Baseline findings

Measuring the impact on gender of a water project in Madagascar

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ABBREVIATIONS AND ACRONYMS

CUA	Commune of Urban Antananarivo
DID	Differences-in-Differences
EIB	European Investment Bank
EU	European Union
FGD	Focus Group Discussion
GA	Greater Antananarivo
INSTAT	Institut National de la Statistique (Malagasy Statistics Institute)
JIRAMA	Jiro sy Rano Malagasy (Madagascar water and electricity utility)
NGO	Non-Governmental Organisation
NRW	Non-Revenue Water
Obs	Observations
UN OCHA	United Nations Office for the Coordination of Humanitarian Affairs
SD	standard deviation
SDG	Social Development Goals
TOC	Theory of change
UNICEF	United Nations Children's Fund
WASH	Water, Sanitation and Hygiene
WB	World Bank
WHO	World Health Organization
WSUP	Water & Sanitation for the Urban Poor

KEY TERMS

Fokontany	A fokontany is the smallest administrative unit (‘neighbourhood’) in Antananarivo.
JIRAMA	*Jiro sy Rano Malagas*y (JIRAMA) is a state-owned electric utility and water services company in Madagascar.
Private water connection	In Antananarivo households can apply for a private water connection to JIRAMA to receive water through the piped water supply network directly to the residence.
Tanker	The *camion-citerne* (or tanker) is a tank trunk with water that can be send to communities experiencing extreme water shortages by JIRAMA.
Water kiosk	In Antananarivo water kiosks are public standpipes that are providing safe and affordable water through the piped water supply network. Most water kiosks are managed by the respective community.
WSUP	Water and Sanitation for the Urban Poor (WSUP) is a London-based water, sanitation and hygiene (WASH) non-governmental organisation (NGO) active in Madagascar.

EXECUTIVE SUMMARY

Inadequate access to safe water compromises health and socio-economic development in myriad ways. Despite average global progress regarding access to clean water over the past decades, targets for the 2030 Agenda for Sustainable Development to provide universal, equitable and safe access to drinking water are unlikely to be met, especially in much of Sub-Sahara Africa. Madagascar where this study is set, is no exception, and in fact is lagging even more than the average SSA country, with only 54% of the population having access to basic water services compared to 68% as the SSA average.

This report presents the results of a baseline study to ameliorate the situation for the capital city of Madagascar, Antananarivo. The baseline study is part of a rigorous impact evaluation to understand the effects of Jiro sy Rano Malagasy Water III project prioritaire (JWIII-P). This is a multi-partner water infrastructure improvement project, partially financed by the EIB, and a grant from the European Commission and implemented by JIRAMA, Madgascar's water and electricity utility company. Water and Sanitation for the Urban Poor (WSUP), an international non-governmental organisation (NGO) active in Madagascar, also co-finances JWIII-P and further contributes through local community trainings on Water Sanitation and Hygiene (WASH) and institutional capacity building activities.

Households in the Antananarivo agglomeration served by JIRAMA obtain water through public standpipes – locally also referred to as water kiosks (World Bank, 2022b), a tanker truck and sometimes private connections. The water situation in Antananarivo is dire, with 80% coverage in the urban communities, and 72% in its agglomeration. Outside of the JIRAMA network, households obtain water from protected and unprotected sources including boreholes, rivers and surface water. Due to rapid urbanisation and population growth, there is an increased demand for water that cannot be met with the present old, and often deficient, water infrastructure, resulting in water pressure problems, cuts and overall low reliability of water supply. Moreover, there are substantial commercial losses due to leakages and an increased risk of water pollution. Water fetching is primarily (for 85% of households) carried out by women, who spend about an hour per day to fetch water, thereby compromising time for productive activities and leisure and contributing to physical and mental health issues, intra-household tensions and reduced levels of wellbeing.

JWIII-P aims to ameliorate the water situation in greater Antananarivo by improving coverage to 87% through (i) renovation of a water treatment plant and the construction of a new treatment plant; (ii) renovation of water pipes and grid extension through new pipes; (iii) construction of a water tank; (iv) the installation of water booster pumps and (v) the construction of approximately 400 new public water kiosks and 5000 private household connections across the Antananarivo agglomeration. JWIII-P comprises a "tranche urgente" where the works will start. This entails the Eastern part of the Antananarivo agglomeration containing new pipes and a new treatment plant. Once the "tranche urgente" has been completed the remaining works for JWIII-P will be implemented.

The Theory of Change developed for the intervention stipulates that the activities listed above are expected to lead to an extension of the water grid, less leakages, less water contamination, more private connections and more public water kiosks as outputs, which is expected to lead to the following three categories of water-related outcomes including (1) proximity/access, (2) water quantity and (3) water quality. Expected impacts on the short-term relate to time gains, less use of unimproved water sources, increased water use, a decrease in physical pain, improved mental health, women empowerment, and less water expenses as share of total expenses.

The project will be evaluated using a matched difference-in-differences design with two time periods on a sample of 210 fokotanies and 12 households per fokotany spread across urban and peri-urban areas. Treatment takes place at the fokotany level where fokotanies represent the smallest administrative units comparable to neighbourhoods. Documents from JIRAMA on where the works are planned were used to classify fokotanies into "treatment" and "control" areas resulting in 60 initial treatment and 150 control fokotanies. Control fokotanies were oversampled to allow for downstream effects. Given the scope and long timespan of the project, there are various uncertainties about the exact roll-out and implementation of the many different project elements, and the time it takes to complete. Once JWIII-P has been completed, the original treatment assignment will be reviewed and updated if necessary. Balance checks show that "treatment" fokotanies are statistically the same as "control" fokotanies which is a useful starting point for the quasi-experimental evaluation. Ex-ante power calculations showed that the sample is well powered to detect medium to large effects (0.3 – 0.8 standard deviation changes) for all relevant outcomes. For a substantial number of outcomes, the current design is even able to detect impacts as small as 0.2 standard deviation change. It is however recommended to repeat the power calculations post-intervention with updated information on treatment and control fokotanies and attrition rates.

The baseline data collection took place between September and November 2023 and comprised household member's responses to a comprehensive survey that included questions on household demographics, water access, water availability, water quality, socio-economic status, time-use, intra-household decision-making, women empowerment, hygiene, and mental health plus qualitative data gathered through focus group discussions with household members, professional water carriers, and public kiosk managers.

Baseline descriptives show that the water situation in the Antananarivo is dire. Only about 11% of households in our sample have a private connection either in their own house or shared with neighbours or others at the same plot. While about 30% relies on water from public water kiosk as their primary source, most households have other primary water sources, many of them considered unsafe like unprotected wells, and surface water including rice fields and rainwater. The average distance to the nearest source is about 120 meters for households that have no access to a private connection and average round-trip time to the source is slightly more than 10 minutes. Considering that households typically go multiple times per day this reflects a substantial time burden for water fetchers, the majority of which are adult women. Water availability is problematic for all households regardless of having a private connection or relying on public kiosks due to frequent cuts and low pressure. As a result, average daily per capita water usage is only 21 litres which falls well below the WHO recommendation of 50-100 litres per person per day. Moreover, in anticipation of cuts and (or) low pressure, households resort to storing water which may induce contamination, buy water from people with a private connection at a surplus price or rely on other sources that may be unsafe. In terms of water quality, most households using JIRAMA water either through a private connection, water kiosk or tanker truck report that the water is of good quality based on colour, smell and taste and slightly more than half of the sample treats the water before drinking, primarily by boiling. Water prices at the public kiosks typically do not vary much within a fokotany and are typically set at 40-50 MGA (about 0.01 Euro) per jerrycan of twenty litres. Depending on the household's resources, water fetching can take up a substantial share of total household's revenues, although the noisiness of and often lack of income data makes it difficult to determine how high this share really is. Fetching water reportedly leads to physical pain from carrying, and sometimes violent incidents in- and outside the households.

The project has a strong focus on improving gender equality, and while baseline descriptives show that women have overall fairly high levels of agency, a fairly strong internal locus of control, and a say in important household decisions, the vast majority of women is responsible for fetching water in addition to other household chores thereby possibly compromising wellbeing, mental health and time spent on productive activities, leisure or other tasks. JWIII-P has the potential to ameliorate these and other outcomes for women and their household members.

1. INTRODUCTION

Inadequate access to safe water compromises health and socio-economic development in myriad ways. Albeit progress regarding access to clean water has been made over the past decades, targets for the 2030 Agenda for Sustainable Development to provide universal, equitable and safe access to drinking water are unlikely to be met. More than a third of countries worldwide are lagging, especially in Sub-Saharan Africa (WHO and UNICEF, 2017).

In fact, Madagascar, the setting of this study, ranks substantially lower than other countries in the region, with merely 54% of the population having access to basic water services, compared to 68% for the rest of Sub-Saharan Africa (World Bank, 2022a). New initiatives have been developed to address this pressing issue. This report presents the baseline data collected as part of one of such initiatives: the implementation of *Jiro sy Rano Malagasy* (JIRAMA, Madagascar water and electricity utility) Water III project prioritaire (hereafter, called: JWIII-P).

In the Antananarivo agglomeration, the drinking water system is implemented and managed by JIRAMA, the state-owned water company that serves only 54% of the population in its service area, the majority through public standpipes – locally also referred to as water kiosks (World Bank, 2022b). According to JIRAMA, the number of private connections is partly limited by its capacity to supply sufficient debit into the system to sustain a higher number of water access points. As a result, many households access water through water kiosks connected to the JIRAMA water network. Else, they access water outside the network, by collecting water from wells and rivers, rainwater, or water infrastructure installed by other development projects. In addition to peaks in demand due to the rapidly growing population in and around the Antananarivo region, the city's hilly landscape cause water pressure in certain areas to be insufficient during the day, and sometimes also at night. Moreover, old and deficient water infrastructure implies major water and commercial losses, rendering the system at risk of water pollution, especially during floods, further worsening water quality. In sum, the drinking water network is currently failing to meet the increased demand for water across the city, while facing degrading infrastructure at treatment plants and across networks, as well as an insecure water supply. Importantly, in Madagascar, fetching water is largely carried out by women – in 2018, 85% were responsible for fetching water in their respective households, corresponding to 11 hours per week (UNICEF, 2019). As a result, women lack time to participate in public life or taking greater part in income-generating activities and suffer from mental stress and intra-household tensions (de Berry, 2023).

The JWIII-P, partially financed by the European Investment Bank (EIB) and a grant from the European Commission (EC) aims to improve the availability, quality, coverage and institutional framework of the current water system in Greater Antananarivo. The project aims to upgrade and enlarge the water grid through the construction and renovation of water treatment plants and water pipes, the implementation of water tanks and water booster pumps, and the provision of approximately 400 public water kiosks and about 5,000 private water connections. Complementary programmes, funded by the World Bank, foresee another 48,000 private and public water connections to the grid, to improve residents' access to drinking water in unserved regions. Water and Sanitation for the Urban Poor (WSUP), a WASH non-governmental organisation (NGO) active in Madagascar, also co-finances the JWIII-P project, and is expected to further enhance beneficial effects of these activities through water and sanitation training to local communities and institutional capacity building. Jointly, these interventions are expected to substantially improve Antananarivo inhabitants' access to safe water, through (i) private connections to the grid, (ii) water kiosks closer to home, (iii) better water quality, and (iv) more regular availability thanks to higher pressure and higher water volume flow rates in the water network.

The objectives of this study, funded by a European Investment Bank University Research Scholarship (EIBURS), are (i) to develop a rigorous methodology to assess the impact of improved access to drinking water on the beneficiary population; (ii) to collect and analyse baseline data as part of the impact evaluation of JWIII-P; and (iii) to prepare EIB and other stakeholders for the subsequent phases of the impact evaluation and policy learning.

Specifically, this report intends (i) to provide a benchmark of key outcomes and variables that are expected to influence the impact of the intervention for different subgroups and mechanisms underlying the causal path from inputs to impacts, prior to the rollout of JWIII-P in fokontanies[1] where JIRAMA plans to intervene, and similar areas where no JWIII-P intervention is planned; and (ii) to document descriptive associations between outcome variables and other household key characteristics.

Regarding key outcomes, this study will measure household proximity to water sources; quantity and quality of water; physical and mental health among beneficiary households; household access to adequate hygiene; time to fetch water; income-generating activities; and agency and equality for women within their household and community. Note that, the intervention being technically complex, multi-dimensional, multi-partnered, long-term and often indirectly delivered, it is particularly challenging to isolate the causal effect of JWIII-P from the impact of other initiatives in the area. Throughout this report, the intervention is defined as a comprehensive package consisting of various programmes and programme components, focusing on the attribution of JWIII-P to improved water access, quantity and quality.

In the next section, the intervention is presented, followed by a brief description of the theory of change, evaluation questions and research design described in a detail in a methodological note which is incorporated in Annex A to C in this report. Section 3 presents a series of baseline data descriptive statistics. In addition to understanding the target population of the programme, these data permit an initial assessment of the validity of some of the causal pathways of the theory of change pre-established in the methodological note. Section 4 concludes this report.

[1] A ‘fokontany’ is the smallest administrative unit (‘neighbourhoods’) in Antananarivo.

2. PROJECT DESCRIPTION, THEORY OF CHANGE AND EVALUATION QUESTIONS

2.1 JIRAMA Water III – Prioritaire

In the Antananarivo region, the drinking water system is implemented and managed by JIRAMA, the state-owned water company. Over 80% of the water is currently supplied by the main treatment plant at the Mandroseza lake, fed by the Ikopa river. Overall appropriate drinking water coverage is estimated at around 72% Antananarivo agglomeration; still, coverage tends to be higher in the Urban Commune of Antananarivo (CUA, by its French acronym), where drinking water access rates are higher than 80% (JICA, 2019)

The population in the Antananarivo agglomeration has access to drinking water through different sources that include *private water connections, water kiosks, tanker trucks* or other *unimproved water sources*. In some fokontanies, matters of property rights prevent households from applying for a private connection. In 2021, JIRAMA provided water to 95,607 domestic or private connections, and to 2,785 water kiosks across the Antananarivo region (JIRAMA project monitoring indicators, 2021). In addition, households have access to water outside the JIRAMA network; water provided by private companies (mostly in the West) water collected from *wells, rivers* or *surface water*, and water from infrastructure installed by other development projects. Some households also hire professional water carriers to fetch water for the household. Importantly, all these different sources are not mutually exclusive – households may combine them to fulfil their overall water needs and may vary sources during dry and wet seasons.

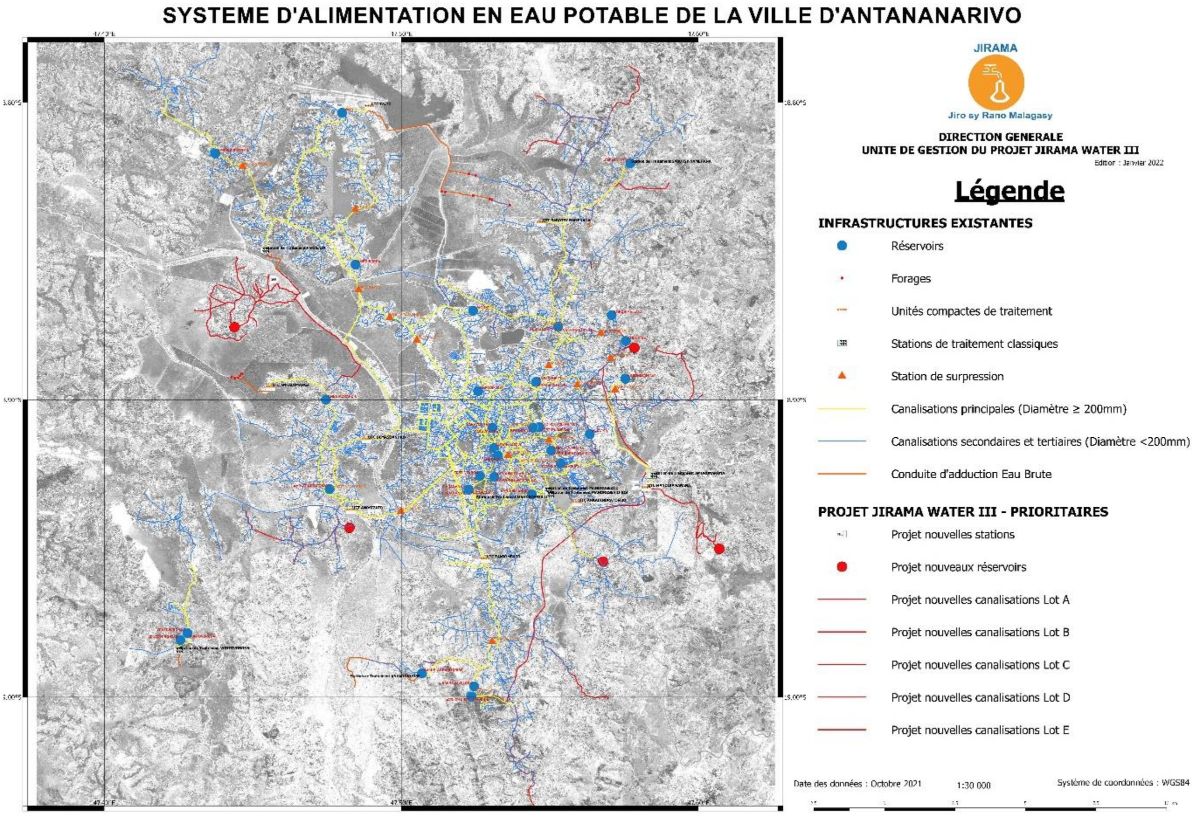
Presently, the drinking water network is failing to meet the rapidly increasing demand for water across the city, while facing degrading infrastructure at treatment plants and networks, as well as insecure water supply. As the population in and around the CUA speedily grows, more and more communities cannot access the JIRAMA network.

JWIII-P project aims to improve the availability and quality of the current water system, and to expand the coverage of the water network, to reach 87% of the population of Antananarivo by the end of the project term. Another component – though not part of the impact evaluation exercise – aims at improving the institutional framework of the system – related to, among others, payment structures, water quality assurance, monitoring, service sustainability, and JIRAMA's reputation as utility provider. To increase public participation and perceptions, consultations were held during the project preparation phase including diverse stakeholders, such as fokontany representatives, JIRAMA staff, delegated managers of the drinking water network, local social and environmental NGOs, as well as representatives of women's organisations.

The EIB became actively involved in 2016 through a programmatic approach – the JWIII-P project. JWIII-P is partially financed by the EIB and the EC with the goal to implement construction works to the water utility infrastructure in Antananarivo. Works were scheduled to start early 2024. Yet, they have been severely delayed, and project activities have changed along the way which may compromise the impact evaluation exercise and should be carefully considered before undertaking the endline. This may take the form of monitoring intervention changes in scope, time and space communicated by JIRAMA, redefine treatment and control areas and built-in endline measures that can serve as manipulation checks for the roll-out of the intervention.

The intervention JWIII-P on the water system initially consisted of five main components, as detailed in Figure 1, across urban areas and areas surrounding the capital: (i) implementation and renovation of water treatment plants; (ii) implementation and renovation of water pipes; (iii) implementation of water tanks; (iv) implementation of water booster pumps; and (v) construction of approximately 400 water kiosks and 5,000 private water connections.

Figure 1. JWIII-P intervention area

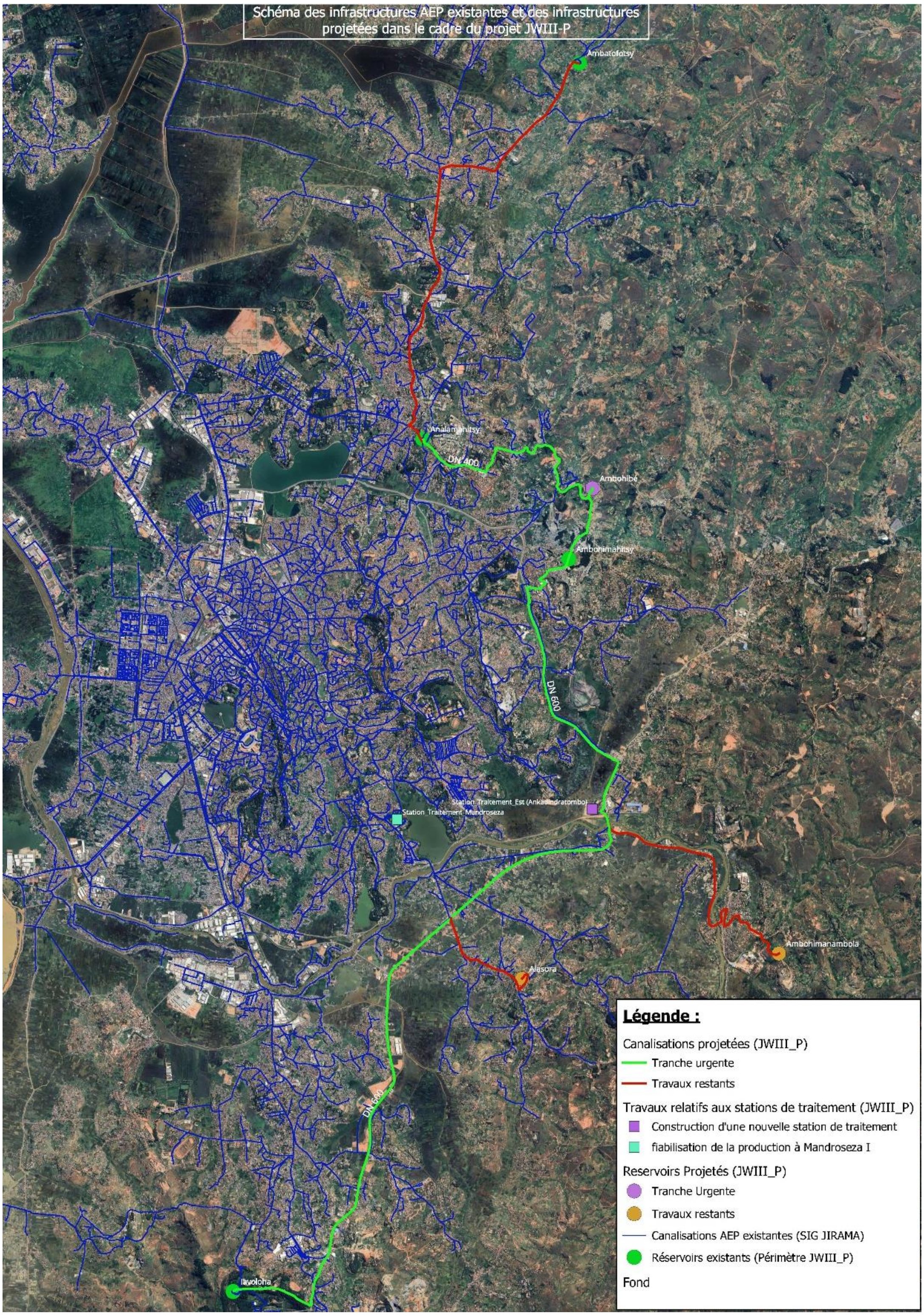


Source: Map provided by JIRAMA (based on data from January 2022).

Yet, since anticipated costs of all planned renovation and expansion works identified for JWIII-P would be higher than any foreseen financial contribution by the EIB, the project team indicated that EIB's contributions would be used to start the works with the highest priority. This phase called 'tranche urgente' should include 44 km of pipe renovations (concentrated, but not exclusively, in the CUA), and the construction of a treatment plant in the East of the city (i.e. 2km upstream of Mandroseza) with a pipeline to the North (i.e. the Ambohibé reservoir) and a gravity pipeline to the existing network of the Analamahici reservoir (see Figure 2). Works in the 'tranche urgente' areas were scheduled to start in early 2024 but have been delayed due to unanticipated circumstances. After completing the works under the 'tranche urgente', the remaining scheduled works under JWIII-P will be addressed. This includes extensions from the above-mentioned new treatment plant to the South (i.e. via the Alasora and another existing reservoir) and the East (i.e. via the Ambohimanambo reservoir). The evaluation will consider all changes occurring under JWIII-P, i.e., both the works under the 'tranche urgente' and those following once the 'tranche urgente' has been completed.

In addition to the financing provided by the EIB and the EC, complementary interventions supported or implemented by multiple partners are planned. First, WSUP co-finances the project, and will strongly be involved in its activities through a partnership and a complementary capacity building component aimed at strengthening JIRAMA's operational capacity and improving access to water delivery to unserved and underserved consumers in the capital. Upcoming activities include building better communal and social water infrastructure through the connection of existing tanks to the grid and building social connections for vulnerable households in unserved areas; improving JIRAMA's water quality management as well as its non-revenue water (NRW) and network management; and strengthening commune level water and sanitation services (WSUP contribution, 2022). Arguably, the activities of WSUP are very intertwined with the JWIII-P project; they will also influence the impacts the intervention will have on the beneficiaries – and as such, will also be considered with the impact evaluation.[2]

Figure 2. JWIII-P urgent works



Source: Map provided by JIRAMA (based on data from March 2023).

[2] The JWIII-P project team also mentioned that there might be additional NGOs and agencies that will (continue) implementing activities in the water sector in the capital, such as Water Aid and UNICEF.

Next to the work supported by EIB and EC, the World Bank also has a project on water infrastructure that overlaps with JWIII-P. On June 20, 2022, the government of Madagascar and the World Bank signed the $220 million National Water Project Projet d'Amélioration de l'Accès à l'Eau Potable à Madagascar (PAAEP). The closing date is September 30, 2027. JIRAMA is its implementing agency. Specifically, this project seeks to improve and secure water production in Greater Antananarivo (GA) through support to JIRAMA in meeting the growing water production gap caused by the increasing demand. Raw water production for GA is set to be increased by 20% (40,800 m3/day), and water losses will be reduced through a distribution network renewal programme. Moreover, the project aims at improving and extending water supply services in GA and secondary towns.[3] According to their estimations, the project will directly provide improved water services to 625,000 people, including 460,000 among the most vulnerable, through the social connections programme (connect the poorest households to the network).

The JWIII-P project team already indicated that the World Bank's contribution will be used (i) to cover the remainder of the pipe renovation, directly complementing EIB's contributions; (ii) to build an additional treatment plant in the West of the city (that is if the ongoing hydrological study shows that there is a sufficient untapped underground water source); and (iii) to subsidise the addition of 48,000 private connections across the city. The latter has been mentioned as a big challenge by the JWIII-P project team, as well as by other JIRAMA experts responsible for Antananarivo water network as the network currently cannot sustain such a high number of private water connections. As such, any additional water access points that are not sufficiently supported by improvements in water pressure, would not improve users' actual water access (World Bank, 2022).

2.2 Theory of change

As an essential tool in the design of an impact evaluation, a theory of change (ToC) explains how and why a particular program or policy is expected to lead to specific outcomes and impacts.[4] This helps the implementing organization think along the entire causal chain of results from inputs to activities, outputs, outcomes and, finally, intended impacts. It also explicitly states the underlying assumptions that must hold for outcomes and impacts to materialize (White, 2009).

Figure 3 schematically presents the ToC of the JWIII-P project, developed based on insights from the existing literature, project documentation shared with the team, and a mission that took place in November 2022, during which field observations and key informant interviews were conducted to provide accurate insights into the current constraints people face with respect to water access. During this exploratory mission, water kiosks and shared connections were visited in various fokontanies in the centre and (North-)East of the city of Antananarivo.

2.2.1 Activities, outputs and main assumptions

The program's activities and outputs are summarized in Figure 3. The main assumptions of this TOC are as follows:

- There is complementarity in the water infrastructure interventions in Antananarivo, such as the JWIII-P and the World Bank project. Albeit with different goals, both components are equally necessary, and individually insufficient to reach the desired impact.
- More water connections will increase the number of people with access to water from the (piped) grid for different purposes, including drinking, hygiene, laundry, and cooking. Hence, it is expected to see a reduction in the number of people that need to fetch water from other sources such as canals, lakes, private providers, or water pits. Piped water sources are considered

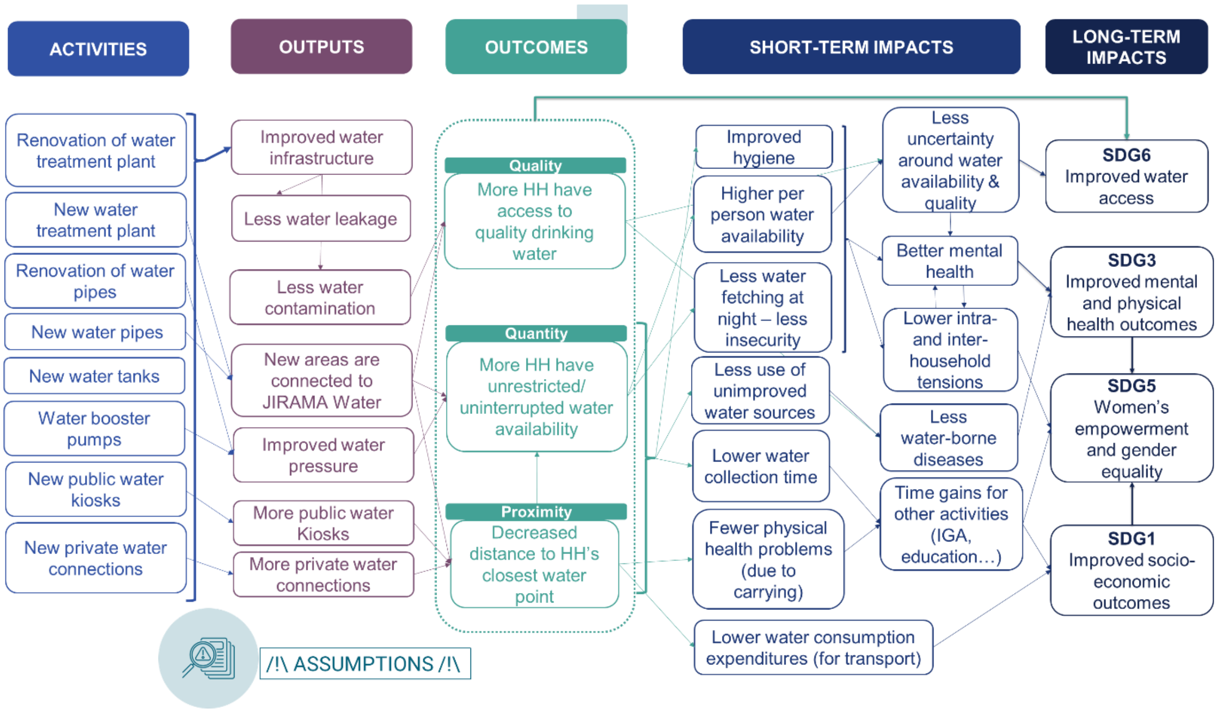
[3] These include Antsirananana, Mahajanga, Antsirabe, Fianarantsoa, and Manakara.

[4] Outcomes are results likely to be achieved once the beneficiary population uses the project outputs, whereas impacts are the final results induced by the changes in the outcomes. Typically, impacts have multiple drivers and are achieved over a longer period of time (Gertler et al., 2016).

improved water sources by the WHO/UNICEF Joint Monitoring Program (JMP), and, as such, have the potential to deliver safe water.

- People who benefit from piped water sources are expected not to engage in water storage practices that are detrimental to their health, as long-term storage of water in their house results in contamination. Moreover, it is assumed that stakeholder organisations, such as WSUP, will continue capacity building on hygiene and sanitation practices, including safe water storage.
- Improvements in water network infrastructure, i.e. construction of water pumps and new pipes, and renovation of water pipes and the water treatment station, are expected to lead to fewer leakages and higher water pressure, which altogether should result in greater water availability through higher water volume flow rate during a longer time span during the day and night.
- Additional financial investments may come in to build complementary water infrastructure, for instance, water kiosks, service reservoirs, and extended pipe networks to strengthen the water utility operations. The underlying ToC for this impact evaluation only considers activities that were reported to the research team by the time of writing this report.
- JIRAMA can manage water upgrading works effectively and build managerial and institutional capacity to oversee the construction works and operations to control the larger grid effectively and efficiently.
- Despite a potential price increase, water remains affordable at both private and public connections.

Figure 3. Theory of change



Note: The ToC was developed based on insights from the existing literature, JWIII-P project documentation, and qualitative insights gathered during fieldwork. Source: EIBURS project 2022.

2.2.2 Outcomes

The intervention is expected to lead to improved household level access to clean water in three ways.

First, **the construction of public water kiosks and private water connections is expected to increase proximity of safe water for households living in intervention areas.** More connections increase the number of people who have access to water from the grid for laundry and cleaning, personal hygiene, cooking and drinking, and reduce the number of people that need to fetch water from other sources such as canals or lakes, private providers, water pits or rainwater. According to assumption 2, the newly established water connections are expected to result in better water proximity, when people (i) receive a new private connection; (ii) receive a new private connection shared with several households; or (iii) have access to a newly built public water kiosk closer to home.

Second, **the JWIII-P project is expected to increase the quantity of safe water.** Improved water pressure across the network directly affects water volume flow and the availability of water accessed from the grid at different locations and times of the day, including areas with higher altitude.[5] Hence, if assumption 4 holds, increased water pressure and the resulting more regular water flow are outcomes that will benefit all inhabitants of Antananarivo, even those where no new water kiosk construction is foreseen.

Third, the **quality of the drinking water network is expected to improve**. On the one hand, newly connected households or households accessing water from a newly constructed water kiosk will now have access to JIRAMA water that must comply with WHO standards for drinking water quality, as opposed to alternative, uncontrolled water sources. On the other hand, renovating pipes of existing infrastructure will prevent water from getting contaminated in the grid through leakages during floods; renovating treatment plants will also provide better quality drinking water.

2.2.3 Impacts

The project is expected to provide a higher share of the population in Antananarivo with access to safe water (contributing to SDG 6). Nevertheless, it is worth mentioning that the JWIII-P project works alone will – only – cover about 10% of the unserved population in the Antananarivo region. Supposing assumptions 1 to 7 hold, the hypothesis is that better access to clean water triggers a chain of direct and indirect impacts for beneficiary households in various domains, in the short, medium and long term.

Better access (proximity, quantity and quality of water) reduces time spent on fetching water, which, as confirmed by field observations, is currently a **time-consuming activity**. This does not only comprise the time it takes to get to the water source,[6] but also the entire task of fetching water, i.e. waiting in line or returning multiple times a day when no water is available. Options to reduce time of fetching water like storage are typically costly and add to households' water consumption expenditures. Moreover, long-term storage carries a high risk of water contamination.

Better access to water should thus contribute to **lower expenditures on water consumption**, because the storage of jerrycans at the water kiosk or professional water carriers may become obsolete, or the cost of these services will reduce (as time gains could also apply to professional water carriers).[7]

Within households, in the medium to longer term, such time and monetary gains may result in **productivity gains**. For instance, **school attendance** among children in charge of fetching water may increase, leading to improved **educational outcomes**. Also, working-age household members in charge of fetching water could now increase home production, invest in assets and durable goods or time spent on more productive activities such as **wage-work or self-employment**. Such productivity gains will contribute to more income, reducing poverty and contributing to SDG 1.

Improved health conditions, both mental and physical health, are also expected, therefore contributing to SDG 3 and SDG 6. First, the current uncertainty about when water is available does not only increase

[5] Anecdotal evidence indicates that currently, water flow can be highly volatile during the day, especially at the end of each branch of the network, where it depends on water usage in areas that are first served by the grid. Moreover, water flow drops in locations at higher altitude. Due to low pressure in the network, these areas only get water provided there is less water usage between them and JIRAMA treatment plant, which is generally at night, while, during the day, inhabitants are not served. If water flow is relatively low, fokontanies may take rationing measures, limiting their access to water substantially; else, JIRAMA sends water trucks to temporarily provide water.

[6] Note that the mere distance to the water source may not necessarily reduce strongly due to the JWIII-P project, because the water kiosk infrastructure is already quite dense in urban Antananarivo. A reduction in the distance to the water source are rather expected in (semi-)rural areas.

[7] Yet, such changes will have adverse impacts on service providers (not shown in TOC). For instance, extra income collected by water kiosk managers may reduce and the income-generating activity of professional water carriers may also decrease or disappear.

time for fetching water but might also put a mental burden on household members. Insecure water access and the constant worry about when water is available can negatively affect well-being in the form of depression, anxiety, decreased life satisfaction and intra-household tensions (Roy and Crow, 2004; Sultana, 2011; Tsai et al., 2016; Asaba et al., 2013; Caruso et al., 2018, 2015; Nounkeu and Dharod, 2022). Hence, a more reliable and **secure access to water** can have significant positive impacts on **mental health**, particularly among household members responsible for managing and fetching water.

Second, the health of household water fetchers for whom closer proximity may decrease **health issues related to carrying heavy weights** is also considered. Both quantitative and qualitative evidence suggests that neck, chest and back pains are prevalent among people carrying water (Geere, et al., 2018; Sorenson et al., 2011). For professional water carriers too, this may be important. In addition, water fetchers will be **less exposed to violence and insecurity** if waiting times are shorter, kiosk visits become more effective, and water fetching activities are carried out during the day instead of at night.

Third, improved health outcomes will result from better quality of water from the tap and **less use of contaminated water**, if assumptions 2 and 3 hold. The negative impact of contaminated water on the transmission of waterborne diseases – particularly diarrhoea – is well documented (WHO, 2014; 2023).[8] Also, **improved sanitation and personal hygiene** might result from larger quantities of water available per person and decreased rationing of water. This is particularly important for vulnerable populations.

The long-term gendered impact of the intervention is related to the **empowerment of women**, as women are often in charge of fetching water in Madagascar. Following Kabeer's (1999) framework, (female) empowerment could be defined along three dimensions: (i) resources (gaining access – or future claims – to material, human, and social resources that enhance the ability to exercise choice); (ii) agency (capacity to define and influence decision-making on strategic life choices and act upon them); and (iii) achievements (meaningful improvements in well-being and other life outcomes). The JWIII-P project through increased proximity and quantity to safe water may enable women to gain access to resources in the form of **time gains**, which they can spend on leisure, resting or other domestic and/or productive activities, depending on social norms and gendered practices related to work. As mentioned above, such time gains may stem from shorter distances to a water access point, but also from a **reduced burden of managing water availability** under conditions of unreliable and insecure water access. With these time gains potentially leading to **productivity gains**, women may achieve better agency by participating in more **household decisions** (even on water-fetching chores), as well as **community decisions**, provided they actively participate in water user associations (WUAs). Another dimension of agency may be improved due to **lower exposure to violence or harassment** when fetching water, and **lower exposure to intra-household conflict** resulting from the failure to secure enough water for the household. Finally, women may achieve better life outcomes through **higher education** or **income-generating jobs** in the form of **(mental and physical) well-being** due to less depression, anxiety and water-related stress, more self-efficacy and self-esteem, and higher life satisfaction.

2.3 Evaluation questions

Guided by this ToC, the following evaluation questions are defined. The first question refers to the direct outcomes of the project, the second, to medium, and the third, to longer-run impacts.

[8] Note that impacts related to waterborne diseases are not considered part of the impact evaluation. The most important reason is that in the underlying context, many other factors might contribute to the prevalence of such diseases (e.g. contaminated food or lack of sanitation infrastructure), which complicates attribution.

Table 1. Evaluation questions

1. How does JWIII-P affect households' clean water access in terms of:
   - proximity to a clean water access point;
   - quantity/availability of water; and
   - quality of the main water source?
2. What are the direct impacts resulting from better water access on beneficiary households and their members in terms of:
   - time allocation;
   - allocation of financial resources;
   - hygiene;
   - drudgery from water-related chores;
   - intra-household decision-making;
   - mental well-being; and
   - inter- and intra-household tensions?

   a. Do these impacts differ for subgroups of beneficiaries, such as gender, age, role in the household and (not) being a professional water carrier?

   b. What are the mechanisms leading to the impacts observed?
3. What is the longer-term impact of better access to water on beneficiary households and their members in terms of:
   - socio-economic conditions related to income, employment and education;
   - physical and mental health conditions; and
   - women's empowerment (resources, agency and well-being)?

Source: EIBURS project.

2.4 Evaluation design

JWIII-P is a multi-partner, multi-component long-term intervention where ex-ante information about what, where and when these components are planned, can (substantially) deviate from what is ultimately realized. This is not uncommon in complex infrastructural projects like JWIII-P and requires a flexible approach to a rigorous evaluation design. Given the non-random allocation of treatment areas, and the possibility to collect baseline data, a matched difference-in-differences design (DiD) was considered the most robust and flexible design for this context. A DiD design allows for controlling for observed and unobserved time-invariant differences between treatment and control groups while matching further improves identification by only considering households that are similar in terms of observable baseline characteristics (e.g. households that are similar in size, income and education levels, are matched).

As there will be at least two treatment phases ('tranche urgente' and the remaining planned works under JWIII-P) households will start benefitting at different points in time and a modified DiD design is able to capture such treatment heterogeneity accounting for "staggered timing". For more details on the DiD methodology and econometric techniques employed we refer the reader to Annex A.

Since treatment is considered at the fokotany level we used a stratified two-stage sampling procedure with fokotanies as the primary sampling unit, and households within fokotanies as our secondary-sampling unit. The total number of fokotanies in the Antananarivo agglomeration is 550. A random sample a total number of 210 fokotanies was drawn stratified by fokotany access to piped water and water availability. Within each fokotany 12 households were randomly selected to be part of the survey sample. Ex-ante power calculations were done with parameter value selection based on relevant literature and information from JIRAMA and show a well-powered design to identify medium to large effects for all outcomes, and for various outcomes even small effects can be detected. Next to survey data, 12 fokotanties were randomly selected for qualitative data collection through focus group discussions. Focus group discussions were held with members of water users' associations, men and women using JIRAMA's public water kiosks, men and women using private water connections, and water carriers to obtain a comprehensive picture of the water situation and related challenges from different types of users. More details on quantitative and qualitative sampling strategies, statistical power balance tests can be found in Annexes A and B.

3. DESCRIPTIVE BASELINE FINDINGS

Data collection started on September 13, 2023, and ended on October 19, 2023. Data were collected over an extended area, in and surrounding Antananarivo across 210 fokontanies, belonging to 41 communes, and 4 districts, resulting in a total of 2,520 household surveys, i.e. 12 households surveyed per fokontany. 28 Focus Group Discussions were conducted in 12 fokontanies, including households, professional water carriers and people involved in the management of kiosks.

In this section, we provide descriptive findings from the baseline study, offering an overview of the current water situation in the sampled area, and permitting a preliminary assessment of the theory of change outlined above. First, characteristics of surveyed households, principal respondents and household water fetchers are presented. Second, variables of interest grouped by evaluation questions are described. Means and standard deviations for the whole sample of surveyed households are presented. When applicable, statistics are compared by (i) type of water source primarily used for drinking;[9] (ii) urban or peri-urban fokontanies; and (iii) gender (of principal respondents or water fetchers). Third, correlation coefficients are estimated between selected variables of interest. While such correlations should not be interpreted as definite links between those variables, their sign and significance help to refine the causal mechanisms in the theory of change to be tested during subsequent evaluation phases.

3.1 Sample summary statistics

Table 2 presents sampled household characteristics. Average household size is slightly less than 4 members. 20.6% are female-headed. 28.4% of members of sampled households are 15 years old or less, and 9.6%, 60 years old or more. The highest completed education level within sampled households is middle (29.1%), primary (25.7%), or high school (24.5%). Last month revenue is reported to be, on average, MGA 400,091.691.[10]

Table 3 presents dwelling characteristics. According to interviewers, 28.1% of surveyed households live in dwellings that are in good or very good conditions. The majority, 71.6%, lives in a villa. 73.6% of dwellings have at least one functional shower, and 95.0% have a latrine. 66.5% use electricity as their main source of lighting. Still, 90.6% do not dispose of a private water tap connection; only 7.9% do, and 1.5% share connection with their neighbours. Among those households whose dwelling is privately connected, households report having been connected for an average of 18.3 years. When households are not privately connected, 93.2% had not, at the time of fieldwork, applied to JIRAMA to get connected.

Table 4 characterises primary respondents. 23.5% of primary respondents are water managers, 71.3%, water fetchers and managers, and 5.3% solely fetchers. 73.8% are women. Among female primary respondents, 23.1% are managers, 74.1% fetchers and managers, and 2.8% solely fetchers. On average, primary respondents are 41 years old. 39.5% are household head; and 70.3% are married or cohabitate with their partner.

[9] While it is not possible to present statistics by the exact type of water source improvement that will be implemented by the JWIII-P programme at this stage, water sources are lumped together in five categories, according to which ones JIRAMA intends to upgrade – (i) in-house, in-yard private connection or at a neighbour's house, (ii) water kiosk and tanker, (iii) water carrier, (iv) protected well and boreholes, and (v) unprotected well, surface water, rice field or other sources.

[10] Equivalent to EUR 81.79 (on July 11, 2024).

Table 2. Household characteristics

	Obs (1)	Mean (2)	SD (3)
Female-headed household	2520	0.206	0.404
Household's highest completed level of education			
None	2519	0.037	0.188
Still in school	2519	0.007	0.082
Primary school	2519	0.257	0.437
Middle school	2519	0.291	0.454
High school	2519	0.245	0.430
Some tertiary education	2519	0.164	0.370
Reported household size	2520	3.932	1.564
Proportion of members 15 years of age or younger	2520	0.284	0.224
Proportion of members 60 years of age or older	2520	0.096	0.225
Last month household revenue	2520	400091.691	377160.696

Notes: Estimation sample size, mean and standard deviation of listed variables.

Table 3. Dwelling characteristics

	Obs (1)	Mean (2)	SD (3)
General condition of the dwelling is good or very good (surveyor's observations)	2520	0.281	0.45
Type of dwelling			
Villa	2520	0.716	0.451
Concession	2520	0.137	0.344
Building	2520	0.008	0.089
Apartment	2520	0.125	0.331
Other	2520	0.013	0.115
Electricity is the main source of lighting	2520	0.665	0.472
Has a tap or access to a private water connection			
No	2520	0.906	0.293
Yes, private	2520	0.079	0.270
Yes, shared with neighbours	2520	0.015	0.122
If yes, number of years of private water connection in the dwelling	157	18.261	17.858
If not, the household has applied to JIRAMA to be connected			
No	2333	0.932	0.251
No, but intention to do so directly/through the owner of the accommodation	2333	0.015	0.123
Yes, less than a year ago	2333	0.008	0.088
Yes, over a year ago	2333	0.029	0.168
The accommodation has at least one functional shower	2520	0.736	0.441
The accommodation has a latrine	2520	0.950	0.219

Notes: Estimation sample size, mean and standard deviation of listed variables.

Table 4. Sociodemographic characteristics of primary respondents

	Obs (1)	Mean (2)	SD (3)
Status			
Manager	2520	0.235	0.424
Water fetcher and manager	2520	0.713	0.453
Water fetcher	2520	0.053	0.224
Status of female respondents			
Manager	1,860	0.231	0.421
Water fetcher and manager	1,860	0.741	0.438
Water fetcher	1,860	0.028	0.166
Age	2520	40.573	14.357
Household head	2520	0.395	0.489
Civil status			
Married	2520	0.698	0.459
Single with no children	2520	0.091	0.288
Divorced/separated	2520	0.058	0.234
Single with child(ren)	2520	0.017	0.131
Widow/Widower	2520	0.131	0.337
Cohabiting with partner	2520	0.005	0.072

Notes: Estimation sample size, mean and standard deviation of listed variables.

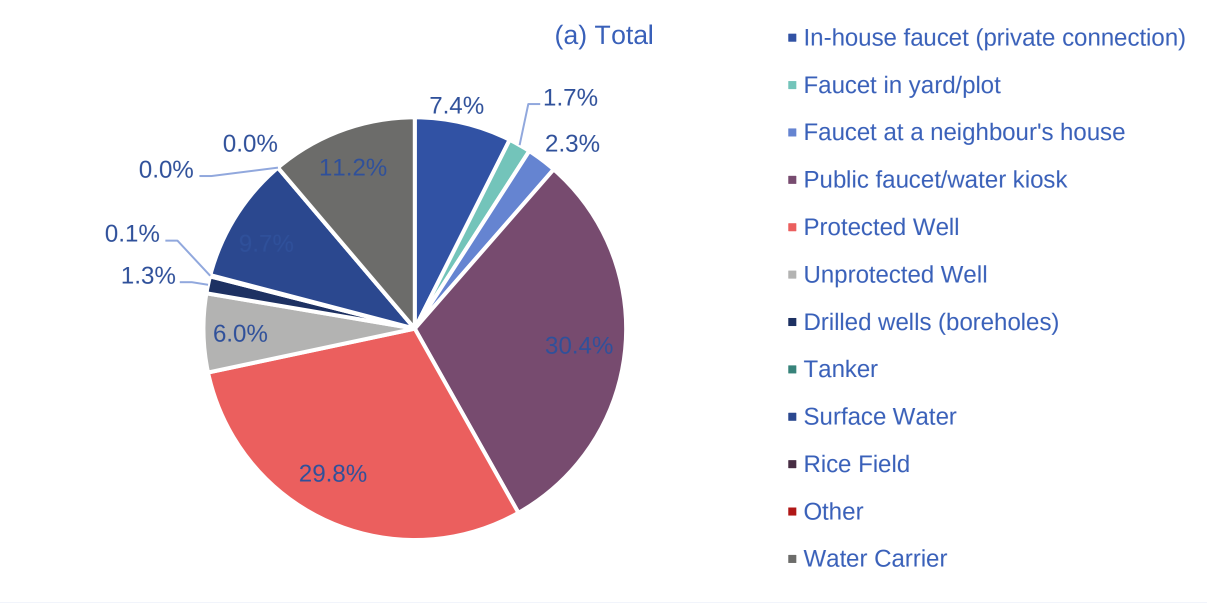
3.1.1 Water access

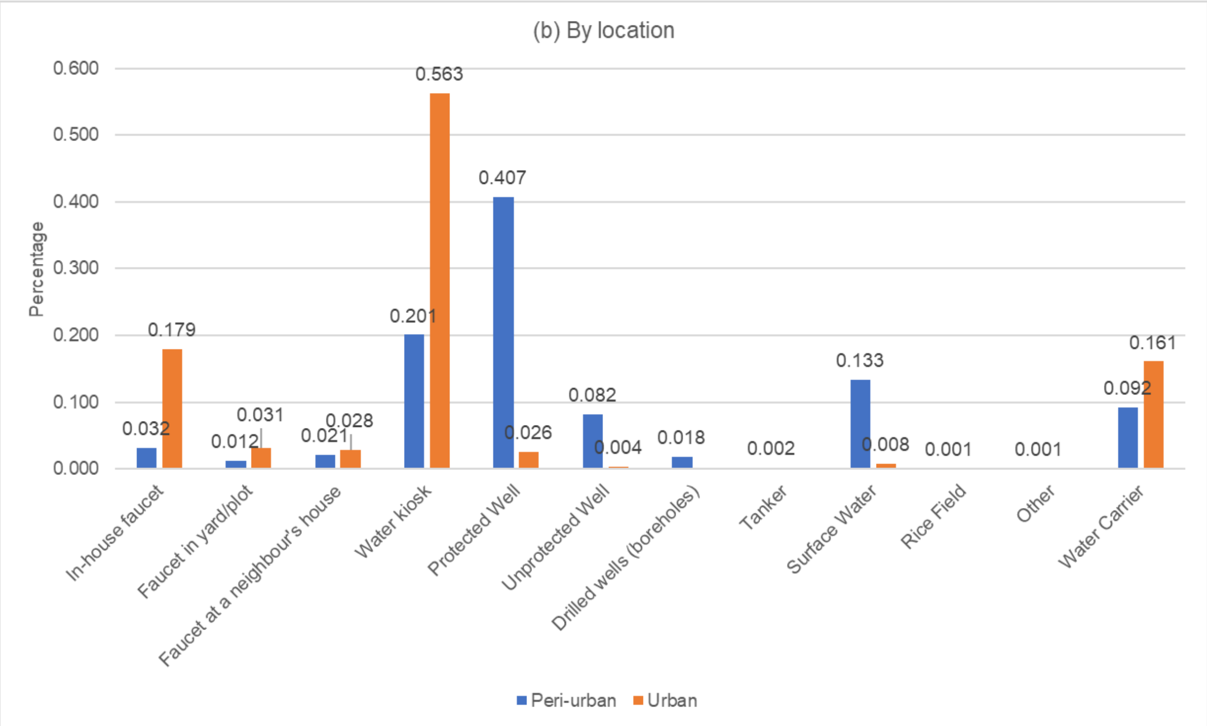
Below, we present statistics on the primary sources of water used for drinking during a typical week during the year. For households that use distinct sources in dry and wet seasons, values for the dry season are reported. It is explained how baseline data (quantitative and qualitative) compared to the expected changes to indicators as pre-specified by the theory of change.

Table C.1, in Annex, and Figure 4. Primary source of water inform on the type of water sources households access water from, and the use they make of available water.[11] Figure 4. Primary source of water indicates that 11.4% of sampled households access drinking water through private connection – in-house faucet (7.4%), in-plot faucet (1.7%), or faucet at a neighbour's house (2.3%). 30.4% fetch drinking water at a public water kiosk, and 0.1% access drinking water via tanker (*camion-citerne*). 11.2% use water carrier services, mainly (68.0%) because no household member is available to collect water. 31.1% use protected or drilled wells as primary drinking water source. The remaining 21.7% resort to unprotected wells, surface water, or rice fields to access drinking water. In urban fokontanies, most sampled households, 56.3%, fetch drinking water at a water kiosk, 23.8 % access drinking water through private connection, in particular in-house faucet (17.9%), and 16.1% use water carrier services. In contrast, 20.1% of households sampled in peri-urban fokontanies fetch drinking water at a public water kiosk, but 40.7% fetch water at protected well. Merely 6.5% access drinking water through private connection, and 9.2% use water carrier services.

[11] On average, households use 1.2 distinct water sources in a typical week during the year. Specifically, 2,456 (97.5%) households use the same water sources in dry and wet seasons, out of which 562 use multiple water sources in a typical week. 64 (2.6%) households use different water sources in dry and wet seasons, out of which 16 use multiple water sources in a typical week. Note that those statistics corresponding to the primary water sources used during a typical week for households reporting using similar water sources in dry and wet seasons, and statistics corresponding to the primary water sources used during a typical week in dry season for households that reported using different sources in dry and wet season, as baseline data were collected during dry season.

Figure 4. Primary source of water





Notes: Main source of water the household uses in a typical week during the year, by urban or peri-urban fokontany status. Statistics corresponding to the main water sources used during a typical week for households reporting using similar water sources in dry and wet seasons, and statistics corresponding to the main water sources used during a typical week in dry season for households that reported using different sources in dry and wet season.

Tables C.2 and C.3 present sampled household and dwelling characteristics by primary water source type, respectively. There is little variation in household size, even though households having private connection or using water carrier services have a greater share of members who are 60 years old or more. However, almost 30% of households having private connection or using water carrier services are female-headed, when less than 20% are female-headed among households using protected or drilled wells or other types of water source. Slightly less than 50% of households having private connection have member(s) with some tertiary education, compared to 20% or less, among households accessing water through alternative means. There are major differences in last month revenue, reported to be above sample average for households having private connection (MGA 683,167.138) or using water carrier services (MGA 482,678.712), but below for those accessing drinking water through water kiosks or tankers (MGA 360,126.801), protected or drilled wells (MGA 358,404.668), or other water sources (MGA 295,301.128). Respective asset indices are correspondingly the greatest for the former group, and the lowest for the latter.

Table C.3 confirms similar discrepancies regarding dwelling characteristics. While the majority lives in a villa, and in an accommodation with a latrine, 60.6% of surveyed households who have private connection live in dwellings that are in good or very good conditions, 35.2% of households using water carrier services, 25.3% of those accessing water at protected or drilled wells, 21.4% of those using water kiosks or tankers, and 18.1% using other types of water sources. There is similar variation in using electricity as the main source of lighting, or having at least one functional shower in their dwelling. Among households without a tap or access to a private water connection, a minority has not applied to JIRAMA to get connected (and does not intend to), except among those using other types of water source (97.0%).

3.1.2 Proximity

Access to clean water is a significant challenge, with many residents raising the issue of the time needed to collect water. Table 5 provides a series of statistics informing on primary water source proximity. Among those households using a public water kiosk as their main source of drinking water, distance between dwelling and water kiosk is, on average, 0.138 kilometres. Even though there is no difference in average, nor median, distance between urban and peri-urban households, Figure 5 indicates greater variation among urban fokontanies, where households report water kiosks to be at most 1.93 kilometres away from their dwelling, compared to peri-urban households who use water kiosks that are up to 0.74 kilometres away from their dwelling.

Overall, among households reporting as primary drinking water source water kiosk, wells, tanker truck, surface water, rice field, or others, time to collect water for a roundtrip is, on average, 10 minutes.[12] However, as Figure 5 shows, there is some variation, which is also confirmed by participants of focus group discussions, who, reportedly, must travel long distances, sometimes up to 20 minutes each way, to access alternative water sources such as communal wells or springs, that could dry up during periods of high demand.

Most households, 87.6%, fetch water in the morning; 98.6% collect water on foot. There is no significant difference in distance, time, time of the day, or means of transportation to collect water between urban and peri-urban fokontanies. Overall, collecting water is considered primarily a morning task, as reflected in both qualitative and quantitative results.[13]

Improved management and maintenance of the JIRAMA network, as well as the expansion of the water network, are expected to improve the proximity of households to clean water. The existing water kiosks in the visited fokontanies are considered to be insufficient, also leading to long queues and water shortages, especially during peak hours and in higher-altitude areas, further contributing to the time required to collect water.

[12] A roundtrip includes the time it takes to get from the home to the water source, the time for queuing, and the time it takes to get from the water source to the home. The average time might be slightly underestimated, because according to some enumerators some households left out the queuing time in their calculation.
[13] Note that the time of the day reported is as perceived by the respondent. That is, the questionnaire did not clarify concrete time intervals for morning, afternoon, evening and night. In focus group discussions, the task is mentioned to be done as early as 2 AM. Considering that only 2% of respondents to the survey report to collect water at night, there is a reason to believe that occurrences of collecting water in the 2AM - 4AM window were considered morning.

Table 5. Water source proximity by urban or peri-urban fokontany status

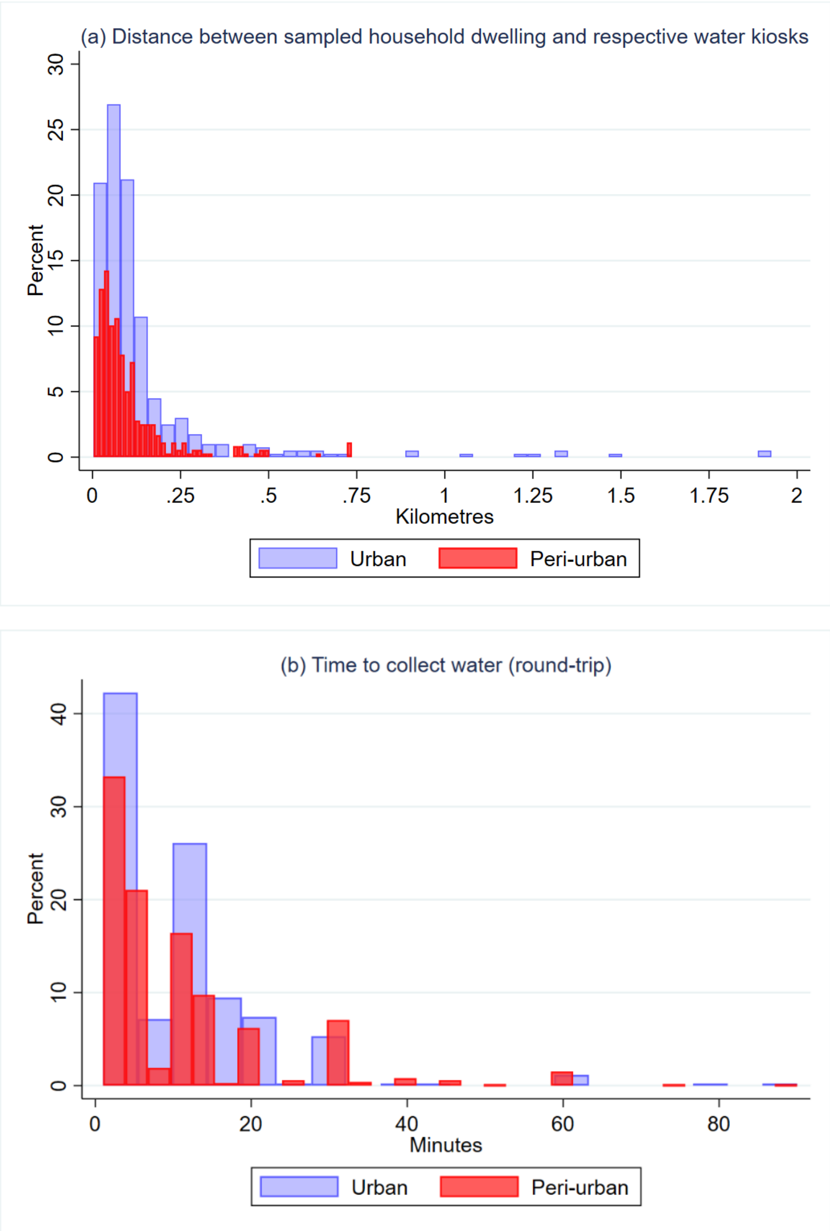
	Total			Peri-urban			Urban		
	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Distance from dwelling to public tap or water kiosk (kilometres) (a)	759	0.124	0.185	358	0.102	0.117	401	0.145	0.228
Time to collect water (round-trip in minutes)	1949	10.319	11.148	1516	10.264	11.337	433	10.513	10.470
Time of day water is collected									
Morning	1950	0.876	0.329	1517	0.887	0.316	433	0.838	0.369
Afternoon	1950	0.037	0.190	1517	0.033	0.179	433	0.053	0.225
Evening	1950	0.065	0.247	1517	0.063	0.244	433	0.072	0.258
At night	1950	0.021	0.142	1517	0.016	0.127	433	0.035	0.183
Usual means of transportation to get to water fetching point									
On foot	1950	0.986	0.119	1517	0.992	0.089	433	0.963	0.189
Bicycle	1950	0.001	0.032	1517	0.001	0.026	433	0.002	0.048
Charette	1950	0.011	0.106	1517	0.007	0.081	433	0.028	0.164
Other	1950	0.001	0.032	1517	0.001	0.026	433	0.002	0.048

Notes: Estimation sample size, mean and standard deviation of listed variables, by urban or peri-urban fokontany status. Statistics corresponding to the main water sources used during a typical week during the year and in dry season for households that reported using separate sources in dry and wet season, and for households who reported using as their main source of water: public tap/water kiosk, protected and unprotected wells, drilled wells, tanker truck, surface water, rice field, or others.

(a) Corresponding statistics for households that reported using public tap/water kiosk as their main source of drinking water during a typical week during the year for which GPS coordinates of household dwellings and their respective water kiosk are not missing. Excludes a single household reporting an extreme value of 10.80 kilometres.

The installation of a private water connection is overall considered a significant improvement to proximity. However, the cost of installation can be prohibitive. Interviews with JIRAMA technical staff suggest that a sharp increase of the number of private water connections in the network, without sufficient improvements to the network itself, would decrease water pressure and thereby water availability (see Section 3.3.2). Participants in FGDs raise an additional trade-off to be considered in decisions regarding private water connections, as the quality of the water from alternative sources is sometimes preferred over water from JIRAMA sources, with regular mentions of sediment, green particles, and taste and smell of chlorine. Survey results confirm households' concerns with water quality, Detailed results are presented in Section 3.3.3.

Figure 5. Water source proximity



Notes: Distance statistics correspond to households that reported using public tap/water kiosk as their main source of drinking water during a typical week during the year for which GPS coordinates of household dwellings and their respective water kiosk are not missing. Excludes a single household reporting an extreme value of 10.80 kilometres.

Table 6. Sociodemographic characteristics of water fetchers by gender

	Total			Male			Female		
	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Age	1936	38.570	14.125	508	38.051	15.073	1428	38.755	13.773
17 years old or younger	1936	0.025	0.157	490	0.027	0.161	1446	0.025	0.156
Household head	1936	0.359	0.480	508	0.778	0.416	1428	0.210	0.408
Level of education									
None	1863	0.123	0.328	506	0.091	0.288	1357	0.135	0.342
Still in school	1863	0.029	0.168	506	0.065	0.247	1357	0.015	0.123
Primary school	1863	0.389	0.488	506	0.374	0.484	1357	0.394	0.489
Middle school	1863	0.264	0.441	506	0.247	0.432	1357	0.270	0.444
High school	1863	0.138	0.345	506	0.152	0.360	1357	0.133	0.339
Some tertiary education	1863	0.057	0.232	506	0.071	0.257	1357	0.052	0.221
Activity in the last three months									
Self-employed	1936	0.674	0.469	508	0.656	0.476	1428	0.680	0.467
Waged-employed	1936	0.214	0.410	508	0.175	0.381	1428	0.228	0.420
Non-remunerated employee	1936	0.002	0.039	508	0.004	0.063	1428	0.001	0.026
Job Seeker	1936	0.018	0.131	508	0.031	0.175	1428	0.013	0.112
Inactive	1936	0.032	0.175	508	0.024	0.152	1428	0.034	0.182
Retired	1936	0.029	0.168	508	0.043	0.204	1428	0.024	0.153
Student	1936	0.029	0.168	508	0.065	0.247	1428	0.016	0.126
Handicap	1936	0.004	0.060	508	0.002	0.044	1428	0.004	0.065
Civil status									
Child (max 15 years)	1936	0.008	0.091	508	0.016	0.125	1428	0.006	0.075
Married	1936	0.693	0.461	508	0.657	0.475	1428	0.706	0.456
Single with no children	1936	0.108	0.310	508	0.234	0.424	1428	0.063	0.243
Divorced/separated	1936	0.054	0.227	508	0.028	0.164	1428	0.064	0.244
Single with child(ren)	1936	0.018	0.131	508	0.000	0.000	1428	0.024	0.153
Widow/Widower	1936	0.114	0.317	508	0.061	0.240	1428	0.132	0.339
Cohabiting with partner	1936	0.005	0.072	508	0.004	0.063	1428	0.006	0.075
Who should be responsible for fetching water (a) all primary respondents									
Solely men	2512	0.272	0.445	657	0.344	0.475	1855	0.247	0.431
Solely women	2512	0.130	0.337	657	0.075	0.263	1855	0.150	0.357
Both men and women	2512	0.598	0.49	657	0.581	0.494	1855	0.603	0.489
Solely adults	2512	0.642	0.48	657	0.673	0.47	1855	0.631	0.483
Solely children	2512	0.085	0.279	657	0.079	0.27	1855	0.087	0.282
Both adults and children	2512	0.273	0.446	657	0.248	0.432	1855	0.282	0.450

Notes: Estimation sample size, mean and standard deviation of listed variables, by gender of water fetchers.

(a) Statistics by gender of primary respondents.

Table 6 and Table 7 provide the profiles of those who collect water, i.e. household members who are water fetchers and professional water carriers. Table 6 presents characteristics of household water fetchers. When asked who should be responsible for fetching water, 59.8% of primary respondents believed both men and women should be. This contrasts with the fact that, among sampled households, 73.8% of household members fetching water are women. Water fetchers are on average 39 years old, out of which 2.5% are 17 years old or less, in line with most primary respondents, 64.2%, believing that solely adults should be responsible for fetching water. 35.9% of respondents are household head. Water fetchers have, on average, completed primary (38.9%) or middle school (26.4%). The majority is active and working, as self- or waged-employed – 67.4% and 21.4%, respectively. Most water fetchers, 69.3%, are married.

Table 7. Sociodemographic characteristics of water carriers

		Total			Peri-urban			Urban	
	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
15 years old or more	275	0.905	0.293	160	0.875	0.332	115	0.948	0.223
Female	275	0.269	0.444	160	0.256	0.438	115	0.287	0.454

Notes: Estimation sample size, mean and standard deviation of listed variables, by urban or peri-urban fokontany status, reported by household primary respondents.

3.1.3 Water availability

Table 8 informs on water availability. It indicates that households fetch water, on average, 18.7 times per week, equivalent to 2.7 times a day, which is close to the average number of times water carriers bring water – a mean of 2.186 times a day.

Table 8 further suggests that only 50.2% report not having any water shortages at their primary water source. Most households (85.9%) indicate having very low pressure.

Water availability varies strongly across fokontanies. Therefore, the expected impact as per the TOC might vary across contexts. Table 8 indicates that, in urban fokontanies, water cuts are significantly more prevalent than in peri-urban areas (24.0% report no shortage in the former; 59.9%, in the latter group). The situation described by participants in the FGDs confirms this.

Table 8 indicates that surveyed households. Among water fetching households, each member consumes, on average, 21.3 litres of water daily. Note that this excludes households with a private connection and is displayed for all households fetching water regardless of the source where they fetch water from. Price per litre of water for households fetching from a water kiosk or tanker truck is reported to be MGA 4.049; and water carrier remuneration the remuneration of professional water carriers per jerrycan is higher in the latter group. One possible explanation may be that professional carriers in peri-urban areas are only used among households that live far away from an improved water source.

Last, Young et al.'s (2019) household water insecurity experiences (HWISE) scale is used to measure experiences of household water insecurity. This scale, tested across low-income and middle-income countries through a weighted score of 12 items, ranges from 0 to 36, where higher scores indicate greater household water insecurity. 12 being considered the cut-off point determining whether a household is water insecure, a binary variable is constructed taking on unity when the calculated HWISE scale is equal or greater than 12, and 0, otherwise. The resulting variable indicates that 14.6% of sampled households are water insecure.

"The water points far from the water source and situated at higher altitudes have low water pressure, unlike those located in the lower parts of the fokontany, closer to the water source. Once all the taps are opened downhill, the taps located uphill run out of water."

– Person with private connection in Ambohibahiny (yellow)

Table 8. Water quantity by urban or peri-urban fokontany status

	Total			Peri-urban			Urban		
	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Water fetching									
Number of times per week	1950	18.702	11.827	1517	19.548	11.933	433	15.739	10.955
Litres of water used per day	1949	76.421	46.213	1517	73.106	42.510	432	88.063	55.873
Litres of water used per day per household member	1949	21.252	14.645	1517	20.577	13.944	432	23.623	16.680
Price per litre of water (a)	746	4.049	3.092	342	4.169	2.033	404	3.947	3.762
Water carrier									
Number of times per day the water carrier fetches water	280	2.186	1.725	165	2.261	1.987	115	2.078	1.258
Remuneration of the water carrier per jerrycan (20 litres)	275	387.989	176.463	160	418.731	198.670	115	345.217	128.925
Private connection and water fetching									
No water shortage	2239	0.502	0.500	1635	0.599	0.490	604	0.240	0.427
No very low pressure (b)	1060	0.141	0.348	484	0.132	0.339	576	0.148	0.355
Cannot use as much water as desired per day (rationing)	2239	0.221	0.415	1635	0.206	0.404	604	0.262	0.440
Limiting daily water consumption due to lack of money									
No, never	2239	0.584	0.493	1635	0.616	0.487	604	0.497	0.500
Yes, sometimes	2239	0.228	0.419	1635	0.195	0.396	604	0.316	0.465
Yes, often	2239	0.130	0.337	1635	0.109	0.312	604	0.187	0.390
Stores drinking water (c)	2052	0.619	0.486	1577	0.590	0.492	475	0.716	0.452
All households									
Household Water InSecurity Experiences Scale (d)	2494	4.719	6.181	1790	4.395	5.956	704	5.541	6.651
Water insecure (c)	2494	0.146	0.354	1790	0.140	0.347	704	0.162	0.369

Notes: Estimation sample size, mean and standard deviation of listed variables, by urban or peri-urban fokontany status. Statistics corresponding to the main water sources used during a typical week during the year and in dry season for households that reported using separate sources in dry and wet season. Level of statistical significance: * < 5%, ** < 1%.

(a) Statistics corresponding to households that reported using as their main source of water during a typical week during the year: public tap/water kiosk or tanker truck.

(b) Corresponding statistics for households that reported using as their main source of water during a typical week during the year: private connection, connection in yard/plot, connection at a neighbour's house, public tap/water kiosk, tanker truck or other.

Low water availability has led households to adopt coping strategies, each with their own risks and benefits. Households reportedly store higher volumes of water when water is available – Table 8 indicates that 71.6% of sampled households store drinking water in urban fokontanies, and 59.0% in peri-urban clusters – illegally buy water from households with a private water connection at a surplus price, or collect water from alternative sources with varying water quality and more time needed to collect water. In some places, interventions, such as large water containers at the kiosk or the provision of trucks with water tanks, extended the operating times of water access points in the fokontany.

3.1.4 Water quality and water treatment

Table 9. Water quality

	Obs (1)	Mean (2)	SD (3)
Most of the time, water colour is (a)			
Crystal clear/no deposit	1058	0.734	0.442
Brackish	1058	0.193	0.395
Green	1058	0.005	0.069
With mud	1058	0.067	0.250
Most of the time, the smell of water from the spring is (a)			
Odourless	1058	0.789	0.408
Smells like chlorine	1058	0.169	0.375
Smells muddy/musty/sewer	1058	0.041	0.198
Most of the time, the taste of water from the spring is (a)			
Tasteless	1058	0.865	0.342
Tastes like chlorine	1058	0.093	0.290
Salty	1058	0.003	0.053
Bad taste	1058	0.034	0.181
Treats water before drinking (b)	2238	0.576	0.494
If yes, water treatment method			
Boiling	1288	0.928	0.259
Adding bleach/chlorine	1288	0.049	0.216
Solar disinfection	1288	0.001	0.028
Chemical disinfection (chlorination)	1288	0.004	0.062
Straining it through a cloth	1288	0.005	0.068
Using a filter (ceramic/sand/composite/etc.)	1288	0.008	0.088
Letting it sit	1288	0.005	0.074
Other	1288	0.001	0.028

Notes: Estimation sample size, mean and standard deviation of listed variables. Statistics on the main sources of water used for drinking during a typical week during the year and in dry season for households that reported using separate sources in dry and wet seasons. Level of statistical significance: * < 5%, ** < 1%.

(a) Corresponding statistics for households reporting using as their main source of drinking water during a typical week during the year: private connection, connection in yard/plot, connection at a neighbour's house, public tap/water kiosk, tanker truck.

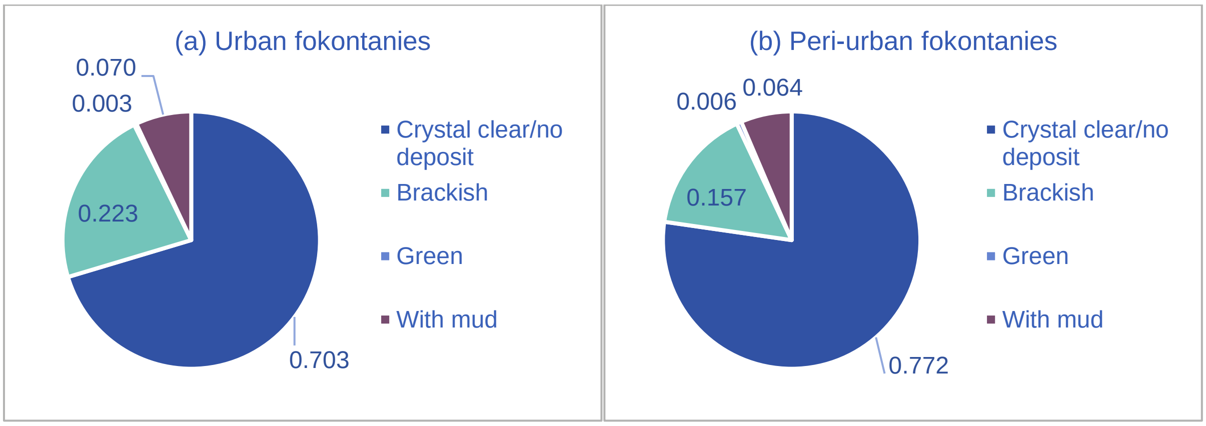
(b) Statistics corresponding to households that reported using as their main source of drinking water during a typical week during the year: private connection, connection in yard/plot, connection at a neighbour's house, public tap/water kiosk, protected and unprotected well, drilled wells, tanker truck, surface water, rice field or others.

Overall, among sampled fokontanies, water quality is perceived to be high, even though there is variation between urban and peri-urban fokontanies. Table 9 and Figures 6 to 8 inform on water quality and treatment. 73.4% of sampled households consider that water colour is, most of the time, crystal clear, i.e. with no deposit. 78.9% deem it odourless; and 86.5%, tasteless. This is confirmed by FGD participants who generally agreed that water quality of JIRAMA water access points was 'good'.

Still, water is, in urban fokontanies, less clear (70.3%), and more likely to be brackish (22.3%), compared to peri-urban fokontanies (77.25 and 15.7%, respectively), as indicated by Figure 6. One possible explanation is that the risk of contamination through other factors is higher than in peri-urban areas, although this was not confirmed by the qualitative evidence.

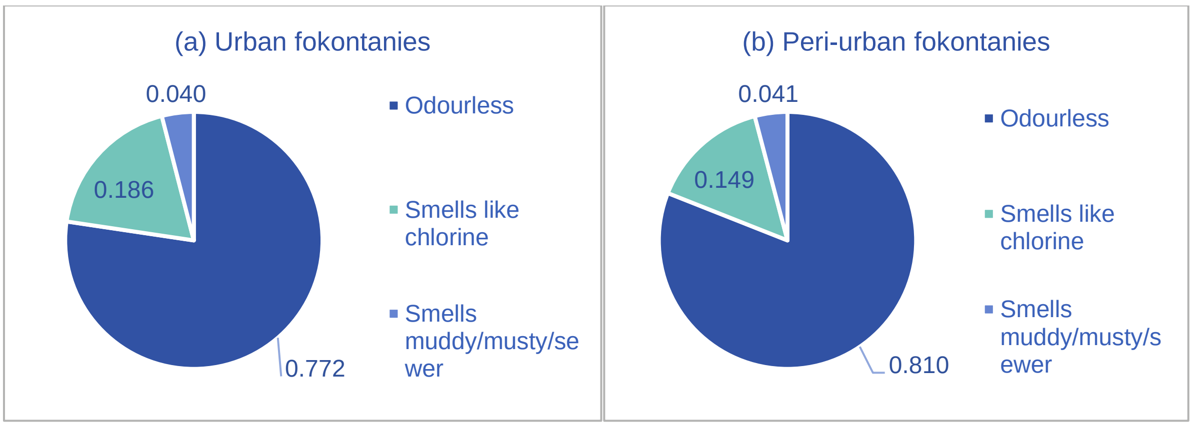
To ensure sufficient water quality, many FGD participants reported engaging in water treatment practices, such as boiling water, using chlorine, or solar disinfection. Table 9 confirms that 57.6% of sampled households treat water before consuming it, among which, the majority – 92.8% – resorts to boiling water. Urban households are more likely to treat water than peri-urban households (65.2% against 54.7%). They are also more likely to boil water and less likely to add bleach or chlorine to water before drinking it, as illustrated by Figure 9. This is aligned with results on perceived quality in each area, where peri-urban households report better perceived water quality than households in urban areas. Better information provision and awareness in urban areas about the necessity to treat water may be an alternative or complementary explanation.

Figure 6. Water colour



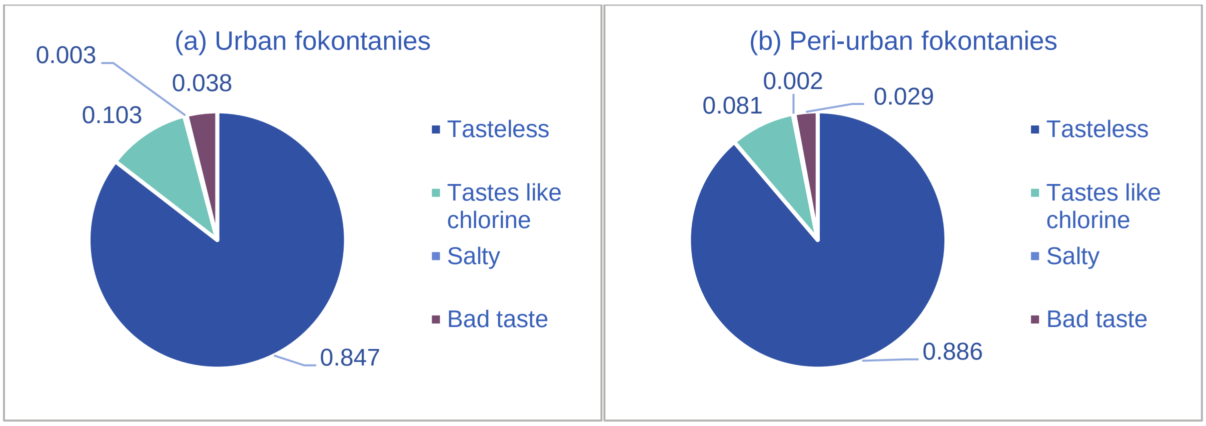
Notes: Corresponding statistics for households reporting using as their main source of drinking water during a typical week during the year: private connection, connection in yard/plot, connection at a neighbour's house, public tap/water kiosk, tanker truck.

Figure 7. Water smell



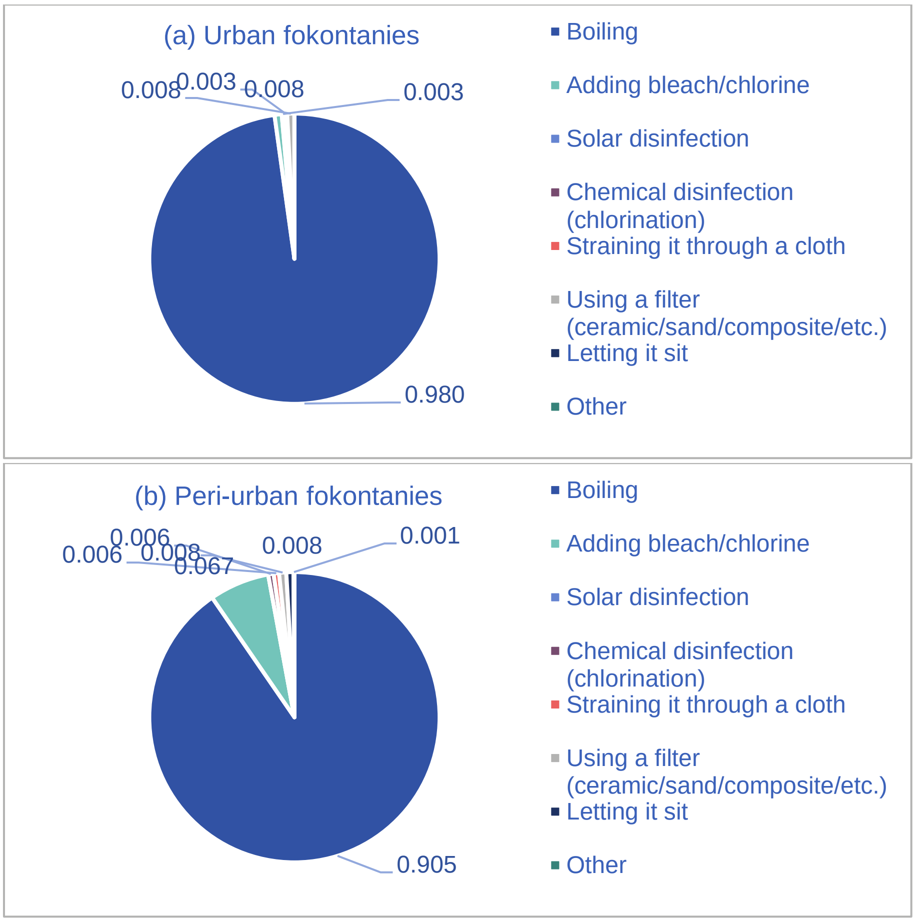
Notes: Corresponding statistics for households reporting using as their main source of drinking water during a typical week during the year: private connection, connection in yard/plot, connection at a neighbour's house, public tap/water kiosk, tanker truck.

Figure 8. Water taste



Notes: Corresponding statistics for households reporting using as their main source of drinking water during a typical week during the year: private connection, connection in yard/plot, connection at a neighbour's house, public tap/water kiosk, tanker truck.

Figure 9. Water treatment method



Notes: Statistics corresponding to households that reported using as their main source of drinking water during a typical week during the year: private connection, connection in yard/plot, connection at a neighbour's house, public tap/water kiosk, protected and unprotected well, drilled wells, tanker truck, surface water, rice field or others, and that reported treating water before drinking it.

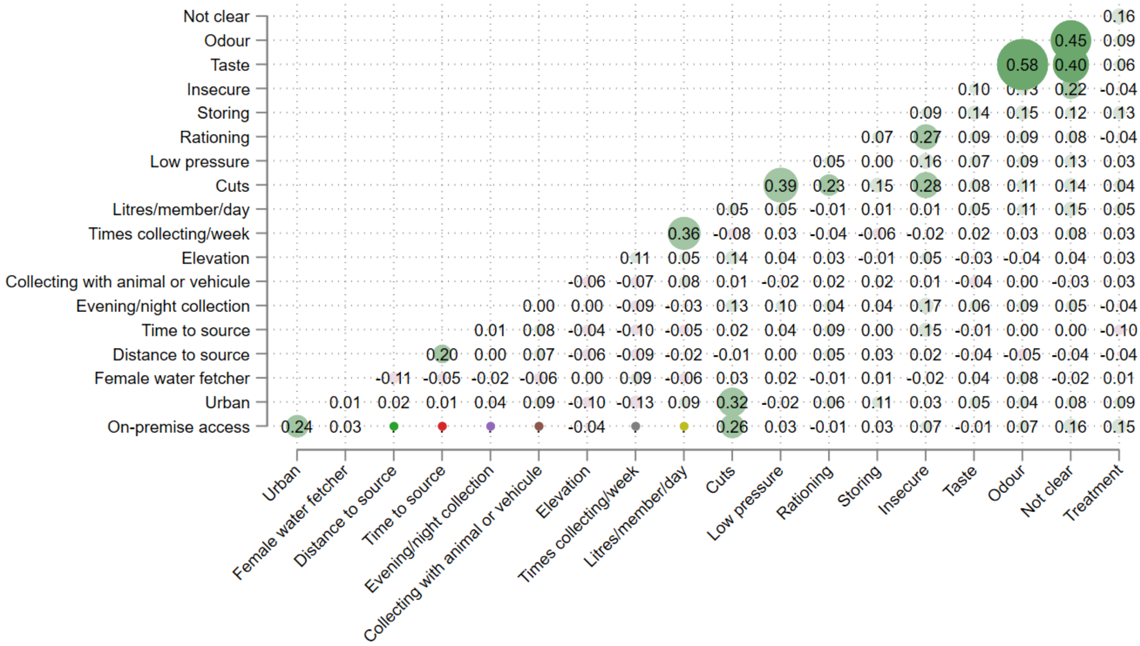
Specific events strongly affect water quality. Participants in FGDs, report worse quality in times of rain (more yellow), and green organic particles when there has been a lot of sun. When water has been cut, and becomes available again, there is a need to let the water run for a while before using it. The first water coming out of taps in those instances was described as 'chocolate' and 'faeces.'

3.1.5 Correlates

Figure 10 presents pairwise correlation coefficients of variables characterizing proximity, availability and quality of water. Green indicates a positive correlation, and red, a negative correlation. Numbers refer to correlation coefficients. Circle size is proportional to statistical significance. It should be kept in mind, nonetheless, that such correlations should not be interpreted as definite links between the various components of water access – correlations do not imply causation. This exercise should be understood as partially informative. Below, correlation coefficient estimates that are statistically significant at 5% or lower are reported.

Figure 10 indicates that, on-premise water access is significantly and positively associated with cuts (0.261). Even though on-premise connection does not appear correlated with low pressure nor rationing, it is significantly and positively related with insecurity around water access (0.071), as well as worse water odour and colour. As a result, the association with treating water before drinking it is positive (0.15).

Figure 10. Correlation matrix of variables capturing water proximity, availability and quality



Notes: Pairwise correlation coefficients of variables constituting the theory of change. Green indicates a positive correlation, and red indicates a negative correlation. Numbers refer to correlation coefficients. Circle size and circle colour intensity indicates statistical significance. Elevation corresponds to dwelling elevation for households reporting on-premise connection, or to water kiosk elevation for households reporting collecting water at a water kiosk as primary water source.

While distance to household primary drinking water source and time to get to that source are significantly and positively related (0.198), as expected, distance to the source does not appear related to limited availability nor low-quality water. Still, time to get to the source is significantly and positively correlated with household experience of water insecurity (0.146), and negatively with treating water (-0.099). Primary water source elevation is only positively associated with water cuts. And, while the number of times a week a household collects water is significantly and negatively associated with cuts (-0.077), there is no visible relation with low pressure, nor insecurity associated with water availability. That a water fetcher is female is significantly and negatively associated with distance (-0.1091), time (-0.053), and collecting water with an animal (charrette) or a vehicle (-0.056).

There are strong positive correlations between various measures of water availability – cuts, low pressure, rationing or experiencing water insecurity – correlation coefficients ranging from 0.05 for low pressure and rationing, to 0.386, for cuts and low pressure – and smaller but significant, positive correlations with worse water quality. Households' propensity to store water is positively associated with water cuts (0.15), and, to a lesser extent, worse water quality. Measures of low-quality water – water with taste, odour or not crystal clear – are strongly and positively related with each other, as well as with household propensity to treat water before drinking it.

3.2 Outcomes capturing direct impacts

This sub-section describes variables possibly capturing JWIII-P direct impacts at baseline and reflects on how quantitative and qualitative baseline data compare to the expected changes as posited by the theory of change.

3.2.1 Time allocation

Table 10 and Figure 11 present information on the time-use allocation task where the primary respondent allocates 48 beans (with each bean representing 30 minutes) on selected activities he or she undertook on the previous working day. On average, respondents spent 0.98 hours fetching water; 76.5% have spent at least 30 minutes of the previous working day collecting water. There are notable differences between female and male respondents. Male respondents tend to spend significantly more time on paid work and leisure; female respondents, on domestic chores or unpaid work, and caregiving. Yet, there is no difference regarding water fetching according to gender, meaning that male and female water fetchers spend about the same time on fetching water. Time spent on water fetching through the time-use allocation task is higher than the reported round-trip time. One explanation may be that queuing has not been considered (or not systematically by all respondents) when asking for round-trip time.

Time (and money) spent on collecting water might increase when water availability is low, depending on household preferences. FGD participants report that the time required for collecting water is exacerbated by irregular water availability and resulting kiosks' operating times. Limited operating times of kiosks can cause long waiting times in the moments that water is available. Also, some need multiple trips to the kiosk, specifically if the number of jerrycans does not cover a household's daily water needs. Long waiting times in the FGD may reflect perceptions and represent relative (i.e. respondents compare waiting times across different situations) rather than absolute long waiting times. Households reportedly cope with this time issue in different ways. FGD also revealed that some households pay the manager of the kiosk 'extra' to have their jerrycans filled in their absence. Many others hire water carriers, especially those with demanding jobs, or who value convenience. Such coping strategies increase the cost per unit of water consumed.

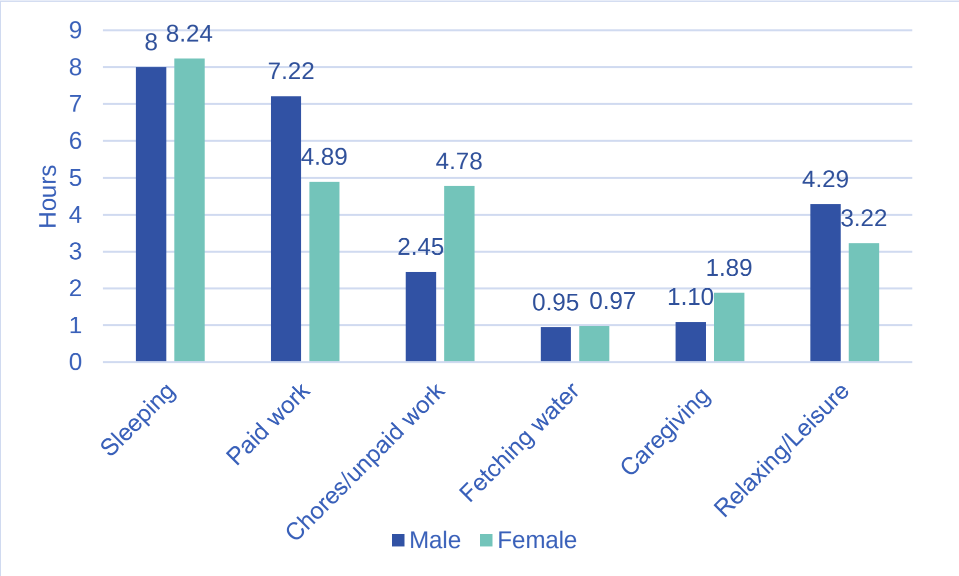
Table 10. Time allocation of primary respondents

	Obs (1)	Mean (2)	SD (3)
Time spent on			
Sleeping	2520	8.173	1.225
Paid work	2520	5.499	3.969
Chores/unpaid work	2520	4.169	2.469
Fetching water	2520	0.977	0.746
At least 30 minutes spent fetching water	2520	0.765	0.424
Caregiving (exclusive)	2520	1.679	1.784
Relaxing/Leisure	2520	3.502	2.255

Notes: Estimation sample size, mean and standard deviation of listed variables.

As water is often only available at night (between 1 and 3 AM), this variability significantly impacts participants' daily schedules, forcing adjustments to sleep patterns, other routine activities, and, for some, income generating activities. However, "night" has not been systematically defined as hour intervals in the survey which may account for some discrepancy between the quantitative and qualitative data.

Figure 11. Time allocation of primary respondents by gender



Notes: Time spent on listed activity in hours, on the previous working day, by gender of primary respondents.

3.2.2 Financial resource allocation

The price of water depends on the respective water source. Qualitative information from the mission conducted by the research team in November 2022, reported on a universal tariff set by JIRAMA. The tariff set for water kiosks is usually set at MGA 40-50 per jerrycan (i.e., 20 litres).[14] However, depending on the availability of water in the respective fokontany, the tariff can vary strongly. This was observed by the research team on their mission in September 2023, where water kiosks were encountered with prices set at MGA 100 per jerrycan.[15] Prices per fokotany may vary depending on how the WUA or community decides. Professional water carriers charge the price per jerrycan prevailing at the respective water kiosk and an individually chosen service fee that depends on the distance to the water kiosk and the time of the day. For households with a private connection, a so-called 'social tariff' for a fixed volume of water each month applied. The social tariff was set around MGA 416 per m^3 for the first 10 m^3 in a month[16], and a higher price on all additional consumption. Households with private water connections receive an invoice each month.

Table 11 presents average household revenues, litres of water used and for a subsample of people using water kiosks or tanker trucks the price per litre of water and the share of water fetching expenses as part monthly household's revenue, which is high at 68.2%. Note that full information on the latter two variables is only obtained from 746 households which may represent a (very) selective sample.[17,18]

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[14] Less than EUR 0.01 (on September 23, 2024).
[15] Less than EUR 0.02 (on September 23, 2024).
[16] Around EUR 0.08 (on September 23, 2024).
[17] In Table 13, the share of last month's household revenue allocated to water fetching is calculated as the number of litres of water used daily by a household times the reported price of collecting water at a water kiosk or tanker truck. Only 745 households reported on all required variables.
[18] Note that the number of households reporting this information is substantially lower than the overall sample. Next to compromising statistical power, readers should thus be cautious in generalizing this figure to the larger sample.

These findings are supported by qualitative data. FGDs show major expenses, in terms of time and money, due to irregular water supply. As mentioned before, many pay water carriers to ensure a reliable supply, or kiosk managers to shorten the time needed to collect water, which adds a direct cost to their monthly expenses.

> *"Since the wells are a bit far away and frequent, travel can be exhausting and even lead to health risks. We are forced to use the services of water carriers. Unfortunately, this leads to additional expenses."*
>
> – Person relying on shared connection in Soavinarivo (red)

Mixed effects on the income of water-related IGAs are expected. Some participants earn their income from providing laundry services to other households. They report that better access to water would significantly improve their productivity. Currently, longer traveling times, irregular water availability and quality, and resulting peak times, limit the number of households they can serve. Others, who indicate to be responsible for water collection and laundry within their own household, think that saving time on such tasks would allow them to increase their income up to threefold.

Table 11. Financial resources and water expenditures

	Obs (1)	Mean (2)	SD (3)
Last month's household revenue	2520	400091.69	377160.7
Water fetching			
Litres of water used per day	1949	76.421	46.213
Price per litre of water (a)	746	4.049	3.092
Share of last month household revenue allocated to water fetching (a)	745	0.682	4.861

Notes: Estimation sample size, mean and standard deviation of listed variables. Statistics corresponding to the main water sources used during a typical week during the year and in dry season for households that reported using separate sources in dry and wet season.

(a) Statistics corresponding to households that reported using as their main source of water during a typical week during the year: public tap/water kiosk or tanker truck.

For water carriers, there may be negative effects as they expect to see a drop in demand for their services upon completion of JWIII-P infrastructure works. Some indicate they would be able to cope through shifting to other income-generating activities such as providing laundry services.

3.2.3 Decision-making

Women play a crucial role in intra-household decision-making regarding water purchase and use. Table 12 assesses intra-household decision-making through a series of binary variables taking on unity if female primary respondents are solely or jointly responsible for taking decisions, or if male primary respondents are responsible for taking decisions with their partner. Table 12 indicates that, on average, women tend to participate in making household decisions. Specifically, in 67.7% of surveyed households, women take sole or joint decisions regarding water purchase, and in 85.2% of surveyed households, regarding water use. While FGDs did not cover decision-making processes within households as such, discussions do confirm that most times, women oversee water management and decisions around water use.

However, participation in Water User Association (WUA) activities among all primary respondents is somewhat low, at 4.8%. Of the 46 FGD participants that were members of WUAs, there were 8 men and 38 women. The gender-ratio was consistent throughout the associations, with only 1 out of 4 presidents being a man.

Table 12. Decision-making

	Obs	Mean	SD
	(1)	(2)	(3)
Female primary respondent alone or with partner, and male primary respondent with partner responsible for taking decisions related to (a)			
Everyday shopping	2520	0.714	0.452
Major purchases	2515	0.814	0.39
Water purchase	1867	0.677	0.468
Water use	2520	0.852	0.355
Use of own income	2514	0.820	0.384
Urgent healthcare	2517	0.834	0.372
Education	2456	0.831	0.375
Work outside the household	2494	0.664	0.472
Participation in Water User Association (WUA) activities	2520	0.048	0.213

Notes: Estimation sample size, mean and standard deviation of listed variables, by urban or peri-urban fokontany status

(a) Series of binary variables taking on unity if female primary respondents are solely or jointly responsible for taking decisions, or male primary respondents are responsible of taking decisions with their partner; 0 if female primary respondents' partner, male primary respondent alone, or others are responsible of taking decisions.

3.2.4 Hygiene

The majority of respondents wash themselves daily and hygiene at dwellings was acceptable. **Error! Reference source not found.** and Figure 12 indicate that 20.3% of sampled households have a place to wash hands in their dwellings. Among those 512 households with handwashing facilities on premises, 83.8% have adequate handwashing facilities, that is with soap and water. In addition, most sampled respondents, 85.6%, report washing themselves at least once a day, at home, either with running water in a shower, or in the yard with basins or canisters. Surveyors confirmed that 84.0% of sampled households lived in dwellings where hygiene was acceptable or very good. This suggests that despite severe issues related to water access, most households are able to uphold some standards of hygiene.

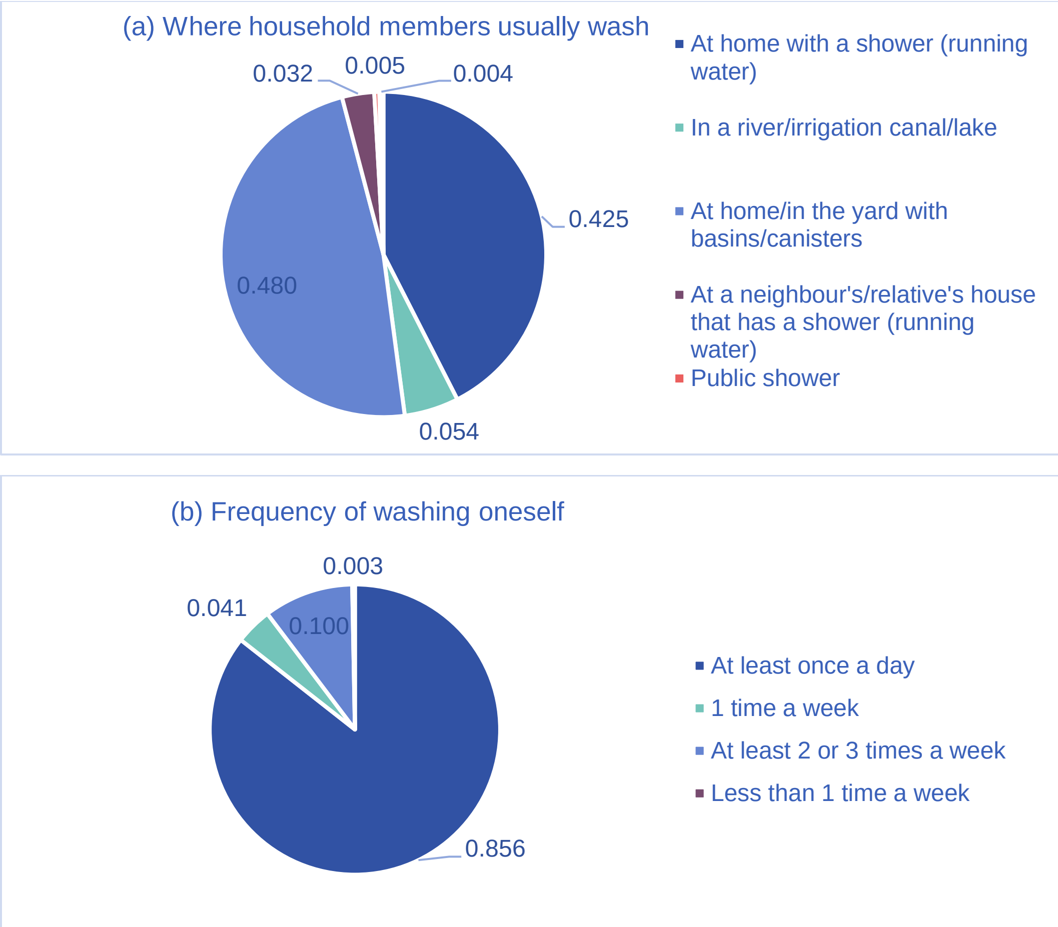
When water is scarce, households choose to prioritize personal hygiene. FGD participants indicate that the limited and unpredictable water availability calls for prioritizing its use for essential activities such as cooking, personal hygiene, and drinking water. This often led to an important reduction in water use for other purposes, such as laundry, cleaning, or gardening. Some also indicate that when water is scarce, they only wash part of their body, or wash themselves in an open water source.

Table 13. (Personal) hygiene

	Obs	Mean	SD
	(1)	(2)	(3)
There is a place to wash one's hands in dwelling	2520	0.203	0.402
Adequate handwashing facilities (on premises, with soap and water)	512	0.838	0.369
General state of dwelling hygiene is acceptable or very good (surveyor's observations)	2520	0.840	0.367

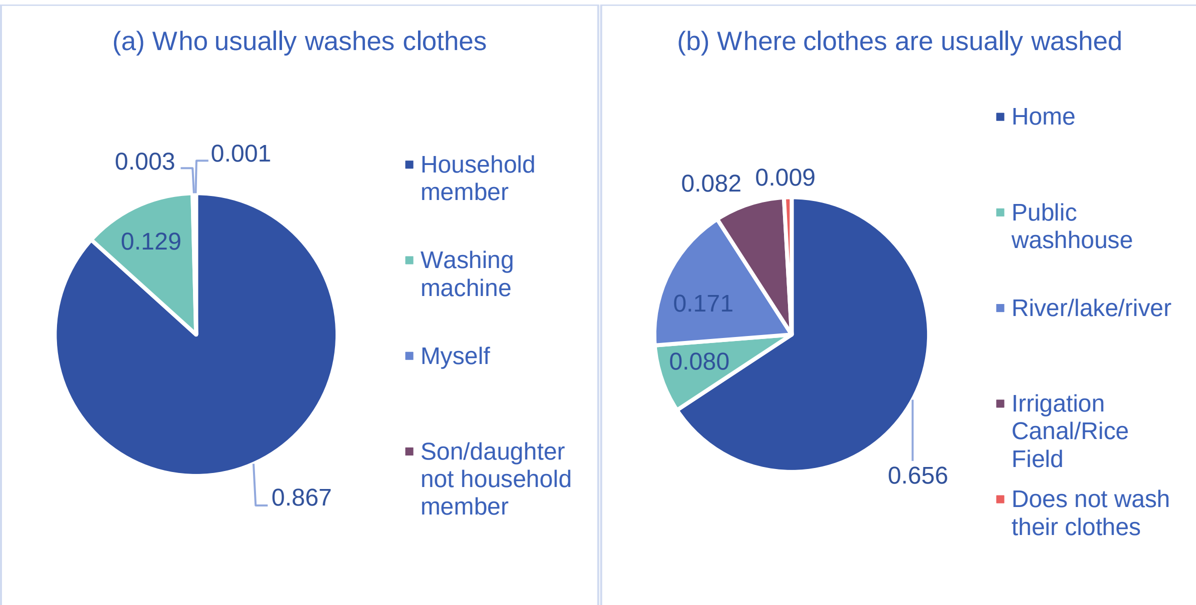
Notes: Estimation sample size, mean and standard deviation of listed variables.

Figure 12. Personal hygiene



Notes: Estimation sample mean of listed variables.

Figure 13. Laundry



Notes: Estimation sample mean of listed variables.

Figure 13 further indicates that, in most surveyed households – 86.7% – at least one household member washes clothes, usually at home (65.6%).

> *"During the dry period, I have difficulties in terms of access to water, even for laundry, there are no alternatives because even in the rice fields, the source is dry."*
>
> – Person relying on shared connection in Ambohitrandriamanjaka (yellow)

3.2.5 Drudgery of water-related chores

Collecting water is viewed as a cumbersome activity; most report suffering from at least one physical problem. Drudgery of water-related chores is captured through a series of questions related to the occurrence of an accident or sexual harassment while fetching water, or the experience of any physical problems due to fetching. Table 14 indicates that 7.9% of principal respondents who are water fetchers have had an accident this year, while collecting water. In addition, 82.3% have had at least one physical problem due to water fetching over the past year, primarily feeling fatigued (69.8%), shoulder pain (41.6%) or back pain (38.8%). Figure 14 suggests slight differences between male and female water fetchers, that are mostly statistically insignificant.

FGDs are in line with quantitative results. Participants often referred to musculoskeletal pain from collecting water, particularly in the arms, shoulders, back and neck. This is worse in areas where infrastructure is less developed, and water carriers need to navigate challenging terrains.

Limited water access often creates the need to collect water at night. The necessity to fetch water during early hours at night (e.g. 1-3 am) reportedly disrupts sleep, leading to general fatigue. This is exacerbated by the physical effort required to transport water, often resulting in a lack of energy for other daily activities. This sometimes led to (minor) frustrations within households, when the allocation of this chore is considered unfair.

> *"For me, it (benefits from increased water access) would be more the increase in my sleep time because I would no longer have to get up at 3am to wait in line."*
>
> – Person relying on shared connection in Mahatsinjo (yellow), about potential benefits from improved water access

Security issues are reported, although limited in frequency. Communities have set in place coping mechanisms to minimise exposure. Some FGD participants expressed safety concerns about collecting water at night, particularly for young people and women. Some mentions of theft or assaults are shared, including first-hand experiences by participants. For instance, 1.0% of female respondents who are water fetchers had been sexually harassed when collecting water this year.[19] Some FGD participants report collecting water together with people from other households, which they refer to as a positive example of community cooperation.

Some tensions around water are observed, within communities and households. **Error! Reference source not found.** indicates that 9.2% of sampled respondents report tensions within their community; 6.7% and 10.7%, arguments within their household about who is responsible of fetching water and use of available water, over the past four weeks, respectively. Figure 14 suggests that female respondents are more likely to report tensions regarding who is responsible for collecting water (7.6%), or the use of available water (11.7%), over the last four weeks, than male respondents (4.1% and 8.1%, respectively).

[19] Note that this topic being of a sensitive nature, respondents might underreport its occurrence.

Table 14. Drudgery

	Obs (1)	Mean (2)	SD (3)
Accident while collecting water (a)	1922	0.079	0.269
Victim of sexual harassment during water collection (b)	1427	0.010	0.099
At least one physical problem due to water fetching (a)	1917	0.823	0.382
Tensions within community related to water access (c)	2514	0.092	0.289
Arguments within household who is responsible for fetching water	2504	0.067	0.25
Arguments within household use of available water	2510	0.107	0.309

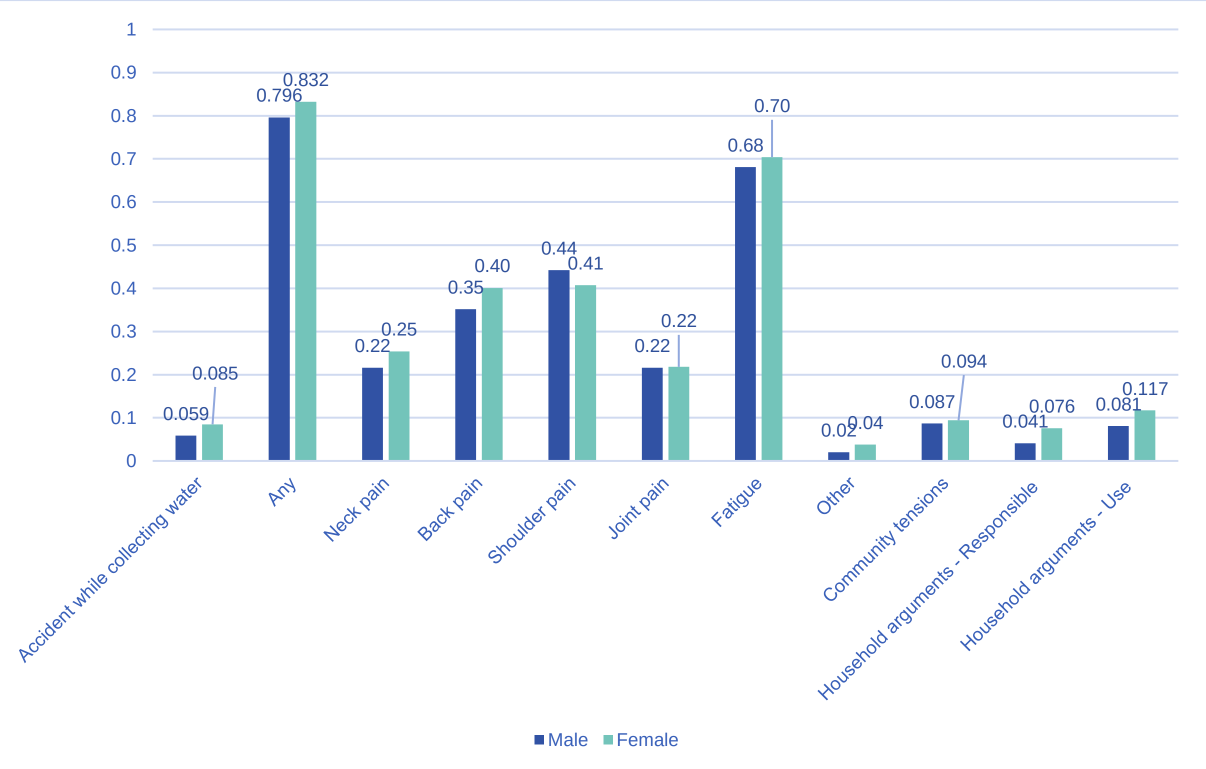
Notes: Estimation sample size, mean and standard deviation of listed variables.

(a) Statistics reported by principal respondents who are water fetchers.

(b) Statistics reported by principal respondents who are water fetchers and women.

(c) Defined as a binary variable taking on unity if sometimes, often, or always; 0 if never or rarely, over the past four weeks.

Figure 14. Drudgery by gender of primary respondents



Notes: 'Other' includes types of physical problems that are not, a priori, related to water fetching, specifically chest pain (7 observations), chest and tooth pain (5), pain from stitches (2), dizziness (2), hypertension (2), lack of sleep (1), toothache (28), toothache and hip ache (1), tooth and throat ache (1), headache (1), stomach ache (1), breathing difficulties (6). Sample: 1917 observations. Statistics reported by principal respondents who are water fetchers.

3.2.6 Correlates

Table 15 presents pairwise correlation coefficients of variables capturing direct impacts and water access, as posited by the theory of change. Green indicates a positive correlation, and red, a negative correlation. Numbers refer to correlation coefficients. Colour gradient is proportional to statistical significance.

Table 15 confirms that time allocated to collecting water daily is positively and significantly related to time required to get to household primary drinking water source (0.101) meaning more time is spent on fetching water when the average round-trip time is higher; it is also positively associated with evening- or night-time collection, albeit to a lower extent (0.045). Time spent collecting water is positively associated with limited water availability, such as low pressure (0.068), or experiencing insecurity around water (0.066). However, this relation is negative (and non-negligeable) with worse water quality. This may reflect the proportion of households that rely on bad, unimproved sources that are close and the development of new water kiosks may eliminate households' need to use such unimproved sources.

Being self- or waged-employed is significantly and negatively associated with on-premise water access, hence households with a private tap are less likely to be wage-employed or self-employed. This is somewhat surprising as we would expect households with income from wage or self-employment are overall wealthier and more likely to own a private tap. Wage or self-employed household members also experience lower quantity of water available per household member and worse water quality, but less cuts. School attendance is significantly and positively associated with the number of litres of water used daily per household member, consistent with the idea that school attendance reflects higher socio-economic status which is expected to correlate positively with the daily amount of per capita water use.

Table 15 confirms a positive and significant correlation between the share of household revenue allocated to water expenses and time to get to the primary drinking water source (0.137), evening- or night-time collection (0.089), as well as the number of litres of water per household member (0.132), even though this variable does not appear related with limited availability, nor low quality. This confirms the finding from FGDs that the longer people need to travel to collect water, the more prone they are to hiring the services of a water carrier. Note that time to get to the primary source was only asked to households who indicated fetching water themselves, not those who reported to rely on professional water carriers. Community decision-making, captured by participation in WUA activities, is negatively, albeit weakly, related with time to get to the source, but strongly and positively related with limited availability, as captured by cuts (0.133) or insecurity concerning water access (0.050). There is a negative, significant relation with one indicator of low quality, water not being crystal clear (-0.065).

Table 15 confirms a positive link between having had an accident or having felt any physical pain while fetching water in the last year and time to get to the source, the number of litres of water per household member, limited availability and bad-quality water. This relation is in line with the pathway pre-established – albeit weaker for sexual harassment – and is supported by most testimonies from FGDs.

Correlations confirm a negative and significant association between distance to get to the primary drinking water source and having in-house handwashing facilities or showering at home, and a positive link with on-premise connection and the number of litres of water per household member. Households with a private connection may be wealthier and (or) better informed about the importance of hygiene. Also, a private connection facilitates the practical use of in-house handwashing facilities and a shower.

Last, Table 15 displays a significant and positive relation between the presence of tensions within communities and indicators of proximity to primary water sources, specifically time to get to the source and collecting water in the evening or at night. There is also a positive correlation between greater inter-household tensions and limited availability – cuts, low pressure and insecurity. Intra-household arguments regarding who is responsible for fetching or the use of available water, appear more likely to occur when water availability is limited, as well as when water is of worse quality.

Table 15. Estimated correlations of variables capturing direct impacts and water access

	Time collec-ting water	Self- or waged-employed	Attending school	Expenses	WUA	Hand-washing	Showering	Accident	Harassed	Pain	Community tensions	Household arguments
On-premise access	-0.276	-0.122	0.028	.	-0.040	0.385	0.265	-0.024	-0.024	-0.067	-0.028	-0.030
Urban	-0.105	-0.106	0.067	-0.016	0.127	0.270	0.188	0.038	0.088	-0.002	0.077	-0.030
Distance to source	0.031	0.019	-0.012	0.043	-0.030	-0.019	-0.055	-0.005	-0.021	0.044	0.017	-0.033
Time to source	0.101	0.046	-0.031	0.137	-0.043	-0.107	-0.126	0.123	-0.010	0.145	0.090	0.042
Collecting in the evening/at night	0.045	0.019	0.021	0.089	-0.005	-0.026	-0.003	-0.032	0.023	-0.021	0.095	0.058
Number of times fetching/week	0.102	-0.011	-0.014	0.015	-0.011	0.024	0.109	0.052	-0.031	-0.030	-0.038	0.027
Litres of water used/day/household member	0.008	-0.067	0.048	0.132	0.015	0.148	0.118	0.072	0.068	0.038	-0.003	-0.062
Cuts	0.016	-0.087	0.008	0.048	0.133	0.119	0.189	0.039	0.036	0.114	0.167	0.167
Low pressure	0.068	-0.018	-0.006	0.032	0.011	-0.001	0.006	0.101	0.053	0.047	0.094	0.069
Insecure	0.065	0.013	-0.001	0.036	0.050	-0.042	0.033	0.105	0.045	0.133	0.221	0.168
Taste	0.024	-0.028	-0.029	0.037	0.000	-0.049	-0.146	0.081	0.172	0.090	0.041	0.123
Odour	-0.072	-0.012	-0.039	0.037	-0.021	0.040	-0.052	0.098	0.160	0.097	0.027	0.056
Not clear	-0.118	-0.056	-0.045	0.004	-0.065	0.117	0.085	0.102	0.120	0.055	0.047	0.087
Treatment	-0.054	-0.067	-0.017	-0.004	0.002	0.225	0.193	0.029	0.031	-0.087	-0.043	-0.039

Notes: Pairwise correlation coefficients of variables constituting the theory of change. Green indicates a positive correlation, red indicates a negative correlation. Numbers refer to correlation coefficients. Colour intensity indicates statistical significance.

3.3 Indicators capturing longer term impacts

This sub-section describes variables possibly capturing JWIII-P longer term impacts and reflects on how quantitative and qualitative baseline data compare to the expected changes as posited by the theory of change.

3.3.1 Psychological well-being

Table 16 characterises survey respondents' mental health, specifically depression, self-esteem, and self-reported emotional state and life satisfaction. Depression is measured as a weighted sum of responses to a series of ten questions, normalized by the number of items to ease comparability, following Andresen et al.'s (1994) Center of Epidemiologic Studies Depression Scale, 10-item version (CES-D-10). The measure for self-esteem is similarly constructed following Rosenberg (1965).

Quantitative data in Table 16 suggest that surveyed respondents score 0.506 on average on the depression scale which is below the commonly used thresholds for classifying people as depressed. Average self-esteem is 0.751. 68.8% of respondents report being happy or very happy, which corresponds to an average life satisfaction of 5.9 on a scale of 10. Female respondents display a significantly higher score on the depression scale than male respondents; they are also less likely to report being (very) happy.

The incidence of water collection at night might be negatively affecting well-being. An important caveat here is that this association is only reported through the FGDs; only 2% of the quantitative survey respondents reported collecting water at night, possibly due to ambiguity in the survey question on which time intervals are associated with "night" as opposed to "morning". FGD participants suggest that improving both proximity and availability could significantly improve community well-being and productivity. In a fokontany where water availability recently improved, participants were especially positive about more time for sleeping and resting, as well as more time for household chores.

> *"About 3 months ago, I struggled a bit when it came to collecting water. During that time, there was a need to wait in line around 1-2 am for water collection. But now, the situation has improved, and my well-being has gotten better."*
>
> – Person relying on shared connection in Ampefiloha (green)

Table 16. Mental health by gender of primary respondents

	Total			Male			Female		
	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD
	(1)	(2)	(3)	(12)	(13)	(14)	(15)	(16)	(17)
Depression (a)	2488	0.506	0.121	647	0.486	0.110	1841	0.513	0.124
Self-esteem (b)	2508	0.751	0.098	656	0.751	0.094	1852	0.751	0.099
Happy (c)	2520	0.688	0.463	660	0.730	0.444	1860	0.674	0.469
Life satisfaction (d)	2520	5.869	1.495	660	5.829	1.436	1860	5.883	1.516

Notes: Estimation sample size, mean and standard deviation of listed variables, by gender of primary respondents.

(a) Measured as a weighted sum of responses to a series of ten questions, normalized by the number of items to ease comparability, following Andresen et al.'s (1994) Center of Epidemiologic Studies Depression Scale, 10-item version (CES-D-10).

(b) Constructed using the self-esteem scale following Rosenberg (1965).

(c) Binary variable taking on unity if respondent reports being very or rather happy; 0, if neither happy or unhappy, quite or very unhappy.

(d) Life satisfaction consists in a 0-10 scale, the highest values representing best life.

3.3.2 Correlates

Table 17 confirms a strong link between worse mental health – higher scores on the depression scale – and time to get to a household's primary water source (0.115), limited availability, in particular feeling of insecurity regarding water (0.282), and the three indicators of bad-quality water. Reversely, Table 17 indicates significant associations of opposite sign with self-esteem, being happy, and, to a lesser extent, life satisfaction. This suggests that if JWIII-P succeeds in achieving greater proximity, improved availability or better-quality water, one may indeed expect improvements in mental well-being, for instance by decreasing depression and raising self-esteem, as indicated in the TOC.

Table 17. Estimated correlations of variables capturing mental health and water access

	Depression	Self-esteem	Happy	Life satisfaction
On-premise access	-0.039	0.091	0.032	0.127
Urban	0.025	0.040	0.001	0.068
Distance to source	0.023	0.007	0.032	0.003
Time to source	0.115	-0.126	-0.091	-0.112
Collecting in the evening or at night	0.055	-0.014	-0.036	0.004
Number of times fetching/week	0.016	0.045	0.005	0.003
Litres of water used per day per household member	-0.017	0.094	0.023	0.057
Cuts	0.159	0.062	-0.057	0.045
Low pressure	0.140	-0.004	-0.099	-0.015
Rationing	0.119	0.011	-0.051	-0.045
Insecure	0.282	-0.031	-0.111	-0.152
Taste	0.167	-0.084	-0.052	0.067
Odour	0.138	-0.001	-0.090	0.060
Not clear	0.091	0.052	-0.030	0.054
Treatment	-0.103	0.104	0.057	0.184

Notes: Pairwise correlation coefficients of variables constituting the theory of change. Green indicates a positive correlation, red indicates a negative correlation. Numbers refer to correlation coefficients. Colour intensity indicates statistical significance.

3.3.3 Women's empowerment

Following Dickin et al. (2021), women's empowerment is measured at the individual, household and societal level. Table C.4, in the Annex, summarises the elements consisting in Dickin et al.'s (2021) measure of women's empowerment. These include measures representing the women's empowerment dimensions of resources (i.e., most importantly time use) and well-being (i.e., physical and mental health). In the following, this section will further explore the dimension of agency.

First, 60.3% of sampled women believe that collecting water is a task reserved for men and women; 24.7%, exclusively for men; 15.0%, for women. There are statistically significant differences between urban and peri-urban female respondents: urban women are more likely than peri-urban women to state that such a task is the responsibility of men.

Second, 97.5% and 96.2% of sampled women report to be, alone or jointly, with their partner, responsible for taking decisions related to water use and water purchase, respectively; and 88.9% to 92.3% to have, alone or jointly, control over household assets – everyday shopping, major purchases, use of their own income, or urgent healthcare.

Third, female respondents report having spent, on average, slightly less than an hour fetching water on the previous working day, equivalent to more than 30 minutes for 76.9% of sampled women. Table C.2, indicates that 86.1% of women in peri-urban fokontanies spent at least 30 minutes collecting water daily, when 54.4% of women in urban fokontanies do. Overall, time allocated to domestic tasks and productive work represents 1.2 of the time allocated to leisure or rest, with no apparent difference between urban and peri-urban women.

Within their respective community, only 5.3% of sampled women participate in water use association (WUA) activities – 9.6% in urban clusters, compared to 3.6% in peri-urban clusters. While this is a small percentage, men are even less represented in WUAs: 3.2% in the overall sample and 7.2% and 1.7% in the respective urban and peri-urban areas.

Table 18. Female agency

	Obs (1)	Mean (2)	SD (3)
Setting goals			
Motivational autonomy			
External motivation (a)	1858	0.224	0.417
Introjected motivation (a)	1858	0.251	0.434
Autonomous motivation (a)	1858	0.619	0.486
Relative autonomy index (RAI) (b)	1858	1.158	1.531
Capacity to set goals			
It is important for me to make decisions (alone or with partner) regarding			
Everyday shopping	1857	0.981	0.136
Major purchases	1855	0.983	0.130
Water purchase	1282	0.991	0.096
Water use	1856	0.989	0.103
Use of own income	1851	0.989	0.103
Urgent Health Care	1857	0.995	0.069
Education	1807	0.988	0.107
Work outside the household	1832	0.983	0.131
Perceived control and ability to achieve goals			
Internal locus of control (normalized)	1830	0.762	0.129
Self-efficacy (normalized)	1853	0.818	0.119
Acting on goals			
Primary respondent alone or with partner is responsible for taking decisions related to			
Everyday shopping	1860	0.923	0.267
Major purchases	1855	0.889	0.314
Water purchase	1207	0.962	0.192
Water use	1860	0.975	0.157
Use of own income	1854	0.901	0.298
Urgent Health Care	1857	0.914	0.281
Education	1796	0.908	0.289
Work outside the household	1834	0.744	0.436

Notes: Estimation sample size, mean and standard deviation of listed variables of female principal respondents.

(a) Binary variable taking on unity if the respondent considers a vignette (story) completely or somewhat similar to their life experience; 0 otherwise.

(b) Weighted sum of external motivation (-2), introjected motivation (-1) and autonomous motivation (+3).

Table 18 presents measures of female agency. In line with Donald et al. (2020), female agency is defined as (i) setting goals; (ii) perceived control and ability to achieve goals; and (iii) acting on goals. First, setting goals is measured by a respondent's motivational autonomy and their capacity to set goals. Motivational autonomy – whether an individual's actions are 'regulated by self' – is measured as Ryan and Deci's (2000) relative autonomy index (RAI) that assesses to what extent the motivation behind actions is driven by an individual's own goals ('intrinsic motivation'), or externally regulated through internalised social pressure or coercion ('introjected' and 'external' motivation, respectively), the greater the index, the stronger a respondent's autonomy. A respondent's capacity to set goals is measured by asking who they feel would be the ideal decision maker for household purchases, water use, own income use, education or work outside their household. Among sampled women, autonomous motivation is greater than external or introjected motivation, leading to an average RAI of 1.158; on average, 98.1% to 99.5% consider it important to make decisions, alone or jointly, on a multitude of household decisions, including water purchase and use.

Second, perceived control and ability to set goals is measured through locus of control (LOC) – the degree to which an individual believes that events are caused by one's own behaviour (internal LOC) versus external factors (external LOC) as per Rotter's (1966) Internal-External (I-E) Locus of Control Scale – and self-efficacy – the belief in one's capabilities to act effectively toward a goal, as per Chen et al.'s (2001) New General Self-Efficacy Scale. Greater values indicate stronger internal LOC and self-efficacy. Using a weighted sum of responses to a series of four and eight questions, respectively, and normalized by the number of items to ease comparability, we observe that sampled women display an average internal LOC of 0.762, and average self-efficacy of 0.818, Being greater than 0.5, these confirm sampled women to have a well above average perceived control and ability to set goals.

Third, as for Dickin et al.'s (2021) household measure of women's empowerment, acting on goals is measured through a set of intra-household decision-making questions, confirming that 77.4% to 97.5% of sampled women report to have, alone or jointly, with their partner, control over household assets – everyday shopping, major purchases, use of their own income, or urgent healthcare – education, work outside their household, or purchase and use of water, as mentioned earlier. Table C.5, in Annex, indicates that, in comparison to male primary respondents, women display a greater likelihood to report taking decisions alone or jointly regarding everyday shopping, water purchases and water use, but a lower likelihood to report taking decisions, alone or jointly, when it comes to working outside the household.

3.3.4 Correlates

Table 19 presents estimated correlations between variables capturing women's empowerment and water access.

Women might, because of the JWIII-P water project, gain time, as suggested by the negative (positive) link between time dedicated to collecting water daily and on-premise water access (time to get to the primary source). Daily time spent collecting water is also positively associated with limited availability, such as water with low pressure, water rationing, or insecurity about water availability, and indicators of worse quality.

However, women's inputs into decisions regarding water use or water purchase only appears significantly and positively associated with one indicator of bad quality water – water colour. In fact, whether women deem it important taking decisions, solely or jointly, about water purchase or use is hardly associated with any indicators of proximity, availability or water quality. This suggests that women's inputs regarding decision-making on water purchase or use are deemed important as a principle and do not depend on the drudgery or ease of the tasks concerned.

Table 19. Estimated correlations of variables capturing women's empowerment and well-being and water access

	Time spent collecting	WUA	RAI	LOC	Self-efficacy	Decision: Water purchase	Decision: Water use	Accident	Harassed	Pain	Depression	Self-esteem	Happy	Life satisfaction
Private connection	-0.245	-0.051	-0.028	0.077	0.057	0.052	0.044	-0.018	-0.024	-0.092	-0.035	0.080	0.021	0.113
Urban	-0.113	0.123	-0.061	0.094	0.106	0.000	-0.018	0.051	0.088	-0.005	0.001	0.050	0.005	0.071
Distance to source	-0.057	-0.012	-0.083	-0.040	0.048	-0.046	0.023	0.069	-0.021	0.091	-0.018	0.026	0.062	0.071
Time to source	0.090	-0.036	-0.022	-0.043	-0.060	-0.009	-0.014	0.149	-0.010	0.151	0.086	-0.135	-0.101	-0.099
Collecting in the evening or at night	0.016	0.000	-0.002	0.004	0.070	-0.031	-0.031	-0.034	0.023	-0.028	0.060	-0.000	-0.038	0.015
Number of times fetching/week	0.127	-0.022	0.058	0.046	0.054	0.025	0.031	0.048	-0.031	-0.058	0.003	0.073	-0.003	-0.012
Litres of water used per day per household member	0.031	0.043	0.030	0.121	0.049	0.044	0.027	0.083	0.068	0.017	-0.027	0.109	0.002	0.079
Cuts	0.024	0.168	0.069	0.074	0.132	0.026	-0.018	0.052	0.036	0.107	0.159	0.049	-0.049	0.055
Low pressure	0.068	0.045	-0.002	-0.070	0.060	-0.023	-0.032	0.106	0.053	0.047	0.145	-0.028	-0.097	0.009
Rationing	0.051	0.045	0.001	-0.008	0.003	-0.036	-0.007	0.065	0.052	0.126	0.123	0.031	-0.047	-0.046
Insecure	0.053	0.075	0.037	0.030	-0.027	0.004	-0.014	0.097	0.045	0.125	0.293	-0.029	-0.108	-0.134
Taste	0.018	-0.009	0.089	-0.096	0.059	0.039	0.003	0.102	0.172	0.087	0.148	-0.098	-0.050	0.102
Odour	-0.062	-0.040	0.049	-0.033	0.041	0.028	-0.007	0.113	0.160	0.118	0.130	-0.016	-0.093	0.100
Not clear	-0.135	-0.073	0.051	0.055	0.078	0.103	0.074	0.134	0.120	0.049	0.107	0.058	-0.025	0.111
Treatment	-0.058	-0.013	0.011	0.139	0.102	0.058	0.026	0.035	0.031	-0.068	-0.099	0.124	0.071	0.203

Notes: Pairwise correlation coefficients of variables constituting the theory of change. Green indicates a positive correlation, red indicates a negative correlation. Numbers refer to correlation coefficients. Colour intensity indicates statistical significance.

While women's agency, as captured by their relative autonomy, internal locus of control, self-efficacy, and decision-making power regarding water purchase and water use, appears greater with on-premise connection or water availability, there is no clear pattern that emerges from this correlation exercise. However, women's participation in WUA activities is significantly and positively correlated with limited availability, specifically water cuts, rationing and insecurity regarding water availability. One should however bear in mind that only just over 5% of women are involved WUAs which makes it difficult to interpret such a correlation.

Women that had an accident, were harassed, or felt any pain when fetching water, are positively associated with time to get to their household's primary source, limited availability, and worse water quality. Similarly, indicators of psychological health – depression, self-esteem, happiness or life satisfaction – worsen with time to get to the source, limited availability or low-quality water; but improve with on-premise access.

In sum, this correlation exercise provides some insights into which dimensions of women's empowerment may be impacted through JWIII-P. Improved access to drinking water either in the form of a private water connection or higher reliability can increase women's empowerment either through the dimension of resources, because less time needs to be dedicated towards collecting water, or the dimension of well-being, because of better physical and/or mental health. It is important to note that these correlations should be interpreted with caution, as they only show how selected variables that are *causal* pathways of the JWIII-P project correlate, before the intervention took place.

4. LESSONS LEARNED AND CONCLUSION

4.1 Water access in the Antananarivo region

This report presents the results of a comprehensive qualitative and quantitative data collection effort in 2023 that maps the drinking water situation for 210 fokotanies and 2520 households in the Antananarivo region. Overall, both qualitative and quantitative descriptive data analyses demonstrate that households face numerous challenges in obtaining safe drinking water. Some of these challenges are less salient for households with on-site access compared to households who primarily rely on public sources, yet issues related to both quantity and quality also impact those with private connections suggesting there is a lot of scope for improvement both on primary (access, proximity, quality) as well as secondary outcomes (e.g. mental health. Wellbeing and women empowerment) Also, while one could expect that areas who are expected to receive JWIII-P are more in need of water infrastructure improvements than fokotanies where there is no JWIII-P, we find - perhaps surprisingly - there are few statistical differences between areas that are planned to receive JWIII-P and those that are not. This suggests that there are many more fokotanies that would require an intervention like JWIII-P than is currently foreseen. Also, the observed balance between treatment and control fokotanies provides a useful starting point for the quasi-experimental impact evaluation as it will facilitate matching procedures that help to create a valid comparison group.

4.2 Reflections on the theory of change

The report also reflects on parts of the theory of change by correlating key household characteristics with first order indicators of access, quantity and quality. Socio-economic status, hygiene and drudgery outcomes are better for households that on average are better connected and experience less water insecurity and quality issues. Also, second order effects related to mental health, wellbeing and empowerment demonstrate strong correlations with better access, quality and quantity suggesting JWIII-P has the potential to positively impact these outcomes that are increasingly associated with poverty alleviation.

4.3 Finalization of the evaluation

Baseline estimation sample power calculations confirmed that the proposed design with underlying assumptions about attrition and treatment allocation is well-powered to identify medium to large effects, lower than or equal to 0.5 and 0.8 SDs, respectively (see Annex A Section A.2.1.4). Also, it is possible to even identify small effects for various outcomes including the round-trip time to the water source, the household water insecurity indicator, the time spent on water fetching, the share of household revenue allocated to water fetching, an indicator for a person's emotional state and the measure for life satisfaction. Yet, while identifying small treatment effects may be overall informative, the scope and monetary investments involved in JWIII-P probably require impacts on most, if not all primary outcomes, to be of medium to large size to make the program cost-effective. One should however consider that power calculations need to be updated based on actual attrition rates and post-intervention information on which fokotanies ultimately received treatment. As a result, the minimum detectable effect sizes may still change for any outcome of interest.

As described in Section 4.1, the fact that fokontanies without planned works have similar characteristics than those in the treatment group facilitates a robust evaluation of JWIII-P as the envisioned control fokontanies are credible counterfactuals. Given the volatile environment surrounding JWIII-P, it is important to monitor the program implementation progress. This will help to ex-post determine treatment status at fokotany level and may even allow for differentiation in treatment intensity at household level (e.g. some but not all households may benefit from a new public water kiosk depending on their own geographical location and that of the kiosk). Also, some households may benefit from the public works *and* receive a private connection. Such information should ideally be gathered both through administrative data from JIRAMA and be cross-checked with household's self-reports during the post-intervention household data collection. This can potentially be used to refine the treatment variable. It is also important to carefully monitor other interventions in treatment and control fokotanies that may affect outcomes. Knowing this facilitates controlling for such confounds in an appropriate way.

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ANNEX A. IMPACT EVALUATION APPROACH

A.1 Design

As explained above, the JWIII-P project is a technically complex, multi-stakeholder (EIB, WSUP, WB), multi-component intervention (pipes, connections, plants, renovation and construction, capacity building), embedded in the context of Antananarivo. The technical components of the JIRAMA project are arguably strongly interdependent. For instance, the renovation of pipes and extension of the underground water grid will not have any significant impact on beneficiaries unless people are widely connected to the grid through private, social or public water connections. Yet, these (extra) connections will only improve water access if water pressure in the grid is increased through renovation and construction of water pumps and treatment plants. It follows that only the combined components will result in significant improvements – attempting to isolate the effect of one of these components is not relevant. The intervention is therefore best considered as a package of interdependent components.

During the preparation of the methodological note, a discussion on evaluation questions of interest to stakeholders showed that most interest related to policy learning from a water infrastructure intervention. EIB is interested in learning if and how water infrastructure interventions benefit the population, in particular women. For the impact evaluation, the entire set of water infrastructure works will be considered, irrespective of which donor organisation bought into a particular component. In other words, it would be equally interesting to learn about the impact of social connections funded by the World Bank as the private connections established under the EIB funded component.

As discussed in section 2, a Theory of Change was developed to help clarifying the expected causal pathways and underlying assumptions required for achieving desired outcomes, thereby guiding the evaluation design and ensuring a comprehensive assessment of JWIII-P's impact.

In sum, the intervention is considered as a ‘comprehensive package’ comprising the components that jointly affect the beneficiaries. Therefore, it was decided to:

- Consider the overall JWIII-P infrastructure works as the intervention to be evaluated, including the grid extension and renovation works planned within JWIII-P and connections to the grid;
- Refrain from attempting to isolate the net effect of specific donor investments; and
- Focus evaluation questions on the short to long term impacts of ‘improved access to safe water’ as intervention outcomes, through better water quality, quantity of and proximity to water access, instead of focusing on the impact of intervention activities, components and outputs as different ‘treatment arms.’

This approach allows exploring a rich set of indicators at different stages in the causal chain that are attributable to the comprehensive JWIII-P intervention. Another important remark is that, at this stage of the impact evaluation, there is still uncertainty about the concrete timing of each intervention component, and the final location of the new water kiosks, rendering imprecise which households will benefit from private or social connections. Our approach permits developing a design that is flexible with respect to changes in construction plans, and reduces the risk of wrongly selecting treatment and control areas.

A.1.1 Quantitative analysis

The quantitative analysis is based on relevant outcome variables and covariates measured through primary surveys on a large sample of households, conducted before the intervention begins, at baseline, and once the intervention is finalised, at endline. In determining an adequate quantitative impact evaluation methodology, a few specific characteristics were considered:

- The connected structure of the water network implies that large-scale works on the network that are carried out in one area of Antananarivo may have an impact in other areas of the city due to downstream effects.[20] This means that, while there are clearly identifiable areas where works take place (that is, where new pipes are installed, treatment plants or pumps are put into place, etc.), there are also many less easily identifiable areas where downstream effects may occur. The final sampling frame should thus be large enough to allow for measuring the impacts of such downstream effects, as well as the direct impacts of planned works as such.
- At this stage of the project, there is still some uncertainty regarding certain planned (smaller-scale) works. In particular, the precise location of new private tabs and new water kiosks has not yet been determined and will be demand-driven. It was decided to provide a sampling frame large enough to allow for measurement of the impacts of new private and public water access points, in addition to the impact of the previously described works on the network of existing private and public access points.

Because of such attributes, a large set of fokontanies was sampled across the agglomeration of Antananarivo. While it was not possible to clearly identify treatment and control areas ex-ante in developing the methodological note, the most up-to-date information on planned works was used as one of the stratifying variables. This, on one hand, ensured having fokontanies in our sample where works were and were not planned, and would provide sufficient flexibility in determining ex-post which fokontanies would have been affected (including indirectly through downstream effects) by the intervention. While households may not be aware of the project, and other interventions may have taken place in these areas, it would still be possible to capture whether they experienced any improvements in water availability or water pressure, and directly ask, in our survey, whether they have been part of other water infrastructure interventions during the period of the JWIII-P project. Survey information on the latter could also be triangulated with other sources of information (e.g. from NGOs, the Malagasy government, international organisations) on water projects taking place in the area. This approach was deemed less risky than any approach that would classify fokontanies as treatment and control, with the likely event that the classification might be wrong ex-post.[21]

It is important to note that (urban) infrastructure projects rarely lend themselves to experimental methods. As Mesplé-Somps et al. (2016) indicate, (i) randomized methods tend to be suitable only for national-scale infrastructure projects, randomizing the distribution of interventions between villages or towns; (ii) most projects are not limited to the provision of private goods to households, such as electricity or soil consolidation, suitable for experimental evaluations, but provide 'products' from which residents benefit collectively, i.e. public goods; (iii) the geographical areas where infrastructure is built or upgraded are often not sufficiently far from each other, which possibly generates externality (or spillover) effects; and (iv) such projects tend to have several components. These features make randomization difficult. It is thus recommended to adopt a quasi-experimental approach to identify the causal effect of JWIII-P.

Given the multi-faceted nature of the JWIII-P intervention and complementarity of inputs, questions of attribution could only apply to the entire JWIII-P 'package,' not its subcomponents. This is why all inputs and activities are considered together as the comprehensive JWIII-P intervention, and propose to assess three project outputs (quality, quantity, proximity), and to, subsequently, study in detail how those registered outputs are associated with outcomes (e.g. time use) and impacts (e.g. empowerment).

Specifically, difference-in-differences (DID) will be estimated, comparing, on average, outcome (or impact) indicators of households residing in fokontanies where JIRAMA have intervened (treated or treatment group) with households residing in fokontanies where JIRAMA not have intervened (control

[20] JWIII-P targets different steps of the drinking water infrastructure network and the impacts occurring from improvements are not locally bounded. For instance, with a new water treatment plant in the East, not only the communities in the East will benefit, but also other areas of the city to which water from the new treatment plant caters to. Or, water pipe renovations at the beginning of the water distribution network may not only benefit communities located there, but also communities that are being served through these pipes later in the network through improved water pressure.

[21] Note that, for the purpose of this report, balance is assessed between two groups of households that, according to the most updated information that was shared, reside in fokontanies where JIRAMA plans or does not plan to intervene, the former group forming the treatment, or treated, group, and the latter, the control group.

group), before and after works had begun and ended. The average change in indicators between these two groups before and after the intervention will give the impact of the project.

By considering the change in indicators for the treated group before and after the intervention and subtracting the change in indicators for the control group before and after the intervention, this approach controls, in theory, for pre-intervention differences between the two groups, and for any factors that might be (un)observed that are time-specific, i.e. that similarly affect these two groups in each period.

The basic hypothesis of a DID is that of the parallel trend, according to which changes over time that cannot be observed would be the same for treated and control groups, in the absence of treatment. In other words, the indicators specific to beneficiaries and non-beneficiaries should follow a 'parallel' evolution, had there been no intervention. The advantage of a DID is that it makes it possible to create a counterfactual situation from existing data, even if beneficiaries and non-beneficiaries present pre-intervention differences (self-selection), and without randomizing the allocation of the project. Its disadvantages are, however, (i) the requirement to have a 'pure' control group; (ii) the need for pre- and post-intervention data for both groups; and (iii) the absence of a statistical test to ensure the validity of the parallel trend hypothesis.

In practice, the following regression will be estimated:

$$Y_{ijt} = \alpha + \beta treatment_{ij} + \gamma post_t + \delta\left(treatment_{ij} * post_t\right) + \varphi X_{ijt} + \varepsilon_{ijt}$$

Where Y_{ijt} refers to any of the outcome (impact) indicators of household i in fokontany j at time t, α is the constant term or baseline average, β captures ex-ante time-invariant differences between treatment and control groups, and γ captures any time-specific effects t common to treatment and control group. δ is the coefficient of interest that estimates the DID effect – the causal effect of JWIII-P on the treatment group post-intervention compared to the control group. φ refers to impact of time-varying covariates, and ε is the error term. Standard errors should be clustered at the fokontany level.

In principle, if differences between the beneficiary and control groups exist before the intervention, this estimator minimises the factors confounding the identification of the impact of the intervention – the 'noise' contained in the error term – by conditioning on control variables (Wooldridge, 2002). More systematic ex-ante differences between the two groups may require additional techniques, such as estimating a DID on a previously matched sample, to create a better counterfactual scenario by eliminating pre-existing observable differences (matched difference-in-differences). It is thus proposed to estimate a DID on a sample previously matched on pre-intervention covariates at the household level, so that treated and control groups would be more similar (in terms of observable ex-ante characteristics). Pre-intervention covariates to be used to match households in treated and control clusters should not be affected by the JIRAMA project; they could include whether households are female-headed, the age and education of household heads, household size and age composition, household wealth, and dwelling type.

Last, elements shared by stakeholders suggested works will occur in (at least) two stages depending on their priority. Works deemed 'urgent' will first begin, followed by 'priority' works. This implies that different fokontanies will get treated at different times. In this situation, the standard DID, or two-way fixed effects (TWFE) estimation, will likely be biased. This might be problematic, as there is possible heterogeneity in the treatment effect over time – the DID estimator may not properly represent the weighted average of unit-level treatment effects (Goodman-Bacon, 2021).

At this stage of the evaluation, it is not clear when endline data will be collected. Collecting data after the end of 'urgent' works, but before starting 'priority' works, would allow using as control units fokontanies where the JWIII-P project does not plan to intervene as well as 'priority' work fokontanies where works have not begun yet, i.e. fokontanies that are 'not yet treated.' However, if endline data are collected once both ‘urgent’ and ‘priority’ works are finalised, the staggered nature of the intervention should be accounted for in estimating the proposed DID.[22]

A.1.2 Qualitative analysis

A purposive sampling approach in an iterative data collection design was applied for the qualitative component. 24 focus group discussions (FGDs) were conducted in 12 different fokontanies, over a three-week period in October 2023. The goal was to generate anecdotal evidence for triangulation with other data collection activities. The team applied the concept of ‘saturation’ to determine when the volume of FGDs was sufficient, i.e. when additional data contained a high level of duplication. As more data were collected, additional FGDs became more focused on the topics where new insights continued to emerge, and where questions arose based on preliminary analysis from the collected survey data.

The FGDs were conducted in close collaboration with the local data collection partner (COEF), who liaised with fokontany authorities to receive consent to conduct the discussion, find a proper location, and identify and reach out to relevant participants. As such, a representative of the data collection team visited each fokontany at least two days in advance to meet with the local authorities and kiosk manager. They introduced the local water carriers and members of the Association of Water Users (where applicable), all of whom were invited to participate in the FGDs. They also referred the team to a selection of households that rely on the kiosk, or live nearby but have a private connection. All discussions were led by the national member of the team and had a note-taker and observer present alongside them. At the end of each day, a remote debrief was organised in which the team discussed main findings against the evaluation matrix developed in the methodological note, and updated the discussion guides for the next days. These regular sessions, in which the structure of the evaluation questions was followed, facilitated analysis and triangulation with survey data.

While the recommended size for FGDs is between 6 and 12 people to facilitate sufficient discussion on different topics, bigger groups sizes also come with a higher risk of people with divergent opinions to remain silent. Size of around 8 participants was aimed for.

During the interpretation of the qualitative data collected during the focus group participants, the team considered any perceived power dynamics within the group, which may have affected participants’ public statements. The observer especially looked at body language and interactions between participants to be able to add context to the collected findings. For that reason, many of the FGDs were conducted with only women.

A.2 Data collection

A.2.1 Quantitative data: household survey

A.2.1.1 Sampling

210 fokontanies (out of 550) were sampled, spread across the area of Antananarivo, following a two-stage stratified random cluster design.[23] Sample stratification was based on information related to water access and JWIII-P planned works, as shared during the preparation of the methodological note, specifically:

- Combined information on access to piped water and water availability
    - *Usage of piped water sources.* Based on the last census (2018) as provided by INSTAT[24], the relevant question inquired which water sources a household used on a

[22] Advances in accounting for the staggered nature of an intervention in estimating DIDs are in constant evolutions. At the time of writing this report, two alternatives could be suggested: (i) Callaway and Sant’Anna (2021); or (ii) imputation methods such as Borusyak et al. (2024).

[23] As basis for sampling, Madagascar administrative boundaries as provided by the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) was used.

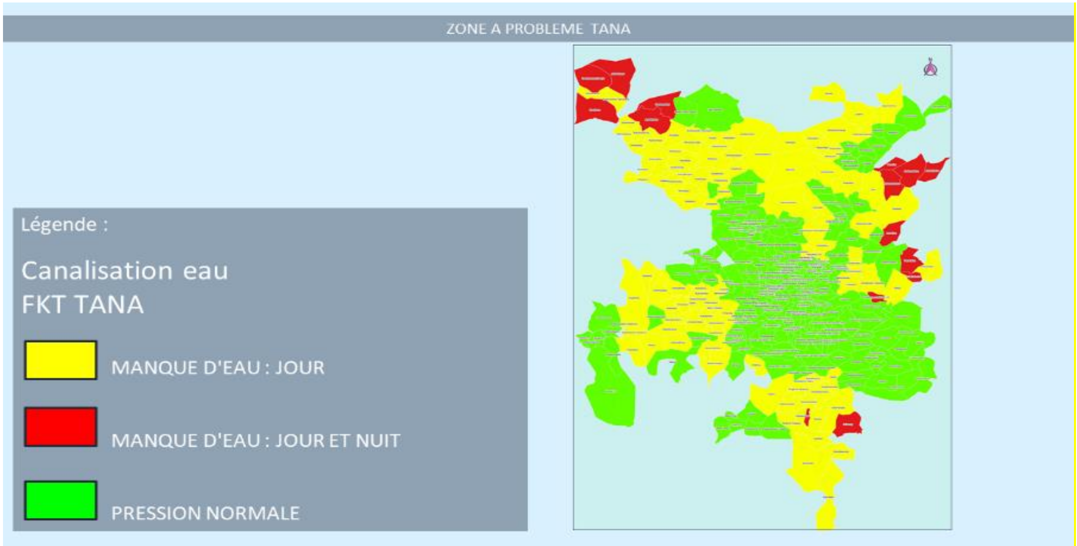
[24] INSTAT-MDG Résultats du Recensement Général de la Population et de l’Habitation, 2018.

regular basis. The answers to this question allowed us to distinguish between usage of piped water and other water sources and determined whether piped water[25] was accessed by almost all households (99% or more), or whether piped water was used by strictly less than 99% of households, in a particular fokontany.[26]

  - *Water availability.* Provided by JIRAMA, the original map (Figure A.1) displayed information on water availability from water sources administered by JIRAMA during the day and at night, split into three categories. To the best of our knowledge, this information was based on data on claims combined with internal background data.[27] Two of the categories were combined to get a simplified picture that distinguished areas that have good water availability from those that do not, where the latter category includes fokontanies with availability issues during the day and/or at night.

- Information on water availability permitted refining information on piped water access, to differentiate areas where (i) almost all households have access to piped water, and water availability is deemed good; (ii) where access to piped water is strictly below 99%, but there is good water availability; and (iii) where access to piped water is strictly below 99%, but there is bad water availability.
- Information on JWIII-P planned works, as shared during the writing of the methodological note.

Figure A.1. Antananarivo fokontanies lacking water



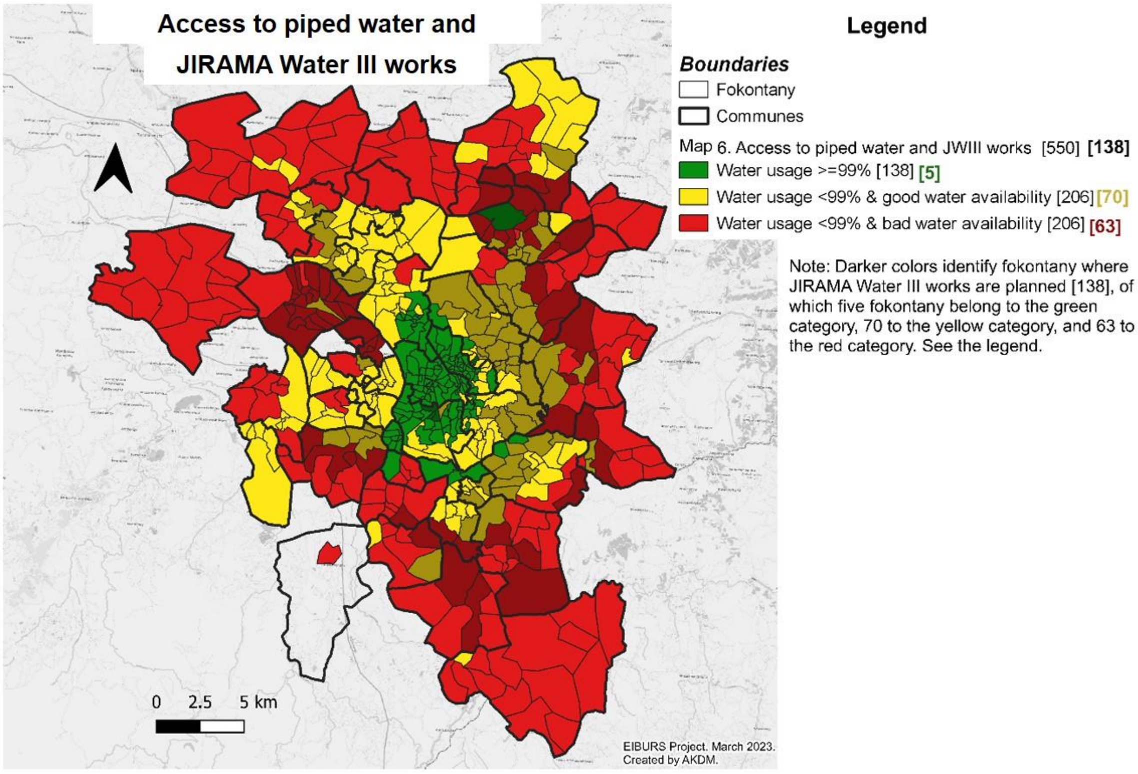
Source: Map provided by JIRAMA (based on data from September 2022).

Figure A.2 presents our final sampling frame. It shows the three categories of water access as explained above, overlayed with information on planned works, with darker colours identifying fokontanies where JIII works are planned to take place.

Table A.1 displays the number of fokontanies in each of these strata.

[25] Piped water sources (piped dwelling, piped yard plot, shared tap (exterior), water kiosk), boreholes, and water bumps, hereafter referred to piped water sources because boreholes and water bumps are the primary water sources in 0.7% of Antananarivo's households.
[26] This high threshold is justified as the sample will be further divided by the subsequently introduced stratification variables. 98.9% of usage of piped water sources is the 75th percentile of the water usage distribution.
[27] Figure A1 shows the areas in Antananarivo that are connected to the JIRAMA network where there is a lack of water due to low water pressure, during the day only (yellow) or during the day as well as at night (red). Data are from September 2022; they are based on reported complaints combined with data from the JIRAMA network.

Figure A.2. Sampling frame



Source: Authors' own calculations

Table A.1. Water access and JWIII-P works: Fokontanies per strata

Water access	Planned works	No planned work
Green	5	133
Yellow	70	136
Red	63	143

Source: EIBURS project.

210 fokontanies spread across these strata were selected. These clusters were allocated to maximise the probability of having a large enough sample of clusters where works will take place, and where impacts were expected to occur. It was decided to under-sample fokontanies in the green category since they have good water access and good water availability ex-ante. There, any impacts would only materialise through increased pressure. Moreover, only five 'green' fokontanies are expected to receive JWIII-P works, likely because pipes need to originate from green areas to reach yellow and red areas. In other words, works in green areas are primarily of technical necessity rather than meant to improve water infrastructure in these fokontanies. It was decided to ignore those five fokontanies, and only consider 30 'green' fokontanies where no work was planned. Any improvements made in green areas are expected to have, primarily, downstream benefits. It was thus considered more relevant to ensure to include households in red and yellow zones. The remaining 180 fokontanies were split evenly among yellow and red areas. In a second step, those clusters were divided between groups that are scheduled to receive work and those that are not. In doing so, the distribution of fokontanies in the original data

was roughly followed, about a third,[28] meaning that unbalanced numbers are assigned to the strata of 'work' and 'no work.'

Table A.2. Water access and JWIII-P works: Selected fokontany per strata

Water access	Planned works	No planned work
Green	0	30
Yellow	30	60
Red	30	60

Source: EIBURS project.

30 fokontanies (clusters) where works were planned, and 60 clusters where no work was planned were randomly selected, for each of the three water access groups (except for the green category), as presented in Table A.2. With this distribution, it was expected to have a sufficiently large number of fokontanies that experience downstream effects, and of fokontanies that do not experience such effects, while at the same time, having a sufficiently large number of clusters where works are planned. This assignment strategy was opted for because of the downstream effects of the planned works that are expected in strata that do not receive works themselves. Ideally, it would have been preferred to identify ex-ante which fokontanies are expected to experience downstream effects. However, this has proven difficult given that the exact location of water kiosks and of households who will apply for (and receive) a private water connection is still unknown. Table A.3 summarizes the distribution of sampled fokontanies. 60 fokontanies belong to the CUA; the rest are in peri-urban areas.

Table A.3. Distribution of sampled fokontanies and number of questionnaires by region

Region		Fokontanies	Questionnaires
CUA	1er Arrondissement	14	168
	2e Arrondissement	9	108
	3e Arrondissement	9	108
	4e Arrondissement	11	132
	5e Arrondissement	12	144
	6e Arrondissement	5	60
Ambohidratrimo		44	528
Antananarivo Atsimondrano		62	744
Antananarivo Avaradrano		44	528
Total		210	2520

Source: EIBURS project.

Each sampled fokontany thus constitutes one cluster. Within each cluster, 12 households were surveyed, a standard number of households per cluster for socio-economic surveys, leading to a sample of 2,520 households. Before the start of the data collection, in August 2023, COEF-Ressources, the survey firm in charge of fieldwork, asked the fokontany chiefs for their registers to draw a random selection of households to visit. However, these records were not digitised, which selecting households based on these records infeasible. Hence, a random walk was opted for; here, the three enumerators started in a central place of the fokontany (as suggested by the respective fokontany chief) and each

[28] As shown in the original data (Table 2), fokontanies with works in yellow and red areas add up to 32.3% (about a third) of the total of fokontanies in the yellow and red categories (=(70+63)/(70+136+63+146)). Analogously, using data from Table 3, the result is 33.3% (=(30+30)/(30+60+30+60)).

went in a different direction to interview every fifth and then every tenth household on the left side of the street.

Selecting primary household respondents is not trivial. Acknowledging the different roles that household members might have in managing drinking water availability and water collection, and the inclusion of some questions from which it was crucial to obtain accurate information based on first-hand experience and not on other members' perceptions about those experiences, a couple of 'screening' questions were asked in the first module of the questionnaire to select the most adequate respondents. Screening question answers enabled us to select as primary respondent the household member identified as household water manager. When the water manager was not the water fetcher, the (main) household water fetcher was interviewed. Respondents thus have one of three mutually exclusive roles: (i) water manager and water fetcher, (ii) water manager, or (iii) water fetcher. Table A.4 presents the distribution of primary respondent roles in the final sample.

Table A.4. Primary respondent role of surveyed households

Role	Planned works	No planned work	Total
Water manager	431	160	591
Water manager and fetcher	1253	543	1796
Water fetcher	100	33	133
Total	1784	736	2520

Source: EIBURS project.

A.2.1.2 Instruments

The main source of information used to address the various research questions of this study comes from primary data collected through a large-scale household survey among 2,520 households in and surrounding Antananarivo administered to the household member identified as household water manager and/or water fetcher, as explained above. Survey instruments were reviewed and approved by the EIB before baseline data collection. Survey modules are listed in Table A5. Note that, before interviewing household respondents, an introductory text was inserted, clarifying the mandate and the objective of the study, to guarantee respondents' trust in the survey and consent. Informed consent was obtained from every survey participant, clearly indicating that participation in the survey was voluntary, and respondents were free to not answer questions or drop out altogether at any point in time. Survey respondents were also informed that their answers would be anonymized and identifying information would never be revealed to members outside of the research team and with the sole purpose of being able to track respondents for the follow-up data collection round.

Table A.5. Questionnaire structure

Module	Topic
A	Interviewer and household identification
B	Household composition
C	Dwelling characteristics
D	Water source, water use, water fetching
E	Water fetching drudgery and norms
G	Hygiene
H	Water rationing
I	Time use
J	Agency
K	Well-being
L	Conflict

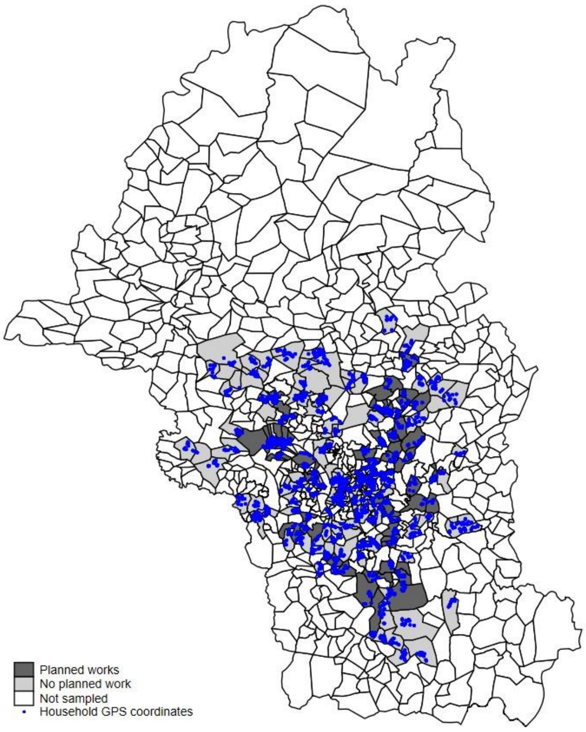
Source: EIBURS project.

A.2.1.3 Fieldwork

Synthesis

The firm COEF-Ressources, under the direct supervision of the team of researchers, led the baseline data collection as part of the impact evaluation of the JWIII-P project. Data collection started on September 13, 2023, and ended on October 19, 2023. Data were collected across 210 fokontanies, belonging to 41 communes, and 4 districts, resulting in a total of 2,520 household surveys, i.e. 12 households surveyed per fokontany. Figure A.3 presents the location of respondents across sampled fokontanies; it confirms baseline data were collected over an extended area, in and surrounding Antananarivo. Table A.6 lists fokontanies where households were sampled and JWIII-P planned works.

Figure A.3. Surveyed household localisation



Sources: Figure generated from non-missing GPS coordinates of sampled households (2,518 observations) as part of the baseline data collection.

Table A.6. List of fokontanies where households were sampled and JIRAMA planned works

District	Commune	Fokontany	Fokontany identifier
	2e Arrondissement	Ambatoroka	MG11101002010
	2e Arrondissement	Andohan'i Mandroseza Ambohibat	MG11101002013
	4e Arrondissement	Andrefan'ambohijanahary IIIG-I	MG11101004001
	5e Arrondissement	Ambatomainty	MG11101005001
CUA	5e Arrondissement	Ivandry	MG11101005006
	5e Arrondissement	Ambodivoanjo Ambohijatovo Fara	MG11101005007
	5e Arrondissement	Ambatobe	MG11101005010
	5e Arrondissement	Amboditsiry	MG11101005011
	5e Arrondissement	Manjakaray IIb	MG11101005013

	5e Arrondissement	Anjanahary IIa	MG11101005017
	5e Arrondissement	Ambohidahy	MG11101005021
	5e Arrondissement	Ambatokaranana	MG11101005022
	5e Arrondissement	Ambohimirary	MG11101005023
Antananarivo Avaradrano	Alasora	Sud Ambohipo	MG11102010004
Antananarivo Avaradrano	Alasora	Ankadindratombo	MG11102010006
Antananarivo Avaradrano	Alasora	Amboaroy	MG11102010013
Antananarivo Avaradrano	Alasora	Ambodivondava	MG11102010017
Antananarivo Avaradrano	Alasora	Mendrikolovana	MG11102010019
Antananarivo Avaradrano	Ankadikely Ilafy	Ilafy	MG11102039009
Antananarivo Avaradrano	Ankadikely Ilafy	Manjaka	MG11102039010
Antananarivo Avaradrano	Ankadikely Ilafy	Ambohitrarahaba	MG11102039012
Antananarivo Avaradrano	Ankadikely Ilafy	Manazary	MG11102039013
Antananarivo Avaradrano	Ankadikely Ilafy	Andrononobe	MG11102039014
Antananarivo Avaradrano	Ankadikely Ilafy	Mandrosoa Ilafy	MG11102039015
Antananarivo Avaradrano	Ankadikely Ilafy	Ambohibe	MG11102039017
Antananarivo Avaradrano	Ambohimanambola	Ambohipeno	MG11102050003
Antananarivo Avaradrano	Sabotsy Namehana	Atsinanantsena	MG11102079001
Antananarivo Avaradrano	Sabotsy Namehana	Lazaina	MG11102079003
Antananarivo Avaradrano	Sabotsy Namehana	Ambohitrinimanga	MG11102079004
Antananarivo Avaradrano	Sabotsy Namehana	Faravohitra	MG11102079005
Antananarivo Avaradrano	Sabotsy Namehana	Ambatofotsy	MG11102079009
Antananarivo Avaradrano	Sabotsy Namehana	Ambohidrano	MG11102079011
Antananarivo Avaradrano	Sabotsy Namehana	Antsofinondry	MG11102079012
Antananarivo Avaradrano	Sabotsy Namehana	Manarintsoa	MG11102079014
Antananarivo Avaradrano	Sabotsy Namehana	Namehana	MG11102079016
Antananarivo Avaradrano	Sabotsy Namehana	Tsarafara	MG11102079017
Antananarivo Avaradrano	Sabotsy Namehana	Ambohinaorina	MG11102079018
Antananarivo Avaradrano	Sabotsy Namehana	Andrefantsena	MG11102079020
Antananarivo Avaradrano	Ambohimangakely	Soamanandrariny	MG11102099009
Antananarivo Avaradrano	Ambohimangakely	Ambohimangakely	MG11102099011
Antananarivo Avaradrano	Ambohimangakely	Ikianja	MG11102099014
Antananarivo Avaradrano	Ambohimangakely	Amoronakona	MG11102099017
Antananarivo Avaradrano	Manandriana	Mahatsinjo	MG11102210004
Antananarivo Avaradrano	Ambohimanga Rova	Ambohitrandriamanjaka	MG11102319013
Ambohidratrimo	Ambohidratrimo	Ambohidratrimo	MG11103010001
Ambohidratrimo	Talatamaty	Amboropotsy	MG11103050001
Ambohidratrimo	Talatamaty	Ambohitravao	MG11103050006
Ambohidratrimo	Talatamaty	Talatamaty	MG11103050008
Ambohidratrimo	Ambohitrimanjaka	Ambatolampy Avaratra	MG11103130001
Ambohidratrimo	Ambohitrimanjaka	Beloha	MG11103130002
Ambohidratrimo	Ambohitrimanjaka	Ampanomahitsy	MG11103130004
Ambohidratrimo	Ambohitrimanjaka	Ambatomainty	MG11103130005
Ambohidratrimo	Ambohitrimanjaka	Anosimanjaka	MG11103130006
Ambohidratrimo	Ambohitrimanjaka	Andranomahitsy	MG11103130007

Ambohidratrimo	Ambohitrimanjaka	Antanetibe	MG11103130008
Ambohidratrimo	Ambohitrimanjaka	Miadana	MG11103130009
Ambohidratrimo	Ambohitrimanjaka	Antsahamarina	MG11103130010
Ambohidratrimo	Ambohitrimanjaka	Fiakarana	MG11103130011
Ambohidratrimo	Ambohitrimanjaka	Ampahibe	MG11103130012
Ambohidratrimo	Ambohitrimanjaka	Antsahafohy	MG11103130016
Ambohidratrimo	Ambohitrimanjaka	Andringitana	MG11103130018
Ambohidratrimo	Ambohitrimanjaka	Ikopakely	MG11103130019
Ambohidratrimo	Ambohitrimanjaka	Ambodivona	MG11103130020
Ambohidratrimo	Ambohitrimanjaka	Namorana	MG11103130022
Ambohidratrimo	Ambohitrimanjaka	Ambatolampy Atsimo	MG11103130023
Ambohidratrimo	Ambohitrimanjaka	Antsahavolo	MG11103130024
Antananarivo Atsimondrano	Ampitatafika	Ampitatafika Vaovao	MG11117011001
Antananarivo Atsimondrano	Ampitatafika	Faliarivo	MG11117011006
Antananarivo Atsimondrano	Ampitatafika	Ankaditany	MG11117011007
Antananarivo Atsimondrano	Ampitatafika	Ambohimangidy	MG11117011009
Antananarivo Atsimondrano	Ambohidrapeto	Ambohidrapeto	MG11117050003
Antananarivo Atsimondrano	Fiombonana	Marobiby	MG11117090001
Antananarivo Atsimondrano	Fiombonana	Anosivita Boina	MG11117090002
Antananarivo Atsimondrano	Andoharanofotsy	Iavoloha	MG11117170008
Antananarivo Atsimondrano	Soalandy	Ambatomanoina Lovasoa	MG11117210003
Antananarivo Atsimondrano	Ampanefy	Antalata	MG11117270008
Antananarivo Atsimondrano	Ambohijanaka	Lohanosy	MG11117350005
Antananarivo Atsimondrano	Ambohijanaka	Ambatolampy	MG11117350006
Antananarivo Atsimondrano	Ambohijanaka	Antovontany	MG11117350008
Antananarivo Atsimondrano	Ambohijanaka	Mahaimandry	MG11117350009
Antananarivo Atsimondrano	Ambohijanaka	Ankadivola	MG11117350012
Antananarivo Atsimondrano	Bongatsara	Anjomakely	MG11117390001
Antananarivo Atsimondrano	Bongatsara	Ambohibao	MG11117390003

Notes: List of fokontanies where households were sampled and JIRAMA planned works, according to the information shared when writing the methodological note. Note that few households were sampled at the border of fokontanies where fieldwork took place, but not in the exact same fokontany. JIRAMA planned intervention was assigned according to the fokontany households lived in according to GPS coordinates.

Pilot

The household questionnaire was first piloted in the field, and then validated by the research team, before being configured in the data collection software Survey To Go (STG). This exercise helped assessing the actual duration of the survey and question consistency to adjust the questionnaire and STG settings. This pilot was carried out in 3 fokontanies – Antsahatsiresy, Antsofinondry and Soanindanana – part of the rural commune of Sabotsy Namehana, on September 7, 2023.

Data collection

Surveys were administered in two distinct areas. In the first area, the Urban Commune of Antananarivo (CUA), fieldwork began on September 13, 2023, and ended on September 22, 2023. In the second area, peripheral areas of Antananarivo Avaradrano, Ambohidratrimo and Antananarivo Atsimondrano districts, fieldwork began on September 25, 2023, and ended on October 19, 2023. 18 enumerators, divided in 3 groups of 6 enumerators, each group being managed by one supervisor, were mobilized to collect data.

Data collection took place in each CUA and peri-urban districts. Each individual household interview was conducted, with an average duration of 45 minutes to 1 hour 30 minutes. The quota of 720 households was fully reached for the CUA. However, in some instances, surveys had to be redone, because of (i) the proximity of surveyed households, or (ii) errors in the choice of those interviewed. The latter led to cancelling one survey because the primary respondent should have been the water manager and/or fetcher if the household water fetcher was a minor. For peri-urban areas, the quota of 1,800 households was also reached in its entirety; no survey needed to be repeated.

Data quality checks

Several checks, at each stage of data collection, were carried out to ensure the quality of the data, and that all the questionnaires were completed consistently and precisely:

- At the end of each day, when the daily quota of 4 households was reached, interviewers and supervisors discussed any challenges encountered and field observations. They then synchronized data on STG for data managers to control the quality of collected data. This led to making various updates to STG to provide more relevant answers while surveys were taking place.
- Every week, a periodic report covering the days of Wednesday to Tuesday was shared with the research team. This report (i) compared planned and actual surveyed household quotas; (ii) indicated the number of survey refusals and the main reasons for refusal; (iii) listed the challenges encountered during fieldwork, and strategies adopted by supervisors or suggested by the research team.
- Once all surveys were administered, the raw database was cleaned to be provided to the research team. It consisted of (i) merging the various databases; (ii) translating and coding labels and response categories; (iii) updating or modifying variables to ensure response consistency, for instance, depending on the status of primary respondents, their civil status, or their respective water sources. In case of inconsistency, respondents were contacted by phone to correct data.

A.2.1.4 Statistical power

Below, the size of the minimum detectable effect (MDE) is calculated for a set of outcomes of interest. This informs on the magnitude the true effect of an intervention should be to be detected, given statistical power, statistical significance and sample size. The below formula is followed:

$$\beta_{MDE} = \left(Z_\beta + Z_{\alpha/2}\right) \times \sqrt{\frac{\sigma^2}{Jp(1-p)}} \times \sqrt{\frac{1+(m-1)\times ICC}{m}}$$

Where β_{MDE} represents MDE size; Z_β, desired power; $Z_{\alpha/2}$, statistical significance; σ^2, outcome variable variance; J, cluster number; p, proportion of treated clusters; m, cluster size; and ICC, intra-cluster correlation.

For this exercise, treated clusters are fokontanies where JIRAMA planned to intervene, and control clusters are those where it did not plan any works, as communicated at the time of writing the methodological note. Statistical significance is set at 5%, and power at 80%, typical parameters in the impact evaluation literature. Since a two-stage clustered sampling design is used, cluster size is set to 12, and intra-cluster correlations are estimated for each outcome of interest. Columns (1) to (5) of Table A.7 list parameters. Column (6) presents estimated MDEs, and column (8), MDEs expressed in estimation sample standard deviations.

Column (7) of Table A.7 informs that estimation sample MDEs range from 0.063 to 0.424 of a standard deviation (SD) for key outcome variables. It follows that the proposed design should be well-powered to identify medium to large effects, that is lower than or equal to 0.5 and 0.8 SDs, respectively, according to Cohen (1988). Its ability to detect small magnitude effect, lower or equal to 0.2 SDs, will depend on a combination of variance, sample size, cluster number and ICC, separately for each outcome of interest. This exercise can be repeated ex-post, i.e. after the intervention happened, when it is exactly known which fokontanies were treated and which ones were not.

Table A.7. Estimated minimum detectable effects

Variables	Mean (1)	Standard deviation (2)	Cluster (3)	Treated clusters/Total clusters (4)	Intra-cluster correlation (5)	Minimum detectable effect (6)	Standardized minimum detectable effect (7)
Distance from dwelling to public tap or water kiosk (kilometres)	0.138	0.429	143	0.280	0.000	0.099	0.230
Time to collect water (round-trip in minutes)	10.319	11.148	214	0.304	0.190	0.705	0.063
No water shortage (a)	0.502	0.500	216	0.301	0.296	0.175	0.350
No very low pressure (a)	0.141	0.348	156	0.301	0.099	0.120	0.346
Household Water InSecurity Experiences Scale	4.719	6.181	215	0.298	0.177	0.514	0.083
Water insecure (a)	0.146	0.354	215	0.298	0.112	0.107	0.303
Most of the time, water colour is crystal clear, without deposit (a)	0.734	0.442	156	0.301	0.213	0.171	0.388
Most of the time, the smell of water from the spring is odourless (a)	0.789	0.408	156	0.301	0.055	0.114	0.280
Most of the time, the taste of water from the spring is tasteless (a)	0.865	0.342	156	0.301	0.088	0.116	0.338
Treats water before drinking (a)	0.576	0.494	216	0.301	0.082	0.116	0.235
There is a place to wash one's hands in dwelling (a)	0.203	0.402	216	0.301	0.157	0.126	0.312
Adequate handwashing facilities (on premises, with soap and water) (a)	0.838	0.369	172	0.314	0.174	0.138	0.373
General state of dwelling hygiene is acceptable or very good (surveyor's observations) (a)	0.840	0.367	216	0.301	0.072	0.097	0.265
Experienced any physical problems due to water fetching (a)	0.823	0.382	213	0.300	0.161	0.124	0.325
Participation in Water User Association (WUA) activities (a)	0.048	0.213	216	0.301	0.057	0.071	0.332
Time spent on fetching water (hours, previous working day)	0.977	0.746	216	0.301	0.091	0.146	0.196
Share of last month household revenue allocated to water fetching	0.682	4.861	139	0.288	0.024	0.376	0.077
Depression scale (normalized)	0.506	0.121	215	0.298	0.045	0.051	0.424
Happy emotional state (a)	0.688	0.463	216	0.301	0.012	0.087	0.187
Life satisfaction from 0 (worst life) to 10 (best life)	5.869	1.495	216	0.301	0.056	0.186	0.125

Notes: Minimum detectable effect, assuming statistical power of 80%, statistical significance of 5%, and setting cluster size to 12.

(a) Binary variables.

A.2.2 Qualitative data: Focus group discussions

A.2.2.1 Sampling

In the context of selecting fokontanies for qualitative FGDs, the adopted methodology involved taking a sample of four fokontany per zone - red, yellow, green. As a reminder, for the survey, 60 fokontanies from the CUA and 150 from peripheral zones were considered. For the interviews, a selection of 12 fokontanies was drawn from this sample. To ensure the selection of fokontanies include a variety of contexts, while not pursuing strict representativeness, the same proportion of participants from the CUA as chosen for the implementation of the survey was not applied.

The sampling of fokontanies per zone was established in proportion to the number of fokontanies per zone (two for the CUA, three for the district of Ambohidratrimo, three for the district of Antananarivo Avaradrano, four for the district of Antananarivo Atsimondrano). Only two fokontanies within the CUA were chosen since access to water there is less difficult and more homogenous than in the peripheral areas. In addition to these criteria, the selection of fokontanies to be visited under the qualitative component aims to capture as much diversity in circumstances as possible. To achieve this, a deliberate choice was made to select communes and fokontanies at different distances from the CUA.

The final selection of fokontanies is summarized in Table A.8, and covers all three levels of accessibility.

Table A.8. List of selected Fokontany for qualitative data collection

District	Commune	Fokontany	Day	Rationale	Groups am	Groups pm
3e Arrondissement	3e Arrond.	Ankadifotsy Befelatanana	D1	Selected not only due to high water supply in these fokontany but also due to their respective distances	1 AU	1 BP
4e Arrondissement	4e Arrond.	Ilanivato Ampasika	D2		1 TE	1 BC
Antananarivo Atsimondrano	Soavina	Vahilava	D3	Only fokontany with good water supply in peripheral zones	1 AU	1 BC
Antananarivo Atsimondrano	Anosizato Andrefana	Ampefiloha	D4		1 TE	1 BC
Antananarivo Atsimondrano	Ankaraobato	Ambohibahiny	D5	Selected based on level of access to observe all situation in the district	1 AU	1 BP
Antananarivo Atsimondrano	Ambohidrapeto	Antsahamasina	D6		1 TE	1 BP
Antananarivo Avaradrano	Ambohimanga Rova	Ambohitrandriamanjaka	D7	2 yellow fokontany and 1 red fokontany selected to meet the internal ratio of the district where water access is most basic among the intervention districts.	1 TE	1 BC
Antananarivo Avaradrano	Alasora	Mahatsinjo	D8		1 TE	1 BC
Antananarivo Avaradrano	Ambohimanambola	Iharamy	D9		1 AU	1 BC
Ambohidratrimo	Ambatolampy	Soavinarivo	D10	1 yellow fokontany and 2 red fokontany selected to meet the internal ratio of the district where water access is most basic among the intervention districts.	1 TE	1 BC
Ambohidratrimo	Ambohidratrimo	Ambohidehilahy	D11		1 TE	1 BC
Ambohidratrimo	Ivato Firaisana	Mandrosoa Ivato	D12		1 TE	1 BC

Note: Group abbreviations: Water users of kiosk or shared tap (BC); Water users private water connection (BP); Water transporters (TE); Members of water associations and kiosk managers (AU).

The selection of FGD participants within each fokontany aimed at establishing a distribution between four target categories for the focus groups: (1) members of water users' associations (25%), (2) men and women using JIRAMA's public water kiosks (37.5%), (3) men and women using private water connections (12.5%), and (4) water carriers (25%). Below more details on each target category are provided, while the actual composition of FGD participants is presented in Table A.9.

- Members of water users' associations included members of the association's management committee as well as water kiosk operators who manage the kiosk and report to the water infrastructure managers.

- Groups of water consumers consisted of a sample of water users/infrastructures installed in the fokontany or individuals with private connections in their homes. They were identified in collaboration with fokontany administration and invitations were extended to attend the FGDs, specifying the location and start time;
- For the group of water transporters, salaried individuals (both men and women) who work for households for daily water transport were identified. This required collaborating with water managers to approach them. Normally, they came to the kiosks every morning, and were invited to participate in the focus group sessions as well.

Table A.9. Summary of number of focus group discussion participants

Zone	Household public water kiosk (men/women)	Household private water connection	Water carriers	Water management
Green	35 (2/33)	10 (2/8)	23 (7/16)	6 (1/5) Water managers 11 (2/9) Kiosk manager 4 (1/3) Presidents
Yellow	34 (8/26)	9 (4/5)	28 (13/15)	5 (0/5) Kiosk manager
Red	37 (11/26)	9 (1/8)	24 (9/15)	10 (4/6) Kiosk manager
Total	**106 (21/85)**	**28 (7/21)**	**75 (29/46)**	**36 (6/30) Kiosk manager** **6 (1/5) Water managers** **4 (1/3) Presidents**

Note: Focus group discussions were organised with groups of men and women whose main water source is (i) a kiosk, (ii) a private water connection, and with groups of (iii) water carriers and (iv) members of the water associations, responsible for the management of the kiosks.

A.2.2.2 Instruments

Specific discussion guides were developed for each of the group types, based on the envisioned contributions in the evaluation matrix, ensuring complementarity with the survey. As additional evidence was being collected through ongoing FGDs, the guide was revised to match emerging data gaps and preliminary survey results.

The discussion guide included probing questions about clean water access, possible areas of outcomes of improved water access (incl. time allocation, household finances, and hygiene), and impacts (incl. socio-economic and health outcomes). As such, the scope of the FGDs was consistent with the TOC.

The team began all meetings, interviews and FGDs with personal introductions, an explanation of the study, an exploration of participants' backgrounds, an assurance of neutrality and confidentiality, and a check on participant willingness to proceed. It was emphasized that participation would have no negative effects on participant interests, and that anyone who did not wish to take part was free to withdraw without negative consequences, at any time. Last, it was clearly stated that the team did not work for JIRAMA, nor had any effect on the implementation of JWIII-P.

A.2.2.3 Fieldwork

As there already was previous approval of district chiefs and mayors for the quantitative data collection exercise, requested in advance by supervisors, follow-up visits to the fokontany chiefs were scheduled to explain the objectives of this qualitative part and the methodology to be adopted for the selection of different participants for the various FGDs.

The discussions themselves were conducted between 6 and 20 October 2023, by the local team member with support of the local data collection partner (COEF). Regular check-in sessions with the rest of the team ensured alignment between both data collection components, and good coverage across all topics. Notably, there was a limited participation of men during all focus groups discussions with water users. The team decided not to undertake specific efforts to increase male participation, prioritizing participation of those household members responsible for water management. No major issues were observed during the implementation.

A.3 Data cleaning and analysis

A.3.1 Household survey

The final database was shared by COEF-Ressources with the team of researchers through surfdrive; a secured server, in line with General Data Protection Regulation (GDPR) standards. Data cleaning began on February 2, 2024, and ended on June 17, 2024. Cleaning and analysis were carried out with the statistical software Stata, version 16.1. The research team complied with GDPR data protection guidelines for variables containing personal information, and anonymized data to prevent from identifying respondents.

A.3.2 Focus group discussions

Between November 2023 and January 2024, the interview notes underwent an iterative quality assurance process to ensure it included all relevant information from the discussions (which took place in Malagasy), and that this information was registered clearly and concisely. In first instance, COEF processed the notes into the reporting template, including a French translation of the discussion. Afterwards, the team's local expert revised the French translation on completeness and clarity. The notes were then shared and remote exchanges took place between the remote and local teams to ensure alignment on the content.

Interview notes were translated into English and processed in MaxQDA. English and French translations were kept alongside each other during the processing of evidence, to allow for cross-checking in case of any doubts. Team members processing the notes are fluent in both languages.

The output of this process was a MaxQDA project with coded segments, structured by the output, outcome, and impact level, and by topic within each of these levels. As such, all evidence can be mapped on the TOC, facilitating linkages with the survey results.

A.4 Data limitations

First, during data collection, which spanned 35 calendar days, a few events, not linked to the survey per se, occurred, that could have influenced the respondents and their responses:

1) Selecting sample households typically would follow a procedure where supervisors would determine a central starting point in each fokotany and choose one direction for their team from this central point. Thus, one team would go in the Northern direction, one in the South-Eastern direction and one in the South-Western direction. This proved challenging due to various reasons specific to each area. For instance, the CUA has an outdated urban plan; some fokontanies have sectors, either widely dispersed or very close to each other. Several fokontanies are mainly composed of complex corridors, which makes household selection difficult. In addition, the managers of certain housing estates refused access to visitors or strangers to their place of residence for security reasons (case of 67ha Afovoany Andrefana). Also, in peripheral areas, the significant dispersion of fokontany sectors proved a challenge. To address this, supervisors assigned each interviewer to a specific fokontany sector according to a triangular model. Here, enumerators deviated from the strict directions of North, South-Eastern and South-Western, but dispersed in a triangular shape.
2) Another challenge concerned obtaining information from respective household water kiosks. Most households that use community water sources do not have information specific enough to

answer questions related to their respective water sources such as the name of the kiosk or kiosk manager. While such information is often passed on during periodic community meetings, the daily rhythm of urban life hinders residents' participation in those meetings. With many identifying information missing on public water kiosks used by the household interviewers had to return to the households with pictures of all nearby water kiosks and let households identify which one(s) they used. Having recorded GPS coordinates of all public water kiosks allows us to now directly measure the distance between households' dwelling location and that of the water kiosk they are using.

3) During fieldwork, it was common to face individuals who refuse to participate in the survey. Interviewers received a total of 271 refusals, including 207 within CUA areas and 64 within peri-urban areas. To maximise response rates, interviewers collaborated with fokontany officials to incite and facilitate household participation, but also to overcome the immediate refusal to participate in the survey. When it was impossible to conduct the survey, the original household was replaced by a neighbouring household.
4) The delimitation of fokontanies was, sometimes, not sufficiently precise. To minimise errors in locating households, interviewers asked households for their addresses before beginning surveys. Sometimes, the help of a guide who was a member of the fokontany office was requested to accompany interviewers throughout their interviews. Some also carried out GPS scanning to be certain that the areas they visited were still included in the targeted fokontanies.

Second, as estimated MDEs indicate, the design is well-powered to detect medium to large effects, but it is unlikely to detect small statistically significant effects, if present. In other words, there is a possibility that it lacks the necessary statistical precision to estimate clear effect sizes. To mitigate this concern, the integration of qualitative evidence in the evaluation will help better triangulate quantitative evidence. In addition, households residing in control and treated fokontanies were selected to display strong comparability, as confirmed by the below balance analysis.

Last, it should be reminded that the JWIII-P project is a highly complex intervention, with a multitude of partners. This represents a challenge as, till now, its exact programming, and, as a result, the theory of change that was inferred, might evolve. While this might not be problematic at endline, once the operation is (fully) implemented, and works, easily observed, at this stage of the evaluation, there was still uncertainty regarding when, and in which exact location, which component(s) of the project will be implemented, threatening the ability of the proposed design to identify impacts, if present.

ANNEX B. BALANCE TESTS

Statistical balance between households living in fokontanies where JIRAMA plans to intervene and households living in fokontanies where, a priori, JIRAMA does not plan to intervene, to gauge the validity of the proposed impact evaluation design. Given the multi-faceted nature of the JWIII-P intervention and complementarity of inputs, questions of attribution could only apply to the entire JWIII-P 'package,' not its subcomponents. This is why all inputs and activities are considered together as 'treatment'. For the purpose of this report, balance is assessed between two groups of households that, according to the most updated information that was shared, reside in fokontanies where JIRAMA plans or does not plan to intervene, the former group being the treatment, or treated, group, and the latter, the control group.

Below, Table B.1 to Table B.3 report sample size, means and standard deviations, as well as differences in means between those groups with corresponding statistical significance as well as normalized differences,[29] of baseline characteristics of households, dwellings and primary respondents.

Table B.1 to Table B.3 confirm ex-ante balance between these two groups. This provides evidence supporting the validity of the impact evaluation design proposed in the methodological note and detailed in Annex A. Only one indicator, the number of years a household has been connected to JIRAMA water network, greatly differed between these two groups. Table B.2 indicates that, among those households whose dwelling is privately connected, households report having been connected for an average of 18.3 years. This average raises to 19.7 years in fokontanies with no planned work, compared with 12.7 years in fokontanies where JIRAMA plans to intervene – a difference that is statistically significant and of large magnitude, as suggested by the corresponding normalized difference. This is, in fact, expected, given the objectives of the JWIII-P project.

[29] Imbens and Wooldridge (2009) suggest as a rule of thumb that a normalized difference greater than 0.25 (one quarter), linear regression methods would likely be sensitive to the specification.

Table B.1. Household characteristics by fokontany treatment status

	Total			No planned work			Planned work			Differences in means	Normalized differences
	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD	(5)-(8)	(8)-(5)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Female-headed household	2520	0.206	0.404	1784	0.200	0.400	736	0.219	0.414	-0.019	0.032
Highest completed level of education in the household											
None	2519	0.037	0.188	1784	0.034	0.180	735	0.044	0.204	-0.010	0.036
Still in school	2519	0.007	0.082	1784	0.006	0.078	735	0.008	0.090	-0.002	0.017
Primary school	2519	0.257	0.437	1784	0.265	0.442	735	0.238	0.426	0.027	-0.044
Middle school	2519	0.291	0.454	1784	0.286	0.452	735	0.302	0.459	-0.016	0.024
High school	2519	0.245	0.430	1784	0.240	0.427	735	0.257	0.437	-0.017	0.028
Some tertiary education	2519	0.164	0.370	1784	0.169	0.375	735	0.151	0.358	0.018	-0.034
Reported household size	2520	3.932	1.564	1784	3.957	1.557	736	3.870	1.579	0.088	-0.040
Proportion of members 15 years of age or younger	2520	0.284	0.224	1784	0.285	0.225	736	0.281	0.220	0.004	-0.014
Proportion of members 60 years of age or older	2520	0.096	0.225	1784	0.095	0.223	736	0.098	0.228	-0.003	0.010
Last month household revenue	2520	400091.691	377160.696	1784	402992.322	352549.710	736	393060.813	431206.899	9931.510	-0.018

Notes: Level of statistical significance: * < 5%, ** < 1%.

Table B.2. Dwelling characteristics by fokontany treatment status

	Total			No planned work			Planned work			Differences in means	Normalized differences
	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD	(5)-(8)	(8)-(5)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
General condition of the dwelling is good or very good (surveyor's observations)	2520	0.281	0.45	1784	0.28	0.449	736	0.284	0.451	-0.004	0.006
Type of dwelling											
Villa	2520	0.716	0.451	1784	0.738	0.44	736	0.664	0.473	0.073**	-0.113
Concession	2520	0.137	0.344	1784	0.127	0.333	736	0.162	0.368	-0.035*	0.071
Building	2520	0.008	0.089	1784	0.008	0.088	736	0.008	0.090	0.000	0.002
Apartment	2520	0.125	0.331	1784	0.112	0.316	736	0.158	0.365	-0.046**	0.094
Other	2520	0.013	0.115	1784	0.016	0.124	736	0.008	0.090	0.008	-0.049
Electricity is the main source of lighting	2520	0.665	0.472	1784	0.639	0.480	736	0.728	0.445	-0.089**	0.136
Has a tap or access to a private water connection											
No	2520	0.906	0.293	1784	0.899	0.302	736	0.923	0.267	-0.024	0.060
Yes, private	2520	0.079	0.270	1784	0.089	0.284	736	0.057	0.232	0.031**	-0.086
Yes, shared with neighbours	2520	0.015	0.122	1784	0.013	0.113	736	0.020	0.141	-0.007	0.041
If yes, number of years of private water connection in the dwelling	157	18.261	17.858	125	19.688	19.186	32	12.688	9.603	7.001*	-0.326
If not, the household has applied to JIRAMA to be connected											
No	2333	0.932	0.251	1636	0.934	0.248	697	0.928	0.258	0.006	-0.016
No, but intention to do so directly/through the owner of the accommodation	2333	0.015	0.123	1636	0.013	0.115	697	0.02	0.14	-0.007	0.037
Yes, less than a year ago	2333	0.008	0.088	1636	0.01	0.098	697	0.003	0.054	0.007	-0.062
Yes, over a year ago	2333	0.029	0.168	1636	0.029	0.169	697	0.029	0.167	0.001	-0.003
The accommodation has at least one functional shower	2520	0.736	0.441	1784	0.717	0.451	736	0.781	0.414	-0.064**	0.105
The accommodation has a latrine	2520	0.950	0.219	1784	0.945	0.229	736	0.962	0.191	-0.017	0.058

Notes: Level of statistical significance: * < 5%, ** < 1%.

Table B.3. Sociodemographic characteristics of primary respondents by fokontany treatment status

	Total			No planned work			Planned work			Differences in means	Normalized differences
	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD	(5)-(8)	(8)-(5)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Status											
Manager	2520	0.235	0.424	1784	0.242	0.428	736	0.217	0.413	0.024	-0.041
Water fetcher and manager	2520	0.713	0.453	1784	0.702	0.457	736	0.738	0.440	-0.035	0.056
Water fetcher	2520	0.053	0.224	1784	0.056	0.230	736	0.045	0.207	0.011	-0.036
Female	2520	0.738	0.440	1784	0.728	0.445	736	0.764	0.425	-0.036	0.058
Age	2520	40.573	14.357	1784	40.530	14.431	736	40.679	14.186	-0.150	0.007
Household head	2520	0.395	0.489	1784	0.396	0.489	736	0.394	0.489	0.002	-0.002
Civil status											
Married	2520	0.698	0.459	1784	0.694	0.461	736	0.707	0.456	-0.013	0.019
Single with no children	2520	0.091	0.288	1784	0.098	0.297	736	0.076	0.265	0.021	-0.054
Divorced/separated	2520	0.058	0.234	1784	0.057	0.232	736	0.06	0.237	-0.003	0.008
Single with child(ren)	2520	0.017	0.131	1784	0.018	0.133	736	0.016	0.127	0.002	-0.009
Widow/Widower	2520	0.131	0.337	1784	0.128	0.335	736	0.136	0.343	-0.008	0.016
Cohabiting with partner	2520	0.005	0.072	1784	0.005	0.071	736	0.005	0.074	0.000	0.004

Notes: Level of statistical significance: * < 5%, ** < 1%.

ANNEX C. ADDITIONAL DESCRIPTIVE STATISTICS

Table C.1. Water source type and use

	Total		
	Obs	Mean	SD
	(1)	(2)	(3)
Number of distinct water sources used in a typical week during the year (a)	2520	1.238	0.446
Main source of water the household uses in a typical week during the year			
In-house faucet (private connection)	2520	0.074	0.262
Faucet in yard/plot	2520	0.017	0.131
Faucet at a neighbour's house	2520	0.023	0.150
Public faucet/water kiosk	2520	0.304	0.460
Protected Well	2520	0.298	0.457
Unprotected Well	2520	0.060	0.237
Drilled wells (boreholes)	2520	0.013	0.112
Tanker	2520	0.001	0.034
Surface Water	2520	0.097	0.296
Rice Field	2520	0.000	0.020
Other	2520	0.000	0.020
Water Carrier	2520	0.112	0.315
This source is used to...			
Drink	2520	1.000	0.020
Cook	2520	0.990	0.097
Personal hygiene	2520	0.917	0.276
Washing clothes	2520	0.688	0.463
Second source of water the household uses in a typical week during the year (b)			
In-house faucet (private connection)	578	0.002	0.042
Faucet in yard/plot	578	0.005	0.072
Faucet at a neighbour's house	578	0.016	0.124
Public faucet/water kiosk	578	0.074	0.263
Protected Well	578	0.304	0.461
Unprotected Well	578	0.062	0.242
Drilled wells (boreholes)	578	0.009	0.093
Collected rainwater	578	0.003	0.059
Tanker	578	0.003	0.059
Surface Water	578	0.415	0.493
Rice Field	578	0.019	0.137
Water Conveyor	578	0.087	0.281
This source is used to...			
Drink	578	0.310	0.463
Cook	578	0.353	0.478
Personal hygiene	578	0.623	0.485
Washing clothes	578	0.853	0.354

Third source of water the household uses in a typical week during the year (c)			
Public faucet/water kiosk	22	0.045	0.213
Protected Well	22	0.273	0.456
Unprotected Well	22	0.091	0.294
Surface Water	22	0.409	0.503
Water Conveyor	22	0.182	0.395
This source is used to...			
Drink	22	0.227	0.429
Cook	22	0.318	0.477
Personal hygiene	22	0.318	0.477
Washing clothes	22	0.818	0.395
Reasons for using a water carrier (d)			
No household member is available	275	0.680	0.467
To save time because the source is far	275	0.113	0.317
To save time as there is often a long queue	275	0.044	0.205
No physical strength to carry water	275	0.156	0.364
Other	275	0.007	0.085

Notes: Statistics corresponding to the main water sources used during a typical week for households reporting using similar water sources in dry and wet seasons, and statistics corresponding to the main water sources used during a typical week in dry season for households that reported using different sources in dry and wet season.

(a) 2,456 (97.46%) households use the same water sources in dry and wet seasons, out of which 562 use multiple water sources in a typical week. 64 (2.54%) households use different water sources in dry and wet seasons, out of which 16 use multiple water sources in a typical week.

(b) Corresponding statistics for households that reported using a second water source during a typical week during the year. 16 (0.635%) households, who reported using different water sources in wet and dry seasons, use two distinct water sources in a typical week. 540 (21.429%) households, who reported using similar water sources in wet and dry seasons, use two distinct water sources in a typical week.

(c) Corresponding statistics for households that reported using a third water source during a typical week during the year. 22 (0.873%) households, who reported using similar water sources in wet and dry seasons, use three distinct water sources in a typical week.

(d) Corresponding statistics for households that reported using a water carrier as their main source of water during a typical week during the year.

Table C.2. Household characteristics by water source type

	Private connection			Water kiosk and tanker			Water carrier			Protected or drilled well			Other		
	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Female-headed household	289	0.277	0.448	770	0.205	0.404	281	0.260	0.439	783	0.180	0.384	397	0.166	0.373
Highest completed level of education in the household															
None	289	0.014	0.117	770	0.034	0.181	281	0.025	0.156	782	0.042	0.201	397	0.055	0.229
Still in school	289	0.007	0.083	770	0.010	0.101	281	0.000	0.000	782	0.005	0.071	397	0.008	0.087
Primary school	289	0.114	0.319	770	0.253	0.435	281	0.167	0.374	782	0.280	0.449	397	0.388	0.488
Middle school	289	0.180	0.385	770	0.310	0.463	281	0.267	0.443	782	0.312	0.464	397	0.310	0.463
High school	289	0.215	0.411	770	0.268	0.443	281	0.335	0.473	782	0.238	0.426	397	0.174	0.379
Some tertiary education	289	0.471	0.500	770	0.125	0.331	281	0.206	0.405	782	0.123	0.328	397	0.065	0.248
Reported household size	289	3.713	1.717	770	4.130	1.613	281	3.744	1.518	783	3.849	1.481	397	4.003	1.497
Proportion of members 15 years of age or younger	289	0.229	0.222	770	0.298	0.222	281	0.265	0.222	783	0.292	0.227	397	0.296	0.217
Proportion of members 60 years of age or older	289	0.148	0.282	770	0.076	0.191	281	0.135	0.269	783	0.088	0.218	397	0.082	0.208
Last month household revenue	289	683167.138	741689.708	770	360126.801	262299.970	281	482678.712	328431.328	783	358404.668	286190.622	397	295301.128	228703.864
Asset index (*via principal component analysis*)	288	1.118	1.570	770	-0.079	0.798	281	0.291	1.069	783	-0.213	0.726	397	-0.442	0.469

Notes: Estimation sample size, mean and standard deviation of listed variables, by type of primary drinking water source corresponding to the main water sources used during a typical week for households reporting using similar water sources in dry and wet seasons, and statistics corresponding to the main water sources used during a typical week in dry season for households that reported using different sources in dry and wet season.

Table C.3. Dwelling characteristics by water source type

	Private connection			Water kiosk and tanker			Water carrier			Protected or drilled well			Other		
	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
General condition of the dwelling is good or very good (surveyor's observations)	289	0.606	0.490	770	0.214	0.411	281	0.352	0.479	783	0.253	0.435	397	0.181	0.386
Type of dwelling															
Villa	289	0.706	0.456	770	0.643	0.479	281	0.665	0.473	783	0.773	0.419	397	0.791	0.407
Concession	289	0.131	0.339	770	0.160	0.367	281	0.157	0.364	783	0.129	0.335	397	0.098	0.298
Building	289	0.014	0.117	770	0.014	0.119	281	0.007	0.084	783	0.001	0.036	397	0.005	0.071
Apartment	289	0.142	0.350	770	0.151	0.358	281	0.157	0.364	783	0.095	0.293	397	0.103	0.305
Other	289	0.007	0.083	770	0.032	0.177	281	0.014	0.119	783	0.003	0.051	397	0.003	0.050
Electricity is the main source of lighting	289	0.931	0.254	770	0.732	0.443	281	0.836	0.371	783	0.585	0.493	397	0.378	0.485
Has a tap or access to a private water connection															
No	289	0.183	0.388	-	-	-	-	-	-	-	-	-	-	-	-
Yes, private	289	0.692	0.462	-	-	-	-	-	-	-	-	-	-	-	-
Yes, shared with neighbours	289	0.125	0.331	-	-	-	-	-	-	-	-	-	-	-	-
If not, the household has applied to JIRAMA to be connected															
No	102	0.902	0.299	770	0.912	0.284	281	0.879	0.327	783	0.957	0.204	397	0.970	0.171
No, but intention to do so directly/through the owner of the accommodation	102	0.020	0.139	770	0.023	0.151	281	0.028	0.167	783	0.005	0.071	397	0.010	0.100
Yes, less than a year ago	102	0.020	0.139	770	0.006	0.080	281	0.018	0.132	783	0.004	0.062	397	0.008	0.087
Yes, over a year ago	102	0.029	0.170	770	0.039	0.194	281	0.064	0.245	783	0.018	0.133	397	0.008	0.087
The accommodation has at least one functional shower	289	0.924	0.266	770	0.740	0.439	281	0.879	0.327	783	0.736	0.441	397	0.489	0.501
The accommodation has a latrine	289	0.976	0.154	770	0.927	0.260	281	0.986	0.119	783	0.958	0.201	397	0.932	0.252

Notes: Estimation sample size, mean and standard deviation of listed variables, by type of primary drinking water source corresponding to the main water sources used during a typical week for households reporting using similar water sources in dry and wet seasons, and statistics corresponding to the main water sources used during a typical week in dry season for households that reported using different sources in dry and wet season.

Table C.4. Women's empowerment (Dickin et al., 2021)

	Total			Peri-urban			Urban		
	Observations	Mean	Standard deviation	Observations	Mean	Standard deviation	Observations	Mean	Standard deviation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Individual level									
Intrinsic attitudes about WASH roles and responsibilities									
Collecting water is a task reserved for									
Men	1855	0.247	0.431	1318	0.205	0.404	537	0.350	0.477
Women	1855	0.150	0.357	1318	0.170	0.376	537	0.101	0.301
Men and women	1855	0.603	0.489	1318	0.625	0.484	537	0.549	0.498
Household level									
Input into decisions about WASH roles and responsibilities									
Primary respondent alone or with partner is responsible for taking decisions related to water use	1860	0.975	0.157	1321	0.977	0.151	539	0.970	0.170
Input into decisions about WASH expenditures									
Primary respondent alone or with partner is responsible for taking decisions related to water purchase	1207	0.962	0.192	681	0.962	0.192	526	0.962	0.191
Control over household assets									
Primary respondent alone or with partner is responsible for taking decisions related to everyday shopping	1860	0.923	0.267	1321	0.927	0.261	539	0.913	0.282
Primary respondent alone or with partner is responsible for taking decisions related to major purchases	1855	0.889	0.314	1317	0.896	0.305	538	0.872	0.335
Primary respondent alone or with partner is responsible for taking decisions related to use of own income	1854	0.901	0.298	1321	0.910	0.286	533	0.880	0.325
Primary respondent alone or with partner is responsible for taking decisions related to urgent healthcare	1857	0.914	0.281	1319	0.919	0.273	538	0.901	0.298
Time Allocation									
Time spent fetching water on the previous working day (hours)	1860	0.986	0.749	1321	1.040	0.597	539	0.853	1.018
Time spent fetching water on the previous working day is greater than 30 minutes	1860	0.769	0.422	1321	0.861	0.346	539	0.544	0.499
Work balance	1860	1.183	0.447	1321	1.192	0.428	539	1.162	0.489
Societal level									
Community									
Group membership: Participation in Water User Association (WUA) activities	1860	0.053	0.225	1321	0.036	0.185	539	0.096	0.296
Local WASH institutions and authorities									
If participates in WUA activities, very or relatively active participation	99	0.929	0.258	47	0.894	0.312	52	0.962	0.194
If participates in WUA activities, leadership role	99	0.232	0.424	47	0.255	0.441	52	0.212	0.412

Notes: Statistics reported for female principal respondents, by urban or peri-urban fokontany status.

Table C.5. Agency by gender of primary respondents

	Total			Male			Female		
	Obs	Mean	SD	Obs	Mean	SD	Obs	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Setting goals									
Motivational autonomy									
External motivation (a)	2518	0.227	0.419	660	0.236	0.425	1858	0.224	0.417
Introjected motivation (a)	2518	0.241	0.428	660	0.211	0.408	1858	0.251	0.434
Autonomous motivation (a)	2518	0.622	0.485	660	0.632	0.483	1858	0.619	0.486
Relative autonomy index (RAI) (b)	2518	1.172	1.522	660	1.212	1.495	1858	1.158	1.531
Capacity to set goals									
It is important for me to make decisions (alone or with partner) regarding									
Everyday shopping	2514	0.963	0.189	657	0.912	0.284	1857	0.981	0.136
Major purchases	2514	0.981	0.137	659	0.976	0.154	1855	0.983	0.130
Water purchase	1708	0.989	0.102	426	0.986	0.118	1282	0.991	0.096
Water use	2516	0.986	0.119	660	0.976	0.154	1856	0.989	0.103
Use of own income	2510	0.987	0.114	659	0.980	0.139	1851	0.989	0.103
Urgent Health Care	2516	0.992	0.087	659	0.985	0.122	1857	0.995	0.069
Education	2435	0.986	0.116	628	0.981	0.137	1807	0.988	0.107
Work outside the household	2487	0.986	0.119	655	0.994	0.078	1832	0.983	0.131
Perceived control and ability to achieve goals									
Internal locus of control	2480	0.762	0.131	650	0.762	0.138	1830	0.762	0.129
Self-efficacy	2511	0.820	0.119	658	0.827	0.118	1853	0.818	0.119
Acting on goals									
Primary respondent alone or with partner is responsible for taking decisions related to									
Everyday shopping	2520	0.776	0.417	660	0.362	0.481	1860	0.923	0.267
Major purchases	2515	0.866	0.341	660	0.802	0.399	1855	0.889	0.314
Water purchase	1609	0.934	0.248	402	0.851	0.357	1207	0.962	0.192
Water use	2520	0.950	0.219	660	0.879	0.327	1860	0.975	0.157
Use of own income	2514	0.880	0.325	660	0.820	0.385	1854	0.901	0.298
Urgent Health Care	2516	0.890	0.313	659	0.822	0.382	1857	0.914	0.281
Education	2411	0.889	0.314	615	0.834	0.372	1796	0.908	0.289
Work outside the household	2489	0.783	0.412	655	0.892	0.311	1834	0.744	0.436

Notes: Statistics reported for all principal respondents, by gender.

(a) Series of binary variables taking on unity if the respondent considers a vignette (story) completely or somewhat similar to their life experience; 0 otherwise.

(b) Weighted sum of external motivation (-2), introjected motivation (-1) and autonomous motivation (+3).