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184

Gender Dimensions of Community-based Groundwater Governance in Ethiopia: Using Citizen Science as an Entry Point

Likimyelesh Nigussie, Jennie Barron, Alemseged Tamiru Haile, Nicole Lefore and John Gowing

IWMI International Water Management Institute

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Nigussie, L.; Barron, J.; Haile, A. T.; Lefore, N.; Gowing, J. 2018. *Gender dimensions of community-based groundwater governance in Ethiopia: using citizen science as an entry point.* Colombo, Sri Lanka: International Water Management Institute (IWMI). 24p. (IWMI Working Paper 184). doi: 10.5337/2018.222

/ gender / groundwater management / groundwater development / water governance / water security / water resources / water management / water availability / water use / community involvement / citizen participation / participatory approaches / monitoring / role of women / women's participation / equity / empowerment / sustainability / decision making / natural resources management / wells / Ethiopia /

ISSN 2012-5763
e-ISSN 2478-1134
ISBN 978-92-9090-873-9

Please direct inquiries and comments to: *IWMI-Publications@cgiar.org*

A free copy of this publication can be downloaded at www.iwmi.org/publications/iwmi-working-papers

Acknowledgements

The authors would like to thank all the people in Dangeshta and Farawocha *kebeles*, who participated in the study and shared their views and experiences with us. We would also like to acknowledge the contribution of Dawit Bunduro from Boloso Bombe *Woreda* Agriculture and Natural Resources Development Office and Addisu Mulu from Dangila *Woreda* Agriculture and Natural Resources Development Office for their support in the field research conducted in Ethiopia.

Project

This paper is an output from the REACH program funded by the UK Department for International Development (DFID) for the benefit of developing countries (Aries Code 201880).

Collaborators

International Water Management Institute (IWMI)

Newcastle University, UK

Donors

REACH Program, Oxford University, UK

UK Department for International Development (DFID)
The views expressed and information contained in this Working Paper are not necessarily those of or endorsed by DFID, which can accept no responsibility for such views or information or for any reliance placed on them.

This research was carried out as part of the CGIAR Research Program on Water, Land and Ecosystems (WLE) and supported by CGIAR Trust Fund Donors (https://www.cgiar.org/funders/).

Contents

Executive Summary

Understanding the gender dimensions of community-based groundwater governance is important because men and women differ in (i) their needs, level of access to and benefits from having access to groundwater; (ii) their participation in groundwater management and development; and (iii) their willingness to participate in groundwater monitoring. Women play a leading role in obtaining and safeguarding water. However, this role is not usually reflected in the institutional arrangements for water management. Addressing the gender inequality in groundwater governance could lead to equal participation of men and women in groundwater monitoring, women's empowerment and the sustainability of groundwater management. Participation by men and women in groundwater management would also give them the opportunity to explore, learn and share information about groundwater, which is critical for sustainability.

This paper explores gender aspects of community-based groundwater governance in Dangeshta and Farawocha *kebeles* in Dangila and Boloso Bombe *woredas*, respectively, in Ethiopia. Data and information were collected through a literature review, in-depth discussions with key informants at the *woreda* level, separate household interviews with spouses, and focus group discussions with men's and women's groups in the communities. The findings suggest that women place a high value on groundwater and could be motivated to play a greater role in governance of the resource. However, the constraints that women face in participating in groundwater development and management, particularly exclusion from decision-making, suggest that their effective participation and leadership could be significantly curtailed without specific interventions. Indeed, this is reflected in women's willingness to participate in groundwater monitoring, as well as men's reluctance to allow their wives to participate. This is in contrast to a high number of men willing to participate.

Citizen science as an entry point for community-based groundwater governance relies on (i) the active involvement of myriad actors (including men and women citizens) whose actions interact with the hydrological processes; and (ii) volunteer interest (i.e., willingness to participate). A gender-sensitive approach to programs, gender awareness training, and partnerships with organizations working for women's empowerment, natural resource management and adult literacy are recommended to support a citizen science approach to groundwater monitoring.

INTRODUCTION

Sustainable and equitable groundwater use, achieved through monitoring, management and governance using integrated and precautionary approaches, can play a critical role in achieving multiple development objectives. In the context of the United Nations Sustainable Development Goals (SDGs), groundwater is most explicitly linked to ensuring the availability and sustainable management of water and sanitation for all (SDG 6). Yet, groundwater use can also directly contribute to poverty eradication (SDG 1); food security (SDG 2); gender equality (SDG 5); sustainability of cities and human settlement (SDG 11); combating climate change (SDG 13); and protecting terrestrial ecosystems (SDG 15) (Conti et al. 2016).

Groundwater supports numerous aspects of human development, including poverty eradication, human dignity and well-being, by providing water for domestic use, enabling food production and sustaining critical ecosystem functions (Moench 2003). When accessed through context-appropriate infrastructure, groundwater has the potential to significantly improve the livelihoods of women, children, the elderly and people with disabilities (Cap-Net and GWA 2006). However, gender disparity affects access to water in relation to social, economic, cultural or political behaviors and patterns, or a combination of these factors. Access is largely structured by social and gender relations, with implications for environmental stewardship, and local and global development goals.

Groundwater governance can be implemented through citizen science. Citizen science refers to the participation of the general public (i.e., non-scientists, citizens or community members that volunteer) in the generation of new scientific knowledge, together with professional scientists (Buytaert et al. 2014). Groundwater governance using citizen science needs to involve the myriad actors who interact with hydrological processes and play a role in the management of water resources (Conrad and Hilchey 2011). The evidence suggests that citizen science can be applied to monitor weekly or monthly changes in water levels within studies on baseflows (Lowry and Fienen 2013) and local flash flood events (Starkey et al. 2017). In Ethiopia, Haile et al. (Forthcoming) showed that citizen science can be applied for the rapid assessment of water availability in ungauged micro-watersheds, with a focus on the monitoring of the shallow groundwater (SGW) resource. In that example, authors used data collected by community members to describe the hydrological behavior of the micro-watersheds and to qualitatively evaluate the impact of watershed interventions. Citizen science can enhance participatory monitoring of water resources at community levels, and climate and hydrological monitoring, particularly in data-scarce rural areas of Ethiopia.

Community-based monitoring provides many benefits to society, including environmental democracy, scientific literacy, social capital, citizen inclusion in local issues, strengthened governance, and healthier ecosystems (Conrad and Hilchey 2011). The approach engages community members in the scientific process and ultimately enables them to play a larger role in decision-making (Buytaert et al. 2014). Citizens are involved in participatory activities, but more focused on scientific data collection and analysis rather than on collective action in managing resources. That said, citizen science may be complementary to other participatory activities that aim to improve natural resource management, such as games and interactive participatory mapping.

Understanding the gender dimensions of community-based groundwater governance is critical to improving the effectiveness of citizen science interventions. Access to groundwater by men and women, and their participation in the development and management of groundwater resources are largely shaped by social and gender relations. Women play a leading role in providing and safeguarding water in many contexts. However, this role is usually not reflected in the informal and formal institutional arrangements for water management (Snellen and Schrevel 2004). In this regard,

gender relations and how those are reflected in governance have implications for environmental stewardship and sustainable management of groundwater.

Specifically, men and women differ in their:

(i) need for and uses of groundwater;

(ii) access to groundwater;

(iii) level of participation in groundwater management;

(iv) amounts of groundwater abstraction; and

(v) willingness to participate in groundwater monitoring, and resource planning and management, i.e., citizen science activities.

Deliberate and targeted measures that address gender inequality in groundwater governance are needed. Participation by both men and women in groundwater monitoring and assessment – through citizen science approaches – could provide the opportunity to explore, learn and share knowledge about groundwater within the existing social context. Ideally, the process of collecting data, collectively monitoring water resources and jointly engaging in assessments of local water resources could improve both the sustainability of collective groundwater management and, more generally, contribute to women's empowerment. This paper seeks to contribute to scant studies on citizen science, groundwater and gender.

OBJECTIVE OF THE STUDY

This study generally seeks to explore the potential of citizen science as an entry point for enhanced groundwater governance. More specifically, the study highlights the gender dimensions of water security concerns and the capacity of different members of the community to engage in the collection of data on, and monitoring and management of, groundwater resources. Gender relations is a factor in the implementation of citizen science around groundwater, because women and men both have roles in groundwater access, use and management. Inclusion of both women and men in processes for groundwater monitoring and resource planning is assumed to improve overall management. At the same time, inclusion of women in citizen science approaches to groundwater governance may enhance gender equity and support achievement of broader empowerment goals. Toward understanding the existing conditions and potential impacts of citizen science, the study addresses the following key questions:

- Are there significant differences in the opportunities and constraints for men and women, which determine access to, control over and sharing of benefits generated from water sources?
- How do household members participate in groundwater development and management committees? How does this affect their participation in community-based groundwater monitoring?
- Are men and women willing to participate in groundwater monitoring tasks as para-hydrologists? If not, what constraints hinder or disincentivize participation?
- How can gender sensitivity be incorporated into citizen science – specifically community-based groundwater monitoring – to enhance gender equity and the empowerment of women in groundwater management and governance?

To respond to these questions, researchers explored gender relations in terms of needs, access and use of groundwater; and participation in groundwater development and management. Finally, they considered the willingness and capacity to participate in groundwater monitoring by both women and men.

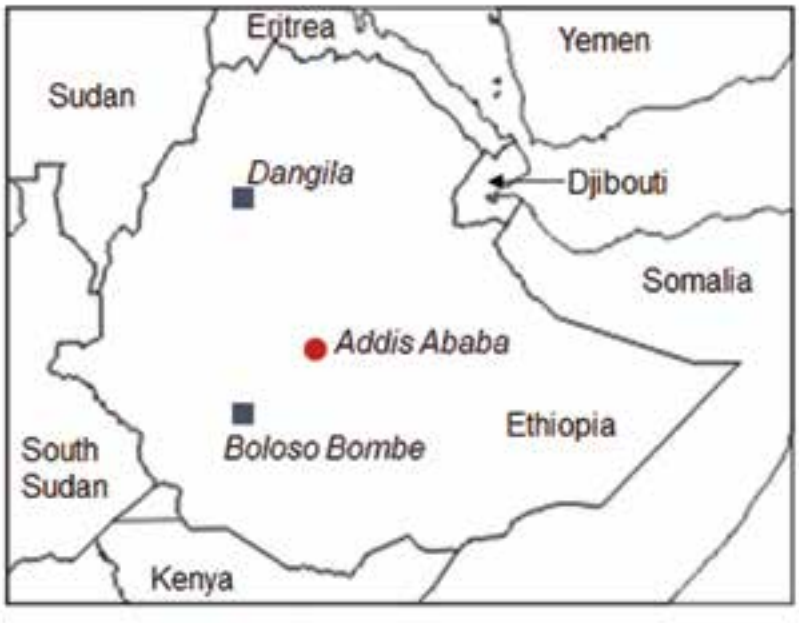
DESCRIPTION OF THE STUDY AREAS

The study was carried out in two locations (see Figure 1):

- Dangeshta *kebele*[1] in Dangila *woreda*[2] of Amhara National Regional State of Ethiopia.
- Farawocha *kebele* in Boloso Bombe *woreda* of the Southern Nations, Nationalities, and People's Region (SNNPR).

The rationale for selecting these *kebeles* for this study was the presence of existing groundwater monitoring activities. The International Water Management Institute (IWMI) and Newcastle University in the United Kingdom, consulted the Ministry of Agriculture and Natural Resources of Ethiopia to select the study sites. Accordingly, the ministry suggested the two *kebeles* where groundwater level monitoring is essential, based on existing initiatives. Farawocha *kebele* is one of the intervention *kebeles* for the Sustainable Land Management Program (SLMP), which is a major government project to combat land degradation, protect natural resources and restore soil fertility in Ethiopia. Similarly, there are interventions in Dangeshta *kebele* focusing on shallow groundwater development supported by the Agricultural Growth Program (AGP) and the Ethiopian Agricultural Transformation Agency (ATA). Existing site activities ensured the relevance of citizen science activities, and enabled the study results to contribute to ongoing efforts through the generation of hydrological data and knowledge. The data serve as an input to the evaluation of the impacts of the SLMP and AGP interventions.

FIGURE 1. Map of Ethiopia highlighting the study areas.



Note: Grey squares - study sites (Dangila and Boloso Bombe *woredas*); red circles - major cities that are in close proximity to the study sites.

[1] *Kebele* is the smallest administrative unit of Ethiopia.

[2] *Woreda* is the third-level administrative division of Ethiopia.

The most recent Ethiopian census conducted by the Central Statistics Agency (CSA) (see Table 1) in 2007 recorded that the Boloso Bombe *woreda* has a total population of 87,956, of which 42,848 are men and 45,108 are women; 1,057 or 1.2% of its population are urban dwellers. Dangila *woreda* has a total population of 158,688, of which 80,235 are men and 78,453 are women; 27,001 or 17.02% of its population live in cities.

TABLE 1. Age breakdown of the population in Boloso Bombe and Dangila *woredas*.

Age group	Boloso Bombe *woreda*			Dangila *woreda*		
	Total	Male	Female	Total	Male	Female
0-14	44,016	22,231	21,785	70,578	36,320	34,258
15-34	28,410	12,897	15,513	56,433	28,112	28,321
35-64	14,092	6,873	7,219	27,151	13,389	13,762
65+	1,438	847	591	4,526	2,414	2,112
Total	87,956	42,848	45,108	158,688	80,235	78,453

Source: Census conducted by CSA in 2007.

Mixed farming is the main livelihood activity of communities living in the Farawocha and Dangeshta *kebeles*. Most farmers in these *kebeles* cultivate cereals using rainwater during the rainy seasons. In addition, some farmers use the water from rivers for the irrigation of crops in the dry season. Poultry production, livestock rearing (cattle, goats and sheep) and selling eucalyptus timber are also livelihood activities in the study sites.

Most farmers in Farawocha *kebele* cultivate crops such as maize, teff, *boloke*[3], *enset*[4], coffee, *boyna*[5], potato, avocado, mango and banana using rainwater for both consumption and sale in the market. Some also grow tomato, green pepper, maize (in large quantities), cabbage and carrot (in small quantities) during the dry season, using water from the Magere River for irrigation. In Dangeshta *kebele*, under rainfed systems, farmers cultivate crops such as finger millet, teff, barley, *nug* (*Guizotia abyssinica*) and maize during the rainy season. They also pump water from the river to irrigate potatoes, onion and barley during the dry season (November-April) for both consumption and sale in the market. Farmers in Dangeshta *kebele* also use water from private shallow wells to irrigate fruits, vegetables and trees, again for both consumption and sale in the market. These include *gesho* (*Rhamnus prinoides*), mango, avocado, orange, coffee, khat, green pepper, onion, garlic and others.

Women in both Farawocha and Dangeshta *kebeles* participate in all agricultural activities except for digging the land and plowing. In Dangeshta *kebele*, women are responsible for backyard cultivation using private wells. They are also responsible for tending livestock, producing poultry and conducting petty trade (local drinks, enjera[6] seasonally in Farawocha *kebele* only), gathering eggs, making butter and growing fruits, including mango, avocado, banana and others. Women also engage in other income-generating activities and projects; in Farawocha *kebele*, women's associations (e.g., the Efficient Fuel Stove Association) produce and sell energy-saving stoves.

[3] *Boloke* is haricot bean. The botanical name is *Phaseolus* vulgaris.

[4] *Enset* is also called false banana and it is a source of food. The botanical name is *Ensete ventricosum*.

[5] *Boyna* is taro. The botanical name is *Colocasia esculenta*.

[6] *Enjera* is an Ethiopian staple food made from teff.

Seasonal migration for agricultural work by men is also common in both *kebeles*. Women find it more difficult to do this, because their mobility is limited by domestic chores, especially the responsibility of looking after the family, and because they are afraid to go far away from their local area, due to the lack of confidence and fear of gender-based violence. However, women have just as much opportunities as men to get temporary paid work with nearby farmers. In particular, in Farawocha *kebele*, women are hired to process *enset* and clean cattle pens.

METHODOLOGY

Sex-disaggregated data and information were collected through a literature review, in-depth discussions with key informants at *woreda* level, separate household interviews with spouses within a household, and focus group discussions (FGDs) with men's and women's groups. The literature reviewed included gender-related project reports, citizen science-related project reports, academic journals and government documents focusing on gender, water and/or agriculture in Ethiopia.

Discussions with representatives of Women and Children Affairs offices aimed to gain insight on the opportunities and constraints – at the *woreda* level – to achieving gender equality. This also included discussions on gender issues in the *woreda* and efforts made to mitigate any constraints by providing technical support to sector offices. In addition, discussions were held with representatives from the Agriculture and Natural Resources Development offices in the two *woredas* to understand the local water situation, current initiatives to improve landscapes, and perceived opportunities and barriers to the equal participation of men and women in these initiatives.

A purposive sampling method was used to identify men and women that were willing to participate in the study. In particular, households with private wells in their yards and/or living in the micro-watershed were invited to participate. Separate FGDs were held with men and women community groups. FGDs included a total of 35 community members, divided into two groups of women and two groups of men. Husbands and wives from 43 households were interviewed separately (see Table 2). The Amharic language was used for the FGDs and household interviews in Dangeshta *kebele*. In Farawocha *kebele*, a translator was used to translate the discussions from the local language – Wolayta – to Amharic. Participants in the FGDs were subdivided into smaller groups to encourage participation, based on whether they lived upstream, midstream or downstream of the micro-watershed. The field study in Dangeshta *kebele* was conducted on April 5-9, 2017, and the study in Farawocha *kebele* was conducted on April 20-23, 2017.

TABLE 2. Number of focus group discussions (FGDs) held and interviewees in each *kebele*.

No.	*Kebele*	Number of FGDs with men	Number of FGDs with women	Number of women interviewed	Number of men interviewed
1	Farawocha *kebele*	2	2	11	9
2.	Dangeshta *kebele*	2	2	12	11
Total		4	4	23	20

SITUATIONAL CONTEXT

According to a time-use survey by CSA (2014), rural households in Ethiopia obtain water mostly from wells or from public/private taps outside their homes. Thirty-percent of households get water from unprotected wells outside of the household; 22% from a protected well outside of the household; and 25% from natural sources (rivers, springs, etc.). About 22% get water from a shared/ community tap, and less than 1% of households reported having access to piped water on their premises. The survey found that women and girls spend a significant amount of time collecting water. About 56% of rural households have to travel less than 1 hour to get water, but a large share (37%) have to travel between 1 and 2.5 hours, and about 15% have to travel even further to fetch water. Specific gender roles determine the capacity of men and women to allocate their labor and time to economically productive activities and to respond to economic incentives (Ilahi 2000; Blackden and Wodon 2006). Easy access to water mostly benefits women and girls, as it reduces the burden of water collection that disproportionately falls on them, and makes time available for education and economically productive activities. It also reduces the physical challenges they face (i.e., exposure to physical hardship, sexual and physical violence), when they travel long distances to fetch water (UN Women 2014). Yet, achieving equity within and among rural communities remains challenging and can compromise the sustainability of groundwater use.

Men and women often have separate – and sometimes conflicting – priorities for water usage. A sustainable and integrated approach to water management means including complete information on all sources, uses and users of water. For example, men primarily use water from household private wells for irrigation, while women and children also use the water for domestic purposes and livestock watering, according to a study on gender dynamics on water use within households in Jawe and Upper Gana *kebeles* of SNNPR (Nigussie et al. 2017). As such, men and women may benefit from new water investments in different ways. For these reasons, a water-based project should give specific attention to gender-based needs and concerns to prevent reinforcing inequities in opportunities for water access and governance or social norms against women (World Bank 2016).

The Ethiopian Water Resources Management Policy (2001) (MoWR 2001a) supports this approach. Section 2.2.10 (gender issues) states that the policy aims to: *Promote the full involvement of women in the planning, implementation, decision making and training as well as empower them to play a leading role in self-reliance initiatives*. Moreover, section 4.1.8 (gender mainstreaming) of the Ethiopian Water Sector Strategy (2001) (MoWR 2001b) states that the strategy aims to:

- *Pay special attention to the role of women while establishing community-based structures for the management of localized water supply and sanitation (WSS) and small-scale irrigation systems. Allocate a specific number of seats for women in these community-based structures, depending upon the nature and size of the scheme.*
- *Enhance the active involvement of women for the success of water projects and programs; and for the sustainable services of water schemes. Launch campaigns to encourage women to contribute in improved management of water schemes.*
- *Take steps to relieve women from the huge burden of fetching and carrying water for the family by empowering them in decision-making in water projects.*

Nevertheless, studies show that women are far less involved in water projects than men (NBI 2012). Women are also routinely absent from local decision-making processes on how to mitigate or address the impacts of climate change (Masika 2002). Identifying and addressing the needs of women and their access to water resources is of a normative nature, but there are as yet no guidelines on how this should be done. It is now standard practice for development programs

to be built upon 'gender mainstreaming' approaches, but the result is often nothing more than a satisfied quota (e.g., a certain number of women in groups or on water management committees), rather than actual participation or influence in decision-making (Brett 2003; White 1996; Cleaver and Nyatsambo 2011; Lefore et al. 2017).

Several studies in Ethiopia have noted that women are not active participants in collective action groups. Indeed, men are about six times more likely than women to participate (24% and 4% of man and women, respectively) and five times more likely to hold a leadership position (Mogues et al. 2011). A lack of time, a patriarchal culture discouraging membership, little education and limited decision-making power in the household are often cited as the most important factors constraining the involvement of women in cooperatives (Woldu et al. 2013). According to a survey conducted by CSA in 2013, of the rural people over the age of five, about 60% of the females reported never attending school, compared to 41% of the males (CSA 2014).

To encourage their participation, some rural organizations target women and set quotas for leadership positions. However, researchers have found that such positions tend to be more symbolic than authoritative, implying that quota setting is not sufficient to address gender inequalities. The absence or limited involvement of women in leadership or decision-making bodies most likely means that their interests, concerns and views do not factor into decisions that affect them. On the other hand, the active participation of women in collective groups helps them to build self-esteem, confidence, leadership skills, social networks and solidarity (Woldu et al. 2013; FAO 2012; IFAD 2009; Baden 2013). Steps must be taken to address the root causes of women's lack of participation, such as high demands on their time due to domestic responsibilities, and social norms that discriminate against them (Warner et al. 2015).

FINDINGS OF THE STUDY

Groundwater Availability, Access and Use

This study examined how different groundwater sources are used by men and women for various purposes in the Farawocha and Dangeshta *kebeles*. Understanding differences in groundwater use, development and management by men and women is critical to identifying constraints to their equal participation in groundwater monitoring.

Women in both *kebeles* collect water for drinking, cooking, bathing, washing and watering livestock. Women in Dangeshta *kebele* also use the water to grow fruits and vegetables in their backyards. Men in Dangeshta *kebele* mainly use groundwater for irrigating their plots, as well as for watering livestock and watering gardens.

Men and women in Farawocha *kebele* use different water sources for various purposes, as illustrated in Table 3. They cultivate tomato, pepper, carrot, beetroot and cabbage in their home gardens at the time the wells were drilled in the mid-1980s. However, they could not benefit as expected, because they had limited access to vegetable markets. Now, although the market links have improved, water from the private wells is not sufficient for both domestic uses and irrigated backyard cultivation.

TABLE 3. Uses of groundwater by men and women in Farawocha *kebele*.

Water sources	Uses of groundwater by men	Uses of groundwater by women
Minchi Spring	Men collect water from this source in two special cases. The first case is when women in households are unable to collect water (i.e., due to sickness or child delivery). The second case is when a large quantity of water is needed in the household, specifically during occasions such as holidays, weddings and other social events).	Women use the water for cooking and drinking for the household. They collect water for domestic uses. The Minchi Spring was once a protected source, where water flowed through a pipe. However, the concrete covering the water is broken, so women and children must use buckets to lift water from the source. It can only be used early in the morning, because the water gets polluted later in the day due to interventions by humans and animals.
Magere River	Men use the water for irrigation (using the gravity-fed furrow irrigation technology) when their plots are located near the river.	Women use water for watering livestock, washing and bathing. They take indigenous cattle to the rivers to drink water, and carry water from the river for hybrid cattle, which stay in the pens near the household for closer attention and care.
Public fountain in Adila *kebele*	Men accompany women and children to fetch water after dark. They collect water when a large volume is needed (e.g., to prepare local drinks). Men sometimes pay ETB[a] 5 to rent a mule cart to transport 20-liter jerry cans of water from the fountain.	Women use the water for cooking and drinking for the household. They collect water from the fountain for domestic uses, which takes over an hour and even more during the dry season, due to low discharge and long queues.
Private well/s	Men use the well water for bathing and washing. They use buckets to lift the water out of the wells.	Only a few households have private wells. Women use well water for bathing, washing, poultry production, watering livestock and making local drinks, such as 'Areke'.

Note: [a] Exchange rate at the time of field research in April 2017: USD 1 = ETB 22.5796.

Likewise, men and women in Dangeshta *kebele* use different water sources for various purposes, as illustrated in Table 4.

Men and women having access to water depends on a number of factors: distance to source; water quality and availability; and access to technologies such as drilling, pumping and water treatment. Findings from this study indicate that women in Dangeshta *kebele* have better access to groundwater of reasonable quality (i.e., cleaner and safer for consumption) and at a reasonable distance (i.e., does not require walking a long way to obtain) compared to women in Farawocha *kebele*. All of the households in Dangeshta *kebele* that participated in the study have wells; there are 681 private wells, owned by 647 households, according to the *Kebele* Agriculture Office. Only 65% of participating households from Farawocha *kebele* have private wells. That said, water from private wells is only used for drinking purposes by the very few households that do not have communal wells nearby and are located far from Albina Spring. Water is extracted from the wells using pulleys, ropes and washer pumps, buckets and pedal pumps. Women in Farawocha that do not have wells need more than an hour to fetch water (especially for drinking and cooking). They have a greater burden of access to water than men in the *kebele* and women in Dangeshta *kebele*.

Easy access to groundwater in Dangeshta *kebele* enables the women who live there to use their time and labor for activities other than water collection. According to the study, they need between 5 and 30 minutes to collect adequate water for cooking and drinking. This leaves them

TABLE 4. Uses of groundwater by men and women in Dangeshta *kebele*.

Water sources	Uses of groundwater by men	Uses of groundwater by women
Branti River	Men use the water for irrigation when their plots are located near the river.	Women use the water for irrigation, watering home gardens when private wells run dry in the dry seasons, particularly in March and April, watering livestock, washing and bathing. They take indigenous cattle to the rivers to drink water, and carry water from the river for hybrid cattle, which stay in the pens near the household for closer attention and care. For irrigation, women carry hoses to the fields and apply water to the plots.
Albina Spring		Women use the water for cooking and drinking for the household. They collect the water. The spring can only be used early in the morning, because the water gets polluted later in the day due to interventions by humans and animals.
Communal wells		Women use the water for cooking and drinking for the household. They collect the water.
Private well/s	Men use well water for livestock watering, washing clothes, watering gardens, and bathing.	Women use the water for drinking, watering gardens, bathing, washing, poultry production and livestock watering, and making local drinks, such as 'Areke'. They collect the water. Women and children are mainly responsible for watering gardens.

with sufficient time to invest in activities such as cultivating fruits and vegetables, which contribute to higher incomes, more diverse household diets, and reduced household expenditure on fruits and vegetables. Access to well water also contributes to better hygiene practices by the family, such as more frequent bathing and washing clothes, which in turn can improve health and labor productivity. Access to groundwater has been initiated in the area through public and donor interventions. Bahir Dar University, the Feed the Future Innovation Lab for Small-Scale Irrigation (ILSSI) project (http://ilssi.tamu.edu/), and the Bureau of Agriculture have been active in the area since 2014 to support both men and women farmers to install and maintain water-lifting technologies primarily for groundwater access for productive purposes. Households will also use this groundwater for domestic purposes, reducing the burden on women in collecting water.

Participation of Men and Women in Groundwater Resources Development and Management

Men and women have different roles in developing and managing groundwater resources. Different water sources involve different types of management. Rivers and springs require watershed management activities and participation in irrigation water user associations (WUAs) (both as leaders and members). Private and communal wells entail water source development and management. The participation of men and women in irrigation WUAs and in watershed management committees at different levels in the two *kebeles* is summarized in Table 5.

TABLE 5. Participation of men and women in irrigation water user associations (WUAs) and watershed committees in the Farawocha and Dangeshta *kebeles*.

Water sources	Responsibilities of irrigation WUAs and watershed committees	Responsibilities of men in the development and management of groundwater	Responsibilities of women in the development and management of groundwater
	Irrigation WUAs are responsible for the equitable distribution of water to users.	In Farawocha *kebele*, 44 out of 45 members of irrigation WUAs are men.	In Farawocha *kebele*, of the members of irrigation WUAs, only one is a woman.
		In Dangeshta *kebele*, eight men irrigate their farms with water from the Branti River. In both *kebeles*, all leadership positions are held by men.	In Dangeshta *kebele*, no women irrigate their farms with water from the Branti River. Women do not hold leadership positions in either *kebele*.
Rivers and springs	In both *kebeles*, watershed management committees exist at the community, *kebele* and *woreda* levels.	In Farawocha *kebele*, the ratio of men to women participating in the Sustainable Land Management Program (SLMP) is 60:40. The ratio of men to women participating in watershed management committees in Farawocha is: 60:40 in community watershed committees. 90:10 in *kebele* watershed committees. 100:0 in *woreda* watershed committees (both in technical and steering committees). In Dangeshta *kebele*, the ratio of men to women participating in the SLMP is 60:40 The ratio of men to women participating in watershed management committees in Dangeshta is 60:40 at the community level. At the *kebele* level, only one of the seven committee members is a woman.	

The role of a community watershed committee is to mobilize community members to participate in watershed planning and rehabilitation, identify watershed-related problems, develop annual work plans, and prepare reports to share with the *kebele* watershed committee. The watershed plan provides details of the list of activities that will be implemented in a given micro-watershed. The lists of activities are focused on soil and water conservation work and infrastructure development (e.g., water resources development and road construction). The *woreda* watershed committee has two subcommittees: the *woreda* watershed technical committee and the *woreda* watershed steering committee. The role of the technical committee is to evaluate the watershed plans delivered by the *kebeles*. The steering committee evaluates the plans and reports presented by the *woreda* technical watershed committee, and integrates the watershed plans and reports in the *woreda's* annual plans and reports. The role of the *kebele* watershed committee is to check the plans and reports presented by the community watershed committees, make changes to those plans and reports based on the local situation, and report back to the *woreda* watershed committee. Members of this committee include the *kebele* chairperson, agriculture office head (who serves as secretary for the committee), and people representing women, police, the elderly, youth and development agents. Committee members represent different community groups across wealth status, gender, age and religion.

As shown in Table 5, women do not often participate in irrigation WUAs and watershed management committees. According to FGDs in the two study *kebeles*, the reasons for their low participation include their heavy workload in the household, low educational status, male-dominated culture (where women need to get permission from their husbands to participate), limited understanding about the concept of participation (i.e., who can participate, what is involved, what weight is given to the voices of women) and lack of self-confidence. The same factors may also limit the participation of women in groundwater monitoring.

Results of the FGDs also showed that the gender division of labor in the community disproportionately burdens women. Women are responsible for domestic, production and community roles, which allows less time to engage and lead development activities. Men in both *kebeles* are mostly responsible for farm activities such as plowing, digging, planting, sowing, weeding, irrigating, harvesting, storing and marketing. For their part, women support farm activities by providing seeds, sowing, preparing the land, weeding and harvesting, and providing food and drinks for the farm workers. Women are also responsible for collecting water and the domestic activities that depend on water, including cooking, washing, housekeeping and child care. Responsibilities for animal care relate to poultry production, tending cattle and cleaning the animal pens. Women are also responsible for energy needs, particularly fuelwood collection. However, Dangeshta *kebele* is an exceptional case where men and young boys are responsible for collecting fuelwood.

According to participants of the study in both *kebeles*, there is a perception among community members that girls should only attend school until grade 6 or 8, after which she should quit and get married. There are also norms and practices (represented in local sayings and proverbs) that discourage the active participation of women in community life, resulting in low self-confidence. For example, sayings such as "A woman is to the kitchen as a man is to a court" and "Whatever is known by a woman, a man concludes", among others. The other issue is that men are reluctant to support women in domestic work, undermining women's ability to seek productive work.

Men and women also have different responsibilities with regard to the development and management of private and communal wells. In Dangeshta *kebele*, both men and women contribute labor to develop private and communal wells. However, women are primarily responsible for managing private wells. In the case of a communal well, water user committees including both men and women are established to manage the water points. Although women are represented in the water user committees for communal wells, their participation in decision-making is limited due to the same reasons mentioned above. As seen in Table 6, women usually serve the committees as cashiers, storekeepers and pump attendants/care takers, while men serve as chairs and secretaries with the mandate to make decisions. According to the FGDs, participants and key informants, the main reason for women in positions such as cashier and store keeper is due to social perceptions. For example, women are considered more trustworthy with handling money and resources than men. Key informant interviews indicated that women are assigned pump attendant roles due to social perceptions: (i) the task is easily manageable by women, and (ii) men are busy with other, more important productive work and women have time available.

Most often, women do not participate in decision-making related to water resources development and management, particularly on decisions related to productive activities (e.g., agriculture, construction). The low level of input implies that women's knowledge and experience are usually not reflected in the decisions that are taken; women's needs are often not taken into account. However, women who have the opportunity to participate actively in development programs, including water resources development and management, are far more likely to be empowered, because they have the opportunity to explore, learn and share (Nigussie et al. 2017).

TABLE 6. Participation by the government, men and women in groundwater resources development and management in Farawocha and Dangeshta *kebeles*.

Water sources	Responsibilities of the government and other stakeholders	Responsibilities of men in groundwater resources development and management	Responsibilities of women in groundwater resources development and management
Communal wells in Dangeshta *kebele*	The *woreda* water, mining and energy office provides technical support for the construction of communal wells. It also keeps part of the cash contributed by the community, which is used for maintenance when needed.	The household is expected to contribute cash[a] (between ETB 50 and ETB 150) for management, operation and maintenance.	
		Men dig pits, excavate soil from the pits and transport construction materials.	Women provide the same labor contribution as men, except for digging.
		Men serve as chair, secretary, guards and managers or maintenance laborers in a committee set up to manage the communal well.	Women in the committee serve as cashiers, storekeepers and pump attendants[b]/care takers.
		Chairperson and the secretary have the power to make final decisions about well development and use.	
Private wells in Dangeshta *kebele*		Men dig (or hire someone to dig) wells using hoes and plows, with depths ranging from 5 m to 20 m depending on local biophysical factors.	Women excavate soil from the pit, and provide food and drinks for the workers. They ensure that the well is covered and the area near the well is clean.
Private wells in Farawocha *kebele*	All private wells were dug by the government in the 1980s, with depths ranging from 20 m to 35 m.	Once a year (usually in April), men clean the wells by removing sediment from the pits.	Women take responsibility for fencing, covering wells and cleaning the area near the well on a regular basis.
			Once a year, they help men to clean the well by removing dirt and sediment.

Notes: [a] The amount of the cash given depends on the number of households that contribute. The larger the number of households, the less the cash contribution.

[b] Pump attendant is a person who is responsible for preventive maintenance and daily operation of the water supply facility.

Willingness and Capacity to Participate in Groundwater Monitoring Activities

The varying levels of willingness by men and women to participate in groundwater monitoring in Dangeshta and Farawocha *kebeles* is shown in Table 7.

Table 7. Willingness of men and women to participate in groundwater monitoring.

	Farawocha *kebele*		Dangeshta *kebele*	
	Women	Men	Women	Men
Not willing to participate in groundwater monitoring	56%	10%	54%	28%
Willing to participate in groundwater monitoring	44%	90%	46%	72%
Not willing to have wife participate in groundwater monitoring		20%		45%
Total number of respondents	11	9	12	11

In both study sites, more than half of the women respondents were not willing to participate in groundwater monitoring. In Farawocha *kebele*, the main reason given for this was illiteracy. In Dangeshta *kebele*, the reasons included low self-esteem, heavy work burden (both domestic and productive labor), illiteracy, fear of gender-based violence from other men in the area and fear of being bitten by dogs near wells in private homesteads. Their heavy workload is also a concern for the women that are willing to participate in groundwater monitoring, although they stated they could plan their time efficiently and expressed determination to participate.

A few of the male respondents were unwilling to participate in groundwater monitoring. In Dangeshta *kebele*, the reasons given for this unwillingness to participate were old age, illiteracy and the perception that the work would be overly demanding and time consuming. The only reason given in Farawocha *kebele* for the unwillingness of men to participate was illiteracy. A para-hydrologist in Dangeshta *kebele* indicated that groundwater needs to be monitored every week during the dry season and every other day during the rainy season. However, the payment made for carrying out this work is insufficient. For example, a para-hydrologist that monitors wells for 11 households would need to spend about 2.5 hours per day on this work, earning only ETB 200 per month.

> "*The compensation we get is not sufficient, when compared to what we have to give up in the household. But, we appreciate the knowledge and the experience we are acquiring through the process."*
>
> A para-hydrologist[7] from Dangeshta *kebele*

Significantly, 45% and 20% of the men in Dangeshta and Farawocha *kebeles*, respectively, do not want their wives to participate in groundwater monitoring. The reasons given for this in Dangeshta *kebele* were limited mobility due to age, illiteracy, the lack of a substitute to cover domestic chores, and fear that the wives would be bitten by dogs. The only reason given in Farawocha *kebele* was illiteracy.

CONCLUSION AND RECOMMENDATIONS

The study described the gender disparities related to groundwater in terms of access, use, need, and participation in the development and management of groundwater resources in Farawocha and Dangeshta *kebeles*, which could potentially affect the participation of men and women in community-based groundwater monitoring. According to the study, women place a high value on water and are concerned about the use and sustainability of groundwater resources. However, the limitations that women face in participating in (and leading) community development programs (including water development and management programs) suggest the need for specific interventions. Indeed, these limitations affect the degree to which women are willing to participate in groundwater monitoring, as well as the willingness of men to allow women to participate. In contrast, key informant interviews suggested that men have the autonomy and freedom of mobility to participate as they wish, and the majority of men are willing to participate themselves.

Citizen science could be constrained within this context, because it relies on (i) the active participation of myriad actors (including men and women citizens) whose actions interact with the hydrological processes; and (ii) volunteer interest (i.e., willingness to participate). The active and

[7] The project defines 'para-hydrologist' as a person who has not studied hydrology through a formal education system, but learned it in the field with continuous engagement in hydrological monitoring and knowledge generation.

equal participation of men and women is important because they have different needs, priorities and uses for groundwater. Citizen science works best when citizens (men and women) volunteer to participate and are able to participate equally without structural barriers. Conditions would need to be created and supported to achieve the expected benefits. A number of possible interventions are listed below.

- Develop a gender-sensitive approach to encourage women's participation in community-based groundwater monitoring programs. This should include capacity development programs for men and women to help men understand the importance of women's involvement in groundwater monitoring, and to help women to express their ideas in public and support empowerment. Community-based gender awareness training is important to highlight the importance of equal participation by men and women in groundwater monitoring for better development outcomes. The training could also contribute to achieving greater gender equality and women's empowerment in the household and at community levels, as it would help both men and women to better understand and support each other.
- Work with women's organizations, government organizations, nongovernmental organizations, networks and cooperatives that are concerned with women's empowerment, natural resource management and water.
- Expand adult literacy programs to increase the number of women volunteers that are willing and able to participate in groundwater monitoring.

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Water, Land and Ecosystems

ISSN: 2012-5763
e-ISSN: 2478-1134
ISBN: 978-92-9090-873-9