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The State of Maintenance: Can Government and Citizens Cooperate for Improved Water Access?

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Corresponding Author:	Aidan Coville World Bank SOUTH AFRICA
First Author:	Aidan Coville
Order of Authors:	Aidan Coville
	Daniel Rogger
	Jerome Sansonetti
	Luca Stanus Ghib
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The State of Maintenance: Can Government and Citizens Cooperate for Improved Water Access?

Pre-Results Paper

Aidan Coville, Daniel Rogger, Jérôme Sansonetti and Luca Stanus Ghib

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Abstract

Nearly half of the communal water points in Tanzania do not produce water. While local government and communities are each expected to contribute to infrastructure maintenance, task responsibility is often ambiguous in practice, leading to inefficiency and inertia. We explore whether strengthening coproduction between district governments and village water community organizations can improve coordination between both parties, strengthen maintenance practices, and increase communal water point functionality. Specifically, we conduct a large-scale cluster-randomized controlled trial to assess the impacts of repeated 'action-learning' consultations led by an independent facilitator that encourages information sharing and the resolution of maintenance responsibility ambiguities between the two parties.

Keywords: Water and sanitation, maintenance, infrastructure, coproduction, incomplete contracts, common-pool resources.

JEL codes: O18, O13, Q25

Study pre-registration: American Economic Association (AEARCTR-0011267)

Timeline for Project *Maji Endelevu* (‘Sustainable Water’)

2016: Formative research *(complete)*

2017: Design of intervention *(complete)*

2018: Baseline collection *(complete)*

2019: At-scale pilot *(complete)*

2020 – 2023: Treatment implementation, collection of implementation data *(complete)*

2023: Endline collection

Contents

List of Tables

List of Figures

1 Introduction

Two billion people lack access to safe water. Though public and private actors have invested in building water systems over the past four decades, water infrastructure in Sub-Saharan Africa displays high levels of disrepair (Foster 2013). The number of people in the region without access to safely managed water has been steadily increasing despite significant capital investments.[1] In Tanzania, only 59% of the country's communal water points (e.g. wells, handpumps) could produce water in 2021.[2] Such disrepair has significant impacts on citizen welfare, with 90% of Tanzanians relying on communal water points to access water (Joseph et al. 2018). In contrast, the majority of dysfunctional communal water systems in Tanzania require limited investments to bring them back into service: of water points which do not produce water, 88% could be rehabilitated at a lower cost than building equivalent new infrastructure.[3] This combination of widespread dysfunction of water infrastructure and a lack of institutional support for repair suggests an important line of investigation: what are the institutional arrangements that support maintenance of local infrastructure in low and middle income countries?

The solution to maintenance in higher-income countries is to legislate monopolies over water supply to utilities (Cowan 1997; Joskow 2007). Though utility monopolies exist in many low- and middle-income countries, these are primarily used in urban areas with contracting issues and financial viability having restricted their success (Soppe et al. 2018; Van den Berg et al. 2017). Most of the existing evidence on maintenance explores direct provision by government (Besley et al. 2004) or by communities (Miguel 2004; Ostrom 1990). However, both approaches miss important complementarities between the two actors – government has specialized skills and resources; communities have local information and corresponding assets.

Ostrom (Ostrom 1990, 1996; Ostrom et al. 1993) argues that coproduction between governments and communities in the maintenance of "common-pool" resources such as communal water points, capitalizes on their distinct comparative advantages. This is the case in many sub-Saharan African contexts: on the one hand, local governments are best placed to source and develop expertise and undertake major capital investments. On the other hand, local communities can directly observe breakdowns at low cost, and process day-to-day repairs efficiently. The literature on co-production goes further, and suggests that by building 'relational contracts' between parties, institutions for solving production challenges organically arise (Gibbons et al. 2012; Macchiavello 2022). Compared with single-provider governance, however, coproduction requires one additional input: coordination between the two parties. In Tanzania, we observe that coordination frequently fails to occur (Bailey 2017).

Little evidence exists on effective incentives and schemes for local governments and communities to coordinate effectively for public action. This study evaluates the impact of 'Maji Endelevu' ('Sustainable Water' in Swahili), a governance intervention implemented in Tanzania from 2018 to 2023. Maji Endelevu aims to improve coproduction between the two parties which are *de jure* jointly responsible for maintaining communal water points: district governments and village water community groups (*Water Supply and Sanitation Act* 2019). Rather than attempting to write

[1] Numbers based on WHO/UNICEF Joint Monitoring Program data.
[2] Calculated by authors from third-party data. See description of data in Appendix C.
[3] Estimated using 2018 baseline data from this study.

ex-ante contracts between them for all possible contingencies, it aims to build their relationships and reduce the transaction costs of assigning responsibilities among each other for pre-emptive maintenance tasks, and when breakdowns arise.

Specifically, the intervention consists of repeated 'action-learning' consultations between the two parties. The consultations are led by an external facilitator who was trained to support relationship building and identify policy 'grey areas', i.e. ones where the two parties show different understandings of their respective responsibilities. The core of the intervention lies in leading the two parties to agree on how they will fulfill their mutual responsibilities, at two levels: to repair the specific breakdown at hand (leading to a registry of action points) and to provide better maintenance support more generally. Consultations are repeated quarterly, allowing parties to keep each other accountable on past agreements, and build a relationship over time. Each location receives a total of four consultations, generally one in-person lasting a day, and three over the phone lasting an hour. This approach was inspired by bottom-up interventions which create an interface between the service provider and end-users (Björkman et al. 2009, 2010, 2017), but adapted to a setting where both parties jointly act as the service provider.[4]

To evaluate the 'Maji Endelevu' intervention, we work with the Government of Tanzania to conduct a cluster-randomized controlled trial across 99 districts and 803 villages in mainland Tanzania. We first randomly select 40 of the 99 districts to be treated and the remainder to become 'district controls'. Within treated districts, 156 villages are randomly assigned to receive the intervention and 183 villages are assigned to control through a random lottery, stratified at the district level. This allows us to test for potential within-district spillovers which may occur if local government officials involved in the intervention divert resources from control to treatment villages within the district they support redor if these officials use the intervention to improve how they interact with control villages. We do this by comparing changes in the distribution of outcomes of interest in control villages within treated districts to those in non-treated districts.

The key contribution of the paper is to investigate the role of consultation in building a more effective state. Our research is closely linked to an incomplete contracting setting in which the responsibility for public action lies with both public officials and citizens; with the capacity to coordinate over the fulfilling of joint responsibilities constrained by a broader context of state and community coordination failures. In developing countries and other resource-constrained environments, this is a relatively common structure for delivering public services. Many facilities are supported financially or otherwise by community members. Similarly, communities frequently play a role in the implementation and management of a broad range of infrastructure from rural roads to irrigation. Studies have explored provision of common-pool resources from the lens of government (Besley et al. 2004) and communities (Miguel 2004; Ostrom 1990). There is far less evidence on coproduction, particularly with the scale of measurement and methodological scope of this study. Existing evidence finds positive effects on irrigation infrastructure in Nepal (Ostrom et al. 1993) and Taiwan (Lam 1996), and on education provision in Brazil (Ostrom 1996). Though there is an emerging literature on 'relational contracts' (Gibbons et al. 2012), it has not been explored in the setting of the joint

[4]The intervention is funded by the United Kingdom's Foreign, Commonwealth and Development Office (FCDO), and designed and implemented in partnership between the FCDO, the Government of Tanzania and the World Bank's Development Impact Evaluation Department (DIME).

delivery of public services. Our study will produce randomized evidence along the full chain of co-production and service delivery, from changes in public officials knowledge of communities to shifts in community maintenance practices.

Such an approach complements our existing understanding of the sources of inefficiency in public infrastructure spending and the functioning of polities that are able to sustain effective service delivery.[5] Political favoritism (Burgess et al. 2015), poor-functioning bureaucracies (Bandiera et al. 2009) and implementation delays (Bancalari 2020) introduce significant inefficiencies in government spending and public infrastructure effectiveness. Community-level accountability interventions have been found to be an effective way to improve service delivery in some settings (Björkman et al. 2009, 2010, 2017; Ferraro et al. 2021; Slough et al. 2021), although the role of consultation in this process is poorly understood. Community monitoring is less effective when benchmarked against auditing and enforcement (Bedoya et al. 2023; Coville et al. 2020; Olken 2007), and the characteristics of government providers have been shown to be an important determinant of successful infrastructure provision (Rasul et al. 2016). In this context, it does seem that the interaction between public officials and citizens is a key factor in determining the sustainability of water infrastructure (Rogger et al. forthcoming). Our research intends to provide frontier evidence on the consequences of this relationship.

In the water sector, evidence exploring ways to expand basic service delivery has focused primarily on new infrastructure extension by subsidizing connection costs (Guiteras et al. 2015; Lee et al. 2020), offering credit (Devoto et al. 2012), or increasing demand through behavior change campaigns (Briceño et al. 2017; Cameron et al. 2019). However, the failure to maintain water points is a key determinant of water access, and thus welfare, in a multitude of settings around the world. Our paper is unique in that it explores the role of water governance to improve access through rehabilitation and maintenance of existing infrastructure, rather than the provision of new infrastructure. As such, it links studies of water sustainability to an under-explored but potentially significant element of a polity: the joint preservation of services by government and citizens.

This paper is structured as follows. Section 2 describes the research design, including Tanzania's context in terms of water point sustainability and a description of the intervention. Section 3 goes on to outline the empirical strategy, including the identification strategy and data. Then, section 4 describes the empirical model and outcomes to be studied. Finally, section 5 specifies the hypotheses which will be tested once endline surveys are completed, and section 6 provides power calculations.

2 Research Design

2.1 Tanzania's Context for Water Access

2.1.1 Water Access

Water access in Tanzania is dominantly through a community water source. 89.6% of Tanzanians rely on communal water points to access water (e.g., well, handpump). Few homes have private con-

[5] The paper also relates to the theoretical literatures on coordination (such as (Alonso et al. 2008) and (Sákovics et al. 2012), communication (such as (Chakraborty et al. 2010)), and political accountability (Besley et al. 2009); and to lab experiments related to coordination such as (Brandts et al. 2006).

nections (Joseph et al. 2018). The most common water point in Tanzania is a communal standpipe (60.7%), i.e. a pipe with a tap.[6] Only 12.4% of water points use electric power for water extraction (e.g., fuel, solar, grid), while the remaining water points rely on manpower (e.g. handpumps) or gravity.[7] Standpipes like these generally rely on a pressure system that requires a significant degree of maintenance to ensure a sustainable water supply.

The country is estimated to have a total of 108,415 communal water points with 151,363 water point outlets in total, as some water points have more then one water outlet (typically a tap). Given the country's population, this implies each outlet must serve over 400 individuals on average, if all water points were functional.

Tanzania's communal water points show a widespread lack of functionality. In a 2021 water point verification exercise across the country, only 58.9% of the country's communal water points (e.g. wells, handpumps) produced water. Of these, many water points failed to meet flow rate requirements to be considered 'functional' with the average water point taking 20 seconds to fill a 5L jerry can.[8] The median duration for non-functional water points to have been in a state of disrepair is four months. Such pervasive and prolonged functionality issues have marked consequences for the water access of Tanzanian citizens.

Non-functionality is predominantly driven by simple hardware problems. We find that 31.6% of water points have a hardware issue, with a broken tap (42.9%) being the most common problem. Of water points which do not produce water, 88% could be rehabilitated at a lower cost than building equivalent new infrastructure. As such, there is a substantial volume of water infrastructure in Tanzania that requires relatively small investments to make functional once again. In turn, these investments would lead to significant increases in water access for Tanzania's population.

One important characteristic of communal water points is that there are limited fees paid by users for service. The baseline survey finds that only 55.8% of water points have a user-fee applied to them. In addition, fee amounts frequently do not reflect the cost of service. For example, 31% of user-fees are collected as a monthly fee per household which is not sensitive to the quantities consumed. Looking at the methods used for setting fee amounts, 88% of fees are set through consultations with end-users, while only 8% are set using financial predictions.

In turn, we find underinvestment in the sustainability of communal water points. When asked what prevents non-functional water points from being repaired, the top two responses from baseline respondents were lack of funds coming from the village community organization (53.6%) and lack of funds coming from the district government (29.6%). The institutional structures that are in place to overcome water point dysfunction are failing on multiple levels.

[6] Throughout this section, unless indicated otherwise, we describe communal water points drawing on this study's baseline data, as described in section 3.4.1.

[7] Most water points use deep ground water (41.0%), or shallow ground water (34.5%), while a minority rely on surface water such as rivers (17.9%).

[8] The last statistics are calculated by the authors from third-party data, as described in Appendix C The rest of this section draws on this study's baseline survey, as described in 3.4.1.

2.1.2 Organizational Structure

In Tanzania, maintenance of communal water points involves two distinct parties: district governments, and village water community organizations. The Government of Tanzania is separated into distinct administrative levels: central government, regions, districts, Local Government Authorities (LGAs), wards, and villages. Public sector water investments are managed by the Rural Water Supply and Sanitation Agency (RUWASA), a semi-autonomous agency managed by the Ministry of Water. Each region has a RUWASA Regional Manager, and each district has a RUWASA District Manager, both of whom generally are trained engineers. One district has one or more LGAs, up to three. In districts with more than one LGA, the LGA constitutes the operational unit of RUWASA (e.g. relating to budget allocations), but there is only one District Manager, sitting at the district level. Mainland Tanzania, which excludes the Zanzibar archipelago, has a total of 185 LGAs, falling under 143 districts (of which 99 are eligible for the Maji Endelevu program) and 26 regions. One LGA comprises of 60 villages on average.

There are 11,153 villages across mainland Tanzania, and each has a village government. It includes a “Village Chairperson” who is elected, and acts as a Mayor, and a “Village Executive Officer” who is appointed, and handles administration. In some villages, the village government administers the communal water points. But in most villages, citizens form water community organizations which administer water points instead of the village government. They are in charge of conducting ‘minor’ repairs autonomously (*Water Supply and Sanitation Act* 2019), and collecting user-fees to finance those repairs. Their degree of formalization varies and the most advanced categories consists of “Community-Based Water Supply Organizations” (CBWSOs). Those obtain formal registration from district governments, who certify them after a constitution process.[9]

2.1.3 Coproduction

In Tanzania, maintenance of communal water points is split between “minor repairs” and “major repairs”. Minor repairs are expected to be conducted autonomously by village water community groups, without direct support from district governments (*Water Supply and Sanitation Act* 2019). This includes raising the funds to process the repair, hiring technicians to conduct it, and purchasing necessary spare parts. In contrast, district governments are expected to collaborate with village water community organizations for major repairs (*Water Supply and Sanitation Act* 2019). The law does not define minor and major repairs (*Water Supply and Sanitation Act* 2019), leading to the potential for substantial coordination issues around which parties are responsible for public action. Given the nature of many local public goods, our setting has similarities to many public policy settings in which government and citizens attempt to collaborate, and is a window into related underprovision of many local public goods. For example, our setting is analogous to coproduction around the building, equipping and staffing of primary health centres, or the transfer, adoption and continued usage of improved agricultural technologies. These are both cases in which both local public institutions and the community intend to have a role in effective service delivery, but in which

[9]They require having a written Constitution and a bank account, among others. In addition, the organizational structure of CBWSOs is set by law (*Water Supply and Sanitation Act* 2019), which includes a Water Committee, in charge of strategy, and a Water Management Team, in charge of operations. Tanzania started registering CBWSOs in 2019, and it is a policy objective that, in time, all villages have one. This will involve gradually registering existing community organizations into CBWSOs. Some CBWSOs may cover several villages when those are remote or have few communal water points, a process called “clustering”.

too often this relationship does not provide services as intended.

Coproduction, or the joint exercise of solving water point breakdown issues, is expected *de jure* in the case of major repairs. However, even in the case of minor repairs it is sometimes expected by village water community organizations *de facto*, because the two parties display distinct comparative advantages, and therefore their collaboration can bring synergies. On the one hand, district governments can benefit from economies of scale, benchmark best practices, and recruit engineers more easily; on the other hand, local communities can directly observe breakdowns, collect user-fees, and process repairs at a lower cost. Of the 185 LGAs in mainland Tanzania, 179 fall under RUWASA for their water service[10], and the coproduction governance system described above. The other six, located in highly urban areas, have their water service managed by utilities called "water authorities", and therefore apply a single-provider governance type. This study focuses specifically on the coproduction model, which constitutes the majority of LGAs.

The objective of the coproduction approach to the management of local water infrastructure is based on principles of encouraging communities to invest resources in their water points, as well as limiting any moral hazard in their use. The sharing of responsibilities aims to encourage responsible use of the infrastructure. However, by creating an 'incomplete contract' between parties through the introduction of ambiguity in which repairs are which party's responsibility, the approach generates inefficiencies in water point maintenance. Coproduction between district governments and village water community is limited by high coordination costs in practice and most district government resources are invested in new water supply infrastructure, rather than in maintaining old systems.

We provide two examples from this study's baseline survey of village water community organizations that illustrate the above points. First, the two parties have limited interaction. Over the six months prior to the baseline survey, on average, water community organizations received only one visit by the district team. This reflects the logistical difficulties found on the ground (vast areas to cover, limited district staff, difficulty and duration of transport). One alternative would be to coordinate remotely. However, we find little evidence of contact between the two parties beyond this single visit. Over the six months prior to the survey, 37% of community organizations had never been in touch with their district team, and only 26% were in touch with them on a monthly basis.

Second, we find substantial confusion about the respective responsibilities of both parties. The baseline survey included a vignette question considering the concrete case of a broken pipe costing TZS 20,000 to repair (i.e. USD 8 at the time of the survey). This case was selected because it is unequivocally minor and therefore the responsibility of the community organization. Yet, we find that only 17.5% of community organizations indicate that they are able to conduct all three steps of the repair (funding, spare part and expertise) without requiring government support. Only 35% would be able to conduct two steps out of the three. This suggests that, even in what would otherwise be seen as a clearly defined responsibility, substantial heterogeneity exists in what communities believe they are able to (or should) address independently. Therefore, we document that even for breakdowns whose magnitudes seems unambiguous, their exist important differences in what the two parties expect from each other, with the possibility of technically and financially

[10] as of August 2022.

repairable breakdowns remaining unaddressed.[11]

Thus, the law has created an incomplete contract in the respective responsibilities of district governments and village water community organizations in terms of maintaining communal water points. Efforts to clarify responsibilities in the law have not been successful. Attempts were made to map ex-ante all possible repairs to either minor or major, through manuals, guidelines and training. However, this turned out to be impossible due to the large number of circumstances. Indeed breakdowns vary along several margins, each with large internal variation: cost of repair, type of water point technology, spare part required, breakdown duration, or possible links with other public providers (e.g., electricity). As such, Tanzania's water access is suffering from an institutional failing with very real consequences for citizen welfare.

These issues are embedded in a broader context of state and community coordination failures which reduce the capabilities of any actor to improve coordination over the fulfilling of joint responsibilities. Government departments are constrained by protocols that are targeted at centralized control (Bailey 2017) which limit the capacity of individual officials to resolve clear coordination failures. Communities are limited in how effectively they can hold officials to account or generate relevant cooperation within their community. Our intervention thus aims to investigate whether developing a stronger relational contract - not one enforced by public service rules or community norms - is able to overcome governance failures in a setting of general governance weakness.

2.2 Description of the *Maji Endelevu* Intervention

To address this institutional failing, this paper outlines the implementation of an intervention that aims to improve coordination and coproduction between district governments and village water community organizations. The intervention, named Maji Endelevu, builds on the experience of projects that aim to build a community interface between users and service providers (Björkman et al. 2009, 2010, 2017).[12] It was implemented from February 2020 until February 2023, after an at-scale pilot in 2019.

Maji Endelevu consists of repeated 'action-learning' consultations between district governments and village water community organizations. The consultations were designed to serve two purposes: to address concrete cases of outstanding breakdowns, and to derive longer-term agreements on how to address water point maintenance more generally by building a stronger relationship and mutual understanding between communities and local government.

The intervention was funded through FCDO within the broader Payment-by-Results (PbR) program supporting the Ministry of Water. Maji Endelevu as an intervention was conceived of and designed as part of a joint development process between the Ministry of Water national team, RUWASA, FCDO and the research team. The design built on the qualitative and quantitative evidence generated through the PbR program, with the objective of addressing some of the key remaining bottlenecks to improving water infrastructure sustainability. The intervention was implemented by an NGO (OIKOS Instituto) that is regularly used by the government to support RUWASA planning and

[11] This could be thought of as akin to 'hold up' in an incomplete contracts framework.

[12] The intervention was developed from 2017 alongside the Government of Tanzania and the UK's FCDO and began with two years of formative research into the key areas of institutional failure in the Tanzanian water sector.

implementation. Each round of consultations was preceded by a letter from RUWASA's Director of Planning and CBWSO Coordination to District Managers (who are employees of RUWASA) alerting them of the planned meetings. CMOs were invited to the consultations directly by the NGO rather than a donor organization. The letter of invite was in standard government formatting emphasizing the role of the government in the program.

Each consultation discusses questions which were revealed by formative research as "grey areas" where the two parties show different understandings, among which: What differentiates a major (requiring government intervention) from a minor repair (not requiring district government intervention)? Which party formally owns communal water points and what implication does this have for respective responsibilities? Are village water community organizations allowed to make operational and financial decisions without approval from district governments? The consultations aim to assist the two parties in reaching a mutual understanding on these areas.

The consultations between district and community representatives were intended to be "semi-structured discussions" rather than a formal lecture. Facilitators opened the consultation by asking village representatives to describe breakdowns in their areas, and explain why they remain unrepaired. Upon hearing the presentation, district government representatives shared their view of how the breakdowns should be repaired. Facilitators pointed out any differences of opinion between the two parties, and related the disagreements to the three wider grey area topics above. While they recall official policy when relevant, the core of the intervention lies in leading the two parties to agree to mutual responsibilities for the specific issue at hand, and developing joint arrangements to address future maintenance issues.

Facilitators were recruited based on two types of skills: hard skills, i.e. their knowledge of Tanzania's water policy and sector, and soft skills, i.e. their ability to drive a semi-structured discussion. Fifteen facilitators were hired, including two senior ones, and received several forms of dedicated training. This included a two-day kick-off training organized in Dodoma in March 2019 before the at-scale pilot, and another one in Dodoma in February 2020 before roll-out. The training mixed classroom training and learning-by-doing – this allowed the implementing partner which hired the facilitators to ensure all of them were sufficiently skilled to undertake the consultations. During roll-out, facilitators received on-the-job training from the two senior facilitators, who shadowed their consultations and provided feedback. Finally, remedial workshops were organized in October 2021 and April 2022. During these, the project team shared feedback from the implementation data filled out after each consultation. The feedback was shared in aggregate form, as well as individually when specific misunderstandings were found.

Consultations were repeated quarterly, and a total of four rounds were conducted. The first round was held in-person and lasted a day, serving to set objectives. In each treated district, the facilitators gathered relevant district government staff working in the water sector and representatives from treated villages in the district.[13] The district government had three representatives, namely the Dis-

[13] In each treated district, generally four villages were selected into treatment. For each treated village, the water community organization representing the village was selected using the following protocol: i) If the village has a registered Community-Based Water Supply Organization (CBWSO), the CBWSO is selected for participation. CBWSOs are the most institutionalized form of water community organization, and they normally supervize all water points in the village. A description of CBWSOs is provided above in section 2.1; ii) If the village does not have a registered CBWSO, and only has one community organization managing all water points, that organization is selected

trict Manager and two lower-ranked team members: a technical staff (e.g. water technician) and a non-technical one (e.g. community development officer). The Regional Manager corresponding with the district also attended. For each of the treated villages, the community organization had two representatives: the highest-ranking official (generally called "Chairperson"), and one with operational responsibilities (e.g. Secretary General, Treasurer). This mix was selected to ensure authoritative decision-making and follow up capacity within the respective organizations was represented in the consultations.

All participants traveled to one of the treated villages, where the first consultation was held. The consultation was held in a public location of the village which provided privacy and comfort, such as a school, health center or other community location. Participants received compensation for their travel costs through a per diem, and were provided with lunch and refreshments during the day. Aside from the main participants cited above, the in-person round also convened local dignitaries specifically for the opening session of the consultation: Ward Councilor, Village Chairperson and Village Executive Officer. This ensured there was local political support for the exercise.

The second, third and fourth rounds were conducted over the phone, and lasted one hour each. In this remote format, each treated village had their one-hour consultation with the district team separately from the other treated villages. As such, each district government had four consultations in a given round (one with each village), while each village had one only. The consultation followed the same structure and contents as in Round 1, with the exception that from Round 2 onwards, facilitators also sought a status update on the action points agreed in previous round. To ensure that the phone calls were manageable, the number of participants on a given call was reduced compared with the in-person format: up to two participants from the district government's side (as opposed to three in Round 1, and the corresponding Regional Manager), and each village included had their own consultation with up to two representatives (as opposed to all treated villages jointly included in the Round 1 group consultation).[14] Due to complications arising from the start of the COVID pandemic, nine of the 40 treated districts also received their first consultation round in a remote, rather than in-person format.

3 Empirical Strategy

3.1 Identification Strategy and Treatment Assignment

The impact of 'Maji Endelevu' is evaluated through a cluster-randomized controlled trial. We start by describing the sampling process for the baseline and endline surveys, and then describes the randomization process.

for participation; iii) If the village has several community organizations supervizing different subsets of water points, one of these organizations is randomly drawn to participate. To do so, a water point from the baseline sample frame (see section 3.2 was drawn from the village at hand, and the community organization managing that water point was selected to participate.

[14] To cover physical costs of in-person consultations and opportunity costs of time for remote consultations, district managers were provided with an average compensation grant of USD 11 by consultation, and community organizations received on average USD 38 by consultation.

3.2 Sampling Process

To form the *sampling frame* a survey consisting of 2,107 villages across 108 districts was conducted in 2017 as part of the "Payment-by-Results" project, a water access project funded by the UK's FCDO. The survey was representative of the 108 districts (129 LGAs) covered, which was where the FCDO-supported program was initially being implemented in the country.

To create the *study sample*, we randomly drew by computer eight villages per LGA from the sampling frame. In LGAs which had eight or fewer village observations available, all villages in the sampling frame were included (this happened in 7 LGAs). Villages were then excluded from the study if they met any of the following criteria: (i) a village had no communal water points; (ii) the village water points were supervised by a "water authority"[15], i.e. a utility company. The reason is that water authorities are exceptions to the *de jure* coproduction framework explored in this study: they operate maintenance directly, without collaboration with water community groups; (iii) there was no active water community group, or failing that, a village government supervising water; and (iv) the village fell within an urban area. This resulted in a study sample of 803 villages spread across 129 LGAs and 99 districts.

3.3 Randomization Process

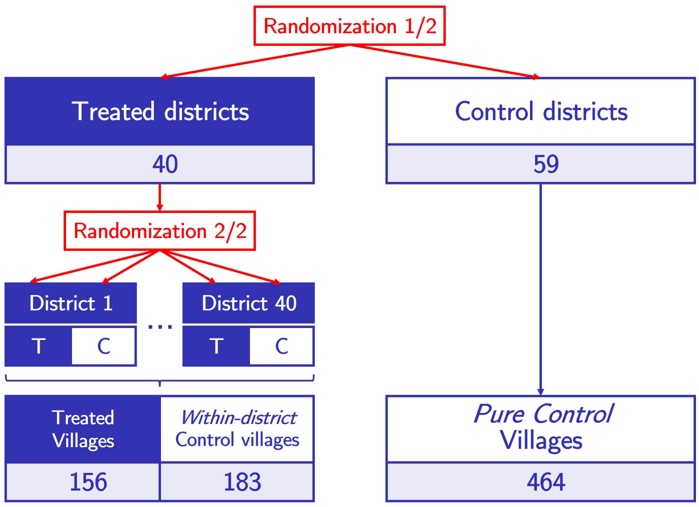
The clustered RCT follows a two-stage randomization process, as depicted in Figure 1: first selecting treatment districts, and then assigning a subset of villages within treatment districts to receive the intervention. We randomize at the district level, as opposed to LGAs, because RUWASA District Managers manage all LGAs in their districts. Out of the 99 districts, 40 were randomly drawn into treatment by a lottery operated by government (i.e. "treated districts"). The second randomization stage consisted of drawing villages into treatment (i.e. "treated villages"), and this was operated by computer. In each of the 40 treated districts, we randomly drew villages into treatment in the following way. If the district had over eight sampled villages, we drew four treated villages, leaving the remaining sampled villages as controls. If the district had eight villages or fewer, we drew half of them into treatment, with the caveat that if the district had an odd number of villages, the split village had a 50% chance of being drawn into treatment. This yielded a total of 156 treated villages. In the 40 treated districts, the villages which were not drawn into treatment constitute the subgroup of "within-district controls". There are 183 of them, which is slightly more than 156 because some districts had more than eight sampled villages. In the 59 non-treated districts, all villages in the sample constitute the "cross-district controls", and there are 464 of them. After villages were assigned, and before treatment implementation started, it was revealed that five treatment villages had transitioned from the default coproduction scheme, to falling under a Water Authority - an exclusion criterion from the study. As such, these five villages[16] were randomly replaced, keeping the total number of treated villages to 156. After treatment implementation started, three treated villages had their community organizations merged with nearby villages as part of a 'CBWSO clustering' program. These villages were not replaced, but the follow up survey will tag these, and any other other villages that may have potentially been clustered with other villages to assess

[15]"mamlaka" in Swahili.

[16]The replaced villages are Itigi Mjini (Manyoni district), Ungurodi (Gairo district), Kibedya (Gairob district), Mabale (Biharamulo district), and Nyakahura (Biharamulo district).

whether this affects treatment compliance.

Figure 1: Randomization Process



3.4 Data

This study relies on three types of original data: baseline, implementation and endline.

3.4.1 Baseline Data and Balance

A baseline survey of village water community organizations was collected in 2018.

In this paper, we use the baseline to provide stylized facts about the context, to estimate minimum detectable effects, and to check for balance across treatment subgroups. The baseline was collected at the end of 2018 (see Section 3.2) and has two components. The first is a survey of the village's main water community organization. In each sampled village, we selected the community organization using the protocol outlined in section 2.2. The questions were meant to assess the community organization's management practices, its constraints (budget, staff, transport, spare parts), its understanding of the coproduction framework, and its effective coordination with district governments. The respondent was a member of the organization's leadership (e.g., General Secretary, Treasurer), and the survey lasted around 1.5 hours. Table 1 provides descriptive statistics on the 803 villages in the study sample (156 treated villages, 183 within-district controls and 464 cross-district controls).

The second component was a water points assessment module, which surveyed two water points in each sampled village. The same sampling frame used to select study villages was used to radomly select water points in the village. "Abandoned" water points were excluded since they were no longer supervised by any organization. The two water points were randomly drawn by computer. When the sampled water point could not be surveyed on the ground, for instance if the enumerator could not find it, it was replaced with a different one in the village. Some villages have fewer than two non-abandoned water points, in which case the single water point was included in the survey. Three main areas were covered. First, the module documented general characteristics of the water point (e.g., technology type, source, extraction method, GPS coordinates). Second, it surveyed indicators used to deduce its functionality status (e.g., whether water is produced, flow, presence of hardware issues, repairability). Third, the water point's governance structure was surveyed (e.g., type of community organization, whether a user fee is levied). Since there are some cases where more than one village water community organization operates in a village, some of the selected water points were supervised by an organization other than the one in our baseline, although this was uncommon (9% of villages in the study sample have more than one organization supervising water points in them).

Table 1: Baseline Survey Descriptive Statistics

	N	mean	sd	min	max
Respondent					
CMO: Respondent is female	803	0.16	0.36	0	1
Respondent's age	803	45.97	10.24	22	65
CMO: Respondent position: Chairperson	669	0.57	0.50	0	1
CMO: Respondent position: Treasurer	669	0.12	0.32	0	1
CMO: Respondent position: Secretary General	669	0.27	0.44	0	1
Years' experience working at organization	803	3.48	3.22	0	12
Community Organization					
Organization is registered community	803	0.39	0.49	0	1
Organization is non-registered community	803	0.47	0.50	0	1
Organization is village government	803	0.15	0.35	0	1
CMO: Chairperson is elected	663	0.80	0.40	0	1
CMO: Share of women among CMO leaders	679	0.38	0.19	0	1
Organization has a Constitution	685	0.51	0.50	0	1
Management Practices					
Number of water points supervised	802	13.64	10.40	1	40
Organization collects user-fees	802	0.53	0.50	0	1
Organization tests water quality	798	0.06	0.24	0	1
Organization works across several villages	682	0.21	0.41	0	1
Organization delegates to private sector	801	0.02	0.15	0	1
Organization has bank or mobile account	797	0.47	0.50	0	1
Observations	803				

We explore balance between subgroups: Table 2 compares treated villages and cross-district controls; Table 3 compares treated villages and within-district controls; and Table 4 compares within-district controls and cross-district controls. The balance tables draws on 44 pre-intervention variables – for each, they show the means by subgroups, means difference across subgroups, along with its statistical significance. The number of imbalanced tests at the 5% level is found to be: four in the comparison between treated villages and cross-district controls, six in that between treated villages and within-district controls, two in that between within-district controls and cross-district controls. While this is slightly larger than would be expected by chance (9%), many of the imbalances go in the direction of potentially underestimating the treatment effect (increasing the chance of a false negative).[17] To allay concerns that imbalances may drive observed effects, we will conduct a double-LASSO section

[17]For example, as shown in Table 3, within-district control villages are more likely to have a Constitution (55% vs 43%), to be faster to reach from the district capital (1.7 hours by motorbike vs 2.0 hours), to receive district visits (1.1 visits over six months vs 0.6 visits), to receive training from the district (22% of villages over the past six months vs 13%), and to believe that water point functionality will improve in the next six months (70% vs 58%). The only imbalanced measure possibly increasing the chance of overestimating impact is that within-district control villages are less likely to source spare parts for minor repairs autonomously from the district – however, the magnitude is relatively small (17% vs 26%).

procedure as a robustness check.

Table 2: Full Balance Table – Treated Villages vs Cross-District Controls

	(1) Treated		(2) Cross Control		T-test (pval) Difference
Variable	N/[Clus]	Mean/(SE)	N/[Clus]	Mean/(SE)	(1)-(2)
Respondent org is a community org, not village government	156 [40]	0.83 (0.03)	464 [59]	0.84 (0.02)	0.71
Respondent org is a registered COWSO	156 [40]	0.38 (0.05)	464 [59]	0.37 (0.03)	0.80
Oversees WPs across several villages	156 [40]	0.20 (0.03)	464 [59]	0.21 (0.02)	0.89
Village is supervized by several community orgs	156 [40]	0.08 (0.02)	464 [59]	0.09 (0.02)	0.88
Community org has a Constitution	156 [40]	0.43 (0.05)	464 [59]	0.52 (0.03)	0.10
Community org has a Chairperson position	156 [40]	1.00 (0.00)	464 [59]	0.99 (0.00)	0.02**
Community org has a Treasurer position	156 [40]	0.91 (0.02)	464 [59]	0.92 (0.01)	0.77
Community org has a Secretary General position	156 [40]	0.96 (0.02)	464 [59]	0.98 (0.01)	0.30
Community org collects user-fees	156 [40]	0.52 (0.04)	464 [59]	0.52 (0.03)	0.95
Community org gives user-fee discounts to vulnerable users?	156 [40]	0.62 (0.04)	464 [59]	0.57 (0.02)	0.29
Community org has a bank or mobile money account	156 [40]	0.50 (0.04)	464 [59]	0.44 (0.03)	0.26
Community org has a dedicated internal auditor	156 [40]	0.13 (0.03)	464 [59]	0.15 (0.02)	0.40
Community org conducts water quality tests	156 [40]	0.05 (0.02)	464 [59]	0.08 (0.01)	0.29
Nb of end-users supervised by community org (winsorized 95th)	156 [40]	3190.43 (241.98)	464 [59]	2850.69 (164.18)	0.25
Number of officials on community org staff	156 [40]	5.26 (0.33)	464 [59]	5.61 (0.20)	0.36
Hours to travel to district capital by motorbike	156 [40]	2.00 (0.16)	464 [59]	1.50 (0.09)	0.01***
Has breakdowns pending an input from the district	156 [40]	0.49 (0.04)	464 [59]	0.49 (0.03)	1.00
Has breakdowns pending an input from the community org	156 [40]	0.37 (0.04)	464 [59]	0.42 (0.02)	0.22
Has difficulty accessing technical experts (past 6 months)	156 [40]	0.21 (0.03)	464 [59]	0.22 (0.02)	0.74
Nb of WPs supervised by community org (winsorized 95th)	156 [40]	14.06 (1.46)	464 [59]	13.32 (0.78)	0.65
Share of WPs without hardware issues (self-reported)	156 [40]	0.59 (0.04)	464 [59]	0.58 (0.02)	0.79

CMO: Share of DPs that have no hardware issue	156 [40]	0.57 (0.03)	464 [59]	0.59 (0.02)	0.46
Share of WPs with a meter (self-reported)	156 [40]	0.21 (0.04)	464 [59]	0.23 (0.02)	0.71
Share of WPs that had a breakdown (past 6 months)	156 [40]	0.30 (0.03)	464 [59]	0.33 (0.02)	0.24
Share of broken down WPs which were repaired (past 6 months)	156 [40]	0.35 (0.03)	464 [59]	0.31 (0.02)	0.35
Understands responsibility split depending on minor or major	156 [40]	0.81 (0.03)	464 [59]	0.80 (0.02)	0.76
Would autonomously process funding for minor repair	156 [40]	0.62 (0.04)	464 [59]	0.63 (0.03)	0.84
Would autonomously process spare parts for minor repair	156 [40]	0.26 (0.03)	464 [59]	0.22 (0.02)	0.31
Would autonomously process technical expertise for minor repair	156 [40]	0.68 (0.04)	464 [59]	0.70 (0.03)	0.63
Able to contact district water team for technical matters?	156 [40]	0.58 (0.03)	464 [59]	0.62 (0.02)	0.28
Nb of district visits (past 6 months)	156 [40]	0.63 (0.08)	464 [59]	0.95 (0.07)	0.00***
Received district guidance to focus on maintenance (past 6 months)	156 [40]	0.28 (0.04)	464 [59]	0.33 (0.03)	0.26
Community group received training district (past 6 months)?	156 [40]	0.13 (0.03)	464 [59]	0.23 (0.02)	0.02**
Requires district approval to withdraw funds	156 [40]	0.29 (0.04)	464 [59]	0.29 (0.02)	0.89
Has already submitted data to District Water Team	156 [40]	0.49 (0.04)	464 [59]	0.54 (0.02)	0.28
Chairperson is a volunteer	156 [40]	0.80 (0.03)	464 [59]	0.84 (0.01)	0.20
Currently runs a deficit	156 [40]	0.72 (0.04)	464 [59]	0.77 (0.02)	0.30
Functionality improved over past six months (self-reported)	156 [40]	0.32 (0.05)	464 [59]	0.41 (0.02)	0.09*
Believes that functionality will improve over next six months (self-reported)	156 [40]	0.58 (0.05)	464 [59]	0.68 (0.02)	0.07*
Very satisfied with outcomes of district visits (past 6 months)	156 [40]	0.41 (0.02)	464 [59]	0.44 (0.02)	0.20
Relationship with district water team has improved (past 6 months)	156 [40]	0.23 (0.03)	464 [59]	0.28 (0.02)	0.15
Relationship with district water team will improve over next six months (self-re	156 [40]	0.56 (0.05)	464 [59]	0.59 (0.02)	0.50
Community org is able to make decisions autonomously	156 [40]	0.44 (0.05)	464 [59]	0.44 (0.02)	1.00

Notes: The value displayed for t-tests are p-values. Standard errors are clustered at variable district. All missing values in balance variables are treated as zero.***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table 3: Full Balance Table – Treated Villages vs Within-District Controls

	(1) Treated		(2) Within Control		T-test (pval) Difference
Variable	N/[Clus]	Mean/(SE)	N/[Clus]	Mean/(SE)	(1)-(2)
Respondent org is a community org, not village government	156	0.83 (0.03)	183	0.84 (0.03)	0.72
Respondent org is a registered COWSO	156	0.38 (0.04)	183	0.43 (0.04)	0.44
Oversees WPs across several villages	156	0.20 (0.03)	183	0.21 (0.03)	0.96
Village is supervized by several community orgs	156	0.08 (0.02)	183	0.10 (0.02)	0.53
Community org has a Constitution	156	0.43 (0.04)	183	0.55 (0.03)	0.02**
Community org has a Chairperson position	156	1.00 (0.00)	183	0.99 (0.01)	0.27
Community org has a Treasurer position	156	0.91 (0.02)	183	0.95 (0.02)	0.19
Community org has a Secretary General position	156	0.96 (0.01)	183	0.97 (0.01)	0.75
Community org collects user-fees	156	0.52 (0.04)	183	0.56 (0.04)	0.48
Community org gives user-fee discounts to vulnerable users?	156	0.62 (0.03)	183	0.60 (0.03)	0.70
Community org has a bank or mobile money account	156	0.50 (0.04)	183	0.51 (0.04)	0.79
Community org has a dedicated internal auditor	156	0.13 (0.03)	183	0.18 (0.03)	0.18
Community org conducts water quality tests	156	0.05 (0.02)	183	0.04 (0.02)	0.76
Nb of end-users supervised by community org (winsorized 95th)	156	3190.43 (210.74)	183	2928.56 (181.16)	0.34
Number of officials on community org staff	156	5.26 (0.24)	183	4.81 (0.19)	0.13
Hours to travel to district capital by motorbike	156	2.00 (0.15)	183	1.66 (0.09)	0.05**
Has breakdowns pending an input from the district	156	0.49 (0.04)	183	0.48 (0.04)	0.85
Has breakdowns pending an input from the community org	156	0.37 (0.04)	183	0.42 (0.04)	0.28
Has difficulty accessing technical experts (past 6 months)	156	0.21 (0.03)	183	0.14 (0.03)	0.10*
Nb of WPs supervised by community org (winsorized 95th)	156	14.06 (0.92)	183	14.11 (0.77)	0.97
Share of WPs without hardware issues (self-reported)	156	0.59 (0.03)	183	0.63 (0.02)	0.29

CMO: Share of DPs that have no hardware issue	156	0.57 (0.03)	183	0.60 (0.02)	0.31
Share of WPs with a meter (self-reported)	156	0.21 (0.03)	183	0.25 (0.03)	0.27
Share of WPs that had a breakdown (past 6 months)	156	0.30 (0.03)	183	0.36 (0.02)	0.07*
Share of broken down WPs which were repaired (past 6 months)	156	0.35 (0.03)	183	0.34 (0.03)	0.83
Understands responsibility split depending on minor or major	156	0.81 (0.03)	183	0.85 (0.03)	0.31
Would autonomously process funding for minor repair	156	0.62 (0.04)	183	0.66 (0.04)	0.46
Would autonomously process spare parts for minor repair	156	0.26 (0.03)	183	0.17 (0.03)	0.04**
Would autonomously process technical expertise for minor repair	156	0.68 (0.04)	183	0.63 (0.04)	0.38
Able to contact district water team for technical matters?	156	0.58 (0.04)	183	0.65 (0.04)	0.17
Nb of district visits (past 6 months)	156	0.63 (0.08)	183	1.08 (0.10)	0.00***
Received district guidance to focus on maintenance (past 6 months)	156	0.28 (0.04)	183	0.36 (0.04)	0.09*
Community group received training district (past 6 months)?	156	0.13 (0.03)	183	0.22 (0.03)	0.03**
Requires district approval to withdraw funds	156	0.29 (0.03)	183	0.22 (0.03)	0.07*
Has already submitted data to District Water Team	156	0.49 (0.04)	183	0.56 (0.04)	0.16
Chairperson is a volunteer	156	0.80 (0.03)	183	0.83 (0.03)	0.42
Currently runs a deficit	156	0.72 (0.04)	183	0.70 (0.03)	0.69
Functionality improved over past six months (self-reported)	156	0.32 (0.04)	183	0.33 (0.03)	0.86
Believes that functionality will improve over next six months (self-reported)	156	0.58 (0.04)	183	0.70 (0.03)	0.02**
Very satisfied with outcomes of district visits (past 6 months)	156	0.41 (0.02)	183	0.47 (0.03)	0.09*
Relationship with district water team has improved (past 6 months)	156	0.23 (0.03)	183	0.27 (0.03)	0.37
Relationship with district water team will improve over next six months (self-re	156	0.56 (0.04)	183	0.60 (0.03)	0.41
Community org is able to make decisions autonomously	156	0.44 (0.04)	183	0.40 (0.04)	0.52

Notes: The value displayed for t-tests are p-values. All missing values in balance variables are treated as zero.***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table 4: Full Balance Table – Within-District Controls vs Cross-District Controls

Variable	(1) Within Control N/[Clus]	(1) Within Control Mean/(SE)	(2) Cross Control N/[Clus]	(2) Cross Control Mean/(SE)	T-test (pval) Difference (1)-(2)
Respondent org is a community org, not village government	183 [40]	0.84 (0.03)	464 [59]	0.84 (0.02)	0.98
Respondent org is a registered COWSO	183 [40]	0.43 (0.04)	464 [59]	0.37 (0.03)	0.29
Oversees WPs across several villages	183 [40]	0.21 (0.03)	464 [59]	0.21 (0.02)	0.92
Village is supervized by several community orgs	183 [40]	0.10 (0.02)	464 [59]	0.09 (0.02)	0.59
Community org has a Constitution	183 [40]	0.55 (0.04)	464 [59]	0.52 (0.03)	0.47
Community org has a Chairperson position	183 [40]	0.99 (0.01)	464 [59]	0.99 (0.00)	0.59
Community org has a Treasurer position	183 [40]	0.95 (0.02)	464 [59]	0.92 (0.01)	0.23
Community org has a Secretary General position	183 [40]	0.97 (0.01)	464 [59]	0.98 (0.01)	0.34
Community org collects user-fees	183 [40]	0.56 (0.06)	464 [59]	0.52 (0.03)	0.58
Community org gives user-fee discounts to vulnerable users?	183 [40]	0.60 (0.03)	464 [59]	0.57 (0.02)	0.45
Community org has a bank or mobile money account	183 [40]	0.51 (0.05)	464 [59]	0.44 (0.03)	0.18
Community org has a dedicated internal auditor	183 [40]	0.18 (0.04)	464 [59]	0.15 (0.02)	0.50
Community org conducts water quality tests	183 [40]	0.04 (0.02)	464 [59]	0.08 (0.01)	0.14
Nb of end-users supervised by community org (winsorized 95th)	183 [40]	2928.56 (235.98)	464 [59]	2850.69 (164.18)	0.79
Number of officials on community org staff	183 [40]	4.81 (0.26)	464 [59]	5.61 (0.20)	0.01**
Hours to travel to district capital by motorbike	183 [40]	1.66 (0.10)	464 [59]	1.50 (0.09)	0.23
Has breakdowns pending an input from the district	183 [40]	0.48 (0.04)	464 [59]	0.49 (0.03)	0.85
Has breakdowns pending an input from the community org	183 [40]	0.42 (0.04)	464 [59]	0.42 (0.02)	0.96
Has difficulty accessing technical experts (past 6 months)	183 [40]	0.14 (0.03)	464 [59]	0.22 (0.02)	0.02**
Nb of WPs supervised by community org (winsorized 95th)	183 [40]	14.11 (1.09)	464 [59]	13.32 (0.78)	0.56
Share of WPs without hardware issues (self-reported)	183 [40]	0.63 (0.02)	464 [59]	0.58 (0.02)	0.13

CMO: Share of DPs that have no hardware issue	183	0.60	464	0.59	0.77
	[40]	(0.03)	[59]	(0.02)	
Share of WPs with a meter (self-reported)	183	0.25	464	0.23	0.51
	[40]	(0.04)	[59]	(0.02)	
Share of WPs that had a breakdown (past 6 months)	183	0.36	464	0.33	0.31
	[40]	(0.02)	[59]	(0.02)	
Share of broken down WPs which were repaired (past 6 months)	183	0.34	464	0.31	0.46
	[40]	(0.03)	[59]	(0.02)	
Understands responsibility split depending on minor or major	183	0.85	464	0.80	0.08*
	[40]	(0.02)	[59]	(0.02)	
Would autonomously process funding for minor repair	183	0.66	464	0.63	0.51
	[40]	(0.03)	[59]	(0.03)	
Would autonomously process spare parts for minor repair	183	0.17	464	0.22	0.18
	[40]	(0.03)	[59]	(0.02)	
Would autonomously process technical expertise for minor repair	183	0.63	464	0.70	0.27
	[40]	(0.06)	[59]	(0.03)	
Able to contact district water team for technical matters?	183	0.65	464	0.62	0.54
	[40]	(0.04)	[59]	(0.02)	
Nb of district visits (past 6 months)	183	1.08	464	0.95	0.31
	[40]	(0.11)	[59]	(0.07)	
Received district guidance to focus on maintenance (past 6 months)	183	0.36	464	0.33	0.48
	[40]	(0.04)	[59]	(0.03)	
Community group received training district (past 6 months)?	183	0.22	464	0.23	0.96
	[40]	(0.04)	[59]	(0.02)	
Requires district approval to withdraw funds	183	0.22	464	0.29	0.08*
	[40]	(0.03)	[59]	(0.02)	
Has already submitted data to District Water Team	183	0.56	464	0.54	0.64
	[40]	(0.05)	[59]	(0.02)	
Chairperson is a volunteer	183	0.83	464	0.84	0.63
	[40]	(0.03)	[59]	(0.01)	
Currently runs a deficit	183	0.70	464	0.77	0.19
	[40]	(0.04)	[59]	(0.02)	
Functionality improved over past six months (self-reported)	183	0.33	464	0.41	0.10*
	[40]	(0.04)	[59]	(0.02)	
Believes that functionality will improve over next six months (self-reported)	183	0.70	464	0.68	0.66
	[40]	(0.04)	[59]	(0.02)	
Very satisfied with outcomes of district visits (past 6 months)	183	0.47	464	0.44	0.45
	[40]	(0.03)	[59]	(0.02)	
Relationship with district water team has improved (past 6 months)	183	0.27	464	0.28	0.73
	[40]	(0.04)	[59]	(0.02)	
Relationship with district water team will improve over next six months (self-re	183	0.60	464	0.59	0.86
	[40]	(0.04)	[59]	(0.02)	
Community org is able to make decisions autonomously	183	0.40	464	0.44	0.46
	[40]	(0.04)	[59]	(0.02)	

Notes: The value displayed for t-tests are p-values. Standard errors are clustered at variable district. All missing values in balance variables are treated as zero.***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

3.4.2 Implementation Data

This study collects implementation data on the consultations[18], specifically through three data sources. The first source is a facilitators form, which facilitators fill out online immediately after conducting a consultation. The form captures what occurred during the consultation. This includes overall characteristics of the consultation (e.g., date, duration), the individuals who participated (e.g., function, number, gender), and the policy areas discussed. On that last item, the form goes into detail to document whether the consultation exhibited differences in understanding between participants, how marked those were, whether they were solved through the discussion, and how.

The second source of implementation data is an action points registry which is maintained throughout the intervention's duration. Every time participants solve an outstanding breakdown through the consultation, the facilitator guides participants to commit to specific action points. At the end of the session, those are read out loud once more, to ensure all parties agree. For each action point, the form records the agreed action, the party in charge, and the deadline. Between two consultation rounds, facilitators seek a status update from participants (complete, ongoing, not started, no longer applicable). Action point registries are maintained in hard copy by facilitators, in Swahili. They are then digitized and translated into English for the research team.

3.4.3 Endline Data

The endline is expected to be conducted in late 2023. It will consist of four original surveys: one of district governments, one of village water community organizations, a water point mapping module, and a survey of Village Executive Officers. First, the survey of district governments will be administered online, ahead of the other three components. It will survey all 99 districts in Maji Endelevu's study sample, and the respondent will be the District Manager. The questionnaire will consist of a roster going through all the villages in the study sample (treated or control) located in the district. The questions will assess the District Manager's (i) knowledge of the villages' maintenance situation, and (ii) investments into them (time, funding).

Second, the survey of village water community organizations will follow the same approach as at baseline, as described in section 3.4.1, together with an expanded set of outcome measures. Where village water community organizations have changed structure since baseline in control villages, the highest ranking organization will be surveyed to be directly comparable to the treatment group.

Third, the water points mapping module will follow the same approach as at baseline, as described in section 3.4.1; however, all communal water points in the village will be surveyed, rather than limiting to the two selected at baseline.

Fourth, a survey of Village Executive Officers will be conducted in all surveyed villages. It will measure public efforts undertaken in the village across social sectors – water, but also health, education, security or agriculture. Efforts will be measured in terms of government visits to the village, village

[18]The implementation data serves two purposes. First, it helps track implementation and assure quality. The facilitators forms and action points registry were used for high-frequency checks, and when it emerged that some facilitators did not fully apply the design as agreed, targeted feedback was provided. Second, it provides a rich description of the implementation fidelity and content of the consultations to help contextualise results, and shed light on potential mechanisms.

budget allocations, and satisfaction with district administration. Among others, this will help detect possible cross-sector spillovers towards the water sector, and away from others.

4 Empirical Model

4.1 Econometric Specification

As outlined in section 4.3, we measure Maji Endelevu's impact along three indices to mitigate the potential of false positives from multiple hypothesis testing.

4.1.1 District-Clustered Specification

The most plausible threat to the study's internal validity is the possible presence of within-district spillovers. This could create a downward bias of our estimate if the District water team diverts resources from control to treatment villages within the same district. It could also create an upward bias if the District water team learns how to more effectively engage with communities through this process and is able to better support control villages as a result. Meaningful spillovers of this type would first manifest themselves through a reallocation of District time and financial resources across villages. We are able to explicitly test for this in the design using the District Manager survey, which is rolled out prior to the other surveys. Specifically, we will measure whether there is a difference in (i) the number of visits undertaken by the District water team to a village and (ii) the amount of funds used for the village, by comparing across-district control and within-district control villages. This is done by running the following specification, where standard errors are clustered at the district level. The parameters are defined with respect to village v in district d.

$$Y_{vd} = \alpha_0 + \alpha_1 T_{vd} + \alpha_2 S_{vd} + \alpha_3 X_{vd} + \epsilon_v \tag{1}$$

- Y_{vd} is the outcome variable for village v in district d.
- T_{vd} is the treatment dummy, equal to 1 if village v in district d is a treated village, and 0 otherwise.
- S_{vd} is a dummy equal to 1 if village v is a "within-district control", i.e. a non-treated village in a treated district d, and 0 otherwise.
- X_{vd} is a vector of covariates, when applicable (e.g. robustness checks, controlling for baseline values).

Here, we are interested in α_2 which estimates the *Spillovers on Non-Treated (SNT)* (Baird et al. 2014). The *Spillover on Non-Treated* is the difference between the outcome of within-district and across-district control villages.

A significant value of α_2 red(in either direction) would suggest the presence of within-district spillovers, in which case we will rely on the full *district-clustered* experimental design using all 99 districts in the study to measure treatment effects (Equation 1: T_{vd}).

If α_2 is not found to be significantly different from zero, this suggests that the intervention does not induce meaningful within-district spillovers, in which case our primary specification for measuring program impact will rely on the *village-clustered* experimental design, focusing on the 40 treatment districts (see Section 4.1.2).

We conduct power calculations in section 6.1 and the minimum detectable effects (MDEs) of several district-related outcomes are provided in Tables 7 and 8. The MDEs under district-level randomization are relatively low, relative to the means, and precision can be improved by controlling for baseline values, confirming the study is sufficiently powered to detect the possible presence of meaningful spillovers.

4.1.2 Village-Clustered Specification

In the case where we find no evidence of district-level spillovers, we will rely on the specifications below, which are based on village-level randomization. For village-level outcomes, we will estimate treatment effects through Equation 2, where parameters and subscripts are defined in the same way as in Equation 1. It also includes district fixed effects, with D_d representing the vector of district strata dummies, equal to 1 if the village is located in district d. We declare districts as strata in Stata (standard errors are not clustered at the district level). The model is run across all surveyed villages in the 40 treated districts.

$$Y_{vd} = \alpha_0 + \alpha_1 T_{vd} + \alpha_2 X_{vd} + D_d + \epsilon_v \tag{2}$$

For water point-level outcomes (w), we estimate treatment effects through Equation 3. Standard errors are clustered at the village level, and we declare districts as strata in Stata.

$$Y_{wvd} = \alpha_0 + \alpha_1 T_{vd} + \alpha_2 X_w + D_d + \epsilon_w \tag{3}$$

4.2 Multiple Hypothesis Testing

The endline survey includes a large number of variables to understand the possible impacts of the program. Measuring the impact of each individually would increase the chances of false positives. To address this, we develop three indices following Anderson (Anderson 2008) to capture (i) water point functionality, (ii) district-level maintenance; and (iii) village-level maintenance. Given the limited number of tests, we do not correct for multiple hypotheses in the paper. To explore possible mechanisms, we also plan to report results from the individual variables making up the three indices, however these will be flagged as exploratory in nature and not subject to multiple hypothesis correction. Additional exploratory variables that are not part of these three indices, but will help untangle potential coproductiona and coordination impact channels are also described in Section D of Table 5.

4.3 Outcomes of Interest

Table 5 shows the main outcome variables which will be collected through the endline, and used to conduct the analyses outlined in section 5.

Table 5: List of Outcomes

	Outcome	Level	Definition
			A. Water Point Functionality
O1	**WP functional**	Water point	Equal to 1 if all outlets on the water point are functional, i.e., the outlet produces water (O1.a equal to 1) and (ii) passes the flow test (O1.b equal to 1), 0 otherwise.
O1.a	Produces water	Water outlet	Whether the water outlet produces water (binary variable).
O1.b	Flow test	Water outlet	Whether the water outlet passes the soft flow test, i.e., if the outlet is a hand pump, taking 10 pumps or fewer to start drawing water; if the outlet is other types, taking 60 seconds or fewer to fill 5L.
			B. Village Maintenance Index
O2	**Village Maintenance Index**	village	Index of Community Organization's Maintenance Management and Practices (from 0 to 1), from the following indicators:
O2.a	Meets regularly	village	Whether organization meets on a regular basis and discusses maintenance
O2.b	Has policies and procedures	village	Whether organization has documentation, policies and procedures
O2.c	Collects user fees	village	Whether organization raises funds for maintenance (e.g., forecasting, saving, expenditure)
O2.d	Uses pricing methodology	village	Whether organization assesses appropriate pricing for optimal use
O2.e	Inspects infrastructure	village	Whether organization inspects water infrastructure in a routine manner
O2.f	Inspections are comprehensive	village	Whether water infrastructure inspections review all major threats to sustainability
O2.g	Has feedback mechanism	village	Whether organization has a rigorous user feedback response mechanism
O2.h	Has resolution mechanisms	village	Whether sufficient mechanisms are in place to ensure maintenance issues are resolved
			C. District Maintenance Index
O3	**District Maintenance Index**	village	Index of District Water Team inputs into village maintenance (from 0 to 1), from the following indicators:
O3.a	Knows village organization	village	Whether the District Manager knows the organizational structure of the village's community group
O3.b	Conducts technical Visits	village	Frequency of visits by the District Water Team to the village
O3.c	Provides financial support	village	Financial investments by the District Water Team to the village's water points
			D. Possible Channels: Strengthening Connections Between Local Government and Communities

Frequency of contact			
A1	Frequency of contact with district	village	How often organization and district were in touch over past six months (indexed from 0 to 1)
Nature of relationship			
A2	Relationship very good	village	Whether relationship between organization and district is 'very good'
A3	Relationship improved	village	Whether relationship between organization and district improved (past 6 months)
A4	Index of nature of relationship with district water team	village	Normalized and aggregated responses to "To what extent do you agree with the following sentences? The local government water team is ... accessible, considerate, friendly, constructive, responsive?"
Clarity of responsibilities			
A5	Understands minor vs major	village	Whether organization recognizes that district involvement depends on whether breakdown is minor or major
A6	Understands village responsibility	village	Whether organization recognizes which responsibilities are mapped to the village, not district (e.g., user fees, preventive checks)
A7	Understands district responsibilities	village	Whether organization recognizes which responsibilities are mapped to the district, not village (e.g., major repairs)
A8	Autonomy solving minor	village	Whether organization would autonomously solve a minor repair (funding, spare parts, expertise)

5 Analysis

5.1 Primary Hypotheses

The overall objective of the intervention is to improve access to reliable water services by increasing communal water point functionality. We measure this through one binary outcome stating whether or not the water point is functional. A water point is functional if all of its water outlets are functional – in turn, a water outlet is functional if two conditions are met, i.e., it produces water and has sufficient flow (see details in *Panel A* of Table 5). These definitions follow Tanzania's official typology (see Appendix B).

We expect that the intervention will help increase the share of functional communal water points, which we reflect in the following hypothesis.

Hypothesis 1 (Water Point Functionality) *The intervention increases the share of communal water points which are functional (see Outcome O1).*

5.2 Secondary Hypotheses

We expect that the intervention will improve water point functionality through changes in village water community organization and district government actions.

First, we expect that the intervention increases the maintenance inputs supplied by village water community organizations. We measure this through a Village Maintenance Index ranging from 0 to

1, which captures eight main indicators shown in *Panel B* of Table 5.

Each main indicator in the index captures several variables, such that the Village Maintenance Index draws on 26 variables in total, taken from the endline survey of village community organizations. These variables cover two dimensions of community organizations' efforts: maintenance management (e.g., holding dedicated meetings, collecting revenue, having Standard Operating Procedures) and maintenance practices (e.g., conducting preventative infrastructure checks, having a user feedback mechanism, having resolution mechanisms). The details of the 26 variables and how the Village Maintenance Index is calculated are shown in Table 11 (Appendix D).

Hypothesis 2 (Village Maintenance Index) *The intervention increases the Village Maintenance Index (see Outcome O2).*

Second, we expect that the intervention increases the maintenance inputs supplied by district governments. We measure this through a District Maintenance Index ranging from 0 to 1, which captures three main indicators shown in *Panel C* of Table 5: knowledge of the village community's organizational structure, visits by the district to the village, and financial support for maintenance. Each main indicator in the index captures several variables, such that the District Maintenance Index draws on six variables in total, taken from the endline surveys of village community organizations and district managers. The details of the six variables and how the District Maintenance Index is calculated are shown in Table 12 (Appendix D).

Hypothesis 3 (District Maintenance Index) *The intervention increases the District Maintenance Index (see Outcome O3).*

5.3 Possible Channels

The intervention is expected to improve maintenance practices and waterpoint functionality by strengthening the relationships between local government and communities, making it easier to interact and coordinate on maintenance responsibilities.

We explore this along a series of variables shown in *Panel D* of Table 5. First, we explore whether the *frequency of contact* has increased by asking how often the community organization has interacted with the district in the past six months (A1). We then explore whether the *nature of the relationship* has changed, by asking about the quality of the relationship (A2), whether this has improved (A3) and an index consisting of questions on whether the community organization finds the district water team accessible, considerate, friendly, constructive or responsive (A4). Finally, we explore whether the *clarity of responsibilities* improves by asking the community organization how well they understand the difference between minor and major repairs (A5), the maintenance responsibilities of villages and districts (A6 and A7) and whether the village organization would autonomously address a minor repair (A8).

Hypothesis 4 (Strengthening connections between local government and communities) *The intervention increases contact, builds stronger relationships, and improves clarity of roles and responsibilities between district governments and village water organizations.*

Finally, we explore whether the intervention generates cross-sector spillovers towards water, and away from other social sectors (for instance if resources are reallocated from education, agriculture or health to support water point maintenance). We will explore this using the Village Executive Officers survey described in section 3.4.3, by comparing different social sectors in terms of: village budget requests, visits from government officials, satisfaction with district administration.

6 Power Calculations

We conduct power calculations for the outcomes listed in this paper, following the method used in similar evaluations (as in Jakiela et al. 2020). The minimum detectable effect (MDE) increases in the intra-class correlation, and holding constant total sample size, it increases in the size of a cluster, and decreases in the number of clusters. Specifically, the formula to calculate an outcome's MDE in a setting with uneven clusters is the following:

$$MDE = (t_{1-k} + t_{\alpha/2})\sigma\sqrt{\frac{1}{N_1}(1+(s_1-1)\rho) + \frac{1}{N_2}(1+(s_2-1)\rho)} \tag{4}$$

We use standard statistical norms of limiting the risk of 'Type I' error (i.e. false positives) to 5% ($\alpha = 0.05$) and 'Type II' errors (i.e. false negatives) to 20% ($k = 0.8$). The other terms in this equation are defined as follows:

- σ is the standard deviation of the outcome.
- ρ is the intra-class correlation (ICC) of the outcome.
- N_1 is the total number of observations across all 59 district clusters in the control group.
- s_1 is the cluster size (i.e. number of observations per cluster) in the control group.
- N_2 is the total number of observations across all 40 district clusters in the treated group.
- s_2 is the cluster size (i.e. number of observations per cluster) in the treated group.

Equation 4 also applies to non-clustered designs by setting s_1 and s_2 to 1.

6.1 District-Level Randomization

We start by specifying power calculations for the district-level randomization design, where districts constitute clusters. To specify N_1, N_2, s_1 and s_2, we differentiate between outcomes at the village level, and those at the water point level. For outcomes at the village level, the control group has a total number of observations N_1 equal to 464 villages, and cluster size s_1 equals 8 villages ($\approx 464/59$). In the treated group, N_2 is equal to 156 villages, and cluster size s_2 equals 4 villages ($\approx 156/40$).

For outcomes at the water point level, the clustering is still done at the district level, however the observation is at the water point level. We estimate from the third-party data described in section C that on average we will survey 8 water points per village. Therefore, the control group has a total number of observations N_1 equal to 3,776 water points ($\approx 464 \times 8$), and cluster size s_1 equals 64 water points ($= 8 \times 8$). In the treated group, N_2 is equal to 1,280 water points, and cluster size s_2 is equal to 32 water points ($= 4 \times 8$). Effective sample size can be lower than the planned sample sizes described above. That is because some of the outcomes used in this study are only collected conditional on the survey's skip pattern on previous questions.[19] Effective sample size is shown in column "N" of Table 8.

We then turn to the ICC and standard deviation, which vary depending on the outcome. We estimate them using this study's baseline data for village level outcomes, and the third-party data described in section C for water point level outcomes. The results for each outcome are shown below in Table 8. In Stata, we calculate the ICC using the commands shown below.

```
loneway outcome district
display r(rho)
```

The next step is to calculate the MDE. We do this using Stata command `clsampsi`, as it allows for the control and treatment groups to have different numbers of clusters and different cluster sizes. Command `clsampsi` outputs the power, rather than the MDE, so we guess-and-check the MDE until the power is found to be approximately 80%. Below, we provide the example for outcome B.5, which measures how often the community organization was in touch with the district water team in the previous six months, indexed from 0 to 1. From baseline, we estimate that the outcome's mean is 0.45, its standard deviation is 0.42, and its ICC is 0.04. We find that the MDE is equal to 0.12, meaning that we are powered to detect at least a difference in means of 0.45 in the control group and 0.57 in the treated group.

```
clsampsi 0.45 0.57, k1(59) k2(40) m1(8) m2(4) sd(0.42) rho1(0.04) alpha(0.05)
display r(estpower)
```

In Table 8, we derive the MDEs for a series of baseline variables which are related to the outcomes studied as part of this evaluation. The definitions of these variables are provided in Table 8 (see appendix A). In Table 7, we assess power for outcomes O.2 and O.3. To do this, we calculate the MDE of a generic index, standardized with mean equal to 1 and standard deviation equal to 0. We derive the average ICC across the variables related to outcomes 0.2 and 0.3 in Table 8, which equals 0.065 – for that ICC value, we find that the index's MDE equals 0.29 standard deviation. Table 7 also provides a sensitivity analysis, with three other ICC values: 0.01; 0.1 and 0.2. We find that the respective MDEs are 0.27, 0.31 and 0.35 standard deviation.

6.2 Village-Level Randomization

We then specify power calculations for the village-level randomization design (the MDEs are also shown in Table 8). The mean and standard deviation are estimated using the same data as above. In terms of sample size, we distinguish between outcomes at the village level, and those at the water point level. For outcomes at the village level, there are no clusters – we reflect this by setting s_1 and s_2 to 1. The number of observations in the control group N_1 is equal to 183 villages (i.e.,

[19] For instance, outcome B.5 measures the wait time after community organizations requested a visit from the district water team, averaged over the previous six months. As such this question only applies to those villages which received at least one visit. We adjust sample size accordingly, using baseline data to assess the adjustment.

within-district controls), and in the treated group, N_2 is equal to 156 villages. We assess power for outcomes O.2 and O.3 in Table 7, by calculating the MDE for a generic index, standardized with mean equal to 0 and standard deviation equal to 1. We find that it equals 0.31 standard deviations.

For outcomes at the water point level, villages act as clusters. As discussed above, we estimate that on average we will survey 8 water points per village, resulting in s_1 and s_2 equal to 8. With 183 villages in the control group and 156 in the treated one, this yields a total number of water points equal to 1,464 in the control group (N_1), and 1,248 in the treated group (N_2).

Table 6: Power Parameters

Baseline Variable Name	Level	Feeds into Outcome	Mean	Sd	District-Level Rand.			Vill-Level Rand.		
					N	ICC	MDE	N	ICC	MDE
WP functional	WP	O1	54.7%	0.50	4582	0.15	0.12	2373	0.33	0.10
WP produces water	WP	O1.a	59.8%	0.48	4799	0.14	0.11	2712	0.32	0.10
Time to fill 5L	WP	O1.b	19.26	13.86	1896	0.26	4.50	1017	0.43	3.35
Strokes needed to draw water	WP	O1.b	4.07	4.53	948	0.13	1.31	678	0.22	1.10
Collects user-fees	village	O2.c	53.6%	0.50	632	0.08	0.15	339	NA	0.15
Share of WPs with meter	village	O2.c	23.7%	0.38	632	0.19	0.13	337	NA	0.12
Financial predictions	village	O2.d	10.8%	0.31	217	0.01	0.16	121	NA	0.16
Water quality tests	village	O2.f	7.0%	0.26	632	0.12	0.08	337	NA	0.08
Preventive checks	village	O2.f	77.5%	0.42	573	0.05	0.12	318	NA	0.13
Low access technician	village	O2.h	19.4%	0.40	632	0.02	0.11	334	NA	0.12
Low access spare parts	village	O2.h	46.5%	0.50	632	0.01	0.13	339	NA	0.15
Breakdowns repairs	village	O2.h	33.8%	0.42	474	0.07	0.14	244	NA	0.15
Is registered	village	O2.b	39.5%	0.49	632	0.11	0.16	339	NA	0.15
Has constitution	village	O2.b	52.9%	0.50	533	0.07	0.16	289	NA	0.17
Has bank account	village	O2.b	48.6%	0.50	632	0.09	0.15	337	NA	0.15
Chairperson elected	village	O2.b	79.8%	0.40	474	0.04	0.13	278	NA	0.14
Chairperson remunerated	village	O2.b	16.6%	0.37	474	0.02	0.12	278	NA	0.13
Nb of district visits in six months	village	O3.b	0.98	1.28	632	0.05	0.37	335	NA	0.39
Received training from district	village	O3.c	21.1%	0.41	632	0.05	0.12	339	NA	0.13
Index of contact with district	village	A1	45.2%	0.42	632	0.04	0.12	330	NA	0.13
Relationship very good	village	A2	30.9%	0.46	533	0.02	0.14	303	NA	0.15
Relationship improved	village	A3	28.3%	0.45	632	0.05	0.13	332	NA	0.14
Empathy with district on staff	village	A4	30.5%	0.46	632	0.01	0.12	339	NA	0.14
Empathy with district on budget	village	A4	56.5%	0.50	632	0.02	0.13	339	NA	0.15
Empathy with district on transport	village	A4	33.3%	0.47	632	0.02	0.13	339	NA	0.14
Understand minor vs major	village	A5	81.4%	0.39	573	0.00	0.10	323	NA	0.12
Understand preventive checks	village	A6	82.1%	0.38	632	0.01	0.10	338	NA	0.12
Understand user-fees	village	A6	91.0%	0.29	632	0.01	0.08	335	NA	0.09
Understand technical assistance	village	A7	65.0%	0.48	632	0.03	0.13	336	NA	0.15
Understand financial assistance assistance	village	A7	66.1%	0.47	632	0.04	0.13	336	NA	0.15
Autonomy score (from 0 to 3)	village	A8	1.52	0.98	632	0.09	0.30	339	NA	0.30

Table 7: Power for a Standardized Index – Sensitivity to ICC

Outcome Variable Name	Level	Feeds into Outcome	Mean	Sd	District-Level Rand.			Vill-Level Rand.		
					N	ICC	MDE	N	ICC	MDE
Generic Standardized Index	village	O.2; O.3	0	1	632	0.010	0.266	336	NA	0.306
						0.065	0.294			
						0.100	0.310			
						0.200	0.350			

One final determinant of power is attrition from treatment implementation to the endline. In our setting, attrition did not occur at the level of districts, as none withdrew from treatment. At the level of villages and water points, there is a possibility of attrition, albeit limited. For village-level outcomes, some villages may be mapped away from RUWASA, and towards a water authority which expanded, which is an exclusion criterion for treatment assignment (see section 3.2). For water point level outcomes, water points can become unobservable. Indeed, they can be demolished, or become private rather than communal. Also, enumerators may fail to find them on the ground, for logistical reasons. This risk is manageable, and we expect attrition to be very limited. Attrition would affect the treatment and control group in similar fashion, which is why we argue it would be non-differential.

We explore attrition's effect on power below (as in Jakiela et al. 2020), referring to the setting with districts are clusters (the non-clustered setting derives from it as a simplification). Attrition creates a decrease in sample size, which should intuitively result in lower power. The effect of the reduced size is mediated by the outcome's intra-class correlation. Indeed, when intra-class correlation is high, reducing the number of observations per cluster (holding constant the number of clusters), has a more limited impact on the MDE. Formally, building on Equation 4, let D_1 be the number of control districts, such that cluster size s_1 is equal to N_1/D_1. Similarly, D_2 is the number of treated districts, and treated cluster size s_2 is equal to N_2/D_2. We derive the following ratio, where subscript A refers to attrition:

$$\frac{MDE_A}{MDE} = \sqrt{\frac{\frac{1}{N_{A1}}(1+(\frac{N_{A1}}{D_1}-1)\rho)+\frac{1}{N_{A2}}(1+(\frac{N_{A2}}{D_2}-1)\rho)}{\frac{1}{N_1}(1+(\frac{N_1}{D_1}-1)\rho)+\frac{1}{N_2}(1+(\frac{N_2}{D_2}-1)\rho)}} \tag{5}$$

$$\frac{MDE_A}{MDE} = \sqrt{\frac{N_1}{N_{A1}}}\sqrt{\frac{N_2}{N_{A2}}}\sqrt{\frac{N_{A2}(1+(\frac{N_{A1}}{D_1}-1)\rho)+N_{A1}(1+(\frac{N_{A2}}{D_2}-1)\rho)}{N_2(1+(\frac{N_1}{D_1}-1)\rho)+N_1(1+(\frac{N_2}{D_2}-1)\rho)}} \tag{6}$$

Let us assume that we experience 5% attrition in within-cluster observations, in both control and treatment groups. If the intra-class correlation ρ is zero, we find that $\frac{MDE_A}{MDE} = \sqrt{\frac{N_1}{N_{A1}}}\sqrt{\frac{N_2}{N_{A2}}}\sqrt{\frac{N_A}{N}}$, where $N = N_1 + N_2$ and $N_A = N_{A1} + N_{A2}$. This simplifies to $\frac{MDE_A}{MDE} = 1/\sqrt{\frac{N_A}{N}}$ because attrition is not differential, and affects the treatment and control groups at the same rate. Therefore, attrition multiplies the original MDE by $1/\sqrt{0.95}$, i.e. 1.0260, meaning that it increases by 2.60%. If ρ is greater than 0, the increase in MDE is more limited. We use as an example outcome A.1 (i.e., whether the water point produces water), whose ICC is 0.14 (see Table 8). This yields $MDE_A/MDE = 1.0035$, meaning that the MDE increases by 0.35%.

7 Conclusion

This pre-results paper presents the design of a cluster-randomized controlled trial of an intervention that intends to improve the functionality of communal water points, maintenance practices, and measures of coordination between the parties across rural Tanzania. By bringing together evidence on a low-cost but at-scale intervention focused on the resolution of one of the country's, and world's, largest development challenges, it hopes to produce frontier and policy-relevant results related to the relationship between citizens and public officials.

8 References

Alonso, Ricardo, Wouter Dessein, and Niko Matouschek (Mar. 2008). "When Does Coordination Require Centralization?" In: *American Economic Review* 98.1, pp. 145–79. DOI: 10.1257/aer.98.1.145. URL: https://www.aeaweb.org/articles?id=10.1257/aer.98.1.145.

Anderson, Michael L (2008). "Multiple inference and gender differences in the effects of early intervention: A reevaluation of the Abecedarian, Perry Preschool, and Early Training Projects". In: *Journal of the American statistical Association* 103.484, pp. 1481–1495.

Bailey, Julia (2017). *Bureaucratic blockages : water, civil servants, and community in Tanzania.* World Bank Group.

Baird, Sarah et al. (2014). *Designing experiments to measure spillover effects.* The World Bank.

Bancalari, Antonella (2020). *Can white elephants kill? Unintended consequences of infrastructure development in Peru.* Tech. rep. IFS working paper.

Bandiera, Oriana, Andrea Prat, and Tommaso Valletti (2009). "Active and passive waste in government spending: evidence from a policy experiment". In: *American Economic Review* 99.4, pp. 1278–1308.

Bedoya, Guadalupe, Jishnu Das, and Amy Dolinger (2023). *Randomized Regulation: The impact of minimum quality standards on health markets.* Tech. rep. National Bureau of Economic Research.

Besley, Timothy and Torsten Persson (Sept. 2009). "The Origins of State Capacity: Property Rights, Taxation, and Politics". In: *American Economic Review* 99.4, pp. 1218–44. DOI: 10.1257/aer.99.4.1218. URL: https://www.aeaweb.org/articles?id=10.1257/aer.99.4.1218.

Besley, Timothy et al. (2004). "The Politics of Public Good Provision: Evidence from Indian Local Governments". In: *Journal of the European Economic Association.*

Björkman, Martina and Jakob Svensson (May 2009). "Power to the People: Evidence from a Randomized Field Experiment on Community-Based Monitoring in Uganda". In: *The Quarterly Journal of Economics* 124.2, pp. 735–769.

– (May 2010). "When is Community-Based Monitoring Effective? Evidence from a Randomized Experiment in Primary Health in Uganda". In: *Journal of the European Economic Association* 8.2-3, pp. 571–581.

Björkman, Martina, Damien de Walque, and Jakob Svensson (Jan. 2017). "Experimental Evidence on the Long-Run Impact of Community-Based Monitoring". In: *American Economic Journal: Applied Economics* 9.1, pp. 33–69.

Brandts, Jordi and David J. Cooper (June 2006). "A Change Would Do You Good .... An Experimental Study on How to Overcome Coordination Failure in Organizations". In: *American Economic Review* 96.3, pp. 669–693. DOI: 10.1257/aer.96.3.669. URL: https://www.aeaweb.org/articles?id=10.1257/aer.96.3.669.

Briceño, Bertha et al. (2017). "Are there synergies from combining hygiene and sanitation promotion campaigns: evidence from a large-scale cluster-randomized trial in rural Tanzania". In: *PloS one* 12.11, e0186228.

Burgess, Robin et al. (2015). "The value of democracy: evidence from road building in Kenya". In: *American Economic Review* 105.6, pp. 1817–1851.

Cameron, Lisa, Susan Olivia, and Manisha Shah (2019). "Scaling up sanitation: evidence from an RCT in Indonesia". In: *Journal of development economics* 138, pp. 1–16.

Chakraborty, Archishman and Rick Harbaugh (Dec. 2010). "Persuasion by Cheap Talk". In: *American Economic Review* 100.5, pp. 2361–82. DOI: 10.1257/aer.100.5.2361. URL: https://www.aeaweb.org/articles?id=10.1257/aer.100.5.2361.

Coville, Aidan et al. (2020). *Financing municipal water and sanitation services in nairobi's informal settlements*. Tech. rep. National Bureau of Economic Research.

Cowan, Simon (Mar. 1997). "Competition in the water industry". In: *Oxford Review of Economic Policy* 13 (1), pp. 83–92. ISSN: 0266-903X. DOI: 10.1093/OXREP/13.1.83.

Devoto, Florencia et al. (Nov. 2012). "Happiness on Tap: Piped Water Adoption in Urban Morocco". In: *American Economic Journal: Economic Policy* 4 (4), pp. 68–99. ISSN: 1945-7731. DOI: 10.1257/POL.4.4.68.

Ferraro, Paul J. and Arun Agrawal (July 2021). "Synthesizing evidence in sustainability science through harmonized experiments: Community monitoring in common pool resources". In: *Proceedings of the National Academy of Sciences* 118.29. Authors' Info Affiliations, e2106489118. DOI: 10.1073/pnas.2106489118.

Foster, Tim (Nov. 2013). "Predictors of sustainability for community-managed handpumps in subsaharan Africa: Evidence from Liberia, Sierra Leone, and Uganda". In: *Environmental Science and Technology* 47 (21), pp. 12037–12046. ISSN: 0013936X. DOI: 10.1021/ES402086N/SUPPL_FILE/ES402086N_SI_001.PDF.

Gibbons, Robert S. and Rebecca M. Henderson (2012). "Relational Contracts and Organizational Capabilities". In: *Organization Science* 23, pp. 1350–1364.

Guiteras, Raymond, James Levinsohn, and Ahmed Mushfiq Mobarak (May 2015). "Encouraging sanitation investment in the developing world: A cluster-randomized trial". In: *Science* 348 (6237), pp. 903–906. ISSN: 10959203. DOI: 10.1126/SCIENCE.AAA0491/SUPPL_FILE/GUTIERAS.SM.PDF.

Jakiela, Pamela et al. (2020). "Evaluating the Effects of an Early Literacy Intervention". In: *Journal of Development Economics*. DOI: 10.1257/rct.4425-1.0.

Joseph, George, Sabrina Haque, and Sophie Ayling (2018). *Reaching for the SDGs : the untapped potential of Tanzania's water supply, sanitation, and hygiene sector*. World Bank Group.

Joskow, Paul L. (Jan. 2007). "Regulation of Natural Monopoly". In: *Handbook of Law and Economics* 2, pp. 1227–1348. ISSN: 1574-0730. DOI: 10.1016/S1574-0730(07)02016-6.

Lam, Wai Fung (1996). "Institutional design of public agencies and coproduction: a study of irrigation associations in Taiwan". In: *World development* 24.6, pp. 1039–1054.

Lee, Kenneth, Edward Miguel, and Catherine Wolfram (Apr. 2020). "Experimental evidence on the economics of rural electrification". In: *Journal of Political Economy* 128 (4), pp. 1523–1565. ISSN: 1537534X. DOI: 10.1086/705417/SUPPL_FILE/2016544DATA.ZIP.

Macchiavello, Rocco (2022). "Relational Contracts and Development". In: *Annual Review of Economics* 14.1, pp. 337–362. DOI: 10.1146/annurev-economics-051420-110722. eprint: https://doi.org/10.1146/annurev-economics-051420-110722. URL: https://doi.org/10.1146/annurev-economics-051420-110722.

Miguel, Edward (2004). "Tribe or Nation? Nation Building and Public Goods in Kenya versus Tanzania". In: *World Politics* 56 (3), pp. 327–362. ISSN: 1086-3338. DOI: 10.1017/S0043887100004330.

Olken, Benjamin A. (2007). "Monitoring Corruption: Evidence from a Field Experiment in Indonesia". In: *Journal of Political Economy* 115.2, pp. 200–249. DOI: 10.1086/517935.

Ostrom, Elinor (Nov. 1990). "Governing the Commons: The Evolution of Institutions for Collective Action". In: *Governing the Commons*. DOI: 10.1017/CBO9780511807763.

– (1996). "Crossing the great divide: coproduction, synergy, and development". In: *World development* 24.6, pp. 1073–1087.

Ostrom, Elinor and Roy Gardner (Dec. 1993). "Coping with Asymmetries in the Commons: Self-Governing Irrigation Systems Can Work". In: *Journal of Economic Perspectives* 7.4, pp. 93–112.

Rasul, Imran and Daniel Rogger (2016). "Management of Bureaucrats and Public Service Delivery: Evidence from the Nigerian Civil Service". In: *The Economic Journal* 128.608, pp. 413–446. DOI: 10.1111/ecoj.12418.

Rogger, Daniel and Ravi Somani (forthcoming). "The Persistent Impact of Electoral Incentives on the Quality of Infrastructure". In: *Journal of Public Economics*.

Sákovics, József and Jakub Steiner (Dec. 2012). "Who Matters in Coordination Problems?" In: *American Economic Review* 102.7, pp. 3439–61. DOI: 10.1257/aer.102.7.3439. URL: https://www.aeaweb.org/articles?id=10.1257/aer.102.7.3439.

Slough, Tara et al. (July 2021). "Adoption of community monitoring improves common pool resource management across contexts". In: *Proceedings of the National Academy of Sciences* 118.29. Ed. by Arun Agrawal. Edited by Arun Agrawal, University of Michigan, Ann Arbor, MI, and approved February 9, 2021 (received for review August 1, 2020), e2015367118. DOI: 10.1073/pnas.2015367118.

Soppe, Gerhard, Nils Janson, and Scarlett Piantini (Nov. 2018). *Water Utility Turnaround Framework*. World Bank. DOI: 10.1596/30863.

Van den Berg, Caroline and Alexander Danilenko (2017). "Performance of water utilities in Africa". In.

Water Supply and Sanitation Act (2019). Government of Tanzania.

9 Administrative Information

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Institutional Review Board
Necessary approvals are in place. This study has been reviewed and approved by Solutions IRB, under Protocol #2021/11/17.

Declaration of Interest
The authors hereby state that they have no competing interests.

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Appendix A Definition of Variables for Power Calculations

Table 8: Definition of Variables for Power Calculations

Name	Level	Definition
WP functional	Water point	Whether the outlets are functional (soft criteria), averaged at level of water point
WP produces water	Water point	Whether the outlet produce water, averaged at level of water point
Time to fill 5L	Water point	Time for outlet to fill a 5L jerrycan in seconds, averaged at level of water (winsorized 99th)
Strokes needed to draw water	Water point	Strokes needed for outlets to draw water, averaged at level of water (winsorized 99th)
Nb of district visits in six months	Village	How many times the organization received a district visit in past 6 months (winsorized 95th)
Received training from district	Village	Whether organization received training from district (past 6 months)
Collects user-fees	Village	Whether organization collects user-fees on water points
Share of WPs with meter	Village	Share of water points supervized by organization which are metered
Financial predictions	Village	Whether organization sets user-fees using financial predictions
Water quality tests	Village	Whether organization conducted water quality tests (past 6 months)
Preventive checks	Village	Whether organization conducted preventive checks (past 6 months)
Low access technician	Village	Whether organization struggled to access technician service (past 6 months)
Low access spare parts	Village	Whether organization struggled to access spare parts (past 6 months)
Breakdowns repairs	Village	Share of broken down water points which were repaired (past 6 months)
Is registered	Village	Whether organization is registered
Has constitution	Village	Whether organization has a Constitution
Has bank account	Village	Whether organization has a bank account
Chairperson elected	Village	Whether the Chairperson position is filled through an election
Chairperson remunerated	Village	Whether the Chairperson is compensated or paid, not volunteer
Index of contact with district	Village	How often organization and district were you in touch over past six months (indexed from 0 to 1)
Relationship very good	Village	Whether relationship between organization and district is 'very good'
Relationship improved	Village	Whether relationship between organization and district improved (past 6 months)
Empathy with district on staff	Village	Whether organization understands that lack of staff is among top district constraints
Empathy with district on budget	Village	Whether organization understands that lack of budget is among top district constraints
Empathy with district on transport	Village	Whether organization understands that lack of transport is among top district constraints
Understand minor vs major	Village	Whether organization understand district involvement depends on whether breakdown is minor or major
Understand preventive checks	Village	Whether organization understands that preventive checks is their responsibility not district's
Understand user-fees	Village	Whether organization understands that collecting user-fees is their responsibility not district's
Understand technical assistance	Village	Whether organization understands that technical assistance on major repairs is district's responsibility
Understand financial assistance assistance	Village	Whether organization understands that financial support on major repairs is district's responsibility
Autonomy score (from 0 to 3)	Village	Whether organization would autonomously solve a minor repair across funding, spare parts, expertise (from 0 to 3)

Appendix B Functionality Definitions

This appendix shows Tanzania's official functionality statuses using "soft criteria". Another set of definitions exist as per "hard criteria", which are similar in nature, although with more strigent thresholds to separate status *"functional needs repair"* from status *"functional"*.

Table 9: Tanzania's Functionality Statuses

Functionality	For a Water Outlet	For a Water Point
Functional	- The water outlet produces water, **AND** - It passes the flow test, meaning that: for hand-pumps, it takes 10 pumps max to draw water; for other outlets, it takes max 60 seconds to fill a 5L jerry can	All water outlets on the water point are functional
Functional Needs Repair	- The water outlet produces water, **AND** - It fails the flow test, meaning that: for hand-pumps, it takes over 10 pumps to draw water; for other outlets, it takes over 60 seconds to fill a 5L jerry can	- At least one water outlet on the water point is functional needs repair, **OR** - The water outlets on the water point are a mix of functional and not functional, **OR** - The water outlets on the water point are a mix of functional and abandoned
Not Functional	- The water outlet does not produce water, **AND** - It is not beyond repair, meaning that it would not cost more to repair it than to build a new one	- All water outlets on the water point are not functional, **OR** - The water outlets on the water point are a mix of not functional and abandoned
Abandoned	- The water outlet does not produce water, **AND** - It is not beyond repair, meaning that it would cost more to repair it than to build a new one	All water outlets on the water point are abandoned

Appendix C Third-Party Data

For estimation and contextualization purposes, this paper draws on third-party data collected around the Payment-by-Results (PbR), a project funded by the United Kingdom (UK)'s Foreign, Commonwealth and Development Office (FCDO). As part of PbR, two nationally representative surveys of Tanzania's water points were conducted in 2019 and 2021. In terms of sampling strategy, the surveys were built as follows. First, the samples were stratified at the Local Government Authority (LGA) level, which included 181 LGAs in 2019, and 179 in 2021. Second, village-clusters were selected within LGAs. Third, within sampled villages, all water points on the ground were surveyed. In terms of sample size, the 2019 and 2021 collections surveyed respectively 14,413 and 7,195 water points. The decrease in sample size is explained by budgetary reasons. Of the villages sampled in 2021, 317 had already been surveyed in 2019, which enables us to track village-level outcomes over two data-points, and therefore estimate autocorrelation.

The surveys collected two types of data on water points. The first type of variables were static, and documented the water point's village, GPS coordinate, technology, extraction method, source, etc. The second type of variables were dynamic, including indicators destined to determine the water point's functionality status. Those are outlined in Appendix B, and include: whether the water point produces water; if so, whether the flow test indicates sufficient flow; if not, whether the water point is repairable. Dynamic variables also included the type of community organization managing the water points, and whether certain management practices are applied to the water point, such as collecting user-fees. Summary statistics for the 2019 and 2021 surveys are provided below in table 10.

Table 10: Third-Party Data – Summary Statistics

	2019			**2021**		
	N	mean	sd	N	mean	sd
DP Characteristics						
Extraction method is electrical	13938	0.29	0.45	7195	0.27	0.44
Extraction method is other	14413	0.25	0.43	7195	0.73	0.44
Source is deep	13938	0.31	0.46	7162	0.40	0.49
Source is surface	13938	0.53	0.50	7162	0.55	0.50
Source is shallow	13938	0.15	0.35	7162	0.06	0.23
Source is other	13938	0.00	0.00	7162	0.00	0.02
Management Practices						
DP collects user-fees	12735	0.44	0.50	6792	0.60	0.49
Community managing DP is registered	14279	0.26	0.44	5912	0.60	0.49
Functionality Status						
DP is functional	12046	0.40	0.49	6477	0.55	0.50
DP is functional needs repair	12046	0.04	0.20	6477	0.05	0.22
DP is not functional	12046	0.49	0.50	6477	0.35	0.48
DP is abandoned	12046	0.07	0.25	6477	0.05	0.22
DP produces water	12739	0.45	0.49	6792	0.60	0.48
Flow test: time to fill 5L	3623	18.73	17.90	2630	19.63	16.57
Flow test: strokes to draw water	1752	3.90	3.14	1326	4.48	10.25

Appendix D Maintenance Indices

Table 11 outlines the variables used to calculate the Maintenance Index and how these calculations are made. Table 12 provides similar information for districts.

Table 11: Village Maintenance Index – Calculation Details

Indicator Name		Indicator	Mapping to Index Points
O2.a	**Meetings**	Does the community organization meet on a regular basis and include maintenance in discussions?	How often does the community organization meet? - 1 point if 'Weekly' - 0.8 point if 'Bi-weekly' - 0.6 point if 'Monthly' - 0.4 point if 'Every quarter' - 0.2 point if 'Every six months' or 'Once a year' - 0 point if 'Never'
			How often is the head of the CMO present? - 1 point if 'Weekly' - 0.8 point if 'Bi-weekly' - 0.6 point if 'Monthly' - 0.4 point if 'Every quarter' - 0.2 point if 'Every six months' or 'Once a year' - 0 point if 'Never'
			How often do these meetings include a discussion of preemptive maintenance of the community's water points? - 1 point if 'Weekly' - 0.8 point if 'Bi-weekly' - 0.6 point if 'Monthly' - 0.4 point if 'Every quarter' - 0.2 point if 'Every six months' or 'Once a year' - 0 point if 'Never'
			In general, do the meetings relate to concrete maintenance actions performed in the community? - 1 point if 'Always' - 2/3 point if 'Often' - 1/3 point if 'Sometimes' - 0 point if 'Never'
O2.b	**Record Keeping**	Does the community organization have records of the physical water supply infrastructure, associated guidelines (responsibilities/pricing tarriffs/etc.)?	Does the community organization have a charter? - 1 point if 'Yes' - 0 point if 'No'
			Does the community organization have a Constitution or equivalent? - 1 point if 'Yes' - 0 point if 'No'
			Does the community organization have written Standard Operating Procedures (SOPs)? - 1 point if 'Yes' - 0 point if 'No'

			Does the community organization have a record of DPs and other water infrastructure? - 1 point if 'Yes' - 0 point if 'No'
			Does the community organization have a record of water outages and water point breakdowns? - 1 point if 'Yes' - 0 point if 'No'
O2.c	**Financial Management**	Are funds for maintenance raised systematically (evidence of forecasting/saving/expenditure on relevant activities)?	On how many water points does your community management organization collect a user fee? - 1 point if proportion falls above median of positive distribution - 0.5 point if proportion falls below median of positive distribution - 0 point if none
			What is the average monthly revenue jointly generated by all the water points overseen by your community group (TZS)? Average monthly costs paid? - 1 point if net proceeds fall above median of positive distribution - 0.5 point if net proceeds fall below median of positive distribution - 0 point if none
			Does your community group have a bank or mobile money account which is actively used to store revenue and disburse payments? - 1 point if 'Yes' - 0 point if 'No'
			How often do community management organization meetings include a discussion of financial planning and analysis including a forward-looking budget? - 1 point if 'Always' - 2/3 point if 'Often' - 1/3 point if 'Sometimes' - 0 point if 'Never'
			Which of the following items does your community management organization include in its budget?: a) General operations (including salaries, fuel, etc.); b) Infrastructure depreciation and/or breakdown; c) Infrastructure replacement. - 1 point if selected all - 2/3 point if selected any two - 1/3 point if selected any one - 0 points if selected none

O2.d	**Demand Management**	Is there evidence that the community organization assesses appropriate pricing for optimal use?	Which of the following methods are used to determine the amount of user-fees?: a) formal consultation of end-users (e.g. townhall meeting); b) Unstructured discussions with end-users; c) Benchmarks from other neighbouring villages; d) Ministry of Water and Irrigation guidelines and manuals; e) Financial predictions by the community group to ensure sustainability; f) Based on previous cost of service and cost of repairs; g) No real system; h) Other. - 1 point if selected two or more constructive activities - 0.5 point if selected any single constructive activity - 0 point if selected none
			Does your community management organization have a strategy or plan for when water supply is not sufficient to cover current demand? - 1 point if 'Yes' - 0 point if 'No'
			How easy would it be for you to change the tariff if demand management required it? - 1 point if 'Very easy' - 2/3 point if 'Somewhat difficult' - 1/3 point if 'Possible but difficult' - 0 point if 'Not possible'
O2.e	**Frequency of maintenance inspections**	Does the community organization inspect physical infrastructure in a routine manner?	Over the past six months, how frequently were you able to conduct preventative maintenance checks on the water points you monitor? - 1 point if 'Once a month or more' - 0.75 point if 'Once every 3 months' - 0.5 point if 'Once every 6 months' - 0.25 point if 'Once a year' - 0 point if 'Less than once a year or never'
O2.f	**Comprehensive maintenance inspections**	Over the past six months, when undertaking inspections, did the community organization undertake a comprehensive inspection of all major threats to service sustainability?	In terms of water quality? - 1 point if 'Once a month or more' - 0.75 point if 'Once every 3 months' - 0.5 point if 'Once every 6 months' - 0.25 point if 'Once a year' - 0 point if 'Less than once a year or never'
			In terms of infrastructure integrity? - 1 point if 'Once a month or more' - 0.75 point if 'Once every 3 months' - 0.5 point if 'Once every 6 months' - 0.25 point if 'Once a year' - 0 point if 'Less than once a year or never'

			In terms of functionality/accuracy of metering? - 1 point if 'Once a month or more' - 0.75 point if 'Once every 3 months' - 0.5 point if 'Once every 6 months' - 0.25 point if 'Once a year' - 0 point if 'Less than once a year or never'
			In terms of security of the infrastructure? - 1 point if 'Once a month or more' - 0.75 point if 'Once every 3 months' - 0.5 point if 'Once every 6 months' - 0.25 point if 'Once a year' - 0 point if 'Less than once a year or never'
O2.g	**Identification of problem areas through customer complaints/user feedback**	Does the community organization have a rigorous customer feedback response mechanism?	What mechanisms are in place for community members to share complaints regarding the water points under your jurisdiction? [list of options from IBNET] - 1 point if selected two or more constructive activities - 0.5 point if selected any single constructive activity - 0 point if selected none
			To what extent are all members of the community equally able to share complaints regarding water points? [list of options from IBNET] - 1 point if selected two or more constructive activities - 0.5 point if selected any single constructive activity - 0 point if selected none
O2.h	**Effective resolution system**	Are there sufficient mechanisms in place to ensure maintenance issues are resolved?	How quickly did your community management organization respond to the most recent breakdowns? - 1 point if above median of positive distribution - 0.5 point if below median of positive distribution - 0 point if no response
			How effectively has the community management organization been in sourcing external support (incl. technicians) when they are required? - 1 point if 'Very effective' - 2/3 point if 'Effective' - 1/3 point if 'Rarely effective' - 0 point if 'Not effective'
			How effectively has the community management organization been in sourcing spare parts when they are required? - 1 point if 'Very effective' - 2/3 point if 'Effective' - 1/3 point if 'Rarely effective' - 0 point if 'Not effective'

Table 12: District Maintenance Index – Calculation Details

Indicator Name		Indicator	Mapping to Index Points
O3.a	**Knowledge of Village**	Does the District Manager know whether the village has a CBWSO?	- 1 points if 'Yes' - 0 point if 'No'
O3.b	**Number of Visits**	How many times did the District Water Team visit the village for a technical servicing visit, over the past year?	- 1 point if falls above median of positive distribution - 0.5 point if falls below median of positive distribution - 0 point if no technical visits
O3.c	**Financial Investments**	To what extent has the District Water Team invested financial resources into the village's water points, over the past year?	Has the District Water Team spent financial resources on spare parts for repairs? - 1 point if 'Yes' - 0 point if 'No'
			Has the District Water Team spent financial resources on hiring technicians for repairs? - 1 point if 'Yes' - 0 point if 'No'
			Has the District Water Team spent financial resources on providing the community organization technical training? - 1 point if 'Yes' - 0 point if 'No'
			Has the District Water Team spent financial resources on any other item? - 1 point if 'Yes' - 0 point if 'No'