kedir *et al.*, 2018; Mekuria *et al.*, 2023). PFM is one of the main nature-based solutions and adaptation strategies for climate change. According to Tesfaye *et al.* (2011), 2015, Abebaw *et al.* (2012), and Ameha *et al.* (2014), the implementation of PFM is essential to boosting a sense of ownership, enhancing socioeconomic conditions, and boosting local communities' resilience to external shocks like climate change.

In Ethiopia, the number and area of forests under PFM have increased considerably over recent years. Such as Gebradima forest, Beleta Gera forest, Chilimo forest, Bonga forest, southwest Ethiopia, and Adaba dodola forest in southern Ethiopia, are some of the forests. Different studies indicated that the introduction of PFM in forests and adjacent communities in general brings considerable changes and also has an important role to play in improving the livelihood of poor rural communities, Ahmed Ali and Tariku Bachano, (2020). PFM was introduced to Ethiopia during the 1990s by non-governmental organizations and donor agencies, notably FARM Africa, SOS Sahel, and GIZ, and in the recent REDD+ investment program launched to enhance forest sector capacity and form new PFM sites (Oromia, SNNPR, Southwest Ethiopia, Gambella, and Amhara Region) Haile Mariam *et al.* ( 2015).

The Ethiopian government has taken actions to stop forest losses and give NGOs the chance for NGOs to participate in SFM through PFM practices. As a result, several NGOs and bilateral programs have launched PFM in the country. In this arrangement, the government holds ownership of the forest, while the local communities, organized in FUGs, have use rights Ameha *et al.* (2016). The PFM approach is also designed to form a component of the broader rural development strategy that aims at improving rural livelihoods, promoting gender equality, and reducing poverty while protecting the forest from degradation (Tesfaye *et al.*, 2010; Ameha *et al.*, 2014).Community forest management enhances forest products by regulating ecosystem services, increasing agricultural production, moderating local and regional climate, and increasing the adaptive capacity of rural livelihoods to adverse climate change by diversifying income and ensuring food security. However, the livelihood of populations that depend on forests is severely impacted by the alarming rates of deforestation and forest degradation (The Global Forest Goals Report, 2021). According to Bassan *et al.* (2020),

agricultural growth continues to be the main cause of deforestation and forest fragmentation. PFM is a crucial solution to strengthening the protection of forestlands through improving rule enforcement and the commitments of both formal and informal institutions to managing forest resources.

A recent report of the Ethiopian Forestry Development and the then Environment, Forest, and Climate Change Commission covering the 2016-2020 planning period indicated that the total areas of natural forests under PFM had reached 2 million ha under the Environment, Forest, and Climate Change Commission in 2020, indicating that PFM is one of the main strategies to achieve the commitment of Ethiopia to reducing deforestation and degradation (Habtemariam *et al.*, 2022)

## **2.2. Community Forest and PFM Formation Process**

According to the proclamation of forest development, protection, and utilization (2018), “the state forest is one where the use rights and management responsibilities are transferred to an organized local community or forests developed by an organized community on communal land.” This proclamation has recognized in clear terms the user's right and management responsibility of the local communities on the state forests that are transferred to be managed by them. According to MoA (2012), PFM is used to describe systems in which communities and government institutions providing technical services in the forest sector work together by defining the rights of forest resource use, identifying and developing forest management responsibilities, and agreeing on how forest benefits will be shared between forest users the community and the government partner. The guidelines of PFM indicate that all the PFM models exercised in Ethiopia were: introduction of the concept, popularization, and community mobilization; establishment of forest management associations or community-based

organizations; participatory forest resource assessment; forest management plan preparation; signing of the management agreement; and finally, implementation of the management plans.

Effectively, the PFM process is complete; the system is legalized within an officially signed Forest Management Agreement and further activities. After legalizing the PFM, community forest management groups or cooperatives are legally enabled to sustainably manage and use forest resources. PFM involves the legal transfer of forest resources (use rights) from the government forest services to a community management group or cooperative. Each step of the forest transfer negotiation is documented in the Forest Management Agreement. The Forest Management Agreement includes detailed information and clear rules and regulations for both parties for the sustainable management of forest resources. The main objectives of these negotiations are the conservation of the forest and its environment and the sustainable use of forest resources for economic increment (Peter *et al.*, 2014).

### **2.3. The Role of Participatory Forest Management practices**

#### **2.3.1. Role of PFM for Climate Change Mitigation and Adaptation**

Nowadays, climate change is a real environmental and development threat that needs global concern (Abid *et al.*, 2015). Forests are a stabilizing force for the climate. Restoring forest landscapes helps enhance climate change mitigation and adaptation. Forests cover 31 percent of the world's land surface, store an estimated 296 giga-tonnes of carbon, and are home to the majority of the world's terrestrial biodiversity. Forests are a source of fiber, fuel, food, and fodder, and they provide livelihoods for millions of people, including many of the world's poorest, According to Nature (2020; FAO, 2022)

Forests are more than trees and are fundamental for food security and improved livelihoods. Through reducing emissions from deforestation and forest degradation (REDD) activities, forests contribute to reducing emissions and enhancing carbon stock in forests while contributing to sustainable development. Forest provides ecosystem services both in the form of possible payments for ecosystem service provision and also in the form of the services themselves. Some environmental services provide global benefits, such as carbon sequestration for climate change mitigation, and others provide local or regional services, such as the provision of clean and ample water. Forest ecosystems are resilient, and many species and ecosystems have adapted historically to changing conditions. Future changes are potentially of such magnitudes or will occur at rates that are beyond the natural adaptive capacity of forest species, ecosystems, and forests to enhance forest carbon stocks and sequestration capacity. Forests can primarily reduce vulnerability or shocks from natural disasters or climate extreme events or increase resilience and capacity to respond to the progressive adaptive capacity of the community, Habtamu (2015).

Climate change is a global phenomenon. Its impact on agricultural activities in developing countries has been increasing because they are rain-fed dependents. Higher temperatures and decreasing precipitation amounts caused by climate change depress crop yield potential. This is particularly true in low-income countries, where adaptive capacities are perceived to be low. The vulnerability of poor countries could be due to weak institutional capacity, limited engagement in environmental and adaptation issues, and a lack of validation of local knowledge.

Forest management requires appropriate adaptation measures that can mitigate these adverse consequences. (Amero *et al.*, 2012). The global world temperature has increased by around 1 °C

since the pre-industrial era, and various anthropogenic or human factors are contributing to additional GHG emissions. This increasing warming is around 0.2°C on average per decade, according to an IPCC special report (2018). Community forests can store large amounts of carbon, depending on the type of plant species present. They also help regulate weather patterns, such as temperature and rainfall, at local levels. This in turn reduces flash floods, landslides, droughts, and forest fires because of reduced soil erosion and, therefore, being able to retain more water.

The UN Environment's sixth Global Finding has also prioritized the sustainability of forest resources and combating climate change impacts. The Sustainable Development Goals (SDGs) adopted by the United Nations in 2015 have 17 goals: Goal 15 is sustainable management of forests, combat desertification, halt and reverse land degradation and halt biodiversity loss, while Goal 13 aims to 'take urgent action to combat climate change and its impacts' (UN, 2015). Forests provide multiple socio-economic and cultural benefits and ecosystem services but also play a vital role, particularly in mitigating the adverse impacts of climate change due to its ability to sustain its carbon stock in several pools, such as standing trees, roots, leaves, litter, and soil, and remove additional atmospheric carbon Rijal *et al.*, (2021)

### **2.3.2. Role of PFM for forest cover, forest deforestation and degradation**

Rodgers (2012) showed that successful community forestry programs have provided input for REDD+ as regards best practices for forest governance and thus reduced deforestation and forest degradation. In addition, community-based forest management is enhancing community engagement in forest management, reducing rural poverty, and promoting forest resource conservation and forest cover (Charles *et al.*, 2022). Participatory forest management takes on

the challenge of preventing the degradation of natural resources while sustaining forest-based benefits to people's livelihoods (Tadesse *et al.*, 2017). The study was conducted in the Heban Arsi district, Central Rift Valley, Ethiopia, to investigate the contribution of participatory forest management (PFM) to improving households' livelihood assets and mitigating forest degradation (Gonche *et al.*, 2022).

The recent study results assured that the main driving forces for deforestation and forest degradation are free livestock grazing, fodder use, and fuel wood collection and charcoal production, followed by farmland expansion, fires, and construction wood harvesting. The underlying causes of deforestation and degradation based on a framework analysis were identified as population growth, insecure land tenure, and poor law enforcement. For all challenges, the PFM Approach is the solution to improving sustainable management and reducing the rate of deforestation.

The research carried out in the Adaba-Dodola Forest Priority Area and Bale Eco-region has significant evidence, according to Tesfaye (2011). Currently, degraded forest rehabilitation activities are implemented through community-based forest management activities; similarly, rehabilitation of forests through afforestation, agroforestry, soil and water conservation structures, reforestation, and area enclosures with a PFM approach is another conservation effort. The recent study by Lemenih *et al.*, (2015) based on satellite imagery in the Chillimo forest showed that the PFM intervention stopped deforestation and improved forest cover (Mulugeta and Habtemariam, 2014; Temesgenet *et al.*, 2015). The study findings show that in the Bonga forest, by Gobeze (2009), participatory forest management was introduced as one of the solutions to solve the problem of open access to forest resources, promote sustainable forest

management in the country, reduce forest resource degradation and deforestation, and increase forest cover through active local community participation. According to Habtamu, (2016), the investigation explained that PFM helped to reduce deforestation, brought improvement in forest regeneration, encouraged the growth of new young seedlings, and improved the existing forest status or cover.

### **2.3.3. Role of PFM for rural livelihood**

According to Jana *et al.* (2014) and Siraj *et al.* (2018), forests provide an important source of livelihood for local communities in Ethiopia. The results showed that forest products are important for covering direct household needs, such as food, medicines, housing, and animal feed, as well as for generating income. Forest coffee has an important role in income generation. Non-timber forest products became the main income source in most of the areas after implementing PFM. Firewood (dead wood in most cases) fills an important role in income generation more often after PFM has been introduced.

According to Kassahun and Omer (2019), the findings show that in Northwest Ethiopia, the results of the study indicate that PFM is a practical alternative for improving both forest cover and the livelihoods of smallholder farmers. Similar to Habtamu, F. (2016), in terms of PFM's contribution to improving the livelihoods of the local communities, 271 (98.54 percent) of respondents reasoned out that it has a crucial role in improving the livelihoods of the local community, especially marginalized groups like women and poor people. PFM is found to be the third important contributor to the livelihood of households, next to crop and livestock production, forest products obtained from the plantation, and natural forests like construction wood, fuel wood, thatch grass, and others (leaves, bark, and twigs), according to the study

findings of Alemayehu (2014). Forest products are sources of income for many rural communities across the globe (Suleiman *et al.*, 2017; Soe and Yeo-Chang, 2019a, 2019b). The global Forest Goals report estimated that 1.6 billion people, or 25% of the global population, rely on forests for their subsistence needs, employment, income, and other livelihoods (The Global Forest Goals Report, 2021).

#### **2.4. Climate Change Effects on Forest Ecosystem**

Climate change is one of the world's greatest challenges and has effects on the forest ecosystem. Forest ecosystems are sensitive to climate change; thus, climate change has significant effects on species distributions, the growth rate, and the structure of forests. Climate change strongly affects forest ecosystems by altering the growth, mortality, and reproduction of trees. Increasing temperatures change the timing of life cycle events (phenology), with earlier bud bursts, leafing, and flowering in trees. Climate change can modify disturbance regimes that affect the carbon cycle, forest structure, and species composition and alter forest ecosystem function. Disturbances such as fire, species invasions, and insect and disease outbreaks are disrupting the structure, composition, and function of the forest ecosystem (Marshet *et al.*, 2020; Abera, 2021).

Climate change that intensifies disturbances may have a significant impact on the species composition, ecological structure, and carbon sink capacity of forests. The ecosystem of the forest is being disrupted by disturbances including fire, drought, species invasions, pest and disease outbreaks, and storms like hurricanes (Seidl *et al.*, 2017).

Climate change affects forest health by spreading pests and pathogens that are likely to increase, either through the direct effect of climate change on their abundance or distribution or the indirect effect of increased water stress or wind damage. Climate change will increase the

susceptibility of trees to attack and also alter the disturbance dynamics of native forest insect pests and pathogens, as well as facilitate the establishment and spread of non-indigenous species. Collectively, global climate change has a significant impact on forest ecology, according to Rustad *et al.*, (2020).

## **2.5. Determinate factors affecting Participatory Forest Management practices**

### **2.5.1. Population Growth**

Rapid population growth has been associated with various aspects of resource degradation, including deforestation, overgrazing, soil erosion, soil nutrient depletion, and other problems. Deforestation is the conversion of forested areas to non-forest lands through cutting, clearing, and removal of the forest and related ecosystems into less diverse ecosystems such as pasture, cropland, plantations, and urban use-logged areas or wasteland (Legese and Diriba, (2021). Many types of economic activity (farming, construction of settlements, highways, and railways, engineering structures, development of mineral deposits in the forest zone, etc.) are carried out without supervision, which leads to a reduction in forested areas, loss of biodiversity in forest ecosystems, and other environmental problems in India. Dhurve, J.S. (2022).

Population growth, combined with other direct factors such as poverty, corruption, and weak property rights, contributes to forest loss and severe environmental degradation. In recent years, integrated management of population pressure and natural resources has been widely implemented by researchers. Intense population pressure on environmental resources is the leading factor in modifying the land use pattern of an area. Forest resources are a vital element that supports life on the surface of the earth, but human pressure on land has raised several

environmental problems and created a huge impact on forests Hazarika and Bhattacharjee, (2022).

The rapid increase in population results in the clearing of forests to provide land for the construction of housing complexes and meet timber demand. Besides this, human activities, agriculture, and the logging of trees are also prime reasons behind the deterioration of forests all over the world (Misra *et al.*, 2014). Large portions of the Ethiopian population live in rural areas where they highly depend on forests and tree stock for their livelihood. For a long time, the natural forest has been exploited, cleared, suffered damage, and has gradually declined in extent (Yemiru, 2011). Especially in times of crop failure, unemployment, and other kinds of hardships, the high-level dependence of the local communities on the forest has had intense effects on the resource, leading to deforestation and serious land degradation (Chomini *et al.*, 2022).

### **2.5.2. Increasing the Demand for Forest Products**

About 60 percent of the world's forests approximately 2.4 billion hectares are primarily or partially used for the production of wood and non-wood forest products. Wood fuel, including charcoal, accounts for about half of total global round wood production, and industrial round wood accounts for the other half, Most wood fuel is used in its country of production, particularly in rural areas and in developing countries, for heating and cooking, usually on open fires or in simple cook stoves Choi and Kim, (2018). The increasing demand for fuel wood in urban areas has also taken its toll on the forests. In Africa south of the Sahara, dependence on fuel wood is almost total; wood provides over 90% of the total national energy consumption in countries like Tanzania, Mali, the Upper Volta, and Ethiopia. With the increasing demand for fuel wood from the growing population, the rate of deforestation has

also increased, especially where market forces have come into play. Charcoal making, a commercial activity, is in most countries largely unregulated and outside government control (Hangrasa, 2018).

The increase in rural population has resulted in a rise in the demand for forest products locally, the fragmentation of forest areas, and a need to ensure that the remainder is managed effectively to provide the basic needs of those dependent on the forest, as well as rapid and sustained growth in industries transforming raw materials into finished and semi-finished wood products for export (Yemiru, 2011; Tekalign *et al.*, 2015).

In Ethiopia, demand for wood and forest products is expected to increase by 27% over the next 20 years. Today, 12.9% of the national GDP already comes from forests and an estimated 57 million people more than half of the country's population work full- or part-time in the forest sector. Of them, more than 11 million rural households rely almost exclusively on forests for their sustenance. Billions of bees are hard at work in Kaffa, producing honey and beeswax for a business that employs 3,500 people. Another company in Addis Ababa harvests bamboo to build furniture, contributing \$2.6 million (91 million birr) to the national economy. Together, forest products like these, grown by businesses and communities, add more than \$2.6 billion (91 billion birr) to Ethiopia's GDP (Anderson, 2020).

### **2.5.3. Expansion of Agriculture**

It is a common occurrence that households located adjacent to forests and woodlands continue to expand their farms gradually. Some farmers organized at the micro level to acquire lands for the cultivation of crops and eucalyptus trees. The ongoing encroachment of crop cultivation into the surrounding woodlands has resulted in further forest degradation. Farmland expansion is responsible for 90 percent of deforestation around the world, including crops grown for both

human and animal consumption, as well as the clearing of forests for animal grazing. On its own, grazing accounts for 40 percent of deforestation, and the new data also confirms an overall slowdown in global deforestation while warning that tropical rainforests, in particular, are under high pressure from agricultural expansion. Accounting for 70–90% of deforestation, global agriculture is the biggest driver of forest loss. Over half of all deforestation globally serves to clear land for crops and almost 40% to clear land for livestock (FAO, 2021). The different findings show that between 90% and 99% of all deforestation in the tropics is driven directly or indirectly by agriculture, according to the Stockholm environment institute, (2022). Agricultural expansion is a primary cause of tropical deforestation and therefore a key driver of greenhouse gas emissions, biodiversity loss, and the degradation of ecosystem services vital to the livelihoods of forest-dependent and rural people (FAO, 2022).

An estimated 420 million ha of forest has been lost worldwide through deforestation since 1990, but the rate of forest loss has declined substantially. In the most recent five-year period (2015–2020), the annual rate of deforestation was estimated at 10 million ha, down from 12 million ha in 2010–2015. Africa had the highest annual rate of net forest loss in 2010–2020, at 3.9 million ha, followed by South America at 2.6 million, and the rate of net forest loss has increased in Africa in each of the three decades since 1990 (FAO, 2020). A large proportion of the rural population in Ethiopia depends on community-managed forests for food security and livelihoods. However, the government and development partners have paid little attention to the governance challenges that limit the contributions of community-managed forests to food security and livelihoods.

#### **2.5.4. Forest fires**

Forest fires are lit by grazers and hunters in natural forests, and in some cases; they are caused by charcoal burning which is an illegal practice. The fires are also caused by smokers who carelessly leave burning cigarette butts while traveling in the forest for unknown reasons. In other cases, the fires are a result of accidents such as during honey harvesting. Most forest loss by forest fire results from changes in land uses especially the conversion of forest land to agriculture and settlement over the last decades (EFS, 2012).

#### **2.5.5. Community Dependency on forest resource**

The local people living around the forest depend heavily on the forest as their source of livelihood, among other uses. This has led to overexploitation of forest resources such as timber and mostly poles, which are used for building. Firewood is used for cooking and is also extracted from the forest without proper control. Herbs, which are used as medicine for humans and animals, are over extracted from the forest without proper control. Fruits are over-extracted from the forest for food. Quarrying was once carried out in the forest uncontrolled, thus damaging vegetation at the site of mining (FAO, 2008). Rural livelihoods are highly dependent on environmental sources in developing countries.

The major depleting forest resources such as timber, firewood, food, and medicines play a vital role in the livelihood of rural people (Fikir *et al.*, 2019). Based on the literature on forests, people's dependency on forest resources depends on various elements, among which socioeconomic and demographic factors are the most crucial (Garekae *et al.*, 2017; Furo and Feng, (2022).

### **2.5.6. Weak enforcement of law:**

Forests under PFM, though relatively better protected, still face illegal encroachers. In some cases, these are people who abandoned PFM membership during the inception process. There are rules, and regulations, while others are excluded based on set membership criteria. These often clash with the legal owners. These non-members are repeatedly caught in some areas while illegally harvesting forest products. However, PFM members and the executive committee complain that they are not getting adequate support from legal authorities (the police and courts) in timely and appropriately penalizing encroachers Nugroho and Eko, (2019).

To effectively and fairly address the complex challenges forest management, it is essential to differentiate between illegal activities arising from poverty, such as timber production, utilization of non-timber forest products, fuel wood extraction, and fodder collection, and the lack of awareness. Forest crime largely results from weak governance and subsequent poor law enforcement in the forest sector. Poverty reduction approaches targeted at forest-dependent populations involved in forest crimes will be a particular necessity, especially in situations where broad development programs are implemented (World Bank, 2011; International Forestry Research, 2012). Nugroho and Eko, (2019)

### **2.6. Empirical Literature Review**

The empirical research suggests that participation varies by context, and some factors, such as the socio-economic characteristics of local populations, resource characteristics, and program design, may support or constrain local people's participation in collaborative forestry programs. Most empirical evidence shows that the success of conservation initiatives is largely dependent

on the extent to which local people participate and benefit from forest resources (Mohammed *et al.*, 2020)

## **2.7. Factors Affecting Participation in participatory forest management practices**

### **Demographic Factors Affecting PFM**

According to Askal *et al.* ;( 2022), Northwestern Highlands of Ethiopia in Alemsaga Forest by using a binary logistic regression model, Age is another demographic factor that has a negative impact on participation. The finding confirms that age is an important determinant factor in households' decisions to participate in PFM. The result showed that age has a negative B coefficient and is significant at a 5% probability level. This implies that an increase in the age of the household decreases participation in PFM activities because, unlike the older group, the youth have an interest in participating in conserving the forest because they have high labor power to manage the forest. Based on the result of the odds ratio and other variables being constant, a unit increase in a household's age would decrease the interest in participation by a factor of 0.936 compared to the reference category of the younger age group.

Solomon *et al.* (2017) examine the level of forest users' participation at different stages of a participatory forest management (PFM) program in southwestern Ethiopia to analyze data using the binary logistic regression model. Results revealed that of the total household respondents (172), 80.8% were male and the remaining 19.2% were female. Even though the PFM approach encourages women's participation, most of the female-headed households were not members of the PFM program owing to their double burden of work and cultural barriers during participation, which were higher for male-headed households as compared to female-headed households. In a similar vein, the finding suggests that in Ethiopia's Metema and Quara districts of the Amhara region, the research was conducted by Walle, and Nayak, (2022). The

sex of the household head plays an essential role in forest conservation and decision-making aspects of PFM activities.

Male cooperative members were more interested in participating than female cooperative members in the forest conservation and decision-making activities of the PFM program. such as afforestation and reforestation, controlling fire, controlling illegal forest harvesting, meeting attendance, and participation in meetings and also Insights from key informant interviews and group discussions indicate that male household heads were more aware of and able to express village related conservation and development issues compared with their female counterpart.

The educational level of the household head had a positive influence on forest management practice in Kenya the study was undertaken on the Ontukigo and Ngare are community forest management cooperative. According to Musyoki *et al.* (2016), most of the high-level participants were of upper primary (35.9%), secondary school, and (31.3%), and lower primary (20.3%) levels of education. Though the influence of education on level participation in PFM seems to be significant in this study ( $\chi^2 = 10.829$ ,  $p=0.2$ ), it is still clear and consistent with other studies that illiterate farmers are less likely to participate in forestry programs. Education is an important tool to motivate local community involvement in various rural development and natural resources conservation initiatives individuals with better education levels are more aware of the forest resource conservation benefits and the adverse effects of forest degradation and thus become more positive in their views of forest conservation management practices (Chetri *et al.* (2013); Tonin, 2018). According to Mudaca *et al.* (2015), members of the forest user group who are illiterate are expected to involve less in decision-making activities, in comparison to literate individuals. This research shows that reported that literate household

heads were more interested and expected to participate more in conservation projects which implement new conservation techniques.

In line with (Engda, 2013; Askal *et al*; 2022), the binary logistic regression result showed that family size is positive and significant at a 1% probability level ( $p < 0.01$ ). According to the result, a relative majority of the respondents had a household with a large number of family sizes and tended to participate in participatory forest management activities. A unit increase in family size increases the probability of participation in forest management by 44.4%. This is most likely due to more demand for forest resources for household consumption compared to households' having small members. Households with small sizes are less impacted, as they are heavily engaged in farm activities even in the off-season. Similar findings were reported that the greater family size contributes to a positive response to PFM. It has been noted that households with large family sizes have extra opportunities to work with community forest management.

### **Socio-Economic Factors Affecting Participation in PFM**

This study investigated the factors affecting farmers' participation in participatory forest management in the Yayo coffee forest. Two-stage sampling procedures were used to select sample households for data collection. A total of 120 sample households were randomly selected. Data collections was done through group discussions, key informant interviews and transect walks in the study area. Descriptive and inferential statistics Models were used to identify variables determining decision-making. The study anticipates that the landholding of the household has a negative correlation with the emergence of collective forest management. On average, a 2.89 ha mean difference is observed between the two groups.

The result shows that large land holdings have a negative and not significant impact on a household's decision to participate in PFM at a less than 5% probability level. As expected, farmland owned by the household is negatively related to participation at the planning stage at a 5% probability level. This result implied that households with larger land sizes have a low intensity of participation in forest management activities. This could be because the large land enabled them to have enough fodder, ground grass, and other forest-related benefits they could have gotten. Therefore, the odds ratio of farm size implies that if farm size increases by one hectare, the probability of a household participating decrease by a factor of 4.01, according to Belete Limani Kerse (2016).

In the study conducted by Musyoki *et al.* (2016) in Kenya and Oli and Treue (2015) in Nepal, livestock holding size had a negative sign and was statistically not significant at the 5% level, which satisfies the prior expectation. The highest number of livestock owned by households requires a high amount of feed resources. So, they want to participate in forest management activities actively. Because the major feed resources utilized by the household were grasses, crop residue, trees, and shrubs, Therefore, the source of grasses, trees, and shrubs is obtained from an enclosed forest area of PFM.

The major livestock feeding system in the study was the cut-and-carry system due to the absence of grazing land. (Habtmu Kenea, 2020), contrary to the expected hypothesis, respondents who have enough livestock had a better interest in the concept of PFM. The marginal effect implies that additional livestock in the Tropical Livestock Unit would increase the intensity of participation, the probability of participation, and both participation and intensity of participation in participatory forest management by 6.22 units, 5.7%, and 6.4 units,

respectively. The respondents who had a high number of cows would be more interested in participating actively in PFM activities.

### **Biophysical Factor Affecting Participation in PFM**

According to Tadesse and Abay (2013), the study focuses on explaining the determinants of community-based forest management evidence from Alamata, Ethiopia. To achieve the objectives of the study, data were collected from 157 household respondents from different sampling units. A logistic regression model was employed to determine the relative importance of variables. The study shows that the distance of the forest from the home hurts farmers' participation in the protection of forest activities at a 10% level of statistical significance. The household far from the forest did not benefit from the forest because it requires additional costs for the transportation of grasses and other forest resources.

Similarly Teklewolde *et al.* (2018), the study examines, as predicted earlier in the hypothesis of this study, that distance from the forest has been negatively related to the level of participation at the monitoring and evaluation stage at a 5% significant level, as indicated in Table 6. This was because, as a household further away from the forest resource, they interact less with the forest, which probably leads them to associate fewer values with the forest. The odd ratio result confirmed that as an increase in distance from home to the forest increases, the likelihood of household engagement in forest management at monitoring and evaluation decreases by a factor of 2.09.

### **Institutional Factors Affecting Participation in PFM**

The study conducted by Meseret and Addisie (2022), the determinant factors that affect community participation in the Alemsaga forest. The study employed a mixed research design where quantitative and qualitative approaches to data collection and analysis were

implemented. Household heads from three rural kebeles were used as a target population, and the questionnaire survey was administered to randomly selected sample households. A binary logistic regression was employed to identify the major determinants of PFM in the study area. The result shows access to training and experience-sharing has a significant positive influence on the household's decision to participate in forest management activities. The result of training has a positive relationship with participation in PFM and is significant at a 5% level of significance. Therefore, the regression result showed that other things were constant: the training increased household participation in forest management by a factor of 2.700.

In line with Belete Limani Kerse (2016), As hypothesized, access to different training and experience sharing has a significant positive influence on the likelihood of deciding on participation in forest management activities. Thus, when training and experience were shared, the greater the awareness of a household about the importance of managing forests collectively. Therefore, the regression result showed that other things were constant and household engagement in forest management at the implementation stage increased by a factor of 1.6. These situations in their environments initiated the local people to participate in the reforestation project by anticipating immediate improvements.

## **2.8. Conceptual Framework**

The conceptual framework presents a collection of concepts illustrating how the dependent variable and independent variables of the study are interrelated. This framework is often expressed through diagrams, charts, graphs, pictographs, flow charts, organograms, or mathematical equations (Ndunguru, 2007). The elements that influence the practice of community forest management are divided into demographic, socio-economic, institutional, and biophysical factors that may have either positive or negative correlations with participation

in PFM. To clarify the factors affecting community participation in PFM, a simple conceptual framework has been developed. The figure below displays the conceptual framework for this study.

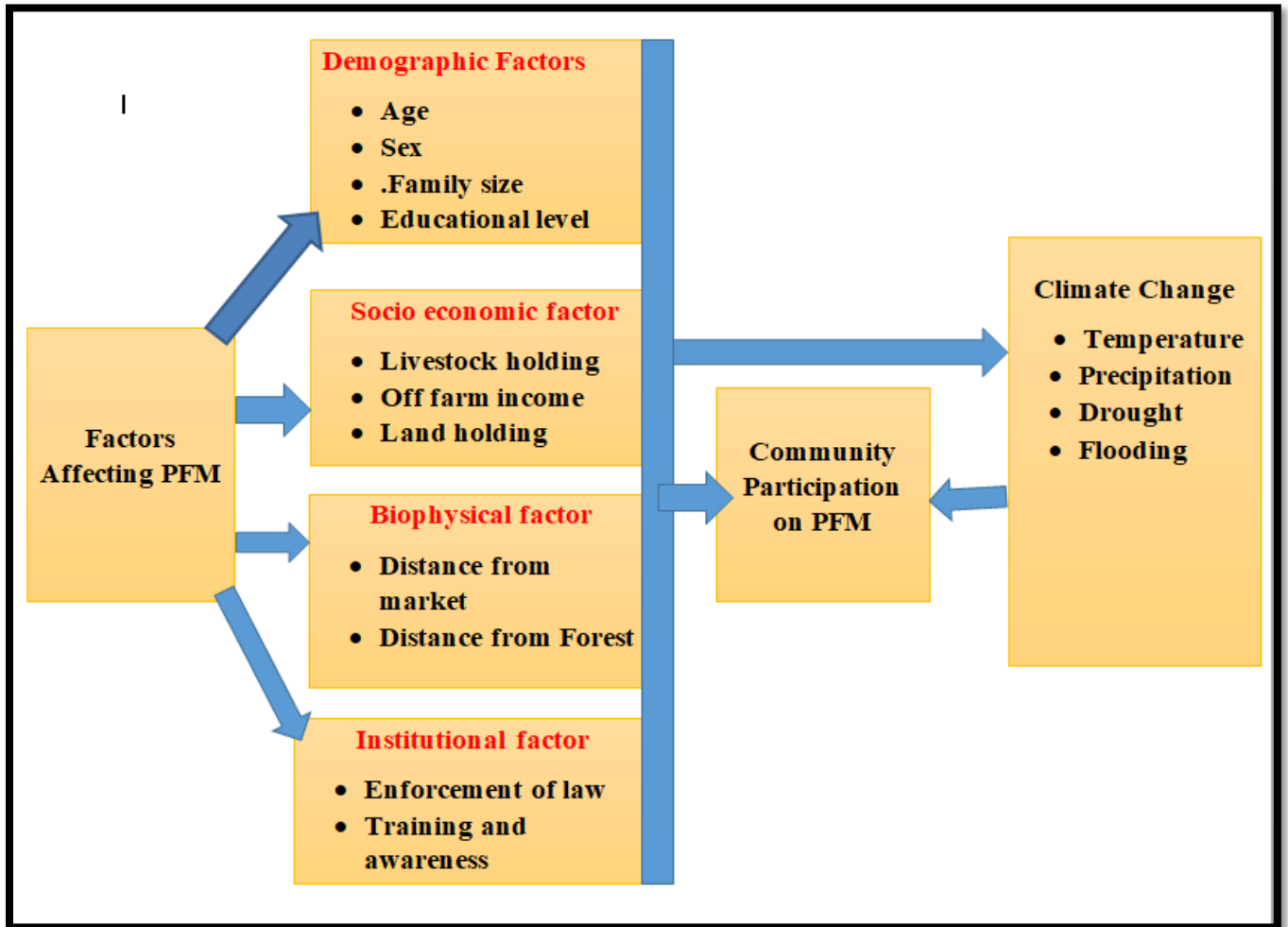


Figure 1: Conceptual framework

Source: researcher, (2023)

## **CHAPTER THERR**

### **RESEARCH METHODOLOGY**

#### **3.1. Description of the Study Area**

##### **3.1.1. Location**

The study area geographically located between  $7^{\circ} 10' N$  Latitude and  $37^{\circ} 10' E$  Longitude (Fig.2) The area is located about 500 km southwest of Addis Ababa, and 270 K.M from Administrative city of Bonga. Mareka Woreda is one of the 10 Woreda administrative and 2 city administration of Dawuro Zone, southwest Ethiopia Regional state. Mareka woreda is bordered to the southwest by Isara woreda, to the west by Mari Mansa woreda, to the northeast by Tarcha Zuria and to Zaba Gazo woreda, and the southeast by Loma Bossa. Mareka Woreda has 15 kebeles; the administrative center of the woreda is Wake town.

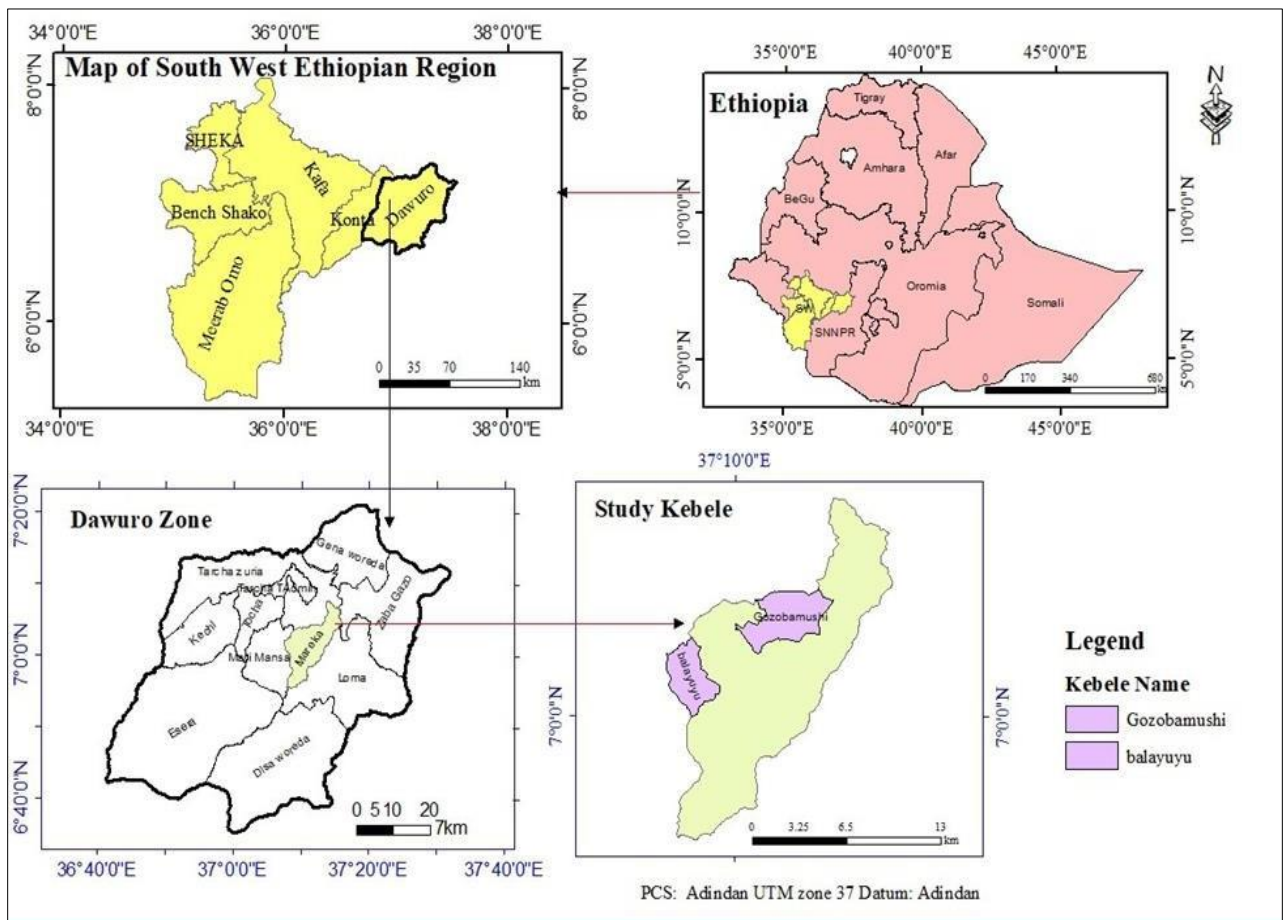


Figure 2: Map of the study area

Source, Researcher, (2023)

### 3.1.2. Climate

The Woreda is divided into three agro ecological zones. Namely, highland (dega), temperate (Woina dega), and lowland (kola) have total landholdings of 53%, 30%, and 17%, respectively. The mean annual rainfall is 1395–1716 mm, and the rainfall distribution is bimodal, where the short and main rainy seasons exist. The highest rainfall occurs in the wet season (April to September) and the lowest rainfall occurs in the last half of the dry season (February and March). The annual mean temperature is 16.97–29 °C. According to National Metrology Agency (2023).

### **3.1.3. The Bio-physical feature of the study area**

The total area of the woreda is about 46220 ha. The elevation of the district ranges between 1360 and 2541 m.a.s.l. The divisions of relief features include plateau, plain, and valley. With the total area coverage, 3170 hectares (6.8%) are covered by forest, 12,000 hectares (25.9%) are grazing land, and 28640 hectares (61.9%) are cultivating land. The remaining 2410 hectares (5.2%) comprise bushes, savannas, rivers, springs, stagnant waters, and hills. The dominant soils in the area were dystric nitro sols derived from metamorphic Precambrian basement rock types (FAO, 1983). The major land uses and covers were permanent crop cover (12.15%), annual crop cover (40.46%), settlement area (11.73%), pastoral land (0.79%), forest and bush land (20.27%), and others (14.6%), (MWARDO, (2023).

### **3.1.4. Socio-economic Characteristics**

The population of Mareka District is estimated at 147,950, of which 73,235 (49.5%) were males and 74,715 (50.5%) were females (CSA 2010). The farming systems of the area are predominantly subsistence farming based on mixed crop-livestock production. The dominant crops grown in the study area include legume crops (fava bean, lentil, and field peas), cereal crops (wheat, rye, barley, and maize), perennial crops such as Enset, coffee, different agroforestry tree species, eucalyptus plantations, root crops (potatoes and taro), and others. The livestock reared in the area are cattle, goats, sheep, horses, poultry, and donkeys (MWARDO, 2023), and Shitaye (2019).

## **3.2. Research Design**

The study utilized a cross-sectional or non-experimental survey research design. Cross-sectional studies helped gather information about a particular population in Woreda. It is quick,

easy, and cheap to perform effectively. It is also appropriate and suitable to use data collection tools such as questionnaire interviews, key informant interviews (KII), focus group discussions (FGD), and field observation analyses. The study was conducted using quantitative (survey) and qualitative data collection (focus group discussion, field observation, and key informant interview) components. Many researchers have used cross-sectional research designs (Dereje, *et al*, 2016).

### **3.3. Data Type and Sources**

This study works on both qualitatively and with a quantitative data type collected from primary and secondary data sources. Primary data were collected from respondents by using a semi-structured interview, key informant interviews, focus group discussions, and field observations. Secondary data were collected from published and unpublished documents that include books, published research, unpublished agriculture and natural resource office annual reports, the Forest and Environment Protection Office report and rain fall and temperature data from Meteorology.

### **3.4. Sampling Procedure and Sample Size Determination**

In this study multi-stage sampling technique were used. Out of 15 rural kebeles the sampling sites were selected based on the size of forest area and the presence of active PFM operational.

The selected two sample kebeles were stratified into two strata (participant and non-participant in forest management). Finally, the sample respondent participant was selected using a systematic random sampling technique from the cooperative member list, and non-participants were selected from the list of Keble administration using a simple random sampling technique. A total of 270 sample respondents have been drawn by taking into account the probability proportional to the sample size of the identified households in each of the two selected kebeles.

To estimate sample size, the simplified formula suggested by Yamane (1967) was used at a precision level of five percent ( $e = 0.05$ ), with confidence interval of 95%.

$$n = \frac{N}{1+N(e)^2}; n = \frac{846}{1+846(0.05)^2}; n = \frac{846}{3.115} \sim 272$$

Where:  $N$  = population size (846);

$n$  = sample size (270);  $e$  = the acceptable sample error (0.05).

Then, out of 846 household heads, 272 sample households (173 participants and 99 non-participants) were selected and interviewed. The sample size was determined using Kothari's (2004) formula and the proportionate-to-size sampling technique. This sample size (272) was real located to each kebeles using the probability proportion to size using the following formula:

$$n_i = \frac{n_i(n)}{\sum N_i}$$

Where  $n_i$  is the number of sample households selected from each kebele;  $N_i$  is the total number of households living in each selected kebele, and  $n$  is the total sample of kebeles.  $\sum$  is the summation sign, and  $\sum N_i$  is the sum of the total population in selected kebeles.

Table 1: Sample size determination

No	Selected kebeles	Total number of HH			Proportion %	Sample respondents of HH			Percent
		Participant	Non-Participant	Total		Participant	Non-Participant	Total	
1	Gozo Bamushe	230	185	415	0.319	83	50	133	48.9%
2	Bala yoyo	240	193	433	0.319	90	49	139	51.1 %
	Total	470	378	848		<b>173</b>	<b>99</b>	<b>272</b>	<b>100 %</b>

Source: Survey data (2023)

### **3.5. Method of data collection**

Data was collected by using a semi-structured questionnaire and a focus group discussion with local community elders and leaders, kebeles administrators, cooperative members, the executive committee, youth and women, marginalized community leaders, NGOS experts, and Woreda agricultural and environmental protection and forest office experts. Both primary and secondary data sources were used for the study. Primary data such as demographic, socioeconomic (education status, benefit derived or expected from the forest (forest dependency), forest cooperative membership, institutional factors (rules and regulations, and extension services), perception of household, and constraints) were collected through the questionnaire. Secondary data were collected by reviewing the relevant material or documents, such as scientific papers, books, reports, documentary sources, and meteorology data. Six enumerators, from the selected two kebeles, were employed based on their knowledge of the local language, culture, and experiences in data collection. The training was provided to the enumerators on the procedure they followed while interviewing both participant and non-participant respondents, and a discussion was also held to make the questionnaire clear

#### **3.5.1. Key Informant Interview (KII)**

A key informant interview was conducted with different individuals at different levels and by sex ratio and Age distribution. At the Keble level, individual interviews were conducted, and they gained sufficient knowledge about the area and were able to memorize its historical forest management practices and climate change trends from their own experiences and knowledge freely to solve the existing problems. Experts with environmental and agricultural backgrounds in Kebeles, woreda, and including other stockholders, during this study, eight respondents were

involved in key informant interviews. Thus, (1) from the woreda agriculture office head, (1) from the woreda forest expert, (2) experts from two selected kebeles extension agents, (1) from the woreda cooperative office, (1) from the Woreda REDD+ program coordinator, and (2) kebeles chairpersons were used for a key informant interview.

### **3.5.2. Focus Group Discussion**

One focus group discussion was held at each kebele, including women's, who they were not involved in the household survey. The major target of FGD in this research was individuals who have lived in the area for a long time and have good educational back ground and knowledge about the study area, including local elders (2), community leaders (2), religious leaders (2), women and youths (4), non-participants of PFM (2) participants, and marginalized groups that depend on forest (Manja clan) (2), Kebeles land use and supervision committee (2). To guide the discussion, a semi-structured checklist was designed specific to the research issue. Focus Group Discussions were carried out in each kebele with 6–8 individuals participating in each session.

### **3.5.3. Field observation**

Field observation or direct observation was used to collect data. Information collected during observation was very useful for analyzing and interpreting the data. The researcher has directly observed a meeting of the executive committee and a general assembly and observed the participation of the community forest users group in the meetings, transparency in information, and accountability of the PFM members in Ali and Lili Forest. The researcher has also tried to observe their participation in activities planned to ensure forest conservation and the forest under their management. The regeneration or degradation status of the forest in the study area was also observed. An observation checklist was used as an instrument for this method of data

collection. During observation, a photograph was also taken using a digital camera and smartphone.

#### **3.5.4. Household survey**

To generate quantitative and qualitative information at the household level, a household survey was undertaken using a semi-structured questionnaire. A semi-structured questionnaire was designed for scheduled household survey. Both closed and open-ended questions were used as a tool to collect data from sample households. The survey is to collect data related to household socio-demographic, economic, institutional, and environmental characteristics and the possible factors that determine community participation in participatory forest management, as well as the effects of climate change. The survey was undertaken in purposeful selected two kebeles with a sample size of 272: Gozo Bamushe, 83 participants, 50 non-participants, and Bala Yoyo, 90 participants, 49 non-participants were interviewed appropriately. Based on information acquired from informal discussions with farmers, field observation, and literature reading, structural questions were developed. Before conducting the survey, enumerators were trained, and the questionnaire was tested for clarity and understanding. Unclear and unrelated questions to the respondents and enumerators were modified, and additional questions were also included to make the questionnaire clear and capture relevant information.

#### **3.6. Methods of Data Analysis**

Per the objectives of the study and the nature of the collected data, both descriptive statistics and inferential statistics were applied to analyze the collected data. Descriptive statistics like mean, frequency distribution, maximum and minimum, percentage distribution, and standard

deviation were used to describe and understand the socioeconomic, demographic, and institutional situations of the sample households. Inferential statistics such as the Chi-square test and the t-test were used. Chi-square was used to analyze the associations between categorical variables, and the t-test was also used to compare mean differences between continuous variables.

The long-term temperature and rainfall trend of climatic variability was analyzed by undertaking liner and trend analysis and calculating the coefficient of variation. Intra-seasonal rainfall variability was analyzed using the coefficient of variation. The Excel sheets were used for raw data entry, sketching graphs, and calculating coefficient variation (CV). The qualitative data from open-ended questions in the questionnaires, key informants, interviews, and focus group discussions was presented through a qualitative description. The data analysis was entered into statistical software (SPSS version 20). Figures and tables were used to represent the collected data to be analyzed. In addition, econometric models, binary logistic regression, were adopted. A binary logistic model was used to analyze the objective of the study, which was intended to identify factors that affect community participation in the study area. Before data analysis checks and model fitness, multicollinearity or association among the hypothesized independent variables were conducted.

### **3.6.1. Econometrics model specification**

To explain the observed variation in participation, a logistic model in which the dependent variable Participation is regressed as a function of the explanatory variables: economic, social, institutional, and biophysical. The response of the participants as to whether they participate in PFM can be outlined as a binary-choice model, with an outcome (decision of households) of

participation or no participation. The decision of households to participate in PFM depends on economic, social, institutional, and biophysical factors (see Table 2 for a detailed explanation of explanatory variables). Simply put, in the logistic model,  $Y_i$  represents the dependent variable, participation, which equals 1 if the respondent participates in PFM and 0 if not. The probability of household participation in PFM,  $\Pr(Y_i = 1)$ , is a joint probability density function/likelihood function evaluated at  $X_i\beta$ , where  $X_i$  is a host of explanatory variables and  $\beta$  is the coefficient of the predictor variable explaining the change in the dependent variable as a result of a unit change in an explanatory variable. The estimation from the logistic transformation of the probability of participants' opinions in favor of participation in PFM  $\Pr(Y_i = 1)$  can be represented as:

$$\Pr(Y_i = 1) = \frac{\exp(X_i \beta)}{1 + \exp(X_i \beta)}$$

The above equation can be reduced to:

$$\Pr(Y_i = 1) = B_0 + B_1X_1 + B_2X_2 + \dots + B_iX_i$$

Where:

$P$  is the probability of the presence of the characteristic of interest, community participation.

$B$  is the coefficient of the predictor variables and is estimated from calibration data using the maximum likelihood technique.

$X$  is a host of explanatory variables

$$P(P) = \beta_0 + \beta_1(\text{SEX}) + \beta_2(\text{AGE}) + \beta_3(\text{EDU}) + \beta_4(\text{HHFZ}) + \beta_5(\text{LAN}) + \beta_6(\text{TLU}) + \beta_7(\text{OFFFARM}) + \beta_8(\text{TRAINA}) + \beta_9(\text{ACCREDIT}) + \beta_{10}(\text{DISTMAR}) + \beta_{11}(\text{DISFO}) + \beta_{12}(\text{E LOW})$$

Before data analysis and checking model fitness, it is critically important to check the presence of multicollinearity or association among the hypothesized independent variables. The

existence of multicollinearity is a situation where independent variables are correlated. Hence, it is difficult to separate the effect of each explanatory variable to predict the parameters of interest. Two measures are often suggested to test the existence of multicollinearity. In this study, the variance inflation factor (VIF) was used to check multicollinearity among the continuous explanatory variables, while contingency coefficients (CC) were used for dummy variables (Gujarati, 1995).

VIF is computed as follow:

$$\text{VIF}(X) = \frac{1}{1 - R^2}$$

When  $R^2$  approaches 1, VIF approaches infinity. I.e. the existence of co-linearity increases, the variance of the estimator increases, and in the limit, it can reach infinity. If there is no co-linearity between the repressors, the value of VIF will be 1; as a rule of thumb, a value of VIF greater than 10 is assumed to indicate the existence of a multicollinearity problem in the model. According to Gujarati (2003), to avoid serious problems of multicollinearity, it is quite essential to omit the variable with a value of 10 or more from the logit analysis. In the same way, contingency coefficients were computed from survey data to check the existence of a high degree of association among discrete independent variables. The decision rule for contingency coefficients states that when their value approaches 1, there is a problem of association between the discrete variables, i.e., the values of contingency coefficients range between 0 and 1, with zero indicating no association between the variables and values close to 1, indicating a high degree of association.

According to Abate, (2009), CV values are classified as follows;

- ✓ <20% less variable
- ✓ 20-30% moderately variable
- ✓ >30% as highly variable

$$CV = \frac{SD}{\bar{X}} * 100$$

Where CV is the coefficient of variation, SD is the standard deviation, and X is the mean.

**3.6.2. Standardized anomaly index (SAI):** the SAI was used to identify drought during the period under consideration using annual rainfall data. The SAI is a statistical measure to detect unusual weather events and then determine how often droughts of certain strengths are likely to occur. The practical implication of a defined drought is that the deviation from the normal amount of precipitation would vary from one year to another. SPI with negative values represents periods of below-normal rainfall (dry), while positive values reflect above-normal rainfall (wet) (Muthoni *et al.*, 2019; Anose *et al.*, 2021).

It can be calculated as follows:

$$SPI = \frac{X_i - \bar{X}}{\sigma}$$

Where SPI refers to a rainfall anomaly (irregularity) on a multiple-time scale,  $x$  represents annual rainfall in year  $t$ ;  $\bar{x}$  represents the long-term mean rainfall; and  $\sigma$  represents the standard deviation over period observation. According to McKee *et al.*, (1993) and Mahmoudi *et al.* (2021), the drought severity classes are:

Table 2 , SAI value classification (McKee et al., 1993)

Moisture category	SAI value
Extremely wet	Above 2
Very wet	1.5-1.99
Moderately wet	1.0-1.49
Near normal	-0.99 to -0.99
Moderately dry	-1.0 to -1.49
Severely dry	-1.5 to -1.99
Extremely dry	-2 or less

### 3.6.3. Mann Kendall trend analysis

Man-Kendall tren tests such as Mann-Kendall sta (S), Kendall's tau, and p values were computed to detect the trend of temperature and rainfall. In general, the non-parametric Mann-Kendall test (Kendall, M. (2015)) was used to assess the presence of significant trends in precipitation and temperature data. The Mann-Kendall statics S of the series x are given by the test,(Mann,1945;1975).

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^n \text{sgn}(x_j - x_i)$$

Where,  $x_j$  and  $x_i$  are the annual value in years  $j$  and  $i, j > i$ , respectively, and

$$\text{sgn}(x_j - x_i) \begin{cases} 1 & \text{if } x_j - x_i > 0 \\ 0 & \text{if } x_j - x_i = 0 \\ -1 & \text{if } x_j - x_i < 0 \end{cases}$$

The positive value of S connotes "an upward trend or increasing trend, while the negative value of S indicates "a downward trend or decreasing trend." It is necessary to compute the probability associated with S and the sample size, to statistically quantify the significance of the trend.

### **3.7. Definition of Variables and Working Hypothesis**

#### **The Dependent Variable (Participation)**

The study used a binary dependent variable, taking the value of the dependent variable as the community's participation status in participatory forest management (PFM). It was measured as a dummy variable, with a value of 1 indicating that a household participated in PFM and a value of 0 indicating that it did not. The participants were defined as members of the community who were actively involved in PFM practices, while the non-participants were members who were not directly engaged in PFM activities. The potential explanatory variables that are hypothesized to influence PFM participation in the study area are summarized and presented in Table 2.

#### **Explanatory Variables /Independent Variables/**

Independent variables are those variables that are hypothesized to affect the dependent variable in one way or another. These variables are selected based on the available literature and previous research works related to the theme of this study and are discussed below:

#### **Description of Variables and Respective Hypothesis**

**Sex of household head (SEXHH):** This variable is a dummy variable, taking a value of 1 if the household head is male or 0 if the household head is female. Gender had a significant influence on participation in PFM activities and membership. This variable found that the probability of participating in forest management was higher for male-headed households as compared to female-headed households (Musyoki *et al.*, 2016). Male and female community members experience different circumstances that affect their participation in forest conservation activities such as firefighting and forest patrol, among other activities, but women are quite disadvantaged due to their social and household burden such as child care, fetching

water, cooking, and farming. This also affects their attendance at forest management activities and limited access to climate change information.

**Age of household head (AGE HH):** It is defined as the period from the respondent's birth to the time of the interview, measured in years; this variable is continuously measured in years. From the findings of different studies, the age of the household and head are found to negatively affect participation and have lower participation in PFM. Therefore, age affects community participation negatively. At younger ages, the probability of participating in community forest management is higher. But as the farmer gets older and older, his managerial ability and physical capacity are expected to decrease. As a result, the age of the year will increase, participation in forest management will decrease, overall labor hours will decline, and the demand for leisure will increase (Lebeta, 2017). Therefore, this variable was hypothesized to influence community forest management practice participation negatively.

**Educational levels (EDULHH):** It is dummy variable taking the value of schooling. Education equips individuals with necessary knowledge of how to make living. Highly educated person were more readily adopt participation in forest management and perceive climate change than uneducated.. Education has a positive effect on the probability of deciding to participate in participatory forest management. The education variable is found by different researchers as the literate respondents most probably participate in forest management practices than their illiterate counterparts (Abay, 2018). This can be due to their knowledge of the technologies they can get from education or by reading or utilizing social media. Based on these reasons, this variable was hypothesized to be that the more educated the respondent, the

greater the probability of participating in forest management practice than the illiterate respondent.

**Household sizes in adult equivalency (AE):** It is a continuous variable measured in terms of adult-equivalent (AE). Adult equivalency in a household is calculated by using the conversion factor, multiplying each household member with the respective conversion factor, and then summing. In rural households, family labor is the major input used in agricultural production. Households with large adult equivalents will have more labor for agricultural production. Households with large family sizes utilize higher community forest resources and are hence likely to participate more in PFM to meet their needs for forest products. This has a positive effect on participation in forest management. This indicates that households with fewer members are less likely to participate in social forestry activities and utilize a small amount of forest resources (Mehari, L., 2020). Therefore, this variable was hypothesized to have a positive effect on household heads' decisions about forest management participation.

**Landholding size (LANDHH):** it refers to the size of land owned by the household and continuous variable measured in hectares. PFM members and non-members had larger farms available for their use, probably because they had more interest in growing crops on their farm and had more livestock; they got fodder and grazing grass; they got firewood and construction material easily from their farm; but low-landholding farmers have low access to fulfill their needs, so they were able to access community forest for their needs from grazing, fodder, and non-timber production; and they depended on forest for income generation. According to Mbeche *et al.* (2021), households with larger land sizes have a low intensity of participation in

forest management activities. Large land holdings are negatively related to the probability of participating in forest management.

**Total livestock holding (TLU):** This is a continuous variable measured in the Tropical Livestock Unit (TLU). Livestock is an indicator of wealth and a source of income to purchase agricultural input. It is therefore hypothesized that the livestock holdings of households with a large number of livestock have high-intensity participation in participatory forest management activities. Households with more livestock units are more inclined to use community forests for fodder and grass. Thus, they are more inclined to participate in community forest management, and it was expected that income from livestock has a significant positive relationship with participation (Abay and Tilaye, 2018).

**Off-farm income (OFFFARMA):** It is a dummy variable measured in birr. The farm income of the household has a positive and significant impact on participation in forest management. Therefore, this variable was hypothesized to influence use participation, positively gaining income from off-farm activity, reducing forest resource exploitation, and diversifying income to reduce the dependency on forests. In line with Issahaku & Abdula. (2019), the results reveal that off-farm activities positively and significantly affect participation in forest management.

**Training and awareness (TRANING):** This variable is a dummy variable, taking on 1 if the farmer has access to training on the issue of community forest management or 0 if the farmer did not get any form of training regarding forest management issues. As hypothesized, access to different training and awareness-creation activities has a significant positive influence on the likelihood of deciding on participation in forest management activities. The training was positively associated and significant with participation, according to Demissew *et al.* (2021).

**Access to credit (ACCREDIT):** The availability of credit is vital for farmers to adopt new agricultural technology and diversify income sources. Credit can be used to narrow financial constraints for farmers to introduce improved farm technology, buy fertilizers, and fulfill necessary inputs. It is a dummy variable that indicates 1 for farmers who had access to credit and 0 otherwise. Therefore, it was hypothesized to influence farmers' participation in PFM positively.

**Distance from the market (DISTMKT):** This is a continuous variable measured in kilometers. It refers to the distance between the household's home and the nearest market. This shows access to the market to buy input and sell output. As the farmer is nearer to a market, there is a lower chance to participate in PFM, and they often depend on off-farm activities for income generation to support their livelihood.

**Distance from the forest (DISM)** it is continuous variable; measured by the time spent to reach the forest. PFM involves both the protection and utilization of forest resources. For those who are far away from the forest, it may be difficult to equally participate with those who are inside the forest in forest protection; hence, participants who travel far to reach the forest may decide not to participate, which negatively affects community participation in PFM ,Wegi, B., and Eshetu, O. (2019).

**Enforcement of laws (ENLOW)** refers to the action of the government to enforce environmental laws and bylaws. It is a dummy variable and coded as 1 if the government enforces the law and 0 if they complain that they are not getting adequate support from legal authorities. Enforcing forest laws and protecting the bylaws of the community to practice PFM. Therefore, the enforcement of laws affects community participation in PFM positively.

According to Noor, (2021), reducing forest-related crimes within society enhances community participation in all stages of the PFM approach, ultimately improving income from livelihood activities.

**Table 3: The summary of independent and dependent variables, types, measurements, and expected sign**

No	Variables	Type of variable	Unit of Measurement	Expected sign
Dependent Variables				
1	Participation on PFM	Dummy	0 and 1	
Independent Variables				
1	Gender of HH (SEXHH)	Dummy	0 and 1	+/-
2	Age of HH (AGE HH):	Continuous	Year	-
3	Educational levels (EDUL HH)	Dummy	0,illiterate1 literate	+
4	Household Family sizes (HHFSIZE)	Continuous	Adult equivalent	+
5	Landholding size (LANDHH)	Continuous	Hectare	+
6	Total livestock holding (TLU)	Continuous	TLU	+
7	Off Farm income (OFFFARM)	Dummy	0 and 1	+
8	Training and awareness (TRAINAWR)	Dummy	0 and 1	+
9	Access to credit (ACCREDIT)	Dummy	0 and 1	+
10	Distance from the market	Continuous	Kilometer	-
11	Distance from the forest (DISFO)	Continuous	Kilometer	-
12	Enforcement of laws (ENLOW)	Dummy	0 and 1	+

## CHAPTER FOUR

### 4. RESULTS AND DISCUSSION

This chapter presents the results and discussion of the study obtained from quantitative and qualitative data from descriptive and econometric analyses based on the objectives. The result of the chapter includes socio-demographic information about the respondents, existing forest management practices in the community, the temporal trend of climatic variability (temperature and rainfall), and the determinant factors that affect community participation in the PFM practice in study area.

#### 4.1. Characteristics of sample Household

##### 5.1.1. Demographic and socio-economic characteristics of the respondents

In this section, age, sex, education levels, family size, off-farm income, access to training, access to credit, enforcement of law total land holding, TLU, distance from forest and distance from market are analyzed and described in detail.

#### I. Categorical variable

**Gender:** The total sample of respondents considered during the survey was 272. The results show that 72 (26.4%) respondents were from female and the remaining 200 (72.2%) were male. In general, there were 173 participants and 99 non-participating respondents. Among the 272 respondents, 56 (20.7%) were female participant, and 117 (43.3%) were male participant. 16 (5.8%) were female non-participants and 83 (30.2%) were male non-participants. As Table 3 shows, 43.3% of male and 20.7% of female households agreed to participate in forest management. Therefore, the study is similar to the expected hypothesis that household sex negatively affects people's participation in PFM. Based on these arguments, it was anticipated

that male-headed households would be more likely to participate than female-headed households because of the absence of equal gender participation. In addition, the expectation was that the proportion of female-headed households' decisions to engage in PFM would be lower than that of male-headed households. Because females have cultural and household burdens, such as childcare, fetching water, cooking, and farming, this also affects attending forest management activities and meetings. However, in contrast to this result, Tadesse *et al.* (2017), even though the PFM approach encourages women's participation, most female-headed households were not members of the PFM program owing to their double burden of work and cultural barriers.

**Education:** About 71.9% of the sampled household heads were unable to read and write, while 16.3% of the sample households were between 1 and 4. Similarly, 4.4% of the sample households range between (5–8) grade, 4.1% are secondary, and 3.3% are college and above. The study findings show that households with a high level of education participate better in PFM activities. Similarly, the expected hypothesis predicts that relatively educated households show better participation in participatory forest management practices. The results of the chi-square test show a significant relationship between participation in forest management and education level at the 1 % probability level.

The survey results showed that forest users with relatively high levels of education are more likely to participate in PFM because they understand the danger of ecological and social crises of forest destruction, which bring change to their daily activities.

Table 4: Descriptive statistics results of categorical variables.

Discrete variable		Category of participation						X <sup>2</sup>	Sig (2 sided)
		Total		Participant		Non-participant			
		No.	%	No.	%	No.	%		
Sex	Female	72	26.4	56	20.7	16	5.8	10.8	0.001
	Male	200	72.2	117	43.3	83	30.5		
	Total	272	100.0	173	64	99	36		
Education	Unable To Read& Write	194	71.9	129	47.7	65	24	13.475	.009
	Grade1- 4	44	16.3	30	11	14	5		
	Grades 5- 8	12	4.4	8	2.9	4	1.4		
	Grade 9 – 12	11	4.1	5	1.8	6	2.2		
	College &	9	3.3	1	0.37	8	2.94		
	Total	270	100.0	173	64	97	35.9		
Off –farm in come	Yes	115	42.6	114	53.3	41	15	13.241	.000
	No	155	57	59	21.8	56	20.5		
	Total	270	100.0	173	64.1	97	35.9		
Access to training	Yes	200	74.1	119	44	16	5.9	6.266	.012
	No	70	25.9	54	19.8	81	30		
	Total	270	100.0	173	64.1	97	35.9		
Access to credit	Yes	208	77.04	144	53.3	64	23.7	9.511	.002
	No	62	22.96	29	10.7	33	12.2		
	Total	270	100.0	173	64.1	97	35.9		
Enforcement of low	Yes	180	66.7	108	40	59	21.9	7.993	.005
	No	90	33.3	65	24	38	14		
	Total	270	100.0	173	64.1	97	35.9		

**Participation in off farm income:** As shown out of total (270) sample households, (155)57%) did not participate in off-farm income activity, and only (115) 46.6%) participated in off-farm income activity. Of total (114), 53.3% were PFM participants, and approximately 21.8 percent were non-participants. Of the 56 non-participants, 20.5 percent did not participate in off-farm income activities, whereas the rest (15 percent) participated in off-farm activities. This result implies that the majority of the non-participants did not participate in off-farm activities. The

chi-square test results indicate that there is a significant association between participation in off-farm income and participation in forest management activities at a probability level of less than 1% (Table 3).

**Training and awareness:** Of the 270 respondents, 74.1 percent were trained and 25.9 percent were not trained in forest management activities. Among the 173 participants, 44 percent of farm households were trained in PFM activities, and 19.8 percent were not trained. Of the 97 non-participants, 83.5 percent were not trained in forest management activities, while the rest stated that they were trained. The result of this variable indicates that the number of households that have obtained training in forest management practices is higher than that of the non-participant households. The chi-square test result indicated a highly significant association between the PFM participants and non-participants in terms of participation in training at the 1% significance level.

**Access to credit services:** The survey indicated that 22.96% of 270 households were not accessed for credit services, while the remaining 77.04 percent were accessed for credit services. Out of a total of 173 participants, 10.7 percent did not access credit services and 53.3 percent did. Of the 97 non-participants, 12.2 percent did not have access to credit services, while the remaining 23.7 percent did. The chi-square test showed a significant association between access to credit services and the forest management categories of the respondents at a probability level of less than 1%. (Table; 3)

**Enforcement of laws:** Forest laws, and respect for bylaws were enhance community participation in forest management practices. Therefore, the enforcement of laws positively affects community participation in PFM. Of the total (270) farmhouses, 33.3 percent were not

accessed for law enforcement services, while the remaining 66.7 percent were accessed for law enforcement support. Among 173 participants, 40 percent had access to low-level enforcement services. Table 3 shows that of the 97 non-participants, 21.9 percent had accessed the law enforcement service. The Chi-square test findings revealed that the enforcement of low was positively associated and significant at the 1% level with participation.

**i. Continuous variable**

Table 5: Demographic and socio economic Characteristics of Continuous variable

Continuous variables	Category of participation								
	Non- participant (Y=0 )			Participant (Y=1)					
	N	Mean	Std. Dev.	N	Mean	Std.	Min	Ma	t-test
Age	97	47.58	8.152	173	44.18	9.249	28	70	.003
Family size	97	4.66	1.464	173	4.01	1.329	2.73	10	.000
Total land	97	1.85	.305	173	1.68	.391	1	4	.000
TLU	97	5.465	.83597	173	5.730	.9485	2.73	5.57	.018
Distance forest	97	1.85	.727	173	1.57	.683	30min	3hr	.002
Distance market	97	1.73	.878	173	2.02	.756	1hr	4hr	.004

Source: own survey data, (2023)

**Age of the household:** The study showed that the mean age of the participants was 44.18 years, whereas that of the non-participant household heads was 47.58 years, and the majority of household heads (93 %) were under 60 years of age. Only 7% of households were over 60 years old. These results show that younger age groups of less than 18 years and above 65 years of age are not members of the PFM because they did not actively participate in voting for the executive committee. The results indicated that the ages of the non-participants were higher than those of the participants. In this study, the t-test showed that there was a significant mean

difference between the participants and non-participants. In Table 4, the mean difference in household head age between the non-participant and participant was sign.

**Family size of the household:** The availability of labor in households is one of the most important resources in participatory forest management activities. When family size increases, households want to expand their income from forest products and thus are interested in participating in PFM.

Therefore, the expected hypothesis is that a large family size has a positive effect on participation in PFM. The average family size was 4.24 people. However, the number of families ranged between 1 and 10 in the study area. The mean HH size of the non-participants was 4.66, whereas that of the participants was 4.01. This shows that the HH size of PFM participants was greater than that of non-participants. The mean average national family size is 4.7 people per household (CSA 2007). The t-test value showed that there was a statistically significant mean difference between the non-participants and participants at the 1% probability level.

**Total land size of house hold:** Landholding size was hypothesized to have a negative effect on participation in PFM. Large farmland owners have less active participation in PFM activities compared to those with low landholdings. The result shows that, out of the total (270) mean land of the total sample household, 1.74 ha. This was greater than the national average land holding of 1.2ha (Gebrat, (2013). This might be due to the fact that in the study area, people are sparsely populated and have large land holdings in some households. The mean land size in hectares of non-participant respondents was 1.85, whereas that of participants was 1.68. The results confirm that the mean land size in hectares of non-participants was greater than that of participants. The t-test showed that the mean difference between the participant and non-

participant groups concerning total household size was statistically significant at a probability level of less than 1 %.

**Total numbers of livestock:** Among the total sample households, the mean livestock ownership in TLU is 5.56 based on Karaczun, and Bojanowski, (2022), each livestock population number was converted into a tropical livestock unit (TLU). The mean livestock ownership of PFM participants was 5.730, whereas that of non-participants was 5.465. The mean tropical livestock ownership in the TLU for PFM participants was greater than that of non-participants. This might reflect the fact that livestock is one of the most important and critical assets for farmers and their main source of income. The highest number of livestock owned by households requires a large amount of feed resources and other medicinal grasses. Therefore, they want to participate actively in forest management activities. The major household types were grasses, crop residues, trees, and shrubs. Therefore, the sources of grasses, trees, and shrubs were obtained from the enclosed forest area of the PFM. This study shows that there is a significant difference in the mean ownership of livestock in TLU at the less than 1 % probability level between participants in PFM and non-participants, as indicated in Table 4.

**Market distance:** One factor that limits community participation in participatory forest management negatively affects forest management activities. The respondents who are very close to the market have no better expectations of joining PFM activities. Promoting forest production with market integration is important for raising rural income and forest value, but rapid market integration is often associated with higher rates of forest clearance. In the long term, market integration will increase pressure on open access, illegal extraction of forest products, and collective forest management, according to Yibeltal and Diptimayee (2022).

From the descriptive analysis, the mean walking market distances of the participants and non-participants were 2.02 hours and 1.73 hours, respectively. The descriptive analysis revealed that there was a significant difference in the distance of the market from the household residence between participants and non-participants in forest management practices at the 5% significance level. The results indicate that the market distance for participants was higher than that of non-participants (Table 4).

**Distances to forest (km):** Home distance had a negative impact on community participation in the protection of forest management activities at the 1% level of statistical significance. The mean distance of the participants was 1.73 km, while the non-participant distance was 2.02 km. This showed that the mean distance of non-participants in kilometers was greater than that of the participants. The negative sign indicates that when the distance between forest areas increases, community participation decreases because collective activities require energy, time, and money to participate in PFM activities in the study area. The household far from the forest did not benefit from the forest because it required additional costs for transportation of grasses and other forest resources.

#### **The socio-economic activities in study area**

Farmers in study area are engaged in mixed farming activities, including staple food crops production such as legume crops (fava bean, lentil, and field peas), cereal crops (wheat, rye, barley, and maize) which produced in in two farming season. Perennial crops such as Enset, coffee, different agroforestry tree species, eucalyptus plantations, root crops (potatoes and taro), and others. The livestock reared in the area are cattle, goats, sheep, horses, poultry, and donkeys. Sample farmers maintain animals for various uses, including milk, meat, eggs and for means of transportation.

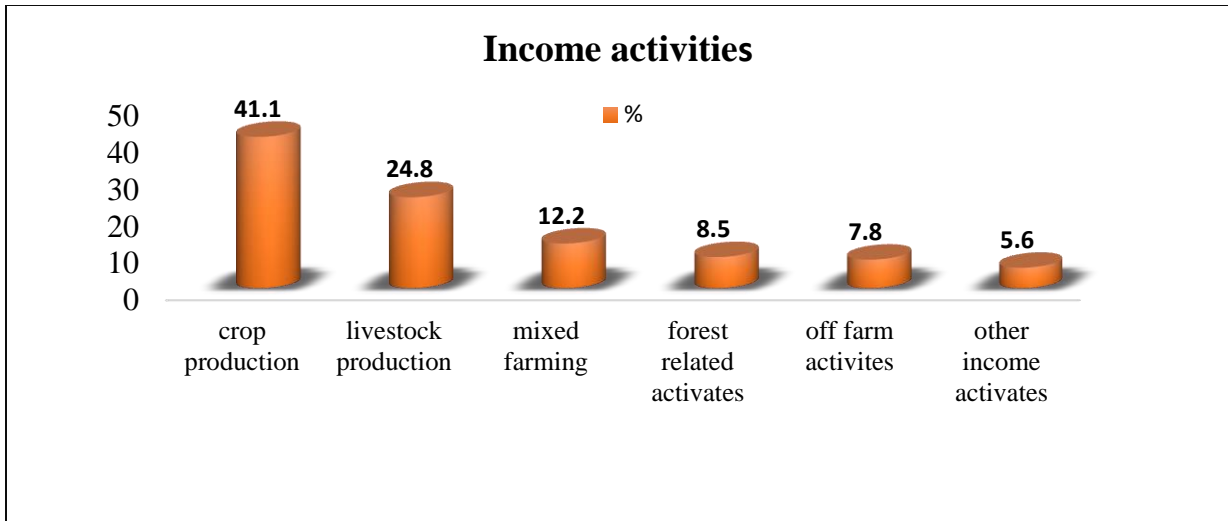


Figure 3: The major economic activities in study area.

Source: own survey data, (2023)

## 5.2. The Existing Forest Management Practices

### 5.2.1. Traditional forest management practices in study area

Forests in the study area were traditionally governed by the state. Ali and Lili forests in Gozo Bamushe and Bala Yoyo Kebeles are dominated by indigenous trees, grass, and shrubs of different species. Before the implementation of PFM, the forest area was well managed and conserved. The secrets behind such traditional management are the spiritual, religious, and cultural values of society. In the community, cutting trees, shrubs, and their products is strictly prohibited. Both the primary and secondary data gathered showed positive the role of traditional forest management practices.

Traditional forest management practices enforce customary law codes to protect forests from different activities such as cutting trees from forests, unwise use of forest trees during harvesting, debarking, shrinking of forest areas, and herding of animals. According to informants, when forest trees are cut down by unknown individuals, there is a shrinking of the

boundary for agricultural activity, or someone finds himself herding his cattle inside the forest, his case is presented to traditional leaders. If a crime is committed by an unknown person, local administrative bodies call the people by blowing a local instrument called Lokuwa (meleket in Amharic). There was a transparent and open judicial system in which the people gathered in an open place called "Dubusha" under a big tree, by Yaa, an assembly of the people, to investigate the case.

When a suspected person participated in such activities, they would have been informed and assigned a specific time to submit their reason. Finally, they implement the rules if the person is proven guilty and replace the boundary stone with the original place. A person who is proven guilty is obliged to pay the required money or offer in kind. If a guilty person refused to pay punishment, traditional leaders would inform the whole community/Gagarasha. This is because the final punishment or sanction could not be enforced without the involvement of the whole community. The practices of traditional institutions are similar to those of modern courts. If anyone fails to fulfill these obligations, he/she will suffer from social sanctions such as being excluded from any social organization, lack of support from the community during illness, death, etc. They will also prevent herding of cattle from common grazing lands. This final punishment is implemented when an individual refuses to pay money or kind, and the final punishment is social sanctions, which means excluding them from the social organization. This customary law has been regularly implemented. These traditional forest management practices have existed and sustained forest resources for a long time in society in the study area.

The results showed that government administrative structures also manage cases related to the illegal exploitation of forest resources in the study area. The administration attempts to control

and regulate it according to the rule of law. However, the enforcement of legislative actions was less than that of the traditional forest management system.

Table 6. The knowledge of respondents to ward forest management system in management structure

Forest management practices	Participant	Non-participant	Frequency	%
Traditionally	40	28	68	25.2
Government	39	24	63	23.3
Participatory	94	45	139	51.5
Total	173	97	270	100

Source, field data survey, (2023)

Overall, there seems to be a positive attitude towards community-based forest management (participatory) compared with the other two structures. This is evident from the higher percentage of participants (51.1%) who believed it is the best practice compared to traditional governance (25.2%) and state governance (23.7%). Additionally, the participation rate was highest for the participatory structure (51.1%) compared to the other two structures (25.2% for Traditionally Governed and (23.7%) for state governance). This suggests that people are more likely to be involved in forest management when they state that the best forest management approach is PFM, as shown in Table 5.

The Forests and their resources in Ethiopia have been conserved by rules and regulations in the top-down system for a long time. Many studies have stated that shifting the forest management system from a state-managed top-down approach to a people-centered bottom-up approach is an effective and efficient method for forest management practices (Demissew *et al.*, 2021).

Proclamation No. 1065/2018 Forest Development, Conservation, and Utilization Proclamation

does not include a traditional forest management system. In Ethiopia, forest ownership includes private forest, community forest, association forest, and state forest. During group discussions and interviews, the current state of the forest was under treatment.

### **5.2.2. Participatory forest management in practices**

There are several phases in the establishment of a PFM system. The first written guidance, as well as the more recent harmonized national guidelines, presents a three-phase approach: the first focuses on investigating current and past forest conditions. Community forest management groups and government foresters clearly define who forest users are and how they use the forest (stakeholder analysis), conduct participatory forest resource assessments, understand management needs, and explore forest-based livelihood opportunities. The second involves negotiations on which actions can improve forest conditions and explore the rights and responsibilities of communities. A forest management plan was prepared, and a co-management agreement was signed between the community and the government through transparent negotiation. The final phase involves forest management actions to improve forest conditions and sustainable use. The forest management and utilization plan has been translated into practice, including the sustainable harvest and marketing of forest products.

### **5.2.3. The interesting characteristics of PFM structures in study area**

**Inclusiveness:** All stakeholders, including women, marginalized groups, and youth, should have a voice in decision-making. **Transparency:** Decisions and financial information must be transparent to all members. **Equity:** Benefits and responsibilities should be shared fairly among members. **Accountability:** Leaders should be accountable to the community for their actions. **Capacity building:** Communities need training and resources to effectively manage forests.

Successful PFM requires long-term commitment from all stakeholders, ongoing capacity building, and adaptation to changing circumstances.

The different interest groups and resource user groups who should be involved in sustainable forest management, these groups are referred to as stakeholders. The principle of inclusive management depends on an understanding of the different stakeholders and the institutions that they represent. There is a need to clearly understand who could gain or lose from changes in resource management systems. Identifying how people perceive their own rights and responsibilities, as well as those of others, is a crucial starting point in initiating discussions over who should have which rights and responsibilities in the management system.

#### **5.2.4. The major cause of Deforestation in study area**

Again, the key informants and FGD noted that some individuals maximized the utilization of forest resources, and the local government also provided forest land to landless farmers and youth associations. Some people have no land for agricultural purposes, and they use forests and forest products for sale to sustain their lives and feed their families.

The Manja clan, a marginalized society, resides in the study area near the forest and serves as their primary source of income through the collection of dry wood for cooking and the production of charcoal for sale. The implementation of PFM in the Gozo Bamushe and Bala Yoyo natural forests revealed the severe extent of these issues. Unfortunately, forest resources were mismanaged and unfairly distributed among a select few individuals. Consequently, forest cover has deteriorated over time, leading to the encroachment of farmers living near the forests and the expansion of their farms. The majority of respondents attributed forest

deforestation and degradation for the purpose of agricultural activities, charcoal production, and firewood gathering.

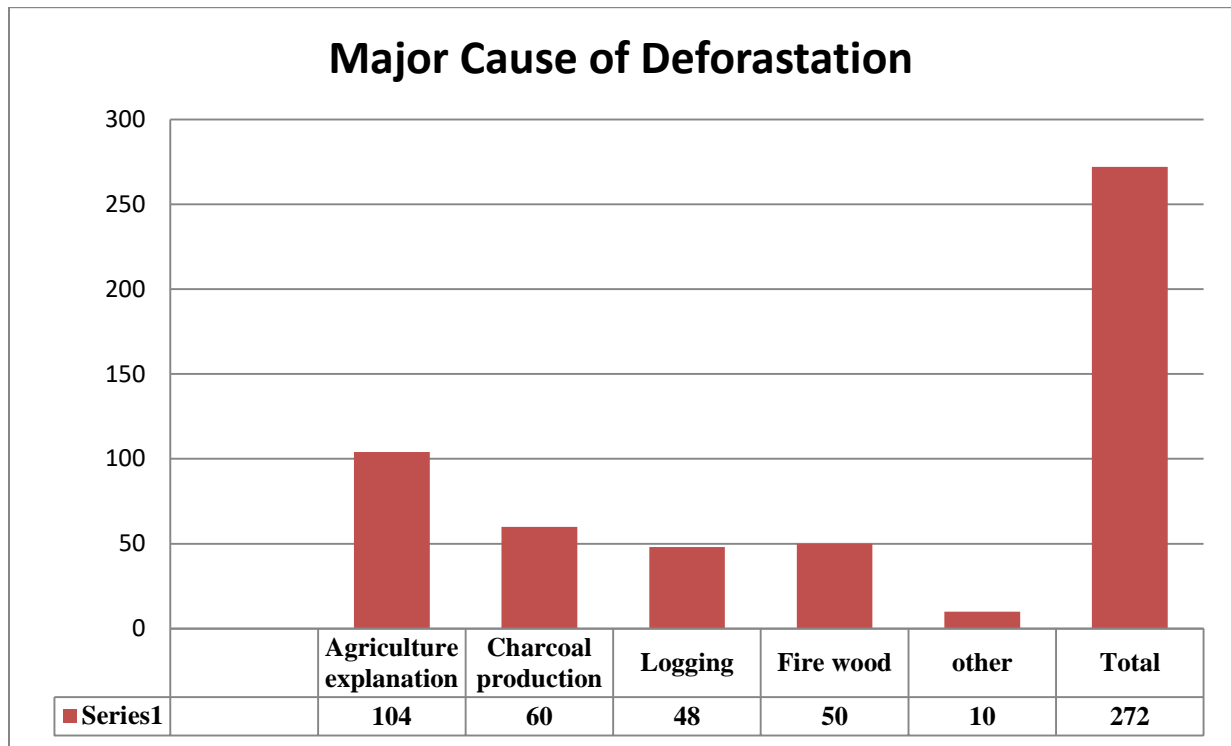


Figure 4: Major causes of deforestation and degradation in the study area

Source: own survey data, (2023).

The survey findings in Figure 4 reveal that agriculture was the leading cause of deforestation in the study area, accounting for (104)38% of the total. This could be due to several reasons, such as expanding croplands to meet growing food demands, clearing land for livestock grazing, shifting cultivation practices, and charcoal production being the second highest contributor, responsible for (60)22% of deforestation. Charcoal is often used as a cooking fuel and its production can involve unsustainable logging practices. Logging accounted for (48)17.6% of the deforestation. Unsustainable logging to harvest timber for furniture is a major concern in this study area. Other factors, such as firewood collection, construction purposes, and other accounts, contributed to a smaller proportion of deforestation (2.2%, 3.7%, and 3.7%,

respectively). However, it is important to remember that even seemingly small contributions can have a significant impact on the environment. Based on these data, it is clear that agriculture, charcoal production, and furniture production are the major drivers of deforestation and forest degradation in the study area. Similar studies conducted by Barton (2014), Zegeye (2017), and Oljirra (2019). They argue that major factors of deforestation were agricultural expansion and illegal encroachment of people for the sake of forest product and land expansion.

### 5.2.5. Community Participation in Forest Management Activates and Different Implementation Stages.

Table 7: Respondent’s involvement in the Forest Management Activities and Implementation Stage

No.	Activities	Participant		Non-participant	
		Frequency	Percent (%)	Frequency	Percent
1	Planning stage	159	93	25	25
2	Decision making stage (General assembly, executive committee meeting)	168	98	18	18
3	Monitoring and evaluation stage	72	42	7	7
4	Nursery and Seedling preparation	165	96	6	6
5	Weeding and hoeing planted seedlings	170	99	50	51
6	Forest management(Forest development , Forest resource utilization, Forest protection)	169	98	35	36

Source: field survey, (2023).

The number of participants and non-participants in different stages of implementation for community participation in forest management activities, in the planning stage, there were 159 participants and 25 non-participants, involves the initial development of plans and strategies for forest management, where the input and involvement of the community are crucial for

PFM. During the decision-making stage, there were 168 participants and 18 non-participants. This stage involves making important decisions regarding forest management, such as setting goals, determining priorities, and allocating resources.

Community participation in this stage ensures that decisions are inclusive and representative of the community's interests. In the monitoring and evaluation stage, there were 71 participants and 7 non-participants. This stage involves assessing the progress and effectiveness of forest management activities. Community participation in monitoring and evaluation ensures transparency and accountability in the management process in this stage only executive, forest expert, and some members of cooperatives. During nursery and seedling preparation, there were 165 participants and 6 non-participants participate are participate in this stage. This stage involves the establishment and maintenance of nurseries to produce seedlings for reforestation and afforestation purposes.

Community participation in this stage helps in ensuring the availability of quality seedlings and promotes local ownership of the forest management process. In contrast, there were, the weeding and hoeing of planted seedlings stage, there were 170 participants and 50 non-participants. This stage involves the maintenance and care of newly planted seedlings by removing competing vegetation. Community participation in this stage supports the survival and growth of the seedlings, leading to successful reforestation efforts.

In the forest management stage, which includes forest development, forest resource utilization, and forest protection, there were 169 participants and 35 non-participants. This stage involves various activities aimed at sustainable forest management, including promoting forest growth, utilizing forest resources responsibly, and protecting the forest ecosystem. Community

participation in this stage ensures the implementation of sustainable practices and the preservation of the forest's ecological integrity. Participation rates are generally higher among participants compared to non-participants in most stages, indicating active involvement in forest management tasks. It's important to further investigate the reasons behind the differences in participation rates to enhance community engagement and optimize forest management practices effectively.

This result shows that all cooperative members and the majority of non-cooperative members actively participated in plantation activities (Green legacy) mainly rather than participating in monitoring activities, Line with, (kasahun Gashu, 2019) that identify the massive population in PFM actively participate on plantation stage in Gonder zuria Worda (56%) participate in plantation activities. The results from interviews, focus group discussions, and data from attendance confirmed that the involvement of forest users in plantation activities was high compared to discussion making and monitoring, and evaluation.

#### **4.2.6. Community Perspectives on Participatory Forest Management**

Table 7, displays the perspectives of respondents who participated in PFM regarding how it fosters a sense of community ownership, as depicted in Table 5. The results indicate that the majority of participants strongly agreed (160 individuals or 92.5%), while a few respondents agreed (13 individuals or 7.5%). Meanwhile, non-participants who were questioned on this matter revealed that the highest number strongly agreed (74 individuals or 76%), and 21 individuals (21.6%) agreed, while the remaining 4 individuals (4%) remained neutral.

In terms of the view of participants from the study Kebeles, the majority strongly agreed (164 individuals or 95%) or agreed (9 individuals or 5%) that PFM serves as an alternative source of income for households. On the other hand, among the non-participant respondents on this

issue, 69 individuals (71%) strongly agreed, 25 individuals (25.7%) agreed, and the remaining 3 individuals (3%) remained neutral.

PFM members were given the Likert scale perception tasting questions to gauge how they felt about the PFM improves forest management and reduces forest degradation. Accordingly, around 158(91%) of respondents strongly agreed that PFM highly improves forest status and reduces forest deforestation and degradation establishing after 6 years, and 15(9%) respondents Agree. In the case of non-participants, PFM 83(85.5) strongly Agree, and 9(9.2%) agreed 2(2%) were neutral and, the remaining 3(3%) are dis agreed on the issue.

The result shows that the community's perception of PFM's dual goals of protecting the forest is to diversify household income through non-forest products (NTFP) and by fattening sheep and goat, as well as reduce the risk of soil erosion and increase soil fertility. They live in lower-catchment communities. During the FGD and interview, the majority of the participants and non-participants revealed that PFM is a good mechanism for protecting against forest fires. Before establishing PFM, forest fires destroy crops, goats, and sheeps that are rare in the forest. Our result is also in line with the findings of other studies, Mufedei and Kasim,. (2018), Belete (2016), and Yibeltal and Diptimayee (2022). PFM improved their livelihoods and covered about 62% of their total income. Overall, the results show the effectiveness of PFM in achieving its dual goals of protecting forests and enhancing community well-being.

Table 8: Community Perception of PFM

Statement	Participant					Total	Non-participant					Total
	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree		Strongly agree	Agree	Neutral	Disagree	Strongly disagree	
As PFM creates a sense of community ownership	160	13	0	0	0	173	74	21	4	2	0	97
As a result, the PFM has an alternative source of income for a household	164	9	0	0	0	173	69	25	3	0	0	97
As PFM improves forest management and reduces forest degradation	158	15	0	0	0	173	83	9	2	3	0	97
As PFM increase woman's participation in natural resource management	141	26	6	0	0	173	80	13	4	0	0	97
As PFM enhance Biodiversity conservation	131	35	7	0	0	173	72	15	8	2	0	97
Dose PFM increase non-timber forest product	139	29	5	0	0	173	60	26	11	0	0	97

Source, survey data, (2023)

#### 4.2.7. Forest Status before and after the introduction of PFM

Before PFM, the REDD+ program assessed forest resources for baseline data and then launched this approach in the study area. After five implementation years, the forest resources increased by volume and hectare, the number of species increased by 51 to 70 species from 2008 E.C. to 2014 in 5-year intervals. The area coverage of Ali Forest ranged from 312 in 2008 E.C. to 329.75 in 2014 E.C. The variance of Lili Forest was 17.75 and Ali Forest was 15.125. The grammatical change occurred through the active involvement of the community in seedling planting and natural forest conservation collaboration with local government.

The community has transformed their low-productive agricultural land, small plots, hillsides, and neighboring forest areas into high-altitude coffee species and multipurpose trees sourced from their community nursery. Through nurturing the seedlings planted over different years, continuous weeding, and pruning practices, the seedlings have adapting well to the dry

seasons, survived successfully. The species planted in the area include *Cordia Africana*, *Podo corpuses*, *Juniperus procera*, *Croton*, *Gravelia robusta*, avocado, bamboo, and eucalyptus trees for firewood purposes. Additionally, incorporating modern and traditional beehives, Nurseries,. Producing vegetables, practicing CSA around the forest has provided an extra source of income for the community and using Fuel efficient stoves, solar panel.

During FGD discussions and key informant interviews, it was recognized that PFM has provided a solution for the deterioration of forests that were once open to access due to things like commercial timber for building materials, firewood, and the grazing of livestock. In line with Mayo et al.,(2021),Axelsson &Grady, (2022), community-based forest management has enhanced community engagement in forest management, reduced rural poverty, and promoted forest resource conservation. In the study conducted by Kasim and Hussen (2018), respondents reported that the establishment of PFM has improved their livelihoods. About 62% of the sampled households reported that they have increased household income. Farmers in Gozo Bamushe and Bala Yoyo practiced different forest management practices in response to environmental climate change and to fulfill their livelihoods.

The community activates efforts to increase the area covered by forests by managing the cutting and weeding around valuable wood species, the quantity and quality of forest products produced inside the forest are increasing as constrictio wood, forest coffee, medicinal plants, and different types of spices are controlled, leading to an increase in the regeneration of "wild" coffee plants in natural forests and the return of wild animals due to hunting restrictions, such as wild pigs, monkeys, hornets, and deer. Similarly, the results of the focus group discussion also indicated that the major sources of income for PFM members were related to forests. They

stated that they own a small amount of farmland, which is insufficient to maintain the food security of their households. With the establishment of PFM, they are engaged in NTFP activities such as beekeeping, controlled hunting, and pasture selling, which, as a result, have improved their income and livelihood. According to Mussa et al. (2021), Agnoletti et al. (2022), and Song et al. (2021), the PFM approach is formed based on a common interest to conserve forests and forests, drastically reduce deforestation and forest degradation, and enhance community lives.

Table 9: Forest area coverage per/ha before and after PFM

Keble	Forest name	2008 E.C	2014 E.C	Variance
Forest area coverage				
Gozo Bamushe	Lili forest	312	329.75	17.75
Bala yoyo	Ali forest	73	88.125	15.125

Source: MWEFPO forest resource Assessment report document secondary data, (2023).

#### **4.2.8. Factors affecting community participation in PFM**

##### **4.2.8.1. Challenges that affect PFM implementation and community participation**

Different challenges face PFM. The main causes of forest resource degradation that affect the implementation and participation of PFM, such as rapid population increase, led to deforestation, overgrazing, soil erosion, soil nutrient depletion, and other issues. Wood and non-wood forest product consumptions are one of the challenges that affect PFM implementation. Also, individuals who live close to forests and woodlands frequently continue to gradually expand their farms—another factor next to forests fire caused by humans in the study area. During the interview and discussion of respondents' responses, in figure 14, below

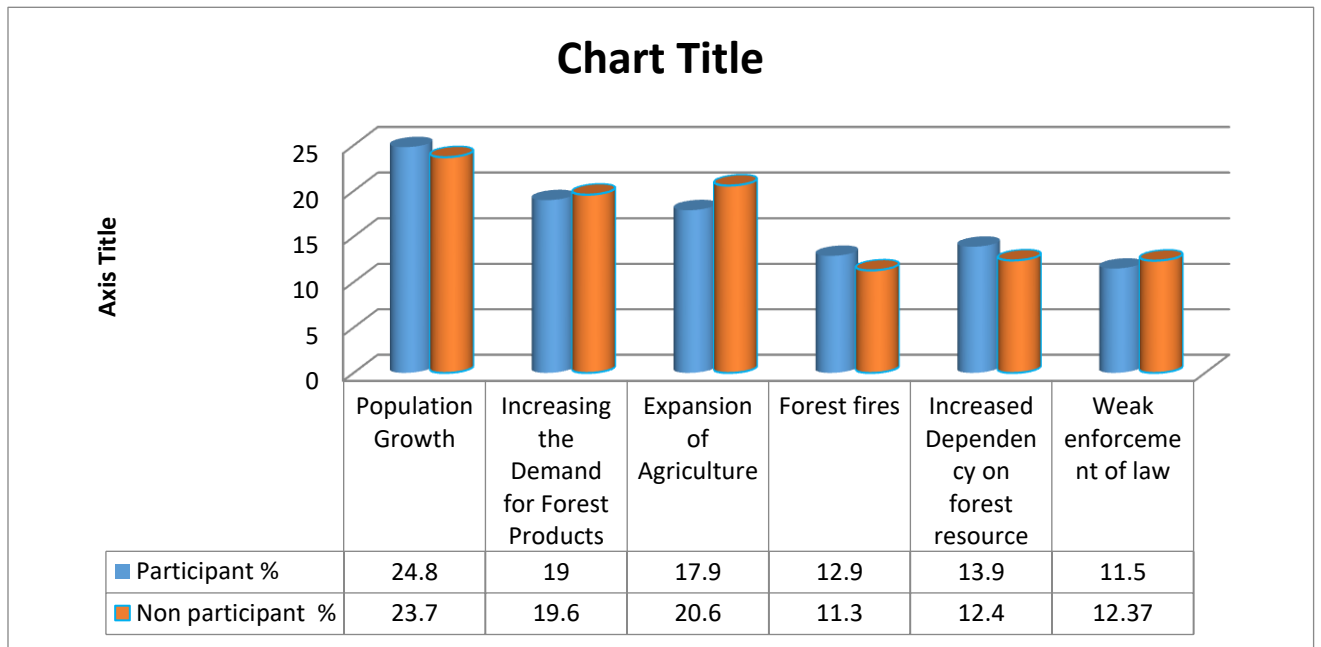


Figure 5, Challenges of participation and PFM implementation

Source, filed survey data, (2023)

The statistics show the percentage of respondents who identified different challenges and factors that influence participation and implementation of PFM. Population growth is a common challenge for both groups, as 24.8% of participants and 23.7% of non-participants mentioned it. However, the increment in dependence on forest resources is more prominent for participants (13.9%) than for non-participants (12.4%). The demand for forest goods (19%), while the least important challenge is weak enforcement of law (11.5%), The increasing demand for forest goods (19.6%), and increment in dependence on forest resources (12.4%). The high population growth and increasing demand for forest goods imply that there is a high pressure on the forest resources and a need for more effective and equitable management of the resources. The expansion of agriculture and human-caused forest fire indicate that there is a threat of deforestation and degradation of the forest ecosystem. The increment in dependence

on forest resources suggests that the local communities rely heavily on the forest for their livelihoods and well-being. The weak enforcement of law implies that there is a lack of institutional support and regulation for the PFM program.

To address the challenges, the awareness and participation of the local communities in the PFM program by providing them with information, training, and incentives. Promote the diversification and improvement of the livelihoods of the local communities by providing them with alternative and complementary income sources, such as off-farm activities, value-added products, and ecotourism. Strengthen the collaboration and coordination among the stakeholders, such as the government, NGOs, and private sector, to provide technical, financial, and legal support for the PFM program.

Monitor and evaluate the impacts and outcomes of the PFM program on the forest condition, biodiversity, and socio-economic well-being of the local communities. The line is with Treue, T., *et al.* (2014) and Zande, R., & Mzuza, M. K. (2022). The increase in population is demanding land for settlement and agriculture, and efforts to meet basic needs in such situations are attainable, resulting in depleting existing forests without being involved in the management of forest resources.

### **4.3. The Demographic and Socio-economic factors affecting community participation in PFM**

#### **4.3.1. Explanation of significant explanatory variables in binary logistic model analysis**

The binary logistic regression model was employed to analyze factors influencing community participation in PFM. As indicated in Table 15, among the 12 variables used in the model, eight variables are significant with respect to participation in PFM at different probability

levels. Sex and training are the variables that are significant at a 1% probability level. The variables that are statistically significant at a 5% level of confidence are education, family size, TLU, access to credit, and law enforcement, but land holding by the household is negatively significant, and the remaining four explanatory variables age, distance from the forest, and distance from the Market do not show the significance of community participation.

Table 10: Binary Logistic Result of Independent Variable

Variable	B	S.E.	Wald	Sig.	Exp( $\beta$ )
SEXHH	1.184***	.402	8.685	.003	<b>3.267</b>
AGEHH	-.205	.329	.389	.533	<b>.815</b>
EDUHH	.320**	.153	4.380	.036	<b>.726</b>
FAMILSIZ	.244**	.123	3.947	.047	<b>1.784</b>
TOTLAND	-.916**	.444	4.253	.039	<b>1.400</b>
TLU	.656**	.180	6.443	.011	<b>1.434</b>
OFFFARM	-.433	.321	1.818	.178	<b>.649</b>
ACESSCRIDT	1.746**	.373	4.004	.045	<b>3.474</b>
DISTFOREST	-.419	.222	3.559	.059	<b>.658</b>
DISMARK	-.301	.189	2.534	.111	<b>.740</b>
TRAINING	1.074***	.376	8.150	.004	<b>2.927</b>
ENFORCELOW	.6628**	.328	4.085	.043	<b>1.940</b>

**Pearson-  $\chi^2$  value= .260; -2Log Likelihood = .304a; Nagel kerke= 0.357;**

Source: model output/2023\*\*\* Significant at 1%, \*\* 5% probability level

**SEX of Household:** The sex of the household was found to greatly influence participation in activities related to participatory forest management (PFM) and membership. The researcher's

hypothesis suggested that male-headed households were more likely to participate in forest management compared to female-headed households due to the biological and social burdens that women, face which restrict their active involvement in all stages of PFM. It is commonly observed that men predominantly engage in discussions and decision-making processes in community-based development programs. However, recognizing the low level of women's participation in various development initiatives, the PFM approach encourages the inclusion of women. The odds ratio calculated indicates that, when all other factors are equal, the likelihood of male participation in PFM is 3.267 times higher than female participation. This positive association between gender and participation suggests that being male is associated with a greater likelihood of engaging in forest management activities within the PFM approach. It is important to note that other studies by Kassahun Gashu & Omer Aminu (2019) and Musyoki et al. (2013) also found a significant relationship between gender and participation in forest conservation, with males displaying higher levels of active involvement compared to females. This can be attributed to the presence of heavy social burdens placed on women, limiting their ability to actively participate.

**Household Educational Level:** Participation in PFM activities is positively associated with educational level, and this association is statistically significant at a 1% level. The coefficient suggests that for every year of increase in educational attainment, there is a 0.726 increase in the likelihood of a household participating in PFM activities compared to households with one less year of education. This indicates that households with higher levels of education are more likely to engage in PFM activities. One possible reason for this pattern is that households with formal education have better access to information, knowledge, and resources that allow them to understand and appreciate the benefits of forests. They are more adept at communication,

reading literature, and utilizing media, which may contribute to their increased participation in PFM activities. This finding is consistent with previous research conducted by Abay Mehari and Tilaye Teklewolde (2018), Demissew Wondafrash et al. (2021), and Yibeltal and Diptimaye (2022), who also found the importance of education in motivating local community involvement in rural development and natural resource conservation efforts.

Moreover, education seems to have a positive impact on individuals' views of forest conservation management practices. Those with higher education levels are more likely to hold positive perspectives on the importance and effectiveness of forest conservation strategies. These study findings the role of education as a crucial tool for promoting community engagement in various rural development and environmental conservation initiatives, particularly in the realm of forest management.

**Household member size:** The size of a household has been found to have a positive and statistically significant effect on the likelihood of participating in forest management activities. This was expected and supported by previous hypotheses. Specifically, households with more family members were found to have a higher probability of participating in forest management. Additionally, the odd ratio revealed that for every 1 unit increase in the labor force of the household, the probability of participating in forest management practices increased by 1.784 times.

This can be explained by the labor-intensive nature of forest management practices, which require a high amount of physical work, such as nursery establishment, pit preparation, planting, and firefighting. Therefore, households with larger family sizes are more likely to have the necessary manpower to engage in these activities. This finding is consistent with previous research conducted in Nepal, specifically by Chhetri et al. (2013) and Solomon et al.

(2017). These studies also found that households with larger family sizes were more actively involved in community forest management activities compared to households with smaller family sizes.

**Land Holding Size:** Landholding size was found to be negatively correlated with participation in forest management, confirming the previous hypothesis at a 5% significant level. The odds ratio of 1.400 indicates that for every one-unit increase in land holding, the odds of participation decrease by a factor of 1.400. The negative beta ( $\beta$ ) coefficient of -0.916 further supports this finding and indicates that as land holding increases, participation decreases.

The researchers observed that participants and non-participants in forest management who had large land holdings were less likely to engage in forest management practices and decision-making processes. This could be attributed to their greater interest in cultivating crops on their farms and their ability to easily obtain fodder, grass, firewood, and construction material from their land. On the other hand, farmers with small land holdings had limited access to resources and therefore relied more on the community forest for their needs, such as fodder and non-timber products, as well as income generation. Overall, these results suggest a negative relationship between landholding size and participation in forest management. Individuals with larger landholdings are less likely to participate compared to those with smaller landholdings. This finding aligns with the conclusions made by Belete Limani Kerse (2016) and Keshawn Gashu and Omer Aminu (2019), who also found that households with sufficient grazing land, showed lower levels of participation in forest management activities.

**The number of livestock:** The number of livestock in a Tropical Livestock Unit (TLU) is found to have a positive relationship with participation in participatory forest management

(PFM). This relationship is statistically significant at a 5% level. The odds ratio of 1.434 indicates that for each unit increase in TLU, the odds of participating in PFM are 1.434 times higher, assuming all other factors remain constant. These findings suggest that a higher number of TLUs is associated with a greater likelihood of participating in forest management activities. In other words, individuals with more TLUs tend to be more involved in PFM. This positive relationship was also observed in a study conducted in Nepal by Musyoki et al. (2013) and Oli and Treue (2015). To further elaborate on the relationship, the results imply that higher levels of TLUs are linked to a higher level of participation in PFM. This indicates that individuals with more TLUs not only have a greater chance of participating in PFM but also demonstrate more active involvement in the management activities.

In general, the analysis reveals a significant positive relationship between TLUs and participation in PFM. Higher levels of TLUs are associated with increased involvement in forest management activities. Similar conclusions were drawn from a study conducted in Nepal, suggesting that respondents with a larger number of livestock have a higher intensity and probability of participation in participatory forest management activities.

**Credit Access:** The presence of Credit Access had a strong and positive impact on participation in participatory forest management (PFM), as indicated by the statistical analysis conducted at a 5% significance level. The odds ratio suggests that individuals with credit access are 3.474 times more likely to participate in PFM compared to those without credit access, while controlling for other variables. The beta (B) value indicates that for every unit increase in credit access, there is a corresponding increase of 1.746 units in participation in PFM, holding all other factors constant. The results obtained from the household survey further

support this finding. It revealed that among households with access to credit, 73% demonstrated better participation in forest management activities. These households were able to reduce their heavy reliance on forest products by purchasing agricultural inputs such as improved seeds and fertilizers or livestock for resale after fattening them. Additionally, they utilized credit to acquire materials like solar panels and wood-consuming cooking stoves, with the aim of minimizing their consumption of firewood.

These findings align with the research conducted by Mbeche et al. (2021), which also concluded that credit access positively influences participation in PFM. Similarly, a study conducted in China by Jiayun Dong et al. (2020) found that access to credit led to increased participation in forest management and private forest investment. In summary, the presence of credit access significantly influences participation in PFM, with higher levels of credit access associated with increased engagement. This finding emphasizes the importance of facilitating credit access as a means to promote active participation in forest management initiatives.

**Access to Training and Awareness:** The availability of training and awareness plays a crucial role in influencing households' decisions to participate in forest management activities, according to our analysis. Our study indicated a strong positive association between training and participation, with statistical significance at the 1% level. This means that, holding other factors constant, individuals who had higher levels of training and awareness were nearly three times more likely to participate compared to those with lower levels.

Furthermore, the regression analysis showed an odds ratio of 2.927, indicating an increased likelihood of participation among individuals with enhanced training and awareness. In terms of the beta ( $\beta$ ) value, for each unit increase in the training and awareness variables, the log

odds of participation were estimated to increase by 1.074 units. Negashe, A. G., & Addisie, M. B. (2022) Supporting our findings, Negashe, and Addisie,(2022). Also discovered that involvement in forest management is influenced by knowledge and awareness of the management's goals, Similarly, Demissew Wondafrash (2021) noted that access to various training and experience exchange opportunities significantly enhances the likelihood of choosing to participate in forest management activities. The research revealed a substantial and statistically significant positive relationship between training and participation, with a 1% level of significance.

**Enforcement of law:** The enforcement of law has a noteworthy positive impact on the household's decision to participate in forest management activities, according to the results of our study. The findings showed that law enforcement exhibited a positive and significant association with participation, at a significance level of 5%. Specifically, the odds ratio of 1.940 suggests that participants residing in areas with better enforcement of forest laws are 1.940 times more likely to engage in community participation in forest management activities compared to those living in areas with poor law enforcement.

Through survey interviews and group discussions, it became evident that inadequate governance of forest resources and weak rule of law undermine sustainable economic growth, equitable societal development, and environmental conservation. The unsustainable management of forests and the prevalence of illegal forest activities have led to significant losses in forest resources and their ecological value. However, communities exhibited a willingness to participate in the participatory forest management (PFM) approach when forest laws, rules, and regulations were enforced effectively. The community's adherence to accepted forest management principles was also respected and encouraged. According to Noor, (2021),

reducing forest-related crimes within society enhances community participation in all stages of the PFM approach, ultimately improving income from livelihood activities. Similarly, our findings align with those of Nugroho et al. (2019), which indicate that communities facing issues such as illegal logging, encroachment, forest fires, and other problems are less likely to engage in forest management activities. .

#### 4.4. Trends of Rainfall and Temperature variability in the study area

##### 4.4.1. Community perception on climatic variability on Temperature & Rainfall

Respondents were asked whether they had observed or sensed any long- or short-term changes in climate change and variability to better understand how respondents in the study area perceived climate change and variability. The question was asked in multiple stages, first in general about the climate system, and then, particularly on temperature and rainfall.

Table 11: Community Knowledge on Temperature and Rainfall change

Statement		Participant		Non-participant	
		Frequency	Percent	Frequency	Percent
Do you observe climate change and variability?	Yes	169	97.6%	88	90%
	No	4	2.4%	9	9.2%
Change in Temperature	Increase	170	98%	90	92.7%
	Decrease	3	1.7%	5	5%
	No change	0	0%	2	2%
Change Rainfall	Increase	4	2.3%	6	6%
	Decrease	166	95%	91	94%
	No change	3	1.73%	0	0%

Source: filed survey data, (2023)

The table above shows the community observations of indicators of climate change and variability in the study area. Climate change was well perceived by farmers in the study area, as most of them observed changes in temperature, precipitation, timing of rainfall, and related

frequent droughts (Table 9). Approximately 97.6% of participants and 90% of non-participants perceived the problem of higher temperatures in the Mareka Woreda. In contrast, only 2 percent of participants and 9% of non-participants did not observe any changes. During the FGD and interviews with the elderly and agricultural experts, responses were very concerned with the increasing number of dry days and high temperatures.

The respondent, who lived in Keble for a long time during the interview, had no problems with rainfall because it was sufficient and predictable. However, since the early 2000s, we have been experiencing slow changes. To date, we have not received sufficiently predictable rainfall data in most seasons. This has affected the agricultural production of both crops and livestock. When asked questions about changes in a specific climatic parameter (rainfall and temperature), farmers responded that there was a long-term or short-term change, rather than a general question.

Community perceptions of climatic variability (temperature and rainfall) changes were summarized into three categories (increase, decrease, and no change). The response categories were not mutually exclusive because farmers understood the change in rainfall in different ways. Some farmers believe that there is no change in the amount of rainfall, but they all agree that the pattern becomes unpredictable, and others feel that the rainfall amount changes significantly as it becomes unpredictable. Based on this, approximately 95% of participant's' respondents and 94% of non-participants felt that the amount of rainfall was decreasing and believed that it was unpredictable. Approximately 2.3% of participants and 6% of non-participants reported an increase in rainfall. Similarly, 98% of participants and 92.7% of non-participants perceived an increase in the temperature, and approximately 2.3% of participants

and 6% of non-participants perceived a decrease in the temperature. Two% of non-participants responded with no change.

As discussed during the FGD and key informant interviews, farmers in the study area understood the temperature change as the number of hot days increased annually and the daily temperature. As indicated in Table 9, the survey findings illustrate that temperature is less unpredictable than rainfall. Based on the FGD and key informants, temperature is more predictable than rainfall because it has only an increasing trend, and the study area has a long dry season. The results confirmed that a higher percentage of respondents perceived climate change (temperature and rainfall). A similar study conducted by Tesfaye and Seifu (2016) in the study area reported that 95% of the respondents perceived temperature change, whereas 86% of the respondents perceived a change in rainfall.

#### **4.4.2. The Trend of rainfall variability (1998–2022)**

The study findings on the climate graph show that the mean monthly maximum temperature decreases at a rate of 0.275 and the minimum temperature increases at a rate of 0.2007. The mean monthly rainfall of April and May highly increased, and June–September was statistically also increasing. The respondents also perceived the change, as mentioned during the FGD, key informant interviews, and HH surveys. FGD participants discussed that nursery seedling preparation began at the beginning of January and planting started in April. The variability in rainfall amounts could also make it difficult for forest seedlings to establish and grow consistently from year to year and also affect the survival rate of planted seedlings. Reducing seedling preparation and changing planting seasons during the Belg season because

of a significant reduction in rainfall and the unpredictability of rainfall. Meteorological rainfall data analysis was also in line with the farmers' perceptions of rainfall decline.

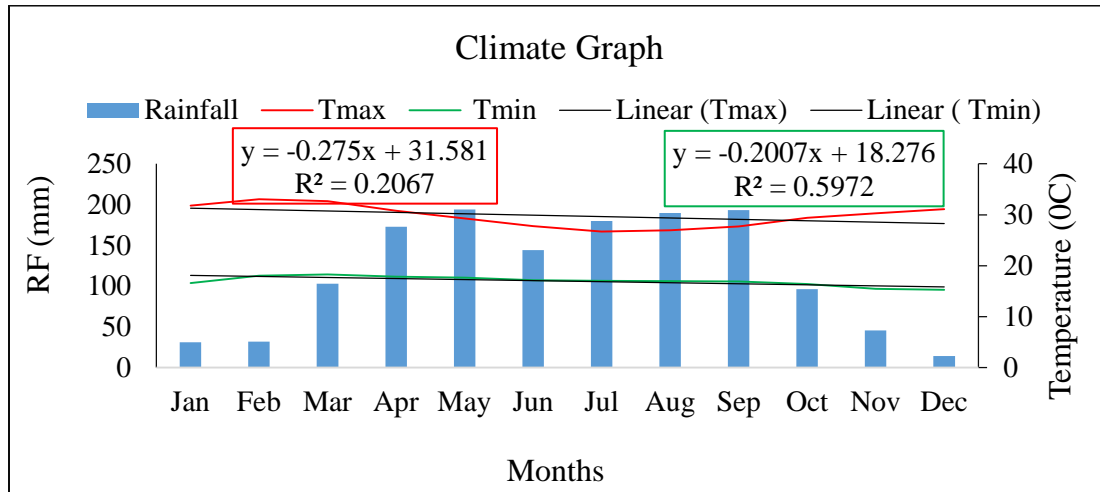


Figure 6: Monthly rainfall distribution of Mareka District (1998–2022)

Source: National Metrology Agency (2023).

The annual rainfall has less variability than the seasonal rainfall based on the degree of variability between the years 2000, 2012, and 2022 in the study area. On the other hand, in trend analysis in Figure 7, the annual rainfall showed a decreasing trend at a rate of 0.4182 mm. The coefficient of determination value indicates that the annual rainfall has decreased by 0.03% in the study area.

Therefore, the variability and decreasing pattern of annual rainfall have a critical impact on nursery preparation and seedling survival, as well as the degradation and deforestation of forests by fire in the study area. And also, the FGD and key informant interview results showed that the respondent's perception was that the rainfall in the study area had a shorter duration with a high volume of rainfall, whereas in other years it reversed in both main rain seasons.

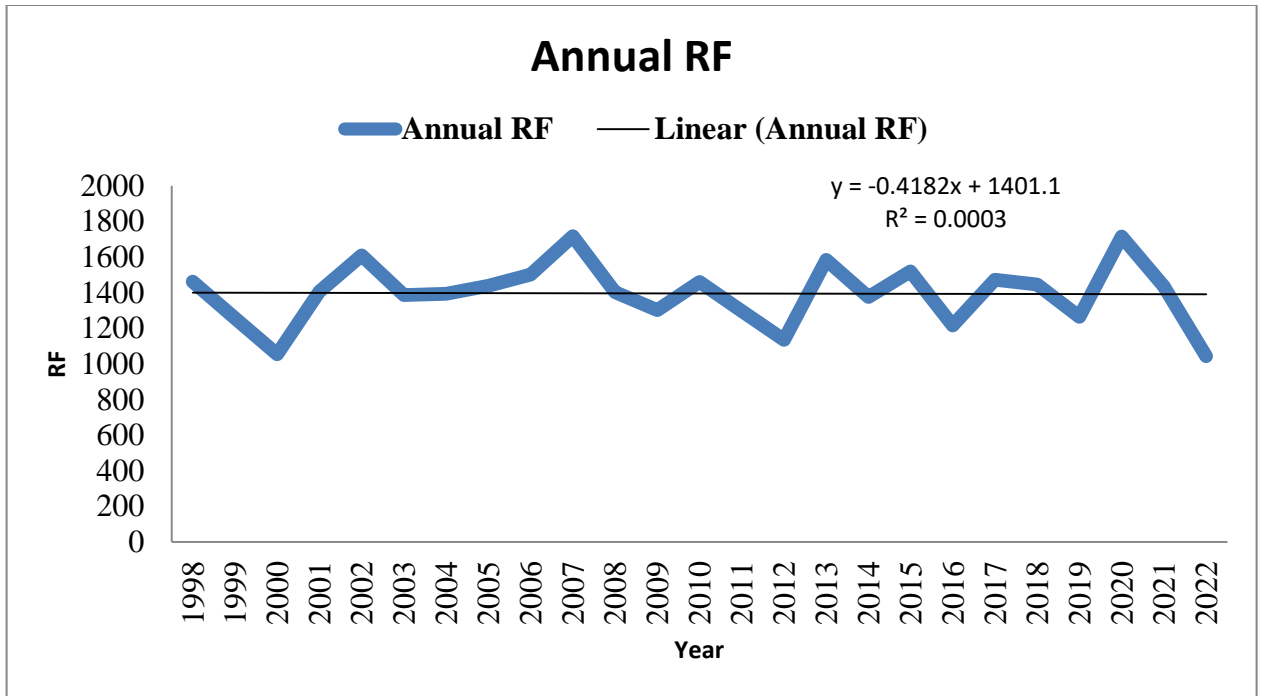


Figure 7: Annual rainfall distribution of Mareka District (1998–2022)

Source: National Metrology Agency (2023).

#### 4.4.2.1. Seasonal rainfall variability and trend analysis

Seasonal variability was found in the study areas, with varying magnitudes. The seasonal rainfall variability for all the study areas indicated that the Belg season rainfall was more variable than the Kiremt season rainfall. This inter- and intra-annual variability could affect the productivity of forests and their resources. Consistent with this result, Das, S. (2018). Reported a higher CV value for Belg rainfall than Kiremt rainfall (Table 11). The annual rain fall of the study area ranged between 1395 and 1716 mm, and the mean annual rainfall was 1395.62 mm (Table 11), and its inter-annual variability was low, with a CV of 12.24%. The Kiremt rainfall also showed low inter-annual variability (CV, 15.08%). Belg and Bega rainfalls showed moderate variability (CV 26.03% and 25.45%, respectively).

This result also agrees with the findings of Yibrah et al. (2019), who reported that the variability in Belg season rainfall was higher than that in Kiremt season rainfall.

In this study, the mean contribution of Belg rainfall to the total amount of rainfall in the Mareka district was found to be approximately 35.95%. Likewise, the mean contribution of Kiremt rainfall to the total rainfall in the districts was, on average, approximately 50.63%. On the other hand, the contribution of Bega rainfall to the total amount of rain that fell in the Mareka district was relatively low, at 13.41% (Table 11).

The woreda mean rainfall trend from the area of influence evaluated by the MK test shows annual and Kermit season negligible decreases with Sen’s slope estimator magnitudes of 5.168 mm/decade and 52.48 mm/decade, respectively. While the rest of the seasons showed an insignificant increasing trend with a magnitude of 6.084 mm/decade and 3.045 mm/decade in Belg and Bega sessions, respectively, for the study period, the annual decreasing rate of 0.51 mm/year is from a yearly mean of 1395.62 mm/year for the study area (1998–2022) (Table 11). Annual and Kiremt rainfalls show a statistically non-significant decreasing trend, while Bega and Belg rainfalls show a statistically non-significant increasing trend at the  $p = 0.05$  level.

Table 12: Average rainfall trends in Mareka District (1998–2022)

Variable	Min	Max	Mean	Contribution (%)	CV	T	p-value	B	Nature of Change
Annual	1043.29	1716.0	1395.62	100.00	12.24	-0.0267	0.8717	-0.5168	NS Decreasing
Belg	270.40	807.80	501.76	35.95	26.03**	0.1867	0.2020	6.0841	NS Increasing
Kermit	490.30	893.90	706.66	50.63	15.08	-0.2200	0.1306	-5.2484	NS Decreasing
Bega	109.30	304.20	187.20	13.41	25.45**	0.0133	0.9448	0.3045	NS Increasing

\*\* $\tau$ ,  $\beta$  and NS: moderately variable, Kendall's tau, Sen's slope and non-significant trend at  $\alpha=0.05$  respectively Source:

National Metrology Agency (2023)

There was inter-seasonal variability in the Belg and Bega rainfalls, but the Kiremt rainfall was stable. The rainfall in the Belg season showed an increasing trend from 1999 to 2000 (Figure 8). This has increased by 4.242% per year over the past 25 years. On the other hand, Kiremt rain showed a decreasing trend (Figure 9); its amount decreased by 4.3877% mm per year in the period noted above. Similarly, Bega rain has shown a decreasing trend (Figure 9); its amount has decreased by 0.273% in mm over the last 25 years. The minimum mean annual rainfall (1043.29 mm) and the maximum mean annual rainfall (1716.0 mm) were recorded in 2022 and 2020, respectively (Appendix 2). The coefficient of determination value indicates that the annual, Kiremt and Bega rainfall has decreased by 0.03%, 8.82%, and 0.17, respectively, and the Belg rain fall has increased by 5.49%, respectively, in the study area.

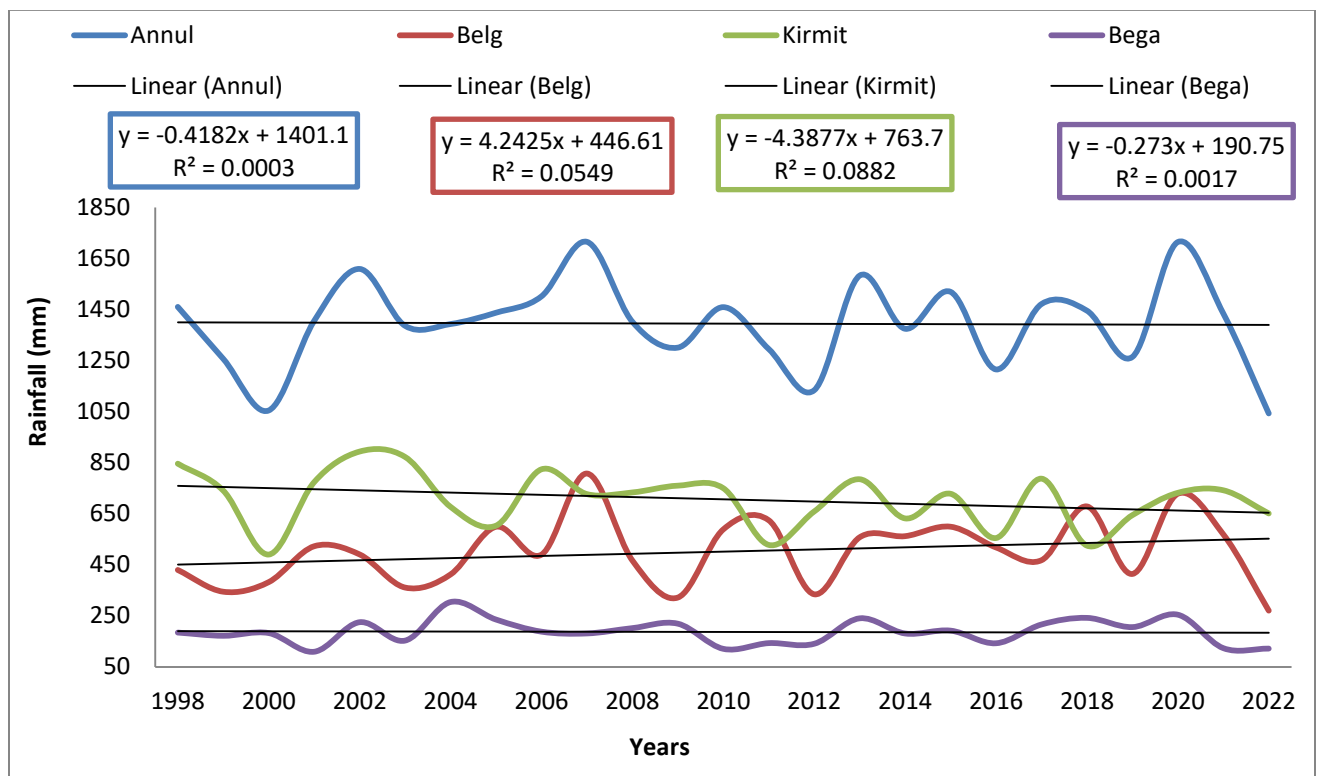


Figure 8: Trends of annual and seasonal rainfall in Mareka woreda (1998–2022)

Source: National Metrology Agency (2023).

#### **4.4.3. Standard Anomaly Index (SAI) of rainfall (1998–2022)**

The positive anomaly in annual rainfall indicates the wetness. The annual standard anomaly index for the past 25 years (1998–2022) in terms of drought and wet frequency revealed that the study area is near normal and moderately dry conditions. The 2022 and 2020 rainfall amounts were the lowest and highest with the SAI records (-2.0625 and 1.874), respectively, and extreme drought and moderate wetness occurred in the observation period. There were two very wet years (2007 and 2020) with SAI values of 1.875 and 1.874, respectively. Drier conditions mean that less water is available for forests. This can affect the overall health and productivity of trees and the ecosystem. This may lead to decreased growth rates, increased stress, and potentially higher mortality rates in trees. The extreme wettest conditions can cause

Flooding, land slide, this affects nursery establishments. During the key informant interview and FGD, farmers perceive that the fluctuation of temperature and rainfall affect seedling growth, NTFP, and the outbreak of pests and diseases. Other studies reported declining annual rainfall for southern Ethiopia in recent decades (Zelege et al., 2017); in the Gidabo watershed (Belihu et al., 2017); and a negligible decrease in annual rainfall in the Rift Valley basin (Kassie et al., 2014; Gleixner et al., 2017).

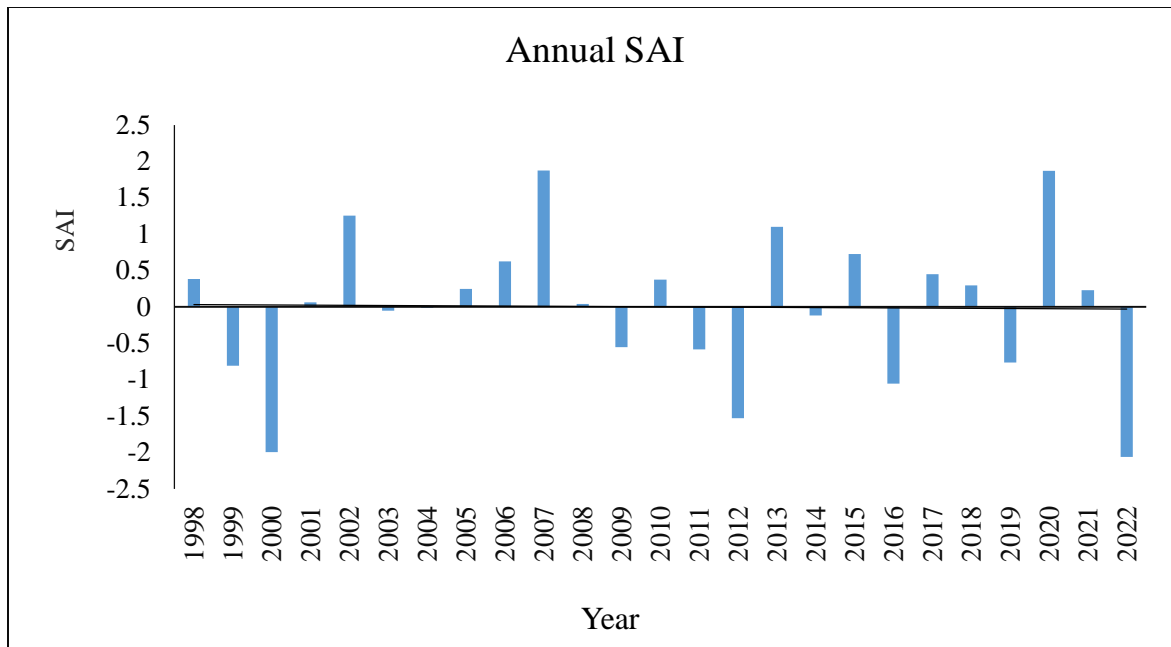


Figure 9: temporal variations in the annual rainfall anomalies of Mareka District (1998–2022)

Source: National Metrology Agency (2023).

The annual and seasonal rainfall standardized anomaly index categories in Table 12 and Figure 10 showed that the highest positive anomaly (extremely wet) was observed in 2007 during the Belg season and in 2004 in the Bega season. The standard anomaly index value indicates (2.343, 2.455), respectively.

The severe dry conditions were observed in 2011 and 2019 in the Kiremt seasons the SAI value indicates -1.6768, -0.5815 and respectively. The extremely dry conditions were also observed in the Kiremt and Bega season in 2000 and 2001, with the SAI value, -2.0306 and -1.6359. Moderately dry condition was observed that 5 years in Bega, 16 years in Kiremt and 4 years in Belg season respectively. Similarly moderately wet condition was observed in all seasons in different year (figure 10, appendix).

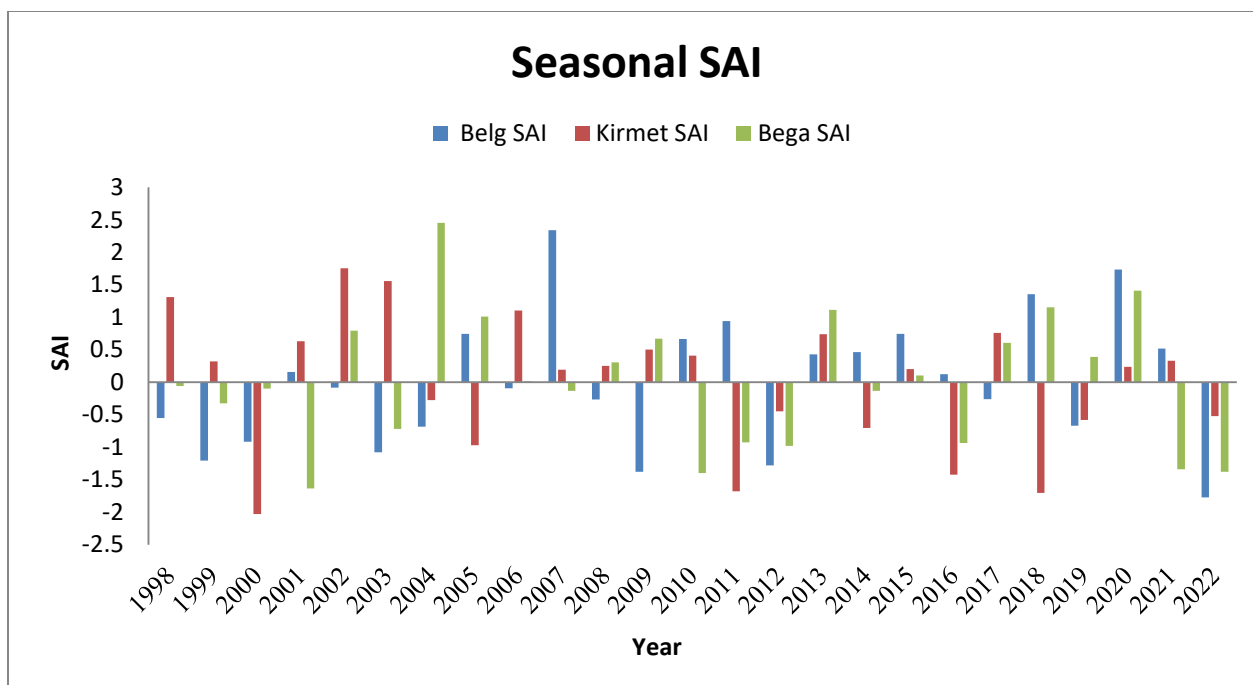


Figure 10: temporal variations in the sessional rainfall anomalies of Mareka District (1998-2022)

Source: National Metrology Agency (2023).

Table 13: Annual and seasonal percent proportion of Standard Anomaly Index (SAI) values of the study area for the Baseline Years 1998–2022

Variable	Positive Anomalies		Negative Anomalies		Wettest year	Driest year
	No. of years	% proportion	No. of years	% proportion		
Annul	14	56	11	44	2007	2022
Belg	12	48	13	52	2007	2022
Kermit	15	60	10	40	2002	2000
Bega	12	48	13	52	2004	2001

Source: National Metrology Agency (2023).

The proportions of positive and negative anomalies were 48% and 52%, respectively, of the total observations in table 12. The 2004s were wetter than the preceding decades for Bega. Kiremt rainfall shows considerable inter-annual variations throughout the period of

observation. A large proportion of positive anomalies were observed in the Kiremt rainfall (60% of the total observations) table 12

As shown in Table 12, the driest and wettest years over the observation period were 2022 and 2007, respectively. The Belg sessions in 2007 and 2022 were known to be the wettest and driest years. Similarly, in Kermit, both 2002 and 2000 were categorized as the wettest and driest years. Additionally, the Bega sessions in 2004 and 2001 experienced extreme rainfall conditions, with the wettest and driest years, respectively. These instances highlight the fact that the rainfall distribution is not consistent, as there are months within even good rain years that can remain dry.

#### **4.4.4. Temporal variability and trends of temperature (1998–2022)**

The MK trend and Sens's slope estimation were used to analyze the annual and seasonal maximum and minimum temperature trends for each year. The average minimum, maximum, and annual temperature data for the period 1998–2022 are presented to determine the temporal variability and trends (Table 13).

##### **A. Maximum temperature**

The minimum temperature showed greater relative variability than the maximum temperature. The variability ranged from a maximum temperature of 1.79 in the Kermit season to 2.58% in the other seasons. For the annual and all seasons, less variability was recorded for the maximum temperature in Mareka Woreda (Table 14).  $H_0$ : There is no trend in the series;  $H_a$ : There is a trend in the series. As the computed p-value is lower than the significance level (at 0.05), one should reject the null hypothesis  $H_0$  and accept the alternative hypothesis  $H_a$ .

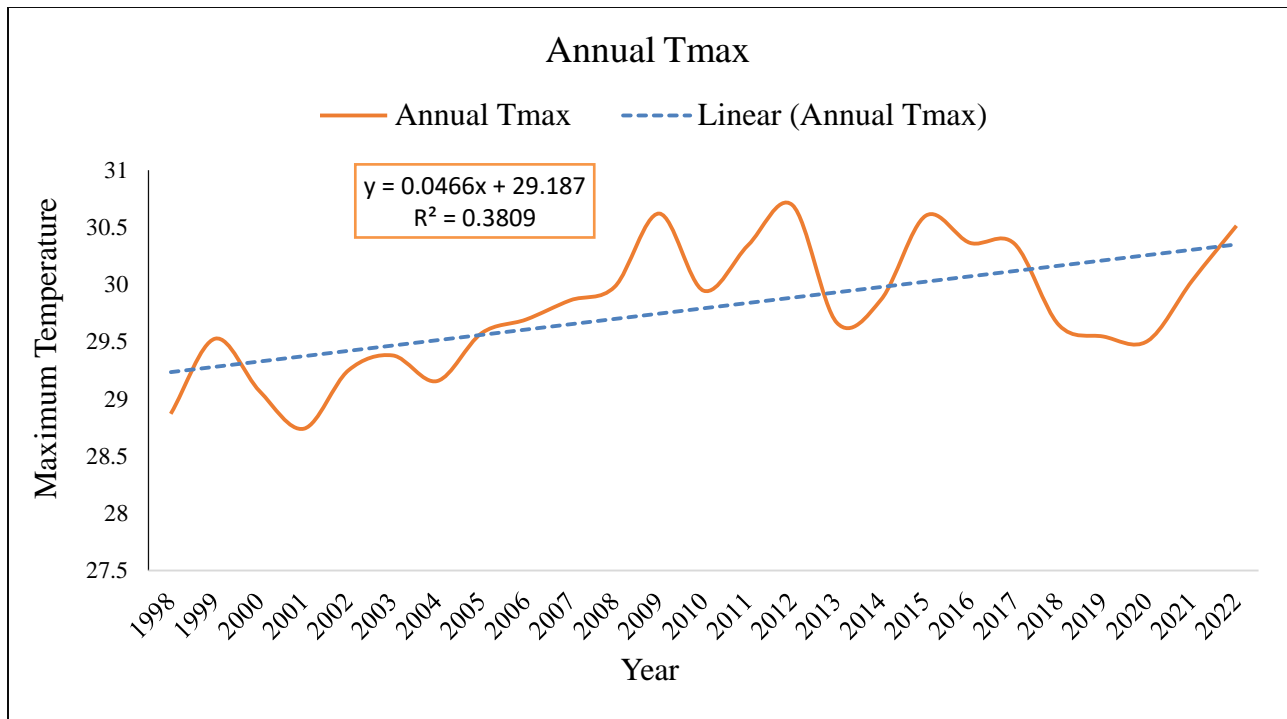


Figure 11: Temporal trends of annual maximum temperature (1998–2022). Source: National Metrology Agency (2023).

The annual maximum temperature indicated a statistically significant increasing trend (at 0.05 levels) in Mareka Woreda, with a magnitude of 0.51 °C/decade. The maximum temperature of the Kermit and Bega sessions indicated a statistically significant increasing trend (at 0.05 levels) in the study area with magnitude of 0.53 °C/decade and 0.51 °C/decade (Table 14).

(Figure 12, table 14 and Appendix 2) shows that the seasonal maximum temperature showed higher variability in Belg, Kiremt, and Bega at 33.0590°C, 28.716°C, and 30.906°C, respectively, which are the minimum seasonal temperatures of 30.075°C, 26.070°C, and 29.414°C, respectively. The mean seasonal temperatures were 31.44782, 27.8756, and 30.64447°C. The Temperature during the Belg season showed an increasing trend from to 1998-2000 below. In the last 25 years, the seasonal temperature has changed by 0.4060, 0.404520, and 0.0540°C. However, the Belg session showed no statistically significant increasing trend (at 0.05) in the study area. This result is in agreement with those of Kahsay *et*

al. (2019), Berck, (2018). And Karieny *et al.* (2019), as most farmers have observed long-term climate change based on real climatic data recorded in the last two decades.

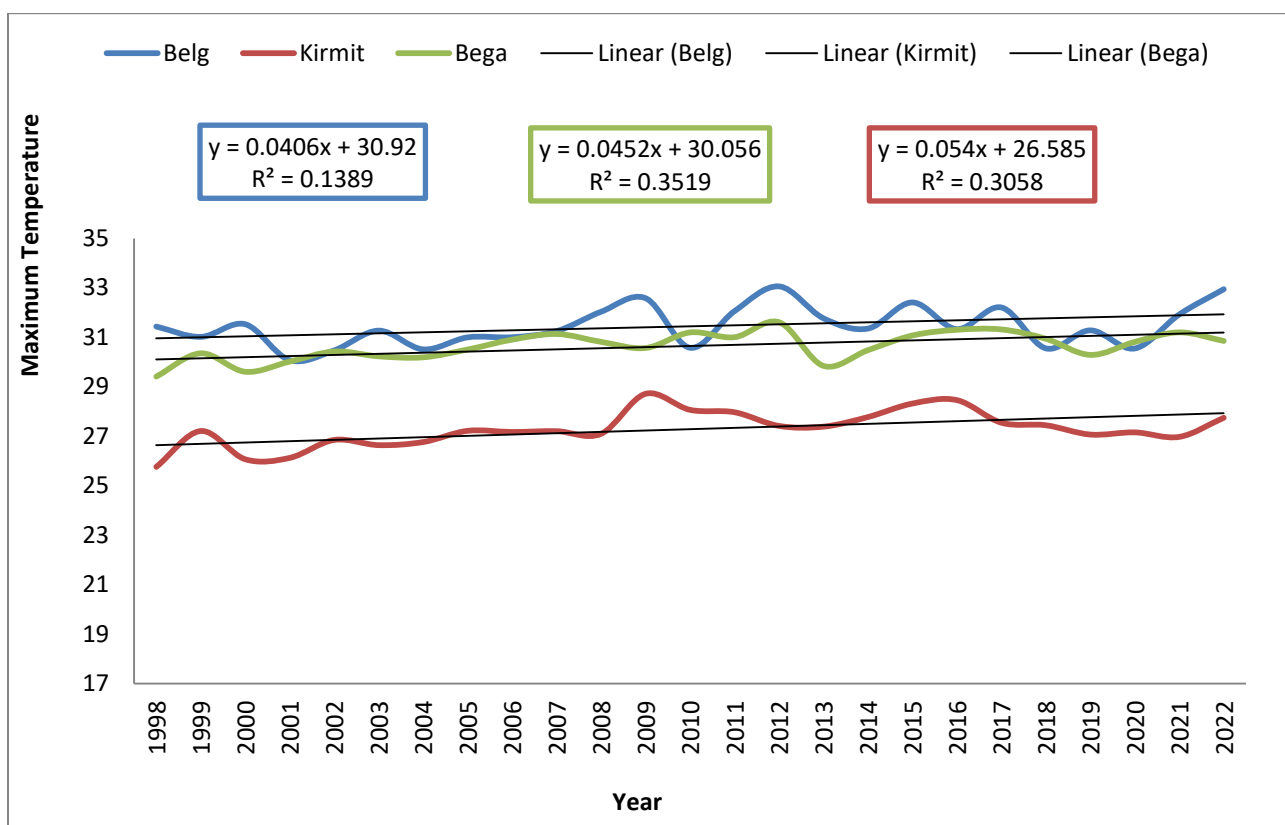


Figure 12: Temporal trends of sessional Maximum temperature (1998–2022).

Source: National Metrology Agency (2023).

Table 14: Average maximum temperature, coefficient of variation, and trends in Mareka District (1998-2022)

Maximum temperature						
Variable	Mean	CV	Kendall's tau	p-value	Sen's slope	Nature of Change
Annual	29.79	1.83	0.440	0.002***	0.051	Sig. Increasing
Belg	31.45	2.50	0.247	0.089	0.041	NS Increasing
Kiremt	27.29	1.79	0.367	0.010***	0.053	Sig. Increasing
Bega	30.64	2.58	0.433	0.002***	0.051	Sig. Increasing

Minimum temperature						
Annual	16.972	1.87	0.400	0.005***	0.025	Sig. Increasing
Belg	17.963	2.42	0.380	0.007***	0.033	Sig. Increasing
Kiremt	17.010	2.30	0.553	< 0.001***	0.043	Sig. Increasing
Bega	15.943	3.10	0.127	0.392	0.013	NS Increasing

\*\*\* Sig: Significant trend at  $\alpha=0.05$ ; NS: non-significant trend at  $\alpha=0.05$  respectively

Source: National Metrology Agency (2023).

Higher temperatures can lead to increased evaporation and soil moisture loss, which can negatively affect the health and productivity of forests. Participatory forest management practices often involve community members in activities, such as tree planting, forest maintenance, and water conservation. However, maintaining adequate soil moisture levels becomes more challenging at higher temperatures, and these practices may need to be adapted to ensure the survival and growth of newly planted trees and existing vegetation (Naorem *et al.*, 2023).

Moreover, increased maximum temperatures may also affect the timing and intensity of forest fires. Higher temperatures can enhance vegetation dryness, making forests more susceptible to ignition and faster-spreading fires. This finding was supported by Blauw *et al.* (2017). Participatory forest management practices usually involve community participation in fire prevention and firefighting. However, the increased risk of forest fires due to higher temperatures may necessitate additional measures such as increased vigilance, firebreak construction, and improved fire management strategies. The alteration in the ecosystem can challenge existing participatory management plans, which are often designed based on an understanding of current species composition and ecological dynamics.

## B. Minimum temperature

The variability ranged from a minimum temperature of 1.87 at the annual level to 3.10% at a seasonal level in Bega. For the annual and all seasons, less variability was recorded for the minimum temperature in Mareka Woreda (Table 14).

H0: There is no trend in the series; Ha: There is a trend in the series. As the computed p-value is lower than the significance level (at 0.05 levels), one should reject the null hypothesis H0 and accept the alternative hypothesis Ha. As evidenced by the positive Mann-Kendall statistics (S), Kendall's tau, and Z statistics. The presence of positive changes per month was also demonstrated using the Sen's slope. Sen's slope for the sessional minimum temperature is shown in Figure 13. The mean minimum temperature for the period 1998–2022 shows a warming trend, as shown in (Table 14). The Mann-Kendall test indicated a significant warming tendency at the 0.05 significance level for two sessions, except in the Bega session (Table 14).

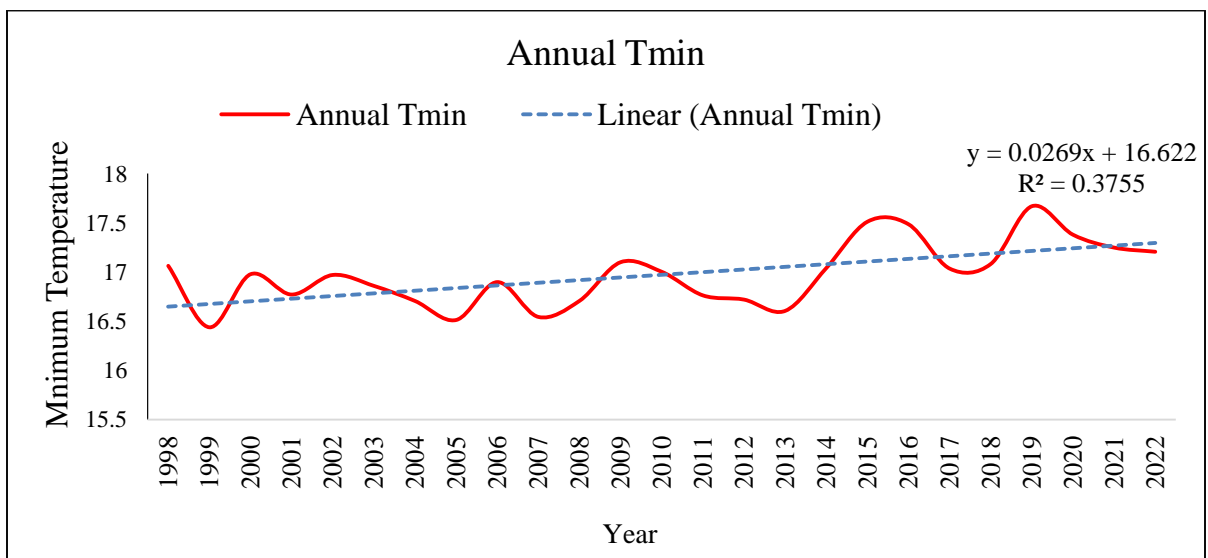


Figure 13: Temporal trends of annual minimum temperature (1998–2022). Source: National Metrology Agency (2023).

The predicted trend line for the yearly average temperature is given by  $y = 0.0269x + 16.622$ .

The positive slope of the trend line suggests that, during the previous 25 years, the average

temperature increased by 0.3755 °C. The maximum and lowest temperature trends for this period were computed using a straightforward regression equation. This result is in agreement with those of Kahsay *et al.* (2019), Berck *et al.* (2018), and Karienyé *et al.* (2019), since the majority of farmers saw long-term climate change based on real climatic data recorded in the last two decades.

The minimum temperature in annual, belg and Kiremt showed significant increasing trends and bega in significant increment temperatures recorded over the past 25 years (1998–2022) in the area. The average minimum temperature increases by 0.03°C, 0.0401°C and 0.0106°C in beleg, kiremit and bega respectively. While the coefficient of determination value indicates that the minimum temperature was increased by 24.74%, 54.6% and 2.39% beleg, kiremit and bega respectively in the study area (Figure 14). The national average minimum temperature has shown a rising trend of 0.37 °C/ decade in the past 55 years (1950–2005) (NMA, 2007) and 0.2 °C/ decade in the last 50 years (EPCC 2015).

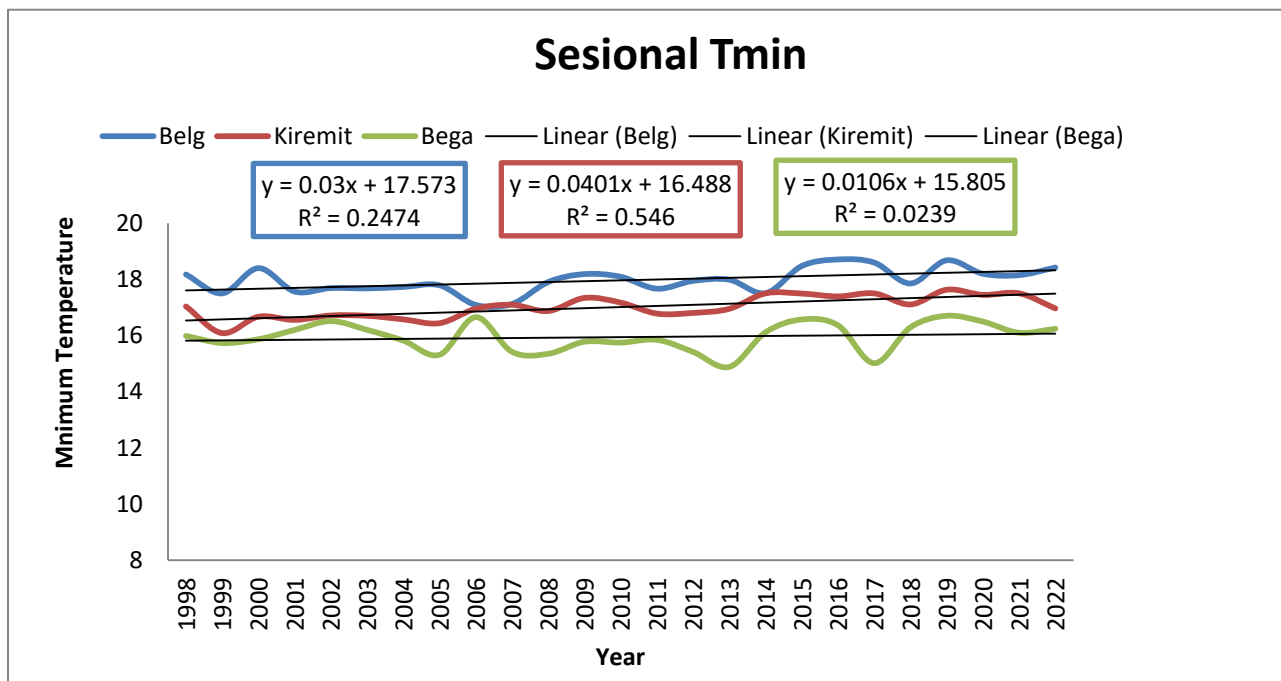


Figure 14: Temporal trends of sessional minimum temperature (1998–2022). Source: National Metrology Agency (2023).

#### 4.5. Effect of climate change on forest management practices and its resource in the study area.

The impact of climate change extends beyond timber resources to also influence the availability and quality of non-timber forest products. Examples include forest coffee, honey production, various spices (such as black pepper, cinnamon, turmeric, and cloves), and medicinal plants. The timing of fruiting and flowering can be disrupted by changes in precipitation patterns and temperature, leading to potential damage to the forest and its products. The effects of climate change on forest resources in Mareka Woreda are expected to be complex and diverse, as they are influenced by various factors, including changing local climate conditions, a degraded forest ecosystem, and the disturbance of different species and ecological processes.

**Table 15: Effect of climate change on forests**

<b>Variables</b>	<b>Frequency</b>	<b>Percent (%)</b>
Change forest ecosystem services	72	26.7
Forest fire	40	14.8
Forest resource degradation	52	19.3
Increase pest and disease	43	15.9
Decrease regeneration and seedling survival.	63	23.3
Total	270	100.0

Source: own survey data, (2022).

The study findings from the Focus Group Discussion (FGD) and Key Informant Interviews (KII) revealed that forests can be significantly affected by climate change. One notable impact is the alteration of temperature and rainfall patterns, which can negatively affect the growth

and survival of seedlings and nurseries. Shifts in temperature and rainfall can cause stress and even death among seedlings. The study reveals that 40 respondents have observed an increase in the frequency of forest fires, likely influenced by climate change. The rising temperatures and altered precipitation patterns can lead to drier conditions, thereby escalating the risk of forest fires. These fires pose a significant threat to forest ecosystem services, including the loss of forest cover, the destruction of habitats, and adverse effects on air and water quality. Moreover, forest resource degradation was reported by 52 respondents, which can be attributed to the effects of climate change. Changes in temperature and precipitation patterns can disrupt forest ecosystems, leading to the deterioration or depletion of valuable resources such as timber, non-timber forest products, and biodiversity. Sustainable forest management practices are crucial for mitigating the impacts of climate change on forest resources. The survey data indicated that there was an increase in pests and disease; this means a decrease in their natural predators, which can be linked to climate change.

The survey data revealed that 43 respondents observed that warmer temperatures and altered weather patterns create more favorable conditions for pest and disease outbreaks. Simultaneously, shifting ecosystems can disrupt the natural balance between pests and their predators, resulting in increased pest populations. Effective climate change measures are necessary to mitigate the negative impacts on forest health and productivity. According to the data, a decrease in forest regeneration and seedling survival was observed in 63 interviewees, likely influenced by climate change. Altered climatic conditions, including temperature and precipitation changes, can negatively affect the natural regeneration of forests and the survival of newly planted seedlings.

This poses a significant challenge to maintaining forest biodiversity and ecosystem resilience in the face of climate change. So, the urgent need for climate change mitigation and adaptation strategies in forest management is needed. Experts in forest management, interviewed during the study, explained that fluctuating rainfall resulted in large areas of planted seedlings drying up. Nursery sites were also affected by invasive species and weeds, impacting the health of seedlings. The line with Abera Adugna's (2020) study further supported these findings, asserting that forest production, health, growth, and regeneration are all impacted by climate change disturbances such as fires, insect outbreaks, and wind throws.

The other findings by Sturrock et al. (2011) and Khaine and Woo (2015) revealed that, however, global climate change may have a serious impact on genetic resources in tropical forest trees. Genetic diversity plays a critical role in the survival of populations in rapidly changing environments. Furthermore, most tropical plant species are known to have unique ecological niches, and therefore changes in climate may directly affect the distribution of biomes, ecosystems, and constituent species. Climate change may also indirectly affect plant genetic resources through effects on phenology, breeding systems, and plant-pollinator and plant seed disperser interactions, and may reduce genetic diversity and reproductive output.

## CHAPTER FIVE

### 5. CONCLUSION AND RECOMMENDATIONS

#### 5.1. Conclusion

In conclusion, forests provide a wide range of ecosystem services, including provision, regulation, and cultural and support services. However, the heavy dependence of local communities on forest resources has caused forest deforestation and degradation. Inclusive and active community participation provides a solution to the current challenges of forest degradation and deforestation.

The primary management goals of the PFM system are to conserve biodiversity, halt forest degradation, promote sustainable forest management, and guarantee sustainable socioeconomic livelihood improvement and environmental benefits for local communities. Therefore, this study was conducted to investigate the factors that determine community participation in participatory forest management, as well as the effects of climate change in Mareka District, Dawuro Zone, Southwest Ethiopia. This study used a cross-sectional survey research design and collected data from 270 households. Both qualitative and quantitative data were analyzed using descriptive and logistic regression models. As the study shows that respondents are from female-headed households with low participation in decision making and executive committee members, there is a need to promote gender inclusivity in PFM activities.

The results of the descriptive statistical analysis of basic data showed that the participatory forest management practices (PFM), is the best forest management approach, compared to the other two forest management structures, traditional forest management and government-centered forest management practices, in both participants and non-participants. The

respondents who actively participated in the PFM and members of the Forest Management Cooperative were more aware of climate change than those from the non-participants. Binary logistic regression model analysis showed that total landholding negatively affected participation in forest management. Hence, gender, educational level, family size, TLU, access to credit, training, and enforcement of the law had a positive and significant ( $P < 0.05$ ) effect on PFM practices.

Additionally, the study area has experienced climate change, as farmers have observed changes in temperature and rainfall patterns. The results of this study suggest that the trend of climate variability in the study area is generally variable. Both participant and non-participant respondents perceived that the rain fall has been decreasing and it was unpredictable. The average maximum and minimum temperatures increased continuously. Secondary data were obtained from the Ethiopian National Metrology Agency (ENMA) (1998–2022), showing that annual and Kermit rainfall are decreasing, Belg rainfall is increasing, and the average maximum and minimum temperatures are increasing.

The study identified challenges such as high population growth and the expansion of agriculture, indicating that there is a high pressure on deforestation and degradation of the forest ecosystem in the study area. Overall, the results showed that participatory forest management practices have a positive effect on effective forest management, halt deforestation, reduce the adverse effects of climate change, and enhance rural livelihood.

## 5.2. Recommendation

Based on the findings of the study, the following recommendations are proposed:

- To encourage gender inclusivity in participatory forest management practices, it is important to actively involve female-headed households. The study highlights low participation among these households, highlighting the need to promote gender inclusivity in all PFM activities. To achieve this, equal participation and representation of women in decision-making processes must be ensured, as well as equitable access to resources and benefits derived from forest management. To raise awareness and encourage active participation in sustainable forest management and climate change adaptation initiatives, it is recommended to engage multiple stakeholders such as governmental bodies, private organizations, NGOs, and women and youth offices at various levels, from Woreda to region
- Stakeholders, such as woreda government bodies, forest offices, NGOs, and other forest agencies, should prioritize engaging with disadvantaged groups and individuals who are close to the forest and actively participate in the decision-making process. This can be achieved by providing training, workshops, specialized technical support, and ongoing awareness campaigns to bridge the knowledge gap and increase their participation in Participatory Forest Management activities
- To address the growing population and agricultural expansion in the study area, it is recommended to prioritize the preservation of forests and their resources. This can be done by implementing alternative income sources like off-farm activities, value-added products, ecotourism, and climate-smart agriculture. To effectively support the

Participatory Forest Management (PFM) program, stakeholders including woreda government, NGOs, and the private sector should collaborate and coordinate efforts, providing technical, financial, and legal support at different levels

- The study suggests that the study area's climate variability is generally variable with increasing maximum and minimum temperatures and decreasing rainfall. It recommends integrating climate change management into forest management plans, implementing sustainable land-use practices, and promoting resilience-building measures to mitigate the impact on forest ecosystems. It also suggests involving various stakeholders, such as the Agriculture and Environment Office, NGOs, research institutions, Ethiopia Metrology Agency, and private sectors, to develop capacity-building initiatives. Lastly, it recommends disseminating information through various means like TV, magazines, newspapers, training, and other mechanisms to enhance the community's understanding of sustainable forest management practices, climate change impacts, and the importance of forest management and biodiversity conservation.
- First of all, the scaling up of PFM practices by the regional agriculture, environment, and forest offices is concentrating on capacity building at different levels: of woreda and kebeles staff to enable support community based PFM practices and field-based extension agents service.; at the zonal level for the agriculture sector to take the lead in coordinating and monitoring PFM implementation and facilitating forest carbon inventory for trading.
- Therefore, further research should be conducted on carbon stock estimation by Lili and Ail natural Forest under PFM, which is not covered in this study because of time and budget constraints.

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## 7. APPENDICES

### APPENDICES.1 Annual Rainfall Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
<b>1997</b>	<b>47.202</b>	<b>36.787</b>	<b>84.614</b>	<b>171.830</b>	136.700	193.600	263.300	214.300	175.300	108.200	29.100	0.000	1460.933
1998	45.500	0.000	97.100	73.100	174.400	169.600	249.600	134.500	187.200	111.300	13.600	1.400	1257.300
1999	0.000	0.000	33.700	220.700	127.800	89.900	115.200	116.100	169.100	137.000	34.200	11.300	1055.000
2000	20.300	28.200	229.700	139.600	125.300	168.700	229.400	212.900	163.110	64.200	23.300	1.500	1406.210
2001	57.400	0.800	192.900	175.800	121.200	192.600	149.700	363.200	188.400	68.000	0.600	99.100	1609.700
2002	38.800	50.400	92.400	108.900	109.200	158.700	249.800	218.500	245.800	40.300	68.400	5.500	1386.700
2003	72.000	48.900	80.900	178.900	103.500	136.100	152.200	149.700	239.300	161.600	18.900	51.700	1393.700
2004	37.200	17.700	136.900	95.300	349.200	154.400	209.100	119.100	120.900	180.500	17.800	0.000	1438.100
2005	28.200	47.600	108.500	162.500	171.200	150.400	195.500	261.700	216.700	115.300	5.000	39.500	1502.100
2006	135.000	99.100	145.400	172.000	391.300	143.100	225.900	143.200	215.000	37.200	8.800	0.000	1716.000
2007	27.800	13.000	80.200	151.400	222.500	131.800	189.300	231.200	181.400	119.500	53.400	1.200	1402.700
2008	59.800	16.300	99.300	130.800	75.300	156.500	211.400	174.900	<b>217.508</b>	109.700	26.600	<b>23.134</b>	1301.243
2009	11.300	68.200	121.600	119.800	279.300	128.100	140.300	236.600	245.300	36.000	49.800	23.600	1459.900
2010	15.400	5.800	86.700	283.700	248.500	131.900	126.900	146.000	123.200	12.700	114.800	0.200	1295.800
2011	0.000	0.000	37.900	194.800	101.800	110.700	185.100	107.200	256.100	27.300	88.000	25.300	1134.200
2012	44.600	11.900	151.000	176.400	218.500	190.700	222.900	189.700	182.200	153.100	<b>41.946</b>	0.600	1583.546
2013	4.300	1.200	124.200	196.900	240.000	122.200	148.500	<b>218.660</b>	142.600	90.000	86.600	0.000	1375.160
2014	1.300	0.000	137.300	113.600	348.500	123.700	155.100	261.300	188.400	93.500	60.700	36.600	1520.000
2015	62.900	39.800	88.310	238.400	151.600	133.000	111.500	159.800	150.700	45.500	31.700	2.500	1215.710
2016	0.000	78.500	70.200	86.100	233.200	136.300	137.400	176.100	338.000	188.100	28.100	0.000	1472.000
2017	0.000	104.700	63.200	238.400	272.600	161.300	77.300	181.400	105.200	92.300	149.800	0.000	1446.200
2018	0.000	10.900	62.700	145.200	195.400	145.800	200.400	176.300	122.200	116.300	63.200	26.400	1264.800
2019	<b>48.075</b>	33.700	214.400	273.800	206.600	87.300	190.400	216.000	238.500	155.600	46.900	3.900	1715.175
2020	6.500	65.700	7.600	298.700	197.500	147.800	170.000	205.200	219.200	67.300	46.800	2.800	1435.100
2021	13.500	19.900	26.200	178.100	46.200	<b>136.679</b>	<b>189.116</b>	<b>129.155</b>	<b>196.284</b>	<b>74.806</b>	<b>35.831</b>	<b>2.477</b>	1043.294

**Appendix: .2. Annual Temperature Data**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	15.90323	18.11487	17.07865	17.00161	18.62609	17.21667	16.84194	17.01935	17.05667	17.40645	15.36333	14.90645
1999	16.52581	18.54643	17.49355	17.04333	16.9129	15.40667	16.28065	16.19032	16.45667	16.21613	14.77	15.41935
2000	17.14839	18.97586	20.15161	17.14333	17.31926	16.86733	16.50323	16.58065	16.72333	16.34839	14.94667	15.02258
2001	16.93548	17.99643	17.34194	17.65	17.26452	16.44	16.51935	16.92581	16.33	16.47419	15.27	16.10645
2002	16.78387	18.43929	17.52581	17.15	17.63871	16.96667	16.97097	16.37419	16.53667	16.52903	16.01333	16.71613
2003	16.32903	17.60714	17.58065	17.73	17.79032	16.61667	16.6871	16.96774	16.53333	16.03226	16.53333	15.90323
2004	17.0129	17.51034	18.31613	17.76	17.32258	16.88333	16.34839	16.67742	16.38333	15.69355	15.12667	15.43548
2005	16.58065	18.51786	18.19355	18.03333	16.40323	16.88333	16.40323	16.53226	15.93333	15.74194	14.81667	14.1129
2006	16.64516	18.08929	17.04839	16.88333	16.32258	16.76786	17.27419	16.85484	16.91667	17	16.31667	16.65484
2007	16.95806	16.925	16.95484	17.35	17.25806	17.21379	17.12581	17.17419	16.85333	15.43226	14.93667	14.34516
2008	16.43871	18.03793	18.52258	17.72667	17.32258	17.21	16.69032	16.88387	16.7	16.14194	14.37333	14.43548
2009	16.11935	17.655	18.63871	18.36333	18.0871	17.29	17.74516	17.2129	17.1	16.75806	14.83333	15.4
2010	16.44839	18	18.02903	18.19	18.14129	17.42667	17.14516	17.20258	16.91	16.15484	15.22	15.16129
2011	16.44516	17.06429	17.79032	17.8	18.00645	17.09	16.67742	16.79355	16.55333	15.54194	16.54	14.85161
2012	15.79032	17.5931	18.92258	17.72667	17.53226	17.19	16.72581	16.60323	16.69333	15.20323	15.37667	15.28387
2013	16.17742	17.85714	18.33871	18.07667	17.66774	17.18667	16.92581	16.6871	17	16.69667	14.3	12.34839
2014	16.22258	17.55185	17.68929	17.3	17.47857	17.35	17.85806	17.5	17.29667	17.16774	16.03667	15.02581
2015	15.76774	18.48214	18.99355	18.5	17.91613	17.976	17.5129	17.26452	17.21333	17.13871	16.67333	16.7
2016	17.95484	18.43103	18.96452	19.08333	18.34333	17.44333	17.42903	17.32581	17.36333	16.84516	15.38	15.26452
2017	15.07742	18.61786	18.82258	18.85	18.09032	18.03667	17.39032	17.06129	17.50667	17.02258	15.08667	12.86129
2018	16.66129	17.5	17.90968	18.02667	17.96452	17.05667	17.23871	17.29355	16.83	16.44516	15.98333	16.07419
2019	16.28065	18.98929	19.02258	18.81	17.88065	17.91	17.46774	17.5	17.64	16.67419	17.04667	16.80645
2020	18.50645	17.84483	18.50645	18.04333	18.39677	17.36	17.49355	17.46129	17.46667	16.71935	15.53667	15.21613
2021	16.7	18.2	18.6	18	17.8	17.6	17.5	17.2	17.7	#N/A	#N/A	#N/A

**Appendix: 3. the binary Logistic Result of the independent variable**

<b>Model Summary</b>			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1.852 <sup>a</sup>	.260	.357

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

<b>Omnibus Tests of Model Coefficients</b>			
	Chi-square	df	Sig.
Step	81.311	12	.000
Step 1 Block	81.311	12	.000
Model	81.311	12	.000

<b>Variables in the Equation</b>							
	B	S.E.	Wald	df	Sig.	Exp(B)	
Step 1 <sup>a</sup>	SEXHH	1.184	.402	8.685	1	.003	3.267
	AGEHH	-.205	.329	.389	1	.533	.815
	EDUHH	.320	.153	4.380	1	.036	.726
	FAMILY	.244	.123	3.947	1	.047	1.784
	TOTLAND	-.916	.444	4.253	1	.039	1.400
	TLU	.656	.180	6.443	1	.011	1.434
	OFFFARM	-.433	.321	1.818	1	.178	1.541
	ACCESSCRIDT	1.746	.373	4.004	1	.045	3.474
	DISMARK	-.301	.189	2.534	1	.111	.740
	DISTFOREST	-.419	.222	3.559	1	.059	.658
	TRAIING	1.074	.376	8.150	1	.004	2.927
ENFORCELOW	.662	.328	4.085	1	.043	1.927	

a. Variable(s) entered on step 1: SEXHH, AGEHH, EDUHH, FAMILSHH, TOTLAND, TLU, OFFFARM, ACCESSCRIDT, DISMARK, DISTFOREST, TRAIING, ENFORCELOW.

## Appendix 4: Questionnaire

**HAWASSA UNIVERSITY**  
**COLLEGE OF AGRICULTURE**  
**SCHOOL OF ENVIRONMENT GENDER AND DEVELOPMENT STUDIES**  
**DEPARTMENT OF CLIMATE CHANGE AND SUSTAINABLE AGRICULTURE**

Dear respondents!

My name is Tilahun Belayneh Bala, I'm a M.Sc. student at Hawassa University and conducting research: "**Factor That Determines Community Participation in Forest Management and Effect of Climate Change: The Case of Mareka District Dawuro Zone, South West Ethiopia Regional State.**" Your information has great value for the success of this research. I confirm that all data will be used for academic purposes and help different stakeholders and policymakers to make appropriate measures on factors affecting community participation in PFM and its effect on climate change. I highly appreciate in advance to your kind cooperation in providing the necessary information.  
*Thank you!*

### General Information

Circle the choices for closed-ended questions and mention your suggestions for open-ended questions in the space provided

1. Name of Enumerator \_\_\_\_\_
2. Woreda name \_\_\_\_\_
3. Keble name \_\_\_\_\_
4. Respondent ID.NO \_\_\_\_\_
5. Village name \_\_\_\_\_
6. Date of interview \_\_\_\_\_

### Part I. Demographic and Socio-Economic Information

#### A: Demographic factors Information

1. Sex: 1. Male 2. Female
2. Age of the respondents: 1) 18-30 2) 31- 40 3) 41-51 4) 51-61 5) Above 62
3. Marital status:  
1) Single 2) Married 3) Divorced 4) Widowed
4. Level of Education:  
1. Unable to read and write 2) Grade1- 4 3) Grade 5- 8 4) Grade 9 - 12 5) Some College Education
5. Household family size 1) 1- 3 2) 4 – 7 3) 8 – 9 4) Above 10
6. Major occupation of Households 1) Crop farm 2) Mixed farming 3) Livestock 4) Others, please specify \_\_\_\_\_

#### B. Socio-Economic Factors Information

1. Do you have your own land? 1. Yes 2. No

2. If “Yes” how many hectares? \_\_\_\_\_ ha 1) < 1 ha 2) 1-2ha 3)3-4 ha 4) > 5ha

Specify each land use type by filling in the following table

No.	Land use type	Marks(x)	Hectares
1	Forest land		
2	Cultivated land		
3	Grazing land		
4	Fallow land		
5	Others		

3. Do you have livestock? 1. Yes 2. No

4. If “Yes” Please list your livestock in number and Types in the following table

No	Types of livestock	Marks(x)	Number	Remark
1	Oxen			
2	Cow			
3	Heifer			
4	Sheep			
5	Goat			
6	Horse			
7	Donkey			
8	Mule			
10	Hen/chicken			
	Total			

5. What are your main Household activities and their contribution to income per year?

No	Main household activities	Tike	Total income
1	Crop production		
2	Livestock production		
3	Forest related activities		
4	Labor excluding your own land		
5	Petty trade		
6	Others		

### C: Physical factors information

1. Distance from forest hours: 1.30min-1hour 2. One hour-2hour 3.above 3 hours

2. Is the distance of forest site to your house affect participation? 1. Yes 2. No

3. If "Yes" how to affect \_\_\_\_\_

4. Distance from the market in KM: 1) Below 5 2) 5-9 km 3)10- 19 km 4) >20km

### D: Institutional factors information



4. If your answer for Q.3 is less active, what are the reasons for your less involvement?  
\_\_\_\_\_

5. Do you attend meeting called by PFM executive and sub-committee? 1. Yes 2. No

6. If your answer for Q. 5 is yes, how many times? 1. Always 2. Sometimes

7. If your answer for Q. 5 is no, why? \_\_\_\_\_

8. In which activities of PFM you highly participate. You can choose more than one

1. Seedling and Nursery 2. Forest utilization 3. Plantation 4. Monitoring and evaluation

5. Protection of forest 6. Others, (specify) \_\_\_\_\_

9. In which activities of PFM from the under listed you don't participate? You can choose more than one

1. Seedling and Nursery 2. Forest utilization 3. Plantation 4. Monitoring and evaluation 5. Protection of forest 6. Others, (specify) \_\_\_\_\_

10. What the reason could be for your answer of Q.9? \_\_\_\_\_

11. Select in which stage of participation you are involved in PFM and the frequency of your involvement

No.	Stages of participation	Frequency of participation			
		Always	Several	Few times	Never participated
1	Planning Stage				
2	Decision Making Stage				
3	Execution Stage				
4	Controlling Stage				

12. How do you level your participation in the below listed activities in table?

No.	Activities	Very active	Active	Less active
1	Forest user's identification			
2	Preparation of PFM bylaws and operational plan			
3	Forest protection			
4	Forest product utilization			

13 What are the major factors that enhance yours participation in forest management?

Please list down by priorities -----  
-----

**Part VI: forest deforestation and degradation**

1. Have you reduced cutting tree after the introduction of the new PFM?

- 1) Yes 2) No

2. If yes for Q.1 why? -----

3. If No for Q.2 why? -----

2. How you rate the changes you have observed on the communal forests since you know the place. 1. Heavily disturbed 2. slightly disturbed 3. better than before 4. Still the same with the past

3. How is the status of the communal forest degradation in your area currently?

1. Increasing 2. decreasing 3. No change

4. What are the major causes for the depletion of the communal forests around your locality? Put in the table according to their rank causes for the depletion of the communal forests around your locality:

Activities	Ranks the for the removal of communal forest				
	1st	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>
Agriculture					
Charcoal					
Furniture					
Firewood					
House					
building					
Others					

5. Who you think is responsible for protecting the communal forests? 1. Government 2. Community 3. Both 4. Mention (if any other) \_\_\_\_\_

6. Who has the right to use the communal forest nearest to you? 1. Only the dwellers nearby the forest 2. All the dwellers of the village 3. Both 4. Mention (if any other)

**Part V: Perception on climate change and variability**

1. You have any idea about climate change and variability

1. Yes \_\_\_\_\_ 2. no \_\_\_\_\_

2. If your answer is yes where did you get the information? 1. Radio 2. TV 3. Training 4. School 5. Newspaper and magazines 6. Specify, other

3. Do you agree there is climate change observed in past ten year in your district/kebeles?

1) Strongly agree                      2) agree                      3) disagree                      4) strongly disagree

4. If **strongly agree** or **agree** to the above question, how do you describe the type of change for each climate change related event? (Answer should be increase or decrease) 1. Level of Temperature..... 2. Amount of Rainfall..... 3. Changes in the frequency of extreme weather events..... 4. Length of dry season..... 5. Length of the rainy Season..... 6. Others, specify.....

5. Have you observed Temperature change in your village? 1. Increase..... 2. Decrease..... 3. No change observed.....

6. Have you observed rainfall variability in your village? 1. Yes ..... 2. no change observed.....

7. If yes to the above question, how do you describe the variability?

1. Rain comes early and leaves late 2. Rain comes and leaves early 3. Rain comes late and leaves early

8. For question No. 7 if your answer came late and left early, what was the change in crop yield? 1. Decrease in crop yield 2. Increase in crop yield 3. No change in yield 4. Decrease in long cycle crops 5. Others

9. Do have forest deforestation and degradation in your Keble?

1) Yes 2) No

10. What do you think are the major causes of deforestation in the area?

1) Illegal cutting of wood 2) Over-grazing 3) Urbanization 4) Agricultural expansion

11. Do you know the cause of climate change in your district? 1. Yes 2.No

(If yes mention the major cause)

---

12. What are the Major problems you faced due to climate change or/and variability

1. Draught
2. Flooding
3. soil erosion
4. Decrease agricultural productivity
5. increasing livestock disease and Lack of fodder
6. food shortage
7. crop \_ pest and disease

13. What is the effect of climate change on forests and its resource?

1. Forest degradation 2. Forest resource depletion 3. Forest fire 4. Illegal encroachments 5. Lack of seedling survival 6. Pest and disease spread 7. Others specify.....

14. There is the relation between forest management and climate change? 1. Yes 2. No

(If yes or no mention your reason)

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## Appendix 5: Questionnaire

### Checklist for Key Informant Interviews

My name is TILAHUN BELAYNEH BALA Dear key informants, this interview guideline is intended to collect data on " Factor That Determines Community Participation in Forest Management and Its Effect on Climate Change: The Case of Mareka District Dawuro Zone, South West Ethiopia Regional State." The researcher hereby assures you that the information you provide is going to be reported and communicated in aggregate and most care and will be for its confidence. General Information Name of kebeles/Woreda \_\_\_\_\_

#### CHECKLIST IN INTERVIEW (IN-DEPTH INTERVIEW)

1. Do you think PFM addresses Forest Conservation and Community's Livelihoods improvement issues? 1. Yes 2. No. 3. Don't Know, put a reason
2. Does the participatory forest management approaches create a great sense of accountability to the forest users?
3. What kind of new technology distribute to the community to reduce forest resource loss?
4. How is PFM balancing between conservation and meeting the local community's needs?
5. What is the role of your organization in relation to climate change?
6. What are the main indicators of climate change and variability in the area?

#### Appendix 6: Questionnaire

1. How do you see potential forests before and after the introduction of PFM?
2. What do you think causes forest resource depletion in your locality? So, what solution do you suggest to preserve forest resources?
3. What are the threats to forest management?
4. What are the major factors that enhance your participation in forest management? Please list down by priorities.
5. Did you perceive any long and /or short-term change in the climate system in your area?
6. Do you know the cause of climate change in your district?

#### Appendix 7: Questionnaire

#### OBSERVATION CHECKLIST

The below listed are observation checklists used in field observation.

1. What are the roles of cooperative members? Do women represent in the committees of the approach?
2. What is being done to protect and conserve forests?
3. Do women physically take part in forest management activities?
4. What are people talking about forest management?
5. What does the forest look like? Is it regenerating? Is there forest destruction?

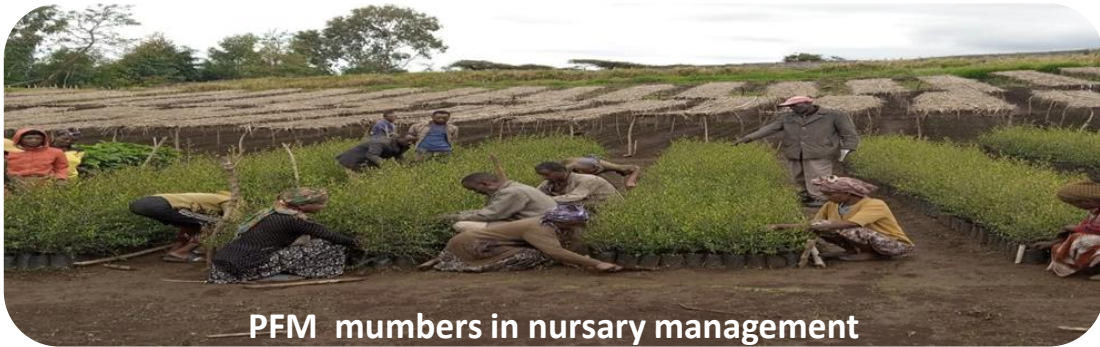
***Thanks for your cooperation!***



Ali PFM forest in Bala yoyo



KII



PFM numbers in nursery management



FGD in Gozo Bamushe