European Journal of Sustainable Development Research
2026, 10(2), em0376
e-ISSN: 2542-4742
https://www.ejosdr.com/

MODESTUM

Review Article

OPEN ACCESS

Adoption, impacts, and policy challenges of watershed management practices in Ethiopia (2015–2025): A systematic review

Tsedey Tesfahun [1,2*], Assefa Abegaz [1], Esubalew Abate [1]

[1] Addis Ababa University, ETHIOPIA
[2] Kotebe University of Education, ETHIOPIA
***Corresponding Author:** tset4884@gmail.com

Citation: Tesfahun, T., Abegaz, A., & Abate, E. (2026). Adoption, impacts, and policy challenges of watershed management practices in Ethiopia (2015–2025): A systematic review. *European Journal of Sustainable Development Research, 10*(2), em0376. https://doi.org/10.29333/ejosdr/17947

ARTICLE INFO

Received: 23 Jul 2025

Accepted: 03 Dec 2025

ABSTRACT

The main objective of this systematic review is to examine Ethiopia's adoption of watershed management techniques between 2015 and 2025, evaluating the effects on the environment, society, and agriculture as well as the main policy issues influencing their sustainability and efficacy. The six steps of the PSASAR methodological framework—Procedure, Search, Appraisal, Synthesis, Analysis, and Reporting—were used in the study. This research shows how Ethiopia's adoption of watershed management techniques greatly advances Sustainable Development Goal (SDG) 2 by increasing food security via increased agricultural output and revenue diversification. By enhancing groundwater recharge, controlling stream flow, and expanding access to water, it also advances SDG 6. Additionally, it helps achieve SDG 15 by encouraging ecosystem restoration, lowering land degradation, and boosting biodiversity through soil and forest conservation efforts. It also promotes SDG 13 by bolstering climate resilience through soil moisture retention and microclimate regulation. The findings indicate that the adoption of WMP differs depending on the context and is impacted by gender roles, the availability of extension services and NGO support in Oromia, education in Amhara, and incentive systems in the southern regions. Higher crop yields and efficient erosion control are important effects in Amhara, whereas diversifying livelihoods and preserving soil fertility are advantageous outcomes in Oromia. In the Southern region, WMP improved household income and resilience to climate shocks, particularly through gender-sensitive approaches. In Amhara, poor coordination and institutional disengagement following project completion are frequent challenges that result in sustainability problems. In Oromia, communities experience fatigue and a dearth of follow-up, especially in areas where short-term NGO projects are the norm. In the Southern region, climate-smart agriculture and WMP plans are frequently out of sync, which suggests a lack of policy integration. Dispersed institutional duties and insufficient policy enforcement pose a danger to cohesion and scalability at the national level. Regional institutional, social, and technical problems frequently impact Ethiopia's adoption of WMP. The following gaps are identified by the review: Little research has been done on the Afar, Benishangul-Gumuz, Dire Dawa, Harari, and Somali regions, despite their reliance on rain-fed agriculture and the threats posed by climate change. Long-term adoption trends following donor withdrawal are not well documented. Socioeconomic advantages are not well or consistently evaluated, especially when it comes to indices of income diversity and resilience. There aren't many quantitative studies of environmental impacts, such as variations in soil fertility, groundwater levels, or erosion rates. There is a dearth of empirical research on the dynamics of involvement and the implementation of gender-inclusive policies, as well as on the post-project sustainability of watershed initiatives, policy enforcement, and institutional cooperation. To optimize long-term benefits, this review recommends policies and support systems must be coordinated, inclusive, and localized.

Keywords: climate smart agriculture, common policy challenges, PSASAR framework, SDG, watershed management practices

INTRODUCTION

In Ethiopia, where agriculture is the main source of income in rural and highland areas, watershed management practices (WMP) are crucial for tackling issues related to land degradation, water scarcity, and climate change (Dessie et al., 2025; Wolancho, 2015). The highlands are under threat from overgrazing, deforestation, and soil erosion (Teketay, 2001; Teku & Derbib, 2025) and even in areas with plenty of rainfall, there are still seasonal water shortages (Gemeda et al., 2024; Teka et al., 2020). Flooding during rainy seasons and drought

during dry seasons is caused by inadequate infiltration and runoff management (Malede et al., 2025; Mera, 2018). Good watershed management techniques preserve soil, restore plants, and maintain ecosystems (Abebaw, 2019; Wolka et al., 2023). They are essential to disaster risk reduction and climate resilience because they also improve groundwater recharge, control streamflow, and facilitate irrigation (Woldearegay et al., 2023). Food security is threatened by land degradation and unpredictable rainfall, which also reduce agricultural output (Bouteska et al., 2024). Watershed management increases household resilience and stabilizes yields by enhancing soil fertility, water retention, and microclimate adjustment (Xing et al., 2024; Yang et al., 2022). Degraded watersheds immediately lower earnings because rain-fed crops and cattle are essential to rural livelihoods (Belay & Lebeza, 2024; Wassie, 2020). Irrigation and agroforestry restoration can boost productivity and diversify revenue streams (Zerssa et al., 2021).

Ethiopia's commitments to international frameworks, such as the Paris Agreement, Land Degradation Neutrality, and the Sustainable Development Goals (SDGs), particularly Zero Hunger (SDG 2), Clean Water (SDG 6), and Life on Land (SDG 15), are furthered by watershed projects. They safeguard infrastructure by lowering flood and sediment damage to farms and roadways (FDRE, 2017). Participatory strategies, including user groups and watershed committees, improve local ownership, social cohesion, and governance (Teressa, 2020; Thapa et al., 2022). In South Wollo, 64% of farmers employ soil bunds, terraces, check dams, and vegetation bunds, demonstrating the increased adoption of soil and water conservation (SWC) practices (Yifru & Mihretu, 2022). Important motivators include farmer education, perceived erosion severity, and conservation benefits. The likelihood of adoption increases by 0.3% to 0.6% for every extra year of education (Tadesse & Hailu, 2024). Extension services continue to be essential, but farming expertise and institutional involvement significantly boost acceptance (Fenta et al., 2021; Teku & Derbib, 2025). SWC interventions improve infiltration, soil fertility, and plant cover, according to case studies conducted in the Tigray and Tana sub-basins. Incentive mechanisms, such as food-for-work initiatives, input subsidies, and performance-based programs, significantly enhance the adoption rates of watershed management practices (WMP) across various regions. For example, Ethiopia's Productive Safety Net Program (PSNP), which offers food or cash in exchange for community-based conservation work, markedly improve soil and water conservation practices in the Amhara Sayint Woreda (Demissie et al., 2024). Research indicates that regions with structured incentives—typically organized by NGOs or government-led watershed programs—exhibit higher adoption rates of WMP. However, the temporary nature of such incentives often results in a decline in adoption and maintenance once external support is withdrawn, highlighting the necessity for long-term, institutionalized incentive schemes to sustain community engagement (Demissie et al., 2024). Secure land tenure also plays a critical role in enabling farmers to invest in sustainable land management. Farmers with recognized or titled land are more inclined to adopt and maintain conservation practices, as they are assured of future returns. In contrast, those facing uncertain property rights exhibit lower adoption rates due to concerns regarding inheritance and expropriation risks. Evidence from the Teleyayen sub-watershed in Northeastern Ethiopia confirms that tenure security significantly influences farmers' participation in watershed programs (Agidew & Singh, 2018). Household-level analyses further demonstrate that secure rights extend farmers' planning horizons, motivating them to progress from initial adoption to the maintenance phases of soil and water conservation (Teshome et al., 2016). Adoption rates are also influenced by financial capacity. A lot of smallholder farmers don't have the money to pay for the labor and supplies needed to build and maintain structures like check dams, terraces, and bunds. According to research done by having access to institutional and financial assistance significantly improves farmers' capacity to implement climate-smart conservation techniques, while lack of support restricts adoption (Mosissa et al., 2019). Likewise, a study conducted in the Lege-Lafto Watershed found that the availability of family labor, market accessibility, and financial limitations were important factors influencing adoption rates (Yifru & Miheretu, 2022). These results highlight the necessity of equitable and inclusive financing solutions that are suited to the requirements of marginalized rural households, such as government-backed investments, cooperative loans, or microfinance. Significant investment is needed for resource-intensive restoration, and scale-up is constrained by a lack of funding (Abebaw, 2019). Zerssa et al. (2021) point out that although irrigation and agroforestry increase yield, they require ongoing funding. For wider use, tailored financial programs and institutional assistance are necessary (Fenta et al., 2021).

Ethiopian watershed management research is still dispersed and primarily case-specific, short-term, and unequal spatially. Without methodically connecting adoption trends, socioeconomic and environmental implications, or policy dimensions, studies frequently concentrate only on donor-driven projects, adoption motives, or specific watersheds. Few incorporate post-project sustainability, climate-smart agriculture, or the involvement of underrepresented populations. By mapping contributions to SDGs, emphasizing underserved areas, and combining findings from 50 studies (2015–2025) into a national perspective, this review closes these gaps.

The review methodically looked at adoption factors, impacts, and policy difficulties using the PSASAR methodology (protocol formulation, search, appraisal, synthesis, analysis, reporting) (Mengist et al., 2020). Scopus, Science Direct, PubMed, and Google Scholar were among the databases that were examined, with an emphasis on research that was published between 2015 and 2025. The rural Ethiopian setting, consideration of social and economic factors, and coverage of at least one WMP (such as SWC, forest conservation, or climate-smart agriculture) were among the requirements. Low-quality publications, pre-2015 work, and gray literature were all excluded.

In order to compile data on adoption determinants, socioeconomic and ecological effects, and policy impediments, fifty relevant papers were categorized and examined. Actionable suggestions for expanding watershed management

through more robust institutions, funding sources, and inclusive governance are offered by this body of evidence.

Therefore, the main intention of this study is to synthesize existing evidence on the adoption, impacts, and challenges—including policy aspects—of WMP in Ethiopia. And, specific the study intensions are: To assess the level and determinants of adoption of WMP across Ethiopia; to evaluate the socio-economic and environmental impacts of WMP on rural households and to examine the challenges and policy-related barriers to effective and sustainable implementation.

In contrast to previous disjointed evaluations, this analysis provides approaches for inclusive, climate-resilient, and SDG-aligned watershed management by tying technical interventions to political economy and labor settings. Additionally, it highlights the significance of quantitative evidence, which is currently lacking in Ethiopian literature, for quantifying adoption rates, yield impacts, and resilience results in an objective manner.

The Rationale of the Review and Its Significance

This literature study aims to address recent information on the demand for a comprehensive understanding of to synthesize existing evidence on the adoption, impacts, and challenges—including policy aspects—of WMP in Ethiopia. Provided that agriculture is the primary livelihood for over 70% of the population, disruptions caused by droughts and floods can lead to severe food insecurity and economic instability. The review will provide consolidated output to evaluate and fill critical gaps in the existing literature through systematically collecting and analyzing the complicated challenges faced by the communities. It provides valuable insights into how the adoption of watershed management affects agricultural productivity, household income, soil restoration and ecosystem rehabilitation.

The significance of this review extends to serve as a vital resource for policymakers, non-governmental organizations (NGOs), local governments, and community leaders by offering evidence-based recommendations for effective interventions aimed at enhancing resilience. Besides, the review will foster interdisciplinary collaboration by integrating insights from climate science, economics, and social sciences, promoting innovative approaches to address these complex challenges. By aligning with several Sustainable Development Goals, particularly those focused on poverty reduction and climate action, this review will contribute to the global dialogue on sustainable development. Ultimately, by raising awareness of the issues confronting rural communities, this work aims to support advocacy efforts that mobilize resources and attention to address the benefits of watershed management, thereby promoting the well-being and resilience of these vulnerable regions and communities covered in the literature survey. Generally, the review was conducted to address the following research questions:

RQ1 What is the extent and pattern of adoption of WMP across Ethiopia, and what factors influence this adoption?

RQ2 What are the socio-economic and environmental impacts of WMP on rural livelihoods?

RQ3 What policy and institutional challenges constrain the effectiveness and sustainability of WMP?

This study takes a new approach by methodically combining national-level data on Ethiopia's watershed management strategies between 2015 and 2025. Using the PSALSAR paradigm, it connects biophysical, socioeconomic, and policy factors, highlighting understudied areas and relating local research to global sustainability priorities.

METHODOLOGIES

The six steps of the PSASAR framework reported in Mengist et al. (2020) for SLR were followed. These include:

1) Protocol (defining the literature study scope),
2) Search (define searching string and types of databases),
3) Appraisal (pre-defined literature inclusion and exclusion criteria),
4) Synthesis (extract and categorized data),
5) Analysis (narrate the result, show the trends, and identify gaps and result comparison, and conclusion), and
6) Reporting (summarizing the report result for the larger public).

The reporting step followed the PRISMA (P Scope and boundaries of the review (Protocol).

The review included a diverse range of geographic contexts, encompassing highland areas such as the Amhara, Oromia, and South regions, as well as comprehensive studies about Ethiopia. Besides, the review considered multiple types of adoptions, including soil and water conservation, forest conservation, and climate-smart agriculture, allowing for a comprehensive examination of their impacts, and on a variety of benefits such as agricultural productivity, food security, soil restoration, and ecosystem rehabilitation. The temporal scope focused on recent literature, within the last decade (2015-2025), ensuring that the analysis reflects current trends and challenges related to the adoption, impacts, and policy challenges of watershed management. Moreover, diverse methodologies, including quantitative assessments, qualitative interviews, meteorological, remote sensing, and GIS-based data reports, were included. This methodological diversity was believed to enrich the findings and provide a well-rounded perspective on the adoption, impacts, and policy challenges of watershed management in rural Ethiopia.

Search Strategy and Keywords Used

To conduct this review task, published articles on related journals that are indexed and abstracted on Scopus, Science Direct, PubMed, and Google Scholar were systematically searched and reviewed. The search was performed using phrases of keywords like "soil and water conservation", "adoption of watershed management impact on livelihood", "Watershed management practices to agricultural productivity", "Watershed management practices to crop production", "Watershed management practices to food security and livelihood", "Watershed management practices impact to soil restoration" and "livelihoods and food security",

Table 1. Criteria for inclusion and exclusion of articles for SLR study

Inclusion/Exclusion Criteria	Decision
If the article is published assured as in a peer-reviewed (reputable) journal	Inclusion
If the predefined keywords exist as a whole or at least in the title, keywords, or abstract section of the article	Inclusion
If the article is published in the English language (with possibilities in an abstract in a local language)	Inclusion
If the article addresses at least one environmental and one economic (livelihood) aspect	Inclusion
If the article addresses at least one watershed management practice (soil conservation, water & forest conservation, etc.)	Inclusion
If the study area of the article is in rural areas of Ethiopia	Inclusion
If there are articles duplicated in the search folders	Exclusion
If the article is not accessible (not free), conference paper, institutional report etc.	Exclusion
If the paper does not primary/original	Exclusion
If the article is published before 2015	Exclusion
If the volume of the journal in which the article published is below 7	Exclusion

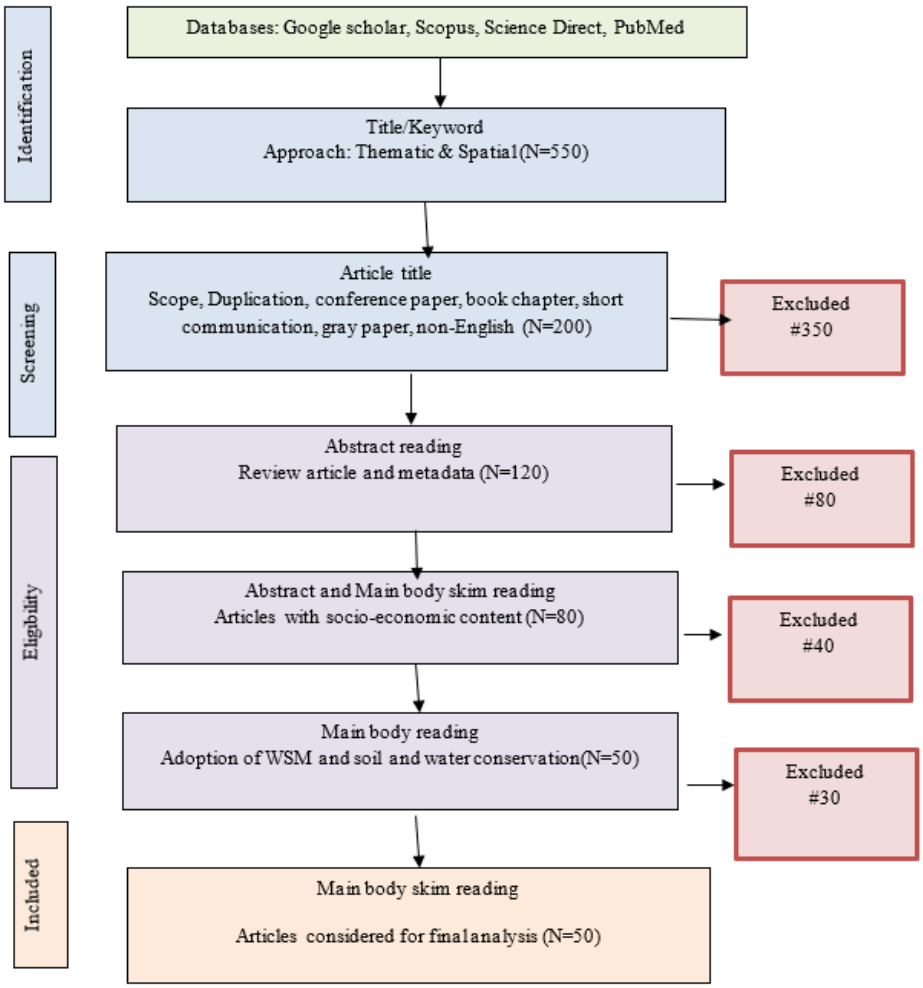

Figure 1. Process for database search for publications for systematic reviews (Adapted from Mengist et al., 2020)

and "adoption of WM households in Ethiopia", " policies gaps in implementing of WSM practices in rural areas of Ethiopia". Each article in the respective keywords (phrases) was managed separately.

Inclusion and Exclusion Criteria

12 criteria were used for inclusion and exclusion of articles in the scientific literature study, as indicated in **Table 1A** in **Appendix**.

Screening Process and Selection Criteria (Appraisal)

The general screening processes and the flow of selecting relevant literature were presented in **Figure 1**. In the initial stage, a total of 550 records were attempted to be accessed. After removing some of the literatures such as gray literature, conference presentations, keynotes, book chapters, non-English language papers, and inaccessible publications, low volume publications, the number of literatures was reduced to 200 articles retained for further title reading. Next, only 120 articles were found to fulfill the eligibility criteria for further abstract reading. After further reading the abstract and main body skimming, only 80 articles remained for the main body reading. Among them, 80 of them were assessed for socio-economic content, and later with Watershed management impact alignment. During main body reading, articles that lack

Table 2. Criteria used for the extraction of data/information from selected articles

S. No.	Criteria	Classes	Explanation
1	Year of publication	2015-2025	Studies before 2015 were discarded
2	Study site/regions	Name of the regions in Ethiopia	To include studies from all geographical areas representing Ethiopia
3	Method	Look-up tables	Use of existing values from the literature
4	Data sources	Primary to the article	Data derived from samples or field (e.g., field data, surveys, interviews, or FGDs)
		Secondary to the article (Trend analysis)	Data derived from other readily available sources (e.g., other articles, remote-sensed data, socioeconomic data, and mixed sources)
		Mixed up in the article	Use of readily available source combined with data from study samples or field
5	Type of WMP	Soil and water conservation	The adoption of watershed management practices across different regions of Ethiopia
		Forest conservation	
6	Impacts/role	Climate-smart agriculture Socio-economic impacts: Agricultural productivity: Household income: Livelihood diversification: Environmental impacts: Soil rehabilitation, Water conservation, Biodiversity, and land cover: soil restoration and land rehabilitation	 Change in the crop production pattern (change) Exploring the impact on soil restoration and rehabilitation To what extent do households and communities benefit? The economic status of the society due to the adoption of WMP
7	Review outcome (Purpose of the review)	Nationwide studies	Those covered more than two regions
		Disseminating site-specific knowledge	What specific knowledge is contributed by the study
		Mitigation/adaptation recommendations	What management options are provided as a recommendation
		Policy support	What existing policies are reported, and what policy recommendations are forwarded

clear alignment were manually removed. In the end, 50 articles fulfilled the inclusion criteria for the work.

Data Extraction and Synthesis Process

In this phase, the data was extracted based on the objectives, and using a predefined criteria indicated in **Table 2**. The data from each of the selected paper was extracted into an Excel spreadsheet for further categorization and analysis. The extracted and theme-based categorized data are indicated in the results section.

FINDINGS

Adoption of Watershed Management Practices in Ethiopia

Watershed Management Practices (WMP) adoption is context-specific and impacted by several factors, such as gender roles, availability of extension services and NGO support in Oromia, education in Amhara, and incentive systems in the southern areas (Dufera et al., 2020). Initiatives to raise awareness and provide training have become universal adoption facilitators, underscoring the urgent need to increase farmer capacity everywhere. External assistance, especially from NGOs and government initiatives, has a big impact on the adoption of WMP nationally, but this assistance is frequently unsustainable in the absence of long-term institutional integration. Research in the areas of Afar, Beneshangul Gumuz, Dire Dawa, Harari, and Somalia is noticeably lacking. These regions, which are large and on Ethiopia's outskirts, are primarily dependent on rain-fed agriculture. Uneven irrigation water distribution and changes in rainfall patterns can harm agricultural productivity if watersheds are not managed effectively. Food security in these areas may eventually be jeopardized by poor management practices that reduce agricultural land production by failing to retain soil. Therefore, areas with less research on farming technology adoption and their socioeconomic circumstances should be given priority in future studies. The effects of violence have limited WMP implementation and evaluation in Tigray, exposing serious governance and data shortages (Tewodros et al., 2016). The need for customized, region-specific tactics is highlighted by the reported regional differences in adoption rates and institutional effectiveness. According to this assessment, although WMP in Ethiopia has quantifiable advantages when put into practice, adoption is still uneven, and institutional flaws make long-term sustainability difficult. Even if there are localized success stories, to expand and maintain the benefits of WMP across the nation, larger systemic issues—specifically those about institutional coordination, policy alignment, and post-project continuity—must be resolved. Furthermore, as seen in places like Chiracha in the Gibe Basin, treated micro-watersheds exhibit greater adoption rates than untreated ones. Besides, **Figure 2** illustrates the topic's importance and the reasons why a large number of scholars in that field are interested in it. This noteworthy rise suggests that adoption studies are getting more attention from academics and are becoming a more prominent research topic. This implies that research on the application of watershed management strategies has grown in importance over the last ten years as a means of advancing scientific knowledge to create appropriate farming practices that will mitigate the effects of climate change (Wang et al., 2016; Wolka et al., 2023).

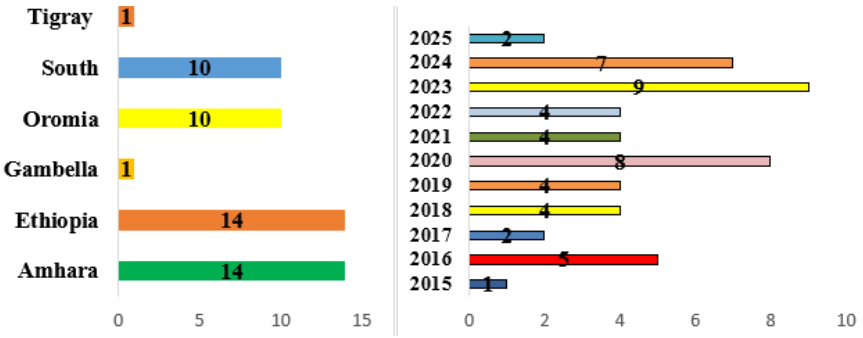

Figure 2. Reviewed papers across the regions of Ethiopia (Source: Authors' own elaboration)

Impacts of Watershed Management on Rural Households and Ecosystems

There have been reports on improved food security, higher crop yields, and agricultural productivity in places like Geshy, Gambela, and Damota. Diversified income sources and decreased susceptibility to calamities are associated with household income. Furthermore, the adoption of off-farm activities in some situations has been seen as a means of diversifying livelihoods (Dessalegne & Abebe, 2016). One of the environmental effects is soil restoration, which has boosted organic content and decreased erosion, especially on steep slopes in the Ijara watershed. Several highland regions have seen a decrease in runoff and an increase in water availability as a result of water conservation initiatives. Research by Chot et al. (2019), Masha et al. (2021), Melese (2022) and Tilahun et al. (2023) also show some signs of vegetation recovery and replanting. When treated and untreated areas are compared, the treated areas show steady improvements (e.g., Dessie et al., 2025; Tilahun et al., 2023). Water management practices (WMP) have improved soil fertility, reduced erosion, and increased agricultural output in areas like Amhara and Oromia (**Table 3**). When gender and livelihood incentives have been properly taken into account, initiatives in the Southern region have raised household income and improved resilience to climatic shocks. Positive effects are noticeable on a national level; however, these results frequently rely on the effectiveness of execution, community involvement, and follow-up assistance.

Policy and Institutional Challenges to WMP Implementation

Post-project disengagement is a recurring problem in Amhara and Oromia, where institutions commonly find it difficult to sustain momentum when donors or NGOs exit, as the reviewed study regularly points out. Local implementation and national strategies are significantly out of sync, which is made worse by lax enforcement and little community ownership. When project phase-out results in the dissolution of watershed management program (WMP) institutions, institutional difficulties become especially apparent (Belachew et al., 2020; Gebregziabher et al., 2016; Teka et al., 2020). Various ministries, such as those in charge of agriculture, water, and the environment, have different responsibilities. During donor-funded phases, community participation is typically substantial; however, during the post-exit sustainability phase, it drastically decreases. Additionally, there have been several instances of gender exclusion (Belayneh, 2023; Demissie et al., 2024; Gobena et al., 2025; Sherka, 2023). Policy documents and recommendations show a lack of support for the scaling up of climate-smart WMP, along with uneven success in integrated watershed policy instruments (Habtu, 2023; Mazengiya, 2024; Teka et al., 2020). Policy misalignment is a problem in the southern areas, especially when it comes to integrating national climate-smart agriculture (CSA) initiatives with WMP. The scaling and institutionalization of WMP have been severely hampered at the national level by disjointed institutional functions, weak enforcement tools, and poor interagency cooperation.

Table 3. Thematic synthesis matrix for watershed management studies in Ethiopia (2015-2025)

No.	Authors, year	Study area	Sample size	Focus of study	Key adoption findings	Socio-economic/ environmental impacts	Policy or institutional challenges
1	Tesfaye et al., 2016	Gedeb, Amhara	498	Decisions about soil conservation	Education and land slope are related to adoption.	Reduced erosion and a moderate improvement in yield	Restricted support for extensions
2	Mengistu & Assefa, 2020	Gibe, Oromia	304	Participation of the community	High adoption with assistance from NGOs	Increased food security and soil fertility	After the project, the community disengages; institutional coordination is weak.
3	Chot et al., 2019	Gambela	2943	WMP effects	Not specifically evaluated	Food security has significantly improved.	Insufficient integration of climate policies
4	Tilahun et al., 2023	Geshy watershed, South	384	Climate effect-aware WMP	High uptake with incentives for climate-smart	Enhanced resilience and productivity	Gaps in policy following donor removal
5	Naji et al., 2024a	Central Highlands, Oromia	1636	Engagement and sustainability	Training access drives community adoption	Increased income and decreased migration	Restricted availability of extension services

Table 3 (Continued). Thematic synthesis matrix for watershed management studies in Ethiopia (2015-2025)

No.	Authors, year	Study area	Sample size	Focus of study	Key adoption findings	Socio-economic/ environmental impacts	Policy or institutional challenges
6	Sileshi et al., 2019	Oromiya	790	Adoption of conservation measures for soil and water	Information availability and the stability of land tenure have an impact on adoption.	Enhancing yield and managing erosion	Regional implementation capacity variability
7	Tewodros et al., 2016	Ethiopia	NA	Regional adoption drivers	Community mobilization and extension were important motivators.	Increased production of the land	Inadequate local leadership
8	Agidew & Singh, 2018	Amhara	NA	Farmers' involvement in watershed initiatives	The perceived advantage of community involvement varies.	Improvements in soil fertility	Lack of plans for follow-up maintenance
9	Debisa et al., 2025	Oromia	NA	Slope and conservation structures' effects	Awareness of slope gradients was connected with adoption.	Better qualities of the soil	Financial limitations and insufficient M&E
10	Muche et al., 2024	South	123	Effectiveness and strategy of IWM	Demo sites and farmer training increase adoption; awareness and adoption are strongly correlated.	Improved forest cover and water availability	Coordination between sectors is lacking.
11	Providoli et al., 2019	Ethiopia	190	Sustainability and conservation	Variability in the climate affected the adoption of practices.	Degradation of the land has decreased.	Restricted support for extensions
12	Abegaz et al., 2024	Ethiopia	100	Impacts of CSAP Adoption on Livelihood and NRM	Variability in the climate affected the adoption of practices.	Enhanced food security and resilience	Inadequate adherence to national CSA regulations
13	Assefa et al., 2018	Amhara	296	Conservation and sustainability	Economic incentives boost adoption	Increased revenue and preservation of resources	Lack of favorable rural credit policies, inadequate technical skills, and weak institutional capacity
14	Daniel & Mulugeta, 2017	Amhara	112	Adoption of SWC factors	Adoption is influenced by peers and prior experiences.	Water retention and siltation control	Inadequate post-project support systems
15	Dessalegne & Abebe, 2016	Amhara	246	Diversification of livelihoods	Adoption linked to a variety of land use	Increased household income and notable improvements in livelihood	little ability to monitor technically
16	Dufera et al., 2020	Oromia	123	Adoption in micro watersheds that are treated versus those that are not	Increased adoption in regions addressed with NGO assistance, Technology adoption is associated with hotspots for erosion	Reduction of risk in areas of high risk	Neglect and institutional inertia
17	Mengistu & Assefa, 2020	Ethiopia	107	Risk mapping for erosion	Adoption spurred by threats to livelihood	Decreased susceptibility	Unreliable implementation assistance
18	Gashu & Muchie, 2018	Amhara	100	Degradation and livelihoods are related.	Adoption was impacted by landholding size and training.	Increases in yield and decreases in erosion	Challenges with institutional cooperation
19	Wordofa et al., 2020	Oromia	120	Increased usage of SWC structures	Increased food security in WMP regions	Fewer gaps in food	Low levels of community ownership
20	Takele et al., 2023	Amhara	216	Food security and WMP	Increased adoption with an emphasis on improving livelihoods	Gains in employment and income were reported.	Lack of assistance for market linkage
21	Meles & Mulugeta, 2022	South, Hadiya	82	IWM's socioeconomic effects	Adoption is encouraged by a high benefit-cost ratio.	Better land usage results in higher revenue.	Institutional follow-up gaps
22	Fekadu et al., 2024	South, Gombora	117	IWM's economic analysis	Evidence of an increase in the availability of water	Improved soil stability and irrigation	Scalability constraints on data
23	Yericho & Belay, 2015	South, Kaffa	200	Food security and WMP effectiveness (PSM analysis)	Food security was greatly enhanced by adoption.	Decreased scarcity of seasonal foods	Bias against women in the design of extension services
24	Mideksa et al., 2023	Oromia	250	The involvement of women in SWC	Gender-responsive strategies increased adoption.	Female farmers with empowerment	Inadequate adherence to national CSA regulations

Table 3 (Continued). Thematic synthesis matrix for watershed management studies in Ethiopia (2015-2025)

No.	Authors, year	Study area	Sample size	Focus of study	Key adoption findings	Socio-economic/ environmental impacts	Policy or institutional challenges
25	Sherka, 2023	South	234	Conservation and sustainability	Variability in the climate affected the adoption of practices.	Enhanced food security and resilience	Lack of favorable rural credit policies, inadequate technical skills, and weak institutional capacity
26	Tsedey et al., 2024	Upper Gelana watershed, Amhara	150	Using technologies to conserve forests, water, and soil	Adoption rates and contributing factors that have been quantified	Enhanced resilience and sustainability	Restricted incentives and extension
27	Yifru & Miheretu, 2022	Lege-Lafto Watershed, Amhara	304	Adoption of soil and water conservation practices	Drivers and obstacles found	Beneficial effects on livelihood and the environment	Absence of assistance for follow-up
28	Yigezu, 2021	Ethiopia	NA	Ethiopian agriculture's challenges and future	Issues with general adoption in agriculture, Conservation increased stability	Systemic impediments were highlighted.	Fragmentation of institutions
29	Gashu & Muchie, 2018	Chilga district, Amhara	100	Link between livelihood and land degradation	decrease in post-exit maintenance	Decreased susceptibility	Issues with finance and coordination
30	Teka et al., 2020	Eastern Tigray	409	Watershed management status after the project	Realized potential for resilience-building	Loss of advantages for the environment	Insufficient preparation for sustainability
31	Wolka et al., 2023	Southwest Ethiopia	255	The importance of watersheds in adapting to climate change	Increases in income and yield	Increased soil retention and food security	Fragmentation by sector
32	Masha et al., 2021	Damota Area, South Ethiopia	378	Effects of soil and water management	Despite the advantages, little awareness	Benefits to the economy and land rehabilitation	Lack of tools and high labor expenses
33	Demissie et al., 2024	Ethiopia	NA	Adoption of climate-smart agriculture	maintained the integrity of the environment	Possibility of reducing land deterioration	Limitations in financing and capacity
34	Mena et al., 2017	Ethiopia	NA	Ecosystem balance through IWM	Displayed models that were successful.	Enhancement of moisture and fertility	Poor inter-institutional cooperation
35	Tilahun et al., 2023	Ethiopian Highlands	NA	Water management scaling up for rainfed agriculture	Socioeconomic and awareness factors were found.	decreased runoff and increased output	Poor scaling techniques
36	Asfew et al., 2023	Bench-Sheko Zone, South Ethiopia	423	Perception and acceptance of soil and water conservation	Documentation of both traditional and contemporary practices	Preventing erosion and stabilizing slopes	Ineffective methods of engagement
37	Moges & Bhat, 2020	North-western highlands, Amhara	210	Degradation of watersheds and management techniques	Adoption rates and contributing factors that have been quantified	Reversing degeneration with varying degrees of success	Lack of continuous institutional support
38	Wassie, 2020	Eastern Ethiopia	120	Adoption of structural soil and water conservation measures	Farm variables and socioeconomic drivers were discovered.	Benefits of soil structure and moisture	Limitations on training and credit access
39	Habtu, 2023	Semi-arid Ethiopia	NA	Watershed integration for agriculture and water	Renewed usage of watersheds	Increased accessibility to water	Inefficiencies in coordination
40	Naji et al., 2024b	Central Highlands, Oromiya	1636	Participation of the community in the development of watersheds	Associated with trust and education Performance evaluation	Improved local government	Poor representation and a lack of trust
41	Belayneh, 2023	Gumara watershed, Amhara	NA	Adoption and efficacy of SWC policies	Increased resilience and yield	Increases in productivity	Poor review and feedback

Table 3 (Continued). Thematic synthesis matrix for watershed management studies in Ethiopia (2015-2025)

No.	Authors, year	Study area	Sample size	Focus of study	Key adoption findings	Socio-economic/ environmental impacts	Policy or institutional challenges
42	Zerssa et al., 2021	Ethiopia	246	Opportunities for smallholder farmers to adopt CSA	Better results are produced by more engagement.	Effects of food security	Gaps in awareness and training
43	Gobena et al., 2025	Qarsa woreda, Oromia	337	Increasing community involvement to ensure food security	Adoption of enhanced nutrition and availability of food.	Increased production and preservation of food	Insufficient institutional support
44	Takele et al., 2023	Northwest Ethiopia	216	Effects of watersheds on household food security	Benefits and challenges assessed,	Increased wealth and a more varied diet	Absence of post-project assistance
45	Melese, 2022	Korocho Watershed, South Ethiopia	82	The effects of integrated watershed management on society and the economy	discovered economic feasibility	Better quality of life	Limitations in monitoring
46	Fekadu et al., 2024	Horuwwa Watershed, South Ethiopia	117	An economic evaluation of IWM procedures	Farm variables and socioeconomic drivers were discovered.	Increased farm revenue	Expensive for low-income farmers
47	Yericho & Belay, 2015	Chena Woreda, Kaffa Zone, South Ethiopia	200	Watershed Management Interventions' Effectiveness	Interventions in watersheds improved conservation and land use.	Increased sustainability and productivity in agriculture	Absence of sustained observation
48	Mideksa et al., 2023	Eastern Ethiopia	250	Effects of conserving water and soil on food security	Food security was greatly enhanced by SWC techniques.	Increased availability of food in households	Limitations in scaling and targeting
49	Addis et al., 2020	Northern Highlands, Amhara	27 data points	SWC's financial advantages at the sub-catchment level	Benefits of investing in SWC that can be measured Barriers connected to gender	Positive land productivity and return on investment	Expense and resource needs
50	Belachew et al., 2020	Northwest, Amhara, Ethiopia	150	Factors affecting adoption of SWC	Age, sex, education level, household size, livestock holding, land size, access to credit, access to extension service and training	Increase agricultural productivity	The provision of formal and non-formal training and difficult to find effective extension service

Regional Trends in Watershed Management Practice (WMP) Adoption in Ethiopia

Common determinants of adoption

In Amhara, geography (land slope), training accessibility, and educational attainment all have a big impact on the adoption of practices (**Table 4**). These elements support focused application of water and soil conservation measures as well as well-informed decision-making. Access to extension services and NGOs' assistance is important factor in Oromia, emphasizing the influence of institutional presence and outside facilitation on adoption rates. Gender roles and incentives, such as livelihood benefits and demonstration locations, are important in the Southern Region. This emphasizes the significance of socio-cultural dynamics and motivational structures. The lack of data in Tigray due to recent conflicts makes it difficult to evaluate the factors that influence adoption now. Socioeconomic factors like education level, farm size, gender (especially lower female participation), and income level are often mentioned, as are institutional factors like the presence of NGOs or government programs, extension services, and local training; and environmental factors like rainfall patterns, land slope, and the severity of erosion (Mengistu & Assefa, 2019, 2020, 2021; Dufera et al. 2020; Naji et al., 2024b). Although the efficacy of these activities varies by region and project setting, government and non-governmental organization backing, as well as training programs, are frequently linked to the adoption of water management methods at the national level.

Key socio-economic and environmental impacts

Increased crop yields and efficient erosion control are among the benefits mentioned in Amhara, demonstrating advancements in agricultural production and environmental health. Positive effects in Oromia are concentrated on diversifying livelihoods and restoring soil fertility, indicating a wider developmental advantage. WMP in the Southern Region has improved household income and resilience to climatic shocks, especially in regions where gender-sensitive strategies were used. Due to the ongoing fighting in Tigray, there is currently insufficient data to conduct a thorough impact assessment. Last but not least, overall effects at the national level vary depending on elements like project design, local involvement, and sustainability after the initiative.

Table 4. Logistic regression results

Predictor	Coefficient (β)	Odds ratio (OR)	p-value	Meaning
Intercept	−1.10	0.33	0.001	When all predictors are equal to zero, the baseline log-odds of adoption are negative, meaning that there is a low likelihood of adoption.
Training	+1.23	3.42	0.002	WMP adoption is 3.4 times more likely to occur in households that receive training than in those who do not.
Land tenure	+0.79	2.20	0.015	Adoption odds are increased by a factor of 2.2 when land tenure is secure. This difference is statistically significant.
NGO support	+1.52	4.58	0.001	The strongest predictor of adoption is that households receiving NGO help are 4.6 times more likely to adopt.
Gender inclusion	+0.48	1.62	0.087	The likelihood of adoption is 1.6 times higher in gender-inclusive households, however this difference is only slightly significant (p = 0.087). Though not strong, it is suggestive.

Common Policy and Institutional Challenges

In the Amhara region, poor coordination and institutional disengagement following project completion pose serious challenges that result in sustainability problems. Oromia, on the other hand, experiences community weariness and a dearth of follow-up, especially in regions where short-term NGO programs predominate. Watershed Management Practices (WMPs) and climate-smart agriculture strategies are not always aligned in the Southern Region, which suggests a lack of policy integration. Disrupted governance in Tigray limits the ability to examine institutional concerns. The most commonly mentioned issues at the national level are insufficient policy enforcement and dispersed institutional responsibilities, which compromise the scalability and cohesion of the country. Overall, a mix of regionally specific institutional, social, and technical factors affects Ethiopia's adoption of WMP. Where adoption takes place, the effects are generally favorable; nevertheless, sustainability and scaling initiatives are hampered by a lack of institutional continuity, policy coherence, and regional integration. An illustration of policy misalignments is the fact that different ministries—such as Agriculture, Environment, Water, and Energy—are responsible for managing watersheds, each of which is working on different projects. Ineffective planning results in redundant work, wasteful use of resources, and contradictory messages to farmers. Efficient soil and water conservation requires decades of dedication, watershed management projects usually last 3 to 5 years. Projects, not sustainability, are the main emphasis of funding and reporting. Some areas use cash-for-work or food-for-work schemes, while others depend on community volunteers. When households evaluate advantages across districts and may stop participating if incentives differ, this inconsistency undermines reliability. Secure land tenure encourages farmers to adopt watershed management techniques, but land policy changes are frequently sluggish and uneven. Promotion of conservation initiatives is done without accompanying assurances about land tenure. While farmers concentrate on yields and food security, Ethiopia's Climate Resilient Green Economy (CRGE) policy places a higher priority on carbon storage. Local livelihood goals and national carbon goals are not sufficiently aligned.

Weighting of Evidence and Sensitivity Analysis

Using the data that is already available, sensitivity analysis is carried out by giving each piece of evidence a weight in order to prevent areas with more studies (10 or more) from overshadowing areas with fewer studies (1 to 2). Sample size, technique clarity, and statistical reporting are the three dimensions along which weights can be allocated; high = 1.0, medium = 0.7, and low = 0.4 are examples of these values. Direct adoption studies are given precedence over secondary or indirect studies in terms of their applicability to WMP adoption. In order to reduce geographic bias, it is recommended that under-researched regions be given somewhat greater weight in terms of geographic representation. To guarantee they have a meaningful voice, studies from Afar or Gambela, for instance, can be given a "representation multiplier" (e.g., ×1.2). It is more practical to compute your pooled estimations (such as adoption rates and yield effects) as weighted means as opposed to simple averages. The study put in place a weighting system based on study rigor and geographic breadth to address the issue of unequal regional representation. Sensitivity testing was conducted by adjusting the anticipated adoption rates for data-scarce regions (Afar, Gambela, Harari, and Somali) and by removing substantially represented regions (Amhara and Oromia). According to these calculations, the overall direction of benefits (positive effects on yield, food security, and erosion reduction) stays consistent, even though national adoption estimates decrease by roughly 10–15% when Amhara and Oromia are taken out of the equation.

Although Ethiopia's watershed management strategies are becoming more in line with the SDGs, their ability to influence decisions is constrained by the preponderance of qualitative evidence. The case for scaling effective techniques is undermined by the absence of effect sizes, such as measurable increases in household income, crop yield, or erosion reduction. While it is advantageous to correlate policy gaps with corrective activities, the lack of quantitative results makes it more difficult to prioritize expenditures, show cost-effectiveness, and evaluate contributions to SDG targets. Incorporating gender-sensitive indicators, extending research into under-studied areas, and putting strict monitoring procedures in place can all contribute to producing the solid data required to move beyond policy alignment to quantifiable impact.

Cost–Benefit Considerations and Labor Requirements in Watershed Management Practices

Ecological results, as well as the relative costs, benefits, and labor requirements of each intervention, all have an impact on Ethiopia's adoption of watershed management practices (WMPs). Research indicates that techniques like

check dams, terraces, and soil and stone bunds need a large initial labor commitment, which frequently deters long-term involvement (Agidew & Singh, 2018). The benefits of afforestation and reforestation projects only become apparent in the medium to long term, and they also come with expenditures associated with seedling acquisition, land preparation, and multi-year upkeep. Agronomic practices like crop rotation, mulching, and cover crops, on the other hand, are more dependent on seasonal labor availability but involve less capital investment and provide more rapid increases in crop output and soil fertility. Adoption patterns at the household level are influenced by perceived return on investment: agronomic and agroforestry practices usually yield faster yield and income benefits, while physical structures offer long-term soil and water conservation benefits but postpone short-term economic returns. Local case studies repeatedly highlight the trade-offs, despite the lack of quantitative evidence on real cost-benefit ratios (e.g., Tilahun et al., 2023; Wolancho, 2015).

Labor Costs and Strategies for Reduction

WMP adoption is often hampered by work intensity, especially in rural homes with limited family labor resources or conflicting off-farm obligations. In contrast to agronomic procedures, which require 5–10 person-days per hectare annually, the construction of terraces or stone bunds may need 20–40 person-days. Since they frequently provide unpaid work for community initiatives without explicit incentive mechanisms, women and young people are disproportionately impacted (Daniel & Mulugeta, 2017). Three crucial tactics are suggested in order to lessen these costs.

i. Minimal mechanization

   The time and effort required to build terraces, check dams, and water-harvesting structures can be decreased by introducing inexpensive, small-scale equipment (such as mini-tractors, stone crushers, and earth augers).

ii. Collective work with incentives

   The task can be divided among households by bolstering community labor-sharing agreements like wonfel or debo. In a number of Ethiopian highland projects, tying such group efforts to cash-for-work, food-for-work, or performance-based subsidies has shown promising results (Mena et al., 2017).

iii. Targeted training and scheduling

   Training on effective construction methods and flexible scheduling of communal work outside of the busiest agricultural seasons can assist strike a balance in the distribution of labor between WMPs and domestic farming requirements.

Incorporating these labor- and cost-sensitive tactics into WMP policy frameworks would improve the sustainability and equality of watershed interventions on a broader scale in addition to increasing participation.

DISCUSSION

Adoption Patterns and Determinants

According to a number of studies, there are a number of interrelated reasons why WMPs usage in Ethiopia varies greatly among regions. Adoption is mostly dependent on awareness and education. According to research by Tesfaye et al. (2016) and Tewodros et al. (2016), farmers who have greater access to education and information are more likely to comprehend and subsequently implement the advantages of WMP. These studies demonstrate how basic literacy and awareness-raising initiatives can have a big impact on adoption rates. Training and extension services are also essential facilitators. According to Naji et al. (2024a) and Wordofa et al. (2020), farmers are more likely to adopt WMP if they obtain technical assistance or training from extension agents. By offering helpful advice and bridging the knowledge gap, these services increase the accessibility and applicability of practices. Adoption is further encouraged by outside aid, such as that provided by NGOs, the availability of demonstration sites, and incentives associated with climate-smart agriculture. According to Mengistu and Assefa (2020) and Tilahun et al. (2023), farmers are more inclined to embrace and maintain WMP methods when they see successful instances in demonstration plots or when they are given resources and incentives (such as equipment or seedlings). Another crucial component is the land's qualities, especially its slope. According to Debisa et al. (2025), steep slopes typically make an erosion management method more necessary, which leads to greater adoption rates in those locations. On the other hand, flatlands might not provide the same sense of urgency, which would lower motivation. Community involvement is also very important, especially when it comes to gender inclusion. According to Sherka (2023) and Takele et al., (2023), because inclusive procedures foster trust and responsibility, there is more community commitment and sustained effort when women and marginalized groups are involved in planning and execution. But there are still obstacles to WMP adoption. Abebe (2022) and Chot et al. (2019) point out several persistent problems: Low local ownership reduces the incentive to sustain practices over time when communities believe WMP is imposed from without. High labor needs make implementation more difficult for smallholders who don't have a lot of family or hired labor. The need for improved exit strategies and sustainability planning is highlighted by post-project disengagement, which occurs when communities stop maintaining structures after government or NGO funding ends.

Socio-Economic and Environmental Impacts

Increased food security and higher crop yields are two of the most commonly mentioned advantages of watershed management practices (WMP). According to studies by Mideksa et al. (2023) and Mengistu and Assefa (2021), WMP techniques, including terracing, rainfall collection, and soil and water conservation, can greatly increase agricultural production. These techniques help farmers produce more food by reducing water runoff and improving moisture retention, which immediately improves household and local food security. Notable advantages of WMP include job generation

and income increase. According to Abebe (2022), the application of WMP has resulted in higher income through better crop sales, increased productivity of livestock, and the creation of jobs in areas where labor is required for the construction and maintenance of physical structures like check dams and terraces. Local economies are multiplied by this economic recovery. Erosion prevention and increased soil fertility are major benefits from an environmental standpoint. Implementing WMP decreases topsoil loss and restores soil nutrients, claim Sileshi et al. (2019) and Yifru and Miheretu (2022). These improvements support long-term productivity and environmental health in addition to stabilizing the ground. WMP also helps people become more resilient to climate change. Practices like water harvesting and agroforestry assist communities in withstanding climate-related shocks like droughts and unpredictable rainfall, as demonstrated by Abegaz et al. (2024) and Wolka et al. (2023). These tactics increase the adaptability of farming systems and reduce their susceptibility to environmental hazards. However, despite these obvious advantages, a number of studies point out sustainability's difficulties. Muche et al. (2024) and Teka et al. (2020) warn that in areas where initiatives rely significantly on donor money, many beneficial effects are frequently fleeting. Local communities often lack the institutional, financial, or technical capacity to sustain the practices or maintain the structures after external financing stops. Weak monitoring and evaluation (M&E) systems also make it difficult to track a long-term effect, which makes it more difficult to improve and adapt to future initiatives. In conclusion, although elements like education, support networks, the surrounding environment, and inclusive participation encourage the adoption of WMP, obstacles like high labor costs, a lack of community ownership, and a lack of ongoing assistance still prevent wider acceptance. These conclusions, which are reinforced by a number of case studies from Ethiopia, highlight the necessity of community-driven, context-specific, and well-supported approaches to land and water management.

Institutional and Policy-Related Challenges

Even though the advantages of Watershed Management Practices (WMP) are widely known, enduring institutional and policy-related obstacles frequently impede their long-term success. Critical problems that compromise these programs' efficacy and sustainability have been found in a number of studies. Poor policy integration and a lack of cooperation across sectors are major problems. Water, agriculture, environmental, and rural development projects frequently function in silos, leading to overlapping mandates, contradictory aims, and inefficient resource utilization, according to research by Muche et al. (2024) and Mena et al. (2017). WMP initiatives may become dispersed and inconsistent due to a lack of distinct institutional ties or coherent policies, which would reduce their overall impact. Implementation is further hampered by inadequate extension support and weak institutional competence. The main challenges, according to Daniel and Mulugeta (2017) and Gashu and Muchie (2018), include understaffed agencies, insufficient field worker training, and a dearth of strong local institutions. As a result, farmers and communities frequently lack the direction and ongoing assistance required to implement and sustain WMP successfully. Another persistent problem is a lack of long-term sustainability planning, especially once donor support ceases. According to Naji et al. (2024a) and Yericho and Belay (2015), a lot of WMP initiatives are donor-driven and pay little attention to funding, community capacity building, or post-project continuity planning. Because of this, structures decay and practices are often abandoned after financing stops. The inclusivity and equity of WMP are further compromised by gender bias in program design and delivery. Despite being important contributors to the management of natural resources, Sherka (2023) emphasizes how women and other marginalized groups are frequently left out of decision-making processes or targeted support. The initiatives' overall efficacy and legitimacy are weakened by this exclusion. Lastly, two major obstacles still exist: Insufficient funding and restricted access to technical resources. According to Mazengiya (2024) and Addis et al. (2020), local institutions usually lack the funding, equipment, or technology necessary to assist planning, execution, and monitoring. Even well-designed WMP programs have difficulty establishing them or scaling successfully in the absence of adequate funding. In conclusion, all of these studies highlight the necessity of systemic reform for WMP to be successful and long-lasting in Ethiopia. Stronger sector-integrating policy frameworks increased institutional capability, better gender and social inclusion integration, and systems to guarantee local ownership and continuity outside of donor funding cycles are all examples of this. Even the most technically competent WMP attempts will be vulnerable to failure if these structural problems are not resolved.

Political Economy Dimensions Needing Enhancement

The political economics that underpins the implementation of watershed management practices (WMPs) in Ethiopia has an impact on their efficacy in addition to biophysical considerations and labor viability. Three primary problems are highlighted by current evidence. Decisions about labor distribution, site selection, and incentive distribution (cash or food-for-work) are often dominated by local elites. In addition to discouraging active participation from vulnerable groups like women, youth, and households with limited resources, this erodes confidence in collective action. Besides, the majority of WMPs run on three to five-year project cycles with little to no post-project follow-up. This leads to insufficient incentives for the sustained upkeep of plantings or soil structures, especially when the benefits take longer to manifest than the donor had anticipated. Moreover, fragmented governance is a result of the Ministries of agriculture, water, and environment having overlapping responsibilities as well as entities operating at the regional and woreda levels. The enforcement of maintenance regulations is hampered and resource duplication results from the lack of a clear accountability system.

Steps like aligning incentives, such as tying leadership performance reviews at the kebele level to WMP result; putting in place measures to prevent elite capture, such as gender/youth quotas in community projects and open labor registers. Simplifying institutional frameworks by establishing

interministerial forums with distinct roles for financing might bolster the political economic component.

CONCLUSION AND RECOMMENDATION

Conclusion

Watershed management practices (WMPs) have improved food security, soil fertility, water availability, and climate resilience in Ethiopia, according to this review (2015–2025). However, the majority of the data is qualitative in nature and is centered in Ethiopia's southern, Amhara, and Oromia areas. Comparability and national extrapolation are hampered by the sparse reporting of quantitative effect sizes. Lack of data, inconsistent financial incentives, poor post-project assistance, restricted female inclusion, and poor institutional coordination are some of the main obstacles. Stronger inter-sectorial coordination institutionalized monitoring, improved tenure and financial incentives, gender-responsive programming, and standardized quantitative measures are all necessary to address these problems and support long-term adoption and evidence-based policies. In conclusion, these suggestions support a paradigm change in land and water resource management from transient, outside-driven interventions to inclusive, integrated, and robust systems. Achieving food security, improving climate adaptation, and advancing sustainable development across Ethiopia all depend on this change.

Recommendation

This systematic review seeks to determine the most successful study for each region in order to fill the research deficit in the Afar, Beneshangul Gumuz, Gambella, and Somali, Harari, and Dire Dawa areas. Additionally, longitudinal monitoring is crucial in geographical areas like Somalia and the Afar Region (Lowland/Pastoral Areas) in order to assess the effects of water management practices (WMP) in areas vulnerable to drought, displacement, and war. In addition to highlighting rights to mobility, communal rangeland governance, and land tenure, this entails using socioeconomic studies to identify adoption barriers for pastoralists and agro-pastoralists. On the other hand, lowland, forested places like Gambella and Beneshangul Gumuz require quantitative environmental assessments that concentrate on hydrological changes, deforestation, and soil erosion. After WMP implementation, it is also critical to evaluate crop yields, income diversification, and ecological services. Examining indigenous resource management techniques and how they are incorporated into formal watershed planning will be the main focus of participatory rural evaluations.

Suggestions for policy

i. Framework for national watershed governance

   Create a unified institutional and legislative framework that combines water, forestry, and agricultural policies with Watershed Management Plans (WMP). Direct inter_ministerial councils to coordinate activities among regional bureaus, the Ministry of Agriculture (MoA), and the Ministry of Water and Energy (MoWE).

ii. Mandate for regional research equity

   Encourage academic institutions and non-governmental organizations (NGOs) to carry out WMP research in areas that need more attention, like Afar, Benishangul Gumuz, and Harari. Provide competitive research funds for agro-ecologies that have been neglected.

iii. Sustainability clauses after the project

   All WMP initiatives that receive outside funding must include a commitment to locally funded capacity-building and maintenance for five to ten years. Connect evidence of community ownership structures to donor sponsorship.

iv. Climate-smart finance for watersheds

   Create carbon credit programs or green bonds tailored to a given watershed, with the earnings going toward agroforestry and soil conservation projects. Make implementing climate-resilient crops and water collecting systems in watersheds a top priority.

v. Incentive systems that are inclusive

   Give farmers that plant terraces, reforestation, or conservation tillage in watershed areas direct cash, tax breaks, or input subsidies. To avoid perpetuating inequality, tailor incentives according to gender, land tenure, and the variety of livelihoods.

Decision making tools

i. Index of watershed prioritization (WPI)

   Watersheds are ranked using a composite scoring system that takes into account factors like population pressure, climatic sensitivity, food security demands, and degradation risk. It helps decision-makers allocate scarce resources to "hotspot" watersheds that are given priority.

ii. Watershed-agriculture integrated dashboard

   A GIS-based platform that connects data on crop productivity, hydrology, land use, and soil health. Makes it easier to track WMP results in real time and encourages flexible policy changes.

iii. Simulation models for policy impact

   To forecast how different policy options (such as subsidies versus carbon credit systems) would affect adoption rates, yields, and equity outcomes, use agent-based or econometric models.

iv. Systems for participatory decision support (PDSS)

   Platforms run by the community that combine scientific data with traditional knowledge. It maintains technical rigor while making sure judgments represent local needs.

v. Protocols for longitudinal monitoring

   Standardized techniques for monitoring farm revenue, water availability, and soil erosion rates across geographical boundaries.it increases the strength of the quantitative evidence base and makes cross-project comparability easier.

CRITICAL ANALYSIS OF THE PAPER

The review indicates that the majority of studies are concentrated in Amhara, Oromia, and SNNPR, while pastoral and lowland regions remain insufficiently researched. This concentration risks distorting the "national picture" toward highland farming systems, potentially neglecting how Watershed Management Practices (WMP) may be implemented in fragile or conflict-prone lowlands. While the document emphasizes several positive impacts (such as soil fertility, water availability, and resilience), the reliance on descriptive or qualitative reporting complicates the establishment of effect sizes or causal relationships. The absence of consistent quantitative indicators (such as yields, incomes, and erosion rates) limits the ability to make robust comparisons across studies.

Author contributions: TT: writing – review & editing, writing – original draft, software, project administration, methodology, investigation, formal analysis, data curation, conceptualization; **AA:** supervision, methodology, formal analysis; **EA:** supervision, methodology. All authors agreed with the results and conclusions.

Funding: No funding source is reported for this study.

Ethical statement: The authors stated that the study adhered to the Ethiopian National Research Ethics Review Guideline (5th edition). The Institutional Research Ethics Review Committee (IRERC) approved this study. The researchers affirm their commitment to ethical principles, including respecting participants' rights and dignity, ensuring confidentiality, and maintaining transparency and integrity throughout the study. The Author confirms that this manuscript has not been previously published and is not under consideration for publication elsewhere. The manuscript has been approved by all co-authors.

AI statement: The authors stated that they used AI-assisted language tools for proofreading and improving readability. The content, data analysis, and conclusions were produced and verified by the authors.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from corresponding author.

REFERENCES

Abebaw, W. A. (2019). Review on the role of integrated watershed management for the rehabilitation of degraded land in Ethiopia. *Journal of Biology, Agriculture and Healthcare*, *9*(11).

Abebe, A. M. (2022). Factors affecting the adoption of watershed management programs in Mirab-Abaya districts of Southern Ethiopia. *Journal of Agriculture and Horticulture Research, 5*(2), 122-130. https://doi.org/10.33140/JAHR.05.02.07

Abegaz, A., Abera, W., Jaquet, S., & Tamene, L. (2024). Adoption of climate-smart agricultural practices (CSAPs) in Ethiopia. *Climate Risk Management, 45*, Article 100628. https://doi.org/10.1016/jcrm.2024.100628

Addis, H. K., Abera, A., & Abebaw, L. (2020). Economic benefits of soil and water conservation measures at the sub-catchment scale in the northern highlands of Ethiopia. *Progress in Physical Geography*: *Earth and Environment, 44*(2). https://doi.org/10.1177/0309133319878118

Agidew, A.-m. A., & Singh, K. N. (2018). Factors affecting farmers' participation in watershed management programs in the Northeastern highlands of Ethiopia: A case study in the Teleyayen sub-watershed. *Ecological Processes, 7*, Article 15. https://doi.org/10.1186/s13717-018-0128-6

Asfew, M., Bakala, F., & Fite, Y. (2023). Adoption of soil and water conservation measures and smallholder farmers' perception in the Bench-Sheko Zone of Southwest Ethiopia. *Journal of Agriculture and Food Research*, *11,* Article 100512. https://doi.org/10.1016/j.jafr.2023.100512

Assefa, H., Tilahun, D. Y., & Feyisa, T. (2018). Integrated watershed intervention in improving livelihood and natural resource management in Western Amhara Region, Ethiopia. *RUFORUM Working Document Series, 17*(2), 244-254. http://repository.ruforum.org

Belachew, A., Mekuria, W., & Nachimuthu, K. (2020). Factors influencing adoption of soil and water conservation practices in the Northwest Ethiopian highlands. *International Soil and Water Conservation Research*, *8*(1), 80-89. https://doi.org/10.1016/j.iswcr.2020.01.005

Belay, T., & Lebeza, T. M. (2024). Livelihood vulnerability of rural households to climate variability and change: An agroecological system-based approach in northwestern Ethiopia. *Heliyon, 10*(23), Article e40570. https://doi.org/10.1016/j.heliyon.2024.e40570.

Belayneh, M. (2023). Factors affecting the adoption and effectiveness of soil and water conservation measures among smallholder rural farmers: The case of Gumara watershed. *Resources, Conservation & Recycling Advances, 18*, Article 200159. https://doi.org/10.1016/j.rcradv.2023.200159

Bouteska, A., Sharif, T., Bhuiyan, F., & Abedin, M. Z. (2024). Impacts of the changing climate on agricultural productivity and food security: Evidence from Ethiopia. *Journal of Cleaner Production, 449*, Article 141793. https://doi.org/10.1016/j.jclepro.2024.141793

Chot, G., Moges, A., & Shewa, A. (2019). Impacts of soil and water conservation practices on livelihood: The case of the watershed in Gambela region, Ethiopia. *African Journal of Environmental Science and Technology*, *13*(6), 241-252. https://doi.org/10.5897/AJEST2018.2643

Daniel, A., & Mulugeta, N. (2017). Factors influencing adoption of soil and water conservation practices: The case of Wereillu Woreda (district), South Wollo Zone, Amhara Region, Ethiopia. *International Soil and Water Conservation Research, 5*(4), 273-279. https://doi.org/10.1016/j.iswcr.2017.10.002

Debisa, A., Regasa, T., & Mammo, S. (2025). Effects of physical soil and water conservation structures and slope gradients on selected soil properties in Ijara watershed, Nonno district, West Shewa, Ethiopia. *Discover Sustainability, 6*, Article 147. https://doi.org/10.1007/s43621-025-00935-1

Demissie, Y., Assefa, A.-m., Addis, M., & Payne, W. A. (2024). Assessing the impact of productive safety net program on soil and water conservation practices in the Amhara Sayint Woreda, Ethiopia. *Agriculture, 14*(10), Article 1818. https://doi.org/10.3390/agriculture14101818

Dessalegn, A., & Abebe, E. (2016). Determinants of rural household livelihood diversification strategy in South Gondar Zone, Ethiopia. 548-560.

Dessie, T. A., Getahun, A. A., & Guadie, Y. w. (2025). Farmers willingness to participate in integrated watershed management practice in North West Ethiopia using logistic regression model approach. *Scientific Reports, 15*(1), Article 27131. https://doi.org/10.1038/s41598-025-09837-8

Dufera, B., Dube, D., & Aschalew, A. (2020). Socio-economic impacts and factors affecting the adoption of watershed management practices between the treated and untreated micro-watersheds in the Chirachasub-Watershed of Ethiopia. *PalArch's Journal of Archaeology of Egypt/ Egyptology, 17*, Article 4528.

FDRE. (2017). *The 2017 voluntary national reviews on SDGs of Ethiopia: Government commitments, national ownership and performance trends*. National Planning Commission. https://planipolis.iiep.unesco.org/en/2017/2017-voluntary-national-reviews-SDG-ethiopia-government-commitments-national-ownership

Fekadu, A., Yohannes, H., & Abera M. (2024). Economic analysis of integrated watershed management practices, the case of Horuwwa watershed in Gombora district, Central Ethiopia. *International Journal of Biosciences,* 2222-5234.

Fenta, A. A., Tsunekawa, A. Haregeweyn, N., Tsubo, M., Yasuda, H., Kawai, T., Ebabu, K., Berihun, M. L., Belay, A. S., & Sultan, D. (2021). Agoecology-based soil erosion assessment for better conservation planning in Ethiopian river basins. *Environmental Research*, *195,* Article 110786. https://doi.org//10.1016/j.envres.2021.110786

Gashu, K., & Muchie, Y. (2018). Rethink the interlink between land degradation and the livelihood of rural communities in Chilga district, Northwest Ethiopia. *Journal of Ecology and Environment*, *42*, Article 17. https://doi.org/10.1186/s41610-018-0077-0

Gebregziabher, G., Abera, D. A., Gebresamuel, G., Giordano, M., & Langan, S. (2016). *An assessment of integrated watershed management in* Ethiopia (IWMI working paper 170). International Water Management Institute. https://doi.org/10.5337/2016.214

Gemeda, F. T., Gemeda, B. S., & Sori, T. (2024). Watershed management in Ethiopia and its effects on soil quality and productivity. *European Journal of Sustainable Development Research, 8*(1), Article em0242. https://doi.org/10.29333/ejosdr/13890

Gobena, T., Bantider, A., Mulugeta, M., & Teferi, E. (2025). Scaling up community participation in watershed management for food security improvement: The case of Qarsa woreda, East Haraghe zone, Ethiopia. *F1000Research*. https://doi.org/10.12688/f1000research.153669.1

Habtu, S. (2023). *Revitalizing key conditions and integrated watershed management approach to sustain water availability and agriculture in Semi-Arid regions*. Qeios. https://doi.org/10.32388/6X185Z

Malede, D. A., Elumalai, V., Andualem, T. G., Mekonnen, Y. G., Yibeltal, M., Demeke, G. G., Alamirew, T., Kassaye, S. M., Hagos, Y. G., Kassie, A. E., Kassa, M., Berihun, G. S., & Ray, R. L. (2025). Understanding flood and drought extremes under a changing climate in the Blue Nile Basin: A review. *Environmental and Sustainability Indicators*, *26*, Article 100638. https://doi.org/10.1016/j.indic.2025.100638

Masha, M., Yirgu, T., & Debele, M. (2021). Impacts of soil and water management measures on crop production and farm income of rural households in the Damota area districts, southern Ethiopia. *International Journal of Agronomy, 2021*(1), Article 5526713. https://doi.org/10.1155/2021/5526713

Mazengiya, M. N. (2024). Review on the opportunities and challenges to implement climate smart agriculture practice in Ethiopia. *Discover Agriculture, 2,* Article 110. https://doi.org/10.1007/s44279-024-00118-y

Melese, M. (2022). Socio-economic impact of integrated watershed management practices, Case study at Korocho Watershed, Gibe District, Hadiya zone, Southern Ethiopia. *Journal of Biodiversity and Environmental Sciences,* 21(1), 83-95.

Melese, M., & Mulugeta, A. (2022). The role of participatory watershed management practices for sustainable rural livelihood improvement in Handosha Watershed, Gibe District, Southern Ethiopia. *Journal of Biodiversity and Environmental Sciences, 21*(5), 198-216.

Mena, M. M., Madalcho, A. B., & Dana, D. (2017). Integrated watershed management for ecosystem balance & climate change: Ethiopia. *Civil and Environmental Research*, *9*(9), 1-12.

Mengist, W., Soromessa, T., & Legese, G. (2020). Method for conducting systematic literature review and meta-analysis for environmental science research. *MethodsX, 7*, Article 100777. https://doi.org/10.1016/j.mex.2019.100777

Mengistu, F., & Assefa, E. (2019). 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

Mengistu, F., & Assefa, E. (2020). Towards sustaining watershed management practices in Ethiopia: A synthesis of local perception, community participation, adoption and livelihoods. *Environmental Science and Policy*, *112*, 414-430. https://doi.org/10.1016/j.envsci.2020.06.019

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

Mera, G. A. (2018). Drought and its impacts in Ethiopia. *Weather and Climate Extremes, 22*, 24-35. https://doi.org/10.1016/j.wace.2018.10.002

Mideksa, B., Muluken, G., & Eric, N. (2023). The impact of soil and water conservation practices on food security in eastern Ethiopia. A propensity score matching approach. *Agricultural Water Management, 289*, Article 108510. https://doi.org/10.1016/j.agwat.2023.108510

Moges, D. M., & Bhat, H. G. (2020). Watershed degradation and management practices in north-western highland Ethiopia. *Environmental Monitoring and Assessment*, *192*, Article 664. https://doi.org/10.1007/s10661-020-08628-0

Mosissa, D., Mohammed, A., & Tesfaye, Y. (2019). The effectiveness of soil and water conservation as climate smart agricultural practice and its contribution to smallholder farmers' livelihoods. The case of Bambasi district Benishangul Gumuz Regional State, Northwest of Ethiopia. *World Journal of Agriculture and Soil Science*, *2*(4). https://doi.org/10.33552/WJASS.2019.02.000542

Muche, A. T., Ketsela, Y. S., & Ali, B. M. (2024). Assessing the effectiveness of integrated watershed management practices and suggesting innovative strategies in southern Ethiopia. *Heliyon, 10*(19), Article e38619. https://doi.org/10.1016/j.heliyon.2024.e38619

Naji, T. A., Teka, M. A., & Alemu, E. A. (2024a). Enhancing watershed management in developing countries: Insights from Ethiopia. *Discover Sustainability, 5*, Article 131. https://doi.org/10.1007/s43621-024-00334-y

Naji, T. A., Teka, M. A., & Alemu, E. A. (2024b). The impact of watershed on household food security: A comparative analysis. *Journal of Agriculture and Food Research, 15*, Article 100954. https://doi.org/10.1016/j.jafr.2023.100954

Providoli, I., Zeleke, G., Kiteme, B., Bantider, A., & Mwangi, J. (Eds.). (2019). *Shaping sustainable socio-ecological landscapes in Africa: The role of transformative research, knowledge, and partnerships*. Centre for Development and Environment (CDE), University of Bern, with Bern Open Publishing (BOP). https://doi.org/10.7892/boris.125341

Sherka, T. D. (2023). Factors affecting women's participation in soil & water conservation in Abeshege district Southern Ethiopia. *Cogent Economics & Finance, 11*(1), Article 2192455. https://doi.org/10.1080/23322039.2023.2192455

Sileshi, M., Kadigi, R., Mutabazi, K., & Sieber, S. (2019). Determinants for the adoption of physical soil and water conservation measures by smallholder farmers in Ethiopia. *International Soil and Water Conservation Research, 7*(4), 354-361. https://doi.org/10.1016/j.iswcr.2019.08.002.

Tadesse, A., & Hailu, W. (2024). Causes and consequences of land degradation in Ethiopia: A review. *International Journal of Science and Qualitative Analysis,* 10(1), 10-21. https://doi.org/10.11648/j.ijsqa.20241001.12

Takele, A., Berhanu, A., Wondimagegnhu, B. A., & Ebistu, T. A. (2023). The impact of watershed development on the food security status of farm households: Evidence from Northwest Ethiopia. *Cogent Economics & Finance*, *11*(2), Article 2288466. https://doi.org/10.1080/23322039.2023.2288466

Teka, K., Haftu, M., Ostwald, M., & Cederberg, C. (2020). Can integrated watershed management reduce soil erosion and improve livelihoods? A study from northern Ethiopia. *International Soil and Water Conservation Research, 8*(3), 266-276. https://doi.org/10.1016/j.iswcr.2020.06.007

Teketay, D. (2001). Deforestation, wood famine, and environmental degradation in Ethiopia's highland ecosystems: Urgent need for action. *Northeast African Studies, 8*(1), 53-76. https://doi.org/10.1353/nas.2005.0020

Teku, D., & Derbib, T. (2025). Uncovering the drivers, impacts, and urgent solutions to soil erosion in the Ethiopian Highlands: A global perspective on local challenges. *Frontiers in Environmental Science, 12*. https://doi.org/10.3389/fenvs.2024.1521611

Teressa, D. (2020). Community participation on watershed management programme. The case of Gemechis district, Oromia, Ethiopia. *Civil Engineering and Environmental Systems, 10*(9), 10-17.

Tesfahun, T., Abegaz, A., & Abate, E. (2024). A quantitative analysis on the adoption of soil, water, and forest conservation technologies in the upper Gelana watershed, Northeast Ethiopian highlands. *Heliyon, 10*(17), Article e36794. https://doi.org/10.1016/j.heliyon.2024.e36794

Tesfaye, A., Radeny, M., Ogada, M. J., Recha, J. W., Ambaw, G., Chanana, N., Huyer, S., Demeke, G., & Solomon, D. (2023). Gender empowerment and parity in East Africa: Evidence from climate-smart agriculture in Ethiopia and Kenya. *Climate and Development, 15*(9), 768-778. https://doi.org/10.1080/17565529.2022.2154124

Teshome, A., de Graaff, J., & Kassie, M. (2016). Household-level determinants of soil and water conservation adoption phases: Evidence from North-Western Ethiopian highlands. *Environmental Management, 57*, 620-636. https://doi.org/10.1007/s00267-015-0635-5

Tewodros, T., Girmay, T., Eyasu, E., Mulugeta, D., & Irene K. (2016). Drivers for adoption of agricultural technologies and practices in Ethiopia A study report from 30 woredas in four regions.

Thapa, P. S., Chaudhary, S., & Dasgupta, P. (2022). Contribution of integrated watershed management (IWM) to disaster risk reduction and community development: Lessons from Nepal. *International Journal of Disaster Risk Reduction, 76*. Article 103029. https://doi.org/10.1016/j.ijdrr.2022.103029

Tilahun, A., Mezegebu, G., Anantha K., Garg, K. K., & Barro, J. (2023). Scaling-up water management interventions for rain-fed agriculture in the Ethiopian highlands: Status, issues, and opportunities. In *Rainfed systems intensification and scaling of water and soil management: Four case studies of development in family farming* (pp. 79-98). ICRISAT.

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, 967-994. https://doi.org/10.1007/s11676-016-0293-3

Wassie, S. B. (2020). Natural resource degradation tendencies in Ethiopia: A review. *Environmental Systems Research, 9*, Article 33. https://doi.org/10.1186/s40068-020-00194-1

Wolancho, K. (2015). Evaluating watershed management activities of campaign work in Southern nations, nationalities and peoples' regional state of Ethiopia. *Environmental Systems Research, 4*, Article 6. https://doi.org/10.1186/s40068-015-0029-y

Woldearegay, K., Grum, B., Hessel, R., van Steenbergen, F., Fleskens, L., Yazew, E., Tamene, L., Mekonnen, K., Reda, T., & Haftu, M. (2023). Watershed management, groundwater recharge and drought resilience: An integrated approach to adapt to rainfall variability in northern Ethiopia. *International Soil and Water Conservation Research*, *12*(3), 663-683. https://doi.org/10.1016/j.iswcr.2023.08.009

Wolka, K., Uma, T., & Tofu, D. A. (2023). The role of integrated watershed management in climate change adaptation for small-scale farmers in Southwest Ethiopia. *Environmental and Sustainability Indicators*, *19*, Article 100260. https://doi.org/10.1016/j.indic.2023.100260

Wordofa, M. G., Okoyo, E. N., & Erkalo, E. (2020). Factors influencing adoption of improved structural soil and water conservation measures in Eastern Ethiopia. *Environmental Systems Research, 9*(1), Article 13. https://doi.org/10.1186/s40068-020-00175-4

Xing, Y., Zhang, X., & Wang, X. (2024). Enhancing soil health and crop yields through water-fertilizer coupling technology. *Frontiers in Sustainable Food Systems, 8*. https://doi.org/10.3389/fsufs.2024.1494819

Yang, Y., Wu, J., Du, Y., Gao, C., Tang, D., & Ploeg, M. (2022). Effect on soil properties and crop yields to long-term application of superabsorbent polymer and manure. *Frontiers in Environmental Science, 10*. https://doi.org/10.3389/fenvs.2022.859434

Yericho, M., & Belay, S. (2015). Assessment of the effectiveness of watershed management intervention in Chena Woreda, Kaffa Zone, Southwestern Ethiopia.

Yifru, G. S., & Miheretu, B. A. (2022). Farmers 'adoption of soil and water conservation practices: The case of Lege-Lafto watershed, Dessie Zuria district, South Wollo, Ethiopia. *PLoS ONE, 17*(4), Article e0265071. https://doi.org/10.1371/journal.pone.0265071

Yigezu, G. W. (2021). The challenges and prospects of Ethiopian agriculture. *Cogent Food & Agriculture, 7*(1), Article 1923619. https://doi.org/10.1080/23311932.2021.1923619

Zerssa, G., Feyssa, D., Kim, D.-G., & Eichler-Löbermann, B. (2021). Challenges of smallholder farming in Ethiopia and opportunities by adopting climate-smart agriculture. *Agriculture, 11*(3), Article 192. https://doi.org/10.3390/agriculture11030192

APPENDIX

Table 1A. Selected articles with with description of study area, sample size,journal name and year of publication

Title	Study area	Sample size	Journal	Authors, year
The role of integrated watershed management in climate change adaptation for small-scale farmers in Southwest Ethiopia	South	255	Environmental and Sustainability Indicators	Wolka et al., 2023
Impacts of soil and water management measures on crop production and farm income of rural households in the Damota Area Districts, Southern Ethiopia	South	378	International Journal of Agronomy	Masha et al., 2021
Review on the opportunities and challenges to implement climate smart agriculture practice in Ethiopia	Ethiopia	NA	Discover Agriculture	Mazengiya, 2024
Integrated Watershed Management for Ecosystem Balance & Climate Change: Ethiopia	Ethiopia	NA	Civil and Environmental Research	Mena et al., 2017
Scaling-up water management interventions for rainfed agriculture in the Ethiopian Highlands: Status, issues, and opportunities	Eth	NA	Ecological Processes	Tilahun et al., 2023
Adoption of soil and water conservation measures and smallholder farmers' perception in the Bench-Sheko Zone of Southwest Ethiopia	South	423	Journal of Agriculture and Food Research	Asfew et al., 2023
Watershed degradation and management practices in north-western highland Ethiopia	Amhara	210	Environ Monit Assess	Moges & Bhat, 2020
Factors influencing adoption of improved structural soil and water conservation measures in Eastern Ethiopia	Oromiya	120	Environmental system research	Wordofa et al., 2020
Revitalizing Key Conditions and Integrated Watershed Management Approach to Sustain Water Availability and Agriculture in Semi-Arid Regions	Ethiopia	NA	Qeios	Habtu, 2023
Level of communities' participation in watershed development and management practices in the Central Highlands of Ethiopia	Oromiya	1636	Review of Socio-Economic Research and Development Studies	Naji et al., 2024
Factors affecting the adoption and effectiveness of soil and water conservation measures among small-holder rural farmers: The case of Gumara watershed	Amhara	NA	Resources Conservation & Recycling Advances	Belayneh, 2023
Challenges of smallholder farming in Ethiopia and opportunities by adopting climate-smart agriculture	Ethiopia	246	Agriculture	Zerssa et al., 2021
Scaling up community participation in watershed management for food security improvement: the case of Qarsa woreda, East Haraghe zone, Ethiopia	Oromiya	337	F1000Research	Gobena et al., 2025
The impact of watershed development on food security status of farm households: Evidence from Northwest Ethiopia	Amhara	216	Cogent Economics & Finance	Takele et al., 2023
Socio-economic impact of integrated watershed management practices, Case study at Korocho Watershed, Gibe District, Hadiya zone, Southern Ethiopia	South	82	Journal of Biodiversity and Environmental Sciences	Melese, 2022
Economic Analysis of Integrated Watershed Management Practices, the case of Horuwwa Watershed in Gombora District, Central Ethiopia	South	117	International Journal of Biosciences	Fekadu et al., 2024
Assessment of the Effectiveness of Watershed Management Intervention in Chena Woreda, Kaffa Zone, Southwestern Ethiopia	South	200	Journal of Water Resource and Protection	Yericho & Belay, 2015
The impact of soil and water conservation practices on food security in eastern Ethiopia. A propensity score matching approach	Oromiya	250	Agricultural Water Management	Mideksa et al., 2023
Economic benefits of soil and water conservation measures at the sub-catchment scale in the northern Highlands of Ethiopia	Amhara	27 data points	Progress in Physical Geography	Addis et al., 2020
Factors affecting women's participation in soil & water conservation in abeshege district Southern Ethiopia	South	234	Cogent Economics & Finance	Sherka, 2023
Factors influencing adoption of soil and water conservation practices in the northwest Ethiopian highlands	Amhara	150	International Soil and Water Conservation Research	Belachew et al., 2020