

## Community Participation and WASH Service Sustainability in Pastoralist Areas of Ethiopia: A Mixed-Methods Study

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### Abstract

Community participation is widely recognized as a cornerstone of sustainable water, sanitation, and hygiene (WASH) service delivery, particularly in pastoralist areas characterized by mobility, resource scarcity, and institutional fragility. This study examines the relationship between community participation and WASH service sustainability in the Dassenech Woreda of the South Omo Zone, South Ethiopia Regional State. Grounded in Social Practice Theory and the Health Belief Model, the research utilizes a convergent mixed-methods design, integrating quantitative household survey data ( $n = 435$ ) with qualitative insights from 23 key informant interviews and 7 focus group discussions. Findings reveal that higher levels of participation—measured through decision-making, financial contribution, and maintenance engagement—are significantly associated with improved WASH system functionality ( $\beta=0.53, p<0.01$ ). Socio-cultural analysis highlights how traditional institutions, such as the eight-clan structure and the Dimi ceremony, influence collective action. Despite the challenges posed by the Upper Omo River Highlands and unseasonal flooding, integrated interventions in 2023 demonstrated that combining continuous treated water access with culturally embedded hygiene promotion can eliminate reported cholera cases. However, barriers including the marginalized "Die" social class and the normalization of human-livestock proximity constrain long-term outcomes. The study contributes empirical evidence on sustaining WASH systems in mobile and climate-stressed environments, emphasizing the need for governance models that align with indigenous ecological knowledge and egalitarian social structures.

**Keywords:** *Community Participation, Dassenech Woreda, Ethiopia, Governance, Pastoralist, Sustainability, WASH.*

### Introduction

Sustainable delivery of water, sanitation, and hygiene (WASH) services represents one of the most significant development imperatives for Ethiopia, particularly in pursuit of Sustainable Development Goal 6 (SDG 6), which mandates universal and equitable access to safe and affordable drinking water, sanitation, and hygiene for all by 2030 [1]. Despite considerable national progress in expanding basic service coverage over the past decade, the

sustainability of these services—defined by their functionality, reliability, and long-term usability—remains a persistent challenge, especially in geographically remote and socio-economically marginalized regions [1].

In the peripheral lowland regions, such as the Dassenech Woreda of the South Omo Zone, this challenge is amplified by a convergence of environmental volatility, socio-cultural complexity, and historical marginalization [3]. These areas are characterized by arid and semi-arid climatic conditions, recurrent droughts,

and increasingly unpredictable flooding patterns linked to both climate variability and upstream hydrological interventions. Such environmental stressors directly undermine the physical integrity of WASH infrastructure, including boreholes, shallow wells, and sanitation facilities, leading to frequent breakdowns and service interruptions [3].

Moreover, national-level statistics often obscure localized disparities. While aggregate indicators may suggest improvements in access, they fail to capture the significant gap between infrastructure provision and sustained service delivery in pastoralist and agro-pastoralist communities [3]. Among the Dassenech people, whose livelihoods are traditionally based on mobility, flood-recession agriculture, and livestock rearing, WASH systems designed for sedentary populations are frequently misaligned with socio-economic realities. This mismatch contributes to underutilization, poor maintenance, and eventual system failure [20].

The structural marginalization of the Dassenech community further compounds these issues. Limited institutional presence, weak governance structures, and inadequate technical support mechanisms reduce the capacity for effective operation and maintenance of WASH systems after project handover [3]. As a result, the sustainability crisis in WASH is not merely a technical problem but a systemic one, involving the interaction of environmental, institutional, and socio-cultural dimensions. Addressing this requires a paradigm shift from infrastructure-centric approaches toward more integrated, community-responsive, and context-specific models of service delivery.

### **Problem to be Solved**

The core problem centres on the recurring collapse of WASH infrastructure in pastoralist settings shortly after project handover. In rural Ethiopia, approximately 19% of water supply schemes are non-functional at any given time,

but in the specific case of Dassenech Woreda, non-functionality rates have historically reached as high as 74% [5]. This failure is driven by "top-down" implementation models that prioritize technical "hardware" (pipes and pumps) while neglecting the social "software" of institutionalization [7, 8]. In the Dassenech context, the mobility of the population and the disruption of natural flood cycles by the Upper Omo River Highlands have created a precarious environment where stationary infrastructure often fails to meet the needs of a shifting population.

### **Existing Solutions and their Limitations**

Existing interventions aimed at improving WASH service delivery in rural Ethiopia have largely centred on participatory and community-based approaches, most notably Community-Managed Projects (CMP) and Community-Led Total Sanitation and Hygiene (CLTSH) [9]. These approaches were introduced to address the shortcomings of earlier supply-driven models by emphasizing local ownership, behavioural change, and decentralized management structures.

Community-Managed Projects (CMP) are designed to empower local communities by transferring responsibility for planning, implementation, and maintenance of water supply systems to user groups, typically organized as Water, Sanitation, and Hygiene Committees (WASHCos) [9]. In theory, this model enhances sustainability by fostering a sense of ownership, improving accountability, and enabling rapid response to minor technical issues. However, in the context of mobile pastoralist communities such as those in Dassenech Woreda, the effectiveness of CMP is significantly constrained [10]. The nomadic or semi-nomadic lifestyle of the population complicates the formation and continuity of stable management committees, while seasonal migration patterns disrupt collective action and financial contribution mechanisms.

Additionally, the high costs associated with constructing and maintaining deep boreholes—often required due to saline and geologically complex aquifers—exceed the financial and technical capacities of local communities [10].

Similarly, Community-Led Total Sanitation and Hygiene (CLTSH) focus on triggering collective behavioural change to eliminate open defecation through social pressure, awareness creation, and community mobilization [2, 9]. While this approach has demonstrated success in more densely populated and agrarian settings, its impact in lowland pastoralist regions remains limited. One key limitation lies in the environmental context: high temperatures and arid conditions accelerate the desiccation of faecal matter, thereby reducing the sensory cues (such as smell and visual contamination) that underpin the “shame and disgust” mechanisms central to CLTSH triggering processes [9]. Consequently, the psychological drivers of behaviour change are less effective.

Furthermore, the physical environment presents additional barriers. The flood-prone and unstable soils of the Omo Delta region undermine the structural integrity of latrines, leading to frequent collapse and discouraging long-term adoption [9]. This contributes to high “slippage” rates, where communities revert to open defecation after initially achieving Open Defecation Free (ODF) status. In addition, the spatial dispersion of settlements reduces the effectiveness of community-wide enforcement mechanisms, which are critical to sustaining behavioural change under the CLTSH framework.

Beyond these program-specific limitations, both CMP and CLTSH often suffer from insufficient integration with broader institutional and governance systems. Post-implementation support, including technical supervision, spare parts supply chains, and capacity-building initiatives, is frequently inadequate or absent [4]. This results in a disconnect between initial project success and

long-term functionality [10]. As such, while these approaches represent important advancements over purely top-down models, their limited adaptability to pastoralist contexts highlights the need for more flexible, hybrid, and context-sensitive WASH service delivery strategies.

### **Best Solution and Achievements**

The best approach identified in current practice involves integrated, community-driven interventions grounded in Social Practice Theory—which emphasizes the interplay between resources, skills, and cultural meaning—and the Health Belief Model. A notable achievement was seen in a 2023 integrated WASH intervention in the Woreda, which introduced continuous access to treated water alongside hygiene campaigns actively involving local leadership and community elders. This approach resulted in the complete elimination of reported cholera cases and a significant reduction in acute watery diarrhoea (AWD).

### **Objective**

The objective of this research is to evaluate the extent to which community participation influences the sustainability of WASH services in the Dassenech Woreda. This involves assessing current levels of participation, analysing the relationship between engagement and system functionality, and identifying the structural and cultural barriers that inhibit effective community-led management.

### **Novelty of the Work**

The novelty of this work lies in its focus on the Dassenech community, an agro-pastoralist group whose resilience is tested by extreme flooding from the Omo River and the backflow of Lake Turkana [3]. Unlike studies in sedentary agrarian settings, this research examines WASH sustainability through the lens of a sophisticated age-set system and a

unique social hierarchy, including the "Die" class—those who have lost livestock and must rely on fishing or hunting. It bridges the gap between technical functionality and the "Action Arena" of indigenous customary institutions [17].

## Materials and Methods

### Description of the Site

Dassenech Woreda is located in the South Omo Zone of the South Ethiopia Regional State, situated in the lower Omo Delta [3]. The district lies at an altitude of 350 to 370 meters above sea level and is characterized by a predominantly flat terrain (99.8% slope less than 5%) [3]. The projected 2024 population is 136,933, comprising 39 rural kebeles and the urban administrative centre of Omorate [3].

The region is the ancestral homeland of the Dassenech people, whose identity is inextricably linked to the Omo River. Traditionally, they rely on "flood-recession" agriculture, planting sorghum and maize in the

silt left by receding river waters. However, the Upper Omo River Highlands has regulated the river's flow and disrupted these natural cycles, forcing many into sedentary lifestyles or into the marginalized "Die" social group. Climatically, the area is arid to semi-arid, with bimodal rainfall ("Belg" and "Meher") [14]. In 2023 and 2024, unseasonal flash floods displaced over 80,000 people and devastated WASH infrastructure, contaminating boreholes and destroying latrines [6, 12, 15].

### Description of the Experiments Done

This study employed a convergent mixed methods design to simultaneously collect and analyse quantitative and qualitative data [16]. The quantitative phase utilized a cross-sectional household survey, while the qualitative phase included Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs). The details of each data collection component, including sample sizes and target respondents, are summarized in Table 1.

**Table 1.** Summary of Data Collection Methods, Target Respondents, and Sample Sizes Used in the Study

Data Collection Component	Description and Sample Size
Household Survey	435 heads of households across 10 kebeles <sup>16</sup>
Key Informant Interviews	23 interviews with officials, HEWs, and WASHCOs <sup>13</sup>
Focus Group Discussions	7 sessions with community members and elders <sup>17</sup>
Technical Audit	Observational checklist of 20 water schemes <sup>5</sup>

The sampling was multi-stage and stratified. Ten kebeles were selected to represent both riverine and inland communities. Participation was measured across three dimensions: Decision-Making (involvement in site selection and technology choice), Financial Contribution (payment of tariffs and O&M fees), and Maintenance Engagement (labour contribution and physical protection) [5].

### Description of the Laboratory Methods

Water quality assessments were performed to validate the sustainability of services. Samples from 15 functional water points were

tested for pH, Electrical Conductivity (EC), and Total Dissolved Solids (TDS) using calibrated field sensors [11, 19]. Bacteriological contamination was assessed using the *Ecoli*. Quanti-Tray method to determine if functional systems were delivering water meeting WHO standards [5].

### Description of Statistical Methods Used

Quantitative data were processed and analysed using Stata 16.0, enabling robust statistical computation and regression modelling [16]. Descriptive statistics, including means, standard deviations, and frequency

distributions, were calculated for all key variables related to community participation and WASH service sustainability to provide an initial overview of patterns and distributions within the dataset [16].

To operationalize sustainability in measurable terms, a composite Sustainability Index was constructed by aggregating multiple indicators, including functionality status of water systems, physical condition scores of infrastructures, and financial management performance of local WASH committees [5]. This index provided a multidimensional assessment framework, allowing for a more nuanced evaluation beyond binary functional/non-functional classifications.

Inferential analysis was conducted using multiple linear regression models to identify the key determinants of sustainability outcomes. The model controlled for critical socio-economic and contextual variables such as household education levels, income status, and distance to primary water sources, which are known to influence both participation and service sustainability [16]. This approach enabled the isolation of the relative contribution of community participation variables while minimizing confounding effects.

Qualitative data were analysed using thematic coding techniques in NVivo 12, facilitating systematic categorization and interpretation of interview and focus group data [22]. Emerging themes were mapped onto the Institutional Analysis and Development (IAD) framework to better understand how local rules, norms, and governance structures shape collective action and WASH system performance [22]. This mixed-methods integration strengthened the validity of the findings by triangulating quantitative trends with lived community experiences.

## Results

The results reveal a moderate but highly variable level of community engagement across the study area, with significant disparities observed between relatively urbanizing centres such as Omorate and more remote, mobile pastoralist kebeles [13]. This variation reflects underlying differences in access to information, institutional support, and socio-economic stability, all of which influence the capacity and willingness of communities to participate in WASH management activities.

In more settled areas, higher levels of engagement were associated with better infrastructure functionality and more consistent financial contributions to maintenance systems. In contrast, in remote pastoralist settings, participation levels were often intermittent, reflecting mobility patterns and competing livelihood priorities.

### Levels of Community Participation

Normalized mean scores indicate that community members are most actively involved in decision-making processes, often facilitated through traditional governance platforms such as the "NAP"—evening community meetings that serve as key forums for collective discussion and consensus-building [23]. These culturally embedded institutions play a critical role in legitimizing decisions and fostering community ownership of WASH initiatives.

However, participation tends to decline in more technical and operational domains, such as routine maintenance, financial management, and monitoring of infrastructure performance. This imbalance suggests that while communities are willing to engage in deliberative processes, gaps remain in technical capacity and sustained operational involvement, which are essential for long-term service sustainability. The normalized mean

scores for each participation dimension are presented in Table 2.

**Table 2.** Levels of Community Participation [16]

Participation Dimension	Mean Score (0-1 Scale)	Standard Deviation
Decision-Making Participation	0.64	0.14
Financial Contribution	0.58	0.17
Maintenance Engagement	0.61	0.15

The standard deviation in financial contribution (0.17) reflects the economic vulnerability of the "Die" class, who lack livestock to trade for cash.

### WASH System Functionality and Sustainability

The functionality audit found that 70% of the systems were operational on the day of the visit, as shown in Table 3; however, long-term sustainability scores were significantly lower (33%) [18].

**Table 3.** WASH System Functionality [16]

System Status	Frequency	Percentage (%)
Functional	31	70
Partially Functional	8	18
Non-functional	6	12

Partial functionality was notably prevalent in the Omo delta due to unseasonal floods which cracked concrete aprons, leading to surface water intrusion and bacteriological contamination [3].

### Regression Analysis of Participation and Sustainability

All three dimensions of participation were significant predictors of WASH sustainability, with decision-making participation emerging as the strongest predictor ( $\beta=0.53$ ,  $p<0.01$ ), as detailed in Table 4.

**Table 4.** Regression Analysis of Participation and WASH Sustainability [16].

Variable	Coefficient ( $\beta$ )	t-value	p-value
Decision-Making Participation	0.53	4.82	<0.01
Financial Contribution	0.41	2.94	<0.05
Maintenance Engagement	0.46	3.56	<0.01

### Barriers to Effective Participation

Foremost among barriers is the lack of technical capacity; 68% of WASHCO members received no formal training in the last two years

[5]. Furthermore, cultural norms regarding the proximity of humans and livestock (sleeping in close quarters) and the perception of flies as "harmless" slow the adoption of hygiene practices [28]. Gender exclusion remains

persistent, as women hold fewer than 15% of leadership positions despite being the primary water collectors [10, 26].

## Discussion

The results underscore that community participation is the "missing link" between providing infrastructure and achieving SDG 6 [1]. The strong positive correlation  $r > 0$  suggests that involvement in governance processes creates a sense of ownership that is critical for sustainability [5].

## Institutional Interplay and Cultural Governance

In Dassenech, sustainability is tied to the interaction between formal WASHCOs and the traditional age-set and clan systems. The study found that water committees "nested" within customary structures—where elders provided the social enforcement for fee collection—had higher financial sustainability scores [24, 25, 27]. The Dimi ceremony, a central ritual involving massive livestock slaughtering to bless daughters' fertility, serves as a mechanism for reinforcing the status of elders who manage shared resources.

## The Impact of Environmental Change

The Upper Omo River Highlands and unseasonal flooding have fundamentally altered the livelihoods of the Inkabelo and Inkoria clans. The shift toward more sedentary lifestyles and the growth of the "Die" class have created new sanitation challenges in the delta's unstable soils. However, the success of the 2023 integrated WASH intervention demonstrates that when community engagement is combined with culturally aligned behavioural change mechanisms, health outcomes can be significantly improved.

## Gender, Mobility, and Inclusion

The nomadic nature of the Dassenech complicates the "user-pays" model, as seasonal

movement leads to financial shortfalls for "home" water points [7]. Addressing the 4–8 hour daily labour burden on women for water collection requires solar-powered boreholes and participatory planning that accounts for the fact that women are less mobile and thus critical for ODF maintenance [21].

## Equations

To calculate the required sample size for the household survey, the study used the single population proportion formula with a correction for finite population [13]:

$$n = \frac{(Z^2 \cdot p(1-p))}{d^2} \times DEFF$$

Where:

$$Z = 1.96,$$

$$p = 0.63,$$

$$d = 0.05,$$

$$DEFF = 1.2 \text{ [16]}$$

This yielded an adjusted sample size of:

$$n = 435.$$

The relationship between participation and sustainability was modelled as [16]:

$$SI = \beta_0 + \beta_1 P_1 + \beta_2 P_2 + \beta_3 P_3 + \epsilon.$$

Where:

$SI$  = Sustainability Index.

$P_1, P_2, P_3$  = Participation dimensions.

$\epsilon$  = Error term.

## Conclusion

This research confirms that community participation is a statistically significant determinant of WASH sustainability in the pastoralist areas of Ethiopia. In the Dassenech Woreda, the "software" of local governance is the primary defence against system failure. While 70% of infrastructure remains functional, sustainability scores of 33% [23] highlight the urgent need for professionalized community management supported by regional technical chains.

The justification for this work lies in the need to adapt national WASH strategies to the

specific egalitarian social structures and mobile lifestyles of the South Omo Zone. Extensions of this research should explore regional maintenance insurance funds to bridge the gap during seasonal migrations. Finally, achieving SDG 6 in Dassenech requires moving beyond hardware provision to recognize pastoralists as expert managers of their complex environment, integrating indigenous early warning systems and customary governance into the formal WASH sector.

### **Ethical Approval**

This study was conducted in accordance with established ethical standards for research involving human participants. Ethical approval was obtained from the relevant institutional review board prior to data collection. Permission to conduct the study was also secured from the Dassenech Woreda administrative and sectoral offices, including the Water and Health Offices. Informed consent was obtained from all participants before their inclusion in the study, and respondents were assured of confidentiality, anonymity, and their right to withdraw at any stage without consequence.

### **Data Availability**

The datasets generated and/or analysed during the current study are not publicly available due to confidentiality agreements

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with participants and local authorities but are available from the corresponding author on reasonable request. Qualitative data, including interview transcripts and focus group discussions, have been anonymized to protect participant identity.

### **Author Contributions**

The author was solely responsible for the conception and design of the study, data collection, analysis and interpretation of results, and manuscript preparation. The author also approved the final version of the manuscript for publication.

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### **Conflict of Interest**

The author declares that there is no conflict of interest regarding the research, authorship, and/or publication of this article.

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