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COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR FOOD SECURITY STUDIES

EFFECTIVENESS OF WATERSHED MANAGEMENT APPROACHES AND PROGRAMS FOR FOOD SECURITY IN QARSA WOREDA OF EAST HARERGHE, ETHIOPIA

A Doctoral Dissertation

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DECLARATION

I, **Tena Gobena Fufa,** do hereby declare to Addis Ababa University School of Graduate Studies that this dissertation paper is a product of my original research work, and it has not been submitted to any other university for any academic degree. Materials and information other than my own are dually acknowledged.

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DISSERTATION APPROVAL

This is to certify that the thesis prepared by Tena Gobena Fufa Entitled "*Effectiveness of Watershed Management Approaches and Programs for Food Security in Qarsa Woreda of East Harerghe, Ethiopia*" and Summited to the Center of Food Security Studies in fulfillment of Degree of Doctor of philosophy in Food Security and Development complies with the regulation of Addis Ababa University and meets the accepted standards with respect to orginality and quality.

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XCUTIVE SUMMERY

Ethiopia has rich natural resources crucial for food availability, livelihoods, and sustainable development. The agricultural sector, which relies heavily on these resources, is critical to providing food for the population and generating income. Indeed, the country has introduced and adopted various rural development initiatives since the 1960s to boost agricultural productivity through modern practices, better access to seeds and fertilizers, and farmer cooperatives. The government has also improved infrastructure, such as roads and irrigation, and invested in education and healthcare to support sustainable development and enhance living standards in rural areas. However, the problem of food insecurity continues to be exacerbated by a multifaceted array of environmental, social, economic, political, and infrastructural challenges. Since the 1970s, integrated watershed management has gained recognition for addressing these interconnected challenges. However, despite some progress in biophysical aspect , sustainability and scalability have not been fully realized, resulting in ongoing resource degradation and food insecurity. This study aims to assess the effectiveness of watershed management in improving food security and identify factors hindering its success. The study was conducted in three micro-watersheds within Qarsa Woreda, East Hararghe Zone, developed through the Free Mass(Community) Mobilization (FMM), the Productive Safety Net Program Public Works (PSNP-PW), and the Sustainable Land Management Programme II (SLMP II), each utilizing different methodologies while following a common watershed guideline framework. A mixed-methods approach was utilized for comprehensive data collection, including household surveys with 337 farmers and 63 professionals from various government organizations at different hierarchical levels, supplemented by secondary data. Additionally, focus group discussions, document analyses, and direct observations were conducted to enrich the findings. Data management and analysis were performed using GIS tools like ArcGIS 10.3 and the People Participation Index, along with diffirent statistical software such as Microsoft Excel and SPSS version 26, enabling a thorough multi-dimensional analysis.

The findings indicate that watershed management interventions in three micro watersheds produced mixed results. Satellite imagery and household interviews showed improvements in land use and cover, reduced soil erosion, and enhanced soil productivity, leading to increased agricultural yields and food availability. Despite these benefits, challenges persist in achieving

comprehensive watershed management. An analysis of the People Participation Index (PPI) showed a moderate level of engagement among farmers, with no significant differences observed among the three micro watersheds. Additionally, the evaluation indicator metrics revealed variability both within and among the micro watersheds. However, the Sustainable Land Management Program outperformed the Productive Safety Net Public Work and Free Mass Mobilization programs.The findings also revealed a significant lack of mutual understanding between farmers in the three micro watersheds and professionals from various organizations regarding regarding the concept of watershed management. An analysis of mental models showed a significant disparity: only 36.5% of professionals and 12.7% of farmers viewed it as part of rural development, while, a large portion of both groups primarily saw it as a means of managing natural resources or conserving soil and water. This divergence, along with limited farmer engagement, undermines the effectiveness of watershed management in enhancing food security, leading to a focus on physical conservation strategies rather than a more comprehensive approach. The study showed that there is a lack of collaboration and integration among institutions and line departments involved in watershed management both at lower and higher levels. Discussions with various stakeholder groups have shown that the absence of collaboration at higher levels highly affects the effective management of watersheds at lower levels. In summary, challenges including inadequate accountability, competing interests, and insufficient commitment at different administrative levels, are hindering the effectiveness of watershed management. Political interference, ineffective organizational frameworks, and low community awareness exacerbate these issues at the woreda and kebele levels. This study emphasizes the need for strong institutional frameworks to enhance coordination and understanding among stakeholders for a comprehensive watershed approach that supports long-term food security. Furthermore, promoting comprehensive community involvement and cultivating a shared understanding of the watershed approach as a fundamental component of institutional, political, and economic frameworks is essential for the successful management of watersheds for food security improvement.

Keywords: Coordination, household, institutional framework,landuse landcover, participation, watershed sustainability,

ABBREVIATIONS

ADLI:	Agricultural Development-Led Industrialization
CSA:	Central Statistical Agency
DA:	Development Agent
FAO:	Food and Agricultural Organization
FDRE:	Federal Democratic Republic of Ethiopia
FEDB:	Finance and Economic Development Bureau
FGD/s	Focus Group Discussion/s
GTP:	Growth and Transformation Plan
IFAD:	International Fund for Agriculture Development
IIED:	International Institute for Environment and Development
IWM:	Integrated watershed management
MoA:	Ministry of Agriculture
MoARD:	Ministry of Agriculture and Rural Development
MoFED:	Ministry of Finance and Economic Development
NRM:	Natural Resources Management
OBoANR:	Oromia Bureau of Agriculture and Natural Resources
OECD	Organization for Economic Co-operation and Development
PNSP_PW	Productive Safety Net Program Public Work
SLMP II	Sustanable Land Manamgment Program II
PPI	People Participation Index
WM	Watershed Management
WMP	Watershed Management Practice
UNDP:	United Nations Development Program
UNICEF	United Nations International Children's Emergency Fund
PSNP:	Productive Safety Net Program
UNFCCC:	United Nations Framework Convention on Climate Change
USAID:	United States Agency for International Development

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CHAPTER ONE: GENERAL INTRODUCTION

1.1 Background of the study

Sustainable food security is a multifaceted issue beyond merely meeting immediate dietary needs. It involves a complex interplay of economic, environmental, and social factors that ensure future needs are met (Jarosz, 2014; Lang and Barling, 2012; Sonnino et al., 2014; Ramankutty et al., 2018). However, issues such as rapid population growth, climate change, land degradation, loss of biodiversity, and the overuse of natural resources pose significant challenges, especially in areas where agriculture is the main economic activity (SDSN, 2013; Laurance et al., 2014; UNFCCC, 2015; Lynch & Sachs, 2021). Addressing these interconnected challenges simultaneously requires integrated strategies that promote coordinated actions across all levels, from local to global and various sectors (Hoyos et al., 2010; UNDP, 2018). Integrated watershed management has emerged as a holistic approach to sustainable management of natural resources while fostering economic development and ensuring food security (Brooks and Eckman, 2000; Gregersen et al.,2007; Shiferaw et al., 2008; FAO, 2017). The approach also facilitates coordination across various stakeholders and acknowledges the value of inclusive decision-making processes that involve multiple disciplines (German et al., 2007; Gadisa, 2016).

Studies by Lee and Chung (2007) and Reed et al. (2016) reported that integrated watershed management promotes synergy among agriculture, forestry, land use, and other activities, recognizing their interconnections while also addressing the mutual dependencies among sectors to ensure the long-term sustainability of natural resources. It effectively combines ecological functions and socio-economic factors to balance human needs with environmental conservation (Rawat, 2014; Nerkar et al., 2015; FAO, 2017). This holistic perspective enables more comprehensive and effective management practices that adapt to changing conditions while addressing the diverse needs of communities (Rawat, 2014). Despite growing concerns about watershed management, there remains limited understanding of its role as an essential unit for development planning and improving food security (Wagener, 2005; Veale, 2010; Vasić et al., 2024).

In fact, watershed management was initially focused on soil and water conservation, addressing fundamental issues pertinent to the problem of these critical resources (Wani et al., 2008; Molle, 2009). However, as populations grew and demand for natural resources increases , engineering methods often

failed to address complex issues of resource degradation and social inequalities (Darghouth et al., 2008). This situation necessitated a reevaluation of the watershed approach and highlighted the importance of transitioning towards the development of integrated and participatory strategies, which acknowledge the interrelationships among various environmental elements (Brook et al., 1994; Darghouth et al., 2008; Joshi et al., 2008). This shift has transformed the strategies from a narrow focus on conservation to a broader framework that includes ecological, social, and economic aspects (Suhas et al., 2010; Pandurang et al., 2012; Naburi et al., 2020). Following the 1992 Earth Summit, the idea further developed into a crucial framework for socio-political-ecological systems, promoting rural development while simultaneously tackling complex environmental and socio-economic issues (Bantider, 2007; Wang et al., 2016; Lalthansanga, 2020). It is now widely recognized among policymakers, administrators, scientists, and researchers as an approach for sustainable development and improving living standards globally (Darghouth et al., 2008; Shiferaw et al., 2008; Wani et al., 2008; Suhas et al., 2010).

Studies carried out in various countries show that integrated watershed management greatly enhances agricultural productivity, safeguards ecological systems, and promotes sustainable rural development by efficiently coordinating the management of land and water resources with success(Personal and Archive, 2007; Wani and Garg, 2008; Darghouth et al., 2008). For instance, studies conducted in China, Sri Lanka, and the Philippines highlight the role of watershed management in fostering overall development and addressing environmental, social, and economic issues (Bandaragoda, 2006; Suhas et al., 2010; Rockstrom et al.,.2011; Reddy et al., 2017). Similar findings from France, Cuba, and Nepal affirm its efficacy in agricultural and rural development (FAO,2006; Charnay,2011; Adhikariet al.,2015). Additionally, research in Canada and Italy underscores how the watershed approach integrates environmental and socio-economic factors, contributing to public health improvements (Singh et al.,2010; Katusiime & Schütt,2023). Joshi et al. (2009) also found that in India, watershed management increased irrigated areas by 51%, cropping intensity by 35.5%, and improved groundwater availability while reducing soil loss by 1.1 t ha-1 and runoff by 46%.

Studies by Wang et al. (2016) and Bantider et al. (2019) reveal that a successful watershed strategy harmonizes infrastructure, water management, and land use planning to effectively address food security challenges in the context of a growing global population and climate change. Studies by different scholars also revealed that adopting a holistic watershed management framework can enhance food production, protect natural resources, and build resilience against environmental challenges (Personal

and Archive, 2007; Wani and Garg, 2008; FAO, 2006; Wani et al., 2006; Darghouth et al., 2008). According to the FAO (2017), effective watershed management encompasses ecological, social, and economic factors that are essential for improving food security while minimizing environmental impact. Similarly, Joshi et al. (2005) found that effective watershed management boosts productivity, promotes sustainable resource use, and improves market access by integrating technologies, policies, and institutional structures. Various studies conducted by different authors have further substantiated that integrated watershed management enhances food security by broadening income sources, reducing reliance on single crops, and strengthening resilience to climate and economic changes (Darghouth et al., 2008; Cohen & Davidson, 2011; Change, 2015; Yaebiyo et al., 2015; Wang et al., 2016).

In Sub-Saharan Africa, including Kenya, South Africa, and Ethiopia, effective watershed management is essential for ecosystem preservation, optimizing land use, improving water quality, conserving biodiversity, and enhancing ecosystem resilience (Nick and Woldehanna, 2012; FAO, 2017). Furthermore, integrated watershed management practices in Uganda significantly improved food security and alleviate poverty among local communities in watershed areas (Hadush, 2015; Gebregziabher et al., 2016). Wani (2011) furthermore highlighted that integrated watershed management can enhance sustainable agriculture and food security while protecting ecosystems, particularly in developing countries, where agricultural systems are often vulnerable to climate change and other environmental stresses. Comprehensive assessment of watersheds across various regions also indicated its effectiveness in enhancing food security by integrating technological, socioeconomic, and institutional elements in response to environmental challenges (Wani and Garg, 2008; MoA, 2010; Nerkar et al., 2015; Kerse, 2017).

However, Koohafkan (2001) presents a compelling argument regarding the early adoption of watershed management in developing countries, highlighting how these initial decisions have had a lasting impact on contemporary practices. This Authour further underscores that the emphasis on specific technical solutions during this period has shaped current methodologies and influenced their effectiveness in addressing watershed management challenges. Lalthansanga (2020) complements Koohafkan's concerns by noting that early initiatives prioritized the success of physical interventions, often at the expense of critical elements essential for sustainable management practices. This limitation has continued to create difficulties in aligning watershed management with goals related to food security and rural development in these regions (Nick & Woldehanna, 2012; Palanisami & Kumar, 2009). Consequently, adopting

comprehensive watershed management practices has remained challenging in many developing countries, including Ethiopia (Wani & Garg, 2011).

In Ethiopia, as in many other developing countries, the watershed approach was first introduced in the 1970s to combat widespread land degradation. However, the early efforts often prioritized technical solutions without adequately addressing the socio-economic context of the affected communities. As a result, the initiative failed to address the complex interplay between environmental and social factors (Destal et al., 2005; Gebregziabher et al., 2016; Teressa, 2018; Bantidar et al., 2019). Consequently, the focus shifted from purely soil conservation techniques to a more integrated discipline (Yitaferu, 2007; Tefera & Sterk, 2010). Particularly since the 1990s, the Ethiopian government has increasingly emphasized the watershed approach as a strategy to enhance rural development and reduce poverty (Tesfa & Sangharsh, 2015; Gebregziabher et al., 2016; FAO, 2017; Tesfay & Mohammed, 2017; Teressa, 2018). This emphasis has led to substantial investments in watershed management by governmental and non-governmental organizations to rehabilitate degraded lands, improve water availability, and promote sustainable agriculture, ultimately enhancing food security and community resilience (Mulugeta, 2014; Dagnew et al., 2015). Different research shows that despite some achievements, the watershed approach continues to face significant challenges, with poverty and food insecurity remaining major problems in the country (Meshesha et al., 2015; Gadisa, 2016; Bantidar et al., 2019; Daniel, 2020).

In this regard, different researchers have shown mixed findings on the performance of watershed management in the country. For instance, studies by Addisu et al. (2013) highlight that effective watershed management practices can significantly mitigate land degradation, thereby improving soil health and increasing agricultural productivity. Similarly, Mulugeta (2014) emphasizes the positive impact of watershed management on food security, noting that improved water management and conservation techniques lead to better crop yields and more reliable food sources for local communities. Gebregziabher et al. (2016) and Mekuriaw et al. (2018) further support this view by demonstrating that integrated watershed management initiatives can enhance the livelihoods of rural populations through diversified agricultural practices and increased resilience to climate variability. Additionally, Dagnew et al. (2015) found that such management practices can lead to a 60% reduction in runoff, a 36% decrease in sediment concentration, and an 80% reduction in sediment load. Furthermore, Yaebiyo et al. (2015) reported that the implementation of watershed management contributes to increased production in both

crops and livestock, as well as higher annual incomes for households. Other studies have also shown that the approach has the potential to enhance cropping intensity and overall production levels, alongside various benefits for both agricultural and non-agricultural sectors (MoA, 2010; Kerse, 2017).

On the contrary, studies on land degradation showed that the degree and extent of past and current rates of natural resource base degradation continued and became the causes of declining agricultural productivity, food insecurity, and vulnerability (Temesgen et al., 2014; Hurni et al., 2015; Gashaw et al., 2017; Mekuriaw et al., 2018). Equally, the decline in soil fertility is increasingly prevalent throughout Ethiopia, negatively impacting the quality of both cultivated and grazing lands (Teklewold et al., 2013). Research indicates that over 40% of the country's land is affected by soil acidity, significantly hindering agricultural productivity and threatening the sustainability of farming practices (Genizeb, 2015; Zingore et al., 2015). Dirba (2020) reports that nearly 85% of the land in the country is experiencing degradation, leading to considerable soil loss estimated between 10 and 80 tons annually. Studies also shows soil erosion occurs over twenty times faster than natural replenishment, threatening agricultural productivity and highlighting the need for effective soil solutions (Tamene and Vlek, 2008; Nyssen et al., 2015).

Numerous studies have emphasized that the depletion of natural resources significantly intensifies climate change, which in turn adversely impacts food and nutritional security among disadvantaged populations (Suhas et al 2010; IPCC, 2015; Tesfaye and Mohammed, 2017; Sulistyaningsih, et al, 2021). Sterner and Persson (2007) also emphasize that shifting weather patterns, increased frequency of extreme events, and changing agricultural conditions disrupt food production systems. Studies by Bates (2008), the IPCC (2015), and Tebebu (2017) show that climate change reduces agricultural productivity, disproportionately impacting marginalized communities and worsening existing inequalities, which threatens their access to adequate nutrition. As a result, over ten million people in Ethiopia rely on food aid to meet their basic dietary needs (IFPRI, 2017; FAO, 2016). This situation highlights the critical need for further investigation into the effectiveness of the watershed management approach in the country, particularly as a strategy to enhance resilience and improve food security amidst the challenges posed by climate change (FAO, 2011; Dorosh & Rashid, 2012; Guo, 2014).

Moreover, while the potential of watershed management is widely recognized and has historical support in the country, there is a significant lack of research into the factors contributing to the initiative's inability to achieve its expected goals. Furthermore, key elements necessary for successful watershed

management—such as integration, coordination, and institutional frameworks—are often poorly implemented (Adimassu et al., 2013; Mulugeta, 2014; Tiki et al., 2016; Welteji, 2018). These components are vital for the comprehensive management and preservation of watershed resources. Consequently, the holistic approach to watershed management has not yet gained widespread acceptance or effective implementation (Bewket, 2007; Bantider et al., 2019). This left, the country remained highly susceptible to drought, poverty, and food insecurity (Dorosh and Rashid, 2012; FAO, 2017). Translating watershed management principles into effective practices to meet rising food demands requires considerable work and thorough investigation (Alexandratos & Bruinsma, 2012; Teressa, 2018).

There is aslo limited studies on how stakeholder engagement, accountability, and responsibility have been implemented and their effects on the success of watershed management (Mulugeta, 2014; Tiki et al., 2016; Welteji, 2018). Furthermore, there has been inadequate investigation into the level of community awareness, understanding, and active participation in this initiative and how these factors affect their success or failure (Tarresa, 2018; Aynekulu & Yaekob, 2017). Consequently, the integration of socio-economic factors into watershed management practices remains under-explored. Additionally, the diverse perspectives among stakeholders complicate the implementation of cohesive and effective strategies in watershed management (German et al., 2007).

The lack of thorough research on agency collaboration in watershed management, as highlighted by Gadisa (2016) and Fufa and Tona (2019), significantly hinders stakeholders' understanding of successful cooperative strategies. They further indicated that this gap limits the development of best practices for inter-agency communication and resource sharing. Similarly, contemporary watershed management strategies often lack integration, thereby impeding the practical application of holistic approaches in real-world scenarios (Desta et al., 2005; Wani and Garg, 2011; Hurni et al., 2015; Aynekulu & Yaekob, 2017). Moreover, there is lack of research on stakeholders' understanding of watershed management concepts and the interconnectedness of its components, which, along with the failure to address its holistic nature, leads to fragmented knowledge and biased policy approaches (Perez and Tschinkel, 2003; William and Edella, 2005; Bewket, 2007; Wang et al., 2016).

To address existing gaps, further research is crucial in watershed management, which extends beyond physical interventions to encompass social, economic, and environmental factors. A deeper examination of barriers to participation, institutionalization, and outcomes is necessary to understand its

complexities. This study utilizes a case study in Qasrsa Woreda, East Hararghe Zone, Oromia Region, chosen for its extensive experience with watershed management amid ongoing land degradation and food shortages. The aim is to assess the effectiveness and inclusivity of watershed management initiatives designed to improve food security.

1.2 Statement of the problem

Ethiopia is endowed with a natural resources which are vital for achieving food security, improving livelihoods, and promoting sustainable development in Sub-Saharan Africa (SSA). Nevertheless, the country faces severe challenges, including frequent droughts, widespread poverty, and ongoing food insecurity (Dorosh & Rashid, 2012; FAO, 2017). Infact, since the 1960s, Ethiopia has made substantial investments in a range of development programs aimed at boosting agricultural productivity and ensuring food security. Notable initiatives include the Chilalo Agricultural Development Unit (CADU), established in 1967, and the Arsi Rural Development Unit (ARDU) both aimed at addressing agricultural challenges and enhancing resource management among farmers (Diriba, 2020). Despite these initiatives, progress has been hindered by factors such as resource underutilization, an emphasis on sector-specific planning, and insufficient technological advancement, resulting in persistent poverty (Bewket, 2007; Teshome et al., 2016; Diriba, 2020).

Following the devastating drought and famine of 1973–74, Ethiopia revised its development strategy to incorporate environmental considerations into planning and policy frameworks (MoARD, 2010; Gashaw, 2015; Guush et al., 2017). This shift led to the emergence of watershed management initiatives aimed at soil and water conservation (Haregeweyn et al., 2015). However, until the late 1980s and early 1990s, this approach was also limited by its focus on technical solutions, top-down planning, and minimal community engagement (Destal et al., 2005). As a result, the efforts aslo faced challenges, leading to continued land degradation and unmet food demands of the growing population (Herweg, 1993; Bekele et al., 2018; Bantidrer et al., 2019).

Since 1991, however, integrated watershed management has received considerable attention from government bodies and has been recognized as a vital strategy for rural development (Bantidrer et al., 2019).

. This strategy focuses on diversifying livelihoods, empowering local communities, and improving infrastructure to address challenges related to food security and poverty (Spielman et al., 2011; Meshasha and Berhanu, 2015; Amenu, 2019). Consequently, substantial effert and resources have been invested to watershed management to enhance agricultural productivity and conserve natural resources,while improving food security (Alemu et al., 2002; Bewket, 2007; Amsalu, 2015; Teshome et al., 2016; Guush et al., 2017; Bekele et al., 2018). Particularly since the early 2000s, various programs, including the Productive Safety Net Program (PSNP), the National Sustainable Land Management Project (SLMP), and Free Community Mobilization, have been implemented to enhance land and water management, elevate agricultural production, and promote sustainable livelihoods and food security in the country including in the Oromia regional state.

The Oromia Regional State is one of Ethiopia's regional states actively implementing integrated watershed management to enhance ecosystem and environmental functions while simultaneously improving food security and promoting sustainable livelihoods. According to the 2018 report from the Regional Bureau of Agriculture, over the past decade, more than 12 million hectares of land in Oromia have been treated with physical and biological conservation measures through initiatives such as the Sustainable Land Management Program II (SLMP-II), the Productive Safety Net Program-Public Works (PSNP-PW), and Free Mass Mobilization. Similarly, the Agriculture Office of Qaresa Woreda in the East Hararghe Zone, where this study was conducted, also reported similar proporation of progress in watershed management during the same period by these programs.

Despite these initiatives, land productivity in the region remains severely challenged, worsening food and social insecurity. Key issues like land degradation, which is mainly manifested in the form of soil erosion and deforestation, are hindering agricultural output and threatening rural livelihoods. Furthermore, ongoing soil degradation, insufficient water resources, and climate change are exacerbating malnutrition and food insecurity in the region in general and the study area in particular. This underscores that, despite the government's commitment to integrated watershed management, translating theory into practical measures for local food security remains a significant challenge with high proportion of households in Qarsa Woreda continue to face food insecurity, and the local economy remains largely dependent on external assistance.

A study by Bantider et al. (2020) also confirmied that, despite substantial financial and human resource investments over several years, only 23% of Ethiopia's land had been treated with physical and biological conservation measures up to 2016. This statistic points to a notable disparity between the resources invested and the extent of conservation achieved. Research by Mulugeta (2014), Dagnew et al. (2015), and Bantider et al. (2019) further reveals that the difficulties encountered are not solely attributable to the scale of investment but are also associated with challenges related to the sustainability and scalability of watershed management programs. Additionally, although there has been a movement towards a more integrated framework for watershed development, the practical application of watershed management as a planning unit remains insufficiently addressed by relevant organizations. As highlighted by Alexandratos and Bruinsma (2012) and FAO (2017), the underutilization of resources significantly hampers the implementation of effective solutions for achieving meaningful and sustainable improvements in food security and rural livelihoods.

Additionally, the sectoral approach to watershed management, which emphasizes specific domains through various governmental agencies, intensifies challenges due to poor coordination and a lack of tailored solutions. Furthermore, the absence of interdisciplinary integration, inadequate policies, insufficient extension services, and numerous institutional obstacles significantly hinder the effectiveness of these management efforts (Amsalu et al., 2007; Tizale, 2007; Bekele et al., 2015; Tesfa & Sangharsh, 2015). Furthermore, many research initiatives in the field have been confined to single-case studies, lacking comparative evaluations of program effectiveness, which underscores the deficiency in shared accountability (Tarresa, 2018). Consequently, watershed management has failed to evolve into a comprehensive and inclusive framework. This inadequacy signifies a limited comprehension and implementation of the holistic approach essential for effective rural development across various levels. Furthermore, the concept needs to be uniformly applied among stakeholders to tackle the diverse social, economic, and environmental aspects.

Therefore, the objective of this research was to evaluate the watershed management strategies employed across various programs, with an emphasis on identifying existing deficiencies and core challenges. Additionally, the study assessed the level of community engagement in holistic practices and analyzed the efficacy of the prevailing institutional framework. It also investigated stakeholder awareness concerning the comprehensive concept of watershed management and the sustainable use of resources. By identifying key factors that influence the success of these strategies, the research aims to provide

recommendations for improving watershed management and promoting resource sustainability to ensure food security.

1.3 Objective of the Study

The primary goal of this study is to explore the effectiveness of integrated watershed management strategies in enhancing food security. This research evaluated the holistic approach of integrated watershed management, which recognizes the interconnectedness of social, environmental, and economic factors in watershed governance, viewing the watershed as a unified system. The study concentrated on planning and implementing inclusive, integrated watershed management practices to promote sustainable development and improve food security. The investigation was directed by a clear set of specific objectives.

1. Examining the biophysical changes implemented in micro watersheds following different approaches in the last five years 2014-2020
2. Assessing the impact of watershed management on improving the food security of farming households.
3. Investigating the current level of community participation and identifying the factors that affect their involvement in different stages of planning, implementation, and monitoring of watershed management practices in the Qersa distric
4. Analyze the organizational frameworks and comprehensive understanding of integrated watershed management at different levels.

1.4 Research Questions

The central inquiries of this thesis dissertation revolve around the effectiveness of watershed management practices implemented over the past decade, particularly from 2014 to 2020. Did these practices yield tangible improvements in the field? Are the institutional frameworks appropriate to foster a shared understanding and coordinated efforts among diverse stakeholders? Furthermore, was community engagement regarded as an essential element throughout all stages of watershed management? Additionally, which programmatic approaches proved more or less effective, and what factors contributed to these outcomes? This research aims to investigate the perceptions and practices associated with watersheds, with specific research questions designed to address the aforementioned primary objectives.

Research Questions for Objective 1 and 2: To what extent have integrated watershed management practices implemented from 2014 to 2020 led to improvements in food security, including changes in agricultural productivity, resource availability, and environmental conditions? Specific questions to this research question include:

1 What were the effects of implementing watershed management practices on the biophysical state of micro watersheds over time?
2 Did the implementation of watershed management practices lead to noticeable transformations in land use and land cover across all three micro watersheds, and where are the most significant changes observed?
3 How do farmers perceive the biophysical changes occurring in the watersheds across all three micro watersheds, and what is their assessment of these changes' impacts on their farming practices
4 How the adoption of integrated watershed management practices impacted the food security of the household?

Research Questions for Objective 3 : What is the extent of community involvement in watershed management, and what factors affect participation at different phases? Specific questions to this research question include:

1 What is the current level of community participation in the planning, implementation, and monitoring stages of watershed management practices in the Qersa district?
2 What are the key factors influencing community involvement in the different stages of watershed management practices in the Qersa district?
3 Is community involvement in watershed management planning, implimentaion, montoring and evaluation inclusive and knowledge-based?

Research Questions for Objective 4: How do stakeholders perceive watershed management and its associated institutional frameworks at various levels? Specific questions to this research question include

1 Why do various shareholders interpret the concept of watershed management?
2 How institutional frameworks have been established to facilitate integrated watershed management practices across various programs at different levels of government?
3 What strategies can be adopted to enhance the effectiveness of watershed management practices in order to achieve food security across various levels of government and within local communities?

1.5 LITERATURE REVIEW: THE THEORETICAL AND CONCEPTUAL UNDERPINNINGS

1.5.1 Theoretical Underpinnings

The evolution of watershed management reflects an increasing recognition of the complex interplay between land and water systems and their critical role in sustainable development (Wang et al., 2016). The term "watershed," first introduced in 1920 to denote water-parting boundaries (Malo, 2020), was fundamental in elucidating the dynamics of water movement across landscapes shaped by topography, soil characteristics, and vegetation (Brooks et al., 1994). As scientific understanding advanced, the definition of "watershed" expanded to incorporate both natural and anthropogenic factors, including vertical land boundaries and horizontal water flow (Tiwari,et al., 2009). This expanded definition reflects a growing recognition of watersheds as complex systems influenced by various factors beyond just physical boundaries (Cruz, 1999; Tiwari,et al., 2009).

By the mid-20th century, the focus expanded to include integrated and participatory approaches, recognizing watersheds as socio-political-ecological systems (Brooks et al., 1991; Guangyu et al., 2016). This shift from a primarily hydrological focus to a comprehensive framework integrating ecological, social, and economic dimensions underscores the need for holistic watershed management (Joshi et al., 2008; Molle, 2009). Since the 1992 Earth Summit, watershed management has shifted its emphasis from traditional resource conservation to poverty alleviation, food security, rural development, and livelihoods (Sharda, 2012; Sulistyaningsih, 2021). Consequently, the definition of watershed management has evolved to encompass the process of guiding and organizing land and resource use within a watershed to provide desired goods and services while preserving soil and water resources (Suhas et al., 2010; Tesfa and Sangharsh, 2015; Reed et al., 2016).

According to Heathcote (2009), formal watershed management frameworks began during the Great Depression and Dust Bowl (1929-1940) in the U.S to address the pressing issue of soil erosion. During this period, various conservation organizations were established to implement physical infrastructure for soil and water conservation, including techniques such as rainwater harvesting to mitigate erosion (Darghouth et al., 2008; Rockstrom., 2011). Over time, this focus evolved from purely physical measures to encompass broader ecological, social, and economic aspects. The development of Integrated

Watershed Managemen (IWM) in the mid-20th century represented a shift towards viewing watersheds as complex socio-ecological systems that require coordinated management strategies (Joshi et al., 2008).

Additionally, after 1992, watershed management shifted to emphasize community engagement and collaborative governance, reflecting a broader trend in environmental management (Suhas et al., 2010; Tesfa & Sangharsh, 2015; Reed et al., 2016; Guangyu et al., 2016). Studies indicate that global recognition of community involvement serves as an effective approach to enhancing environmental conservation efforts (FAO, 2006; Wani et al., 2008; Suhas et al., 2010). This shift has led to the development of integrated watershed management frameworks, which have garnered substantial support from policymakers and researchers as effective tools for addressing critical issues in agriculture, water management, and environmental protection (Brooks et al., 1994; Darghouth et al., 2008; Wani et al., 2008; Guangyu et al., 2016). Watershed management is now globally recognized as an effective strategy for rural development, addressing poverty alleviation and food security while also promoting environmental conservation (FAO, 2006; Wani et al., 2008; Suhas et al., 2010).

1.5.2 Empirical literatures

Empirical studies across various regions have demonstrated that watershed-based management is a socially and economically acceptable approach for optimizing natural resource use while minimizing environmental degradation (Desta et al., 2005; Wani et al., 2008; World Bank, 2008; Wang et al., 2016; Bantider et al.,2019). A study in India focused on watershed management demonstrated that these practices provided significant benefits for farmers, including a 51% increase in irrigated land, a 35.5% rise in cropping intensity, a reduction in soil erosion to 1.1 t ha-1, a 46% decrease in runoff (Wani et al., 2010). Similarly, research by Meena et al., (2022) in the same country examined 221 watersheds and found that implementing effective management strategies led to an average increase in groundwater recharge of 1.94 meters, with variations from 0.10 to 10 meters. Additionally, this study noted an improvement in carbon sequestration, averaging 0.34 tonnes per hectare, with observed values ranging from 33 kg to 722 kg. Studies conducted in watersheds in China show that successful management strategies have led to a doubling of land productivity and an increase in farmers' per capita income. This has contributed to economic growth, environmental enhancement, and the improvement of ecosystem services (Lixian, 2002; Vasić et al., 2024).

The analysis of watersheds throughout Indonesia indicates that the implementation of effective management strategies has led to a significant decrease in surface runoff and erosion, achieving reductions of 67% and 80%, respectively, in contrast to regions that do not employ conservation practices (Supangat et al., 2023). Similarly,in the Philippines, watershed management contributes significantly to biodiversity conservation, underscoring its role in preserving ecological balance (Francisco, 2004). In Canada, the approach is leveraged to promote tourism and enhance public health, illustrating its multifaceted benefits (Wolfe,2019; Dodds, 2020). Integrated watershed management represents a holistic development framework that harmonizes human, social, physical, financial, and technical resources, thereby playing a vital role in ensuring food and economic security while providing essential life-support services to rural communities (Kerr, 2007; Wani et al., 2008).

When watershed management was introduced to developing countries in the 1970s, it often focused narrowly on the biophysical aspects of feasibility, neglecting the sociopolitical, cultural, and economic contexts of local communities (Koohafkan, 2001; Sheng, 1999). The strategies implemented were frequently grounded in soil and water conservation practices without considering the broader spatial and temporal dimensions critical to effective watershed management (Sheng, 1999; Nick & Woldehanna, 2012; Wang et al 2016). Additionally, the approach was typically top-down, prioritizing national priorities over local needs and conditions (Floress,2009). As a result, while the strategies may have been technically sound, they frequently failed to address the real needs and circumstances of the local populations, leading to limited effectiveness and sustainability of the watershed management practices (Wagener, 2005).Watershed management faces significant challenges due to its extensive scale and the fact that it often spans multiple administrative and political jurisdictions, complicating effective coordination and implementation (Cohen & Davidson, 2011). Moreover, while integration is a central theme in watershed management, numerous and often conflicting perspectives on what should be integrated add another layer of complexity (Brooks et al., 1994). While studies recognize watersheds as critical planning units, differing stakeholder views on their application complicate the development and implementation of effective management strategies (Cardwell et al., 2006; Petry and Dombrowsky, 2007).

1.5.3 Watershed Management in Ethiopia

The evolution of watershed management in Ethiopia has seen significant changes since its inception in the 1970s. Initially, efforts were predominantly focused on engineering solutions to address soil erosion and water scarcity, driven by technical approaches aimed at managing biophysical aspects of watersheds (Desta et al., 2005; Gebregziabher et al., 2016). However, the devastating droughts of 1984/1985 highlighted the limitations of these technical approaches, prompting a significant shift towards a more comprehensive framework that prioritized integrated and participatory management approaches (Webb & Yohannes, 1992, Chisholm and Woldehanna, 2012). Despite this shift, study revealed that the focus remained on large watersheds, typically ranging from 3,000 to 4,000 hectares (Desta et al., 2005). This scale of the watershed management projects hindered their effectiveness and replicability, due to difficulties in stakeholder engagement, high costs, and limited beneficiary participation (Bekele, 2003; Gete, 2004;Desta et al., 2005).

While Ethiopia has a longstanding tradition of natural resource conservation, this issue has not been prioritized sufficiently as a critical element in ensuring food security and combating hunger (Alemu et al., 2002; Bewket, 2007;; Teshome et al., 2016; Guush et al., 2017; Bekele et al., 2018). Consequently, this neglect has led to considerable difficulties within the agricultural sector, which is fundamentally dependent on the availability and sustainability of natural resources, including water, soil, and biodiversity (Berhanu, 2012; Amsalu, 2015). Recognizing the essential relationship between natural resource management and food security, Ethiopia has been progressively improving its watershed management approaches since the 1990s (Desta et al., 2005). This evolution reflects a broader understanding of the intricate relationships among environmental health, agricultural productivity, and the livelihoods of rural communities(FAO, 2006; Tesfaye, 2011).

Ethiopia has made notable progress in its watershed management strategy with the introduction of the "Community-Based Participatory Watershed Development Guidelines" by the Ministry of Agriculture in 2005. This initiative has created standardized planning and management practices throughout the country (Gebregziabher, 2012). The guidelines emphasize the integration of environmental, social, and economic factors while encouraging active community involvement in the planning, implementation, and assessment of sustainable watershed management initiatives (Worku & Tripathi, 2015). This shift from traditional engineering-focused methods to a more comprehensive approach highlights the

significance of watershed management as a crucial strategy (Gadisa, 2016; Tesfaye, 2011). Consequently, watershed management has become an essential element in efforts to reduce poverty and enhance food security (Gadisa, 2016).

Empirical studies further validate the effectiveness of the watershed management practices in Ethiopia, showing its significant impact beyond conservation. Research by Desta et al. (2005), Wani et al. (2008), and the World Bank (2008) highlights that these practices not only prevent environmental degradation but also enhance productivity and improve livelihoods. Watershed management has been shown to play a crucial role in protecting the environment, promoting gender equity, preserving biodiversity, and ensuring food security (Gebregziabher et al., 2016; Teresa, 2018). Similarly, Yaebiyo et al. (2015) observed significant improvements in farm income, food security, and access to health and education services in the Sheka watershed in Tigray. Additionally, studies by MoA (2010) and Kerse (2017) highlight improvements in cropping intensity and production levels. Furthermore, numerous studies underscore the effectiveness of watershed management in contributing to rural development and food security by enhancing agricultural productivity, improving livelihoods, and fostering market access (Bekele, 2003; Addisu et al., 2013; Tsegaye et al., 2014; Worku et al., 2028; Arfasa & Tona, 2019; Tesfay et al., 2023).

Despite its acknowledged value, various arguments have been made regarding the limited effectiveness of watershed management in these areas. A study by Change (2015) identified several factors contributing to this issue, including problems related to data limitations, financial constraints, conflicting priorities, and integration strategies. Additionally, while watersheds are recognized as critical units for planning, stakeholders often have differing views on their application, complicating the development and execution of effective management strategies (Mekonnen et al., 2015). Germenn et al. (2007) further noted that a lack of awareness or understanding of watershed management concepts and practices among planners, managers, and decision-makers can lead to divergent perspectives. he involvement of diverse stakeholders with varying interests complicates decision-making processes, potentially hindering the achievement of comprehensive and sustainable outcomes (Nyssen et al., 2010). Gender equity and social inclusion are often overlooked, resulting in marginalized communities lacking representation and facing an uneven distribution of benefits (Veale, 2010; Chirenje et al., 2013; Kacho & Asfaw, 2014).

Additionally. despite a global understanding of watershed approaches, Ethiopia faces significant challenges due to complex scales—encompassing river basins,watershed, and micro-watersheds alongside fragmented institutional frameworks and varying local capacities (Kerr et al., 1998; Ffolliott et al., 2002; Wani et al., 2008). Further, this complexity often spans multiple administrative and political jurisdictions, complicating the coordination and implementation of effective management strategies (Nyssen et al., 2010; Taye et al., 2015). Additionally, institutional inertia and resistance to change can hinder the application of watershed management approaches (Wakjira, et al., 2013). The lack of a robust institutional framework further complicates the integration of watershed management into broader planning initiatives, particularly in addressing complex issues such as poverty and food insecurity (Haregeweyn et al., 2012). Consequently, watershed management has not yet been fully integrated into a cohesive strategy to effectively tackle these critical challenges in Ethiopia.

Studies have also shown that the impact of watershed management on livelihoods and food security is limited when the emphasis is placed solely on prioritizing natural resources (Chandrudu, 2010). Several studies have demonstrated that to improve food security, needs to go beyond conservation initiatives and consider all aspects of sustainability (Desta et al.,2005; Wani et al.,2008; World Bank, 2008). Additionally, scholarly investigations reveal that complex worldwide environmental concerns, such as land degradation, food insecurity, and climate change, cannot be tackled in isolation and require the implementation of integrated planning approaches (Laurance et al., 2014; UNFCCC, 2015). However, the diverse range of perspectives on watershed management poses a challenge to attaining common goals throughout the planning, implimentaion, monitoring and evaluation phases (Veale, 2010). This limitation underscores the need for planning frameworks that address both natural resource management and socio-economic factors to effectively improve livelihoods and food security (Chandrudu, 2010). According to Nenes and Booher (2015), these frameworks help coordinate efforts, enhance stakeholder communication, and create opportunities for environmental and socioeconomic goals to work together.

1.5.4 The component of integrated watershed management

Effective Integrated Watershed Management (IWM) involves a range of interconnected components essential for sustainable resource management and food security. According to Förch and Schütt (2004) and MoA (2020), IWM encompasses various sectors including human resource development (community development), soil and land management (conservation and utilization), water management

(conservation and utilization), afforestation, pasture development, crop development, livestock management, and rural energy management. These components are intricately linked and influence one another (Denning & Fanzo, 2016; FAO, 2021). Gurjar (2017) further underscore the necessity of a thorough understanding of the various components of a watershed, as this knowledge is essential for creating benefits that extend to both human populations and the natural environment.

In Ethiopia, where agriculture is vital for food security and livelihoods, effective management of land, human, and natural resources within a watershed is essential for achieving sustainable food security (Chisholmand Woldehanna, 2012; Bezu, 2018; Asenso-Okyere, 2013). An awareness and understanding of system dynamics can greatly assist practitioners in designing more effective management strategies by considering the complex impacts and implications of human-nature interrelationships. This holistic approach is crucial for ensuring food security, as it helps to anticipate and address the interdependencies between environmental processes and human activities (Aborisade & Bach, 2014; Denning & Fanzo, 2016; FAO, 2021).

Comprehensive watershed management strategies can mitigate factors contributing to food insecurity, including drought, reduced food production capacity, plant and animal disease outbreaks, poor soil fertility, inadequate infrastructure, crop losses, and natural disasters (MoFED, 2010; Negatu, 2011; Blal, 2016). Joshi et al. (2005), Shiferaw et al. (2008), and Brouwers (2013) underscore that integrated watershed management can address food security by harmonizing technologies, policies, and institutions, which enhances productivity, resource sustainability, and market access, while tackling local food insecurity. Bakala and Asfaw (2020) and Laura et al. (2014) assert that effective watershed management involves key components that collectively enhance agricultural productivity and resilience, thus supporting sustainable food security. Förch and Schütt (2004) noted that watershed management has evolved to address diverse natural and societal components, such as human resource development and agriculture, which often leads to competing interests but supports sustainable economic growth.

Studies show that the implementation of a holistic watershed management approach in the country aims to integrate diverse land management strategies with other resource use practices to enhance environmental sustainability, local well-being, and food security (Desta et al., 2005; Teshome et al., 2016; Gebregziabher et al., 2016). However, this approach faces significant challenges in adoption and effectiveness, especially when assessing its various components in real-world applications (Teklewold et

al., 2013; Kerse, 2017). Sector-based planning approaches, combined with differing stakeholder perspectives, obstruct the multidisciplinary nature of holistic watershed management, making it challenging to achieve multiple objectives simultaneously. These challenges can impede progress in areas such as productivity enhancement, employment generation, income improvement, soil and water conservation, and ecosystem resilience, especially in the context of climate change (Villela et al., 2017). Fragmented management practices can result in the misuse and degradation of natural resources, negatively affecting social, economic, and environmental conditions. This fragmentation can also exacerbate climate change impacts, including increased frequency and severity of extreme weather events like droughts and floods, which further threaten food security (Sterner & Persson, 2007; Bates, 2008; IPCC, 2015).

Shiferaw et al. (2012) and Wang et al. (2016) argue that comprehensive and sustainable watershed management planning must account for various developmental factors and engage all relevant stakeholders. Moreover, successful watershed management is a complex and multifaceted endeavor that requires a holistic planning framework combined with effective collaboration among organizations (Bantider et al 2020). This approach involves setting clear objectives, identifying potential conflicts, and developing strategies that address multiple goals simultaneously. Efficient collaboration ensures that different entities work cohesively, avoid redundancy, and leverage their collective strengths to achieve shared objectives, thereby enhancing the overall effectiveness of their initiatives (Teklewold et al., 2013; Kerse, 2017; Hailemariam et al., 2016). Efficient coordination among different organizations is crucial for improving soil quality, biodiversity, and agricultural productivity, which in turn enhances food accessibility for rural populations (Hailemariam et al., 2016). Effective watershed-based planning seeks to balance environmental, socio-economic, and political goals, which are essential for ensuring food security. Achieving this balance requires addressing current fragmentation and coordination failures among organizations involved in watershed management (Hailemariam et al., 2016). Figure 2 illustrates these interrelationships and their dependencies, highlighting the complexity of managing these elements effectively.

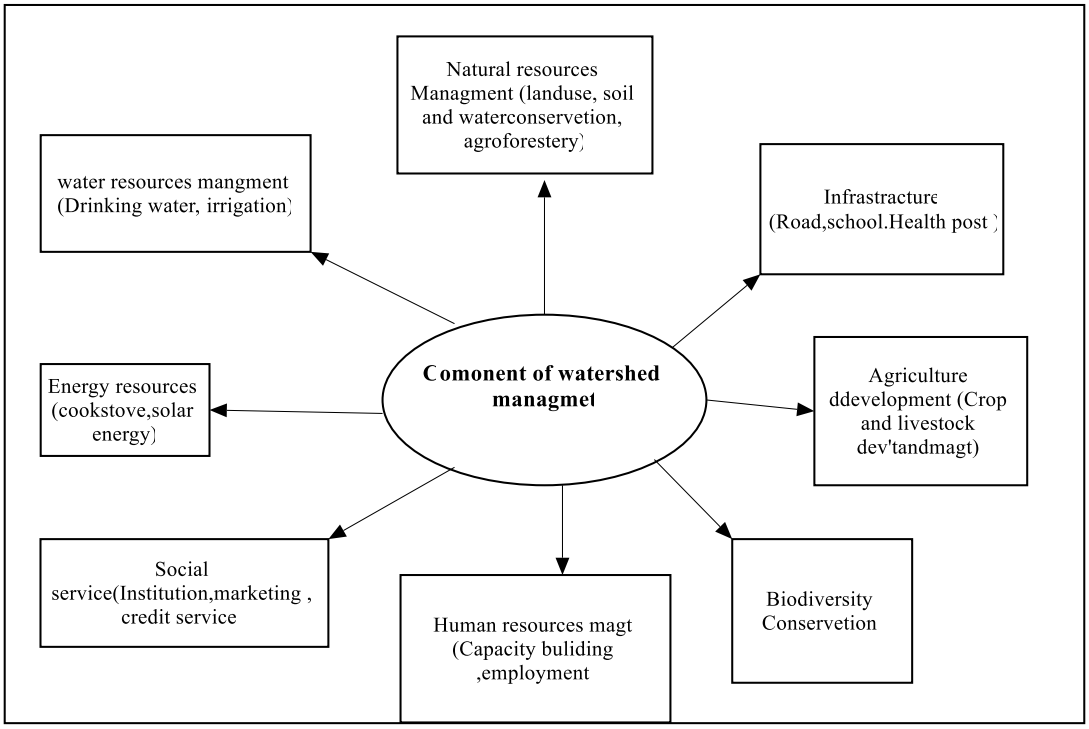

Figure 1: Component of Watershed mangment

1.5.5 Planning Theory

Planning theory provides a fundamental framework for analyzing various aspects of planning, including practices, processes, institutions, and the inherent attributes of plans. In the realm of effective watershed management, the necessity of an integrated approach is particularly clear. As highlighted by Guo (2014), effective watershed management view natural and human systems as interconnected components of a unified entity rather than isolated elements. This holistic approach facilitates a thorough assessment of land use, water resources, and ecological interactions, leading to more effective and integrated management strategies (Guo, 2014; Cohen & Davidson, 2011; Brooks et al.,1994). Studies highlight that successful watershed management incorporates adaptive practices, stakeholder engagement, policy alignment, and resilience prioritization, thereby enhancing both effectiveness and sustainability (Bantider et al., 2020; Teklewold et al., 2013; Kerse, 2018; Hailemariam et al., 2016). Planning theory provides a framework for understanding and managing the complex interactions within watersheds. It promotes a multidisciplinary approach that integrates scientific knowledge with socio-economic considerations to develop effective and sustainable management practices, ultimately aiming to improve the overall well-being of the communities relying on these vital systems (Guo, 2014; Brooks et al., 1994).

Friedmann (1993) and Innes & Booher (2015) emphasize the importance of planning theory in guiding the planning process and addressing specific issues. The integration of knowledge from both social and natural sciences presents significant challenges, which can be approached through various methodologies such as bottom-up versus top-down approaches, objectivity versus advocacy, centralization versus decentralization, comprehensive versus incremental planning, and planning for people versus planning for place (Friedmann, 2008; Tâm et al., 2016; Wilkinson, 2012). By incorporating insights from sociology, geography, economics, and environmental science, planning theory provides a structured approach to managing complex environmental challenges (Friedmann, 2008; Innes & Booher,2015). This reflects a broader trend towards recognizing the interconnectedness of knowledge, context, and stakeholder engagement in developing effective planning strategies (Alexander, 1992; Friedmann, 2003).

The development of planning theory has been profoundly influenced by a range of intellectual movements and practical needs. In the mid-20th century, the field largely focused on positivist and rationalist approaches that emphasized structured methodologies, often neglecting the complex realities of practice (Lane, 2005). Recently, there has been an integration of critiques from postmodern viewpoints as well as ethical considerations, broadening the perspective to encompass communicative rationality and the societal impacts of spatial planning (Healey, 1997). Planning theory can be categorized into explanatory theories, which clarify functional processes, and normative theories, which offer prescriptive frameworks based on specific values (Fainstein & DeFilippis, 2016). Both categories are instrumental in shaping planning methodologies by providing diverse insights into the aims and functions of planning.

Friedmann (1987) identifies four planning traditions: social reform (state-led progress through scientific knowledge), policy analysis (data-driven decision-making), social learning (collaborative knowledge sharing), and social mobilization (grassroots efforts against power dynamics). Critics argue that these traditions often fail to address real-world complexities, leading to alternative participatory methods. Effective watershed management relies heavily on strategic planning principles. Baumann et al. (2013) stress the importance of proper planning for effectively evaluating integrated watershed management approaches. Alexander (1992) defines planning as a rational course of action involving social reform and policy analysis, while Salsano (1987) and Gelfand (1985) stress the importance of the planning system in decision-making. This research applies planning theory, including communicative and

rationalist approaches, to assess how watershed management can improve food security by taking watersheds as planning units (Randhir, 2007; Roth et al., 2016; Wang et al., 2016).

1.5.5.1 Rationalist Planning Theory

The rational planning model emerged as a dominant framework in the mid-20th century, advocating for systematic and objective approaches to decision-making (Fainstein, 2010; Anon, 2014). It is characterized by its reliance on scientific and quantitative data, reflecting a positivist epistemology that values objective knowledge and systematic analysis (Alexander, 1999). Rationalist planners argue that deliberation and inclusion are less efficient compared to a top-down approach guided by expert analysis (Lawrence, 2000). This approach is marked by a strong technical focus, where planners and experts are responsible for formulating recommendations and making decisions (Morgan, 2012). It assumes that interests are predetermined and scientific methods are the most reliable means of achieving public goals (Fainstein, 2010). Typically, rationalist planning employs a top-down approach, with decisions being made at higher levels of authority and implemented throughout various tiers of governance (Lawrence, 2000).

Botes and Van Rensburg (2000) and Nikkhah & Redzuan (2009) identify three major issues when planning is treated merely as a means rather than an end. First, the paternalistic approach inherent in rationalist planning often undervalues community knowledge, as the planning process is dominated by experts (Morgan, 2012). This can lead to a disconnection between planning outcomes and community needs. Second, an excessive focus on reporting successes can obscure critical information that might be necessary for refining intervention strategies. Third, there is a tendency to prioritize "hard" factors, such as material and financial resources, over "soft" factors like community engagement and empowerment, which can restrict the effectiveness of resource management solutions (James, 2007).

Despite its limitations, rationalist principles continue to shape many watershed management planning processes (Schindler, 2017). In practice, watershed management frequently fails to fully incorporate diverse stakeholder input, leading to a lack of comprehensive participation in the planning process (Bewket, 2007; Haregeweyn et al., 2015). Furthermore, the management approach often does not handle multiple tasks concurrently, which can hinder the effectiveness and efficiency of implementation (Gebregziabher et al., 2016). Plans are commonly implemented and revised with minimal holistic monitoring or evaluation, resulting in limited feedback between the planning and implementation

phases(Teshome et al., 2016). Additionally, the involvement of a varied set of stakeholders, each with distinct and sometimes conflicting agendas, adds another layer of complexity to the management process Gebregziabher et al., 2016; Gessesse et al., 2016).

1.5.5.2 Communicative Planning Theory

Communicative planning theory emerged as a response to the limitations of rationalist approaches, emphasizing collaboration, participation, and stakeholder engagement in planning processes (Innes & Booher,2015; Schindler, 2017). This model prioritizes building connections through dialogue and shared experiences (James, 2007; Innes, 1998). It views the planner as a mediator who bridges knowledge and action, enhancing community capacity to meet its objectives (Healey, 1998). While divergent thinking can complicate planning, the focus remains on effective communication and inclusivity (Tâm et al., 2016; Wilkinson, 2012). Communicative theorists advocate for a pragmatic approach to planning, emphasizing the importance of real-world case studies to address issues of distorted communication and to improve the quality of decision-making(Fischler, 2000; Sager, 2017). This theory recognizes that Knowledge is shaped by social contexts and varies across discourse communities (Murray, 2005; Saravanan et al., 2009). It enhances democratic planning by improving dialogue among planners, politicians, citizens, and private sector representatives, aiming to build consensus through collaborative discussion and the "force of better argument" to ensure diverse perspectives and mutual understanding (Mattila, 2019).

Conventional planning frameworks often hinder consensus due to uneven communication and power dynamics, leading to the exclusion of certain participants (Murray,2005). Communicative Planning Theory (CPT) addresses these issues by promoting inclusive dialogue and equitable participation among stakeholders .It encourages interaction among diverse cultural communities to develop shared values and interests, ultimately fostering a consensus that guides planning actions and decisions (Healey, 1998; Sager, 2012). CPT also aims to neutralize power imbalances through deliberative forums, creating a "shared-power-world" where communication is open and honest, allowing all participants to express their views and influence decisions (Healey, 1998; Fischler, 2000). In this ideal environment, discourse is marked by openness, honesty, and a lack of manipulation, providing all participants with equal opportunities to express their views and influence the decision-making process (Saravanan et al., 2009). Consequently, planners are

encouraged to facilitate discussions that promote genuine idea exchange, ensuring that every voice is recognized and considered. This approach offers several benefits: it creates ownership of outcomes, enhances support for implementation, improves communication, promotes mutual learning, and increases the democratisation of decision-making (Healey, 1997).

However, empirical data indicates that watershed management planning in Ethiopia does not fully align with these principles. Instead, it represents a hybrid of communicative planning theory and rationalism. There are efforts to involve various stakeholders in the planning process, such as local communities, government agencies, and other stakeholders. This indicates the recognition of participatory approaches and the need to consider diverse perspectives. On the other hand, the existing approach also shows signs of rationalism, as it relies heavily on technical expertise and scientific analysis. Decision-making processes may be more top-down, with experts and professionals playing a dominant role in shaping the planning, implementation, and monitoring of watershed management (Teresa 2018). This hybrid approach can create a top-down decision-making process that may not fully incorporate community input, potentially resulting in solutions that lack practical relevance This is because watershed management planning requires a high degree of communication and collaboration among stakeholders to build trust, foster cooperation, and promote social equity (Murray,2005).

Further more, integrated watershed management is a cohesive framework where changes in one element impact others (Reed et al.,2016). Successful management strategies must comprehensively address social, economic, political, and biophysical factors influencing the ecological system (Mena & Dana, 2017). Hence, the planning of watershed management requires to follow open dialogue among stakeholders in order for integrating their perspectives into the planning process..

Qi and Altinakar (2011) further elaborate on the concept of watershed management by highlighting its integrative nature, which combines both social and environmental data into the decision-making process. This integration is crucial for developing strategies that are not only environmentally sound but also socially equitable. Swallow et al. (2001) describe watershed management as a complex interplay of art and science, which effectively addresses the intricate relationships among social, economic, and environmental factors. This complexity is acknowledged by researchers such as Brooks et al. (1994) and Kerr et al. (2007), who recognize that successful watershed management requires a nuanced understanding of these interconnections and the ability to navigate them thoughtfully. If integrated

watershed management does not adopt an inclusive approach, the challenges associated with development will likely become increasingly marginalized compared to their current state (MoA, 2020). In this context, collaborative strategies involving diverse stakeholders, including farmers, government agencies, marginalized groups, and local residents, are essential to address community issues (Wani & Garg, 2011; Morgan, 2012).

1.5.6 Coordination Theory

Coordination theory serves as a conceptual framework for enhancing the synchronization of activities and promoting collaboration among various stakeholders. Coordination theory, introduced by Malone and Crowston in 1994, aims to enhance synchronization and collaboration among diverse stakeholders by managing interdependencies among activities. It emphasizes on understanding the reasons for coordination rather than just its outcomes, highlighting its importance in addressing challenges like task interdependencies and aligning efforts with organizational goals (Malone and Crowston,1994). Crowston et al. (2015) stress the need for collective resource utilization and shared decision-making, while Jody (2013) identifies three key elements for effective coordination: common goals, shared understanding, and mutual respect, all supported by timely communication and collaborative problem-solving.

Coordination theory emphasizes the significance of collaboration in addressing complex challenges, as individual efforts often fall short. According to Maloney and Roos (2005), effective problem-solving relies on aligning the contributions of diverse stakeholders, each bringing unique expertise to work towards a shared goal. This concept is especially relevant in fields such as environmental management, food security, and watershed management, where interdependence necessitates coordinated actions. The existing lack of effective collaboration among these disciplines often leads to considerable inefficiencies, delays, and obstacles in achieving their goals (Mohr & Spekman, 1994). This issue is especially evident in watershed management, where diverse stakeholders have conflicting priorities and management styles (Tiwari et al., 2009)

Effective watershed management requires a multidisciplinary approach involving various stakeholders to address economic, social, and environmental challenges (Terefe et al., 2015; Wang et al., 2016). Coordination theory is vital for enhancing this strategy . The success of management efforts relies on the integration of diverse professionals at every stage, from planning to evaluation (Mawhorter, 2010;

Cohen & Davidson, 2011; Berhanu & Belay, 2015; Bantider et al., 2019). However, failures in coordination can create significant obstacles, resulting in fragmented objectives that impede the execution of management plans (Mohr & Spekman, 1994). In the absence of effective coordination, conflicting goals can disrupt consensus and slow the development of cohesive strategies, complicating both decision-making and implementation processes (Anghileri et al., 2013; Koontz & Newig, 2014).

In fact coordination failures may often arise from a range of factors, including cognitive constraints and cultural differences among stakeholders. DiMaggio (1997) highlights that cognitive limitations, such as difficulties in processing complex information and differences in knowledge levels, can impair effective coordination. Bechky (2003) further emphasizes that misunderstandings arising from varying cognitive perspectives contribute to coordination challenges. Additionally, cultural differences between partner organizations, including divergent organizational practices and communication styles, exacerbate these issues (Greenwood, & Hinings, 2000). Tilcsik (2010) points out that such cultural barriers can lead to misalignments in goals and approaches. Effective communication is crucial for the successful coordination of watershed management (Malone & Crowston, 1994). Without it, coordination failures can result in fragmented management strategies where stakeholders pursue individual plans without considering the broader impact on the watershed (FAO, 2017). These disjointed approaches can compromise the overall effectiveness of watershed management efforts, leading to inefficient use of resources and reduced efficacy in addressing environmental challenges (Mohr & Spekman, 1994). Addressing coordination failures through better communication and collaborative approaches is critical for achieving cohesive and effective watershed management.

1.5.7 Effective watershed management as a pathway to improved food security

The concept of food security has evolved from focusing primarily on food supply adequacy to a more nuanced understanding that includes various factors affecting food access, with over 250 definitions highlighting its complexity (Degefa, 2005, Pinstrup, 2009). It is now framed through four core pillars: availability, access, utilization, and stability, emphasizing that everyone has the right to a healthy diet (USDA ,2022). Watershed management principles are closely linked to the four pillars of food security. For instance, effective watershed management can enhance sustainable agricultural practices ,environmental conditions, social equity, and supporting economic stability, all of which are integral to the four pillars of food security (Barrett & Lentz, 2009; Neachell, 2014). It also protects agro-ecosystems, addresses gender issues, and generates social and economic benefits for rural communities.

Pillars of food security

a) Availability: refers to the physical presence of food within a specific area, encompassing national, regional, and household levels. It includes both domestically produced and imported food, ensuring there is a sufficient supply to meet the population's needs (Pangaribowo et al., 2013). The availability of food is critically dependent on a range of natural resources, including land, fresh water, genetic resources, and minerals (UNEP, 2016). Effective management of natural resources and adoption of good agronomic practices, such as intercropping, minimum tillage, and conservetion agriculture are essential for enhancing environmental quality and agricultural productivity (Adimassu et al., 2013; Arfasa & Tona, 2019). Furthermore, the adoption of of high-yield crop varieties, and organizic fertilizer are critical enhance the efficiency and productivity in food production (HLPE., 2016). However, the degradation of watershed resources can lead to reduced water availability, negatively impacting crop yields, fish catches, and livestock production. This deterioration poses significant challenges that could ultimately lead to food shortages(Chimdesa,2016). Therefore, successful and sustainable watershed management is vital to maintaining productivity and ensuring food security (Barrett & Lentz, 2009; Berhanu & Belay, 2015). Addressing these complex challenges necessitates coordinated efforts among individuals, groups, institutions, and organizations (HLPE, 2016).

b) Access: access to food is a multifaceted concept that encompasses the ability of households or individuals to secure sufficient and nutritious food. Access is significantly influenced by a variety of factors, including physical infrastructure, economic conditions, and social dynamics. According to Webb et al. (2006) and FAO (2013), the access ot food is not solely determined by its presence in the market but is also shaped by the ability of individuals to reach and afford it. Ecker and Breisinger (2012) and Abduselam (2017) emphasize that when communities have reliable access to water and improved agricultural practices, they can produce surplus food, which can then be sold in local and regional markets. Kerse(2017) also argued that effective watershed management is key to developing essential infrastructure, like roads and irrigation systems, which significantly improves the livelihoods of marginalized populations reliant on natural resources. In addition the MoA (2020) highlights that improved rural infrastructure boosts market access for smallholder farmers, particularly benefiting marginalized groups who face barriers due to poor infrastructure. The watershed management strategy also empowers individuals, promotes economic development, reduces gender disparities, ensures equitable resource access, and enhances food security(Saravanan et al., 2009; Chimdesa, 2016; Katusiime & Schütt, 2023).

c) Utilization refers to the effective application of food resources to meet dietary needs and ensure optimal nutritional health. This multifaceted concept encompasses a range of elements, including the preparation, storage, and consumption of food (HLPE, 2016). Integrated watershed management (IWM) is crucial for enhancing food utilization by promoting sustainable agricultural practices and ensuring access to clean water, which is necessary for food preparation and sanitation, ultimately contributing to public health (Degefa, 2005; Nerkar et al., 2015). Additionally, effective natural resource management enhances soil health, boosts crop yields, and improves the nutritional quality of food, leading to better dietary quality and overall food utilization (Barrett, 2010). Further, studies confirm that integrated watershed management is crucial for reducing dependence on a single food source and promotes diversification, leading to the cultivation of a variety of fruits and vegetables and improved nutritional intake (Joshi et al. 2005; Nerkar et al., 2015; HLPE, 2016). It also advances the improvement of the livestock sector, which is crucial for providing animal-sourced foods such as meat, milk, and eggs. These foods are rich in essential micronutrients like iron, vitamin A, iodine, and zinc, contributing significantly to optimal nutrition (HLPE, 2016) addressing the sustainability challenges facing agriculture and income,and decreasing the vulnerability of communities to economic fluctuations and climate variability. However, there is a notable lack of focus on the potential benefits of integrated watershed management for enhancing food utilization.

d) Stability, the fourth element of food security, ensures reliable access to nutritious food over time despite economic disruptions, natural disasters, or political unrest (USAID, 2011). Comprehensive watershed management plays a crucial role in enhancing the sustainability dimension of food security by ensuring efficient resource use, promoting soil and water conservation, mitigating environmental risks, and engaging local communities (World Bank, 2008; Yaebiyo et al., 2025; UNEP, 2016). It involves practices such as agroforestry and sustainable farming methods that help maintain land productivity and prevent overexploitation of resources. By implementing advanced irrigation systems and conservation practices, watershed management secures a reliable water supply, which supports consistent crop yields. Additionally, it protects ecosystems, supporting biodiversity and resilience against pests, diseases, and climate changes (Roth et al., 2016). Engaging local communities in management decisions and fostering economic opportunities further enhances the sustainability of food systems by aligning practices with local needs and capacities (Förch and Schütt, 2004). This holistic approach not only creates a stable and enduring food system but also ensures

resilience to environmental and economic challenges by protecting and restoring ecosystems (FAO, 2021; Roth et al., 2016).

1.5.8 Conceptual framework of study

Watershed management is recognized as an effective strategy for rural development, aiming to enhance food security and livelihoods while preserving environmental resources (Brooks & Eckman, 1994; Joshi et al., 2005; Wani & Garg, 2008). To evaluate its effectiveness, frameworks such as DPSIR (Driving Forces, Pressures, State, Impacts, and Responses), PSR (Pressure-State-Response), and SWM (Sustainable Watershed Management) are employed. The DPSIR framework analyzes cause-effect relationships but tends to oversimplify interactions and neglect feedback loops, which are crucial for understanding the dynamic nature of watersheds(Asbjornsen et al., 2015). Meanwhile, the PSR framework focuses on environmental pressures and responses but often overlooks important social and economic aspects, which are essential for a holistic understanding of sustainability challenges (Hazbavi et al., 2020). The SWM framework offers a more comprehensive approach by integrating environmental, social, and economic factors. It addresses the limitations of both DPSIR and PSR frameworks by emphasizing the interconnectedness of watershed components and balancing stakeholder needs with ecosystem preservation (Vishnudas, 2007, 2008).

The SWM framework emphasizes the complexity of watershed systems, where biophysical, socio-economic, and environmental factors are interconnected. Changes in one area, like land use, can impact water quality and local livelihoods, necessitating a comprehensive management approach (Vishnudas, 2008). Effective watershed management requires integrating ecological, social, and economic perspectives, analyzing connections between factors such as water quality, soil erosion, community livelihoods, and resource use (Campos et al., 2012; Laura et al., 2014). Additionally, understanding the interactions among ecological processes, human activities, and economic factors is crucial for successful management, particularly regarding the impacts of agricultural practices and infrastructure development on local communities (Sulistyaningsih et al., 2021; Roth et al., 2016; Wang et al., 2016).

The Sustainable Watershed Management (SWM) framework also highlights the need to reform governance structures within watersheds by utilizing collaborative, adaptive, and outcome-oriented approaches that address technical, organizational, and political aspects (Mollinga, 2007; Mawhorter, 2010). Cohen & Davidson (2011) further stresses the significance of governance reform in creating

multi-sectoral coordination frameworks essential for achieving sustainable watershed management and enhancing food security. Moreover, the International Institute for Environment and Development (IIED, 2000) argues that effective watershed development relies on aligning local planning with governance reforms to produce meaningful outcomes. A thorough understanding of the social context—including the demographics, skills, and social dynamics of agricultural households—is crucial for integrating ecological and socio-cultural factors into effective management strategies (Imperial, 2004).

The research employs the Sustainable Watershed Management (SWM) framework as a holistic tool for evaluating watershed management practices. This framework provides a broad perspective on sustainability, encompassing environmental, social, and economic aspects (Vishnudas, 2008), and includes governance reforms that prioritize integrated, collaborative and outcome-oriented management approaches (Mawhorter, 2010). Consequently, the study developed a conceptual framework which will be verified and tested during the research (see Figure 2) illustrating how the interaction among biophysical, institutional, and socio-economic factors can bolster food security and enhance the capital assets of rural communities through effective watershed management.

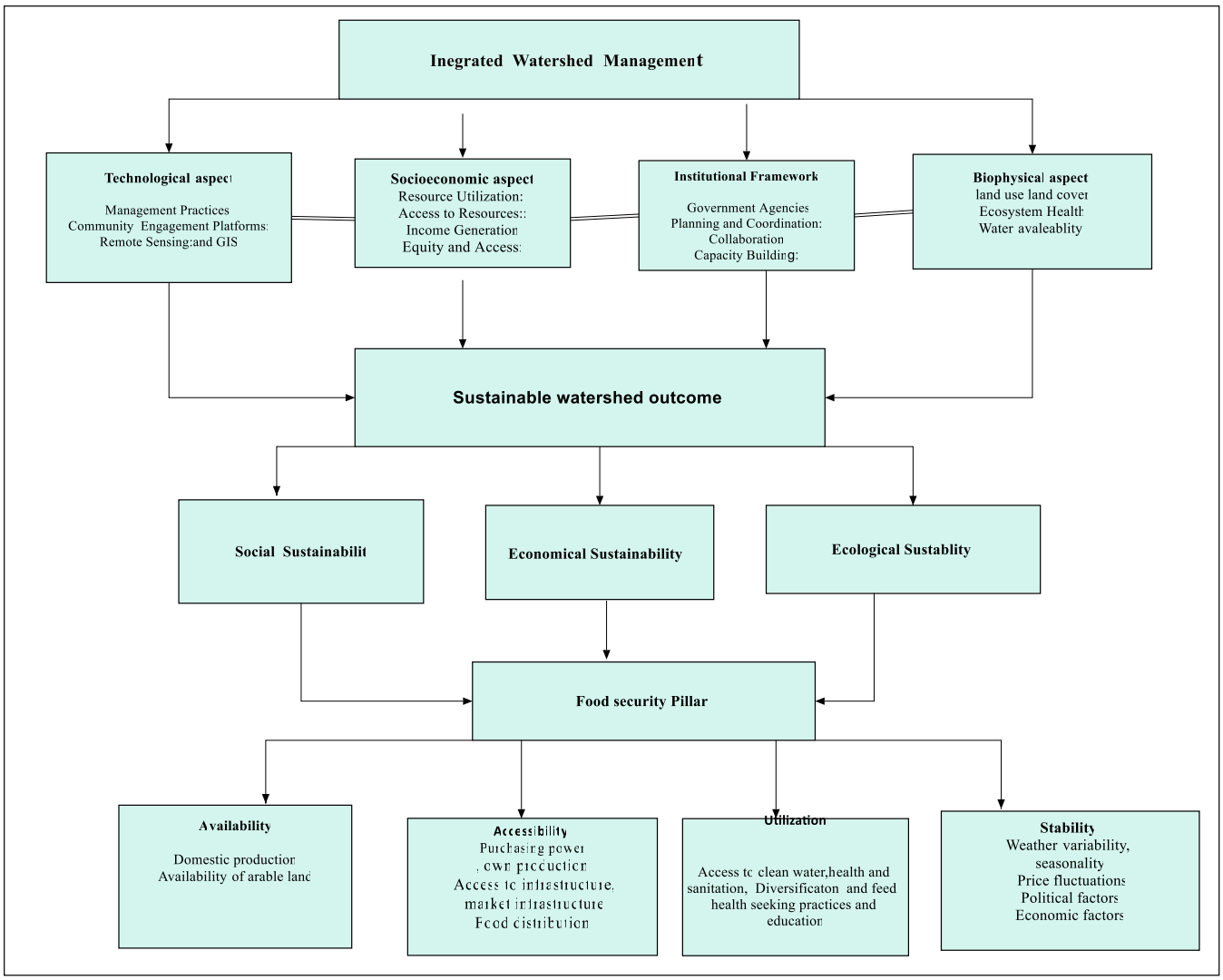

Figure 2: Conceptual framework of the study modified from Vishnudas, (2006) and Mawhorter, (2010) and from experience

1.6 Research Methodology

This section outlines the research methodology, starting with a description of the study area and the specific watershed under investigation. It outlines the research philosophy, design, and data types and sources. The methodology includes data gathering methods, such as surveys and interviews, and explains sampling techniques and procedures for selecting participants. It also covers how data was presented and analyzed, using statistical or thematic approaches. Finally, it addresses ethical considerations, including consent and confidentiality, to ensure a rigorous and ethical research process..

1.6.1 *Description of study area*

The research was conducted in Qarsa District, East Hararghe Zone, Oromia region, Ethiopia. Qarsa District is located at 478 kilometers east of Addis Ababa and 42 kilometers west of Harar Town, which serves as the capital city for both the East Hararghe Zone and Harari Regional State. Geographically, the district is positioned between 9^0 17' to 9^0 29'N and 41^0 12' to 41^0 56' E. The woreda is categorized as one of the food insecure woredas in the East Hararghe Zone. The rural community heavily relies on land resources for food cultivation, energy provision, shelter construction, and other purposes. However, the growing human and animal populations are putting strain on the ecosystem, leading to land degradation such as loss of biodiversity, soil erosion, and deforestation. As a result, the problem of food insecurity is worsened. This study focused on three micro watersheds implemented under different program approaches including Free Mass Mobilization, Sustainable Land Management Program II, and the Productive Safety Net Public Work which are adjacent to each other (Figure 3)

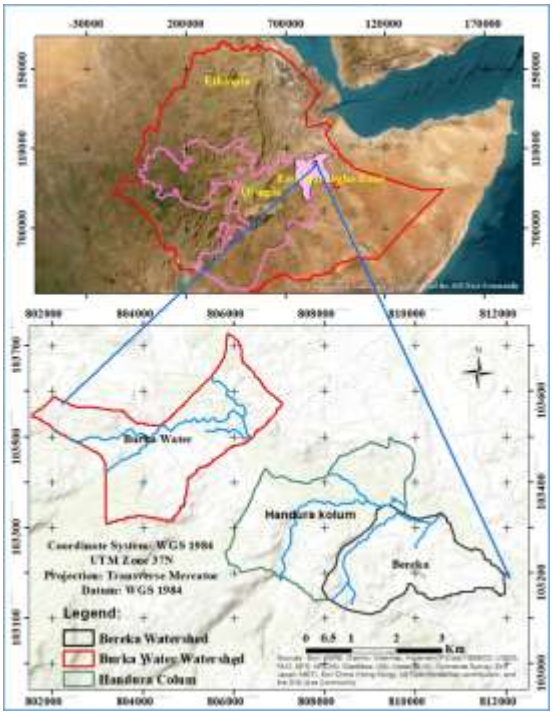

Figure 3: Location map of the Study Area

Demographic Characteristics

Qarsaa Woreda is characterized by a rich tapestry of demographic diversity, with a population estimated at approximately 246,071 individuals. This population is composed of 121,805 males and 124,266

females, reflecting a relatively balanced gender distribution. A notable feature of this demographic landscape is the significant proportion of individuals under the age of 30, which presents both opportunities and challenges for the woreda. This youthful demographic can drive economic growth and innovation, but it also necessitates a robust focus on education, employment opportunities, and healthcare services to meet their needs effectively. The Oromo ethnic group is the predominant demographic in Qarsaa Woreda, contributing to the cultural richness of the area. Afaan Oromoo serves as the primary language spoken by the majority of the population, fostering a strong sense of community and cultural identity. The religious landscape is predominantly Islamic, with Islam being the principal faith practiced by the majority of residents. However, there is also a presence of Christians and individuals who adhere to traditional beliefs, adding to the cultural and religious diversity of the woreda. (Sources Qarsa Woreda Administrative office 2022 Report).

Economic Activity

Agriculture is the primary economic activity for rural residents, who practice mixed crop-livestock production systems at a subsistence level. Most farmers rely on rain-fed agriculture, as opposed to irrigation, due to limited access to water resources. They cultivate staple crops such as maize (*Zea mays L.*) and sorghum (*Sorghum bicolor*), which form the dietary foundation for these communities. Maize and sorghum are crucial for food security, providing essential nutrients and caloric intake. Additionally, farmers grow cash crops like khat (*Catha edulis*) and coffee (*Coffea arabica*), which are sold in local and regional markets to generate income. Khat, in particular, holds significant cultural and economic value, while coffee remains a major export commodity. Vegetable cultivation is another important aspect of rural agriculture. Vegetables serve dual purposes: they contribute to household food security by providing essential vitamins and minerals, and they offer additional income when sold in local markets. This diversification of crops helps stabilize income and nutrition for farming families.

The livestock sector is integral to the rural economy, with cattle, sheep, goats, and donkeys being the primary livestock types. Cattle are especially important as they are a key source of income, either through the sale of meat, milk, or as draught animals. Livestock also plays a critical role in household resilience by providing a buffer against economic shocks and fluctuations in crop yields. They contribute to food security by supplying meat and dairy products and can be used for trade or sale to generate cash in times of need. In addition to agriculture and livestock, rural residents engage in petty trade, which includes small-scale commerce and local crafts. Daily labor opportunities, such as casual

work on farms or construction projects, also provide essential income. Food aid programs, including public work schemes and direct support, offer additional assistance to those in need, helping to bridge gaps in food availability and support the livelihoods of the most vulnerable populations. While the integration of crop cultivation, livestock rearing, and supplementary income sources fosters a diverse and resilient rural economy, several challenges can undermine productivity and livelihoods. Land degradation, driven by unsustainable agricultural practices and deforestation, reduces soil fertility and agricultural output. Limited access to resources, such as water and modern farming technologies, further hampers productivity and exacerbates food insecurity.

Climate

Based on 20 years of meteorological data (2001–2020) from the Ethiopian National Meteorology. Agency, Qarsa Woreda experiences an average annual rainfall of 1,225 mm. This substantial amount of rainfall supports the region's agricultural and environmental needs (Figure 4). The climate is characterized by a bimodal rainfall pattern, which includes two distinct periods of precipitation each year. The small rainy season, known as Belg (Arfasa), occurs from March to May. This period provides essential moisture for the initial stages of crop growth and is crucial for early agricultural activities. However, the distribution of rainfall during this season can be erratic, leading to variability in the amount of precipitation received. The main rainy season, Kiremt (Gana), spans from June to September. This is when the majority of the annual rainfall occurs, making it the most critical period for sustaining crops and replenishing water sources. The Kiremt season generally offers more consistent and reliable rainfall compared to the Belg season, which is beneficial for agricultural productivity and water resource management. From October to February, Qarsa Woreda experiences a dry season with minimal precipitation. This period can present challenges for agriculture and water availability, requiring effective management strategies to cope with reduced moisture levels. During this time, maintaining soil moisture and ensuring adequate water supplies become crucial for sustaining agricultural activities and supporting local livelihoods. Understanding these climatic conditions is essential for effective agricultural planning, water resource management, and environmental conservation in Qarsa Woreda. The bimodal rainfall pattern, combined with temperature variations and the dry season, necessitates careful planning and management to optimize agricultural outcomes and ensure sustainable resource use in the region.

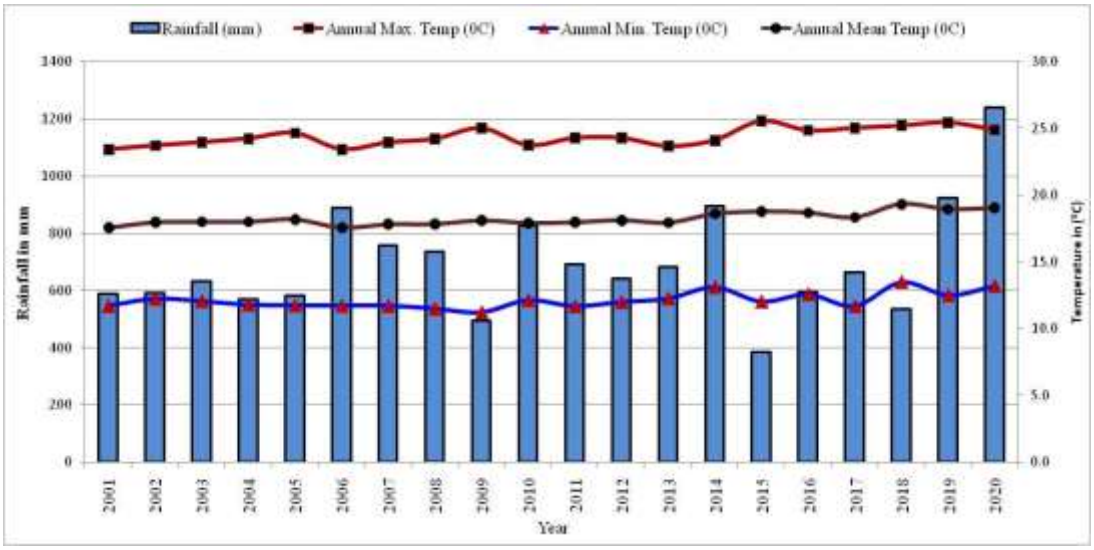

Figure 4 : Seoasonal rain fall for 2000-2020 Qarsaa Woreda

Land use land cover

According to the District Agriculture and Natural Resources Office (2021), the district encompasses a total area of 54,494 hectares. Of this, 28.5% is arable or cultivable, 2.3% is allocated for pasture, and 6.2% is covered by forest. The remaining 56.3% of the land is designated as built-up, degraded, or otherwise unusable The average landholding per household is approximately 0.6 hectares(Qarsa agricultural office report, 2021). The rural population's livelihood is closely tied to the effective utilization of land resources, which are critical for food production, energy, and shelter. However, the mismanagement of these resources has led to significant challenges. Traditional land cultivation practices have resulted in the removal of productive topsoil, leading to decreased land productivity. This decline has both economic and environmental repercussions. Additionally, the high demand for wood for construction and fuel has accelerated resource depletion. The imbalance between natural regeneration and resource extraction has exacerbated land degradation, putting additional strain on household livelihoods. Addressing these issues requires sustainable land management practices to restore soil health, reduce deforestation, and improve the overall productivity and sustainability of land use in the district.

1.6.2 *Describition of the study micro watersheds*

This study examines three distinct watershed management programs applied to adjacent micro watersheds, each with unique methodologies and funding mechanisms. The programs under evaluation are Free Mass Mobilization, Sustainable Land Management Program II (SLMP II), and Productive Safety Net Public Work (PSNP-PW) (see Figure 3**).** Free Mass Mobilization represents a government-led initiative without external financial backing. This program relies on local community engagement and mobilization to implement watershed management practices. It emphasizes grassroots involvement and the utilization of local resources to address environmental and agricultural challenges. The program aims to improve food security and reduce poverty by leveraging community participation, despite the constraints of limited financial support**.**

Sustainable Land Management Program II (SLMP II), initiated in 2008 and funded by the World Bank, operates within a comprehensive framework of community-based watershed development. This program integrates a range of interventions including soil and water management, agro-forestry, area closure development, and soil fertility enhancement. SLMP II also focuses on livestock development and institutional strengthening. The program is designed to address environmental degradation and enhance agricultural productivity through a holistic and participatory approach, incorporating various sustainable land management practices. Productive Safety Net Program (PSNP-PW**),** started in 2005 and also funded by the World Bank, centers on public work activities aimed at natural resource conservation and rural infrastructure development. PSNP-PW's interventions include forestry, agro-forestry, gully control, and the establishment of small-scale irrigation systems. The program also invests in infrastructure such as rural roads, schools, and health facilities. By promoting collaborative efforts between the government and local communities, PSNP-PW seeks to improve food security and support rural livelihoods through a combination of environmental and developmental investments. The selection of these three programs is based on their long-standing implementation history and ongoing importance in promoting effective watershed management and enhancing food security. The description and characteristics of each selected watershed are detailed in Table 1.

Despite their proximity and adherence to similar watershed management guidelines, each watershed shows distinct variations in program design, funding sources, and levels of community engagement. These differences influence how well strategies are adopted and sustained. A comparative study of these

micro watersheds can reveal the effectiveness of various approaches, highlighting successful strategies for improving food security and reducing poverty.

1.6.3 *Rationale for Selecting East Hararghe Zone and the Study Area*

East Hararghe Zone was selected for this study due to its long history of watershed management practices and the critical need for evaluating their effectiveness. Over the years, significant efforts have been made in this region to combat environmental degradation through various watershed management interventions. These efforts include the establishment of terraces, soil bunds, and the planting of millions of tree seedlings aimed at reversing land degradation and enhancing soil fertility. Despite these substantial investments, the zone continues to face severe environmental and agricultural challenges.

The district is marked by persistent issues such as land degradation, soil erosion, loss of vegetation, and a decline in soil fertility. These problems are exacerbated by water stress, frequent rainfall failures, and chronic food and nutrition insecurity. A notable example of environmental decline in the region is Lake Haramaya, which was once renowned as one of Ethiopia's beautiful and famous lakes but has now deteriorated significantly due to the effects of degradation in its watershed.

Additionally, there is a lack of comprehensive documentation on the effectiveness of watershed management activities and a detailed examination of the factors influencing these practices in the area. Given these issues, Qersa District was purposively selected for this study. The district is representative of the broader challenges faced in East Hararghe Zone and features a variety of sustainable land management projects, including government-led regular activities through voluntary mass mobilization, the Sustainable Land Management Project (SLMP) funded by external sources, and the Productive Safety Net Program (PSNP) Public Work interventions. The combination of these diverse management approaches in Qersa District provides a unique opportunity to assess their relative effectiveness and impact on watershed management. By focusing on Qersa District, this study aims to contribute valuable insights into the successes and limitations of different watershed management strategies and to identify key factors affecting their implementation.

Table 1: List of study micro watershed

N o	Name of micro watershed	Implemented by	Agro Ecology	Altitude	Soil type	Area in Ha	Population	
							HH	Sample size
1	Andhura Kosum	Free Mass Mobilization	H/L	2000-2700	Luvisols, Lithosols, Cambisols	759.5	734	112
2	Baraka	PNSP	H/L	1900-2700	Luvisols, Lithosols, Cambisols	565.7	639	107
3	Burqa Watar	SLMP	H/L	2100-2700	Luvisols, Lithosols, Cambisols	853.1	765	118
						2178	**2138**	**337**

H/L= Midland

1.6.4 *Methodological philosophy of the study*

The philosophical foundations of methodology, particularly ontology (the nature of reality) and epistemology (the nature of knowledge), are crucial for developing research methods and guiding study execution and interpretation (Al-Ababneh, 2020). Researchers must base their work on these concepts, as they significantly impact theoretical frameworks and methodological choices (Jackson, 2016). Ontology, the study of the nature of reality and existence, involves exploring what entities exist in the world and how they can be categorized (Wasik, 2016). This exploration is crucial because it determines the researcher's underlying assumptions about the nature of the subject matter and influences how they conceptualize and investigate phenomena. This ontological perspective significantly influences the selection of research methodologies: an objectivist ontology typically aligns with a positivist approach, characterized by systematic methods, hypothesis testing, and quantitative metrics aimed at revealing objective truths (Carson, 2001). In contrast, a subjectivist ontology posits that reality is socially constructed and varies across contexts, leading researchers to employ interpretivist methodologies, such as qualitative interviews and case studies, to investigate meanings that are contextually relevant (Scotland, 2012).

Epistemology explores the relationship between researchers and the reality they study, focusing on how knowledge is created, validated, and shared It raises important questions about the nature, validation, and acquisition of knowledge (Carson 2001; Wasik, 2016). Key paradigms include objectivism, which views knowledge as independent of perception; constructionism, which sees knowledge as created through interaction; and subjectivism, which posits that meaning is individually constructed (Saunders,

2009). Understanding these paradigms is essential for researchers, as they shape methodological choices and interpretations of results. The two pillars shape a researcher's methodology and theoretical framework, combining positivist views that emphasize deductive reasoning and quantitative techniques with interpretive views that prioritize inductive reasoning and qualitative research for deeper insights (Scotland, 2012).

In watershed management research, the interplay of ontology and epistemology influences methodological choices. An objectivist ontology views watersheds as quantifiable entities, leading to quantitative methods, while a subjectivist ontology sees them as social constructs, favoring qualitative approaches. Epistemologically, a positivist approach emphasizes objective measurement, whereas an interpretivist perspective values subjective interpretation.This study adopts a pragmatic stance, integrating both quantitative and qualitative methods to address the complexities of watershed management, acknowledging that knowledge and reality are shaped by practical and social factors.

According to Baker & Schaltegger (2015), pragmatism focused on the practical application of knowledge and create both theoretically sound and applicable to real-world settings. Biesta (2010) explains that a pragmatic approach integrates different perspectives and viewpoints, allowing for a more holistic analysis of the various components that contribute to the subject matter. This means that the research did not limit itself to a single theoretical framework or methodological approach, but rather drew on multiple sources of knowledge. Through the utilization of both quantitative and qualitative methods, it offers a comprehensive and detailed understanding of the subject matter (Morgan, 2014). This approach prioritized practical results and real-life implications, using empirical data and multiple perspectives to fully comprehend the phenomenon.

Integrated watershed management involves the management of various interconnected components. These components are influenced by a wide range of factors including physical, biological, social, and economic aspects. This pragmatic research philosophy facilitated a thorough and detailed examination of the watershed phenomenon, taking into account not just the scientific and environmental aspects but also the social, economic, and cultural factors. Therefore, it is essential to adopt a mixed-methods approach in order to fully understand and addressthe complex and diverse characteristics of integrated watershed management. A mixed-methods research approach, enable researchers to leverage the strengths of both qualitative and quantitative methods while overcoming their respective limitations

(Scotland, 2012). In fact, qualitative and quantitative researchers have different views on reality. Eyisi (2016) argues that qualitative and quantitative research differ in their epistemological and ontological foundations, which shape their approaches to understanding reality and the assumptions about its nature.

Qualitative researchers believe in constructivism, recognizing the subjective nature of reality and the impact of social and cultural factors on knowledge. In contrast, quantitative researchers take an objectivist stance, believing in an objective reality that can be measured and understood through empirical observation and statistical analysis(Creswell, 2009). Positivists view the world as external and assert that there exists a single objective reality for any research phenomenon or situation, irrespective of the researcher's perspective or belief (Eyisi,2016). Consequently, they adopt a controlled and structured approach to research by defining a clear research topic, formulating appropriate hypotheses, and selecting a suitable research methodology (Carson, 2001). On the other hand, interpretive researchers challenge the positivist notion of reality and argue that reality is socially constructed by individuals and can be subjectively understood and altered (Shidur, 2016). In some cases, a qualitative approach may be more appropriate, while in others, a quantitative approach may be more suitable.

However, Johnson and Christensen (2012) identified that many researchers recognize the value of both approaches and advocate for a more integrative that combines elements of both positivism and interpretivism. According to Creswell (2010), both qualitative and quantitative methods are subjective and seen as representing different ends of a continuum. For the complex and multifaceted nature of research including integrated watershed management, a mixed-methods approach is appropriate rather than an attempt to confine within one approach to enable a comprehensive understanding of the issues under consideration. Cresswell (2010) also showed that the use of mixed methods provides a better understanding than either approach alone. Furthermore, human behavior concerning resource use is too complex to be captured in a single methodology. Pragmatists argue that a combination of quantitative and qualitative methods can provide a more comprehensive understanding of complex social phenomena(Collins et al., 2006; Bowling, 2009).

Morgan (2014) also suggests that by combining the mixed-methods approach with pragmatism, researchers can effectively incorporate both qualitative and quantitative methods to gain a comprehensive understanding of a research topic. This approach is particularly suitable for integrated watershed management (IWM), which involves complex issues across different sectors and intersecting

social and environmental concerns. A pragmatic multi-disciplinary approach is well-suited for IWM as it emphasizes the practical implications and real-world applications of research. By using a mixed approach, researchers have the flexibility to utilize all available tools instead of being limited to a specific set of approaches. Therefore, a pragmatic multi-disciplinary approach is ideal for studying the social, economic, and environmental aspects of watershed management, which is the main focus of the study.

1.6.5 *Study design*

The study design employed in this research was survey and case study method, which involved the collection of both qualitative and quantitative data. According to Tellis (1997), the case study method is particularly useful when the event being studied has already occurred and the researcher has no control over the variables during the event. Yin (2006) further explains that the case study method allows for an in-depth exploration of a specific phenomenon within its real-life context. This design was chosen to provide a detailed understanding of how integrated watershed management was being practiced in specific cases. By examining multiple cases, the researchers were able to identify patterns, trends, and commonalities, which contributed to a more robust and comprehensive application of watershed mangment practice.

Different methods were employed to gather qualitative data, such as interviews, observations, and document analysis. Key stakeholders, including individuals involved in watershed management, field experts, and relevant authorities, were interviewed to gain a deeper understanding of their experiences and perspectives. Observations were also carried out to collect data on the practical application of watershed management practices. This approach yielded valuable contextual information and improved the overall comprehension of the research subject.

Quantitative data was collected through the use of household surveys and field data collection methods. Additionally, satellite images were utilized to analyze the patterns of land use and land cover in the designated study area. To enhance the accuracy of the satellite images, ground data was acquired using GPS. Through the integration of data from these sources, a thorough comprehension of the land use patterns within the study area was attained. In addition to primary data collection methods, secondary data sources were also utilized. Policy documents, journal articles, reports, watershed planning documents, previous studies, and meeting minutes were gathered to supplement the primary data. These

secondary sources provided valuable context, background information, and insights into the study area, contributing to a more comprehensive analysis.

1.6.6 *Data requirements, sources, and methods of collection*

To achieve the goals of the study, a combination of primary and secondary data was utilized. The primary data was obtained through a field survey using closed and open-ended questions. The secondary data, such as climatic data for the period 2000–2020, were obtained from the National Meteorological Agency and satellite imagery, and information on previous conservation initiatives was acquired from relevant websites and reports. The surveys were designed to obtain detailed information from the head of the household for both types of analysis. To adapt the instruments to local conditions, the relevance of the question was pretested on 12 randomly selected individuals (four from each sub-watershed) who were not part of the sampled households. Given the responses received, adjustments were made to pertinent issues, including the coverage of the interview schedule and the arrangement and wording of the questions. Then, primary data were gathered through personal interviews with a sample of household heads using the pretested semistructured interview schedule. The study collected information on the background of the watershed, including the socio-economic and demographic characteristics of the households. It also examined institutional aspects. The study also looked at community participation at different stages of watershed management practices, and indicators of these issues were analyzed. The questionnaire was translated into the local language of the study area to ensure clear comprehension by both enumerators and respondents.

In addition to data collected from household surveys, focus group discussions (each comprising 7–12 participants) were selected purposefully as they were expected to be experienced and knowledgeable about the issues under investigation. Accordingly, 5 FGDs were conducted, one at each micro watershed level (kebele level), one at the district level, and one at the zone level based on the prepared checklists. Interviews with 15 key informants were also used to capture data from them on a one-on-one basis. Accordingly, interviews were conducted with higher officials, senior experts, subject matter specialists (SMS), supervisors, DAs, and kebele administrations from different sectors at various levels (from federal up to kebele level). They were selected based on their engagement in watershed management, their expertise, and their current roles within their respective organizations.

Furthermore, survey and interviews conducted with 63 professionals from different sectors and at various levels. These interviews allowed for a deeper exploration of the research topic by engaging with individuals who had expertise and experience in relevant fields. The insights gained from these interviews provided valuable qualitative data that complemented the quantitative findings. Consequently, a total of nine (9) respondents were selected from the federal level of different sectors: 14 from the regional level, 13 from the zonal level, 14 from the woreda level, and 13 from the kebel level. The researcher also used guided transect-field-walk observations, allowing participants to discuss while walking. This approach helped address uncertainties and unfamiliarities. The walks were done with development agents and knowledgeable elders, who willingly provided evidence-based responses about the local watershed management practice***s***

1.6.7 *Sampling technique and sample size*

This study used a three-stage random sampling technique to select the micro watershed and household heads. The woreda was purposively selected due to the presence of Free Mass Mobilization, Sustainable Land Management Program II, and Productive Safety Net Program in the woreda. The selection of smaple micro watersheds were based on specific set of criteria such as the historical similarity before and after watershed management interventions, similar land use systems and soil and water conservation practices used, and sites within adjusting to each other. Accordingly, one micro watershed from each program approach was selected. For the household selection, the list total household heads were obtained from the kebele administration and development agents for the three micro watersheds (see Table 1). The sample size of respondent was then determined using Kontir's (2004) sample size determination equation as indicated here under

$$S = \frac{Z^2 * P * (1-P)}{C2} \text{ ----------(-1)} \qquad \text{Equation 1}$$

Where: Z = Z-value (1.96) for 95 confidence level

P = is the percentage picking a choice, expressed as a decimal (0.5)

C = is the confidence interval expressed as a decimal (0.05 = ±0.05)

Subsequently, the actual sample size for the study area was determined as:

Where: SSkp = is the sample size for the known population size = is the sample size for the unknown population calculated using P_k = is the known population size from which the sample size is

calculate Accordingly 118 (35%) from Baraka, 107 (31.8%) from Burka Watter, and 112 (33.2) from Adhura Kosum were selected (Table1).

1.6.8 *Methods of data analysis*

The research employed SPSS version 26 and Stata version 14 statistical softwares, and Arc GIS 10.3 software to carry out data entry and processing. These software programs offered the necessary tools and functionalities for data entry, management, analysis, and visualization, ensuring the accuracy, efficiency, and reliability of the research findings. Descriptive statistics were employed to summarize the demographic, socio-economic, and institutional characteristics of the data. This approach involved the calculation of percentages, means, chi-square values, and cross-tabulations to offer a thorough overview of the variables being examined.

To assess the extent of farmers' involvement in watershed management across various stages, a people participation index was applied, alongside a binary logistic regression model to analyze the factors affecting farmer engagement in watershed management. This model facilitated the exploration of the connections between multiple independent variables and the probability of farmers engaging in watershed management initiatives. In addition to quantitative analysis, qualitative data was collected through focus groups, key informant interviews, and repeated firsthand observations to validate the findings. This qualitative information provided valuable insights and contextual understanding that enhanced the results obtained from the household survey. The qualitative data was carefully analyzed, interpreted, and generalized to ensure its relevance and reliability in supporting the research outcomes.

1.7 Limitations and scope of the research

This research examined watershed management practices at the micro level, focusing on the Qarsa District of Oromia National Regional State, Ethiopia. The assessment of the watershed management approach on food security improvement is limited to three micro watersheds in three rural kebeles. Several factors have also impeded the data collection process of the research activity, impeding its anticipated contribution. Notably, the primary obstacle has been the absence of peace and stability in the country. As with any research endeavor, the extent and limitations of this investigation facilitate a deeper comprehension of specific matters, while leaving other significant inquiries unexamined or unresolved. However, it is important to acknowledge that the findings and recommendations derived

from this study might be extended to other areas with similar agro-ecological zone and socioeconomic settings with a certain level of adjustment.

1.8 Significance of the Study

This study contributes to the growing body of knowledge focused on improving our understanding of watershed management by providing a practical tool for evaluating and improving management practices. The research provides a viable method for creating a stronger connection between the watershed management component and the results by using indicators as a way of evaluation. Effective management of watersheds is essential for safeguarding resources, minimizing misuse, and decreasing climate change. Ultimately, this study contributes to the broader goal of achieving sustainable watershed management by enhancing our understanding of the complex dynamics at play and providing a practical tool for evaluating and improving management practices. To ensure the long-term viability of watershed management, it is imperative to employ robust and easily navigable tools. Therefore, this study will help in filling the existing knowledge gap of the concerned topic and will contribute to the community of local people and regional development actors to think of the importance of the watershed management approach to enhance the food security and livelihoods of the rural communities. The study will enhance knowledge on watershed management, bridge the gap between theory and practice, and provide data for stakeholders, academics, policymakers, and organizations to develop sustainable practices. It will also serve as background knowledge for similar research projects.

1.9 Ethical Considerations

Ethical considerations are of paramount importance in research methodology as it ensures that the research is conducted in an ethical and responsible manner. The researcheres followed the necessary protocols regarding ethical considerations that are crucial for researchers to address. In their pursuit of knowledge, researchers ensure that they give proper credit to the work of others and avoid presenting someone else's ideas or findings as their own and they were properly cited the work of others to demonstrating academic integrity and respect for their peers' contributions. Additionally, the researchers followed appropriate study design, data collection methods, and valid analysis techniques to obtain significant findings.

The researcher followed appropriate protocols to obtain authorization from government officials and community leaders before conducting the study in specific villages. They avoided creating any

misleading perceptions about their identity or the nature of the research. During the data collection phase, the researcher placed a strong emphasis on ethical considerations, ensuring the protection of the well-being, credibility, confidentiality, and informed consent of the individuals who generously provided information. To safeguard the identities of the participants, the researcher implemented stringent measures to maintain confidentiality, ensuring that their personal information would not be disclosed or linked to the data they provided. Moreover, the researcher went to great lengths to obtain informed consent from the participants. Prior to conducting interviews and discussions, the researcher took the time to explain the purpose of the study, the potential risks and benefits involved, and the voluntary nature of participation. Respecting the autonomy and privacy of the participants, the researcher ensured that their consent was obtained in a respectful and non-coercive manner. The participants were given ample opportunity to ask questions, seek clarification, and withdraw their consent at any point during the study without facing any negative consequences.

1.10 Structure of the research of dissertation

This thesis is structured in a way that the main research topics are addressed in logical order. The first chapter contains an introduction and statement of the problem which presents the background to the research domain and introduces various contextual issues in the field of watershed management and the rationale for the study and its relevance. It lists the main and specific objectives, and the research questions, Additionally, this chapter outlines the main and specific objectives, research questions, research methodology, sampling design, and analytical tools utilized in the study. Chapter two seven deals with the watershed management practices treated under diffirent program and the perceived ecological and socio-economic benefits of program from the farmers' perspectives and biological change observed from land use land cover change. Chapter three focuses on the levels and variations of community participation in watershed management, specifically during the planning, implementation, evaluation, and monitoring stages, while also considering the factors that influence their participation. Chapter four provides an overall understanding of watershed management among various actors and discusses the institutional arrangements at different levels within the micro watersheds studied. Finally, chapter five presents a synthesis of the knowledge, community participation, and institutional arrangements, emphasizing their role in sustaining the use and planning for the upscaling of watershed management practices. This chapter also includes the conclusions drawn from the study and outlines future directions for research in this field.

1.11 Definition of terminologyies

In scientific study, precise definitions of terminology are crucial for ensuring clear and effective communication. When stakeholders possess differing viewpoints within a particular domain, it can result in misunderstandings and misinterpretations, which may ultimately impede progress and sound decision-making. In the context of watershed management, varying interpretations of the term "watershed" among different stakeholders are obstructing effective management practices. To foster a shared understanding and enable accurate analysis, this thesis outlines operational definitions of key terminology as used through out the this thesis. They are:

1. Watershed: A watershed is a defined land area where all surface water drains into a common outlet, encompassing hydrological, socio-political, and ecological aspects that influence food security, social stability, and economic welfare (Anonymous, 2009).
2. Watershed Development: Watershed development involves the application of physical engineering techniques, such as soil erosion control and water harvesting, to improve watershed functionality and resource management (Wani et al., 2008).
3. Watershed Management: is the systematic planning and implementation of strategies that integrate natural and human resources, considering social, political, and economic factors, to achieve ecological and socio-economic goals (Dixon, 1992).
4. Watershed Management Practices:is changes in land use, vegetative cover, and various structural and nonstructural actions that help achieve ecosystem-based, multiple-use objectives for watershed management (Dixon, 1992).
5. Integrated Watershed Management Approach (IWM**A)**: IWM involves the coordinated management of land, water, and related resources to enhance economic and social benefits while maintaining environmental sustainability (Schot et al., 2006).
6. Watershed Management Program refers to a specific set of organized activities, initiatives, and interventions designed to manage a watershed's resources (MoA ,2020).
7. Participatory Community-Based Watershed Management: This approach engages local users in identifying issues, setting management criteria, evaluating solutions, and monitoring outcomes to ensure sustainable watershed management (Johnson et al., 2001).
8. Watershed governance: encompasses to the institutional structures and arrangements that coordinate and oversee watershed management initiatives (Sulistyaningsih, et al, 2021).

1.12 Reference

Aborisade, B., & Bach, C. (2014). Assessing the pillars of sustainable food security. *European International Journal of Science and Technology*, *3*(4), 117–125.

Addisu, S., Goshu, G., Selassie, Y. G., & Tefera, B. (2013). Evaluation of watershed development plan and technology adoption level of farmers in Amhara Region, the case of SWHISA Project, Ethiopia. *International Journal of Scientific and Research Publications*, *3*(2), 1-11.

Adhikari, A. P., Dahal, G. P., Mahat, I., Regmi, B., & Subedi, K. (2015). Sustainable Livelihood Systems in Nepal: Principles, Practices and Prospects.

Adimassu, Z., Kessler, A., & Stroosnijder, L. (2013). Co-investments in land management: lessons from the Galessa watershed in Ethiopia. *International Journal of Sustainable Development & World Ecology*, *20*(6), 532-541.

Al-Ababneh, M. (2020). Linking ontology, epistemology and research methodology. *Science & Philosophy*, *8*(1), 75-91.

Alexandratos, N., & Bruinsma, J. (2012). World agriculture towards 2030/2050: the 2012 revision.

Amsalu, A. (2015). Institutional context for soil resources management in Ethiopia: a Review.

Amsalu, A., Stroosnijder, L., & de Graaff, J. (2007). Long-term dynamics in land resource use and the driving forces in the Beressa watershed, highlands of Ethiopia. Journal of Environmental management, 83(4), 448-459.

Anon, (2014). The Implication of Integrated Watershed Management for Rehabilitation of Degraded Lands : Case Study of Ethiopian Highlands. , 3(6), pp.78–90.

Anonymous, (2009). White Paper Holistic Water Resources Management: A Professional Education Plan, H2C1 Team Mississippi State University http://www.gri.msstate.edu/ publications / docs /2009 /09 /6310 WatershedCourseWP2 Sep09.pdf, Date Accessed: 21.07.2012

Arfasa, F. G., & Tona, B. A. (2019). Review on Contribution of Community-Based Participatory Watershed Management Practice for Sustainable Land Management in Ethiopia. Journal of Resources Development and Managment, 55, 13–27. https://doi.org/10.7176/JRDM

Asbjornsen, H., Mayer, A. S., Jones, K. W., Selfa, T., Saenz, L., Kolka, R. K., & Halvorsen, K. E. (2015). Assessing impacts of payments for watershed services on sustainability in coupled human and natural systems. *BioScience*, *65*(6), 579-591.

Asenso-Okyere, K., Daniel, A.M. and Elias, Z. (2013). Determinants of Food Security in Selected Agro-pastoral Communities of Somali and Oromia Regions, Ethiopia. Journal of Food Science and Engineering (3), Pp: 453-471

Asfaw, S., Shiferaw, B., Simtowe, F., & Haile, M. G. (2011). Agricultural technology adoption, seed access constraints and commercialization in Ethiopia. Journal of Development and Agricultural Economics, 9, 436-477.

Bakala, F., & Asfaw, M. (2020). The Role of Natural Resources for Sustaining Food Security in Ethiopia: A Review. Food Science and Quality Management, 97, 5–13. https://doi.org/10.7176/fsqm/97-02

Baker, M., & Schaltegger, S. (2015). Pragmatism and new directions in social and environmental accountability research. *Accounting, Auditing & Accountability Journal*, *28*(2), 263-294.

Bakker K (2012). Water security: research challenges and opportunities. Science 337:914–915

Bandaragoda, J. (2006). Institutional adaptation for integrated water resources management: An effective strategy for managing Asian river basins. IWMI.

Bantider, A. (2007). *Landscape Transformation and Opportunities for Sustainable Land Management along the Eastern Escarpment of Wello (EEW), Ethiopia* (Doctoral dissertation, Verlag nicht ermittelbar).

Bantider, A., Desta, G., Zeleke, G., Alamirew, T., & Tadesse, M. (2020). Post-1990 Natural Resource Management Policies and Laws in Ethiopia : A Scrutiny in the Lens of Integrated Landscape Management Approach. Vol.42 No., 1–42.

Bantider. A, zeleke. G, desta. G., alamirew T., Alebachew. Z, ProvidolI. I and Hurni, H. (2019). From Land Degradation Monitoring to Landscape Transformation: Four Decades of Learning, Innovation and Action in Ethiopia. Centre for Development and Environment (CDE), University of Bern, with Bern Open Publishing (BOP).

Barrett, C. B. (2010). Measuring food insecurity. *Science*, *327*(5967), 825-828.

Barrett, C. B., Bell, R., Lentz, E. C., & Maxwell, D. G. (2009). Market information and food insecurity response analysis. *Food Security*, *1*, 151-168.

Bates, B., Kundzewicz, S. and. Palutikof J., Eds. (2008). Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 210 pp

Bekele, B., Wu, W., Legesse, A., Temesgen, H., & Yirsaw, E. (2018). Socio-environmental impacts of land use/cover change in Ethiopian Central Rift Valley Lakes Region, East Africa. *Applied Ecology & Environmental Research*, *16*(5).

Bekele, W., and Drage, L. (2003). Soil and water conservation decision of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto. *Ecological Economics*, *46*(July), 437–451. https://doi.org/10.13140/RG.2.1.2334.3200

Berhanu Y, Belay S. (2015). Watershed Management Intervention in Chena District, Kaffa Zone, Southwestern Ethiopia: Journal of Water Resource and Protection, 2015, 7, 1257-1269

Bewket, W. (2007). Soil and water conservation intervention with conventional technologies in northwestern highlands of Ethiopia: Acceptance and adoption by farmers. Land use policy 24, 404-416.

Bezu, D. C. (2018). A review of factors affecting food security situation of Ethiopia: From the perspectives of FAD, economic and political economy theories

Bhattacharya, A. (2008). *Sustainable Livelihood Based Water Management-"Watershed Plus" Approach.* Manila. Retrieved April 15, 2015, from http://www.iges.or.jp/en/ea/activity080731.html.

Biesta, G. (2010). Pragmatism and the philosophical foundations of mixed methods research. In Handbook of Mixed Methods in Social and Behavioral Research, 2nd ed. Edited by Abbas Tashakkori and Charles Teddlie. Thousand Oaks: Sage, pp. 95–117

Blal Adem E. (2016): Ecosystem services for watershed management and planning ; Doctoral thesis in Environmental Engineering, University of Trento

Boas, I., Biermann, F. & Kanie, N. (2016). Cross-sectoral strategies in global sustainability governance: towards a nexus approach. *Int Environ Agreements* **16,** 449–464 https://doi.org/10.1007/s10784-016-9321-1

Bowling, A. (2009). Research methods in health (3rd ed.). Maidenhead: Open University Press.

Boyne, G. A., Gould-Williams, J. S., Law, J., & Walker, R. M. (2004). Problems of rational planning in public organizations: An empirical assessment of the conventional wisdom. *Administration & society*, *36*(3), 328-350.

Brahmi, M. K., & Thakur, K. S. (2012). Factors Affecting People's Participation in Hariyali Project under Nalagarh block of Himachal Pradesh. *International Journal of Farm Sciences*, *1*(1), 105–111.

Brooks, K.N., P.F. Ffolliott, H.M. Gregersen, and K.W. E. (1994). *Sustainable Development: The Role of Watershed Management.* Policy Brief No. 6 Environmental and Natural Resources Policy and Training Project (EPAT)/Midwest Universities

Brouwers, J.H.A.M. (2013). CDI and theory of change. Issue Brief, Centre for Development Innovation. Wageningen: Wageningen University & Research Centre. https://www.wageningenur.nl/en/show/CDI_issuebrief_theory_of_change.htm

Campos, M., Velázquez, A., Verdinelli, G. B., Priego-Santander, Á. G., McCall, M. K., and Boada, M. (2012). Rural People ' s Knowledge and Perception of Landscape : A Case Study From the Mexican Pacific Coast,. *Society & Natural Resources: An International Journal*, *30(8)*, 759–774. https://doi.org/10.1080/08941920.2011.606458

Carson, D. (2001). *Qualitative Marketing Research*. Sage Publications.

Central Statistical Agency (CSAE) & the World Bank. (2013). Ethiopia Rural Socioeconomic Survey report.

Chandrudu, M. V. R. (2010). Future Search for Watershed Development Projects in India; Priorities for Policy and Practice. Secundarabad, Telangana. Retrieved July 17, 2015, fromhttp://www.wassan.org/Consultation_Workshop/documents/Future_Search_For_Watershed_Development.pdf.

Change, C. (2015). The Role of Community Based Watershed Management for Climate Change Adaptation in Adwa, Central Tigray Zone Meaza Hadush Dept.of geography, Adigrat University, Adigrat, Ethiopia. , 1(1), pp.11–35.

Charles, H., J., C., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Pretty, J., Robinson, S., Thomas, S. M., & Toulmin, C. (2010). Food security: The challenge of feeding 9 billion people. Science, 327(5967), 812–818. https://doi.org/10.1126/science.1185383

Charnay, B. (2011). A system method for the assessment of integrated water resources management (IWRM) in mountain watershed areas: the case of the "Giffre" watershed (France). *Environmental management*, *48*(1), 189-197.

Cheng G D, Li X. (2015). Integrated research methods in watershed science. Science China: Earth Sciences, 58: 1159-1168, doi:10.1007/s11430-015-5074-x

Chimdesa G. (2016). Historical Perspectives and Present Scenarios of Watershed Management in Ethiopia. International Journal of Natural Resource Ecology and Management. Vol.

Chirenje, L. I., Giliba, R. A., & Musamba, E. B. (2013). Local communities' participation in decision-making processes through planning and budgeting in African countries. *Chinese journal of population resources and environment*, *11*(1), 10-16

Chisholm N. and Woldehanna T. (2012). Managing watersheds for resilient livelihoods in Ethiopia. 109–121. https://doi.org/10.1787/dcr-2012-15-en

Cohen, A., & Davidson, S. (2011). The watershed approach: Challenges, antecedents, and the transition from technical tool to governance unit. *Water alternatives*, *4*(1), 1.

Collins, K. M. T., Onwuegbuzie, A. J., & Sutton, I. L. (2006). A model incorporating the rationale and purpose for conducting mixed methods research in special education and beyond. Learning Disabilities: A Contemporary Journal, 44, 1-32.

Creswell, J. W. (2010). Mapping the developing landscape of mixed methods research. In A. Tashakkori & C. Teddie (Eds.), Handbook of mixed methods in social & behavioral research (2nd ed.) (pp. 45-68). Thousand Oaks, CA: Sage.

Crowston, K., Rubleske, J., & Howison, J. (2015). Coordination theory: A ten-year retrospective. In Human-computer interaction and management information systems: Foundations (pp. 134-152). Routledge.

Cruz, R. V. O. (1999). Integrated land use planning and sustainable watershed management. *Journal of Philippine Development*, *26*(1), 27-49.

Dagnew, D. C., Guzman, C. D., Zegeye, A. D., Tibebu, T. Y., Getaneh, M., Abate, S., ... & Steenhuis, T. S. (2015). Impact of conservation practices on runoff and soil loss in the sub-humid Ethiopian Highlands: The Debre Mawi watershed. *Journal of Hydrology and Hydromechanics*, *63*(3), 210-219.

Daniel J.N. (2020). Constraints of Watershed Management Practices in Ethiopia and Ways Forward, *International Journal of Environmental Protection and Policy*. Vol. 8, No. 4, , pp. 70-76. doi: 10.11648/j.ijepp.20200804.11

Darghouth, S., Ward, C., Gambarelli, G., Styger, E., & Roux, J. (2008). Watershed management approaches, policies, and operations: Lessons for scaling up. Water Sector Board Discussion Papers, 11, 1–164\ . http://documents.worldbank.org/curated/en/2008/05/9608907

Degefa, T. (2005). Combining household qualitative data and quantitative data in food security research: Trial lecture for the PhD-degree,Trondheim, 10.06.2005. 5. Acta Geographica - Trondheim. https://studylib.net/doc/8694616/

Denning, G., & Fanzo, J. C. (2016). Ten forces shaping the global food system.

Desta, L.; Carucci, V.; Wendem-Ageňehu, A.; Abebe, Y. (Eds). (2005). Community based participatory watershed development: A guideline. Addis Ababa, Ethiopia: Ministry of Agriculture and Rural Development (MoARD)

Diriba, G. (2020).Agricultural and rural transformation in Ethiopia. Ethiopian Journal of Economics, 27(2), 51–110.

Dodds, R. (2020). Using a participatory integrated watershed management approach for tourism. *Tourism Planning & Development*, *17*(1), 1-16.

Dorosh P. A. and Rashid S/ Eds (2012). Food and Agriculture in Ethiopia Progress and Policy Challenges. International Food Policy Research Institute Philadelphia, Pennsylvania 19104-4112 www.upenn.edu/pennpress

Ejigu, K., Gebey, T., & Preston, T. R. (2009). Constraints and prospects for apiculture research and development in Amhara region, Ethiopia. Livestock Research for Rural Development, 21(10), 172.

Engdawork, A. (2012). Landscape Dynamics and Sustainable Land Management in Southern Ethiopia. Unpublished PhD's Dissertation. Institute of Ecosystem Research and Geoarchaeology.

Eyisi, D. (2016). The usefulness of qualitative and quantitative approaches and methods in researching problem-solving ability in science education curriculum. *Journal of education and practice*, *7*(15), 91-100.

Fainstein, S. S., & DeFilippis, J. (2016). Introduction: The structure and debates of planning theory. In *Readings in Planning Theory: Fourth Edition* (pp. 1-18). wiley

FAO (2006). The new generation of watershed management programmes and projectsA resource book for practitioners and local decision-makers based on the findings and recommendations of an FAO review ISBN 92-5-105551-3

FAO (2013). Resilience Index: Measurement and Analysis model. The European Union through the "Improved Global Governance for Hunger Reduction Programme.

FAO (2017). Watershed management in action – lessons learned from FAO field projects. Rome.

FAO (2016). Situation Report. FAO Representative, Addis Ababa, Ethiopia

FAO (2011). The state of the world's land and water resources for food and agriculture (SOLAW) – Managing systems at risk. Food and Agriculture Organization of the United Nations, Rome and Earthscan, London.

FAO (2019). National gender profile of agriculture and rural livelihoods – Ethiopia. Country Gender Assessment Series, Addis Ababa. 84 pp. Licence: CC BY-NC-SA 3.0 IGO

FAO(2021). The State of Food and Agriculture 2021. Making agrifood systems more resilient to shocks and stresses. Rome, FAO. https://doi.org/10.4060/cb4476en

Ffolliott, P., Baker, M., Tecle, A. & Neary, D. (2003): A Watershed Management Approach to Land Stewardship. The Journal of the Arizona-Nevada Academy of Science 38: 1-4.

Fikru A.(2009) Assessment of Adoption Behavior of SWC Practices in the Koga Watershed, Highlands of Ethiopia

Firdaus R.(2014).Doctoral Dissertation Assessing Land Use and Land Cover Change toward Sustainability in Humid Tropical Watersheds, Indonesia

Fischler, R. (2000). Communicative planning theory: A Foucauldian assessment. *Journal of planning education and research*, *19*(4), 358-368.

Floress, K., Mangun, J. C., Davenport, M. A., & Williard, K. W. (2009). Constraints to Watershed Planning: Group Structure and Process 1. *JAWRA Journal of the American Water Resources Association*, *45*(6), 1352-1360. Chicago

Food Security Information Network [FSIN]. (2020). Global report on food crises. Retrieved march, 2020, from https://www.sadc.int/file

Förch, G. & Schütt, B. (2004): Watershed Management - An Introduction. FWU, Vol. 4, Lake Abaya Research Symposium 2004.

Francisco, H. A., & Salas, J. C. (2004). Realities of watershed management in the Philippines: the case of the Iloilo-Maasin watershed (No. 2004-22). PIDS Discussion Paper Series

Fredrik Söderström, Ulf Melin, Ida Lindgren, Zara Galzie (2018). Coordinating Public E-services - Investigat- ing Mechanisms and Practices in a Government Agency. 17th International Conference on Electronic Government (EGOV), Krems, Austria. pp.85-97, 10.1007/978-3-319-98690-6_8. hal- 01961524

Friedmann, J. (1993). Toward a non-Euclidian mode of planning. Journal of the American Planning Association, 59(4), 482-485.

Friedmann, J. (2003). Why do planning theory?. *Planning theory*, *2*(1), 7-10.

Friedmann, J. (2008). The uses of planning theory: A bibliographic essay. Journal of Planning Education and Research, 28(2), 247–257. https://doi.org/10.1177/0739456X08325220

Friedmann, J. (2017). Two centuries of planning theory: An overview. *Explorations in planning theory*, 10-29.

Fufa G. A. and Tona B. A. (2019). Review on Contribution of Community-Based Participatory Watershed Management Practice for Sustainable Land Management in Ethiopia. Journal of Resources Development and Management an International Vol.55, 201

Fulcher, C., Prato, T., and Zhou, Y. (1996), Watershed Management Decision Support System, published in Proceedings of Watershed 96, Moving ahead Together Technical Conference and Exposition, June 8 - 12, 1996, Baltimore, MD;

Gadisa C.(2016). Historical Perspectives and Present Scenarios of Watershed Management in Ethiopia. International Journal of Natural Resource Ecology and Management. Vol. 1, No. 3, 2016, pp. 115-127. doi: 10.11648/j.ijnrem.20160103.17

Gashaw, T. (2015) The Implications of Watershed Management for Reversing Land Degradation in Ethiopi

Gebregziabher, G. (2012). Watershed Management in Ethiopia. Agwater Solution Solutions.

Gebregziabher, G.; Abera, D. A.; Gebresamuel, G.; Giordano, M.; Langan, S. (2016). An assessment of integrated watershed management in Ethiopia. Colombo, Sri Lanka: International Water Management Institute (IWMI). 28p. (IWMI Working Paper 170). doi: 10.5337/2016.214

Geels F. (2004). From sectoral systems of innovation to sociotechnical systems: insights about dynamics and change from sociology and institutional theory. Res Policy. 33(6–7): 897–920.

German L, Mansoor H, Getachew A, (2007) Participatory integrated watershed management: Evolution of concepts and methods in an ecoregional program of the eastern African highlands. Agricultural Systems 94(2): 189–204

Gessesse, B., Bewket, W., & Bräuning, A. (2016). Determinants of farmers' tree-planting investment decisions as a degraded landscape management strategy in the central highlands of Ethiopia. *Solid Earth*, *7*, 639–650. https://doi.org/10.5194/se-7-639-2016

Glavan, B.(2007). "Coordination Failures, Cluster Theory and Entrepreneurship: A Critical View," MPRA Paper 6275, University Library of Munich, Germany.

Gregersen, H. M., Ffolliott, P. F., & Brooks, K. N. (2007). *Integrated watershed management: Connecting people to their land and water*. CABI.

Grumbine, R. E. (1997). Reflections on "What is ecosystem management?". *Conservation Biology*, *11*(1), 41-47.

Guangyu W. S, Mang, Haisheng C., Shirong L, Zhiqiang Z, Liguo W. and John L. (2016). Integrated watershed management: evolution, development and emerging trends J. For. Res. DOI 10.1007/s11676-016-0293-3

Guo, M. (2014). Effective Watershed Management: Planning, Implementation, and Evaluation. Journal of Waste Water Treatment & Analysis, 05(04), 4–6. https://doi.org/10.4172/2157-7587.1000e119

Gurjar, G. N., Meena, N. K., Swami, S., Telkar, S. G., & Lyngdoh1\, E. A. S. (2017). Concept of Watershed Management and its components. Current Agriculture Trends, 2(5), 9–11. -

Guush Berhane, G. B., Hoddinott, J., & Neha Kumar, N. K. (2017). The impact of Ethiopia's Productive Safety Net Programme on the nutritional status of children: 2008-2012.

Hailemariam, S. N., Embassy, R. N., Soromessa, T., & Teketay, D. (2016). Institutional Arrangements and Management of Environmental Resources in Ethiopia. February. https://doi.org/10.5539/enrr.v6n1p67

Haregeweyn N, Berhe A, Tsunekawa A, et al. (2012) Integrated watershed management, an effective approach to curb land degradation: A case study of the Enabered watershed, northern Ethiopia. Journal of Environmental Management 50: 1219–1233

Haregeweyn, N., Tsunekawa, A., Nyssen, J., Poesen, J., Tsubo, M., Tsegaye Meshesha, D. & Tegegne, F. (2015). Soil erosion and conservation in Ethiopia: a review. *Progress in Physical Geography*, *39*(6), 750-774.

Hazbavi, Z., Sadeghi, S. H., Gholamalifard, M., & Davudirad, A. A. (2020). Watershed health assessment using the pressure–state–response (PSR) framework. *Land degradation & development*, *31*(1), 3-19.

Healey P, (998). Building institutional capacity through collaborative approaches to urban planning" Environment and Planning A 30 1531 ^ 1546

Heathcote, I.W.(2009). *Integrated Watershed Management: Principles and Practice*. 2nd ed. Hoboken, NJ: John Wiley & Sons, Inc.

HLPE. (2016). Sustainable agricultural development for food security and nutrition: what roles for livestock? A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.

Hoyos, D., Bermejo, R., & Arto, I. (2010). Sustainable Development in the Brundtland Report and Its Distortion: Implications for Development Economics and International Cooperation. *ResearchGate*, *January*, 13–34

http://dx.doi.org/10.4236/jwarp.2015.715102

Hurni K, Zeleke G, Kassie M, Tegegne B, Kassawmar T, Teferi E, Moges A, Tadesse D, Ahmed M, Degu Y, Kebebew Z, Hodel E, Amdihun A, Mekuriaw A, Debele B, Deichert G, Hurni H. (2015). Soil Degradation and Sustainable Land Management in the Rainfed Agricultural Areas of Ethiopia: An Assessment of the Economic Implications. Report for the Economics of Land Degradation Initiative. 94 pp

IFPRI, (2017). Global Hunger Index, the Inequalities of Hunger, Washington, DC / Dublin / Bonn

Imperial, M. T. (2004). Intergovernmental Challenges of Watershed Management:Strategies for Improving Watershed Governance. (V. Grover, Ed.) USA: Oxford & IBH Publishing Co. Pvt. Ltd, India & India and Science Publishers, Inc., U.S.A.

Innes J, (1998)``Information in communicative planning" Journal of the American Association of Planners 64 52 ^ 63

Innes, J. E., & Booher, D. E. (2015). A turning point for planning theory? Overcoming dividing discourses. Planning Theory, 14(2), 195–213. https://doi.org/10.1177/1473095213519356

IPCC. (2015). Climate Change . Geneva: Intergovernmental Panel on Climate Change.

Jackson, E. A. (2016). Ontological and epistemological discourse (s) on sustainable development: Perspective on Sierra Leone in the aftermath of a decade of civil unrest. *Management of Sustainable Development Sibiu, Romania*, *8*(1).

Jagannatha Rao, R. (2005). 'Participatory watershed management (PWM): an approach for integrated development of rural India: a case study from Karnataka, southern India', Int. J. Environmental Technology and Management, Vol. 5, No. 1, pp.107–115.

James, D. (2007). A Critical Analysis of Communicative Planning Theory as a Theoretical Underpinning for Integrated Resource and Environmental Management Author Downloaded from Griffith Research Online A Critical Analysis of Communicative Planning Theory as a Theoretical U.

Jarosz, L. (2011). Defining world hunger: Scale and neoliberal ideology in international food security policy discourse. Food, Culture and Society, 14(1), 117–139. https://doi.org/10.2752/175174411X12810842291308

Jarosz, L. (2014). Comparing food security and food sovereignty discourses. *Dialogues in Human Geography*, *4*(2), 168-181.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. Journal of Mixed Methods Research, 1, 112-133. doi: 10.1177/1558689806298224

Joshi, P.K., Jha, A.K., Wani, S.P., Joshi, Laxmi and R.L. S. (2005. Meta-analysis to assess impact of watershed program and people's participation. Comprehensive assessment Research Report 8, Colombo, Sri Lanka: Comprehensive Assessment Secretariat. IWMI,

Joshi, P.K.; Jha, A.K.; WaniSuhas, P.; Sreedevi, T.K.; Shaheen, F.A. (2008). Impact of watershed program and conditions for success: A meta-analysis approach. Global Theme on agroecosystems Report no. 46. Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 24p.

Kacho, B., & Asfaw, M. (2014). Local Communities' Accountability for Natural Resource Conservation: a Comparative Study of Chiro and Fiche, Ethiopia. *Developing Country Studies*, *4*(14), 48–55.

Katusiime, J., & Schütt, B. (2023). Towards Legislation Responsive to Integrated Watershed Management Approaches and Land Tenure. *Sustainability*, *15*(3), 2221.

Kerr, J., Milne, G., Chhotray, V., Baumann, P., & James, A. J. (2007). Managing watershed externalities in India: Theory and practice. Environment, Development and Sustainability, 9(3), 263-281.

Kerse, B. L. (2017). A Review Paper on : The Multi-Functional Implication of Integrated Watershed Management : The New Approach to Degraded Land Rehabilitation in Ethiopia. 7(17), 21–30

Koohafkan, P. (2001). Integrated Watershed Management and Sustainable Food Production. Sustainability of Agricultural Systems in Transition, 64, 1–272. https://doi.org/10.2134/asaspecpub64

Lafferty W. M. (2004). Introduction: form and function in governance for sustainable development. In: Governance for Sustainable Development: the challenge of adapting form to function (ed. W. M. Lafferty) pp. 1-31. Edward Elgar Publishing Limited, Cheltenham

Lalthansanga. C. (2020). Agriculture and Food Security : Theoretical and Practical Aspects of Coordination in Relation to Agricultural Administration. Journal of Society & Change, XIV(3).

Lang, T., & Barling, D. (2012). Food security and food sustainability: reformulating the debate. *The geographical journal*, *178*(4), 313-326.

Laura G., Hussein M., Getachew A., Waga M., Tilahun A. and Anne S. (2014): Participatory Integrated Watershed Management *Evolution of Concepts and Methods*https://www.researchgate.net/publication/237568596

Lisa. M. L, (2007). Evaluating Participatory Watershed Management: A Case Study of the Albemarle Pamlico. Masters project submitted to the Nicholas School of the Environment and Earth Sciences of Duke University.

LiviaB Darren Swanson Dimple R.(2011): Evaluation of Integrated Management Initiatives; International Institute for Sustainable Development (IISD) http: // WWW.iisd.org.

Lixian, W. (2002). Theory and practice of watershed Management in China. The 12th ISCO Conference, 356–361.

Ludi, E. (2004). Economic Analysis of soil Conservation: Case studies from the highlands of Amhara Region, Ethiopia. Geographica Bernensia, African Studies Series A 18. Bern: institute of Geography

Lynch, A., & Sachs, J. (2021). Sustainable development solutions network (sdsn) and sdsn usa. *Sustainable Development*.

Malone, T. W., & Crowston, K. (1994). The interdisciplinary study of coordination. *ACM Computing Surveys (CSUR)*, *26*(1), 87-119.

Malo, M. (2020). Concept of Watershed Management and its Benefit. Current Agriculture Trends, 2(11), 9–11. https://www.researchgate.net/profile/Mousumi-

Martens, K. (2013). Communicative planning theory : change needed to change practice Working paper Institute for Management Research , Radboud University Nijmegen.

Mattila H. (2019). Habermas revisited: Resurrecting the contested roots of communicative planning theory. Progress in Planning 141: 100431.

Mawhorter, J. H. (2010). Environmental management reform through the Watershed Approach : A multi-case study of state agency implementation. " PhD diss., University of Tennessee, 2010.https://trace.tennessee.edu/utk_graddiss/825

Meena, D. C., Pal, S., & Chand, P. (2022). Asssment of watershed management ecosystem services in India: a meta-analysis. Current Science, 123(11), 1352–1358. https://doi.org/10.18520/cs/v123/i11/1352-1358

Mekuriaw, A. Heinimann, G. Zeleke, H. H.(2018). Factors influencing the adoption of physical soil and water conservation practices in the Ethiopian highlands International Soil and Water

Conservation Research, 6 (2018), pp. 23-30

Mena, M. M., & Dana, D. (2017). Integrated Watershed Management for Ecosystem Balance & Climate Change : Ethiopia. 9(9), 1–12

Merkineh M M, Aklilu B M, Efrem G, Gashaw G. (2018). Community Adoption of Watershed Management Practices at Kindo Didaye District, Southern Ethiopia. Int J Environ Sci Nat Res. 2018; 14(2): 555881. DOI:10.19080/IJESNR.2018.14.555881.

Meshesha, Y.B. and Birhanu, B.S. (2015) Assessment of the Effectiveness of Watershed Management Intervention in Chena Woreda, Kaffa Zone, Southwestern Ethiopia. *Journal of Water Resource and Protection*, **7**, 1257-1269.

Miralles-Wilhelm,F .(2021). Nature-based solutions in agriculture – Sustainable management and conservation of land, water, and biodiversity. Virginia. FAO and The Nature Conservancy. https://doi.org/10.4060/cb3140en

MoA (2010). Sustainable Land Management Technologies and Approaches in Ethiopia: Published by the Sustainable Land Management Project (SLMP),

MoA. (2020). Community-based Participatory Watershed and Rangeland Development : A Guideline I NFOTECHS ON TECHNOLOGIES FOR WATERSHED. January.

MoARD.(2009), Food Security Program 2010–2014 (Addis Ababa: Ministry of Agriculture

MoFED.(2010), *Growth and Transformation Plan I*, Ministry of Finance and Economic Development, Addis Ababa, http://extwprlegs1.fao.org/docs/pdf/eth144893.pdf.

Mohammed S.(2019). The Veer from Frontier Economics to Eco-Development Paradigm: Approaches, Policies and Strategies of Sustainable Development - Engineering. Vol. 4, No. 2, 2019, pp. 21-29. doi: 10.11648/j.jeece.20190402.11

Molle, F. (2009). "River-basin planning and management: The social life of a concept." *Geoforum.* 40 (3): 484-494.

Mondal B , Alka Sb and Girish K (2012). Impact of Watershed Development Programmes on Farm-specific Technical Efficiency: A Study in Bundelk hand Region of Madhya Pradesh;Agricultural Economics Rearch Review Vol. 25(No.2)

Morgan, David. L. (2014). Pragmatism as a paradigm for social research. Qualitative Inquiry 20: 1045–53. [CrossRef]

Mowo, J., Adimassu, Z., Masuki, K., Lyamchai, C., Tanui, J. and Catacutan, D. (2011). The Importance of Local Traditional Institutions in the Management of Natural Resources in the

Highlands of Eastern Africa. Working Paper No 134. Nairobi: World Agroforestry Centre.http://dx.doi.org/10.5716/WP11085.PDF

Mulugeta Gebrehiwot (2014). A delicate balance: land use, minority rights and social stability in the Horn of Africa Addis Ababa: Institute for Peace and Security Studies

Munang, R. T., Thiaw, I., & Rivington, M. (2011). Ecosystem management: Tomorrow's approach to enhancing food security under a changing climate. *Sustainability 3*(7), 937–954. https://doi.org/10.3390/su3070937

Murray, D. (2005). A critical analysis of communicative rationality as a theoretical underpinning for collaborative approaches to integrated resource and environmental management. Environments 33(2), 17.

Naburi, N. D., Obiri, J., & Mugalavai, E. (2020). Watershed Governance for Food Security in the Sio River Basin: A Paradox of Kenya's Devolution System. *Budapest International Research and Critics Institute-Journal (BIRCI-Journal) Vol*, *3*(3), 2465-2478.

Nandees wara Rao,and S. (2015). Evaluation of Rural Development police and strategy of Ethiopia ISSN:2348-7666 , Volume 2Issue1(3)

Neachell, E. (2014). Book Review - Environmental flows: Saving rivers in the thrid millennium. River Research and Applications, 30(January), 132–133. https://doi.org/10.1002/rra

Negash T, Mesfin K. (2011). Integrated watershed management on Gibe-Omo basin. PHE Ethiopian Consortium. Proceeding of National Workshop, Addis Ababa, Ethiopia

Nerkar, S. S., Pathak, A., Lundborg, C. S., & Tamhankar, A. J. (2015). Can integrated watershed management contribute to improvement of public health? A cross-sectional study from Hilly Tribal Villages in India. International Journal of Environmental Research and Public Health, 12(3), 2653–2669. https://doi.org/10.3390/ijerph120302653

Nick and Woldehanna (2012). Managing watersheds for resilient livelihoods in Ethiopia; Development Co-operation Report Lessons in Linking Sustainability and Development © OECD 2012 109 PART Chapter 8 DOI: 10.1787/dcr-2012-15-en/

Nigatu, R. (2011). Small holder farmers coping strategies to household food insecurity and hunger in Southern Ethiopia. *Ethiopian Journal of Environmental Studies and Management Vol. 4 No.1*.

Nikkhah, H. A., & Redzuan, M. (2009). Participation as a medium of empowerment in community development. European Journal of Social Sciences, 11(1), 170–176.

Noywuli, N., Sapei, A., Pandjaitan, N. H., & Eriyatno. (2018). Sustainability assessment on watershed management in the Aesesa Flores watershed, East Nusa Tenggara Province of Indonesia. Journal of Sustainability Science and Management, 13(2), 129–142

Nyssen, J., Clymans, W., Descheemaeker, K., Poesen, J., Vandecasteele, I., Vanmaercke, M., & Walraevens, K. (2010). Impact of soil and water conservation measures on catchment hydrological response—a case in north Ethiopia. *Hydrological processes*, *24*(13), 1880-1895.

Nyssen, J., Poesen, J., Lanckriet, S., Jacob, M., Moeyersons, J., Haile, M.& Deckers, J. (2015). Land degradation in the Ethiopian highlands. *Landscapes and landforms of Ethiopia*, 369-385.

OECD/FAO 2017). OECD-FAO Agricultural Outlook 2017-2026, OECD Publishing, Paris.http://dx.doi.org/10.1787/agr_outlook-2017-en

Osman, M.; Sonune, S.V.; Shankar, K.R.; Ravi, D.; Pandit, W. (2013). Impact evaluation of Kadwanchi watershed in Maharashtra: Lessons for post-project sustainability. *Indian Journal of Dryland Agricultural Research and Development* 28(2): 9-15.

Palanisami, K., & Kumar, D. S. (2009). Impacts of watershed development programmes: experiences and evidences from Tamil Nadu. *Agricultural Economics Research Review*, *22*(conf), 387-396.

Pandurang, K. V., Kulkarni, S. S., & Swami, V. A. (2012). Watershed Management: Concept, Principles and Challenges to Improving Productivity, Resources and Livelihoods. I-Manager's Journal on Civil Engineering, 2, 1–10. https://doi.org/10.26634/jce.2.2.1833

Peña-Guzmán, A. C., Melgarejo, J., Prats D., Torres, A. & Martínez, S., (2017). Urban Water Cycle Simulation/Management Models, Water, 9, 285; doi:10.3390/w904028

Perez, C., & Tschinkel, H. (2003). *Improving watershed management in developing countries: a framework for prioritising sites and practices*. London, England: Overseas Development Institute. Agricultural Research and Extension Network.

Personal, M., & Archive, R. (2007). *Munich Personal RePEc Archive Sustainable Practices in Watershed Management : Global Experiences Sustainable Practices in Watershed Management : 5854*.

Philosophy, D. O. F., & Agrawal, S. (2015). A study on Impact of Watershed Development Programme in Income , Employment generation and change in Cropping pattern of the beneficiaries of Jabalpur district (M . P .) Department of Extension Education.

Pimbert, M., & Pretty, J. (1997). Parks, People and Professionals: Putting "Participation" into Protected-area Management. In K. Ghimire & M. P. Pimbert (Eds.), *Social Change and Conservation* (pp. 297–330). London: Earth-scan.

Pinstrup-Andersen, P. (2009). Food security: definition and measurement. *Food security*, *1*, 5-7

Qi, H., & Altinakar, M. S. (2011). A conceptual framework of agricultural land use planning with BMP for integrated watershed management. Journal of Environmental Management, 92(1), 149–155. https://doi.org/10.1016/j.jenvman.2010.08.023

Ramankutty, N., Mehrabi, Z., Waha, K., Jarvis, L., Kremen, C., Herrero, M., & Rieseberg, L. H. (2018). Trends in global agricultural land use: implications for environmental health and food security. *Annual review of plant biology*, *69*(1), 789-815.

Randhir, T.O. (2007). Watershed Management: issues and approaches. London, UK: IWA Publishing. 155 p.

Rawat M.S.(2014) : Hydrological cycle in forested and deforested Watershed Systems, Central Himalaya, India. "Final Project Report" submitted to D.S.T. (Govt. of India), Development of Geography, Kumaun University, Nainital, PP.1-151.

Reddy Ravinder, C.h., Wani, S.P. (2007) Informal groundnut seed system in Andhra Pradesh: A case study. Journal on Leis India 17-19.

Reddy, V. R., Saharawat, Y. S., & George, B. (2017). Watershed management in South Asia: A synoptic review. *Journal of hydrology*, *551*, 4-13.

Reed, J., van Vianen, J., Deakin, E.L., Barlow, J. & Sunderland, T. (2016). Integrated landscape approaches to managing social and environmental issues in the tropics: learning from the past to guide the future. Global Change Biology, 22: 2540–2554.

Robinson J. (2004) Squaring the circle? Some thoughts on the idea of sustainable development. Ecological Economics 48: 369-384.

Rockstrom, J., Sahrawat, K. L., & Wani, S. (2011). Integrated watershed management in rained agriculture. CRC Press.

Roth, V., Nigussie, T. K., & Lemann, T. (2016). Model parameter transfer for streamflow and sediment loss prediction with SWAT in a tropical watershed. *Environmental Earth Sciences*, *75*(19), 1321.

Sager T (2012). Reviving Critical Planning Theory: Dealing with Pressure, Neo-Liberalism, and Responsibility in Communicative Planning. New York: Routledge.

Sager, T. (2017). Communicative planning. In *The Routledge handbook of planning theory* (pp. 93-104). Routledge

Sani, S. and Ke-maw, B. (2019) Analysis of Rural House-holds Food Security in Western Ethiopia. Food and Nutrition Sciences, 10, 249-265. https://doi.org/10.4236/fns.2019.103019

Saravanan, V. S., McDonald, G. T. & Mollinga, P. P. (2009). Critical review of integrated water resources management: moving beyond polarised discourse. Natural Resources Forum 33, 76–86.

Saunders, M. (2009). Research methods for business students. *Person Education Limited*.

Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J.-L., Shell, D., Meijaard, E., . . . Buck, L. E. (2013). Ten Principles for landscape approach to reconciling agriculture, conservation, and other competing land uses. PNAS, 110(21), 8. http://dx.doi.org/10.1073/pnas.1210595110

Schindler, J. (2017). Sustainability impact assessment for improved food security The benefit of local stakeholder participation.

Scotland, J. (2012). Exploring the philosophical underpinnings of research: Relating ontology and epistemology to the methodology and methods of the scientific, interpretive, and critical research paradigms. *English language teaching*, *5*(9), 9-16.

Shah, A., Joshi, H., & Desai, J. (2008). Revisiting Watershed Development in Madhya Pradesh: Evidence from a Large survey. Technical Report, Forum for Watershed Research and Policy Dialogue, Ahmedabad, Gujrat.

Sharda, V.N.; Sikka, A.K.; Juyal, G.P. (2012). Participatory integrated watershed management: A field manual. Dehradun, India: Central Soil and Water Conservation Research and Training Institute (CSWCRTI).

Sheng, T. C. (1999). Important and controversial watershed management issues in developing countries. In *10th. International Soil Conservation Organization Meeting, Purdue University, USA.*

Shiferaw, B., Kebede, T.A. & Reddy, V.R. (2012). Community watershed management in semiarid India: the state of collective action and its effect on natural resources and rural livelihoods..

Shiferaw,B.,Cynthia Bantilanand S.P. W. (2008). Rethinking policy and institutional imperatives for integrated watershed management: Lessons and experiences from semi-arid India. Journal of Food,Agriculture & Environment Vo.6(2).370-377

Singh, P., Behera, H. C., & Singh, A. (2010). Impact and effectiveness of 'watershed development programmes' in India. *Mussorrie India Centre Rural Stud*, *29*, 1-55.

Snyder, K. A., Ludi, E., Cullen, B., Tucker, J., Zeleke, A. B. & Duncan, A. (2014). Participation and Performance: Decentralized Planning and Implementation In Ethiopia. Public Administration and Development, 34**,** 83-95.

Sonnino, Roberta, Moragues Faus, Ana and Maggio, A. (2014). Sustainable Food Security: An Emerging Research and Policy Agenda International Journal of Sociology of Agriculture and Food. International

Spielman, D. J., Davis, K., Negash, M., & Ayele, G. (2011). Rural innovation systems and networks: findings from a study of Ethiopian smallholders. *Agriculture and human values*, *28*, 195-212.

Sterner T. & U.M. P. (2007). An Even Sterner Review.Washington DC, Resources for the Future, RFF DP 07-3.

Suhas P. Wania , Thawilkal Wangkahartb , Yin Dixinc , Zhong Lid and N.V. (2010). Community watersheds for food security and coping with impacts of climate change in rainfed areas WS3.1 Climate Change: Watershed Management and Food Security; 9th European IFSA Symposium, 47 July 2010, Vienna (Austria)

Sulistyaningsih, T., Nurmandi, A., Kamil, M., Roziqin, A., Salahudin, Jainuri, Sihidi, I. T., Apriyanto Romadhan, A., & Loilatu, M. J. (2021). Formulating Sustainable Watershed Governance Model: A Meta-analysis of Watershed Governance. Academic Journal of Interdisciplinary Studies, 10(2), 90–104. https://doi.org/10.36941/ajis-2021-0041

Sundaram KJ, Dawe D, Haen DH, Stamoulis K, Wiebe K.(2012) The state of food insecurity in the world 2012: economic growth is necessary but not sufcient to accelerate reduction of hunger and malnutrition. Rome:

Supangat, A. B., Basuki, T. M., Indrajaya, Y., Setiawan, O., Wahyuningrum, N., Purwanto, Putra, P. B., Savitri, E., Indrawati, D. R., Auliyani, D., Nandini, R., Pramono, I. B., Nugroho, A. W., Wuryanta, A., Adi, R. N., Harjadi, B., Cahyono, S. A., Lastiantoro, C. Y., Handayani, W., … Anggraeni, I. (2023). Sustainable Management for Healthy and Productive Watersheds in Indonesia. Land, 12(11), 1–34. https://doi.org/10.3390/land12111963

Sustainable Development Solutions Network (SDSN),(2013): Thematic technical report Group 7 on Sustainable Agriculture and Food Systems Cornell U niversity, US

Tâm, T., Và, N. C. Ứ U., Giao, C. Ể N., Ngh, C., & Chu, Ả N B Ụ I. (2016). 済無No Title No Title No Title (Vol. 01).

Tamene, L., & Vlek, P. L. (2008). Soil erosion studies in northern Ethiopia. *Land use and soil resources*, 73-100.

Tebebu, T. Y. (2017). Characterization and Amelioration of Degraded Soils in the Ethiopian Highlands (Doctoral dissertation, Cornell University).

Ted C. Sheng (1994). Challenges and Strategies of Integrated Watershed ManagementiIn Developing countries• ·Paper presented to the 8th International Soil Conservation Conference, New Delhi, India, Colorado State University, Fort Collins, CO 80523, USA December 4 to 8, 1994. .

Tefera, B and Sterk, G. (2010). Land management, erosion problems and soil and water conservation in Fincha'a watershed, western Ethiopia.Land Use Policy. 27: 1027-1037.

Teklewold, H., Kassie, M., Shiferaw, B., & Köhlin, G. (2013). Cropping system diversification, conservation tillage and modern seed adoption in Ethiopia: Impacts on household income , agrochemical use and demand for labor. Ecological Economics, 93, 85–93. https://doi.org/10.1016/j.ecolecon.2013.05.002

Temesgen G, Amare B and Abraham Mahari (2014). Evaluations of Land Use/Land Cover Changes and Land Degradation in Dera District, Ethiopia: GIS and Remote Sensing Based Analysis. International Journal of Scientific Research in Environmental Sciences. 2(6):199-208.

Temesgen G, Amare B and G/Silassie. H (2017). Land Degradation in Ethiopia: Causes, Impacts and Rehabilitation Techniques. Journal of Environment and Earth Science Vol.4, No.9, 2014

Temesgen, G. (2015). The implications of watershed management for reversing land degradation in Ethiopia. Research Journal of Agriculture and Environmental Management, 4(1), 5–12.

Teresa. D (2018). Community Participation on Watershed Management Programme. The Case of Gemechis District, Oromia, Ethiopia. International Journal of Comprehensive Research in Biological Sciences. Volume -5; Issue -9; Year -2018; Pages: 7-18

Tesfa Worku and Sangharsh Kumar Tripathi (2015) Watershed Management in Highlands of Ethiopia: A Review. *Open Access Library Journal*,**02**,1-11. doi: 10.4236/oalib.1101481

Tesfaye A and M Mohammed, (2017). Participatory integrated watershed management research for sustainable resource use and livelihood improvement in site selection and interventions in Southern Zone of Tigray, Ethiopia. Inter J Agri Biosci, 6(6): 281-288. www.ijagbio.com (©2017 IJAB. All rights reserved)

Tesfaye H (2011) Assessment of sustainable watershed management approach case study Lenche Dima, Tsegur Eyesus and Dijjil watershed. Master thesis, Faculty of the Graduate School of Cornell University

Teshome, A., de Graaff, J. & Kassie, M. (2016). Household-Level Determinants of Soil and Water Conservation Adoption Phases: Evidence from North-Western Ethiopian Highlands. Environtal Management, 57**,** 620-636.

Tiki, L., Kewessa, G., & Wudneh, A. (2016). Effectiveness of watershed management interventions in Goba district, southeastern Ethiopia. International Journal of Agricultural Sciences, 6(9), 1133–1140. www.internationalscholarsjournals

Tiwari, K. R., Bajracharya, R. M., & Sitaula, B. K. (2009). Natural Resource and Watershed Management in South Asia: A Comparative Evaluation with Special References to Nepal. Journal of Agriculture and Environment, 9, 72–89. https://doi.org/10.3126/aej.v9i0.2120

Tizale, C. Y. (2007). The dynamics of soil degradation and incentives for optimal management in the Central Highlands of Ethiopia (Doctoral dissertation, University of Pretoria).

UNDP (2018). Ethiopia National Human Development Report 2018: Industrialization with a Human Face. http://hdr.undp. org/sites/default/fles/ethiopia_national_human_development_report_2018.pdf. Accessed 16 Aug 2019

UNEP (2016) Food Systems and Natural Resources. A Report of the Working Group on Food Systems of the International Resource Panel. Westhoek, H, Ingram J., Van Berkum, S., Özay, L., and Hajer M..

UNFCCC, (2015.Adoption of teh Paris Agreement FCCC/CP/2015/L.9/Rev.1 United Nations Framework Convention on Climate Change

USAID (2011). Livelihood & Food Security Conceptual Framework. Livelihood and Food Security Technical Assistance (LIFT) Project FHI360 1825 Connecticut Avenue NW Washington, DC 20009

USDA (2022). Definitions of Food Security. U.S. Department of Agriculture Economic Research Service

Vasić1, F., Caković1, M., Dragović, N., Jovanović, N., Rončević, V., Živanović1, N., & Zlatić, M. (2024). Current Trends and Future Perspectives of Integrated Watershed Management. South-East European Forestry, 15(1), 103–116. https://doi.org/10.15177/seefor.24-12

Veale, B. J. (2010). Assessing the Influence and Effectiveness of Watershed Report Cards on Watershed Management: A Study of Watershed Organizations in Canada.

Villela, R. G., Sánchez Chávez, J. J., Bravo Inclán, L. A., Mijangos C, M., Izurieta, A, J., Tomasini O, C., Rivera Ruíz, P., Mantilla Morales, G., & Banderas Tarabay, A. G. (2017). Holistic Approach to Watershed Management and Freshwater Conservation and Rehabilitation: A Case Study. Modern Environmental Science and Engineering, 03(07), 451–459. https://doi.org/10.15341/mese(2333-2581)/07.03.2017/003

Vishnudas, S., Hubert. Savenije, H. G., & Pieter Zaag, V. Der. (2007). A conceptual framework for the analysis of sustainable watershed management projects. IAHS-AISH Publication, 317, 263–269.

Vishnudas, S., Savenije, H. H. G., & Zaag, P. Van Der. (2005). *A Conceptual Framework for Sustainable Watershed Management*. (April 2014).

Vishnudas, S., Savenije, H. H. G., Van der Zaag, P., Ajith Kumar, C. E., & Anil, K. R. (2008). Sustainability analysis of two participatory watershed projects in Kerala. Physics and Chemistry of the Earth, 33(1–2), 1–12. https://doi.org/10.1016/j.pce.2007.04.004

Wagener, A. D. L. (2005). Constraints to the implementation of effective environmental management in coastal areas of developing countries. *Anais da Academia Brasileira de Ciências*, *77*, 613-623.

Wakjira, D. T., Fischer, A., & Pinard, M. A. (2013). Governance change and institutional adaptation: A case study from Harenna Forest, Ethiopia. *Environmental management*, *51*, 912-925.

Wang, G., Mang, S., Cai, H., Liu, S., Zhang, Z., Wang, L., & Innes, J. L. (2016). Integrated watershed management: evolution, development and emerging trends. Journal of Forestry Research, 27(5), 967–994. https://doi.org/10.1007/s11676-016-0293-3

Wani, S. P., & Garg, K. K. (2008). Community watersheds for improved livelihoods through consortium approach in drought prone rain-fed areas. *Journal of Hydrological Research and Development*, *23*, 55–77.

Wani, S. P., Anantha, K. H., Sreedevi, T. K., Sudi, R., Singh, S. N., & D'Souza, M. (2011). Assessing the environmental benefits of watershed development: evidence from the Indian semi-arid tropics. *Journal of Sustainable Watershed Science and Management*, *1*(1), 10-20.

Wani, S. P., Wangkahart, T., Yin, D., Zhong, L., & Thang, N. V. (2010). Community watersheds for food security and coping with impacts of climate change in rain-fed areas. *Building Sustainable*

Rural Futures: The Added Value of Systems Approaches in Times of Change and Uncertainty. 9th European IFSA Symposium, Vienna, Austria, 4-7 July 2010, July, 1389–1400.

Wani, S.P., Joshi, P.K., Raju, K.V., Sreedevi, T.K., Mike Wilson, Amita Shah, Diwakar, P.G., Palanisami, K., Marimuthu, S., Ramakrishna, Y.S, Meenakshi Sundaram, S.S. and Marcella D'souza (2008). Community Watershed as Growth Engine for Development of Dryland areas - Executive Summary. A Comprehensive Assessment of Watershed Programmes in India. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, A.P, India, 32 p.

Wąsik, Z. (2016). Epistemology–the theory of knowledge or knowing? Appreciating Gregory Bateson's contribution to the cartography of human cognition. *Revista Română de Comunicare şi Relaţii Publice*, *18*(3), 23-35.

Webb, P., Von Braun, J., & Yohannes, Y. (1992). *Famine in Ethiopia: policy implications of coping failure at national and household levels* (Vol. 92). Intl Food Policy Res Inst.

Weber, S. and McKenney L. (2008) .Watershed Management. Integrating People, Land and Water. Irvine, USA. RBF Consulting

Welteji D., (2018): A critical review of rural development policy of Ethiopia: access, utilization and coverage. https://doi.org/10.1186/s40066-018-0208-y

Wilkinson, C. (2012). Social-ecological resilience: Insights and issues for planning theory. Planning Theory, 11(2), 148–169. https://doi.org/10.1177/1473095211426274

William Blomquist&EdellaSchlager (2005) Political Pitfalls of Integrated Watershed Management, Society & Natural Resources, 18:2, 101-117, DOI: 10.1080/08941920590894435

Wolfe, J. D., Shook, K. R., Spence, C., & Whitfield, C. J. (2019). A watershed classification approach that looks beyond hydrology: application to a semi-arid, agricultural region in Canada. *Hydrology and Earth System Sciences*, *23*(9), 3945-3967.

Worku, T. and Tripathi, S. (2015). Watershed Management in Highlands of Ethiopia: A Review. *Open Access Library Journal*, **2**, 1-11. doi: 10.4236/oalib.1101481

World Bank, (2008). Watershed Management Approaches, Policies, and Operations: Lessons for Scaling Up. Washington, DC

World Bank, (2016). Country based rural population: https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations ET

Yaebiyo, G. Tesfay. Y Assefa D. 2 (2015). Socio-Economic Impact Assessment of Integrated Watershed Management in Sheka Watershed , Ethiopia . 6(9), 202–213

Yesuph, A. Y. (2019). Prospects of Sustainable Land Management amidst Interlocking Challenges in the Upper Beshillo Catchments, Northeastern Highlands of Ethiopia Declaration I declare that "Prospects of Sustainable Land Management amidst Interlocking Challenges in the (Issue March). https://uir.unisa.ac.za/handle/10500/26493

Yitaferu B (2007). Land degradation and options for sustainable land management in the Lake Tana Basin (LTB) Amhara region, Ethiopia. Center for Development and Environment (CDE) Geographisches Institute Universitat Bern, Bern.

Zeleke, G. (2004). Integrated watershed management experiences in eastern and central Africa: Lessons from Ethiopia. *Bekele Shiferaw and KPC Rao*, 73.

Zerihun G.A , Lukas K. Oosthuizen& H.D. van Schalkwyk (2002) Agricultural development policies of Ethiopia since 1957, South African Journal of Economic History, 17:1-2, 1-24,

CHAPTER TWO: WATERSHED MANAGEMENT INTERVENTION ON LAND USE LAND COVER CHANGE AND FOOD SECURITY IMPROVEMENT AMONG SMALLHOLDER FARMERS.

2.1 Abstract

Natural resource bases are the basic foundations of food security. However, they are facing problems both in quantity and quality, leading to decreased land productivity and societal issues. Watershed management is the most effective technique for managing and utilising these resources while improving food security. The study evaluated the effectiveness of the watershed management approach using Arc GIS 10.3 to track changes in land use cover for the years 2009, 2014, and 2020 and surveyed 337 households in three different Programmes. The findings showed six land-use land cover areas, where the proportion of farmland and bare land decreased while the proportion of settlements and shrub land increased in the three micro-watersheds. Population pressure and exotic species' invasion were significant factors contributing to the decline in farmland, while a decrease in bare land and an increase in shrub land were the results of successful watershed management interventions. Survey results showed that approximately 93.4% and 84.9% of respondents reported reduced soil erosion and deforestation, respectively. Further, the integrated watershed approach implemented in the area improved water availability, reduced dependency on single crops, and increased off-farm activity. Thus, scaling up an integrated watershed approach can enhance food security and protect natural resources

Keywords: Natural resources, Production, and Productivity, Watershed approach.

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2.2 Introduction

There is growing consensus in Ethiopia that improving the country's natural resource base is crucial for ensuring food security and self-sufficiency (FAO 2017, Bakala & Asfaw 2020). They serve as the foundation of food security, either directly by generating the necessary food or indirectly by producing goods and services that may be exchanged for food (Wani et al. 2010). As described by Gashu and Muchie (2018) natural resources are the supreme gifts without which life in any form cannot exist on planet Earth. As several research studies have also shown, managing the natural resource base is essential for improving production and enhancing human well-being both now and in the future (Gashu and Muchie 2018; Ewunetu et al. 2021). However, these resource bases are facing serious challenges both in terms of quantity (per capita) and quality, resulting in decreased land productivity and increased social problems (Bazezew and Worku 2018; Meyfroidt et al. 2019). As the population continues to grow, the task of providing adequate food will become progressively more difficult under existing management practices, necessitating immediate corrective measures (FAO, 2017)

.In this respect, it is found that watershed management is among the best tools to ensure sustainable utilisation and management of natural resources to obtain the desired goods and services without adversely affecting environmental resources (Reddy et al. 2017; Worku and Sangharsh 2015). Furthermore, studies conducted over the past 50 years in India and China on watershed management showed remarkable successes in improving the basic conditions of agricultural production and promoting the rural economy, especially in rain-fed and drought-prone regions (Wani et al. 2010). In Ethiopia, a study conducted by Gebregziabher et al. (2016) in three regions (Oromia, Amhara, and Tigray) showed that watershed management has increased farm incomes and food security by an average of 50 and 56 percent, respectively. Additionally, Ethiopia's Climate Resilient Green Economy Policy and Strategy issued in 2011 reiterates the significance of watershed management as a part of the nation's economic development to enhance the condition of the natural resources and meet the demands of the population for sustainable livelihoods.

Despite these facts, the effectiveness of an integrated watershed management approach as a method of reducing poverty and improving food security was not widely recognised among the various actors (Mengistu and Assefa 2019; Worku and Sangharsh 2015**)**. As a result, attention given to the integrated assessment of the biophysical and socioeconomic components of watershed management for improving

food security was minimal. However, the management of watersheds and food security are closely related. For instance, several issues that cause food insecurity are linked to the degradation of the natural resource bases, including land degradation, drought, floods, poverty, conflict, poor health, and ineffective governance (Mekuriaw 2017; Adimassu et al. 2017; Mena, 2018). Numerous research studies have indicated that managing the natural resource base will increase the sustainability of water availability, production from agriculture, income, and environmental, and ecological status and also contribute to climate change mitigation (Gopa et al. 2021; Legesse et al. 2018). However, only a few studies have examined how comprehensive watershed management practices contribute to ensuring food security.

Furthermore, given the long history of watershed management in the country in general and the study area in particular, there have only been a few attempts to evaluate the biophysical, socioeconomic, and environmental components of watershed management practices to ensure food security. Many past studies have attempted to primarily focus on specific criteria, ignoring the other components of the watershed development (Gebregziabher et al., 2016; Desta et al., 2005). In addition, Bekele et al. (2018) and Worku & Sangharsh (2015) reported that there was a lack of clear understanding to guide the integration of multiple actors in watershed management to alleviate land degradation while improving food security. A comprehensive study on the approach's effectiveness in improving community food security while improving natural resources is so important. Thus, the objective of this research was to assess the contribution of biophysical, and environmental components of watershed management practices to assuring food security under different Programmeme approaches including the Sustainable Land Management Project (SLMPII), the Productive Safety Net Programmee (PSNP PW), and the Free Community Mass Mobilization Programmeme in Qarsa Woreda of the East Hararghe zone of Oromia region

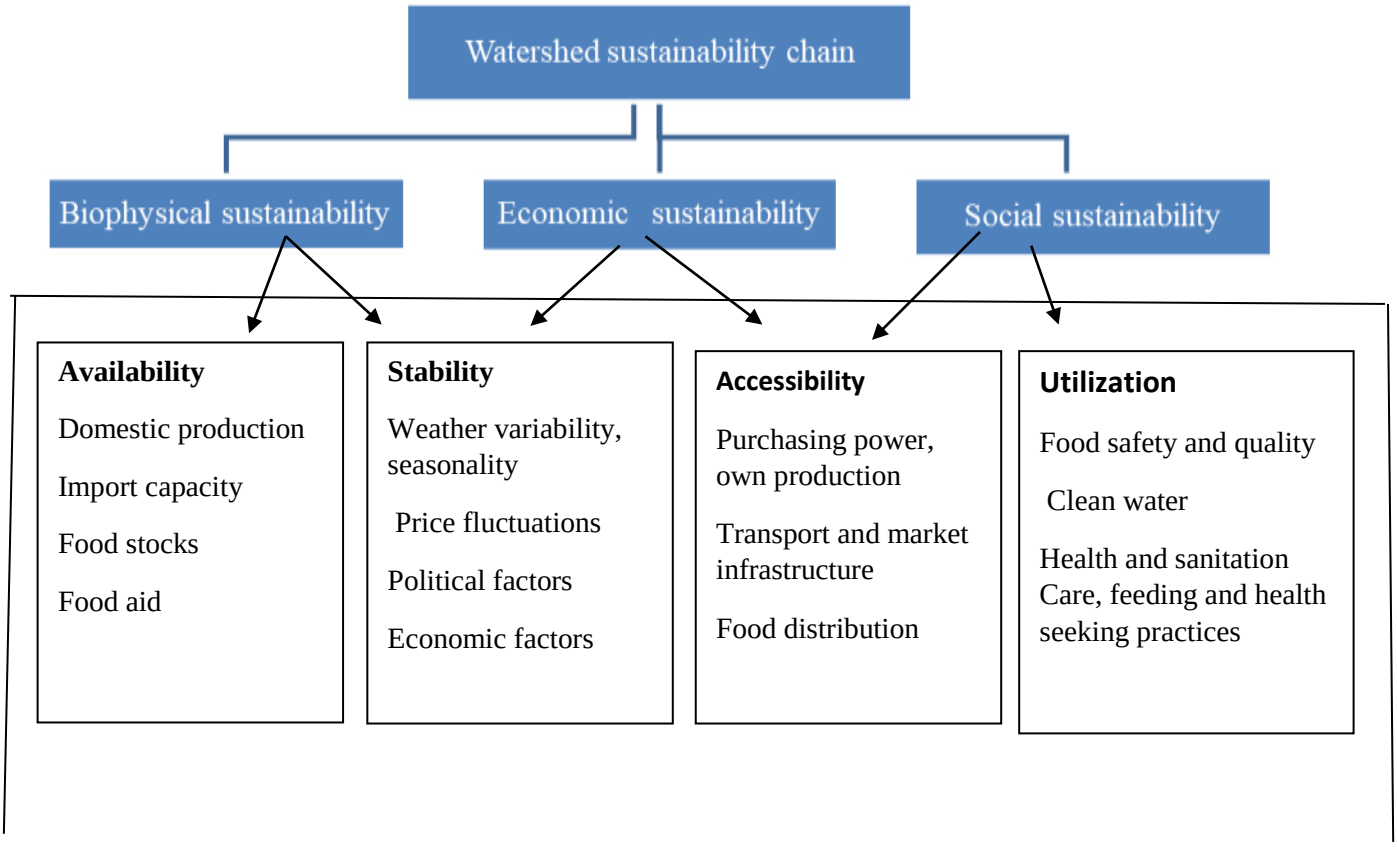
2.3 Materials and Methods

2.3.1 Conceptual framework of the study

The multiple links between watershed management and food security are expressed in various scientific literature (Wang et al. 2016 ; Bakala & Asfaw 2020). These research works vividly show that the concepts of food security and sustainable watershed management are closely interrelated. Watershed management is the most effective method for managing natural resources, and it has either directly or

indirectly enabled the four pillars of food security—accessibility, sustainability, and utilization—of food. In addition, Guiné et al. (2021) and Moroda et al. (2018) confirmed this idea by explaining that food security in Ethiopia is affected by a variety of factors including the environment, availability and quality of natural resources, including water resources as well as economic factors which among other things include, availability of oxen, land size, social and political/policy frameworks including the scope of the level of participation of stakeholders in decision-making processes.

According to FAO (2017), watershed management interventions also address the basic livelihood needs of poor people- such as drinking water supply, savings and credit, transportation, communications, off-farm income generation, and access to health and education services. As a result, using a watershed management approach is one of the best strategies for organizing land use and other resource holistically (Anantha & Wani 2016; Gopa et al. 2021). Watershed management has a positive impact on a variety of biophysical, environmental, and socioeconomic aspects, including income, employment, asset creation, health, education, and the mode of use of energy resources all of which contribute directly or indirectly to the four dimensions of food security (FAO 2017 ; Teressa 2020). The study used biophysical, social, and economic sustainability outcomes such as reduced runoff, reduced downward watershed flood, enhanced soil fertility, enhanced vegetation, improved crop yields and farm income, and enhanced food supplements for livestock as tools for investigating the effectiveness of watershed management as a sustainable approach for the promotion of food security, as shown in Figure 5.



Food Security Dimensions

Figure 5: Conceptual framework of the study modified from Vishnudas, (2006) and Mawhorter, (2010) and from experience

2.3.2 Description of the study area

The study was conducted in *Qarsa* Woreda of East *Hararghe* zone, Oromia region of Ethiopia. Geographically, the district lies between 9^0 17' and 9^0 29'N latitudes and 41^0 12' and 41^0 56'E longitudes to the west of the zonal capital, Harar town. The woreda is one of the food insecure in the East Hararghe zone. The livelihood of the rural inhabitants is closely linked to the use of land resources for food production, energy sources, shelter constriction, and so on. Watershed management strategies have been applied in the area for a very long period through different initiatives and Programmes. However, the woreda continued to be the most affected by difficulties with chronic food and nutrition security, soil erosion, plant loss, declining soil fertility, and water stress. This study focused on three different Programme approaches: Free Mass Mobilization, Sustainable Land Management Programme II, and the Productive Safety Net Public Work which are adjacent to each other (Figure 6). All the Programmes are using watershed management as one of the main tools for improving food security and reducing poverty, but the experiences and Programme approaches have varied. Free Mass Mobilization is the government's regular Programme and has no external funding support. Sustainable Land Management Programme II and Productive Safety Net Programme are funded by the World Bank.

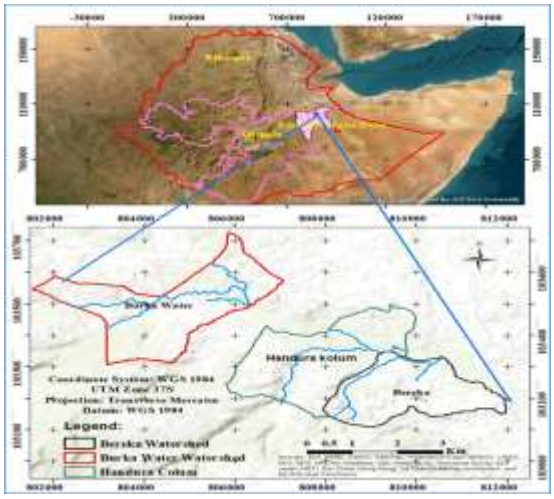


Figure 6: Location of map of the study area.

Agriculture is the main economic activity of the rural residents with mixed crop-livestock production systems on a subsistence level. The rain-fed production system is the most dominant and practiced by the majority of the farmers. Maize (*Zea mays L.*) and Sorghum (*Sorghum bicolor*) are produced as staple crops while Khat (*Catha edulis*) and coffee (*Coffea arabica)* as important cash crops. Livestock is also an important source of food and household income. The description and characteristics of each selected watershed are presented in (Table 2).

Based on a 20-year dataset (2001 to 2020) obtained from the Ethiopian National Meteorology Agency (Figure 7). Qarsa Woreda receives an average annual rainfall of 1,225 mm. The climate exhibits notable variability, with distinct wet and dry seasons. The annual mean temperatures for the area show a minimum of 12.5°C and a maximum of 26.6°C, indicating a moderate temperature ranges throughout the year. The woreda is characterised by a bimodal rainfall pattern with an erratic distribution. The "Belg" or "Arfasa" season, occurs from March to May. This rainy season is crucial for the early growth of crops but tends to be irregular and less predictable in terms of total rainfall. The "Kiremt" or "Gana," takes place from June to September. This period is vital for agricultural activities, as it supports the cultivation of staple crops. From October to February, the area experiences a dry season, with little to no rainfall. This extended dry period can lead to water shortages and impacts the availability of pasture for livestock. The uneven distribution of rainfall, combined with the variability in the timing and intensity of both the Belg and Kiremt seasons, contributes to the challenges of agricultural planning and land management in the area. This climate pattern, marked by significant seasonal variation, is critical to understanding the land use and land cover changes, as it directly influences agricultural practices, water availability, and vegetation growth.

Table 2: List of micro watershed management systems covered by the study

No	Name of micro watershed	Implemented by	Agro-Ecology	Altitude	Soil type	Area in Ha	Population THH	Sample size
1	Andhura Kosum	Free Mass Mobilization	H/L	2000-2700	Luvisols, Lithosols, Cambisols	759.5	734	112
2	Baraka	PNSP	H/L	1900-2700	Luvisols, Lithosols, Cambisols	565.7	639	107
3	Burqa Water	SLMP	H/L	2100-2700	Luvisols, Lithosols, Cambisols	853.1	765	118
						2178.3	2138	337

PNSP= (Productive Safety Net Programme) , SLMP = (Sustainable Land Management Programme)

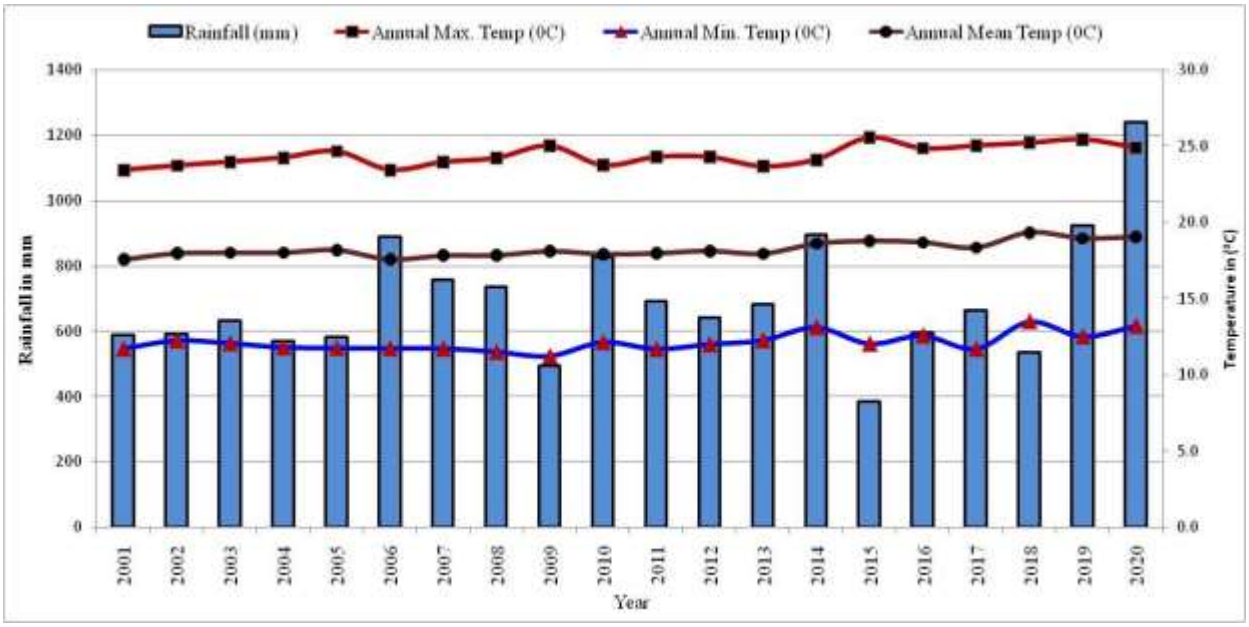


Figure 7: Mean annual temperature and rainfall of Qarsa woreda (2000-2020).

2.3.3 Data requirements, sources, and methods of collection

The study employed both primary and secondary data to achieve its objectives. Primary data were collected through a variety of methods, including focus group discussions, key informant interviews, household surveys, and field observations. These methods provided direct insights into local conditions, perceptions, and practices. Secondary data were also integral to the research, including satellite imagery and reports on past conservation initiatives. The secondary data were sourced from relevant websites and official reports, which complemented the primary data. Together, the primary and secondary data were used to provide a comprehensive analysis and to substantiate the study's findings.

2.3.4 Data sampling technique

This study used a three-stage sampling technique to select the micro watershed and household heads. The woreda was purposively selected due to the presence of Free Mass Mobilization, Sustainable Land Management Programme II, and Productive Safety Net Programme in the woreda. The selection of the micro watershed was based specific set of criteria such as the historical similarity before and after watershed management interventions, similar land use systems and soil and water conservation practices used, and sites within adjusting to each other. Accordingly, one micro watershed from each Programme approach was selected. For the household survey, lists of household heads were provided by the Kebele administration and development agents as indicated Table 2**.** Following the identification of the total households in the micro watershed, we determined the sample size by using the sample size determination equation that takes into account the desired confidence level (95 percent), error margin (5 percent), and non-response rate (10 percent) where the exact number of households in each micro watershed is known by using (Kothari 2004) sample size correction calculator as indicated hereunder

$$S= \frac{Z^2 * P * (1-P)}{C2} \text{ ----------(-1)}$$

Where: Z = Z-value (1.96) for 95 confidence level

P = is the percentage picking a choice, expressed as a decimal (0.5)

C = is the confidence interval expressed as a decimal (0.05 = ±0.05)

Subsequently, the actual sample size for the study area was determined as:

$$SS_{kp} = \frac{S}{1+\frac{S-1}{P_L}} \text{ ----------(2)}$$

Where: SSkp is the sample size for the known population size

S is the sample size for the unknown population calculated using Equation 1

P_k is the known population size from which the sample size is calculated

In addition to data collected from household surveys, focus group discussions (each comprising 7–12 participants) were selected purposively as they were expected to be experienced and knowledgeable about the issues under investigation. Accordingly, 5 FGDs were conducted one at the watershed level (kebele level) 1 at the district, and 1 at the zone level based on the prepared checklists.

2.3.5 Satellite data source and processing

To analyze the land use and land cover of the study watershed, multi-spectral, multi-temporal LANDSAT satellite data of East Hararghe of Qarsa Woreda were acquired for three years namely, 2009, 2014, and 2020. All LANDSAT images have been taken from USGS which were from January to ensure uniformity and low cloud cover images. The satellite images were brought to the Universal Transverse Mercator (UTM) projection in zone 37 N and were used to investigate land cover changes in the study area. In addition sentinel images were also used for its high spatial resolution for identification different land use types like water bodies detection and settlements. The selection of the satellite images was strategically guided by the study's objectives: 2009 provided a baseline for the watershed before watershed management interventions began; 2014 marked the initiation of watershed management projects in three micro-watersheds; and 2020 was chosen to assess the effects of these management practices on biophysical changes following their implementation. Detailed information regarding each satellite image is provided in Table 3. Ground Control Points (GCPs) were established using GPS data collected through field observations, which were essential for the accurate classification of the satellite images and the subsequent analysis of land cover changes in the study area.

2.3.6 Determination of land use classification system

The land use land classes of interest were carefully selected and established using information from key informants, field observation, expert opinions, a reconnaissance survey of the existing LULC distribution in the study, and the use of related previous studies. Accordingly, six main land-use and land-cover classifications have been identified for the analysis of changes in land use and land cover (Table 3).

Table 3: Description of Landsat image

No.	Date production	Pass/Row	Scale	Source
1	January, 2009	166/54	30 m	Earth Explorer USGS
2	January, 2014	166/54	30 m	Earth Explorer USGS
3	January 2020	166/54	10 m	Earth Explorer USGS

Source:(Mzava et al. 2019;Hassan et al. 2016)

Table 4: Description of land use and land cover categories considered in image classification

LULC	Description
Agricultural land	Land areas mainly under rain-fed farming of annual crops growing and perennial crops. Major, crops grown include cereals (maize, wheat, barley, etc.), spices, and cash crops (coffee/chat).
Forest land	land covered by natural or planted trees that exceed 2 meters in height, have a canopy cover of more than 20%, and an area cover of above 0.5 hectares.
Shrub/bushland	Covered by multi-stemmed scrubs, sparse small trees, and shrubby undergrowth. Found in the escarpments, on steep slopes (either at early years of enclosure or area closure
Bare land	Areas with no or very little vegetation cover and are characterized by the shallow and rocky surface along the flooding area of the local stream valleys, over gentle and steep slopes
Rural settlements	Areas occupied by residential houses of rural communities, buildings, and small towns
Waterbody	Areas covered by open waters (mainly lakes, reservoirs, streams, canals, and others)

Source: Adaptted from Africover classification system (FAO).

Accuracy assessment

Accuracy assessments were conducted on the classified satellite images from 2009, 2014, and 2020 to ensure the reliability of the results. Alongside the remote sensing work, additional data sources, including GPS data from field visits, topographic maps, and raw images, were utilized (Congalton & Green, 2009). During field visits, 60 Ground Control Points (GCPs) were collected using GPS and Google Earth. Classification accuracy was evaluated using error matrix analysis, overall accuracy, and

Kappa coefficient analysis. The error matrix helped assess both user and producer accuracy, while the Kappa coefficient indicated the level of agreement between the interpreters (Foody, 2022). The producer and user accuracy were calculated using the confusion matrix, which also included overall accuracy and the Kappa coefficient (Congalton, 2001). To meet the study's quality standards, all output maps were required to have 85% accuracy. For detecting land use and land cover changes, a visual comparison of features was made, and the confusion matrix analysis was applied. The areas converted from one land cover class to another were quantified, and the directions of these changes were determined to better understand the dynamics of land use and cover transformations in the watershed.

Overall accuracy:

According to Bhatta (2008), an error matrix is one way to express the accuracy of classifications (confusion matrix or contingency table). To use the error matrix the ground control point must collect as a viable sample based on which an error matrix is formed. Generally, 6 samples for control points as data sampling were collected, and the relationship between known reference data (ground data) was calculated as 83.3%.

Kappa coefficient:

In the classification process, where pixels are randomly assigned to classes will produce a percentage correct value. The resulting kappa measure compensates for chance agreement in the classification and provides a measure of how much better the classification performed in comparison to the probability of randomly assigning pixels to their correct categories.

Therefore, it is calculated as follows:

$$\kappa = \frac{N\sum_{i=1}^{n} m_{i,i} - \sum_{i=1}^{n}(G_i\, C_i)}{N^2 - \sum_{i=1}^{n}(G_i\, C_i)}$$

When:-

i the class number

N is the total number of classified values compared to truth values

$\mathbf{m_{i,\,I}}$ the number of values belonging to the truth class **i** that have also been classified as class **I** (i.e., values found along the diagonal of the confusion matrix)

$\mathbf{C_i}$ is the total number of predicted values belonging to class **i**

$\mathbf{G_i}$ is the total number of truth values belonging to class **i**

Accuracy assessment in this study revealed a kappa coefficient of 76.66%, 76.66%, and 80.00% for 2009, 2014, and 2020, respectively. The overall accuracies of 80.55%, 80.55 and 83.33% were calculated for 2009, 2014, and 2020, respectively

2.3.7 Image classification and detection of changes

ArcMap 10.3 was utilized to create land use maps for the years 2009, 2014, and 2020, which were subsequently analyzed using several key methods. First, a supervised classification technique was employed to categorize the land cover types. Second, all different land use classes were displayed in the same layer for easy comparison. Finally, the area of each land use class was calculated to quantify the extent of different land uses over time. To detect changes in land use patterns, a land use table was generated, which included the areas of the various land cover classes for each year. While the three components have different impacts, the reasons are unclear: why have higher levels of social and environmental impacts failed to translate into economic impacts?

2.3.8 Data analysis methods

ArcGIS 10.3 and ERDAS IMAGINE software were utilized for image classification, land use and land cover change detection, and mapping. Data from interviews, focus groups, field observations, and secondary sources were collected, edited, coded, and entered into SPSS 26 for analysis. The biophysical characteristics of the watershed, along with information from household surveys, were integrated for further interpretation. Descriptive statistics, such as mean, percentage, and chi-square tests, were employed to summarize the data and interpret the findings, allowing for a comprehensive analysis of the land use changes and the socio-economic and environmental factors influencing them.

2.4 Results and discussion

2.4.1 Land use and land cover change detection over the period 2009, 2014, and 2020

The findings presented in Figures 8-10 show land use and land cover maps generated from ground truth and classified Landsat images for three time periods (2009, 2014, and 2020). These maps reveal that land use in the study area changed significantly over time, with shifts occurring from one land use type to another in either an increasing or decreasing manner. The analysis indicates notable changes in the spatial distribution of various land cover classes, reflecting the impacts of watershed management interventions and other influencing factors. The findings emphasize the complexity of land use changes in the watershed and underscore the importance of integrated watershed management strategies that

address both environmental and socio-economic factors. These shifts in land use and land cover are essential for understanding the long-term sustainability of the watershed and its ability to support both ecological health , human livelihoods and food security.

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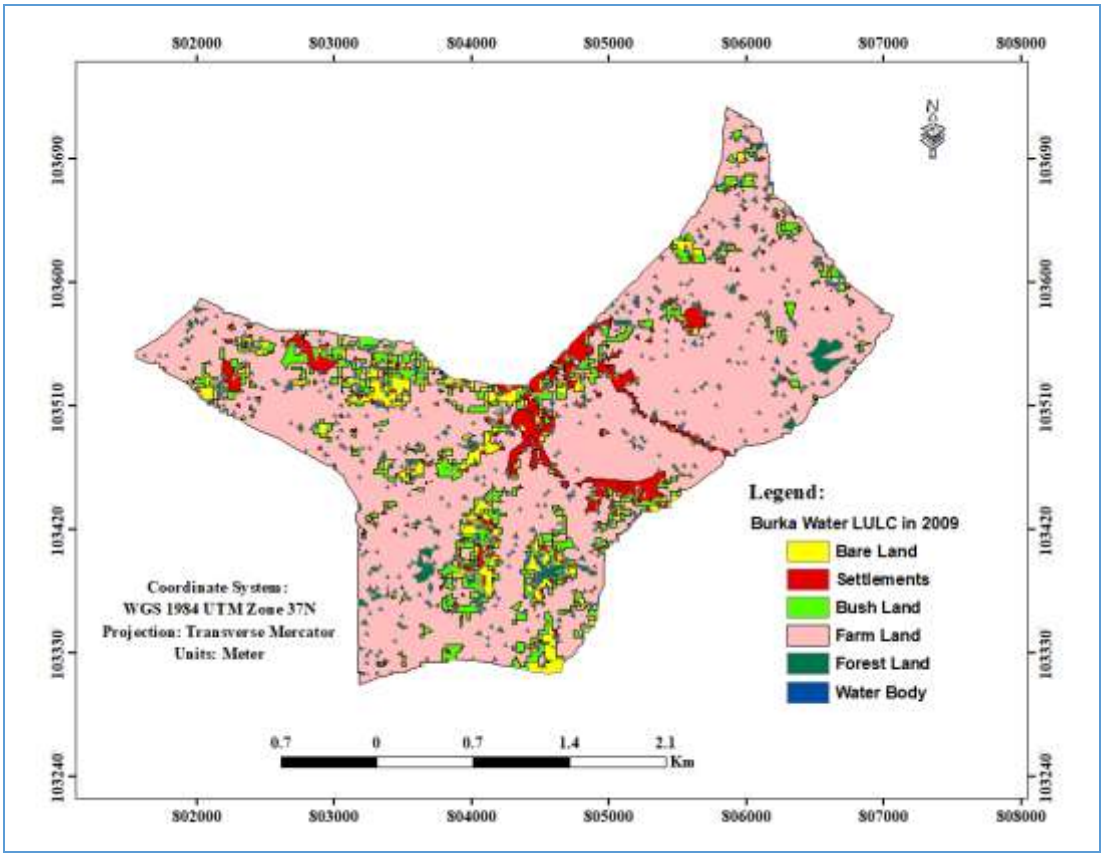
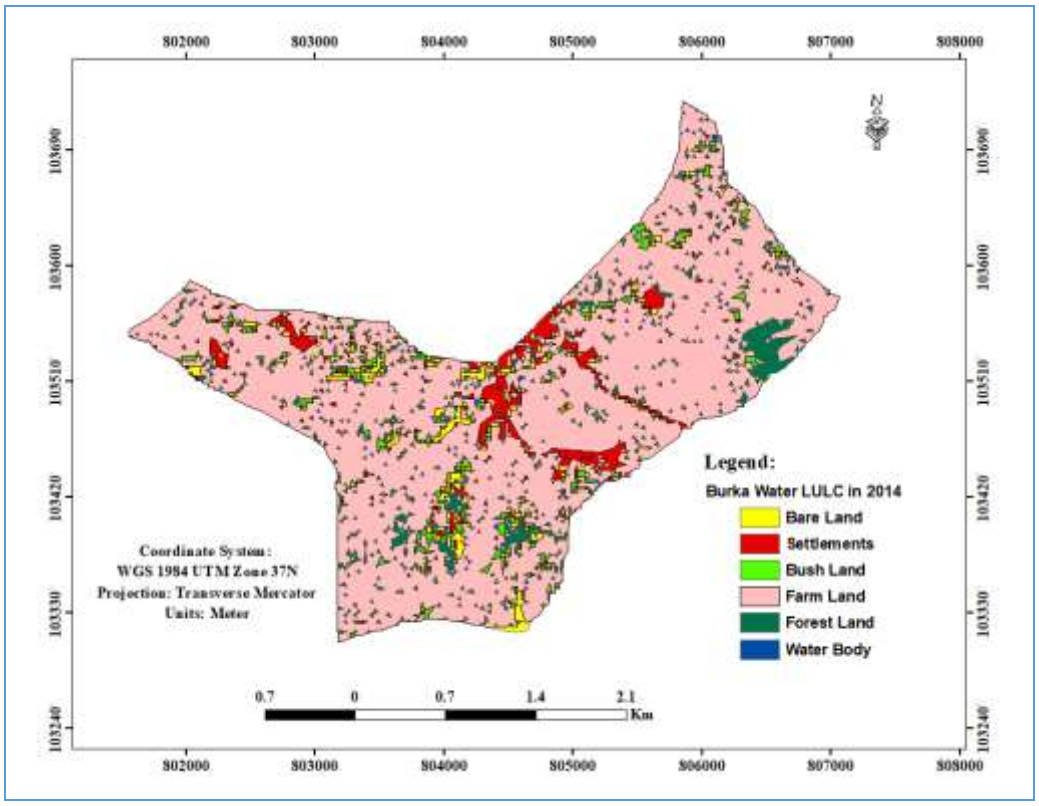




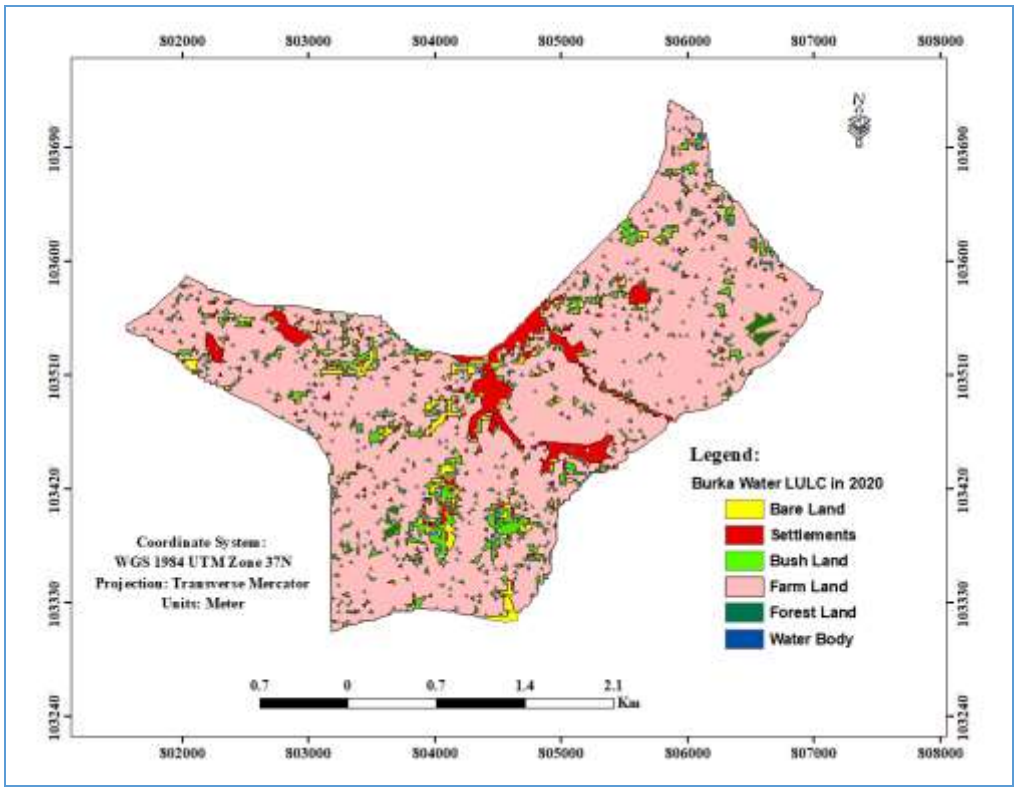
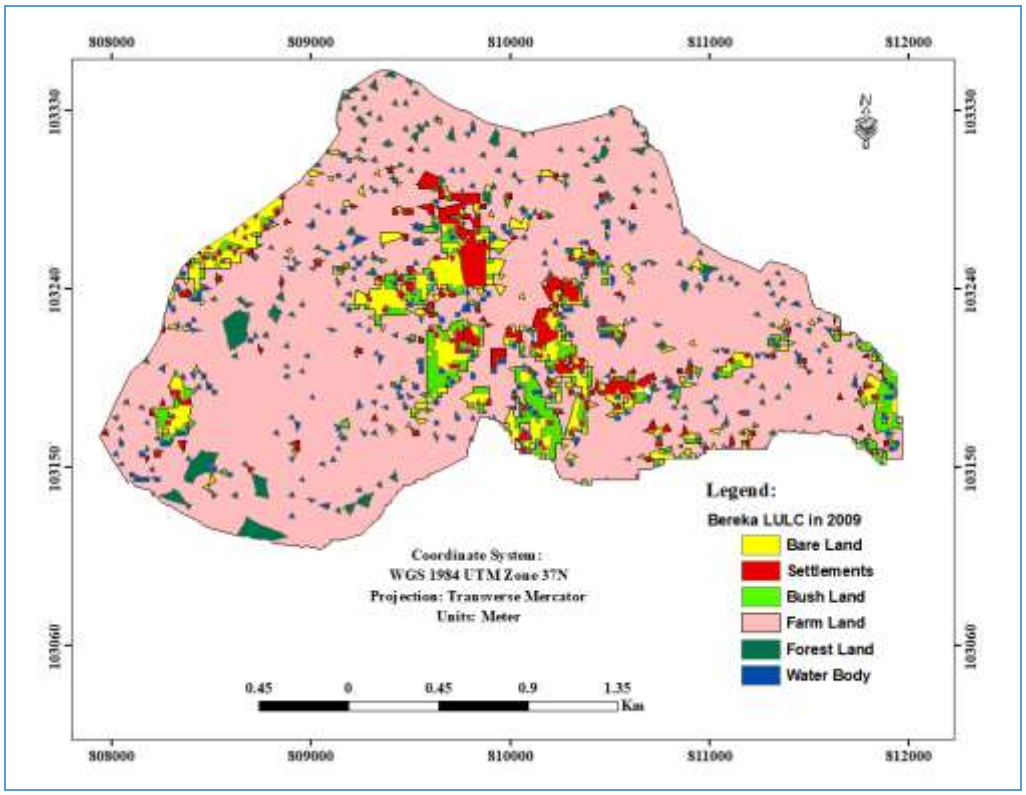


Figure 8: land use the land cover of Burqa Water (2009-2020)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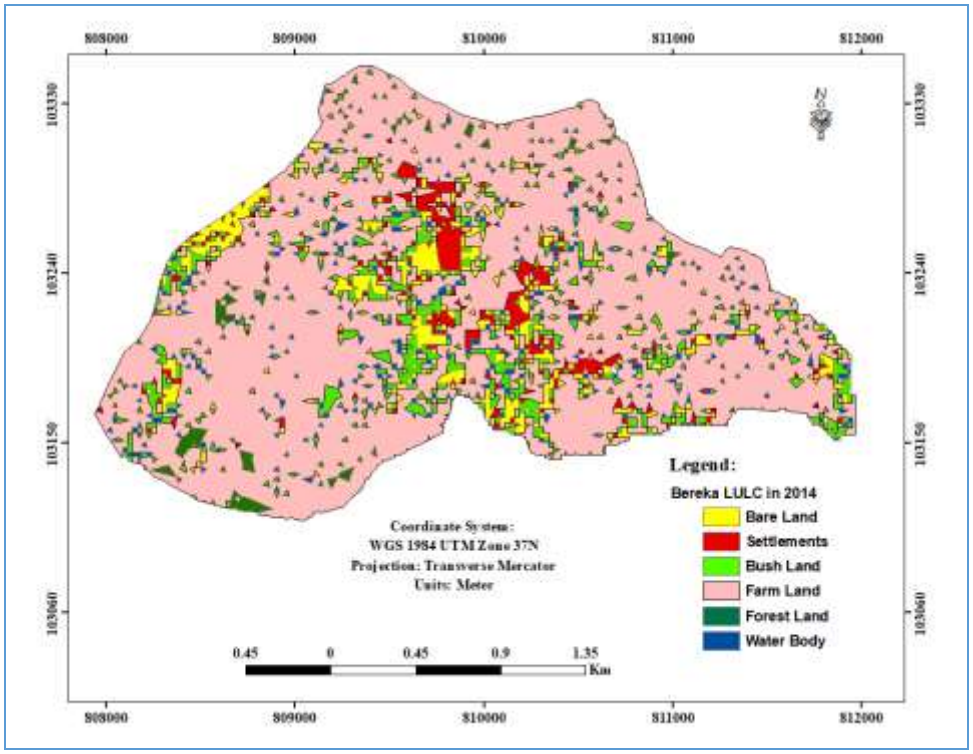
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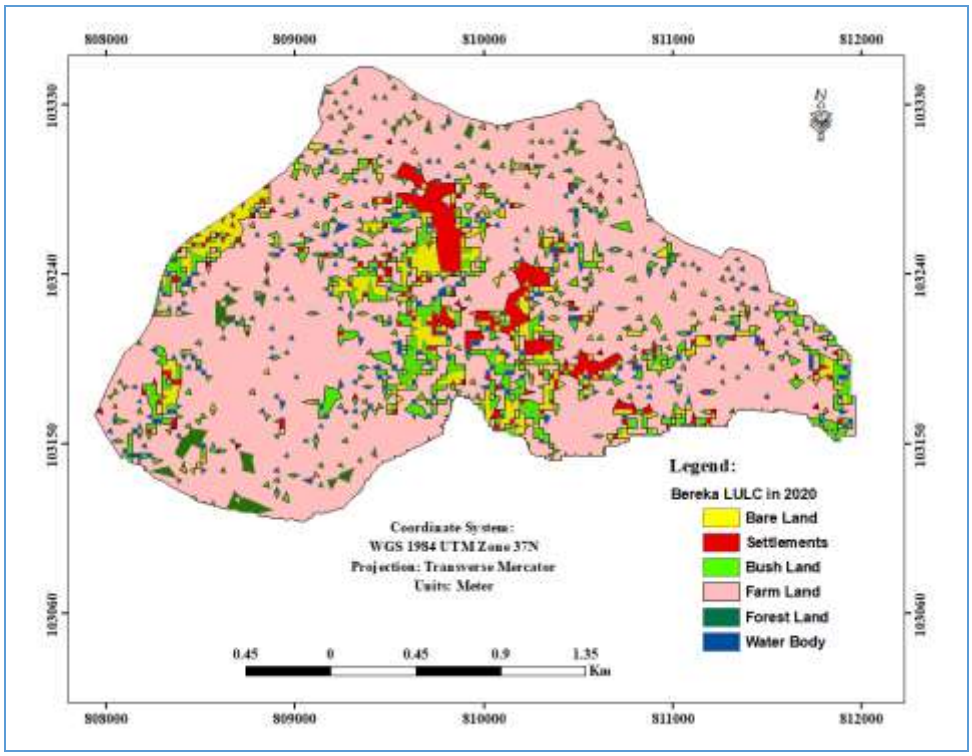
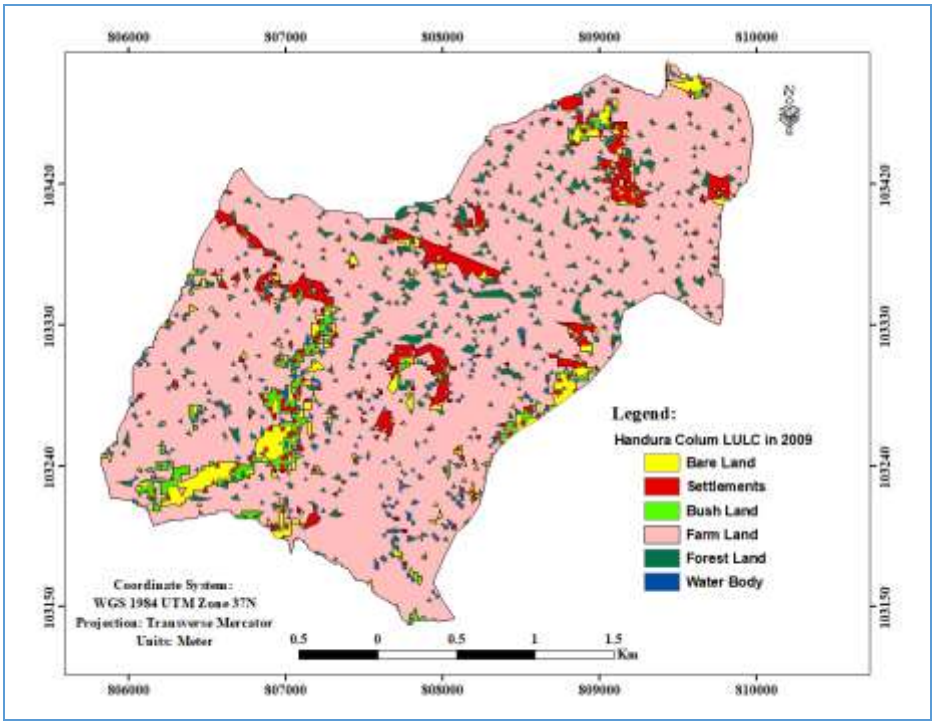
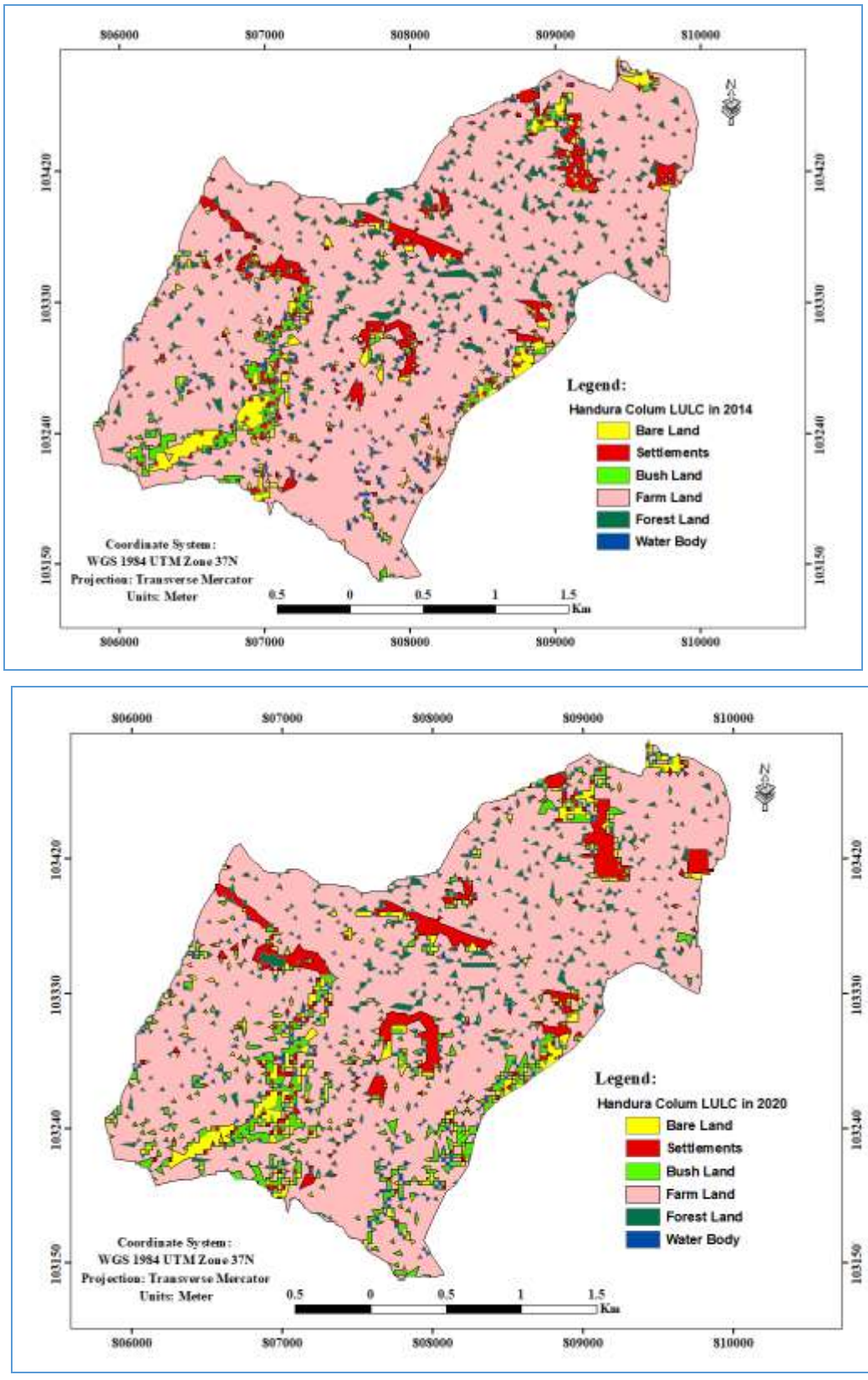


Figure 9: Land use land cover of Barka (2009-2020)





Figurer 10: land use land cover of Adhura Kusum (2009-2020

During the study period (2014-2020) six different categories of land use land cover were identified: settlements, water bodies, bare land, agricultural/farmland, shrub and brush land, and forest land. Farmland was the most dominant land use type in all three micro watersheds, accounting for around 80.24 percent of Burka water, 77.75 percent of Andhra Kosum, and 74.59 percent of Barka micro watersheds. Interestingly, the proportion of farmland and bare land decreased in all three intervention areas by 0.95 and 0.56 percent in Burka Water, 0.7 and 0.55 percent in AduraKosum, and 0.76 and 0.57 percent in Baraka micro watersheds. Settlement area and shrub land, on the other hand, increased in all three micro watersheds by 0.41 and 0.49 percent, 0.63 and 0.62 percent, and 0.76 and 0.68 percent in Burka water, Andura Kosum, and Barka micro watersheds, respectively. The decrease in bare land in both micro watersheds indicates the effectiveness of watershed management interventions in restoring degraded land. This result aligns with other studies by Assefa & Singh (2018) and Tesfay et al. (2023). However, the decrease in farm / agricultural land is contrary to the general trend of previous land use and land cover change studies in Ethiopia and Assefa & Singh, (2018) but consistent with Tesfay et al. (2023). Key informants interviewed also confirmed that population pressure is the main factor contributing to the reduction of farmland, and it may remain a problem even in the future despite the positive impact of the watershed intervention on reducing bare land. In addition, during the focus group discussion, they explained that the spread of invasive alien plant species such as Striga and *Parthenium hysterophorus* on agricultural land was another reason for the decrease in farmland. A study on the impact of an invasive alien weed species in Eastern Hararghe also confirmed that the invasion of farmland by invasive alien plant species reduced farmland for crop production (Tamiru 2020). A 90-year-old farmer from Adhura Kosum shared a story that illustrates the impact of population pressure on land ownership.

> He explained that he shared his 3-hectare land with his four male children, who then divided their share with their grandchildren. The children of his grandchildren have no more land to share with the next generation because they only receive a piece of land on which they can construct their homes. The opportunity to inherit land in his family is almost impossible.

This is in line with the general trend of central statistical agency population projections which indicated the average land holding size per holder has in general been decreasing due to population growth and the degradation of agricultural land. The findings also highlighted that sustaining food security in the area

through agricultural land is the most pressing concern now and in the future and that establishing an integrated watershed Management approach is an essential strategy in the area.

2.4.2 Land use land cover inter-class conversion and change path

The conversion matrix displaying the LU LC change gained, lost, substituted, and net persisted values for the years (2009 to 2014) and (2014 to 2020) is shown in Tables 5 and 6. From (2009 to 2014) LU LC change conversion, the decrease occurred on bare land, followed by forest land, while settlement areas, bushland, and farm land showed an increasing trend. According to LU LC conversion, between (2014 to 2020) decrease occurred in barren lands followed by farm land, whereas settlement areas, bushland, water bodies, and forest land showed an increasing trend. The key informant interviews, focus group discussions, and image interpretation confirmed that bare land is decreasing and shrub land and waterbody are increasing. Further, practical field observations also revealed that the watershed management practice resulted in a biophysical change in all of the study micro watersheds. The land use and land cover change study revealed the success of integrated watershed management practices in restoring degraded land, which contributed to increased water availability (Table 5). A similar study by Tsegaye et al. (2014) also reported the impact of watershed management on changes in land use and land cover and increased production.

Table 5 : Summary of land-use for the year 2009, 2014 and 2020

LULC Category	Area(ha) in trends			Change in ha	Change in ha.
	2009	2014	2020	2009-2014	2014-2020
Bare Land	118.37	106.48	95.47	-11.89	-11.01
Settlement	110.55	117.65	125.2	7.1	7.55
Bush Land	121.75	125.44	129.23	3.69	3.79
Farm Land	1693.78	1694.25	1692.51	0.47	-1.74
Forest Land	81.37	81.78	82.85	0.41	1.07
Water Body	52.39	52.61	52.96	0.22	0.35
Total	2178.21	2178.21	2178.21		

Table 6: Matrix for land use and land cover changes for 2009 to 2014 in Hectares (ha)

	LULC in 2014(ha)						
LULC in 2009(ha)	Bare Land	Settlement	Bush Land	Farm Land	Forest Land	Water Body	Grand Total
Bare Land	72.09		15.53	30.75			118.37
Settlement		110.55					110.55
Bush Land	15.07		43.35	60.39	2.95		121.75
Farm Land	23.80		72.25	1590.84	6.89		1693.77
Forest Land			0.94	13.09	67.34		81.38
Water Body					1.29	51.10	52.39
Grand Total	110.96	110.55	132.07	1695.07	78.47	51.10	2178.2

Table 7: Matrix for land use and land cover changes for 2014 to 2020 in Hectares (ha)

	LULC in 2020(ha)						
LULC in 2014(ha)	Bare Land	Settlement	Bush Land	Farm Land	Forest Land	Water Body	Grand Total
Bare Land	94.4	3.7	7.5	0.9			106.5
Settlement		117.7					117.7
Bush Land	0.0	0.1	120.4	4.7	0.2		125.4
Farm Land	0.7	11.3	8.0	1671.9	1.9	0.5	1694.2
Forest Land	0.5		4.6	7.8	69.0		81.8
Water Body				0.3	0.3	52.1	52.6
Grand Total	95.60	132.66	140.49	1685.58	71.33	52.56	2178.2

LULC= land use land cover change

2.4.3 Observed changes in ecological status as perceived by farmers after the watershed management intervention.

According to Key Informant interviewers, before the watershed management intervention, there was a severe problem of soil erosion and floods flowing from the upper slopes, destroying many individuals' farmland. The massive removal of soil from farm and pasture areas has resulted in crop production problems and livestock feed shortages. A study conducted by Tsegaye et al. (2014) in the surrounding

area also confirmed that the problem of flooding from the sloppy area has destroyed many farmlands and resulted in the disappearance of various water bodies like Lake Alamaya. in the area. However, as stated by key informant interviewers following the watershed management intervention, various physical conservation structures have been constructed in the area, resulting in several noticeable improvements such as the restoration of degraded areas, reduced soil erosion, and the reemergence of previously disappeared water bodies.

Similarly, during the Focus Group Discussion, participants from the three micro watersheds confirmed that the problem of soil erosion, sedimentation, and flooding had been reduced, and as a result, crop and pasture productivity had improved. The practical field visit also confirmed the visible changes as a result of the watershed management intervention in the restoration of degraded land and the reemergence of previously disappeared water bodies (Figure 11). This is congruent with studies by Legesse et al.(2018), and Gebregziabher et al. (2016) which reported that watershed management practices reduced the rate of soil erosion, and sedimentation in the downstream, and improved soil moisture while increasing productivity.

Figure 11: Biophsical change obderved

Similarly, the household survey confirmed both the idea raised by the key informant and the focus group discussion as indicated in the table (Table 7). Almost all of the households interviewed in the three micro watersheds stated that the soil and water conservation practices, as well as the enclosed area, enhanced their livestock feed. About 93.4 percent of surveyed households said that soil erosion had decreased after the watershed intervention, 3.6 percent reported no change, and 1.5 percent reported that soil erosion was increasing. Furthermore, 84.9 percent of the respondents said that deforestation has

been reduced. 5.5 percent answered there had been no change, and 8.6 percent stated that deforestation was increasing. Similar studies by Tadele & Dananto, (2018); Adimassu & Langan, (2016); and Haregeweyn et al., (2012) also found that watershed management has been proven to preserve sustainable biological conditions by restricting surface runoff generation, which results in an incremental rise in groundwater that is similar to the finding in Table 7. A study conducted by Munro et al. (2008) in Tigrayi's central plateau also found watersheds effective in controlling soil erosion and increasing land productivity. However, the key informant stated that poor policy implementation and lack of clear roles and responsibilities among different stakeholders are still major challenges for sustainable watershed management in the area.

Table 8: Household response on effectiveness of biophysical land rehabilitation

No	Status after Watershed Management Interventions	Increased		Decreased		No change		Difficult to tell		Worsen	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
1	Reduced soil erosion	5	1.5	313	93.4	12	3.6	4	1.2	1	0.3
2	Reduced Deforestation	25	8.6	248	84.9	16	5.5	1	0.3	2	0.7
3	Overgrazing	12	3.7	283	86.5	27	8.3	4	1.2	1	0.3
4	Gully formation	23	7.1	256	79.3	40	12.4	4	1.2	0	0.0
5	Plough steep slopes	23	7.1	237	73.4	52	16.1	8	2.5	3	0.9
6	Cutting trees for fuel wood	44	13.6	224	69.1	44	13.6	11	3.4	1	0.3

2.4.4 Ecological and economic benefits that contribute to increased food security

Attaining food security through its four pillars is heavily dependent on the effectiveness of land and water management practices as well as the success of other sectors (Diriba 2020). In line with this, the results of the study indicate that watershed management practice contributes to the four dimensions of food security: availability, access, utilization, and stability. About of the households reported that after the watershed management intervention, their dependency on a single crop was reduced as a result of diverse possibilities. This is in line with the findings of the study conducted in Tigray by Adimassu et al. (2017) which examined how farmers were able to grow a variety of fruits, vegetables, trees, and forages after rehabilitating degraded land. The interviewed households have also confirmed the effectiveness of

watershed management on their socioeconomic improvement in terms of enhanced agricultural input, credit services, increases in off-farm income, reduction in post-harvest loss, irrigation development, health, and veterinary service. Table 8 also demonstrates the environmental and economic improvements that the respondent households witnessed after the watershed management intervention in the three micro watersheds.

Table 9: Household responses to the effectiveness of WMP for socioeconomic improvement**.**

No	Improvement after watershed management	Increase		Decrease		No change	
		Freq.	%	Freq.	%	Freq.	%
1	Improvement of agricultural and rural credit after IWSM implementation	220	65.3	20	5.9	97	28.8
2	Irrigation practices after IWSM implementation	260	77.2	7	2.1	67	19.9
3	Pest infestation after IWSM implementation	238	70.6	10	3.0	89	26.4
4	Dependence on single harvest after IWSM implementation	21	6.2	266	78.9	50	14.8
5	Off-farm income improvement after IWSM implementation	294	87.2	6	1.8	37	11.0
6	Post-harvest losses after IWSM implementation	7	2.1	268	79.5	62	18.4
7	Health /malaria problem after IWSM implementation	11	3.3	295	87.5	31	9.2

IWSM = (Integrated Watershed Management)

Practical field observations also revealed the potential of watershed management, which involves combining various activities on a single piece of land to contribute to food security(Figure 12)

Figure 12: Multiple activities on a single piece of land at watershed level

. The majority of the households interviewed in the three micro watersheds also reported that watershed management interventions had enabled the restoration of degraded which resulted in a significant

improvement in land productivity and thereby ensured their food security. A similar study on watershed management by Mekuriaw (2017) and Gashaw (2015) also confirmed that physical soil and water conservation with agronomic practices are essential for improving both the provisioning and management of ecosystem services, as well as food security. Studies by Mulugeta et al. (2018), Assefa & Singh (2018), and Mohammed (2015) also confirmed that watershed management activities help to increase household income, and access to water for irrigation, human, and livestock.

The focus group and key informants also revealed that before the implementation of the watershed intervention in the areas, women and children had to travel long distances to fetch water. However, following the development of the watershed, small springs emerged, as a result of which the local people began to fetch water from a short distance close to their residences. They also confirmed that soil conservation and water harvesting structures in the watershed helped increase water availability for cattle and other domestic uses, consequently improving the perennial supply of water from the streams. The majority of the interviewed households also revealed that after the watershed management intervention, they had noticed changes in the socioeconomic and environmental conditions. A key informant interview and focus group discussion further demonstrated that the physical and biological conservation measures implemented had resulted in the rehabilitation and reclamation of severely degraded areas, which resulted in notable improvements in land productivity. Table 9 also confirms this.

Table 10**:** Household Repose on effectiveness of Watershed Management on access to water and livestock feed

Status of Watershed Management after Interventions	Increased		Decreased		No change		Difficult to tell		Worsen	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Access to livestock feed	197	60.2	52	15.9	71	21.7	4	1.2	3	0.9
Access to potable water	207	63.9	35	10.8	74	22.8	7	2.2	1	0.3
Access to irrigation water	235	72.3	29	8.9	56	17.2	4	1.2	1	0.3
Crop productivity	236	72.6	26	8	53	16.3	10	3.1	0	0
Livestock productivity	188	57.5	30	9.2	86	26.3	23	7	0	0

Secondary data from the three micro-watersheds also confirmed that the irrigated area has increased by 0.72 percent, in the Burka Water 0.69 percent in Adhura Kosum, and 1.5 percent in Barak after the

watershed intervention. Interviewed agricultural experts also confirmed that watershed management practices have assisted crop and livestock production and productivity. This will in turn improve household food security. The findings are consistent with those of Mekuriaw (2017) and Gashaw (2015), who also reported that watershed management Programme increased crop yields, reduced run-off and soil loss, increased groundwater, and reduced poverty. Yet, the main challenge is that neither government officials nor practitioners seem to understand the connections between food security and integrated watershed management practices. Therefore, the local community, extension agents, experts, and policymakers must give attention to the watershed management approach to make the watershed a viable solution to the problem of food insecurity.

2.4.5 Household Response on food security status from own farm after and before watershed management intervention

In the context of food security, smallholder farm productivity is crucial for both food production and household consumption levels. In this section, we compared the number of months people experienced food shortages before and after the intervention to learn more about the effects of the biophysical and socioeconomic changes brought about by watershed management on rural household food security in the study area. The PSNP's experience, which involved transfers for six months at times of shortages of food, was used as a benchmark (Tasew et al., 2022).

Table 11: The number of months food shortage before and after integrated watershed management**.**

	Baraka WS_PNSP N= (118)		BurkaWater_SLMP N=(107)		Adhura kosum-Regular N=(112)		Total N=(337)	
No of Month	Before %	After %	Before %	After %	Before %	After %	Before %	After %
1-3 month	19 16.1)	(45) 38.1	(6) 5.6	(53) 49.5	(26) 23.2	(59) 52.7	(51) 15.1	(157) 46.6
3-6 month	(52) 44.1	(39) 33.1	(63) 58.9	(53) 49.5	(48) 42.9	(50) 44.7	(163) 48.3	(142) 42.2
7-9 month	(27) 22.9	(31) 26.3	(38) 35.5	(1) 0.93	(37) 33.0	(3) 2.68	(102) 30.3	(35) 10.4
Above 10 month	(20) 16.9	(3) 2.5			(1) 0.9		(21) 6.2%	(3) 0.89

Chi-Square = 51.846 P-Value = 0.00 before 56.616 P-value = 0.00 after

Before the implementation of watershed management practices, around 16% of PNSP PW, 5.6 % of SLMPII 23% of mass mobilization reported experiencing food shortages for one to three months. However, following the implementation of watershed management, the proportion of respondents reporting food shortages for one to three months changed to 38.1%, 49.5%, and 52.7%, respectively, for the PNSP, SLMPII, and mass mobilization interventions.Additionally, following watershed management practices, the percentage of PNSP PW who responded to food shortages lasting longer than 10 months decreased from 16.9% to 2.56%. Similar results were also observed in SLMP II and Free Mass Mobilization, where 35% and 33% of respondents, respectively, showed the complete transformation from experiencing 7-9 month food shortages to 3- 6 months after watershed management intervention. Statistical analysis of the chi-square test also showed a significant difference at P-Value =000 in both the pre-and-pre-and-pre- and post-watershed management intervention. However, productive Safety Net and SLMP Programme participant farmers showed a significant improvement in their food security status as compared with free mass mobilization Programme participants.

Our findings suggest that watershed management improves the food shortage of the respondent households by 62% as compared to before the watershed management (Table 10). Similarly study by Berhane et al. (2014) in PNSP public reported that watershed management has improved food security by 1.29 months**.** Studies conducted in different parts of the country also confirmed the effectiveness of watershed management interventions in enhancing food availability, water access, and reliable income (Worku et al., 2018; Mekuriaw 2017; Gashaw 2015). However, challenges still exist about the status of food security as both Programme approaches are focused on physical conservation rather than comprehensive watershed management. Therefore, if food security is to be sustained in the long run, equal understanding and knowledge of watershed management needs to be implemented in all three Programme approaches.

2.5 Conclusions

The findings of the study in both three micro watersheds on land-use land cover change and Household survey have indicated that watershed management interventions have yielded tangible results. The land use dynamics between 2014 and 2020 showed a decrease in bare land area and an increase in shrub lands, forest land, and water bodies. The household survey also confirmed that watershed management

intervention has played an important role in reducing soil erosion, improving moisture retention and soil productivity, and allowing farmers to diversify their production alternatives and incomes. This would indicate how much a watershed management approach improves degraded agricultural land, thereby attributing to increased production and productivity, water availability, and fodder security for the community while mitigating the effects of drought. However, the watershed approach is still more focused on physical conservation rather than comprehensive watershed management. Therefore, food security is to be sustained in the long run, it is crucial to develop the linkages between the environmental, social, and economic issues to manage watersheds effectively

2.6 Reference

Adimassu, Z., & Langan, S. (2016). *Comprehensive impact assessment of watershed management interventions in Comprehensive impact assessment of watershed management interventions in Ethiopia* (Issue May).

Adimassu, Z., Langan, S., Johnston, R., Mekuria, W., & Amede, T. (2017). Impacts of Soil and Water Conservation Practices on Crop Yield, Run-off, Soil Loss and Nutrient Loss in Ethiopia: Review and Synthesis. *Environmental Management*, *59*(1), 87–101. https://doi.org/10.1007/s00267-016-0776-1

Anantha, K. H., & Wani, S. P. (2016). Evaluation of cropping activities in the Adarsha watershed project, southern India. *Food Security*, *8*(5), 885–897. https://doi.org/10.1007/s12571-016-0613-7

Assefa, A. A., & Singh, K. N. (2018). Determinants of food insecurity in the rural farm households in South Wollo Zone of Ethiopia: the case of the Teleyayen sub-watershed. *Agricultural and Food Economics*, *6*(1). https://doi.org/10.1186/s40100-018-0106-4

Bakala, F., & Asfaw, M. (2020). The Role of Natural Resources for Sustaining Food Security in Ethiopia: A Review. *Food Science and Quality Management*, *97*, 5–13. https://doi.org/10.7176/fsqm/97-02

Bazezew, A., & Worku, A. (2018). Households' Participation in Watershed Management in Gonji Kolella District of the Amhara National Regional State, Ethiopia. *EJSS*, *4*(1).

Bekele, A., Aticho, A., & Kissi, E. (2018). Assessment of community based watershed management practices: emphasis on technical fitness of physical structures and its effect on soil properties in Lemo district, Southern Ethiopia. *Environmental Systems Research*, *7*(1). https://doi.org/10.1186/s40068-018-0124-y

Berhane, G., Gilligan, D. O., Hoddinott, J., Kumar, N., & Taffesse, A. S. (2014). Can social protection work in Africa? The impact of Ethiopia's productive safety net programme. *Economic Development and Cultural Change*, *63*(3), 1–26. https://doi.org/10.1086/677753

Bhatta, B. (2008). Remote sensing and GIS. In *gis.Science - Die Zeitschrift fur Geoinformatik* (Issue 2). https://doi.org/10.1201/9780429326349-15

Congalton, R. G. (2001). Accuracy assessment and validation of remotely sensed and other spatial

information. *International Journal of Wildland Fire*, *10*(3–4), 321–328. https://doi.org/10.1071/wf01031

Congalton, R. G., & Green., K. (2009). *Assessing the Accuracy of Remotely Sensed Data Principles and Practices Second Edition 55127_C000.indd 1 11/4/08 7:12:20 PM*. https://www.taylorfrancis.com/books/mono/10.1201/9781420055139/assessing-accuracy-remotely-

Desta, L., Carucc, V., Abebe, A., Wendem-Ageňehu, & Contributors, Y. (2005). *Community Based Participatory Watershed Development A Guideline* (G. Contributors (Alphabetical) Yitayew Abebe, AMAREW Tariku Alemu, WFP Abiye Astatke, ILRI Volli Carucci, WFP Lakew Desta, MoARD Sileshi Getahun, MoARD Tesfai Mebrahtu (ed.); Issue January).

Diriba, G. (2020). Agricultural and rural transformation in Ethiopia. *Ethiopian Journal of Economics*, *27*(2), 51–110.

Ewunetu, A., Simane, B., & Teferi, E. (2021). *Mapping and Quantifying Comprehensive Land Degradation Status Using Spatial Multicriteria Evaluation Technique in the Headwaters Area of Upper Blue Nile River*.

FAO. (2017). *Watershed Management in Action: Lessons -learned from FAO field projects*.

Foody, G. M. (2022). Land Cover Classification Accuracy Assessment. *Springer Geography*, *80*, 105–118. https://doi.org/10.1007/978-981-16-5149-6_6

Gashaw, T. (2015). The implications of watershed management for reversing land degradation in Ethiopia. *Research Journal of Agriculture and Environmental Management*, *4*(1), 5–012. http://www.apexjournal.org

Gashu, K., & Muchie, Y. (2018). Rethink the interlink between land degradation and livelihood of rural communities in Chilga district , Northwest. *Journal of Ecology and Environment*, *42/17*, 1–11.

Gebregziabher, G., Assefa, D., Gebresamuel, G., Meredith, G., & Simon, L. (2016). *An assessment of integrated watershed management in Ethiopia. International Water Management Institute (IWMI), Colombo. (IWMI Working Paper 170)*.

Gopa, L., Gokhale, Y., & Mini, G. (2021). *Food and Land Resources : Incorporating Watershed- Based Approaches for Better Sustainability-productivity balance.*

Guiné, R. de, Pato, M. L. de J., da Costa, C. A., da Costa, D. de V. T. A., da Silva, P. B. C., & Martinho,

V. J. P. D. (2021). Food security and sustainability: Discussing the four pillars to encompass other dimensions. *Foods*, *10*(11). https://doi.org/10.3390/foods10112732

Haregeweyn, N., Berhe, A., Tsunekawa, A., Tsubo, M., & Meshesha, D. T. (2012). Integrated watershed management as an effective approach to curb land degradation: A case study of the enabered watershed in northern Ethiopia. *Environmental Management*, *50*(6), 1219–1233. https://doi.org/10.1007/s00267-012-9952-0

Hassan, Z., Shabbir, R., Ahmad, S. S., Malik, A. H., Aziz, N., Butt, A., & Erum, S. (2016). Dynamics of land use and land cover change (LULCC) using geospatial techniques: a case study of Islamabad Pakistan. *SpringerPlus*, *5*(1). https://doi.org/10.1186/s40064-016-2414-z

Kothari, C. . (2004). *Research methodology: Methods and techniques, Second Edition* (Issue 1). New Age International (P) Limited, Publishers,New Delhi -.

Legesse, A., Bogale, M., & Likisa, D. (2018). Impacts of community based watershed management on land use/cover change at elemo micro-watershed, Southern Ethiopia. *American Journal of Environmental Protection*, *6*(3), 59–67. https://doi.org/10.12691/env-6-3-2

Mekuriaw, A. (2017). Assessing the effectiveness of land resource management practices on erosion and vegetative cover using GIS and remote sensing techniques in Melaka watershed, Ethiopia. *Environmental Systems Research*, *6*(1). https://doi.org/10.1186/s40068-017-0093-6

Mena, M. M. (2018). Community adoption of watershed management practices at Kindo Didaye District, Southern Ethiopia. *International Journal of Environmental Sciences & Natural Resources*, *14*(2). https://doi.org/10.19080/ijesnr.2018.14.555881

Mengistu, F., & Assefa, E. (2019). International soil and water conservation research farmers ' decision to adopt watershed management practices in Gibe basin , southwest Ethiopia. *International Soil and Water Conservation Research*, *7*(4), 376–387. https://doi.org/10.1016/j.iswcr.2019.08.006

Meyfroidt, P., Abeygunawardane, D., Ramankutty, N., Thomson, A., & Zeleke, G. (2019). ScienceDirect Interactions between land systems and food systems. *Current Opinion in Environmental Sustainability*, *38*, 60–67. https://doi.org/10.1016/j.cosust.2019.04.010

Mohammed, A. A. (2015). Determinants of household food security and coping strategies: the case of Bule-Hora District, Borana Zone, Oromia, Ethiopia. *European Journal of Food Science and*

Technology, *3*(3), 30–44. www.eajournals.org

Moroda, G. T., Tolossa, D., & Semie, N. (2018). Food insecurity of rural households in Boset district of Ethiopia: A suite of indicators analysis. *Agriculture and Food Security*, *7*(1), 1–16. https://doi.org/10.1186/s40066-018-0217-x

Mulugeta, M., Tiruneh, G., & Alemu, Z. A. (2018). Magnitude and associated factors of household food insecurity in Fedis Woreda East Hararghe zone, Oromia region, Ethiopia. *Agriculture and Food Security*, *7*(1), 1–8. https://doi.org/10.1186/s40066-017-0140-6

Munro, R. N., Deckers, J., Haile, M., Grove, A. T., Poesen, J., & Nyssen, J. (2008). Soil landscapes, land cover change and erosion features of the central plateau region of Tigrai, Ethiopia: Photo-monitoring with an interval of 30 years. *Catena*, *75*(1), 55–64. https://doi.org/10.1016/j.catena.2008.04.009

Mzava, P., Nobert, J., & Valimba, P. (2019). Land cover change detection in the urban catchments of Dar es Salaam, Tanzania using Remote Sensing and GIS Techniques. *Tanzania Journal of Science*, *45*(3), 315–329. www.ajol.info/index.php/tjs/

Reddy, V. R., Saharawat, Y. S., & George, B. (2017). Watershed management in South Asia: A synoptic review. *Journal of Hydrology*, *551*(October), 4–13. https://doi.org/10.1016/j.jhydrol.2017.05.043

Tadele, D., & Dananto, M. (2018). Quantifying the impact of integrated watershed management on groundwater availability in Gerduba watershed, Yabello district, Ethiopia. *International Journal of Water Resources and Environmental Engineering*, *10*(7), 90–99. https://doi.org/10.5897/ijwree2018.0781

Teressa, D. (2020). Community Participation on watershed management programme . The Case Community Participation on Watershed Management Programme . The Case of Gemechis District , Oromia , Ethiopia. *International Journal of Comprehensive Research in Biological Sciences*, *5*(December), 9–17.

Tesfay, F., Tadesse, S. A., Getahun, Y. S., Lemma, E., & Gebremedhn, A. Y. (2023). Evaluating the impact of land use land cover changes on the values of ecosystem services in the Chacha Watershed, Ethiopia's central highland. *Environmental and Sustainability Indicators*, *18*(April), 100256. https://doi.org/10.1016/j.indic.2023.100256

Tsegaye, D. M., Tsunekawa, A., Tsubo, M., Ali, S. A., & Haregeweyn, N. (2014). Land-use change and its socio-environmental impact in Eastern Ethiopia's highland. *Regional Environmental Change*, *14*(2), 757–768. https://doi.org/10.1007/s10113-013-0535-2

Wang, G., Mang, S., Cai, H., Liu, S., Zhang, Z., Wang, L., & Innes, J. L. (2016). Integrated watershed management: evolution, development and emerging trends. *Journal of Forestry Research*, *27*(5), 967–994. https://doi.org/10.1007/s11676-016-0293-3

Wani, S. P., Wangkahart, T., Dixin, Y., Li, Z., & Thang, N. V. (2010). *Community watersheds for food security and coping with impacts of climate change in rain - fed areas Importance of Rain - fed Agriculture and Constraints* (Issue July).

Worku, T., & Sangharsh, T. (2015). *Watershed management in highlands of Ethiopia : A Review*. 1–11. https://doi.org/10.4236/oalib.1101481

Worku, T., Tripathi, S. K., & Khare, D. (2018). Household level tree planting and its implication for environmental conservation in the Beressa Watershed of Ethiopia. *Environmental Systems Research*, *6*(1). https://doi.org/10.1186/s40068-017-0087-4

CHAPTER THREE: SCALING UP COMMUNITY PARTICIPATION IN WATERSHED MANAGEMENT FOR FOOD SECURITY IMPROVEMENT: THE CASE OF QARSA WOREDA , EAST HARAGHE ZONE, ETHIOPIA[2]

3.1 Abstract

The watershed management approach has been well-acknowledged as an effective strategy for improving food security. However, the significance of community engagement, which is vital for the success of this strategy, has not been adequately acknowledged. The study examined the level of community involvement and the factors influencing their participation in watershed management in three different programming approaches that are part of the government's watershed development initiatives in East Haraghe, Qarsa Woreda. A household survey of 337 household heads, focus group discussions, and key informant interviews were used to collect the data. Descriptive statistics, a people participation index, and a binary regression model were used for data analysis. The results of the people participation index indicated a moderate level of farmers' participation in the planning, implementation, monitoring, and evaluation phases, with no significant differences observed between the three micro watersheds. However, there were variations in the indicator metrics within and across the micro watersheds, with participants from the Sustainable Land Management Program II (SLMPII),micro watershed showing significant differences compared to those from the Productive Safety Net Public work (PSNP_PW) and free mass mobilization at levels of 0.01 and 0.05, respectively. The results of binary logistic regression indicated that the overall level of farmer participation was significantly affected by the frequency of extension contact, livestock ownership, education level, family size, and group membership. Thus, consideration should be given to the variation between indicator measurements to achieve comprehensive watershed management for food security improvement. Strengthening the capacity of farmers and establishing ownership is imperative, rather than simply providing them with explícitas instructions to follow.

Keywords: Comminity involvement, farmers, micro watershed, rural development sustainability

[2] *Based on a paper accepted for puplication at All Earth*

3.2 Introduction

The use of watershed management has been widely acknowledged as an effective strategy for reducing poverty, improving food security, and increasing agricultural productivity while also protecting ecological resources (Iroye & Tilakasiri, 2015; Wang et al., 2016; Chimdesa, 2016). The approach gained attention especially after the 1992 Rio Earth Summit in many developing countries, including Ethiopia (Wani & Garg, 2009; Molle, 2009; FAO, 2017). Studies by Tefera et al. (2020) and Taye (2021) found that watershed management practices in Ethiopia has numerous benefits, such as increasing food production, preserving the environment, promoting gender equality, and addressing biodiversity concerns, all which are contributing to food security improbvement. However, the sustainability and the scaling up of this approach have not met the expected level of succes (Teressa, 2018; Gizaw et al., 2018).

According to Bantider et al. (2019), Ethiopia has made significant progress and dedicated significant resources to watershed management; however, the approach has not moved beyond basic conservation practices and has failed to incorporate comprehensive watershed management practices for sustainable livelihoods and food security improvement. The studies by Tesfahun and Chawla (2017), Ananga (2015), and Reed (2008) have demonstrated that the success or failure of watershed management relies on a comprehensive approach that takes into account economic, social, and environmental factors. Furthermore, Wang et al. (2016) argue that to address diverse concerns related to the economy, society, and environment, watershed management requires the active participation of the community in all phases of the watershed management process. A lack of comprehensive engagement by all stakeholders can lead to inconsistencies and the failure of the strategic plan (Mengistu & Assefa, 2021).

Furthermore, the shift in development ideology towards a human-centered approach emphasizes the significance of community participation as a fundamental element in rural development (Pimbert & Pretty, 1995; Wang et al., 2016). According Reed et al. (2018), Usadolo & Caldwell (2016), and Haregeweyn et al. (2015), community empowerment plays a critical role in ensuring inclusive progress and sustainable development at the local level. Bantider et al. (2019) indicated that the effectiveness of watershed management programs heavily relies on the active participation of the community as it directly affect their own lives. Community engagement can enhance various aspects in different contexts by promoting connections, resolving conflicts, and facilitating knowledge exchange (Reed et al., 2018; Usadolo & Caldwell, 2016). Yet, the importance of community participation in watershed

management is often underestimated, as it is commonly seen only as a labor-intensive contribution (German et al., 2006; Snyder et al., 2014; Haregeweyn et al., 2015; Mengistu & Assefa, 2021).

The studies conducted by Tefera et al. (2020), Wang et al. (2016), Ayele et al. (2016), and Terefe et al. (2015) revealed that relying solely on technical solutions is inadequate in addressing the complex challenges faced of watershed management approach and extending beyond is imparative. Mengistu and Assefa (2021) further highlight sustainable watershed management, ultimately require more comprehensive planning for efficient solutions. However, studies in different parts of the country showed biased toward evaluating watershed management programs in terms of biophysical indicators, with less attention to livelihood improvement of people (Ayele et al., 2016; Tessema & Tibebe, 2017). Furthermore, studies conducted by Desta et al. (2005), Kidane et al. (2014), Teresa (2018), and Fekadu and Assefa (2019) have revealed that the top-down planning approach used in watershed management practices fails to take into account the valuable knowledge and input of the local community.

Furthermore, different people have different views on the concept of participation in watershed management (Germen et al.,2007). Indeed, multiple factors play a role in community participation in watershed management, including , institutional, sociological, technological, and logistical aspects. According to Botes and Van Rensburg (2000) proposed paradigm the external obstacles, such as financial and technological barriers, government encouragement for involvement, development experts, and selective engagement have an impact on community engagement. Nikkhah and Redzuan (2009) further argue that the local community's ability to set its goals is affected when the development experts dominate decision-making processes. This lack of empowerment hinders the development of communities as they are not allowed to actively participate in shaping their future. Local political dynamics also play a role in limiting community participation by preventing them from having a voice in decision-making processes. Community participation is also impacted by low awareness, poverty, distrust in government programs, and village politics (Bekele et al., 2023; Sangchini, 2023).

Similarly, although Ethiopia has demonstrated a high commitment to community-based participatory watershed management,the integration of community participation into comprehensive watershed management processes particularly in planning, implementation, and monitoring has been insufficient. There is also limited research on the extent and factors influencing comprehensive community involvement in all phases of watershed managements. As a result, the management practices of watersheds suffer from a lack of comprehensive planning, implementation, and evaluation, thus falling

short of addressing the distinct requirements and preferences of the community (Haregeweyn et al., 2015). Consequently, this has impacted the widespread adoption and recognition of watershed management strategies as a holistic approach. Therefore, this study aimed to examine the extent of farmers' participation and the factors influencing their involvement in various stages of watershed management in the Qarsa woreda, East Harghe, Ethiopia, under diffirent program approach.to improve livelihoods and food security for the local community.

3.3 Material and methods

3.3.1 Conceptual framework of study

The complex and dynamic nature of watershed management requires the active involvement of the community in all stages of the process to attain food security. The active participation of the local communities in the planning, implementation, and monitoring of watershed management initiatives is crucial for improving agricultural productivity, water availability, horticulture, animal husbandry, and other vital services that support food security improvement (Vishnudas et al., 2008; Devi, 2015; Onyancha et al., 2022). However, the extent of community participation in watershed management intervention is influenced by varying perceptions, definitions, and approaches of participation (Alemu et al., 2023).

The concept of participation has been thoroughly analyzed and categorized by various scholars, each offering their perspectives. For instance, Pretty (1995) delineates levels of citizen engagement, ranging from non-participation to tokenism and ultimately to full citizen control. This classification allows for a better understanding of the varying degrees of engagement that individuals can have in participatory processes. Beierle (2002) examines the motivations and objectives behind participation, distinguishing between normative participation, driven by ethical considerations, and pragmatic participation, motivated by self-interest. Tippett et al. (2007) introduced an objective-based model for participation, categorizing it into instrumental, expressive, and deliberative types. These different perspectives provide valuable insights into the motivations, objectives, and outcomes of participation, ultimately contributing to more effective and inclusive participatory practices in development.

The study adopted a pragmatic approach to explore the practical implications of community participation in watershed management, emphasizing the importance of involving stakeholders in decision-making processes. The study also draws on the work of Reed (2008) and Tippett et al. (2007)

to highlight the importance of participation rooted in empowerment, equity, and learning. This philosophy emphasizes the need for community members to have a voice in decisions that will significantly impact their daily lives. It also recognizes the importance of knowledge and technical skills of individuals in decision-making, seeking their input, and recognizing their contributions for successful watershed management (Alemu et al., 2023; Assefa et al., 2018). In this study, "participation" refers to the active involvement of the community in all stages of watershed management practices, allowing them to voice their opinions on developmental matters that will significantly affect their daily lives.

Thus, for effective watershed management, it is essential to assess community involvement through diverse strategies beyond conventional methods ,which often rely on simple surveys asking community members about their participation in specific programs or activities. While this method provides some insight, it overlooks the complexity of involvement and individual motivations (Butterfoss, 2006; Kuruvilla & Sathyamurthy,2015). Consequently, to gain a more comprehensive understanding of community engagement, this study has developed a more advanced methodology that incorporates a diverse array of measurement indicators, building on the research of Roba et al. (2022) and Bagdi & Kurothe (2018), which highlights the importance of employing additional indicators for a thorough evaluation of community involvement. The framework also considers various influencing factors, including institutional dynamics, demographics, and individual attributes such as age, gender, family size, educational level, landholding, and income (Derkyi et al., 2021; Roba et al., 2022; Mengistu & Assefa, 2021). This approach promotes a more comprehensive and inclusive understanding of community engagement by enabling a systematic assessment of farmers' involvement in various stages of watershed management, such as planning, implementation, and evaluation. By incorporating diverse indicators and local insights, the methodology ensures that the viewpoints and experiences of local farmers are properly recognized and integrated throughout the entire process. As a result, this can lead to more effective and sustainable management practices that align with the community's needs and priorities. Figure 11 illustrates the representation of the dependent and explanatory variables, providing a visual framework for understanding the dynamics of community engagement in watershed managemet.

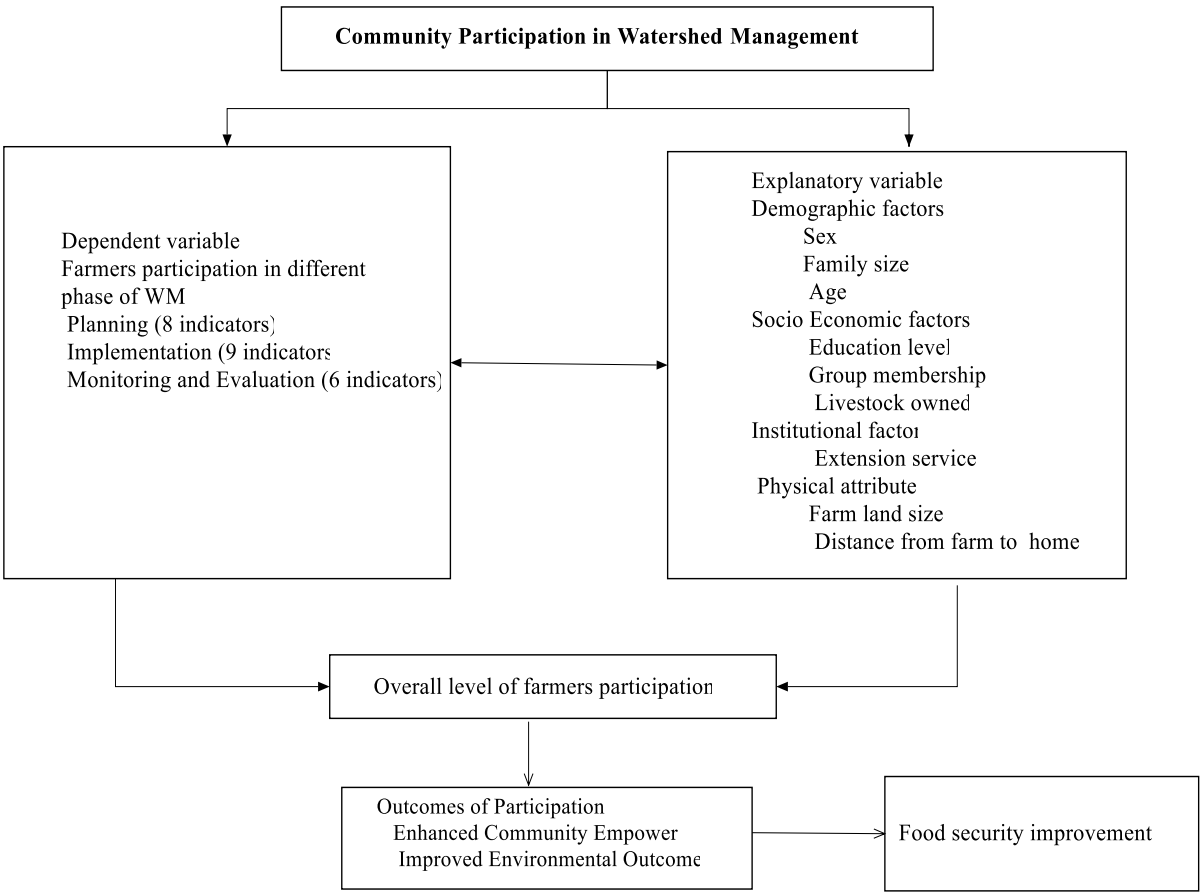


Figure 13: Conceptual frame work of the study

3.3.2 Description of the study area

The study was conducted in *Qarsa* Woreda of East *Hararghe* zone, Oromia region of Ethiopia. Geographically, the district lies between 9^0 17' and 9^0 29'N latitudes and 41^0 12' and 41^0 56'E longitudes to the west of the zonal capital, Harar town. The woreda is one of the food insecure in the East Haralrghe zone. The livelihood of the rural inhabitants is closely linked to the use of land resources for food production, energy sources, shelter constriction, and so on. Watershed management strategies have been applied in the area for a very long period through different initiatives and programs. However, the woreda continued to be the most affected by difficulties with chronic food and nutrition security, soil erosion, declining soil fertility, and water stress. This study focused on three micro watersheds that are part of the Free Mass Mobilization, Sustainable Land Management Program II, and Productive Safety Net Public Work initiatives, which are adjacent to each other (refer to Figure 12). The Free Mass Mobilization micro watershed is an initiative led by the government that does not rely on external

funding, while the Sustainable Land Management Program II and the Productive Safety Net Program receive support from the World Bank. Despite the variations in approach and funding sources, all three micro watersheds share a common approach of utilizing watershed management as a fundamental strategy to improve food security and reduce poverty.

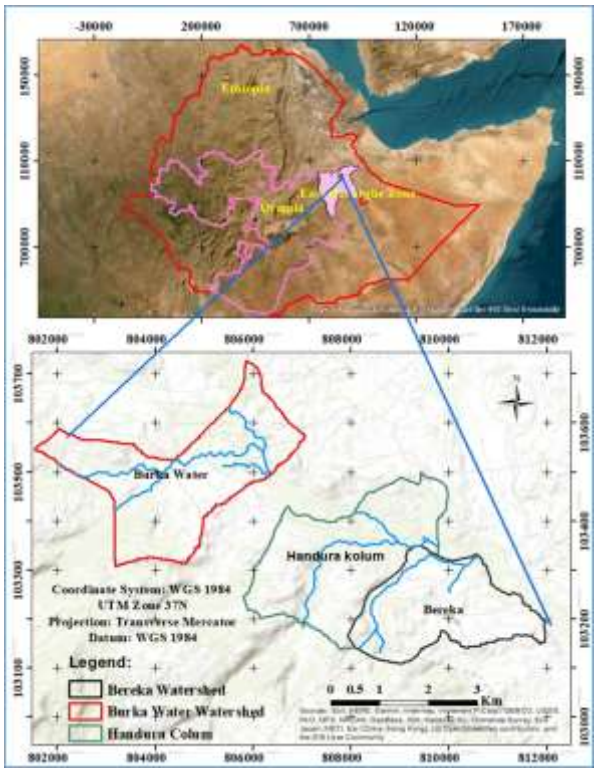


Figure 14: Map of the Study Area

3.3.3 Studydesign, sample size and data collection method

The study employed a mixed research design, combining quantitative and qualitative methods, to provide a coensive analysis. Quantitative data were gathered through a household survey, while qualitative insights were obtained from focus groups and key informant interviews, following Creswell's (2012) guidelines. A three-stage random sampling method was employed to select micro watersheds and household heads. The study woreda was purposely chosen because the Free Mass Mobilization, Sustainable Land Management Program II, and Productive Safety Net Program were all simultaneously present. Micro watersheds were selected based on criteria including historical similarities between watershed management interventions, comparable land use systems, and soil and water conservation practices. As a result, one micro watershed was selected from each program approach. For the household

survey, lists of household heads were provided by the Kebele administration and development agents (Table 1). The selection of respondent households was determined using Kothari's (2004) sample size formula to ensure statistical validity, as outlined below.

$$S = \frac{z^2 * P * (1 - p)}{c_2} \quad \text{----------(1)}$$

Where: Z = Z-value (1.96) for 95 confidence level

P = is the percentage picking a choice, expressed as a decimal (0.5)

C = is the confidence interval expressed as a decimal (0.05 = ±0.05)

Subsequently, the actual sample size for the study area was determined as:

$$SS_{pk} = \frac{s}{1+\frac{s-1}{p_k}} \quad \text{----------(2)}$$

Where: SSkp is the sample size for the known population size

S is the sample size for the unknown population calculated using Equation 1

P_k is the known population size from which the sample size is calculated

Table 12: List of sample size of households from each selected micro watershed

No	Name of micro watershed	Program approach	Area in Ha	Population	
				THH	Sample size
1	Andhura Kosum Micro watershed	Free Mass Mobilization	759.5	734	112
2	Baraka Micro watershed	PNSP-PW	565.7	639	107
3	Burqa Water micro watershed	SLMP-II	853.1	765	118
			2178	2138	337

Sources : (Kebele administration and DA)

Focus Group Discussions**:** Alongside the quantitative household survey, five focus group discussions were conducted one in each microwatershed, one at the woreda level and one at the zone level—to deepen understanding of watershed management. Each discussion group, comprising 7 to 9 participants, included a variety of viewpoints from different levels within the community. The participants were local residents, community leaders, stakeholders, and government experts. The goal of these discussions was to capture local perceptions of participation, evaluate community needs, and review current watershed

management practices. The use of open-ended questions encouraged dynamic conversation, yielding valuable qualitative insights. Additionally, key informant interviews were conducted to collect detailed information on watershed management..

Secondary Data: Secondary data were acquired through online research and the review of existing documents, including journal articles, books, and reports from reputable databases related to watershed management. Furthermore, office reports from government levels—woreda, zone, and regional offices—provided valuable quantitative and qualitative information. Access to these resources was secured through an official request letter. This secondary data was instrumental in supplementing and validating the primary data collected for the study**.**

Indicators measurement:

To systematically assess community participation in watershed management, a comprehensive set of 23 participation indicators was developed through a rigorous process. This development was informed by extensive consultations with a variety of stakeholders, including the Kebele watershed committee, local elders, development agents, and the Woreda watershed technical committee. The process also incorporated guidance from participatory community-based watershed management guidelines outlined by Desta et al. (2005) and the Ministry of Agriculture (2020), ensuring that the indicators were both contextually relevant and methodologically sound, as supported by theoretical foundations from Roba et al. (2022) and Tesfaye et al. (2018). The involvement of these diverse groups ensured that the indicators were grounded in local realities and reflective of practical experiences..

The indicators were structured to address three key stages of watershed management: planning, implementation, and monitoring and evaluation. Specifically, eight indicators were allocated to the planning phase, nine to the implementation phase, and six to the monitoring and evaluation phase. Each indicator was assessed using a five-point Likert scale, ranging from 1 (very low) to 5 (very high). This scale allowed for a nuanced evaluation of farmer participation, capturing variations in engagement levels across the different stages of the management process. To categorize participation levels, farmers were briefed on the Pretty (1995) framework and asked to identify the aspect that aligned with their involvement. Then farmers' scores were analyzed, with those scoring at or above the average classified as active participants, while those scoring below the average were categorized as non-participants. This approach provided a detailed understanding of community involvement and facilitated targeted improvements in watershed management practices.

3.3.4 Statistical data analysis

A comprehensive approach was employed to achieve the research objectives, utilizing SPSS version 26 for data analysis. Descriptive statistics, including frequencies, percentages, means, standard deviations, and chi-square tests, were employed to summarize the data and explore relationships among categorical variables. The People's Participation Index (PPI) assessed farmers' involvement in various phases of watershed management. Cronbach's alpha was assessed to evaluate the scale's internal consistency, with values of 0.93 indicating strong reliability. A binary logistic regression model was used to identify significant factors influencing participation levels.

People participation index

People's Participation index (PI) was established through the use of a modified formula (Bagdi & Joshi, 2018) to precisely quantify the level of farmers' participation at the each stage of watershed management as follows.

$$PP_i = \frac{\text{Mean Participation Score (P)}}{\text{Maximum Participation score}} \times 100 \quad (3)$$

$$P = \frac{\sum_{i=1}^{N} P_i}{N} \quad (4)$$

Where, N = the total number of respondent

$$P_i = \sum_{i=1}^{k} (PP_i + PI_i + PM_i) \quad (5)$$

where: PPi is the total scores obtained by a respondent due to participation in program planning; PIi is the total scores obtained by a respondent due to participation in program implementation; PMi is the total scores obtained by a respondent due to participation in program monitoring and evaluation; K is the total number of statements on which responses of the respondents were recorded; Pi is the total participation scores obtained by individual respondent in planning, implementation, and maintenance.

The overall PPI was created by adding values of participation at the three stages, and the classification of the participation index into three categories was adopted based on Roba et al. (2022), Bagdi & Joshi (2018), and the normal distribution curve and standard deviation (SD). The mean and standard deviation (SD) of marks were used to separate participants into low, moderate, and high levels of participation (Table 2).

Table 13: Categorization of people's participation according to normal distribution curve values

	Normal distribution curve range	PPI value	PI category
1	< Mean- SD	< ± 38.93	Low level
2	Mean-SD, to mean +SD	38.94 - 75.72	Moderate level
3	>Mean+SD	> ±75.73	High level

3.3.5 Variables and model specification

To investigate the factors influencing farmers' engagement in watershed management practices, a binary logistic regression model was employed to assess the relationship between independent variables and the binary outcome of their participation level. This statistical method is especially appropriate for scenarios where the dependent variable is binary, indicating two possible outcomes—specifically, participation or non-participation in watershed management activities (Greene 2008). To apply the logistic regression model, the overall participation score was transformed into a dummy variable. The scores were categorized by grouping them according to the average participation score. This categorization did not affect the size and significance of the main effects, types of associations, or interactive effects (Greene 2008; Talaei et al., 2023). The response is a binary variable, with a value of 1 indicating active or high participation if the score in indicator metrics is equal to or higher than the mean. Conversely, a value of 0 is assigned if the respondents' score is lower than the mean in indicator metrics, categorizing them as less active. The overall participation score is then converted into a binary variable, represented as a dummy variable.The likelihood of farmers actively participating in the practice of watershed management, denoted as Pr (Yi = 1), can be determined by evaluating a cumulative density function at $X_i\beta$. In this context, Xi represents a set of explanatory variables, while β refers to the parameters that need to be estimated. To model this cumulative density function, a logistic probability function can be employed, as described by (Getacher & Tafere, 2013)

$$.P_r(Y_i = 1) = \frac{exp(X_i\beta)}{1+\exp(X_i\beta)} \quad (6)$$

The estimation form of this logistic transformation for the probability that a respondent will express a higher participation P_r (Y_i=1) is represented as (Greene, 2002);

$$Ln\left[\frac{P_r(Y_i=1)}{1-P_r(Y_i=1)}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots \beta_n X_n \quad (7)$$

where P_r denotes the probability that the ith respondent had for active participation; X_i is a vector of explanatory variables; β is the parameters to be estimated. The dependent variable of this study is the level of farmers' participation in watershed management practices, which is coded as 1 if the respondent had actively participated in the program and 0 otherwise. The study chose several explanatory variables, including age, sex, educational attainment, family size, total number of animals held, farmland size, frequency of extension contact, group membership, and distance from plot to home, as predictor variables to explain the level of community participation. These variables were selected based on the available data and their expected influence on participation in the study area, as well as on previous empirical literature on participation in watershed management practice (Derkyi et al., 2021; Roba et al., 2022; Mengistu & Assefa, 2021). Table 4 presents the hypothesized explanatory variables used in the logistic model, along with their expected direction of association with the response variables.

Table 14.:Explanatory variables included in the logistic regression model influencing level of participation

Variables	Description	Measurement procedure	Expected sign
SEX	Sex of the household head	1 if male, otherwise 0	(Men are expected to be more involved than women)
AGE	Age of household head	Year	(Older people are more engaged than younger)
EDU	The educational level of the household head	1 unable to read and write otherwise educated	Educational achievement is expected to have positive outcome
FSIZE	Family size of of the household head	Number	Increase in familywise has expected to have positive out come
DISTANCE	Walking distance in Minutes from farm to home	Min.	Nearest farm have expected positive impact on watershed activities
TOTALLAND	Total land holding of the household head as a proxy indicator of income	Ha	Have more land hold have expectation of active participation
TLULSK	Livestock holding in TLU as a proxy indicator of income	TLU	Have more livestock holding have expectation of active participation
EXTNSSEVIC	Extension service provided	0 Yes otherwise 1	Accessing extension services is expected to have a positive outcome
COMTMBR	Member community watershed committee	0 Yes otherwise 1	Being committee member have given more opportunity of participation

3.4 Results and Discussion

3.4.1 Socio-demographic characteristics of the household

Table 5 presents the socio-demographic characteristics associated with the level of farmers' participation. Among the respondents included in this study, 294 (87.2%) were males, while the remaining were females. Regarding age distribution, approximately 19.6% of the farmers fell within the 18–30 year age group; 144 (42.7%) were aged between 31 and 45 years, 114 (33.8%) belonged to the 46–64 year age category; and 13 (3.9%) were above 64 years old. This suggests that the sample captured a diverse range of ages within the farming population. The educational background of farmers plays a crucial role in their farming activities and overall productivity. In this regard, it was found that 191 (56.7%) had no formal education, 52 (15.4%) were able to read and write, 29 (8.6%) had completed grades 1 to 4 in primary school, 43 (12.8%) had completed grades 5 to 8 in secondary school, and 22 (6.5%) had completed grades 9 to 12. A significant portion of farmers lack basic skills, and this highlights the need for targeted educational and extension programs to enhance their knowledge and skills in watershed management. Furthermore, the average size of livestock holdings was determined to be 2.58 tropical livestock units (TLU). Livestock production holds significant importance as one of the primary agricultural activities.

Table 15: Socio-demographic characteristics of households

Variables	Categories	Frequency	Percent
Sex of the household	Male	294	87.2
	Female	43	12.8
Age of the Household	18-30	66	19.6
	31-45	144	42.7
	46-64	114	33.8
	>64	13	3.9
Educational level	No formal Education	155	46.0
	Read and write	89	26.4
	Primer (1-4)	46	13.6
	Secondary (5-8)	30	8.9
	Complete (9-120	17	5.0
Family size	1-3	65	19.3
	4-6	90	26.7
	7-10	172	51.0
	>10	10	3.0
Livestock holding LUT	No livestock	155	46.0
	1-5	135	40.1
	6-10	32	9.5
	>10	15	4.5

Total land holding in Hectare	<=.025	214	63.5
	.26-.0.5	95	28.2
	0.6-.99	19	5.6
	>=1	9	2.7

3.4.2 Community participation in different stages of watershed management

Effective watershed management practices are vital for tackling complex environmental and food security challenges. A key aspect of this effort is the involvement of various stakeholders, particularly the active participation of local communities, which is essential for successfully implementing management strategies (Mengistu & Assefa, 2021). The People Participation Index (PPI) revealed differing levels of farmer engagement across three micro watersheds, with greater participation linked to more effective and sustainable management outcomes. In contrast, lower levels of participation led to less favorable results, highlighting the importance of increased community involvement in improving watershed management effectiveness. A thorough analysis was carried out at each phases to ensure a comprehensive evaluation and enhancement of management practices.

3.4.2.1 Level of community participation in the planning phase

Table 15 presents a comprehensive analysis of farmer involvement during the planning phase of watershed management. High involvement in awareness-raising meetings was noted across all three micro watersheds, with participation rates of 86.9% for SLMP II, 79.4% for PNSP-PW, and 78.6% for Free Mass Mobilization. However, involvement in providing suggestions and feedback was notably lower, with participation rates of 42.1% for SLMP II, 44.9% for PNSP-PW, and 46.6% for Free Mass Mobilization. This findings indicate that, despite a strong emphasis on raising awareness among farmers, the low levels of active participation in feedback mechanisms point to a lack of inclusivity during the planning stage. Additionally, variability in farmer participation was evident among the programs concerning certain indicators, with the SLMP II program demonstrating greater engagement in specific participatory techniques, such as resource mapping and transect walks, as well as a stronger focus on the inclusion of marginalized and vulnerable communities, in contrast to the other programs (Table 15). This highlights the effectiveness of SLMP II in fostering technical aspect in watershed management planning. However when it comes the overall level participation, the People Participatory Index (PPI) showed moderate level across all micro watersheds: SLMP II at 57.8%, PNSP-PW at 55.5%, and Free Mass Mobilization at 52.6%, with no statistically significant differences (P = 0.852). The comparable

PPI scores suggest that whilethere was high participation in some indictors and programs overall participation remains relatively consistent across the programs.

During focus group discussions, community members expressed concerns that the watershed management planning process has been influenced by development agents, experts, and government representatives. They reported that these higher-level authorities often impose their ideas and solutions without fully understanding or incorporating the specific needs and perspectives of the farmers. As a result, the planning approach frequently fails to address the challenges and priorities of farmers in their local contexts, leading to less effective and less relevant solutions. This aligns with Mawhorter's (2010) study, which highlighted that natural resource management planning is often dominated by professional experts in government agencies, limiting public engagement. Similarly, Teressa (2018) found in West Harraghe that decision-making authority largely rests with government officials, with minimal community involvement. Félix et al. (2015) also observed that the planning process is natural resources shaped by officials rather than reflecting local community concerns.

However, research indicates that for watershed management to be truly effective, it must integrate the ideas and knowledge of local stakeholders. Desta et al. (2005) emphasize that a comprehensive planning approach should value input from a wide range of stakeholders to ensure holistic management. Darghouth et al. (2008) argue that community participation should begin at the planning stage to ensure that the strategies developed are more tailored to and effective in addressing the specific needs and challenges of local environments. Engaging farmers in the planning process can lead to more relevant and practical solutions, ultimately enhancing the success and sustainability of watershed management efforts. These findings underscore the need for more inclusive policy formulation that actively engages farmers and marginalized groups, supports technical training, and shifts towards collaborative planning methods. Addressing these issues can enhance watershed management effectiveness, leading to improved food security and sustainable agricultural outcomes.

Table 16: Level of community participation in the planning stage of watershed management practices

Watershed management practices at the planning stage	PNSP _PW N=118 Freq&%	SLMP _II N=107 Freq&%	Free Mass Mobilization N= 112 Freq&%	Total N=337 Freq&%	Chi-Square	P-Value
I have participated in an awareness-creation meeting organized and provided before watershed management planning.	94 (79.4)	93 (86.9)	88 (78.6)	275 (81.6)	18.26	0.019**
I took technical training on the CBPWM guidelines for proper watershed planning	60 (50.8)	73 (68.22)	57 (50.9)	190 (56.4)	17.825	0.023*
I have participated participation in PRA techniques like resource mapping, social mapping, transect walks, etc., following CBPWM principles.,	57 (48.3)	64 (59.8)	55 (49.1)	176 (52.2)	27.55	0.001**
I gave my suggestions, and information and raised ideas during the planning of the watershed management in my locality	70 (59.3)	55 (51.4)	52 (46.4)	177 (52.5)	16.985	0.030**
I feel my suggestions were taken into consideration	53 (44.9)	45 (42.1)	50 (44.6)	148 (43.87)	12.359	0.136
I am a witness that the poor and marginalized members of the community participate in the micro watershed planning	56 (47.5)	62 (57.9)	57 (50.9)	175 (52.1)	9.858	0.275
I actively participated during the election of Kebele watershed committee members	50 (42.4)	46 (43)	60 (53.6)	156 (46.31)	5.551	0.697
I have been participating in the process of watershed plan approval	62 (52.5)	57 (53.3)	56 (50.0)	175 (51.93)	11.95	0.153
Overall PPI %	**55.5**	**57.8**	**52.6**	**55.2**		**0.852**

*NB * significate at P =0.01 and p= 0.05 and farmers score medium and above were considered as active participant are considered*

3.4.2.2 Level of community participation in the implementation phase

Table 16 provides a comprehensive analysis of farmer engagement during the implementation phase of various watershed management practices. The study reveals significant differences in participation rates: SLMP II demonstrates superior performance in technical training with a participation rate of 69.2%, significantly higher than PNSP (43.2%) and Free Mass Mobilization (43.8%), as indicated by a Chi-Square value of 52.60 (P = 0.001**) indicating the program's effectiveness in equipping farmers with essential skills. Conversily , Free Mass Mobilization excels in family engagement, achieving the highest participation rate of 85.7% compared to PNSP (66.1%) and SLMP II (67%), with a Chi-Square value of

70.52 (P = 0.03*), highlighting the program's success in fostering family involvement. However, level of farmers participation in physical soil and water conservation, as well as in contributing labor and materials were found high across all programs, ranging from 83.0% to 90.0%, without significant differences (X^2 = 11.276, P = 1.87; X^2 = 11.891, P = 0.152) reflecting a universal recognition among farmers of the importance of these practices for maintaining land productivity and addressing environmental challenges like soil erosion and water scarcity. On the other hanad the the result showed that level of farmers participation in supervising ongoing activities, developing watershed management bylaws, and engaging in economic activities related to forage and livestock development, crop production, and off-farm income generation remains low, ranging from 31.3% to 44.6% suggesting that while physical conservation practices are well-integrated, there is a pressing need to enhance participation in regulatory and economic aspects to improve the overall effectiveness of watershed management and support food security.

The participants in the focus groups at community level have also confirmed that the implementation of watershed management tends to prioritise physical conservation measures over a comprehensive strategy. Field observations further revealed that numerous community members possess a greater familiarity with concrete conservation techniques, which may detract from recognizing the significance of incorporating regulatory and economic dimensions vital for successful watershed management. This tendency may arise from knowledge gaps that limit the comprehensive application of watershed practices. This observation aligns with Biswas et al. (2012), who stress the importance of knowledge-based entry-point activities for improving community engagement. Supporting this, Akello et al. (2017) and Mutune & Nunow (2018) advocate for a more integrated approach to watershed management that enhances community involvement.

Moreover, Etsay et al. (2023) emphasize that empowering farmers through education and training is crucial for promoting sustainable practices and improving food security. This perspective is corroborated by Roba et al. (2022), Brombal et al. (2018), and Montemayor (2023), who highlight the need for inclusive participation across all aspects of watershed management to boost agricultural productivity and food security. Addressing these gaps requires a comprehensive strategy that not only integrates technical training and conservation practices but also focuses on the economic dimensions of watershed management. Bridging these gaps is essential for advancing food security and ensuring the long-term sustainability of watershed management practices.

Table 17: Level of community participation at the implementation stage of watershed management practices

Watershed management practices at the implementation stage	PNSP N=118	SLMP II N= 107	Free Mass Mobilization N=112	Total **N=337**	Chi-Square (X^{2})	P-Value
	Score &%	Score& %	Score &%	Score &%		
I have participated in technical training that acquire the knowledge and skills required for practical implementation	51 (43.2)	74 (69.2)	49 (43.8)	174 52.60	25.21	0.001**
My family members a participants in the community's watershed management practices.	78 (66.1)	73 (68.5)	96 (85.7)	247 (73.5)	20.917	0.03*
I have participated in contributing resources such as labor, money, and so on during watershed implementation	107 (90.7)	94 (87.9)	96 (85.7)	297 (88.08)	11.891	0.152
I have participated in physical soil and water conservation both on my own farm/common land in the watershed	102 (86.94	97 (90.7)	92 (82.1)	283 (83.9)	11.276	1.87
I have participated in and practiced forage development or livestock development activities as part of the watershed	47 (39.8)	33 (30.8)	50 (44.6)	130 (38.44)	52.79	0.00**
I have participated in and practiced crop production and improved crop varieties as part of the watershed management practice	40 (33.9)	38 (35.5)	39 (34.8)	117 34.74	16.614	0.83
I have participated in off-farm income-generation activities as part of the watershed management practice	37 (31.4)	39 36.4	35 (31.3)	111 (33.02)	41.94	0.00**
I have participated in supervising the ongoing activities/works undertaken in the fields and community lands	49 (41.5)	41 (38.3)	41 (36.6)	131 (38.82)	34	0.90
I have participated in developing watershed management bylaws	50 (42.4)	46 (43)	57 (50.9)	153 (45.42)	5.55	0.69
Overall PPI %	**52.80**	**55.12**	**53.00**	**53.30**		**0.893**

NB * significate at P =0.01 and p= 0.05 and *farmers score medium and above were considered as active participant are considered*

3.4.2.3 Level of community participation in the Monitoring and evaluation phase

Monitoring and Evaluation (M&E) are essential for the effective management of watersheds, helping to ensure that actions are aligned with established goals and that desired outcomes are achieved. Table 17 provides a comprehensive assessment of the People Participation Index (PPI) across different M&E indicators. The study reveals significant variability in farmer participation across watershed management programs. SLMP II demonstrates high engagement in maintaining physical conservation and conducting regular assessments, with participation rates of 64.5% and 63.6%, respectively (P = 0.020**; P = 0.000**). In contrast, Free Mass Mobilization excels in protecting area closures, achieving a participation rate of 50.9% (P = 0.006**). Meanwhile, PNSP PW leads in attendance at regular meetings at 47.5%, although this difference is not statistically significant (P = 0.062). These findings indicate that while SLMP II effectively promotes active farmer involvement, Free Mass Mobilization successfully fosters community-driven conservation efforts, and PNSP PW shows potential in enhancing meeting participation. Despite individual strengths, the overall Farmers' Participation Index (PPI) shows moderate engagement across all programs: PNSP at 45.6%, SLMP_II at 49.2%, and Free Mass Mobilization at 45.4%, with no significant difference (p = 0.590). This suggests that while each program excels in certain areas, comprehensive monitoring and evaluation in all three micro-watersheds is lacking.

Additionally, Focus group discussions indicated that the administrative structure at the kebele level frequently overlooked the significance of monitoring and evaluation (M&E) as essential elements of watershed management. Participants typically viewed M&E responsibilities as solely belonging to government officials and extension workers, which consequently undermined the perceived value of local community participation. This viewpoint may impede the success of watershed management efforts, given that robust community involvement is crucial for promoting accountability and cultivating a sense of ownership in management practices.The findings of this study are consistent with Yusuf et al. (2020) who emphasized that community participation in decision-making is essential for sustainable development. Tadesse et al. (2017) also demonstrated a significant link between community participation in monitoring and evaluation (M&E) and project sustainability, aligning with our data suggesting that enhanced M&E practices are needed for greater effectiveness. Additionally, Gebregziabher et al. (2016) noted that many programs fail due to insufficient community involvement in M&E, which resonates with our findings that higher-level government organizations were not fully

acknowledged the importance of farmer engagement in this processes. This study highlights the need for active and comprehensive community participation in monitoring and evaluation to improve the impact and sustainability of watershed management efforts.

Table 18 : Level of community participation in the monitoring and evaluation phase

Participation at the monitoring and evaluation	PNSP _PW N=118 Freq&%	SLMP _II N=107 Freq&%	Free Mass Mobilization N= 112 Freq&%	Total N=337 Freq&%	(X^2)	P-Value
I have followed the watershed management implementation actions based on existing community organizations	50 (42.4)	50 (46.7)	45 (40.2)	145 (43.1)	10.775	0.215
I attended regular meetings to discuss watershed management actions while in operation	56 (47.5)	48 (44.9)	47 (42.0)	151 (44.8)	14.83	0.062
I have participated in the protection of area closure and other rehabilitated watershed areas in the micro watershed	51 (43.2)	44 (41.1)	57 (50.9)	152 (45.1)	21.515	0.006**
I participated in the decision-making process for the micro watershed.	47 (39.8)	49 (45.8)	44 39.3	139 (41.3)	23.629	0.003**
I regularly checked the quantity and quality of work in line with the Community-based Watershed Management Guidelines.	50 (42.4)	68 (63.6)	49 (43.8)	156 (46.5)	34.599	0.000**
I have participated regularly in the maintenance of the physical conservation activities undertaken in the micro watershed	69 (58.5)	69 (64.5)	67 (59.8)	205 (60.8)	18.335	0.020**
Overall PPI %	45.6	49.2	45.4	46.7		

NB * significate at P =0.01 and p= 0.05 and farmers score medium and above were considered as active participant are considered

3.4.2.4 Overall People's Participation in Watershed Development Programs

Achieving comprehensive watershed management requires a well-rounded strategy that integrates planning, implementation, and monitoring and evaluation (M&E), while also ensuring substantial stakeholder involvement and the application of effective practices. The analysis showed that farmers suggestions and ideas was (52.38%) while contributing resources such as labor and money supports

watershed management activities about (88%). This showed that farmers are more involved only in thire labour and resources. The analysis of Table 18 further indicates that while farmer participation is generally moderate, there are marked differences in engagement across the various stages and programs. Specifically, participation is higher during the planning and implementation phases, reflecting strong initial engagement. However, a significant drop in participation is evident during the M&E phase across all programs. This decline is problematic, as effective monitoring and evaluation are essential for identifying issues, adapting strategies, and ensuring that watershed management practices are achieving their intended outcomes

The study underscores a tendency among farmers to concentrate on physical conservation measures rather than engaging comprehensively with all indicator measurements. This focus on physical measures, although important, is insufficient for addressing broader food security issues. Effective watershed management requires a more holistic approach that integrates physical conservation with comprehensive resource management strategies. Research by Bantider et al. (2019) and Okongo (2018) supports this view, emphasizing that integrated resource management, which combines physical conservation efforts with broader resource management practices, is essential for reducing poverty and enhancing food security.

The significant drop in participation during the M&E phase indicates a potential gap in maintaining farmer engagement throughout the entire management process. Without robust involvement in M&E, it becomes challenging to identify problems, adapt strategies, and ensure that the watershed management practices are effectively contributing to food security. To improve the impact of watershed management on food security, it is critical to enhance farmer engagement across all stages, with a particular focus on M&E. Adopting a more integrated approach that addresses both physical conservation and comprehensive resource management is essential for achieving long-term improvements in food security.

Table 19: Overall level of community participation in planning, implementation monitoring, and evaluation phases

	PNSP-PW	SLMP II	F MM	Total
Planning	55.5	57.8	52.6	55.2
Implementation	52.8	55.12	53	53.6
Monitoring and Evaluation	45.6	49.2	45.4	46.7
Overall PPI	51.3	54.0	50.3	51.8

3.4.3 Factors affecting level of community participation in watershed management

Table 19 presents the results from the binary logistic regression model that examined the factors influencing farmers' involvement in watershed management practices at various stages. The findings revealed that demographic, socioeconomic, and biophysical factors significantly affected farmers' participation. A statistically fit model has substantiated the accuracy of its specifications. The Chi-square test ($\chi^2 = 215.68$, $p < 0.001$) demonstrated considerable explanatory power, and the Nagelkerke R Square indicated that approximately 82% of the variance in participation levels could be explained by the independent variables. The variance inflation factors (VIF) remained below the acceptable limit of 10 which suggests a fit and reliable analytical characteristic (see Apedex 2). Among the ten explanatory variables investigated in the binary regression model, all of them demonstrated statistical significance at both the 1% and 5% probability levels.

Table 20: Results of logistic regression model analysis

Variables	B	S.E.	Wald	df	Sig.	Exp(B)	95% CI. for EXP(B)	
							Lower	Upper
Sex of the household(1)	-1.027	0.352	8.512	1	0.004	0.358	0.18	0.714
Extension advice service (1)	9.13	1.16	61.957	1	0.000	9226.667	950.03	89609.05
Member community watershed committee(1)	2.733	0.312	76.564	1	0.000	15.38	8.339	28.369
Educational level			95.728	4	0.000			
Educational level(1)	2.063	0.301	46.956	1	0.000	7.867	4.361	14.191
Educational level(2)	4.049	0.63	41.303	1	0.000	57.333	16.678	197.093
Educational level(3)	3.258	0.573	32.286	1	0.000	26	8.451	79.993
Educational level(4)	3.401	0.779	19.058	1	0.000	30	6.516	138.13
Distance from farm plot to home in Min.			54.655	3	0.000			
Distance from farm plot to home in Min.(1)	3.904	0.765	26.042	1	0.000	49.593	11.073	222.114
Distance from farm plot to home in Min.	2.814	0.756	13.844	1	0.000	16.679	3.788	73.446
Distance from farm plot to home in Min.(3)	-1.478	1.247	1.404	1	0.236	0.228	0.02	2.629
Age of farmer			62.247	3	0.000			
Age of farmer(1)	2.02	0.433	21.751	1	0.000	7.541	3.226	17.628
Age of farmer(2)	3.453	0.461	56.099	1	0.000	31.607	12.803	78.027
Age of farmer(3)	2.943	0.722	16.622	1	0.000	18.964	4.609	78.035
Constant	-2.132	0.4	28.433	1	0.000	0.119		
family size			108.56	3	0.000			

family size(1)	0.281	0.884	0.101	1	0.750	1.325	0.234	7.493
family size(2)	4.991	0.748	44.522	1	0.000	147.121	33.958	637.39
family size(3)	5.223	1.289	16.417	1	0.000	185.5	14.828	2320.652
Livestock holding			120.53	3	0.000			
Livestock holding (1)	3.646	.345	111.980	1	0.000	38.325	19.507	75.295
Livestock holding (2)	5.538	1.048	27.943	1	0.000	254.118	32.607	198.431
Livestock holding (3)	3.325	.623	28.516	1	0.000	27.794	8.203	94.174
Land holding	1.595	236	45.483	1	0.000	4.927	3.100	7.832

Note: indicates significance at < 0.01 and at < 0.05 probab ility level

The results of the logistic regression analysis showed a significant and positive relationship between gender and the level of involvement. This suggests that male participants had a higher level of participation compared to females (b = 1.027, P = 0. 0.004; Table 10). Gender norms play a significant role in shaping the level of gender participation in development activities. It is observed that men tend to be more actively involved in such activities, whereas women are predominantly burdened with childcare and household chores. This finding aligns with the outcomes of a study conducted by Nasrabadi et al., (2013) revealed that the multitude of responsibilities shouldered by women significantly hinders their level of participation in development activities. The relationship between extension contacts and community participation in watershed management practices has been found to be significant and positive across all stages. This indicates that farmers who have access to extension services are more likely to actively participate compared to those who do not have access to such services (b = 9.13, P = 0.00; Table 10). Access to extension contacts can empower farmers with knowledge, skills, and resources enabling them to actively contribute to the sustainable management of their local watersheds. This is in line with a study by Getacher, & Tafere (2013),which found a significant and positive correlation between participation level and technical knowledge regarding watershed management. Being a member of a community-based watershed management program is a significant indicator of participation. The odds ratio for this predictor indicates that farmers who are part of the community watershed management and operate in the nearby area are 9.95 times more inclined to participate compared to those who are not engaged in the committee. This suggests that efforts should be made to encourage farmers to join community-based watershed management programs and to create an enabling environment that supports their active involvement. The binary logistic regression marginal effect analysis further confirms for every unit increase in the distance of farmland from the homestead, there is a 4.6% decrease in the likelihood of participation in watershed

management. However, it’s crucial to note that the significance of this effect varies across different distance categories. This variation suggests that while distance generally impacts participation negatively, the degree of impact may differ depending on specific thresholds or ranges of distance. This could be due to various factors such as the inconvenience of traveling long distances to participate, lack of awareness or understanding of the importance of watershed management, or limited resources and capacity to engage in such activities. The result is consistent with research by Sangchini, (2023) on forest management, which identifies distance as a significant factor influencing households' participation.

Educational level of individuals is another important factor consistently and positively influenced community participation in all stages of watershed management methods. The odds ratio of 30.00 indicates a significant difference in participation rates between individuals with higher and lower educational attainment. Farmers with a higher level of education in the area are 30.00 times more likely to engage in participation compared to those with lower educational attainment. This suggests that education plays a crucial role in fostering a sense of responsibility and awareness among individuals, leading to increased involvement in watershed management initiatives. Sex of the household, Livestock holding (LUT), significantly contribute to farmers' participation in watershed programs Further more, the level of participation has also significant correlation with land holdings size. This is in line with Chala & Reddy, (2014) and Mosisa et al., (2018) who reported that farmers with larger plots have more opportunities to participate in conservation activities.

The results from Focus Group Discussions and Key Informant interviews also further confirmed that the level of participation was significantly impacted by the lack of strong local leadership that prioritizes farmers' needs and interests at different decision-making levels as well as the inconsistent training provided to farmers in every aspect of the development of the watershed. The lesson learned from this study indicates that, despite achievements in some biophysical aspects of watershed management activities, the sustainability of the practices as a comprehensive approach to tackling the pervasive issues of food insecurity and poverty was not fully realized. As a result, to ensure the successful implementation of the watershed management practice, policymakers and extension workers need to focus on education and extension services.

3.5 Conclusions and recommendations

This study investigated the degree and factors that impact the involvement of farmers in the implementation of watershed management in three distinct program approaches. The findings revealed that farmers' participation was moderately observed in all three micro watersheds, with no notable variations in any stage of watershed management practice. Nevertheless, variations in farmer participation were observed across different indicators and metrics, with certain activities demonstrating higher levels of involvement while others exhibited lower levels. These differences were statistically significant in all three micro watersheds during various phases of watershed management. The study findings also revealed that all three program approaches favored physical conservation strategies over a comprehensive watershed management approach. As a result, this bias prevented the approach from fully developing into a holistic solution to address the extensive problems of food insecurity and poverty.

The findings of the research also showed that while there was moderate leveleof the involvement of local communities in the planning, implementing, and monitoring process did not adequately consider the needs and preferences of farmers. Instead, external actors like government officials and experts had a significant impact on the decision-making process. This lack of focus on farmers' perspectives resulted in the adoption of less sustainable and efficient management strategies. The level of farmers' participation in different stages of watershed management activities mainly depends on their understanding, ownership, and ability to make informed decisions, rather than solely relying on a predetermined approach. To ensure the active and inclusive participation of farmers in all aspects of watershed management, it is advised to give priority to improving their knowledge, facilitating capacity building, and fostering a strong sense of ownership than merely giving farmers a strict set of instructions or guidelines to follow.

3.6 Reference

Akello, S., Turyahabwe, N., Sseguya, H., Okullo, P., & Agea, J. G. (2017). Local Community Participation in Restoration of Watersheds in Uganda. *American Journal of Environmental Protection*, *5*(2), 25–32. https://doi.org/10.12691/env-5-2-1

Alemu, T., Tolossa, D., Senbeta, F., & Zeleke, T. (2023). Household determinants of continued adoption of sustainable land management measures in central Ethiopia. *Heliyon*, *9*(3), e13946. https://doi.org/10.1016/j.heliyon.2023.e13946

Ananga, E. O. (2015). The Role of Community Participation in Water Production and Management: Lessons From Sustainable Aid in Africa International Sponsored Water Schemes in Kisumu, Kenya. *Scholar Commons*, *December 2015*, 1–201. http://scholarcommons.usf.edu/etdhttp://scholarcommons.usf.edu/etd/5900

Assefa, S., Kessler, A., & Fleskens, L. (2018). Assessing farmers'willingness to participate in campaign-based watershed management: Experiences from Boset District, Ethiopia. *Sustainability (Switzerland)*, *10*(12). https://doi.org/10.3390/su10124460

Ayele, G. K., Gessess, A. A., Addisie, M. B., Tilahun, S. A., Tebebu, T. Y., Tenessa, D. B., Langendoen, E. J., Nicholson, C. F., & Steenhuis, T. S. (2016). A Biophysical and Economic Assessment of a Community-based Rehabilitated Gully in the Ethiopian Highlands. *Land Degradation and Development*, *27*(2), 270–280. https://doi.org/10.1002/ldr.2425

Bagdi, G. L., & Joshi, U. (2018). People's participation in implementation of soil and water conservation program: Case study of Antisar watershed in Kheda district of Gujarat. *Indian Journal of Extension Education*, *54*(4), 74–83.

Bagdi GL, Kurothe R. 2014. People's participation in watershed manage- ment programmes: evaluation study of Vidarbha region of Mahara- shtra in India. Int Soil Water Conserv Res. 2:57–66.

Bantider, A., Zeleke, G., Desta, G., Alamirew, T., Zewdu, A., Isabelle, P., & Hans, H. (2019). *F*rom Land Degradation Monitoring to Landscape Transformation: Four Decades of Learning, Innovation and Action in Ethiop*ia*.

Bekele, Y., Kebede, B., & Kuma, T. (2023). Assessing the role of community participation in integrated watershed management in Dandi Lake watershed Dandi district, West Showa, Oromia, Ethiopia. *Applied Water Science*, *13*(11), 1–16. https://doi.org/10.1007/s13201-023-02009-x

Beierle, T. C. (2002). The Quality of Stakeholder-Based Decisions. Risk Analysis, 22, 739-749.

http://dx.doi.org/10.1111/0272-4332.00065

Biswas, S., Vacik, H., Swanson, M. E., & Haque, S. M. S. (2012). Evaluating integrated watershed management using multiple criteria analysis - A case study at chittagong hill tracts in Bangladesh. *Environmental Monitoring and Assessment*, *184*(5), 2741–2761. https://doi.org/10.1007/s10661-011-2148-x

Botes, L., & Van Rensburg, D. (2000). Community participation in development: Nine plagues and twelve commandments. *Community Development Journal*, *35*(1), 41–58. https://doi.org/10.1093/cdj/35.1.41

Brombal, D., Niu, Y., Pizzol, L., Moriggi, A., Wang, J., Critto, A., Jiang, X., Liu, B., & Marcomini, A. (2018). A participatory sustainability assessment for integrated watershed management in urban China. *Environmental Science and Policy*, *85*(January), 54–63. https://doi.org/10.1016/j.envsci.2018.03.020

Butterfoss, F. D. (2006). Process evaluation for community participation. Annual Review of Public Health, 27(February 2006), 323–340. https://doi.org/10.1146/annurev.publhealth.27.021405.102207

Chala, S., & Reddy, R. U. (2014). Farmer ' s Attitude towards Soil Conservation on Cultivated Lands : The Case of Guliso Woreda , Western Wellega Zone , Oromia Regional State , Ethiopia. *European Academic Research*, *II*(1).

Chimdesa, G. (2016). Climate Change Impacts and Adaptation Actions in Central Rift Valley of Ethiopia. 6(3), 84–93.

Creswell, J. W. (2012). Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research. 4th Ed. *University of Nebraska–Lincoln.* http://repository.unmas.ac.id/medias/journal/EBK-00121.pdf

Darghouth, S., Ward, C., Gambarelli, G., Styger, E., & Roux, J. (2008). Watershed management approaches, policies, and operations: Lessons for scaling up. *Water Sector Board Discussion Papers*, *11*, 1–164. 2

Derkyi, M. A. A., Appau, Y., & Boakye Boadu, K. (2021). Factors influencing community participation in the implementation and monitoring of FLEGT-VPA in Ghana. *Forestry Economics Review*, *3*(1), 19–37. https://doi.org/10.1108/fer-07-2020-0010

Desta, L., Carucc, V., Abebe, A., Wendem-Ageňehu, & Contributors, Y. (2005). Community Based Participatory Watershed Development A Guideline (G. Contributors (Alphabetical) Yitayew

Abebe, AMAREW Tariku Alemu, WFP Abiye Astatke, ILRI Volli Carucci, WFP Lakew Desta, MoARD Sileshi Getahun, MoARD Tesfai Mebrahtu (ed.); Issue January).

Devi, S. (2015). Community Participation and Sustainable Livelihoods : A Study on Watershed Management in Odisha. 509, 278.

Etsay, H., Kelelew, A., Kinfu, S., & Berhe, M. (2023). Do livelihood strategies affect the willingness to participate in land conservation? The case of landless people in rural Tigray. *Sustainable Environment*, *9*(1). https://doi.org/10.1080/27658511.2023.2277559

FAO. (2017). Watershed Management in Action: Lessons -learned from FAO field projects.

Félix, K. A., Pascal, H., Anastase, A. H., Houinsou, D., & Armel, G. S. O. (2015). Farmers' Perceptions on Soil Degradation and Their Socioeconomic Determinants in Three Watersheds of Southern Benin. *Journal of Biology, Agriculture and Healthcare*,

Gebregziabher, G., Assefa, D., Gebresamuel, G., Meredith, G., & Simon, L. (2016). *A*n assessment of integrated watershed management in Ethiopia. International Water Management Institute (IWMI), Colombo. (IWMI Working Paper 170).

German, L., Mansoor, H., Alemu, G., Mazengia, W., Amede, T., & Stroud, A. (2007). Participatory integrated watershed management: Evolution of concepts and methods in an ecoregional program of the eastern African highlands. *Agricultural Systems*, *94*(2), 189–204. https://doi.org/10.1016/j.agsy.2006.08.008

Getacher, T., & Tafere, A. (2013). Explaining the Determinants of Community Based Forest Management: Evidence from Alamata, Ethiopia. *International Journal of Community Development*, *1*(2), 63–70. https://doi.org/10.11634/233028791301431

Gizaw, T., Debebe, Y., & Fikirie, K. (2018). Soil Erosion Risk Assessment Using GIS Based USLE Model for Soil and Water Conservation Planning in Somodo Watershed , South West Ethiopia. International Journal of Environmental & Agriculture Research (IJOEAR), 4(5), 35–43.

Greene WH. (2008). Econometric analysis. 6th ed. Upper Saddle River, New Jersey: Pearson Prentice Hall.

Haregeweyn, N., Tesfaye, S., Tsunekawa, A., Tsubo, M., Meshesha, D. T., Adgo, E., & Asres Elias. (2015). Dynamics of land use and land cover and its effects on hydrologic responses : case study of the Gilgel Tekeze catchment in the highlands of Northern Ethiopia. https://doi.org/10.1007/s10661-014-4090-1

Iroye, K. A., & Tilakasiri, S. L. (2015). Watershed Management and Sustainable Development in

Nigeria. *International Journal of Multidisciplinary Studies*, *2*(2), 30. https://doi.org/10.4038/ijms.v2i2.71

Kidane, D., Mekonnen, A., & Teketay, D. (2014). Contributions of Tendaho Irrigation Project to the Improvement of Livelihoods of Agropastoralists in the Lower Awash Basin , Northeastern Ethiopia. *Ethiopian E-Journal for Research and Innovation Foresight*, *6*(2), 1–19.

Kothari, C. . (2004). Research methodology: Methods and techniques, Second Edition (Issue 1). New age International (P) Limited, Publishers,New Delhi -.

Kuruvilla, C., & Sathyamurthy, K. (2015). Community Participation Towards Effective Social Work Practice. Indian Journal of Applied Research, 5(12), 16–18.

Mawhorter, J. H. (2010). Environmental management reform through the Watershed Approach : A multi-case study of state agency implementation. http://trace.tennessee.edu/utk_graddiss/825

Mengistu, F., & Assefa, E. (2021). Community participation in watershed management: analysis of the status and factors affecting community engagement in the upper Gibe basin, South West Ethiopia. *Journal of Environmental Planning and Management*, *64*(2), 252–288. https://doi.org/10.1080/09640568.2020.1762550

Molle, F. (2009). River-basin planning and management: The social life of a concept. Geoforum, 40(3), 484–494. https://doi.org/10.1016/j.geoforum.2009.03.004

MoA. (2020). Community-based Participatory Watershed and Rangeland Development : A Guideline I Nfotechs On Technologies For Watershed. January.

Montemayor, M. B. (2023). Linking public perspectives on watershed issues to indicators , and natural regions as management units within a large watershed. 1–24. : https://doi.org/10.21203/rs.3.rs-2402682/v2

Mosisa, D., Debela, A., Shanko, D., & Hora, B. (2018). Community Based Soil and Water Conservation Practice : In Case of Haro Bakke Kebele , Yabello Woreda , Borana Zone. *Journal of Environment and Earth Science*, *8*(1), 134–139.

Mutune, J., & Nunow, A. (2018). Community participation in transformation of rural livelihoods and climate smart farming technologies in the semi-arid lands of Kenya. *International Journal of Peace and Development Studies*, *9*(4), 53–59. https://doi.org/10.5897/ijpds2018.0323

Nasrabadi, A., Karami, E., & Ahmadvand, M. (2013). Determinants of participation in watershed development projects in Khorasan, Iran. *Journal of Agricultural Science and Technology*, *15*(6), 1

Nikkhah, H. A., & Redzuan, M. (2009). Participation as a medium of empowerment in community

development. *European Journal of Social Sciences*, *11*(1), 170–176.

Onyancha, E. O., Ondieki-Mwaura, F., & Njoroge, L. (2022). Effect of Farmers' Participation in NGO Interventions on Household Food Security in Yatta Sub County, Machakos County Kenya. *International Journal of World Policy and Development Studies*, *8*(82), 34–42. https://doi.org/10.32861/ijwpds.82.34.42

Pimbert, Michel P, and Jules Pretty. 1995. "Parks, People and Professionals: Putting `Participation' into Protected Area Management," no. 57.

Pretty, J. N. (1995). Participatory learning for sustainable agriculture. *World Development*, *23*(8), 1–17. https://doi.org/10.1016/0305-750X(95)00046-F

Reed, M. S. (2008). Stakeholder participation for environmental management : A literature review. *Biological Conservation*, *1*. https://doi.org/10.1016/j.biocon.2008.07.014

Reed, M. S., Vella, S., Challies, E., de Vente, J., Frewer, L., Hohenwallner-Ries, D., Huber, T., Neumann, R. K., Oughton, E. A., Sidoli del Ceno, J., & van Delden, H. (2018). A theory of participation: what makes stakeholder and public engagement in environmental management work? *Restoration Ecology*, *26*(April), S7–S17. https://doi.org/10.1111/rec.12541

Roba, B. H., Woldeamanuel, T., Tsegaye, M. G., & Park, D. B. (2022). Determinants of community participation in a watershed development program in Southern Ethiopia. *Community Development*, *53*(2), 150–166. https://doi.org/10.1080/15575330.2021.1946576

Sangchini, E. K. (2023). Evaluation of watershed management projects implemented in terms of improving the spirit of public participation in Rimeleh Watershed , Lorestan Province. *15*(3), 452–466. https://doi.org/10.22092/IJWMSE.2022.359806.1989

Snyder, K. A., Ludi, E., Cullen, B., Tucker, J., Zeleke, A. B., & Duncan, A. (2014). Participation and performance.:Decentralised planning and implementation in ethiopia *Public Administration and Development*, *34*(2), 83–95. https://doi.org/10.1002/pad.1680

Tadesse, S., Woldetsadik, M., & Senbeta, F. (2017). Forest users' level of participation in a participatory forest management program in southwestern Ethiopia. *Forest Science and Technology*, *13*(4), 164–173. https://doi.org/10.1080/21580103.2017.1387613

Talaei, R., Salehpour, A., & Beyrami, B. (2023). *P*rioritization of Factors Influencing People ' s Participation in Watershed Management Projects of Siyahposh Basin , Ardabil Province , Iran. *6*(1), 70–87.

Taye, T. (2021). Evaluating Implication of Long Term Watershed Development on Plant Diversity

Dynamics in Maybar Sub-Watershed, South Wello Zone, Ethiopia. https://doi.org/10.21203/rs.3.rs-153227/v1

Tefera, M., Hailemichael, A., & Teshome, A. (2020). Integrated Watershed Management (IWM) in Ethiopia : A baseline study in Dire Dawa , Deder and Zeway Dugdar (Issue September).

Terefe, H. R., Zemede Asfaw, & Demissew, S. (2015). The Link between Ethnobotany and Watershed Development for Sustainable Use of Land and Plant Resources in Ethiopia. *Journal of Ecosystem & Ecography*, *05*(02). https://doi.org/10.4172/2157-7625.1000161

Teressa, D. (2018). Community Participation on Watershed Management Programme . The Case Community Participation on Watershed Management Programme . The Case of Gemechis District , Oromia , Ethiopia. *International Journal of Comprehensive Research in Biological Sciences*, *5* 9–17.

Tesfahun, A. A., & Chawla, P. A. S. (2017). *P*eople's Participation in Development: The Actors and Factors Shaping People's Participation in Environmental Conservation Initiatives in Eferatena Gidem District, Ethiopia. *7*(3), 1–17. www.iiste.org

Tesfaye, G., Alamirew, T., Kebede, A., & Zeleke, G. (2018). Institutional functionality in participatory integrated watershed development of Tana sub-basin, Ethiopia. *Land*, *7*(4). https://doi.org/10.3390/land7040130

Tessema, B. G., & Tibebe, M. (2017). Farmers' Participation in and Impacts of Watershed Management on Farmers' Investments in Soil and Water Conservation and Tree Planting. *April*. https://www.researchgate.net/publication/316038091

Tippett, J., Handley, J. F., & Ravetz, J. (2007). Meeting the challenges of sustainable development-A conceptual appraisal of a new methodology for participatory ecological planning. *Progress in Planning*, *67*(1), 9–98. https://doi.org/10.1016/j.progress.2006.12.004

Usadolo, S. E., & Caldwel, M. (2016). A Stakeholder Approach to Community Participation in a Rural Development Project. *SAGE Open*, *6*(1). https://doi.org/10.1177/2158244016638132

Vishnudas, S., Savenije, H. H. G., Van der Zaag, P., Ajith Kumar, C. E., & Anil, K. R. (2008). Sustainability analysis of two participatory watershed projects in Kerala. *Physics and Chemistry of the Earth*, *33*(1–2), 1–12. https://doi.org/10.1016/j.pce.2007.04.004

Wang, G., Mang, S., Cai, H., Liu, S., Zhang, Z., Wang, L., & Innes, J. L. (2016). Integrated watershed management: evolution, development and emerging trends. *Journal of Forestry Research*, *27*(5), 967–994. https://doi.org/10.1007/s11676-016-0293-3

Wani, S. P., & Garg, K. K. (2009). Watershed Management Concept and Principles. In 150 Problemas de ECG. https://doi.org/10.1016/b978-84-8086-474-9.50110-x

Yusuf, O. J., Adekunmi, A. O., & Ayanda, I. F. (2020). Community Participation *a*nd Sustainability of the Community and Social Development Projects in Kwara State, *Nigeria*. *25*(1), 157–174.

CHAPTER FOUR: INSTITUTIONAL ARRANGEMENTS AND STAKEHOLDER KNOWLEDGE OF WATERSHED MANAGEMENT FOR FOOD SECURITY IMPROVEMENT: A CASE STUDY OF QERSA DISTRICT, EAST HARAGHE ZONE, ETHIOPIA.[3]

4.1 Abstract

This study investigates the perceptions and coordination challenges of stakeholders involved in community-based watershed management in Qarsa Woreda, East Hararghe Zone, and examines its impact on food security. Data were collected from 63 professionals and 337 farmers through surveys and interviews. The findings reveal a significant disparity in perceptions: 64% of professionals view watershed management primarily as natural resource management or soil and water conservation, while only 36% acknowledge its broader rural development and economic benefits. Conversely, farmers recognize improvements in crop yield and income but largely see these practices as environmental conservation efforts, with only 12.6% viewing them as part of a comprehensive rural development strategy. Institutional arrangements, including the roles of the Ministry of Agriculture and the Oromia Bureau of Agriculture, show that weak coordination and accountability mechanisms undermine effectiveness. The lack of specialized structures for managing programs like the Sustainable Land Management Program (SLMP) and the Rural Productive Safety Net Program (PSNP) at the woreda level further complicates implementation. To address these challenges, improving coordination platforms, enhancing accountability, increasing local involvement, and establishing specialized units for program management. Further research is needed to identify potential barriers to coordination and collaboration among the stakeholders involved in watershed management.

Key words: Coordination, farmers, integration, professionals, rural development

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4.2 Introduction

Integrated Watershed Management (IWM) has gained global recognition as a critical strategy for fostering sustainable food security and mitigating environmental impacts. It is widely acknowledged for its ability to address complex environmental issues while promoting socio-economic resilience (Godfray et al., 2010; Munang et al., 2011; FAO, 2021). Successful implementations in countries such as China, Sri Lanka, and the Philippines showcase IWM's effectiveness in managing environmental challenges, enhancing social equity, and improving economic stability (Suhas et al., 2010; Rawat, 2014; Parvathi, 2013). In sub-Saharan Africa, including Uganda and Kenya, IWM has also demonstrated success in ecological preservation, promoting sustainable land use practices, and increasing resilience to climate change impacts (Nick & Woldehanna, 2012; FAO, 2017).

In Ethiopia, IWM was initially introduced in the 1970s to address soil erosion and land degradation through a top-down, centralized approach (Alemu & Kidane, 2014; Moken et al., 2015; Gadisa, 2016). This period was marked by "planning in the dark" due to unclear criteria for land rehabilitation technologies, coupled with a policy framework emphasizing stringent government regulation (Bantider et al., 2019). This approach often led to ineffective planning and persistent natural resource depletion (Hassen, 2022; UNEP, 2016; Nigussie et al., 2018) highlighting the limitations of the early integrated watershed management strategy (Mekonnen et al., 2011; Tefera, 2015).

Since 1991, Ethiopia has made significant strides in IWM by broadening its focus beyond soil and water conservation to include socio-economic and environmental objectives (German et al., 2007; Bantider et al., 2020). The introduction of various policies and strategies, such as the agricultural-led industrialization development policy, has integrated watershed management into broader economic and rural development goals, including food security (FDRE, 2012; Assefa, 2012; Amogne, 2014; Bantider et al., 2020). Additionally, the establishment of community-based participatory watershed management guidelines in 2005 has facilitated standardized planning and coordination among institutions (Desta et al., 2005). Despite some improvements in natural resource conservation, agricultural practices, and livelihoods, and fostering synergies among technologies, policies, and institutions, the initiative has not fully met expectations for advancing rural development and food security (Worku et al., 2018; Mekuriaw, 2017; Gebregziabher et al., 2016; Gashaw, 2015; Bantider et al., 2019; Gashaw et al., 2014; Alemu & Kidane, 2014).

One of the primary challenges in watershed management is the varied interpretation and understanding of its concept, which has led to confusion in conservation and development planning (Vasant & Lin, 2012; Beley & Bewket, 2015; Devi, 2015; FAO, 2017; Setyo, 2019; Elfithri et al., 2018; Heal, 2019). This lack of consensus among stakeholders—who often possess differing knowledge, values, and priorities—results in fragmented approaches and conflicting objectives that undermine effective implementation (German et al., 2007; Gashaw et al., 2014; Alemu & Kidane, 2014; Tefera, 2015). Additionally, the absence of a cohesive institutional framework and inadequate knowledge exchange exacerbate these issues, leading to compromised outcomes (Reddy et al., 2017; Arfasa & Tona, 2019; Thiemann et al., 2018). Policies developed since 1990 have generally fallen short of their goals due to the limited scope of individual institutions and insufficient integration of local knowledge (Bantider et al., 2020).

It is widely acknowledged that effective watershed management requires strong institutional frameworks and a shared understanding among stakeholders (Gulati et al., 2012; Bantider, 2019). However, existing studies tend to focus on the physical aspects of watershed management and overlook the importance of institutional factors and the interconnected nature of the management process (Nigussie et al., 2018; Hurni et al., 2015; Gashaw et al., 2014; Alemu & Kidane, 2014). Furthermore, the fragmentation caused by evolving concepts and sector-oriented planning hinders integrated approaches, with agriculture, forestry, and water resources often operating in isolation and neglecting their interconnections (Brooks et al., 1991; Wang et al., 2016). There is also a lack of research addressing practitioners' perspectives on how watershed management relates to rural development and food security (Mulugeta, 2015). Addressing these challenges is vital for advancing watershed management to enhance food security and rural development. This study aims to examine stakeholder perspectives and analyze the institutional framework for watershed management in Qarsa Woreda, East Hararghe Zone, Oromia Regional State, to address the gaps between theoretical frameworks and practical implementation, ultimately aiming to improve food security outcomes.

4.3 Methodology of the study

4.3.1 Theoretical Framework

Integrated watershed management is characterized by its hydrological aspect, ecosystem-centered approach, inclusivity, and integration of both biophysical and socioeconomic considerations (Perry & Thompson, 2019). However, the complexity of integrated watershed management can lead to challenges in communication and understanding among stakeholders (Molle, 2009; Linton and Budds, 2014; Norman et al., 2012). A study by Meierdiercks et al. (2024) found significant misconceptions between community members and professionals regarding watershed management principles, stemming from differing terminology, expertise levels, and priorities. Furthermore, Wang et al. (2016) highlight the importance of a comprehensive understanding of the dynamic nature of watersheds, as gaps in this knowledge can impede collaborative efforts and hinder the effective execution of management strategies. The mental model approach is instrumental in exploring stakeholder perspectives such as individuals' knowledge, perceptions, and beliefs and improving communication strategies (Abel et al. 1998; Morgan et al. 2001).

Numerous research initiatives have effectively used the mental model framework to explore environmental understanding. For instance, Shepardson et al. (2007) examined students' perceptions of watersheds to assess their ecological awareness. Similarly, Deborah et al. (2014) combined an expert model with local community mental models to evaluate knowledge of watershed ecology in a Midwestern city. Matheve et al. (2011) investigated the mental models of various stakeholders in water management to identify diverse viewpoints and promote collaboration. Each study provided valuable insights into different aspects of environmental comprehension.

The application of mental model methodologies is crucial in the context of integrated watershed management, as it facilitates an in-depth analysis of the diverse perspectives and conceptual frameworks possessed by stakeholders from various groups (Abel et al., 2021). This approach is particularly valuable because it recognizes that different stakeholders—such as local communities, government agencies, environmental organizations, and other pertinent stakeholders—often have unique experiences, values, and knowledge that shape their understanding of watershed issues (Lynam et al. 2012). By employing mental model methodologies, practitioners can systematically explore these varied viewpoints, leading

to a more comprehensive understanding of the watershed and opportunities within a watershed (Erdem, 2019).

The mental model employed in this research examined the phenomenon through an individual lens, focusing on interpersonal interactions while considering the historical and cultural backdrop (Erdem, 2019). The notion of watershed management has transitioned from a primary focus on soil and water conservation to encompass multiple objectives, including social and economic development and the empowerment of communities (Wang et al., 2016). Integrated watershed management is defined not only by its hydrological coherence but also as a socio-political, ecological system that is vital for ensuring food security, social stability, and economic well-being, in addition to delivering critical life support services to rural populations (Bantider et al., 2019; Wang et al., 2016). Despite numerous studies aimed at elucidating the concept of watershed management (Linton and Budds, 2014; Norman et al., 2012; Molle, 2009), the comprehension of this approach as a holistic development strategy among stakeholders often remains inadequate (Meierdiercks et al., 2024).

According to Vygotsky (1991), it is essential to comprehend the interplay between scientific principles and personal experiences in shaping individuals' beliefs and behaviors. This perspective highlights that how individuals interpret and communicate is significantly affected by a blend of scientific understanding and their respective of social and cultural environments. In the context of watershed management, integrating these diverse elements—scientific data, social values, cultural practices, and personal experiences—creates a more comprehensive view of watershed issues (Reddy et al., 2017). By mapping out and analyzing the mental models of various stakeholders, practitioners can better understand how different groups perceive and interact with watershed systems. This thorough understanding enables the creation of management strategies that are both scientifically valid and sensitive to social and cultural contexts, leading to practices that are more sustainable and broadly supported (Allan et al., 2008). This approach will bridge gaps between theoretical concepts and practical applications, enhancing the understanding of how watershed management is perceived across different contexts and informing the development of more effective and integrated management strategies.

4.3.2 Description of study area

The study was conducted in Qarsa Woreda, which is situated in the East Hararghe zone of the Oromia region in Ethiopia. Geographically, the Woreda is located between latitudes 9°17' and 9°29'N, and longitudes 41°12' and 41°56'E to the west. The district experiences a bimodal rainfall pattern characterized by an average annual rainfall of 1225 mm/year. The annual mean minimum and maximum temperatures are recorded at 12.5°C and 26.6°C, respectively. The rainy seasons include Belg (Arfasa) from March to May and Kiremt (Gana) from June to September, with a dry season prevailing from October to February (Qarsa Woreda Agriculture Office, 2022).

Agriculture forms the backbone of the rural economy in Qarsa Woreda, predominantly practiced under rain-fed conditions. The agricultural system is characterized by mixed crop-livestock production, with maize (Zea mays L.) and sorghum (Sorghum bicolor) serving as staple crops. Additionally, khat (Catha edulis) and coffee (Coffea arabica) are important cash crops cultivated in the area. Watershed management strategies have been implemented over an extended period through various initiatives such as Free Mass Mobilization (FMM), Sustainable Land Management Program II (SLMPII), and Productive Safety Net Public work (PSNP_PW) for an extended period of time. However, despite these efforts, the woreda continued to face significant challenges related to chronic food and nutrition security, soil erosion, soil infertility, and water stress.

The study focused on these micro watersheds (Figure13). Specifically, the Free Mass Mobilization program was a government initiative that did not receive any external funding support. Conversely, the Sustainable Land Management Program and Productive Safety Net Program were funded by the external sources. Despite their differences, all three programs adhered to the same watershed management guidelines and shared a common objective: promoting sustainable natural resources management and enhancing ecosystem health to improve food security. This unified objective underscores their commitment to addressing local challenges such as soil erosion, soil infertility, and water stress and other related watershed management activities of livelihood improvement .

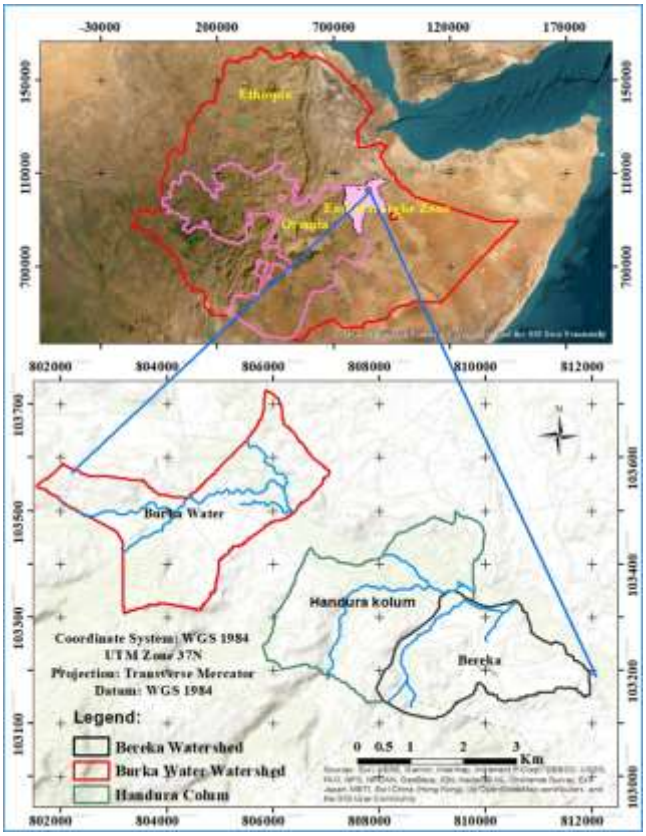


Figure 15: Map of the Study Area

4.3.3 Sample design and data collection methods

The study utilized a mixed-methods approach, combining quantitative data collection through a household survey with qualitative data from focus groups and key informant interviews (following Creswell, 2003). The study area, Qarsa Woreda, was purposefully selected due to the presence of free mass mobilization, a sustainable land management program, and a productive safety net program simultaneously. The micro watershed was selected based on specific criteria, such as sites adjacent to each other, historical similarity of watershed management interventions, similar land use systems, and soil and water conservation practices. Based on this, one micro watershed from each program approach was selected. For the household survey, comprehensive lists of household heads in each micro watershed were provided by the Kebele administration and development agents (see Table 1). Respondents were then selected using Kothari's (2004) formula to ensure statistical validity. The final sample comprised 118 household heads (35%) from Baraka, 107 (31.8%) from Burka Watter, and 112 (33.2%) from Adhura Kosum, as detailed below.

$$S = \frac{z^2 * P * (1 - p)}{c_2}$$ ----------(1)

Where: Z = Z-value (1.96) for 95 confidence level

P = is the percentage picking a choice, expressed as a decimal (0.5)

C = is the confidence interval expressed as a decimal (0.05 = ±0.05)

Subsequently, the actual sample size for the study area was determined as:

$$SS_{pk} = \frac{s}{1+\frac{s-1}{p_k}}$$ ----------(2)

Where: SSkp is the sample size for the known population size

S is the sample size for the unknown population calculated using Equation 1

P_k is the known population size from which the sample size is calculate

Additionally, 63 professionals and managers were selected based on their expertise, organizational roles, and current involvement in watershed management. The selection process involved individuals from different levels: 9 from the federal level, 14 from the regional level, 13 from the zonal level, 14 from the woreda level, and 13 from the kebele level. This stratified selection process was designed to capture a diverse range of perspectives and insights from those directly engaged in the management and implementation of watershed programs. Furthermore, five focus group discussions were conducted at various government levels and within the three micro watersheds. Each group consisted of 7 to 9 members selected based on their knowledge, gender, age, experience, educational background, social status, and understanding of watershed management and community participation including marginalized or less vocal groups. This approach ensured that the discussions were inclusive and reflected a broad spectrum of experiences and viewpoints.

Table 21: List of total and sample households from each selected micro watershed

N o	Name of micro watershed	Program approach	Area in Ha	Population	
				THH	Sample size
1	Andhura Kosum Micro watershed	Free Mass Mobilization	759.5	734	112
2	Baraka Micro watershed	PNSP-PW	565.7	639	107
3	Burqa Water micro watershed	SLMP-II	853.1	765	118
			2178	2138	337

4.3.4 Test of Knowledge

Prior to the commencement of the study, a meticulously designed log sheet was established to record the daily activities of professionals and development agents engaged in local watershed management across two zones, two districts, and six kebeles. This log sheet recorded activities, including personal experiences, understanding of watershed concepts, actions undertaken, challenges encountered, and achievements, from planning to monitoring and evaluation. The log sheet adhered to community-based participatory guidelines outlined by Desta et al. (2005) and updated by the Ministry of Agriculture (2020) while also incorporating elements from Förch and Schütt (2004) and systematically documented these activities to provide a thorough assessment of current practices, evaluate the effectiveness of existing strategies, and gauge the knowledge levels of local experts and development agents.

The activities recorded in the log sheet were subjected to descriptive analysis and indicated that existing watershed management strategies tend to emphasize technical solutions while overlooking the essential equilibrium among technical and socioeconomic considerations. Moreover, the stakeholders involved in watershed management possess diverse interpretations of what the watershed concept entails, including terminologies such as soil and water conservation, water harvesting, conservation initiatives in hilly areas, gully management, natural resource stewardship, ecological sustainability, landscape preservation, catchment management, and integrated rural development. Employing Horowitz's Cultural Consensus Model (2009), the diverse perspectives surrounding watershed management were categorized into three fundamental components of the knowledge domain: soil and water conservation, natural resource management, and integrated rural development. This classification encapsulates the understanding of watershed management as perceived by various stakeholders. A mental model framework was then applied to analyze how stakeholders perceive and implement these concepts (refer to Figure 14)." This

approach was instrumental in revealing the nuanced differences in the mental models held by each group, thereby clarifying the distinct interpretations and interactions of various stakeholders with the principles of watershed management.

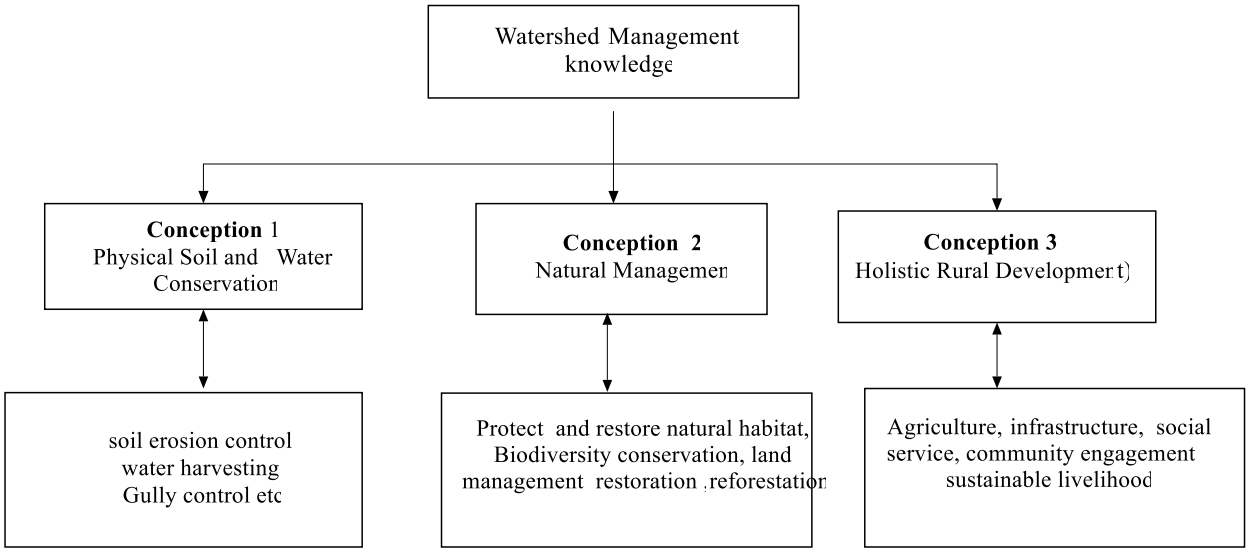


Figure 16: The actors' perspectives on watershed management.

Conception 1: Watershed as physical soil and water conservation: This conception views the watershed primarily as a physical entity focused on soil and water conservation. It emphasizes practical interventions aimed at managing physical resources to prevent erosion, control runoff, and sustain water availability.

Conception 2: Watershed as a natural resoutces management process: This conception sees the watershed as a natural system governed by ecological processes and interactions. It focuses on understanding and managing the watershed as a dynamic ecosystem, including its flora, fauna, and natural processes.

Conception 3: Watershed as holistic approach for rural development: This conception adopts a holistic view of the watershed as integral to broader rural development. It considers the watershed's role in supporting community well-being, economic development, and overall rural prosperity. These concepts were serve a benchmark for evaluating the perceptions and understandings of different stakeholders regarding the idea of watershed management

Institutional Analysis:

An institutional analysis was performed to understand the hierarchical structure of watershed management across federal, regional, and local levels. This involved reviewing organizational documents, policy frameworks, and reporting structures to assess how responsibilities are distributed and how effectively coordination occurs.

4.3.5 Data analysis

The data collected from household surveys, interviews with professionals, and focus group discussions were systematically organized and analyzed using SPSS 26. Initially, the quantitative data from surveys and professional interviews were subjected to basic descriptive statistical analyses, including calculations of means, standard deviations, and frequencies. The chi-square test was employed to examine associations between variables such as program participation, knowledge aspects, and perceptions of watershed management. This analysis helped identify significant factors influencing stakeholder understanding and engagement. For the qualitative data obtained from focus group discussions, discourse analysis methods were applied to delve deeper into the emerging trends and patterns. Discourse analysis facilitated a detailed examination of the themes, narratives, and discourses prevalent in the participants' responses. This approach enabled the identification of significant trends and insights that were not immediately apparent from quantitative data alone. In addition to descriptive statistics and discourse analysis, the evaluation of institutional capacity was approached through a combination of subjective and objective interpretations.

4.4 Results and discussion

4.4.1 Socio-demographic characteristics of the household and professionals

4.4.1.1 Socio-demographic characteristics of the household

This section provides an overview of the characteristics of farm households. The data reveals that the majority of participants (87.2%) belonged to male-headed households, while 12.8% were from female-headed households. In terms of education, 56.7% had no formal education, while 15.4% had basic literacy skills, 15.4% were in primary education, 8% were in secondary school, and 6.5% had completed grade 9. The average age of the participants was calculated to be 41.2, with a standard deviation of 11.35 (Table 21). The characteristics of farm households surveyed in this study indicate a predominantly male-headed, low-educated, middle-aged population engaged in subsistence farming. Thus capacity building measures need be adapted to enhance the watershed management practices for the livelihoods and Food security improvement.

Table **22**: Socio-demographic characteristics of households

Variable		Frequency	Percent
Sex of the household	Male	294	87.2
	Female	43	12.8
Age of farmer HHS	18-30	66	19.6
	31-45	144	42.7
	46-64	114	33.8
	>64	13	3.9
Educational level HHs	Cannot read & and write	191	56.7
	Read and write	52	15.4
	Primer (1-4)	29	8.6
	Secondary(5-8)	43	12.8
	complete(9-120	22	6.5

Sources: 2021-2022 survey

4.4.1.2 Socio-demographic characteristic professionals

Table 22 provides a detailed summary of the socioeconomic characteristics of the professional individuals included in the study. The data shows a significant gender imbalance in professional roles, with the majority of respondents being male (84.7%). Additionally, a large number of participants had extensive professional experience, with over half having more than 10 years of experience (55.1%). This suggests that the survey included a group of professionals with a wealth of experience. In terms of education, most participants held a bachelor's degree (59.7%), while only a small percentage had a certificate (1.4%). The survey also ensured a diverse representation of government levels, allowing for a comprehensive understanding and effective resolution of relevant issues.

Table 23: Descriptive statistics of professionals respondent characteristics

Characteristics	Groups	Frequency	Percent
Sex of the respondent	Male	61	84.7
	Female	11	15.3
Government hierarchy level	Federal level	12	16.7
	Regional level	16	22.2
	Zone level	15	20.8
	Woreda level	16	22.2
	Kebele level	13	18.1
Age of the respondent	(20-29)	8	11.1
	(30-39)	40	55.6
	(40-49)	18	25.0

	Above 50	6	8.3
Organizational position	DA	9	12.5
	Supervisor	2	2.8
	Expert	24	33.3
	Team leader	27	37.5
	Manager	10	13.9
Work Experience	1- 5	19	26.4
	6-10	13	18.1
	Above 10	40	55.5
The educational level of the respondent	Certificate	1	1.4
	TVET/Diploma	7	9.7
	Degree	43	59.7
	MSC	21	29.2

Sources: 2021-2022 survey

4.4.2 Knowledge and perception on integrated watershed management among professionals

Over the past decade, watershed science has faced significant scientific and technical challenges that have shaped current integrated watershed management strategies for rural development (Wang et al., 2016; Gopa, 2021). Our survey and interview results reveal notable variations in how professionals perceive integrated watershed management: The findings from our survey reveal that 54.2% of professionals primarily view integrated watershed management as natural resource management, reflecting a strong emphasis on the technical and scientific aspects of the field. In contrast, 36.5% interpret it as rural development, indicating a recognition of the socio-economic benefits and broader developmental impacts. About 9.5% perceive it mainly as soil and water conservation, highlighting a narrower focus on specific conservation practices (Figure 15). The absence of consensus on integrated watershed management approaches are undermining efforts to address pressing issues like food security and rural development. When agricultural practices and conservation efforts are misaligned, it can lead to adverse outcomes such as soil degradation, water scarcity, and biodiversity loss. These impacts jeopardize the sustainability of rural development projects and food security initiatives. This finding is consistent with Meierdiercks et al. (2024), who observed that 96% of definitions describe a water- shed merely as a geographical region, with only 35% linking it to terms such as river basin, drainage basin, or catchment, and just 7.8% incorporating human activities. Similarly, Meshesha and Tripathi (2015)

observe that despite dvances in watershed management, conceptualization issues persist, affecting the effectiveness of management strategies for sustainable rural development.

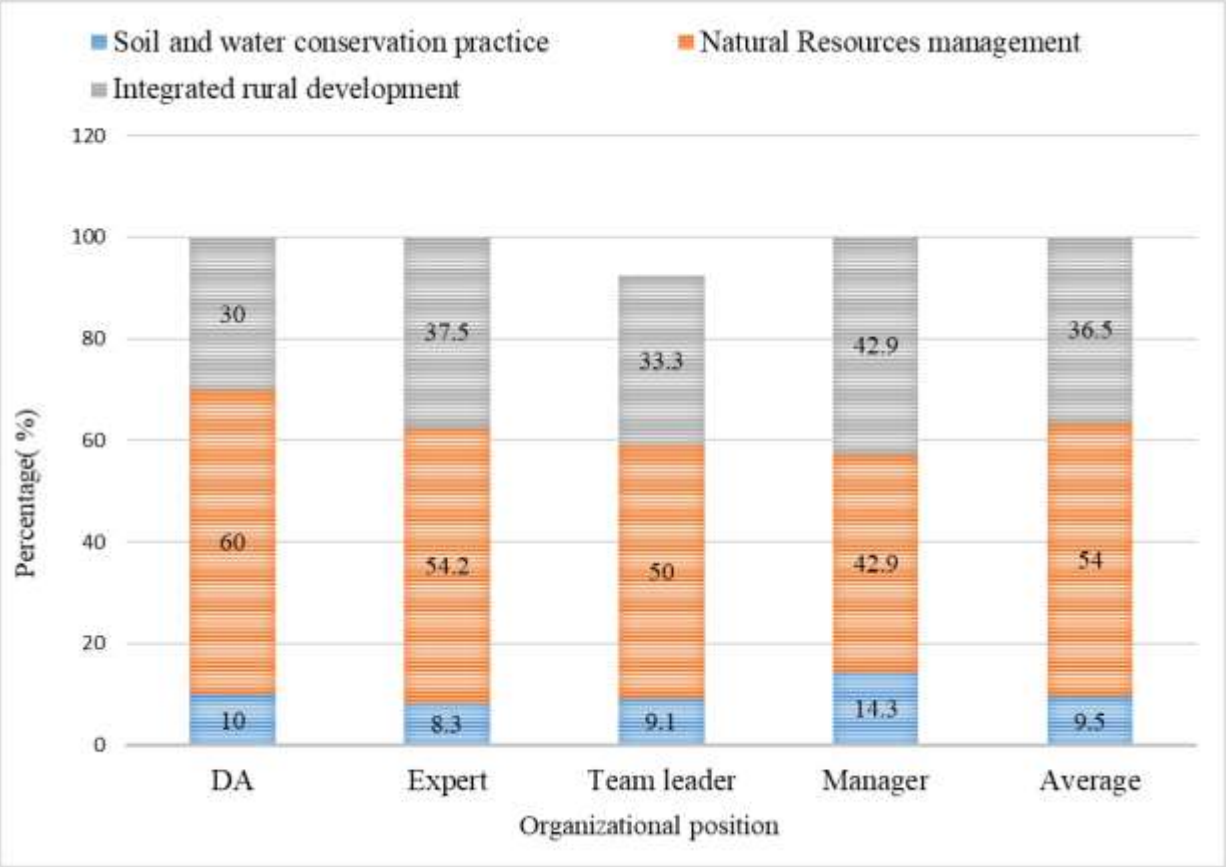


Figure 17: Perceived understanding of WM concept by professional by organizational position (Sources: 2021-2022 surve)

Stakeholders' perception and understanding of the watershed management concept were also assessed using factors such as type of organization, work experience, field of study, organizational hierarchies, organizational positions, and educational level (Table 23). The chi-square test revealed that the type of organization, work experience, and field of study significantly impacted stakeholders' understanding of the concept, with P values of 0.016, 0.031, and 0.002, respectively. Interestingly, positions within an organization and educational background demonstrated similar comprehension and perception of the watershed management concept. Individuals with expertise in natural resources or related fields showed a greater understanding of watershed management than those from different backgrounds. This implies that watershed management is often seen primarily as part of natural resources management rather than a sustainable approach to rural development. Similarly, individuals working in agriculture had a better

grasp of watershed management than those in other sectors, suggesting that other organizations may not see watershed management as a viable strategy for rural development. Further ,the significant associations found in this study emphasize the need for tailored approaches and targeted interventions to enhance stakeholders' comprehension of this concept, particularly for those with different organizational affiliations, work experiences, and academic backgrounds.

Table 24: Knowledge and understanding of professionals about watershed management at different level (N=63)

Group	Soil and water conservation practice(%)	Natural Resources management(%)	Integrated rural development (%)	Chi-Square	Df	P-Value	SF level
Type of organization affiliation(name)	18.9	55.3	25.8	24.746	12	0.016	SN
Organizational hierarchy	5.93	54.03	40.04	7.228	8	0.512	NSF
Organizational position	5.43	45.79	48.77	5.404	8	0.714	NSF
Work Experience	6.1	60.8	33.1	10.604	4	0.031	SF
Field of study (professions)	3.85	57.22	38.93	20.819	6	0.002	SF
Educational level	2.56	67.53	29.9	4.809	6	0.569	NSF
Overall	7.13	56.78	36.09				

Sources: 2021-2022 survey

4.4.3 Knowledge and perception of farmers about watershed management

Regarding the knowledge and understanding of the local community; the study's findings revealed that the perception of watershed management varied among the local community. About 17.8% of farmers involved in SLMP II micro watershed, 11.9% in PNSP_PW, and 8.9% in community mass mobilization micro watershed considered watershed management as rural development approach, while, the majority of the respondents prioritize viewed as natural resources management and soil and water conservation (Table 24). This indicated that a limited number of individuals within the community perceived it as a means to enhance economic progress and enhance the standard of living in rural regions. Conversely,

the majority of farmers predominantly regarded it as a method of environmental preservation, prioritizing it over alternative approaches The chi-square test's statistical analysis also revealed a significant difference among the three micro watersheds in terms of their performance. Specifically, the micro watershed where participants of the SLMP II program were involved showed a significantly better compared to both the PNSP_PW micro watershed and the free mass mobilization micro watershed at (P=0.04).

The findings from the surveyed households and focus group discussions reveal insights into how different groups of farmers perceive watershed management and the associated resources provided by various programs. Farmers involved in PNSP-PW and SLMP II micro watershed projects view the resources and financial aid not as integral components of watershed management but as incentives or compensation for their labor. On the other hand, farmers participating in the free mass mobilization program see watershed management as a government-driven enforcement program that mandates their involvement in activities such as soil conservation work during the dry season and tree planting in the summer months. The varying viewpoints within the three micro watersheds demonstrate the influence of indigenous knowledge and traditions on perspectives regarding watershed management. Farmers' perceptions are primarily influenced by their direct participation in specific projects rather than by institutional frameworks or comprehensive strategies. This narrow perspective prevented farmers from fully understanding the importance of sustainable watershed management practices in promoting long-term environmental health, improved soil fertility, and increased water availability, which are crucial for enhancing food security. The findings align with the research of German et al. (2007) and Terefe et al. (2015), who noted that differing stakeholder perceptions make it challenging to adopt a holistic watershed management approach. Similarly, Thiemann et al. (2018) reported that reliance on traditional methods and strategies poses a significant challenge to holistically implementing watershed management. Linking the financial aid and resources to the broader objectives of watershed management is important rather than as mere compensation.

Table 25: Knowledge of farmers about watershed management across the three micro watersheds**.**

	PNSP-PW (N=118)	SLMP (N=107)	FMM N= 112	Over all (N=337	Pearson Chi-Square	Df	P- value
Soil & and water conservation	49 (41.5)	36 (33.6)	52 (46.4)	137 (40.7)			
Natural Resources Management	55 (46.6)	52 (48.6)	50 (44.6)	157 (46.6)	9.9	4	. 0.042
Integrated rural development	14 (11.9 %)	19 (17.8%)	10 (8.9%)	43 (12.8)			

Sources: 2021-2022 survey

4.4.4 Knowledge and perception of watershed among professionals and the local community

Figure 16 illustrates the varying perception and knowledge of watershed management across different tiers of government and community levels. At the federal level, approximately 67% of respondents perceived it as a holistic approach to rural development, while 33% saw it as natural resource management. Similarly, at the regional level, 57 % considered watershed management a comprehensive rural development, with 43% linking it to natural resource management. This result indicate a consistent perception at the federal and regional levels, with a strong emphasis on watershed management as part of comprehensive rural development. However, opinions at the zonal, woreda, and kebele levels exhibited significant divergence, with a predominant view of watershed management as natural resource management, reflected in 64.3% and 61.5% of responses, respectively. The community-level survey results displayed a mix of opinions, with 46.6% considering watershed management as natural resource management, 40.7% as soil and water conservation, and only 12.7% regarding it as comprehensive rural development. The comparative analysis reveals that while higher governance levels tend to view watershed management as integral to comprehensive rural development, lower levels and community perspectives often focus more on natural resource management and conservation. This divergence in focus can lead to inconsistencies in policy implementation and strategy execution, ultimately hindering the effectiveness of watershed management initiatives. Focus group discussions confirm that the lack of alignment among different governance levels creates significant obstacles and leads to fragmented initiatives. This

fragmentation diminishes the effectiveness of watershed management and impacts food security and broader development goals. The study's findings align with previous research by Wang et al. (2016), Cohen & Davidson (2011), Worku & Tripathi (2015), and Gashaw (2015), which also point out that current watershed management approaches often prioritize physical aspects over a more comprehensive strategy.

Narendra et al. (2021) further underscore the need for a unified vision and a holistic approach to watershed management. Their study highlights the critical role of education in fostering a collective understanding and improving management practices. Without a cohesive approach across all levels, the trend of fragmented and less effective management is likely to persist.

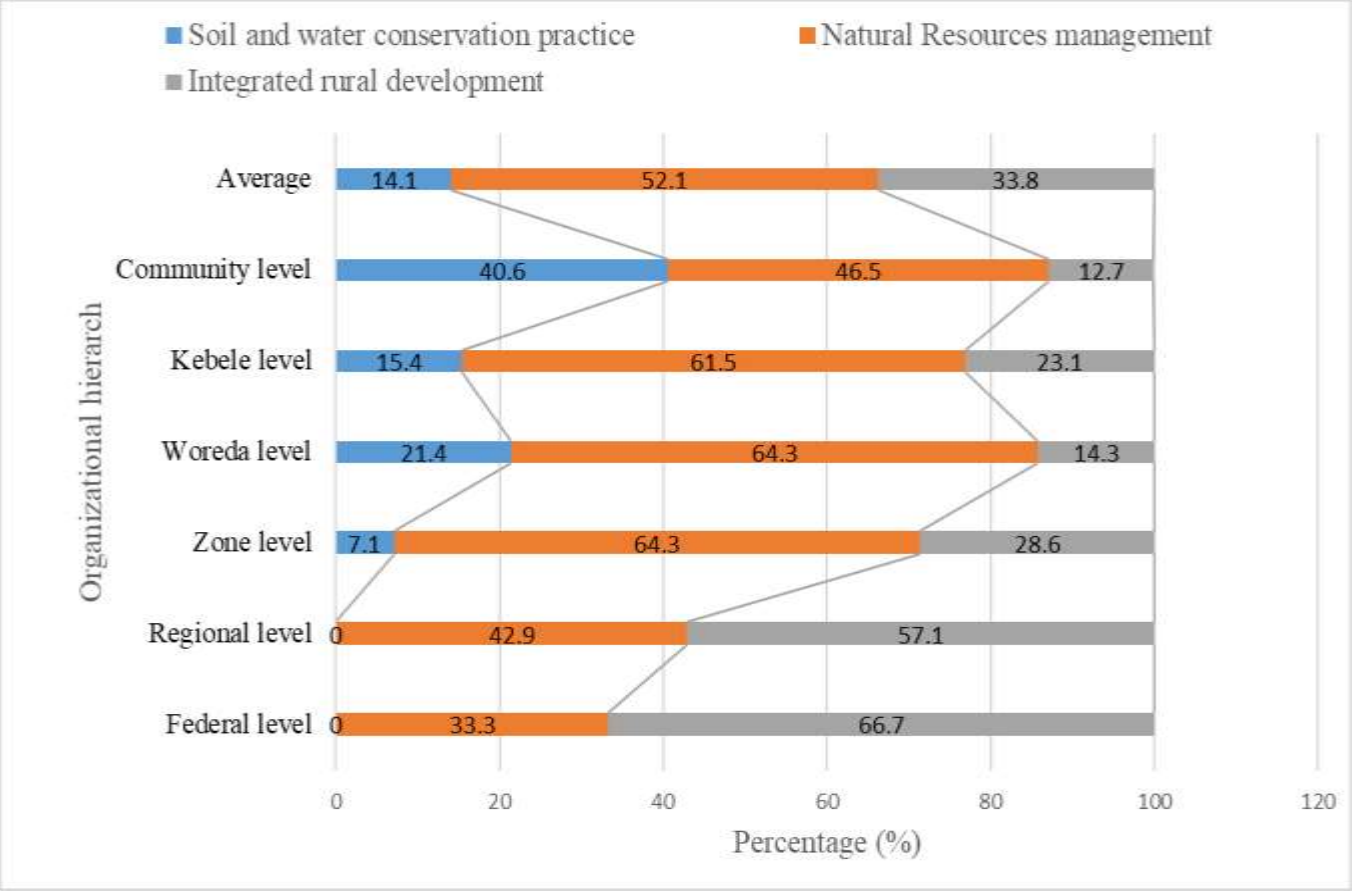


Figure 18: Perceived understanding of WM across government hierarchies (Sources: 2021-2022 survey

4.4.5 Institutional arrangement for watershed management

This section examines how the three micro-watershed approaches handled watershed management practices at the local level and the institutional structure in place across different governance levels. At the federal level, the Ethiopian Federal Democratic Republic amended Proclamation No. 1263/2021, showing that watershed management responsibilities are divided among the Ministry of Agriculture, the Ministry of Water and Energy, the Ministry of Irrigation and Lowland Areas Development, and the Environmental Protection Agency under the Ministry of Planning. Each ministry has specific duties that contribute to a comprehensive management strategy, including policy formulation, supervision, and coordination of watershed management efforts across the country.

The Oromia Proclamation No. 242/2021 has distributed watershed management responsibilities among various regional bureaus and entities, such as the Oromia Bureau of Agriculture, Oromia Bureau of Land, Oromia Bureau of Irrigation and Pastoral Development, Oromia Bureau of Water and Energy, Oromia Environment Commission, and Oromia Forest and Wildlife Enterprise, as well as their corresponding line departments at the zone and district levels. Each entity has specific duties and responsibilities aimed at a comprehensive management approach, including policy development and implementation, oversight, capacity building, coordination, and on-the-ground execution of watershed management activities across the region and specific areas. At the community level, the kebele administration and development agent are primarily responsible for overseeing watershed management.

Figure 17 provides a detailed illustration of the hierarchical structure of watershed management across federal, regional, and community levels in the three micro watersheds. This arrangement involves a multi-tiered approach where different levels of government and local bodies play distinct roles in managing watershed activities. At the federal level, the Ministry of Agriculture (MoA) and regional line departments, including the Oromia Bureau of Agriculture, are central to coordinating watershed management efforts. Their responsibilities encompass overseeing community-based participatory watershed management, integrating programs such as the Sustainable Land Management Program (SLMP) and the Rural Productive Safety Net Programme (PSNP). Each of these programs operates with its own dedicated organizational structure and staff within the MoA and the Oromia Bureau of Agriculture. This specialized setup allows for focused management and implementation of program-

specific activities, ensuring that both SLMP and PSNP receive the attention and resources needed to achieve their objectives.

However, at the woreda level, there is no distinct organizational structure for managing SLMP-II and PSNP-PW; instead, the woreda agriculture office assumes the multifaceted role of overseeing both programs. This office is responsible for the management and coordination of watershed activities across the woreda, which includes handling the diverse tasks and responsibilities associated with SLMP-II and PSNP-PW. The lack of specialized units for these programs means that the woreda agriculture office must balance multiple demands with a limited staff, potentially leading to resource constraints and challenges in effectively prioritizing and executing program activities. At the local level, the management of the three micro-watersheds is primarily carried out by the Kebele Administration and community-based watershed committees. These local bodies are crucial for the practical, on-the-ground management of watershed activities. Their roles include implementing local watershed practices, engaging with the community, and ensuring that watershed management activities are adapted to the specific needs and conditions of the micro-watersheds

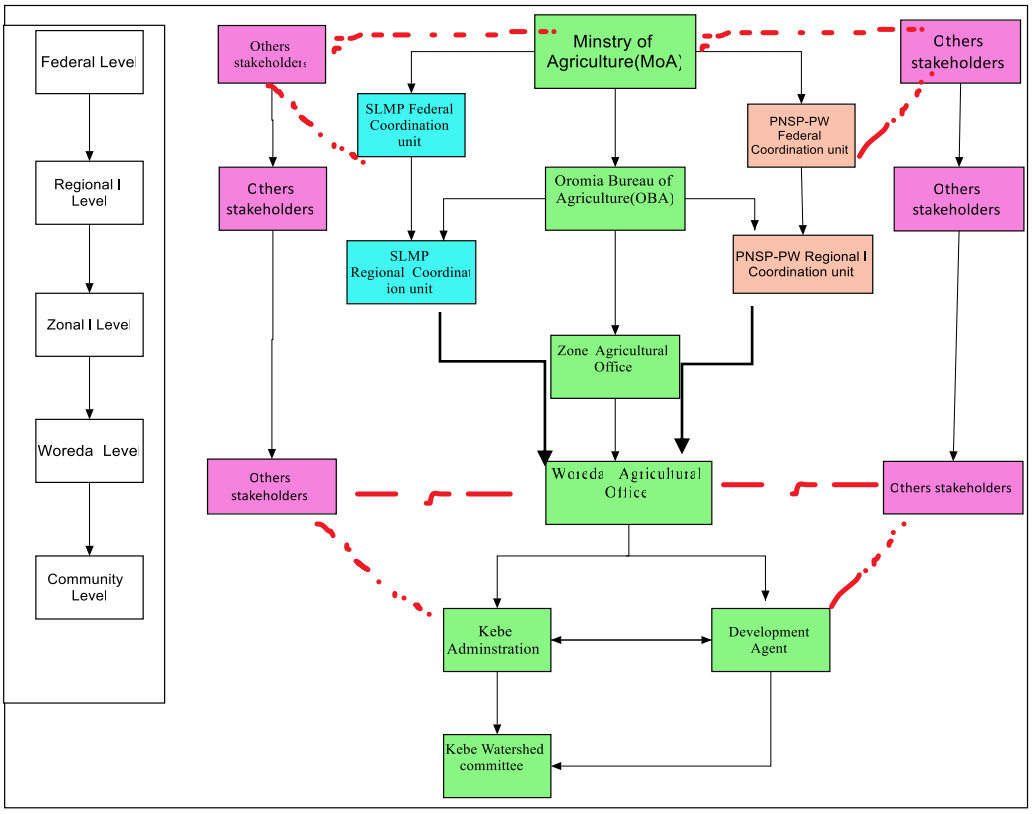


Figure 19: PSNP, SLMPII, and FMM institutional arrangement (Source: constructed by authors).

Despite the structured framework for watershed management established across federal, regional, and local government hierarchies, significant challenges persist at the village level. The household survey indicated significant gaps in the participation and coordination of federal and regional entities at the village level (see Figure 18). A majority of participants (approximately 97% in the mass mobilization program, 94% in PNSP-PW, and 78% in SLMP-II) expressed dissatisfaction with the lack of support from federal and regional authorities, as well as the inconsistent monitoring and evaluation of the program at the village level. Furthermore, the Development Agents (DAs) and district-level experts interviewed emphasized that the decentralization process has not fully empowered local authorities to effectively plan and allocate budgets based on their criteria to address the needs of their communities. This finding reveals conflicting perspectives on attributing the main challenges in watershed management solely to local government and community involvement. Instead, the success or failure of a specific integrated watershed management strategy relied on the engagement of higher-level government authorities and their commitment to their responsibilities (Nigussie et al., 2018; Abuto, 2009).

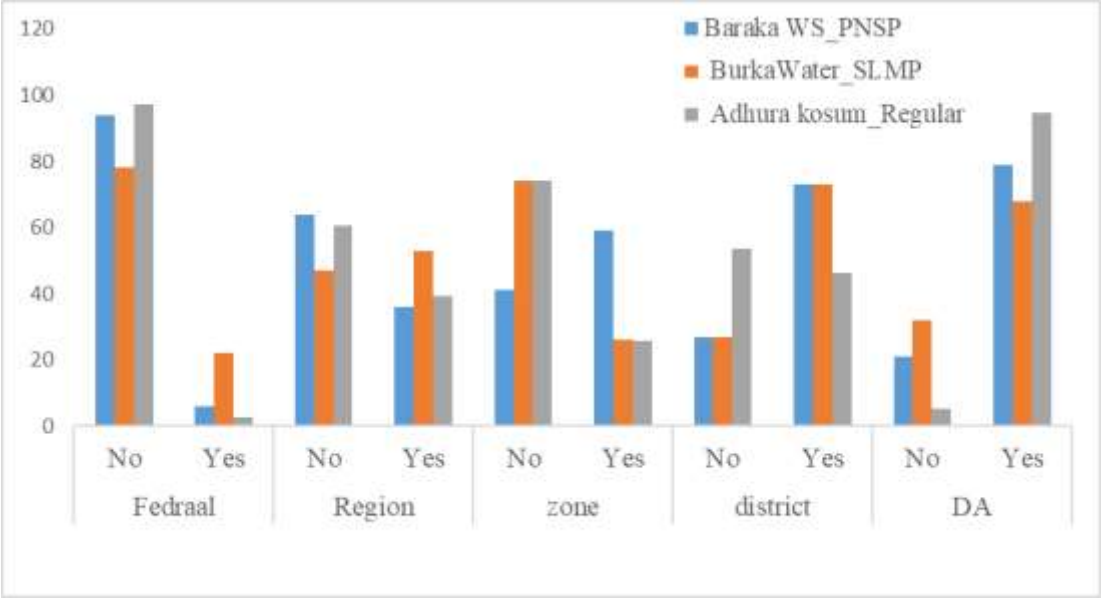


Figure 20: Farmer feedback on government support for watershed management in three micro watersheds at the community level

The findings from the survey underscore the existence of well-organized watershed committees in the three micro watersheds as a positive aspect of the initiatives. Nevertheless, respondents from the three program approaches and woreda-level experts have reported that there is a lack of transparency in the

selection of watershed management committee members, which was predominantly made by the political leaders and DAs, as indicated in Figure 19. Focus group discussions also criticized the selection process at both kebele and woreda levels, with political leaders and development agents having a significant influence. They further explained that, despite this, the SLMP II program approach is better at involving the community in the selection process of committee members than the PNSP-PW and Free Mass Mobilization. However, none of the program approaches followed the watershed guidelines during committee selection or any watershed management process.

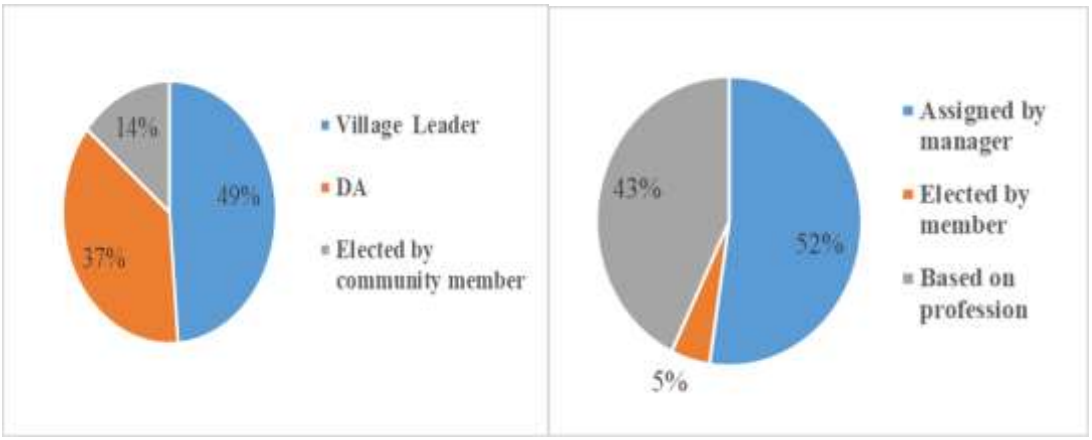


Figure 21: Kebele and Woreda watershed committee selection approach as indicated by the participate respectively

Watershed management at the local level involves not only formal strategies but also informal systems that rely on community-based organizations, traditional leaders, religious leaders, established regulations, and cultural norms. However, interviews with the Focus Group discussion in all three program approaches have revealed that the importance of informal institutions has been declining over time as the government structures have taken over their responsibilities. These interviews have also unveiled that this transition towards formalization in watershed management has led to the loss of traditional knowledge, cultural practices, and community unity, which have been vital in different environmental and social aspects. The study also reveals that government structures may not always be as responsive or adaptable to local needs and conditions as informal systems and lack practical application on the ground at the local level. Almost all of the watershed committee members in the three micro watersheds indicated that the institution lacked practical application on the ground and was politically affiliated and affected the community participation in decision-making, planning, implementation, and evaluation of watershed practices. However, the success of an integrated watershed

management approach depended on the involvement of government authorities at all levels and the local community. The finding aligns with Gashaw et al., (2014) emphasis on the importance of inclusive community institutions in reducing poverty. Kidane et al. (2014) also highlighted the role of local institutions in conserving natural resources at the community level. Other studies by Nigussie et al.(2018) and Abuto (2009) have also shown that the success or failure of integrated watershed management strategies relies on the participation of higher-level government authorities and their dedication to their duties. This study suggested creating transparent and accountable multi-stakeholder platforms to enhance communication and collaboration among government agencies, local communities, and other stakeholders that consider the interests and concerns of local communities in watershed management.

4.4.6 Partnership and stakeholder coordination in Watershed Management

The success or failure of watershed management may depend on the degree of responsibility that partners feel for cooperation and coordination. The study assessed variables influencing collaboration and coordination among stakeholders at various government levels. Figure 20 provides a visual representation of the feedback from respondents at each government level, highlighting how these factors are perceived across different tiers of government. Furthermore, respondents from the SLMPII and PNSP-PW projects at the federal and regional levels reported that, despite having formal platforms for the technical and steering committees for planning, implementation, monitoring, and evaluation of watershed management activities, coordination and integration were notably weak or even nonexistent due to the lack of effective accountability mechanisms. In the context of free mass mobilization, experts and managers at the federal and regional levels indicated that there was no collaborative platform. Instead, each ministry, organization, and department operated with its own separate plan. This lack of integration was also confirmed by experts at the zonal and woreda levels, who observed that watershed management planning was largely sector-based driven by top management directives. Development agents further highlighted that, although the planning process is intended to be bottom-up, it frequently takes place at higher levels and is then handed down to lower levels. Kebele watershed committees shared this perspective, emphasizing their limited knowledge and understanding of coordination and integration, which are crucial for effective watershed management

The study on three micro watersheds has shown that, despite the existence of formal platforms for technical and steering committees responsible for the planning, implementation, monitoring, and

evaluation of watershed management activities at different levels for SLMP-II and PSNT_PW, and at the woreda and kebel levels for free mass mobilization micro watersheds, there is a significant lack of coordination and integration due to the ineffective accountability mechanisms in place across all three watersheds. Moreover, the watershed management practices across all three micro watersheds studied are not aligned with the specific laws and guidelines established for each watershed. This observation is consistent with the FAO (2017) study, which indicated that the absence of accountability mechanisms negatively influences the effectiveness of promoting collaborative actions within watershed management. Similarly, research by Berardo et al. (2019) and Ballweber (2006) reported that the lack of proper coordination results in ineffective watershed management. Many experts also concur that "sectoral ego" contributes to the lack of coordination, leading to fragmented interventions that fail to produce cumulative positive impacts. Further supporting this view, Bantider et al. (2020) examined eight policy documents and sixty-three laws enacted post-1990s related to natural resource management. Their study found that these policies did not achieve the intended outcomes largely due to ineffective implementation and inadequate communication with local stakeholders.

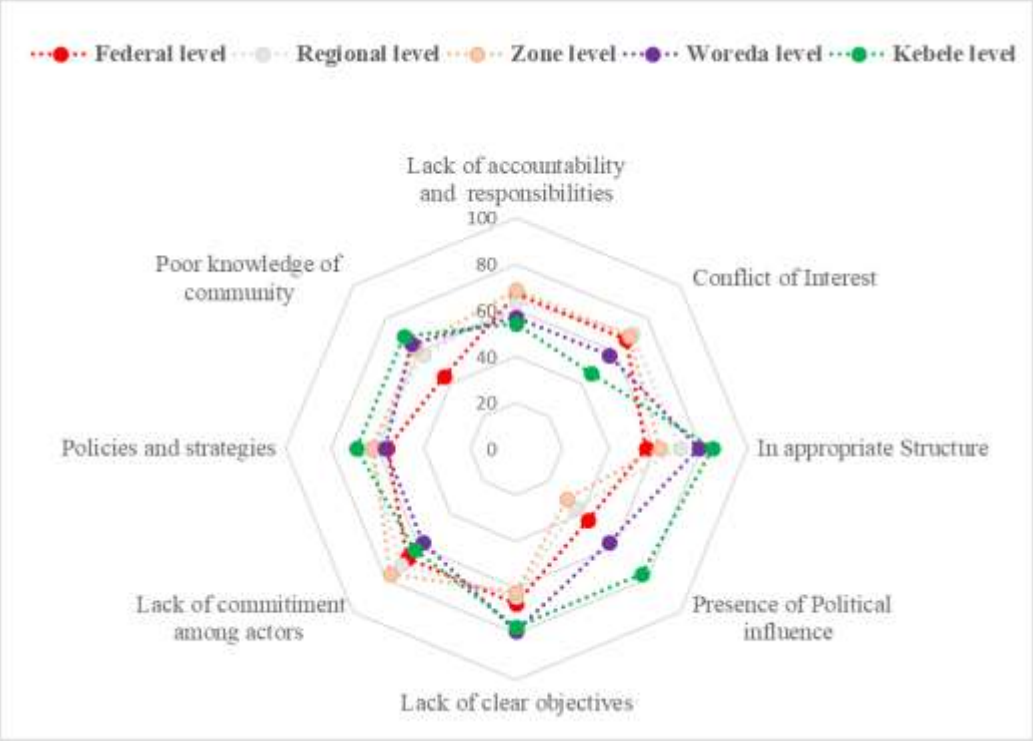


Figure 22: Factor influencing coordination in watershed management across government hierarchs (Sources: 2021-2022 survey)

4.4.7 Watershed management contribution for food security

The study explored the impact of watershed management on food security, focusing on factors such as water availability, soil fertility, and agricultural practices, based on household perceptions. The results revealed that a majority of households experienced increased crop yields due to the implementation of watershed management practices, including soil and water conservation measures. Specifically, 72.3% of households in mass mobilization programs, 75.4% in PNSP-PW, and 78.5% in SLMP-II reported improvements in food security. Additionally, households reported enhancements in water availability, animal feed, and income opportunities across the three micro watersheds studied. Figure 21 shows a summary of the improvements reported by households in the three programs in detailed data. These findings align with Degefa's (2005) definition of food security, which describes it as the ability of farmers and pastoralist households to meet their food and essential needs through diverse livelihood activities, including farming, livestock raising, non-farm businesses, or wage labor. Gashaw (2015) also highlighted that integrated watershed management covers various sectors—such as environment, agriculture, forestry, and animal husbandry—with the goal of improving food security. while Danacioglu and Tagil (2019) emphasized the potential of watershed management to enhance agricultural productivity and in promoting sustainable tourism through the preservation of natural and cultural heritage.

Despite the positive effects of watershed management on food security, the study identifies several challenges that limit its full potential across the three micro watersheds. A primary challenge is the divergence in perceptions and priorities regarding watershed management between different levels of government and local communities. These discrepancies in understanding and approach can lead to coordination difficulties, reducing the overall effectiveness and sustainability of watershed management interventions. At the federal and regional levels, it is viewed as integral to rural development. However, at the zone and woreda levels, opinions vary, with a stronger emphasis on natural resource management. At the community level, there is a mix of viewpoints: some see watershed management primarily as natural resource management, while others focus on soil and water conservation (see Table 24 and Figure 15). Sector-specific planning and a limited understanding of about coordination among the watershed committees have contributed to an incomplete recognition of watershed management's transformative potential in enhancing food security. Without addressing these underlying issues, the

potential benefits of watershed management may not be fully realized. This aligns with Moken et al. (2015), who highlight that a holistic approach to watershed management is crucial for balancing environmental, socio-economic, and political objectives to improve the quality of life for local communities and ensure sustainable management. Additionally, Gashaw et al. (2014) and Hurni et al. (2015) emphasize the need to bring together various stakeholders, including government agencies, local communities, and others, to develop a shared understanding of the holistic concept of watershed management. The study emphasizes the need for utilizing knowledge-sharing platforms, such as extension services, training programs, and community-based organizations, to adopt a holistic approach to watershed management.

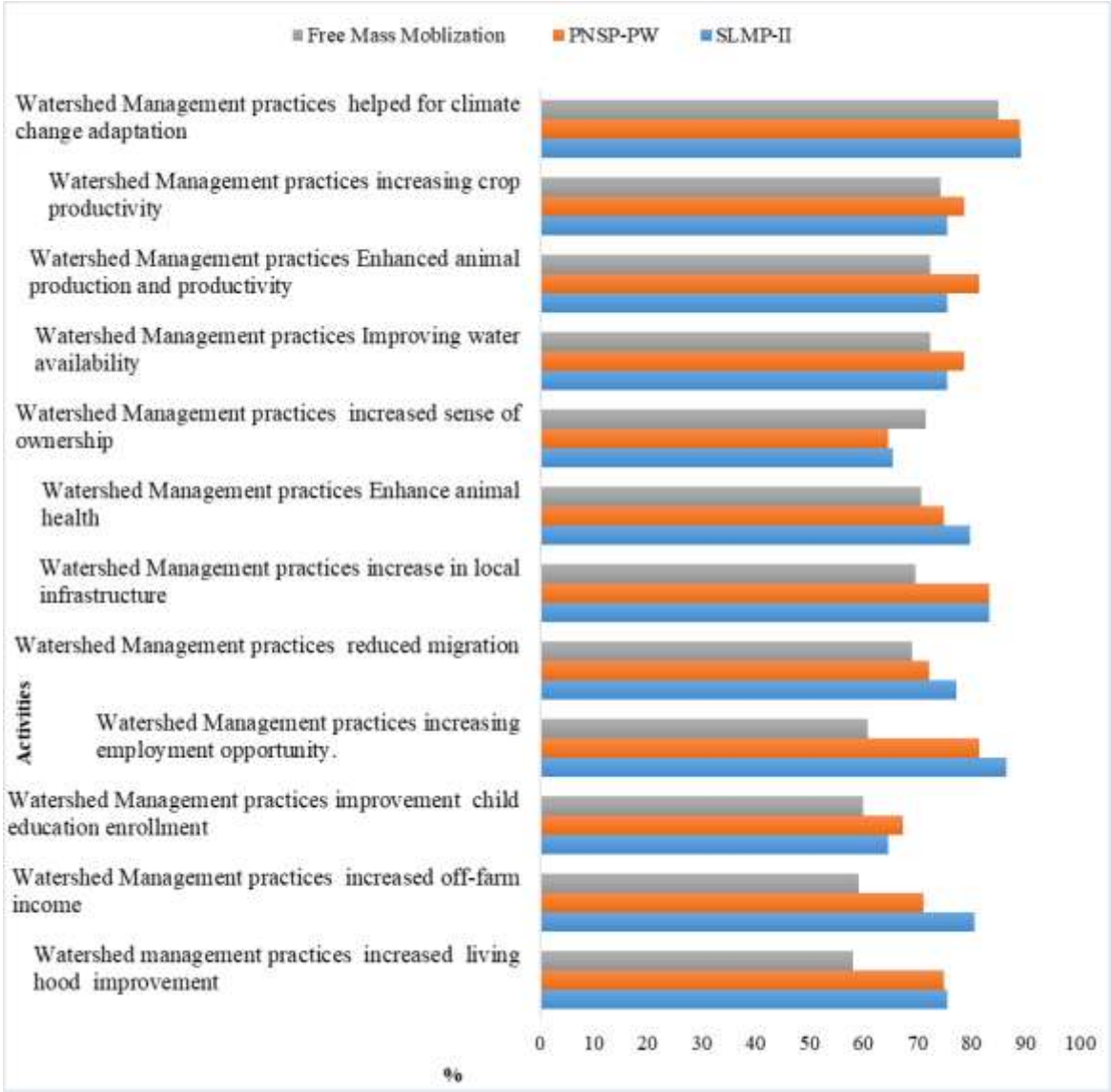


Figure 23: Households' perception on the effectiveness of watershed management practices for food security (Sources: 2021-2022 survey *)*

4.5 Conclusion

The study investigated how institutional frameworks and stakeholder knowledge impact watershed management and its influence on food security. Findings from three micro watersheds demonstrate that effective watershed management significantly boosts agricultural productivity, improves water resource management, creates employment opportunities, and enhances livestock feed availability, thereby contributing to improved food security. However, there is a substantial gap in understanding between professionals and farmers. Approximately 64% of professionals view watershed management primarily as natural resource management or soil and water conservation, while only 36% recognize its broader rural development and economic benefits. Conversely, although farmers appreciate the improvements in crop yield, water availability, and income, they tend to see these practices mainly as environmental conservation efforts, with only 12.6% viewing them as part of a comprehensive rural development strategy. This limited perspective restricts the adoption of a more integrated approach to watershed management.

Furthermore, the study highlights significant issues with stakeholder coordination and accountability, including insufficient collaboration both vertically (across different government levels) and horizontally (among various departments and agencies). Despite having an established framework for watershed management across federal, regional, and local levels, focus group discussions with local participants indicate a lack of adequate support from higher-level organizations. Additionally, while lower-level entities are tasked with implementing initiatives on the ground, their limited involvement in the planning process creates a disconnect that undermines the effectiveness and success of watershed management efforts. To address these challenges, the study recommends strengthening institutional coordination and developing collaborative frameworks among government, local authorities, and communities to align objectives. Increasing local stakeholder engagement is also critical to ensure contextually relevant and culturally appropriate strategies. These measures will enhance the efficiency, sustainability, and effectiveness of watershed management, improving food security and supporting rural development. Further research is also needed to identify barriers to coordination and innovative solutions to enhance stakeholder collaboration.

4.6 Reference

Abiye, W. (2019). Review on the Role of Integrated Watershed Management for Rehabilitation Degraded Land in Ethiopia. Journal of Biology, Agriculture and Healthcare, Vol.9, No.(June). https://doi.org/10.7176/jbah/9-11-02

Addis Kokeb, M. M., & Molla, E. (2015). Assessing the Physicochemical Properties of Soil under Different Land Use Types. Journal of Environmental & Analytical Toxicology, 05(05). https://doi.org/10.4172/2161-0525.1000309

Alemu, B., & Kidane, D. (2014). The Implication of Integrated Watershed Management for Rehabilitation of Degraded Lands: Case Study of Ethiopian Highlands. Journal of Agriculture and Biodiversity Research, *3*(February), 78–90. http://www.onlineresearchjournals.org/JABR

Amogne, A. E. (2014). Forest resource management systems in Ethiopia: Historical perspective. International Journal of Biodiversity and Conservation, 6(2), 121–131. https://doi.org/10.5897/ijbc2013.0645

Arfasa, F. G., & Tona, B. A. (2019). Review on Contribution of Community-Based Participatory Watershed Management Practice for Sustainable Land Management in Ethiopia. 55(Anon 2015), 13–27. https://doi.org/10.7176/JRDM

Assefa, E. (2012). Landscape Dynamics and Sustainable Land Management in Southern Ethiopia.

Bantider, A., Desta, G., Zeleke, G., Alamirew, T., & Tadesse, M. (2020). Post-1990 Natural Resource Management Policies and Laws in Ethiopia : A Scrutiny in the Lens of Integrated Landscape Management Approach. Vol.42 No., 1–42.

Bantider, A., Zeleke, G., Desta, G., Alamirew, T., Zewdu, A., Isabelle, P., & Hans, H. (2019). From Land Degradation Monitoring to Landscape Transformation: Four Decades of Learning, Innovation and Action in Ethiopia.

Bekele, Y., Kebede, B., & Kuma, T. (2023). Assessing the role of community participation in integrated watershed management in Dandi Lake watershed Dandi district, West Showa, Oromia, Ethiopia. Applied Water Science, *13*(11), 1–16. https://doi.org/10.1007/s13201-023-02009-

Beley, M., & Bewket, W. (2015). Enhancing Rural Livelhoods through Sustanable land Water

managment in North West Ethiopia (pp. 1–22).

Berardo, R., Turner, V. K., & Rice, S. (2019). Systemic coordination and the problem of seasonal harmful algal blooms in lake erie. Ecology and Society, *24*(3). https://doi.org/10.5751/ES-11046-240324

Brooks, K. N., & Eckman, K. (2000). Global perspective of watershed Management. Land Stewardship in the 21st Century: The Contributions of Watershed Management, 11–20.

Cohen, A., & Davidson, S. (2011). The watershed approach: Challenges, antecedents, and the transition from technical tool to governance unit. Water Alternatives, 4(1), 1–14.

Degefa, T. 2005. Combining household qualitative data and quantitative data in food security research: Trial lecture for the PhD-degree,Trondheim. Working papers on Population and land use in central Ethiopia, no. 5. Acta Geographica - Trondheim

Danacioglu, S., & Tagil, S. (2019). Watershed management based on ecological risk characterization in bakircay watershed. Fresenius Environmental Bulletin, 28(1), 62–76.

Darghouth, S., Ward, C., Gambarelli, G., Styger, E., & Roux, J. (2008). Watershed management approaches, policies, and operations: Lessons for scaling up. *Water Sector Board Discussion Papers*, *11*, 1–164. http://documents.worldbank.org/curated/en/2008/05/9608907

Deborah K. Hersha, Robyn S. Wilson & Anne M. Baird (2014) What individuals know, do not know, and need to know about watershed health in an urbanizing USA Midwestern city: A mental model approach, Urban Water Journal, 11:6, 482-496, DOI: 10.1080/1573062X.2014.881891

Desta, L., Carucc, V., Abebe, A., Wendem-Ageňehu, & Contributors, Y. (2005). Community Based Participatory Watershed Development A Guideline (G. Contributors (Alphabetical)

Devi, S. (2015). Community Participation and Sustainable Livelihoods : A Study on Watershed Management in Odisha. 509, 278.

Elfithri, R., Mokhtar, M., Abdullah, M. P., Taha, M. R., Toriman, M. E., Yasin, R. M., Yaakub, J., Khirotdin, R. P. K., Sultan, M. M. A., Ishak, S. A., Ramzan, N. M., Kamarudin, M. K. A., Juahir,

Ghazali, A., Ismail, A., & Gasim, M. B. (2018). Watershed Sustainability Index for Langat UNESCO

HELP River Basin, Malaysia. International Journal of Engineering and Technology(UAE), 7(3.14

Gadisa Chimdesa (2016). Historical Perspectives and Present Scenarios of Watershed Management in Ethiopia. International Journal of Natural Resource Ecology and Management. Vol. 1, No. 3, 2016, pp. 115-127. doi: 10.11648/j.ijnrem.20160103.17

Gashaw, T. (2015). The implications of watershed management for reversing land degradation in Ethiopia. Research Journal of Agriculture and Environmental Management, 4(1), 5–012. http://www.apexjournal.org Special Issue 14), 187–190. https://doi.org/10.14419/ijet.v7i3.14.16882

FAO. (2017). Watershed Management in Action: Lessons -learned from FAO field projects.

FAO, F. A. agriculture organization of T. U. N. (2021). Systems at breaking point.

FDRE (Federal Democratic Republic of Ethiopia). (2012). Ethiopia's Climate-resilience Green Economy: Green Economy Strategies. Addis Ababa, Ethiopia.

FCCC. (2015). Adoption of the Paris Agreement FC/CP/2015/L.9/Rev.1 United Nations Framework Convention on Climate Change. Gornyi Zhurnal, 7, 14–21\ . https://doi.org/10.17580/gzh.2021.07.02

Förch, G., & Thiemann, S. (2004). Definitions of Watershed Management : SCSA Soil Conservation Society of America (1982): Watershed Management is the integrated utilisation, regulation and care of the water and land resources in a watershed with the aim of meeting predefined development. *FWU, Vol. 4, Lake Abaya Research Symposium*, *4*, 119–133.

Gashaw, T. (2015). The implications of watershed management for reversing land degradation in Ethiopia. Research Journal of Agriculture and Environmental Management, 4(1), 5–012. http://www.apexjournal.org

Gashaw, T., Bantider, A., & G/Silassie, H. (2014). Land Degradation in Ethiopia: Causes, Impacts and Rehabilitation Techniques. Journal of Environment and Earth Science, 4(9), 98–105. http://www.iiste.org/Journals/index.php/JEES/article/viewFile/12963/13288

Gebregziabher, G., Assefa, D., Gebresamuel, G., Meredith, G., & Simon, L. (2016). An assessment of integrated watershed management in Ethiopia. International Water Management Institute (IWMI),

Colombo. (IWMI Working Paper 170).

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. Research Policy, 33(6–7), 897–920. https://doi.org/10.1016/j.respol.2004.01.015

German, L., Mansoor, H., Alemu, G., Mazengia, W., Amede, T., & Stroud, A. (2007). Participatory integrated watershed management: Evolution of concepts and methods in an ecoregional program of the eastern African highlands. Agricultural Systems, *94*(2), 189–204. https://doi.org/10.1016/j.agsy.2006.08.008

Godfray, H., J., C., Crute, I. R., Haddad, L., Muir, J. F., Nisbett, N., Lawrence, D., Pretty, J., Robinson, S., Toulmin, C., & Whiteley, R. (2010). The future of the global food system. Philosophical Transactions of the Royal Society B: Biological Sciences, 365(1554), 2769–2777. https://doi.org/10.1098/rstb.2010.0180

Gopa, L., Gokhale, Y., & Mini, G. (2021). Food and Land Resources : Incorporating Watershed- Based Approaches for Better Sustainability-productivity balance.

Gulati, R., Wohlgezogen, F., & Zhelyazkov, P. (2012). The Two Facets of Collaboration: Cooperation and Coordination in Strategic Alliances. Academy of Management Annals, 6(1), 531–583. https://doi.org/10.1080/19416520.2012.691646

Hassen, G. A. (2022). *A*nalysis of the Soil and Water Conservation Structural Design and Its Effect in Response To Land Use and Land Cover Changes : the Case of Gidabo River Sub-Basin Analysis of the Soil and Water Conservation Structural Design and Its Effect in Response To La.

Heal, K. (2019). Watershed Management in Action: Lessons Learned From FAO Field Projects. *Mountain Research and Development*, *39*(1), M5–M6. https://doi.org/10.1659/mrd.mm230

Horowitz, D. M. (2009). A review of consensus analysis methods in consumer culture, organizational culture and national culture research. *Consumption, Markets and Culture*, *12*(1), 47-64.

Hurni, K., Zeleke, G., Kassie, M., Tegegne, B., Kassawmar, T., Teferi, E., Moges, A., Tadesse, D., Ahmed, M., Degu, Y., Kebebew, Z., Hodel, E., Amdihun, A., Mekuriaw, A., Debele, B., Deichert, G., & Hurni, H. (2015). The Economics of Land Degradation. Ethiopia Case Study. Soil

Degradation and Sustainable Land Management in the Rainfed Agricultural Areas of Ethiopia: An Assessment of the Economic Implications. Report for the Economcs of Land Degradation Initiative, 94.

Katusiime, J. (2023). Land Tenure Dynamics and Integrated Watershed Management A cumulative dissertation for the degree of Doctor rerum naturalium

Kidane, D., Mekonnen, A., & Teketay, D. (2014). of Agropastoralists in the Lower Awash Basin , Northeastern Ethiopia. 6(2), 1–19.

Kothari, C. . (2004). Research methodology: Methods and techniques, Second Edition (Issue 1). NEW

Lynam, T., R. Mathevet, M. Etienne, S. Stone-Jovicich, A. Leitch, N. Jones, H. Ross, (2012). "Waypoints on a Journey of Discovery: Mental Models in Human-Environment Interactions." Ecology and Society 17 (3): 23. doi:10.5751/ES-05118-170323.Age International (P) Limited, Publishers,New Delhi -.

Mathevet, R., Etienne, M., Lynam, T., & Calvet, C. (2011). Water management in the Camargue Biosphere Reserve: insights from comparative mental models analysis. *Ecology and society*, *16*(1).

Mekonnen, M., Keesstra, S. D., Stroosnijder, L., Baartman, J. E. M., & Maroulis, J. (2015). Soil Conservation Through Sediment Trapping: A Review. Land Degradation and Development, 26(6), 544–556. https://doi.org/10.1002/ldr.2308

Meierdiercks, K. L., Finewood, M. H., & Bennett, C. (2024). Defining the term watershed to reflect modern uses and functions as inter- and intra-connected socio-hydrologic systems. *Journal of Environmental Studies and Sciences*, 236–255. https://doi.org/10.1007/s13412-024-00891-8

Mekuriaw, A. Heinimann, G. Zeleke, H. Hurni (2018). Factors influencing the adoption of physical soil and water conservation practices in the Ethiopian highlands International Soil and Water Conservation Research, 6 (2018), pp. 23-30 https://doi.org/10.1016/j.iswcr.2017.12.006

MoA. (2020). Community-based Participatory Watershed and Rangeland Development : A Guideline I NFOTECHS ON TECHNOLOGIES FOR WATERSHED. January.

Mulugeta, S. (2015). Research Article Attitude Towards Watershed Management Programs And Level Of Participation : Liaison Analysis In Southern Ethiopia * Mulugeta Sisay. April.

Munang, R. T., Thiaw, I., & Rivington, M. (2011). Ecosystem management: Tomorrow's approach to enhancing food security under a changing climate. Sustainability, 3(7), 937–954. https://doi.org/10.3390/su3070937

Narendra, B. H., Siregar, C. A., Dharmawan, I. W. S., Sukmana, A., Pratiwi, Pramono, I. B., Basuki, T. M., Nugroho, H. Y. S. H., Supangat, A. B., Purwanto, Setiawan, O., Nandini, R., Ulya, N. A., Arifanti, V. B., & Yuwati, T. W. (2021). A review on sustainability of watershed management in Indonesia. Sustainability (Switzerland), 13(19), 1–29. https://doi.org/10.3390/su131911125

Nick and Woldehanna (2012). Managing watersheds for resilient livelihoods in Ethiopia; Development Co-operation Report Lessons in Linking Sustainability and Development © OECD 2012 109 PART Chapter 8 DOI: 10.1787/dcr-2012-15-en/

Nigussie, Z., Tsunekawa, A., Haregeweyn, N., & Adgo, E. (2018). Land Use Policy Applying Ostrom ' s institutional analysis and development framework to soil and water conservation activities in north-western Ethiopia. 71(November 2017), 1. https://doi.org/10.1016/j.landusepol.2017.11.039

Ndwiga, G. M. and J. (2015). This document is discoverable and free to researchers across the globe due to the work of AgEcon Search . Help ensure our sustainability .. *AgEcon Search*, 18. file:///F:/Spec 2/Traffic Delay Model.pdf

Nyssen, J., Haile, M., Moeyersons, J., Poesen, J., & Deckers, J. (2004). Environmental policy in Ethiopia: A rejoinder to Keeley and Scoones. Journal of Modern African Studies, 42(1), 137–147. https://doi.org/10.1017/S0022278X03004518

Ogbaharya, D., & Tecle, A. (2010). Community-based natural resources management in eritrea and ethiopia: Toward a comparative institutional analysis. Journal of Eastern African Studies, 4(3), 490–509. https://doi.org/10.1080/17531055.2010.517417

Ratna Reddy, V., Saharawat, Y. S., & George, B. (2017). Watershed management in South Asia: A synoptic review. Journal of Hydrology, 551(May), . https://doi.org/10.1016/j.jhydrol.2017.05.043

Rawat, M. S. (2014). Integrated Watershed Management : An Alternative Approach for Sustainable Development in Nagaland. 1(1), 1–14.

Rushemuka, N. P., Bizoza, R. A., Mowo, J. G., & Bock, L. (2014). Farmers' soil knowledge for

effective participatory integrated watershed management in Rwanda: Toward soil-specific fertility management and farmers' judgmental fertilizer use. Agriculture, Ecosystems and Environment, *183*, 145–159. https://doi.org/10.1016/j.agee.2013.10.020

Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J. L., Sheil, D., Meijaard, E., Venter, M., Boedhihartono, A. K., Day, M., Garcia, C., Van Oosten, C., & Buck, L. E. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. Proceedings of the National Academy of Sciences of the United States of America, https://doi.org/10.1073/pnas.1210595110

Setyo, P. A. (2019). Watershed Management in Indonesia: A Regulation, Institution, and Policy Review. Jurnal Perencanaan Pembangunan: The Indonesian Journal of Development Planning, 3(2), 185–202. https://doi.org/10.36574/jpp.v3i2.74

Suhas P. Wania , Thawilkal Wangkahartb , Yin Dixinc , Zhong Lid and N.V. Thang 2010). Community watersheds for food security and coping with impacts of climate change in rainfed areas WS3.1 – Climate Change: Watershed Management and Food Security; 9th European IFSA Symposium, 47 July 2010, Vienna (Austria)

Sheng, T. C. (1994). Challenges and Strategies of Integrated Watershed Management in Developing Countires. 8th Soil Conservation Conference, New Delhi, 1–10.

Sieker, H. (2006). Development of a decision support system for integrated water resources management in intensively used small watersheds. Water Practice and Technology, *1*(1). https://doi.org/10.2166/wpt.2006004

System, D., Naburi, N. D., Obiri, J., & Mugalavai, E. (2020). Watershed Governance for Food Security in the Sio River Basin : A Paradox of Watershed Governance for Food Security in the Sio River Basin : A Paradox of Kenya ' s Devolution System. September, 2465–2478. https://doi.org/10.33258/birci.v3i3.1226

Tefera, T. (2015). Soil And Water Conservation Practices In Lailay May Chew Woreda, Centeral Tigray, Tigray Region, Ethiopia (Vol. 21, Issue 1).

Teketay, D., & Fetene, M. (2003). State of the Environment in Ethiopia : Past , Present and Future Prospects State of the Environment in Ethiopia : Past , Present and Future Prospects. January 2003.

Terefe, H. R., Zemede Asfaw, & Demissew, S. (2015). The Link between Ethnobotany and Watershed Development for Sustainable Use of Land and Plant Resources in Ethiopia. Journal of Ecosystem & Ecography, 05(02). https://doi.org/10.4172/2157-7625.1000161

Thiemann, S., Schubert, H., & Schütt, B. (2018). Course Reader Integrated Watershed Management. 6(November), 16–63. https://doi.org/10.17169/Fudocs

UNEP. (2016). Food Systems and Natural Resources. A mentally sound practices Report of the Working Group on Food Systems of the International Resource Panel. Westhoek, H, Ingram J., globally and in its own activities.

Vasant, P. G., & Lin, C. (2012). Determinants of Institutional Performance in Watershed Management: A Study of the Nature and Performance of Watershed Development Institutions in Andhra Pradesh, India Vasant. Journal of Gender, Agriculture and Food Security, 1(3), 1–29.

Veale, B. J. (2010). Assessing the Influence and Effectiveness of Watershed Report Cards on Watershed Management: A Study of Watershed Organizations in Canada.

Wang, G., Mang, S., Cai, H., Liu, S., Zhang, Z., Wang, L., & Innes, J. L. (2016). Integrated watershed management: evolution, development and emerging trends. Journal of Forestry Research, 27(5), 967–994. https://doi.org/10.1007/s11676-016-0293-3

Worku, M. T., & Tripathi, S. K. (2015). An Evaluation of Watershed Management Practice in Ethiopia: A Preliminary Review 1*. CRDEEPJournals International Journal of Environmental Sciences Tesfa & Tripathi, 4(1), 24–30. www.crdeep.com

Worku, T., & Sangharsh, T. (2015). Watershed Management in Highlands of Ethiopia : A Review. 1–11. https://doi.org/10.4236/oalib.1101481

CHAPTER FIVE : SYNTHESIS AND FUTURE RESEARCH

5.1 Introduction

This thesis investigated the effectiveness of three micro watershed management approaches in promoting food security. It analyzed the biophysical, institutional, and socioeconomic factors that influence watershed processes, with a specific emphasis on three micro watershed implemented as part of Free Mass Mobilization, PSNP-PW, and SLMP II. The study employed a mixed-methods approach, combining both quantitative and qualitative research methods to provide a robust analysis of the subject matter. Data collection involved in-depth interviews, focus group discussions, and surveys, supplemented by secondary data sources such as satellite imagery and document reviews. The biophysical component of the research focused on assessing ecological characteristics of the watersheds. This included analyzing land use and land cover changes and their subsequent impacts on water availability, vegetation cover, and biodiversity. By evaluating these factors, the thesis aimed to elucidate how different watershed management strategies influence ecosystem productivity and resilience.and food security.The study also explored the role of community involvement in watershed management. It assessed the extent of community participation in management activities and evaluated how this participation impacts the success of the initiatives. The degree of community participation in watershed management activities have vital for the success of the initiatives. It considered the varying levels of knowledge and understanding among stakeholders regarding watershed dynamics and how these factors influence the effectiveness of watershed management strategies. The study also examined how institutional frameworks and stakeholder knowledge affect watershed management, particularly in enhancing food security. This component considered the varying levels of stakeholder knowledge and understanding of watershed dynamics and how these factors influence the effectiveness of management strategies. The thesis explores how comprehensive understanding of watershed management plays a crucial role in shaping watershed management outcomes. Different stakeholders have varying levels of knowledge and understanding of the complex dynamics of watersheds.

5.2 Key finding

I. The impact of biophysical changes in watershed management on improving food security for households

The research findings indicate that the implementation of watershed management interventions in three micro watersheds has resulted in significant positive outcomes. Conservation measures such as reforestation, soil conservation, and area enclosure have successfully revitalized the natural habitats within the watershed, contributing to environmental restoration and improved ecosystem health. Another notable achievement of the watershed management intervention was the reduction of soil erosion. Through the implementation of soil conservation practices such as terracing, contour plowing, and cover cropping, the initiative effectively minimized soil erosion within the watershed. The analysis of satellite imagery has revealed a noticeable increase in vegetation cover within the micro watersheds, indicating improved water availability for plants and animals. This increase in vegetation cover has not only contributed to the overall biodiversity of the area but has also played a crucial role in reducing the risk of floods and droughts. The survey data reveal that 93.4% of households reported reductions in soil erosion, while 84.9% noted a decrease in deforestation following the implementation of watershed interventions. Furthermore, the impact on food security is notable; participants in the Productive Safety Net Program (PNSP) Public Works (PW) program experienced a decline in food shortages, with the percentage of households facing scarcity over a ten-month period dropping from 16.9% to 2.56%. Similarly, in SLMP II and Free Mass Mobilization, 35% and 33% of respondents, were shifted from 7-9 month food shortages to 3-6 months after implementing watershed management interventions respectively. The findings of this study provide compelling evidence for the effectiveness of integrated watershed management approach in enhancing environmental resilience and boosting food security, highlighting the critical need for continued investment in this sustainable practice. The investigation coinciding with the discovery of different researchers carried out in various countries, for instance, a study conducted in India revealed that a comprehensive evaluation of watershed programs indicated that an overwhelming majority of (99% of) these initiatives exhibited economic viability (Wani et al., 2010). This inquiry also discovered that in Asia, these programs effectively alleviate poverty without exacerbating the degradation of natural resources (Wani et al., 2009; Sreedevi and Wani, 2009). Scholars like Bebermeier et al. (2017) and Teka et al. (2020) have examined the effectiveness of watershed management in controlling erosion and sedimentation. Furthermore, Butsel et al. (2017) have

emphasized the importance of Integrated Water Management (IWM) in addressing water-related challenges, including water scarcity, pollution, and the preservation of ecological balance within a watershed. Moreover, several studies (Nyssen et al., 2010; Schmidt & Tadesse, 2012; Taye et al., 2015; Tadesse et al., 2017) have highlighted the potential of watershed management in enhancing biophysical aspects such as soil and water conservation measures, ultimately leading to improved productivity.

II. Watershed management practice along with the related organizational structures at different levels of implementation

The historical development of integrated watershed management has been extensive, spanning from ancient times to the present day. However, there are still gaps in knowledge and challenges in implementing the concept in practice (Wang et al., 2016;UNEP, 2021). Additionally, the use of terms related to natural resource management, soil and water preservation, and integrated watershed management can be misused or applied arbitrarily. This is because different actors at different levels use these concepts in their discussions and strategic documents to pursue the goals of sustainable rural development. To bring about real changes in the actual environment, it is essential to understand what integrated watershed approach really mean? In the context of the case study sites, the study findings indicated that the participants have diverse perspectives and observations regarding the integrated watershed approach. The diversity in comprehension of watershed management can be attributed to the dynamic nature of watersheds. Watersheds are complex and ever-changing systems where strategies are continuously evaluated and modified based on new information and changing conditions. By incorporating the latest scientific findings into managerial approaches, the gap between theoretical knowledge and practical implementation can be bridged. This integration holds the potential to create a shared understanding and promote collaborative efforts among scientists, policymakers, and stakeholders, ultimately guiding the achievement of sustainable watershed management.

However, at present, the responsibility of watershed management in Ethiopia in general and in the Oromia Regional State in particulalr where the case study sites located, is distributed among various organizations, each with its own hierarchical structure, ranging from the Federal level down to the Kebele level. The research results indicate an absence of efficient networking, coordination, and collaboration between the federal Ministry of Agriculture, the Oromia Bureau, pertinent line agencies at the zonal and woreda levels, as well as the project coordinators operating at both federal and regional tiers. Specifically, the technical and steering committee duties for both SLMP and PNSP-PW were being

fulfilled voluntarily at all levels because there is no officially recognized platform for inter-ministerial (horizontal) cooperation.

This demonstrates that without a clear and unified framework, there may be overlapping or conflicting mandates among different organizations involved in watershed management. This creats confusion and inefficiencies in decision-making processes, as well as hindered the implementation of cohesive strategies. Second, the absence of an integrated organizational structure leads to a fragmented approach to watershed management. Different organizations have their own priorities, objectives, and strategies, which may not align with each other or with the overall goals of sustainable watershed management. Third, the absence of a clear hierarchical structure hindered the accountability and monitoring mechanisms. Without a well-defined chain of command and reporting systems, it can be challenging to track progress, evaluate the effectiveness of interventions, and hold responsible parties accountable for their actions or lack thereof.

Furthermore, integrated watershed management is hindered by a fragmented institutional framework and a sectoral approach to planning. This fragmentation leads to delays in achieving comprehensive and inclusive management of interconnected priorities, as well as conflicting objectives and inefficient use of resources. Therefore, it is essential to establish robust institutional frameworks that define clear mandates, roles, responsibilities, and accountability mechanisms for coordination, collaboration, and information sharing for all organizations involved and capacity build are also necessary to enable local communities to participate actively in decision-making processes, making watershed management efforts more effective, efficient, and sustainable. This, in turn, can enhance food security.

III. The level of community participation at different phases of watershed management

Adopting a watershed-based planning approach has been widely acknowledged as a strategy to achieve sustainable development. This holistic perspective allows for the identification of synergies and trade-offs between different sectors, enabling the development of integrated and sustainable solutions (Yusuf et al., 2020; Addisie & Molla, 2021). The process of watershed management involves planning, implementation, monitoring, and evaluation, necessitating diverse forms of participation at each phase to attain sustainable development. The study endeavors to offer a comprehensive comprehension of farmers' involvement in various phases of watershed management practices by employing an extensive array of indicator measurement questions. The outcomes of the study revealed that the farmers'

participation level, across all three micro-watersheds and at each stage, was moderate and predominantly inclined towards physical conservation measures. This shows that rather than other aspects of watershed management like agricultural development, off-farm activities, and sociocultural aspects, farmers were more likely to engaged in practices like afforestation, check dam construction, and soil erosion control. This finding concurs with Mengistu & Assefa, (2021) and Teressa, (2018) who find that similar find of moderate level of farmer participation in watershed management at different part of the country. Furthermore, assessing the level and effectiveness of farmers' involvement in watershed management practices is also not a straightforward task, as indicated by research findings. The absence of universally accepted criteria hinders the development of effective and inclusive strategies. Additionally, insights gained from the study area indicate that community participation was not adequately prioritized as a fundamental element of current programs and practices in watershed management. The study also discovered that the effectiveness of farmers' participation in watershed management is impacted by a range of contextual elements, including socio-economic circumstances, institutional backing, and resource accessibility. This outcome aligns with the findings of Assefa & Kidane (2016) and Reed et al. (2018), who emphasized the influence of extension services and knowledge on the effectiveness of participation. Hence, it is essential to consider these factors when assessing the level and effectiveness of farmers' participation. This requires a comprehensive approach that takes into account the broader socio-economic and institutional context in which watershed management projects are implemented.

IV. Summary of the finding: implementing an integrated watershed management approach is crucial for enhancing food security in rural areas.

Throughout the evolution of development planning, there has been a notable shift in focus from simply increasing production to prioritizing efficiency, effectiveness, and ultimately sustainable development. Integrated watershed management has emerged as a valuable strategy for rural development within this context (Bouma et al., 2007**;** Wani et al., 2010;FAO, 2017). The use the integrated watershed management as planning unit has been widely recognized (Ratna Reddy et al., 2017). Howe ever, in most of the cases the concept of integrated watershed management has not been applied beyond the physical conservation at micro watershed level. The finding of this study highlight that the sector-based strategy for watershed planning has restricted the acknowledgment of interconnected priorities and the comprehensive comprehension of watershed dynamics. Moreover, the fragmented institutional framework hinders the effective management of local watersheds and the meaningful involvement of

local communities in comprehensive planning. However, in order to effectively use watershed planning and apply the principles of watershed management, it is crucial to promote a shared understanding of the concept among both institutions and communities (Mireku & Mensah, 2015). This shared understanding allows for a common language and framework to be established, ensuring that all stakeholders are on the same page when it comes to identifying issues, setting goals, and implementing strategies. Additionally, multi-stakeholder platforms are essential in this process as they provide a space for different actors to come together, share their perspectives, and collaborate on finding solutions. Furthermore, multi-stakeholder platforms facilitate the coordination and integration of efforts across different sectors and levels of governance ensuring that actions are aligned and complementary. Watersheds often span multiple jurisdictions, and coordinating actions to balance natural resource preservation and utilization, enhance land productivity, optimize livestock management, and streamline multi-asset administration (Thiemann et al., 2018; Alemu & Kidane, 2014; Gopa et al., 2021).

Traditional approaches often focus on isolated aspects of watershed management, potentially leading to fragmented and less effective outcomes. This thesis has prposed new IMMA to enhance the effectiveness and sustainability of watershed management efforts by integrating three key components: Watershed Governance, the Watershed Sustainability Chain, and Watershed Management Planning and implimentaion. Watershed Governance involves a hierarchical structure from federal to local levels, supported by an institutional framework that emphasizes participation, coordination, integration, extension services, and capacity building. This governance reform ensures that various stakeholders are effectively engaged and aligned. The Watershed Sustainability Chain includes biophysical, socioeconomic, and technological dimensions, addressing aspects such as soil conservation, livelihood improvement, and the application of advanced technologies. Watershed Management Planning and implimentaion encompasses critical areas such as water resources management, infrastructure development, sociocultural factors, natural resource management, and agricultural practices. By integrating these elements, the approach fosters coordinated planning, implementation, and monitoring. This comprehensive strategy promotes ecological, economic, and social sustainability, establishing a robust framework that supports the four pillars of food security: availability, stability, accessibility, and utilization. By integrating these dimensions within watershed management practices, the strategy not only enhances ecological health but also ensures that food security outcomes are sustainable and equitable. This holistic approach is essential for fostering resilient communities capable of adapting to

the challenges posed by climate change and other socio-economic pressures, ultimately making effective watershed management pivotal in achieving sustainable food security and improving overall community well-being.

The proposed Integrated Watershed Management Approach addresses the complex and interconnected factors essential for achieving sustainable livelihoods and food security. Figure 22 illustrates the key elements of this approach, highlighting the interdependencies among various components crucial for effective watershed management. This holistic strategy incorporates ecosystem health, community engagement, resource management, and supportive policies, aiming to enhance agricultural productivity and environmental conservation while bolstering community resilience to climate change and socio-economic challenges. By integrating these elements, the approach offers a comprehensive framework that fosters sustainable development and improves food security outcomes for households within the watershed.

First, it is crucial to involve all relevant stakeholders in the planning and implementation of watershed management programs. This includes local communities, government agencies, non-governmental organizations, and other relevant actors. By involving all stakeholders, a more comprehensive and inclusive approach can be taken, ensuring that the needs and perspectives of all parties are considered.

Second, a holistic approach should take into account the interconnectedness of different aspects of watershed management. This includes considering the ecological, social, and economic dimensions of the watershed. By considering these interconnected aspects, a more integrated and sustainable approach can be developed.

Third, a holistic approach should prioritize the conservation and restoration of natural resources within the watershed. By prioritizing the conservation and restoration of natural resources, the overall health and resilience of the watershed can be improved, leading to enhanced household livelihoods and food security.

Fourth, a holistic approach also address the social and economic aspects of watershed management. This includes promoting equitable access to water resources, ensuring the participation and empowerment of marginalized groups, and promoting sustainable livelihood opportunities. By addressing these social and economic aspects, the overall well-being and resilience of local communities can be improved, leading to enhanced household livelihoods and food security.

Lastly, a holistic approach should also consider the long-term sustainability of watershed management programs. This includes monitoring and evaluating the effectiveness of interventions, adapting strategies based on lessons learned, and building the capacity of local communities and institutions. By ensuring the long-term sustainability of watershed management programs, the benefits and impacts can be maximized, leading to enhanced household livelihoods and food security in the long run.

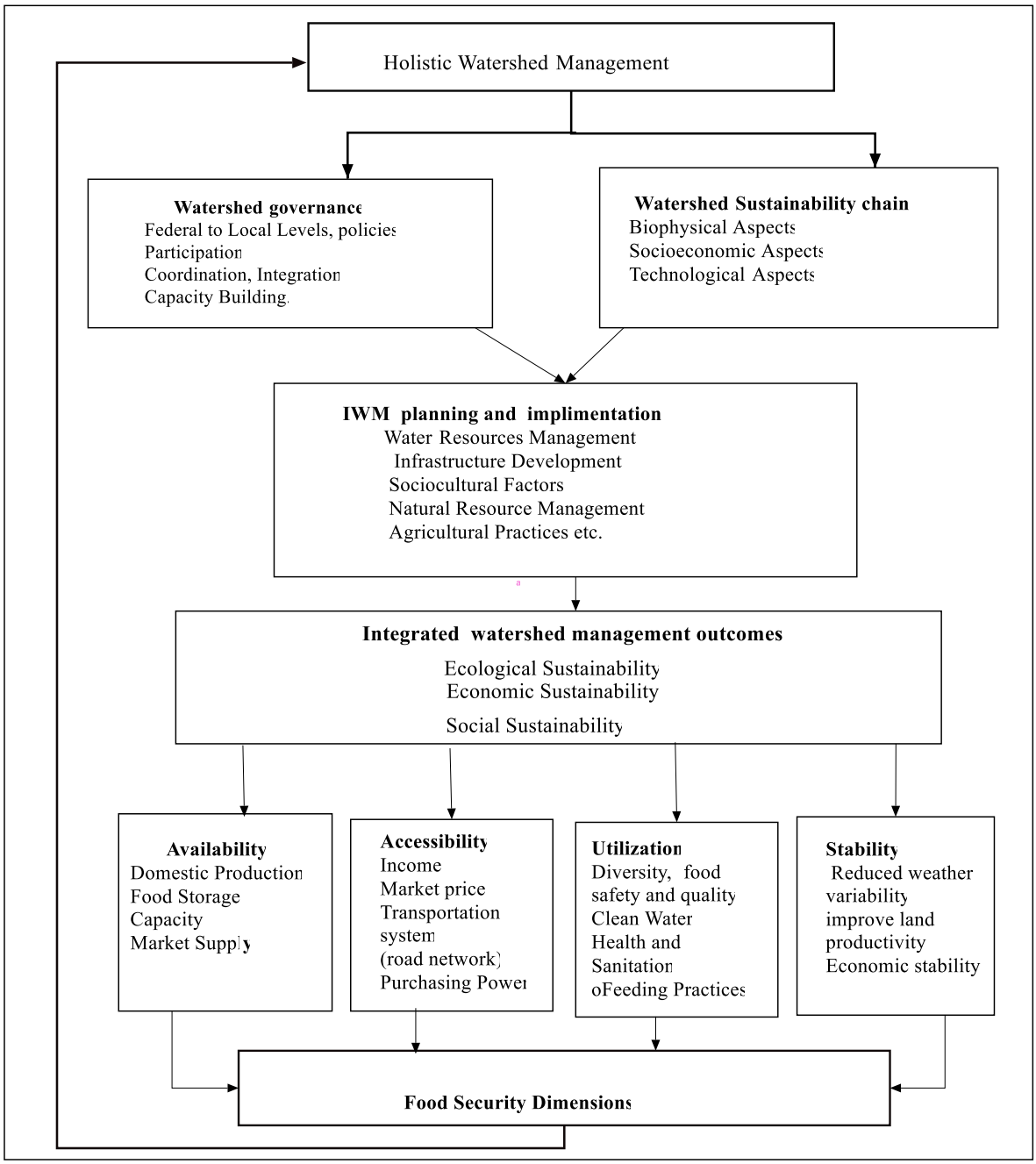
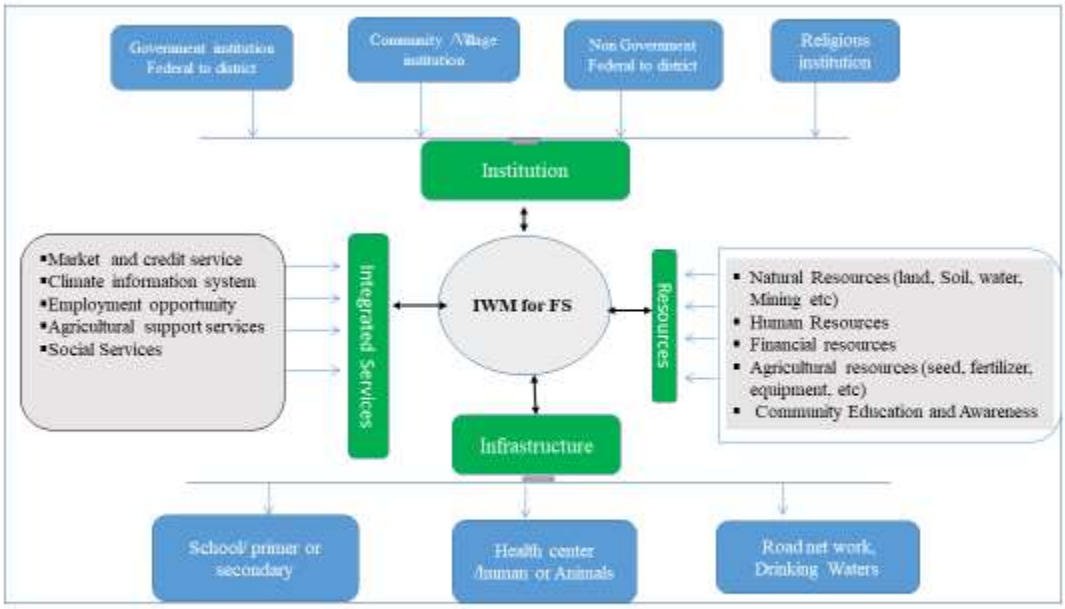


Figure 24: Proposed New Interated Watershed Mangment Approach

Graphic conclusion and recommendation



If integrated watershed management is effectively put into practice, it can fully meet the requirements for food security.

This model effectively engages all stakeholders to enhance understanding of integrated watershed management as a critical component of sustainable development. By incorporating diverse perspectives, it fosters collaboration and collective responsibility for watershed management , ensuring that the needs and insights of all parties are considered. Additionally, it establishes evaluation frameworks to assess environmental and socio-economic impacts, allowing for comprehensive evaluations of management strategies. This inclusive approach not only supports ecological integrity but also bolsters the socio-economic well-being of communities reliant on watershed resources. As a result, it promotes lasting sustainability and resilience, creating a foundation for future success in watershed management initiatives.

5.3 Conclusions and recommendation

The research findings indicate that effective watershed management enhances food security by improving agricultural practices, optimizing water use, creating jobs, and improving local living standards, linking environmental stewardship with socio-economic progress. However, despite the

potential benefits, the program encounter various obstacles in attaining its objective. One of the main challenges is a lack of comprehensive community involvement during the planning, implementation, and evaluation stages. Meaningful community engagement and participation are crucial for the success and sustainability of these initiatives However, lack of thorough engagement leads to a failure to address the specific needs and priorities of the community, resulting in strategies that may be ineffective or misaligned, thus threatening the success and sustainability of watershed management initiatives. Furthermore, there are significant knowledge gaps regarding watershed management principles among professionals and community members, which impede the program's ability to function as a holistic strategy. A lack of thorough knowledge of watershed management concept can lead to implementing strategies that does not improve the watershed's long-term health.

However, despite the potential benefits, the program encounter various obstacles in attaining its objective. One of the main challenges is a lack of community awareness. Many households in these watersheds are not fully aware of the importance of watershed management and how it can positively impact their livelihoods and food security. This lack of awareness hinders the successful implementation of these programs as it reduces community participation and engagement. Insufficient community participation is another obstacle faced by watershed management programs. Meaningful community engagement and participation are crucial for the success and sustainability of these initiatives. However, in many cases, communities are not adequately involved in planning, implementation and monitoring and evaluation of the watershed management activities leading to a lack of ownership and commitment to the program's objectives. Furthermore, there is a failure to acknowledge farmers' perceptions and preferences. Each community has its own unique set of beliefs, values, and practices, which can influence their willingness to adopt new technologies or practices. Ignoring these factors can lead to resistance or limited uptake of watershed management strategies. Inadequate coordination among stakeholders is another obstacle faced by these programs. Effective watershed management requires collaboration and coordination among various stakeholders, including government agencies, non-governmental organizations, and local communities. However, the lack of coordination and communication among these stakeholders often leads to fragmented efforts and a failure to achieve the desired outcomes.

To promote the sustainability and efficacy of watershed management initiatives aimed at improving household livelihoods and food security, it is essential to implement a comprehensive approach (see Figure 20). Furthermore, it is essential to establish dedicated coordination units that focus on the integration of various programs and initiatives at the woreda level. These units will serve as central hubs for collaboration among different sectors, stakeholders, and community organizations, ensuring that efforts are aligned and resources are utilized efficiently to promote sustainable development.

5.4 Suggestions for Further Research

There are several areas within watershed management that are worthy of research. This particular study concentrated on three micro watersheds within a similar area and agro ecology context, each employing slightly different strategies for managing their watersheds. There are numerous other watershed models available that can provide valuable insights into watershed approach reforms. Additionally, this study sought to gain insights from agency experts and managers who have been actively involved in implementing watershed approach strategies. The objective was to understand their experiences, as well as the challenges they faced, in implementing reform practices within institutional limitations. However, it is important to note that this study only captured a limited number of perspectives, and further research is needed to explore other important viewpoints. Specifically, future investigations should focus on how others different program staff and managers perceive watershed approach strategies. Further investigation is necessary to examine how different sector goals can be combined and to determine the most effective tools and approaches for integrated projects. There is a strong need to develop common guidelines for collecting baseline and monitoring data, which would not only help in analyzing the impacts of current and future activities but also plan corrective measures after mid-term evaluation.

5.5 Reference

Alemu, B., & Kidane, D. (2014). The Implication of Integrated Watershed Management for Rehabilitation of Degraded Lands: Case Study of Ethiopian Highlands. *Journal of Agriculture and Biodiversity Research*, *3*(February), 78–90. http://www.onlineresearchjournals.org/JABR

Bouma, J., Van Soest, D., & Bulte, E. (2007). How sustainable is participatory watershed development in India? *Agricultural Economics*, *36*(1), 13–22. https://doi.org/10.1111/j.1574-0862.2007.00173.x

FAO. (2017). *Watershed Management in Action: Lessons -learned from FAO field projects*.

Gopa, L., Gokhale, Y., & Mini, G. (2021). *Food and Land Resources : Incorporating Watershed- Based Approaches for Better Sustainability-productivity balance.*

Mengistu, F., & Assefa, E. (2021). Community participation in watershed management: analysis of the status and factors affecting community engagement in the upper Gibe basin, South West Ethiopia. *Journal of Environmental Planning and Management*, *64*(2), 252–288. https://doi.org/10.1080/09640568.2020.1762550

Mireku, O. D., & Mensah, A. K. (2015). Policy interventions in watershed management: The case of the Inchaban Watershed, Ghana. *International Journal of Water Resources and Environmental Engineering*, *7*(3), 29–37. https://doi.org/10.5897/IJWREE2014.

Ratna Reddy, V., Saharawat, Y. S., & George, B. (2017). Watershed management in South Asia: A synoptic review. *Journal of Hydrology*, *551*(October), 4–13. https://doi.org/10.1016/j.jhydrol.2017.05.043

Teressa, D. (2018). The Effects of Community Based Watershed Management on Livelihood Resources for Climate Change Adaptation the Case in Gemechis District, Oromiya. *International Journal of Environmental Sciences & Natural Resources*, *15*(2), 31–39. https://doi.org/10.19080/ijesnr.2018.15.555906

Thiemann, S., Schubert, H., & Schütt, B. (2018). *Course Reader Integrated Watershed Management*. *6*(November), 16–63. https://doi.org/10.17169/FUDOCS

Wani, S. P., Wangkahart, T., Dixin, Y., Li, Z., & Thang, N. V. (2010). *Community watersheds for food security and coping with impacts of climate change in rain - fed areas Importance of Rain - fed Agriculture and Constraints* (Issue July).

6 Appendixes

Appendex 1: Indicator metrics across watershshed mangment phases

	Indicator meterics	very low	low	moderate	High	very high	>=Moderate as participant
1	Did you participate in an awareness creation meeting before watershed management planning?	16	46	88	113	74	275
2	Did you participate on training about CBPWM guideline for proper watershed planning?	33	121	20	108	55	183
3	Did you participate in PRA techniques like resources mapping, social mapping, transect walks, et	43	118	1	169	6	176
4	Have you suggested information/ideas during the planning of the watershed management	45	115	46	93	38	177
5	Do you feel that your comment taken into account	58	131	39	78	31	148
6	Did the poor and marginalized peoples of the community members participate in the micro watershed planning?	58	104	37	73	65	175
7	Did you participate /Elected/ Involved/ during the election of kebele watershed committee member	58	126	35	70	48	153
8	Have you participated in the process of watershed plan approval?	56	119	35	70	57	162
9	Did you participate in technical training for the implementation of watershed management	48	115	26	113	35	174
10	Did you or your family member participate in community watershed management work during the last five years?	31	62	57	104	83	244

11	Did you contribute resources like labor, money, etc during the watershed implementation?	10	30	77	119	101	297
12	Do you have practiced on any phsical soil and water conserveion on your own farm land during the last five years?	10	36	76	116	99	291
13	Do you have practiced improved forage development or other livestock development activities?	98	109	52	60	18	130
14	Did you participate in crop production and other improved practices recommended by watershed development officials?	98	122	40	58	19	117
15	Did you participate in other income-generation activities?	59	167	25	59	27	111
16	Did you participate by supervising ongoing activities/works undertaken in the fields and community lands	63	134	31	82	27	140
17	Did you participate in enacting the bylaw of the watershed the micro watershed?	58	126	35	70	48	153
18	Follow-up on the watershed management implementation actions based on existing community organization watershed ?	66	126	14	128	3	145
19	Did there regularly meet in the micro watershed to discuss about the watershed management during and after the completion of the work each year?	70	116	74	62	15	151
20	Participation in the protection of area closure and other rehabilitated watershed area in the micro watershed	70	122	49	64	32	145
21	Take part in the micro watershed decision-making process	69	128	53	78	9	140

22	Regular checking the quantity and quality of work in watershed management in accordance with the Community-based Watershed Management Guidelines.	65	105	54	91	22	167
23	Maintenance of the physical conservation activities undertaken on a regular basis in the micro watershed	40	89	77	86	45	208

Appendex 2: Collinearity Statistics test

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	Sex of the the household	.937	1.067
	Age of farmer	.685	1.461
	Educational level	.669	1.495
	family size	.358	2.790
	What is the walking distance (in hours or minutes) from farm plot?	.603	1.659
	Total land holding under diffirent use	.784	1.275
	Livestock holding	.516	1.939
	Extension advice service provided by extension personnel	.312	3.204
	Member community/ Kebele Community watershed committee/	.643	1.555

a. Dependent Variable: over all level of participation

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	140.757[a]	.620	.827

Appendix 3: List respondent from different government Hierarch

	Government Hierarch	No person interviewed
	Federal Level	9
1	Ministry of Agriculture	4
2	The Ministry of Water and Energy	1
3	The Ministry of Irrigation and Lowland Areas Development	2
4	The Environmental Protection Agency	2
	Regional Level	14
5	Oromia Bureau of Agriculture	5
6	Oromia Bureau of Land	2
7	Oromia Bureau of Irrigation and Pastoral Development	2
8	Oromia Bureau of Water and Energy	2
9	Oromia Environment Commission	2
10	Cooperative Expansion agency	1
	Zone level	13
11	Oromia Bureau of Agriculture	5
12	Oromia Bureau of Land	2
13	. Oromia Bureau of Irrigation and Pastoral Development	1
14	Oromia Bureau of Water and Energy	2
15	Oromia Environment Commission	2
16	6. Cooperative Expansion agency	1
	Woreda level	14
17	Oromia Bureau of Agriculture	4
18	Oromia Bureau of Land	1
19	Oromia Bureau of Irrigation and Pastoral Development	2
20	Oromia Bureau of Water and Energy	2
21	Oromia Environment Commission	2
22	Cooperative Expansion agency	2
23	Disaster Risk Management and Development Commission	1
	At kebel level	13
24	Kebel Manager	2
25	Supervisor	2
26	Development Agent	9
	Total	63

Appedex 4 : Research questionnaires, and FGDs and KIIs questions

Part One**:** General Information

1. Zone ---------- 2. Woreda _____ 2. Kebele _____ 3. watershed /Gotti/Village_____
2. Sex of the household head 1. Male 2. Female
3. Religion of the HHH 1. Muslim 2. orthodox 3. protestant 4. Wakefata 5. Other, specify—
4. Age (specify it in complete years) _____
5. Your marital status? 1. Single 2. Married 3. Divorces 4. Widowed
6. Forms of the Marriage 1: Polygamy 2: Monogamy
7. What is your educational status? 1 Illiterate 2. Read & write 3. Primary level (1-4) 4. Lower secondary level (5-8) 5. Secondary levels (9-10) 6. Higher secondary levels or Preparatory (11-12) 7. Above diploma
8. Family size (in number) _____
9. Number of children by age in this household: Below 5 years____ 6-14 _____, 15-18 _____ Above _____
10. Number of children going to school: Male____ Female_____
11. The number of years have you lived in this area (…….)
12. Do have access to school to all your children? 1 Yes____ 2 No _____
13. Do have access to health services in nearby locality? 1 Yes___ 2 No ___
14. The past 5 years, was there your family member movement? 1 Yes 2 No
15. If yes, the kinds of movement 1/ Seasonal 2/ Permanent 3/Resettlement 4/ Others

Part II Economic Activities

2 Land holding and Land use system

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

2.2 If yes, how did you get access to it? (Multiple responses are possible): 1. Through land redistribution 2. Shared with relatives 3. Inherited from parents 4. Purchased 5 Others (specify)

2.3 What are the total sizes of the land under different use during the last 5 years?

Code	Name of the crop	Area Under cultivation						
		2015	2016	2017	2018	2019	2020	
	Total land owned							
	Cultivated land /Crop land							
	Irrigated land							

	Pasture area							
	Forest/trees							
	Homestead							
	Others (e.g. wasteland)							

3 Livestock production

4 Do you have cattle? 1. Yes 2. No

5 If yes, please list your Livestock holding during the last 5 years?

Code	Name of the live stock	Year						
		2015	2016	2017	2018	2019	2020	
	Oxen							
	cows							
	goats							
	sheep							
	horse							
	donkey							
	Poultry							
	Other							

Part III Household Participation in watershed management program

Please indicate your level of participation in planning, implementation and maintenance of watershed development activities duringthe last five years. Code:5 Very high (VH), 4= High (H) 3= Moderate (M), 2= Low (L) and 1= very low/never (VL). Rate the following items (statements) (1,2,3,4,5)

	Planning Phase	1	2	3	4	5
1	I have participated in an awareness-creation meeting organized management planning.					
2	I took technical training on the					

	CBPWM guidelines for proper watershed planning					
3	I have participated in PRA techniques like as resource mapping, social mapping, and transect walks, etc., in accordance with CBPWM principles.,					
4	I gave my suggestions, information and raised ideas during the planning of the watershed management in my locality					
5	I feel my suggestions were taken into consideration					
6	I am a witness that the poor and marginalized members of the community participate in the micro watershed planning					
7	I actively participation during the election of kebele watershed committee members					
8	I have been participation in the process of watershed plan approval					
Implementation Phase						
1	I have participated in technical training that acquire the knowledge and skills required for practical implementation					
2	My family members is a participant in the community's watershed management practices.					

3	I have participated in contributing resources such as labor, money, and so on during watershed implementation					
4	I have Participated in physical soil and water conservation both on my own farm/common land in the watershed					
5	I have Participated and practiced as part of the watershed					
6	I have Participated and practiced the watershed management practice					
7	I have Participated in off farm income-generation activities as part of the watershed management practice					
8	I have Participated on supervising the ongoing activities/works undertaken in the fields and community lands					
9	I have Participated in developing watershed management bylaws					
Monitoring Phase						
1	I have follow-up on the watershed management implementation actions based on existing community organizations					
2	I attended in regular meetings to discuss watershed management actions while in operation					

3	I have participated in the protection of area closure and other rehabilitated watershed area in the micro watershed					
4	I participated in the decision-making process for the micro watershed.					
5	I regularly checked the quantity and quality of work based Watershed Management Guidelines..					
6	I have participated a regular basis in the maintenance of the physical conservation activities undertaken on in the micro watershed					

Part V **Institutional factors**

1. Do you receive any institutional support during the last five years? 1 Yes 2 No
2. If yes, specify institution(s) that provide(s) support? 1 Bureau of Agriculture. 2 Bureau of education 3 Bureau of health 4 Forestry and environment 5 Administration office 6 NGO 7 others, specify
3. How many times the Woreda professionals of different bureau do contact you in this year? 1 weekly 2 1 One in a month 3/ Quarterly 4 / one in six months 5 /one in year 5 nerve
4. What type of support do you receive from them? Multiple answers is possible 1 Information supply 2. Technical and training support 3 Training 4. Credit facilities 5 Inputs support 6 others (specify).
5. IIs there any sort of conflict between organizations (Bureaus) during their support in your micro watershed? 1 Yes 2 No
6. IIf yes, could you please list the name of the organization/s that have conflict with each other's during their support community? 1 Yes 2 No

Watershed committee

1 Is there any committee formed to take care of watershed management program in your locality? 1. Yes 2. No

2 If yes, are your members of this committee? 1. Yes; 2. No

3 If yes, who made you the member? 1. Village leader; 2. DA; 3 Self-motivated. 4. Elected by community member

4 Does the watershed committee have rights and responsibilities to implement watershed management program at the groundlevel? 1 yes 2 no

5 If yes, how does the watershed committee implement its decisions?

6 What is the nature of the working relation between the community watershed and woreda watershed committee?

7 How far does the committee rely on CBPWM guidelines?

8 Are you a member of any more association in your community? 1 Yes 2 No

9 if yes, which type? 1 Religious leader 2 Cooperatives 3 Women's group 4 Farmers' group 5 others (specify) ____

10 What services do you get from the formal organization you belong to? 1Loans/credit 2 Seeds 2 Fertilizer 3 Labor 4Education/information 5 other(specify)

Focus group discussions (FGD) and key informant interview (KII) synthesized data

1. What is the concept of watershed management for you and your community?
2. How accountability is interpreted in watershed management among the different stallholder's in this community?
3. Are there a clear roles and responsibilities among the different stallholder's in watershed management?
4. What is the level of participation among the various stallholder's in watershed management?
5. Is there a clear separation of roles between "users", service providers and enabling agencies in watershed management?
6. watershed management approach bring desired changes in the behavior of people and institutions?
7. you think that there is enough awareness for natural resource conservation and management and its integration with various sector programs at all levels –National, Regional, Zonal and Wereda level Authorities?
    a. What types of service do currently DAs are delivering and what other more services expected from them?

8. Are Das frequent respond to the demands of the community during the last five years and which DA respond more and whichnot? Why?
9. Do the communities are satisfied by the service obtained from DAs during the last five years? (yes – no). If no, why?
10. Do the communities have access other sources of extension service or technology during the last five years? (yes – no). If yes,where and what do you access?
11. How does the technology transfer take place? (Through: extension services, social learning, others). Circle the methods you know. Did watershed management approach bring any changes in terms of?
12. The quality physical activity of soil and water conservation a)Involvement of beneficiaries in timely undertaking of watershed activities b) Collaboration with stakeholders c)Other management aspects
13. Which are the most challenges that you face in regard to participation of the community in watershed management?
14. How do you appraise the watershed intervention currently you are practicing? (Successful, satisfactory, no change, belowexpectation, or a failure)
15. If successful, what proportions of farmers'/community members have experienced positive socioeconomic changes? I. One in ten 2 Three in ten 3. Five in ten 4 Seven in ten 5 All (100%)
16. What alternative approach do you suggest (with respect to planning, implementation, and stakeholders' involvement) to bemore successful

Appendix 5: The log sheet data collection format

A. Log sheet to record daily activities of Development agent

Objective of the assessment: to evaluate the service provision delivered by extension personnel in applying science to the day-to-day routine of farming community in order to achieve food and nutrition security and livelihood improvement.

Locational information: Region_____Zone_____Woreda _____

Name of the Kebele_____Name of the watershed_____Lat/Long _____

1. **Personal information**

- Name: _____
- Sex: (Check one as "**X'**): Male ☐ Female ☐
- Contact Address: _____
- Duty Station_____
- Position Title (Check one as "**X'**): DA ☐ Supervisor , ☐ Expert ☐ Manager ☐)
- Phone: Home _____
- E-Mail Address: _____
- your work experience as extension agent (Check one as "**X'**): 1–5 yr☐ 6–10yr ☐

  11–15yr ☐, above 16 years ☐
- Your profession (academic background) (Check one as "**X'**): Natural Resources Management , Plant science ☐ Animal Scienc☐ ,; other specify _____☐
- Educational level (Check one as "**X'**): certificate ☐, TVET diploma (CIRCLE ONE) (10+1 /10+2/10+3/12+2) ; ☐/BA degree , ☐c degree ☐
- Your age (Check one as "**X'**): 20-29☐; 30–39☐ ; 40–49 ☐, above 50 ☐

2. Your job description when you are assigned to your current position

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

   f. _____

3. Activity plan

3.1 Please list your 2013 detailed activity plans based on quarterly basis and major activity lines per watershed based on the major components of integrated watershed activities: (rehabilitation using different biophysical SWC activities; crop production and protection, livestock development, economic development activities (livelihood improvement activities; infrastructural development in the watersheds; value chain activities; etc.)

Name of the Kebele: _____ Name of Watershed: _____

Category of Activities lines	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual

Plan preparation Sub activities: 1.---------- 2---------- 3---------- …					
Awareness creation. Capacity building <u>Sub activities</u> 1---------- 2---------- 3----------					
Professional support/implementation <u>Sub activities</u> 1---------- 2---------- 3---------- ….					
Monitoring & evaluation Sub activities: 1---------- 2---------- 3---------- ….					
Others					

4 Plan and Performances on the monthly bases

Activity plan

Month: _____

Weekly plan based on days of the week (Circle one): I; II; III; IV) (dates: from ……to …….)

Mon:
_____
_____
_____

Tue_____
_____
_____
_____:

Wed:
_____
_____
_____

Thursday:
_____
_____
_____

Friday_____
_____
_____
_____
_____
_____

5 Activity accomplished on daily basis

Month: ----------

Week (circle one); I; II; III; IV

Date/day	Description of activities performed	Inputs required to complete the task	knowledge, & skills required	Time required	Challenge encountered
Mon					
Tuesday					

Wednesday					
Thursday					
Friday					

B. Log sheet to record daily activities of Extension supervisor

Objective of the assessment**:** to evaluate the service provision delivered by extension personnel in applying science to the day-to-day routine of farming community in order to achieve food and nutrition security and livelihood improvement.

Locational information: Region_____Zone_____Woreda _____

Name of the Kebele_____Number of watershed_____Lat/Long _____

1 Personal information

- Name: _____
- Sex: (Check one as "**X'**): Male Female ☐
- Contact Address: _____
- Duty Station_____
- Position Title (Check one as "**X'** Supervisor: ☐ , Expert ☐ Team leader ☐Manager ☐
- Phone: Home _____
- E-Mail Address: _____

- your work experience as extension supervisor (Check one as "**X'**): 1–5 yr. ☐ 6–10yr , 11–15yr ☐, above 16 years ☐
- Your profession (academic background) (Check one as "**X'**): Natural Resources Management , Plant science ☐ Animal Scienc☐other specify _____ ☐
- Educational level (Check one as "**X'**): certificate ☐, TVET diploma (CIRCLE ONE) (10+1 /10+2/10+3/12+2) ; ☐/BA degree , ☐c degree ☐
- Your age (Check one as "**X'**): 20-29☐; 30–39☐ ; 40–49 ☐, above 50 ☐

2 Your job description when you are assigned to your current position

a._____

b._____

c._____

d._____

e.----------

f. ----------

g.----------

3 Activity plan

3.1 Please list your 2013 detailed activity plans based on quarterly basis based on major components of integrated watershed activities(rehabilitation using different biophysical SWC activities; crop production and protection livestock development, economic development activities (livelihood improvement activities; infrastructural development in the watersheds; value chain activities; etc.)

Name of the kebeles : _____ Number of Watersheds: _____

Category of Activities lines	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
Plan preparation Sub activities: 1.---------- 2---------- 3---------- …					
Awareness creation. Capacity building <u>Sub activities</u>					

1---------- 2---------- 3----------					
Professional support/implementation <u>Sub activities</u> 1---------- 2---------- 3---------- ….					
Monitoring & evaluation Sub activities: 1---------- 2---------- 3---------- ….					
Others					

4 Plan and Performances on the monthly bases

Activity plan

Month: _____

Weekly plan based on days of the week (Circle one): I; II; III; IV) (dates: from ……to …….)

Mon:
_____
_____
_____

Tue_____
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_____
_____:

Wed:
_____
_____
_____

Thursday:
_____
_____
_____

Friday_____
_____
_____
_____
_____
_____

5 Activity accomplished on daily basis

Month: ----------

Week (circle one); I; II; III; IV

Date/day	Description of activities performed	Inputs required to complete the task	knowledge, & skills required	Time required	Challenge encountered
Mon					
Tuesday					
Wednesday					
Thursday					

Friday					

C. Log sheet to record daily activities of woreda watershed experts

Objective of the assessment: to evaluate the service provision delivered by extension personnel in applying science to the day-to-day routine of farming community in order to achieve food and and livelihood improvement.

Locational information: Region_____Zone_____Woreda _____

Number of Kebeles_____ Number of watersheds_____Lat/Long _____

1 Personal information

- Name: _____
- Sex: (Check one as "**X'**): Male ☐ Female ☐
- Contact Address: _____
- Duty Station_____
- Position Title (Check one as "**X'**): Expert ☐ Team leader ☐ Manager ☐
- Phone: Home _____
- E-Mail Address: _____
- your work experience as extension agent (Check one as "**X'**): 1–5 yr☐ 6–10yr ☐ 11–15yr☐, above 16 years ☐
- Your profession (academic background) (Check one as "**X'**): Natural Resources Management , Plant science ☐ Animal Scienc☐ ,; other specify _____☐
- Educational level (Check one as "**X'**): certificate ☐, TVET diploma (CIRCLE ONE) (10+1 /10+2/10+3/12+2) ; ☐/BA degree , ☐c degree ☐
- Your age (Check one as "**X'**): 20-29☐; 30–39☐ ; 40–49 ☐, above 50 ☐

2 Your job description when you are assigned to your current position

a. _____

b. _____

c. _____

d. _____

3 Activity plan

3.1 Please list your 2013 detailed activity plans based on quarterly basis based on major components of integrated watershed activities: (rehabilitation using different biophysical SWC activities; crop production and protection, livestock development, economic development activities (livelihood improvement activities; infrastructural development in the watersheds; value chain activities; etc.)

Name of the woreda_____ Number of Kebeles: _____Number of watersheds _____

Category of Activities lines	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
Plan preparation Sub activities: 1.---------- 2---------- 3---------- …					
Awareness creation. Capacity building <u>Sub activities</u> 1---------- 2---------- 3----------					
Professional support/implementation <u>Sub activities</u> 1---------- 2---------- 3----------					

….					
Monitoring & evaluation Sub activities: 1---------- 2---------- 3---------- ….					
Others					

4 Plan and Performances on the monthly bases

Activity plan

Month: _____

Weekly plan based on days of the week (Circle one): I; II; III; IV) (dates: from ……to …….)

Mon:
_____
_____
_____

Tue_____
_____
_____
_____:

Wed:
_____
_____
_____

Thursday:
_____
_____
_____

Friday_____
_____
_____
_____
_____
_____

5 Activity accomplished on daily basis

Month: ----------

Week (circle one); I; II; III; IV

Date/day	Description of activities performed	Inputs required to complete the task	knowledge, & skills required	Time required	Challenge encountered
Mon					
Tuesday					
Wednesday					
Thursday					
Friday					

D. Log sheet to record daily activities of woreda watershed Team Leader

Objective of the assessment**:** to evaluate the service provision delivered by extension personnel in applying science to the day-to-day routine of farming community in order to achieve food and nutrition security and livelihood improvement.

Locational information: Region_____Zone_____Woreda _____

Number of Kebeles _____ Number of watersheds _____ _____Lat/Long _____

1 Personal information

- Name: _____
- Sex: (Check one as "**X'**): Male Female ☐
- Contact Address: _____
- Duty Station_____
- Position Title (Check one as "**X'**): Expert ☐ Team leader ☐ Manager ☐
- Phone: Home _____
- E-Mail Address: _____
- your work experience as extension agent (Check one as "**X'**): 1–5 yr☐ 6–10yr ☐ 11–15yr☐, above 16 years ☐
- Your profession (academic background) (Check one as "**X'**): Natural Resources Management , Plant science ☐ Animal Scienc☐ ,; other specify _____☐
- Educational level (Check one as "**X'**): certificate☐, TVET diploma (CIRCLE ONE) (10+1 /10+2/10+3/12+2) ; ☐/BA degree , ☐c degree ☐
- Your age (Check one as "**X'**): 20-29☐; 30–39☐ ; 40–49 ☐, above 50 ☐

2 Your job description when you are assigned to your current position

a._____

b._____

c._____

d._____

3 Activity plan

3.1 Please list your 2013 detailed activity plans based on quarterly basis based on major components of integrated watershed activities: (rehabilitation using different biophysical SWC activities; crop production and protection, livestock development, economic development activities (livelihood improvement activities; infrastructural development in the watersheds; value chain activities; etc.)

Name of the woreda_____ Number of Kebeles : _____Number of. watersheds _____

Category of Activities lines	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
Plan preparation Sub activities: 1.---------- 2---------- 3---------- …					
Awareness creation. Capacity building <u>Sub activities</u> 1---------- 2---------- 3----------					
Professional support/implementation <u>Sub activities</u> 1---------- 2---------- 3---------- ….					
Monitoring & evaluation Sub activities: 1---------- 2---------- 3---------- ….					
Others					

4 Plan and Performances on the monthly bases

Activity plan

Month: _____

Weekly plan based on days of the week (Circle one): I; II; III; IV) (dates: from ……to …….)

Mon:
_____
_____
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Tue_____
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Wed:
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Thursday:
_____
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_____

Friday_____
_____
_____
_____
_____
_____

5 Activity accomplished on daily basis

Month: ----------

Week (circle one); I; II; III; IV

Date/day	Description of activities performed	Inputs required to complete the task	knowledge, & skills required	Time required	Challenge encountered
Mon					

Tuesday					
Wednesday					
Thursday					
Friday					

Part II

Cross check question for farmers after completion of expert survey

A Personal information

- Farmer Name: _____
- Contact Address: _____
- Sex Check one as "**X'**): Male ☐ Female ☐
- Phone: _____
- Do you have your own land? Yes ☐ No ☐ if yes specify in ha _____
- Your age (Check one as "**X'**): 20-29 ☐; 30–39 ☐ ; 40–49 ☐, above 50 ☐
- Educational level (Check one as "**X'**): non educated ☐ Primary school ☐ secondary school ☐ rtificate Di☐na , ☐
- For how long have you been farming? (Check one as "**X'**): less than 5 yr. ☐, 6–10yr ☐ above 11 years' ☐

B Service satisfaction

1 At what interval extension workers visits your watershed during community mobilization campaign

Daily ☐ 3 times per week ☐ weekly ☐ 1 times in two weeks ☐
Never ☐

2 How do you rate regarding use and effectiveness of technical assistance provided to you during community based watershed management campaign by agricultural extension workers?

not satisfied ☐ somewhat satisfied ☐ satisfied ☐ highly satisfied

3 How do you ☐ regard the performance of agricultural extension worker in your watershed?

- Extension officers do their job to the best of their ability ☐
- The Extension officer operates in a professional manner ☐
- Generally, performance is less than expected ☐

4 How do agricultural extension workers deliver the extension services for you and the community as whole?

- Visits farms on a regular basis ☐
- conducting farmer group meetings ☐
- Conducting demonstration ☐
- conduct timely meeting ☐
- Giving fair treatment to all farmers ☐
- Follow careful planning, implementing, and monitoring of farming problems ☐
- Have good knowledge of farming problems ☐

5 Whom do you prefer to work with?

Natural resources ☐ Animal science ☐ Plant science ☐ Both ☐
specify why ☐

6 Indicate your perception with regard to the following statements.

a) Trustworthiness and credibility of extensions very Low, ☐ low ☐ high ☐ very high ☐

b) Technical competency of extensions' very Low ☐ low ☐ high ☐ very high

c) Commitmen☐e extension workers very Low ☐, low ☐ high☐ very high ☐