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RESEARCH ARTICLE

Water funds within village savings and loans associations: A promising solution to improve water user fee collection in rural Uganda

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Abstract

Without a functional revenue collection mechanism, rural communities in low-income countries cannot maintain or repair broken water supply infrastructure, such as groundwater wells equipped with handpumps. One approach to promote regular water user payments shifts responsibilities for fee collection from volunteer committees to village savings and loans associations (VSLAs; self-governed investment groups that follow strong accountability practices). We piloted this approach among 10 communities in Kabarole district, Uganda, and evaluated financial outcomes over two years. Qualitative interviews with 249 respondents helped identify drivers of performance and challenges. VSLAs contributed 47–221 USD annually (first-year median: 134 USD, second-year median: 112 USD) for water point upkeep (achieving 45–117% of target amounts). This revenue represented a considerable improvement over the prior scenario where communities had no reserve funds for water point maintenance. Financial transparency and increased social capital appeared to enhance collective efficacy and increase user fee collection. We identified two main threats to VSLA sustainability: perceived unfairness stemming from some water point users not joining the VSLA and the risk of water funds being loaned out if they remained unspent for too long. Coupling the VSLA model with professional handpump maintenance services could help ensure improved long-term water point functionality.

Introduction

In the 1980s, community-based management emerged as the predominant model for operating rural water systems, such as shallow wells and boreholes equipped with handpumps. Backed by foreign development aid, many low- and middle-income country governments enacted policies stipulating that local water user committees, typically comprised of 3–12 elected community members, should be made financially and operationally responsible for continued service delivery [1–3]. This approach appealed to notions of community empowerment, ownership, efficiency, and cost-effectiveness. With limited-to-no training or ongoing support, however, water user committees have struggled to fulfill these lofty expectations of rural water system operation and maintenance [3–8].

this study in Kabarole due to it being one of the funder's priority districts in Uganda. Otherwise, the funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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Notably, voluntary water user committees often ineffectively collect and manage water user fees [1, 5, 9]. This may be in part because fellow water users do not trust in this financial management system and have limited ability and willingness to participate in it [9–13]. Without a functional revenue collection mechanism, most rural communities are left unable to pay for handpump repairs and face extended periods without service [5, 14–17]. Estimates suggest 25% of rural handpumps in sub-Saharan Africa are non-functional at any point in time [18]. In Uganda, this proportion is likely closer to 40% [19–21].

Approximately 60% of Uganda's rural population relies on community-managed handpumps as their primary drinking water source [22, 23]. Although Ugandan national policies have moved away from traditional community-based management (e.g., by promoting payment to professional service providers that can handle infrastructure maintenance), they continue to view water user fees as the primary financing mechanism [24]. Regular water user payments, though, occur at fewer than 25% of handpumps [14, 25, 26]. Identifying approaches to unlock user payments would improve the practicality of Uganda's rural water supply strategy.

One potential approach shifts responsibilities for fee collection to village savings and loans associations (VSLAs). VSLAs are widespread in Uganda as well as much of sub-Saharan Africa and India [27–29]. These self-governed groups of approximately 10–40 members pool their savings to offer each other loans and accrue interest [29–32]. VSLAs have a constitution that is reviewed annually and defines savings and borrowing terms along with the group's bylaws, which include penalties for loan defaulters. Members meet weekly or monthly to deposit savings into a physical lock box. They can take small loans from this internally generated capital. At the end of the year, each member gets back their savings deposited plus a portion of the overall interest earned from loans. To promote accountability, members typically elect three VSLA executives: the chairperson, secretary, and treasurer. In addition, it is common that three other elected members called "key keepers" hold a key to the lock box and record books. The box is usually stored at the treasurer's home. All three keys are needed to open the box, and all transactions take place in public at group meetings. Accounting books are also reviewed at group meetings.

VSLAs, as well as community savings groups and self-help groups more broadly, provide valuable financial services that help poor households manage the day-to-day and alleviate cashflow issues. More broadly, they have the potential to improve economic wellbeing [33–37]. Community savings groups may also help build social capital (i.e., the resource consisting of social networks sharing similar norms and beliefs) and may thus foster collective action (i.e., individuals coordinating and cooperating to achieve a common goal) [38–46]. Studies have found that higher social capital is associated with improved individual and community outcomes across several development domains, including rural water system management [47–52]. These features have made VSLAs an attractive avenue for delivering development initiatives in areas such as climate resilience, health, child protection, gender equality, finance, and agriculture [30, 34, 42, 53, 54]. Similarly, community savings groups have a prolific history in supporting pro-poor urban development, especially related to improved housing and extension of basic services within low-income areas [55–58].

Because of their strong accountability and transparency practices that promote trust, VSLAs may be better suited than traditional water user committees to collect and manage water user fees [59–62]. Multiple organizations in sub-Saharan Africa have experimented with this approach of leveraging VSLAs for water fee collection, but rigorous evidence on the benefits remains limited. An 18-month pilot conducted by The Water Trust in Masindi district, Uganda, found that 18 communities with VSLA-based water funds collected an average of approximately 164 USD for handpump operation and maintenance, compared to 48 USD in

42 control communities relying on water user committees [62]. Since then, The Water Trust has expanded the approach to over 700 hundred rural communities in Uganda, with encouraging improvements in water user payment behaviors [21]. More evidence would help confirm the suitability of this direction. Additionally, qualitative research about underlying community dynamics and perceptions would help elucidate enabling factors and challenges.

This study aimed to assess using VSLAs to collect and manage water user payments in rural Uganda. Specifically, within a 10-community sample, we assessed:

- Whether VSLAs could effectively collect water user fees and outperform the previous model in place for fee collection (i.e., voluntary water user committees);
- How community characteristics and relationships among different sub-groups (i.e., VSLA members and non-members) affect performance of the approach; and
- How factors external to the community (e.g., occasional technical assistance from a facilitating organization and the presence of professional handpump maintenance providers in the area) may affect continued interest in and application of VSLAs for water user fee collection.

Methods

Positionality statement

All of the authors worked for The Aquaya Institute (Aquaya), a nonprofit applied research organization dedicated to advancing equitable, safe, and sustainable water and sanitation solutions. The authors comprised a multi-national team (US, French, and Ugandan citizens) of university-educated scientists and engineers holding at least a bachelor's degree. The first author (KM) resided in the study district for four years, including for the entirety of the study period, and the third author (AM) is a Ugandan national native to the study district. Their firsthand perspectives were central to research implementation and data analysis. Additionally, this study was conducted in consultation with Kabarole's District Water Office and several lower local government units (i.e., sub-counties), who were actively engaged throughout the study. We discussed preliminary findings with the participating communities to ensure the study results reflected their viewpoints.

While the authors' scientific training implies a tendency towards empiricism, through our extensive international experience working in international contexts, our epistemological viewpoint acknowledges the importance of social and cultural influences in knowledge generation. Through our collective experience, we were particularly attuned to the potential of cross-cultural misunderstandings and recognize limitations to the convergence of the worldview of many Ugandans and our own. We contended with the philosophical and ethical dilemmas this poses by adhering to a critical, cautious, responsive, and reflective approach throughout the research process. Additional information regarding the ethical, cultural, and scientific considerations specific to inclusivity in global research is included in the S1 Checklist.

Study area and site selection

Kabarole district has an estimated population of 231,000, mostly (~77%) living in rural areas [63]. Small-scale, subsistence agriculture drives the local economy, followed by commercial tea and livestock farming [64]. The Uganda Bureau of Statistics estimates that 8–20% of the district's population lives below the national poverty line [65]. With respect to water supply, almost half (44%) of Kabarole's population relies on communal shallow wells equipped with handpumps [66]. Surface water is abundant, with an annual rainfall of 1,200–1,500 mm, and

provides the second most common source of household water, serving approximately 33% of the population [64, 66].

Formative research in Kabarole in 2019 sought to understand issues facing rural handpump management and identify potential remedial actions. Investigators reviewed existing literature, conducted seven focus group discussions with rural water users, and measured stated willingness-to-pay for water as part of a 484-household survey. These activities revealed that handpump users may be more comfortable paying monthly fees than pay-as-you-fetch tariffs, particularly if VSLAs managed water funds rather than the traditional water user committees [59].

To introduce and evaluate VSLA-based water payments, we purposively selected 10 rural handpumps (Table 1) in collaboration with the District Water Office. Handpumps had to meet four criteria: (i) estimated user population of 30–100 households, (ii) non-functional but feasible to repair, (iii) not within the present or planned service area of the two piped water utilities (National Water and Sewerage Corporation, Mid-Western Umbrella of Water and Sanitation Authority), and (iv) in a community willing to participate. We selected these criteria as best-case conditions to promote uptake of our intervention, based on the experience from similar programs (personal communication with Water for People and The Water Trust). We chose to rehabilitate non-functional handpumps as an entry point for our intervention to maximize community buy-in and motivation. The District Water Office provided a list of 38 candidate handpumps, of which 28 were excluded after conducting field visits (Fig 1): five had a user population outside of the desired size range, three were functional, four could not be repaired, nine were co-located with piped water services, and seven had users who declined to participate (e.g., land owner did not want the water point fixed). At the start of our study, none of the ten selected communities had reserve funds available for handpump maintenance. As a result, most of the study handpumps had been non-functional for over a year (range: 3 weeks– 10 years, median: 2 years, Table 1).

Table 1. Characteristics of handpumps and study communities.

Handpump[1]	Estimated population served (households)	Year constructed	Time non-functional prior to study	Alternative improved water sources within the community[2]	Distance from district capital (km)
R1	30	2003	2 years	4 shallow wells	22
R2	40	2007	10 years	2 shallow wells;	16
				2 protected springs	
R3	70	2001	3 weeks	2 shallow wells	25
R4	70	1997	2 years	2 shallow wells;	26
				2 protected springs	
K1	65	2001	6 months	2 shallow wells	32
K2	100	2004	8 years	1 shallow well	25
K3	72	1996	1 year	–	24
H1	30	1996	3 years	1 shallow well	20
H2	100	1995	2 years	1 shallow well	18
H3	60	1995	5 years	1 shallow well	16

[1]Handpumps were located in three sub-counties designated by their first letter (R = Ruteete; K = Kasenda; H = Hakibaale). All water sources were shallow wells (<30 meters deep) with India Mark II handpumps.

[2]All communities also actively used traditional dug wells.

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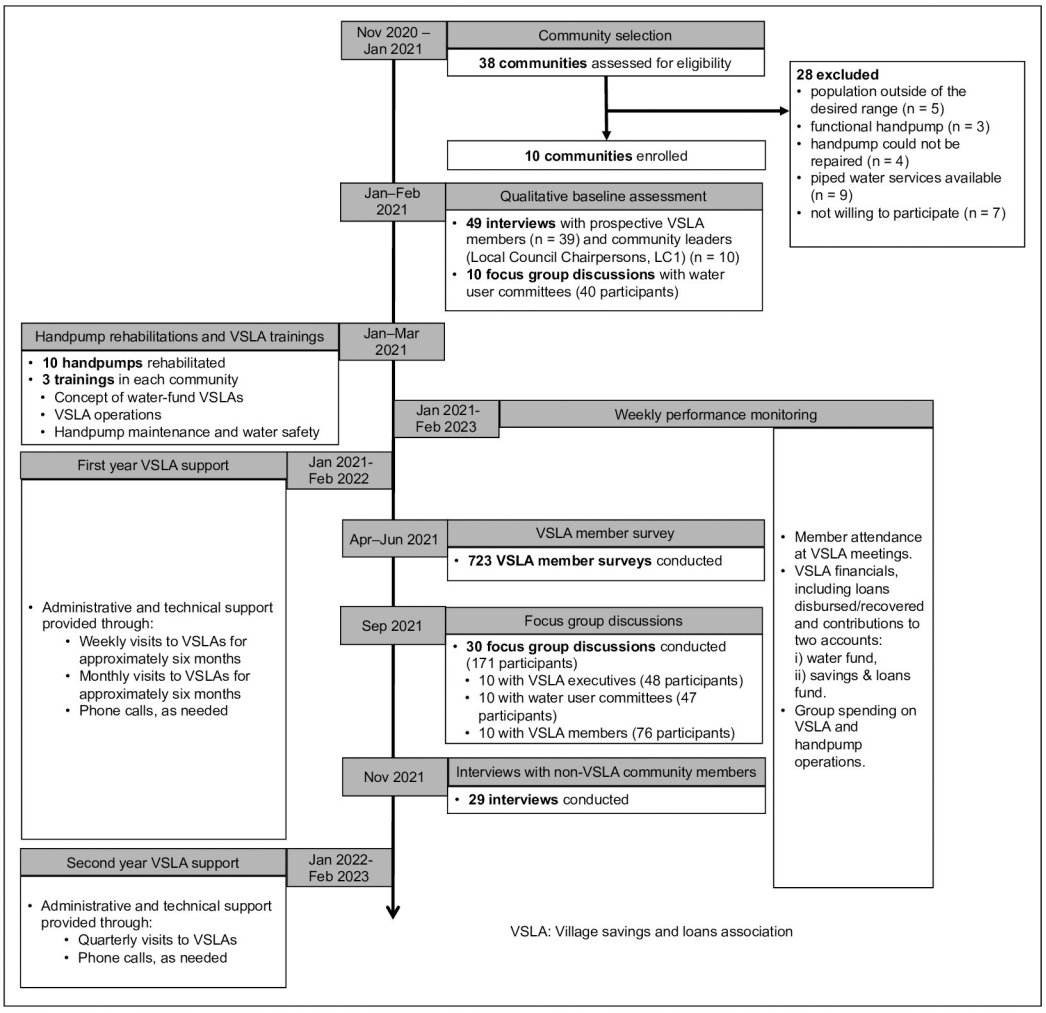

Fig 1. Flow diagram of study activities.

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VSLA implementation

At each handpump, we worked with local government staff including health assistants and community development officers to initiate a new VSLA with a water fund- a ring-fenced account reserved for handpump expenses. We followed guidance from Water for People and The Water Trust, two non-governmental organizations promoting this approach in western Uganda. We also consulted published VSLA training manuals [67–70].

VSLA initiation included the following steps, roughly in order of occurrence:

1. We conducted an initial community meeting to provide an overview of the study and introduce the VSLA-based water fund approach. The elected community leader (Local Council Level 1 Chairperson, or LC1) granted permission to conduct the meeting, mobilized community members to attend, chaired the meeting, and organized a vote on consent to participate.
2. We followed official procedures for rehabilitating handpumps [71]. Namely, communities paid a capital contribution fee of approximately 13 USD to the District Local Government

and we contracted the Kabarole Handpump Mechanics Association to complete the rehabilitations. This involved cleaning the well, repairing and recasting the apron and drainage channel, and replacing all worn and broken pump components.

3. We ensured that communities elected a new four-person water user committee to promote water payments and handpump upkeep. This new committee replaced the previous one, although some of the committee members remained the same.
4. We conducted three in-depth training sessions with community members. The first session provided an overview of the VSLA methodology; the second expounded on practical VSLA operational details; and the third session, jointly delivered by a handpump mechanic and health assistant, focused on handpump operation, maintenance, and water safety. The three trainings took place over 3–4 weeks, at the end of which VSLAs had formed in each community.
5. We supported the VSLAs to draft their constitutions, compile all documents needed to register with sub-county authorities, and paid their registration fee (14–18 USD for two years).
6. We provided each VSLA with a start-up kit consisting of: a metal lock box, three locks, two ledger books, money collection bowls, three cloth money storage bags, a calculator, a ruler, pens, and individual member passbooks. Because the study took place during the COVID-19 pandemic, we also provided each VSLA with a handwashing station and reusable face masks for all members.

Compared to standard VSLAs, water-fund VSLAs featured the following differentiating characteristics:

- Members came predominately from the same community and used the same water source (whereas standard VSLAs may draw members from different communities who have a unifying characteristic such as the same occupation);
- To encourage a large portion of the handpump's user community to join, VSLA membership size was not restricted resulting in larger than typical VSLAs;
- VSLAs were trained to maintain an additional account dedicated to water point management called the water fund;
- The VSLA's constitution emphasized handpump sustainability as one of the two founding objectives (the other being personal economic development) and stipulated the required financial contributions to the water fund.

The Aquaya Institute provided technical and administrative support to the VSLAs over their first twelve months. One author (AM) attended weekly VSLA meetings for approximately the first six months and continued to attend once a month for the remainder of the first year. He was also available via phone to support the VSLAs. We provided a monthly airtime allowance to one VSLA member in each community to ease troubleshooting and performance monitoring. During the second year, support decreased substantially. AM only visited each VSLA four times to check on progress and answer any questions. He continued to be available via phone, though we discontinued the airtime allowance. VSLAs were aware that we would only conduct frequent support visits and provide the airtime allowance in the first year. At the end of the first twelve month, all VSLAs independently decided to continue for a second year.

Quantitative and categorical data collection and analysis

We tracked VSLA financial performance indicators throughout the first two annual cycles from January 2021 to February 2023, including weekly member attendance, weekly contributions to the water fund and to the savings and loans fund, number of members who contributed, number and amount of loans taken and repaid, and VSLA and handpump operational expenses. During the first year, we collected data weekly in person (by reviewing the VSLAs' paper record books) for the first few months and by phone for the remaining months. During the second year, we collected data quarterly in person or by phone in instances when paper records were not available on the day of our visit. After reviewing the data for consistency, we sometimes followed up with VSLA executives by phone to request clarifications and/or reviewed record books to confirm reported data. We digitized and analyzed all data in Microsoft Excel, aggregating weekly data by month for reporting (see S1 Data).

From April to June 2021, we surveyed all VSLA members (n = 723), including the executive committees, to collect information on gender, education level, primary income source, participation in other savings groups, and primary water source. We collected survey data using the mobile application CommCare (Dimagi). We then analyzed associations between these characteristics, handpump characteristics listed in Table 1, and VSLA financial performance using Spearman rank correlation coefficients.

Qualitative data collection and analysis

During the first year, we conducted in-depth qualitative interviews or focus group discussions with a total of 115 VSLA members (39 at baseline, 76 at midline), 48 VSLA executives, 29 non-members, 47 water user committee members, and 10 LC1 community leaders over three rounds of data collection (Fig 1). For all three rounds, we asked community (LC1) or VSLA leaders for assistance selecting respondents for diverse representation of genders, age groups, educational background, and income levels.

At baseline (January–February 2021), after community enrollment but prior to the first training), one author (AM) interviewed each LC1 as well as 39 prospective VSLA members. We also conducted focus group discussions with the 10 newly elected water user committees to understand prior experience with community savings groups, water point management history, and community development priorities. At midline (September 2021, 8–9 months after initiating the VSLAs), two local qualitative research assistants conducted focus group discussions separately with VSLA members, VSLA executives, and water user committees in each of the 10 study locations (total of 30 focus groups). Focus groups had 3–8 participants. These discussions gathered perspectives on the challenges and benefits of VSLAs with regards to personal development, community development, and water point management. Participants also shared their practical experiences with implementation. Finally, at endline (November 2021), the local qualitative research assistants interviewed 29 non-VSLA members across all study communities to understand their perspectives on the VSLA-based water fund approach and perceived influence on water point management.

Local research assistants took handwritten notes and audio-recorded all interviews and focus group discussions. All interviews and focus group discussions were conducted in the local language (Rutooro) and then transcribed from the recordings into English, using their handwritten notes as aids as needed (see S2 Data). Interviews lasted 20–40 minutes and focus group discussions lasted 45–65 minutes. Following data collection in each community, we reviewed the English-language transcripts and sought clarifications as needed from the local research assistants. One author fluent in Rutooro also listened to all audio recordings and

supplemented the transcripts where he had a different interpretation or noticed missing details. We analyzed the written transcripts using inductive coding; that is, we identified themes that emerged from the transcripts and consolidated evidence into nine groupings over multiple iterations of the analysis (Table A in S1 Text).

Implementation cost tracking

We tracked implementation costs over two years, including: handpump rehabilitation (i.e., new pump components, construction materials, mechanic fees), training (i.e., participant refreshments, facilitation materials, allowances for facilitators), start-up kits, sub-county registration fees, and ongoing support (i.e., monthly airtime allowances for VSLA liaisons, staff time, and transportation for visiting communities and fielding phone calls). We then converted implementation costs to USD using an exchange rate of 3,541 UGX per USD for the first year and 3,682 UGX per USD for the second year (Oanda Corporation annual averages between January 2021 and February 2023).

Ethics statement

We obtained informed written consent from each community at the onset of the study. To do this, we convened a community meeting to provide details about the study and data collection activities. Attendees consented to participate by a majority vote. As the political head of the community, the LC1 sanctioned the vote and signed a consent form on behalf of the community. Researchers separately obtained informed written consent from all interview and focus group discussion participants. This study received ethical approval from Mildmay Uganda Research Ethics Committee (#REC REF 0305–2020) and research clearance from the Uganda National Council for Science and Technology (SIR47ES).

Results

VSLA composition

A total of 723 individuals initially joined the 10 VSLAs, although only 635 remained active savers after one year (12% dropout) and 566 after two years (11% dropout). The average VSLA had 74 members at the start (59 in the second year), with a slight majority of females (Table 2). Most VSLA members had a primary education (median: 66%, range: 54–77%), but fewer had a secondary or higher education. The majority relied on subsistence farming. Over half were active in other community savings groups. Elected VSLA executives were generally individuals with prior leadership experience from other savings groups and/or respected positions in the community (e.g., church leaders, teachers, business owners). They had a higher representation of males (63%) and were more educated (53% with secondary or higher education) than the general VSLA membership.

VSLA members overlapped only partially with handpump users. Although most members relied on the study handpump as their primary water source (median: 83%, Table 2), a noticeable fraction did not. These individuals joined the VSLA despite the requirement to make payments towards maintenance of a handpump they did not use. Conversely, all communities had handpump users who chose not to join the VSLA; we were not able to track the exact number. In qualitative interviews, these handpump users explained that they either could not afford to join, were satisfied members of a different VSLA, or had negative past experience with savings groups.

Table 2. Demographic data and financial performance indicators for the village savings and loans associations (VSLAs).

Indicators	Median[1] (min–max) across communities	
	First year	Second year[3]
VSLA characteristics		
Number of members	74 (54–92)	59 (30–80)
% female members	55% (46–69%)	
% members with secondary or higher education	23% (8–33%)	
% members relying on subsistence farming only	58% (44–89%)	
% members active in other savings groups	66% (47–83%)	
% members using study handpump as primary water source	83% (48–96%)	
% female executives	33% (0–100%)	
% executives with secondary or higher education	50% (0–100%)	
Savings & loans fund financials		
Required monthly deposit in savings & loans fund per member[2]	1.13 USD	2.17 USD
	(1.13–2.26 USD)	(1.09–4.35 USD)
Annual deposit in savings & loans fund	1,587 USD	2,594 USD
	(1,024–7,243 USD)	(615–9,742 USD)
Average annual deposit in savings & loans fund per member	25 USD	41 USD
	(17–111 USD)	(21–133 USD)
% achievement of annual savings & loans fund target	197%	196%
	(138–508%)	(102–416%)
Number of loans taken	92	108
	(69–233)	(54–207)
Average individual loan amount	23 USD	36 USD
	(17–70 USD)	(13–69 USD)
Annual interest earned on loans	555 USD	387 USD
	(−1,120–842 USD)	(144–1,533 USD)
Average annual profit per member	9 USD	8 USD
	(-13–16 USD)	(4–21 USD)
Water fund financials		
Required monthly deposit in water fund per member	0.28 USD	0.27 USD
	(0.14–0.28 USD)	(0.14–0.27 USD)
Annual deposit in water fund	134 USD	112 USD
	(84–221 USD)	(47–191 USD)
Average annual deposit in water fund per member	2 USD	2 USD
	(1.5–3.1 USD)	(1.1–3.0 USD)
Annual deposit in water fund by non-members	4 USD	
	(0.1–32 USD)	
% achievement of annual water fund target	80%	78%
	(47–117%)	(45–101%)
Annual expenditures on water point upkeep	17 USD	18 USD
	(0–54 USD)	(0–40 USD)

[1]n = 10

[2]This was the minimum amount. The maximum allowed deposit was five times higher.

[3]We did not collect data on all indicators in the second year.

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VSLAs' financial performance

In the first year, VSLA constitutions typically required members to deposit at least 1.13 USD to the savings and loans fund and 0.28 USD to the water fund monthly (Table 2). In the second year, most VSLAs increased the minimum required monthly deposit into the savings and loans fund (median: 2.17 USD) but maintained the same monthly requirement for the water fund (Table 2). Adherence to these rules fluctuated over the year, with no apparent differences between the first and second annual cycles (Fig 2A). Depending on the month, 54–92% of members contributed to the savings and loan fund and 27–86% contributed to the water fund (Fig 2B). VSLA constitutions did not stipulate any penalties for members who failed to make expected monthly payments, instead requiring that members clear their dues by the end of the 12-month cycle. As a result, water fund contributions spiked noticeably in the last month of

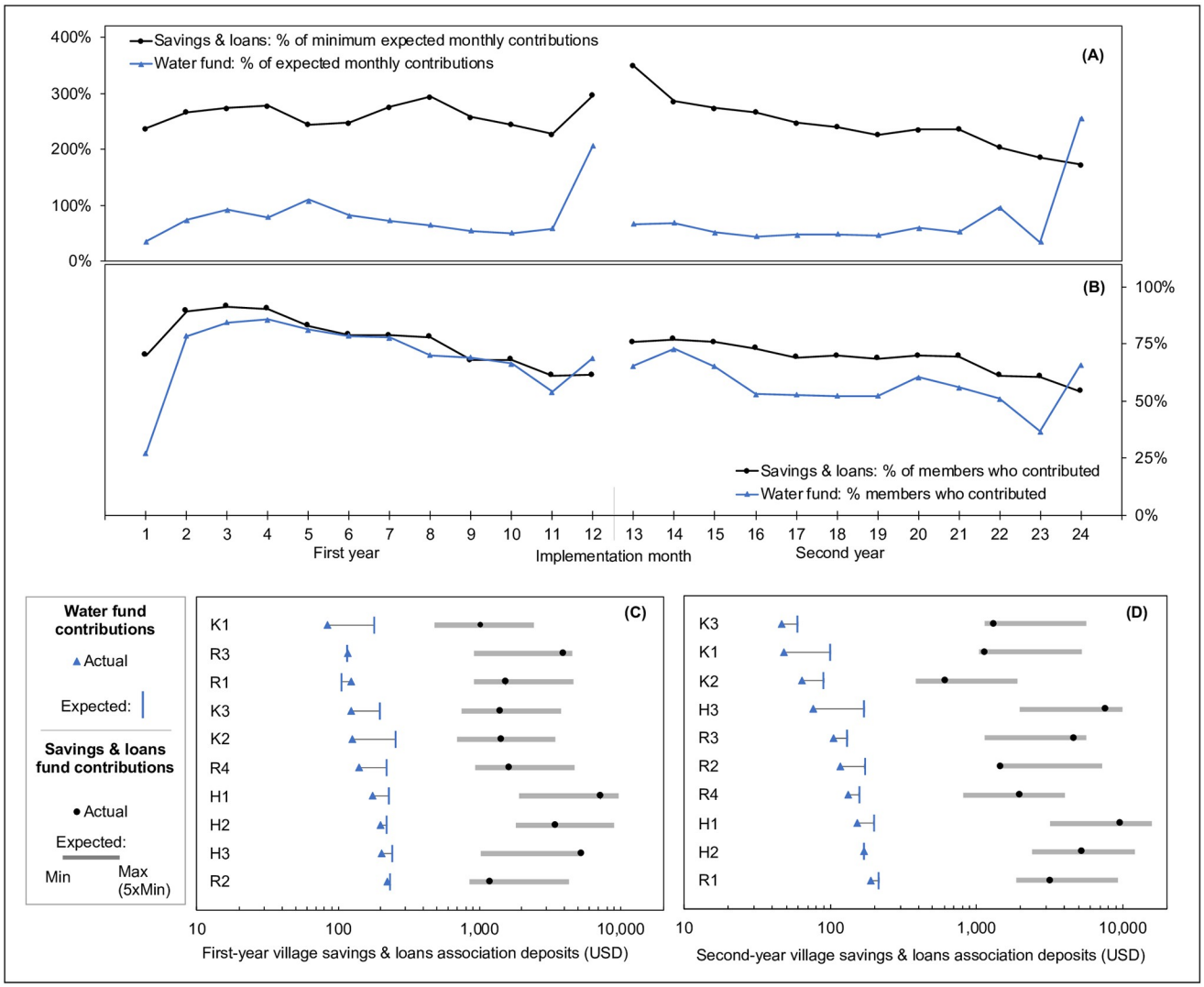

Fig 2. Monthly contributions and total deposits in the savings & loans fund and in the water fund. (A) Monthly contributions to the savings and loans fund (black) and to the water fund (blue) expressed as a percentage of expected amounts. (B) Percentage of members making deposits to the savings and loans fund (black) and to the water fund (blue) each month. (C) Total first-year deposits in the savings and loans funds (black) and in the water funds (blue). (D) Total second-year deposits in the savings and loans funds (black) and in the water funds (blue). For comparison, study communities had no water funds (0 USD) before the intervention.

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both cycles (to 208% in the first year and 256% in the second year; Fig 2A). Executives took from members' accumulated savings to clear their pending water fund payments before closing each annual cycle.

Contribution amounts toward both the savings and loans and water funds varied widely among VSLAs (Table 2; Fig 2B and 2C). While VSLAs tended to exceed the minimum expected savings, only one of ten reached the maximum allowed savings amount in the first year (H1; Fig 2C) and none did in the second year (Fig 2D). The respective performance of VSLAs also varied between the first and second year. With respect to water fund contributions, the VSLA that was in the 8th position in the first year moved to the 1st position in the second year, and the top two VSLAs in the first year were in the 5th and 7th position in the second year (Fig 2C and 2D). Examining the Spearman's rank coefficients showed that first-year water fund payments were higher in communities whose handpump had been non-functional for longer ($r = 0.79$, $p = 0.006$) and that were located a shorter distance from the district's urban center ($r = -0.81$, $p = 0.004$). However, this was no longer the case in the second year. The savings and loan fund performance did not correlate with any community characteristics ($p > 0.05$), although comparisons were limited by the small sample size ($n = 10$).

Within the first year, each VSLA saved approximately 1,587 USD (median) toward savings and loans, corresponding to contributions on the order of 25 USD per member (Table 2). In the second year, savings increased to a median of 2,594 USD per VSLA or 41 USD per member (Table 2). VSLA members exhibited a high demand for loans, with a typical group disbursing approximately 92 loans over the first year and 108 over the second year (Table 2). Loans typically amounted to less than 40 USD (third quartile). Most loans were used to make ends meet (i.e., for everyday household consumption), while only a few went toward income-generating activities such as agriculture or small businesses. This trend may have stemmed from the Covid-19 pandemic and resulting economic crisis. All but one VSLA in the first year generated a profit from interest payments on loans (Table 2; Fig Ai-Aii in S1 Text). Apart from this exception, the VSLAs experienced limited loan defaulting. Two groups in the first cycle and four in the second cycle registered unrecovered loan payments, all less than 3% of the group's annual loan portfolio and typically reflecting unpaid interest. Most loan defaulters fell into one of three categories: i) those with a risk tolerance that led them to borrow beyond their capacity to repay, ii) those who left the community, most often for work, before completing their loan repayment, or iii) those who refused to complete payments due to disagreement with the loan balance. Similar to water fund contributions, loan repayments occurred disproportionally in the last month of each annual cycle (Fig Aiii in S1 Text).

With respect to water funds, the VSLAs collected 84–221 USD (median: 134 USD) over the first year, corresponding to 1.5–3.1 USD per member (median: 2 USD) (Table 2; Fig 2C). Most of these contributions (>98%) were made by VSLA members, with the exception of one community where non-members (handpump users who had not joined the VSLA) contributed 18% of the water fund deposits. In the second year, water fund contributions were 47–191 USD (median: 112 USD) (Table 2; Fig 2D), a small decrease from the first year largely attributable to the smaller membership since contributions per member remained similar (Table 2). In both years, accumulated water funds represented a vast improvement from the prior situation in which these communities had no reserve funds for water point maintenance (i.e., 0 USD), explaining why they had faced long periods of downtime (Table 1).

Water point upkeep

Annually, VSLAs spent a median of 17–18 USD of the water funds on fencing, cleaning supplies, and minor handpump repairs (Table 2). Additionally, most groups followed the training

suggestion to develop rotational cleaning schedules and worked toward ensuring upkeep of the pump surroundings (e.g., removing litter, keeping grass cut low, clearing the drainage channel). Other accounts of improved behaviors included users operating the pump more gently and paying increased attention to using clean water collection containers. VSLA members often credited more active water point caretakers, one of the four water user committee members, for championing these improvements. In the second year, most VSLAs paid caretakers a small monetary token of appreciation from their water fund in recognition of their important role.

VSLA members were grateful for having a restored handpump, which partly explained their motivation for water point upkeep. As one user noted: "*When I heard that a certain organization was going to rehabilitate our source, I was very happy because we had suffered a lot. I decided to join the group so that we can effectively plan for our source.*" Users also credited the VSLA approach for improved community participation in water point maintenance. The VSLAs provided a platform to discuss water point issues. They also changed attitudes towards communal work, which communities often previously refused to participate in (descriptions of community members' prior attitudes ranged from "uncooperative" to "hostile"). One water user committee member articulated, "*Our community previously was very hard to mobilize for any community work, but given now members are in the VSLA, mobilizing them is easy and they are willing to work without being forced.*"

Perceived benefits of water funds

With respect to water funds, VSLA members appreciated making small, regular payments as opposed to inconsistent ad hoc payments that varied in amount (the status quo under the pre-VSLA management model). A respondent explained, "*The water user committee no longer bothers us to contribute abruptly. In case our pump gets any issue, they get some money from the [water fund] bag.*" VSLA members believed water funds would allow them to increase the speed of repairs. One participant explained, "*Previously, we would wait for long to get our source repaired, but for now we don't think it can happen, because we have ready money for repairs.*" All water user committees conveyed willingness to pay for routine service.

As hypothesized, shifting financial management responsibilities from the water user committee to the VSLA increased trust and encouraged payments: "*Previously . . .the treasurer also ended up mishandling the funds and when we would ask for the funds to do the work, you find he has already used it; thus, the community gets angry because we would not do the repair. But currently the funds are kept in the VSLA box, which has padlocks and keys kept by the different people; thus, the community feels their contributions are safe.*" Additionally, researchers' close monitoring of VSLA financials likely enhanced the sense of security that water funds would not be misused, alleviating a common prior concern: "*When we finish contributing, our executives normally give updates to [research team member]. Thus, we feel safe that the executives won't mishandle our contributions, because they know they are being supervised.*"

Other perceived benefits of VSLAs

Focus group participants noted several positive features of the VSLAs, such as transparent financial records, physical security of funds (i.e., in the lock box or bank account), and access to loans. Beyond financial services, members also appreciated that the VSLAs were registered with local authorities, unlike traditional savings groups. They perceived that formal registration would give them recourse in case of loan defaults and might open additional funding opportunities for their community. Additionally, formal links and exposure to higher levels of local government boosted morale, especially among VSLA executives, as one executive

expressed: "*Our group started in a very high gear. That is, a majority of the sub-county authorities were brought on board, like the community development officer, health assistant, and parish chief, who came and advised us on how to run the group. And also we registered our group; thus, our group is recognized. All of this motivates me.*"

VSLA members described additional benefits related to social capital, such as solidarity, friendship, knowledge sharing, and empowerment. One respondent noted, "*Unity among group members has improved and we plan as a family. For instance, when I have a personal problem, I can share it with some group members for advice.*" A VSLA executive also noted, "*My role has helped me to gain confidence in expressing myself in public, which I never used to have.*" Finally, VSLA members appreciated capacity building, noting that the trainings helped to improve bookkeeping and financial literacy.

Perceived challenges

Qualitative data revealed two major concerns about the VSLA water fund approach that might affect its long-term viability. The first stemmed from incomplete overlap between VSLA membership and handpump users. In most communities, VSLA members were concerned (and sometimes resentful) that non-members were not contributing their fair share to the water fund, even though they used the handpump (i.e., "free-riders"). Participants commented: "*We lose morale contributing the water funds when we see our fellow colleagues who fetch water from the very source not paying the funds*," and "*If the water user committee completely fails to collect funds from the non-VSLA members, this at some time will discourage VSLA members to continue contributing as well.*"

Three VSLAs seemed to have established successful strategies to alleviate this concern. In one case, executives highlighted that the number of free-riders was actually small. In another, they ruled that in case of a handpump breakdown, the water user committee would collect contributions from non-members first before using the VSLA water fund. In a third community, non-members made large contributions to the water fund (18% of total deposits) during a one-time campaign when the VSLA executives and water user committee jointly moved around the community to collect water user fees from non-VSLA households. Across communities, focus group participants perceived that sensitization was the best way to get non-VSLA members to pay into the water fund, as opposed to punishment or enforcement (e.g., being arrested, denying access to the handpump).

The second major concern stemmed from accumulated water funds remaining idle. In many cases, VSLA members felt water funds should be put to use (e.g., loaned to members to generate interest). One member explained: "*Since our pump is still functional, we can use our water funds to give out loans to members instead of it being idle in the VSLA box, which in return will attract interest.*" In response, four VSLAs started loaning out water funds at the end of the first year or at the beginning of the second year. These decisions were not surprising, considering that demand for loans was consistently larger than the VSLAs' loan capital. This practice, however, risks eventually suppressing the cash readily available in the water fund for handpump repairs. Estimating future maintenance and repair costs is however difficult for community members, which limits their ability to make well-informed decisions on how to balance the need for loan capital and continuing to grow the water point reserve fund.

Beyond these two key issues, VSLA members expressed common concerns about potential loan defaulters, inconsistent meeting attendance, specific leaders being unsuitable, and volunteer time spent managing large groups (e.g., recording all transactions). These drawbacks characterize all VSLAs [28] and did not relate to the water fund approach specifically. In addition,

multiple members of the same household could join the VSLA, and in this case, each had to pay into the water fund. While we only learned of this qualitatively and do not know the exact number of affected individuals, we believe this was relatively minor occurrence. Some felt the water-supporting VSLA rules would be fairer if members who did not use the handpump or were from the same household as another member could be exempt from water fund payments.

Implementation costs

The first-year costs for establishing the 10 VSLAs and providing technical support (capacity building and monitoring) totaled 17,466 USD, excluding handpump rehabilitation (Table B in S1 Text). Including handpump rehabilitation, first-year implementation costs were 24,958 USD. Staff time and transportation for one field research officer accounted for 52% of these costs, followed by handpump rehabilitation (30%), supplies such as VSLA start-up kits (8%), initial training sessions (6%), engagement with local government (3%), and airtime (1%) (Table B in S1 Text).

During the second year, the VSLAs required much less capacity building and we reduced the community visits to four (down from 24), thus reducing staff time and transportation by approximately 86%. We did not incur additional expenses for start–up kits and training sessions, but maintained engagement with local government. In the second year, supporting 10 VSLAs cost around 220 USD per community (Table B in S1 Text).

Discussion

The 10 VSLAs facilitated in Kabarole district successfully unlocked payments for water, consistent with other experiences in Uganda. Using the VSLA model, the study communities went from having no handpump maintenance reserve funds to having a median of 134 USD at the end of the first year and 112 USD at the end of the second year. The Water Trust found similar results when they introduced VSLA-based water funds in 18 communities in Masindi district: these groups collected an average of approximately 164 USD for handpump operation and maintenance in 18 months [62]. Although sample sizes were small, consistent results are encouraging for the use of VSLAs to collect water user fees in rural Uganda. Notably, financial contributions seemed to vastly improve over the status quo in our study district, where water users typically make regular payments at only 13% of rural handpumps [66]. Regular payments occurred in all our study communities, and median payment compliance was around 80% after two years, much higher than the <20% compliance reported in a pay-as-you-fetch pilot in the same district in 2018 [72]. Further, all 10 VSLAs continued on to a third annual cycle, despite Aquaya no longer being active in the district, showing promise for the durability of the approach.

Dynamics underlying performance

From our extensive qualitative data, we identified four factors explaining why the VSLA model was successful at collecting water user payments. The first motivating factor was improved water access: study communities went from having a broken handpump to a working, well-looked after one and believed the water funds would ensure fast repairs when needed. Second, improved financial management practices, including meticulous bookkeeping, consistent accountability, and assurance that funds were kept safe in a lock box or bank account, helped to restore users' willingness to pay for the water point. The third factor revolved around personal benefits that members derived from taking part in the VSLA, such as loans, interest income, new knowledge and skills, and social networks. These benefits were illustrated by 20%

of VSLA members choosing to join, despite having to pay into a water fund dedicated to a handpump they did not personally use. Fourth, Aquaya's implementation support during the first year (e.g., registration with authorities, start-up kits, ongoing capacity building, and monitoring) raised the profile of the VSLAs and boosted trust among members, contributing to high overall satisfaction.

VSLA benefits extended beyond accumulation of reserve funds for handpump maintenance. Seeing the water fund grow over time seemed to have triggered a virtuous cycle in which individuals became confident in the group's ability to change the status-quo, which motivated them, beyond financial deposits, to more broadly improve water point upkeep. In other words, by collectively contributing to a common goal, VSLA members developed a sense of collective efficacy (i.e., group belief in their collective ability to accomplish a goal; [73–75]). As other authors have suggested, this belief promotes collective action towards community-level outcomes and successful management of common-pool resources [41, 49, 76–78]. These social impacts were consistent with the broader literature on community savings groups and self-help groups, which credits them with building social capital, promoting civic engagement, and fostering resilience [34, 39, 42, 43, 45, 46, 58].

With respect to water supply management, the social benefits of VSLAs provide a clear opportunity to improve individual and collective behaviors. Other authors have suggested that increasing levels of social capital may be one avenue to improving community-level water management [44, 50, 79–83]. In our study, this was apparent in that participation in water point upkeep increased tremendously. It may also be possible to harness the collective efficacy generated by VSLAs to improve other water management behaviors, such as water treatment, safe storage, and elimination of open defecation. Relatedly, prior research found that community savings groups could influence health behaviors (e.g., [34, 42]).

Complementarity with professionalized handpump services

Ranging from 47–221 USD annually, water funds in all communities could have covered the costs of routine operation and minor handpump repairs with local mechanics [84, 85]. Whether accumulated water funds translate to long-term handpump functionality largely depends on the presence of skilled, professional mechanics in the area. Kabarole district has limited professional capacity for handpump maintenance, like most of rural Uganda [64, 86, 87]. By contracting informal mechanics, VSLAs risk facing delays, being overcharged, receiving poor quality parts, and even damaging the handpump [86, 87]. Such negative experiences with handpump maintenance would likely lower VSLA members' motivation to pay, as water funds would ineffectively support expectations of fast, high-quality repairs. Formalizing and professionalizing handpump services thus seems to be a necessary complement to the VSLA approach.

Several other factors point to synergies between VSLA-based water funds and professionalized handpump services. First, VSLA members had concerns about accumulated water funds remaining unspent. Paying a subscription fee for handpump maintenance services would ensure that water funds do not remain idle or become repurposed as loans. When asked, all VSLA executives responded positively to the possibility of paying for routine handpump services if they were available, which warrants further investigation. In turn, professional handpump service providers, who tend to struggle with payment compliance and customer retention [88–91], might benefit from enrolling communities with VSLA-based water funds. Prior research in rural Uganda found that communities receiving professional maintenance services can be reluctant to pay for them while the handpump is functional [13, 91, 92]. The VSLA model may overcome these issues, as communities in our study continued making

deposits in the water fund while the handpump remained functional during and following the study, without expressing major concerns.

Despite their complementarity, however, professional service providers may cost too much for communities with VSLA-based water funds. Organizations in rural Uganda that perform preventive handpump maintenance and guarantee quick repairs in case of breakdowns usually charge communities 300–500 USD annually, a subsidized rate [85, 91]. None of the VSLAs in our study communities, nor contemporaneous VSLA–based water funds in Uganda [21], could have afforded this subscription fee. The fact that the ten VSLAs did not raise enough funds to subscribe to existing professional maintenance services suggests that:

1. At current levels of economic development, expecting rural communities to cover the full costs of water supply operation and maintenance may be unrealistic in some areas. Subsidies are most likely needed to promote affordable, safe, reliable water services, even where water users are able to make a financial contribution.
2. Although already subsidized, professional maintenance services are likely still unaffordable relative to communities' ability to pay. Efforts should be directed toward developing more nimble and cost-effective approaches to handpump maintenance, which may involve consolidated service oversight and risk pooling.

Therefore, unless professional handpump services are further subsidized or scale back their service offering to lower the subscription fee, they may remain impractical in many rural communities in Uganda. One possible approach to increase affordability would be to give VSLAs the startup capital to initiate an income-generating activity (e.g., poultry or pig farming), whose profits would go into the water fund and help pay for the maintenance subscription fee [13, 93]. Sensitizing VSLA members on the lifecycle costs of handpumps, particularly the price of spare parts may also promote willingness to pay [13, 93, 94].

Program implementation costs

First-year implementation costs amounted to approximately 1,700 USD per VSLA, or 24 USD per member, excluding handpump rehabilitation. This is on par with what other VSLA programs have reported in Uganda and elsewhere, with first-year startup costs typically ranging from 20 USD to 50 USD per member [29, 31, 95, 96]. Beyond startup, we estimated that ongoing support, such as occasional auditing of VSLA financial records and sensitizing non-members on the importance of contributing to the water fund, would cost 220 USD per community per year (i.e., 12% of first-year implementation costs). This may be a conservative estimate, but withdrawing all external support could potentially cripple performance, since it was a key factor underpinning the success of the approach. More broadly, all VSLAs and similar community-based groups require ongoing support [7, 28, 97, 98].

When compared with annual accumulated water funds (median of 125 USD per VSLA), implementation costs for startup (1,700 USD per VSLA) and ongoing support (220 USD annually per VSLA) seem high. This should, however, be compared with alternative approaches. One such approach would be for the funder (whether government or external) to pay for handpump repairs directly. It may seem as though sending 125 USD to a skilled handpump mechanic annually would be more cost-effective. However, such an approach would likely cost more than 125 USD per community because there would need to be a system in place to manage these payments and hold mechanics accountable, resulting in staff, transportation, communication, and bank transaction costs. Based on other rural development interventions, the full costs of this approach could amount to approximately twice the direct costs [99, 100], i.e., 250 USD per community. Further, foregoing VSLAs would eliminate their multiple economic

and social benefits such as access to financial services, higher social capital, and increased collective efficacy, which not only promote positive behaviors towards water point upkeep as shown here but potentially also broader community development [51, 58, 101]. Nevertheless, these cost considerations suggest that paying for handpump maintenance directly may be worth testing and comparing with the VSLA model.

Because it promotes financial participation from communities, the VSLA model supports Uganda's national policy for rural water supply [24]. While District Water Offices in Uganda likely do not have sufficient budgets to fully support implementation costs [64, 86], the VSLA model need not be entirely donor-funded either. We recommend exploring opportunities for cost-sharing between District Water Offices and external funding sources such as results-based finance [102]. In an initial pilot by the Aquaya Institute (separate from this study), the District Water Office funded handpump rehabilitations and part of the ongoing support consisting of occasional community visits conducted by local government staff trained by Aquaya on the VSLA approach [103].

Study limitations

This study had a small sample size (10 VSLAs) and only a two-year time frame, which allowed examining financial performance and underlying community dynamics in depth but limits the generalizability of findings both spatially and temporally. Selection of study sites was intentionally biased towards communities where the VSLA model had a higher likelihood of success, since our goal was to understand how and why the VSLA approach worked. It is therefore unlikely that this approach would perform equally well in all rural communities. For example, seven out of 38 screened communities declined to participate. In addition, our analysis largely relied on qualitative data, which are subject to selection, courtesy, and social desirability biases. We aimed to minimize these challenges by hiring independent local research assistants who were not involved in any implementation activities for the qualitative data collection. Translation issues were minimized by having one author fluent in the local language review all audio recordings against English transcripts. Nonetheless, varying cultural interpretations of wording may have affected qualitative data. Finally, this study did not disaggregate perspectives by gender as all focus group discussions included mixed genders. We believe that the findings reflect both male and female opinions and experiences, but we could not further assess gender dynamics.

We note that Aquaya assumed the roles of implementer and evaluator in this study, which may have introduced bias from both the community reporting and evaluation sides. We explicitly considered the unequal power dynamics that would arise between Aquaya and the communities, likely leading to courtesy biases even with data collected by independent qualitative research assistants (contracted enumerators fluent in the local language). We were, therefore, careful to report with comparable emphasis the positive and negative perspectives that emerged from the qualitative data. Additionally, different staff led implementation, evaluation, and review. Ultimately, the insights and rich contextual understanding we gained through implementation allowed us to critically review the findings. We used qualitative reports to triangulate descriptive statistics, which are typically less susceptible to researcher bias.

Future research directions

This study provided encouraging results regarding the potential of village savings and loans associations to collect and manage funds for communal water points. Although piped water services are expanding in rural areas, it will likely take years or decades before they fully replace handpumps. Until then, approaches that increase communities' financial contributions

towards communal water points will remain necessary. In areas where water supply upgrades become available, the community fee collection component of the VSLAs may phase out. However, VSLAs could eventually be leveraged for communities to pay for connection fees to piped networks, as has been shown in urban areas [55–58]. Additionally, this study concurred with prior research that suggests community savings groups, such as VSLAs, may provide durable benefits for individual and community development [34, 35, 42, 97], which would remain relevant regardless of the community's water supply infrastructure.

Future research should evaluate how the VSLA model impacts water point functionality and water management behaviors over time in a larger number of communities. A larger-scale evaluation would help identify community characteristics most favorable for each approach; for example, primary occupation type or poverty proxies may predict payment behaviors, though we could not examine these characteristics due to this study's small sample size. Efforts to professionalize and subsidize handpump maintenance services should take place in parallel to any expansion of the VSLA approach to ensure that water user payments translate into sustained water point functionality.

VSLA-based water funds, although they offer many benefits, may not be the most cost-effective approach to improve water point functionality. Future work could prospectively compare cost-effectiveness of VSLA-based water funds with alternative approaches such as paying for handpump maintenance directly. Understanding how the VSLA-based water fund model can ultimately be delivered through and co-funded by local government is similarly critical [103].

Supporting information

S1 Checklist. Inclusivity in global research.
(DOCX)

S1 Data. VSLA financial data.
(XLSX)

S2 Data. Interviews and focus group discussions.
(PDF)

S1 Text. Supplementary tables and figure.
(PDF)

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