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Government rainwater harvesting initiative in northern Ghana and its impacts on local livelihoods and work-life balance: evidence from Savelugu Municipality

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ABSTRACT

The "One Village One Dam (1V1D)" is a rainwater harvesting technology initiated by the Government of Ghana in 2017 to make water available all year round for animal watering, irrigation and domestic use in dryland areas in northern Ghana. However, scepticism about the potential of the 1V1D to stave off water stress and its associated impact on local livelihood activities is still prevalent in the country. This case study of Savelugu Municipality investigated the impact of the 1V1D on local livelihood activities and the work-life balance of women. Using qualitative data collection methods, 12 focus group discussions and seven key informant interviews were conducted in six communities in the municipality. The results showed that after >5 years of implementation, not much has been achieved for the intended purposes of the project, namely water for animal watering, irrigation and household consumption. Non-performance of the dams was attributed to engineering flaws like poor design and small size which often resulted in early dry out of the dams in the dry season. However, emerging activities like water commercialisation have provided a source of sustenance to water vendors. The services of the vendors save women time to fulfil the demands of work, family and personal life. Overall, the persistence of water stress in the study communities and activities of Fulani herdsmen, who allowed their cattle to pollute the dams' water, necessitates the government to address the design flaws through retrofitting the existing dams and mainstreaming future 1V1D projects to effectively tackle water stress in Ghana's dryland areas.

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KEYWORDS
Agriculture; food and income security; One Village One Dam (1V1D); water commercialisation; water stress; Ghana

Key Policy Highlights

- Emerging commercialisation of the dams' water has created a source of economic sustenance for water vendors.
- The implementation of the 1V1D programme suffers engineering flaws resulting in early dry-out of the dams.
- Overall, the 1V1D project has minimal impact on local livelihoods and the work-life balance of women.

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1. Introduction

Climate change continues to disrupt weather patterns, leading to extreme weather events such as floods and droughts, unpredictable water availability and exacerbation of water stress (Hussain et al. 2020). Water stress refers to the ability, or lack thereof, to meet human and ecological demands for water (Orr and Pegram 2014). It is also defined as a situation where the demand for potable water exceeds its supply leading to water scarcity problems (Felter and Robinson 2021). Water stress has become a major global issue especially in arid and semi-arid regions because of the sensitivity of these areas to climate change and variability (Rafiei-Sardooi et al. 2022). Seasonal and chronic water scarcity is a key challenge to Africa's development efforts and the attainment of many of the sustainable development goals (SDGs) by 2030 (Di Baldassarre et al. 2019), especially SDGs 1, No poverty; 2, zero hunger, 5, gender equality and 6, clean water and sanitation (United Nations 2015). Rural livelihood activities in sub-Saharan Africa like agriculture are highly dependent on rainfall, making them vulnerable to climate change. Water stress has been linked to factors such as the lack of water management infrastructure for storage and distribution and climate change and variability (FAO 2016).

To stave off water stress and address climate change's impact on water availability during extreme dry seasons, strategies, such as increasing water storage and water use efficiency, have been advanced. In recent years, there has been a drive towards promoting water use efficient irrigation systems, planting crops which are well adapted to the local climate, wastewater recycling and reuse and promoting climate-smart agriculture (innovations in areas such as artificial intelligence and genome editing) to address water stress, especially in the dryland regions (DeNicola et al. 2018; Sukhwani et al. 2020). There is also a growing interest in promoting rainwater harvesting (RWH). It involves the collection and storage of rainwater as well as other related activities aimed at conserving and using water efficiently (Helmreich and Horn 2009). The idea of RWH has been around for millennia, not only for agriculture but also for household water supply. It is a well-known solution to flood and drought risk mitigation with different levels of advanced technology associated with it. RWH can be classified into two broad categories: land-based and roof-based (Aladenola and Adeboye 2010). Land-based RWH entails collecting runoff from land surfaces into furrow dikes, ponds, tanks and reservoirs. Roof-based RWH occurs when rainwater runoff is collected from roof surfaces for storage and use (Dos Santos and de Farias 2017). RWH ensures the availability of rainwater to augment rural and urban water supply. The technology can be an effective supplementary water source to surface and groundwater (Che-Ani et al. 2009; Sojka, Younos, and Crawford 2016). It can help alleviate water stress in dryland areas (Owusu and Kofi Teye 2015) and enhance household food security in dryland areas by promoting all-year-round agriculture (Muriu-Ng'ang'a et al. 2017; Mwenge Kahinda and Taigbenu 2011). Many African governments, including that of Ghana, are concerned and eager to take collective action to address climate change-induced water stress. For instance, in northern Ghana, water-deficit stress is a major livelihood and development challenge to households due to its location in the Savannah agro-ecological zone where rainfall is uni-modal with high excesses of evapotranspiration over rainfall (Agodzo, Bessah, and Nyatuame 2023; Incoom, Adjei, and Odai 2020). In recent years, household water-deficit stress has worsened due to changing rainfall patterns linked to climate change. To address the water scarcity situation, the Government of Ghana initiated a flagship project known as "One Village One Dam" (1V1D) in the Northern Savannah agro-ecological zone. The project is a land-based RWH system and entailed constructing multi-purpose small dams across the five regions in northern Ghana. The dams are intended to harvest rainwater to make water available all-year-round for animal watering, irrigation and household consumption (Ministry of Monitoring and Evaluation 2019). The 1V1D project is part of the Government's initiatives under the Infrastructure for Poverty Eradication Program that aimed at improving agriculture, eradicating poverty and inequalities and improving livelihoods in rural communities in Ghana. A total of 560 small dams are to be constructed across

the beneficiary regions. Out of the target, 426 of the dams have been fully completed (Agyeman and Bruce 2021). The rest of the dams are expected to be completed in the next three years (Awadzi 2023). However, amidst these interventions, water stress continues to be a challenge in the northern regions of Ghana, especially during the dry seasons (Handayani et al. 2019). This has led to growing public concerns in the country over the potential of the project to stave off water stress and improve livelihood activities in the beneficiary regions. There is inadequate research attention on the local impact of the project to provide an empirical basis for reviewing and restructuring the project to achieve its intended objectives.

In the traditional setting in rural Ghana, water availability for household consumption remains the duty of women due to strict gender roles which put an additional burden on women compared to their male counterparts in periods of water stress (Kayser et al. 2019; UNESCO World Water Assessment Programme 2019). According to Arku and Arku (2010), women are more prone to the effects of drought or lack of water than men owing to women's reproductive and productive workload. While inadequate water supply in northern Ghana remains a key developmental challenge, its implication on the work-life balance of women has been less investigated. Here, work-life balance is defined to involve two dimensions: the amount of time one spends at work life versus non-work life, and minimal conflict between social roles in work and non-work life (Sirgy and Lee 2018). The focus on work-life balance is because it has remained under-studied. However, the current challenges facing humanity such as increased competition and changing times, especially changes in hours of business, organisations, families and labour markets (Fleetwood 2007) make it imperative for a thorough consideration. Also, the recent attempts by governments, including that of Ghana, feminist groups and organisations to encourage women to work (Ghana Today 2022; Kwaku Ohemeng and Adusah-Karikari 2015; Ministry of Gender Children and Social Protection 2015) make it necessary to understand how the 1V1D project is helping to improve the balance or otherwise between work and family/private lives of women. The Savelugu Municipality located in the northern part of the Northern Region of Ghana is one of the beneficiaries of the 1V1D programme. Even though the municipality experiences water scarcity alongside other parts of northern Ghana, the communities in the municipality are highly engaged in rain-fed agriculture, particularly lowland rice production (Jaharatu 2021). Also, many of the communities in the municipality have been battling for water of all kinds during the dry season (Seidu et al. 2021). Thus, the study area was selected to examine the state of the 1V1D project. The objectives were to investigate the extent to which the implementation of the project has ameliorated water stress and its impact on local livelihoods and the work-life balance of women in the beneficiary communities.

2. A conceptual framework for livelihood enhancement, work-life balance and rainwater harvesting

The study adopted an integrated framework approach by drawing on theories/frameworks on livelihood enhancement and work-life balance. For livelihood enhancement, the study adopted the sustainable livelihood framework because it offers a holistic way to understand the main factors affecting people's livelihoods, namely, vulnerability and the linkages between them. It examined livelihood in terms of vulnerability, assets, transformation, strategies and outcome (DfID 1999; Scoone 1998). Vulnerability involves shocks, i.e. in this study seasonal water stress. The asset comprises the following capitals: human (human resources that are determined by people's qualities), social (human resources determined by the relationships people have with others), natural (natural resources used by people), physical (resources created by people) and financial (finance available to people). Transformation involves private and government structures, such as policies and programmes, for example in this study, RWH facilities. Strategies include activities for preventing or minimising vulnerability to improve people's livelihoods. From a people-centred perspective, analysis of livelihoods requires understanding people's assets, objectives and the strategies adopted to achieve those objectives (FAO 2006). The framework is useful in this study for exploring the linkages between RWH and local livelihood activities.

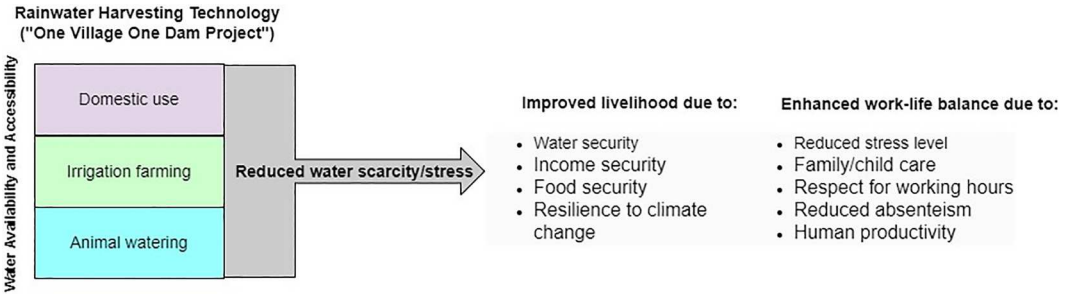

Figure 1. Integrated framework for the impact of rainwater harvesting technology on livelihoods and work-life balance.

The last decades have witnessed increasing research interest in work-life balance. Different theories, such as the segmentation theory and border theories, have been proposed to explain the relationship between work and life activities. The segmentation theory (Young and Kleiner 1992) explains the relationship between work and home as segmented domains, that are independent of each other, while the border theory (Clark 2000) views individual work and family domains as different domains separated by physical, temporal or psychological borders. A key drawback of the theories is that work and family life are considered as separate compartments which means transition or integration can be difficult depending on the kind of permeability existing between the domains (Rincy and Panchanatham 2014).

This study adopted the human capital theory to explain how the development of water resource projects, such as RWH facilities impacts the work-life balance. The theory opines that people can make informed decisions by prioritising their time and making choices about how to spend resources (Shaffer et al. 2001). It posits that time and energy are finite exhaustible commodities; therefore, once spent they are not available for other tasks. Thus, the theory provides insights into understanding how the interaction of family- and work-based inputs drive work-life balance. Struggles to maintain a balance between the two can trigger inter-role conflict when one domain interferes with the other one. According to Greenhaus and Beutell (1985), there is often a struggle between work and family in terms of resource allocation, i.e. time and energy. Here, it is argued that water stress can heighten inter-role conflict between work and family domains of working women. Therefore, intervention programmes such as the 1V1D project aimed at improving households' availability and accessibility to water can save women time and energy. The positive outcomes from both domains, in the context of this study, time and energy saved by women provide rewards like positive impact on how one feels and acts in the other domain (Rincy and Panchanatham 2014) and associated livelihood opportunities for sustenance. The integrated framework (Figure 1) was also used to explore the extent to which RWH can enhance or otherwise the synergies between livelihood activities and work-life balance.

3. Methodology

3.1. Study area

The study was conducted in the Savelugu Municipality in the Northern Region of Ghana located at 9° 37′26.4″N 0°49′40.8″W, (Figure 2). It covers an area of 1550 km^2. The municipality has a population of 122,888 people (Ghana Statistical Service 2021). The main economic activity in the municipality is agriculture. The Savelugu Municipality is in the interior Guinea Savannah woodland agroecological zone which coincides with the Aw climate under the Koppen's classification of climates (Owusu 2018). Like other areas in northern Ghana, the average annual rainfall is about 1000 mm and is restricted to the summer months. The single rainfall which peaks in October is followed by a

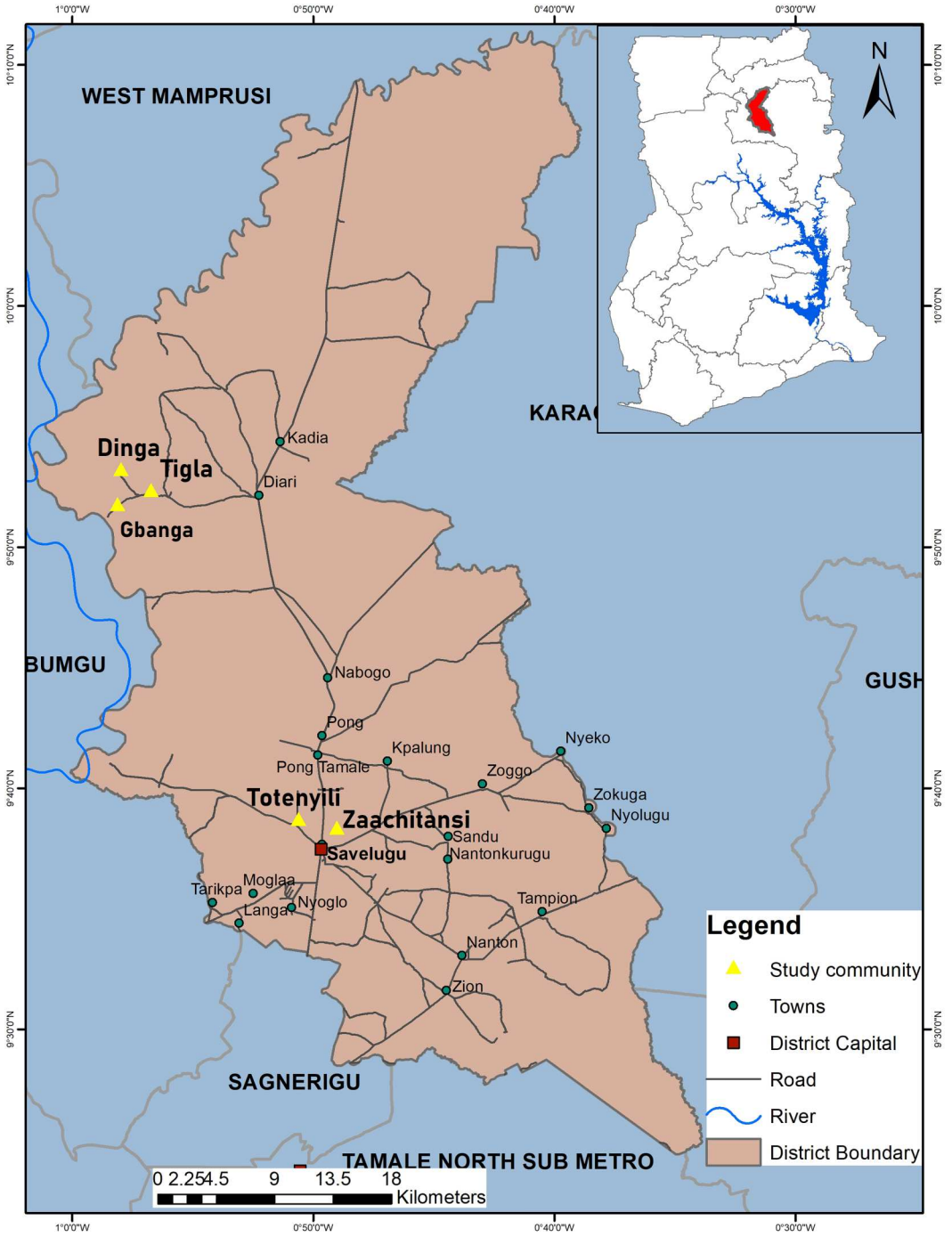

Figure 2. A map of the Savelugu Municipality showing the study sites.

prolonged dry season when the Tropical continental airmass dominates the interior of the West African sub-region. The associated dry, cold and dusty winds from the Sahara Desert known as the "harmattan" are characterised by no rainfall and low humidity that results in high evapotranspiration. Many open water sources like ponds, streams and even rivers dry up during the Boreal winter,

which creates water stress for both domestic and agricultural water needs. The uni-modal rainy season coupled with a lack of irrigation supports one cropping season under rain-fed agriculture which is widely practised in the municipality. The lack of water for all-year-round cultivation is a major hindrance hampering agricultural development, household income and food security. It is, therefore, a welcome relief for the municipality to be able to store rainwater under the 1V1D project for animal watering, domestic water uses and dry season agriculture as intended under the initiative.

3.2. Data collection and analysis

The study used an exploratory qualitative design to explore the experiences of the research participants and to address the conceptual question of whether the implementation of RWH technologies like the 1V1D project can improve livelihoods and work-life balance, especially of women who are culturally responsible for providing the water needs of their households in many Ghanaian settings, including the study communities. The data collection for this study involved sequentially designed steps to ease fieldwork protocols and to ensure that high-quality data were gathered. First, a preliminary interaction was held with key informants before the fieldwork to help map out the study communities and the sites of the dams. The key informant interaction revealed that the Savelugu Municipality is delineated into four geographical zones, namely, Savelugu, Moglaa, Pong-Tamale and Diare. Most of the communities in the different zones had communal and/or private-owned dams (dugouts for water storage) before the implementation of the 1V1D project. At the time of the fieldwork, the project had been implemented in Savelugu and Diare zones, while Pong-Tamale and Moglaa were yet to benefit. Based on the preliminary information gathered, Savelugu and Diare zones were selected for the study. The study communities were Savelugu New Town, Totenyili and Zaachitansi in the Savelugu zone and Dinga, Gbanga and Tigla in the Diare zone.

The next step after mapping out the study communities was the actual fieldwork, which took place in December 2021 just after the onset of the harmattan season. The dry season was a suitable period to allow the study participants to remember and share their current experiences and observations on the dams. Also, the timing of the fieldwork offered the researchers an opportunity to observe the state, performance and possible sustainability of the dams. Because the objectives of the study were to understand the implementation status of the 1V1D and investigate its impact on the livelihoods of the local people and the work-life balance of women, the participants included household heads of both genders engaged in different economic activities. Involving women with diverse livelihood activities was useful to obtain a holistic picture of the impact of the 1V1D project.

Data collection involved the use of focus group discussions (FGDs), key informant interviews (KIIs), informal conversations and field observations. A separate FGD was conducted with a male group and a female group in each of the study communities. There was an average of 11 people in each group. The average age of the participants was 45 years. To select the focus group participants, assistance was sought from local contact persons identified in the communities. The participants were then selected using a convenience sampling technique based on the willingness of the individual to participate in the discussion. The FGDs and KIIs revolved around the following themes: livelihood activities, source of water and water scarcity/stress, water supply and the role of gender, effect of water scarcity/stress on the livelihoods and work-life balance of women. Questions were also asked on the impacts the 1V1D project implementation has had on livelihood activities and the work-life balance of women in the communities (See details of the interview guide in the Appendix). Although the study examined the perspectives of both men and women, regarding work-life balance, we primarily focused on women, because a previous study in northern Ghana by Jeil, Abass, and Ganle (2020) and the preliminary interactions revealed that women disproportionately are responsible for fetching water for domestic use. A total of 12 FGDs (six male and six female groups, Table 1) and seven KIIs (Table 2) were conducted in the study communities. Interviews were conducted in the local

Table 1. Demographic characteristics of the study communities and an overview of the focus group discussions conducted.

Community	Approx. population of the community*	Group§	Number of participants§	Main livelihood activities of participants
Savelugu New-Town	10,000	MG1[a]	11	Farming, trading, teaching, and nursing.
		FG1[b]	10	
Tigla	250	MG2	12	Farming, trading, and teaching
		FG2	12	
Gbanga	500	MG3	15	Farming, trading, and teaching
		FG3	10	
Zaachitansi	1000	MG4	11	Farming and trading
		FG4	9	
Totenyili	230	MG5	13	Farming and trading
		FG5	13	
Dinga	1000	MG6	13	Farming and trading
		FG6	14	

[a]MG (Male Group), and [b]FG (Female Group).
* Population data were based on information provided by key informants in the communities because of challenges in accessing official population data for the communities.
§ Data reported in Owusu and Obour (2023).

Table 2. Overview of key informant interviews conducted.

Level	Occupation	Category
Institutional level		
Municipal Assembly	Municipal Planning Officer	KI1
	Municipal Budget Officer	KI2
Municipal Agriculture Directorate	Agriculture Extension Officer	KI3
Community level		
Savelugu New-Town	Assembly Member	KI4
Adayili	Assembly Member	KI5
Zaachitansi	Assembly Member	KI6
Totenyili	Assembly Member	KI7

Note: KI indicates Key Informant.
Source: Data reported in Owusu and Obour (2023).

dialect (Dagbani) with the assistance of local field assistants. Written notes and audio recordings were taken during the discussions. The recording was done using a digital recorder.

3.3. Data processing and analysis

The study adopted content analysis of the views of the participants in the KII and FGD. First, the recorded interviews were listened to and transcribed into English. Guided by the study objectives, the varied views expressed by the participants were synthesised. Concepts and themes were extracted from the transcriptions guided by the theoretical/conceptual framework underpinning the study. The main thematic areas obtained included the state of water stress, 1V1D implementation status and drawbacks, the 1V1D project and livelihoods and the 1V1D project and the work-life balance. The themes shaped the write-up of the findings and discussion sections. Verbatim quotations were extracted from the transcripts to support descriptions and narratives in the discussions section, whenever necessary.

4. Findings

4.1. implementation of 1VID project in Savelugu Municipality

Although the 1V1D project initiative was launched in 2017, the KII and FGDs indicated that the construction phase of the dams in the Savelugu Municipality began in 2018 as emphasised in the following statement by a participant from the Salelugu Municipal Assembly:

> The project (1V1D) involved constructing dams for rainwater harvesting in the northern regions of Ghana where water scarcity is a perennial problem. I have to say that Savelugu Municipality is very lucky to be a beneficiary. Construction of the dams started in 2018, just about a year after the project was launched. (Male respondent, Savelugu Municipal Assembly)

Implementation of the project in the municipality involved the construction of new dams and/or rehabilitation of existing communal dams. A total of six dams were constructed at the time of the fieldwork in 2021. The distance from the communities to the dams ranged from 1 km in Zaachitansi to about 2 km in Dinga (Table 3).

Management strategies adopted by the communities to ensure the sustainability of the dams included by-laws on the use of the water and periodic communal labour around the dam site to protect the banks from erosion. The main implementation challenges faced by the communities are the pollution of the dams' water by a herd of Fulanis and early dry out due to engineering flaws, especially shallowness and poor design. A 50-year-old farmer in Zaachitansi lamented:

> We told the contractor that the dam he constructed was too shallow and poorly designed in terms of its size and catchment area to collect runoff, but he did not mind us. He told us that we were not the one who awarded him the contract so we cannot tell him what to do so we kept quiet. Now we are the victims of all the shoddy work the contractor did!

4.2. Impact of the 1V1D project

As stated earlier, the 1V1D project was intended to enhance the livelihoods of the local people by improving access to water for livestock watering, domestic activities and all-year-round farming to help alleviate poverty and reduce inequalities, with a particular focus on rural and disadvantaged communities. For the conceptual analytical tool adopted, first, findings on the impact of the project on the livelihood of the local people are presented followed by a presentation of the impacts of the project on the work-life balance of women, especially working women.

4.2.1. Local livelihood activities

Rainfed agriculture is the main source of sustenance in the study communities and there was high hope that the implementation of the 1V1D project was going to enhance irrigation crop production as intended by the project objective. Unfortunately, the dams have not met that expectation due to engineering flaws resulting in rapid siltation and early dry-out. According to a 51-year-old female FGD participant in Totenyili, "because of the small nature of the dam, we (people in the community) are unable to use the dams' water for farming activities because there is not enough water for that purpose".

For animal watering, even though the communities were not formally using the dams' water for animal watering, it was reported that the Fulani herdsmen were using the dams' water for that purpose. Further probes indicated that the herdsmen often flouted the by-laws forbidding animal entry into the dams and instead allowed their herd to drink directly from the water, which was undermining the communities' efforts at preserving the dams. For instance, at the time of the

Table 3. Overview of the 1V1D project implementation and characteristics.

Community	Status of the dam	Approximate distance (km) between the community and the dam	Year of implementation§
Savelugu New-Town	Existing dam	1.3	2020
Tigla	Existing dam	1.2	2020
Gbanga	Existing dam	2.5	2018
Zaachitansi	New dam	1.0	2019
Totenyili	Existing dam	1.4	2018
Dinga	Existing dam	2.0	2020

§ Data reported in Owusu and Obour (2023).

fieldwork, water in the dams at Savelugu New Town and Dinga, highly settled by Fulani herdsmen, was visibly muddy due to pollution by animals. As a result, households in communities settled by Fulani herdsmen were not using the dams' water for household chores as intended. The water was only used for washing and construction as highlighted by the Assembly member of Savelugu New Town:

> The main problem we (the community members) face is competition for water by Fulani herdsmen. In fact, they allow their herd to drink directly from the dams, polluting the water to the extent that people can only use the water for construction. This is something the entire community is working on to find a lasting solution.

With respect to the theoretical/conceptual framework underlying the study, it could be argued that the implementation of the project has not considerably changed the primary livelihood activities of the beneficiary communities. Consequently, the communities remained vulnerable to severe seasonal water shortages which pose an imminent threat to household water and food security. Water stress also has an adverse impact on human health because sometimes people depend on non-potable water for domestic chores. In the opinion of a 45-year-old man in Gbanga:

> Seasonal water scarcity/stress has become a ritual affecting the people in the community (Gbanga). The limited number of boreholes compared to the number of people in the community, means there is so much pressure on it during the dry season. Often the boreholes break down due to excessive use. When that happens, people are forced to depend on any source of water, clean and unclean but the health consequences of using unhygienic water can be huge.

Despite the inability of the project to achieve irrigation farming and animal watering, some unintended benefits have emerged in the communities. Paramount among them was reported to be water commercialisation, especially in Totenyili, Zaachintasi and Savelugu New Town due to the proximity of the communities to the Savelugu township. The commercial vendors fetched water from the dams and delivered it to their customers in Savelugu, as shown in Figure 3.

The sale of water was reported to have created a source of economic sustenance for the vendors thus, enhancing their income security. However, some concerns were raised regarding booming water commercialisation. The KII and FGD highlighted that the activity put pressure on the dams, contributing to early dry out as pointed out by a 68-year-old male key informant in Zaachitansi pointed out that: … *the construction of the dams has created sources of economic sustenance for water vendors … the vendors come to the dam using tricycles to fetch water for sale to customers in and outside the community … thus they fetch the water for commercial purposes …*

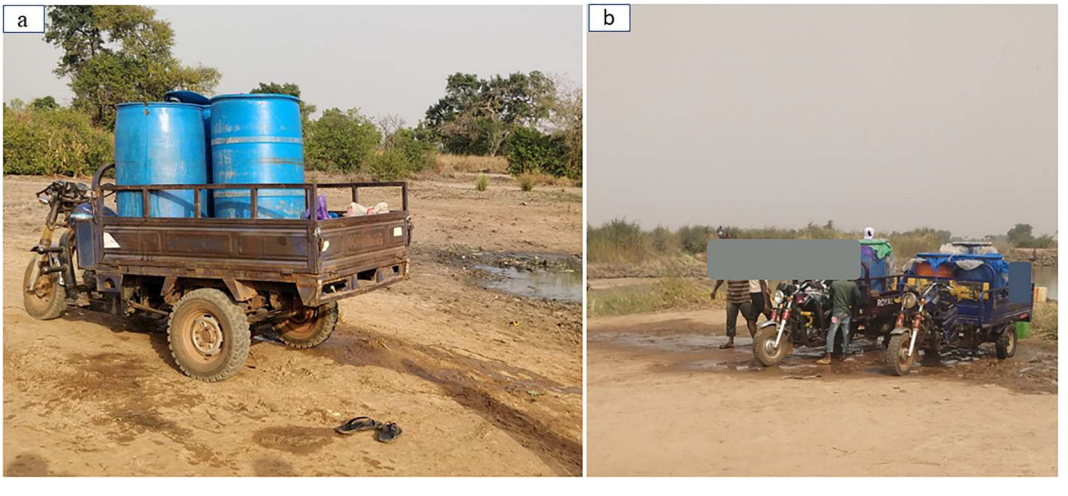

Figure 3. Water vendors fetching water from the 1V1D dam in (a) Zaachitansi and (b)Totenyili to supply to residents in Savelugu.

The above observation was reiterated by a 35-year-old female FGD participant in Totenyili, who said:

> … the dam in this community has been made open for the public. Even people from other communities are allowed to come and fetch the water, and because of that, people come in to fetch the little water and go to sell it to others who want the water to be delivered at their door-steps … the vendors just keep selling the water and if the dam dries out we really suffer … in fact, high demand for water contributes to early dry out of the dam during the dry season when the dams' water is needed most …

In Savelugu New Town, fish reared in the dams are sold to generate income to support community activities. In Zaachitansi and Totenyili, levies collected from water vendors are equally used to support activities like communal labour and festivals.

4.2.2. Work-life balance

The KII and FGDs revealed that the responsibility to fetch water for household use is primarily the work of women and children. For example, only about one-third of the males interviewed assisted their households in collecting water from the dams often on bicycles and motorbikes. Unlike the males, only a quarter of the females interviewed reported that they fetched water using bikes/motorbikes. The majority of the females interviewed (70%) collected water from the dams on foot, as shown in Figure 4. A trip to fetch water from dams can take an average of 40 min on foot, 25 min by bicycle and 15 min by motorbike. During periods when the dams have dried up, the time spent in search of water can be as much as 3 h or more per trip.

The time spent by the women in search of water combined with their family responsibilities such as cooking, washing and running the house at large put a huge pressure on them. A 29-year-old female at Tigla expressed the burden of water stress on women:

> If the government cannot construct an additional dam, they should drill a borehole for the community to take care of the growing population … because women in the community cannot be walking for long hours before getting water during the dry season … how can we, women prepare food for our families if we use all our time to search for water?

Despite the benefits reported, challenges like pollution of water in the dam by cattle and drying out of the dams during the peak of the dry season when households need the water most are major constraints to meeting water demand for household consumption. Overall, it was reported that the implementation of the project has only slightly shifted the period of water shortage to about a

Figure 4. Women carrying water on the head from a dam site in Savelugu Municipality.
Source: Appiah (2021).

month later than it used to be. Households still faced severe water shortages during the peak of the long dry season, around mid-January to February. During this period, households relied largely on the few boreholes within and outside their communities which can be time-consuming and adversely affect the work-life balance of especially women.

Discussion

Water is a major limiting resource for house consumption and rainfed crop production in dryland areas. Rainwater harvesting (RWH) can reduce the socio-economic impacts of water scarcity and restrictions on irrigation in dry years to build community resilience (Adhikari, Timsina, and Lamichhane 2018). Sharma et al. (2009) reported that the use of RWH for supplemental irrigation considered increased crop yields by 100% in Sukhomajri village in India, and by 20–40% in Yongjing County. Tamagnone et al. (2020) and Vohland and Barry (2009) posited that in dryland areas of Africa, high dependency on rain-fed agriculture makes the areas susceptible to increasing climate change and variability, which can adversely affect household food and human security. Biazin et al. (2012) argued that in sub-Saharan Africa, RWH technologies hold important potential for sustaining rain-fed agriculture, and it is a key component in the drive for green revolution and adaptation to increased temperature and rainfall variability caused by climate change.

Rain-fed agriculture is a major livelihood activity of about 90% of the inhabitants in the Savelugu Municipality (Jarawura 2014). Therefore, the implementation of the 1V1D project to improve water security and make water available for supplemental irrigation was expected to strengthen climate change adaptation for resilient agricultural production and enhance local livelihoods. However, at the time of the fieldwork in 2021, none of the water harvesting dams in the study communities supported irrigation farming because of early dry out during the dry season. Ghansah et al. (2022) argued that in addition to rainfall patterns affecting water availability in small dams, the rate of drying out of small dams in the Upper East region in northern Ghana highly depended on the location where the dams were sited (whether up-, middle – or downstream) and size. In the present study, the respondents' narration and the researchers' observation of the dam site showed that early dry-out of the dams in the study communities is strongly attributed to the small and shallow nature of the dams. The engineering flaws have indeed, undermined the potential of the dams to salvage water scarcity issues faced by households, particularly during the peak of the dry season. Thus, during the dry season, households still hugely depended on a limited number of boreholes within and around their communities. Also, agriculture in the study communities remained rainfed which restricted production only to the rainy season. However, water commercialisation that has emerged from the construction of the dams was reported to have provided a source of economic sustenance for many of the youth. But again, water vending is a short-lived activity because of the early dry-out of the dams during the dry season. The findings consolidated the observation by Akuffobea-Essilfie et al. (2020) who pointed out that besides the potential of RWH to address water stress and water insecurity problems in Ghana, the adoption of the technology can create job opportunities to improve the economic livelihoods of people. The present study revealed that the dams have additional benefits like income generation from the sale of fish kept in the dams in Savelugu New Town, and from levies collected from water vendors in Totenyili. The income generated was used to support communal activities like providing refreshments during communal cleaning and other events.

Previous studies in the Volta region by Arku (2010) and Arku and Arku (2010), and in the Northern Region of Ghana by Jeil, Abass, and Ganle (2020) concluded that sporadic water shortage poses a differential burden on female and males in rural Ghana. Evidence from the study communities showed that compared to males, females bear a disproportionately heavy portion of the burden during water stress because of their gender roles. The findings showed that all the women interviewed collected from the dams and other sources for domestic use while only a small fraction of the men (about 20%) reported that they did. Also, except for those who owned or had access to bicycles and motorbikes, women tended to spend many hours and cover longer distances per

trip in search of water compared to men who often fetched water on motorbikes. The results add to previous findings indicating that longer distances are covered in search of water in periods of water stress, which negatively affects the well-being of women in particular because of their cultural responsibility in fetching water for their households (Arku 2010; UNICEF 2017).

With regard to the work-life balance, the findings showed that the implementation of the 1V1D project was reported to have reduced the hassle women and children go through in search of water for household consumption, at least during the early parts of the dry season. The time saved by women enabled them to fulfil the demands of family life and farming and trading, which were the predominant economic activities of the women interviewed. From the point of view of working women, the implementation has an enormous positive impact on their work-life balance because the time spent in search of water has somehow reduced compared to before the implementation of the 1V1D project. The main personal/family-related benefits reported include reduced stress levels, enhanced flexibility of schedule and improved family/childcare. The benefits of the dams to employers/workplaces include were reported to be reduced absenteeism, respect for working times and increased productivity. Overall, the 1V1D has enhanced synergies between local livelihood activities and the work-life balance of women. However, the sustainability of improved work-life balance is threatened by early dry-out of the dams, sometimes before the peak of the dry season when water in the dams is needed most to meet the communities' water needs.

5. Conclusions and recommendations for policy

The study investigated the impacts of the Government of Ghana rainwater harvesting programme popularly called One Village One Dam (1V1D) in dryland areas of northern Ghana on local livelihoods and the work-life balance of women based on a case study of Savelugu Municipality. Evidence from the study suggested that the implementation of the 1V1D project in the study communities has minimal positive impact on household water security despite some reported benefits. The dams have created a means of economic sustenance for water vendors. Availability and accessibility of water in the dams have somehow reduced the distance and time spent by women in search of water for domestic use, which was reported to have a positive impact on the work-life balance of especially working women. However, the benefits of the 1V1D project in the study communities are undermined by two key constraints: (i) pollution of the water in the dams by cattle which made the water unwholesome for domestic use and (ii) early dry-out of the dams due to engineering flaws, which hindered the potential of the dams to support irrigation agriculture during the harmattan season. The study points out the need for the Government of Ghana to address the engineering flaws identified by retrofitting the existing dams and mainstreaming future 1V1D projects. For instance, the shallowness problem can be addressed by constructing deeper dams and raising the dams' banks to reduce siltation. In terms of competing use of the dams' water leading to pollution by animals, different dams should be constructed for specific uses. Also, there is an urgent need for the government to supplement the 1V1D projects with alternative water sources like underground boreholes to reduce pressure on the dams and ensure water availability during the peak of the dry season to effectively tackle water stress in dryland areas in the country. Addressing the flaws identified will also be relevant to change public narratives and scepticism about the potential of the project. The study made significant contributions to policy by outlining major drawbacks of the project that are undermining its intended benefits. Also, the study has provided insights into the conceptual and social question of whether the 1V1D project has improved local livelihoods and work-life balance in the beneficiary communities.

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References

Adhikari, S. P., K. P. Timsina, and J. Lamichhane. 2018. "Adoption and Impact of Rain Water Harvesting Technology on Rural Livelihoods: The Case of Makwanpur District, Nepal." *Rural Extension and Innovation Systems Journal* 14 (1): 34–40.

Agodzo, S. K., E. Bessah, and M. Nyatuame. 2023. "A Review of the Water Resources of Ghana in a Changing Climate and Anthropogenic Stresses." *Frontiers in Water* 4:973825. https://doi.org/10.3389/frwa.2022.973825.

Agyeman, N. K., and E. Bruce. 2021. "426 Dams Built under One Village, One Dam Initiative. Graphic Online (February, 19, 2021). " Accessed November 24, 2023. https://www.graphic.com.gh/news/general-news/426-dams-builtunder- one-village-one-dam-initiative-hawa-koomson.html.

Akuffobea-Essilfie, M., P. A. Williams, R. Asare, S. Damman, and G. O. Essegbey. 2020. "Promoting Rainwater Harvesting for Improving Water Security: Analysis of Drivers and Barriers in Ghana." *African Journal of Science, Technology, Innovation and Development* 12 (4): 443–451. https://doi.org/10.1080/20421338.2019.1586113.

Aladenola, O. O., and O. B. Adeboye. 2010. "Assessing the Potential for Rainwater Harvesting." *Water Resources Management* 24 (10): 2129–2137. https://doi.org/10.1007/s11269-009-9542-y.

Appiah, P. 2021. "Water Crisis in Some Communities in the Savelugu District." *MyJoy Online*, May 10, 2021. Accessed March 17, 2023. https://www.myjoyonline.com/water-crisis-in-some-communities-in-the-savelugu-district/.

Arku, F. S. 2010. "Time Savings from Easy Access to Clean Water." *Progress in Development Studies* 10 (3): 233–246. https://doi.org/10.1177/146499340901000303.

Arku, F. S., and C. Arku. 2010. "I Cannot Drink Water on an Empty Stomach: A Gender Perspective on Living with Drought." *Gender & Development* 18 (1): 115–124. https://doi.org/10.1080/13552071003600091.

Awadzi, H. 2023. "About 440 Communities to Benefit from the One Village One Dam Project, (July 24, 2023)." Accessed November 24, 2023. https://gna.org.gh/2023/07/about-440-communities-to-benefit-from-the-one-village-one-dam-project/.

Biazin, B., G. Sterk, M. Temesgen, A. Abdulkedir, and L. Stroosnijder. 2012. "Rainwater Harvesting and Management in Rainfed Agricultural Systems in sub-Saharan Africa – A Review." *Physics and Chemistry of the Earth, Parts A/B/C* 47-48:139–151.

Che-Ani, A. I., N. Shaari, A. Sairi, M. F. M. Zain, and M. M. Tahir. 2009. "Rainwater Harvesting as an Alternative Water Supply in the Future." *European Journal of Scientific Research* 34 (1): 132–140.

Clark, S. C. 2000. "Work/Family Border Theory: A New Theory of Work/Family Balance." *Human Relations* 53 (6): 747–770. https://doi.org/10.1177/0018726700536001.

DeNicola, E., O. S. Aburizaiza, A. Siddique, H. Khwaja, and D. O. Carpenter. 2018. "Climate Change and Water Scarcity: The Case of Saudi Arabia." *Annals of Global Health* 81 (3): 342–353. https://doi.org/10.1016/j.aogh.2015.08.005.

DfID. 1999. *Sustainable Livelihoods Guidance Sheet*. London: DFID.

Di Baldassarre, G., M. Sivapalan, M. Rusca, C. Cudennec, M. Garcia, H. Kreibich, M. Konar, et al. 2019. "Sociohydrology: Scientific Challenges in Addressing the Sustainable Development Goals." *Water Resources Research* 55 (8): 6327–6355. https://doi.org/10.1029/2018WR023901.

Dos Santos, S. M., and M. M. M. de Farias. 2017. "Potential for Rainwater Harvesting in a dry Climate: Assessments in a Semiarid Region in Northeast Brazil." *Journal of Cleaner Production* 164:1007–1015. https://doi.org/10.1016/j.jclepro.2017.06.251.

FAO. 2006. *Building on Gender, Agrobiodiversity and Local Knowledge: A Training Manual*. Rome. Italy.

FAO. 2016. *Water Accounting and Auditing: A Sourcebook.* Rome. Italy.

Felter, C., and K. Robinson. 2021. *Water Stress: A Global Problem that's Getting Worse*. https://www.cfr.org/backgrounder/water-stress-global-problem-thats-getting-worse.

Fleetwood, S. 2007. "Why Work–Life Balance Now?" *The International Journal of Human Resource Management* 18 (3): 387–400. https://doi.org/10.1080/09585190601167441.

Ghana Statistical Service. 2021. *Ghana 2021 Population and Housing Census General Report*. Accra.

Ghana Today. 2022. "Affirmative Action, the Guaranteed Way to Increasing Women's Representation in Decision Making Spaces in Ghana, 2022."

Ghansah, B., T. Foster, T. P. Higginbottom, R. Adhikari, and S. J. Zwart. 2022. "Monitoring Spatial-Temporal Variations of Surface Areas of Small Reservoirs in Ghana's Upper East Region Using Sentinel-2 Satellite Imagery and Machine Learning." *Physics and Chemistry of the Earth, Parts A/B/C* 125:103082. https://doi.org/10.1016/j.pce.2021.103082.

Greenhaus, J., and N. Beutell. 1985. "Sources of Conflict Between Work and Family Roles." *The Academy of Management Review* 10:76–88. https://doi.org/10.2307/258214.

Handayani, I. G. A. K. R., G. A. K. Rachmi, H. Glaser, S. Monteiro, E. D. Kusumawati, A. K. Jaelani, and F. U. Najicha. 2019. "Water Availability in the Framework of Environmental Justice: Reconstruction of Municipal Waterworks (Pdam) Regulations." *International Journal of Business, Economics and Law* 20 (4): 20–40.

Helmreich, B., and H. Horn. 2009. "Opportunities in Rainwater Harvesting." *Desalination* 248 (1-3): 118–124. https://doi.org/10.1016/j.desal.2008.05.046.

Hussain, M., A. R. Butt, F. Uzma, R. Ahmed, S. Irshad, A. Rehman, and B. Yousaf. 2020. "A Comprehensive Review of Climate Change Impacts, Adaptation, and Mitigation on Environmental and Natural Calamities in Pakistan." *Environmental Monitoring and Assessment* 192 (1): 48. https://doi.org/10.1007/s10661-019-7956-4.

Incoom, A. B. M., K. A. Adjei, and S. N. Odai. 2020. "Rainfall Variabilities and Droughts in the Savannah Zone of Ghana from 1960-2015." *Scientific African* 10:e00571.

Jaharatu, A. 2021. *Understanding the Hydro-Climate Information Needs of Lowland Rice Farmers in Savelugu Municipality of Northern Ghana*. MPhil thesis, University for Development Studies, Tamale.

Jarawura, F. X. 2014. "Perceptions of Drought among Rural Farmers in the Savelugu District in the Northern Savannah of Ghana." *Ghana Journal of Geography* 6:102–120.

Jeil, E. B., K. Abass, and J. K. Ganle. 2020. "'We are Free When Water is Available': Gendered Livelihood Implications of Sporadic Water Supply in Northern Ghana." *Local Environment* 25 (4): 320–335. https://doi.org/10.1080/13549839.2020.1744118.

Kayser, G. L., N. Rao, R. Jose, and A. Raj. 2019. "Water, Sanitation and Hygiene: Measuring Gender Equality and Empowerment." *Bulletin of the World Health Organization* 97 (6): 438–440. https://doi.org/10.2471/BLT.18.223305.

Kwaku Ohemeng, F. L., and A. Adusah-Karikari. 2015. "Breaking Through the Glass Ceiling: Strategies to Enhance the Advancement of Women in Ghana's Public Service." *Journal of Asian and African Studies* 50 (3): 359–379. https://doi.org/10.1177/0021909614530381.

Ministry of Gender Children and Social Protection. 2015. *Mainstreaming gender equality and women's empowerment into Ghana's development efforts*.https://www.mogcsp.gov.gh/?mdocs-file=654, March 7, 2024.

Ministry of Monitoring and Evaluation. 2019. *Rapid evaluation of One Village, One Dam Project Under IPEP*, 2019. Available online: http://mome.gov.gh/rapid-evaluation-of-one-village-one-dam-project-under-ipep/[Accessed.

Muriu-Ng'ang'a, F. W., M. Mucheru-Muna, F. Waswa, and F. S. Mairura. 2017. "Socio-economic Factors Influencing Utilisation of Rain Water Harvesting and Saving Technologies in Tharaka South, Eastern Kenya." *Agricultural Water Management* 194:150–159. https://doi.org/10.1016/j.agwat.2017.09.005.

Mwenge Kahinda, J., and A. E. Taigbenu. 2011. "Rainwater Harvesting in South Africa: Challenges and Opportunities." *Physics and Chemistry of the Earth, Parts A/B/C* 36 (14): 968–976. https://doi.org/10.1016/j.pce.2011.08.011.

Orr, S., and G. Pegram. 2014. *Business Strategy for Water Challenges: From Risk to Opportunity*, 78 pp, Oxford: Routledge.

Owusu, K. 2018. "Rainfall Changes in the Savannah Zone of Northern Ghana 1961–2010." *Weather* 73 (2): 46–50. https://doi.org/10.1002/wea.2999.

Owusu, K., and J. Kofi Teye. 2015. "Supplementing Urban Water Supply with Rainwater Harvesting in Accra, Ghana." *International Journal of Water Resources Development* 31 (4): 630–639. https://doi.org/10.1080/07900627.2014.927752.

Owusu, K., and P. B. Obour. 2023. "An Evaluation of Government's Rainwater Harvesting Program in Dryland Area of Northern Ghana." In *Handbook of Nature-Based Solutions to Mitigation and Adaptation to Climate Change*, edited by Walter Leal Filho, Gustavo J. Nagy, and Desalegn Yayeh Ayal, pp. 1–22, Cham: Springer.

Rafiei-Sardooi, E., A. Azareh, S. Joorabian Shooshtari, and E. J. R. Parteli. 2022. "Long-term Assessment of Land-use and Climate Change on Water Scarcity in an Arid Basin in Iran." *Ecological Modelling* 467:109934. https://doi.org/10.1016/j.ecolmodel.2022.109934.

Rincy, V. M., and N. Panchanatham. 2014. "Work Life Balance: A Short Review of the Theoretical and Contemporary Concepts." *Continental Journal of Social Sciences* 7 (1): 1–24.

Scoone, I. 1998. *Sustainable Rural Livelihoods: A Framework for Analysis*. Brighton: Institute of Development Studies.

Seidu, Y., N. Kyei-Baffour, A. Bawa, A. M. Mohammed, Z. Issaka, and J. Ayuba. 2021. "Assessment of Water Supply Sources in the Three Districts of Northern Ghana in Terms of Availability, Use and Sufficiency." *ADRRI Journal of Engineering and Technology* 5 (3(4) October–December): 17–34.

Shaffer, M. A., D. A. Harrison, K. M. Gilley, and D. M. Luk. 2001. "Struggling for Balance Amid Turbulence on International Assignments: Work-Family Conflict, Support and Commitment." *Journal of Management* 27:99–121. https://doi.org/10.1177/014920630102700106.

Sharma, B., F. Madziva, F. Rwehumbiza, S. Tumbo, S. Sokoine, M. Bouitfirass, M. Boufaroua, M. El Mourid, and A. Ould Salem. 2009. "Rainwater Harvesting in the Management of Agro-Eco Systems." In *Rainwater Harvesting: A Lifeline for Human Well-Being*, edited by J. Barron, 15–23. Stockholm: United Nations Environmental Programme and Stockholm Environment Institute.

Sirgy, M., and D. Lee. 2018. "Work-life Balance: An Integrative Review." *Applied Research in Quality of Life* 13:229–254. https://doi.org/10.1007/s11482-017-9509-8.

Sojka, S., T. Younos, and D. Crawford. 2016. "Modern Urban Rainwater Harvesting Systems: Design, Case Studies, and Impacts." In *Sustainable Water Management in Urban Environments*, edited by T. Younos and T. E. Parece, 209–234. Cham: Springer.

Sukhwani, V., K. Thapa, R. Shaw, S. Deshkar, B. K. Mitra, and W. Yan. 2020. "Addressing Urban–Rural Water Conflicts in Nagpur Through Benefit Sharing." *Water* 12 (11): 2979. https://doi.org/10.3390/w12112979.

Tamagnone, P., L. Cea, E. Comino, and M. Rosso. 2020. "Rainwater Harvesting Techniques to Face Water Scarcity in African Drylands: Hydrological Efficiency Assessment." *Water* 12 (9): 2646. https://doi.org/10.3390/w12092646.

UNESCO World Water Assessment Programme. 2019. *The United Nations world water development report 2019: Leaving no one behind*.

UNICEF. 2017. *Thirsting for a Future: Water and Children in a Changing Climate*.

United Nations. 2015. *Transforming our world: the 2030 Agenda for Sustainable Development*, 2015. https://www.un.org/ga/search/view_doc.asp?symbol¼A/RES/70/1&Lang¼E[Accessed.

Vohland, K., and B. Barry. 2009. "A Review of in Situ Rainwater Harvesting (RWH) Practices Modifying Landscape Functions in African Drylands." *Agriculture, Ecosystems & Environment* 131 (3): 119–127. https://doi.org/10.1016/j.agee.2009.01.010.

Young, L., and B. H. Kleiner. 1992. "Work and Family: Issues for the 1990s." *Women in Management Review* 7 (5): 24–28. https://doi.org/10.1108/09649429210016151.

Appendix 1: Information collected during the fieldwork.

Main theme	Specific information collected
Background information	1. Name of community. 2. The approximate population of the community. 3. The main livelihood activities in the community.
Consultation and construction of the dam	1. When was the 1V1D project implemented in the community? 2. How/why was the community selected to receive the dam? 3. How many of such dams are in the district? 4. Does water stay in the dam throughout the year? 5. Which year did the dam dry out completely or did the level of water reduce drastically? 6. Which month(s) in the year do dry-out occur? 7. Was the community consulted in terms of a. Site selection b. Design c. Ownership d. Management 8. What form did the consultation take? 9. Who was consulted? 10. Who did the consultation?
Challenges and management	1. What are the challenges the dam faces? 2. How are challenges associated with the dam resolved? 3. Are there any abuses in the usage of the dam? 4. What does the community do to maintain the dam? E.g. communal labour, etc. 5. Who has the right to use the dam? 6. What was the dam or water intended for? 7. What is the water being used for now?
Challenges related to dam usage and utilisation competition	1. What are the main challenges with accessing and using water from the dam for the following purpose? [*Irrigation farming, Animal watering, Domestic water needs, other uses*] 2. Is there competition/conflict among the different users of the dam? 3. What are the main competing uses? 4. Does the competition occur throughout the year? 5. What period in the year does competition occur and why?
Impact on livelihood activities	1. What are the key socio-economic livelihood activities in the community? 2. How has the project impacted the livelihood activities?
Impacts on work-life/family balance	1. How does water availability or accessibility or the lack of it affect work-life balance? 2. How has the project impacted the work-life balance of women, particularly those who are working, in this community?