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Research Article

Assessing Community Adaptive Capacity to Climate Change Through Watershed Management: A Case Study of Walacha Watershed, Damot Gale Woreda, Wolaita Zone

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Abstract

Climate change presents significant challenges to agricultural communities, particularly resource-limited households in developing regions. Watershed management has been implemented as a strategy to enhance adaptive capacity and promote self-sufficiency in food, fuelwood, and fodder. The purpose of this study is to assess communities' adaptive capacity to climate change through watershed management practices in the Walacha Watershed of Damot Gale Woreda, It examined communities' climate change adaptive interventions, watershed management strategies, and factors influencing both indigenous and technology-based adaptation in Walacha Watershed. Using a survey research design, data were collected from 140 farm households through questionnaires, key informant interviews, focus group discussions, and field observations. Quantitative data from questionnaires were analyzed using descriptive statistics including frequencies, percentages, and chi-square tests. Qualitative data from interviews, discussions, and observations were analyzed thematically to complement and triangulate quantitative findings. Findings reveal that watershed management activities predominantly focus on farmland conservation, with landowners benefiting more than smallholders. Most interventions are implemented through government-mandated community mobilization rather than farmer initiative. Indigenous knowledge, local crops, and livestock receive inadequate attention despite their potential for climate adaptation. The study identifies institutional, socioeconomic, and technical factors constraining effective watershed management and recommends integrated, participatory approaches that recognize local knowledge and address the needs of diverse stakeholders.

Keywords

Climate Change Adaptation, Watershed Management, Adaptive Capacity, Indigenous Knowledge, Damat Gale, Wolaita Zone

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1. Introduction

1.1. Background

Climate change represents one of the most pressing global challenges confronting humanity in the twenty-first century. Scientific consensus confirms that climate change is occurring, manifesting through increased frequency of extreme weather events including droughts and floods, alongside growing unpredictability and variability in seasonal patterns and rainfall distribution [14]. These changes disproportionately affect agricultural communities in developing regions, where livelihoods depend heavily on climate-sensitive natural resources.

The implications for water security are profound. The Food and Agriculture Organization [3] projects that between 75 and 250 million people will face water scarcity by 2025 due to unreliable rainfall and the drying of springs and rivers. Sub-Saharan Africa bears a disproportionate burden of this crisis, hosting eighteen of the twenty-five countries where over thirty-five percent of the population experiences undernourishment. In nearly half these nations, malnutrition rates have increased since 1990 [3]. Adger et al. [1], project that crop yields in some African countries could decline by as much as fifty percent by 2020, with smallholder farmers facing the most severe impacts.

Ethiopia's economic development, food security, and livelihood systems depend fundamentally on water, soil, land, forests, and biodiversity—all of which face mounting pressure from climate-related shocks and stresses [4]. The National Adaptation Program for Action [10] identifies agriculture, water resources, and human health as the sectors most vulnerable to climate variability and change in Ethiopia.

The economic consequences of climate extremes are substantial. Grey and Sadoff [6] found that droughts and floods reduce Ethiopia's annual growth potential by more than one-third. The 1984-85 drought decreased agricultural production by twenty-one percent, contributing to a 9.7 percent decline in gross domestic product [19]. Temperature projections indicate increases of 0.7 to 2.3℃ by 2020 [1]. Critically, climate change is not a future possibility for Ethiopia but a present reality [4] Ethiopian agriculture remains predominantly rain-fed and highly sensitive to rainfall fluctuations. Chronic food insecurity affects ten percent of the population, with these households unable to meet their food needs even during years of average rainfall [4]. Consequently, climate risk reduction and adaptation have emerged as priority issues on Ethiopia's national policy agenda [11].

Historically, adaptation efforts in Ethiopia followed top-down approaches with limited attention to communities' experiences of climate change and their coping strategies [14]. Watershed development activities have been promoted as adaptation tools for addressing climate change and variability. Watershed management in Ethiopia began during the 1970s and 1980s through centralized, government-mandated community mobilization. However, these early efforts proved inadequate because they failed to recognize local knowledge and community needs [5].

Watershed management encompasses human actions aimed at ensuring sustainable use of watershed resources while improving livelihoods. Soil and water conservation measures have been implemented in Ethiopia for nearly five decades, initially focusing on degraded land rehabilitation. While some "impressive" biophysical structures have been observed [18] these interventions did not translate into improved farmer livelihoods.

Contemporary approaches recognize the necessity of integrating biophysical structures with socioeconomic conditions. This integration is essential because environmental and social challenges are inherently interconnected—socioeconomic problems and climate change risks cannot be addressed in isolation. Effective watershed management must therefore consider the social, economic, and institutional factors operating within and beyond watershed boundaries [2].

1.2. Problem Statement

Despite Ethiopia's reported economic growth, this progress remains vulnerable to reversal unless resource-poor farmers—who bear primary responsibility for national food production—succeed in enhancing their productivity. Climate change thus holds critical strategic importance for Ethiopia, with potential to impede economic progress, reverse development gains, and exacerbate social and economic challenges [4].

Previous research has examined communities' adaptive capacity to climate change in drought-prone areas. Kindu et al. [7] conducted research in the Blue Nile Basin, while Wortmann (2008) emphasized that each watershed possesses unique characteristics requiring site-specific approaches. Similarly, climate change adaptation measures must be tailored to specific sectors and locations [10], with Lakew et al. [9] noting that no single management strategy applies universally.

Damot Gale Woreda in Wolaita Zone, southern Ethiopia, exemplifies the challenges facing rain-fed agricultural systems. Late onset of rainfall delays farm activities, while the period from January to May brings acute food insecurity for resource-limited households due to absence of irrigation. This period coincides with the end of the meher harvest and heightened food demand, while also stressing livestock populations. Youth out-migration to urban areas has emerged as a coping response, though its long-term viability remains questionable.

Watersheds encompass diverse resources including agricultural land, grazing areas, forests, and residential zones with multiple users [12]. However, watershed activities in the study area have concentrated on farm fields, despite many farmers facing severe farmland shortages. This situation necessitates identifying obstacles to effective watershed management that could enhance communities' adaptive capacity in context-appropriate ways.

1.3. Research Objectives

1.3.1. General Objective

The overarching objective of this research is to examine communities' adaptive capacity to climate change through watershed management practices in the Walacha Watershed of Damot Gale Woreda.

1.3.2. Specific Objectives

The specific objectives are to:

1) Identify local-level climate change adaptive interventions employed by communities.
2) Describe watershed management strategies communities use to cope with climate change impacts.
3) Identify factors affecting communities' adaptive efforts in implementing watershed management practices.

1.4. Research Questions

This study addresses the following research questions:

1) What watershed management strategies do local communities employ to adapt to climate change impacts?
2) Why is implementation of watershed management practices necessary?
3) What factors influence community-based watershed management?

1.5. Significance and Scope

This research contributes to understanding how watershed management can enhance communities' adaptive capacity to climate change. Findings provide evidence for policymakers to support socioeconomic and environmental improvements in study communities. The research focuses specifically on assessing adaptive capacity through watershed management in the Walacha Watershed, Damot Gale Woreda, Wolaita Zone.

2. Methodology

2.1. Study Area Description

2.1.1. Location and Topography

Wolaita Zone, located in southern Ethiopia on the western edge of the Rift Valley, features mountainous terrain where homesteads are surrounded by coffee, fruit trees, and local spices, with enset (Ensete ventricosum) dominating home gardens. This study was conducted in the Walacha Watershed, Damot Gale Woreda, approximately 365 kilometers south of Addis Ababa. Geographically, the watershed lies between 6 °53'–7 °6'30" north latitude and 37 °46'–37 °58'40" east longitude, with elevations ranging from 1,501 to 2,950 meters above sea level.

2.1.2. Climatic Conditions

Damot Gale Woreda encompasses three traditional agro-climatic zones: Dega (highland) covering 25.3 percent, Woina Dega (midland) covering 61.2 percent, and Kola (lowland) covering 13 percent [17]. The midland zone dominates the area. Mean annual rainfall ranges from 1,001 to 1,400 mm [15].

2.1.3. Land Use and Agricultural Systems

The Walacha Watershed landscape reflects intensive human modification. Population pressure on land has driven farm intensification and diversification. Farmers follow logical cropping patterns organized by distance from home. In order of proximity, farmers cultivate: local spices immediately adjacent to houses, vegetables, coffee and fruits, enset, maize or taro, sweet potato, beans, cereals, and finally grazing areas.

Traditional land classification in Wolaita recognizes six to seven land types. The key classification, darkuwa (home garden), represents the area nearest to the house, which households continuously improve through soil fertility management [13]. Darkuwa receives the most manure and household refuse. Diverse annual and perennial crops thrive here, including Coffea arabica, avocado (Persea americana), mango (Mangifera indica), casimir (Casimiroa edulis), sugarcane, and indigenous trees such as wanza (Cordia africana), primarily cultivated for income generation and food security. As an ecosystem, darkuwa contains multiple levels of diversity—cultural, genetic, and agronomic [16].

The land use gradient proceeds outward from darincha (immediately adjacent to houses, where medicinal local spices dominate), to darkuwa (diverse perennial and annual crops), to shoka (distant fields), and finally grazing grounds. Chemical fertilizer application is uncommon in near-home farmlands (darincha and darkuwa), where animal manure maintains fertility. Women play crucial roles in soil fertility maintenance, transporting manure in locally made baskets and dispersing it before tillage. Distant fields (shoka), however, rarely receive manure and depend on chemical fertilizers for cereal and haricot bean production oriented toward cash requirements.

2.1.4. Vegetation and Environmental Challenges

Eucalyptus trees dominate the watershed and increasingly replace native woody species. Despite occupying small landholdings and the species' high water consumption, farmers plant eucalyptus due to its multiple benefits for fuelwood and construction. However, eucalyptus provides limited soil erosion control compared to native vegetation.

Strip cultivation characterizes sloped lands, with four to five alternating strips of eucalyptus and crops. This pattern reduces soil moisture availability. Deep gullies and rills increasingly claim farmlands, reaching stages that physically isolate communities. Delayed implementation of soil and water conservation measures has allowed gully expansion to threaten fertile lands.

2.2. Research Design

This study employed a descriptive survey research design to assess communities' adaptive capacity to climate change through watershed management. The research examined household characteristics, traditional climate coping mechanisms, gaps in introduced soil and water conservation measures, and factors affecting watershed management. Data were analyzed using both qualitative and quantitative approaches.

2.3. Sampling Techniques and Sample Size

The research utilized both probability and non-probability sampling methods. The Walacha Watershed comprises twelve kebele administrative units. Four kebeles (Ade Damota, Wandara Gale, Woshi Gale, and Mokonisa) were purposively selected based on site feasibility for achieving research objectives.

From a total of 927 households across the four kebeles, 140 households (15 percent) were selected for questionnaire survey using proportional allocation followed by simple random sampling from each kebele's sampling frame. Sample size was calculated using Kothari's [8] formula:

$$nhh = (Nhh/N) \times n$$

Where:

1) nhh = sample size of the stratum
2) Nhh = total households in each stratum
3) N = total population (household heads in study area)
4) n = total sample size

Table 1. *Sampling Framework.*

Kebele Unit	Total Households	Percentage	Sample Households
Ade Damota	320	34.52	48
Wandara Gale	312	33.66	47
Woshi Gale	190	20.50	29
Damot Mokonisa	105	11.33	16
Total	927	100.0	140

Source: Field survey, 2015

Additionally, purposive sampling identified key informants including elderly farmers, agricultural experts, government authorities, development team leaders, and Development Agents (DAs).

2.4. Data Sources and Collection Methods

Primary and secondary data sources were utilized. Secondary data derived from literature review of publications on climate change adaptation and watershed management. Primary data were collected through:

1) Structured questionnaires administered to 140 sample households
2) Field observations with photographic documentation
3) Key informant interviews
4) Focus group discussions
5) Informal interviews

2.5. Data Analysis

Quantitative data from questionnaires were analyzed using descriptive statistics including frequencies, percentages, and chi-square tests. Qualitative data from interviews, discussions, and observations were analyzed thematically to complement and triangulate quantitative findings.

3. Conclusions and Recommendations

3.1. Conclusions

This study examined communities' climate change adaptive interventions, watershed management strategies, and factors influencing both indigenous and technology-based adaptation in Walacha Watershed. Several key findings emerge:

Watershed Management Focus: Watershed management practices concentrate predominantly on farm fields, largely neglecting surrounding landscapes. Landowners benefit more from soil and water conservation measures than smallholders, suggesting unequal distribution of adaptation benefits.

Implementation Approach: Most activities are implemented through government-mandated community mobilization rather than farmer self-initiative, reflecting persistent top-down approaches that may undermine sustainability.

Conservation Practices: Biophysical structures including fanya juu, soil bunds, strip grass, deep trenches, area closure, and vegetative/agroforestry measures have been implemented.

Soil bunds, fanya juu, and vegetative measures with homestead forestry dominate.

Livestock Considerations: Grazing land shrinkage affects livestock production, though strip grass and area closure have facilitated cut-and-carry (stall feeding) approaches in some areas.

Indigenous Knowledge and Local Resources: Indigenous knowledge receives minimal attention despite its potential value. Local crops and livestock are underutilized as climate adaptation resources relative to their food security contributions.

Vegetation Changes: Eucalyptus expansion poses watershed management challenges, with this exotic species offering limited erosion control compared to displaced native vegetation.

Indigenous Adaptation Mechanisms: Farmers continue employing sharecropping and shared breeding as adaptive interventions, while youth out-migration has emerged as survival-oriented adaptation response.

Sectoral Fragmentation: Watershed management is practiced in fragmented manner, primarily left to agricultural staff rather than interdisciplinary teams.

3.2. Recommendations

Based on study findings, the following recommendations are proposed:

1. *Comprehensive Watershed Planning:* Conduct detailed inclusive engineering surveys for planning soil and water conservation measures, considering potential resettlement of farmers on steep slopes where conservation agriculture proves infeasible.
2. *Enset Integration:* Rethink inclusion of enset in agricultural extension packages to effectively reduce food insecurity. Government should prioritize attention to this crop, supporting research to identify higher food value and climate-resistant varieties.
3. *Capacity Building:* Provide training and education on conservation structure benefits, particularly through adult education, while raising awareness about short-term negative effects that may discourage adoption.
4. *Interdisciplinary Approach:* Establish interdisciplinary committees drawing from hydrology, meteorology, forestry, agriculture, natural resource management, and social sciences to facilitate watershed management addressing multiple problems. Activities should extend beyond farms to encompass entire catchments, benefiting all populations.
5. *Indigenous Knowledge Integration:* Recognize and incorporate indigenous knowledge in watershed management planning, treating farmers as clients with choices rather than beneficiaries with needs.
6. *Policy and Institutional Reform:* Revise watershed management policies to address land tenure and community rights, establishing appropriate regulations for common resource use while supporting institutional arrangements for communal grazing.
7. *Livestock Integration:* Prioritize livestock management within watershed programs, recognizing mixed crop-livestock systems' importance for adaptation and soil fertility.
8. *Climate Information Systems:* Develop systems providing farmers with timely climate information, enabling informed decisions aligned with watershed management objectives.
9. *Extension Coordination:* Improve coordination among extension service providers to deliver integrated knowledge addressing farmers' multifaceted needs rather than fragmented sectoral messages.
10. *Long-Term Planning:* Promote long-term planning and commitment among stakeholders, recognizing that conservation benefits materialize over extended periods requiring sustained investment.

Abbreviation

DAs	Development Agents
RFEDB	Regional Finance and Economic Development Bureau
FAO	Food and Agriculture Organization
FDRE	Federal Democratic Republic of Ethiopia
FGDs	Focus Group Discussions
NAPA	National Adaptation Program for Action
RFEDB	Regional Finance and Economic Development Bureau
WARD	Woreda Agriculture and Rural Development

Author Contributions

Tessema Ankilo Tigicho: Investigation
Tesfaye Shiferaw: Supervision

Conflicts of Interest

There is no conflict of interest.

References

[1] Adger, W. N., et al. (2007). Assessment of adaptation practices, options, constraints and capacity. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden & C. E. Hanson (Eds.), Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 717-743). Cambridge University Press.

[2] FAO. (1986). Strategies, approaches and systems in integrated watershed management. Conservation Guide No. 14. Food and Agriculture Organization.

[3] FAO. (2011). Strengthening Capacity for Climate Change Adaptation in the Agriculture Sector in Ethiopia. Proceedings from National Workshop, Nazareth, Ethiopia.

[4] FDRE. (2011). Ethiopia's vision for a climate resilient green economy (CRGE). Environmental Protection Authority.

[5] Gebrehawaria, G. (2012). Watershed management in Ethiopia. Agricultural Water Management Learning and Discussion Brief. AgWater Solutions.

[6] Grey, D. & Sadoff, C. (2006). Water for growth and development. In Thematic Documents of the IV World Water Forum. Comision Nacional del Agua.

[7] Kindu M., Duncan, A., Derbew K., Tilahun A., Teklemariam B. & Asmare W. (2013). Enhancing communities' adaptive capacity to climate change in drought-prone hotspots of the Blue Nile Basin in Ethiopia. International Livestock Research Institute.

[8] Kothari, C. R. (2004). Research Methodology, Method and Techniques. New Age International.

[9] Lakew Desta, Carucci, V., Asrat Wendem-Ageňehu & Yitayew Abebe (Eds.). (2005). Community Based Participatory Watershed Development: A Guideline. Ministry of Agriculture and Rural Development.

[10] NAPA. (2007). National Adaptation Program for Action. National Meteorological Agency.

[11] Oates, N., Conway, D. & Calow, R. (2011). The mainstreaming approach to climate change adaptation: Insights from Ethiopia's water sector. Overseas Development Institute.

[12] Perez, C. & Tschinkel, H. (2003). Improving watershed management in developing countries: A framework for prioritizing sites and practices. Agricultural Research and Extension Network Paper No. 129. Overseas Development Institute.

[13] Pound, B. & Ejigu J. (2005). Policy and Research Series 2: Soil Fertility Practices in Wolaita Zone, Southern Ethiopia: Learning from Farmers. Farm Africa.

[14] Reid, H., Alam, M., Berger, R., Cannon, T., Huq, S. & Milligan, A. (2009). Community-based adaptation to climate change: An overview. Participatory Learning and Action 60. Russell Press.

[15] RFEDB. (2013). Regional Finance and Economic Development Bureau Report.

[16] Talemos S., Sebsebe D. & Zemede A. (2012). Home gardens of Wolaita, Southern Ethiopia: An ethno-botanical profile. Academia Journal of Medicinal Plants, 1(1), 014-030.

[17] WARD Office. (2014). Woreda Agriculture and Rural Development Office Report.

[18] Woldeamlak B. (2003). Towards integrated watershed management in highland Ethiopia: The Chemoga Watershed case study. PhD Dissertation, Wageningen University.

[19] World Bank. (2011). Project Performance Assessment Report: Ethiopia Productive Safety Net Project.