United Republic of Tanzania
Ministry of Water, Energy and Minerals (MoWEM)
Zanzibar Utilities Regulatory Authority (ZURA)
Zanzibar Water Authority (ZAWA)

Data Collection Survey on Enhancement of Water Administration and Water Utility Management System in Zanzibar in the United Republic of Tanzania

Final Report

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Japan International Cooperation Agency (JICA)

NJS Co., Ltd.（NJS）
Yokohama Water Co., Ltd. (YWC)
Earth System Science Co., Ltd. (ESS)

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Executive Summary

1. Outline of the Survey

1.1 Background of this Survey

In Zanzibar, the United Republic of Tanzania (hereinafter referred to as "Tanzania"), the Revolutionary Government of Zanzibar (RGoZ), took over the water supply utility in 1964, provided water services free of charge mainly for domestic use from a perspective of social security perspective since 1982. As a result, water supply revenue decreased, repairs and expansion of water supply facilities became difficult. Thus, the quality of water services deteriorated. Then, RGoZ published the Zanzibar Vision 2020 in 2004, and the Ministry of Land, Housing, Water and Energy (currently the Ministry of Water, Energy and Minerals (MoWEM)) published the National Water Policy in 2006, and subsequently enacted Water Act. in 2007. By this, paid water supply services were restarted again.

Since the establishment of Zanzibar Water Utility (ZAWA), the Japanese government has implemented the grant-aid project for the development of water facilities in urban areas of Zanzibar, a technical cooperation project which aimed at establishing a water billing and collection system by ZAWA. Phase 2 of this technical cooperation project phase 2 for aimed at the enhancement of measures against non-revenue water and water utility management capacity. In addition to this, the preparatory survey for the Japanese ODA loan project, aims to rehabilitate urban water distribution facilities, attempts to provide a safe and sustainable water supply by improving the financial performance through increasing customer's willingness to pay. The ODA loan project is scheduled to be implemented in the near future. Most recently, Zanzibar Water Advisor was assigned over the period from February 2019 to January 2021, to carry out advisory services for the water sector regarding Japanese ODA loan project management, water resource management, and water administration system reform.

RGoZ has also been receiving support from other donors, and thus the foundation for a sound water utility management is going to be laid due to the improvement of water supply facilities. On the other hand, the water sector of Zanzibar has various issues such as insufficient water supply service (60% of water leakage rate, 6 hours of average water supply), low water revenue (6% of collection rate in Unguja, March 2017), lack of human resources, and organizational issues to receive support from various donors. Additionally, there are concerns about the saltwater intrusion. This is due to the excessive abstraction of groundwater, insufficient groundwater management. The operation of a pre-paid meter system which will be introduced on a trial basis may also be a concern.

1.2 Purpose of this Survey

The purpose of this survey is to collect information that contributes to the enhancement of the Zanzibar water administration and water utility management system through the study of the following four items. The main

areas of information collection are water administration/legislation, human resource development/ organizational operation, water resource management, water supply facility management and customer management.

(1) Study of measures to current urgent issues
(2) Study of Zanzibar water sector's mid-to-long term action plan which will improve the basic management issues such as water source management, facility management, customer management, and underlying issues such as organization operation, human resource development and legal system
(3) Study of current possible measures to support the implementation of above measures
(4) Study of JICA's mid-to-long term support in addition to the planned projects such as the loan project

2. Situation and Issues of the Water Sector in Zanzibar

2.1 Structure of the Water Sector in Zanzibar and Water Supply Situation

(1) Structure of the Water Sector in Zanzibar

At the establishment of ZAWA in 2006, all authority on water supply including water resources was transferred from RGoZ to ZAWA. Therefore, ZAWA has a wide range of authority such as management and conservation of water resources, implementation of facility development projects, implementation of policies, and operation of the water utility.

The responsibilities of MoWEM are only to formulate and revise the Regulations Implementing the Water Act, appoint ZAWA directors, and restrict water use during water shortage periods and emergency situations. Zanzibar Utilities Regulatory Authority (ZURA) is the authority that regulates public utilities with respect to water supply, electricity, and petroleum. With respect to water supply, it possesses licensing authority over water utilities and water resource development. And is also responsible for monitoring water services and tariff.

(2) Overview of Water Supply

ZAWA relies on groundwater for its water supply with 5 spring water sources, 7 cave water and 303 boreholes. In 2018, annual water yield was estimated at 39.4 million m^3 (average daily water yield: approximately 108,000 m^3), annual water consumption was estimated at 14.6 million m^3 (average daily water consumption: approximately 40,000 m^3), and water loss was estimated at approximately 63% by them. The number of boreholes has increased due to water source development and the total number of customers have also increased in recent years. The water meter installation status is low at 12%.

2.2 Overview and Issues of Water Administration and Legislation

(1) Water Administration of Zanzibar

Zanzibar is granted autonomy except for "Union Matters" as provided for in the Constitution Tanzania. Apart from the mainland, Zanzibar establishes national development plans, relevant policies, laws and regulations for various sectors, and development plans and governs Zanzibar. For the water sector, Zanzibar has its own Ministry for water administration, which sets its own policies, laws and regulations. There are no specific laws and regulations of the United Republic or the mainland that affect water resources management and water supply services of Zanzibar.

(2) Framework of Zanzibar Water Sector (Policy, Legal System and Sectoral Development Plans)

The current policies and sector plans for the water sector are as follows

Table 1 Policies and Sector Plans for the Water Sector in Zanzibar

Category	Current Latest Version	Remarks
National Development Plan	Zanzibar Development Vision 2050	Published in 2020
	Zanzibar Strategy for Growth and Reduction of Poverty III (2016-2020)	Not updated
	Roadmap to sustainable development goals (SDGs) in Zanzibar 2020-2030	Published in 2020
National Water Policy	National Water Policy 2004	Under revision
Major Law and Regulations for the Water Sector	Water Act (Act No. 4 of 2006)	Enacted in 2006
	Water Regulations (2007, 2008)、Water Rates and Service Charge Regulations (2013)	As shown on the left
	ZURA Act (Act No. 7 of 2013)	Enacted in 2013
Development Plan for Water Supply	Zanzibar Urban Water Supply Development Plan 1991-2015	Not updated
	Zanzibar Water Investment Program 2022-2027 (ZanWIP)	Published in 2022
	ZAWA Strategic Business Plan 2020-2025	Published in 2020
Regulatory Plan for Public Utility	ZURA Strategic Business Plan 2017-2022	Published in 2017

(3) Status of the Revision of National Water Policy and Related Laws

Currently, MoWEM is in the process of revising the National Water Policy. Water Act will be amended after the revision of this Policy. As of March 2022, MoWEM proceeds with a procurement process for a consultant who will execute the revision work. And UNICEF has expressed its intention to provide financial support for the revision work.

(4) Issues on Water Administration and Legislation

Approximately 20 years have passed since the National Water Policy (2004) was published, and thus an early revision is required. This is because of the reasons that the new national development plan (ZDV2050) was published and the environment surrounding the water sector has been changed significantly. Hence, it is necessary to revise the Water Act and the ZURA Act and develop related laws in line with the revised policy.

In the revision, various considerations are to be reviewed, such as

- the change of environment (natural/social/economic environment, international development issues, policies of related sectors, operating system of the water sector),

- policies and strategies for the establishment of an organization for water resources management based on the integrated water resources management approach,
- policies related to the sector development to improve access to well-managed safe water, the operation of water sector such as monitoring and evaluation through performance indicators, settle discrepancies among various laws related to water resources management,
- setting conservation areas to protect groundwater recharge areas, restricted areas for groundwater source development to prevent saltwater intrusion, etc.

Until the establishment of a water resource management organization, the Water Resources Department of ZAWA will continue to be responsible for administrative procedures related to water resource management. Therefore, it is necessary to strengthen its capacity so that appropriate regulations on the use of water resources will be implemented.

2.3 Overview and Issues of Human Resource Development and Organizational Operation

(1) Overview of Organizational Operation

The Department of Water Development of MoWEM has the jurisdiction over water supply. The director was finally appointed in October 2021. Currently, the organization of the department such as recruiting the staff, identifying the business policy and defining the business contents are ongoing. MoWEM and Ministry of Water and Irrigation (MoWI) in the mainland are discussing the cooperation in the areas of water resources, water supply and sanitation services and it is expected that a MOU will be signed in the near future.

Regarding ZAWA, it has addressed its organizational restructure based on the recommendation proposed in the Technical Cooperation Project Phase 2. Currently, due to changes in the situation such as the change of Director General of ZAWA, discussions are underway to re-examine and re-organize the organizational structure.

(2) Overview of Human Resources of ZAWA

It is recognized that 25% out of 568 ZAWA's staff are unskilled, and the number of skilled staff is insufficient. Additionally, one-third of the ZAWA's staff is over 50 years old. Furthermore, although improvement of groundwater resources management is recognized as a challenge, the shortage of human resources with specialized knowledge of hydrogeology and water resource management is an issue. ZAWA is requesting a budget from RGoZ to hire skilled human resources. However, new recruitment is not considerably progressing due to the financial situation of RGoZ.

ZAWA is formulating a five-year training plan. It aims to strengthen the ability of staff by setting targets for the degree or skill level. It encourages 99 staff from each department to undergo training and study in their respective fields. However, financial support by ZAWA is not promised.

(3) ZAWA Training Centre (ZTC)

The ZAWA Training Centre (ZTC) is registered with the Vocational Training Authority (VTA) as a public training institution in Zanzibar. It is planning and conducting training programs. The operation of the centre is managed by five staff. Cooperation with external training institutions is also being considered, and opinions are being exchanged with the Water Institute (WI) in the mainland and branches of VETA in Dar es Salaam and Arusha.

It has not been so long since the establishment of ZTC and hence the facilities of ZTC are currently not enough. ZTC is considering enhancing the facilities and equipment such as workshop, library, computer room, experimental facilities, and building infrastructures. It also considers improving the capabilities of lecturers and instructors.

(4) Resources for Human Resource Development in Tanzania

WI provides programs to improve the skills of water utilities' staff, Tanzania Public Service College (TPSC) was established as an educational institution for public employees, Ardi University and Dar Es Salaam University have faculties of hydraulic geology and water resource management. Thus, they are potential resources in Tanzania for human resource development. Courses provided by WI are already utilized for training the staff of the water sector in Zanzibar.

(5) Issues on Human Resource Development and Organizational Operation

Zanzibar relies on groundwater resources for water sources. Hence, it is necessary to secure human resources who have knowledge of water resources management, who have the ability to manage the practice of water resources management and who could plan for groundwater monitoring and rainwater utilization. From the viewpoint of human resource development, especially in the area of water resources management, following issues should be addressed.

- Implementation of intensive training on water resources management
- Appropriate organizational operation plan for water resources management
- Construction and operation of Plan, Do, Check and Act (PDCA) cycle of activities

The challenge is to strengthen human resource development for persons in Zanzibar and staff of the water sector by intensifying training activities through ZTC, specially conducting water-related training programs.

Although ZAWA has set key performance indicators (KPIs) in its strategic business plan, it seems that the mechanisms such as quarterly monitoring and implementation management are not established. Accordingly, establishing a precise KPI management system is inevitable.

2.4 Overview and Issues of Groundwater Management

(1) Overview of Department of Water Resources

Department of Water Resources consists of three divisions, namely, Drilling Division (7 members), Water Quality Laboratory (6 members), and the Water Resources Management Division (5 members).

Drilling Division has drilling rigs, but they are not working due to aging. Therefore, current main task of the division is the construction of boreholes through outsourcing, including construction supervision. The Water Quality Laboratory located at Saateni Reservoir is monitoring the quality of supplied water. The testing equipment are in poor condition and there is a lack of reagents and other laboratory supplies. Hence, currently, only basic water parameters such as electrical conductivity, turbidity, pH, salinity, and TDS are monitored. Water Resources Management Division is responsible for the protection and conservation of water resources. Regular monitoring of observations boreholes is not performed sufficiently due to the limitation of staff and transportation. Therefore, the current main tasks of this Division are the issuance of well drilling permits and the issuance and renewal of licenses for registered drilling companies.

(2) Resources for Groundwater Resources Management in Tanzania

Interview survey was carried out with 6 experts, professors and researchers at Ardi University, Dar es Salaam University, Dodoma University, Soikone Agricultural University and National Zanzibar University to confirm the availability of cooperation in water resource management in Zanzibar. It was confirmed that there is a possibility to obtain their cooperation in water resource management to the Department of Water Resources and/or Water Resources Management Board (WRMB) (if it is established).

(3) Overview of Water Use in Other Sectors

Since the water resources management, which ZAWA is currently responsible for, covers all sectors, current water use in the three main sectors (hotels, industry and irrigation) was surveyed.

Three hotels were surveyed in the hotels sector. Two out of the three hotels were identified to treat the water with reverse osmosis membrane filters. In addition, it was confirmed that these private boreholes were registered, and the water charge was paid to ZAWA in line with the meter reading measured through flow meter. However, it is not sure that the situation remains the same for all the hotels in Zanzibar.

One sugar factory was surveyed as the industry sector. In the factory, water was treated with reverse osmosis membrane filter to remove hardness and salt. It was confirmed that the borehole was registered, and water charge was paid.

Regarding the irrigation sector, four schemes in Unguja were surveyed. It was confirmed that boreholes of the schemes did not obtain water pumping permission, did not monitor pumping volume, and did not pay water charges because of the reason that the schemes managed by water users' associations organized under Ministry of Agriculture, Irrigation, Natural Resources and Livestock (MAINRL) are exempted from obtaining a water pumping permit and paying permit fees.

(4) Status of Establishment of Water Resources Management Board (WRMB)

Currently, MoWEM is in the process of revising the national water policy. The draft prepared by ZAWA proposes the establishment of a water resources management organization and to exclude the water resources management functions from ZAWA. However, the establishment of WRMB is not certain as of now because the revision of the national water policy is not completed yet.

(5) Simple Survey for the Status of Saltwater Intrusion

A simple survey was conducted to check the status of saltwater intrusion by measuring the groundwater level and water quality (electrical conductivity, salinity, etc.) at 55 boreholes in the urban area of Unguja, where a large amount of water is expected to be pumped.

The values of electrical conductivity (EC) and salinity were almost within the range of freshwater, but the electrical conductivity (EC) of some boreholes was at the level of brackish water.

In the southern part where the groundwater level (static and dynamic water level) is low, the tendency of increasing electrical conductivity (EC) and salinity overtime was confirmed, and signs of saltwater intrusion noticed.

(6) Issues on Groundwater Management

As a result of a simple survey on saltwater intrusion, it was found that the groundwater quality was affected by seawater in areas where the groundwater level is low. Under such circumstances, if groundwater is used continuously to meet the increasing water demand, saltwater intrusion into groundwater may pose a problem to Zanzibar, in near future.

It is necessary to understand the structure of the groundwater basin, the flow of groundwater and the recharge mechanism in order to estimate the allowable pumping amount. This amount should be within the range that does not cause seawater intrusion into the groundwater. Also, it is necessary to identify the feasible water source recharge areas, which would enhance the conservation and protection of water resources. For that purpose, it is indispensable to carry out a comprehensive hydrogeological survey and to formulate a water resources management master plan. This plan will cater the needs of water resource utilization, conservation and protection based on the identified allowable pumping amount and the water source recharge mechanism.

In addition, in order to manage, conserve and protect water resources based on the master plan, it is necessary to establish a system that can appropriately carry out the permitting and monitoring process.

2.5 Overview and Issues of Water Supply Facility Management

(1) Situation of Water Supply Facilities Developed by ZUWSP

In order to understand the facility management issues of ZAWA, the situation regarding the operation and maintenance of the facilities newly developed by ZUWSP was investigated.

ZUWSP was developed two packages: Package 1 is for the development and rehabilitation of water sources, while Package 2 is for the development of water transmission pipelines, service reservoirs and replacement of water distribution pipelines.

It was confirmed that the water source facilities developed in Package 1 were generally working well. And the electromagnetic flow meters installed at boreholes worked as well.

In Package 2, following were implemented,

- Installation of pipeline from the water sources to the service reservoirs,
- Renewal of the Saateni and Mnarawambao reservoir,
- Introduction of disinfection equipment at Mnarawambao reservoir,
- Laying and replacement of the distribution pipeline including the formulation of Districted Metered Area, and
- Construction of the manifolds

Both Saateni Reservoir and Mnarawambao Reservoir are in operation, and water being distributed from the Reservoirs. Electromagnetic flow meters were installed at the sites of reservoirs at the inlet and outlet. It was noticed during the field survey, that only the inlet flow meter at the Mnarawambao reservoir was working. The cause of the malfunction was not investigated. Regarding the distribution network, DMAs were formulated, and electromagnetic flowmeters were installed at the boundary of the DMAs. But they do not work, and the cause of the malfunction was not investigated. Manifolds for connecting the service connections were constructed by the contractor, but the installation of service connections, which was the responsibility of ZAWA, was delayed. Therefore, the existing pipelines which were planned to be removed are remaining in the network. It was considered that the water pressure did not increase, and the service was not improved in the ZUWSP area due to the water leakage from the remaining existing pipes which are to be removed. Regarding facility operation, the flow meters at the boreholes were in operation, but the operators did not know how to operate the indication panels and thus flow data was not used for facility operation management. It was noticed that the operation management method was not changed even though the new equipment was introduced.

Regarding the maintenance, corrective maintenance in response to problems was carried out, while preventive maintenance wasn't considered, and the basic maintenance policy has not changed before and after the project.

(2) Water Leakage in ZUWSP Area

As mentioned above, water leakage in the ZUWSP area is considered to be the leakage from the remaining existing pipelines those are to be removed. It is necessary to complete the installation of service connections and facilitate the early removal of unnecessary existing pipes.

Even after the removal of unnecessary existing pipes, some of the old pipes will remain because of the fact that all old pipelines were not replaced in the project. It is necessary to continue the leakage repair and replacement of those pipes. Therefore, it is necessary to strengthen the NRW management system especially addressing the water leakage problem.

In the Stone Town area, the roads are narrow and there are many multi-story buildings with water tanks on the roof. So, there is a possibility that water cannot be supplied by simply connecting a water pipeline. Sufficient residual pressure head will not be available for the water to reach the water tank located on the roof. Therefore, a water supply system using a water tank and a pump will be required. However, due to restrictions on the installation and locational constraints, a detailed investigation is required before starting the construction work in Stone Town. It has to be noted that Stone Town is a World Heritage Site.

In addition, since the DMA flow meters can be used for narrowing down the leak locations such as measurement of the minimum flow rate at night and through step test, it is necessary to repair or replace the flow meters.

(3) Issues on Water Supply Facility Management

Leakage reduction in the ZUWSP area is an urgent issue, and it is necessary to secure a budget for implementation and proceed steadily. In ZUWSP, flow meters (unfortunately they are not working) were installed, but there is no monitoring equipment like SCADA. It is also necessary to proceed with the installation of monitoring equipment and develop an organizational system for flow monitoring.

In this survey, it was found that the facility operation and maintenance methods did not change at all before and after the implementation of the project. In projects, various equipment generally will be planned and procured to facilitate the operation and maintenance. Hence, efforts to improve the operation and maintenance methods are required

2.6 Overview and Issues of Customer Management

(1) Situation of Customer Management

Customer data, which was once managed on a paper-pen (hard copy) basis, has now been registered in the customer management system. Customer complaints are also managed. Major complaints are about water volumes and billing.

The installation rate of water meters is still low at 12%, although improvements have been noticed. Information such as installation year and condition of the meters is not fully available.

Meter reading is performed monthly by 12-meter readers. Due to the efficiency of data transfer to the billing management system, mobile phones with meter reading applications were used before, but due to the problem of insufficient memory capacity, the meter reading is performed by handwriting currently. Customers with

registered phone numbers are billed by SMS on their mobile phones, which improves the distribution rate of bills. However, due to the inaccuracy of registered information, billing errors, such as sending bills to non-customer, has also been noticed. Billing and collection of large consumers are done by visiting the premises. Other customers can make payments at the headquarters and at the counters of seven regional offices. In addition, payment services using mobile phones were started. Billing and collection rates were improved by using mobile phones. In the past, ZAWA visited the customers premises to collect the arrears once a week, which is called as "Kata-Kata", but it is not carried out now.

(2) Situation of Water Revenue

Water revenue is increasing year by year, while the amount of unpaid bills is decreasing. The introduction of the SMS system and the mobile payment system brought some improvements, but it still relies on government subsidies for about 60% of its income.

(3) Trial Introduction of Prepaid Meters

In the RIWSSZ, a trial introduction of prepaid meters is planned for 350 large customers in its project area. The system required to operate the prepaid system will be provided by the water meter manufacturer. At this point of time, a water tariff for prepaid meter customers is not decided.

(4) Customer Needs Survey

A total of 500 interview surveys, 100 each in the urban and rural areas of Unguja Island (inside and outside the ZUWSP area) and in the urban and rural areas of Pemba Island were conducted. It was found from the survey that the customers of ZAWA call for an improvement in water services, demanding for a 24-hour water supply and a price reduction in water services.

(5) Issues on Customer Management

The installation rate of water meters is low. Although improvement is seen, the collection rate is not enough and is at 44%. It is necessary to take measures to improve water revenue, such as promoting customers to shift from flat-rate to metered-rate and improving water services.

Billing and collection were improved by introducing systems such as SMS and mobile phone payments. However, for that purpose, the customer's mobile phone number information is required. Since the information on the mobile phone numbers of especially Pemba Island customers are not enough obtained, it is necessary to proceed with the collection of customer information in order to effectively utilize the system. Meter reading becomes a bottleneck if the improvement of billing and collection is achieved by the system. Currently, the number of meters installed is small and the number of meter readers is not adequate. Hence, it is necessary to increase the number of meter readers corresponding with the estimated future increase of water meters.

In addition, it is necessary to evaluate the prepaid meter system which will be introduced on a trial basis and examine the possibility of expansion of prepaid meter introduction.

2.7 Cooperation with Japanese Companies and Water Utilities

To investigate the possibility of utilizing the know-how of Japanese water utilities and the technology of private companies in the areas such as groundwater management including water administration and legislation, NRW management, customer management, human resource development, etc., necessary information was collected through this survey.

(1) Private Companies

There were proposals from private companies for providing ultrasonic flow meters for NRW management, pipeline network ledgers using GIS and optimization of repair and maintenance, high-efficiency pumps, plastic body water meters, leak detection systems, reverse osmosis membrane plants, etc. According to the companies, it is necessary to consider the business environment such as the market size to expand their business to Zanzibar.

(2) Water Utilities

By asking for opinions regarding applicable technologies considering the situation in Zanzibar, opinions on groundwater management and customer management (smart meters and billing/collection) were obtained through questionnaire survey. Regarding the cooperation with Zanzibar, some water utilities answered that there was a possibility, and the utilities may arrange observation tours when an observation group from Zanzibar comes to Japan.

(3) Invitation to Japan

The water sector of Zanzibar faces challenges such as strengthening water resource management, measures for NRW reduction for improvement of financial situation, strengthening of billing and collection, water administration and legislation to implement these, securing and training of human resources. Therefore, it is effective to invite teams from Zanzibar and introduce Japan's practices on these issues. It is also considered effective to have opportunities for discussion with companies that responded to the questionnaire.

In order that Zanzibar's water sector addresses issues continuously, the involvement of executives who make decisions in water administration is necessary. Therefore, the permanent secretary of MoWEM and Director General of ZAWA are recommended as the target persons of the invitation.

3. Measures for Urgent Issues

ZUWSP area is located downstream of the Japanese ODA loan project area. And this loan project area is scheduled to be implemented in the near future. Hence, any water leakage in the area may affect the effectiveness of the ODA loan project. Prepaid meters are scheduled to be implemented within a year in the

Rehabilitation and Improvement of Water Supply and Sanitation for Zanzibar (RIWSSZ) area. Therefore, water leakage reduction in the ZUWSP area and tariff setting for prepaid meter customers were identified as urgent issues that need to be addressed.

(1) Water Leakage Reduction in ZUWSP Area

As mentioned above, in order to take measures against water leakage in the ZUWSP area, (1) implementation of replacement of service connections and disconnection of unnecessary old pipelines from the network, (2) survey and planning for water supply method in Stone Town, and (3) repair or replacement of flow meters not working at reservoirs and DMA, are required.

Regarding (1), the Customer Service Department is currently in charge, and it is possible to carry out if the budget is allocated. Regarding (2), knowledge about water supply and service connections is required. If it is difficult for ZAWA staff to handle the situation, hiring a consultant is one of the options. Regarding (3), the Technical Operation Department will be the responsible department, and it will be possible to carry out if the budget is allocated. It is recommended to consider water volume management equipment such as installing a small panel equipped with a modem and indicator.

(2) Tariff Setting for Prepaid Meter Customers

When setting a new tariff, the basic procedure is that ZAWA formulates a draft tariff and ZURA approves it. Customer Service Department and Legal Unit are in charge of the draft tariff setting, and it will be discussed between ZAWA and ZURA before the start of the operation of the prepaid meter. As a suggestion for tariff calculations, it will be prudent to calculate the average unit price of large customers from the past actual revenue and the actual consumption of water and set the tariff based on the average unit price.

4. Mid to Long Term Action Plan for Zanzibar Water Sector

Based on the current situation of the Zanzibar water sector, aspirations based on the national development plans and policy, strategy and measures to realize the aspirations were examined, and actions of each measure were planned.

During the field survey, a briefing session on the action plan was held, and the Zanzibar team confirmed that the proposed action plan would be referred to and utilized in the operation and management of the water sector. They also expressed their will to discuss who, what, when, how, and the need for external support regarding implementation of the plan between MoWEM, ZURA, and ZAWA.

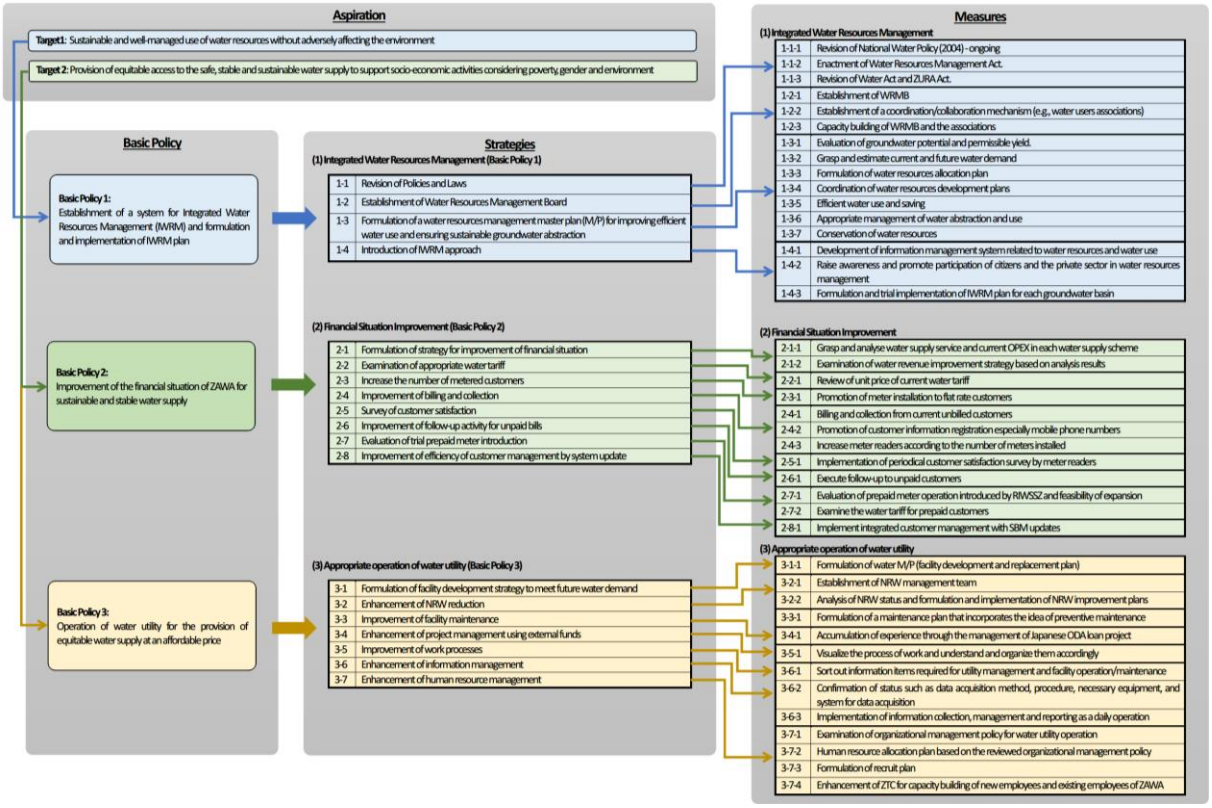

Figure-1 Framework of Strategies and Measures of the Proposed Action Plan

Data Collection Survey on Enhancement of Water Administration and Water Utility Management System in Zanzibar in the United Republic of Tanzania

Final Report

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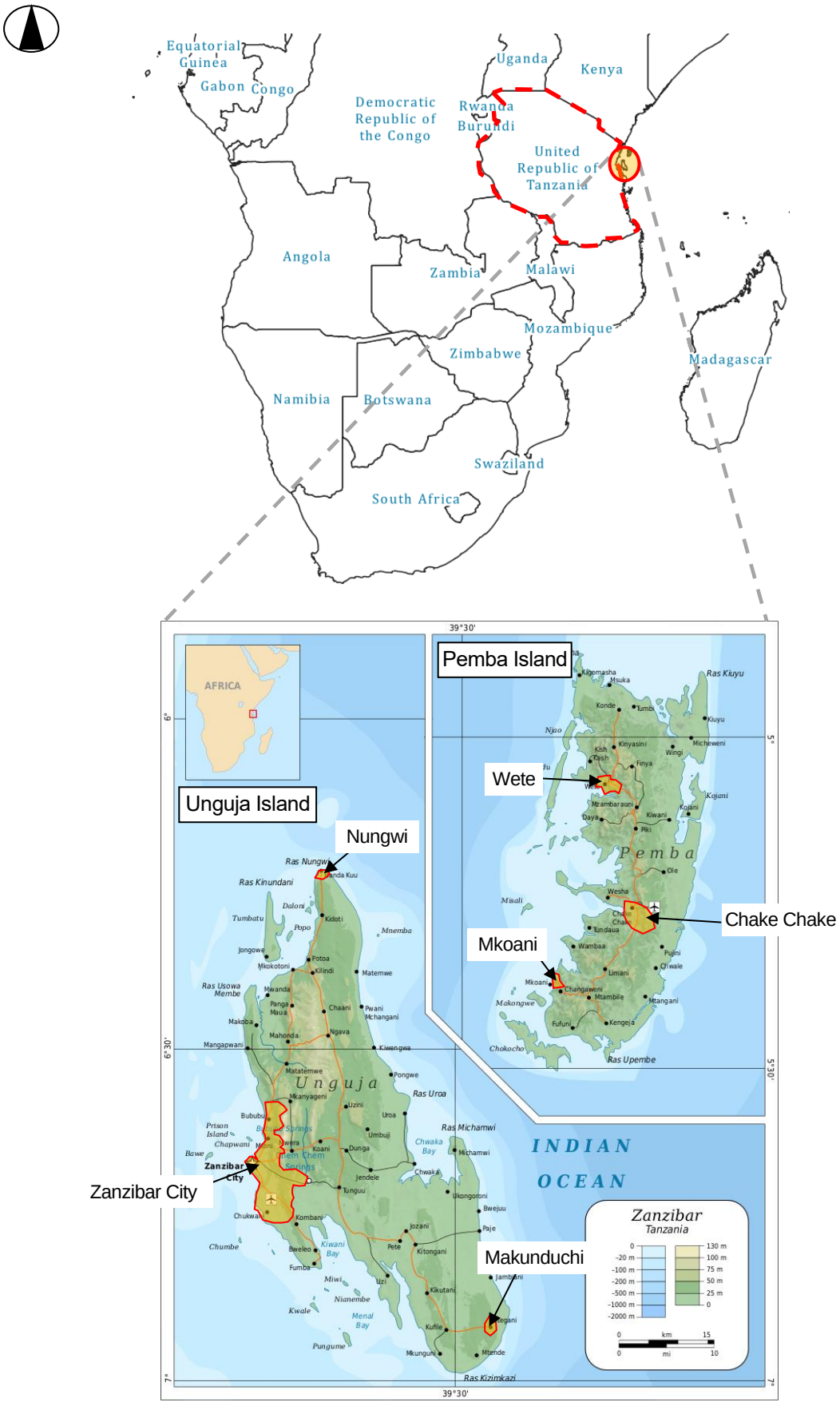


Source: Wikipedia (edited by JICA Survey Team)

Survey area

Photos

Photo 1: Boreholes developed by ZUWSP
Borehole is outside of the chamber and not protected.

Photo 2: Piping in the chamber
A turbine flowmeter used to be used but an electromagnetic flowmeter was installed by ZUWSP.

Photo 3: Indicator of the electromagnetic flowmeter
Instantaneous flow rate was 135.9 m^3/hour, and it is functioning, but the data should be utilized for operation management.

Photo4: Shallow transmission pipeline
The pipeline is exposed above the ground and easy to get damaged.

Photo 5: Rehabilitated borehole by ZUWSP
Water leakage from the air valve was observed. It is not repaired.

Photo 6: Elevated service reservoir by ZUWSP
Mnarawambao reservoir which is RC structure and effective capacity is 1,000m^3. It is in operation.

Photo 7: Flowmeter box at Saateni reservoir site
Flowmeter box constructed by ZUWSP at Saateni reservoir site.

Photo 8: Electromagnetic flowmeter at Saateni
The flowmeter was installed by ZUWSP, and it is not working. It seems the flowmeter is unwired.

Photo 9: ZAWA Training Centre

ZAWA took over the site office of the Contractor of ZUWSP and utilize it as the building of the training centre,

Photo 10: PC room at the Training Centre

Operation of Word and Excel is trained, but the number of PCs is small compared to the number of trainees.

Photo 11: Remote workshop

Workshop for NRW reduction was carried out by TV conference system from Japan. Measures for NRW reduction was discussed.

Photo 12: Workshop for water resources management

MoWEM, irrigation dept., forest dept. JICA Tanzania Office, UNICEF, etc. joined the workshop. Issue of water resources management was discussed.

Photo 13: Prior explanation of the action plan

The action plan prepared by the survey team was explained to ZAWA DG and directors and discussed.

Photo 14: Explanatory meeting of the action plan

The survey team explained the action plan to MoWEM, ZURA and ZAWA, and exchanged opinions in the meeting.

Photo 15: Pack test during meter reading survey

0.3 to 0.4mg/L of residual chlorine was detected by a pack test by the survey team during meter reading survey

Photo 16: Detected water leakage

The puddle was water leakage because residual chlorine was detected.

Abbreviation

AfDB	African Development Bank
ARU	Ardhi University
AWP	Annual Work Plan
BSCLC	Board Secretary and Chief Legal Counsel
CBET	Competency-Based Education and Training
CCM	Chama Cha Mapinduzi（in Kiswahili）
DCS	Directorate of Corporate Services
DoEM	Department of Energy and Mineral
DoWD	Department of Water Development
DMA	Districted Metered Area
DR	Directorate of Regulatory
DWR	Department of Water Resources
EWURA	Energy and Water Utilities Regulatory Authority
EXIM-BI	Export Import Bank of India
FINNIDA	Finnish International Development Agency
GIS	Geographic Information System
GPRS	General Packet Radio Service
HDPE	High Density Polyethylene
IWRM	Integrated Water Resources Management:
JICA	Japan International Cooperation Agency
KPI	Key Performance Indicator
LPG	Liquefied Petroleum Gas
MAINRL	Ministry of Agriculture, Irrigation, Natural Resources, and Livestock
M&E	Monitoring and Evaluation
MKUZA	Mkakati wa Kukuza Uchumi na upunguza Umaskini Zanzibar
MLHWE	Ministry of Land, Housing, Water and Energy
MoEST	Ministry of Education, Science and Technology
MOU	Memorandum of Understanding
MoWEM	Ministry of Water, Energy and Mineral
MWE	Ministry of Water and Energy
NRW	Non-Revenue Water
OJT	On-the-Job Training
PAS	Performance Appraisal System
PDCA	Plan, Do, Check and Action
PR	Public Relation
PSE	Political Science Expert
RGoZ	Revolutionary Government of Zanzibar
RIWSSZ	Rehabilitation and Improvement of Water Supply and Sanitation in Zanzibar
SBM	Smart Billing Manager
SBP	Strategic Business Plan
SCADA	Supervisory Control and Data Acquisition
SDGs	Sustainable Development Goals
SMS	Short Message Service
SWOT	Strengths, Weaknesses, Opportunities and Threats
TPSC	Tanzania Public Service College
TZS	Tanzanian Shillings
UAE	United Arab Emirates
UDSM	University of Dar es Salaam
VETA	Vocational Education and Training Authority
VTA	Vocational Training Authority
ZAWA	Zanzibar Water Authority

ZBS	Zanzibar Bureau of Standards
ZECO	Zanzibar Electricity Corporation
ZEMA	Zanzibar Environmental Management Authority
ZDV	Zanzibar Development Vision
ZNS	Zanzibar Standards
ZPC	Zanzibar Planning Commission
ZPRP	Zanzibar Poverty Reduction Plan
ZSGPR	Zanzibar Strategy for Growth and Poverty Reduction
ZTC[1]	Zanzibar Training Center
ZTC[2]	ZAWA Training Center
ZUWSP	Zanzibar Urban Water Supply and Sanitation Project
ZURA	Zanzibar Utilities Regulatory Authority
ZWDP	Zanzibar Boreholes Drilling Project
WASA	Water Supply and Sanitation Authority
WASH	Water, Sanitation and Hygiene
WI	Water Institute
WRMB	Water Resource Management Board

Chapter 1 Outline of the Survey

1.1 Background of the Survey

(1) From the Commencement of Water Supply to the Establishment of ZAWA

Zanzibar in the United Republic of Tanzania (hereinafter referred to as "Tanzania") has supplied water using groundwater and spring water as water sources since the 1920s. The Revolutionary Government of Zanzibar (hereinafter referred to as "RGoZ"), which took over the water supply business in 1964, provided water services free of charge mainly for domestic use perceived under the social security perspective in 1982. As a result, financial difficulties caused by a decrease in water supply revenue made it difficult to renovate or expand water supply facilities, and the water services were getting worse, such as time-limited water supply and/or suspension of water supply, and at the same time, customer management efforts were neglected.

Under these circumstances, in 2002, RGoZ published Zanzibar Vision 2020, which aims to eradicate absolute poverty, and in response to it, the Ministry of Land, Housing, Water and Energy (currently the Ministry of Water, Energy and Minerals, hereinafter referred to as "MoWEM") published the National Water Policy in 2004. Furthermore, in 2006, the Water Act was enacted and the Zanzibar Water Authority (hereinafter referred to as "ZAWA") was established, and after the Water Regulations were enforced in 2007, the water service shifted to be charged again.

(2) Since the Establishment of ZAWA

In line with this movement, Japan provided grant aid to develop water facilities such as boreholes, service reservoirs, and main pipelines and improve water services in urban areas of Zanzibar and implemented the Technical Cooperation Project to establish a water bill collection system by ZAWA. After that, in addition to further strengthening the bill collection system, the Technical Cooperation Project Phase 2 (hereinafter referred to as "TC Phase 2") was implemented with the main purpose of promoting measures against non-revenue water and strengthening of management capacity. TC Phase 2 included various activities such as business operation, organizational reform, human resource development, updating customer information by conducting water faucet survey, OJT related to meter reading and toll collection work, construction of DMA in a pilot area, and improvement of water supply service by updating old pipelines. However, it has not been sufficiently improved. The expected main causes were low willingness to pay (collection rate: about 6%, at Unguja in March 2017) due to the insufficient water services (leakage rate about 60%, average water supply time less than 6 hours) and unfairness between metered customers and flat-rate customers, the lack of core capacity (intention and attitude to carry out business, management ability, leadership), etc.

In order to improve the situation of the Zanzibar water supply, JICA conducted the preparatory survey to improve the distribution facilities of urban water supply in Urban West Region (hereinafter referred to as "Preparatory Survey") and planned implementation of the Japanese ODA -loan project with the aim of realizing safe and sustainable water supply. In addition, RGoZ also receives assistance from other donors as shown in Table 1.1, and it is expected to significantly improve the water supply facilities of ZAWA and the foundation for sound water service is being formed.

On the other hand, institutional and organizational issues have also arisen to receive assistance from these multiple donors. Improvement of an organizational system for the introduction of prepaid meter system by the EXIM-BI Project and seawater intrusion due to inadequate groundwater management are concerns.

Under these circumstances, JICA dispatched a Zanzibar Water Advisor (from February 2019 to January 2021) to carry out various advisory services of which main items are loan business management, water resource management, and water administration system reform.

In addition, as actions related to the water sector, the Zanzibar Utilities Regulatory Authority (hereinafter referred to as "ZURA") was established in 2015 to regulate the services of water supply, electricity, and oil in Zanzibar. In October 2020, a new government and MWE was established by the reorganization. In May 2021, a new Director General of ZAWA was appointed. In addition, Zanzibar Development Vision 2050, which shows Zanzibar's future development policy, was announced in October 2020.

Table 1.1 Support from Donors

Donor	African Development Bank (AfDB)	UAE Emirate of Ras Al Khaimah	The Export–Import Bank of the India (EXIM-BI)	Japanese ODA Loan Project
Target Area	Urban West Region (Central Area)	All areas	Urban West Region (Other than Central area)	Urban West Region (Welezo, etc.)
Implementation period	Completed in 2020	Completed in 2016	Started in 2017	soon
Main maintenance contents	Repair of boreholes (12 places), New boreholes (9 places), Water transmission pipelines (25.2km), Service Reservoir (2 tanks), Distribution pipelines (63.3km), Water meters (7000 units)	150 Boreholes	Development and Renewal of water supply facilities, introduction of smart meters	Development and Renewal of water supply facilities
Water demand, etc.	Planned demand (2032) 20,100m^3/day※	Supply capacity 45,900m^3/day	Planned demand (2032) 140,000m^3/day※	Planned demand (2032) 22,000m^3/day※

※Water Demand is forecasted values based on the Preparatory Survey Final Report
Source: JICA Survey Team

1.2 The Purpose of the Survey

The purpose of this survey is to collect information that contributes to the enhancement of the Zanzibar water administration and water utility management system through the study of the following four items.

(1) Study of measures to current urgent issues
(2) Study of Zanzibar water sector's mid-to-long term action plan to improve basic management issues such as water source management, facility management and customer management, and underlying issues such as organization operation, human resource development and legal system
(3) Study of current possible support measures for the implementation of above measures and actions
(4) Study of JICA's mid-to-long term support in addition to the planned projects such as the loan project

At present that the improvement of water supply facilities by the various projects is gradually being proceeded with the support of donors, it is important to formulate an Action Plan to solve issues of soft components such as organizational management, human resource development, legal system, and facility management including groundwater, and consider the direction of urgent and mid-to-long term support.

Table 1.2 Survey Area and Survey Cooperation Organizations

Item	Area and Organization
Survey area	Zanzibar
Related organizations	Ministry of Water, Energy and Mineral (MoWEM) Zanzibar Utilities Regulatory Authority (ZURA) Zanzibar Water Authority (ZAWA)
Survey period	From August 2nd, 2021, to February 28th, 2022

Source: JICA Survey Team

Chapter 2 Overview and Issues of Zanzibar Water Sector

2.1 Structure of Zanzibar Water Sector and Overview of Water Supply

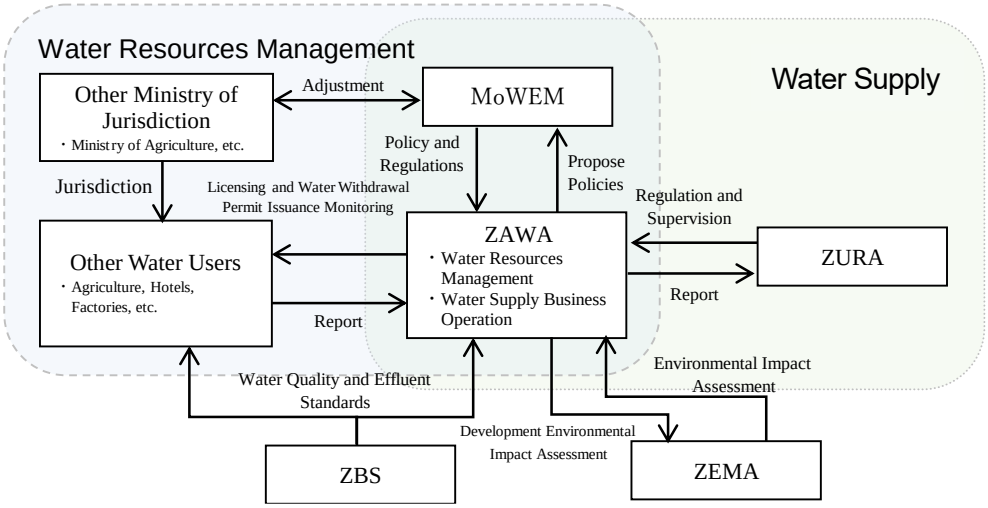
(1) Overall Structure of Zanzibar Water Sector

The water sector in Zanzibar has been managed by the Ministry responsible for water since the Revolutionary Government of Zanzibar took over the water supply utility at Zanzibar's independence in 1964. With the enactment of the Water Act and the establishment of ZAWA in 2006, all authority over water supply, including water resources, was transferred to ZAWA. ZAWA has a wide range of authority, from conservation of water resources to implementation of projects and policies such as development of water supply facilities, and operation of water supply projects, with the following roles defined.

1. Control, management, and protection of all catchment areas, and legal action against violation, disturbance, and encroachment of catchment areas
2. Ensuring continuous water supply throughout Zanzibar
3. Development and maintenance of waterworks plan and implementation of new water supply projects
4. Promotion of conservation and proper use of water resources
5. Management of the sustainable production and distribution of water
6. Advising the government in formulating policies on the development and conservation of water
7. Collection of fees for water supplied and services offered to consumers
8. Implementation of other matters to carry out the provisions of Water Act

The responsibilities of MoWEM are limited in the current Water Act and are to formulate and revise regulations implementing the Water Act, appoint ZAWA Board members, and restrict water use during water shortages and emergency situations.

The agencies related to the water sector include the Zanzibar Environment Management Agency ("ZEMA"), which reviews the environmental impact of development and other activities, and the Zanzibar Bureau of Standards ("ZBS"), which establishes standards related to water quality and wastewater discharge. Figure 2.1 shows the structure of the water sector in Zanzibar.



Source: JICA Survey Team

Figure 2.1 Structure of the Water Sector in Zanzibar

(2) Water Supply Status

According to the 2012 Census, Zanzibar had a population of approximately 1.3 million and 253,608

households in 2012. Population growth in Zanzibar is projected to continue, with the population expected to reach approximately 1.9 million in 2025 and 2.12 million in 2030, according to the National Population Projections (February 2018). Zanzibar is in an environment where water demand is expected to continue to increase as the population grows.

Table 2.1 shows ZAWA's key business indicators. ZAWA relies on groundwater for its water sources and, as of 2018, utilizes 5 springs (2 on Unguja Island and 3 on Pemba Island), 7 cave water (all on Unguja Island), 303 boreholes (173 on Unguja Island and 130 on Pemba Island), and annual water yield was estimated at 39.4 million m^3 (an average of approximately 108,000 m^3/day).

On the other hand, the amount of water consumption was estimated to be 14.6 million m^3 per year (daily average of approximately 40,000 m^3/day), from which the rate of water loss was estimated to be approximately 63%. Although information on water theft has not been managed, it is not expected that there is much water theft that bypasses water meters under the current circumstances due to the small number of water meters installed. Estimated water supply cost (expenses[1]/consumption) in 2018 was 456.4TZS/m^3. The number of boreholes has increased significantly since 2008, and the total number of customers has also increased, but water meter installations remain low.

Table 2.1 Main Indicators Related to Water Services (Estimated Values)

Item	2008	2013	2018
The amount of water yield (1,000 m^3/year)	33,017	34,922	39,417
The amount of water consumption (1,000 m^3/year)	3,058.	14,549	14,584
Coverage rate (%)	65%	74%	83%
Number of boreholes	99	230	303
Non-revenue water ratio	91%	85.2%	63%
Number of new customers	N/A	3,000	5,604
The total number of customers	57,000	71,990	100,010
Water meter installation rate (%)	—	3%	12%

Source: ZAWA Strategic Business Plan 2020/21-2024/25

(3) Summary of Ongoing and Recently Implemented Projects

ZAWA is implementing projects that leverage funding from JICA and other development partners to address weaknesses and challenges related to reliable water supply and is developing water sources (boreholes) and constructing service reservoirs and pipelines. Most recently, Zanzibar Borehole drilling Project ("ZWDP") by Ras Al Khaimah of the UAE, African Development Bank ("AfDB") project to develop water supply facilities in the centre of Zanzibar, including Stone Town (Zanzibar Urban Water and Sanitation Project ("ZUWSP") has been completed. In addition, a project supported by EXIM-BI (Rehabilitation and Improvement of Water Supply System in Zanzibar, hereinafter "RIWSSZ") is underway.

Table 2.2 Outline of the Project in Zanzibar

Project Name	Donor	Project Cost (Mil-USD)	Borehole	Service Reservoir	Pipe Length (km)	Project Object
ZWDP	Ras Al Khaimah	1.5	150	6	251.5	Unguja and Pemba Island
ZUWSP	AfDB	21	New 9, Repair 23	2	80.0	Part of Urban West Region
RIWSSZ	EXIM-BI	92.18	64	7	479.3	West A, West B, Central District

Source: ZAWA Strategic Business Plan 2020/21-2024/25

[1] The expenses were 6,656 million TZS (Report on Audited Financial Statements of Zanzibar Water Authority, 2019)

2.2 Overview of Water Sector in Zanzibar

2.2.1 Overview of Water Administration and Legislation

(1) Water Administration in Zanzibar

Except for "Union Matters"[2] provided for in the Constitution of the United Republic of Tanzania, legislative, executive, and judicial powers are vested to the House of Representatives, the Revolutionary Council, and the High Court and its subordinate courts of Zanzibar for matters relating to the internal affairs of Zanzibar. Under the autonomy, the Revolutionary Government of Zanzibar administers internal affairs separately from the mainland by formulating national development plans for Zanzibar, relevant policies for various sectors, laws and regulations, and sector development programs. Zanzibar has its own policies, laws and regulations, and a competent ministry for the water sector. ZAWA confirmed that no specific laws and regulations of the United Republic or the Mainland affect water resources management and water supply services in Zanzibar.

(2) National Development Plan

The Government of Zanzibar has developed a long-term comprehensive development strategy, the Zanzibar Development Vision, and a medium-term strategy, the Zanzibar Strategy for Growth and Reduction of Poverty ("MKUZA" in Swahili abbreviation). Water, Sanitation, and Hygiene (WASH) has been identified as one of the priority social services to be improved in order to achieve the social well-being of the people that these medium- and long-term strategies aim to achieve.

(a) Zanzibar Vision 2020 and Zanzibar Development Vision 2050

The Government of Zanzibar has developed Zanzibar Vision 2020 (2000-2020)[3] ("Vision 2020") and its succession plan, Zanzibar Development Vision 2050 (2020-2050) ("ZDV50"). The implementation of the Vision is embodied in MKUZA, a five-year medium-term development strategy, and in sectoral policies, strategies, and development programs.

The goal of Vision 2020 and policy objectives related to WASH are shown in Table 2.3. According to the results of the Vision 2020 evaluation[4], nine of the 14 targets were "Achieved," one was "Nearly Achieved," and four were Not Achieved." For the target of access to safe water, the proportion of households using

[2] Applicable areas are as follows: 1. the Constitution of Tanzania and the Government of the United Republic, 2, 4. police, 5. emergency powers, 6. citizenship, 7. immigration, 8. external borrowing and trade, 9. service in the Government of the United Republic, 10. Income tax payable by individuals and by corporations, customs duty and excise duty on goods manufactured in Tanzania collected by the Customs Department, 11. Harbours, matters relating to air transport, posts and telecommunications, 12. All matters concerning coinage and currency for the purposes of legal tender (including notes), banks (including savings banks) and all banking business; foreign exchange and exchange control, 13. Industrial licensing and statistics, 14. higher education, 15. mineral oil resources, including crude oil other categories of oil or products and natural gas, 16. The National Examinations Council of Tanzania and all matters connected with the functions of that Council, 17. civil aviation, 18. research, 19. Research, 19. meteorology, 20. statistics, 21. the Court of Appeal of the United Republic, and 22. registration of political parties and other matters related to political parties (the First Schedule) related to political parties (the First Schedule of the Constitution of the United Republic of Tanzania of 1977 (2005))

[3] Zanzibar Vision 2020 (2000) and Revised Zanzibar Development Vision 2020 Working Document (2011). Based on a review conducted at the end of the first 10 years of the Vision 2020, the government revised the Vision's goal, indicators and targets for each priority area, and the policy directions and targets for each priority area.

[4] Zanzibar Planning Commission (2020) Evaluation of Zanzibar Vision 2020

protected water sources for drinking in the dry season was 91.5% (88.3% in rural, 95.9% in urban)[5], and the proportion of households within 1 km of water source in the dry season was 98.8% (98.0% in rural, 99.8% in urban)[6], which is "Nearly Achieved" compared to the target of 100%.

Table 2.3 Overall Goal of the Zanzibar Vision 2020 and WASH Related Policy Objectives

Goal/Objective		Descriptions
Vision 2020's Goal		[Original Program] To eradicate abject poverty and attain sustainable human development. [2011 Revision] To transform Zanzibar into a middle-income country and enable it to eradicate absolute poverty in the society through building a strong and competitive economy; achieve high quality livelihoods for citizens and improve good governance and the rule of law without compromising Zanzibar's rich culture.
Objectives on Sustainable Provision of Water		• Develop and promote efficient water supply and management systems to ensure reliable water supply for all purposes at a reasonable cost. • Establish and protect water catchment areas and sources of rainwater harvesting systems. • Promote community ownership and rights to the water supply. • Enhance equity of access, distribution, and sustainable supply of clean water to households in rural and urban areas. • Ensure that the installed capacity for water supply functions adequately and is properly maintained. • Encourage a broad range of environmentally sound technologies in the provision of water, including gravity piped, pressure pumps, deep and shallow wells, open wells, and dams. • Encourage the development of rainwater harvesting technologies and activities. • Institute and maintain an efficient and effective water tariff, billing, and timely revenue collection system for all water users.
Objectives on Enhanced Sanitation and Urban Cleanness		• Rehabilitate and improve the sewerage, drainage, and solid waste disposal systems through designing mechanisms for financing urban cleanness, the operation and maintenance of the sewerage and solid waste disposal systems. • Emphasize providing services, specifically, treatment and disposal of wastewater and solid wastes, that provide wider communal benefits. • Develop flexible and responsive institutional mechanisms for providing urban cleanness and sanitary services, with a wider role for community organizations and the private sector. • Promote the establishment of centralized waste disposal facilities and contaminated garbage disposal dumps. • Undertake awareness creation on issues related to urban cleanness and environmental sanitation. • Promote ventilated improved pit (VIP) latrines, especially in rural areas. • Enhance inter-sectoral collaboration in dealing with sanitation problems. • Encourage the use of economic incentives, pricing, and costing methods for efficient use and disposal of water. • Put into place and enforce rules and regulations that provide incentives for urban cleanness and penalize polluters and recognize the roles of municipal and other urban authorities in collaboration with law enforcement agencies in enforcing the rules and regulations.
Objectives in Related Areas	Health	• Improve the health and nutritional standard of the Zanzibar community generally and specifically for women and children. • Provide standard basic health services for all within community vicinities.
	Habitat	• Improve the provision of basic infrastructure and services like water, sewerage systems, electricity, and access roads to the allocated land.

[5] OCGS (2020) 2019/20 Household Budget Survey

[6] same as above

	Children	• Enable all children to have full access to quality education, quality health and water services, and nutritious food, crucial for their future healthy and productive lives. • Strengthen the capacity of households and communities in providing health care and schools' care to children. • Reduce infant mortality rates from 101 (1997) to 20 per thousand live births by the last year of the Vision 2020. • Improve Maternal and Child Health (MCH) services.

Source: Summarized from the Zanzibar Vision 2020 (2000) and Revised Zanzibar Development Vision 2020 Working Document (2011)

To achieve the Vision's goal, the current ZDV50 focuses on four themes, which are "Pillar I: Economic Transformation," "Pillar II: Human Capital and Social Services," "Pillar III: Infrastructural Linkages," and "Pillar IV: Governance and Resilience." ZDV50 has also set "Aspiration" and Key Performance Indicators (KPIs) for each priority area. These KPIs and macroeconomic indicators are evaluated every ten years. The plan also incorporates the evaluation results on the achievement of Vision 2020 and international commitments such as SDGs and the African Union's "Agenda 2063".

ZDV50 places WASH as a priority area under "Pillar II: Human Capital and Social Services," along with education and training, health, social protection and employment, research and innovation, and culture, heritage, and sports. Table 2.4 summarizes the goal of ZDV50 and development objectives on WASH and related areas, and Table 2.5 shows KPI for these priority areas. Definitions and means of verification of KPIs are not explained in ZDV50. Zanzibar Planning Commission (ZPC) is responsible for formulating and monitoring the national development plans. According to the interviews with MoWEM, ZURA, and ZAWA, the organizations have not reported the progress of KPIs to ZPC since the formulation of ZDV50, and definitions and means of verification of the indicators set in ZDV50 are not known.

Table 2.4 Overall Goal of ZDV50 and Policy Objectives Related to WASH

Goal/Objective	Descriptions
ZDV50's Goal	To attain Upper Middle-Income Status by 2050 through sustainable and inclusive human development.
Pillar II: Human Capital and Social Services	[Objective] Develop a healthy, competitive, innovative, and productive human capital base, supported by reliable and sustainable social services for all, to contribute effectively to national and global development.
2.4 Priority Areas in WASH	[Strategic Direction] Towards greater accessibility, affordability, and sustainability of water resources, sanitation services, and hygiene practices, ensuring all households and public institutions have access to safely managed water and sanitation [Aspirations] 2.4.1 Sustainable access to safe and clean drinking water facilitated by an effective water resource management master plan and associated strategies, focusing on integrated water resources management to protect the water ecosystem 2.4.2 Diversified potable water sources reinforced by the exploration of undersea freshwater, rainwater harvesting, and reuse technologies, as well as seawater desalination 2.4.3 Optimal water supply management for agriculture, tourism, industry, and other economic activities supported by continuous R&D on sustainable sources 2.4.4 Sustainable sanitation service provision through effective sanitation-focused interventions, including the enforcement of the 'polluter pays' principle and the construction of sewerage treatment systems for households and industry 2.4.5 Strong institutional framework for the sustainable and responsible collection, processing, and disposal of solid, liquid, and hazardous waste that focuses on

		empowering LGAs and other relevant institutions.
Related Areas	2.1 Education	2.1.6 An optimum school environment with adequate hard and soft infrastructure for learners at all levels, ensuring greater inclusiveness through targeted arrangements for children with special needs, including the disabled and those at risk of dropping out
	2.3 Health	2.3.1 A highly reliable and accessible primary healthcare sector that incorporates strong health promotion and community health programs targeting the prevention and management of non-communicable and communicable diseases, including HIV/AIDS 2.3.6 A multisectoral approach to healthcare at the forefront of social services by strengthening linkages to education through training; to water, sanitation, and hygiene through disease prevention; and to tourism through medical tourism where appropriate
	3.1 Housing and Settlements	3.1.1 Universal access to adequate, safe and affordable housing and basic quality services with adequate access to key transportation networks, emphasized by the upgrading of unplanned settlements and regeneration of urban areas into modern settlement 3.1.2 Eco-friendly, sustainable, innovative, and cost-effective building methods to avoid misallocation of resources and environmental destruction

Source: Summarized from Zanzibar Development Vision 2050 (2020)

Table 2.5 KPIs for WASH and Related Sectors Set in ZDV50

Sector	Indicator[*1]	Baseline (2019)	Target (2030)	Target (2040)	Target (2050)
2.4 WASH	Water supply to demand ratio	67.8	80	85	90
	The proportion of households using protected water sources	91.5	97	100	100
	The proportion of households connected to central sewerage and drainage systems	<10	20	50	70
	The proportion of total solid waste collected regularly	0.03-22.9[*2] (2012)	31	54	78
	Water Quality Index	40	35	30	25
	Wastewater Quality Index	―	TBD[*4]	TBD	TBD
2.1 Education	The proportion of schools with adapted infrastructure and materials for Pupils with Disabilities (PDWs)	―	33	65	100
2.3 Health	Infant mortality rate (per 1,000 live births)	45 (2014/15)	32	28	23
3.1 Housing & Settlements	The proportion of households with access to basic services[*3]	―	41	65	88

*1: Definitions and means of verification of the indicators are not specified in ZDV50.

*2: The baseline values show the minimum and maximum figures disaggregated by regions. The target values are national averages.

*3: A house that fulfils basic infrastructural demands, including electricity, improved sanitation facilities, improved water sources, and access to clean fuels for cooking

*4: TBD: to be determined

Source: Zanzibar Development Vision 2050 (2020)

(b) Zanzibar Strategy for Growth and Reduction of Poverty (MKUZA)

MKUZA is the medium-term development framework for implementing Vision 2020, succeeding the Zanzibar Poverty Reduction Plan (ZPRP) (2002-2005). MKUZA has been formulated over three phases since 2007. MKUZA IV (2020-2025), which corresponds to the first five years of ZDV50, has not been developed at the time of this survey.

MKUZA III was prepared based on Vision 2020 and MKUZA II, with the theme of "economic growth and social development for the well-being of all" and the mission of "achieving social and economic prosperity to reach middle-income status." Under the mission are five Key Results Areas: "A: Enabling Sustainable and

Inclusive Growth," "B: Promoting Human Capital Development," "C: Providing Quality Service for All," "D: Attaining Environmental Sustainability and Climate Resilience," and "E: Adhering to Good Governance Principles." WASH is positioned in the Key Results Area "C: Providing Quality Service for All."

Table 2.6 shows the policies and strategic directions for the WASH sector presented in the first through third strategies.

Table 2.6 Policies and Strategies Related to the WASH Sector in MKUZA

Strategy (Period)	Policies and Strategies Related to WASH Sector
MKUZA (2007-2010)	**[Cluster II]**: Social Services and Well-being **[Goal 3]**: Increased access to clean, safe, and affordable water **[Goal 4]**: Improved sanitation and sustainable environment **[Priority Interventions Related to Water]** • Implement the water policy and water sector reforms. • Protect water sources, catchments, and water corridors to ensure the safety of the water supply in Zanzibar. • Research the potential use of groundwater with a focus on developing management and exploitation plans along with guidelines for underground water extraction. • Putting in place all related legal and regulatory frameworks for these kinds of interventions. • Strengthen the management of schemes (including exploitation of water resources and protection of catchments areas). • Undertake effective rehabilitation and regular maintenance of infrastructure in urban and rural areas. • Promote and strengthen public-private partnership in water development, supply, and financing. • Promote community-based management of water supply to ensure long-term water supply. • Develop and strengthen human resources capacity in management, rehabilitation, and regular maintenance of water supply infrastructure. • Introduce and promote the use of appropriate and affordable water technology. **[Priority Interventions Related to Sanitation and Hygiene]** • Require all public places, such as schools, hospitals, clinics, and markets, to maintain sanitation standards acceptable for sustainable management of solid and liquid wastes. • Formulate policies to guide and encourage large businesses to use modern sewage and solid waste treatment methods that are environmentally friendly. • Promote Ventilated Improved Pits (VIPs) at the village level. • Enforce laws and regulations that guide the provision of sanitation facilities and environmental management. • Incorporate public awareness, hygiene and environmental education as part of water and sanitation services delivery. • Promote public-private partnership and involvement of CSOs and communities in sanitation delivery and environmental and solid waste management. • Develop and implement a comprehensive Zanzibar Waste Management Master Plan.
MKUZA II (2010-2015)	**[Cluster II]**: Social Well-being and Equitable Access to Social Services **[Goal 3]**: Improved access to water and environmental sanitation and hygiene **[Core Cluster Strategies Related to Water Supply]** • Expand water infrastructure and access in both rural and urban areas • Improve and sustain water supply services in rural and urban areas • Ensure cleanness and safety of water • Strengthen technical management of ZAWA • Strengthen financial management of ZAWA • Enhance integrated management of database on groundwater abstraction activities • Ensure efficient and effective Integrated Water Resources Management • Ensure proper coordination of domestic and external financing • Ensure water sector networking and partnership

	[Core Cluster Strategies Related to Sanitation and Hygiene] • Facilitate construction and use of sanitary facilities in both rural and urban areas and good hygiene practices • Strengthen and safeguard the provision of sanitation services • Increase access to sanitation facilities in public places and institutions • Develop sewerage and drainage and solid wastes disposal facilities and promote good hygiene practice
MKUZA III (2016-2020)	**[Key Results Area C]**: Providing Quality Services for All **[Outcome C1]**: Improved access to quality health and sanitation services, safe and clean water, and a mitigated burden of communicable (including HIV, soil-transmitted helminthiasis, neglected tropical diseases) and non-communicable diseases **[Objective in Water Sector]**: To provide equitable access to quality, clean and safe water for all water users, thereby fulfilling the needs of expanding social and economic activities while also considering nature conservation. **[Objective in Sanitation and Hygiene]**: To ensure that all households access improved toilets and other sanitation and hygiene amenities, such as solid waste management, hand washing with soap at critical times, and food hygiene. **[Program for Water Sector]**: Zanzibar well drilling and water supply project, augmentation of water supply schemes, water supply and sanitation project, urban water distribution facilities improvement project **[Key Strategic Actions]**: • Develop and rehabilitate water infrastructure • Conserve and protect catchment areas • Promote water revenue and services • Invest solar energy in pumping stations • Promote safe methods of waste management • Invest in infrastructure to access sanitation and hygiene behaviour and practices in households • Promote safe methods of waste management

Source: Summarized from MKUZA (2007), MKUZA II (2010), and MKUZA III (2017)

(c) Roadmap to Sustainable Development Goals (SDGs) in Zanzibar 2020-2030

The Government of Zanzibar has issued the Zanzibar SDGs Roadmap 2020-2030 and the Annual SDGs Implementation Report 2019/2020 based on the Roadmap in 2020[7]. The Roadmap was developed at the initiative of ZPC as a guide to promoting the implementation, monitoring, and evaluation of SDGs under coordination among relevant stakeholders. It has been designed based on MKUZA III and IV and Vision 2020 and ZDV50. The roadmap outlines the roles of relevant organizations in the implementation, monitoring, and evaluation of the SDGs, as well as the outcomes, outputs, key activities, KPIs, baselines, targets, costs, and responsible entities required to achieve each target of SDGs.

Table 2.7 shows outcomes, outputs, key activities, KPIs, and baselines for "Goal 6 Clean Water and Sanitation." While KPIs for water supply are the same as those used in the evaluation at the end of Vision 2020, no target values are set for these indicators in the Roadmap. In addition, outputs, key activities, and KPIs do not necessarily correspond to each other and are not consistent with the KPIs for the WASH sector set in MKUZA III and ZDV50.

[7] Zanzibar Planning Commission (ZPC) (2020) Roadmap to Sustainable Development Goals (SDGs) in Zanzibar 2020-2030, ZPC (2020) Annual Sustainable Development Goals (SDG) Implementation Report, 2019/2020 Zanzibar. A report on Zanzibar Voluntary National Review (VNR) was also prepared by ZPC in 2019 prior to the formulation of the Roadmap. Information from that VNR report is reflected in Tanzania's 2019 VNR Report submitted by the Government of the United Republic of Tanzania to the United Nations High-Level Political Forum on Sustainable Development (HLPF).

Table 2.7 Expected Outcomes, Outputs, and Key Activities Related to Goal 6 "Clean Water and Sanitation" in the Roadmap to SDGs in Zanzibar

Expected Outcome	Outputs	Key Activities	KPIs	Baseline	Status 2019/20
Attainment of adequate and equitable access to potable and affordable water supply, sanitation, and sewerage services for all by 2030	Developed and implemented water policy and enactment of Act	Support the development and implementation of water policy and enactment of the act to manage, protect and conserve water resources.	The proportion of households using protected water sources for drinking in dry seasons	90.5%	91.5%
	Improved number of people who have access to water resources and services in Zanzibar	Develop and maintain infrastructure for water resources in Unguja and Pemba.	The proportion of households within 1km of drinking water source in the dry season	96.9%	98.8%
		Conduct international, regional, and national capacity building programs in water harvesting, desalination, water efficiency, wastewater treatment, recycling, and reuse technologies.	The proportion of the population using handwashing facilities with soap and water The proportion of the population using safely managed sanitation services, including a handwashing facility with water and soap	25.3%	16.7%
	Reduced occurrences of waterborne disease outbreaks in Unguja and Pemba	Protect and restore water-related ecosystems, including wells, forests, wetlands, rivers, aquifers, and lakes.			
		Promote access to adequate and equitable sanitation and hygiene for all and end open defecation to those in vulnerable situations.			
		Improve water quality by treating and reducing pollution, eliminating dumping and minimizing the release of hazardous chemicals, and recycling materials.			

Source: Roadmap to Sustainable Development Goals (SDGs) in Zanzibar 2020-2030 (2020)

(3) National Water Policy 2004

In response to Vision 2020, the Government of Zanzibar formulated the National Water Policy[8] in 2004 as the basic policy on water resources management and water supply. The implementation structure of the water sector is as follows: the Department responsible for water is assigned with formulating, promoting, and supervising the implementation of water sector policies, carrying out the functions of an executive agent and secretariat of WRMB, coordinating stakeholders, and resolving water-related conflicts; water supply services are provided by water supply institutions established at the level of village(s), towns or larger areas.

At the time of the formulation of the National Water Policy, the Department of Water Development (DWD)

[8] Ministry of Water, Construction, Energy and Lands (2004) National Water Policy

of the Ministry of Water, Construction, Energy and Land (MWCEL) was responsible for water administration and directly managed water supply services. The Policy suggested the need to transform DWD to become autonomous to manage water supply services in urban and rural areas efficiently. The goals, guiding principles, and issue-specific policies and strategies of the National Water Policy are summarized below:

[Goals]

- Public ownership of water resources to ensure access of all Zanzibaris to the resources all the time
- Protection of water resources for quality and use in accordance with water and environmental conservation principles
- Inter-sector linkages for coordinated resource development and management
- Defining the roles of different stakeholders, including beneficiaries, donors, ministries, public, NGOs, and private institutions
- Development and provision of water supply and sanitation in a sustainable manner, with a demand responsive outlook
- Institutional development and local capacity building to ensure a harmonious environment for the policy to act
- Proactive measures to prevent and control floods and to ensure that lands affected by floods are cleaned and reused
- Development of local resource base in terms of skills and materials to promote the local expertise in research and innovation to reduce outside dependence

[Guiding Principles in Water Resources Management and Development]

To comply with the Rio Declaration on Environment and Development, which reflects the concept of Integrated Water Resources Management (IWRM), the Policy addresses the necessity to develop appropriate institutional structures and legal instruments and establish efficient water use programs to attain sustainable resources utilization patterns. The guiding principles for the development and use of water resources are as follows:

- Consideration for water demands of the succeeding generations in the present use of water
- Cost recovery to realize the development and sustainability of water supply schemes
- Community participation in the operation and maintenance of water supply schemes
- Improved water supply as a prerequisite for economic and social development
- Contribution to poverty reduction
- Implementation of hygiene education to ensure the health impact of improved water supply
- Avoiding dependence on donor support
- Clear demarcation of roles of stakeholders involved in the development and maintenance of water supply schemes

Table 2.8 Issues, Policies, and Strategies Addressed in the National Water Policy 2004

Issue	Policy	Strategy
1. Ownership of water resources	Water is a basic resource, which shall remain public all the time.	• Establishment of an independent Water Resources Management Board (WRMB) to control the resources on behalf of the State (and hence the public) • Ensuring safe yields based on a scientific survey, regulation of water abstraction, monitoring of water use and quality, and legal action against violators
2. Satisfaction of basic need for water	The priority in the use of water resources will be given to the satisfaction of the population's basic needs, i.e., domestic water supply, and to satisfaction of sanitation needs of the urban and	• Control of water allocation by WRMB through issuance, withdrawal, and renewal of water extraction licenses • Introduction of the cross-subsidy in tariff structure in favour of domestic use • Introduction of a tariff structure for domestic water that

Issue	Policy	Strategy
	rural population.	discourages uneconomic use beyond basic needs
3. Ownership and management of water supply schemes	The Government wishes to relinquish management and eventually ownership of water supply schemes to beneficiary representative institutions. The role of the Government remains in monitoring, regulating and supporting role.	• Development, operation and maintenance of water supply schemes to be adapted to the requirements and capacity of beneficiaries • Awareness raising among communities to gain their understanding and support for water sector development • Establishment of Water Committees and other community organizations to ensure beneficiaries' participation throughout the project cycle • Contributing to initial funds and meeting the full O&M costs by the community • Enactment of legislation to establish water supply institutions
4. Water funds	Water supply institutions should mainly be self-financing. At least the water institutions should meet operation and maintenance costs.	• Financial sources of water supply institutions: revenues from water service customers, donor finance, local loans, government subsidies, community contributions, and concession agreements
5. Environmental protection	The development of water resources and sanitation shall be done in a way that is not harmful to the environment. The utilization of water by one generation of Zanzibaris should not in any way adversely affect the prospect of the utilization of subsequent generations.	• Regulation by WRMB (measures against pollution of water resources, the establishment of standards and procedures for water abstraction, collection of various data on water resources, issuance of water rights, permits for water resource development and abstraction, encouragement of alternative methods of collecting water (rainwater harvesting, desalination), avoidance of exploitation of perennial springs (for concerns about jeopardizing local ecosystem and economic welfare) • Regulations on importation and handling of chemicals that could lead to contamination of water resources; penalties for violators • Control and regulation on handling of solid waste • Implementation of environmental protection programs in cooperation with relevant agencies in the water, environment, sanitation, and wastewater sectors • Development of management plans within catchment areas in cooperation among the sectors involved
6. Water as an economic and social good	Water has great social importance. However, water should always be recognized as an economic good, and water-related prices, in principle, should reflect its economic value and the need to recover related costs.	• Investments in water resources activities that lead to economic growth, poverty alleviation, and improved public health • Allocation of water resources to different users in a manner that maximizes benefits to communities; adoption of an integrated approach • Conservation of water resources and prevention of negative impacts on the environment • Participation and integration of various social and economic sectors in water resources planning • Commercial principles for operation and autonomy in water supply and sanitation services • Facilitation of proactive involvement of women in planning, implementation, operation, and maintenance of water supply projects
7. Sewerage and solid waste	The effectiveness of the institution in charge of sewage disposal and solid waste handling should be enhanced to perform its tasks. Disposable materials should be	• Cooperation between the ministry responsible for water, water supply institution, and institutions in charge of sewage and solid waste disposal in urban municipalities • Establishment of regulations on the disposal of

Issue	Policy	Strategy
	handled in a safe way for water resources and the environment.	wastewater and standards for the construction of septic tanks, soak pits, and pit latrines • Charging commercial rates for the use of wastewater services • Ensuring regular treatment of industrial waste materials by operators before discharging to the central sewerage system • Establishment of solid waste disposal sites in areas isolated from water sources • Ensuring proper planning and coordination to take into account the increase in domestic wastewater quantity associated with the expansion of the water supply

Source: Summarized from the National Water Policy (2004)

(4) Water Legislation and Related Technical Guidelines and Standards

This section explains provisions of the Water Act 2006 and the ZURA Act 2013, the primary legislation of the water administration in Zanzibar, regulations, and related technical guidelines and standards.

(a) Water Act, No. 4 of 2006

The Water Act, No. 4 of 2006, consisting of seven parts and 61 sections, provides the legal framework for water resources management and development and water supply outlined in the National Water Policy 2004. With the enactment of the ZURA Act 2013, the provisions on amending water tariffs and specifying standards for drinking water quality, effluent, and water equipment (Sections 5(h)(j), 14(d), and 55) were repealed, and the related functions were transferred to ZURA.

Part I: Preliminary Provisions; Part II: ZAWA (Sections 3-9); Part III: the Board of the Authority (Sections 10-19); Part IV: Water Resources (Sections 20-29); Part V: Financial Provisions (Sections 30-34); Part VI: Offenses and Penalties (Sections 35-50); Part VII: Miscellaneous (Sections 51-61)

(i) Regulations and Guidelines

The Water Act has the following regulations. No technical guidelines have been developed.

- Water Regulations, L.N. 43 of 2007

  Consisting of a total of 95 sections, the Regulations provide requirements for water resource development, particularly regulations on well drilling and construction, construction of water supply facilities and installation of equipment, use of water supply services (customer classification, application for the service, billing and payment, and meter installation), use of water sources other than public water supply, planning and design of water supply projects, and offenses and penalties. The Regulations contain a mixture of provisions that apply to ZAWA's water supply services and procedural provisions for water resource management. The provisions related to water resources management apply to the cases where water users opt to construct their own boreholes and abstract and use water from the sources.

- Water Regulations (Amendment), L. N. 48 of 2008

  The amendments consist of establishing water fees and other charges to be collected by ZAWA, adding kiosk/standpipes users to the water service customer classifications, providing additional options and discounts for prepayment of annual water bills by non-metered domestic customers, and amending due

dates for water bills and penalties for late payment. Schedules attached to the amendment stipulate the i) tariff structure of metered and flat-rate water charges, ii) other charges for water supply services, i.e., water application form fee, water connection fees based on pipe size, and monthly service charges, and iii) other charges for well drilling and water abstraction by water users other than ZAWA, including borehole drilling fee, water (borehole) registration fee, annual abstraction permit fee, and drilling license fee.

- Charges for Water and Services, L.N. 61 of 2013

  This Regulation revised ZAWA's metered tariff and other charges set forth in the Water Regulations (Amendment) 2008. The flat-rate water fees remained unchanged from the Amendment 2008. These tariffs have been in effect since 2016.

(ii) Provisions on Establishment of ZAWA

The Water Act provided for the establishment of ZAWA as an authority to centralize the functions of water resources management and development and water supply service provision. ZAWA operates under the supervision of the Director General and on the decision-making by the Board of Directors. The Board, consisting of a Chairperson, three other members, and the Director General, is answerable to the Minister responsible for water. The President of Zanzibar is the appointing authority for the Chairperson and the Director General, and the Minister responsible for water appoints other members of the Board.

Table 2.9 summarizes the functions and powers of the ministry responsible for water and ZAWA as defined by the Water Act. Part of the sections in the Water Act was repealed by the ZURA Act 2013, which were ZAWA's functions to amend water tariffs and designate standards applied to water supply services, as well as some of the provisions regarding the scope of the regulations of the Water Act that can be made and amended by the minister responsible for water. These functions have been transferred to ZURA.

Table 2.9 Functions and Powers of ZAWA Provided in the Water Act

Organization	Main Functions and Powers
Minister Responsible for Water	• Oversight of ZAWA's operations, approval of the annual and supplementary budget • Appointment, suspension, or termination of ZAWA's Board members other than the Chairperson • Consent to establishment and revision of ZAWA's water tariffs and water service charges • Formulation and amendment of regulations of the Water Act **[By the ZURA Act, regulations concerning variations of fees and standards have been removed from the subject that the Minister makes or amends regulations.]** • Submission of ZAWA's annual reports (including audited accounts and reports and other information as directed by the Minister) to the House of Representatives • Declaration on the control and use of water supplies in the event of water shortages and emergencies
ZAWA	• Control, management, and protection of all catchment areas, and legal action against violation, disturbance, and encroachment of catchment areas • Ensuring continuous water supply throughout Zanzibar • Development and maintenance of waterworks plan and implementation of new water supply projects • Promotion of conservation and proper use of water resources • Management of the sustainable production and distribution of water

Organization		Main Functions and Powers
		• Advising the government in formulating policies on the development and conservation of water • Collection of fees for water supplied and services offered to consumers • Specifying standards of water quality, effluent, and water equipment **[Repealed by the ZURA Act]** • Proposal to the Board of Directors to amend water tariffs and water service charges **[Repealed by the ZURA Act]** • Total or partial restriction, reduction, withholding, suspension, turnoff, or diversion of water supply due to the occurrence of water shortages; implementation of repair; extension or alternation of water facilities; firefighting activities; damage to public standpipes; pollution or waste of water; delay in payment of water bills by customers; and interference of waterworks • Selling or renting, installation, and repair of water fittings or appliances to water service customers, and retaining ownership of water fittings or appliances • Entry upon lands owned/occupied by a third party to repair, maintain, renew, remove, inspect, or test water pipes • Investment of ZAWA's available funds, subject to prior approval by the Board of Directors
	Board of Directors	• Approval of annual budget, balance sheet, and statement of accounts • Advice and recommendations for organizational structure • Provision of directives to the Director General • Approval of capital works not included within any program of works approved by the Minister responsible for water (within the amount determined by the Minister) • Examination of legislative proposals relating to water supply and provision of recommendation on the enactment of regulations to the Minister • Appointment of Directors of Departments of ZAWA, approval of hiring, suspension, and dismissal of staff • Approval of staff remuneration based on the recommendation of ZAWA • Approval of amendments of water tariffs **[Repealed by the ZURA Act].**

Source: Summarized from the Water Act 2006 and ZURA Act 2013

(iii) Ownership of Water Resources and Permits for Water Abstraction and Use

Water situated within the territory of Zanzibar, including fresh, saline, marine, surface, ground, flowing or dormant water, regardless of form, location, or condition, is owned by the government, hence public water. Well owners or water rights holders from before the enactment of the Water Act are required to register their rights with ZAWA within six months of ZAWA's establishment. The water rights would expire upon the depletion of the water source or the completion of the term for which the rights were granted.

Since the establishment of ZAWA, water users who wish to independently abstract, use, divert, or store water from sources other than public water supply are required to obtain a license/permit issued by ZAWA. Based on findings from the interviews with ZAWA, water users have the following obligations when using water resources[9]:

- To obtain the following permits from ZAWA and pay charges for water abstraction and use when drilling or extending a well or borehole or constructing or expanding an intake facility of surface water. Abstraction and use of shallow wells are free of charge.

[9] Although all forms of water resources are subject to regulation, the Water Act and its regulations focus on the use of boreholes, as Zanzibar relies on groundwater for the majority of its water sources.

i) Well Owner Construction Permit: applied for and obtained before drilling work.

ii) Agreement of Water Abstraction and Uses of Water Source (Well Water Abstraction Permit): applied for and obtain after completion of borehole construction. Valid for one year and renewable.

- To comply with the use, permitted amount of abstraction, and validity periods specified in the Agreement of Water Abstraction and Uses of Water Source (Well Water Abstraction Permit).
- To take necessary measures to conserve water sources and their surroundings and prevent water pollution.

Regarding provisions for the installation of water meters or flow meters at water sources, the Water Regulations 2007 mention a flow meter as a component required for well head fittings, and also state that when water is abstracted from a well for agricultural use, a fee is charged based on the amount of water pumped as measured by a water meter. However, there is no provision in the Water Act or regulations regarding who is obligated to install water meters and flow meters for these water sources being directly abstracted by water users other than ZAWA and who is responsible for the installation costs.

In addition, drilling companies operating in Zanzibar are required to obtain i) a License to Carry out Water Well Drilling in Zanzibar (valid for one year, renewable) and ii) a borehole drilling permit for drilling every borehole[10].

According to the Department of Water Resources of ZAWA, the Agreements of Water Abstraction and Uses of Water Source (Well Water Abstraction Permit) have only been issued for boreholes. The water abstraction volume granted by the permit has not been set in any of the issued permits. An Excel-based inventory of issued well abstraction permits maintained by DWR has records of approximately 1,710 permits since 2007. It is difficult to ascertain the exact number of permits by categories of users because the user classification of each permit is not entered in the master file. The majority of the permits are for domestic use while commercial entities, hotels, and public institutions are also registered as the permit holders. With regard to the status of permit renewals, the inventory does not necessarily have records of annual renewals and renewal fee payments for every year. Due to this situation, ZAWA is unable to determine the actual status of valid permits and the use of water sources.

In addition, no water abstraction permits have been applied for or issued for water users for irrigation. According to interviews with the Department of Irrigation, Ministry of Agriculture, Irrigation, Natural Resources, and Livestock (MAINRL), the irrigation schemes maintained by the Water Users Associations (WUAs), organized under MAINRL, have been exempted from obtaining water abstraction permits and paying permit fees based on an agreement between MAINRL and the MoWEM's predecessor. WUAs or MAINRL have never notified ZAWA of particulars of intake facilities of the irrigation schemes, nor have they received any requests for information from ZAWA. However, ZAWA is not aware of this arrangement between the ministries. In the actual situation, water abstraction for irrigation is not regulated, while ZAWA is of the opinion that water users for irrigation are equally required to obtain well owner construction permits and water abstraction permits.

[10] In drilling a borehole, the borehole owner is required to obtain a well owner construction permit and the drilling company needs to obtain a borehole drilling permit from ZAWA. Also, both needs to pay permit fees.

(iv) Charges for Water Abstraction and Use

Categories and tariffs for various permits charged to water users and drilling companies are shown in Table 2.10 and Table 2.11. These tariffs are specified in the Charges for Water and Services 2013. Although the Regulation sets a flat rate for issuance and renewal of a well abstraction permit, the reality is that ZAWA applies a metered tariff structure to boreholes owned by commercial entities, hotels, and public institutions if flow meters are installed at the sources and collects fees on a monthly basis.

Also, borehole drilling permit fees are collected from drilling companies, although there is no provision in the Charges for Water and Services 2013. The provisions of the Water Regulations (Amendment) 2008 seem to be still applied.

The charges for water abstraction and use are billed and collected separately from the charges for ZAWA's water supply services. DWR is responsible for billing and collecting charges for water abstraction and use. In the case of urban areas in Unguja Island, ZAWA staff visit water users in each ward to collect well abstraction permit fees. However, due to staff shortages and procedural constraints, the collection of these charges has not been efficiently conducted.

Table 2.10 Charges for Water Abstraction and Use of Water Sources other than ZAWA's Water Supply Schemes

Category of Service	Description		Tariff (Tsh)	Remarks
Well Owner Construction Permit Fee	Domestic		20,000/BH	One-off payment for every borehole before construction
	Other Category		30,000/BH	
Well Registration Fee	All Category		50,000/BH	One-off payment for every borehole after construction
Well Water Abstraction Permit Fee	Non-Metered	Domestic	50,000/year	Flat rate
		Industrial/ Commercial/ Agriculture	500,000/year	
	Metered*1	Commercial	0-15m^3 821.48/m^3 15-30m^3 924.17/m^3 30-50m^3 1,062.85/m^3 >50m^3 1,232.22/m^3	The metered tariffs for water supply services of ZAWA are applied. The charges are collected monthly.
		Hotel and Guest Houses	0-15m^3 1,129.54/m^3 15-30m^3 1,437.60/m^3 >30m^3 1,848.34/m^3	
		Institutions	0-15m^3 924.17/m^3 15-30m^3 1,026.85/m^3 30-50m^3 1,129.54/m^3 50-100m^3 1,232.22/m^3 100-250m^3 1,437.60/m^3 250-500m^3 1,642.97/m^3 500-1,00m^3 1,951.02/m^3 >1,000m^3 2,259.08/m^3	

*1: Not stipulated in the Charges for Water and Services (2013) and other documents issued by ZAWA.
Source: Prepared by the JICA Survey Team based on the Charges for Water and Services (2013) and results of interviews with ZAWA.

Table 2.11 Charges for Licensing Registration and Well Drilling for Drilling Companies

Category of Service	Description	Tariff (Tsh)	Remarks
License for Construction of Well (Application/ Renewal)	Driller (construction of boreholes)	500,000/year	License to carry out water well drilling in Zanzibar
	Other Well Digger (construction of shallow wells/ hand-augured wells)	100,000/year	
Borehole drilling fee (for drilling companies)*1	All Category	300,000/BH	One-off payment for every borehole before construction

*1: There is no applicable provision in the Charges for Water and Services (2013). The provisions of the Water Regulations (Amendment) (2008) seem to be still applied.

Source: Prepared by the JICA Survey Team based on Charges for Water and Services (2013), Water Regulations (Amendment) (2008), and results of interviews with ZAWA.

(v) Water Resources Allocation

The Water Act sets priorities in the use of public water: 1) domestic supply, 2) agriculture and livestock use, 3) tourism development, 4) industrial use, and 5) other uses. If a serious water shortage necessitates the suspension of some water uses, the process respects these priorities, or the order determined by the directive of the Minister responsible for water.

In the event that supplies are inadequate to meet water demands due to excessive use of surface water and groundwater, drought, or emergency conditions, or if water quality has deteriorated or is threatened due to excessive abstraction, ZAWA may suspend all or part of a water abstraction permits issued for the water source or issued within a certain area for the required period. In addition, if the quantity of available water resources in a particular area is not sufficient to cover all of the permitted abstraction in that area, ZAWA may review the allocation of water in that area, reduce the quantity allowed for abstraction, and modify the terms and conditions thereof.

(vi) Conservation of Water Resources

The Water Act defines a "catchment area" as an area of land or water delimited by the Minister responsible for water, which water contributes to the supply of any waterworks, and states that ZAWA is responsible for the regulation, management, and protection of catchment areas. In addition, the Water Regulations 2007 determines a "water sources area" as the national protected area declared under the regulations of the Environmental Management for Sustainable Development Act, No. 2 of 1996[11]. It includes any other areas as shall be declared as water sources, water catchments, and pumping stations to be National Protected Areas. The provisions for establishing protected areas in Zanzibar are described in the Zanzibar Environmental Management Act 2015 and Forest Resources Management and Conservation Act 1999. Currently, no protected areas or catchments have been established to protect sources for ZAWA's waterworks or major groundwater recharge areas.

The provisions in the Water Act 2006 or Water Regulations 2007 for the conservation of catchments and water source areas are as follows:

- Wash or bathe in any part of waterworks and catchment areas or in any vessel used by ZAWA to supply water from any public standpipe, or any other activities that pollute water sources shall be guilty of an offense and liable to fine.

[11] The Act was repealed by the enactment of the Environmental Management Act (No. 3 of 2015).

- Trees shall be planted on the water sources areas or fencing as a protection measure.
- Human settlement shall be located downstream of a source or at least 500m upstream of a source, depending upon the catchments area. No construction shall be allowed within 30m from the riverbank.
- Any person who unlawfully or negligently grazes animals, applies chemical fertilizer, pesticides, and other chemicals, cuts trees or clear shrubs, disposes of all kinds of waste, or conducts any construction activities on water sources area within 200 meters from the source, shall be guilty of an offense and be liable to a fine.
- Environmental Impact Assessment (EIA) shall be conducted accordingly to the level of the project for projects that are planned to serve more than 10,000 people.

ZAWA is currently preparing to legally demarcate its nine boreholes and springs[12], which are the main water sources of ZAWA's waterworks, and their surrounding areas as the catchment areas, and to acquire title deeds for the said sites. On the other hand, ZAWA has not considered identifying groundwater recharge areas to be designated as protected areas.

(vii) Water Supply Services

Regarding the water supply services, the Water Act states that ZAWA is responsible for managing waterworks and water supply throughout Zanzibar. Furthermore, according to the Water Regulations, ZAWA's approval is required for any entities other than ZAWA to prepare proposals for water supply projects to be implemented in Zanzibar or request materials for waterworks. While Community Water Committees are allowed to enter into special agreements with ZAWA to operate and maintain waterworks, the provision has never been applied, and all water supply facilities are owned, operated, and maintained by ZAWA.

Requirements for water supply services are stipulated in the Water Regulations. To use the water supply service, an applicant needs to submit the prescribed application to ZAWA, and upon approval, ZAWA makes the water supply connection. The applicant pays costs for making the service connection as well as the water connection fee based on the size of the water meter. All water supply connections require the installation of a water meter supplied by ZAWA, and customers are required to pay water bills on a metered basis. However, a flat rate is applied if a water meter is not installed. The service connections installed become the property of ZAWA, and in the event of a meter failure, the meter is repaired or replaced at ZAWA's expense.

Customer categories of water supply services are classified as domestic, institutional, commercial/industrial, hotel/guesthouse, agricultural, and kiosk/standpipes. Table 2.12 and Table 2.13 shows metered tariff and flat-rate charges and various service charges established by the Charges for Water and Services 2013.

Meter readings are generally taken during the last week of the month to be billed, and bills are issued within 15 days of the last day of each billing period. Payment is due on the 15th of the month following the issuance of the bill, and a 30% late-payment charge is applied to all overdue amounts. If payment is not made within the same period, ZAWA may disconnect the water supply to the premises. For flat-rate customers, 12-month advance payment is allowed.

[12] Bumbwi Sudi, Chunga, Kaburi Kikombe, Kianga, Kiashange, Mchomeke, Mtopepo, Mwanyanya, Welezo

Table 2.12 Metered Tariff Charges

Customer Category	Block (m^3/month)	Tariff (Tsh/m^3)
Water Kiosk/Standpipes	—	750.00
Domestic	0-8	667.45
	8>12	821.48
	12>15	1,026.45
	15>17	1,232.22
	>17	1,540.28
Institution	0-15	924.17
	15>30	1,026.85
	31>50	1,129.54
	50>100	1,232.22
	100>250	1,437.60
	250>500	1,642.97
	500>1,000	1,951.02
	>1,000	2,259.08
Industrial/Commercial	0-15	821.48
	15>30	924.17
	31>50	1,062.85
	50>100	1,232.22
	100>250	1,437.60
	250>500	1,642.97
	500>1,000	1,951.02
	>1,000	2,259.08
Guest Houses/Hotels	0-15	1,129.54
	15>30	1,437.60
	31>50	1,848.34
	50>100	3,080.56
	100>250	4,017.42
	250>500	5,647.70
	500>1000	6,161.12
	>1,000	7,167.98
Agriculture	0-50	718.80
	50>200	872.83
	>200	1,026.85

Source: Charges for Water and Services (2013)

Table 2.13 Flat Rate Water Fees

Customer Category			Flat Rate (Tsh/month)
Water Kiosk/Standpipes			—
Domestic			4,000.00
Institution	Less than 50 staff		20,000.00
	>50≦100 staff		50,000.00
	>100 staff		200,000.00
	Community and religious, NGOs		3,000.00
Industrial/Commercial	Guest Houses	0－10 rooms	20,000.00
		>10≦20 rooms	40,000.00
		>20 rooms	75,000.00
	Hotels	Grade B	500,000.00
		Grade A	700,000.00
		1 Star	2,000,000.00
		2-3 Stars	3,000,000.00
		4-5 Stars	5,000,000.00
	Restaurants/bakeries		20,000.00
	Building constructors		120,000.00
	Small scale industries		30,000.00
	Petrol stations		20,000.00
	Car washes		40,000.00
Agriculture	Small scale		20,000.00
	Medium scale		90,000.00
	Large scale		150,000.00

Source: Charges for Water and Services (2013)

Table 2.14 Other Charges for the use of Water Supply Services

Service Category	Description	Tariff (Tsh)
Water connection fee	Pipe size 1/2" – 3/4"	46,000.00
	Pipe size 1" – 1 1/2"	56,000.00
	Pipe size 2" or more	126,000.00
Water application form	All applicants	2,000.00
Water registration fee	All customers	2,000.00
Water reconnection fee	All customers	10,000.00
Service charge for metered customers	Size of water meter 1/2" – 3/4"	1,000.00/month
	1"- 1 1/2"	1,200.00/month
	2" – 3"	2,500.00/month
	4" and above	4,000.00/month

Source: Charges for Water and Services (2013)

(b) Zanzibar Utilities Regulatory Authority (ZURA) Act, No. 7 of 2013

The Zanzibar Utilities Regulatory Authority (ZURA) Act, No. 7 of 2013, was enacted to establish ZURA, the regulatory authority for utility services in the water and sewerage, electricity, and downstream petroleum[13] sectors in Zanzibar. The Act consists of 52 sections in eight parts. Its section 24 "Funds of the Authority" was amended by Part 3 Amendment of the Zanzibar Utilities Regulatory Authority Act 2013 in the Written Laws (Miscellaneous Amendment) Act, No. 9 of 2019.

[13] Includes importing, unloading, transporting, storing, refining, and selling.

Part 1: Preliminary Provisions (Sections 1 - 2); Part 2: Composition and Management of the Authority (Sections 3 - 23); Part 3: Financial Provisions (Sections 24 - 27); Part 4: Accountability of the Authority (Sections 28 - 37); Part 5: Complaints and Dispute Settlement (Section 38); Part 6: Offences and Penalties (Sections 39 - 41) Part 7: Appeal (Sections 42-44); Part 8: Miscellaneous (Sections 45-52).

(i) Regulations and Guidelines

The ZURA Act has three regulations prepared as operating procedures for the organization. Regulations specific to water and sewerage services are yet to be formulated. ZURA also has three technical guidelines/manuals in place for the supervision of water utilities. These technical guidelines/manuals currently apply only to ZAWA, as no other organization is licensed as a water utility.

- ZURA (Rules of Procedure), 2016
  Consisting of three parts and 37 sections in all, it establishes the rules on the operations of ZURA and the Board of Directors.
- Financial Regulations, L.N. 110 of 2018
  Consisting of 75 sections in 11 parts, it stipulates the basis of financial management and control of the organization, budgeting and budgetary control, supplemental budget, custody of funds, revenue, account and financial records, auditing, risk management and internal control, investment of fund and capital expenditures, and miscellaneous provisions.
- Consumer Complaints Handling Procedure Regulations, L.N. 85 of 2018
  Consisting of 35 sections in 6 parts, it provides procedures for filing complaints against services provided by utilities in the sectors regulated by ZURA, mediation, formal hearings, and limitation periods.
- Water Quality Monitoring Guidelines for Water Utilities (2020)
  The guidelines explain the framework, procedures, and methodologies of water quality monitoring to be followed by water utilities. The document further describes the requirements in each aspect of compliance monitoring and operational monitoring of water quality, parameters to be tested, the number of samples, frequency of sampling, data analysis and interpretation of test results, and reporting.
- Performance Monitoring of Water Utilities: Key Performance Indicators for Water Supply Services (2020)
  The guidelines summarize the types of KPIs that ZURA requires water utilities to report, their definitions, data collection, and performance evaluation methods. KPIs are set for each category of quality of service, economic efficiency, and operational sustainability, referring to the practices of other regulatory authorities which are members of the East and South Africa Water and Sanitation Regulators Association (ESAWAS)[14].
- Inspection Manual for Zanzibar Water Utilities (2020)
  The manual explains the purpose of routine inspections and special inspections of water utilities conducted by ZURA's water inspectors, inspection items, means of verification of data, and procedures for inspection and reporting. In principle, routine inspections need to be conducted at least once every

[14] The Association has members of ten regulatory bodies for water supply and sanitation services from Tanzania, Kenya, Uganda, Rwanda, Burundi, Mozambique, Zambia, Malawi, and Lesotho (ZURA and EWURA from Tanzania).

quarter.

Furthermore, ZURA is preparing new regulations and guidelines specific to the water supply services, as listed in Table 2.15.

Table 2.15 Regulations and Technical Guidelines being Developed by ZURA

Document	Objectives	Progress
Water Supply (Licensing) Regulations	To provide requirements and procedures for the licensing of water utilities by ZURA. It is envisioned that water supply licenses can be issued to individuals, private entities, and community-based organizations that apply to operate water supply services in areas not served by ZURA.	Preparing for examination of draft regulations at the House of Representatives.
Water Supply (Quality of Service) Regulations	To provide design criteria for water supply facilities and standards for water supply services operated by water utilities.	Waiting for approval by the Attorney General of Zanzibar. After approval, the agreement will enter into force upon signing by the Minister of MoWEM.
Water Tariff Regulations	To determine the calculation method as well as factors to be taken into account when setting water tariffs and other charges of water utilities.	Preparatory stage for drafting. A consultant will be hired to conduct a cost of service study for ZAWA by the end of June 2022 to develop tariff calculation methodologies that will be reflected in the regulations.
Business Plan Guidelines for Water Utilities	To provide guidance on requirements for preparing business plans for water utilities.	Preparatory stage for drafting

Source: Results of interviews with ZURA

(ii) Provisions for Establishment of ZURA

ZURA is an autonomous body corporate, and the departments of the Authority carry out its operations under the Director General and on the decisions of the Board of Directors. The Board consists of a Chairperson, five other members, and the Director General as an ex officio, and is answerable to the Minister responsible for water. The President of Zanzibar is the appointing authority for the Chairperson and the Director General, and the Minister responsible for water appoints other members of the Board. Table 2.16 summarizes the functions and powers of the Ministry responsible for water and ZURA defined in the ZURA Act.

Table 2.16 Functions and Powers of ZURA Provided in the ZURA Act

organization	Main Functions and Powers
Minister Responsible for Water	• Approval of ZURA's annual budget/supplementary budget • Appointment of the Board members other than the Chairperson • Approval of remuneration and allowances for Board members in consultation with the Minister responsible for Finance • Submission of annual reports of ZURA, including audited accounts and reports and other information as directed by the Minister, to the House of Representatives • Inviting nomination of candidates for the selection of members of the Consumer Representative Council; appointment of members • Provision of general recommendations and directions to ZURA regarding regulated utility services within the scope of the ZURA Act and related utility service legislation • Ensuring consistency with environmental and other relevant sector policies when developing and implementing policies for regulated sectors • Designation of utility services to be regulated • Enactment of the Regulations for the implementation of the ZURA Act
ZURA	[Scope of the Authority for Regulation of the Water Sector]

organization	Main Functions and Powers
	• Control of water quality and standards • Regulation of water tariffs, fees, and charges in consultation with the Minister responsible for water • Control of water supply efficiency • Issuance of water resource development licenses and water supply licenses [General Functions and Powers] • Setting standards for regulated goods and services and terms and conditions of their supply • Ensuring adequate service provision and means of finance by all regulated utilities • Preparation of the utilities' code of conduct, reporting requirements, scheme of service, and staff regulations • Facilitation of private sector participation, fair competition, and investment in public utilities • Prescribing the terms and conditions of the license, and issuing, modifying, and revoking the licenses • In consultation with the Minister responsible for water, setting rates, tariffs, and other charges imposed by a licensee in accordance with the regulations of the ZURA Act and the relevant utility legislation • Publication in the Gazette of all tariffs, rates, and charges for the regulated services • Setting performance standards for the utilities, including customer service standards and service quality standards • Ensuring compliance with licenses by the utilities under relevant laws and regulations • Establishment and implementation of adequate systems for monitoring compliance by licensees with standards and applicable regulations, and publication of monitoring results • Issuance of orders, rules, and directives to regulated utility sectors • Development of procedures for receiving, enquiring, and resolving complaints by customers about regulated services • Facilitation of the resolution of complaints and disputes • Due regard to preservation and protection of the environment, conservation of natural resources, and the health and safety of service users • Collecting and disseminating information related to ZURA's operations and conducting necessary inquiries
Board of Directors	• Monitoring of management of ZURA, approval of budget and monitoring of its implementation • Promotion of the interests of users regarding the price, quality, and type of goods and services provided by the regulated utilities • Monitoring of adherence to legislation affecting ZURA's operations • Issuance of Orders of ZURA in accordance with the required procedures • Determination of ZURA's staffing requirements, responsibilities of employees, and terms and conditions of employment; appointment and dismissal • Appointment of directors and other senior staff; convening an interview panel for staff recruitment (by the Public Service Act (2011)) • Setting strategies, action plans, and appropriate work targets for each department • Review and approval of financial and staff regulations • Monitoring of the appropriation and disposal of assets necessary to fulfil ZURA's responsibilities, and approval of capital investments • Preparation of rules of proceedings, with prior approval by the Minister responsible for water, regarding codes of conduct, standards for regulated goods and services, license, tariff, rates and charges, fees payable to the Board, or any other matters including transparent mechanisms for new investments and private participation

Source: Summarized from the ZURA Act 2013

(iii) Licenses Relating to the Water Sector

ZURA issues two types of licenses for the water sector: water resources development license and water supply license. According to the interviews with ZURA, the water resources development license is issued only to ZAWA which is entrusted by the government with the management of Zanzibar's water resources under the

Water Act. The water resources development license is said to authorize ZAWA to develop water sources for its water supply services and regulate the development, abstraction, and use of water resources by other water users for various uses. ZURA suggested in the interview that the management of water resources in Zanzibar should be carried out by an organization established for the same purpose and that the relevant functions should be transferred from ZAWA and ZURA.

The full water supply license is classified into A, B, and C according to the financial capacity of the water utility. For ZAWA, a provisional license with a validity period of two years has been granted, as the organization is largely dependent on government subsidies. At the end of the validity period of the license, ZURA is to review the improvement of ZAWA's financial sustainability and autonomy and decide on the issuance of a license for the next period.

The provision of sewerage and sanitation services is the responsibility of the Local Government Authorities (LGAs). There has been no enactment of regulations under the ZURA Act, issuance of licenses, or supervision by ZURA for regulating the sewerage and sanitation services.

(iv) Regulation of Utility Service Rates and Charges

One of the functions of ZURA under the ZURA Act is to set rates, tariffs, and other charges of regulated utility services, in consultation with the Minister responsible for the regulated sectors and in accordance with the relevant legislation. Furthermore, according to the ZURA Act, the rates and charges of utility services are subject to periodic review. Such review may be initiated by either the utility or ZURA, or other party specified in the regulations of the ZURA Act. The Act also provides the factors to be considered in approving revenue requirements to be included in rates and charges, establishing a method for regulating such rates and charges, and determining the rate design.

The water tariff calculation method and the review and approval procedures will be detailed in the Water Tariff Regulations, for which ZURA is scheduled to conduct a cost of service study. The current provisions of the ZURA Act and the Water Act alone are not clear on the scope and details of the powers of ZURA, as the regulatory body, and ZAWA, as a licensed water utility, to revise water tariffs. According to ZURA, ZAWA needs to submit the proposed revision to ZURA for review for revising the water tariffs and charges, or ZURA can present the proposed revision to ZAWA. In either case, ZURA is to determine the tariffs and charges based on consultation with the Minister of Water, Energy, and Minerals

(c) Related Standards

In its Water Quality Monitoring Guidelines for Water Utilities (2020), ZURA requires water utilities to conduct compliance monitoring to adhere to drinking water quality standards and operational monitoring to ensure that water treatment facilities and distribution networks are operating properly to supply water that meets standards. The Potable Water - Specification (ZNS57:2020), published by the Zanzibar Bureau of Standards (ZBS), is applied to monitor compliance with drinking water quality standards.[15] The standards set by ZBS are part of the legal requirements and technical regulations that water utilities must comply with.

[15] The current "Water Quality Monitoring Guidelines for Water Utilities" (2020) refer to ZNS57:2015 as the requirement for drinking water, but according to ZURA, the latest standard (ZNS57:2020 as of 2022) is to be applied in actual operations.

ZURA supervises compliance with the relevant provisions by the utilities.

ZBS is responsible for the standardization and quality assurance of products and services produced or imported in Zanzibar to ensure safety for both human health and the environment. Functions of ZBS are, among other things, to prepare standards for quality, quantity, and units of measurement, certify products and services, and conduct inspections to check compliance with standards. Each standard will be determined based on consultation with the Ministry in charge of the subject sector and relevant organizations.

The standards listed in Table 2.17 are set for drinking water and sewage and industrial wastewater. Of these, except for the provisions on the definition of terms, are compulsory standards that specify mandatory requirements and essential characteristics necessary to ensure the quality of the product and apply to the relevant products and services.

Table 2.17 Standards related to Drinking Water and Municipal and Industrial Wastewater

Title	ZNS No.	Identical Standard
Potable water - Specification	ZNS57:2020, 2nd Edition	EAS 12:2018
Cationic polyacrylamide of water intended for human consumption – Specification	ZNS286:2018, 1st Edition	
Polyamine for treatment of water intended for human consumption – specification	ZNS287:2018, 1st Edition	
Chemical used for treatment of water intended for human consumption – anionic and non-ionic polyacrylamide - specification	ZNS288:2018, 1st Edition	
Packaged drinking water - Specification	ZNS1:2020, 2nd Edition	
Packaged mineral waters - Specification	ZNS352:2020, 1st Edition	
Municipal and industrial wastewater – General tolerance limit for municipal and industrial waste waters	ZNS14:2014, 1st Edition	TZS 860:2006
Tolerance limits for industrial effluents discharged into inland surface water – Sugar industry	ZNS354:2020, 1st Edition	
Tolerance limits for industrial effluents discharged into inland surface water – Textile industry	ZNS355:2020, 1st Edition	
Water quality - Vocabulary	ZNS308:2020, 1st Edition	EAS 32:2008
Water, sewage and industrial effluents – Glossary of terms – Part 1	ZNS356-1:2020, 1st Edition	

EAS: East Africa Standard TZS: Tanzania Standard

Source: ZBS (2021) Standard Catalogue, September 2021

(5) Revision of the National Water Policy and Related Laws and Regulations

Considering the changes in the sector environment after the development of the National Water Policy 2004, ZAWA submitted draft amendments to the National Water Policy and Water Act to the Ministry of Land, Housing, Water, and Energy, the predecessor of MoWEM, in 2020. The draft was discussed by the relevant organizations. However, after the inauguration of the new government in November 2020 and the reorganization of the ministries, MoWEM, as the new ministry responsible for water, decided to take the lead in revising the National Water Policy and the Water Act. As of March 2022, the Ministry is in the process of selecting a consultant to be commissioned to facilitate the review of the Water Policy. UNICEF has expressed its willingness to provide financial support for this work.

Although it is unclear to what extent the proposed amendments prepared by ZAWA will be adopted, the draft prepared by ZAWA reflects its concerns on issues in the water sector. Major points raised in the draft amendments are outlined below:

(a) National Water Policy

- Clear definition and demarcation of responsibilities of ZAWA, ZURA, ZEMA, LGAs, and other related

institutions

- Enactment of the Water Resources Management Act to establish WRMB
- Regulation of water schemes that are operated by communities and private individuals/entities and constructed in the areas not served by ZAWA or with inadequate services due to low water pressure or limited water supply hours; consolidation of requirements as public water supply facilities; development of operation and maintenance guidelines
- Taking responsibility for both water supply and sanitation services by ZAWA, while LGAs are to be responsible for urban and peri-urban sanitation regulations and stormwater drainage

(b) Water Act

- Revisions on some parts of the functions of ZAWA:
  - Changes due to the transfer of functions related to specifying water quality standards and setting water tariffs to ZURA by the ZURA Act 2013:
    - ✓ Provision of water supply services based on standards of water quality specified by ZURA
    - ✓ Provision of recommendations to ZURA regarding amendment of water tariffs and other charges made for the service provided by ZAWA
  - Inclusion of additional functions related to providing training programs in all aspects of water issues to ZAWA Training Centre (ZTC) and issuing licenses to plumbers, drillers, and other personnel handling waterworks and infrastructure
- Clarification of detailed qualifications of the Board members of ZAWA and review of other operating rules of the Board
- Addition of power to ZAWA regarding the establishment of the district offices
- Addition of power to ZAWA regarding the establishment of a training centre under its auspices either alone or in collaboration with other organizations to provide training programs in all aspects of water issues
- Ensuring a certain offset (5m from centre) from water pipes to houses, buildings, structures, or foundations, and securing the way leave by installing visible signs or beacons
- Revision of priority for the use of water resources (from the provision placing the preferences in the order of domestic use, agriculture and livestock, tourism development, industry, and other uses, to the one that gives the highest priority to domestic water supply)
- Establishment of the Water Tribunal as a body to hear and determine disputes concerning water resources and water supply services (to expeditiously resolve disputes through the establishment of a body responsible for adjudicating minor litigation related to ZAWA's water services)
- Revision of provisions on offenses and penalties

(6) Water Sector Development Program

The Zanzibar water sector had a long-term development plan, the Zanzibar Urban Water Supply Development Plan 1991-2015, funded by FINNIDA. This plan was not reviewed after the formulation of the Vision 2020 and National Water Policy, and in the absence of a master plan, ZAWA has been operating water

supply based on medium-term Strategic Business Plans (SBPs) of the Authority.[16]

SBPs prepared by ZAWA describe business goals, objectives, strategies, activities, KPIs, budget, implementation schedule, and responsible departments based on the performance evaluation and organizational analysis of the previous planning period, and these details are reflected in the annual work plans. The current SPB is the third plan (2020/21-2024/25). For ZURA, the first plan (2017-2022) was developed after the organization was established in 2015. The development of SBPs and annual work plans is one of the requirements for the organizational management of public institutions, as stipulated by the Public Service Management Policy 2010.

Under these circumstances, the Government of Zanzibar announced the Zanzibar Water Investment Programme 2022-2027 (ZanWIP) in March 2022. The interventions identified in the Programme are yet to be reflected in the current SBPs of ZAWA and ZURA. A summary of the ZanWIP and SBPs of ZAWA and ZURA is provided below:

(a) Zanzibar Water Investment Programme 2022-2027 (ZanWIP)

(i) Background

The Program[17] was officially announced by the President of Zanzibar at the High-Level Water Investment Conference[18] hosted by the Global Water Partnership Southern Africa-Africa Coordination Unit (GWPSA-ACU) in Zanzibar in March 2022. With the support of GWP, the program was developed as the first country-specific program of the African Union (AU) Continental Africa Water Investment Programme (AIP)[19]. The program objective is to narrow the water investment gap identified in the Report on Zanzibar Water Sector Reform (2021)[20] by ensuring sustainable investments in water resources management and service provision to achieve the targets of the WASH sector set in ZDV50.

(ii) Program Summary

ZanWIP has established seven components and 30 priority interventions in three investment focus areas, requiring approximately USD 665.5 million in funding. Proposed projects/activities and expected outputs are indicated for each priority action. Among the three priority investment areas, "Water Investment for Meeting Water-related SDG Targets" accounts for 72% of the program cost at USD 476.5 million. The majority of this

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[16] JICA, NJS Consultants Co., Ltd. and Yokohama Water Co., Ltd. (2017) Preparatory Survey on Zanzibar Urban Water Distribution Facilities Improvement Project in the United Republic of Tanzania: Final Report, p3-2

[17] The Revolutionary Government of Zanzibar (2022) Zanzibar Water Investment Programme 2022-2027

[18] Co-sponsored by the African Development Bank (AfDB), Organization for Economic Cooperation and Development (OECD), United Nations Children's Fund (UNICEF), United Nations Development Programme (UNDP), World Bank, and Development Bank of Southern Africa (DBSA)

[19] The Program for Infrastructure Development in Africa (PIDA), a strategic development initiative promoted by the African Union Development Agency (AUDA-NEPAD), is an investment promotion program in the water sector. To achieve the SDG Goal 6, it aims to mobilize USD 30 billion by 2030 to strengthen regional and national water security. In 2021, AIP was formally adopted as part of the PIDA Priority Action Plan Phase 2 (2021-2030) at the AU Heads of State and Government Summit. GWPSA-ACU provides secretariat function of AIP.

[20] MoWEM (2021) Zanzibar Water Sector Reform. The report outlines the areas to be considered for reform. Such areas addressed in the report are policies, legal system, and guidelines; institutional structure, and duties of responsibilities; development and management of water resources; water demand to various consumer groups; management of water sources, harvesting systems, and water facilities; water quality management; water management resources (human and financial resources); and water sector monitoring and evaluation system.

amount is allocated to the priority interventions of "1.2.2 Implement the water infrastructure flagship program (2022-2027)" in "Component 1.2 Improving climate resilience water infrastructure development". The proposed projects/activities include feasibility studies to develop new water sources for various water uses and the development/rehabilitation of water infrastructure. It is unique in that it proposes integrated infrastructure development, which is considered to be based on the nexus approach of water-energy-agriculture (food security), and the introduction of a circular economy approach. In addition, ZanWIP proposes projects to develop rainwater harvesting facilities (estimated cost of USD462.5 million) for 11 sites on Unguja and Pemba islands as part of the priority interventions of the water infrastructure flagship program.

Table 2.18 Investment Focus Areas, Components, and Objectives of ZanWIP

Investment Focus Area	Component	Objectives
1. Water investment for meeting water related SDG targets	1.1 Water investment scorecard and financing water and sanitation services	To mobilize water investments and ensure water security in Zanzibar through sustainable water and sanitation service provision.
	1.2 Improving climate resilience water infrastructure development	To ensure that Zanzibar has reliable and sustainable climate resilient water supply systems to meet its increasing water demands to satisfy its socio-economic development.
2. Building resilience through water investment	2.1 Build climate resilience	To ensure that the water resources and associated infrastructure of Zanzibar are resilient to climate change.
	2.2 Gender equality and social inclusion	To contribute to addressing gender inequality issues in water security and climate resilience building in the country.
3. Water governance and institutional strengthening	3.1 Institutional arrangements and enabling environment	To strengthen the institutional setting of water resources management at the Ministry of Water through actualization of key aspects of IWRM in the water sector.
	3.2 Blue economy and sustainable water resources management	To ensure that the water resources of Zanzibar are managed sustainably through actions that will protect the water source (quantity and quality), enhance water supply and increase efficiency in water uses.
	3.3 Human and financial resource mobilization	To build and develop requisite capacity, both human capital and financial resources, in the water sector in Zanzibar to strengthen the sustainable development and management of water resources for current and future needs.

Source: The Revolutionary Government of Zanzibar (2022) Zanzibar Water Investment Programme 2022-2027

(b) ZAWA Strategic Business Plan 2020/21-2024/25

(i) Background

The current Strategic Business Plan 2020/21-2024/25 (SBP2025) of ZAWA was formulated in consideration of the National Water Policy 2004, MKUZA III, the Chama Cha Mapinduzi (CCM) Manifesto (2020-2025), and the targets of ZDV50.

(ii) Challenges Facing ZAWA

ZAWA has identified the issues shown in Table 2.19 concerning its business operation.

Table 2.19 Major Challenges Addressed in ZAWA SBP2025

No.	Theme	Major Challenges
1	A. Instructional capacity	Inadequate number of pump operators
2		Inadequate number of staff specialized in water resources
3	B. Water resources management	Insufficient water conservation practices
4		Insufficient exploitation of the rainwater harvesting potential
5		Inadequately regulated water abstraction and effluent discharge
6	C. Water service provision	Unreliable water supply in some part
7		Network without suitable pressure and distribution zoning
8		Insufficient water storage tanks
9		Inadequate control of water abstraction and distribution
10	D. Operations and customer management	Inadequate internally generated revenues
11		Non-rationalized power consumption
12		About 80% of customers with no water meter installed
13		High Non-Revenue Water of about 60%

Source: Summarized from ZAWA Strategic Business Plan 2020/21-2024/25

(iii) ZAWA's Core Values

In preparing SBP2025, ZAWA's Board of Directors and management have defined the Authority's core values, focusing on the organization's current state, the challenges in the water sector in Zanzibar, and the social and economic environment. The core values of ZAWA cover the areas of teamwork and transparency; customer satisfaction; competent, committed and motivated staff; good governance; environmental sustainability; efficiency and effectiveness; gender sensitivity; corporate social responsibility; networking; and integrity.

(iv) Implementation Strategy

SBP2025 sets goals, strategies, and activities for each strategy. Although each objective provides a baseline and target value in percentage, ZAWA confirmed that these figures were based on subjective assumptions and are not based on objective and quantitative evaluation of the progress and achievement of the planned activities. The Authority is now reviewing the methods of setting and monitoring the indicators and target values in SBPs.

Table 2.20 Objectives and Strategies of SBP2025

	Objectives	Strategies
1	Improvement of institutional capacity (from 50% to 90% by 2023)	1. Strengthening employees' performance 2. Improving human resource planning 3. Strengthening collaboration with its stakeholders 4. Enhancing institutional coordination 5. Strengthening research, monitoring, and evaluation practices 6. Enhancing governance performance 7. Enhancing management performance 8. Strengthening the legal unit 9. Strengthening the procurement management 10. Updating ZAWA Training Centre to accreditation level 11. Enhancing administrative efficiency
2.	Improvement of water resource management (from 50% to 85% by 2023)	1. Controlling water abstraction 2. Enhancing water resources conservation 3. Developing the effective mechanism for rainwater harvesting
3	Improvement of water service provision (from 83% to 95% by 2023)	1. Enhancing water supply service reliability 2. Reducing non-revenue water 3. Improving Water Infrastructure 4. Enhancing water quality monitoring

4	Improvement of customer management (from 50% to 85% by 2023)	1. Improving information management 2. Improve customer satisfaction 3. Expanding the customer base 4. Expanding the current revenue base 5. Strengthening the internal control system 6. Improving store management

Source: ZAWA (2019) Zanzibar Water Authority Strategic Business Plan 2020/2021-2024/2025

(v) KPIs and Annual Targets

KPIs and annual targets are specified in SBP2025. ZURA will require ZAWA to adopt the performance indicators and monitoring and reporting procedures provided in the Performance Monitoring of Water Utilities: Key Performance Indicators for Water Supply Services (2020) and the Business Plan Guidelines for Water Utilities developed by ZURA. The current KPIs in SBP2025 are listed in Table 2.21.

Table 2.21 KPIs Set in SPB2025

1. Total volume of groundwater abstracted	16. Customer care (response time to complaints of commercial nature)
2. Total protected catchment acreage	17. Customer care (response time to complaints of technical nature)
3. Volume of water produced	18. Customer care (percentage of customer complaints handled)
4. Volume of water sold	19. Revenue (water sale)
5. Non-Revenue Water	20. Revenue (service charge)
6. Water service coverage (No. of new connections)	21. Revenue (others)
7. Water service coverage (No. of public stand posts)	22. Revenue (government subsidies)
8. Water service coverage (No. of total connections)	23. Expenditure/Net Collection Ratio
9. Water service coverage (No. of metered connections)	24. Cash ratio
10. Metering ratio	25. Average collection period
11. Water service coverage	
12. Response time to water leaks and bursts	
13. Percentage of reported leaks and bursts repaired	
14. Percentage of samples of supplied water passing bacteriological quality	
15. Percentage of samples of supplied water passing physical and chemical quality – turbidity	

Source: ZAWA (2019) Zanzibar Water Authority Strategic Business Plan 2020/2021-2024/2025

(c) ZURA Strategic Plan 2017-2022

(i) Background

In relation to the energy and water sectors, the Vision2020 promotes adequate, environmentally sound, alternative and sustained energy supplies and adequate, affordable, economically accessible, and sustained water supplies to all people and sectors using environmentally sound water resource management technologies. The increasing operating costs of energy and water utilities and the demand for efficient and reliable standard services necessitated the creation of an independent regulatory authority to achieve the objectives of the Vision. ZURA was established in 2015 to regulate water and sewerage, electricity, and downstream petroleum services. The current SBP2022 is the first five-year business plan developed since the establishment of ZURA.

(ii) ZURA's Core Values

ZURA has identified its core values in six areas, i.e., transparency and accountability; integrity; independence; effectiveness and efficiency; teamwork; and professionalism.

(iii) Implementation Strategy

SBP2022 defines the following five strategic objectives to be achieved by ZURA over five years:

1. To improve quality and promote reliable, sustainable, and efficient provision of utility services for economic development consistent with the Government's policy.
2. To strengthen the ZURA's institutional capacity to discharge its functions independently and impartially.
3. To increase knowledge and awareness of ZURA amongst all stakeholders.
4. To create, strengthen and enforce the legal and regulatory framework of the regulated utilities and resolve conflicts arising from laws and regulations enacted prior to the creation of ZURA.
5. To improve ZURA's ability to analyse, monitor and evaluate the economic, financial and technical performance of all regulated utilities and sectors.

Also, specific strategies, activities, responsible departments, target year, and budget are set for each strategic objective.

(7) National Policies and Relevant Legislation in Other Sectors Related to Water Resources Management and Water Supply

(a) Environmental Management

- Zanzibar Environmental Policy 2013

  The Environmental Policy sets forth policies to promote the protection, conservation, restoration, and management of Zanzibar's environmental resources, such that their capacity to sustain development and maintain the rich environmental endowment for the present and future generations. The policy identifies the following issues for the water sector:

  - The increase of uncontrolled settlements in the vicinity of major groundwater sources located on the urban fringe of Zanzibar Town, which results in an impact on groundwater recharge capacity, lowering of the groundwater table, and threats to the quality and quantity of water supply
  - Risk of spreading waterborne diseases due to construction of pit latrines, septic tanks, and soak pits near or within the vicinity of groundwater sources in urban areas
  - Pressure on the already scarce water resources due to the growth of population and economy, including tourism and agriculture
  - Decrease in surface and groundwater resources due to catchment encroachment, deforestation, and climate change, and consequent reduction in quantity and quality of water supply

Addressing these challenges, the Government ensures the prevention of contamination of water resources and the protection of water catchment areas for sustainable and safe water supply. Among its implementation strategies, the policy requires the Ministry responsible for water resources management and water supply; to develop and enforce groundwater and catchment management and protection regulations; promote public awareness of protection and sustainable use of water; facilitate IWRM practices and rainwater harvesting techniques; and promote enforcement mechanism of water related laws, regulations, and water services schemes.

- Zanzibar Environmental Management Act, No. 3 of 2015

The Act provides a comprehensive framework, implementation methods, and systems for environmental conservation, protection, regulation, and management.[21] ZEMA, established as the executing agency of the Act, is responsible for managing the processes of Environmental Impact Assessment (EIA) and environmental audits and monitoring EIA certificates after they are issued, issuing and approving various environmental certificates and permits, promoting environmental education and awareness, implementing relevant regulations and ensuring compliance with standards and guidelines, and monitoring the environment in general (biodiversity, ecosystem, coastal areas, waste disposal, and natural resources). The Regulations and guidelines related to environmental assessment are as follows:

- Environmental Assessment Regulations, L.N. 106 of 2019
- Environmental Assessment Guidelines in Zanzibar (2019)
- Strategic Environmental Assessment (SEA) Guidelines in Zanzibar (2019)

EIA certificates are required for projects that have the potential to pose a significant impact on the environment and society. An environmental audit is conducted for an activity that is operating without an EIA certificate and has the potential for significant environmental and social impacts, an activity that has been operating with an EIA certificate for five years, or any activity as may be determined by ZEMA. According to the Environmental Assessment Regulations and the EIA Guidelines, the development of water supply facilities in environmentally sensitive areas or in locations that may result in mass displacement and require the preparation of resettlement action plans, as well as the development of a desalination plant for municipal water supply, are in any case subject to EIA or environmental audits.

Strategic Environmental Assessment (SEA) is required for policies, strategies, programs, and plans, including master plans. According to ZEMA, few SEAs have been conducted in Zanzibar. The recent case is the one that has been conducted in the formulation of a comprehensive development master plan for Pemba Island under the Department of Urban Planning, Ministry of Lands, Housing and Human Settlements Development.

Where water resources management is concerned, in accordance with the Zanzibar Environmental Management Act 2015, the Minister responsible for terrestrial or marine natural resources[22], in consultation with the Minister responsible for environmental management, may declare any area of Zanzibar with ecological importance to be a protected area. In addition, provisions for the conservation of water resources prohibit the destruction or pollution of water resources and catchment areas, with fines or imprisonment for violators. There are no provisions in the Environmental Management Act and other acts on permits for discharging effluent from commercial, industrial, agricultural, and municipal water use to water bodies. According to ZEMA, the EIA certificate covers the purpose of such permits, and the compliance of wastewater with water quality standards is to be monitored through environmental

[21] According to ZEMA, a draft is being prepared by the Law Review Commission of Zanzibar to amend the Environmental Management Act. The amendments include the addition of provisions on biosafety and construction and development in coastal areas, new legislation on non-renewable resources, and a review of the jurisdiction of the Department of Environment and ZEMA.

[22] Under the current implementation structure, the Ministry of Agriculture, Irrigation, Natural Resources and Livestock has jurisdiction.

monitoring. In practice, on-site inspections of the status of discharges to water bodies and wastewater quality standards are conducted only when complaints are received. Water quality testing in such cases is outsourced to the Chief Government Chemist Laboratory Agency.

(b) Forest Conservation

- National Forest Policy for Zanzibar 1999
- Zanzibar National Forest Resources Policy 2015

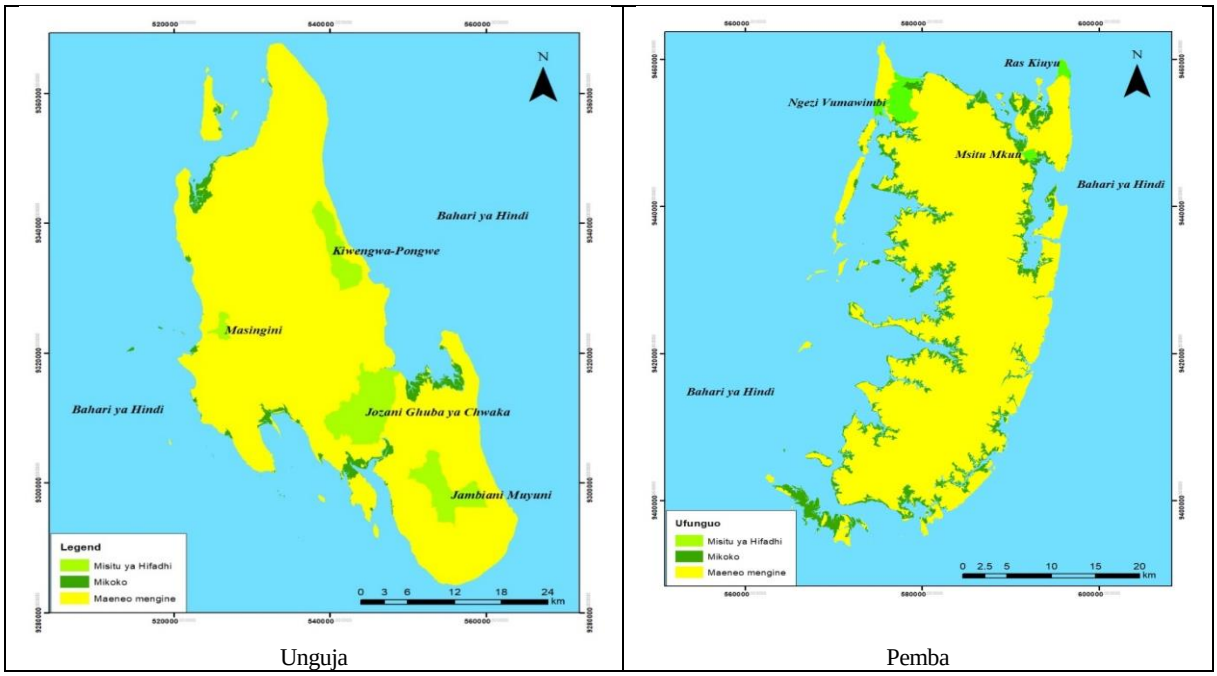
  For the protection, conservation, and development of forest resources, the policy states measures related to the use of resources in the community forest, participatory forest management planning with communities, preservation of natural forests and wildlife for conservation of forests and biodiversity, mangrove conservation, soil and watershed protection, and enhancement of production activities using forest resources. Measures for soil and watershed conservation include developing land use plans for watersheds containing important surface water and groundwater recharge areas in cooperation with relevant sectors to conserve the quality and quantity of drinking water. Other measures mentioned are regulation and control of sand, gravel, and soil extraction to reduce deforestation, groundwater contamination, and soil erosion; afforestation activities; and environmental education and technology dissemination for soil and watershed conservation are also included.

- Forest Resources Management and Conservation Act, No. 10 of 1996, Amended by the Written Laws (Miscellaneous Amendments) Act, No. 14 of 2020

  The Act provides for responsible agencies for forest administration, national forest resource planning, forest reserves and nature forest reserves, community forest management areas, special forest management areas, permits for the utilization of forest resources, wildlife and plant conservation, fire control, forest development funds, and the authority of law enforcement officials. National parks and protected areas designated under this Act and the Environmental Management Act are listed below. ZAWA's main water sources are located in the vicinity of many of these forest reserves or nature forest reserves.

  - National Park: Jozani Chwaka Bay
  - Forest reserves: Kiwengwa-Pongwe, Ras Kiyuku, Msitu Mkuu, Jambiani-Muyuni, Ufufuma Pongwe, Malilini
  - Nature forest reserves: Ngezi-Vumawimbi, Masingini
  - Development regulation and conservation in some areas: Unguja Ukuu, Chaani, Kibele, Dunga
  - Community Forest Management Area (COFMA)
  - Other protected areas: coral lagoon forests, mangrove forests

  Figure 2.2 and Figure 2.3 show the forest reserves and community forest management areas in Zanzibar.

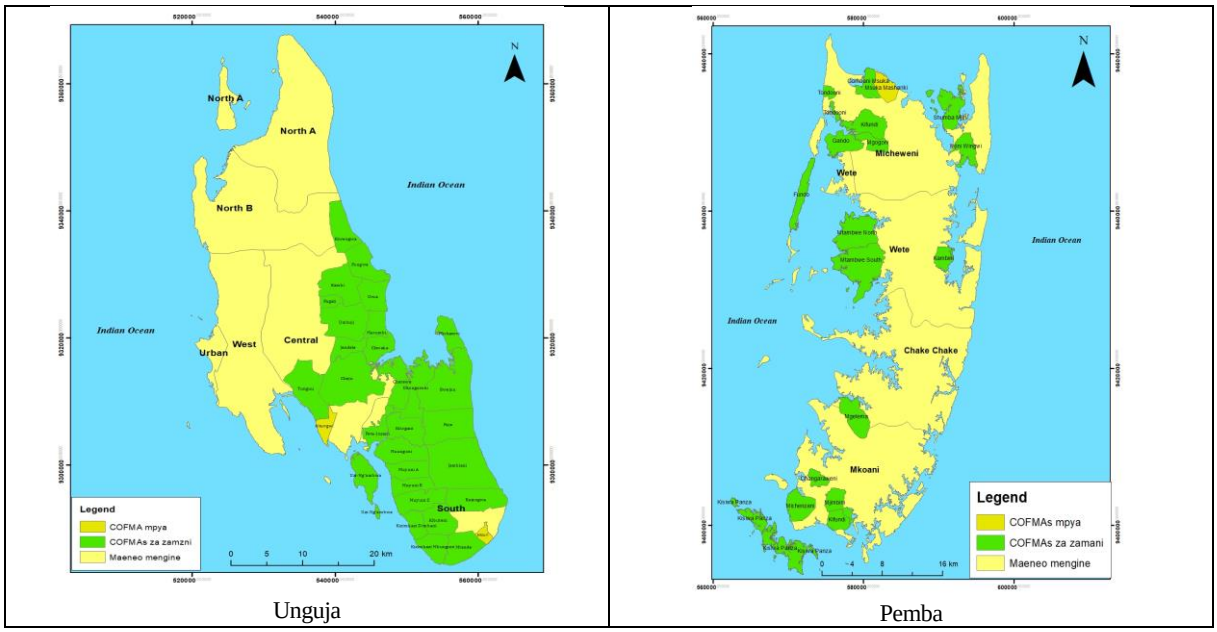


Unguja Pemba

Note: Yellow-green shading in the figure indicates forest reserves, green shading indicates mangrove forests, and yellow indicates other areas.

Source: Department of Forestry and Non-Renewable Natural Resources, MAINRL

Figure 2.2 Forest Reserves in Zanzibar



Unguja Pemba

Note: Yellow-green shading in the figure indicates newly established COFMAs, green shading indicates existing COFMAs, and yellow shading indicates other areas.

Source: Department of Forestry and Non-Renewable Natural Resources, MAINRL

Figure 2.3 Community Forest Management Areas in Zanzibar

Under the current implementation structure, the Department of Forestry and Non-Renewable Natural Resources, MAINRL, identifies the sites for forest reserves and propose them to the Minister for enactment. The Department works with LGAs, communities, and other stakeholders in each region to promote and coordinate the development and implementation of forest management plans. It also conducts activities such as tree planting, nursery management, community awareness-raising, school education on forest conservation, and support for communities to balance forest conservation and

livelihoods.

- Zanzibar National Forest Resources Management Plan 2015-2025 (2016)

  The plan was developed by the Department of Forestry and Non-Renewable Natural Resources to implement the National Forest Resources Policy. One of the objectives of the plan is to strengthen the management and conservation of forest ecosystems to promote biodiversity conservation, carbon sequestration, and soil and water resources conservation. The plan outlines activities and implementation plans for three programs: capacity building of forest administration, biodiversity protection and integrated conservation, and sustainable forest production and utilization.

(c) Land Management

- National Land Policy of Zanzibar 2018

  The National Land Policy prescribes an innovative land administration system and aims to ensure sustainable land management. Where water resources management is concerned, the policy states that a comprehensive and integrated land use management plan should be implemented to protect and conserve environmental, natural, and cultural resources. Environmental and natural resources to be protected and conserved include lagoons, mangrove wetlands, coral reefs, agricultural lands, forest reserves, water catchments, aquifers, springs, and cave water sources. The policy's implementation strategies include legal protection of all areas to be protected, identification of areas of natural resource endowment, boundary demarcation, and land surveying. In relation to the water supply sector, the policy for improving the economic efficiency of land includes promoting sites and services, which are serviced plots with basic services such as access to water and electricity, and strengthening the coordination of development projects between service providers and the land sector.

  Under the policy, the institution responsible for water resources is required to protect and conserve water sources and catchments against degradation, contamination, and encroachments; conduct research to identify and conserve new water catchments and water sources; provide information on water corridors and wetlands to be incorporated into the National Spatial Strategy Framework; supervise private well drilling to monitor the proper use of land.

- National Spatial Development Strategies 2014

  As a 25-year long-term strategy for implementing the National Land Use Policy, it presents measures and action plans for land and spatial use and development throughout Zanzibar. As part of the environmental measures, it points out the need to identify and protect catchment areas to prevent pollution of water sources due to sewage infiltration, soil erosion, and deforestation; issue regulations and permits under ZAWA for development activities within a 200m radius of boreholes and springs; and promote reforestation in the catchment areas. These implementation strategies include: i) identification and mapping of all boreholes, springs, and shallow wells, and their buffer zones by ZAWA; ii) mapping of potential reafforestation sites by the Department of Forestry and Non-Renewable Natural Resources; and iii) ensuring requirements for obtaining related permits from ZAWA when planning and implementing development activities in water catchments.

(d) Sanitation

- Public and Environmental Health Act, No. 11 of 2012

  The Act provides for waste management (including sanitation, sewerage, and drainage facilities), nuisance, prevention and control of infectious diseases, notifiable diseases and vaccinations, prevention and control of vectors and vermin borne diseases, cemeteries, tobacco products and alcohol control, and others.

- Zanzibar Local Government Authority Act, No. 7 of 2014, as amended by the Miscellaneous Amendment Act, No. 5 of 2016 and the Written Laws (Miscellaneous Amendment) Act, No. 14 of 2020

  The Act stipulates the guiding principles of local governance, requirements for the establishment, composition, functions, and powers of LGAs, structures of committees and departments, staffing, planning, and financing. Functions delegated to LGAs include establishment and maintenance of water drainage facilities, waste disposal and management, installation of public toilets, health supervision of households and industrial facilities, and promotion of public health.

(e) Agriculture, Livestock, and Fisheries

- Agriculture Sector Policy 2003

  The policy includes strategies for irrigation development, such as rehabilitation of existing irrigation schemes, strengthening of Water Users Associations (WUAs) formed by users of irrigation schemes, development and promotion of rainwater harvesting technology, encouragement of private sector participation in irrigated agriculture, and introduction of a cost-sharing mechanism by users of the irrigation schemes to cover operation and maintenance costs of water pumping facilities. With regard to the policy on the production of food crops, the priority is put on promoting rice cultivation using irrigation and rainwater harvesting.

  Strategies for soil conservation and water management include assessing land capability and carrying capacity in various areas to prevent land degradation, soil erosion, water depletion, and deforestation. The policy also emphasizes the necessity to coordinate with other relevant agencies to promote integrated strategies for resource use.

- Zanzibar Agricultural Sector Development Programme (ZASDP) (2019/20-2028/29)

  To expand rice production, 16 irrigation facilities totalling 1,619 ha are planned to be developed with funds from the Government of Zanzibar, the World Bank, and the Export-Import Bank of Korea (Korea Eximbank). The program also indicates the implementation of the review of the Zanzibar Irrigation Master Plan[23], formulation of implementation strategies, establishment of a sustainable management system for land and water resources to strengthen resilience to climate change and sustainable natural resource management, and improvement of water management technology and practices associated with irrigation development.

  The following is the current implementation structure of irrigation projects based on interviews with the

[23] Developed by JICA "Zanzibar Irrigation Master Plan Study" (2002)

Department of Irrigation, MAINRL.

MAINRL owns irrigation schemes constructed by the ministry. The responsibility for maintenance and management of irrigation schemes, which was once the responsibility of LGAs, has been returned to MAINRL. The Irrigation Department is responsible for the following functions:

- Planning and implementation of irrigation development
- Maintenance of irrigation schemes in cooperation with WUAs organized by users of irrigation schemes
- Development, dissemination, and guidance of irrigation technology
- Facilitation to form WUAs and advice on operation and maintenance of irrigation schemes
- Bearing repair costs for pumps installed at water sources (daily operation and minor repairs are the responsibility of WUAs).
- Facilitation of resolution of disputes over water use in irrigation schemes

The Department of Irrigation does not have any staff with expertise in hydrogeology and hydrology. It does have several staff members, properly qualified with a bachelor's degree in Water Resources and Irrigation Engineering from the Water Institute on the Tanzanian mainland (only one staff member is currently studying at the said Institute). However, they are responsible for planning the development of irrigation schemes, including the development of water sources. No hydrogeological survey is conducted during the construction of boreholes for irrigation schemes.

The Department has inventories of existing irrigation schemes and the ones under construction that MAINRL owns, and boreholes being used as the water sources for the schemes. With the exception of new facilities, the Department does not have data on the positional coordinates of these schemes and boreholes. In addition, information on major commercial farms and their irrigation schemes is not available at the Department. Table 2.22 shows the information contained in the inventories of irrigations schemes and boreholes retained by the Department.

Table 2.22 Information on Irrigation Schemes and Boreholes Available at the Department of Irrigation

Source	Recorded Items
Irrigation Scheme Inventory	District name, scheme name, potential area, developed area, water source (groundwater/surface water), operational status
Borehole Inventory	Scheme name, name of location of the borehole

Source: Department of Irrigation, MAINRL

MAINRL owns and manages 32 irrigation schemes, 14 in Unguja and 18 in Pemba, including the ones under construction. Water sources for these schemes are either streams/rivers (springs), boreholes, improved rainfed, or a combination of surface water and groundwater. Although 31 boreholes have been constructed in Unguja for the irrigation schemes, these borehole data, except for the items listed in the table above, is not recorded by the Department of Irrigation. Of these irrigation schemes, construction of four new schemes and expansion of two existing schemes, totalling 1,053ha of developed area, are ongoing with an Economic Development Cooperation Fund (EDCF) loan from Korea Eximbank (USD50 million), and are scheduled to be completed by the end of April 2022. The project also includes the construction of 33 boreholes and three dams (two in Unguja and one in Pemba) as water sources for

these new facilities.

Rice is grown in two cropping seasons, and cash crop vegetables are also grown during the dry season. Although demand for rice is high in Zanzibar, local production can cover only about 25-40% of the annual demand of 80,000 tons, making the expansion of rice production as one of the priorities of the agricultural sector. Therefore, the expansion of irrigated areas through improving irrigation schemes is also an important measure to be considered. The System of Rice Intensification (SRI) farming method has been introduced as a water-saving technology.

Farmers using irrigation facilities organize WUAs under the facilitation of the Department of Irrigation to decide on water allocation methods, such as rotation, and irrigation plans, and to maintain and manage irrigation schemes. There are no guidelines/manuals for the organization and activities of WUAs. Farmers engaged in rainfed agriculture organize themselves into separate associations.

Roles and Responsibilities of WUA
- Prepare and implement a plan for the operation and maintenance of irrigation system at the end of each cropping season.
- Prepare and implement water schedule and crop calendar for each irrigation season.
- Monitor the implementation of the operational plan.
- Resolve and manage disputes between the members within their irrigation scheme.
- Regulate the use of water and land in its irrigation system.
- Collect irrigation maintenance service fees.
- Ensure availability and distribution of inputs.
- Organize ordinary and extra-ordinary meetings for their members.
- Enforce the organization's bylaws.
- Develop new sources of income for the organization.
- Act as a link between farmers and key stakeholders.
- Facilitate the marketing of farm produce in collaboration with other related institutions.

(Source: Questionnaire to MAINRL)

The cost of daily maintenance of the irrigation facilities, electricity for the water pumps, and repairs to the control panels are covered by the water user fees paid by the members of WUA. MAINRL pays the entire cost of the pump repairs because of the high cost. MAINRL has an agreement with Zanzibar Electricity Corporation (ZECO) that WUAs pay only half of the electricity bill for pump operation. MAINRL does not have measures to cover the other half of the electricity bills.

Water from irrigation schemes is used only for irrigation purposes, and piping from irrigation schemes for drinking and domestic water supply is prohibited. Although farmers may take water from irrigation facilities back to their homes for domestic use or emergency use, the Department of Irrigation advises them to avoid drinking the water drawn from the irrigation schemes because the sources are not meant for drinking water.

As an arrangement between the Ministry of Water and the Ministry of Agriculture, irrigation schemes managed by WUAs are exempted from obtaining water abstraction permits and paying permit fees. The Department of Irrigation has never notified water abstraction/intake facilities to ZAWA, and ZAWA has not requested any information. The quantity of water abstraction volume is unknown because flow meters are not installed on the boreholes. During the dry season and short rainy season, the pump is operated for approximately 8 hours per day. Boreholes for irrigation use are normally constructed with 10-inch casing pipes, and recently constructed boreholes are equipped with water level observation

holes.

The Department of Irrigation takes measures for water resources conservation, including guiding WUAs on prohibiting practices that contribute to the erosion of riverbanks, planting trees to protect soil erosion, and avoiding the use of pesticides in irrigation schemes. The constitution of WUA also includes these actions.

Most disputes over water allocation within WUA are resolved within the same organization. Although conflicts also arise between WUAs that use the same river, these are resolved by the communities with little intervention by MAINRL. According to the Department of Irrigation, river water is used mainly for irrigation in Zanzibar, and there are no conflicts between WUAs and water users in other sectors over the use of the river.

- Zanzibar Livestock Policy 2011

The policy points out that water resources for livestock development have not been adequately secured and allocated, and water source areas have not been adequately conserved. To promote the development of water sources for livestock and improve livestock farmers' access to water supply, the policy includes strategies on awareness-raising on rainwater harvesting technology, improving the capacity of livestock farmers and businesses to use such technology, reducing water wastage, encouraging relevant agencies to reduce water charges for livestock production, protecting water sources and catchment areas in areas where livestock production takes place, and developing boreholes.

- Zanzibar Fisheries Policy 2014
- Zanzibar Blue Economy Policy 2020

The Fisheries Policy aims to ensure the sustainability of fishery resources, contribute to the conservation of biodiversity in coral reef ecosystems, improve the management of coastal fisheries, and promote the development of the aquaculture industry. The Blue Economy Policy also aims to promote sustainable economic growth and environmental stewardship through the sustainable use of the oceans and marine resources. The policy provides the development directions and strategies for maritime administration and the sectors that use marine resources (fisheries and aquaculture, maritime trade and infrastructure, energy, and tourism). These two policies include measures related to the promotion of aquaculture using coastal areas and state the need for coordination and cooperation with relevant policies and agencies regarding the protection of water resources in the catchment area.

(f) Other Related Fields

- Zanzibar Health Policy 2011

Policies related to water and sanitation include strengthening the capacity to inspect products and substances that affect human health and safety, including drinking water and sewage, health promotion, promoting environmental health standards and related laws and regulations on public health, and strengthening of supervision of these regulations.

- Education Policy 2006

Where water supply is concerned, the policy raises the issues that some schools lack the necessary facilities to protect the health of students and teachers, such as clean and safe water and adequate

sanitation facilities, and that there are no comprehensive guidelines on the requirements for a safe and healthy school environment. The policy further indicates the need to adopt a multi-sectoral approach to promote a healthy and safe school environment and recognizes that the health and safety of children is a fundamental component of education and that the health and safety of teachers at the workplace should also be protected. Implementation strategies include the reintroduction of initiatives such as training in personal hygiene, environmental health, and safety measures; the promotion of a culture of regular and timely maintenance of school physical facilities; and the development of guidelines for the maintenance of school safety and health standards.

- Zanzibar Gender Policy 2016

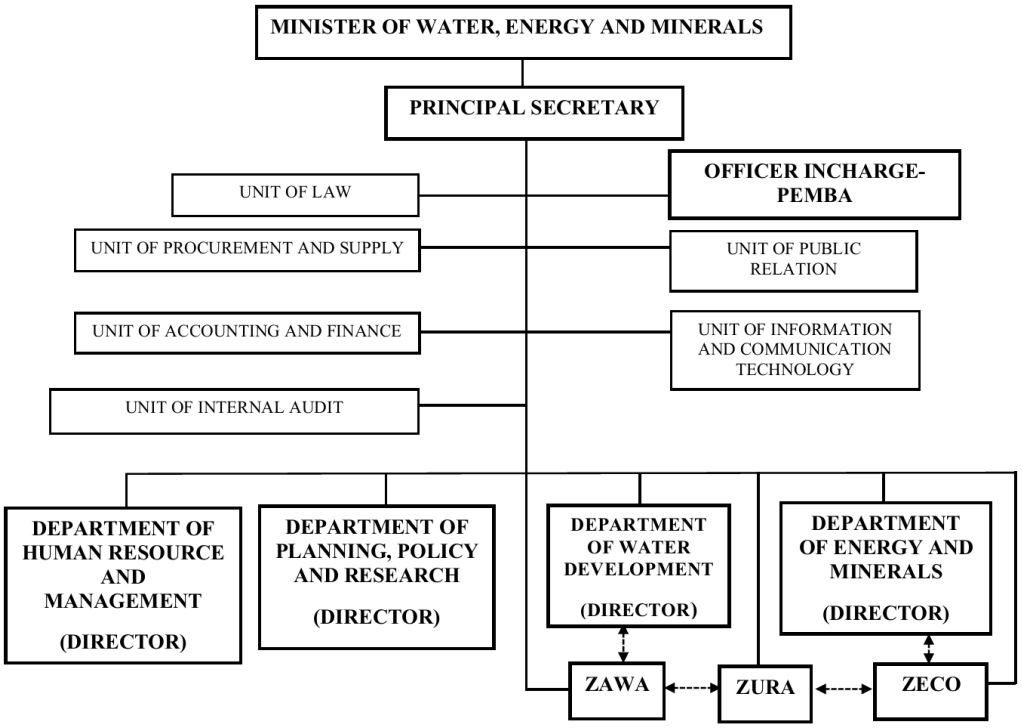
The policy describes the strategies to promote access to social and economic opportunities for women and vulnerable groups. These are: improving water infrastructure to reduce the time spent by women and girls fetching water; promoting access to infrastructure services for social and economic activities by women (as an indicator, the number of viable registered women enterprises with stable power and water supply). In addition, to address the issue of environmental degradation, which particularly affects the livelihoods of women in rural areas, the policy states the necessity for the institutionalization of appropriate environmental conservation mechanisms and the development of programs to address gender needs related to the environment and climate change. The initiative includes increasing women's representation on committees responsible for activities related to water and environmental management, and enhancing partnerships between men and women in the management of water and sanitation facilities and water resources.

2.2.2 Overview of Organisational Operation and Human Resource Development

(1) Ministry of Water Energy and Minerals

(a) Organisational Structure

With the enactment of the Water Act in 2006, ZAWA was established by separating the Water Development Department from the Ministry of Lands, Water, Energy and Environment (MoWEM). The all water related issues and business were transferred to ZAWA. After that, the ministry did not have a department dealing with the water sector, but it was reorganized into MoWEM following the reorganization of ministries and agencies after the inauguration of the new president in November 2020. MoWEM is currently responsible for policy formulation for water and energy in Zanzibar. The ministry supervises three public corporations and public services, ZAWA, ZURA, and ZECO (Zanzibar Electricity Corporation). In addition, the Water Development Department was re-established. Figure 2.4 shows the organization chart of MoWEM as of 2021. On the organizational chart, the Department of Water Development (DoWD) oversees the activities of ZAWA, and the Department of Energy and Mineral (DoEM) oversees the activities of ZECO. Although the Water Development Department was established from in 2020, the department director was not appointed for a while and the situation continued to be non-functional. The department director was appointed in October 2021, and it started its function gradually thereafter. At the beginning of 2022, the department is still the outset of operation, the operational policy and duty contents of the department are under consideration. The planning of practical work is being discussed to acquire the budget for the coming year. Budgeting for operations is expected to be approved after 2021/22.



Source: MoWEM

Figure 2.4 The Organisational Structure of MoWEM in 2021

The Water Development Department is considering hiring the officers for the positions shown in Table 2.23.

The proposed positions indicate that the main focus of the department is the duties related to water resource management, water and sewage, and the environment. As of February 2022, four people have been appointed. In addition, employment of officers with hydraulic geology and environmental background is an issue under consideration.

Table 2.23 Positions that are Being Considered for Employment in the Water Development Department

Position		Eligibility Requirement	Situation in 2022
1	Project engineer	Bachelor or Master	Appointed
2	Engineer (civil engineering)	Bachelor or Master	Appointed
3	Technician (machine)	Bachelor or Master	Appointed
4	Policy planning officer	Bachelor or Master	Appointed
5	Engineer (hydraulic geology)	Bachelor or Master	Vacant
6	Technician (environment)	Bachelor or Master	Vacant

Source: MoWEM

(b) Ministry's Work Purpose

MoWEM's duty objectives are policy formulation for the water sector, supervision and coordination within government agencies, and budgeting of public funds necessary for project implementation for a safe and stable water supply in Zanzibar. Policies need to cover the following areas and issues, with the priority themes to enhance water supply services throughout Zanzibar, regardless of urban areas or rural areas.

i. Water sector policy formulation, program formulation and implementation, supervision
ii. Supervision of construction, maintenance and operation of water infrastructure
iii. Promotion of research related to the development of the water sector
iv. Ensuring clean and safe water supply in both rural and urban areas

(c) Urgent issues Recognized by the Department of Water Development

The Department of Water Development supervises the sustainable management and development of groundwater resources in Zanzibar, supervises the provision of sustainable development and water supply services in both urban and rural areas, and the sustainable use of groundwater resources. Further it provides supervisory advice on water quality management. Current urgent issues include a shortage of competent skilled staff in the water sector, pressure on operating expenditure due to high costs (especially electricity bills), high non-revenue water rates, and a trial introduction of a SCADA system in water infrastructure & water distribution systems. The following items are listed as urgent issues for the Water Development Department.

i. Increase access to clean and safe water for all water users by 95% in urban areas and 85% in rural areas by 2025
ii. Promotion of research on groundwater development

On the other hand, although it is necessary to make plans for implementation of planned works and policies of specific projects in the future and obtain budgets for such implementation, the work of the Water Development Department of the Ministry and its functioning methods have not been decided yet as of 2022. Those will be examined gradually in the future.

(d) Cooperation status with ZAWA

The ministry mainly provides policy guidance and supervision, general ministerial guidance on operational management, and coordination within administrative agencies for ZAWA. ZAWA will be required to report the business directly to MoWEM through the Water Development Department. Based on the necessary reports and discussions, the water sector policy and policy contents will be decided and reflected in the budget. The contents of the reports are assumed to consist of, for example, water production, the number of connections, the number of failures, and the income and expenditure reports. The Water Development Department will monitor the implementation status of ZAWA together with ZURA based on such reports. As a ministry, the Department of Water Development will fulfil the functions of policy formulation, budgeting, and coordination within government agencies in the water sector, especially for issues that emerge from communications and reports.

(e) Cooperation status with ZURA

The ministry mainly provides policy guidance and supervision to ZURA, general guidance on operational management, and coordination within administrative agencies. The Ministry of Water does not have a department for the management ZURA, but the outline of water-related work will be reported directly to MoWEM through the Water Development Department. Since ZURA has the task of creating regulations and standards as well as monitoring, the legal nature of these official documents on the water sector will be dealt with through the Water Development Department. The Water Development Department aims to build a collaborative system to provide regulatory support and improve operations through ZURA for the operations carried out by ZAWA.

(f) Cooperation with the ministry of water in mainland Tanzania

MoWEM signed a Memorandum of Understanding (MOU) in 2020, agreeing to form a partnership with the Ministry of Water in mainland Tanzania. The partnership memorandum includes water resources, water supply and sanitation services as areas of cooperation. The agreement notes cooperative liaison between the ministries regarding 1) institutional improvement, 2) tariff collection and financial improvement, 3) research on rainwater harvesting methods and technology and hence forth as cooperative activities in the near future. No materialised plan has yet been formulated.

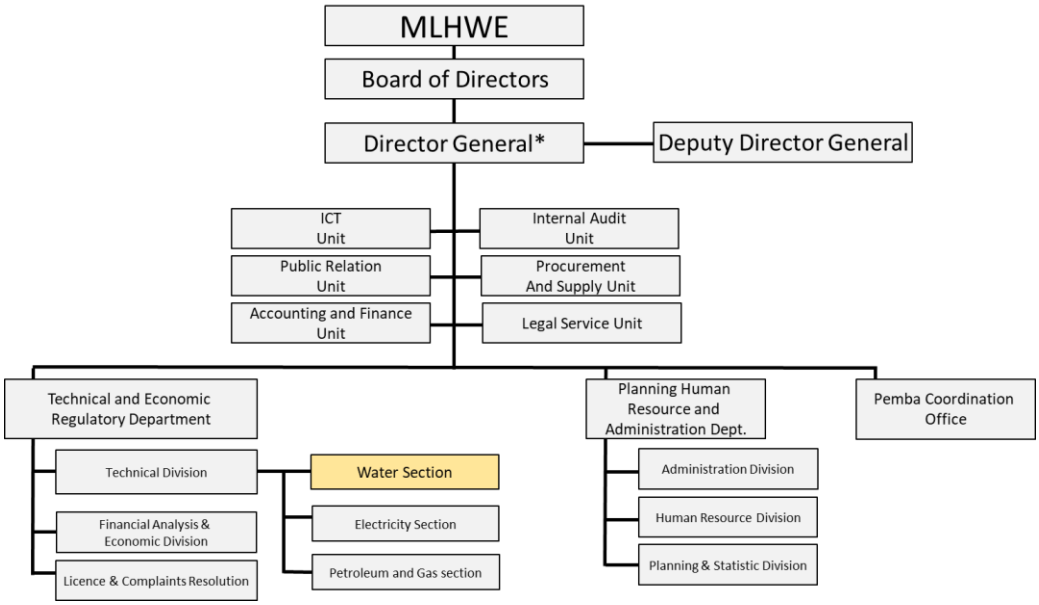
(2) Zanzibar Utilities Regulatory Authority (ZURA）

(a) Organizational Structure

ZURA was established in 2013 by ZURA Act No.7 as a regulatory agency in Zanzibar with the aim of supporting the use, licensing and quality control of the water, electricity and fuel as well as gas sectors from a regulatory perspective. It was made into practice and was launched in 2015. As an external regulatory agency of ZAWA, operations aimed at quality control of ZAWA are planned. Currently, ZURA has an authority to grant a license to AAWA for water utilities and a license for borehole drilling under the authority stipulated in the current legal system.

Figure 2.5 shows the ZURA organization chart. The water section of the Technical and Economic Regulatory Department's Technical Division is in charge of the water sector. The number of staff in charge of the water

section is currently 5 officers, and the total number of ZURA staff is about 80 officers. ZURA started monitoring of water quality of ZAWA water supply network in 2020. Monitoring and confirmation of practical work progress regarding regular operation or particular projects within ZAWA are not performed. Therefore, accountability and supervision may be insufficient to ensure work implementation of duties and service provisions.



Source: ZURA

Figure 2.5 ZURA Organisational Chart in 2021

The water section staff consists of one (1) section chief and four (4) staff, two of whom are assigned to the Pemba office. Table 2.24 shows the staff and positions of the water section of the technical division.

Table 2.24 Water Section Staff and Positions

	Name	Position
1	Said haji Mdungi	Technical section chief
2	Rajab Said Mohammed	Inspector
3	Ramadhan Kombo Ali	Inspector (Sanitation)
4	Suleiman Hamad Masoud	Inspector
5	Zeyana Mwalimu Ali	Assistant inspector

Source: ZURA

(b) Organizational management details

In 2018, a survey was conducted to overview ZURA's operations and issues, and recommendations were made to foster the understanding of its function as a regulatory body and promote the work of the organization. In 2019, when ZAWA's customers bring complains about the water supply services and water quality to ZURA, the reaction of ZURA was limited to consultation with ZAWA and only to provide guidance for improvement. In 2021, the water quality monitoring regulations were enforced, and the budget were allocated to carry out the work. Table 2.25 shows the work carried out by ZURA as stipulated in Section 13 of the ZURA Act.

Table 2.25 Implementation Status of Work Stipulated in the Law for ZURA

Contents of Work		Status in October 2021
1	Regarding preparation of water extraction licensing, provision of conditions, issuance, change, cancellation, etc.	Preparation of license rules
2	Preparation of rules, orders, and guidance, issuance of such governmental orders to public services.	Preparation of tariff renewals
3	Announcement of utility charges and tariffs, published in the official gazette.	Not started
4	Gathering the necessary information.	Conducted as needed
5	License fees, other fees, etc. will be set in accordance with the rules specified by the relevant public utility law and regulations as well as consultation with the Minister.	Preparing for water tariff regulation
6	Conduct surveys according to the necessity or importance.	Conducted as needed
7	Prepare and implement instructions to ensure compliance with the license.	Preparing for water supply regulations
8	Set performance standards for energy and water services, such as customer service standards and quality standards.	Completed KPI for performance monitoring of water utilities

Source: JICA Survey Team

(c) Status of regulations and manuals related to public services

Water utility performance is assessed using performance indicators that measure efficiency and effectiveness in providing water supply services. For that purpose, it is necessary to formulate regulations, legislation, standards, and service processes as a framework. Since the establishment of ZURA in 2015, which is a short while ago, regulatory systems and service processes are still under preparation, and as shown in Table 2.26, in 2020, manuals and guidelines for developing services were prepared. The issued manuals and guidelines obtained are shown in the attachments.

Two regulations on water supply have already been drafted and submitted to the secretary of justice (as of October 2021). When officially enforced with the approval of the Minister of MoWEM, it would be possible to obtain legal support for the specific work of ZURA regarding quality control of water supply. Water supply regulations were not provided because they were in the draft stage. In addition, ZAWA is conducting a survey on service costs through a contracted consultant as of October 2021, and after this survey report is prepared, they plan to carry out work related to water tariffs by referring to the survey results.

Table 2.26 ZURA Related Regulations, Manuals and Guidelines

Regulations, manuals and guidelines		Status in October 2021
1	Inspection manual for water supply utility	Issued in 2020
2	Water supply utility performance monitoring: Key Performance Indicators for water services	Issued in October 2020
3	Water quality monitoring guidelines for water utilities	Issued in October 2020
4	Water supply (permit) regulations	Drafted
5	Water supply (quality of service) regulations	Drafted
6	Water tariff regulations	Drafted

Source: ZURA

(d) Coordination among organizations

The focal points for cooperation with ZURA and ZAWA are the Technical Management Department and the Water Resources Department. ZAWA started water quality monitoring in 2021. ZAWA will conduct sampling

tests at 10points at reservoirs and distribution networks and report the results to ZURA.

(e) Organizational management issues Recognized by ZURA

Table 2.27 shows the current understanding of ZURA regarding organizational management issues.

Table 2.27 Issues on the Organisational Management Recognised by ZURA

Item	Issues
Quality Control	It was pointed out that the reasons for the inadequate quality of water services is that ZAWA is the only service providing institution. Insufficient operation and maintenance of the water supply system, high non-revenue water, inadequate meter reading work, ineffective work management, etc. are pointed out d as issues to be improved. The overall performance of ZAWA would be improved by the supervision function of quality control by ZURA.
Institutional Framework of Water Sector	As the sole implementing agency for water supply, ZAWA has jurisdiction over both water supply and water resource management. There is a growing recognition that another organization than ZAWA should oversee water resource management and ZAWA takes care only of water supply. With the establishment of the Water Development Department in MoWEM, it is expected that the aspect of administrative management from the government will be strengthened.
Decrepit Infrastructure	The existing water supply facility is aging and is operating below the facility's design capacity.
Urban and rural division of water supply	As the islands are small and the lifestyles of cities and villages do not differ so much, there is no great merit in dividing operations by dividing cities and rural areas. On the other hand, the idea is to create a regional division, dividing the Unguja island into about 5 water supply divisions, and establish multiple water supply enterprises.
Issues Related to Capacity Development	ZURA selects training candidates form the staff each year and dispatches them to short-term courses offered at the Water Institute in mainland Tanzania. The short-term courses are programmed for about 2 weeks. As a regulatory authority, there is a need to improve the capacity to support the improvement of the water supply service provider, the framework of regulation, the operation method, etc., so it is necessary to strengthen the knowledge and implementation ability to monitor as a regulatory authority.

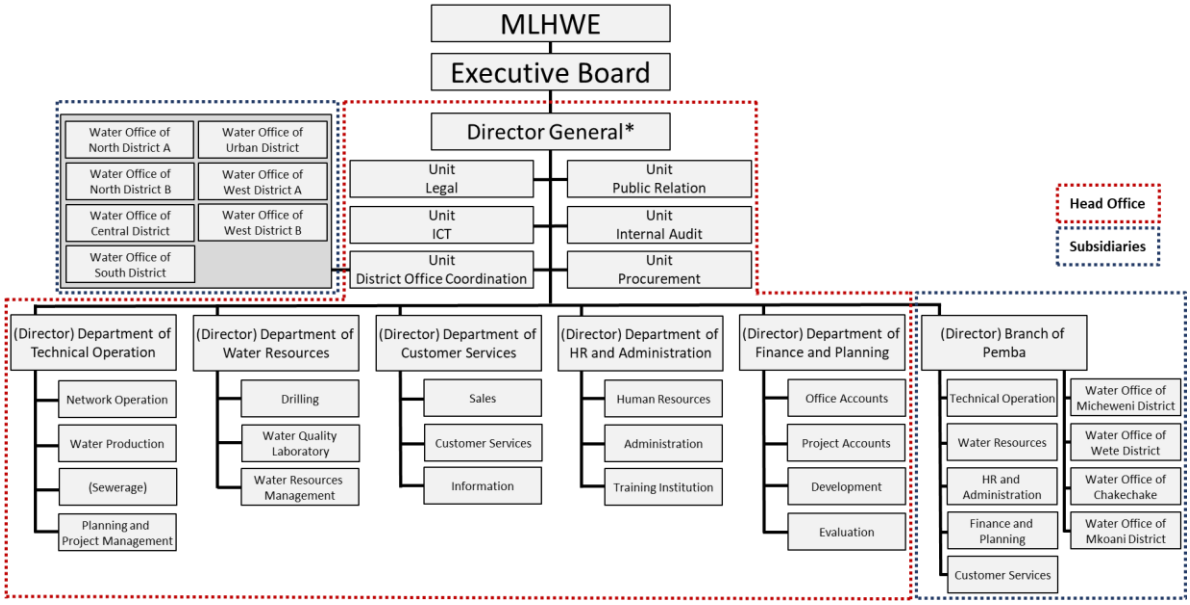
Source: JICA Survey Team

(3) Zanzibar Water Authority

(a) Current state of organizational structure and operation

ZAWA was established in August 2006 as a public entity that operates the water supply services in Zanzibar, and it functions as an implementing agency for water supply services, groundwater development and its management. ZAWA is positioned as a subordinate body of MoWEM, and the president is appointed by the president of Zanzibar.

The water sector in Zanzibar is undertaking a number of institutional and legal reforms aiming at improvement of the management of service delivery systems. Restructuring of the organizational structure has been recommended. Figure 2.6 shows the current organizational structure. The current operation is divided into five departments, and a branch office for Pemba is set up. A District Water Office has been set up for rural water supply and is supervised by the District Coordination Unit. The Department of Water Resources is in charge of groundwater development and management. The number of staff is 568.



Source: ZAWA

Figure 2.6 ZAWA Organisational Structure in 2021

The subsequent implementation status of the organizational restructuring was examined that was proposed in Phase 2 of the Technical Cooperation project by JICA experts. ZAWA actively incorporates the recommendations of technical project and working on to improve operations. Specifically, the finance and general affairs department was divided into the finance and planning department and the HR and administration department. In addition, a new district branch coordinator has been appointed who will be responsible for all branches. This reorganization has improved efficiency and reduced ambiguity of work division.

Table 2.28 Recommendation by Technical Cooperation Project Phase 2 and its Status

Recommendation by Technical Cooperation Project Phase 2		Status 2021
1	Integrate ICT unit and data management department to improve billing and collection efficiency	Undone
2	The ICT unit is in charge of GIS data entry work for the integration of data and GIS data	Done
3	The internal audit section was integrated into the planning and project management section, and utilize the internal audit information for operational management.	Done
4	Plumbers and meter engineers allocated to the sales and customer management department will be transferred to the network department to improve efficiency	Done
5	Integrate technical operation and water resource development to improve the PDCA cycle	Undone
6	Require district office monitoring to improve their performance	Being reviewed

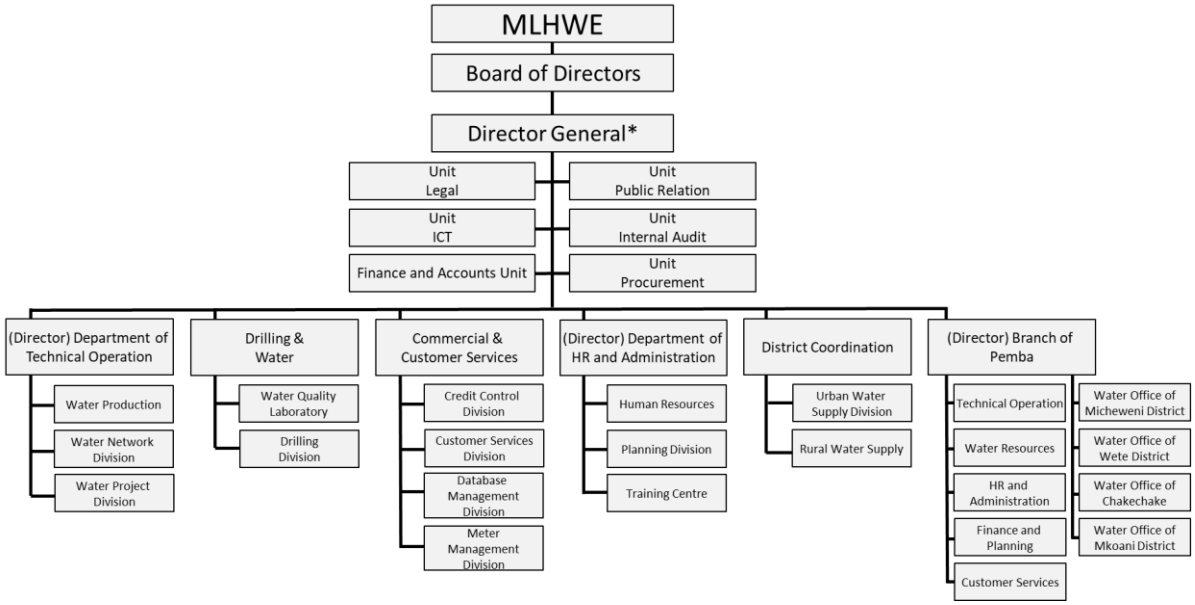
Source: JICA Survey Team

ZAWA submitted a reorganization proposal to the Public Service Commission at the end of 2020, but almost a year has passed without an approval. During that time, the situation changed. Following the change of the president of ZAWA, an instruction to reconsider the proposal of the organizational structure was given again in October 2021. Discussions on the reorganization of the organizational structure are still underway. Figure 2.7 shows the organizational structure proposed to the Public Service Commission in 2020, based on the recommendations of JICA technical cooperation. Table 2.29 shows a list of operational mandates of each department in the organizational restructuring plan. The main points of the proposal are as follows.

i. Reorganize district offices into an organization that manages urban and rural water supplies

ii. Separate the Water Resources Department from ZAWA and establish an independent organization as the Water Resources Management Board aiming to shift operations and expand the work.

iii. The accounting department is to be reorganized into a unit under the direct control of Director General. The monitoring of the accounting department will be strengthened from the management perspective to improve the financial management.



Source: ZAWA

Figure 2.7 ZAWA Reorganization Plan

Table 2.29 Mandates of Departments in the ZAWA Organizational Restructuring Plan

Department		Mandates
1	Public Relations Unit	▪ Public relations
2	Legal Unit	▪ Legal affairs related to organizational management
3	Audit Unit	▪ Auditing
4	Finance and Accounting	▪ Accounting and bookkeeping
5	Procurement Unit	▪ Procurement
	Warehouse	▪ Asset management of repair materials, etc.
6	ICT Unit	▪ Database management ▪ Supply and maintenance of computers and meter reading equipment
7	Technical Operation	▪ Construction, operation, maintenance and repair of facilities and water pipelines
	Water Production	▪ Operation, maintenance and repair of facilities such as workshop, distribution reservoirs and water sources
	Water Network	▪ New laying, renewal, and leak repair of water transmission and distribution pipelines
	Water Projects	▪ Planning and management of water sources and water supplies
8	Districts Coordination	▪ Management and operation of water sources and distribution lines, and customer service in remote areas
	Urban Water Supply	▪ Water supply services in urban areas
	Rural Water Supply	▪ Water supply services in rural areas
9	Human Resources & Administration	▪ Planning, implementation and supervision of personnel and financial management and accounting standards
	Planning	▪ Drafting strategic business plan and organizational policy
	Human Resources	▪ Personnel management, human resources development, employment administration

	Training Centre	▪ Training for staff
10	Drilling & Water Quality	▪ Planning, implementation and supervision of water source development
	Water Quality Laboratory	▪ Water quality tests and reporting
	Drilling	▪ Borehole drilling and water intake management
11	Commercial & Customer Management	▪ Planning, operation and management of customer service and related data management ▪ Rationalization and efficiency improvement of billing and collection operations
	Customer Services	▪ Dealing with complaints, including district branches ▪ Promoting new subscription to the water services
	Credit Control	▪ Collection management of water charges and receivables
	Data Management	▪ Maintenance, monitoring and supervision of customer database ▪ Invoice issuance and distribution
	Meter Management	▪ Meter installation, meter reading, maintenance, calibration, etc.
12	Pemba Branch	▪ Overall water supply management on Pemba Island

Source: ZAWA

(b) Issues of organizational and division of duties

The following three areas are considered as the current priority issues for ZAWA.

i. Enhancement of water resource management
ii. Implementation of prepaid payment method as one of the measures for financial improvement
iii. Improvement of leak management system

(i) Enhancement of water resources

Groundwater is the only water resource in Zanzibar. Its management is an issue of concern to balance its usage and conservation, such as restricting over-exploitation and prevention of saltwater intrusion. The issues of water resource management are summarized below in relation to the institutional and human resources management.

The Water Resources Department in ZAWA is in charge of operation and management of water resource development. Zanzibar relies on groundwater resources for water resources. It needs to take a progressive conservation approach for the sustainable use of water resources. There is a legislation on the protection of catchment areas and resource regulation, and ZAWA is the only regulatory body for water resources. In recent years, water demand exceeded ZAWA's supply and irrigation use has continued to expand, resulting in a significant increase in private borehole drilling. As a result, inadequacy has increased in groundwater resource monitoring, water intake and drainage regulations. ZAWA has published in the official gazette about the catchment area management. The subject on control measures against seawater intrusion into the catchment area is an alarming issue to be considered in the strategic plan up to 2025.

The national water policy formulated in 2004 states that in terms of organization, the management of water sources and the work of water supply should be separated. Therefore, the establishment of the Water Resources Management Board is under discussion for the appropriate development, monitoring, and supervision of water resources. In practice, it has been proposed to separate the Water Resources Department from ZAWA to establish an independent organization and shift the mandates and expand its operations. ZAWA will eliminate a water resource development and management department and in lieu specializes exclusively in the water supply. On the other hand, the establishment of an organization of the Water Resources Management Organization is currently not recognized as an urgent issue. ZAWA is highly

interested in the methods and technologies how to diversify water sources from the strong dependence on groundwater. Rainwater harvesting is taken as an option for further research. ZAWA has interests in technical studies and proposals and proceeding with information gathering. The research efforts related to rainwater utilization is included in the strategic business plan for 2020-25. Before establishing the WRMB, it is necessary to enhance their mandates and operational contents of the Water Resources Department currently placed in ZAWA. For that purpose, it is necessary to have human resources who has knowledge on groundwater resources, practical management, or launch specific projects by outsourcing, monitor and plan groundwater resources. A management of planning of diversification of water resources is also a necessary initiative.

(ii) Development of organizational management system for prepaid system

As one of the measures to improve ZAWA's finances, it is required to improve the tariff collection rate. Currently, as a trial project, the introduction of a prepaid system at a pilot area is being prepared for implementation in a project supported by India. The department in charge is scheduled to undertake the Commercial and Customer Management services, but the management system for how to implement the operation is still under discussion. An introduction of the operation system is an issue for the future. These include:

1) Management of customer information when introduced
2) Determination of workflow within ZAWA
3) Determining payment method and service method (sale of vouchers, use of SMS)
4) How to inform customers
5) Price setting
6) Monitoring of introduction status and evaluation of introduction effect.

The management has to decide and organise how to carry out these tasks. Furthermore, the discussions are still under way for the future water tariff collection system, and in the presence of a flat-rate and a volumetric system, there is still no roadmap to advance after a trial of the prepaid system. Therefore, a strategic plan is necessary to put the idea into an action. Based on the results of the evaluation after the trial of prepaid system, a planning is needed for an implementation of a fee collection and a practical operational management.

(iii) Improvement of leakage management system

Regarding leakage management, the Water Network Division of the Technical Operation Department is in charge of new construction, renewal, and leakage repair of water transmission and distribution pipelines. While the Water Network section has six staff members, the workflow for finding, reporting, and responding to leakage is unclear. In daily work, repairs and measures are not systematically carried out because it is unclear in the organization about identifying leakage points, making decisions about measures and dealing with them, which leads to an increase in NRW. The report of the leakage from the customer is also an important source of information but the information of the complaint from the customer service department is not reflected in the appropriate action list of ZAWA. Also, in the Zanzibar Urban Water Supply area, water leakage is increasing because the old piping network and the new piping network are not well connected. The implementation of the business plan for this connection change has been delayed and has not progressed yet.

Management of work implementation plans, status monitoring, and feedbacks are important in order to act and improve operational practices.

(c) Strategic Planning for the Challenges

As mentioned in 2.2.1 (6), ZAWA has formulated a five-year plan (SBP2025) and an annual plan in order to solve the organizational management issues identified in the implementation plan. The five-year plan identifies improvement needs and plans to address these issues. Based on these findings, more detailed strategies, activity plans and budgets are formulated in the annual plan for 2020-21.

Table 2.30 Issues Identified in the Five-Year Plan

No.	Area	Identified Issues
1	1. Organizational Capacity	Insufficient number of pump operators
2		Insufficient staff numbers with the knowledge of water resources management
3	2. Water Resources Management	Lack of water resource conservation measures
4		Insufficient use of rainwater
5		Shortage of specialists in the field of water resources
6	3. Water Supply Services	There are areas with unstable water supply
7		Network without proper pressure and distribution zoning
8		Insufficient water reservoir
9		Inadequate management of water intake and distribution
10	4. Finance and Customer management	Low internal rate of return
11		Excessive power consumption
12		Approximately 80% of customers have no meters
13		High non-revenue water rate of about 60%

Source: Summarized based on ZAWA Strategic Business Plan 2020 / 21-2024 / 25

In terms of organizational management and human resource development, the activities in Table 2.31 are taken up as issues to be tackled in the five-year plan and are incorporated into the annual plan. The annual plan for 2020-21 has an action plan in line with this five-year plan.

Table 2.31 Objectives for Organizational Management and Human Resource Development

Objective	Improvement of organizational management, performance improvement of about 50% to 90% by 2023
Strategy	i. Enhance employee performance ii. Improving human resources planning iii. Strengthen cooperation with stakeholders iv. Strengthening institutional coordination v. Strengthen research, monitoring and assessment practices vi. Improving governance performance vii. Improved management performance viii. Strengthening the legal department ix. Strengthening procurement management x. Promoted ZAWA Training Centre to an accredited educational institution xi. Improvement of management efficiency

Source: ZAWA Strategic Business Plan 2020/21-2024/25

In line with the five-year plan, the annual plan (2020-21) schedules specific work for the items.

Table 2.32 Overview of Annual Plans Related to Organizational Capacity Areas

TABLE 1: THEME A: Institutional Capacity				
Activities		Performance Indicators/KPIs	Target	Responsible
Objective 1: Institutional capacity increased from estimated 50% to 57% by the end of 2021				
Strategy1: strengthening employees' performance (PAS)				
A1.1	Review and strengthen PAS	PAS in place	568 staffs	HAD
A1.6	Develop incentives guideline	Incentives guideline in place.	1 Guideline	
A1.7	Facilitate salary payment	Payment on time	568 staffs	
A1.8	Prepare staff terminal benefit	Terminal benefit prepared and paid on time	14 staffs	
A1.9	Facilitate payment of salary subsidies	Payment on time	568 staffs	
A1.10	Facilitate payment of wages	Number of workers	200 workers	
Strategy 2: Improve human resources planning				
A 2.1.	Train staff on human resource plan	Training on human resource implemented	7 staffs	HAD
A2.3	Conduct training capacity needs assessment.	Report in place	1	
A2.4	Develop a four-year HR plan addressing, short, midterm and long-term training	Staff training implemented	7 staffs for midterm training and 20 long term training,	
A2.7	Review job description	Job description reviewed and distributed to the staffs	568 staffs	
A2.9	Coordinate innovative knowledge sharing	Quarterly	17 staffs	
A 2.11	Recruit on need basis	Number of vacancies filled	7 vacancies	
Strategy 11: Enhancing Administration				
A11:1	Facilitate office maintenance activities	Good working environment	100%	HAD
A11:2	Repair and maintenance of vehicles and motorcycles	Number motorcycles, motor vehicle	4 vehicles and 3 motorcycles	
A3.1	Increase membership into water services Authorities	Number of memberships	1 membership	PRO
A3.2	Participate in joint conference and consultative forums	More resources opportunities identified and strategized.	2 forums	
A3.3	Organize and participate in seasonal sports and other events (Mapinduzi, Mwenge, biashara, Sheria, Kilimo, May day etc)	Relationship strengthened	2 events	PRO
A3.4	Facilitate study visit programs	Number of programs	2 programs	PRO
A3.5	Establish collaborative agreements with the respective organizations	Number of collaborations	2 collaborations	PRO
A3.6	Facilitate cooperate social responsibility programs	Number of groups	20 groups	PRO
A3.7	Organize sports Bonanza	Number of bonanzas	1 Bonanza	PRO
A3.8	Organize/Participate in water week	Increase social relation and compliance	Once a year	
A3.9	Facilitate media coverage and reporting	Well coverage of ZAWA news	48, (24 TV and 24 radio programs)	
A3.10	Conduct community awareness meetings	Number of awareness meetings	51 awareness meetings	
A3.11	Prepare advertising materials	Number of advertising materials		PRO
	Calendar		1,500 calendars	
	Banners		7 banners	
	Business Cards		1,000 B. cards	
	Flyers,		3,000 fliers	
	Slogans		6 Slogans	
A3.12	Prepare documentaries	Number of documentaries prepared	3 Documentaries	
A3.13	Update staff skills on advertisement and public relation issues	Number of staffs	4 staffs	

TABLE 1: THEME A: Institutional Capacity				
Activities		Performance Indicators/KPIs	Target	Responsible
Strategy 6: Enhancing governance performance				
A6.2	Train the Board on strategic governance and change management	Training conducted	15 trainees	LU
A6.3	Facilitate board of directors' activities	Number of Ordinary meetings, Extra meetings, Board Committee meetings, and site visits	4 Ordinary meetings, 4 Extra ordinary meetings, 6 Board Committee meetings, 5 site visits	
Strategy 7: Enhancing management performance				
A7.1	Facilitate management meetings	Number of meetings conducted	7 meetings	LU
Strategy 8: Strengthen the legal unit				
A8.1	Preparation of legal document	Number of Legal documents Prepared timely	20 legal documents	LU
A8.2	Facilitate on job training for legal drafting and minutes writings	Number of trainings	2 trainings, (1 for legal drafting and 1 minute's writings)	
A8.7	Develop draft of the Water Act No No.4, 2006.	Draft in place	1 Draft	
A.8.8	Conduct stakeholders meeting for review of the Water Act No.4, 2006.	Number of stakeholder's meetings	1 Stakeholder' s meeting	
Strategy 11: Enhancing administration				
A11.4	Procurement of office facilities	Office facilities for legal office procured	2 Office tables, 1 cabinet, 1 white board,1 air condition, and 1colored printer	LU
Strategy 9: Strengthen Procurement Management unit				
A.9.1	Update staff on procurement issues	Number of staff updated	54 staffs	PDMU
A9.2	Update existing and Prepare procurement plan	Procurement plan in place	1 Document	
A9.3	Sensitization on Procurement Act for tender board Members	Improve awareness of the Act	6 members	
A9.4	Coordinate Tender Board meetings	Number of meetings	12 Tender Board	
A9.7.	Coordinate the evaluation committee	Number of evaluations take place	24 Evaluations	
A9.8.	facilitation of clearing and forward	Clearing and forwarding facilitated	Quarterly	
A9.9	Stock verification	Number of stock verification	Once per year	
A9.10	Stock taking exercises	Number of exercises	Once per year	
A9.11	Coordinate negotiation committee for consultancies	Number of negotiations	8 negotiations	
Strategy 10: Update ZAWA Training Centre to accreditation level				
A10.6	Procure the centre facilities and equipment	Facilities and equipment procured	2 photocopies, 4, computers, 3 Laptops, 3 printers, 3 projectors, 100 chairs 100 tables and 3 shelves.	HAD
A10.8	Increase quality assurance (registration of the Pemba branch V.T.A 20/21)	Pemba Branch registered	1 Registration	
A10.9	Procure texts, reference books and journals	References in place	Reference books 40 and 30 scientific journals	
A10.10	Acquire building site	Building sites	1 site	
A10.11	Facilitate administration of the Centre	Centre working smoothly	100%	
A10.12	Building Capacity of the ZTC secretariat	Improve Centre performance	Secretariats (6 staffs)	
A10.13	Develop learning materials	Learning materials in place	15 Modules	
THEME D: Customer management				
Objective 4: Customer management increased from 50% to 58% by 2021				

TABLE 1: THEME A: Institutional Capacity				
Activities		Performance Indicators/KPIs	Target	Responsible
Strategy 1: Improving information management				
D1.1	Perform Computer maintenance	Computer well functi1d	150 computers	ICT
D1.2	Perform Network maintenance	Network operates well	100%	
D1.3	Perform Database maintenance	Database functional well	4 Databases (Pastel, Aruti, GIS, SBM 2)	
D1.4	Update and maintain website	Website updated	100%	
D1.5	Provide Internet services	Proper accessibility of internet services	100%	
D1.6	Train staff on computer user awareness	Computer user awareness conducted	40 staffs	
D1.7	Facilitate short course training on database and Networking	Number of staff trained	5 staffs	
Strategy:5 Strengthening internal control System				
D5.1	Auditing accounting documents accuracy &Procedure	Audit report prepared timely	5 reports	IA
D5.3	Short courses for IA staffs on Risk Assessment and Indicators of fraud	Number of staffs trained	8 staffs	
D5.5.	Review Risk management Framework	Risk management review in place.	1 Framework	
D5.9	Conduct Audit committee meeting	Number of AC meetings	Once per quarter	
Strategy 11: Enhancing administration				
A7.2.3	Procure Of office facilities	Facilities procured/installed	2 office chairs, 2 tables cupboards and 2 curtains.	IA

Source: ZAWA Annual Work Plan 2020/2021

(d) Current status of human resource development

(i) Staffing status

As shown in Table 2.33, ZAWA has 586 employees. Approximately 25% are unskilled staff, and it is perceived that there are few skilled staff. As of 2020, about one-third of the staff are 50 years old or even older.

Table 2.33 The Number of Staff of ZAWA

Area	Unguja	Pemba	Total		Staff
Number of Staff	328	258	586	M	500
				F	86

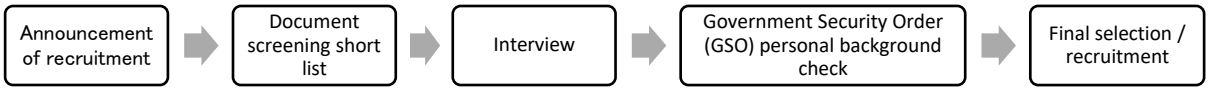
Source: ZAWA

Table 2.34 Educational Background of the Staff

Last Degree	Number of Staff
Master	20（Male 15、Female 5）
Bachelor	23
Diploma	60
Level 4	213

Source: ZAWA

ZAWA has requested a recruitment budget from the central government to make up this shortage of skilled personnel, and MoWEM has approved the recruitment budget, while the Ministry of Finance Planning did not approve it due to insufficient financial resources. Therefore, ZAWA's new hiring plan has not progressed. The recruitment procedure for new staff is as shown in Figure 2.8.

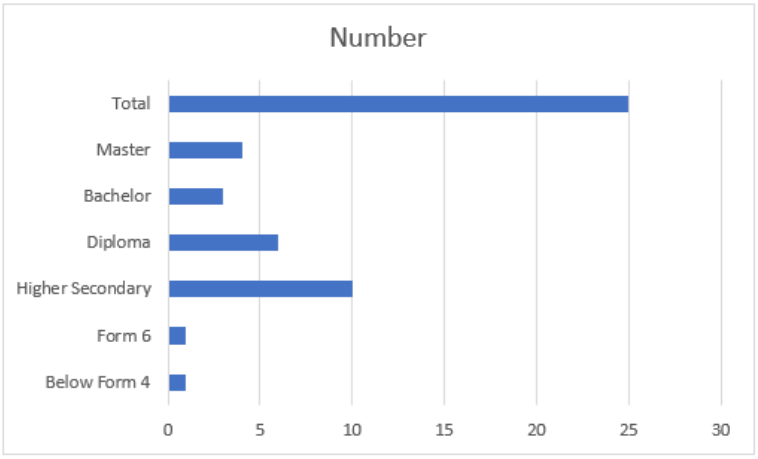


Source: JICA Survey Team

Figure 2.8 Flow of Recruitment

(ii) Current Recruitment Status for groundwater and water resources management

Improving the management of groundwater resources is regarded as necessary, but the shortage of human resources with specialized knowledge of hydraulic geology and water resource management is an issue. There are 25 staff members in the field of water resources management, and only one officer has a degree related to water resources. As for the plan of establishment of the Water Resources Management Board, it is suggested that the Water Development department will be separated and developed in the future.



Source: JICA Survey Team

Figure 2.9 Educational Background of Water Resources Department Officers

The following fields are listed as specialized fields of human resources that are currently required. In particular, personnel with knowledge of groundwater and sea water intrusion, salinization is in high demand. In addition, for staff other than university degree holders, strengthening their knowledge of groundwater and water resources and improving their overall knowledge will lead to improved performance. It is recognized that human resources with specialized knowledge mainly in the field of water resources are needed, and for more appropriate management of groundwater resources, consideration is being given to assigning them to the Water Resources Department and moving to the Water Resources Management Board in the future.

- Water Resources Management Engineering
- Hydrology field
- Geological field
- Geophysics field

(iii) Review of human resources development plan

ZAWA has formulated a training plan for a five-year period, and the training plan for each year will be finalized by June. Budget approval, disbursement of fund will be done in the following fiscal year starting

from July. In the five years as of 2021, ZAWA encourage to set goals for the degree or skill level that employees want to aim for in the future and encourage 99 staff members from each department to systematically attend training and study in their respective fields, aiming to strengthen their abilities. This is a voluntary goal and ZAWA does not promise financial support. Table 2.35 shows the breakdown of the target degrees in the five-year human resources development plan. ZAWA has a Zanzibar training centre (hereinafter referred to as "ZTC") under the Personnel and General Affairs Department. However, currently ZTC's main function is to offer vocational training for the general public. It does not exclusively focus on improvement of internal training and capacity development of ZAWA staff.

Table 2.35 Target Degrees by 2025

No.	Target Degrees	Number of Candidates
1	PHD	2
2	Master	24
3	Batchelor	19
4	Diploma	20
5	Certificate	20
6	Short courses	14
Total		99

Source: ZAWA

(e) Competency assessment

A competency assessment was conducted through a questionnaire survey to ZAWA staff. Behavioural characteristics of core capacity are classified in a few categories related to the quality of work from several perspectives (ex. Implementation capacity, management, organizational development). The questionnaires were distributed mainly to middle managers and above, and randomly selected other staff. Questions are based on the following five categories of awareness and behavioural characteristics that are relevant to the performance of work.

(i) Competency assessment method

- Objective

Survey of awareness and behavioural characteristics to identify issues from a competency analysis

- Assessment target

Random sampling of middle management and above staff and other staff (21 responses)

- Method

Questionnaire survey

- Competency classification considered necessary to obtain high performance

Questions were classified into the following 4 groups.

Group A: Competency for grasping the situation

Group B: Competency of planning

Group C: Competency of work implementation

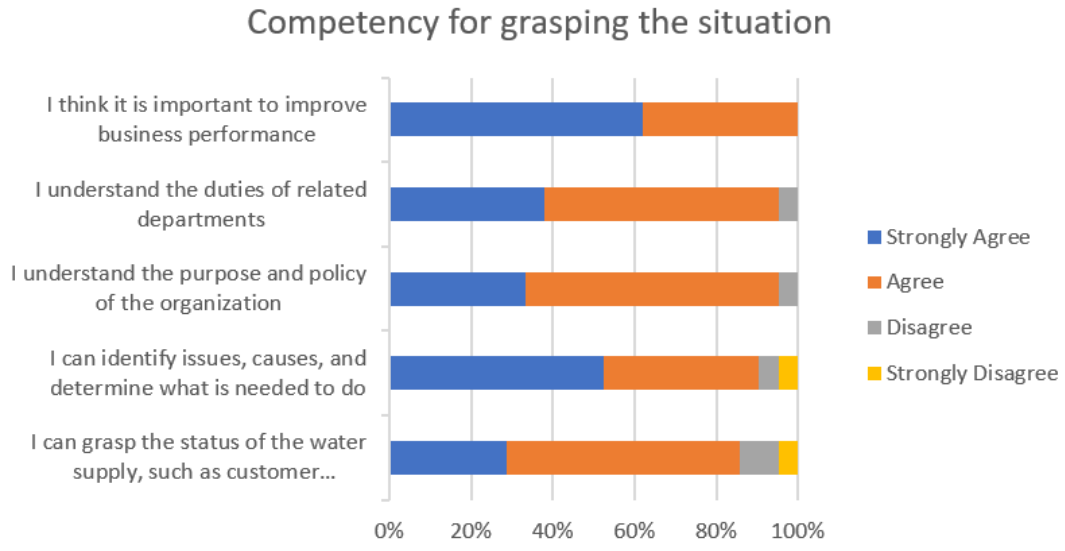
Group D: Competency of records

Group E: Motivation for work, psychology for effort making (engagement)

(ii) Competency assessment

The contents of the competency assessment based on the questionnaire results are shown below.

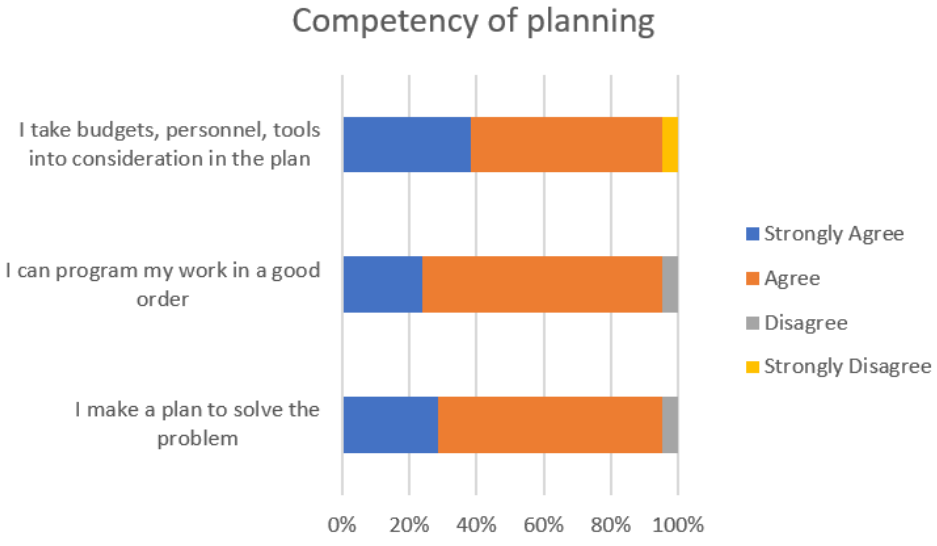
- Group A: Competency for grasping the situation



Source: JICA Survey Team

Figure 2.10 Competency for Grasping the Situation

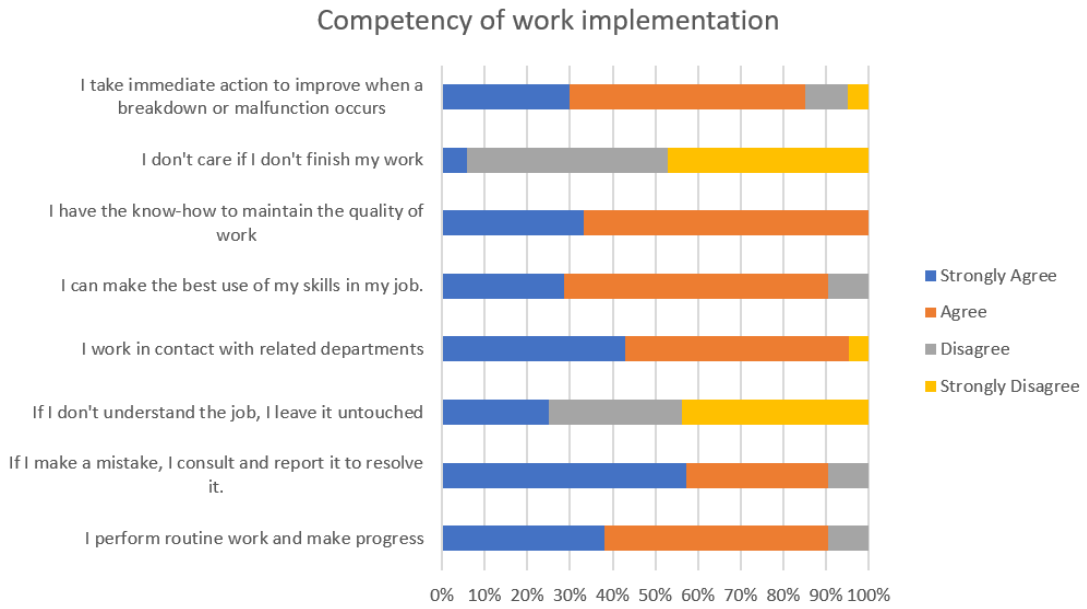
- Group B: Competency of planning



Source: JICA Survey Team

Figure 2.11 Competency of Planning

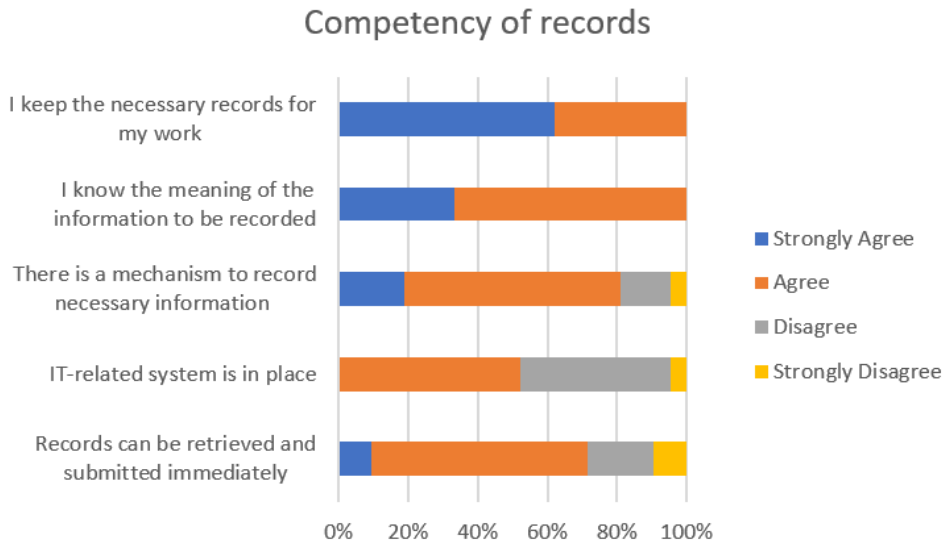
- Group C: Competency of work implementation



Source: JICA Survey Team

Figure 2.12 Competency of Work Implementation

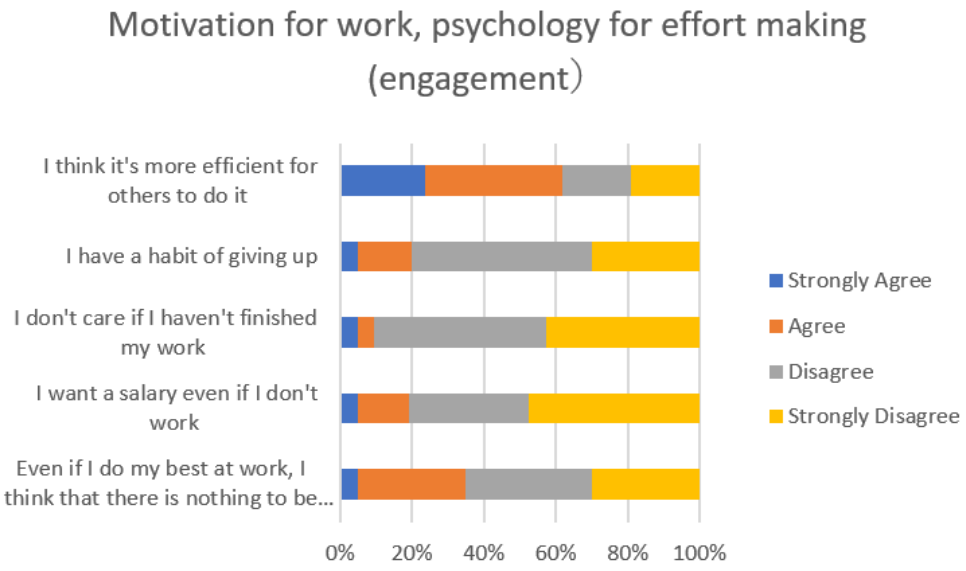
- Group D: Competency of records



Source: JICA Survey Team

Figure 2.13 Competency of Records

- Group E: Motivation for work, psychology for effort making (engagement)

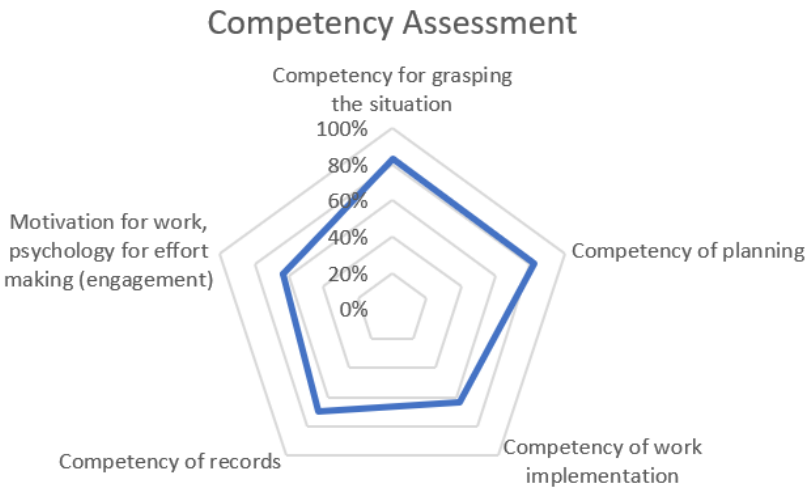


Source: JICA Survey Team

Figure 2.14 Awareness and Behaviour Regarding Engagement

- Summary of competency analysis

Figure 2.15 shows the results of the trends of the above competencies. Awareness towards work is generally kept high with respect to each work category. There is a relatively lower tendency for motivation for work and the psychological barrier for efforts, which may have an impact on the quality of work.



Source: JICA Survey Team

Figure 2.15 Competency Rating Radar Chart

On the other hand, the behavioural aspects of implementation were less strong, and the issues shown in Table 2.36 were identified.

Table 2.36 Results of Competency Questionnaire

Category	Competency
Behaviour/awareness to grasp the situation	Finding issues related to mandate and grasping the situation are a little weak A little weak understanding of the mandate itself
Behaviour and awareness of planning	High awareness of planning Slight weakness for personal level work plans If there is a breakdown or malfunction, it tends to be left untouched There is a delay in the implementation of the activity plan
Behaviour and awareness of work implementation	Weak IT-related mechanism as a recording medium Information recording and retrieval system is a little weak
Behaviour and awareness of records	I keep a high sense of responsibility for my work I am worried about carrying out my work efficiently
Motivation for work, psychology for efforts (engagement)	I think it's more efficient if others do the job Even if I do my best at work, I think that there is not much of a personal gain I have a habit of giving up

Source: JICA Survey Team

(f) Awareness of strengths and weaknesses at the organization and personnel level

(i) SWOT Analysis

Interviews were made within ZAWA for a SWOT analysis in order to analyse the current state of management strategies, business plans, and organizational strengths and weaknesses. The results are shown in Table 2.37.

Table 2.37 Results of SWOT Analysis

Item	Contents
Strength	We are able to supply safe and hygienic water The water network is functioning properly and is in good condition. The water supply network is stretched around ZAWA can carry out pipe repair work Projects are implemented and monitored Activities are followed up ZAWA conducts repair activities and has land ownership With the establishment of the ZAWA Training Centre, knowledge and skills can be improved. ZAWA has motivated staff Zanzibar has sufficient water source
Weakness	There is a discrepancy in the legal framework of water supply No bulk meter installed on the network Not enough water supply Insufficient parts supply Old pipes and other parts cause malfunctioning Insufficient utilization of human resources Insufficient project planning and management Reservoir and water distribution equipment are needed, but the plan has ended There are no highly skilled human resources in the labour market itself, and highly skilled human resources cannot be hired. Aging facilities and frequent pump failures
Opportunities	There are opportunities for training Brick is used for repairing tanks, pump rooms, etc. (durable) With the support of the Government of Zanzibar and Tanzania and the support of development partners The only service provider in the water supply sector
Threat	The only water source is groundwater Intrusion of salt water into groundwater The realization of planned and planned activities is an important issue Low customer willingness to pay Not being able to obtain specialized personnel due to low salaries Frequent illegal connections

Source: JICA Survey Team

(ii) Requests as an incentive to improve the work environment

- Transportation expenses
- Employing skilled workers
- Overtime / holiday allowance
- Improving the installation of campsites for construction work
- Improvement of salary level
- Improvement of business treatment

(iii) Recommendations from the perspective of organizational management and human resource development

The function of training centre can be enhanced and conduct long-term skill improvement training, together with OJT to raise the skill level of ZAWA staff. A sandwich method that mixes classroom lectures and practical work, with an emphasis on practical guidance that allows to immediately apply what is learned is effective to acquire practical skills and knowledge (ex. 3 days a week for practical work such as repair and customer management, 2 days a week for classroom lectures for writing reports, discussions on-site problem-solving methods, learning knowledge, etc.). Incentives can be given at work through improving employment conditions after reaching a certain level after a certain period (half a year, etc.). The training will help improve the weaknesses of the shortage of human capacity. Strengthening the functions of the training centre is considered to be an important measure in the medium to long term.

Regarding the intrusion of salt water into groundwater, which is a threat, there are few engineers with specialized knowledge in Zanzibar. It is not easy to improve skills through training at the training centres. Therefore, building a cooperative system with relevant institutions and universities in the mainland is considered to be an effective measure from the viewpoint of sustainability.

(g) Internal Training Institution

(i) ZAWA Training Centre

ZAWA has established the ZAWA Training Centre (ZTC) and has started internal training programs. ZTC is registered with the Vocational Training Authority (VTA) as a public training institution in Zanzibar and offers piping courses registered with the Zanzibar of the Vocational Training and Education Authority (VETA) under the jurisdiction of the Ministry of Education and Science (MoEST) of the mainland and cooperate with related authorities. The ZTC secretariat is composed of five people plans and manages a training program.

Table 2.38 ZTC Secretariat Personnel Composition

No.	Position
1.	Centres Principal
2.	Deputy Principal – Academic
3.	Assistance of Deputy Principal Academic
4.	Deputy Principal – Administration
5.	Legal Advisor

Source: ZAWA

ZTC offers Level 1 to Level 3 Vocational Training Certificate Courses (2019 certification). As Level 1, 1) Piping Skills Course, 2) Piping Connection Skills Course Level 1 (1 year course) have been offered since 2019. In 2021, Level 2 courses are offered, and students are taken from the Level 1 graduates. The recruitment for the third term has also started, and it started in January 2022. By 2023, all courses from Level 1 to Level 3 plumbing and pipe connection courses are expected to be available. As part of the five-year plan, ZTC are preparing for another course of Level 1 electrical & mechanics from 2019 to 2023. The formulation of other programs is under consideration, but the information has not been disclosed at the time of the survey 2021 because the content has not been finalized. In the future, ZTC aims to offer degree-level courses.

Regarding the invitation of training instructors from outside, when conducting specialized courses, it is necessary to invite outside instructors, and ZTC is considering future plans. The instructor will also consider other institutions in Tanzania and international experts from outside Tanzania as candidates. The candidates for instructors will also be from other institutions in Tanzania and international experts from outside Tanzania.

Some training is being considered in collaboration with external training institutions. ZAWA staff have exchanged opinions on cooperation with the Water Institute (WI), VETA in Dar es Salaam, as well as Arusha branches.

Table 2.39 Training Courses for Educational Institutions Outside Zanzibar Where Collaboration is Considered

Name of Training Institutions	Training contents	Duration
Jeshi la Kujenga Uchumi (JKU: Zanzibar National Service) vocational training institution	Plumbing, electricity, tailoring, refrigeration	1 year
Mazrui vocational training institution	Plumbing	1 year
VETA Dar es salaam	Plumbing, electricity, tailoring, refrigeration, car repair, mechanics	1 year
VETA Arusha	Plumbing, electricity, tailoring, refrigeration, car repair, mechanics	1 year
Dar es Salaam Water Institute	Water resources, water supply	2 years

Source: ZAWA

(ii) Improvement needs of ZTC

ZTC is still in the early days of establishment, and gradual improvement is under way. The following items were indicated as improvement needs.

- Equipment in the workshop
- Library facilities
- Computer room equipment
- Experimental facility
- Building infrastructures
- Improving the skills of instructors

In formulating a training plan at ZTC, ZTC is making plans in consideration of various factors such as discussions on human resources needs within the ZAWA organization and finding candidates in the labour market. Within ZAWA, collaborative meetings are held to discuss training needs and other issues in order to hear opinions from the heads of each department. And ZTC takes an initiative to understand the needs of human resources in specific fields. In addition, ZTC staff visit other related organizations to gather

information and knowledge on how to enhance the centre's function and what is necessary. ZTC also recognizes the needs to look into the potential of human resources in a specific field in the labour market and whether there are promising candidates to be hired who are self-employed.

(h) Resources in Tanzania regarding human resource development

(i) Water Institute: WI

Water Institute is a specialized educational institution for the water sector attached to the Ministry of Water, with the aim of improving the skills and knowledge, especially through training, consulting and research based on the policy guidelines of the Ministry of Water. In particular, training is provided for improving the skills of public utility staff and government staff in order to improve the skills of mid-career engineers.

Both ZAWA and ZURA have dispatched staff to the training. Programs are available for at least 50 short-term courses of several days to two weeks, and a bachelor's degree course at the university level.

Table 2.40 Degree Course Types Offered by Water Institute

No	Course Type
1	Water field skill test course
2	Diploma course
3	Water Field University Level Bachelor's Degree Course

Source: Water Institute

Table 2.41 Summary of Short-Term Courses Provided by WI (Excerpt)

No	Course Field	Specific Theme
1	Water treatment, hydraulic analysis	Sewage treatment applications, applied Water Treatment Applications and applied hydraulic analysis using Epanet
2	Asset Management	Asset Management
3	Customer management	Customer service improvement, community development, contracts, customer acquisition, contract management
4	Safety management	Dam safety technology
5	Design machine	Reservoir dam design, pump machine installation, pump machine structure, hydraulic network design, drip irrigation design, irrigation facility maintenance, hydrometeorological observation meter installation
6	Finance	Financial management
7	Research method	GIS, geological survey method, groundwater exploration, Epanet-based pipe network analysis, modelling, survey report preparation method, remote sensing
8	Civil engineering work	Borehole drilling, contract management, procurement, plumbing, construction supervision, pumping test

Source: Water Institute

In the past, ZAWA staff have taken courses at WI, or students found employment at ZAWA after graduation. WI has not dispatched instructors to ZAWA, ZURA, and MoWEM to teach or to implement training programs. WI may be able to dispatch instructors, conduct short-term courses, tailor-made training, etc.

(ii) Tanzania Public Service Collage（TPSC）

Tanzania Public Services College (TPSC) was established in 2000 as an educational institution for civil servants under the Executive Agencies Act No. 30 of 1997. The main purpose is to strengthen the administration, business management skills, ability and awareness of young and mid-career civil servants as administrative staff engaged in public works projects. Although it is a training institution for administrative staff, it awards graduation qualifications such as certificates, diplomas, and bachelor's degrees that are recognized by the private sector. The focus of the management policy and training framework is summarized

below.

- Technical training at practical training facilities and through programs
- Conducting tests and skill training to strengthen public services
- Improving management, leadership, clerical skills, knowledge, and awareness
- Advisory / consulting services
- Providing training and platforms for knowledge sharing
- Research and dissemination of knowledge on public service management best practices
- Utilization of global expertise in various fields
- Course design that takes into consideration the reduction of financial and work burdens on students
- Promote strategic alliances and partnerships with public, private and development agencies to enhance and provide educational opportunities

Long-term education programs include basic technician certificates, diploma, and university-level bachelor's degree courses. Civil servant exam preparation (PSE) and review courses are offered to civil servants who are required to attend for promotion. As an educational program, the training program is classified into three categories.

Table 2.42 Training Framework of TPSC

No.	Training Framework	Duration
1	Education program based on the management work function framework	Short term
2	Professional Education and Training (CBET) (NTA Levels 4, 5, 6, 7, and 8)	Long term
3	Civil service exam preparation, review course	Short term

Source: Tanzania Public Service Collage

In addition, dozens of short-term courses of several days to two weeks are offered every year for the purpose of continuous capacity improvement of civil servants. There are six campuses in Dar es Salaam, Tabora, Mtwara, Singida, Tanga, Mbeya and the Global Learning Centre.

Table 2.43 Types of Bachelor's Courses Offered at TPSC

No.	Type of Courses Offered
1	Basic technician certificate course
2	Diploma course
3	University level bachelor's degree course

Source: Tanzania Public Service Collage

Table 2.44 Summary of Short-Term Course Outlines Provided by TPSC (Excerpt)

No	Course Field	Specific Theme
1	Management/Governance Field	Audit, corporate governance, management leadership, public sector audit
2	Asset management	Asset management, inventory management, information management, crisis management
3	Audit	Audit, crisis management, accounting management
4	Management general affairs	Presentation skills, new employee training, office management, telephone customer communication, computer management system, office work, procurement
5	Human resources	Personnel evaluation, business analysis, recruitment analysis, personnel planning
6	Customer management	Records, information management, customer service, accountability

Source: Tanzania Public Service Collage

(iii) Ardhi University

Ardhi University (ARU) was founded in 1959 during the colonial era as a higher education institution called the Ardhi Institute and offered a three-year diploma course. It existed as a constituent university of Dar es Salaam University (UCLAS) from 1997 to 2007 and was established as a full-scale national university as of 2007. Currently about 5,000 students are enrolled. A four-year undergraduate course of hydraulic geology and water resource management is offered to undertake classes on water resources, hydrology, and hydraulic geology within the Faculty of Environmental Science and Engineering. In addition, the Faculty of Planning and Sociology, the Faculty of Architecture, the Faculty of Construction Management, the Earth Sciences, the Faculty of Real Estate and the Faculty of Business Informatics are established. Admission requirements are A-level grades in at least two subjects: physics, chemistry, biology, and advanced mathematics.

Table 2.45 Overview of Related Courses

Related Field	Degree
Hydrogeology and Water Resources Management Course	Bachelor of Engineering, Master of Science in Environmental Management and Technology
Water supply facility planning course	Bachelor of Engineering, Master of Science in Environmental Management and Technology
Public service management course	Bachelor of Science in Local Government and Industrial Services Engineering
Information Technology Courses on Databases, Networks and GIS	Bachelor of Geoinformatics, Bachelor of Computers and Networks, Bachelor of Information Management Systems

Source: Ardhi University

ZAWA staff have taken courses at Ardhi University, or students found an employment at ZAWA after graduation. Ardhi University has neither dispatched instructors to ZAWA, ZURA, and MoWEM nor implemented training programs. On the other hand, some of the instructors of the University had working opportunities with water resources-related projects in Zanzibar. They may dispatch instructors, conduct short-term courses, tailor-made training, etc if requested.

(iv) University of Dar es Salaam

The University of Dar Es Salaam (UDSM) was founded in 1961 as a partner university of the University of London, with only the Faculty of Law as the oldest national university in Tanzania. In 1963, along with Makerere University in Uganda and the University of Nairobi in Kenya, it became a constituent university of the University of East Africa. As of 1970 it became a formal university by law, parliament act no. 12 of 1970.

Currently, it consists of two constituent universities, the Faculty of Education of the University of Dar Es Salaam and the Faculty of Education of the University of Mkwawa in Iringa. With 7 campuses, 4 schools and 5 research institutes, it is a comprehensive university offering a large number of faculties and programs. There are a total of 370 degrees in the courses, including doctoral degrees (normal course: 17, dissertation course 99), graduate school 142, graduate school 10, undergraduate 92, special course 5, and diploma 6. The number of students in the 2020/2021 academic year is 39,958, and 46% of all students are female students.

Table 2.46 Outline of Water Resources Course

Related Field	Short Course
Hydrogeology and Water Resources Management Course	Groundwater exploration and exploration management (21 days) Groundwater exploration, excavation survey, various tests, borehole structure, etc.

Source: University of Dar es Salaam

So far, there is no record of official collaboration with ZAWA. There is no record of dispatching instructors to ZAWA, ZURA, and MoWEM or implementing training programs. On the other hand, some of the instructors have engaged in and cooperated with water resources-related projects in Zanzibar. They can dispatch instructors, conduct short-term courses, and tailor-made training. The citizens from the mainland are able to work in Zanzibar as a temporary instructor, as long as it is not a formal long-term employment. It does not fall under the restrictions of the Employment Law.

(v) External agency contacts and resource persons

Table 2.47 shows the experts and contact persons in each field when contacting external organizations.

Table 2.47 Experts and Persons in Charge at External Educational Institutions

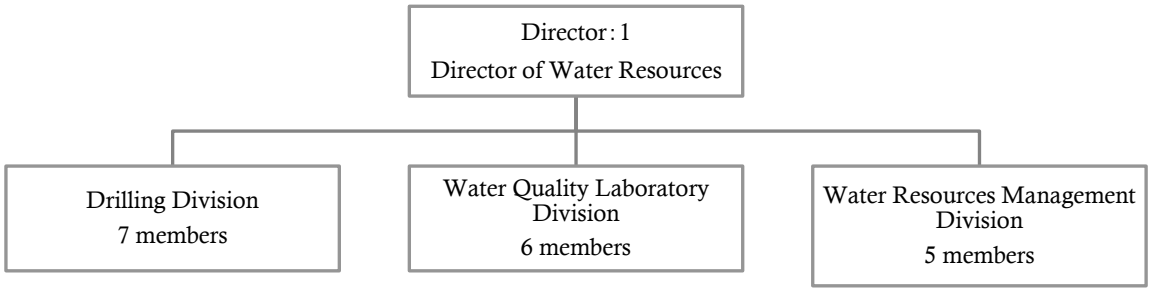
Name	Affiliation	Position
Majura Amon Maila Songo	University of Dar Es Salaam, Faculty of Earth Sciences, Faculty of Mines and Earth Sciences (SoMG)	Laboratory Chief (Geological Hydrology)
Ibrahimu Chikira MJEMAH	Department of Geography and Environment, Sokoine Agricultural University	Planning and Development Bureau Director
Zaina Hussein Mseli	Environmental Engineering, Faculty of Earth Sciences, University of Dodoma	Assistant instructor
Prof. Rubhera R. A. M. Mato	Faculty of Environmental Sciences, University of Ardhi	Associate Professor, Faculty of Environmental Sciences

Source: JICA Survey Team

2.2.3 Overview of Groundwater Management

(1) Overview of ZAWA Water Resources Department

Following the recommendations of the Zanzibar National Water Policy in 2004, ZAWA's responsibility, established by Water Law No. 4 of 2006, is to "manage water resources" and to provide "safe and reliable water supply" to all citizens of Zanzibar. ". Of these, the Department of Water Resources (DWR) of ZAWA is responsible for "management of water resources." As shown in Figure 2.16, the Water Resources Department consists of a water resources department manager (1 person), a borehole drilling division with 7 members, a water quality inspection division with 6 members, and a water resources management division with 5 members. There are a total of 18 members.



Source: ZAWA

Figure 2.16 Organization Chart of ZAWA Water Resources Department

The duties and main activities of each division are described below. This survey was conducted based on the answers to the questionnaire and the results of an interview with the staff of the Water Resources Department conducted on November 30, 2021.

(a) Drilling Division

The drilling division consists of seven members as shown in Table 2.48.

Table 2.48 Member Composition of ZAWA's Drilling Division

Job Title	Number of Members
Division Head	1
Water Resources Engineer	2
Water Resources Technician	1
Driller	4
Total	7

Source: ZAWA

The role of the drilling division is to develop new water sources, protect and monitor water resources, give advice to groundwater users, and mainly carry out the following activities.

- Select the suitable site for borehole drilling.
- Borehole drilling
- Keeping records of all drilling operation
- Make geologist log.

- Make plan for borehole development and monitoring.
- Make borehole design
- Supervise development and pumping test.
- Monitoring of water sources
- Make sure that the water sources and catchment areas (borehole fields) are protected and conserved.
- Advise on all users including private and institutions on groundwater resources management
- Keep record of all water sources.
- Perform geophysical/geological investigation.

Table 2.49 shows the drilling rigs owned by the ZAWA's Drilling Division. The drilling rigs owns two rotary and one percussion, neither of which is currently in operation.

Table 2.49 List of Drilling Rigs Owned by ZAWA Drilling Division

Name of Equipment	Type / Model	Drilling Capacity		Year Made (Obtained)	Number	Condition
		Depth (m)	Diameter (inch)			
Ashok Leyland (India)	Rotary type	350	16	unknown (2013)	1	Not working
Dando (British)	Percussion type	350	21	unknown (1994)	1	Not working
CNHTC (China)	Rotary type	300	20	unknown (2014)	1	Not working

Source: ZAWA

Photo 2.1 shows the Ashok Leyland (made in India) rotary type rig from Table 2.49. The year of manufacture is unknown, but according to the observation of the survey team, the rotary type is a fairly old rig observed to be made in the 1970s and the percussion type is in the 1950s and 1960s, and it is presumed that repair is impossible. ZAWA obtained these rigs relatively recently in 1994 for the percussion type and in 2013 and 2014 for the rotary type, but in 2016 all three became inoperable due to aging. Therefore, since then, it has not been possible to directly manage borehole construction by the borehole drilling division. The current main work of the ZAWA Drilling Division is on borehole construction under contract with a private drilling company, and its guidance, supervision, and advice.

The exact number is unknown, but there are dozens of private drilling contractor in Zanzibar. Most of them are drilling by human power for shallow boreholes, and most of them have no company organization and are not registered as contractors. There are currently 12 private drilling contractors licensed by ZAWA as the drilling contractor. Drilling contractor who holds licenses are obliged to obtain annual license renewal (granting fee, renewal fee: 500,000 Tsh) and drilling permission (permit grant fee: 300,000 Tsh / borehole) for each drilling contract. In addition, licensed private

Photo 2.1 Ashok Leyland Rotary Type Drilling Rig

Contributed to ZAWA in 2013 after an Indian contractor closed a borehole drilling contract. The year of manufacture of the rig itself is unknown. It is said that it is very old, and it is impossible to obtain spare parts.

drilling contractor are obliged to submit a Drilling Completion Report to the ZAWA Drilling Division after drilling works.

Table 2.50 shows the borehole drilling support equipment owned by the Drilling Division, Table 2.51 shows the research equipment, Table 2.52 shows the workshop equipment, and Table 2.53 shows the office equipment.

Table 2.50 Borehole Drilling Support Equipment Owned by the Drilling Division

Name of Equipment	Type / Model	Specification	Year Made	No.	Condition
Cargo Truck	Mitsubishi Canter (Japan)	No information	unknown	1	Working
Cargo Truck	Jifong（Chania）	No information	unknown	1	Not working
Cargo Truck	STEYR（Chania）	No information	2004	1	Not working
Generator	Caterpillar（USA）	No information	unknown	1	Working
Generator	OLYPIAN（USA）	No information	unknown	1	Working
Generator	Stanley（British）	No information	unknown	1	Not working
Generator	Perking（British）	No information	unknown	1	Not working
Compressor	Atlas Copco（Sweden）	No information	unknown	1	Not working
Compressor	CPS（Sweden）	No information	unknown		Working
Compressor	LIUTEC（Chania）	No information	unknown		Not working
Crane	Mitsubishi FUSO (Japan)	No information	unknown		Working

Source: ZAWA

Table 2.51 Survey Equipment of Drilling Division, ZAWA

Name of Equipment	Type / Model	Specification	Year Made	No.	Condition
Water Level Indicator	No information	No information	No information	2	Working

Source: ZAWA

Table 2.52 Workshop Equipment of Drilling Division, ZAWA

Name of Equipment	Type / Model	Year Made	No.	Condition
Lathe	made in China	1965	2	Low Perform.
Drill	made in China	1965	1	Low Perform.
	Made in Finland	1990s	1	Low Perform.
welder	made in China	2000	1	Working
	Oxford（British）	1990s	1	Not working
Air compressor	Made in Finland	1990s	1	Working
Sheet rolling machine	Made in Finland	1990s	1	Working
Sheet bending machine	No information	1990s	1	Not working
Shaping machine	No information	1960s	1	Not working
Machine vice	made in China	1960s	1	Not working
Thread making machine	made in China	1990s	1	Not working
Tyre repair Kit	No information	No information	1	Not working

Source: ZAWA

Table 2.53 Office Equipment of Drilling Division, ZAWA

Name of Equipment	Type / Model	Year Made	No.	Condition
Computer	HP / ENL 303	2012	1	Working
Computer	HP / ENL 303	2013	1	Working
Printers	HP / Lesser Jet p2055d	2010	1	Working
plotter	HP / Design Jet T790		1	Working

Source: ZAWA

As shown in the above tables, there are many equipment that are not currently working, or that are working but with low performance. In addition, the survey equipment is only owned by two water level totals, and it is difficult to implement the groundwater development project directly managed by ZAWA in the future under the given current equipment possession status.

(b) Water Quality Laboratory

The Water Quality Laboratory is composed of the 6 members as shown in Table 2.54.

Table 2.54 Water Quality Laboratory Division, ZAWA

Job Title	Number of Member
Division Head	1
Laboratory Engineer	1
Laboratory Technician	3
Driver	1
Total	6

Source: ZAWA

The water quality inspection division is responsible for monitoring and managing the quality of water supply, and its duties are as follows.

- Supervising the performance of the Laboratory at Saateni
- Making sure that the laboratory is adequately equipped and with the right personnel
- Preparation of annual chemical consumption budget and formulation of the annual procurement plan
- Advice the Head of the Department (DWR) on cost-effective chemicals to be applied.
- Decide on the appropriate type of chemical to be applied at source of production for effective treatment of raw water
- Formulation and advice for borehole cleaning and development after drilling
- Liaise with the Water Supply Engineer on the servicing of chemical pumps and injectors.
- Ensure that every chemical consignment has relevant permits and is sampled accordingly for quality assurance.
- Monitor and keep daily chemical consumption data
- Plan and supervise implementation of water sampling as required by procedures
- Monitor water quality in the distribution network.
- Prepare weekly, monthly, quarterly and annual reports
- Research on environmental related issues.

In addition, the following tasks are carried out as daily activities.

- Water disinfection as scheduled

- Monitoring water quality (physical, chemical, and biological) at ZAWA water sources and private sources
- Provide chlorine to private water supply facilities
- Monitoring on residual chlorine at source and consumer points
- Education to individual water users on chlorine use

The water quality items that can be analysed in the water quality laboratory division are shown in Table 2.55.

Table 2.55 Water Quality Items That can be Analysed by the Division

No.	Water Quality Items (WHO)	Unit	Tanzania Drinking Water Standard (1974)	Items that can be analysed by Water Quality Laboratory	
				Possible	Not Possible
Bacterial items					
1	Coliforms	MPN/100ml	1 - 3	☑	
2	Escherichia Coli.	MPN/100ml	0		☑
Water quality items related to the protection of human health					
3	Cadmium (Cd)	mg/l	0.05		☑
4	Cyanide (CN)	mg/l	0.2		☑
5	Lead (Pb)	mg/l	0.1		☑
6	Arsenic (As)	mg/l	0.05		☑
7	Mercury (Hg)	mg/l	-		☑
8	Selenium (Se)	mg/l	0.05		☑
9	Barium (Ba)	mg/l	1.0		☑
10	Fluoride (F)	mg/l	8.0	☑	
11	Hexavalent chromium (Cr^{6+})	mg/l	0.05		☑
12	Total chromium (T-Cr)	mg/l	-		☑
13	Nitrate (NO_3)	mg NO_3/l	100	☑	
14	Nitrite (NO_2)	mg NO_2/l	-	☑	
15	Boron (B)	mg/l	-		☑
16	Nickel (Ni)	mg/l	-		☑
17	Antimony (Sb)	mg/l	-		☑
18	Molybdenum (Mo)	mg/l	-		☑
19	Organic Carbon (as carbon in Chloroform)	mg/l	0.5		☑
Water quality items related to the obstruction of water utilization for drinking and domestic water					
20	Hardness	mg/l	600	☑	
21	Calcium (Ca)	mg/l	-	☑	
22	Magnesium (Mg)	mg/l	-	☑	
23	Iron (Fe)	mg/l	1.0	☑	
24	Manganese (Mn)	mg/l	0.5	☑	
25	Zinc (Zn)	mg/l	15	☑	
26	Copper (Cu)	mg/l	3	☑	
27	Residue*2	mg/l	-		☑

No.	Water Quality Items (WHO)	Unit	Tanzania Drinking Water Standard (1974)	Items that can be analysed by Water Quality Laboratory	
				Possible	Not Possible
28	Total filterable residue*3	mg/l	2,000		☑
29	Anionic surface-active agents (as ABS)	mg ABS/l	2.0		☑
30	Phenols	mg/l	0.002		☑
31	Hydrogen sulfide (H_2S)	mg/l	-		☑
32	Ammonium (NH_3+NH_4)	mg/l	-	☑	
33	Total nitrogen (Excluding NO_3)	mg/l	1.0	☑	
34	BOD	mg/l	6	☑	
35	Potassium permanganate consumption	mg/l	20	☑	
36	pH	-	6.5 - 9.2	☑	
37	Taste	dilution	not objectionable	☑	
38	Odor	dilution	not objectionable	☑	
39	Color	mg Pt/l	50	☑	
40	Turbidity (Tr)	NTU	30	☑	
41	Temperature	℃	-	☑	
42	Conductivity (EC)	mS/m	-	☑	
43	Residual chlorine (Cl)	mg/l	-	☑	
44	Sulfate (Mg+Na Salts)	mg/l	-	☑-	
Water quality items related to the characteristics of groundwater					
45	Chloride (Cl^-)	mg/l	800	☑	
46	Sodium (Na)	mg/l	-	☑	
47	Potassium (K)	mg/l	-	☑	
48	Bicarbonate (HCO_3^-)	mg/l	-	☑	
49	Total alkalinity	mg/l	-	☑	
50	Sulfate (SO_4^{2-})	mg/l	600	☑	

Source: ZAWA, Water Quality Laboratory Division

The equipment owned by the Water Quality Inspection Division is shown in Table 2.56. Since the current number of equipment owned is shown with the required number of equipment by the Division, the quantity that needs to be maintained in the future is also shown. Regarding laboratory equipment, it was reported that most of the items were in short supply, and it was difficult to perform efficient analysis work.

Table 2.56 Equipment Owned by the Water Quality Laboratory Division

Equipment	No. Owned	Necessary No.	Different No.
Autoclave 40L	0	2	2
Incubator 20L	2	6	4
Distiler10L	0	2	2
Colorimeter DR 900	0	2	2
D.O Meter PRO 20	0	2	2
pH Meter H19811-5	0	2	2
Turbidity Meter 0-1000NTU	1	3	2

Equipment	No. Owned	Necessary No.	Different No.
Salinity Meter 1381	0	2	2
BEAM BALANCE	0	2	2
Oven 20L	0	2	2
Hot Plate	0	2	2
Residual Chlorine Machine ET9270	0	2	2
Conductivity Metter	1	2	1
Photometer	1	2	1
Chlorine mixer (motor)	0	20	20
Refrigerator	0	2	2
Burret 50ml	2	30	28
Pipet25ml	3	50	47
Beaker 50ml	20	100	80
Beaker1000ml	20	100	80
Beaker250ml	20	100	80
Conical Flask50ml	10	100	90
Conical Flask250ml	10	100	90
Conical Flask1000ml	10	100	90
Volumetric Flask 50ml	10	100	90
Volumetric Flask 250ml	10	100	90
Volumetric Flask 1000ml	10	100	90
Test Tube 10ml	0	50	50
Measuring Cylinder 50ml	2	30	28
Measuring Cylinder 100ml	2	30	28
Measuring Cylinder 1000ml	2	30	28
Sample Bottle 300ml	5	30	25
Sample Bottle 500ml	5	30	25
Cool Box 20L	0	3	3
Forceps	1	10	9
Sampler	1	5	4
Dropper 10ml	0	100	100
Retort Stand	2	30	28
Electrical Vacuum Pump	1	3	2
Filter Paper	1	5	4
Petri Dish	20	200	180
Absorbent Pad	2	300	298
Counter Colon	0	2	2
Mask-N-95	0	15	15
Gloves	0	10	10
Laboratory coat	0	10	10
Heavy duty gloves	0	30	30
Rain boots	0	30	30
Eye goggle	0	30	30
Vehicle	1	2	1

Source: ZAWA, Water Quality Laboratory Division

Table 2.57 is a list of reagents stocked by the water quality laboratory Division as of January 2022. The last procurement of reagents was in 2019, and all the reagents were used up in 2020. Therefore, since then, the parameters that can be analysed by the water quality analysis laboratory shown in Table 2.57 have not been analysed (see Photo 2.2). Currently, only inspections such as electrical conductivity, turbidity, pH, salinity, TDS, etc. are carried out using the water quality analysis field kit (Photo 2.3).

Table 2.57 The Reagents Stocked by the Water Quality Laboratory Division (as of January 202)

Reagent	Quantity Stocked	Necessary Quantity	Different Quantity.
Nitraver 5 for nitrate test	0	12	12
Nitraver 3 for nitrite test	0	12	12
Phosver 3 for phosphate test	0	12	12
Buffer powder, citrate type for manganese test	0	12	12
Sodium periodate powder for manganese test	0	12	12
Ammonia salicylate for ammonia test	0	12	12
Sulfaver 5 powder for sulphate test	0	12	12
Iron ferover powder for iron test	0	12	12
Aluver 3 for Aluminium	0	12	12
1,2 silver pillow powder	0	12	12
Culver 5 for cupper	0	12	12
Neutralizing reagent powder pillow for sodium test	0	12	12
Potassium 1,2,3 reagents	0	12	12
Spadns reagent for fluoride test	0	12	12
Potassium chromate indicator	0	3	3
Silver nitrate titrant (0.01 powder)	0	3	3
Phenolphthalein indicator powder	0	3	3
95% ethyl alcohol	0	3	3
Concentrated hydrochloric acid (HCL)	0	3	3
EDTA (Disodium salt) 0.01 powder	0	10	10
Anhydrous calcium carbonate	0	3	3
Methyl red indicator (liquid form)	0	3	3
8N ammonium hydroxide (NH_4OH)	0	3	3
Magnesium sulphate ($MgSO_4$)	0	3	3
Ammonium chloride (NH_4CL)	0	3	3
Anhydrous sodium sulphate (Na_2SO_4)	0	3	3
Eriochrome black-T indicator	0	3	3
Potassium hydroxide solution (KOH)	0	3	3
HHSNN indicator	0	3	3
Murexide indicator	0	3	3
Membrane Lauryl Sulphate BROTH	0	3	3
Spirity	0	10	10
M-End Broth Ampulels	0	3	3
M-FC Broth Ampules	0	3	3

Source: ZAWA, Water Quality Laboratory Division

Photo 2.2 Water Quality Laboratory

Inside the water quality analysis laboratory. Due to the lack of reagents, no laboratory analysis is currently operated.

Photo 2.3 Field Test Kit

A test kit for simple analysis in the field. The photo shows the electrical conductivity and turbidity meter.

(c) Water Resources Management Division

The Water Resources Management Division is composed of 5 members as shown in Table 2.58.

Table 2.58 Member Composition of ZAWA's Water Resources Management Division

Job Title	Number of Members
Division Head (Hydrogeologist)	1
Water Resources Engineer	3
Water Resources Technician	1
Total	5

Source: ZAWA

The Water Resources Management Division is responsible for the protection and conservation of national water resources, and its duties are as follows.

- Regulation of water abstraction
- Groundwater resources monitoring
- Surface water resources monitoring
- Protection of catchments areas (borehole fields)
- Promotion of rainwater harvesting

In addition, the following activities are carried out in daily work.

- Periodical observation of groundwater quality and groundwater level
- Regulate water abstraction, amongst various users, monitor trends in water use and quality and also takes legal action in the event of its expectations failing
- Promote the conservation and proper use of water resources。
- Advise the Government in the formulation of policies relating to the development and conservation of wate。
- Collect fees for water supplied and services offered to consumers （300,000 Tsh/Borehole）
- License issuance and renewal of registered drilling companies （300,000 Tsh/ Borehole）

In fact, groundwater level observation is basically planned to be carried out once a month, but in reality, it is not possible to make regular observations due to lack of transportation and budget shortages. In addition, the

existing borehole do not have a facility structure that allows observation of water levels, so water level observations are expected to be limited. In addition, the legal action of water users is unprecedented since the ZAWA connection in 2006.

Unlike other division (Drilling, Water Quality Labo), the Water Resources Management Section does not have the equipment necessary for construction, surveys, observations, and analysis. It has office furniture, personal computers, UPS, power stabilizers, and vehicles.

(2) Human Resources in Mainland of Tanzania Regarding Groundwater Management

Zanzibar's National Water Policy (2004) states that in the future it will be necessary to establish a Water Resources Management Board (WRMB) to manage Zanzibar's water resources. In Zanzibar however, there is a lack of human resources with expertise in groundwater. Therefore, in this survey, related organizations and personnel in mainland Tanzania that can cooperate in water resource management in Zanzibar are identified, and a questionnaire survey conducted on the possibilities and methods of cooperation.

The survey was conducted from November to December 2021 among six professors and researchers who are experts in groundwater from four universities in mainland Tanzania, namely Ardhi University, Dar es Salaam University, Dodoma University, and Sokoine Agricultural University.

Furthermore, in February 2022, a survey was conducted with the Graduate School of Natural Science and Technology of the National University of Zanzibar. As a result, the Survey Team was able to find human resources who can cooperate in water resource management in Zanzibar, that is, lecturer at the Graduate School of Natural Science and Technology, National University of Zanzibar. The lecturer's basic academic background is not from the field of "geology" or "hydrogeology", but his doctoral degree was obtained through a geochemical survey conducted on the "Kimbiji Aquifer", which is a deep groundwater aquifer in the coastal area of eastern Tanzania. He is also a student of Professor Mato of Ardhi University, a leading hydrogeologist in Tanzania, and has a master's degree from the University of the Ryukyus in Japan.

Table 2.59 summarizes the results of the questionnaire survey.

Table 2.59 Survey Results on Human Resources in Mainland of Tanzania

Item		Contents		
1	Name	Prof. Dr. Rubhera Ram Mato		
2	Affiliation and Duty Position	Prof. School of Environmental Science and Technology, Ardhi University		
3	Experience of Zanzibar Water Resources Sector Involvement	Has experience in groundwater surveys in Zanzibar. The results of the survey were submitted to the African Journal of Environmental Science and Technology as follows. Rubhera Ram Mato (2015) Groundwater quality degradation due to saltwater intrusion in Zanzibar Municipality, pp735-740		
4	Possibility of collaboration with ZAWA Water Resources Department	How to support / Participate	Possibility of Support / Participation	
		1. Support as a technical advisor	☑ Possible	Not Possible
		2. Support as an in-house consultant	☑ Possible	Not Possible
		3. Be entrusted with work as a contracted consultant	☑ Possible	Not Possible
5	Possibility of collaboration if WRMB is established in the future	How to support / Participate	Possibility of Support / Participation	
		1. Participating in the board as a member of WRMB	☑ Possible	Not Possible

		2. Technical advisor to WRMB on discussions and deliberations	☑ Possible	Not Possible
1	Name	Mr. Majura Amon Maila Songo		
2	Affiliation and Duty Position	Principal Laboratory Scientist, School of Mines and Geosciences (SoMG), University of Dar Es Salaam		
3	Experience of Zanzibar Water Resources Sector Involvement	1994-1995: Team member Activities: in the groundwater investigations using geohydrological, Geophysical(resistivity) methods in Zanzibar Urban Water Supply Project. Client: Ministry of Water, government of Zanzibar, Funded by ADB Achievements: twenty successful boreholes were drilled. 2020: Team leader: Consultancy Services for Reconnaissance and Preliminary Hydrogeological Survey for "REHABILITATION AND IMPROVEMENT OF WATER SUPPLY SYSTEM IN ZANZIBAR, PACKAGE II. At Mkorogo, Dimani and Maungani Areas. Activities: Identification of potential sites for geophysical survey. Client: AFCONS, AFCONS INFRASTRUCTURE LIMITED OF INDIA Achievement: Completed successfully and the report is available		
4	Possibility of collaboration with ZAWA Water Resources Department	How to support / Participate	Possibility of Support / Participation	
		1. Support as a technical advisor	☑Possible	Not Possible
		2. Support as an in-house consultant	☑ Possible	Not Possible
		3. Be entrusted with work as a contracted consultant	☑ Possible	Not Possible
5	Possibility of collaboration if WRMB is established in the future	How to support / Participate	Possibility of Support / Participation	
		1. Participating in the board as a member of WRMB	☑ Possible	Not Possible
		2. Technical advisor to WRMB on discussions and deliberations	☑ Possible	Not Possible
1	Name	Ms. Zaina Hussein Mseli		
2	Affiliation and Duty Position	Lecturer, University of Dodoma University, Environmental Engineer and GIS expert		
3	Experience of Zanzibar Water Resources Sector Involvement	None		
4	Possibility of collaboration with ZAWA Water Resources Department	How to support / Participate	Possibility of Support / Participation	
		1. Support as a technical advisor	☑Possible	Not Possible
		2. Support as an in-house consultant	Possible	☑Not Possible
		3. Be entrusted with work as a contracted consultant	Possible	☑Not Possible
5	Possibility of collaboration if WRMB is established in the future	How to support / Participate	Possibility of Support / Participation	
		1. Participating in the board as a member of WRMB	Possible	☑Not Possible
		2. Technical advisor to WRMB on discussions and deliberations	☑Possible	Not Possible
1	Name	Dr Isaack Marobhe		
2	Affiliation and Duty Position	Retired professor in Geophysics at the University of Dar Es Salaam		
3	Experience of Zanzibar Water Resources Sector Involvement	1991～1994：Geophysical surveys for groundwater investigation in Zanzibar municipality, Wete, ChakeChake and Mkoani by FINIDA fund		
4	Possibility of collaboration with ZAWA Water	How to support / Participate	Possibility of Support / Participation	
		1. Support as a technical advisor	☑Possible	Not Possible

	Resources Department	2. Support as an in-house consultant	Possible	☑Not Possible
		3. Be entrusted with work as a contracted consultant	Possible	☑Not Possible
5	Possibility of collaboration if WRMB is established in the future	How to support / Participate	Possibility of Support / Participation	
		1. Participating in the board as a member of WRMB	☑Possible	Not Possible
		2. Technical advisor to WRMB on discussions and deliberations	Possible	☑Not Possible
1	Name	Dr. Ibrahimu Chikira Mjemah		
2	Affiliation and Duty Position	Sokoine University of Agriculture, Planning and Development Manager of Department of Geography and Environment		
3	Experience of Zanzibar Water Resources Sector Involvement	None		
4	Possibility of collaboration with ZAWA Water Resources Department	How to support / Participate	Possibility of Support / Participation	
		1. Support as a technical advisor	☑Possible	Not Possible
		2. Support as an in-house consultant	☑ Possible	Not Possible
		3. Be entrusted with work as a contracted consultant	☑ Possible	Not Possible
5	Possibility of collaboration if WRMB is established in the future	How to support / Participate	Possibility of Support / Participation	
		1. Participating in the board as a member of WRMB	☑ Possible	Not Possible
		2. Technical advisor to WRMB on discussions and deliberations	☑ Possible	Not Possible
1	Name	Dr Norbert		
2	Affiliation and Duty Position	Lecturer and Director of Institute of Resources Assessment at the University of Dar Es Salaam		
3	Experience of Zanzibar Water Resources Sector Involvement	Although not involved as a project, he accepts many students from Zanzibar and gives advice on the projects in which the graduates are engaged.		
4	Possibility of collaboration with ZAWA Water Resources Department	How to support / Participate	Possibility of Support / Participation	
		1. Support as a technical advisor	☑Possible	Not Possible
		2. Support as an in-house consultant	☑ Possible	Not Possible
		3. Be entrusted with work as a contracted consultant	☑ Possible	Not Possible
5	Possibility of collaboration if WRMB is established in the future	How to support / Participate	Possibility of Support / Participation	
		1. Participating in the board as a member of WRMB	Possible	☑Not Possible
		2. Technical advisor to WRMB on discussions and deliberations	☑Possible	Not Possible
1	Name	Dr. Said S. BAKARI		
2	Affiliation and Duty Position	Senior Lecturer School of Social and Natural Science (Environmental Science / Geochemistry / Hydrogeology), State University of Zanzibar (SUZA)		
3	Experience of Zanzibar Water Resources Sector Involvement	2016-Present: As an environmental and social safeguard officer of the ZAWA Zanzibar Urban Water Supply System Improvement Project (Indian Bank Fund), monitor EIA plans for construction activities, field checks of EIA standards, and formulate environmental management plans. 2022: ZAWA Zanzibar Urban Water Supply System Improvement Project, Environmental and Social Impact Assessment (ESIA) Consultant 2020: Proposal for Sustainability of Water Supply and Sanitation Services in Zanzibar: Baseline Survey on Raw Water Quality for Drinking Water-Part II (ZAWA)		

		2020: Proposal for Sustainability of Water Supply and Sanitation Services in Zanzibar: Baseline Survey on Raw Water Quality for Drinking Water-Part 1 (ZAWA)		
	Possibility of collaboration with ZAWA Water Resources Department	How to support / Participate	Possibility of Support / Participation	
		1. Support as a technical advisor	☑ Possible	Not Possible
		2. Support as an in-house consultant	☑ Possible	Not Possible
		3. Be entrusted with work as a contracted consultant	☑ Possible	Not Possible
	Possibility of collaboration if WRMB is established in the future	How to support / Participate	Possibility of Support / Participation	
		1. Participating in the board as a member of WRMB	☑ Possible	Not Possible
		2. Technical advisor to WRMB on discussions and deliberations	☑ Possible	Not Possible

Source: JICA Survey Team

(3) Overview of Water Use by Other Sectors and Involvement in ZAWA's Water Resource Management

ZAWA's responsibilities stated by Water Act (2006) No. 4 are "water resource management" and "safe and reliable water supply", of which "water resource management" is in all sectors and the water use is targeted. Together with the staff of the ZAWA Customer Service Department, the study team investigated the overview of water use in the three main water utilization sectors: hotels, irrigation, and industry, and ZAWA's involvement in them. The outline is summarized below.

(a) Hotel

The hotels visited and investigated are of three facilities, namely Hotel Verde, Park Hyatt Zanzibar, and Forodhani Park Hotel. The survey results are summarized in Table 2.60, Table 2.61 and Table 2.62.

Table 2.60 Hotel Verde

Item	Contents
Location	Mtoni
Year of Established	2015
Scale of Hotel	5 stars, 106 rooms, swimming pool available
Water Intake Facilities	1 borehole on hotel: 200 m^3 / month water intake, supplied as bathroom water without water treatment 2 boreholes outside of the Hotel: 300 m^3 to 420 m^3 / month water intake, supplied as drinking water after water treatment by RO Total water intake (maximum): 620 m^3 / month
Water Treatment Facilities	Two boreholes outside the Hotel are treated with a reverse osmosis membrane (RO) filter to remove chromaticity and salinity.
Involvement of ZAWA	The hotel has obtained a borehole drilling permit from ZAWA. The water usage fee will be paid to ZAWA by measuring the flow meter attached to the borehole. About 100,000 TZS a month on average.

Source: JICA Survey Team

Table 2.61 Park Hyatt Zanzibar

Item	Contents
Location	Mtoni
Year of Established	2015
Scale of Hotel	5 stars, 67 rooms, swimming pool available
Water Intake Facilities	The hotel does not own its own water intake facility and uses the following water supply. 1. Supply from ZAWA: 1,200 m^3 / month (charged by flow meter) 2. Water supply from a private water company (Hussen Hassan): 1,080 m^3 / month Supply by bowser. Total water supply: 2,280 m^3 / month
Water Treatment Facilities	Both ZAWA and Hussen Hassan water are treated with a reverse osmosis membrane (RO) filter on site due to high altitude, high calcium and high salinity
Involvement of ZAWA	Paying the water usage fee to ZAWA by measuring the flow meter.

Source: JICA Survey Team

Table 2.62 Forodhani Park Hotel

Item	Contents
Location	Forodhani
Year of Established	2013
Scale of Hotel	2 stars, 20 rooms, swimming pool is not available
Water Intake Facilities	Owns one borehole, specifications unknown. Water intake of about 300 m^3 / month. Registration with ZAWA and payment of water usage fee are unknown Supply from ZAWA: 200 m^3 / month (charged by flow meter) Total water supply: 500 m^3 / month
Water Treatment Facilities	None. Direct supply
Involvement of ZAWA	Pay the water usage fee to ZAWA by measuring the pipeline water flow meter. Regarding the borehole, the owner refused to investigate it because it is owned by different owner.

Source: JICA Survey Team

All 5 Star Hotels used their own reverse osmosis membrane (RO) filters for water treatment (Photo 2.4). Hotel Verde was treating its own boreholes, but for Park Hyatt, RO was used to treat ZAWA's pipeline water instead of the boreholes. In addition, it was found that even for hotels that do not receive water supply from ZAWA's pipeline, water is supplied from their own boreholes. These boreholes are registered, and water usage fees are collected by the meter reading of the flow meter. However, it is unclear if this is done for all hotels.

Photo 2.4 Reverse osmosis membrane (RO) filters

Both hotels use UAE (United Arab Emirates) made filters.

Photo 2.5 Water Supply by Bowser

A bowser of a private water company that supplies water to Hotel Park Hyatt. Water supply of 36m3 with 9m3 / water supply car 4 round trips a day.

(b) Industrial

The team investigated Zanzibar Sugar Factory Limited which represents industrial water use. The survey results are shown in Table 2.63.

Table 2.63 Zanzibar Sugar Factory Limited

Item	Contents
Location	Mahonda
Year of Established	1974 (Chinese capital → Zanzibar government → Tanzania-Kenya joint venture capital and transition
Scale of Factory	100 full-time employees, 700 fixed-term employees, annual sugar production 8,000 ton.
Water Intake Facilities	1 borehole in the factory: 8" diameter x 60m depth Sugar production period is 3 months x 2 seasons = 6 months. Therefore, the water intake during the production period is 25 m^3 / hour x 8 hours operation = 200 m^3 / day, 200 m^3 / day x 30 = 6,000 m^3 / month.
Water Treatment Facilities	The intake borehole is treated with a reverse osmosis membrane (RO) filter to remove hardness and salinity.
Involvement of ZAWA	The factory has obtained a well excavation permit from ZAWA. As mentioned above, no flow meter is installed in the borehole, and the capacity of the water storage tank is charged by ZAWA.

Source: JICA Survey Team

Photo 2.6 shows a borehole, and Photo 2.7 shows a reverse osmosis membrane (RO) filter water treatment facility. Since the raw water from the borehole has high hardness and salinity, it is treated with a reverse osmosis membrane (RO) filter. Compared to hotels, the casing pipe diameter is large, and the amount of water taken per borehole is large. In addition, the borehole is registered in ZAWA, and although the flow meter is not installed, it is charged by the capacity of the water storage tank.

Photo 2.6 Borehole in the Factory

A borehole installed on the ground of a sugar factory.

Photo 2.7 Reverse osmosis membrane （RO）filters

Reverse osmosis membrane (RO) filter water treatment facility in a sugar factory. Manufacturer and country of manufacture are unknown. High hardness and salinity.

(c) Irrigation

The Department of Irrigation (DI) of the Ministry of Agriculture, Irrigation, Natural Resources and Livestock (MAINRL) currently operates 32 irrigation schemes on the island of Unguja. Of these schemes, two were surveyed in Kianga and Bumbwisudi in the West A area, and one in Chejyu in the Central area, and one in Mtwango in the West B area.

Table 2.64 shows outlines of the Kianga irrigation scheme in West A district, and Photo 2.8 and Photo 2.9 show the photo of the scheme. The scheme is for irrigation with surface water, but since the surface water flow is from an artesian borehole, it is essentially of irrigation with groundwater.

Table 2.64 Kianga Irrigation Scheme

Item	Contents
Location	West A District, Kianga
Year of Established	2005
Irrigation area	15 ha
Water Intake Facilities	Irrigation with surface water. Since the surface water source is an artesian borehole, the water source is practically spring water (groundwater). No flow observation by DI has been performed. February 2022 at the time of the survey was the last month of the dry season and is considered to be the time when the flow rate was the lowest, but we were able to observe a flow rate of about 1.8 m^3 / hour by visual inspection.
Involvement from ZAWA	ZAWA is not involved in water source (borehole drilling) permission, water usage fee billing, water intake restrictions, and water source monitoring.

Source: JICA Survey Team

Photo 2.8 Artesian Borehole in Kianga Scheme

As of February, the last month of the dry season, the water level was visually confirmed to be about GL + 20 cm. In the last month of the rainy season (May), it overflows from the upper part of the borehole.

Photo 2.9 Irrigation Canal of Kianga Scheme

By visual inspection, a width of about 50 cm, a water depth of about 5 cm, and a flow velocity of about 20 cm / sec, that is, a flow rate of 1.8 m3 / hour could be observed.

Table 2.65 outlines the Bumbwisudi irrigation scheme in the West A region, and Photo 2.10 and Photo 2.11. This scheme is the largest of the four schemes surveyed this time, and the irrigated area was 236 ha.

Table 2.65 Bumbwisudi Irrigation Scheme

Item	Contents
Location	West A District, Bumbwisudi
Year of Established	2000 (KOIKA Grant Aide)
Irrigation area	236 ha
Water Intake Facilities	Irrigation with groundwater by a total of 13 boreholes. The casing diameter is all 8", the depth is about 40 to 50 m, the pumping amount is 25 litter / Sec, and the operation is performed for 8 to 10 hours per day (daily amount of 810 m^3 / day). In the entire scheme, more than 700 farmers use the facility to farm. Groundwater level, pumped storage, etc. are not monitored. The water quality inspection has been carried out once in 2019 since the construction of the facility, but it has not been carried out.
Involvement from ZAWA	ZAWA is not involved in water source (borehole drilling) permission, water usage fee billing, water intake restrictions, and water source monitoring.

Source: JICA Survey Team

Photo 2.10 Borehole in Bumbwisudi Scheme

A water source borehole constructed with KOIKA Grant-in-Aid for 2000. Thirteen boreholes with a depth of 40 to 50 m were constructed.

Photo 2.11 Irrigation Canal in Bumbwisudi

Water supply from the borehole (upper part of the photo) to the irrigation canal. Drive for 8 to 10 hours a day.

Table 2.66 shows outline the Sheju irrigation schemes in the Central region. The scheme is irrigation with groundwater.

Table 2.66 Sheju Irrigation Scheme

Item	Contents
Location	Central District, Sheju
Year of Established	1980 (World Bank fund)
Irrigation area	110 ha
Water Intake Facilities	Irrigation with a total of 6 boreholes. The casing diameter is 10", the depth is about 65 to 70 m, and the pumping amount is 25 litter / Sec, and the operation is performed for 8 to 10 hours per day (daily amount of 810 m^3 / day). Groundwater level, pumped storage, etc. are not monitored. The water quality inspection has been carried out once in 2019 since the construction of the facility, but it has not been carried out.
Involvement from ZAWA	ZAWA is not involved in water source (borehole drilling) permission, water usage fee billing, water intake restrictions, and water source monitoring.

Source: JICA Survey Team

Table 2.67 shows outline of the Mtwango irrigation scheme in the West B region. The scheme is irrigation with both surface water and groundwater.

Table 2.67 Mtwango Irrigation Scheme

Item	Contents
Location	West B District, Mtwango
Year of Established	1980 (FAO fund)
Irrigation area	83.6 ha
Water Intake Facilities	Irrigation with surface water and groundwater with two boreholes. Surface water is used only during the rainy season when there is enough water. The borehole has a casing diameter of 6 ", a depth of about 50 m, and a pumping volume of 25 litter / Sec, which operates for 8 to 10 hours per day (810 m^3 / day per day). Groundwater level, pumped storage, etc. are not monitored. The water quality inspection has been carried out once in 2019 since the construction of the facility, but it has not been carried out.
Involvement from ZAWA	ZAWA is not involved in water source (borehole drilling) permission, water usage fee billing, water intake restrictions, and water source monitoring.

Source: JICA Survey Team

As for the water source of the irrigation scheme operated by the Department of Irrigation, it was found that neither for surface water nor for groundwater ZAWA was approached for permission of water source

(borehole drilling), billing of water usage fee, water intake restriction, and monitoring of water source.

There are 32 irrigation facilities[24] operated by the Irrigation Bureau on Unguja Island, with a total irrigation area of 825.9 ha. Irrigation intake per ha was calculated using two schemes, the Bumbwisudi scheme in the West A region and the Sheju scheme in the Central region, where the borehole data seems to be relatively reliable. It is noticed that the Bumbwisudi scheme provides 16,063 m^3/ha/year, and the Sheju scheme provides 15,905 m^3/ha/year, which are relatively close to each other.

If the average value is taken and a yield of 16,000 m^3/ha/year is adopted, the total irrigation area of the irrigation facilities operated by the Irrigation Bureau can be calculated as 13,214,000 m^3/year for a given area of 825.9 ha. This amount of water is about the same as the amount that ZAWA's customer used as shown in Table 2.1. The amount is extremely large for the amount of water that is not controlled or monitored. Additionally, it is expected that the amount used for irrigation will be even higher if unmanaged water is included. Zanzibar has two rainy seasons, a main rainy season (March-May: 130-280 mm) and a short rainy season (November-December: 120-130 mm). Even if it is possible to irrigate with rainwater completely for two months in the middle of the main rain season and one month in the middle of the short rain season, that is, three months a year, 9,910,500 m^3/year of water is used outside the control of ZAWA.

(4) Information on the Establishment of the Water Resources Management Board (WRMB)

In the National Water Policy (2004), water resources are national property (national assets are managed by the government on behalf of the people), and the strategy is to establish a new independent WRMB. Currently, the national water policy was drafted by ZAWA in 2020 and is currently under the finalization process by MoWEM, but the policy regarding the establishment of WRMB has not changed.

Table 2.68 summarizes the current progress and achievements of water resources in the National Water Policy (2004). The National Water Policy (2004) cites the establishment of WRMB, and environmental conservation associated with water resource development as policy goals for water resource development and management. However, at present, no concrete roadmap for establishing WRMB has been shown, and since concrete water resource management has not progressed, the sustainability of water resource utilization cannot be evaluated.

Table 2.68 Progress and Achievement of Water Resources in the National Water Policy

Policy Goal		Status of Progress and Achievement
Owning water resources	Water resources are publicly owned. Establishment of Water Resources Management Board for the purpose of preventing pollution of water resources and controlling saltwater intrusion	The Water Resources Division was established in the Water Development Department of ZAWA as part of the creation of a water resource protection system. Independence is described in NWP Amendment 2020 as an implementing agency for water resources management in the future, but there is no concrete roadmap.
Environmental protection	The development of water sources must not be harmful to the environment and will not affect the next generation of water use	Specific water resource management has not progressed, and the sustainability of water resource use cannot be evaluated.

Source: JICA Survey Team

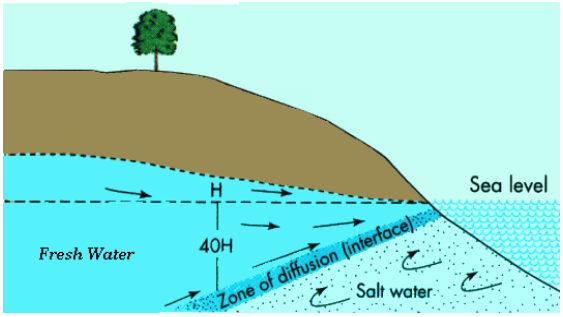
[24] Ministry of Agriculture, Irrigation, Natural Resources and Livestock (2021), The Comprehensive Management Plan for Zanzibar Irrigation Scheme 2021 -2026, 15P

In addition, the direction of discussions on the revision of National Water Policy and related laws and regulations in Zanzibar and the policy for establishing WRMB by MoWEM itself have not been settled. Furthermore, the personnel and organizational structure of MoWEM's Water Development Department is not in place. Under these circumstances, it seems to be a difficult situation to estimate whether MoWEM and other related organizations can be committed to implement specific measures to establish WRMB.

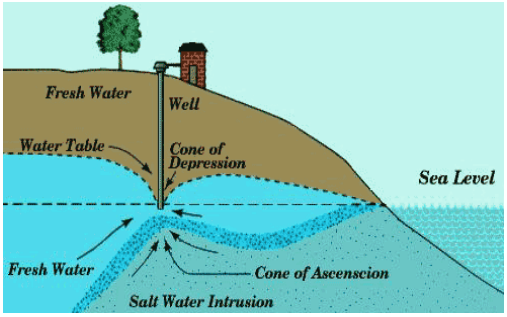
(5) Simplified Survey on the Current State of Seawater Intrusion and Field Survey of Boreholes

(a) Background of the Survey

In Zanzibar, there are no rivers flowing throughout the year due to the characteristics of a highly permeable[25] aquifer (24% infiltration against total precipitation on Unguja Island) consisting of reef limestone. It is, therefore, almost all water sources depend on groundwater. In addition, groundwater (freshwater) floats above saltwater (seawater) as a freshwater lens formed by the difference in density and pressure balance between freshwater and saltwater. There is a risk of groundwater salination (see Figure 2.17).



Relationship between freshwater and seawater before groundwater pumping by a borehole
Source：Lenntech Water Treatment Solutions、Netherland



Groundwater draw down due to pumping and rise of freshwater / seawater boundary

Figure 2.17 Schematic Diagram of Seawater Intrusion into Groundwater

A survey by JICA[26] (2016) showed a tendency for high electrical conductivity in some boreholes (U-008, U-034, U-094, U-172). However, the value was not at a level where seawater intrusion was suspected. Under such circumstances, in this survey, a simplified survey was conducted by subcontracting the site in order to understand the current state of seawater intrusion into groundwater.

(b) Previous Study

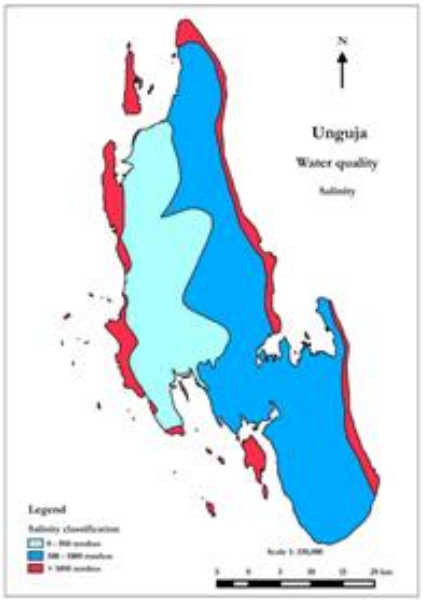
No comprehensive hydrogeological survey has ever been conducted in Zanzibar. However, since before ZAWA was established in 2006, there were already concerns about seawater intrusion into groundwater. This is because the hydrogeological condition of Zanzibar is having high permeable limestone aquifer which is known as a freshwater lens floating in seawater. This condition is similar to the hydrogeological condition of other islands such as Okinawa and Miyakojima in Japan.

According to the results of Water Resources Assessment (2014), which is the Water Resources Management

[25] Haji Shaaban Haji (2010) Water Balance Assessment in Unguja Island, Zanzibar, Tanzania, MSc thesis, International Institute for Geo-Information Science and Earth Observation Enschede, The Netherlands, 52P

[26] JICA（2017）Preparatory Survey on Zanzibar Urban Water Distribution Facility Improvement Project in the United Republic of Tanzania, Final Report, 11-4P

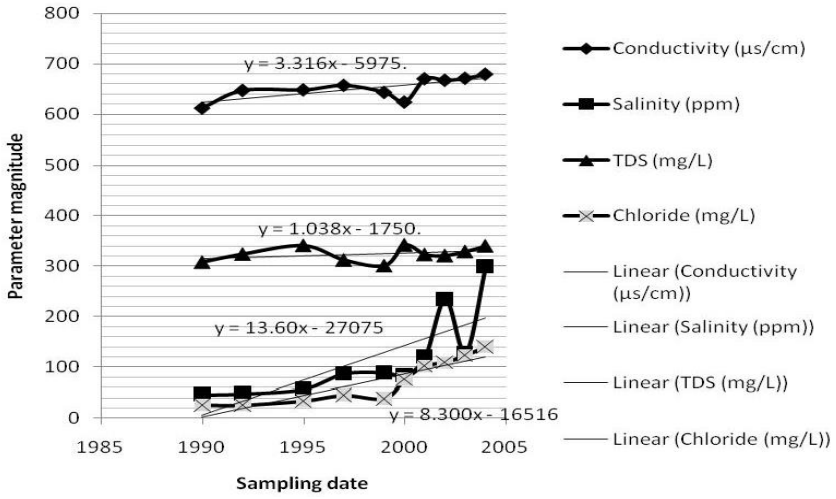
Component Report of AfDB-funded Zanzibar Water and Sewerage Project, the value of electrical conductivity is divided by the 3 zones, namely Zone 1: 0-500μS/cm (light blue), Zone 2: 500-1000 μS/cm (dark blue), and Zone 3: more than 1000 μS/cm (red) as shown in Figure 2.18. As a result, it is pointed out that the certification of groundwater has already begun in the coastal area of Unguja Island (red in the figure).



Source: Water Resources Assessment 2014

Figure 2.18 Groundwater Salinity in Unguja Island

The first journal[27] paper on seawater intrusion into groundwater in Zanzibar (Unguja Island) was a study by Professor Mato[28] of the Faculty of Environmental Sciences, University of Ardhi. As shown in a study by Mato (2015), the variation in EC (electrical conductivity) and salinity of the Kaburikikombe borehole (Borehole ID: U-002) in southern Stone Town showed a slight increase in salinity over time. According to Figure 2.19, the EC (electrical conductivity) was about 610 μS / cm in 1990, but it was 680 μS / cm in 2004, and the salinity was about 45 ppm in 1990, in 2004 has increased to 300 ppm. Neither value is as high salinity as seawater or brackish water, but there is a tendency for increasing salinity.



Source：Groundwater Quality degradation due to saltwater intrusion in Zanzibar Municipality

Figure 2.19 Trends in Salinity Parameters of a Kaburikikombe Borehole

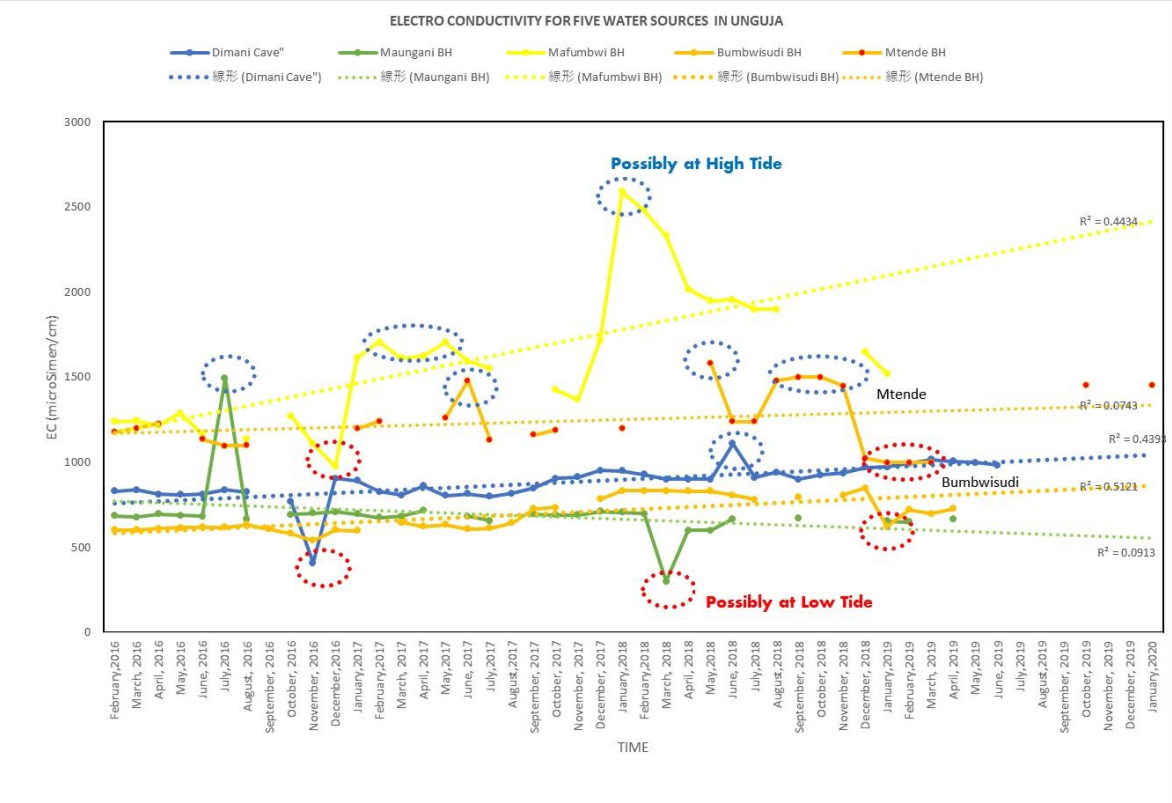
Since an increasing trend in EC (electrical conductivity) and salinity is noticed in 19 other boreholes located in urban areas where pumping is increasing, Mato (2015) concluded that the seawater intrusion into the groundwater was obvious.

[27] African Journal of Environmental Science and Technology (2002)

[28] Rubhera R.A.M. Mato (2015) Groundwater Quality degradation due to saltwater intrusion in Zanzibar Municipality, African Journal of Environmental Science and Technology vol.9(9), pp. 734-740

In addition, Masoud S. et al. (2017) [29] conducted a survey on seawater intrusion into the groundwater from Chwaka and Uzi Bay in central Unguja to the Jozani area and concluded that seawater intrusion into groundwater in the area has already started, although it is time-variant depending on the rainy season and the dry season.

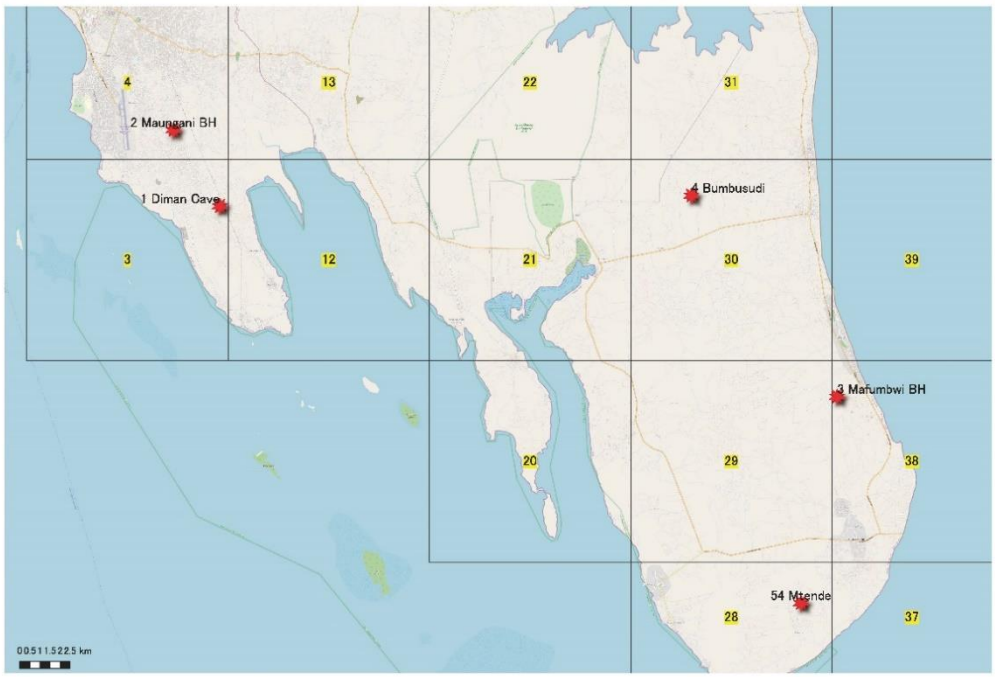
On the other hand, although it is not a regular measurement, the ZAWA Water Quality Laboratory Division measured the EC (electrical conductivity) of about 18 water sources (boreholes and caves (springs) water sources) from 2016 to 2020. Figure 2.20 shows the changes in EC (μS / cm) of five water sources that have relatively long-term data and can identify the aquifer, and Figure 2.21 shows the location of the water sources.



Source: JICA Survey Team

Figure 2.20 Variation of Electrical Conductivity (μS/cm) of 5 ZAWA's Water Source

[29] Masoud S. Said, Salim M.S. Maliondo, Johnson M.R. Semoka, Balthazar M. Msanya (2017) Extent of Seawater Intrusion from Chwaka and Uzi bays into Jozani Groundwater Forest, Zanzibar, Tanzania, International Journal of Scientific & Engineering Research Volume 8, Issue 5, 143 ISSN 2229-5518



Source: JICA Survey Team

Figure 2.21 Location of 5 ZAWA's Water Sources

As shown in Figure 2.20, an increasing tendency of EC (μS / cm) can be observed for 4 of the 5 water sources, namely Dimani cave water source, Mafumbwi borehole, Bumbwisudi borehole, and Mtende borehole. In particular, the Mafumbwi borehole (yellow line) is located along the southern coast, and there is a tendency for high EC values to increase.

According to the ZAWA Water Quality Laboratory Division, the EC value tends to rise at high tide and fall at low tide at any water source. Since there is no record of the time when EC was measured, it cannot be verified whether it was actually the effect of the tide level. However, since one of the five water sources is the Dimani cave water source (Photo 2.12), the rise and fall of the water level due to high tide can be easily observed. Therefore, it is likely to indicate the effect of the tide level.

Photo 2.12 Dimani Cave

The source of the cave formed in the Tertiary limestone layer, which is the main aquifer of Zanzibar. Limestone tends to form caves due to the infiltration of weakly acidic rainwater that takes in carbon dioxide from the atmosphere. Spring water (confined groundwater) is springing from the cave created there.

The EC value (electrical conductivity) of groundwater rises at high tide and falls at low tide, that is, the salinization of groundwater is influenced by the rise and fall of the sea level. This phenomenon is widely known as an example of salinization of groundwater. The same phenomenon is also reported[30] as the status of groundwater salinization in the Hirara groundwater basin of Miyakojima, Okinawa Prefecture.

(c) Outline of the Survey

For the survey, a simplified survey on the current state of seawater intrusion was conducted according to the procedure and contents shown in Table 2.69, and the progress of saltwater conversion to groundwater was evaluated.

Table 2.69 Procedure and Contents of Simplified Survey of Seawater Intrusion into the Groundwater

Item	Contents	Purposes
1. Collection of data and information of existing boreholes	・ Examine the contents of ZAWA's borehole database ・ Collect borehole reports at the time of construction from contractors, ZAWA, etc., and update ZAWA's borehole database.	・ Understand the borehole structure. ・ Understand the hydrogeological structure ・ Understand the previous water quality analysis results
2. Survey on the conditions of existing pumping facilities	・ Collecting information on installed pump specifications, pumping pipes, flow rate, pressure, water level, etc.	・ Evaluate how well the pumping situation can be monitored ・ Perform a simple analysis based on the collected information and select the boreholes (about 50) to be surveyed.
3.Field measurement of water quality	・ On-site water quality measurement on the 50 boreholes selected above.	・ Grasp the current EC, pH, and salinity, compare the regional distribution of water quality with past measurements, and perform a simple analysis.

Source: JICA Survey Team

The survey was conducted by subcontracting to a consultant in mainland Tanzania. The survey began in mid-November 2021. During November, well completion reports were collected from the above survey procedures. So far, ZAWA owns four types of borehole databases (GIS). In order to organize borehole information, the Survey Team integrated the four types of borehole databases into one Excel file. As a result, it was found that there exist the following problems in data management in the borehole database owned by ZAWA.

- There are many overlapping boreholes (about 35% of all boreholes are overlapping)
- Some of boreholes have the same borehole ID number and have different data contents even though they are duplicated boreholes located at the same latitude and longitude.
- Some of boreholes are given different borehole ID numbers and locations but have the same data content.
- Data units (water level, water quality, borehole structure, pumping volume, pump performance) are not always unified.
- Most of the data required for hydrogeological analysis is lacking
- Data related to water level and quality was updated sporadically around 2012-2016 but has not been

[30] Akira Yamanaka et. al（2019）Zenchiren Technical Forum 2019 Okayama, Okinawa Prefecture Miyakojima. Groundwater salinization status in the Hirara groundwater basin, 2P

updated since then.

In order to solve the above problem, the Survey Team created an integrated database by checking the consistency of the data for each borehole with the data in the borehole report or checking with ZAWA staff. This work took longer than expected, and the selection of boreholes to be surveyed was completed in mid-December. As for the target boreholes, 55 boreholes (1 water source is spring water) including spare were selected because it is assumed that some boreholes cannot be investigated when visited. In addition, regarding the selection, the following conditions were emphasized in the selection.

(1) A borehole whose aquifer is Miocene limestone, which is the source of ZAWA's tap water.
(2) Boreholes with as many records of borehole specifications (structure) and hydrogeological information as possible
(3) Boreholes with as many records of past water quality and water level measurement data as possible
(4) ZAWA's urban water supply (Urban West) Boreholes in areas with many boreholes

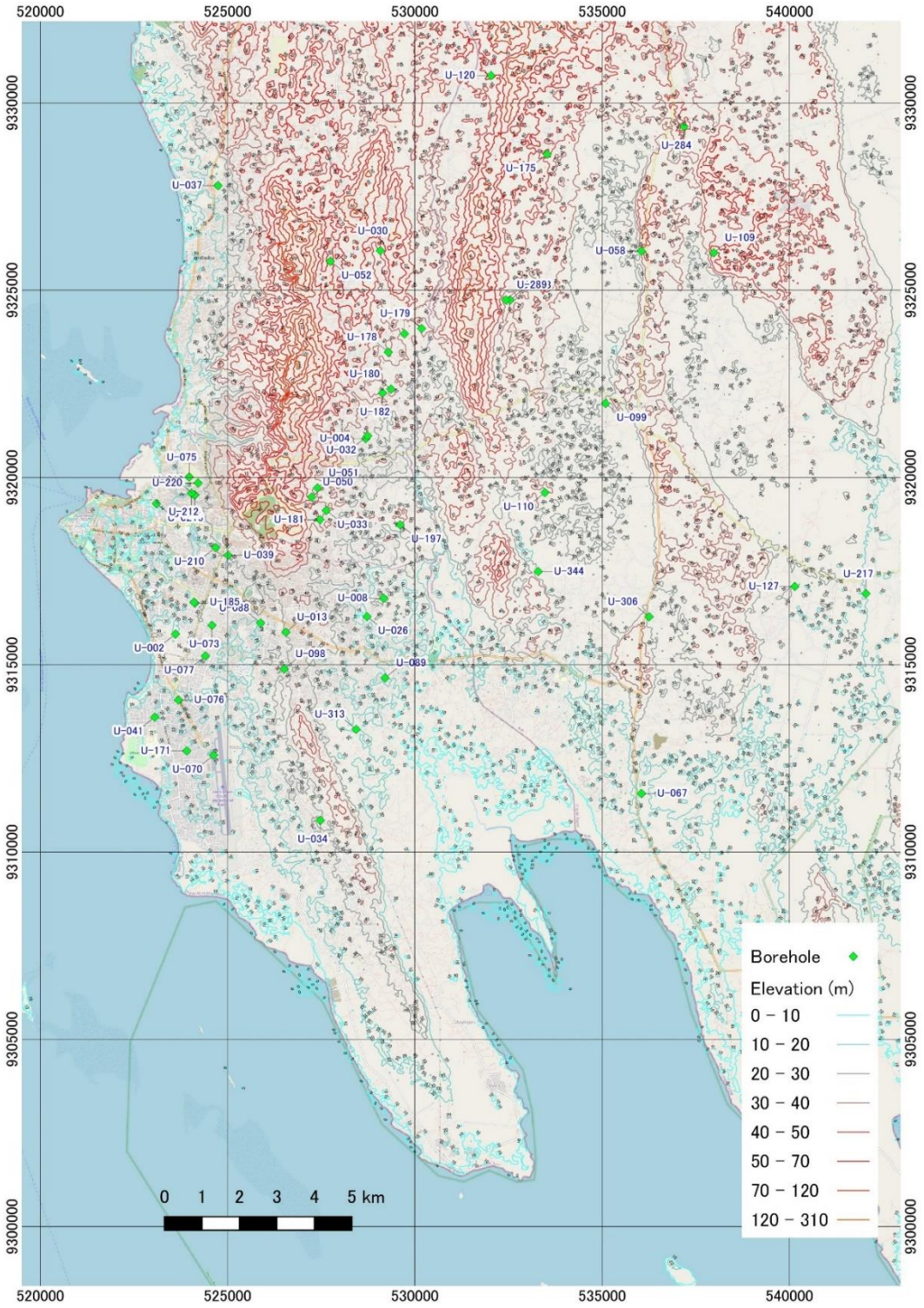
However, in reality, it turned out that the records of (1) and (2) above are very limited. As a result, some survey items cannot be measured or surveyed, but surveys were conducted on all 55 boreholes. Table 2.70 shows the list of boreholes to be surveyed, and Figure 2.22 shows the location of the boreholes to be surveyed on the topographic map of the area.

Table 2.70 List of Selected Boreholes for the Survey

SN	Source ID	Source Type	Water Source Name	State
1	U-002	Borehole	Kaburi Kikombe	Urban West
2	U-070	Borehole	Kiembe Samaki Airport	Urban West
3	U-177	Borehole	N6- Machui	Urban West
4	U-178	Borehole	N7-Kianga	Urban West
5	U-179	Borehole	N8- Machui	Urban West
6	U-180	Borehole	N9-Kianga Chemani	Urban West
7	U-181	Borehole	N13- Mwembe mchomeke	Urban West
8	U-210	Borehole	Sebleni	Urban West
9	U-127	Borehole	Chwaka Jendele(CJ-PBH-1)	South
10	U-183	Borehole	Machui	South
11	U-013	Borehole	Kijito Upele	Urban West
12	U-050	Borehole	Mwembe Mchomeke	Urban West
13	U-051	Borehole	Mwembe Mchomeke	Urban West
14	U-217	Borehole	Chwaka	South
15	U-098	Borehole	Kwarara	Urban West
16	U-175	Borehole	Kiboje	South
17	U-004	Borehole	Kianga	Urban West
18	U-034	Borehole	Maungani	Urban West
19	U-037	Borehole	Kitosani	Urban West
20	U-058	Borehole	Mgeni Haji	South
21	U-171	Borehole	Kiembe Samaki (Masum)	Urban West
22	U-182	Borehole	N9-2-Kianga Mkadini	Urban West
23	U-0216	Borehole	Saateni Pumping Station	Urban West
24	U-120	Borehole	Bumbwi Sudi	South

25	U-026	Borehole	Chunga	Urban West
26	U-211	Borehole	Chumbuni-1	Urban West
27	U-033	Borehole	M/mchomeke	Urban West
28	U-099	Borehole	Dunga (S.S. Mehta)	South
29	U-212	Borehole	Chumbuni-2	Urban West
30	U-220	Borehole	Chumbuni-Mbunge	Urban West
31	U-041	Borehole	Mbweni	Urban West
32	U-076	Borehole	Kiembe Samaki(Ali Yussuf)	Urban West
33	U-077	Borehole	Mombasa (Office)	Urban West
34	U-032	Borehole	Kianga	Urban West
35	U-224	Borehole	Bint Amran	Urban West
36	U-172	Borehole	Chukwani (Hali ya Hewa)	Urban West
37	U-067	Borehole	Kibele	South
38	U-088	Borehole	Masumbani	Urban West
39	U-073	Borehole	Mombasa (Kwa Mchina)	Urban West
40	U-185	Borehole	Bint amran	Urban West
41	U-039	Borehole	Semuso	Urban West
42	U-212	Borehole	Chumbuni-3	Urban West
43	U-109	Spring	Mpapa chemchem	South
44	U-110	Borehole	Ubago	South
45	U-030	Borehole	Kizimbani	Urban West
46	U-089	Borehole	Fuoni	Urban West
47	U-008	Borehole	Chunga	Urban West
48	U-197	Borehole	Msikiti Mzuri N10	Urban West
49	U-075	Borehole	Mwembe Makumbi	Urban West
50	U-052	Borehole	Dole	Urban West
51	U-344	Borehole	Nyakurungwi RAK	South
52	U-284	Borehole	Mitakawani RAK	South
53	U-306	Borehole	Ndijani Mjonga RAK	Urban West
54	U-289	Borehole	Machui bavuai RAK	South
55	U-313	Borehole	Fuoni kipungani RAK	Urban West

Source: JICA Survey Team



Source: JICA Survey Team

Figure 2.22 Location of the Surveyed Borehole on the Topographic Map (Displayed by ZAWA Water Source ID No.)

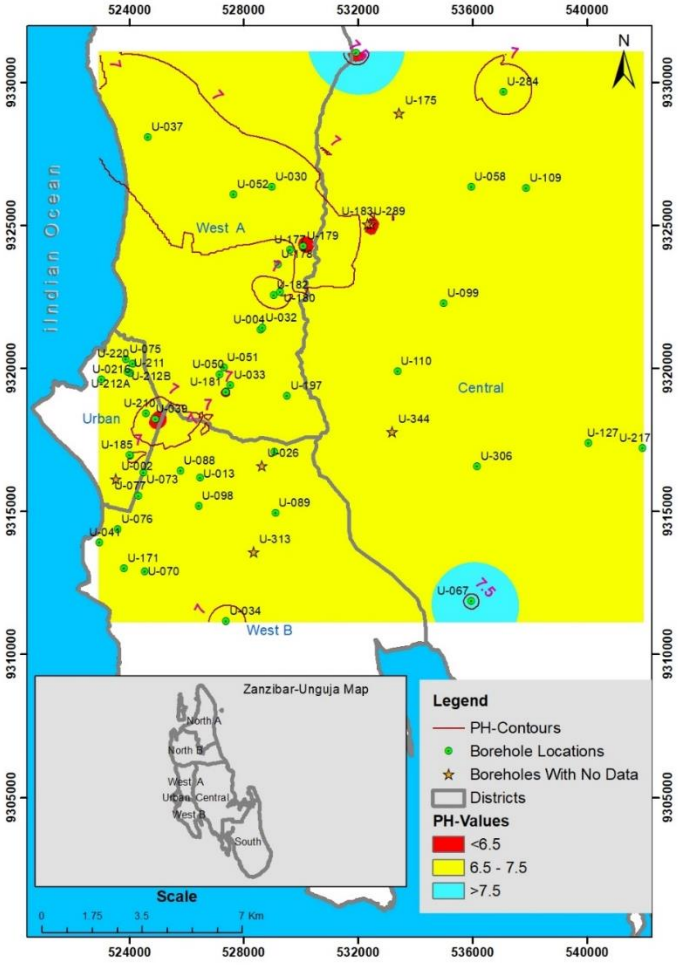
(d) Result of the Survey

The survey and measurement results of all 55 water sources surveyed are summarized in the table in Appendix 4. The following sections show the results of plotting the water quality of each measured borehole and the

distribution of water level data and their interpretation. The plot was created by interpolating borehole point data using ArcGIS spatial analysis tools.

(i) pH

Distribution of pH is shown in Figure 2.23.



Source: JICA Survey Team

Figure 2.23 Distribution of pH in Groundwater

Precipitation takes in carbon dioxide contained in the atmosphere. Furthermore, when it penetrates underground, it takes in carbon dioxide decomposed by organic matter of plant origin deposited in the shallow layer. Therefore, the recharged new (or shallow) groundwater is slightly acidic (pH 6 or less). On the other hand, it has been reported that when groundwater flows through the aquifer, the groundwater quality in the limestone area becomes alkaline [31] due to the action of calcium carbonate in the limestone.

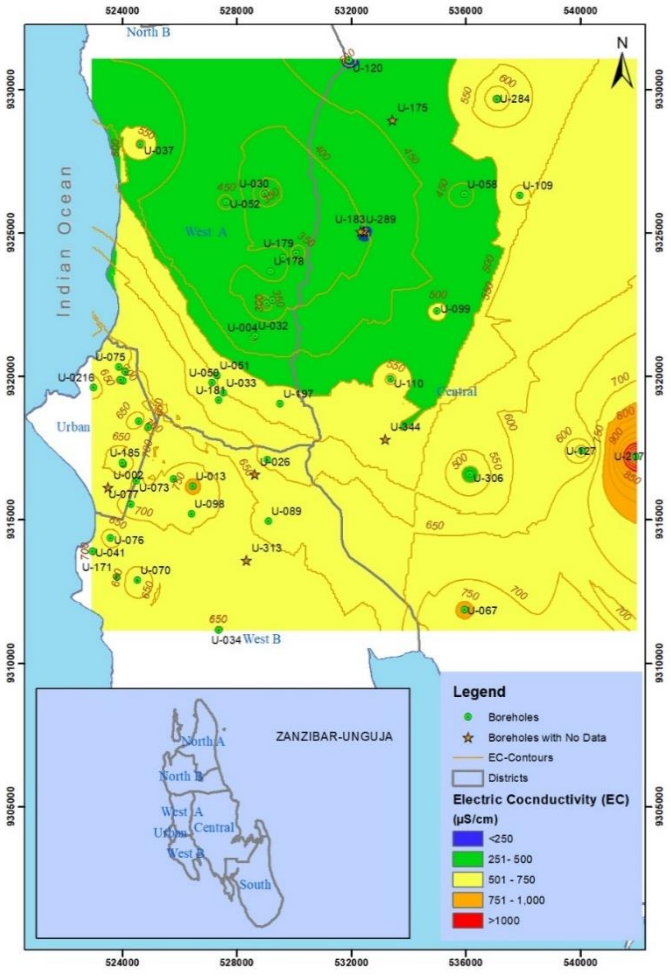
In the range of Figure 2.22, the topography and groundwater level are high in the north and low in the south. Therefore, since the main flow of groundwater is estimated to be from the north to the south, it is expected that the pH value tends to be acidic in the north and alkaline in the south. However, since the distribution is

[31] Shuichi Hasegawa, Hiroki, Watanabe, Tomihiro Sawada（2008） Possibility of limestone erosion by hot aqueous solution, Groundwater Technology Association No. 50 , Vol.12, p 9-14.

based on analysis with a limited number of samples, such a tendency cannot be significantly observed. In the survey area shown in Figure 2.23, the neutral range of pH 6.5 to 7.5 (colour of the legend in the figure: yellow) is distributed in almost the entire area, and alkaline (colour of the legend in the figure: blue) is distributed in spots. On the other hand, looking at the individual data of boreholes in the neutral range with a pH value of 6.5 to 7.5, boreholes on the alkaline side with a pH of 7.1 or higher occupy the predominance. This is considered to reflect that the aquifers of the boreholes surveyed are all limestones.

(ii) Electrical conductivity（EC：μs/cm）

Distribution of Electrical conductivity is shown in Figure 2.24.



Source: JICA Survey Team

Figure 2.24 Distribution of Electrical Conductivity

The general electrical conductivity (EC) of water in nature, as shown by the Japanese Association of Groundwater Hydrology[32], is 30-700 μs/cm for groundwater (freshwater), 1,200-20,000 μs/cm for brackish water, and 20,000-50,000 μs/cm for seawater. It can be said that Figure 2.24 shows the distribution that reflects the hydrogeological conditions that can be predicted from the topography. That is, the area where the low (251 to 500 μs/cm) EC value is widely distributed (Legend in the figure: green) is the area with the highest altitude among the surveyed areas (see Figure 2.22).

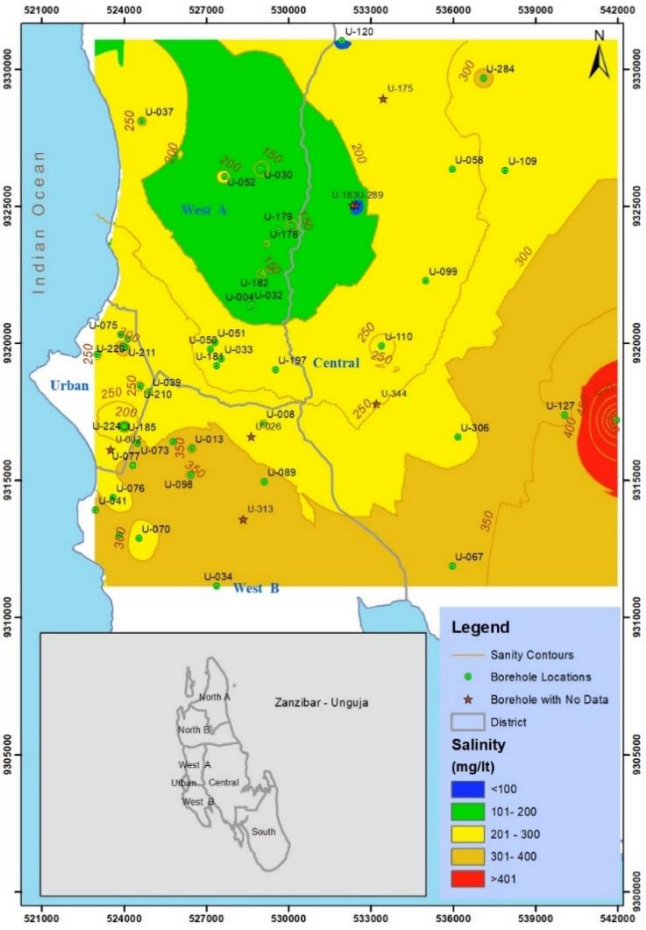
[32] Japanese Association of Groundwater Hydrology (2000) Basics of groundwater quality, 190P, ISBN：978-4-8446-0637-6

Relatively high (501-750 μs/cm) EC values are widely distributed in the southern part where the topography is low. In the south-eastern part, the second highest EC value range obtained in this survey is 751 to 1000 μs/cm (legend in the figure: brown), and the centre part is the highest EC value range of 1000 μs/cm or more. (Legend in the figure: red) is shown. It should also be noted that the EC value of the borehole U-217 in the centre part is 1,380 μs/cm, which already corresponds to the brackish water area, and that it has increased from the 2012 ZAWA measurement of 1,129 μs/cm.

In addition, EC values range of 751 to 1000 μs/cm (Legend in the figure: brown) are scattered in the southern part (U067) and southwestern part (U-013) in the area but are not distributed from the central part to the northern part.

(iii) Salinity（mg/lit.）

Distribution of Salinity is shown in Figure 2.25



Source: JICA Survey Team

Figure 2.25 Distribution of Salinity

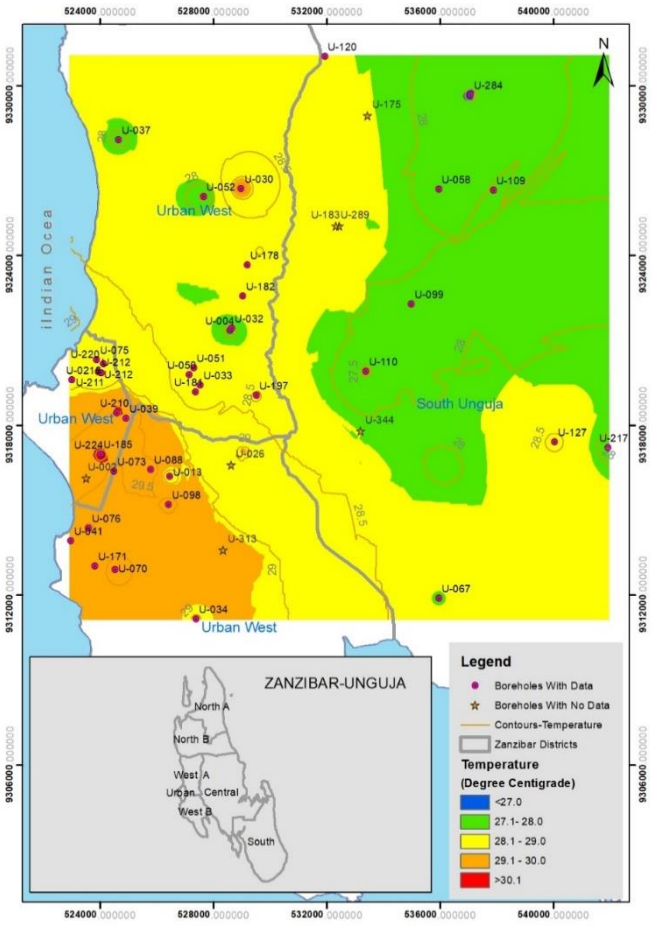
The distribution of salinity in the region is consistent with the distribution of electrical conductivity (EC: μs/cm) as described above. That is, it is low in the northern part where the altitude is high and high in the southern part where the altitude is low. According to Drever[33] (1982), the salinity of natural water is 0 to

[33] DREVER, J. I. (1982.) The geochemistry of natural waters. Prentice-Hall, Inc., Englewood Cliffs, N.J. 388 p.

1,000 mg/L for groundwater (fresh water), 1,000 to 20,000 mg/L for brackish water, and 1,000 to 20,000 mg / L for seawater. In this survey, the salinity of 55 water sources is in the range of 100 to 800 mg/L, so it is within the range of groundwater (fresh water). The borehole with the highest salinity of 790 mg/L is U-217, which is the same as the borehole with the highest value of 1,380 μs/cm in EC measurement.

(iv) Groundwater Temperature (°C: Degree Centigrade)

Distribution of groundwater temperature is shown in Figure 2.26.



Source: JICA Survey Team

Figure 2.26 Distribution of Groundwater Temperature

As for the soil temperature, the annual disparity becomes smaller with the depth of the ground, and eventually it becomes a constant layer that is not affected by the surface of the earth. The depth to the constant layer varies depending on the hydrogeological conditions, but in Japan it is about 15 to 20 m (Kiuchi[34] 1950). Since the depth to the aquifer in this survey area is approximately 10 to 25 m, it is presumed to be the upper layer of the constant layer affected by the ground surface. In addition, Hata et al.[35] (2001) proved that the water temperature inside the borehole is affected by the air temperature and does not show the groundwater temperature affected by the actual ground temperature, based on the pumping test results at the test borehole

[34] Soil Meteorological Research - Considerations on Constant Temperature Depth and Temperature. Geoscience Journal vol.59, no.3, 88-92

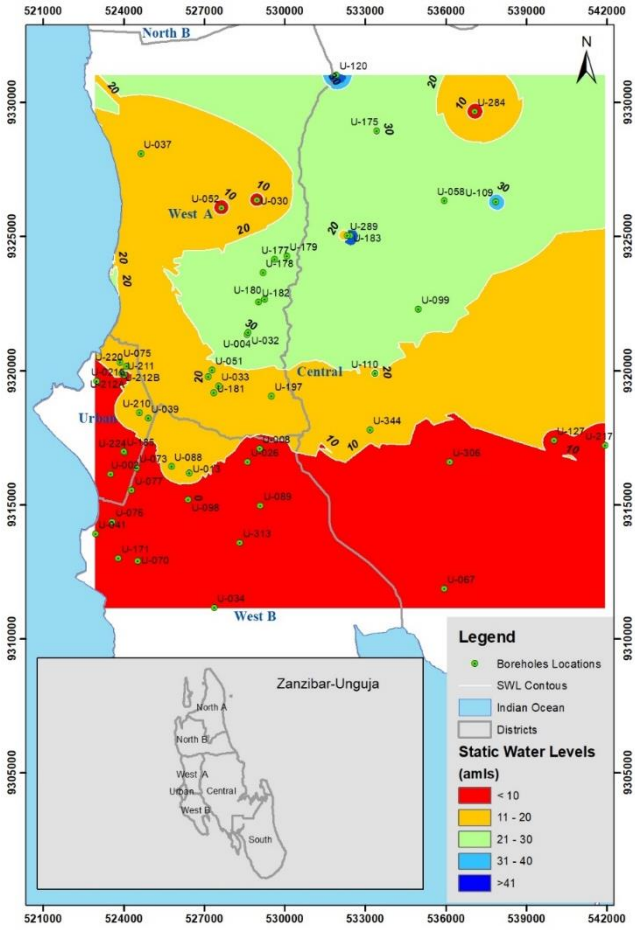
[35] Yuichi HATA et al.（2001）Study of the mechanism of rising dynamic water level due to the temperature difference between well water and groundwater, Groundwater Technology Association of Japan, Groundwater technology No. 43, Vol. 3, p20-32.

in Egypt. That is, the temperature of the groundwater collected from surveyed borehole is more susceptible to the temperature on the ground surface than the temperature of the soil.

As shown in the topographic map of Figure 2.22, the elevation of the ground in the target area is high in the north and low toward the south. This also applies to the Static Water Level (SWL) of groundwater described in the next section. The SWL is deep from the ground surface in high altitude areas and shallow from the ground surface in low altitude areas. The water temperature distribution in the area shown in Figure 2.26 is also high in the north and lower toward the south. It is clear that the area where the altitude is high and the groundwater level is deep having a relatively small effect of the surface temperature, so the water temperature is low, and the area where the altitude is low and the groundwater level is shallow has a large effect of the surface temperature, so the water temperature is high.

(v) Static Water Level (SWL: m, amsl)

Distribution of Static Water Level (SWL) is shown in Figure 2.27.



Source: JICA Survey Team

Figure 2.27 Distribution of Static Water Level (SWL)

The Static Water Level (SWL) of the groundwater obtained in this survey is displayed at Above Mean Sea Level (amsl), and its distribution is shown on a map at five levels from <10 m to >41 m. ZAWA are recording

the SWL at the depth from the surface of the borehole. However, in order to evaluate seawater intrusion into the groundwater, from now on, it should be recorded and analysed at the height above mean sea level (amsl). In this survey, the height from the average sea level (amsl) was calculated from the ground elevation measured in the survey for the SWL of all boreholes recorded by ZAWA. It can be said that the shape of this freshwater lens (Figure 2.28) dictates the distribution of pH, electrical conductivity (EC), salinity, and groundwater temperature.

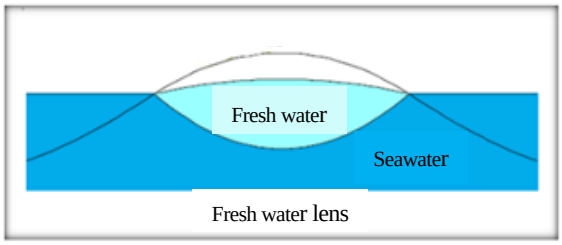
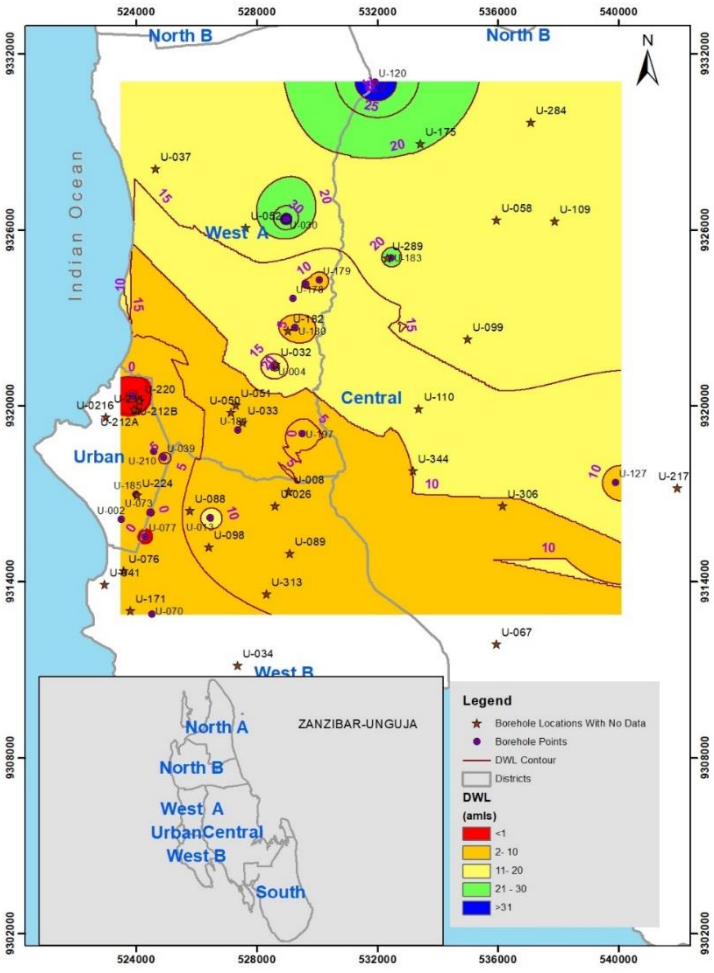


Figure 2.28 Pattern Diagram of Fresh Water Lens

(vi) Dynamic Water Level(DWL): m, amsl）

Distribution of Dynamic Water Level (SWL) is shown in Figure 2.29.



Source: JICA Survey Team

Figure 2.29 Distribution of Dynamic Water Level (DWL)

The Dynamic Water Level is the water level in the borehole that has been lowered by pumping. ZAWA has been recording DWL at the depth from the ground surface as well as SWL. Since DWL means lowered water level, it is easier to understand if it is indicated by the depth. However, in order to analyse hydrogeology, it

should still be recorded at the height above mean sea level (amsl). In this survey, the height from the above mean sea level (amsl) was calculated by the measured ground elevation.

Likewise, SWL, DWL is high from amsl in the north and low from amsl in the south. This clearly indicates that the water level draw down rates is almost the same because the aquifers of the 55 boreholes surveyed are all the same aquifer (Miocene limestone layer).

On the other hand, it should be noted that the area where DWL is already lower than the amsl (-1 m or less, legend in the figure: red) exists in the southwestern urban area. In this survey, 4 of the 55 boreholes are showing negative values below the average sea level. However, the measured values of electrical conductivity (EC) and salinity are high levels as fresh water, but are not the values that can be called brackish water or seawater. In addition, it is difficult to verify because DWL could not be measured in U-217, which showed the highest electrical conductivity during the investigation.

However, excessive pumping of groundwater in urban areas can be easily imagined, and the distribution of low SWL is consistent with that in urban areas, so it is considered to be one of the risk potential areas for future salinization of groundwater.

(vii) Summary of Survey Results

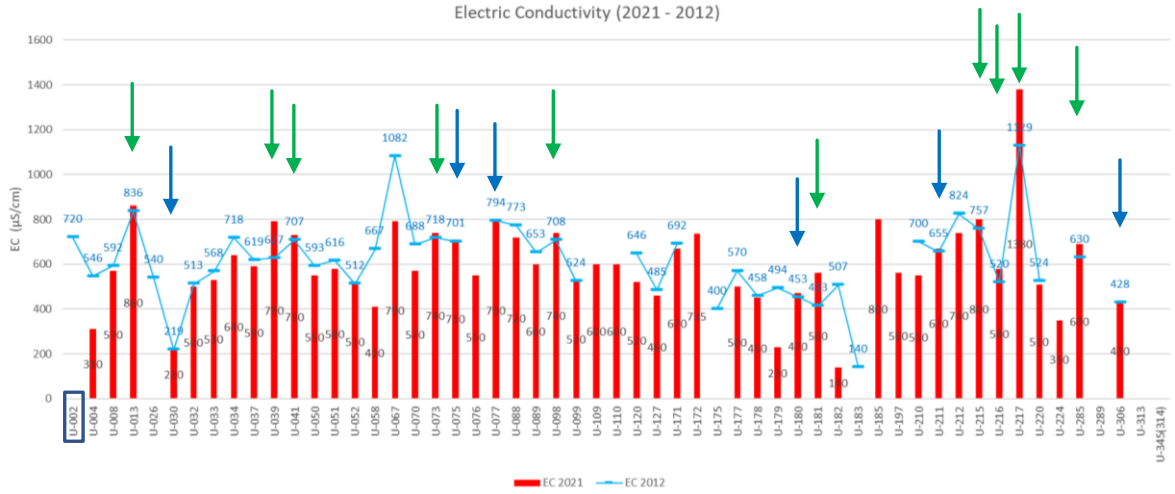
The analysis results of each of the above measurement items can be summarized as follows.

(1) Electric conductivity (EC) and Salinity values are currently within the range of freshwater, and dose not in the range of brackish water.
(2) However, the electric conductivity (EC) and salinity values of many boreholes surveyed are distributed in the higher end of the freshwater range, and the water quality of some boreholes shows the level EC of brackish water with.
(3) Electrical conductivity (EC) and salinity values reflect topography, with low values in high altitude areas (no salinity) and high values in low altitude areas (salination is observed).
(4) When the distribution of groundwater level (both static water level, dynamic water level) is shown as above mean sea level, it shows the same tendency as pH, electrical conductivity (EC), salt concentration, and groundwater temperature. These values are high in the high-altitude area (north) and low in the low altitude area (south). This clearly shows the shape of the freshwater lens (Figure 2.28), which is a hydrogeological characteristic of the islands.

(viii) Sign of Seawater Intrusion into Groundwater

By this survey, the general feature of distribution of water quality, namely electrical conductivity (EC), salinity, pH, water temperature, and water level (static water level, dynamic water level) in the West Urban region where ZAWA's water source are concentrated, has been clarified.

In addition, the survey team also has attempted to evaluate the signs of seawater intrusion into groundwater by comparing the previous data measured by the ZAWA's Water Quality Inspection Division with the measured data by this survey. Figure 2.30 shows the EC value measured in this survey (2021) with a red bar chart, and the EC value observed by the ZAWA in 2012 with a blue line chart.



Source: JICA Survey Team

Figure 2.30 Change in Electrical Conductivity

The arrows in the figure indicate wells whose measured EC value have increased compared to the 2012 measurements. The green arrow indicates an increase of 20 μS / cm or more, and the blue arrow indicates an increase of less than 20 μS / cm. U-002 was an abandoned well and could not be measured in this survey, but this is the Kaburikikombe well where the EC value was reported to increase over time by Mato (2015) as mentioned in section (b) Previous Study.

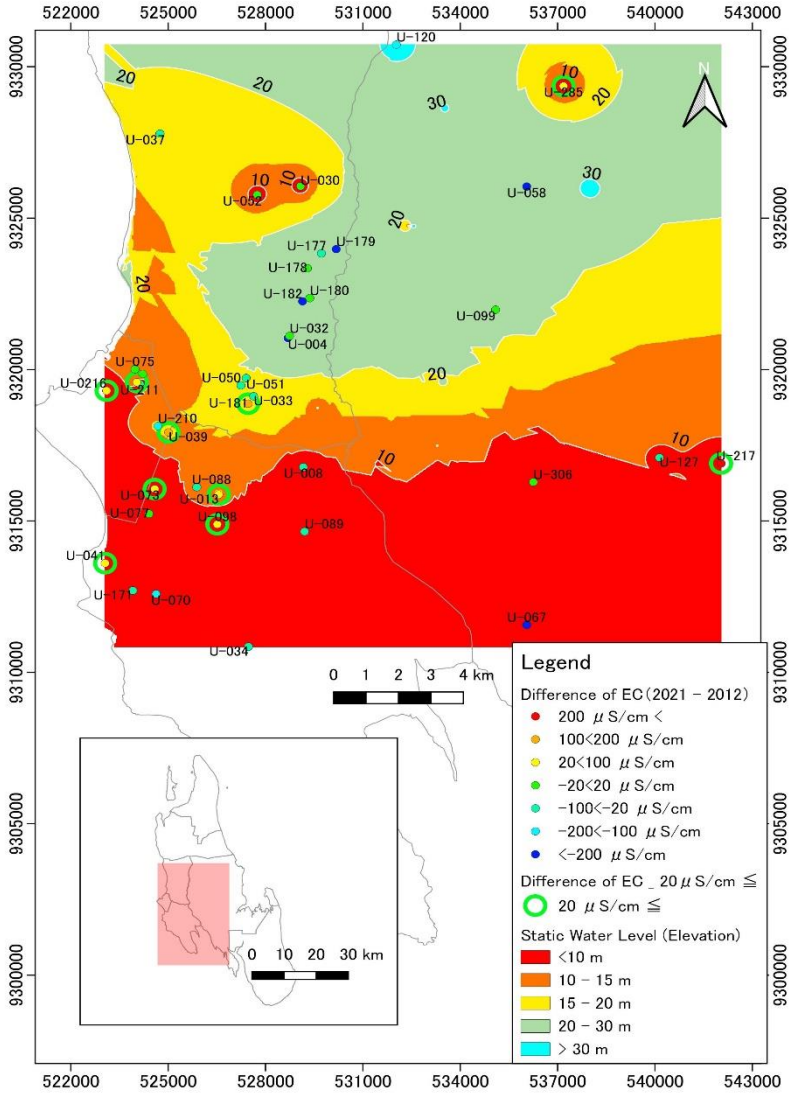
Secondly, for the wells with measured values for both 2012 and 2021, the difference between the measured values for 2021 minus the measured values for 2012 was taken and shown in the distribution map of the Static Water Level (SWL). (Figure 2.31). Furthermore, as supplementary data, the well location of U-002, where an increase in EC value was confirmed over time by Mato (2015), and the location of Dimani Cave spring where increase in EC value at high tide confirmed by ZAWA were indicated on Figure 2.31. In addition, the location of Well No. U-185 showing 800 μS / cm is also shown (green triangle), although there is no measured value in 2012. The wells showing an increase of 20 μS / cm or more in the difference between the measured values in 2012 and 2021 are particularly indicated by the green circle in Figure 2.31.

As can be seen from Figure 2.31, the boreholes with increasing EC more than 20μs/cm during the nine years from 2012 to 202, the wells with high EC (800 μs/cm) even in the region, and a cave spring with high EC value during high tide, those water sources are all concentrated in the area where the static water level of groundwater is the low (15 m or less), except for one well (U-181). In the area where the natural water level exceeds 20 m, the tendency related to the increase in electrical conductivity indicated here has not been observed.

It can be said that this is because the groundwater level is clearly low, that is, in the peripheral area of the freshwater lens where the boundary between freshwater and seawater is shallow, salinity gradually increases over time. Or the electrical conductivity and salinity in low groundwater level area are higher than in areas where the groundwater level is high, and changes in salinity are observed as the tide level rises.

At present, neither the electrical conductivity nor the salinity is shown at the level that can be pointed out as

being clearly salinized. However, it can be concluded that the fact that the numerical values of salinity are affected in the periphery of the freshwater lens is a sign of salinization of groundwater on Unguja Island.



Source: JICA Survey Team

Figure 2.31 The Relationship between the Difference in Electrical Conductivity (2021 and 2012) and the Distribution of Static Water Level

2.2.4 Overview of Water Supply Facility Management

(1) Overview of Current Water Supply Facilities in Zanzibar

(a) Water supply system in Unguja Island

In Unguja Island, water is distributed from spring water and groundwater via service reservoirs and elevated tanks, or directly from boreholes to the pipeline network. Figure 2.32 shows the water supply facilities in Unguja Island.

From the eastern to the southern part of Unguja Island, simple independent water supply systems are built at each community. Western part of the island, from around the Urban West Region to the north, the water pipeline network is integrated, and water distribution zones by elevation are not formulated. In addition, the integrated pipe network makes it easy to cause problems on water supply service due to insufficient water pressure in areas with poor hydraulic conditions such as those at high elevations, areas with few distribution pipelines, and areas with small pipe diameters, or areas far from direct pumping boreholes. In order to solve these problems, development of water supply facilities, renewal of aging water distribution pipelines and service connections, formulation of water distribution zones and DMAs are planned and implemented through ZUWSP (completed), RIWSSZ (ongoing), and Japanese ODA loan project (to be implemented) in Urban West Region.

(b) Water supply system on Pemba Island

Pemba Island, as well as Unguja Island, uses spring water and groundwater as its water source, and distributes water via service reservoirs and elevated water tanks, or directly from boreholes to the pipe network. Figure 2.33 shows a plan of the water supply facilities on Pemba Island. In the Chake area of Pemba, a water distribution system with a pipe network is constructed, but the others are community-based independent water distribution systems.

Source: JICA Survey Team

Figure 2.32 Plan of Water Supply Facilities on Unguja Island

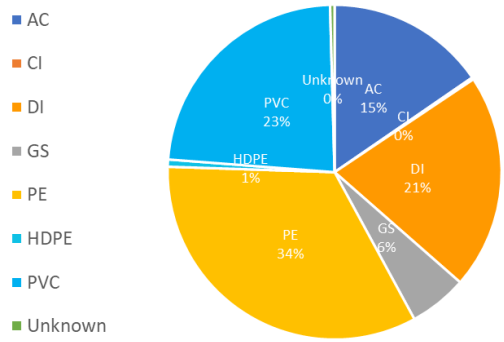
Source: JICA Survey Team

Figure 2.33 Plan of Water Supply Facilities on Pemba Island

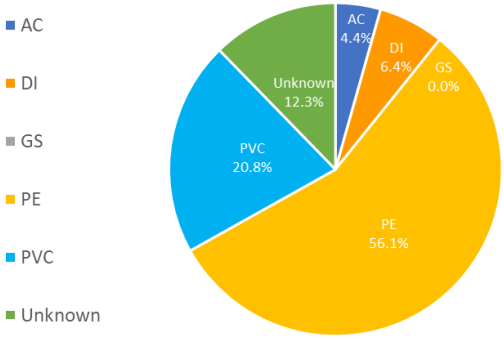
(c) Water facilities in Zanzibar

According to Strategic Business Plan 2025, ZAWA currently provides water supply from boreholes, springs, and caves. As of 2018, the water sources were composed of 303 boreholes (173 on Unguja Island and 130 on Pemba Island), 5 springs (2 on Unguja Island and 3 on Pemba Island), and 7 caves (all on Unguja Island).

According to the information registered in GIS, there are 88 service reservoirs and elevated water tanks, of which 65 are located on Unguja Island and 23 on Pemba Island, and the total effective capacity of major service reservoirs and elevated water tanks (50 m^3 or larger) is 34,295 m^3 on Unguja Island and 13,150 m^3 on Pemba Island. Regarding pipelines, the total length of the water pipeline network with a diameter of 50 mm and more is approximately 1,542 km, broken down into 1,085 km on Unguja Island and 457 km on Pemba Island. Figure 2.34 shows the composition ratio by pipe material of Unguja and Pemba islands. In Unguja Island, polyethylene pipes account for the highest percentage (33.5%), followed by polyvinyl chloride pipes (23.4%), ductile iron pipes (20.8%), and asbestos cement pipes (15.4%) which is 167.5km. Pemba Island has a high percentage of polyethylene pipes (56.1%), followed by polyvinyl chloride pipes (20.8%). Asbestos cement pipes also remain, but with a length of 21.9 km and a composition ratio of 4.4%, they are less than the one in Unguja Island.



(a)Unguja Island



(b) Pemba Island

AC：Asbestos Cement Pipe, DI：Ductile Iron Pipe, GS：Galvanized Steel Pipe, PE：Polyethylene Pipe, PVC：Polyvinyl Chloride Pipe

Source: JICA Survey Team

Figure 2.34 The Composition Ratio by Pipe Material in Unguja and Pemba Island

Table 2.71 Main Water Service Reservoirs and Elevated Water Tanks in Unguja Island

Name of Reservoir	Capacity (m^3)	Structure	Material	Remarks
Bumbwi sudi	250	Ground reservoir	Fibreglass GRP	
Bwejuu	200	Elevated tank	Steel	
Dimani	450	Ground reservoir	Steel	
Dole 1	100	Underground	Concrete	
Dole 2	1,200	Underground	Concrete	JICA Grant Aid Project
JAMBIANI KVULI	100	Elevated tank	Steel	
JAMBIANI MFUMBWI	150	Ground reservoir	Concrete	
Jendele	100	Elevated tank	Steel	
Kandwi	500	Elevated tank	Concrete	
Kinuni	2,700	Underground	Concrete	JICA Grant Aid Project
Kitogani	150	Ground reservoir	Concrete	
Kwa mchina mombasa	150	Elevated tank	Concrete	
Makunduchi 2	390	Elevated tank	Steel	
Marumbi	250	Elevated tank	Steel	
Mfenesini 1	225	Elevated tank	Steel	
Mkwajuni 1	450	Elevated tank	Steel	
Mkwajuni 2	3,000	Ground reservoir	Concrete	
Mnara wa mbao	1,000	Elevated tank	Concrete	AfDB Project
Muyuni	150	Ground reservoir	Concrete	
Ndijani	150	Elevated tank	Concrete	
Nungwi 1	200	Elevated tank	Concrete	
Nungwi 3	3,000	Ground reservoir	Concrete	
Paje	200	Elevated tank	Steel	
Pale Tank	200	Ground reservoir	Concrete	
Saateni 3	1,000	Underground	Concrete	
Saateni 4	1,000	Underground	Concrete	
Saateni 5	2,250	Ground reservoir	Concrete	
Saateni 6	2,000	Elevated tank	Concrete	AfDB Project
Semuso 1	130	Elevated tank	Concrete	
Semuso 2	50	Underground	Concrete	
Tunguu	1,200	Ground reservoir	Concrete	
UKONGORONI	200	Elevated tank	Steel	
Vidogo	500	Elevated tank	Concrete	
Welezo 1	4,000	Underground	Concrete	JICA Grant Aid Project
Welezo 2	4,000	Underground	Concrete	JICA Grant Aid Project
Welezo 3	2,250	Underground	Concrete	
Welezo 4	450	Ground reservoir	Steel	
Total Capacity	34,295			

Source: JICA Survey Team

Table 2.72 Main Water Service Reservoirs and Elevated Water Tanks in Pemba Island

Name of Reservoir	Capacity (m^3)	Structure	Material	Remarks
Bogoa	150	Ground reservoir	Concrete	
Chake 2	250	Ground reservoir	Steel	
Chakechake	3,000	Ground reservoir		Under construction
Chakechake	250	Elevated tank		Under construction
Kambini	300	Elevated tank		Under construction
Kambini	1,000	Ground reservoir		Under construction
Kangani	250	Elevated tank	Concrete	
Kengeja	250	Ground reservoir	Concrete	
Kiwani	450	Ground reservoir	Concrete	
Mizingani	300	Elevated tank		Under construction
Mkoani	800	Ground reservoir		Under construction
Mkoani	250	Elevated tank		Under construction
Mtambile	200	Ground reservoir	Steel	
Ndagoni	1,000	Ground reservoir		Under construction
Pujini	300	Elevated tank	Fibreglass GRP	
Vitongoji	300	Elevated tank		Under construction
Vitongoji	300	Elevated tank		Under construction
Wambaa	500	Ground reservoir		Under construction
Wete	2,500	Ground reservoir		Under construction
Wete	800	Ground reservoir		Under construction
Total Capacity	13,150			

Source: JICA Survey Team

Table 2.73 Pipe Length by Material and Diameter in Unguja Island

Diameter	Pipe Length by Material (m)								
	AC	CI	DI	GS	PE	HDPE	PVC	unknown	Total
Less than 50mm	0	0	0	6,866	27,816	1,241	0	48,183	84,106
50mm	3,944	143	383	12,655	38,417	0	0	0	55,542
60mm	0	311	0	1,936	0	0	0	0	2,247
63mm	1,585	0	0	3,728	93,459	0	1,986	672	101,431
65mm	218	0	0	0	0	0	0	0	218
75mm	4,103	0	2,681	1,287	30,993	0	0	0	39,063
80mm	0	0	0	34	0	0	0	0	34
90mm	10,571	281	997	1,758	44,525	0	6,037	191	64,359
100mm	55,330	1,325	31,271	11,359	459	500	0	399	100,643
110mm	565	0	4,772	0	77,368	4,495	132,735	3,178	223,113
125mm	0	0	0	0	17,535	0	5,684	0	23,219
150mm	58,089	97	51,164	28,269	150	0	878	0	138,648
160mm	87	0	13,396	0	46,431	2,528	80,867	0	143,309
180mm	0	0	1,264	0	603	0	0	0	1,866
200mm	24,130	0	20,383	0	5,813	0	14,053	0	64,378
220mm	0	0	0	0	187	0	829	0	1,016
225mm	887	0	8,163	0	319	0	7,923	0	17,292
250mm	0	0	3,340	0	4,994	0	0	0	8,334
300mm	7,974	0	38,960	0	1,802	0	1,918	228	50,882
315mm	0	0	0	0	0	0	611	0	611
375mm	0	0	92	0	0	0	0	0	92
400mm	0	0	25,652	0	0	0	0	0	25,652
450mm	0	0	7,162	0	0	0	0	0	7,162
500mm	0	0	8,100	0	0	0	0	0	8,100
600mm	0	0	6,670	0	12	0	0	0	6,682
700mm	0	0	1,482	0	0	0	0	0	1,482
Total	167,483	2,156	225,931	67,892	390,882	8,763	253,523	52,852	1,169,482
Total and Composition	167,483	2,156	225,931	61,026	363,066	7,522	253,523	4,669	1,085,376
Rate (50mm and more)	15.4%	0.2%	20.8%	5.6%	33.5%	0.7%	23.4%	0.4%	100.0%

Source: JICA Survey Team

Table 2.74 Pipe Length by Material and Diameter in Pemba Island

Diameter	Pipe Length by Material (m)						
	AC	DI	GS	PE	PVC	unknown	Total
Less Than 50mm	1,938	0	5,345	38,587	7	42,585	88,462
50mm	129	143	0	19,206	3,858	12,860	36,195
63mm	0	0	0	25,035	422	2,958	28,415
75mm	2,423	1,786	0	12,072	1,500	16,378	34,159
80mm	866	0	0	218	16,726	0	17,809
90mm	0	0	0	67,046	0	0	67,046
100mm	5,543	849	0	1,359	34,127	15,065	56,942
110mm	0	0	0	3,591	0	0	3,591
125mm	0	0	0	68,757	3,078	1,951	73,787
150mm	6,891	6,906	0	1,793	27,740	4,809	48,140
180mm	0	0	0	36,209	0	0	36,209
200mm	3,091	6,746	0	3,037	5,659	1,262	19,795
250mm	0	3,580	0	7,363	0	0	10,943
300mm	1,052	6,619	0	0	2,035	801	10,507
315mm	0	0	0	10,629	0	0	10,629
350mm	0	423	0	0	0	0	423
400mm	0	2,104	0	0	0	0	2,104
Total	21,933	29,155	5,345	294,901	95,152	98,669	545,155
Total and Composition	19,995	29,155	0	256,315	95,145	56,084	456,693
Rate (50mm and more)	4.4%	6.4%	0.0%	56.1%	20.8%	12.3%	100.0%

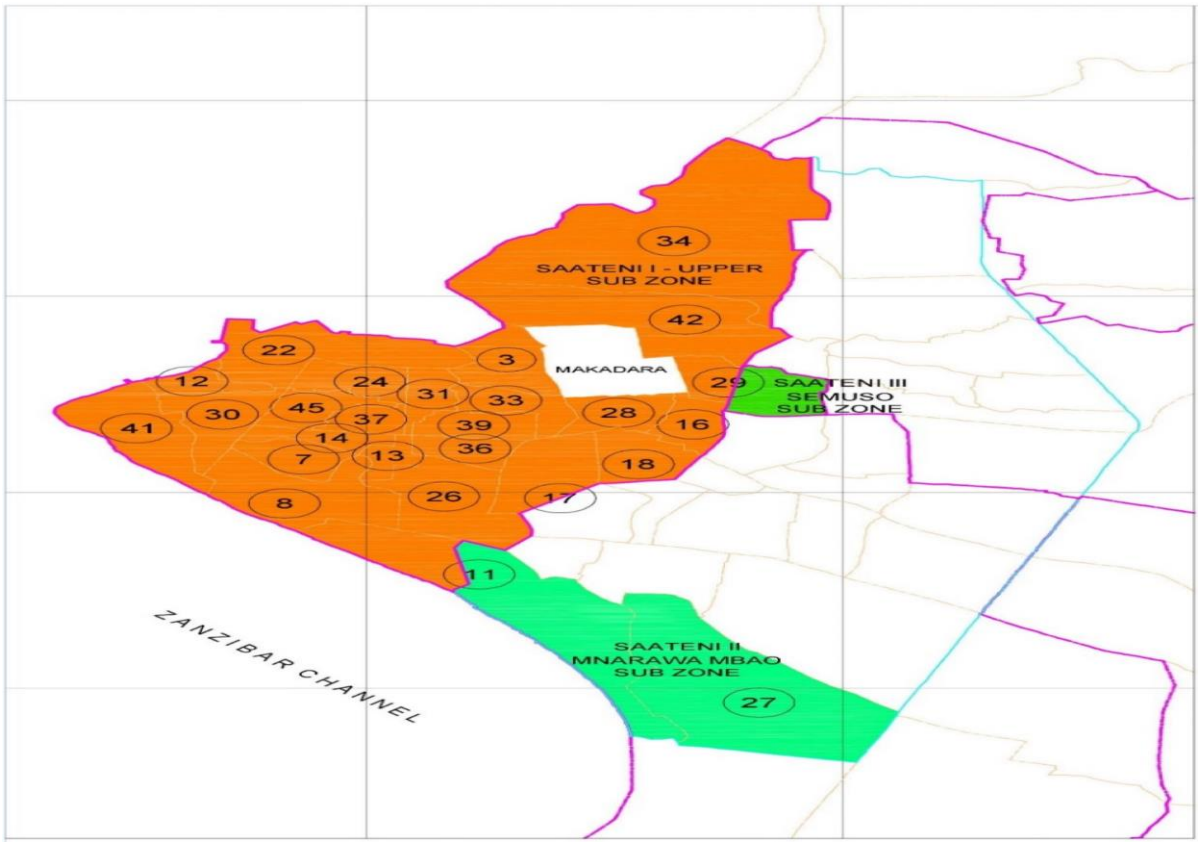
Source: JICA Survey Team

(2) Overview of Facilities Maintained by ZUWSP

In order to analyse the issues of water supply facility management, information on the operation and maintenance status of the facilities developed through ZUWSP, the most recent facility development project financed by AfDB and funded by Zanzibar government, was collected.

The development of new water sources and rehabilitation of existing water sources, development of service reservoirs, and pipelines were carried out through ZUWSP. The project was completed in 2019 and currently those facilities are in operation.

ZUWSP is a facility improvement project to improve water supply in urban areas, including Stone Town in Urban West Region, shown in Figure 2.35, and had two construction packages. The project planned to distribute water from service reservoirs (Saateni, Mnarawambao, and Semuso) to the project area, and three sub-zones were planned as distribution areas for each service reservoir.

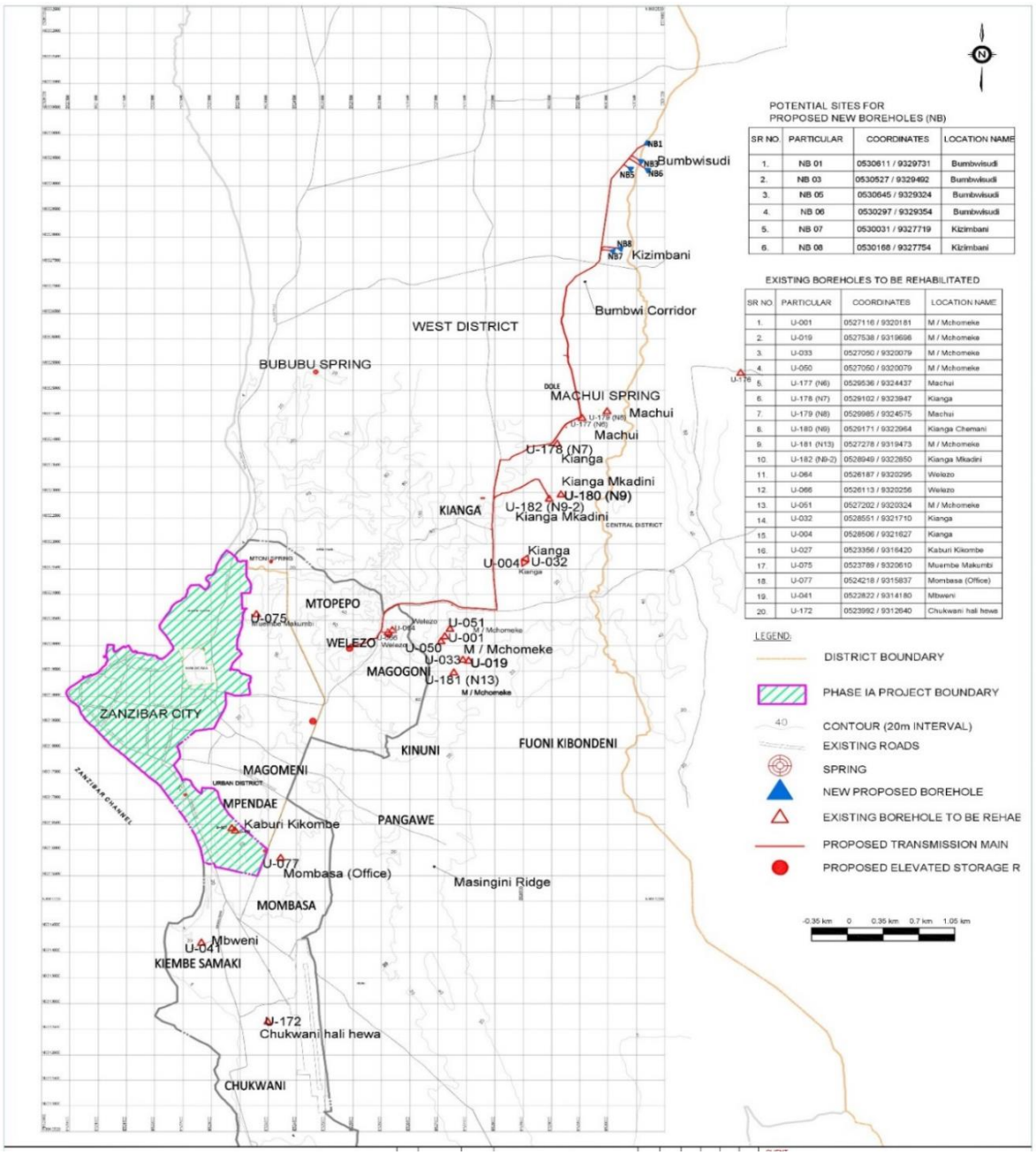


Source: ZUWSP, Project Completion Report

Figure 2.35 Project Area of ZUWSP

(a) Package 1

Package 1 was mainly construction and rehabilitation of water sources: 6 new boreholes, re-drilling of 2 existing boreholes, rehabilitation of 21 existing boreholes, procurement and installation of 25 sets of submersible pump equipment for boreholes (including piping around the pumps) and electrical equipment, and 5 sets of equipment for procurement, construction and repair of the electric room for boreholes, and installation of fencing were major scope of work.



Source: ZUWSP, Project Completion Report

Figure 2.36 Location Map of New Boreholes and Renovated Boreholes

According to the project completion report, as shown in Table 2.75, constructed and rehabilitated borehole capacity of 56,782 m^3/day met the required capacity of 53,315 m^3/day in the contract. It was assumed that this work of the package increased the supply capacity by approximately 21,700 m^3/day.

Table 2.75 Intake Capacity of Maintained Boreholes

Item	Development Capacity (m^3/day)	Required Capacity (m^3/day)	Difference (m^3/day)
Existing Repaired Boreholes	35,046	36,755	-1,709
New Boreholes	21,736	16,560	5,176
Total	56,782	53,315	3,467

Source: ZUWSP, Project Completion Report

(b) Package 2

In Package 2, the construction of new water pipelines (19,945 m) from the boreholes areas developed in Package 1 (Bumbuisudi and Kabrikikombe) to the Saateni and Mnarawambao reservoirs, reinforcement of the water transmission trunk line to the Saateni reservoir (φ350mm × 256m), construction of the Saateni reservoir (2,000m^3) and Mnarawambao reservoir (1,000m^3) (both elevated), installation of water distribution pipeline (approx. 54,000m) , DMA formation, installation of electromagnetic flowmeters (19 locations) and manifolds (345 locations) were conducted. However, due to the difference between the estimated price and the cost proposal by the bidder, the scope of work was reduced (e.g., reduction of the number of constructions of service reservoirs, reduction in the length of pipeline laying and replacement, procurement of water leakage repair equipment, etc). The construction work was completed in December 2019, however, ZAWA currently faces various problems because commissioning before the handout was not carried out and no failure was pointed out during the defect liability period.

(c) Status of facilities currently maintained by the ZUWSP project

(i) Water source facilities

New borehole construction and rehabilitation of existing boreholes were implemented to improve water source facilities. Regarding the newly constructed boreholes by the project, it was confirmed in the site survey that they were working well.

As for the rehabilitated boreholes, one borehole in Kabrikikombe was shut down due to turbidity after a short time of operation so it was relocated to another place. The other boreholes are still in operation. Regarding the rehabilitated boreholes, one borehole in Kabrikikombe was shut down because of turbidity occurred after the operation start, and the pump there was transferred to another place. The other boreholes are working well. At the one of the boreholes visited during the field survey, water leakage from the air valve was found. The borehole was in a condition to continue operation but was left unrepaired.

Exterior of Borehole (New Borehole)

Pressure Gauge and Air Valve at Top of Borehole (New Borehole)

Piping and Flowmeter in Pump Room (New Borehole)

Electromagnetic Flowmeter Indicator (New Borehole)

Piping Around Borehole and Leakage from Air Valve (Rehabilitated Borehole)

Electromagnetic Flowmeter Indicator (Rehabilitated Borehole)

Borehole with Pump Removed (Rehabilitated Borehole)

Borehole with Pump Removed (Rehabilitated Borehole)

Photo 2.13 Photo of Water Source Facilities Constructed and Rehabilitated by ZUWSP

(ii) Saateni and Mnarawambao service reservoirs

Both Saateni and Mnarawambao reservoirs are in operation. The disinfection equipment installed in the Mnarawambao reservoir was not in operation due to running out of breaching powder at the time of the field survey, but the equipment was in good condition with no malfunctions. Electromagnetic flowmeters are installed in the Saateni and Mnarawambao reservoirs (inlet and outlet flowmeters), but only the inlet

flowmeter at the Mnarawambao reservoir was currently working. The reason for the malfunction has not been investigated. The manhole covers of the flowmeter chamber are made of thick concrete and cannot be opened by hand. Therefore, the manhole cover is always open.

Saateni Reservoir

Distribution Flowmeter in Saateni Reservoir

Mnarawambao Reservoir

Disinfection Equipment in Mnarawambao Reservoir

Flowmeter chamber in Mnarawambao Reservoir

Flowmeter in Mnarawambao Reservoir

Photo 2.14 Photo of Water Source Facilities Maintained by ZUWSP

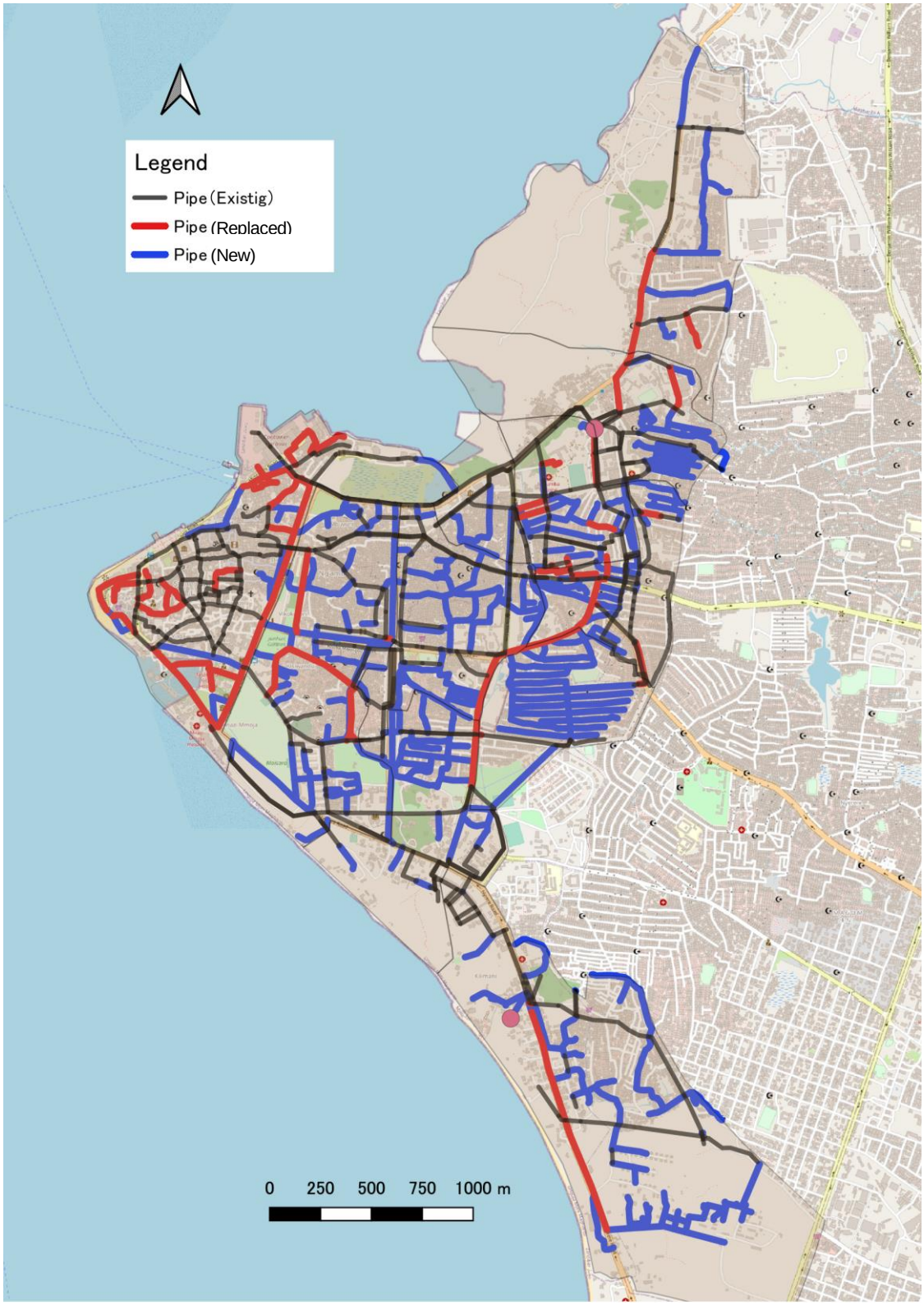
(iii) Distribution pipelines and service connections

Electromagnetic flowmeters were installed on the boundaries of the DMAs, but all these flowmeters are not operational. The reasons have not been investigated and are unknown.

Figure 2.37 shows location map for laid and replaced pipelines by ZUWSP. Although new pipelines were laid and some of existing pipelines were replaced, the reconnection of service connections, which was undertaken by ZAWA, was delayed and not completed. Until this work is completed, the existing pipes planned to be replaced cannot be disconnected due to the presence of customers who obtain water from the existing pipes. So, at present, most of the existing pipes remain as they were before the project started, which is one of the reasons for the water leakage in the project area of the ZUWSP.

In addition, the water distribution area of the ZUWSP is adjacent to the area of Japanese ODA loan project, which has not yet been commenced, and it is expected that some water flows into this area and it is one of

the reasons why water pressure has not increased in the ZUWSP area.



Source: JICA Survey Team

Figure 2.37 Location Map of Laid and Replaced Pipelines by ZUWSP

The manifold system was used for service connections because it has the advantage of reducing the number of branches which can be a cause of water leakage. According to interviews with the Customer Service

Department, 3,450 service connections from manifolds out of the 6,900 service connections planned to be replaced were completed in ZUWSP area as of November 2021. The reasons for the delay in reconnection of service connections were cited as lack of budget for the purchase of materials needed for the reconnection and lack of the number of plumbers.

DMA Flowmeter

Manifold with Meters Already Installed

Manifold in Stone Town

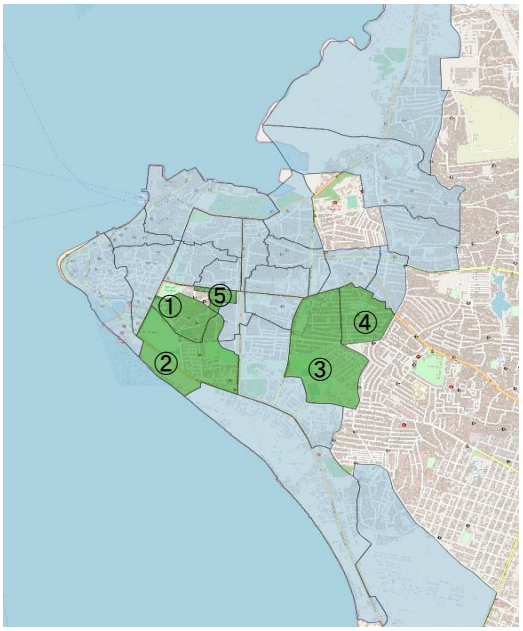
Manifold in Stone Town

Photo 2.15 Photos of DMA Flowmeters and Manifolds Constructed by ZUWSP

According to the plumber in the Customer Service Department, the following five shehias have completed the reconnection of service connections and disconnection of unnecessary existing pipes from the network as of February 2022.

(1) Kikuwajuni Bondeni
(2) Kikuwajuni Juu
(3) Kwaalinatoo
(4) Kwahani
(5) Kisiwandui

Figure 2.38 shows shehias with water supply reconnected.



Source: JICA Survey Team

Figure 2.38 Shehias Reconnection of Service Connection were Completed

(3) Operation and Maintenance for Facilities Developed by ZUWSP

(a) Staff deployment for facility operation

As noted above, 8 new boreholes (including 2 existing boreholes redrilling) were developed, and 21 existing boreholes were rehabilitated by ZUWSP.

While the shortage of borehole pump operators has been identified as one of the challenges of SBP2025, a remote operation system of borehole pumps was not introduced by the project. According to the Director of Technical Operations, borehole operations are manned, with 10 employees assigned to operate these 29 boreholes. By simple calculation, one operator is operating three borehole pumps. Since the actual increase in the number of boreholes is limited to six, operation staff was reallocated for the operation of the boreholes instead of hiring new staff, and the operation system was established as planned.

(b) Operation management

The electromagnetic flowmeters installed at the boreholes are working, but the pumping flow is managed by calculated flow by the design pump discharge and operating hours. The operators don't know how to operate the electromagnetic flowmeter indicator and is unable to read the flowmeter. In addition, the inlet and outlet flowmeters of the service reservoirs are not functioning as described above, and the amount of water distributed from the service reservoirs and the amount of water distributed to the DMAs are also not measured.

(c) Maintenance

According to the Director of Technical Operation, the basic policy of maintenance management is corrective maintenance and preventive maintenance is not introduced. The method of maintenance was not changed before and after the implementation of ZUWSP. The chief maintenance staff is appointed for each field as shown in Table 2.76. Based on ZAWA's basic policy for maintenance, no daily visual inspections or periodic inspections are conducted.

Table 2.76 People in Charge of Maintenance

Category	Official Position	Name
Civil Facilities and Pipelines	Network Manager	Bilali Khalid Abbas
Mechanical Equipment	General Manager, Technical Administration Dept.	Hassan Kjamis Hassan
	Mechanical Engineer	Hafidhi Abdallah Ali
Electrical Equipment	Electrical Engineer	Hassan Haji Kongo
	Electrical Engineer	Ali Said Mohammed

Source: ZAWA, Technical Operation Department

The following six manuals were prepared and submitted to ZAWA for operation and maintenance of the facilities developed by ZUWSP, but no education or training on operation and maintenance were provided to operators prior to the start of operation.

1. Operation and maintenance manual for water transmission facilities
2. Maintenance manual for surge tank operation
3. Operation manual for disinfection equipment
4. Operation manual for electromagnetic flowmeter management system

5. Capacity building and training manual for borehole pumps
6. Maintenance manual for borehole pump operation

(d) Maintenance tools and equipment

Information was collected on ZAWA's equipment holdings. Maintenance of mechanical and electrical equipment is mainly performed in workshops, and a list of workshop equipment was obtained. Plumbing tools are described below in (4) (d).

(4) Leakage Situation in ZUWSP Area

Since SBP2025 states the reduction of NRW as part of the improvement of water service reliability, and leakage control, which contributes to the reduction of physical water loss, is an important issue in reducing NRW. Therefore, information on leakage in ZUWSP area was collected, analyse the root causes of leakage in ZUWSP area and the measures needed to reduce leakage, and analyse the long-term efforts needed to reduce NRW.

(a) Overview of water distribution pipe network development in ZUWSP area

In ZUWSP, the construction and renewal of ductile iron and HDPE water distribution and secondary pipelines with a total length of approximately 53 km and diameters ranging from 90 mm to 315 mm were carried out in the Saateni and Mnarawambao water distribution zones. The scope of work includes pipe installation, installation of ancillary facilities such as valves, air valves, drainpipes, etc., renewal of the water distribution main (645 m of asbestos pipe), installation of electromagnetic flowmeters at the DMA boundary (10 locations), and installation of manifolds at 345 locations.

Table 2.77 Length of Water Distribution Main Pipes

Category	Location	Pipe Material	Length	Remarks
Distribution Main	Saateni	DCIP	1,366 m	New
		HDPE	1,405 m	New
		HDPE	645 m	Replacement for Asbestos Cement Pipes
Total			3,416 m	

Source: ZUWSP Project Completion Report

Table 2.78 Length of Water Distribution Conduit Pipes

DMA	Location	Pipe Material	Length	Remarks
SIDO 1	Shaurimoyo	HDPE	3,836 m	New
SIDO 2	Mumembemakummbi	HDPE	2,974 m	New
SIDO 5	Mikunguni	HDPE	3,628 m	New
SIDO 6	Stone Town	HDPE	7,463 m	New
SIDO 7	Kikwajuni	HDPE	8,197 m	New
SIDO 8	Rahaleo	HDPE	4,738 m	New
SIDO 9	Kwahani	HDPE	7,460 m	New
SIDO 10	Miembeni	HDPE	4,371 m	New
SIIDO 1	Migombani	HDPE	8,124 m	New
Total			50,791 m	

Source: ZUWSP Project Completion Report

Table 2.79 Number of Electromagnetic Flowmeters in DMA

DMA	Location	Pipe Material	Diameter	No.	Remarks
SIDO 1	Shaurimoyo	DCIP	ϕ 150	1	
SIDO 2	Mumembemakummbi	DCIP	ϕ 200	1	
SIDO 3	Glioni	DCIP	ϕ 100	1	Installed on existing pipe
SIDO 4	Makadara	DCIP	ϕ 150	1	
SIDO 5	Mikunguni	DCIP	ϕ 150	1	
SIDO 6	Stone town	DCIP	ϕ 300	1	Diameter is not shown on as-built drawings
SIDO 7	Kikwajuni	DCIP	ϕ 200	1	
SIDO 8	Rahaleo	DCIP	ϕ 150	1	
SIDO 9	Kwahani	DCIP	ϕ 150	1	
SIDO 10	Miembeni	DCIP	ϕ 150	1	
SIIDO 1	Migombani	DCIP	—	0	
Total				10	

Source: ZUWSP Project Completion Report

Table 2.80 The Number of Manifolds Installed

DMA	Location	No.	Remarks
SIDO 1	Shaurimoyo	18	
SIDO 2	Mumembemakummbi	0	
SIDO 5	Mikunguni	33	
SIDO 6	Stone town	45	
SIDO 7	Kikwajuni	79	
SIDO 8	Rahaleo	34	
SIDO 9	Kwahani	51	
SIDO 10	Miembeni	31	
SIIDO 1	Migombani	54	
Total		345	

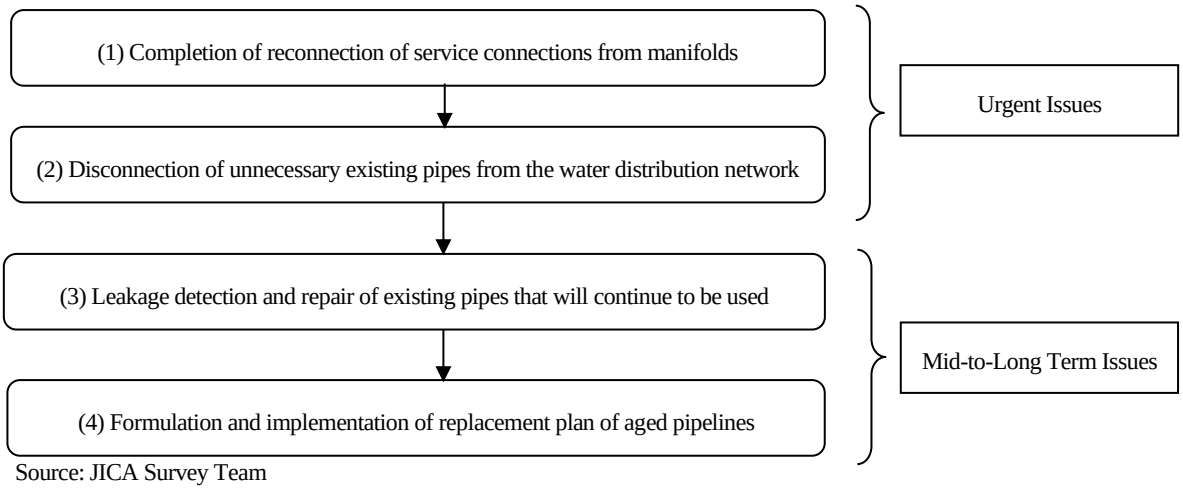
Source: ZUWSP Project Completion Report

(b) Measures carried out within ZUWSP area

In order to address leak repairs in the ZUWSP area after the project was completed, ZAWA has established a dedicated leakage repair team. However, this activity has now been suspended due to ZAWA's personnel and financial constraints. ZAWA is also in the process of developing a leakage repair plan for ZUWSP area, but no concrete information on the plan has been obtained.

(c) Required measures for leakage reduction in ZUWSP area

The cause of the leakage in the area is due to the existing old pipelines that are still in existence. Therefore, the steps required to reduce leakage are shown in Figure 2.39.



Source: JICA Survey Team

Figure 2.39 Procedures for Leakage Reduction in ZUWSP Area

(i) Completion of service connection replacement from new pipe through manifolds

The reason why unnecessary existing pipes cannot be disconnected from the pipe network is that ZAWA has not completed the reconnection of service connections, which is undertaken by ZAWA. So, the reconnection work should be completed first.

In addition, when the reconnecting work, it is also necessary to confirm and update the billing management system database and GIS database necessary for customer management, including customer IDs, water meter numbers, and user information (names, cell phone numbers, etc.).

As for Stone Town, there are many multi-story buildings such as hotels, and the characteristics of the residential area and water users are different. Therefore, a detailed survey of the following items is required.

- Situation of flow and water pressure into Stone Town
- Situation of connection of pipelines between new and existing pipelines
- Situation of water supply to buildings (e.g., water supply tank installation, water supply system, etc.)

Based on the results of the survey, it is necessary to plan and design what kind of service connections are to be installed and how to proceed with construction. In addition, it is necessary to consult with Stone Town Conservation and Development Authority ("STCDA") to proceed with the design and construction.

(ii) Disconnection of unnecessary existing pipes from the water distribution network

Based on the distribution network model analysed in the design stage of ZUWSP, as well as the pipeline installation conditions, such as overlapping existing and new pipelines, unnecessary existing pipes need to be identified and the pipelines need to be disconnected from the distribution network. Disconnection requires, at a minimum, cutting the existing pipes and installing caps and plugs. In addition, it is better to remove the disconnected existing pipes as much as possible because pipes left under the ground may cause subsidence although the cost will increase. Additionally, it is necessary to update the pipe network data registered in the GIS.

Once this step is completed, the water distribution pipe network will be in the state intended by ZUWSP, except for the formation of a complete boundary with the Japanese ODA loan project area, so it is necessary

to complete this step as soon as possible. It is also desirable to compare the water pressures and water supply service hours under this condition with ones before the project implementation. This will help to evaluate the project effects of water service improvement by ZUWSP, and to utilize ZAWA's experience and knowledge obtained through the project when implementing similar projects in the future.

(iii) Leakage detection and repair in existing old pipelines that will continue to be used

Once this step is completed, it will be the time to implement the leakage control measures for the remaining existing pipes in ZUWSP area.

Electromagnetic flowmeters have been installed at the DMA boundary in ZUWSP. However, they are not working, and repair or replacement needs to be implemented. Then, leakage control activities, such as minimum night flow measurement and step-test to narrow down the water leakage pipelines by using the repaired or replaced meters, leakage detection by using leakage detection equipment and leakage repair should be implemented. To do so, ZAWA must obtain skills for leakage management.

Since the water distribution pipes in ZUWSP area are mainly HDPE, and it is expected that leak sound detection may be difficult when water pressure is low, appropriate leak detection equipment should be used depending on local conditions. Table 2.81 shows common leak detection equipment.

Since ZAWA has not provided technical assistance for underground leak detection in past technical cooperation projects, it is difficult to start this activity immediately because ZAWA does not have sufficient equipment, but it is necessary to address this as a mid-to-long term issue.

(iv) Formulation and implementation of replacement plans for remaining existing old pipelines

Although repairing leaks can also reduce NRW, a plan for the replacement of ageing pipelines must be developed and implemented for further reduction of NRW and improvement of water supply services. The formulation of a replacement plan requires analysing information such as characteristics and trends of leakage locations (year of pipe installation, pipe materials, and leakage locations such as valves and joints) based on information accumulated from leakage surveys and repairs, selecting replacement target pipelines. Then, the replacement plan should be carried out.

Although there is some experience in past technical cooperation projects in which the aged pipelines in Makadara shehia were replaced under ZAWA's budget, there has been no technology transfer regarding pipeline information management and analysis, such as analysis of leakage record data. Therefore, the activities related to the old pipeline replacement should be addressed as mid-to-long-term measures.

Table 2.81 General Leak Detection Equipment

Leak Detection Equipment	Overview
Leak Sound Detection Bar 	・A basic tool widely used in leak detection work, as it is easy to handle and the tip is placed over buried valves, water meters, etc., to listen for leaks. ・Although it is difficult to pinpoint the location of a leak, it is possible to confirm the presence of a leak in the vicinity of the survey location. ・It can be inserted into the ground to search for leaks due to the wetness of the tone rod. ・It requires the skill in listening to the sound of leaking water. ・ZAWA has sound tuning rods.
Leak Detector (Ground Microphone) 	・This is a basic tool widely used in leak detection because it is easy to handle and detects the sound of leaks from a microphone placed on the ground above the buried pipeline. ・It is possible to identify the location of a leak by the difference in noise level of the sound of the leak. It is generally used for surveys at night when there is less noise to improve the accuracy of the survey. ・It requires the skill in listening to the sound of leaking water. ・It is inefficient to conduct leakage surveys of all pipelines with this equipment, so it is effective to narrow down the leakage area before conducting the survey.
Correlative Leak Detector 	・Equipment that locates leaks based on the difference in propagation time of the sound of a leak by installing sensors at two points on the pipeline, such as a valve or fire hydrant. ・No special skills required for leak detection. ・In plastic pipelines or pipelines with low water pressure, it is difficult to detect the sound of leaking water, and it may be impossible to locate the leak.
Correlative Leak Detector (Multi-Point Logger Type) 	・Install loggers/sensors at multiple points on the pipe network, such as valves and hydrants, to collect leak sounds and accumulate data ・The basic principle is the same as that of correlative leak detectors, but since data is recorded by loggers, the leak detection performance is higher than that of general correlative leak detectors (since the leak sound is continuous, continuous noise can be detected by logger data). ・No limit to the number of loggers/sensors installed. ・Depending on the product, data can be collected wirelessly from loggers/sensors. ・No special skills required for leak detection
Hydrogen Gas Leak Detector 	・Hydrogen gas (at a safe mixing ratio) is pumped into the pipe, and hydrogen gas coming up from the leak is detected from the ground. ・It is excellent for locating leaks, but not suitable for extensive leakage surveys because water must be cut off for the survey. ・Hydrogen gas can be generated on-site from pure water by using a hydrogen gas generator. ・No special skills required for leak detection.

Source: JICA Survey Team

(d) Current leakage management

(i) Organizational system for leakage management

In Unguja Island, Network Division of the Technical Operations Department at ZAWA Headquarters and the district offices are responsibility for leakage repair. Network Division is in charge of repairing large leakage that cannot be handled by the district offices for entire Unguja island, while each district office is in charge of repairing leakage within its jurisdiction area. Network Division has 10 staff in charge of leakage repair, and the number of plumbers in charge of leakage repair at each district office is shown in Table 2.82.

Table 2.82 Number of Plumbers in Each District Office

District Office	Number of Plumbers
North A	3
North B	4
Central	3
Urban West A	6
Urban West B	4
South	5

Source: ZAWA

Plumbers for leakage repair are assigned to each district office, and the division of roles with the Network Division of ZAWA HQ is clear. The organizational system for leakage management has been improved compared to before.

(ii) Situation of leakage repair

Repairing found leakage within one day is one of the targets of SBP2025 and ABP 2020/2021, and it was set as an activity for the improvement of ZAWA's reliability. The number of leakages repaired at each district office is counted and reported every quarter for monitoring of the activity.

The number of leakages repaired in the first quarter of 2021/2022 is shown in Table 2.83. 509 leakages were reported, and all reported leakages were repaired. By district wise classification, the Urban District accounted for about 70% of the total number of leakages, while Urban West B accounted for about 10% of the total number of leakages. These districts have a long history of water supply and have many old pipelines. In addition, these are densely populated and have long pipe lengths and many branches for service connections. Therefore, it is assumed that these are the reasons of a lot of leakages in the districts. It is not possible to confirm if leakage repair was carried out within the one-day, but all reported leakage were repaired.

Table 2.83 Number of Leaks Repaired from July to September in 2021

District Office	Number of Leakages	Number of Repaired Leakages	Number of Unrepaired Leakages
North A	24	24	0
North B	4	4	0
Canter	11	11	0
Urban	351	351	0
Urban West A	15	15	0
Urban West B	80	80	0
South	24	24	0
Total	509	509	0

Source: ZAWA, Technical Operation Division

(iii) Tools and equipment for leakage repair

Tools and equipment possessed by Network Division of ZAWA are shown in Table 2.84. The division has general tools and equipment including HDPE piping tools.

Table 2.84 ZAWA's Plumbing Tools and Equipment

Category	Equipment
Equipment and Fittings	Fittings (150mm-700mm), other fittings (100mm-300mm)
Measuring Equipment	Surveying instruments, flowmeters and water level indicators, water pressure testers
HDPE Piping Tools	Electric fusion splicers, chain pullers
Detectors	Metal detectors, leak detectors
Excavation Machinery	Backhoe, drainage pump for construction
Piping Tools	Plumbing wrenches, spanners, electric drill drilling rods, grinders, water pipe drilling machines
Hanging Equipment	Chain blocks, chain hooks
Personal Computers	Laptop, external memory, iPad (for GIS)
Generators	Generator
Welding Equipment	Welding machines
Other	Chlorine mixer

Source: ZAWA, Technical Operation Division

(5) Issues Related to Facility Management

(a) Issues related to the development of ZUWSP facilities

(i) Remaining existing pipe

By completion of ZUWSP, the water source capacity increased by approximately 21,700 m^3/day and it was expected to improve water service through the construction of distribution reservoirs and pipelines, however, as mentioned above, the service has not been improved.

There were various reasons for the unimproved services, such as the delay of reconnection of service connections and installation of water meters, which were the responsibility of ZAWA. Besides, in terms of project management, the following problems occurred during the planning, design and construction phases of the project.

(1) Since all of the old water distribution pipelines are not planned to be replaced. Many old pipelines still remain after the project completion.
(2) The effects expected by the project were not realized immediately after the project completion because the replacement of service connections was not included in the scope of work of the contract.
(3) The length of pipelines to be replaced was reduced because of the difference between the budget and the proposed cost by the second contractor (the contract with the first contractor was terminated due to its bankruptcy).
(4) Insufficient final inspection for the project and non-implementation of defect repair during the defect liability period.

In the Japanese ODA loan project, replacement of almost full pipelines except for some sound pipelines, and service connections are planned to be included in the scope of work, therefore, problems such as (1) and (2) are not expected to arise. With regard to (3) and (4), proper implementation of prequalification (PQ), bid evaluation, and construction completion and defects inspections are necessary, as well as the selection of a consultant plays an important role in project management as an engineer, and project management. And these

points are to be improved in future projects.

To improve service conditions in ZUWSP area, it is necessary for the short term to complete the installation of service connections from manifolds constructed by ZUWSP and promote the disconnection of unnecessary existing pipelines from the network. According to the Customer Service Department, reconnection of service connections is being performed by ZAWA staff, with 6,900 reconnections planned in the ZUWSP area. But as of November 2021, progress was reported as 3,450 (50% of the planned number). According to ZAWA, the cost per service connection (procurement and installation) is estimated at 120,000 TZS, and to proceed with the remaining reconnection, a cost of 414,000,000 TZS would be required. In addition, other costs, such as installation of valves to disconnect existing pipes and labour costs for excavation are required. Therefore, the required budget must be secured for steady implementation.

In the long term, leakage repair from the remaining old pipelines in the ZUWSP area and the replacement of old pipelines should be systematically promoted.

(ii) Monitoring of pumping and distribution volumes

In the past, ZAWA had installed impeller-type flowmeters at boreholes and service reservoirs, but the failure of the flowmeters resulted in a situation where water volume could not be monitored. Therefore, ZUWSP installed electromagnetic flowmeters that have no moving parts at the boreholes, service reservoirs, and DMAs, and they will not cause mechanical failures. The electromagnetic flowmeters have a data transmission function with general packet radio services (GPRS). Although facilities that can remotely measure and monitor the volume of water pumped from boreholes, water distributed from the reservoirs, and water flowing into each DMA were installed, while central monitoring equipment such as SCADA have not been installed. Although the flowmeters at the boreholes are working, the flowmeters installed at the reservoirs and DMAs are not functioning, as no commissioning was conducted prior to handover and no defects were noted during the defect liability period.

The borehole pumping volume is still managed by the volume calculated from borehole pump operating hours and design discharge capacity of pumps as in the past because the operators do not know how to operate the electromagnetic flowmeter indication panel, while the installed flowmeters are not utilized for the operation management. Since the management of water volume is essential to control and reduce NRW, it is necessary to change the flow management method to match the equipment that has been installed, in addition to eliminating malfunctioning equipment.

RIWSSZ is going to install a SCADA system at the new ZAWA headquarters building. However, the monitoring of facilities developed by ZUWSP is not included in the system. Incidentally, following functions are planned for the SCADA system being developed by RIWSSZ.

- Monitoring: Flow, pressure, water level, water quality (residual chlorine at pump stations)
- Operation: Pump operation, valve operation (around borehole and DMA valves)

Source: Current Status on the Rehabilitation and Improvement of Water Supply System in Zanzibar (November 2021)

Figure 2.40 ZAWA Office to be Built in RIWSSZ (EXIM-BI Project)

(b) Issues of operation and maintenance

The issues identified by the Director of Technical Operations, obtained through interviews, are as follows

- Lack of skilled operation and maintenance staff
- Insufficient operation and management system development, including automatic operation and remote monitoring equipment
- Restriction of O&M activities due to lack of budget
- Lack of tools and equipment
- Lack of operation and maintenance manuals
- Lack of transportation

Lack of human resources and budgets are always described by ZAWA as reasons for inadequate operation and maintenance as identified by ZAWA. Although ZAWA has operation and maintenance manuals prepared by ZUWSP, according to interviews, education and training are not conducted before the start of operation. In addition, the method of operation and maintenance has not been changed and the previous operation and maintenance methods are still being followed. The problem is that while there are opportunities to improve operation and maintenance and to enhance the skills of staff for operation and maintenance, these opportunities are not being fully utilized.

In a project, various facilities and equipment are planned and introduced to improve the efficiency of operation and maintenance. However, it seems that there is a lack of effort to inform O&M staff of these intentions, and to plan internally within ZAWA regarding how to utilize the equipment for efficient operation and maintenance and how to change operation and maintenance methods before the start of operation of developed facilities and equipment.

RIWSSZ plans to install equipment that will affect operation and maintenance, and meter reading and billing operations, such as SCADA and a trial prepaid meter system. For RIWSSZ the planned Japanese ODA loan

project, O&M plan responding to the facilities and equipment which are to be introduced after the projects, and provision of training should be carried out for O&M staff prior to the start of facility operation in consideration of the changes in the operation methods anticipated after the project.

Regarding transportation, without an allocation of vehicles, it would be difficult to conduct routine facility rounds and inspections, and a lack of tools and equipment would cause delays in maintenance work with any problems that arise. Hence, it is necessary for the Technical Operations Department to continue to coordinate with other departments of ZAWA regarding the allocation of vehicles and to secure budgets for the purchase of tools and equipment.

2.2.5 Overview of Customer Management

Regarding the collection of information related to customer management, the current situation related to customer management was assessed from the questionnaire on customer management and the materials collected from ZAWA. The customer needs survey was subcontracted to a local consultant.

The questionnaire was used to collect information related to customer management. The area covered in the questions were "Customer information management", "Meter management", "Meter reading/Billing/ Collection", "Non-payment settlement work", "Customer satisfaction", and "Financial status". The questionnaire was distributed to the Department of Commercial and Customer Service and the Finance and Accounting Department.

(1) Current Status of Customer Management (Collected Information is as of July 2021.)

(a) Status of customer information management

(i) Customer data

Customer data is updated regularly, and ZAWA manages 67,130 connections in Unguja, 67,130 registered connections in the system, 50,212 in Urban West, and 50,212 registered connections. The registration rate is 100% in each district. At the time of 2016, customers registered in the customer management system were 21.5% of the paper-based customer information. However, it has been improved to 100% at the time of this survey.

(ii) Complaint handling

The number of complaints received in FY2020 was 248, including 128 for water services, 60 for invoices / payments, and 60 for meter reading / billing / collection. Five people are working on it. Most of the complaints were about billing for water used, and many customers are dissatisfied with the billing while the water supply time is limited.

(b) Customer meters management

(i) Customer meter installation rate

The customer's meter installation rate is about 16% in July 2020, and domestic customers, who account for 98% of the total, pay water tariff on a flat-rate basis. The meter installation rate has improved to 3% in 2013 and 12% in 2018. Meter information (installation year, number of operating meters, number of failure meters) on Unguja Island and Pemba Island is not known. Table 2.85 shows the installation status of water meters, Table 2.86 shows the breakdown of installed meters, and Table 2.87 shows the number of flat rate customers.

Table 2.85 Customer Meter Installation Status

Area	No. of connections	Metered customers	Installation rate	No. of operating meters	No. of failure meters	No. of installed metered within 0 to 5 years	No. of meters installed for 5 years or more and less than 10 years	No. of meters installed for 10 years or mote
Unguja Island	67,130	10,895	16.2%	~10,500	~300	1,115	NA	NA
Urban West Region	29,904	4,779	16.0%	4,759	40	6,467	6,467	7,390
Pemba Island	55,000	5,529	10.0%	4,015	1,514	NA	NA	NA

Source: JICA Survey Team

Table 2.86 Breakdown of Installed Customer Meters

Time	Domestic	Institutional	Commercial/Industry	Agriculture	Total
October 2016	6,779	109	354	5,100	12,432
July 2021	9,925	223	546	82	10,776

Source: JICA Survey Team

Table 2.87 Breakdown of Flat-Rate Customer

Time	Domestic	Institutional	Commercial/Industry	Agriculture	Total
October 2016	40,128	247	347	152	40,874
July 2021	53,654	354	452	232	54,692

Source: JICA Survey Team

(ii) New connections

The number of new connections was 4,258 in 2020. The procedure for new connections was completed within 10 business days for 101 units, with an achievement rate of 2.3%. The reason is answered that there is a shortage of meters and accessories. It is far from the goal of ZAWA to complete the procedure within 7 business days.

ZAWA has set a target of 6,300 new connections in 2021. From January to October, the number of new connections was 3,110 (progress rate is about 60%, annualized), and it is difficult to achieve the target.

Table 2.88 summarizes information on connections and metering ratio for 2008, 2013, and 2018, and Table 2.89 summarizes the status of new connections in each district up to January and October 2021.

Table 2.88 Summary of New Connections

Description	2008	2013	2018
No. of new connection	N/A	3,000	5,604
No. of total connection	57,000	71,990	100,010
Connection increase rate	N/A	4%	6%
Metering ratio	N/A	3%	12%

Source: ZAWA Strategic Business Plan 2020/21-2024/25

Table 2.89 Number of New Water Connections in 2021 at District Offices

Time	Urban	Urban West	North "A"	South	Central	North "B"	Total
January	114	96	30	33	38	7	318
February	139	71	23	33	30	6	302
March	136	99	64	38	45	3	385
April	89	55	21	26	33	6	230
May	62	73	16	22	38	5	216
June	86	139	73	39	59	4	400
July	56	84	10	36	45	1	232
August	84	210	9	18	66	5	392
September	80	92	24	30	64	9	299
October	73	92	16	81	71	3	336
Total	919	1,011	286	356	489	49	3,110

Source: ZAWA

(iii) Water tariff collection by prepaid system

ZAWA has set a goal of 90% for the meter installation rate (about 119,000 in number) by 2025 and is planning to adopt a prepaid method (install a prepaid meter) for 10% of them. It is planning that 350 prepaid meters are introduced on a trial basis and ZAWA decides the policy based on the results. The system required to operate the prepaid meters will be provided free of charge by the meter manufacturer. The detailed plan including the installation location is not decided.

(c) Meter reading/Billing/Water Tariff Collection

(i) Meter reading

The meter reading work is carried out by 12-meter readers. In July 2021, no. of 2,610 meters of the 10,688 meters could not be read within the month due to a malfunction of the meter reading equipment. The number of meter readings per month for a meter reader is about 900. A mobile phone is used for meter reading, but it has been discontinued due to insufficient capacity. Meter reading is carried out every month, and the meter reading result is described in the form containing the customer's name, account, reference number, etc. Meter reading is carried out based on the meter reading route described in the form. The meter is installed in a state where it is easy to read the meter

Baylan Meter

Meter installation status

S-N	JINA LA MTEJA		ACCOUNT
1	A1-001	BANK OF TANZANIA	17 18	5[illegible]-2-059493
2	A1-002			
3	A1-003			
4	A1-005	ABUBAKAR A[illegible] FARAJI	31[illegible] 764	[illegible]-2-153655
5	A1-005	RAZAK MOHD HUSSEIN		54-2-080617
6	A1-006	BAKARI ALI BAKARI	310 382	53-2-014413
7	A1-007			
8	A1-008	MGENI SULUHU HASSAN	495 887	53-2-014487
9	A1-009	SALAMA RASHID HAMAD	316 765	53-2-014394
10	A1-010	SIMAI VUAI FOUM	495 888	53-2-152869
11	A1-011	SULEIMAN NYASA JUMA	495 908	53-2-014402
12	A1-012	JAFAR TAIBU ABDUL-RAHINI	495 754	53-2-014404
13	A1-013	TA[illegible] HAMZA SAID		
14	A1-014	SAID KHAMIS ABDULLA	315 763	[illegible]-2-151246
15	A1-015	REHEMA JUMA KHAMIS	867 391	53-2-153534
16	A2-016			
17	A1-017	ASHA OTHM[illegible] ALI	867 151	[illegible]-2-015424
18	A2-018	ABU[illegible] AKARI [illegible] ATIB HAMID		
19	A2-[illegible]			

Meter reading form used at the time of meter reading

ZAWA water with residual chlorine

Photo 2.16 Photos of meter reading

(ii) Billing

The number of billings at Unguja Island is 60,683 (FY2020), the billing ratio to metered customers is 79%, and the billing ratio to flat-rate customers is 92%. Billing distribution to metered customers in Urban West is

8,500, distribution to flat-rate customers is 49,494, and the billing distribution rate is 90%. The billing ratio is unknown because the number of metered and flat rate customers is not known. Billing to flat-rate customers uses SMS (Short Message Service). There are no customer complaints about SMS billing, but there are complaints such as "I was billed despite the lack of water services." Prepaid meters are installed for KIOSK users to keep track of the amount of water used. In addition, there are problems of double billing to customers who are double registered and billing to non-resident customers who are registered in the system.

(iii) Water tariff collection

Water tariff is paid by domestic customers at the counters of the headquarters (2 locations) and 7 regional offices, and no water tariff is collected by visiting domestic customers. Five people are responsible for collecting tariff for large customers.

The tariff collection rate in 2020 is 44%. Compared to 6% in 2016, it has improved at a considerable rate. The reason for the improvement is that the customer management system registration rate of 21.5% in FY2016 was improved by 100% at the time of the survey, and the effect of billing to users including flat-rate customers via SMS (especially the large amount paid by large customers). In addition, KATAKATA activity[36] which complement the current situation where there is no non-payment settlement section, is contributing. In addition, the existence of flat-rate customers, unstable water services, low customer awareness, etc. are cited as obstacles to improve the collection rate, and for customers who do not live at the address at the time of registration due to reasons such as moving. There are reasons such as continuing to distribute billings, which is a factor in lowering the collection rate.

Revenues from hotels, which are large customers, has declined due to the impact of COVID-19. More than 80% of the 350 hotels are closed, and ZAWA is unable to collect tariff from hotels, and ZAWA's normal operations are deteriorating due to the impact of reduced revenue from hotels.

(d) Non-payment settlement work

There is no section to deal with unpaid customer, and KATAKATA activities are used to deal with it. Every Thursday, with the management department, most of the staff participated in KATAKATA activities. The team formation consists of staff from the technical department and the accounting department, and each department manager leads five teams. The activities are mainly carried out as follows.

- Public relations activities: Raising awareness of water bill payment
- Complaint handling: Prompt response to customer complaints
- Illegal connection: Identification of illegal connection customers
- New customer: Identify and register
- Tariff collection: Dealing with unpaid customers

Currently, KATAKATA activity is suspended.

(e) Customer satisfaction

The performance of customer management is determined by looking at response time to complaints of

[36] Activities to visit customers, check payment status, and collect unpaid tariff. If the unpaid tariff is not paid, disconnect the water supply pipe.

commercial / technical nature and the percentage of the number of complaints solved to the total complaints received. Time to respond to commercial natured complaints has been reduced from 48 hours in 2008 to 8 hours in 2018. However, it has increased to 24 hours in 2020. On the other hand, the time to respond to complaints about technical nature is increasing Table 2.90 shows the processing status of complaints.

Table 2.90 Complaints Processing Status

Indicator	2008	2013	2018	2020
Response time to complaints-Commercial Nature (Billing etc.) (Hrs.)	48	N/A	8	24
Response time to complaints-Technical Nature (Water quantity, water quality etc.) (Hrs.)	24	N/A	24	48
Percentage of customer complaints handled	N/A	N/A	50%	50

Source: ZAWA Strategic Business Plan 2020/21-2024/25

(f) Status of water revenue

(i) Situation of Revenue

ZAWA's main sources of income are water sales, service fees and other domestic income. Table 2.91 shows that revenues over the last five years have continued to grow from TZS 4.2 billion to TZS 6.5 billion, respectively, from 2015/2016 to 2019/2020. Government subsidies have increased from TZS 6.7 billion to TZS 10.4 billion, respectively, from 2015/2016 to 2019/2020. For the past five years, government subsidies have accounted for an average of 58.4% of ZAWA's total revenue, and tariff revenues have averaged only 38.6% of total revenue. The remaining percentage represents service charges and other domestic income. Table 2.91 shows the revenue sources, and Table 2.92 shows the proportion of revenue.

Table 2.91 Revenue Sources

Revenue Source	Amount in TZS Mills.						
	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	Average	Proportion (%)
Water sale	4,276	5,336	5,758	5,693	6,593	5,531	38.6
Service charge	7	23	49	41	69	38	0.3
Government subsidies	6,760	7,618	8,424	8,601	10,430	8,367	58.4
Other income	240	81	404	340	329	279	1.9
Total	11,283	13,558	14,635	14,675	17,421	14,314	—

Source: ZAWA Strategic Business Plan 2020/21-2024/25

Table 2.92 Proportion of Revenue

Revenue Source	Proportion of revenue（%）				
	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020
Water sale	38	39	39	39	38
Service charge	0	0	0	0	0
Government subsidies	60	56	58	59	60
Other income	2	4	3	2	2
Total	100	100	100	100	100

Source: JICA Survey Team

(ii) Receivable

It is the role of ZAWA to ensure that customers pay their invoices timely. A good receivables management helps prevent overdue payment or non-payment. Table 2.93 shows the amount of receivable from all customers, and Table 2.94 shows the receivable in percentage. The number of receivables has been increasing from 2013 to TZS 4.2 billion, TZS 5.3 billion, TZS 5.7 billion and TZS 6.6 billion, but from 2018 it has decreased to TZS 2.2 billion, TZS 1.7 billion and TZS 2.2 billion. As for the ratio, domestic customers are high, accounting for 75% in 2017, but it has decreased to 33% in 2020. In 2020, it has decreased to about one-third of the amount receivable in 2017.

Table 2.93 Receivables in TZS Millions

Receivable	Amount in TZS Mills.							
	2013	2014	2015	2016	2017	2018	2019	2020
Domestic	3,169	3,498	3,981	4,174	4,943	716	674	718
Commercial	766	1,390	1,320	1,031	1,171	1,207	774	1,207
Institutions	287	392	441	384	403	190	268	190
KIOSK	41	42	4	76	49	41	29	4
Agriculture	11	14	18	28	25	4	2	4
Total	4,274	5,336	5,764	5,693	6,591	2,158	1,747	2,160

Source: ZAWA Strategic Business Plan 2020/21-2024/25

Table 2.94 Receivables in Percentage

Receivable	Amount in TZS Mills. (%)							
	2013	2014	2015	2016	2017	2018	2019	2020
Domestic	74	66	69	73	75	33	39	33
Commercial	18	26	23	18	18	56	44	56
Institutions	7	7	8	7	6	9	15	9
KIOSK	1	1	0	1	1	2	2	2
Agriculture	0	0	0	0	0	0	0	0
Total	100	100	100	100	100	100	100	100

Source: JICA Survey Team

Domestic customers are the major receivables of ZAWA, with more than 70% of the total receivables in each year. However, since 2018, accounts receivable has decreased considerably as a result of promoting activities for billing using SMS. On the other hand, the reason why payment is not possible is that there are many users who refuse to pay the tariff due to the existence of general customers who have benefited from the free distribution of water services that was implemented before 2013.Commercial and Institutional customers in 2020 will be 56% and 9%, respectively. The percentage as compared to 2017 is increasing. This is because the amount of cash that ZAWA collects from domestic customers has decreased every year, and the proportion of commercial customers has increased. ZAWA provides a long-term loan to her customers indirectly, which affects the liquidity condition of ZAWA. ZAWA should take proactive measures to collect receivables from its customers, with emphasis on domestic customers.

To understand more on the efficiency of ZAWA in the collection of receivables, the receivables turnover ratio and average collection period should be analysed. Receivable turnover ratio keeps decreasing from 0.6 in

2013 to 0.1 in 2020. In other words, the average number of days to convert to those receivables into cash is very high and keeps on increasing every year, from 608 days in 2013 to 3,832 days in 2020.Table 2.95 implies the operating efficiency of collection team is weak, which in turn causes a huge problem in cash flow for ZAWA.

Table 2.95 Ratio for Receivables and Collection Period

Ratio	2013	2014	2015	2016	2017	2018	2019	2020
Receivable turnover	0.6	0.6	0.5	0.4	0.4	NA	NA	0.1
Average collection period (days)	608	608	730	913	913	NA	NA	3,832

Source: ZAWA Strategic Business Plan 2020/21-2024/25, Numbers after 2018 are answers from the questionnaire

(2) Customer Management Targets and Strategies in Strategic Business Plan

The customer management target and strategies presented in SBP 2020/21-2024/25 are shown in Table 2.96. As customer management in 2023, ZAWA has set the targets of improving water supply services by raising the complaints handled rate from customers from an estimated 50% to 85%. Strategic items include improvement of information management, improvement of customer satisfaction, expansion of customer information, increase of income, strengthening of management within ZAWA, and improvement of inventory management.

Table 2.96 Customer Management Strategies Described in SBP 2020/21-2024/25

	Objective	Strategy
4	Customer management increased from guesstimated 50% to 85% by 2023	i. Improving information management ii. Improve customer satisfaction iii. Expanding the customer base iv. Expanding current revenue base v. Strengthening the internal control system vi. Improving store management

Source: ZAWA Strategic Business Plan 2020/21-2024/25

Table 2.97 shows the performance goals for customer management set in SBP 2020/21-2024/25.

Basically, the targets are to increase the number of metered connections with customer meters installed, increase water supply revenue, and simultaneously improve customer compliant response and thus improve customer satisfaction.

Table 2.97 Customer Management Performance Targets in SBP2020/21-2024/25

Description	Unit	Best Perf	2021	2022	2023	2024	2025
No. of new connections	No.	5,604	6,300	6,300	6,300	6,600	6,600
No, of public stand posts	No.	1,945	1,945	2,060	2,184	2,315	2,454
No. of total connections	No.	100,010	106,310	112,310	118,910	125,510	132,110
No. of metered connections	No.	11,677	33,168	52,561	74,200	97,898	118,900
Metering ratio	%	12%	31.2%	46.8%	62.4%	78%	90%
Response time to complaints of commercial nature	Hrs.	24	20	16	12	8	4
Response time to complaints of technical nature	Hrs.	48	36	24	12	6	4
Percentage of customer complaints handled	%	50%	57%	64%	71%	78%	85%
Revenue – Water Sale	TZS Mill.	5,365	5,610	6,507	7,292	8,592	10,138
Revenue – service charge	TZS Mill.	298	313	362	406	478	564
Revenue – Others	TZS Mill.	1,220	1,276	1,480	1,658	1,954	2,305
Revenue – Government Subsidies	TZS Mill.	10,429	10,429	7,821.75	5,214.5	2,607.25	0
Expenditure/Net Collection Ratio	%	80%	75%	70%	65%	60%	55%
Cash Ratio	%	10%	9%	8%	7%	6%	5%
Average Collection Period	Days	913	456	228	114	57	30

Source: ZAWA Strategic Business Plan 2020/21-2024/25

In addition, to achieve the above targets, implementation plans have been formulated for activities, indicators, targets, time, responsible departments, and budgets in the fields of strategies 1 to 6.

- Strategy 1 Improving information management: Perform computer maintenance, network database, and Update staff on record management.
- Strategy 2 Improving customer satisfaction: Train staff in customer services skills, perform mobile payment, Track and analyse customer complain, and Improve meter reading and billing work.
- Strategy 3 Expanding the customer base: Conduct Customer Survey, Update customer database, procure / install water meters for targeted connection, and Install pilot token based pre-paid meter.
- Strategy 4 Expanding current revenue base: Undertake review of water tariff, Debt management policy review and compliance, etc.
- Strategy 5 Strengthening the internal control system: Conduct risk assessment, Undertake asset valuation, etc.
- Strategy 6 Improving store management: Install store management system etc.

Table 2.98 Implementation Plan for Customer Management in SBP2020/21-2024/25

Activity		Performance Indicators/KPIs	Target	Responsible
Strategy 1: Improving information management				
D2.1	Perform computer maintenance	Computers function well	Computers well maintained	Commercial and Customer Service Department (CCSD)
D2.2	Perform network maintenance	The network operates well	Network well maintained	
D2.3	Perform database maintenance	Database function well	Database well maintained	
D2.4	Update &Maintain website	The website is dynamic and updated	Website updated	
D2.5	Provide Internet Service	Access of internet	Internet availability	
D2.6	Train staff on computer user awareness	Raised awareness on computer use	Increase awareness	
D2.7	Facilitate short course training on Database and Networking	Short course conducted	At least 2 staff	
D2.8	Update staff on record management	Record management skills increased	2 staff	
D2.9	Procure record management facilities	Record management facilities procured	Facilities in place	
D2.10	Develop the record management plan	Record management plan developed	Improved record management	
D2.11	Establish Water Historical Archives	Water historical archives established	Archives in place	CCSD/Water Development Department (WDD)
Strategy 2： Improve customer satisfaction				
D2.1	Train staff on developing competence of internal quality	Training conducted	At least 6 staff	Human Resources and Administration Department (HAD)
D2.2	Assign staff on carrying out regular internal quality audit	Staff assigned internal quality responsibilities	Quality review report	
D2.3	Conduct regular quality review	Quality review done		
D2.4	Train staff in customer service skills	Quality customer care	At least 5 staff	
D2.5	Perform mobile payment Promotion/Advertisement	Increase level of sales	At least 75% use mobile payment	Public Relation Office
D2.6	Review customer service charter	Approved customer service charter	Customer service charter	Customer Service Department (CSD)
D2.7	Track and analyze customer complain	Reduced customer complains	85% complains handled	
D2.8	Orient all staff on customer services	All staff become customer focus	At least 95%	CSD/HAD
D2.9	Submit actual meter reading	Meter reading efficiency	95%	CSD
D2.10	Generate and dispatch bills for all accounts	Billing efficiency	100%	
Strategy 3: Expanding the customer base				
D3.1	Conduct Customer Survey	Customer survey conducted Number and customers' issues documented	Customer survey report	CSD/Finance and Planning Department (FPD)
D3.2	Update customer database	Number of customers established	Customer updated	CSD
D3.3	Integrate Customer database into the electronic payment system	Customer database integrated in electronic payment system	Integration of customer database & electronic payment	
D3.4	Procure water meters	Water meters procured	Water meter in place	Procurement Management Unit (PMU)
D3.5	Install water meters for targeted	Water meter connected	118,900 connections	Technical Operation

	connection			Department (TOD)
D3.6	Monitor metered connections	Monitoring reports on metered connection	Meter status report	TOD/WDD
D3.7	Procure token based pre-paid meter	Token based pre-paid meter introduced	Pre-paid meter procured	PMU
D3.8	Install pilot token based pre-paid meter	Token based pre-paid meter introduced	At least 10% of the customers	MPU
Strategy 4: Expanding current revenue base				
D4.1	Undertake review of water tariff	Water tariff reviewed	New water tariff	FPD
D4.2	Diversify sources of revenue	Number of sources identified	New sources	FPD/CSD
D4.3	Diversify sources of revenue	Number of sources identified	New sources	CCSD
D4.4	Use of GIS to map all meters			CCSD/TOD
D4.5	Acquire of a robust billing system			CCSD
D4.6	Introduce e-billing			
D4.7	Use the existing district centers	The district center operates well	District centers operating	FPD
D4.8	Equip them with the necessary facilities	District center well equipped		
D4.9	Reviewing and complying with debt management policy	Reduced debt	30days coll. Period	
D4.10	Establish finance resource mobilization Framework	Funded accessed	A project funded	FPD/WDD
D4.11	Speed up cash receipt	Cash receipt	Daily	FPD
D4.12	Extend credit facilities with suppliers	Credit facilities extended	At least 75%	
D4.13	Forecasting collection	Increased accuracy in collection	At least 90%	
D4.14	Develop financial regulations	Financial regulation developed	Financial regulation in place	
D4.15	Train staff on accounting and financial management	Staff trained	At least 5 trained	
D4.16	Comply with accounting and financial regulations and standards	Improved financial management	At least 95%	
Strategy 5: Strengthening the internal control system				
D5.1	Auditing accounting documents, accuracy & Procedures	Audit report prepared Queries addressed	100%	Internal Audit
D5.2	Preparation of Auditing Manual	Auditing manual prepared	The manual in place	
D5.3	Short Course for IA staffs on Risk Assessment and Indicators of Fraud	IA staff competence improved	At least 4 staff trained	
D5.4	Conduct risk assessment	Risk assessment conduced	90%	
D5.5	Review risk Management Framework	Risk Management Framework reviewed	The framework in place	
D5.6	Undertake asset valuation	Asset values documented	At least 90%	
D5.7	Develop a corporate business continuity strategy	Approved corporate business continuity strategy	The plan is in place	CSD
D5.8	Implement corporate business continuity strategy	Implementation report		
Strategy 6: Improving store management				
D6.1	Procure store facilities	Store facilities in place	95% of procurement budget	PMU
D6.2	Install store management system	Store management system in place	Store management system in use	PMU/FPD
D6.3	Orient staff on store management system	Staff skills increased on store management system	At least 3 staff trained	FPD
D6.4	Obtain Insurance cover for assets	Asset classification Number of license and Insurance	100% of assets	PMU

Source: ZAWA Strategic Business Plan 2020/21-2024/25

(3) Water Meter Introduced in RIWSSZ Project

At the start of this survey, it was assumed that prepaid water meters would be introduced in the RIWSSZ project. At the kick-off meeting of the survey, ZAWA provided information that it plans to introduce smart meters instead of prepaid meters. However, as of January 2022, when the on-site investigation was started, it was confirmed that the introduction of the prepaid meter was changed again, according to the information obtained from ZAWA.

In this survey, the Survey Team collected information from the RIWSSZ project manager regarding the specifications of the meters to be introduced.

(a) Background of the introduction of prepaid meters

The specifications and quantity of water meters in the RIWSSZ construction order book are as follows.

- Specifications: Bronze single jet water meter
- Quantity: 76,000 water meters

ZAWA strongly wanted to introduce prepaid meters in RIWSSZ while changing the specifications to resin multi-jet water meter from the viewpoint of preventing theft of customer meters.

Through consultation with RIWSSZ consultants, prepaid meters require a great deal of technical and IT support for operation and maintenance. It was shared that it is difficult to meet the requirements of prepaid meters in the current Zanzibar environment. As a countermeasure, the prepaid meter manufacturer BAYLAN will provide a system for 350 pilots, free of charge. As a pilot project, 350 prepaid meters will be procured and installed.

(b) Prepaid meter specifications

According to the information from the project manager, it was announced that a prepaid meter made by BYLAN will be procured, but the specific specifications and product name are unknown. Figure 2.41 shows the prepaid meter system confirmed on the BYLAN website.

Source: BYLAN Website

Figure 2.41 Prepaid Meter System Expected to be Procured at RIWSSZ

(c) Comparison of post-paid and pre-paid system

Table 2.99 shows a comparison between the post-paid system and the pre-paid system.

Table 2.99 Comparison of Post-Payment System and Pre-Payment System and Points to Consider

Description	Post-paid system		Prepaid system	
	Description	Points to Consider	Description	Points to Consider
Water consumption management	・Necessary to manage water consumption based on meter reading	Requirement of accurate meter reading	・Possible to manage water consumption using POS.⇒ Easy to manage water consumption (sales volume)	After the introduction of prepaid meters, many cases are occurred in other countries where customers use water for free due to malfunctioned water stop valves. This is because the water stop valve may break down due to water outage due to a power outage or water mixed with sand and mud by negative pressure from the leaking point, and it may be usable even if the purchased water volume reaches 0 m^3. Meter reading is not required, but it is necessary to check the operating status of the prepaid meter on a regular basis. In addition, since there is no regular meter reading, a monitoring system for illegal connections by customers is required.
Meter reading	・Occurrence of misreading and meter reading omission ・There are many complaints about meter reading (water consumption) ⇒ Decreased customer satisfaction due to complaints	Requirement of education system for meter readers.	・No meter reading required ⇒ Reduction of meter reading cost ・No complaints about meter reading (consumption), misreading and meter reading omission ⇒Customers need to know amount of consumption (usable amount) by themselves.	
Billing	・Existence of double billing issues. ・Billing to moving customers⇒ Decrease in collection rate	Requirement of Customer ledger maintenance.	・No billing required ⇒ Reduction of billing cost ・Resolve the problem of double billing and billing to moving customers ⇒ Improving collection rate	
Water tariff collection	・Incomplete response to non-payment customers ⇒ Omission of collection	Necessary to establish a tariff collection section along with the maintenance of the customer ledger.	・Reliable tariff collection ・No need to handle cash ⇒ Avoid accidents such as cash loss ・No need for tariff collection work ⇒ Reduction of tariff collection cost ・No tariff payment counter staff required ⇒ Reduction of personnel ・Since the tariff is paid in advance, there is no omission of collection ⇒ Income increase ・Requires sales costs ⇒ Increased costs	
Revenue income	・There are many cases where tariff collection becomes difficult due to the prolonged tariff collection period ⇒ Management deterioration	Promote the conversion from flat-rate customers to metered customers	・Income can be expected to increase by pre-paid tariff collection ⇒ Management improvement	
Saving water	・Overuse of flat-rate customers ⇒ Requirement of enlightenment activities	Necessary to promote educational activities related to water saving and promote the conversion from flat-rate customers to metered customers.	・Since customers are always aware of the amount used, a water saving effect can be expected. ⇒ This creates a surplus in the amount of water supplied and makes it possible to supply to other customers.	―

Customer convenience	・Customers who do not have the smartphone required for payment need to move to the payment place (ZAWA offices). ・No need-to-know usage.	－	・Customers who do not have a smartphone for paying will have more payment locations other than the ZAWA sales office, and there will be less movement related to payment ⇒ Great advantage for customers ・It is necessary to keep track of the amount used. ⇒ Improving awareness of saving water	Requirement of construction for token sales system
Maintenance	・Periodic check (operation status, etc.) is required. ・Requires a certain amount of inventory ・Power outages and deterioration of water quality can cause meter failures.	Necessary to build a maintenance system	・Periodic check (operation status, etc.) is required. ・Requires a certain amount of inventory ・Power outages and deterioration of water quality can cause meter failures.	Necessary to build a maintenance system

Source: BYLAN Website

(4) Collecting Information Through Customer Needs Survey

(a) Overview of customer needs survey

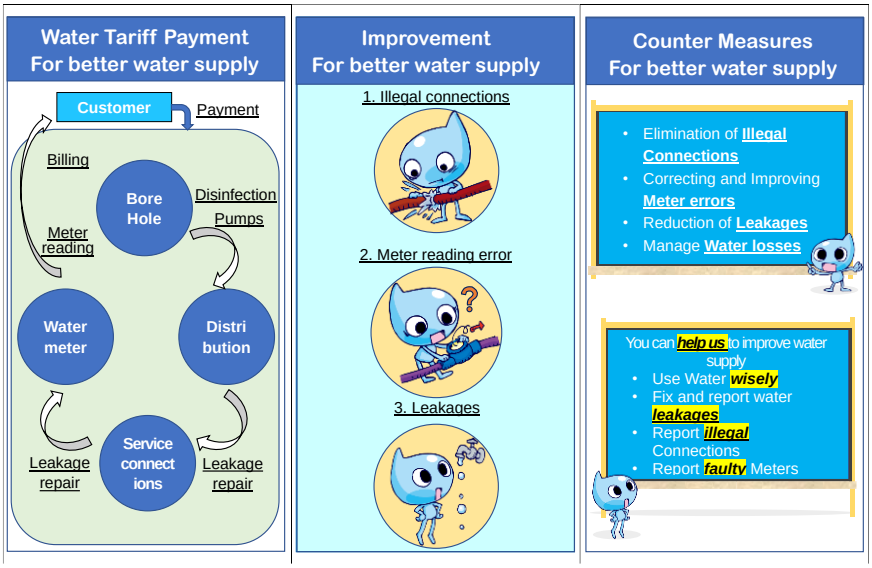
The customer needs survey was conducted with the aim of collecting information on customer management issues and contributing to planning activities for improvement. Table 2.100 outlines the customer needs survey.

The customer needs survey was conducted through interviews, by subcontracting to the site, with the assistance of ZAWA staff. The interview focused on basic customer information, water service usage status and satisfaction, and disparities among residents. The analysis was conducted from the viewpoints of (1) differences due to project implementation, (2) differences between urban areas and villages, and (3) differences between Unguja Island and Pemba Island. In the ZUWSP area where the project has been completed, the survey focused on the relationship between the satisfaction level of water services before and after the project implementation and the willingness to pay water tariff. After the interview, leaflets were distributed and explained to raise awareness about water use and payment. The leaflet was written in Swahili and included ZAWA's policies, measures for better water services and cooperation with residents, and the need to pay water tariff. Figure 2.42 shows a part of the leaflet.

Table 2.100 Outline of Customer Needs Survey for Water Services

Item		Detail	Points to Consider
Survey method		Interviews with customers	Since there is a concern that the valid response rate will decrease for distribution and collection, we will use an interview format.
Survey period		1.5 months	
Total number of surveys		500	The sample will be decided assuming the difference due to the project implementation, the difference between the urban area and the village area, and the difference between Unguja Island and Pemba Island. In particular, in the ZUWSP area, the survey will focus on the relationship between the satisfaction level of water services before and after the project implementation and the willingness to pay water tariff. In particular, in the ZUWSP area, the survey will focus on the relationship between the satisfaction level of water services before and after the project implementation and the willingness to pay water tariff. In addition, leaflets will be distributed and explained to the area as an educational activity regarding water use and tariff payment.
Breakdown: No. of surveys	Unguja Island (ZUWSP area)	100	
	Unguja Island (urban area)	100	
	Unguja Island (rural area)	100	
	Pemba Island (urban area)	100	
	Pemba Island (rural area)	100	
Contents of survey	Customer basic information		Customer number, residence place, family structure, household income, etc.
	Usage of water services		Connection status to ZAWA water supply, other water sources used, amount of water used, intended use, water supply time / frequency, water pressure, water quality, etc.
	Satisfaction with water services		Satisfaction (duration of water supply, amount of water, water pressure, water quality, fairness of beneficiaries, conviction of tariff payment, etc.), opinion on service improvement, intention to pay water tariff.

Source: JICA Survey Team



Source: JICA Survey Team

Figure 2.42 Part of the Public Awareness Leaflet

(b) Survey results

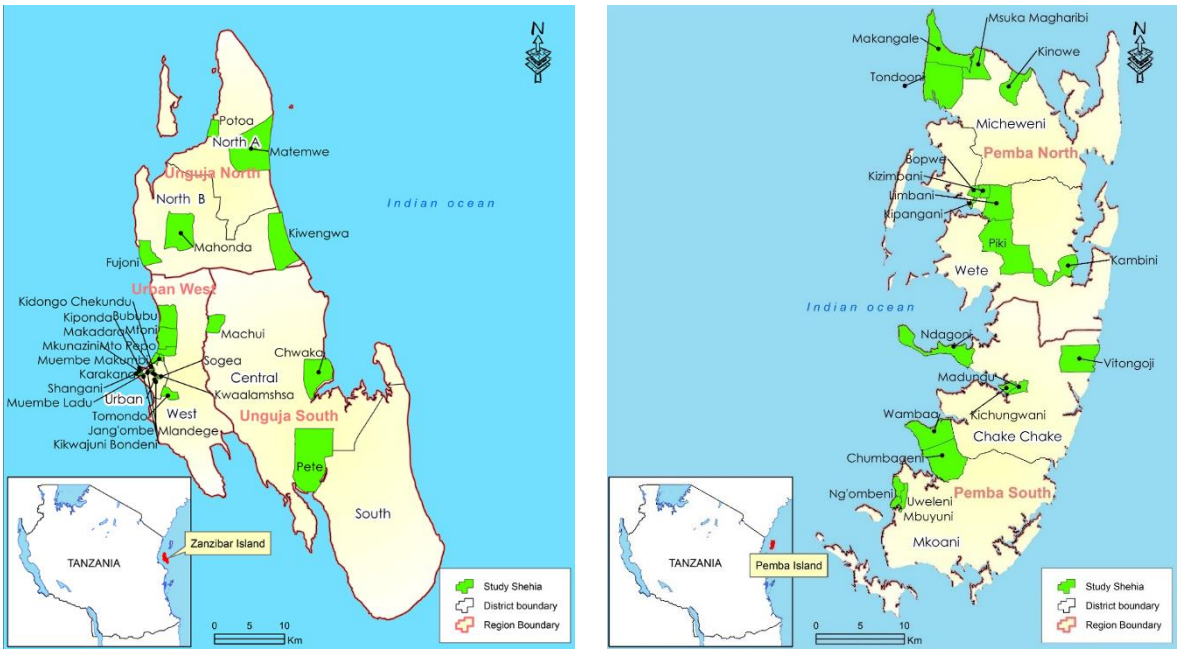
(i) Survey area

The survey targeted five water supply areas on Unguja Island and Pemba Island and selected 10 households as a survey sample for each shehia. Table 2.101 shows the survey area and district, and Figure 2.43 shows the survey district map.

Table 2.101 Survey Area and Shehia

Area	District	Shehia	No. of Samples
ZUWSP area (Unguja)	Urban	Mkunazini	10
		Mwembeladu	10
		Muembe Makumbi	10
		Shangani	10
		Mlandege	10
		Kikwajuni Bondeni	10
		Kwaalamshsa	10
		Makadara	10
		Kiponda	10
		Kwaalinato	10
Urban area (Unguja outside of ZUWSP area)	Urban	Karakana	10
		Sogea	10
		Kidongo Chekundu	10
		Jangombe	10
	West A	Mtopepo	10
		Pangawe	10
		Mtoni	10
		Bububu	10
		Kijichi	10
	West B	Tomondo	10
Rural area (Unguja)	North A	Matemwe	10
		Potoa	10
	North B	Mahonda	10
		Fujoni	10
		Kiwengwa	10
	South	Makunduchi	10
		Pete	10
		Muyuni	10
	Central	Chwaka	10
		Machui	10
Urban area (Pemba)	Chakechake	Gombani	10
		Kichungweni	10
		Madungu	10
		Uweleni	10
	Mkoani	Mbuyuni	10
		N'gombeni	10
	Wete	Kizimbani	10
		Limbani	10
		Bopwe	10
		Kipangani	10
Rural area (Pemba)	Mkoani	Wambaa	10
		Chumbageni	10
	Chakechake	Ndagoni	10
		Vitongoji	10
	Wete	Piki	10
		Kambini	10
	Micheweni	Msuka Magharibi	10
		Tondooni	10
		Makangale	10
		Kinowe	10
Total			500

Source: JICA Survey Team



(a) Unguja Island (b) Pemba Island

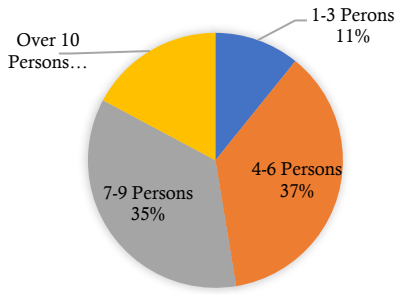
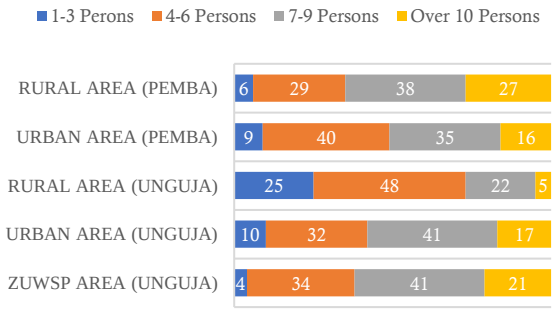
Source: JICA Survey Team

Figure 2.43 Survey Area

(ii) Basic information

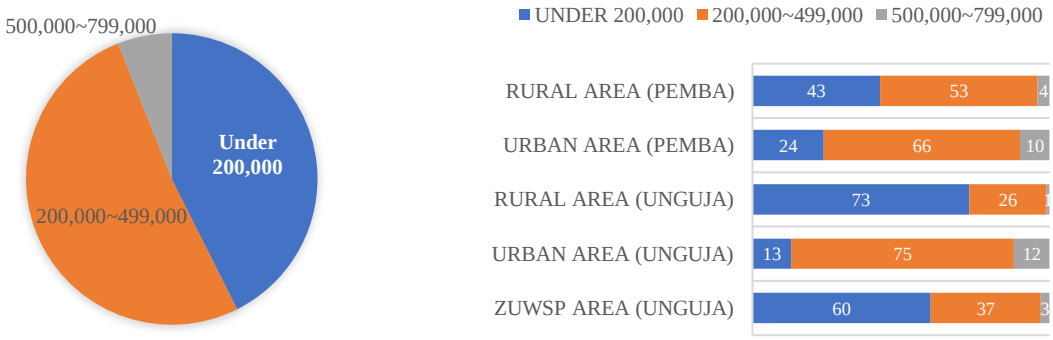
The family structure, household income responses, and points to consider are shown below.

Table 2.102 Family Structure

Family Structure
● Present situation: Regarding information of number of people within one household, 37% of customers indicated that about 4-6 persons live within a household, 35% indicated 7-9 persons, 11% indicated that they have 1-3 persons and 17% indicated over ten (10) persons. Although there are few differences between regions, the number of families in the village of Unguja is small compared to other regions.
● Graph    (a) All areas    (b) Each area
● Points to consider: Since the number of households is a material for formulating a water distribution plan, it is necessary to regularly grasp the situation (family composition) of each household in each region.

Source: JICA Survey Team

Table 2.103 Monthly Average Household Income

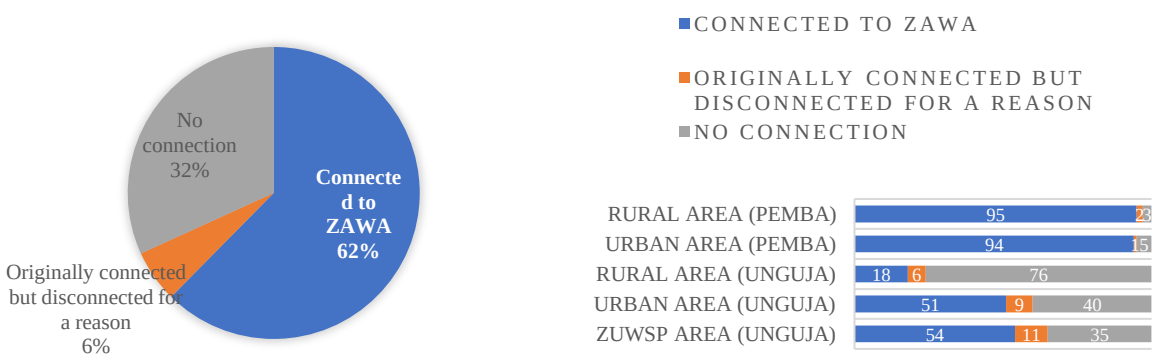
Monthly Average Household Income
● Present situation: Half of the customers (51%) earn on average in the range of 200,000-499,000 TZS (about ¥ 10,000- ¥ 25,000) per month. It is reported that 43% have a monthly income of less than 200,000 TZS (about 10,000 yen). 6% of those surveyed reported an average monthly income of 500,000 to 799,000 TZS (about 25,000 to 40,000 yen). This high-income group is generally divided into the urban areas of Pemba and Unguja.
● Graph    (a) All areas (b) Each area
● Points to consider: Household income is the basic information needed when considering pricing. As with the number of people in a household, it is necessary to keep track of them on a regular basis.

Source: JICA Survey Team

(iii) ZAWA customer

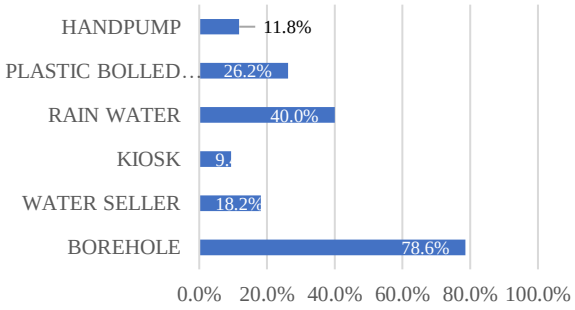
The following table includes responses and notes on connection to ZAWA, non-ZAWA water sources, water consumption per month, purpose of water use, water supply hours, water supply frequency, water shutoff frequency, water pressure, water quality, water meter installation status, water meter operation status, and other information.

Table 2.104 Connection to ZAWA

Connection to ZAWA
● Present situation: Of the households surveyed, 312 (62%) were connected to ZAWA's water services and 159 (32%) were not. 6% are disconnected. By region, 94% of households in urban areas of Pemba Island and 95% of rural areas of Pemba Island are connected to ZAWA water supply. The total number of connections on Unguja Island is about 50%, but in rural areas it is 76% unconnected.
● Graph    (a) All areas (b) Each area
● Points to consider: Considering the present situation of double registration and billing for (moved) vacant houses, it is the issue to maintain a customer ledger.

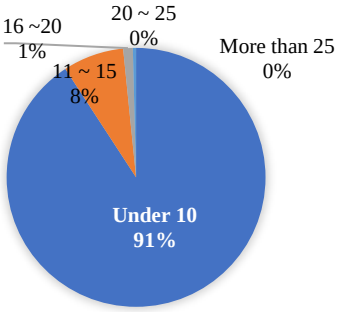
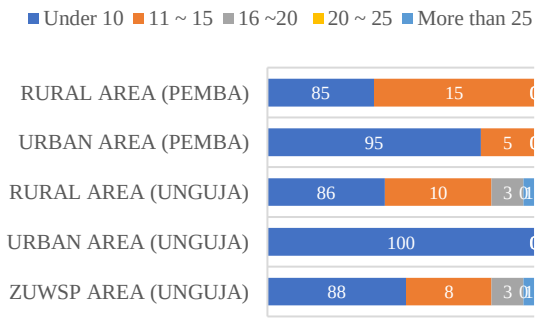
Source: JICA Survey Team

Table 2.105 Water Source Other Than ZAWA Water

Water Source Other Than ZAWA Water
● Present situation: As for water sources other than ZAWA water, the majority of households (79%) use well water, and 40% depend on rainwater. Households are also dependent on PET bottled water (26%), hand pumps (12%), water sellers (18%) and kiosks (9%). Some households have multiple water sources other than the ZAWA water supply.
● Graph 
● Points to consider：Points to consider: For private boreholes, the involvement and management of ZAWA, including water quality surveys, is an issue.

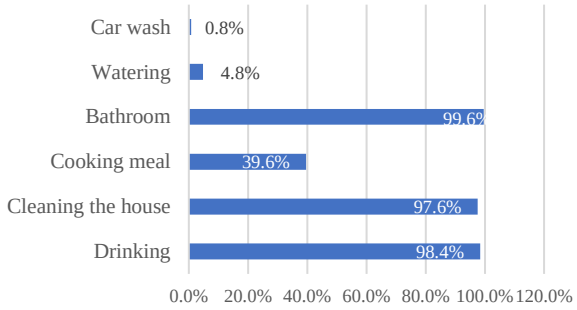
Source: JICA Survey Team

Table 2.106 Water Consumption in a Month

Water Consumption in a Month
● Present situation: Most households (91%) use less than 10 m^3 per month. 8% of households use 11 to 15 m^3 / month. The reason for the large amount of water used in the villages of each island is that water is used to irrigate crops. There is not much difference between other districts.
● Graph  (a) All areas  (b) Each area
● Points to consider: Since water is used to irrigate crops, the amount of water used in the villages of each island is large.

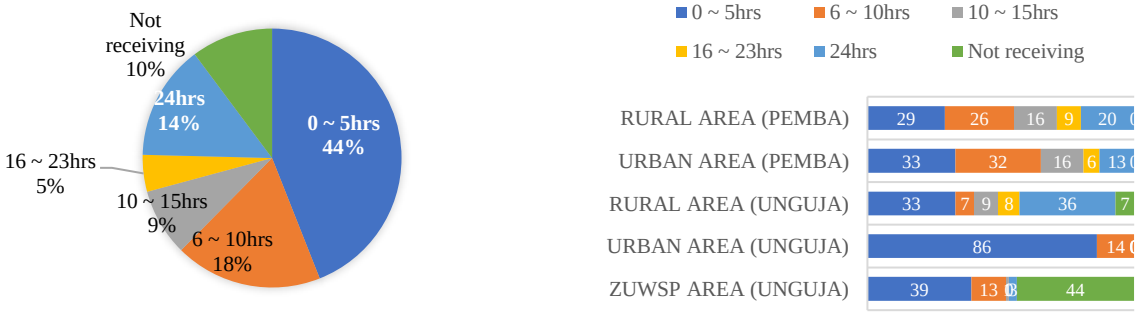
Source: JICA Survey Team

Table 2.107 Purpose of Using Water

Purpose of Using Water
● resent situation: There are few cases where water is used for purposes such as watering (4.8%) and car washing (0.8%), and the awareness of water saving is pervasive. On the other hand, there is little interest in the drainage (leak) of water due to insufficient water stoppage from faucets and toilets within government agencies (ZAWA, ZURA, etc.).
● Graph 
● Points to consider: ZAWA shares the actual situation with related organizations and recommends inspection of water around public facilities. Along with activities to stop unnecessary water from flowing down, water-saving campaigns around water (posters, etc.) are effective.

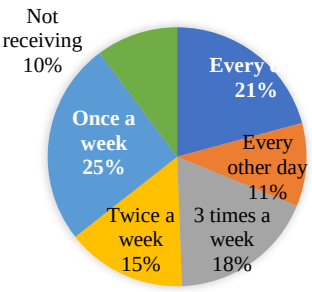
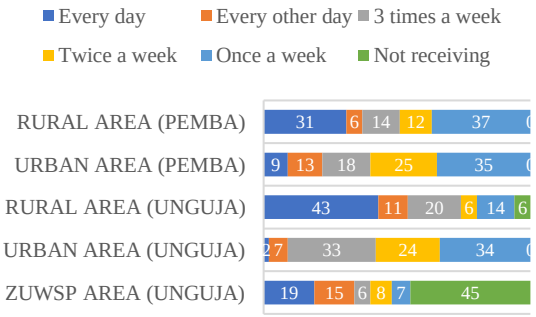
Source: JICA Survey Team

Table 2.108 Water Supply Hours in a Day

Water Supply Hours in a Day
● Present situation: In the entire survey area, 44% of households receive 0-5 hours of water in a day and 18% receive 6-10 hours of water in a day. 14% of households are supplied water 24 hours a day, benefiting rural residents of Unguja and Pemba. 10% of households surveyed say they have not received any water within a day. Residents' households in the Unguja ZUWSP area (44%) and villages (7%) answered that there was no water supply.
● Graph  (a) All areas (b) Each area
● Points to consider：Points to consider: As a result of the survey, 71% of households are not satisfied with the water supply time from ZAWA (dissatisfaction: 30%, very dissatisfied: 41%). Residents of Pemba Island are considerably more dissatisfied with water supply times than residents of Unguja Island. Water supply time has a great influence on customer satisfaction. Improving customer satisfaction by improving water services is an item that greatly contributes to improving water tariff collection. In addition, it is necessary to actively promote efforts to improve water services through public relations to customers.

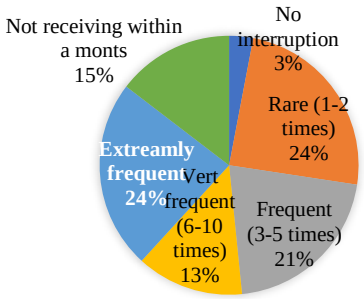
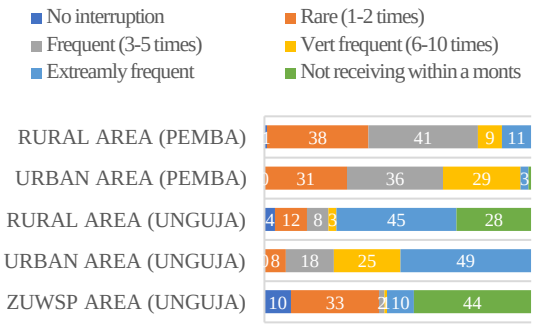
Source: JICA Survey Team

Table 2.109 Water Supply Frequency

Water Supply Frequency
● Present situation: 21% of households benefit from water services, which are supplied water daily. On the other hand, 25% of households have a weekly water supply service. 10% of households do not receive any water. In the ZUWSP district, the percentage of households receiving water more than three times a week is higher than in other districts.
● Graph    (a) All areas    (b) Each area
● Points to consider: In the ZUWSP area, the percentage of households receiving water more than three times a week is higher than in other areas (about 40%), and the project effect can be seen.

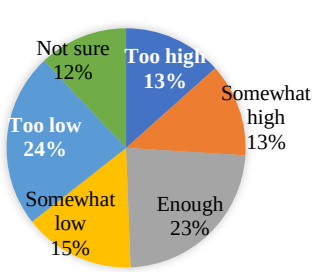
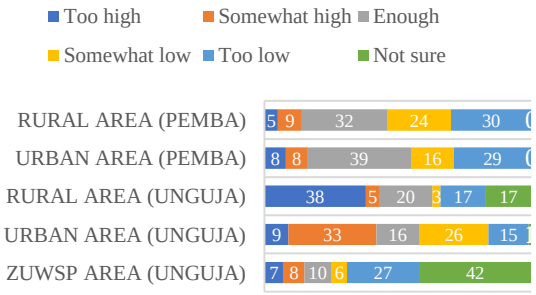
Source: JICA Survey Team

Table 2.110 Frequency of Monthly Water Interruption

Frequency of Monthly Water Interruption
● Present situation: 24% of households answered that the frequency of water outages is once or twice each month. 3% of households reported no water outage within a month. When combined with customers who have 6-10 water outages (13%), frequent water outages (24%), and no water (15%), half of the customers have an unsatisfied water supply. In the ZUWSP area, when combined with no water outages (10%) and rarely (33%), 43% have almost no water outages. In the urban area of Unguja, 74% of respondents say that water outages occur frequently.
● Graph    (a) All areas    (b) Each area
● Points to consider: In the ZUWSP area, when combined with no water outages (10%) and rarely (33%), 43% answered that there was almost no water outage. Project effect can be seen.

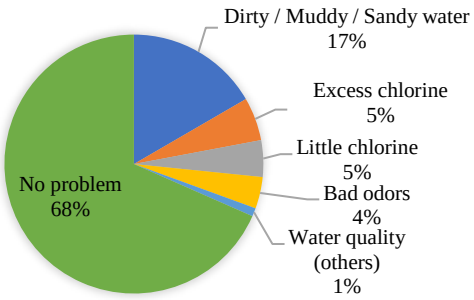
Source: JICA Survey Team

Table 2.111 Water Pressure

Water Pressure
● Present situation: Twenty-three percent of the surveyed households answered they have enough. About half of the households who answered that they were a little low or high were not dissatisfied with the water pressure. 13% of households said the water pressure was too high, and 24% said it was too low. Those who answered that they do not know about water pressure (60 people: 12%) are close to the number of customers who do not receive water supply service (73 people: 15%). Water pressure management on Pemba Island is better than on Unguja Island. In the urban area of Unguja Island, the number of customers who answered that it is too high (38%) is considerably higher than in other areas, and water pressure management is one of the issues.
● Graph    (a) All areas    (b) Each area
● Points to consider: Water pressure has the most important effect on the satisfaction of water supply services. As for the results of satisfaction with water pressure, 33% of the surveyed households were satisfied (5% were very satisfied, 28% were satisfied), 25% were dissatisfied, and 27% were very dissatisfied. 6% said they were neither. Respondents in the urban area of Unguja are less satisfied with water pressure than in other areas. It is necessary to investigate the water pressure in each area, and after the water pressure distribution map is created, it is necessary to take measures to improve the water pressure. Improving water pressure management improves service and is a major factor in improving customer satisfaction.

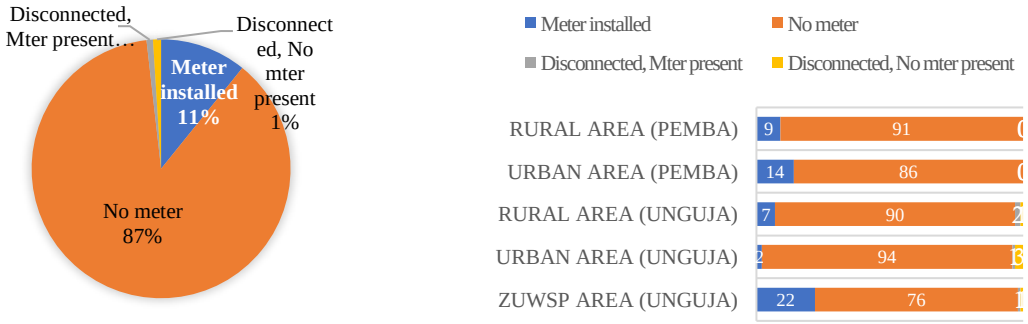
Source: JICA Survey Team

Table 2.112 Water Quality

Water Quality
● Present situation: 68% of respondents said there was no problem with water quality. Others said that water quality was impaired by mud / sand mixed water (17%), excess chlorine (5%), inadequate chlorine (5%), and stinks (4%).
● Graph 
● Points to consider: Regarding to water quality, 56.2% of customers were satisfied (10.8% were very satisfied, 45.4% were satisfied), 3.2% were normal, and 14.4% and 15.46% were dissatisfied and very dissatisfied, respectively. The dissatisfaction rate in the villages of Unguja Island is higher than in other areas, and the satisfaction level in urban areas is higher than in other areas. The water quality, which is a mixture of mud and sand, is caused by insufficient cleaning after pipe construction. There is also the possibility of contamination from the leaking point. Residual chlorine in the area around the ZAWA headquarters is a little higher than the Japanese standard, so some customers say it is excessive and some customers say it is too low. It is necessary to create a concentration map of residual chlorine and manage chlorine properly.

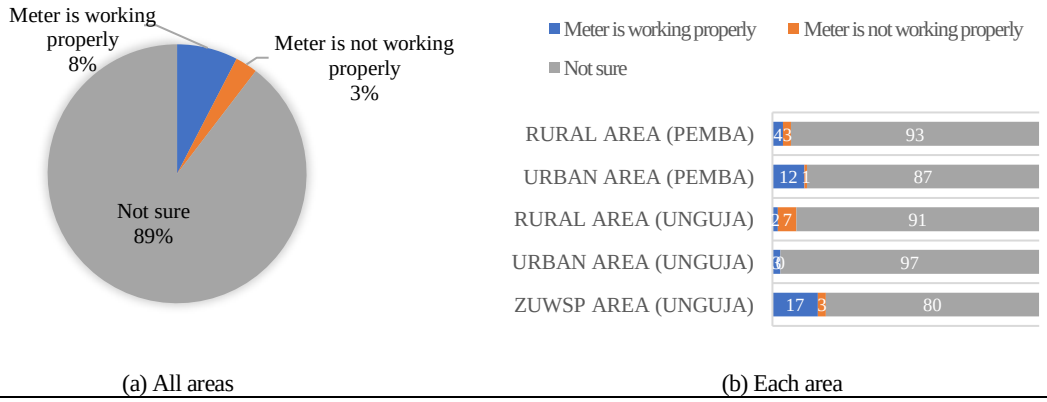
Source: JICA Survey Team

Table 2.113 Customer Meter Installation Situation

Customer Meter Installation Situation
● Present situation: Regarding the installation status of customer meters, 87% of survey households answered that they did not install meters regardless of the survey area. The meter installation rate in the ZUWSP project area on Unguja Island is high compared to other areas (22%).
● Graph    (a) All areas (b) Each area
● Points to consider：In order to increase toll revenue, it is important to further promote the conversion from flat-rate customers to metered customers. It should be noted that there have been many reports of movements to return the meter to the flat rate system as it was stolen because the charges to be paid after the meter was installed (compared to the flat rate system) soared. In consideration of meter theft, it is necessary to build a relationship of trust with customers, such as holding a meeting of residents.

Source: JICA Survey Team

Table 2.114 Meter Condition

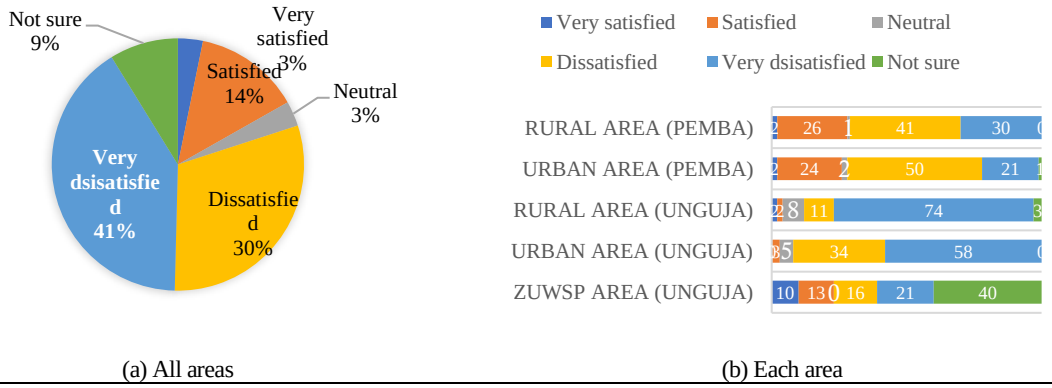
Meter Condition
● Present situation: Of the subjects surveyed, only 38 (8%) were functioning normally and 14 (3%) were not functioning normally. Most of the customers who say they don't know have no meters installed.
● Graph    (a) All areas (b) Each area
● The test bench to measure the accuracy of the meter is installed in the headquarters, but it is not in operation. In the current situation where meter installation is being promoted, it is necessary to reconstruct the system for measuring meter accuracy by performing sufficient maintenance.

Source: JICA Survey Team

(iv) Satisfaction with Water Services

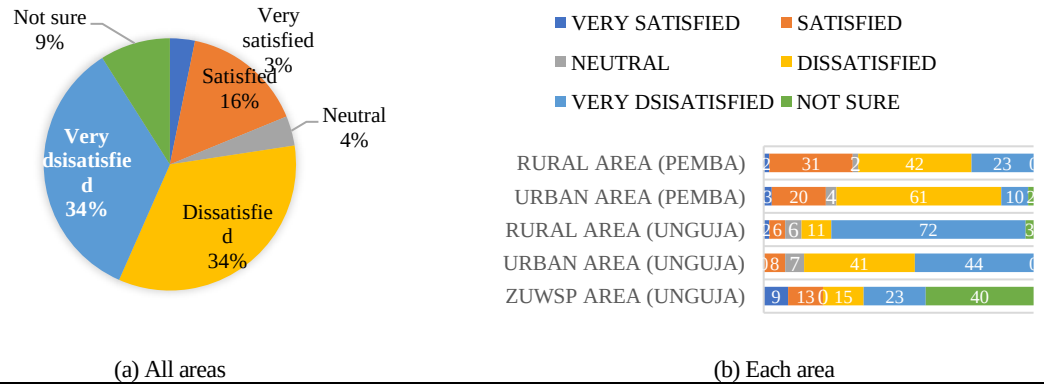
Water supply time, water supply volume, water pressure, water quality, attitude of meter readers, attitude of plumbers, attitude of payment counter staff, response to requests and complaints, answers regarding beneficiary fairness and satisfaction with water charges, and points to consider are shown as below.

Table 2.115 Levels of Satisfaction with Water Supply Time from ZAWA

Satisfaction with Water Supply Time
● Present situation: In the entire survey area, 44% of households receive 0-5 hours of water per day and 18% receive 6-10 hours of water per day. 14% of households receive water full-time (24 hours) a day, benefiting rural residents of Unguja and Pemba. 10% of households surveyed said they had no water supply. Residents' households in the ZUWSP area of Unguja Island (44%) and villages (7%) answered that there was no water supply.
● Graph    (a) All areas (b) Each area
● As a result of the survey, 71% of households are not satisfied with the water supply time from ZAWA (dissatisfaction: 30%, very dissatisfied: 41%). Residents of Pemba Island are considerably more dissatisfied with water supply times than residents of Unguja Island.Water supply time has a great influence on customer satisfaction. Improving customer satisfaction by improving water services is an item that greatly contributes to improving water tariff collection. In addition, it is necessary to actively promote efforts to improve water services through public relations to customers.

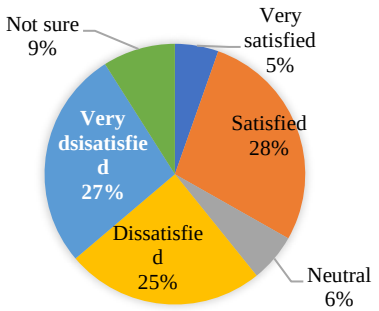
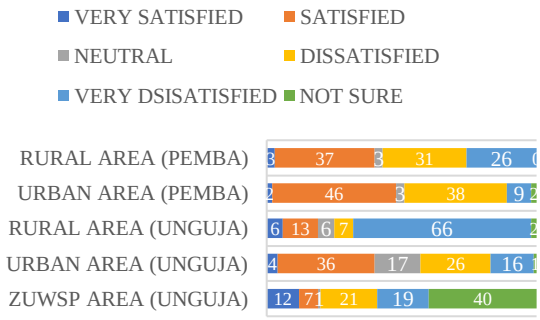
Source: JICA Survey Team

Table 2.116 Levels of Satisfaction with Water Quantity

Satisfaction with Water Quantity
● Present situation: Twenty-one percent of the surveyed households benefit from water services, which are supplied water daily. On the other hand, 25% of households have a weekly water supply service. 10% of households do not receive any water. In the ZUWSP area, the percentage of households receiving water more than three times a week is higher than in other areas (about 40%), and the project effect can be seen.
● Graph    (a) All areas (b) Each area
● Points to consider：68% of customers (dissatisfied: 34%, very dissatisfied: 34%) said they were not satisfied with the water supply of ZAWA. 19% were satisfied (very satisfied: only 3%, satisfied: 16%). Pemba Island and the ZUWSP area are relatively more satisfied than the urban and rural areas of Unguja Island.
● Future surveys will also require a survey of satisfaction with water supply to customers with and without underground tanks. In addition, the frequency of water supply and the frequency of water outages are indispensable items for improving satisfaction, and the effect of improving water services is desired.

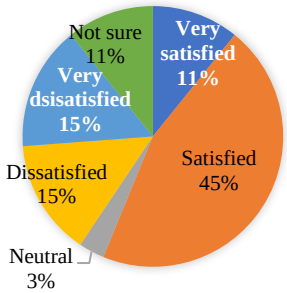
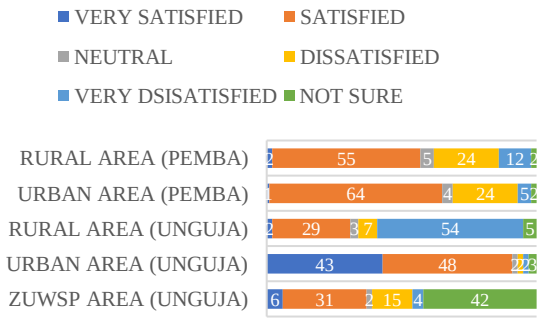
Source: JICA Survey Team

Table 2.117 Levels of Satisfaction with Water Pressure

Satisfaction with Water Pressure
● Present situation: Water pressure has the most important effect on the satisfaction of water supply services. As for the results of satisfaction with water pressure, 33% of the surveyed households were satisfied (5% were very satisfied, 28% were satisfied), 25% were dissatisfied, and 27% were very dissatisfied. 6% said they were neither. Respondents in the urban area of Unguja are less satisfied with water pressure than in other areas.
● Graph    (a) areas    (b) Each area
● Water pressure has the most important effect on the satisfaction of water supply services. As for the results of satisfaction with water pressure, 33% of all households in the survey were satisfied (5% were very satisfied, 28% were satisfied), 25% were dissatisfied, and 27% were very dissatisfied. 6% said they were neither. Respondents in the urban area of Unguja are less satisfied with water pressure than in other areas. ● It is necessary to investigate the water pressure in each area, and after the water pressure distribution map is created, it is necessary to take measures to improve the water pressure. Improving water pressure management improves service and is a major factor in improving customer satisfaction.

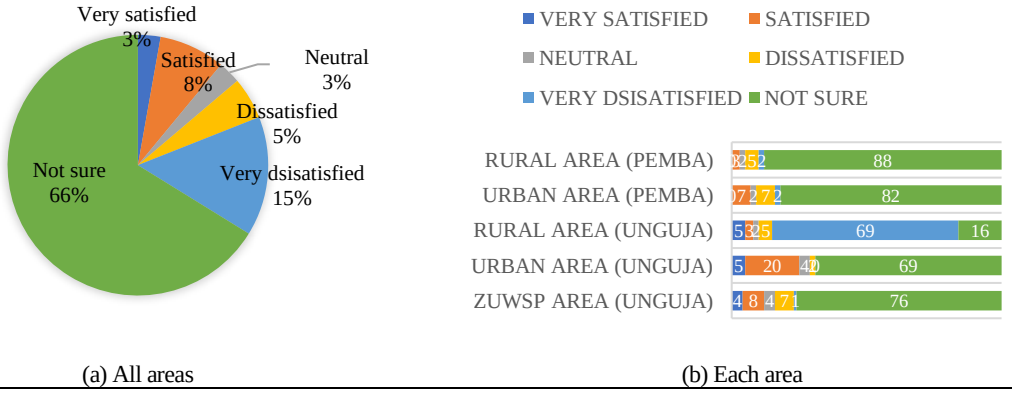
Source: JICA Survey Team

Table 2.118 Levels of Satisfaction with Water Quality

Satisfaction with Water Quality
● Present situation: According to water quality data, 56.2% of customers were satisfied (10.8% were very satisfied, 45.4% were satisfied), 3.2% were normal, and 14.4% and 15.46% were dissatisfied and very dissatisfied, respectively. The dissatisfaction rate in the villages of Unguja Island is higher than in other areas, and the satisfaction level in urban areas is higher than in other areas.
● Graph    (a) All areas    (b) Each area
● According to water quality data, 56.2% of customers were satisfied (10.8% were very satisfied, 45.4% were satisfied), 3.2% were normal, and 14.4% and 15.46% were dissatisfied and very dissatisfied, respectively. The dissatisfaction rate in the villages of Unguja Island is higher than in other areas, and the satisfaction level in urban areas is higher than in other areas. ● The water quality, which is a mixture of mud and sand, is caused by insufficient cleaning after pipe construction. There is also the possibility of contamination from the leaking point. Residual chlorine in the area around the ZAWA headquarters is a little higher than the Japanese standard, so some customers say it is excessive and some customers say it is too low. It is necessary to create a concentration map of residual chlorine and manage chlorine properly.

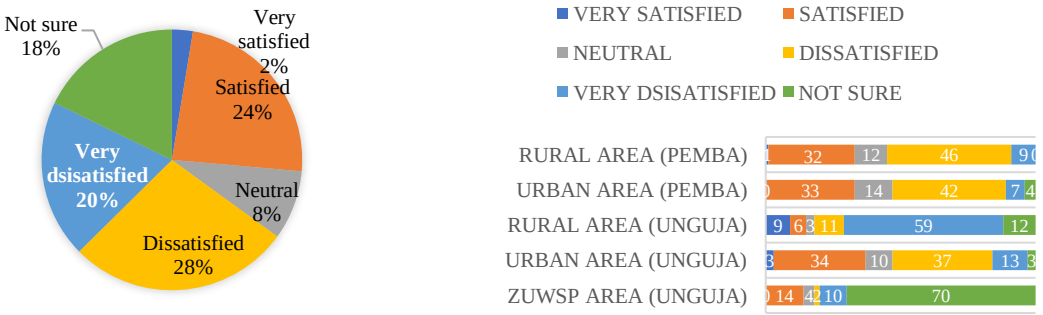
Source: JICA Survey Team

Table 2.119 Levels of Satisfaction with Staff Attitude - Meter Reader

Satisfaction with Staff Attitude - Meter Reader
● Present situation: The evaluation of the attitude of the meter readers was unknown because 66% of households did not have a meter. 15% of the respondents were very dissatisfied, 5% were dissatisfied, and neutral 3%. 11% (satisfied: 8%, very satisfied: 3%) answered that they were satisfied with the attitude of the meter reader. Although there is almost no difference between regions, 74% (dissatisfied: 69%, very dissatisfied: 5%) expressed dissatisfaction in the villages of Unguja Island.
● Graph    (a) All areas (b) Each area
● Points to consider: The number of meters installed in the village of Unguja Island is as small as 7, and it is presumed that the plumbers play the role of meter reading. Many respondents do not understand because there are many responses from customers who do not have meters installed. The total number of meter readers in ZAWA is 12, and plumbers perform meter reading work in areas where meter readers are not stationed. Since the number of customer meters to be installed will increase dramatically in the future, it is an urgent task to establish a meter reading system.

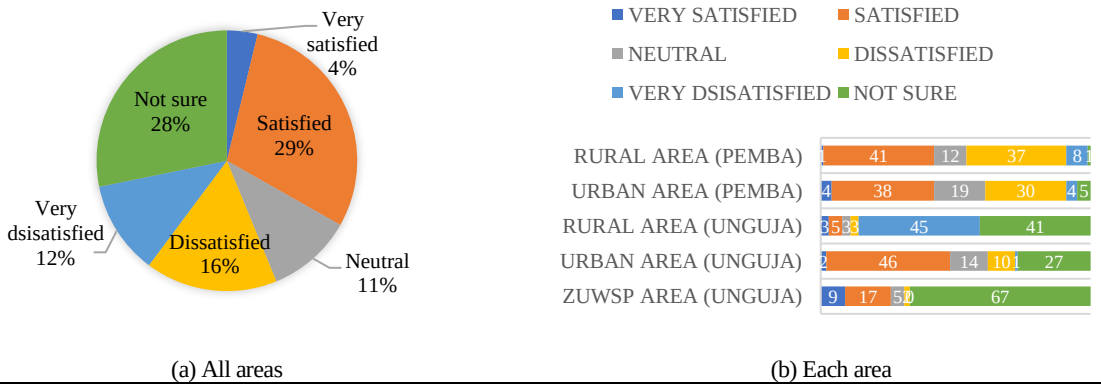
Source: JICA Survey Team

Table 2.120 Levels of Satisfaction with Staff Involved in Pipe Construction and Repair

Satisfaction with Staff Involved in Pipe Construction and Repair
● Present situation: Regarding the staff involved in pipe laying and repair, 26% answered that they were satisfied (2% were very satisfied, 24% were satisfied). Neutral was 8%. 48% of respondents are dissatisfied (dissatisfied: 28%, very dissatisfied: 20%). Residents of the urban areas of Unguja and Pemba Island were more satisfied with the staff involved in pipe laying and repair than the residents of other areas.
● Graph    (a) All areas (b) Each area
● Since meter readers and plumbers have the opportunity to interact with customers, it is necessary to educate them on customer service attitudes (greetings, responding to questions, etc.). Good customer service is one of the factors that improve satisfaction.

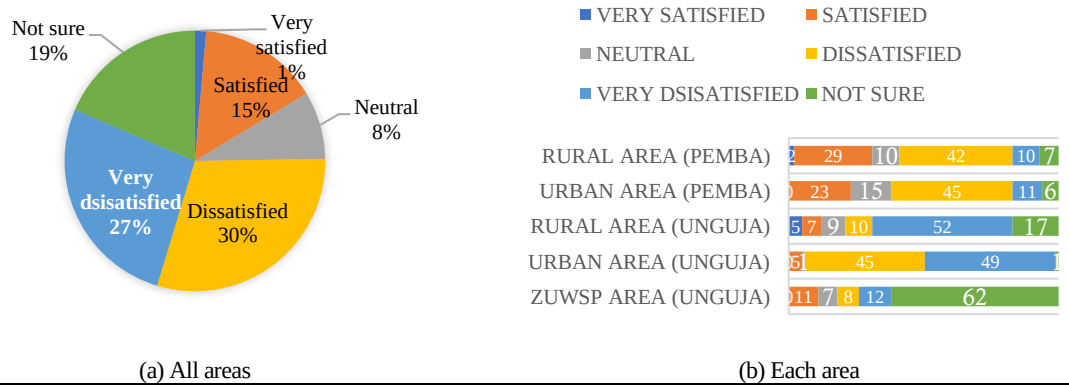
Source: JICA Survey Team

Table 2.121 Levels of Satisfaction with Payment Counter Staff

Satisfaction with Payment Counter Staff
● Present situation: 33% of the respondents were satisfied with the attitude of the staff at the payment counter (4% were very satisfied, 29% were satisfied). Usually 10%, 28% complained, 16% were very dissatisfied and 12% were dissatisfied. 28% answered that they did not understand. Respondents across Pemba Island and in urban areas of Unguja said they were more satisfied with the attitude of payment counter staff than respondents in other regions. On the other hand, nearly half of the responses from the villages of Pemba Island and Unguja Island have expressed dissatisfaction.
● Graph    (a) All areas (b) Each area
● Points to consider: For areas with low satisfaction, it is necessary to understand the customer service status of the counter staff. If necessary, education on customer service is required. It is also necessary to consider creating a customer service attitude manual including FAQ.

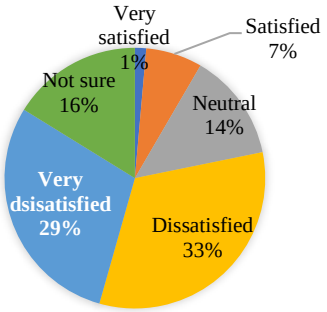
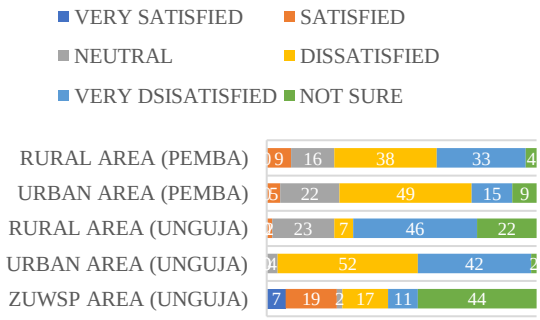
Source: JICA Survey Team

Table 2.122 Levels of Satisfaction with Time to Respond to the Request, Such as Leakage Repair and Payment

Satisfaction with Time to Respond to the Request, such as Leakage Repair and Payment
● Present situation: Satisfaction was 16% (1% was very satisfied, 15% was satisfied) and Neutral was 8% when responding to requests and complaints regarding leak repairs and water tariff. 57% of respondents (30% dissatisfied, 27% very dissatisfied) are dissatisfied. Respondents on Pemba Island were more satisfied than on Unguja Island. Many customers in the ZUWSP area said they were not sure compared to other areas.
● Graph    (a) All areas (b) Each area
● Points to consider: 57% of customers are dissatisfied with ZAWA's response to the request. By region, ZUWSP is 20%, Unguja urban area is 94%, Unguja rural area is 62%, Pemba urban area is 56%, and Pemb rural area is 52%. Unguja Urban areas need immediate action. It is desirable to establish a call center as a quick response to the request and have a specialized department respond to the request / requirement. It is necessary to improve the customer database in response to requests for improvement of fee operations (meter reading, billing). For that purpose, customers should consider visiting all the houses. With regard to meter reading, accurate meter reading information can be obtained by taking a picture at the time of meter reading and constructing a mechanism for sharing the information. It is possible to contribute to profit improvement by billing and collecting based on accurate meter reading.

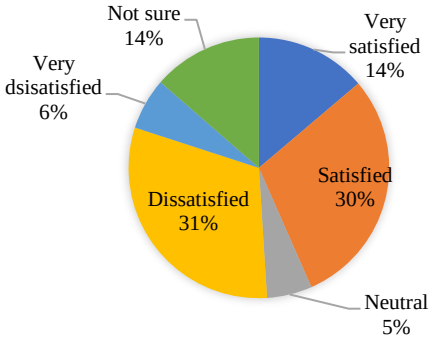
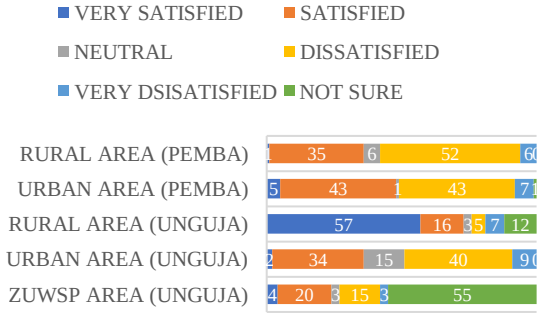
Source: JICA Survey Team

Table 2.123 Levels of Satisfaction with Fairness of Beneficiary

Satisfaction with Fairness of Beneficiary
● Present situation: In terms of beneficiary equity, 8% said they were satisfied (1% very satisfied, 7% satisfied), neutral was 13.4%, dissatisfied 32.6%, and very dissatisfied 29.4%. Although satisfaction was low in both areas, there was a difference in satisfaction between customers on Unguja Island and Pemba Island. Respondents in the ZUWSP region were more satisfied with the fairness of the beneficiaries than in the other survey areas (very satisfied: 7%, satisfied: 19%).
● Graph    (a) All areas    (b) Each area
● Points to consider: About 62% of customers who are dissatisfied need awarenesss and public relations activities regarding ZAWA's water services.

Source: JICA Survey Team

Table 2.124 Levels of Satisfaction with Water Tariff

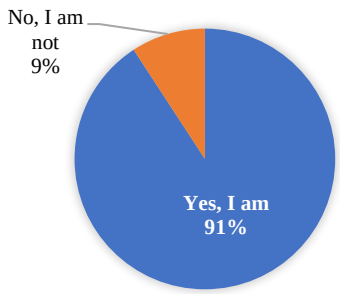
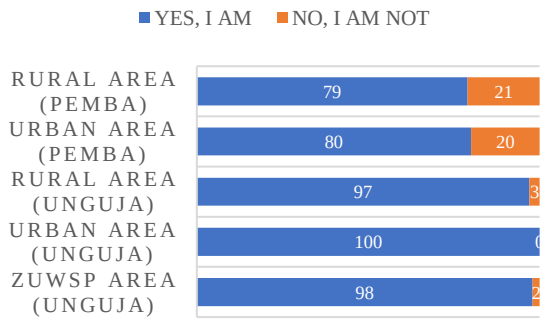
Satisfaction with Water Tariff
● Present situation: As for the satisfaction level of water tariff, 44% answered that they were satisfied (14% were very satisfied, 30% were satisfied), neutral 5%, dissatisfied 31%, and 6% of customers were very dissatisfied. .
● Graph    (a) All areas    (b) Each area
● Points to consider: In the present situation where ZAWA has been promoting the conversion from flat-rate customers to metered customers, public relations activities for users are extremely important. It is necessary to carry out activities to gain the understanding of metered customers (the charges are higher than the flat-rate system).

Source: JICA Survey Team

(v) Willingness to pay water tariff

The answers regarding the willingness to pay water tariff and points to consider are shown below.

Table 2.125 Willingness to Pay Water Tariff

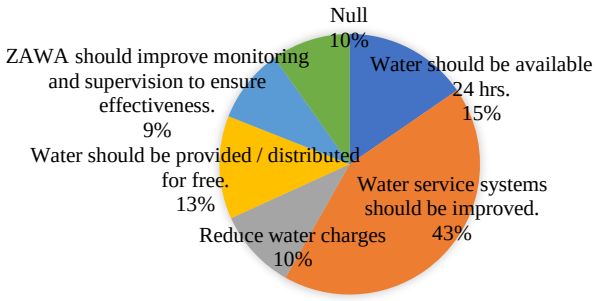
Willingness to Pay Water Tariff
● Present situation: Customers' willingness to pay water tariff is based on their satisfaction with the services provided. Satisfaction is driven by the services provided and is also associated with staff attitudes. The survey found that 91% of respondents were willing to pay for supplied water and some customers (9%) were not willing to payt. There are few regional differences in willingness to pay. However, in the urban area of Unguja Island, 100% of customers answered that they are willing to pay. Customers are suggesting that they will pay if water services, especially 24-hour water availability and improved water pressure, are significantly improved. About 20% of residents on Pemba Island are less willing to pay.
● Graph    (a) All areas    (b) Each area
● Points to consider: Due to past policies, there are many customers who continue to be aware that water is free, which has led to a decline in the collection rate. It is necessary to educate and publicize the residents of Pemba Island to understand the water supply system and the necessity of payment.

Source: JICA Survey Team

(vi) Request on improving water service

The customer's request and points to consider are shown below.

Table 2.126 Customer's Request

Customer's Request
● Present situation: Requests for improved water services (including 24-hour water supply) are high at 58%.
● Graph 
● Points to consider: The study recommends that ZAWA should focus on continuous water supply, increased water pressure, and extended water supply time to improve overall customer satisfaction. In the case of water services, satisfaction is determined by the actual service and is also related to the attitude of the staff involved. ZAWA needs to understand the needs of customers for water services and provide water services with high customer satisfaction that reflect those needs. we also hope that by providing good water services, ZAWA will improve customer satisfaction, contribute to the improvement of tariff profits, and create a virtuous cycle leading to the stabilization of water management.

Source: JICA Survey Team

2.3 Status of Other Donors' Assistance to the Water Sector

2.3.1 Outline of the Survey

Interviews were conducted with other donors regarding the status of their assistance to the water sector. The survey was conducted by sending a survey form via e-mail and obtaining responses from AfDB and KfW, both of which have offices in Dar es Salaam. At this point of time, only the African Development Bank has responded.

The survey items on the questionnaire are listed below.

1. Overview of past and ongoing projects for the water sector in Zanzibar
   - Outline of past and ongoing projects
   - Problems experienced in project implementation
2. Planned projects for the water sector in Zanzibar
   - Areas for improvement in the water sector in Zanzibar
   - Planned project implementation for the water sector in Zanzibar
   - Type of planned project
   - Areas where planned projects are relevant

2.3.2 Result of the Survey

(1) AfDB

(a) Past and ongoing projects

One response was received from AfDB for one project. Table 2.127 shows a summary of that project.

Table 2.127 Outline of the Past Project

Item	Details
Project Name	Zanzibar Urban Water Supply and Sanitation Project （ZUWSP）
Project Period	2013 – 2018
Project Purpose	The project aims to improve sanitation and living standards for the approximately 500,000 citizens of Unguja, which represents 40% of Zanzibar's total population. The project aims to improve access to water supply through the project to maintain other services and socioeconomic activities and benefit from sanitation facilities.
Project Outline	(1) Maintenance of Water Facilities a）Consulting services for detailed design and construction supervision of construction work b）Rehabilitation of existing boreholes. c）Drilling of new boreholes and installation of pumping facilities d）Expansion and rehabilitation of water transmission pipelines and distribution networks e）Supply and installation of flowmeters for DMA flow monitoring f）Supply of water meters g）Electric power facilities, chlorination facilities, operation and maintenance (O&M) facilities, etc.
	(2) Sanitation Promotion and Facility Development a）Consulting services for design and construction supervision b）Construction of Water Sanitation and Hygiene (WASH) in gender-sensitive schools, and sanitation and hygiene promotion and training in schools and communities

	(3) Organizational Management Support a) Project management support/technical assistance, training, cost performance audits b) Strengthen ZAWA's sales, operational capacity, environmental and social management c) Review of water policy and gender sensitivity of ZAWA staff.
Problems in project implementation	(1) Poor performance of contractors ・The first contractor was terminated due to deteriorating business conditions. (2) Weak contract management ・Confusion due to different instructions from consultant and client (3) Weak NRW management ・Water meters procured for the project were not installed by the client at the appropriate time. (4) Quality of fine aggregate ・Due to the non-compliance of the quality of fine aggregate from Zanzibar used in the construction of the water distribution reservoir, it was imported from the mainland. (5) Sustainability ・The fixed fee system, which is not related to consumption, makes it impossible to cover operation/maintenance costs with fee revenue. ・Recovery of operation and maintenance costs through fee revenue is essential to maintaining the system, and will adversely affect the expansion of water supply to currently underserved populations.

Source: JICA Survey Team

(b) Projects to be implemented

At this point of time, there are no plans for projects that have been determined to be implemented, but the government of Zanzibar has indicated that it would be open to implement such projects if requested. The support needed for the water sector in Zanzibar, as considered by AfDB, is shown in Table 2.128.

Water resource management and matters related to water meter installation and rate revenues are considered a need in AfDB as well. At this point in time, a department has been established in the Ministry of Water to handle water-related matters.

Table 2.128 Assistance Considered Necessary

Item	Details
Assistance Considered Necessary	・Establishment of an organization for basin water resources management that will be responsible for water resources management and identification of available water resources. ・Establishment of a dedicated department in charge of NRW ・Revise the rate structure to cover operation/maintenance costs with water supply revenues and install water meters for all customers. ・Establishment of a department for sewerage and conversion of ZAWA into a water and sewerage public corporation. ・Establishment of a department in the Ministry of Water to handle water-related matters
Anticipated Support Projects	・Facility development and human resource development ・Improvement of sewage and reduction of NRW
Anticipated Related Areas of Support	・Organizational management and Human resource development ・Groundwater management ・Customer management ・Sewerage

Source: JICA Survey Team

(2) KfW

(a) Past and ongoing projects

The project related to sewer pipe maintenance in Stone Town was implemented from 2006 to 2010. The survey did not provide any information on problems encountered during the implementation of this project.

(b) Projects to be implemented

Regarding their thoughts on areas needing improvement in Zanzibar's water sector, four areas were mentioned: water administration and legislation, groundwater management, customer management (billing and collection), and sewage (sanitation).

With regard to plans for future project implementation, the responses were social infrastructure for water supply and sewage, and integrated water resources management. On February 3rd, 2022, an Expression of Interest (EOI) for consulting services for a feasibility study covering water supply, water resources management, and sanitation was published, and the procurement process for the consultant was initiated.

The following is a summary of the work described in the EOI and the publicly available documents.

- Drinking water supply: Review and update of the water supply demands; Review of network documentation; Setting up hydraulic network models; Hydraulic analysis; Network optimisation, appropriate zoning; Analysis of energy costs; Estimation of CO_2 and energy cost reduction potential; Review rehabilitation demand and optimisation potential; Design of investment programme, cost estimations
- Wastewater disposal: Review of design report for interceptor and suggested SBR (sequential batch reactor) type of sewage treatment plant in Stone Town, Zanzibar; Suggestion for modifications; Cost update
- Groundwater resources assessment: Analysis of existing information and previous studies for Unguja and Pemba; Snap shot study groundwater table; Analysis of groundwater quality; Analysis of long term effects on groundwater table; Analysis of need and requirements for groundwater modelling, particularly with regard to salt water intrusion in the predominant coastal aquifers; Assessment of vulnerability of groundwater sources and catchment areas to pollutions, propose suitable protective measures; Recommendations for additional ground water monitoring wells; Scoping of groundwater model, Cost estimations
- Non-technical feasibility analysis: Financial analysis, cost and income structure; Target group analysis; Analysis of institutional and financial viability; Assessment of environmental, social, and climate performance; Peace and conflict assessment; Implementation modalities and concept

Revolutionary Government of Zanzibar

Zanzibar Water Authority

Call for the expression of interest, prequalification of interested consulting firms

Partner country:	Tanzania
Project executing agency:	Zanzibar Water Authority; represented by KFW Palmengartenstraße 5-9 60325 Frankfurt Germany
Project:	Zanzibar Water Security Project
Services to be procured:	Consulting services for the preparation of a feasibility study in the field of water supply, water resources management and sanitation services
KFW procurement number:	BMZ 595001300 / KFW 507230
Electronic tender:	Electronic submission of documents. The Tender Process is subject to KfW's „Guidelines for the Procurement of Consulting Services, Works, Plant, Goods and Non-Consulting Services in Financial Cooperation with Partner Countries", see https://www.kfw-entwicklungsbank.de/International-financing/KfW-DevelopmentBank/Publications-Videos/Publication-series/Guidelines-and-contracts/
Submission deadline:	07.03.2022
Language of the tender:	English
Expected start of services:	September 2022
Address where the complete tender documents and further information can be obtained:	Complete tender documents and information about electronic submission of documents can be obtained from the tender agent Mr Harald Heidtmann (Email: znz.tender@posteo.de)

Brief description of expected services:

Drinking water supply: Review and update of the water supply demands; Review of network documentation; Setting up hydraulic network models; Hydraulic analysis; Network optimisation, appropriate zoning; Analysis of energy costs; Estimation of CO2 and energy cost reduction potential; Review rehabilitation demand and optimisation potential; Design of investment programme, cost estimations

Wastewater disposal: Review of design report for interceptor and suggested SBR (sequential batch reactor) type of sewage treatment plant in Stone Town, Zanzibar; Suggestion for modifications; Cost update

Groundwater resources assessment: Analysis of existing information and previous studies for Unguja and Pemba; Snap shot study groundwater table; Analysis of groundwater quality; Analysis of long term effects on groundwater table; Analysis of need and requirements for groundwater modelling, particularly with regard to salt water intrusion in the predominant coastal aquifers; Assessment of vulnerability of groundwater sources and catchment areas to pollutions, propose suitable protective measures; Recommendations for additional ground water monitoring wells; Scoping of groundwater model, Cost estimations

Non-technical feasibility analysis: Financial analysis, cost and income structure; Target group analysis; Analysis of institutional and financial viability; Assessment of environmental, social, and climate performance; Peace and conflict assessment; Implementation modalities and concept

2.3.3 Project Management Related to Donor-Supported Facility Development Projects

As noted above, AfDB has information on implementation issues for the most recently implemented ZUWSP. Since RIWSSZ is currently being implemented, the Survey Team also interviewed ZAWA project personnel regarding implementation issues for each project.

(1) Issues in Implementing Projects in ZUWSP

(a) Design Stage

ZAWA does not have design standards, and the only input from ZAWA side for the design is their past experience, which is highly dependent on the skills and experience of the person in charge. With regard to the consultant's design, the respondents are satisfied with the design because it is being carried out in consultation with the consultant. However, the improvement of the technical skills of the staff to understand the consultant's design was cited as an issue, and the design itself is heavily dependent on the consultant.

(b) Procurement Stage

Respondents indicated that it is difficult to understand the huge volume of bidding documents written in English. Regarding the procurement itself, one respondent commented that the emphasis was on the price of bids received, and that it was impossible to procure quality contractors.

(c) Construction Stage

There were no problems with access to the construction site, coordination with other agencies, payment, or other implementation of the client's responsibilities, according to the report. One issue that was noted during the construction stage was that there were communication problems with consultants and contractors. It is assumed that this applies to the different instructions between the client and the consultant that were pointed out during AfDB interviews.

Challenges to business management as a client include inadequate business management and improved communication.

(2) Project Management Issues in RIWSSZ

(a) Detailed design Stage

RIWSSZ uses a design-build approach rather than a client design. The design manual of Tanzanian mainland was also referenced as a design standard. RIWSSZ personnel also cited the low design skills of ZAWA staff as an issue.

(b) Procurement Stage

No specific problems were reported to have arisen in the procurement of the RIWSSZ, but a lack of capacity related to the procurement process was cited as an issue.

(c) Construction Stage

Although the project is currently under implementation and surveying and soil investigations have been completed, there are similar concerns with ZUWSP.

(3) Issues of Project Management

Based on the examples of the above two projects, it is essential to improve the technical level of ZAWA staff in order to successfully implement large scale projects with donor support, but this will require time and a long-term commitment.

It is necessary to select good quality consultants and to continuously implement technology transfer related to project management by consultants. With regard to the implementation of yen loan projects, it is desirable for consultants to play a role in technology transfer related to project management through close cooperation, information sharing, and discussions with ZAWA's project management team at each stage of the project.

The following is a list of technology transfer items at each stage of the project.

【Design Stage】

- Sharing the design concept of each facility
- Sharing the design conditions for each facility
- Presentation of referenced design standards
- Performance qualification Criteria (PQ Criteria)
- Bid evaluation method

【Procurement Stage】

- Qualification screening evaluation and technical proposal evaluation

【Construction Stage】

- Construction supervision based on contract documents
- Support for design changes

2.4 Issues to be Addressed Based on the Problems Identified by the Analysis of the Current Situation

2.4.1 Issues Related to Water Administration and Legislation

(1) Review of National Water Policy

The Water Policy requires to be revised as it has been almost 20 years since its formulation in 2004. The revised policy should address the response to changes in Zanzibar's natural, social, and economic environment; commitment to the targets of the international development agenda and the national development plans; coordination with relevant sector policies that have been revised or newly formulated after the current Water Policy; and implementation arrangements by DoWD/MoWEM, ZAWA, and ZURA.

ZAWA is responsible for water resources management and water supply provision, of which functions were transferred from the then Department of Water Development, Ministry of Water, Construction, Energy, and Lands. With this arrangement, the executing body for water resources management and water supply provision was separated from the policy formulation body. However, responsibilities related to water resources management and water supply provisions are yet to be separated. The establishment of WRMB, which the National Water Policy indicated as part of its strategies for water resources management and regulation, has not been realized. It is desirable that the revised water policy itemize specific policies and strategies necessary for establishing an implementation structure for water resources management with the IWRM approach, especially on the institutionalization of an organization solely dedicated to water resources management and a coordination body of water users; each aspect of water resources assessment, development, allocation, regulation, and conservation.

With regard to the administration of the water sector, the revised policy should include the strategies for the annual planning and budgeting of the sector, financing, performance monitoring and evaluation. In addition, given the wide range of stakeholders involved in the water sector, including policy formulation bodies, water utilities, other water users, LGAs, and regulators of water resources, water utility services, and environment, it is essential that the policy setting for the implementation structure indicate the desired cooperation and division of responsibilities among these participants.

(2) Review of the Water Act and ZURA Act and Institutionalization of Related Legislation

A comprehensive review of water sector laws and regulations is required. The current Water Act allows ZAWA to function both as a water resources manager and regulator and as a water utility, which is contradictory between the two given functions. The granting of water resources development licenses by ZURA to ZAWA also presents a similar conflict. To separate the responsible bodies for water resources management and water service provision and promote the establishment of WRMB as indicated in the Water Policy, it is necessary to review the current Water Act and ZURA Act and formulate an act or provisions to provide a basis for the establishment of WRMB.

The Water Act also includes no provision for enacting protected areas to conserve the recharge areas of groundwater, the main water resource in Zanzibar. The Water Act defines a catchment area as any area of the land or of water delimited by the Minister responsible for water, which contributes to the supply of ZAWA's

waterworks. The Act empowers ZAWA to manage and protect these catchment areas and take legal actions against any person or entity that violates, disturbs, or encroaches on such areas. These provisions are considered to be for the protection of water sources for ZAWA's water supply services. The revised or new act should stipulate the powers of a water resource management body to establish protected areas which aim to protect water recharge areas, not limited to the water sources for water utilities, and groundwater development-controlled areas for the specific areas where groundwater potential is at risk due to saltwater intrusion and other factors.

As for the water supply, the Water Act does not indicate that ZAWA's water supply service is subject to be licensed and regulated by ZURA, as the ZURA Act was enacted after the Water Act. It is necessary to review and add relevant provisions in the Water Act regarding the acquisition of required licenses and compliance with the regulatory framework. Furthermore, in case the Water Policy promotes the participation of water utilities other than ZAWA and the operation of some water facilities entrusted to community-based organizations, the act should define the legal status, requirements in operation, functions, and powers of these entities.

The related regulations should also be reviewed as some provisions lack clarity due to a mixture of descriptions related to water resources management and water supply services in the Water Regulations. Formulation of the regulations that are yet to be in place among the areas identified in the current acts should also be expedited.

(3) Enhancement of Capacity to Enforce Laws and Regulations Governing Use of Water Resources

Until an independent organization responsible for water resources management is established, DWR/ZAWA will continue to be responsible for administrative procedures related to water resources management. Therefore, it is necessary to strengthen the capacities of DWR/ZAWA to enforce the regulation of water resources appropriately. Especially, the following areas need to be enhanced:

- To ensure application for well drilling permits for the use of boreholes.
- To set water abstraction volume granted by the permit, especially for the large-scale water abstractions, monitor water abstraction, and ensure the renewal of water abstraction permits.
- To manage and maintain information on water sources for which water abstraction permits have been issued and information on the particulars of the permits.
- To facilitate conservation and protection of catchment areas in collaboration with other relevant institutions.

2.4.2 Issues Related to Human Resource Development and Organizational Operation

(1) Enhancement of Organizational System for Water Resources Management

Groundwater management is becoming increasingly important from the perspective of conservation and sustainable groundwater use due to recent concerns about saltwater intrusion into groundwater, the only source of water in Zanzibar, as a result of the increased demand for pumping in recent years. On the other

hand, the organizational challenge is that groundwater management is almost untouched by the lack of human resources with knowledge of groundwater hydrogeology, etc. The National Water Policy formulated in 2004 stipulates that groundwater management is to be carried out in accordance with the National Water Policy. On the other hand, there are almost no personnel with knowledge of groundwater hydrogeology, etc., therefore groundwater management is almost untouched, which is an organizational challenge. The National Water Policy formulated in 2004 states that the management of water resources and water supply operations should be separated in terms of organization. Therefore, the establishment of a Water Resources Management Board to implement appropriate development, monitoring, and supervision of water resources is being considered. As an organizational structure, it is proposed that the current Water Resources Department be separated from ZAWA, and an independent organization be established to transition and deepen the work of the Water Resources Management Board. On the other hand, there is currently no staff with expertise in groundwater hydrogeology, and the separation as an organization may not be able to perform the expected tasks.

Currently, ZAWA has a Water Resources Department, which is in charge of water resources development and other operations, but no studies or measures have actually been taken to address the content of salinization and other issues. In Zanzibar, where water sources depend on groundwater resources, it is necessary to take a proactive approach to conserve for the sustainable use of water resources. There are laws and regulations governing catchment protection and resource regulation, and ZAWA is the sole regulator of water resources. In recent years, private borehole drilling has increased significantly as demand has outstripped ZAWA's supply and irrigation use has continued to expand. As a result, monitoring of groundwater resources, water withdrawal, and drainage are inadequately regulated. In light of ZAWA's significant activities, including the publication of catchment areas in the Official Gazette, control measures against encroachment into catchment areas are an urgent priority in the strategic plan through 2025.

On the other hand, the establishment of the WRMB itself is not recognized as an urgent issue to be addressed, possibly due to the lack of human resources. Before establishing the WRMB as an organization, it is more important to enhance the work of the Water Resources Department, which is currently established within ZAWA, than to establish the organizational structure itself. Therefore, it is necessary to hire personnel who are knowledgeable in groundwater resources and management and who are capable of practical management, or to establish specific projects related to groundwater management through outsourcing, monitoring and planning of groundwater resources, and compilation of useful knowledge on rainwater harvesting, etc. From the viewpoint of human resource development, intensive training on groundwater resource management, structuring of work content, and establishment and operation of a PDCA cycle for work activities are issues to be addressed in the future.

In addition, ZAWA is highly interested in the theme of how to move from a situation in which water sources are secured solely by groundwater to one in which multiple water sources are secured, as an important issue regarding water resources. One promising water source is rainwater harvesting. ZAWA is gathering more information on rainwater utilization studies, technical studies, and proposals, and is including rainwater utilization efforts in its 2020-25 strategic business plan. Diversification of water sources is also an issue to be addressed in an organized manner.

(2) Enhancement of ZAWA Training Centre

ZAWA Training Centre (ZTC) is registered with the Vocational Training Authority (VTA) as a public training institution in Zanzibar. ZTC is also in the process of registering with the Pemba branch, with the goal of registering as well. As for courses, the plumbing course has been designed as a 3-year program and is now in its third year of implementation. An electromechanical course is also being prepared. Other programs are being considered, but the content has not yet been finalized, and as of the time of the 2021 survey, no information has been made public. Therefore, there is a current situation where the training centre is gradually enhancing its activities. Thus, the challenge is to enhance the training activities at the centres and to enhance the provision of water supply and water-related training programs, thereby strengthening the development of human resources within Zanzibar. Training topics to be considered for improving operations include those listed in Table 2.129. Details should be discussed with the experts. Creating training modules on these themes, securing instructors, and procuring necessary materials and equipment are issues to be addressed. Although planning and construction of the overall syllabus for the training centre is also necessary in the long term, it is important to build up one by one in light of the current capacity. On the other hand, it is recommended that a dual system that combines practical training and on-the-job training as a short-term course be considered, since this will lead to the implementation of training that is more directly related to practical work.

Table 2.129 Proposed Themes for Training Centre Courses

Proposed Theme	Contents
Measures against unpaid fees	Currently, fee collection is not progressing, therefore, strengthen measures for fee collection and collection of unpaid fees, and provide training and support for staff.
Customer and Information Management	Customer information management and practices, the use of databases, fee collection management customer service improvement, community development, contracts, customer acquisition, and contract management
Facility Management	Training of pump operators
NRW Management	Pipe maintenance and leakage prevention, leak detection, water meter replacement and installation, illegal connection countermeasures and water supply system inspection
Water Quality Management	Water quality inspection plan, water quality monitoring, information disclosure, and water treatment basics
Water Supply Management and Planning	Water distribution planning, financial planning, environmental health, auditing, corporate governance, management leadership and public sector audits

Source: JICA Survey Team

(3) Improvement Process of Work Through Monitoring and Evaluation

Although both the annual activity plan and the five-year plan have established business evaluation indicators (KPIs), there is no quarterly monitoring or confirmation of implementation. In addition, although each department's tasks and achievements are incorporated into the plans based on the KPIs, it was found that the plans are not shared among the staff. Furthermore, although the company is aware of the issues in the field of operations, the system to systematically address and implement operational improvements is significantly weak, and it is believed that the company is not making progress in addressing and resolving these issues. Although it is possible to improve the work system by checking the results of operations in detail, such management has not been systematized. KPIs and work procedures are not clear, and management is not sufficiently implemented, such as the progress of work execution is not checked, and omissions and

deficiencies in work execution cannot be confirmed. As a result, the quality of work cannot be improved.

2.4.3 Issues Related to Groundwater Management

(1) Determination of Water Resource Availability Based on Hydrogeological Surveys

Although SBP 2025 provides a target water withdrawal control volume (33 million m3/y), this volume is calculated based on the groundwater inflow for the entire Unguja Island, which is estimated from the water balance of each surface water basin. Therefore, it is not an amount evaluated from the actual groundwater availability for each groundwater basin (groundwater basin (vessel)).

The results of the "Brief Survey Related to the Current Status of Saltwater Intrusion" conducted in this study showed that groundwater in the main aquifer of the boreholes that are the source of ZAWA's water supply is not at a level of quality that can be pointed out as being saline at this point of time, but groundwater quality is clearly influenced by seawater in the periphery of the fresh freshwater lens where the topography is lower, namely, there are signs of saltwater intrusion in groundwater.

In Zanzibar, the structure of the groundwater basins that serve as groundwater vessels and the groundwater flow and recharge mechanisms have not been elucidated because comprehensive hydrogeologic studies have not been conducted to date. Therefore, under current conditions, it is impossible to estimate neither the overall groundwater availability nor the allowable pumping rate that could actually be developed.

Under these circumstances, if groundwater development continues to meet the increasing demand for water, ZAWA's water supply sources, which have been developed with the support of Japan and many other donors and development banks, could become saline due to seawater.

For sustainable use of water resources in Zanzibar, it is essential to 1) conduct a comprehensive hydrogeological survey to determine the actual groundwater availability and its flow and recharge mechanisms, and 2) develop a "Water Resources Management Master Plan" with an allowable pumping rate that does not cause sea water intrusion into groundwater.

(2) Establishment of Organizational System for Groundwater Management

ZAWA, as a water utility, implements groundwater development and also has the function of regulating groundwater development (The Water Act 2006). The Water Resources Management Division is responsible for regulating water resources, but it is not fully staffed and is not fully functional, for example, the amount of water withdrawal permitted is not set in the water withdrawal permit.

There is no mechanism to receive reports from borehole owners on the status of water withdrawal and water quality from permitted boreholes, and there is little activity related to monitoring, such as monitoring groundwater levels at observation boreholes.

In order to ensure proper groundwater management, it is necessary to establish a system that can properly implement permitting actions and monitoring. In the future, it is also desirable to separate the water resource management function from ZAWA and make it an independent organization.

(3) Strengthen Conservation and Protection of Water Resources

ZAWA's approach to water conservation and protection under SBP 2025 is limited to catchments. Catchment is essentially a riverine term for an upstream area where water flows by concentrating to a common point of discharge. In the case of ZAWA, this refers to the source of the water, i.e., the borehole district. Although it is important to conserve and protect the source of water, in the case of the Zanzibar aquifer (limestone), which is not a very shallow free groundwater, the source of water (borehole county) and the groundwater recharge area are not the same.

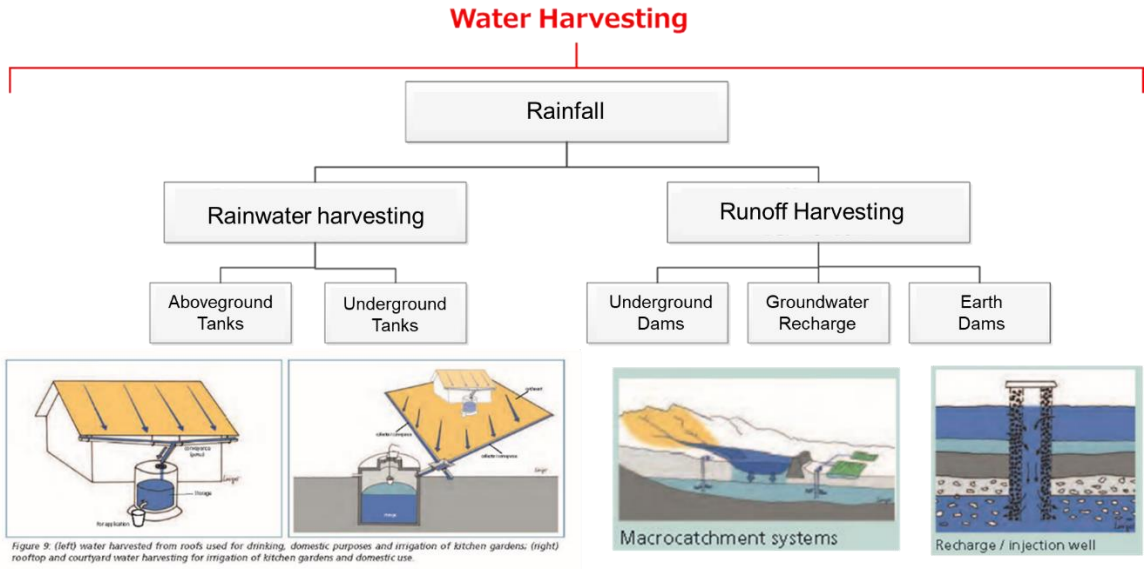
As mentioned above, in the absence of a comprehensive hydrogeologic investigation, the exact groundwater recharge areas cannot be identified. It is necessary to conduct a comprehensive hydrogeological survey, elucidate the groundwater recharge mechanism for each groundwater basin, identify recharge areas, and develop a conservation and protection plan. This would then become a part of the water resources management master plan described in (a).

It is also necessary to establish protected areas and promulgate regulations for conservation and protection of water resources.

(4) Rainwater Harvesting

Rainwater harvesting is an issue that has been mentioned since the 2004 National Water Policy and is one of the key strategies in SBP 2025. On the other hand, ZAWA's rainwater harvesting strategy efforts have been limited to collecting and using water through building gutters.

In recent years, however, the concept of Water Harvesting, which includes runoff at the ground surface (see Figure 2.44), has become mainstream.



Source: JICA Survey Team

Figure 2.44 Concept of Water Harvesting

In the case of Zanzibar, as the aquifer is made of highly permeable limestone with very high porosity, harvesting of surface runoff is most likely to result in direct groundwater recharge. Therefore, water resources

can be stored in natural tanks distributed over a wide area of the aquifer more efficiently than localized rainwater harvesting.

ZAWA should not only be used for limited purposes such as collecting water through building gutters, but also to be used to control runoff to the sea and increase groundwater recharge according to the concept of Water Harvesting. To this end, it is important to conduct a comprehensive hydrogeological survey to elucidate the groundwater basin structure and define the groundwater recharge mechanism.

2.4.4 Issues Related to Water Supply Facility Management

(1) Leakage Reduction in ZUWSP Area

In ZUWSP area, the water supply service has not improved due to leakage from the existing pipes, despite the completion of the construction work, because the replacement of the water supply pipes, which is a matter of burden on Zanzibar side, has not been completed. Therefore, as an urgent issue, it is necessary to complete the re-installation of the water supply pipes and disconnect unnecessary aged existing pipes from the pipe network to bring the project to the state it will be in after the completion of the project.

In the water distribution pipe network development in ZUWSP, not all distribution pipes and water supply pipes have been renewed, and even when the project is fully completed, there may be still, many existing pipes left out in the project area. To improve the service, it is necessary to continue to manage leakage from existing pipes and systematically renew existing pipelines with high leakage as a mid-to-long term initiative, but the flowmeters installed at the entrances and exits of the DMA are not working. Therefore, the flowmeter should be activated through repair (or renewal) to ensure that the boundaries of the DMA are securely delimited, to check the arrangement of valves in the DMA, to narrow down the pipelines with high leakage through night-time minimum flow measurement and step tests, and it is also necessary to improve leakage management capabilities and implement leakage management using the facilities that have been established.

(2) Improvement of Operation and Maintenance Methods Associated with the Implementation of Facility Improvement Projects

Manuals for operation and maintenance of the facility were developed at ZUWSP, while these manuals are not currently being used for actual operation and maintenance. In addition, flowmeters have been installed by ZUWSP to control the intake flow rate, while it is not utilized for operation and management. In addition, daily and periodic inspections are not conducted. In short, the operation and maintenance management methods of the facility have not changed at all before and after the implementation of ZUWSP.

In order to improve the quality of water supply services through appropriate operation and maintenance of facilities, the functions of facilities and equipment that have been developed and introduced by the project should be taken into consideration, and the operation and maintenance management methods that fully utilize them should be studied, necessary systems should be established, education and training should be provided using the manuals, and efforts should be made to realize changes in operation and maintenance methods.

(3) Establishment of System for NRW Management

Although NRW is defined as one of the KPIs in Strategic Business Plan 2025, currently no department has

undertaken the responsibility for NRW management, and no one is in charge of calculating NRW. In addition, no analysis of the water volume composition of NRW (unclaimed water volume, commercial lost water volume such as stolen water, and physical lost water volume such as leaks and overflows) has been conducted.

NRW management involves both technical aspects, such as management of water distribution volume and distribution pipelines, and commercial aspects, such as billing. Therefore, it is necessary to strengthen efforts to reduce NRW by establishing a system such as creating an exclusive department for NRW management, and through NRW management, advising and encouraging the Technical Operations Department and Customer Service Department to implement measures to reduce NRW.

2.4.5 Issues Related to Customer Management

(1) Issues Related to Collection

ZAWA's financial base is weak, and it relies on government subsidies for about 60% of its operating funds. Water supply revenue as a percentage of revenue is low at 38%, and the percentage is not increasing due to various factors. The following factors contribute to the low-rate revenues and need to be improved.

(a) Low collection rate

As of July 2021, the water meter installation rate is approximately 16%, with most of the uninstalled customers being residential customers. Billing for fixed rate customers is done through SMS and payments are made through ZAWA's bill payment counter and cell phone payment services. The low meter collection rate of 44% is attributed to the presence of subscription customers, prolonged arrears due to dissatisfaction with water service, and low customer willingness to pay, all of which exerts pressure on ZAWA's water services.

(b) Shortening of collection period of accounts receivable

In 2013, the fee collection period was 608 days, which was worsened to 3,832 days in 2020. From 2013 to 2017, the amount of fees receivable (TZS) has continued to increase from 4.2, 5.3, 5.7, and 6.6 billion since 2013, but has decreased to 2.2, 1.7, and 2.2 billion since 2018. The lengthening of the fee collection period is causing major cash flow problems for ZAWA. The company plans to reduce the collection period to 30 days in 2025, but even under current conditions, strict measures need to be taken against unpaid and delinquent customers.

(2) Information Management

(a) Customer information

Although the customer registration rate is 100%, there are problems with the accuracy of the registration information, including the lack of some customer information (guesthouses and hotels on Unguja Island) and double billing to customers and relocated families due to double registration.

As the number of new connections is expected to increase significantly and customer meters are being actively replaced, the system for managing this customer information must be enhanced.

(b) Water meter management

While Urban West Province has information on meters that are more than 5 and 10 years old since installation, there is no information on water meters that are more than 5 years old since installation in other areas of Unguja Island. Meter information needs to be collected. Both districts are aware of meters that are malfunctioning, but repairs and other actions have not been taken well, and inadequate meter management has led to leaks, which have caused complaints. In addition, revenue ratio cannot be checked, and proper water distribution planning and leakage repair cannot be performed.

Along with the recognition of the importance of checking meter accuracy, it is necessary to enhance the maintenance system.

(c) Affliction management

Most of the complaints are related to water service, billing and payment, meter reading and collection, etc., leading to a lack of awareness of payment of fees. Although there is a mechanism to share complaint information, the current complaint response time for technical aspects is 48 hours, which is very long from the SBP 2025 target of 4 hours in 2025. It is necessary to analyse the content of technical complaints, identify the deficient skills of the staff, and improve the response.

The complaint processing rate was 50% in 2018, with plans to increase it to 85% by 2025, requiring in-depth measures to be taken.

(3) Promote New Membership to ZAWA

SBP2025 aims to strengthen ZAWA's revenue base by adding 6,300 ~ 6,500 new subscriptions each year over the five years starting in 2021, with a target of 132,110 total customers in 2025. The number of new connections in 2021 was 3,110 (January ~ October), or about 3,700 on an annualized basis (progress rate of about 60%), and the current pace is below the plan.

Of the 4,258 new subscriptions in FY2020, 101 units completed the procedure within 10 working days, a rate of 2.3%. The main reason for the delay in processing was reported as a lack of meters and accessories. ZAWA's goal of completing the process within 7 working days is far from being met.

It is necessary to promote new subscriptions and streamline the subscription process.

(4) Promote Installation of Water Meters

In order to improve the inequitable water supply service between metered and flat-rate systems, the installation rate of water meters must be improved, and SBP 2025 sets targets for the number of meters and meter installation rate for 2025 at 118,900 meters and 90%, respectively. As of July 2021, the meter installation rate was about 16%, lagging behind the plan.

It is necessary to analyse and improve the current bottleneck issues, such as procurement management and material inventory management for purchasing meters and pipe materials, and securing plumbers to install the meters.

Table 2.130 Target of Water Meter Installation in SBP 2025

Item	2020	2021	2022	2023	2024	2025
Number of Meters	11,677	33,168	52,561	74,200	97.898	118,900
Installation Rate	12%	31.2%	46.8%	62.4%	78%	90%
Number of Increase	-	19,870	19,393	21,639	23,698	21,002

Source: Prepared by JICA Survey Team based on the Strategic Business Plan 2020/21-2024/25

(5) Improvement of Meter Reading System

The number of meter reading in 2020 was 11,677, which was handled by 12 meter readers. This is approximately 1,000 meter readings/month per person, requiring an increase in meter readers due to an increase in the number of meters installed (the increase in staffing due to ZAWA policy is being confirmed in the questionnaire). Table 2.131 shows the number of meter readers needed if the number of meter readings per person is set at approximately 1,000 per month.

The number of meter readers will need to be increased by approximately 20 each year to accommodate the installation and replacement of new water meters. In addition, it is necessary to establish a meter reading system that includes the development of meter reading routes, expansion of meter reading equipment, securing of means of transportation for meter reading (it is necessary to confirm whether the emphasis is on efficiency or budget constraints), and the preparation of a meter reading schedule. Since complaints about meter reading account for nearly a half of the total number of complaints (128 complaints in 2020), education for meter readers will be essential.

The introduction of prepaid meters, which is planned to be implemented in the EXIM-BI project as a means to improve the efficiency of meter reading, should be considered to address uncollected charges due to malfunctioning water shutoff valves and illegal connections due to non-implementation of meter reading.

Table 2.131 Target Number of Water Meters and Number of Meter Readers Required Under SBP 2025

Item	2020	2021	2022	2023	2024	2025
Number of Meters	11,677	33,168	52,561	74,200	97.898	118,900
Number of Meter Readers	12	33	53	74	98	119
Number of additional staff required	-	21	20	21	24	21

Source: Prepared by JICA Survey Team based on the Strategic Business Plan 2020/21-2024/25

2.5 Seminars and Workshops Conducted in this Project

2.5.1 Case Study Seminar for Prevention of Seawater Intrusion

(1) Background and Purpose of the Seminars

(a) Background of the Seminar

In Zanzibar, continued groundwater development has increased groundwater utilization, but the potential of groundwater resources based on scientific data has not been fully assessed. According to a report by a water advisor dispatched by JICA, one of the reasons for the inadequate service level of ZAWA is the lack of basic management capacity for water sources.

Considering Zanzibar's hydrogeology, excessive groundwater development increases the risk of seawater intrusion into groundwater. Based on these facts, it is expected to introduce examples of measures against seawater intrusion into groundwater in other countries and deepen discussions to consider future action plans for water resource management on Unguja Island.

(b) Purpose of the Seminar

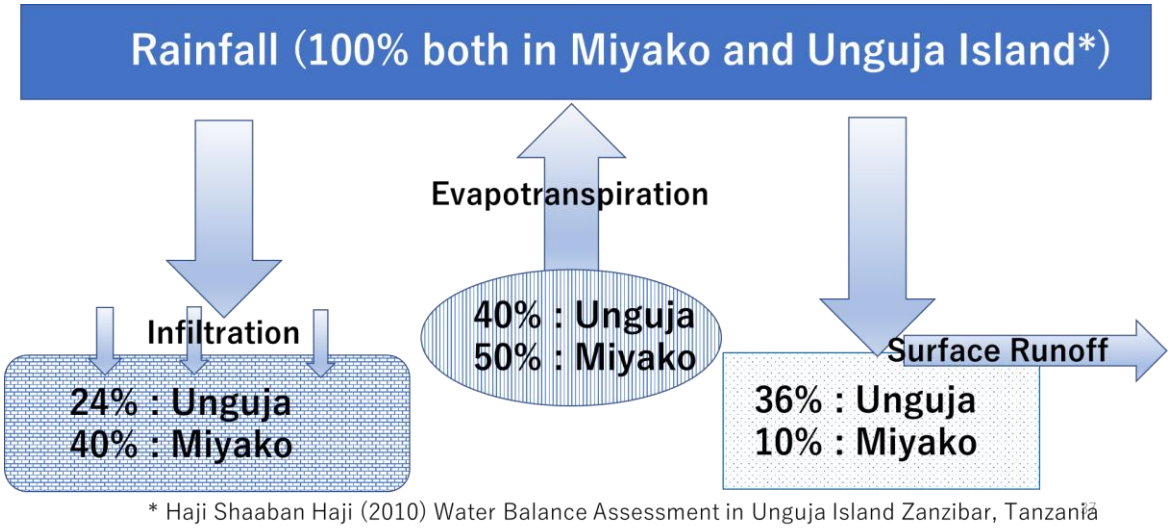
The purpose of the seminar is to discuss future actions for water resource management in Zanzibar by introducing examples of measures against seawater intrusion into groundwater in other countries.

(2) Selection of a Case

The case of Miyakojima, Okinawa Prefecture in Japan, was selected as the case introduction seminar for explain the measures taken against saltwater intrusion into groundwater in other countries. The reasons for selection are as follows.

- The basic measures to prevent seawater intrusion into groundwater in island countries such as Zanzibar is "not lowering the groundwater level" in order to maintain the thickness of the freshwater lens. There are only two methods, that is 1) to control the pumping rate of the area and 2) to build an underground dam.
- Pumping groundwater is always causing a drawdown of groundwater level. Therefore, controlling the amount of groundwater pumping can control the groundwater level. In addition, the underground dam can prevent the outflow of groundwater into the sea and raise the groundwater level. As a result, the underground dam prevents the intrusion of seawater into the groundwater (freshwater).
- Miyakojima City has taken measures for both 1) enacting ordinances to control the amount of pumped water and 2) constructing the world's first large-scale underground dam on Miyakojima.
- The underground dam constructed on Miyakojima has succeeded in maintaining the water quality by maintaining the amount of pumped water and raising the groundwater level.
- Both the geological and hydrogeological structures of Miyakojima are the same as those of Zanzibar, which consists of aquifers of reef limestone and mudstone of the substrate.
- Miyakojima City has succeeded in taking measures against seawater intrusion through both soft measures (groundwater management ordinance) and hard measures (underground dams).

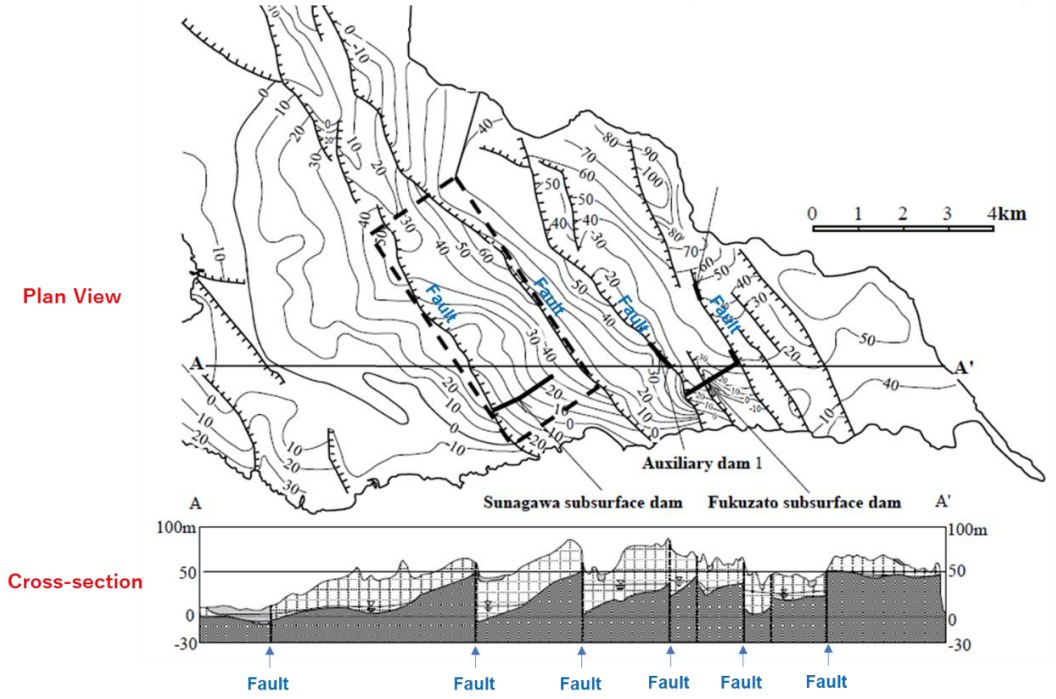
In particular, it is noteworthy that Miyakojima and Unguja island have a lot in common in terms of natural conditions. Figure 2.45 shows the water balance of both islands. Approximately half of the precipitation evaporates, and the other half is infiltrated underground (that is, recharge of groundwater) and is discharged to the surface. It should be noted that both Miyakojima and Unguja Island has extremely high percentages, it is 40% in Miyakojima and 24% in Unguja Island. For example, looking at the water balance of the Wami Ruve basin, which is the closest to Zanzibar in the mainland Tanzania basin, the underground infiltration rate is only 7%. The infiltration rate of rainwater on Miyakojima and Unguja island is extremely high. And this is due to the geology of the island, which is formed of Quaternary reef limestone with a very high porosity ratio.



Source: JICA Survey Team

Figure 2.45 Water Balance of Unguja Island and Miyakojima

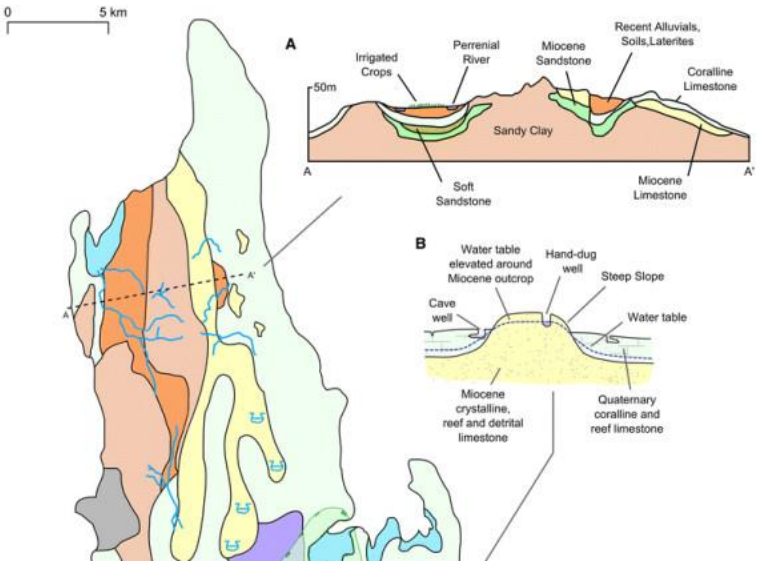
Secondly, the "Groundwater Basin", which is a container for groundwater, has a common feature that it can efficiently store groundwater and prevent the groundwater level lowering. Figure 2.46 shows the plan and cross section of the geological structure of Miyakojima. Quaternary reef limestone is the aquifer of Miyakojima, and the lower Tertiary mudstone is the basement rock. As shown in the figure, a fault develops in the northwest-southeast direction, and this fault plays the role of an impermeable wall (dark grey part in the cross section), and the installed underground dam can efficiently store groundwater.



Source: Miyakojima City

Figure 2.46 Geological Structure of the Miyakojima Island

Figure 2.47 shows the plan and cross section of the geological structure of Unguja Island. Unguja Island is also an aquifer by Quaternary reef limestone, and is based on Tertiary mudstone and marl below it. On Unguja Island, a syncline structure with folds cantered on the north-south direction has been developed. This geological structure plays a role of storing groundwater, and it is possible to efficiently store groundwater by installing an underground dam.



Source: Geological characteristics of Unguja Zanzibar, Mapping hotspots of malaria transmission from pre-existing hydrology, geology and geomorphology data in the pre-elimination context of Zanzibar, United Republic of Tanzania

Figure 2.47 Geological Structure of the Unguja Island

Thus, since the hydrogeological characteristics of Unguja Island and Miyakojima Island are extremely similar, it is highly possible that similar measures can be taken against saltwater intrusion. From these facts, it was judged that Miyakojima City, Okinawa Prefecture, is suitable as an example for a case introduction seminar for explaining the measures taken against saltwater intrusion into groundwater.

(3) Preparation of Seminar Materials

The seminar materials consist of the following contents. The seminar materials are attached in appendix document.

1. Background of Seminar
2. Purpose of the Seminar
3. Selection of a Case
4. Overview of Miyakojima, Okinawa Prefecture, Japan
5. History of Water Use and Development in Miyakojima
6. Mechanism of Seawater Intrusion into Groundwater
7. Underground Dam
8. Similarity of Natural Conditions between Miyakojima and Unguja Island (Possibility of Underground Dam on Unguja)
9. Miyakojima City Groundwater Conservation Ordinance
10. Miyakojima City Basic Plan on Groundwater Utilization

(4) Implementation of Seminar

The seminar was held online on December 14th from 15:00 to 18:00 (Tanzania time from 9:00 to 12:00). The seminar was attended by 9 people shown in Table 2.132.

Table 2.132 List of Participants in Case Study Seminar on Countermeasures against Saltwater Intrusion into Groundwater

No.	Name	Institution	Job Title
1	Ms Rukia Masheko Ally	ZAWA	Principal - Water Institute
2	Ms Thania Salum Nassor	ZAWA	Chemist
3	Ms Haula Hija Haji	ZAWA	Water Resources Engineer
4	Mr. Hassan Zaharani Haji	ZAWA	Head Drilling Section
5	Ms Kazija Ame Thabit	ZAWA	Water Resources Technician
6	Ms Nasra Rajab Salum	ZAWA	Water Laboratory Technician
7	Mr. Rajab Said Mohammed	ZURA	Water Inspector
8	Mr. Emmanuel Nahozya	ESS	Hydrogeologist
9	Mr. Modhakkiru K Katakweba	JICA Survey Team	DCM Engineer

Source: JICA Survey Team

2.5.2 Workshop on Action Plan

(1) Workshop on NRW Reduction (Leakage Reduction)

(a) Outline of the workshop

A workshop on NRW reduction (leakage reduction) was held on December 21st, 2021, which included a

lecture and mini-workshop on the basic NRW management issues. The outline of the workshop is provided below.

- Date and Time：9:00 am. -11:00 am. (local time) on December 21st, 2021,
- Location：TV meeting method (meeting room in ZAWA office)
- Participants：Mid-level staff in related departments

Table 2.133 Participants in NRW Reduction (Leakage Reduction) Workshop

No.	Name	Department	Title
1	Ms Kazija M. Msheba	Commercial & Customer Service	Director
2	Mr. Saidi Mussa Khamis	GIS Section	Head of GIS Section
3	Mr. Khamis Juma Khamis	North district	District Water Officer
4	Mr. Rajab Said Mohammed	ZURA	Water Inspector
5	Ms Pili Masoud	ZAWA	EXIM-BI Project Engineer
6	Ms Salma A. Keis	Commercial & Customer Service	Assistant Credit Officer
7	Mr. Hassan Haji Kongo	Water Production	Electrical Technician
8	Mr. Ahmed Juma Haji	Commercial & Customer Service	Water Meter Officer
9	Mr. Othman M. Othman	Commercial & Customer Service	Assistant Credit Officer
10	Mr. Makame H. Iddi	Commercial & Customer Service	Head Customer Care
11	Mr. Vuai Jabir Yange	Commercial & Customer Service	Assistant Credit Officer
12	Mr. Ahmed Nassor Juma	Commercial & Customer Service	Commercial Meter Reader
13	Ms Nour Shaaban Ameir	Commercial & Customer Service	Assistant Credit Officer
14	Mr. Ali Said Mohammed	Water Production	Electrical Technician
15	Mr. Mahmoud Omar Makame	ICT Unit	Data Base Head Officer

Source: JICA Survey Team

(i) Basics of NRW

Basic information on NRW was explained regarding the water balance of IWA, NRW calculation methods, and the procedure to collect data for NRW calculations.

(ii) Review of measures in Strategic Business Plan 2025 on NRW and leakage reduction

Under Strategic Business Plan 2025, the following four strategies and measures for each strategy are planned to improve water services.

- Improvement of reliability of water service
- Reduction of NRW
- Improvement of water supply facilities
- Strengthening water quality monitoring

From these, the committee reviewed, progressed, and discussed issues related to measures related to NRW reduction and leakage reduction.

(iii) Discussions for action plan development

Discussions were held on three topics (① NRW management (data management), ② leak detection, and ③

leak repair), and discussing the ideas for actions needed to reduce leakage, etc.

(b) Content of Workshop Discussions

Table 2.134 shows the current issues identified as a result of the work and opinions on proposed improvements.

The establishment of a department responsible for the systematic management of NRW in ZAWA based on management involvement and the management of water volume by flow meters, which were mentioned as opinions, are considered to be highly important. In addition, it is recognized that in the case of Japan, most of the number of leakage points are water supply pipes, while in ZAWA, the proportion of water distribution pipes is high. This situation suggests that the water distribution pipelines are in very poor condition, and it is assumed that there is a high need to actively promote the renewal of water distribution pipelines.

Table 2.134 Opinions on Current Issues and Proposed Improvements

Category	Item	Opinions
Current Issues	Responsible for NRW Management	Currently, not present.
	DMA Flowmeters	Installed but not working
	Status of Unbilled Customers	There are schools, religious institutions, and other facilities that have not been billed.
	Current Situation of the Leakage	・Repair surface leaks only ・Estimated that 65% of the leaks are from distribution pipes and 35% from water supply pipes. ・Leaks in large diameter pipes require more time, but otherwise can be repaired on the same day if materials are available.
Future Issues	Improvement of NRW Management	・Establish a department for NRW management ・NRW Management Department will have a team to manage NRW data and a team to conduct leak detection. ・Promote installation of flowmeters and transition to water quantity management with flowmeters. ・Management involvement is needed to improve NRW management.

Source: JICA Survey Team

(2) Workshop on NRW Reduction (Apparent Loss)

(a) Background and objectives of the workshop

ZAWA does not have a department to manage NRW and needs to understand the reality and content of NRW. As part of the acquisition of basic knowledge on NRW reduction necessary for ZAWA's future management improvement, a workshop was held from the viewpoint of commercial loss.

(b) Organizing workshops

The workshop on reducing NRW from commercial losses was held on December 23rd via web conference connecting ZAWA headquarters and Japan, with 15 participants from ZAWA, mostly from customer management departments.

(c) Content of the Workshop

(i) Basic information on commercial losses

Introduced the current status of Yokohama City Waterworks Bureau and ZAWA and explained that the promotion of installation of customer meters and activities are required to increase the rate of fee collection and to improve the payback rate.

Table 2.135 Basic Information of Yokohama City Waterworks Bureau and ZAWA

(a) Yokohama City Waterworks Bureau

Description	Unit	2010	2015	2020
Served population	No.	3,687,255	3,726,317	3,776,102
Cover rate	%	100.0	100.0	100.0
Total number of customer meter	No.	1,753,184	1,824,383	1,907,706
Cover rate	%	100.0	100.0	100.0
Average daily supply volume	m^3/day	1,192,101	1,127,804	1,136938
Annual water distribution volume	m^3/year	435,117,000	412,776,400	414,982,500
Annual revenue water volume	m^3/year	398,901,588	380,430,209	384,916,115
Revenue water rate	%	91.7	92.2	92.8
Annual non-revenue water volume	m^3/year	36,215,412	32,346,191	30,066,385
Unit sales price (1JPY = 0.09 USD)	USD/m^3	1.58	1.54	1.47
Production cost (1JPY = 0.09 USD)	USD/m^3	1.49	1.46	1.55
Balance (sales price - production cost)	USD/m^3	0.86	0.77	- 0.74
Average water consumption	m^3/month	18.8	17.4	16.8
Water consumption for domestics	m^3/month	15.5	14.5	15.1
Water consumption for commercial	m^3/month	99.5	69.8	38.0
Transmission & distribution pipe length	km	9,234	9,251	9, 323

Source: Yokohama City Waterworks Bureau Business Outline

(b) ZAWA

Items	Unit	2013	2018	2025 (Plan)
Served household (= Number of connection)	No.	71,990	100,010	132,110
Water supply coverage	%	74	83	97
Served household (= Number of customer meter)	No.	2,160	11,677 (2020)	118,900
Served household (= Number of customer meter)	%	3	12.2	90
Average daily supply volume	m^3/day	95,667	107,992	115,948
Volume of Annual water production	m^3/year	34,922,000	39,417,000	42,321,000
Revenue: Water sold	Tzs mill.	-	5,365	10,138
Revenue: Service charge	Tzs mill.	-	298	564
Revenue: Others	Tzs mill.	-	63	2,305
Non-revenue water ratio	%	85.2	63	30.00

Source: JICA Survey Team

(ii) NRW cases and measures

Specific examples of noncertified water supply, such as illegal connections, stolen water, vandalism, and water use by unregistered customers, were presented. And those measures to deal with non-certified water supply are effective in educating residents, promoting understanding of ZAWA's services by holding residents' meetings, and providing opportunities to introduce ZAWA's water supply system to students were explained.

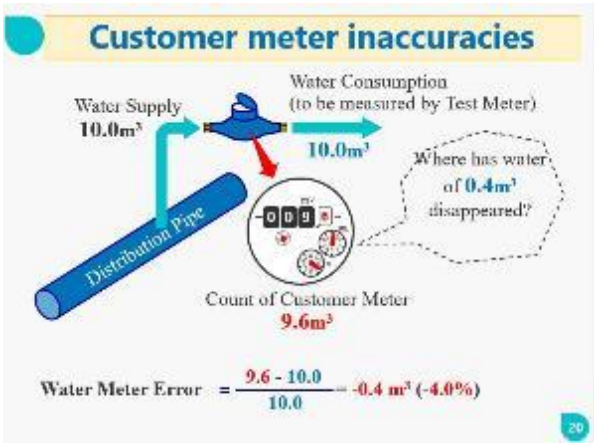
Non-certified Water Supply

Countermeasure

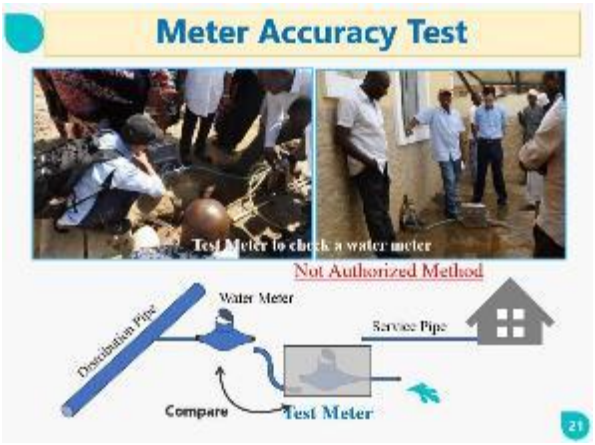
Source: JICA Survey Team

Figure 2.48 Explanation Slides for Non-certified Water Supply

Methods for calculating customer meter error rates and checking the accuracy of customer meters that are not operating properly, how to calculate error rates, and how to take measurements in the field using a test meter were explained. ZAWA staff pointed out that they have a test bench (meter error rate testing equipment) in their headquarters.



Customer Meter Error Rate Calculation Method



Checking with a Test Meter

Source: JICA Survey Team

Figure 2.49 Explanation Slides for Confirmation of Water Meter Error

The following explanation was provided on how to determine and address abnormal water usage at the time of meter reading.

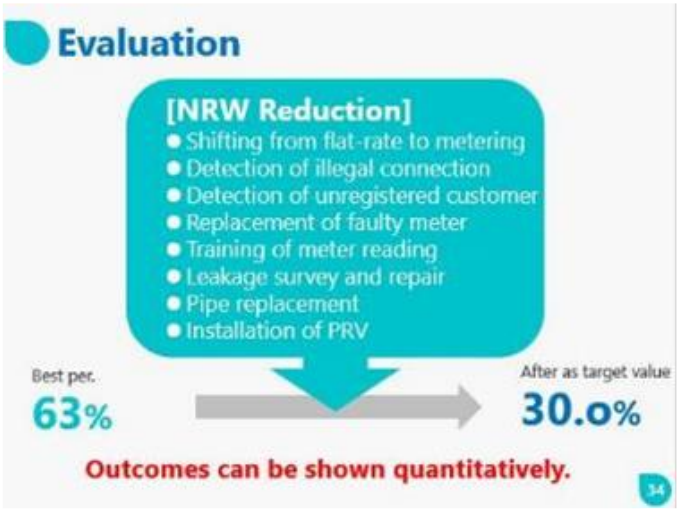
- The method of determining abnormal water usage at the time of meter reading should be ±30% of the previous usage.
- There should be criteria for determining whether a household is over- or under-using the meter, taking into account the standard usage per capita (Yokohama City: 220 L/person/day, ZAWA: 80 L/person/day *ZAWA indicated that it was 100 L/person/day) and the number of people in the household.
- If abnormal water use is identified, ask the family if there is a reason (e.g., family travel, change in family size, etc.), and if the reason is acceptable, refer to the value in the next meter reading.

- If the next meter reading still shows excessive/under-usage, suspect abnormalities in the customer's meter, illegal connections, or leaks in the home.
- Illegal connections and water leaks in the home can be easily investigated during normal meter reading.

(iii) Summary

With regard to NRW reduction, it was explained that it is possible to set a target of 30%, which is ZAWA's goal, from the current NRW rate of 63% by implementing the following measures

- Promote conversion from flat rate to metered rate → Promote installation of customer meters
- Investigation of illegal connections
- Investigate unregistered, dual-registered, and customers who have moved but are still registered.
- Replacement of faulty meters
- Training for meter readers
- Leakage management
- Measures against aging pipes
- Installation of pressure reducing valves (countermeasures against high water pressure)



Source: JICA Survey Team

Figure 2.50 Explanation Slides for the Summary

Photo 2.17 Photos of the Workshop

(3) Workshop on Groundwater Management

(a) Purpose of the Workshop

The purpose is to analyse the ideal future image and current issues regarding ZAWA's groundwater management. Then, based on that, in collaboration with ZAWA, an action plan is to be formulated and included as part of the main strategies that will be formulated in the ZAWA Strategic Business Plan 2020-2025 (SBP: Strategic Business Plan).

(b) Workshop Materials

The materials of the workshop consisted of the following 6 chapters. The materials and teaching materials for the workshop are shown in Appendix 2.

1. Background and Purpose of the Seminar
2. Review of Current Status of Groundwater management
3. Strategy 1: Controlling water abstraction
4. Strategy 2: Enhancing water resources conservation
5. Strategy 3: Developing the effective mechanism for rainwater harvesting
6. Action plan on Groundwater Resources Management

(c) Implementation of the Workshop

The workshop was held on, January 27, 2022, from 9:00 am to 12:30 pm. The participants in the workshop are not only ZAWA staff, but also from the Ministry of Water, Energy and Minerals (MoWEM), the Ministry of Agriculture, Irrigation, Natural Resources and Livestock (MAINRL) Irrigation Bureau, UNICEF and Zanzibar Environmental Management Agency (ZEMA). There were also participants from the Zanzibar Utilities Regulatory Authority (ZURA), JICA Tanzania Office, and a total of 34 people were participated. Active discussions were made, and it was clear that not only ZAWA, but also other organizations are highly interested in "groundwater management".

The contents discussed in the workshop are summarized as in the following section.

(d) SBP Strategy 1：Identifying issues regarding "water abstraction regulation and management" and discussing necessary actions

(i) Issue Identified

SBP Strategy 1: The target values for regulation and management in “Water abstraction Regulation and Management” are set to 339 million m^3/Y (Unguja: 293 million m^3/year, Pemba: 46 million m^3/Y). This numerical value was assumed based on the "Acceptable Aquifer Yield" estimated by the Water Resources Assessment (2014). As described in Section 2.2.3, the "Acceptable Aquifer Yield" is however, a value calculated for surface water basin by the amount of infiltration with respect to the amount of rainfall, and is not a value calculated from the actual amount of groundwater reserve.

Furthermore, considering the hydrogeological conditions of Zanzibar, excessive groundwater pumping has a risk of seawater intrusion. In order to prevent this risk, it is necessary to set the Permissible Yield calculated based on the hydrogeological mechanism and the risks that might arise from pumping. It is also an issue that the provisions for controlling water abstraction in the Water Law and Water Regulations are not properly

enforced, as seen in the following situations.

- The legal requirements for applying for a well drilling permit and water abstraction permit are not properly adhered to by water users.
- Water pumping ratio and the amount are not set in the water intake permit
- Water abstraction from water sources for various purposes other than ZAWA's water service is not monitored

(ii) Necessary Actions

From the above issues, it was discussed and concluded that the following actions are necessary for SBP Strategy 1: "Regulation and management of water abstraction".

- Conduct a comprehensive hydrogeological survey and evaluate the Permissible Yield of pumping for regulation and management of water abstraction (including measures against salinization).
- Raise awareness of water users and policy-making bodies for the purpose of water resource management, and establish law enforcement mechanisms
- Set the amount of water that can be taken in the water abstraction permit
- Monitor water abstraction

(e) SBP Strategy 2：Identifying issues related to "water resources conservation" and discussing necessary actions

(i) Issue Identified

SBP Strategy 2: The target area of "water resources conservation" is limited to the area where the water source (well) of ZAWA's water supply facility is installed, that is, the intake area (well field).

On the other hand, the issue that was identified was that the groundwater intake area and the groundwater recharge area are not the same, and the groundwater recharge area should also be the target of conservation.

In addition, the legal system does not have any specific provisions regarding the establishment of protected areas for the conservation of recharge areas for water resources (groundwater) used for various purposes.

Further, a roadmap for the establishment of the Water Resources Management Board (WRMB), one of the measures set out in the National Water Policy, has not yet been developed.

(ii) Necessary Actions

From the above issues, it was discussed and concluded that the following actions are necessary for SBP Strategy 2: "Water Resources Conservation".

- Conduct a comprehensive hydrogeological survey to identify the groundwater recharge area
- Establish rules for protected areas for the conservation of groundwater recharge
- Develop a roadmap for the establishment of the Water Resources Management Board (WRMB)
- Coordination among stakeholders for water use should be implemented by WRMB in the future

(f) SBP Strategy 3：Identifying issues and discussing necessary actions for "development of the effective mechanism for rainwater harvesting"

(i) Issues Identified

SBP Strategy 3: As an issue for "development of the effective mechanism for rainwater harvesting", the question was first raised whether the storage of only "rainwater" is sufficient or effective. In recent years, as an efficient storage method for rainfall, the concept of Water Harvesting, which includes not only rainwater storage (Rainwater Harvesting) but also runoff storage (Runoff Harvesting), has become conspicuous.

- The characteristic of Zanzibar's water balance is a very high proportion of surface runoff of 36% of total rainfall, which is equivalent to 880 million m3 annually. This large amount of water is currently not being used and is flowing directly into the sea.
- Considering the Zanzibar's water balance and hydrogeological structure, a broader runoff harvesting approach, including groundwater recharge, is needed that is more efficient than the development of local “rainwater harvesting” facilities.

(ii) Necessary Actions

From the above issues, it was discussed and concluded that the following actions are necessary for SBP Strategy 2: “development of the effective mechanism for rainwater harvesting”.

- Conduct a comprehensive hydrogeological survey to identify areas with high potential for runoff harvesting
- Formulation of Water Harvesting Plan

(g) Wrap up of action plans for groundwater management

To comprehend the action plan for groundwater management, it was summarized in three points: action based on the hydrogeological mechanism, legal system, and governance structure.

(i) Action based on the hydrogeological mechanism

It was recognized that it is necessary to implement a comprehensive hydrogeological survey at the earliest stage for all strategies. Then, set the water amount to be regulated and managed based on the elucidated hydrogeological mechanism, and under the given condition that Permissible Yield does not cause seawater intrusion into groundwater. Furthermore, formulation of the water harvesting plan and enactment of water resources conservation are necessary.

(ii) Legal system

The permit for water abstraction should be given with a set allowable amount of water abstraction, and monitoring to be done to confirm the allowable amount.

(iii) Governance structure

It is necessary to formulate a roadmap that includes the development of legal systems at an early stage, establish a Water Resources Management Board (WRMB), and manage water resources by an independent and neutral organization.

(4) Workshop on Human Resource Development and Organizational Management

A workshop on human resource development and organizational management was held on March 2nd, 2022.

- Date and Time：9:30 am. -11:00 am. (local time) on March 2nd, 2021,
- Location：TV meeting method (meeting room in ZAWA office)
- Participants：Mid-level staff in related departments

Table 2.136 Participants in Human Resource Development and Organizational Management Workshop

No.	Name	Department	Title
1	Salma Ali Keis	Finance and Planning	Credit Control Officer
2	Riziki Abbass	Administration and HRD	Office Supervisor
3	Rashid Mohammed	Technical Operation	Civil Engineer
4	Mr. Mahmoud Omar Makame	Commercial and Customer service	Data Base Head Officer
5	Makungu Hamdu Haji	Water Resources	Laboratory Officer
6	Lutfia Ishak Ukasha	Administration and HRD	Human Resources Officer
7	Kombo Ali Hassan	Technical Operation	GIS Technician
8	Kazija Ame Thabit	Water Resources	Water Resources Technician
9	Jabu Haji Shamte	Finance and Planning	M&E Officer
10	Hassan Khalid Abdulrahman	Finance and Planning	Accounts Revenue Accountant
11	Ali Abdu Ali	Technical Operation	Electrical Engineer - District Offices Coordinator

(a) Contents of the workshop

Lectures and mini group work were programmed for the following contents on human resource development and management methods of the organization.

(i) Sharing the results of the competency assessment

The result of a competency assessment conducted remotely in 2021 was shared. It also explained the psychological aspects of the results regarding the work and duties. The workshop participants commented that the analysis of the questionnaire results was generally convincing, and although the sample size was small, the results shown by the competency survey analysis largely reflected the outline of ZAWA's organisational situation

(ii) SWOT analysis and future prospect

As for SWOT analysis, most of the participants did not know the analysis method, so firstly the SWOT analysis framework was explained. Furthermore, after sharing the results of a remote survey conducted in 2021, a group work was conducted to discuss and share ideas to improve these results.

Below is a summary of the opinions on improvement plans that came out as a result of the work.

Table 2.137 Measures for SWOT Analysis Brainstorming Work Results

	Analysis Results	Ideas for Countermeasures
Strength	ZAWA is supplying safe and sanitary water	Continue to supply safe and sufficient water supply that meets WHO standards
	The water network is functioning normally and in good condition	Promote the use of GIS in all water networks
	Water supply network is spread out	Place identification signs along the water network piping route
	Plumbing repair work is possible	
	Project movement and monitoring is under way	
	Follow up on activities is done	
	Repair activities are done and ZAWA owns the land	
	By establishing the ZAWA Training Centre, ZAWA can improve its knowledge and skills.	Strengthen the functions of the ZAWA Training Centre
	There are motivated staff	
	There is sufficient water resource	Maintain / save available water resources
Weakness	There is a contradiction in the legal framework of water supply	Legal system reviews and revisions
	Bulk flow meter is not installed in the distribution network	New installation of bulk flow meter
	Insufficient water supply	New study of water source
	Insufficient parts supply	Procurement of standard parts
	Old pipes and other parts	Update old plumbing
	Lack of utilization of human resources	
	Poor project planning and management	Improvement of planning and management methods
	Reservoir and distribution equipment are needed, but the plan is overdue	Construction of new distribution reservoir
	The labour market lacks highly skilled personnel and cannot be hired	Offer short-term courses Hire skilled, qualified workers
	Aging equipment and frequent pump failures	Procurement of new pumps, installation of control / protection devices
Opportunity	There is a training opportunity	Training of technicians and masons Monitoring training ICT, finance and marketing training Database training
	Bricks can be used to repair tanks, pump rooms, etc. (durable)	Bricks are only used in the construction of pump houses, the main structures are RC and concrete
	Support for Zanzibar, Tanzanian Government and Development Partners is available	Need to increase support in various areas
	ZAWA is the only service provider in the water services sector	There is a need for competition. This is also a threat. It is necessary to develop services with business elements, although not entirely to privatize. It is better to divide the services of Unguja Island and Pemba Island It is necessary to introduce the idea of IWRM
Treat	Groundwater is the only source of water	Ensuring the sustainability of groundwater sources
	Penetration of salt water into groundwater	Find another water source
	Failure to carry out planned activities	Reduce/avoid excessive pumping or have fewer boreholes
	Customers are less willing to pay	Needs support from management
	Low salary makes it impossible to secure specialized personnel	Ensuring improved water supply services
	Frequent illegal connections	Need to raise public awareness

Source: JICA Survey Team

(iii) Training theme brainstorming

Through remote interviews and visits to the training centre, the themes that are considered to be important are clarified when enhancing training at the ZAWA training centre. Discussions were made at the workshop with participants about subject areas to improve and curriculum ideas for each training theme. The ideas are summarized below.

Table 2.138 Ideas about the Content of Each Training Theme

Theme	Training theme Contents Idea
Plumbing	Leak repair, connection work, plumbing materials, mathematics, computer
Electromechanical	Pump operation
Customer management / information management	Cost sharing, measures against unpaid charges, data collection and management (GIS), computer basics
Facility Management	Water resources management, budget and financial management, water facility operation and maintenance
Water quality management	Water treatment, water quality analysis, water sample collection
Groundwater resource management	Conservation of groundwater resources, impact of invasion of catchment areas, water storage and utilization
Non-revenue water management	How to manage water distribution and water loss, NRW impact, non-revenue water
Accounts payable	Improved water services (quantity, quality, service time, pressure and reliability), understanding of unpaid customers, water charges and water laws
Water supply management	Water supply management planning method, pay-as-you-go water supply system

Other lectures included the methods and concepts of service management and skill development on the following themes.

- Capacity development process
- Conceptual framework for training course development
- Workflow monitoring to improve work performance

Mini work presentation

Group work session

Photo 2.18 Human Resources Development / Organization Management Workshop

2.6 Cooperation Plan with Japanese Companies and Water Utilities

2.6.1 Issues of Zanzibar Water Sector and Survey Methodology

As forementioned, various issues were identified from this survey such as the high-water leakage rate (which is also a factor in the high non-revenue water rate), which is a common problem in developing countries, and it is expected that water resources management will be one of the main issues. Based on this, the possibility of utilizing technology and the cooperation from private companies and water utilities in Japan was studied.

The study for cooperation was conducted in the following steps. First, business records of Japanese private companies and water utilities were surveyed, then the possibilities of cooperation were inquired to the respondents with business records. In parallel with these, the Survey Team surveyed the technology of Japanese companies applicable to the improvement of water service sectors in Zanzibar utilizing the existing materials from Japanese organizations such as JICA and Japan Water Works Association (JWWA) and supplemented them with answers to questionnaires and telephone/remote interviews.

2.6.2 Business Records of Japanese Companies and Water Utilities in Zanzibar

(1) Business Records in Zanzibar

(a) Companies' Experiences in JICA's "Technical Cooperation Project"

Only two Japanese companies, which are "NJS Co., Ltd." and "Yokohama Water Co., Ltd.", recently have business experience in the field of water supply in Zanzibar, and they are the constituents of this survey.

Table 2.139 List of Companies in Zanzibar (technical cooperation project)

Project	Type	Year	参加企業
Preparatory survey on Zanzibar urban water distribution facilities improvement project in United Republic of Tanzania	Preparatory Survey	2016-2017	NJS YWC
Technical Cooperation Project for Enhancement of Water Supply Management of Zanzibar Water Authority (Phase 1, 2)	Technical cooperation project	2008-2016	NJS Yokohama Waterworks Bureau
The Project for Zanzibar Urban Water Supply Development (1st, 2nd)	Grant aid	2006-2008 2009-2010	NJS
Basic Design on The Project for Zanzibar Urban Water Supply Development	Feasibility study	2004 2007-2008	NJS

Source: JICA Survey Team

(b) Water Utilities' Experiences in JICA 's "Partnership Program"

Only the City of Yokohama dispatched its staff members to Zanzibar and accepted training participants over a long period of years as in JICA 's "Partnership Program".

Table 2.140 List of Yokohama City's Cooperation in Zanzibar

Project	Format	Year	Municipality
Project for Strengthening Operational Management Capacity of Zanzibar Urban Water Supply System	Expert dispatching	2007	City of Yokohama
Project for improvement of infrastructure development in Zanzibar	Expert dispatching	2009	City of Yokohama
Project for improvement of infrastructure development for zingiber in the United Republic of Zanzibar, Phase 1 and Phase 2	Expert dispatching	2012	City of Yokohama
Dispatch of JICA volunteers to Zanzibar Water Authority for human resource development through the JICA Volunteer Short-Term Dispatch Program	Expert dispatching	2013	City of Yokohama
Acceptance of trainees for numerous projects	Acceptance of trainees	2006-2019	City of Yokohama
Preparatory Survey for the Zanzibar Urban Water Distribution System Improvement Project, Tanzania	Acceptance of Executives' visit	2016	City of Yokohama
Preparatory survey on Zanzibar urban water distribution facilities improvement project in United Republic of Tanzania	Acceptance of Executives' visit	2009	City of Yokohama

Source: JICA Survey Team

Water Works Bureau of City of Yokohama (hereinafter referred to as "YWWB") has cooperated with JICA to provide technical cooperation to Tanzania, especially Zanzibar over a long period of years. From 2006 to 2019, YWWB dispatched 10 staff members to Zanzibar to help develop a manual for bill collection, implement a training program, create a customer database and raise public awareness. On the other hand, YWWB accepted 50 training participants among them executives of the Zanzibar Government and ZAWA.

Table 2.141 Number of people dispatched and received by Yokohama City

	2006	2007	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	計
Dispatch	1		2		3	4								10
Acceptance	1	1	11	1	2	12	10	3	1	5	2		1	50

Source: Waterworks Bureau of City of Yokohama

Since very few Japanese entities participated in the water supply activities in Zanzibar, the Survey Team utilized the JWWA-published document regarding the international activities of water utilities in Japan and expanded the survey target to other countries in the African region and the Pacific-island countries in a similar circumstance to Zanzibar. Japanese large cities such as Yokohama participated in programs through staff dispatch and training acceptance, while Okinawa Prefecture and Miyakojima City joined the cooperation with the Pacific-island countries taking full advantage of the similar circumstance. The table below summarizes the results from 2011 to 2020 respectively. The questionnaire survey described later is selected from these results.

Table 2.142 Overseas Cooperation Achievements in Africa

Water Utility	Country	Project	Scheme	Year
Chiba Water Supply Authority	East Timor	Advisory for improving water supply in the Democratic Republic of Timor-Leste	Dispatch of Experts	2015-2020
Yokohama Waterworks Bureau	Malawi	JICA volunteer collaboration to support Blantyre Water Authority, Malawi	Short-term Expert	2017-2019
	Malawi	The project for strengthening the capacity of NRW reduction for Lilongwe Water Board (LiSCaP)	Long-term Expert	2019-Continuation
	Malawi	Dispatch of Yokohama Waterworks Bureau Staff to Support Water supply sector in Malawi	short-term loan placement	2014-2016
Kobe Waterworks Bureau	Rwanda	Domestic support for "The project for strengthening the NRW reduction for Kigali City, Rwanda"	Domestic Support Committee Member	2016-2017

Source: JICA Survey Team, based on materials from the Japan Water Works Association

Table 2.143 Japanese Training Achievements in Africa

Water Utility	Country	Project	Scheme	Year
Sapporo Waterworks Bureau	Africa and others	Comprehensive Waterworks Facility Technology: Practical Edition for Waterworks Practitioners (B)".	Grope and Region-Focused Training	2017-2020
Tokyo Waterworks Bureau	Republic of South Africa	Republic of South Africa "Water Quality Management" and "Training of Water Treatment Plant and Sewage Treatment Plant Staff (Water Supply)".	Country-Focused Training	2014-2015
Yokohama Waterworks Bureau	Africa and others	Training of Urban Waterworks Engineers in Africa	Grope and Region-Focused Training	2011-2021
Hamamatsu Waterworks Bureau	Africa and others	Water supply non-revenue water management measures (leakage prevention measures)	Grope and Region-Focused Training	2014-2015
Nagoya Water and Sewerage Bureau	Africa and others	Water supply non-revenue water management measures (leakage prevention measures) (A) (B)	Grope and Region-Focused Training	2011-2020
Toyohashi Water and Sewerage Bureau	Africa and others	Water supply non-revenue water management measures (leakage prevention measures) (A)	Grope and Region-Focused Training	2018-2020
Kobe Waterworks Bureau	Africa and others	Urban waterworks maintenance (water purification and quality)	Grope and Region-Focused Training	2015-2019
Hiroshima Waterworks Bureau	Africa and others	Urban waterworks maintenance (water supply and distribution)	Grope and Region-Focused Training	2013-2020
Fukuoka Waterworks Bureau	Tanzania	Water supply non-revenue water management measures (leakage prevention measures)	Grope and Region-Focused Training	2018
Sapporo Waterworks Bureau	Africa and others	Comprehensive Waterworks Facility Technology: Practical Edition for Waterworks Practitioners (B)".	Grope and Region-Focused Training	2017-2020

Source: JICA team, based on materials from the Japan Water Works Association.

Table 2.144 Overseas Cooperation Achievements in Island Areas

Water Utility	Country	Project	Scheme	Year
Chiba Public Enterprises Bureau	Democratic Republic of East Timor	Advisory for improving water supply in the Democratic Republic of Timor-Leste	Dispatch of Experts	2015-2020
Fukuoka City Waterworks Bureau	Republic of Fiji	Project for strengthen water supply service in Nadi Lautoka District	JICA Partnership Program	2017-2020
	Republic of Fiji	Support project for the NRW reduction for the Nadi Lautoka District	JICA Partnership Program	2013-2017
Okinawa water supply authority	Samoa, Fiji, etc.	Water resource management and water supply management on the islands	Regional Training	2010-2020
	Samoa	Project for Strengthening the Capacity of Maintenance and Management for Samoa Water Supply Authority	JICA Partnership Program	2014-2020
Nago City Water and Sewerage Department	Samoa, Fiji, etc. Total 9 countries	Water resource management and water utility operations for Oceania and islands	Regional Training	2020
	Samoa	The Project for strengthening the capacity of maintenance and management for Samoa Water Supply Authority collaboration with Okinawa	Technical cooperation project	2020
Miyako City Water and Sewerage Department	Samoa	Support Project for water supply management for Samoa (Miyako Island Model)	JICA Partnership Program	2010-2012
	Oceania	Training on the management techniques for water treatment using slow filtration	JICA Partnership Program	2006-2008

Source: JICA Survey Team, based on materials from the Japan Water Works Association

2.6.3 Possibility of Japanese Companies' Participation in the Cooperation with Zanzibar

(1) Selection of the Companies Surveyed

As described above, few Japanese companies participated in the water supply business in Zanzibar although many of them operate internationally, which makes it difficult to properly select the companies to be examined the possibilities of participating in the cooperation in Zanzibar. Thus, the Survey Team decided to survey the following group of companies with the keyword of "water" and "overseas".

The Survey Team conducted a survey of members of the "Yokohama Water Business Council," which was established for the purpose of international cooperation related to water and sewerage and has a proven track record. Not only companies in Yokohama city but also companies such as Tokyo are members, and many large, medium and small companies are registered. The survey was conducted on 151 member companies with the cooperation of the YWWB which serves as the secretariat of the council.

In addition, the Survey Team conducted an interview survey with companies that are implementing water supply projects, targeting island countries that have the same environment as Zanzibar.

(2) Questionnaire to the Companies

The content of the questionnaire is shown in the table below.

Table 2.145 Summary of the Question Item and Form

Questionnaire item	How to fill out the form (selection or free description
Fields of technical product	Select from the following: Water conservation, Water leakage prevention, Rainwater harvesting, Water storage through above-ground dams, Groundwater recharge, Seawater desalination, Water supply and distribution (water supply operation) efficiency improvement, Pump efficiency improvement, Water meter and meter reading system improvement, Revenue improvement through water rate setting and collection methods, Organizational and human resource development, etc.
Name of technology or product & Features and Strengths of technical product	Free description
Form of cooperation with Zanzibar	Select from the following as methods of introducing your company's technology and products, and indicate your preference for each," Yes or No" and the reasons for your selection. -Presentation to trainees in Japan -Online Presentations from within Japan -Presentation by a displacing staff

Source: JICA Survey Team

(3) Answer to the Questionnaire

Five member companies of Yokohama Water Business Association answered the questionnaire as shown in Table-Below.

Table 2.146 Questionnaire Responses

Field	Product or technology	Overview
Countermeasure for NRW	Ultrasonic Flowmeter	By installing the sensor from the outside of the piping, the flow rate can be measured without the need to stop the fluid or reconfigure the piping. As the world's first manufacturer to develop and introduce ultrasonic flowmeters, our accumulated know-how enables us to measure even old pipes and fluids containing a few particles.
Facility management	Water Supply GIS	The system is designed to optimize repair and maintenance management of pipeline and toll collection by capturing pipeline network information on a geospatial information system (GIS) and maintaining a ledger.
Energy save & Environment	High-efficiency pumps	1 Land-based Double Suction (e.g., MODEL C NA) Compact design for easy installation, minimal maintenance, etc. 2 Land-based: Single suction (e.g., MODEL GS) 2-pole and 4-pole types for small size and lightweight, etc.
Countermeasure for NRW	Leakage investigation, general NRW control technology	We have experience in providing leakage survey technology, leakage prevention equipment, and survey technology training in India and Vietnam, through JICA projects and our contracts.
Countermeasure for NRW 、Customer management	Made of a plastic water meter	The plastic meter instead of the conventional metal meter. It is lightweight, durable, and has R160 performance for stable, long-term performance. It will also eliminate frequent thefts of metal meters.
Countermeasure for NRW	Leak detection service	(1) Permanent monitoring of pipeline conditions using original ultra-sensitive vibration sensors. (2) Analyses the leak detection results using an original algorithm implemented in the sensor and transmit the results to the cloud to remotely confirm the status of water leakage in the pipeline. (iii) The introduction of a leak detection service allows for extensive permanent monitoring, enabling early detection and early repair of abnormal conduits.
Water resource development	Desalination	(1) Reliability of process engine and system construction and according to raw water and capacity. (2) Reduction of total cost by applying a high recovery model (depending on raw water and other conditions). (3) Abundant delivery record of RO systems (over 600 UNITS)

Source: JICA Survey Team

(4) Possibility of Cooperation from Japanese Companies

Although proposals for products and technologies were obtained, there were many cautious opinions regarding the expansion into Zanzibar, and many respondents said that it was necessary to consider the situation of the market size.

From the results of the questionnaire, the form of cooperation to actively carry out local activities is not considered at present, but when presentation opportunities are prepared for trainees in Japan and local staff in Zanzibar, it was confirmed that many companies want to give presentations and have discussions to understand the local situation.

(5) Technologies owned by Japanese companies

Table below shows the technologies effective in improving water supply business collected from the past JICA projects, internet, brochures, and catalogues.

Table 2.147 List of technologies owned by Japanese companies

No	Area	Type of technology/method	Outline (*Notes)
1	Water resources development	Rainwater harvesting facilities	There are many types of material, plastic, precast concrete, and ceramic, unglazed urns are available, which are inexpensive and economical. Installation can be simplified by selecting the size, material, etc., according to the rainfall conditions and topography of the site. *Since the scale is small, it is necessary to consider using it in combination with other type of water supply. *Water quality is problematic, so care must be taken when drinking
2	Water resources development	Groundwater recharge, underground dams	Experience in Miyako Island can be helpful. *Careful consideration should be given to the scale of development in Zanzibar because of the overwhelming difference between Miyako Island's population of approximately 50,000 and Zanzibar's population of 1.3 million.
3	Water resources development	Water storage by dams	It is worth considering because there are cases where water sources are managed by linking multiple small dams. *Consideration of expropriation of land and environmental conservation aspects is needed.
4	Water resources development	Desalination	Desalination of seawater, which is abundant as a resource, is used *It must be considered countermeasures against the large amount of power consumption.
5	Leakage survey	Labour-saving equipment for water pipe leak detection	Even those without specialized leak detection skills can investigate possible leaks by simply touching the meter with this device. An equipment (TS Leak Checker) determines the presence or absence of a possible leak in about 2 seconds. *Only to be used when water is being supplied.
6	Leakage survey	Permanent automatic leak noise detector	A device installed at the meter of each house to search for possible leaks using only small equipment and inform the user of the possibility of leakage as a result. Once the possibility of leakage is identified, other methods (acoustic and correlation leakage surveys) can be used to easily identify the location of the leak. *Needs constant water supply.
7	Leak detection	Logger correlation type leak detection system	Correlative leakage survey method with multiple loggers installed. *It is difficult to do without constant water supply.
8	Leak detection	Gas exploration	In pipelines that do not have a constant water supply (e.g., intermittent water supply), it is difficult to detect leaks, so hydrogen mixed gas is filled into the pipe to detect leaks.
9	Leakage repair	Repair equipment with high water stoppage	Leak repair equipment with high water stoppage and sustainability. *Expensive to bring in abroad which made in Japan.
10	Leakage repair	Reinforcing an aging existing pipe (pipe reborn method)	Reinforcing the inner surface of the old pipe by inserting a plastic pipe as a sheath pipe while inverting the existing pipe. * Cannot be adopted if there is service pipe branch. *Pipeline renewal is less expensive in case PVC or HDPE pipe can be used.
11	Leakage repair	Reinforcing aging existing pipes (pipe-in-pipe)	The existing pipe is used as a sheath pipe, and a pipe with a smaller diameter is inserted into the pipe to form a conduit. Generally, this method is used for large-diameter straight sections, but stainless-steel bellows pipes can also be inserted into existing pipes with curved sections. *Consider cost of implementation, in most cases pipeline replacement is less expensive.
12	Water conservation	Water-saving eco-valve	Water can be saved by inserting a part (like a packing) into the faucet (water supply unit) that is designed to reduce the amount of water discharged. *Need to match the faucet shape.
13	Water conservation	Water-saving shower head	Water can be saved by reducing the size and number of the holes in the shower head and structure of shower head compared to normal ones *Undetermined how effective it will be if water pressure is not high.

14	Leakage prevention by construction method and materials	Pipe fittings for water supply (cast iron mechanical joints)	For ACP (asbestos pipe), GP (zinc coated steel pipe) and other pipe types that are inferior in strength or corrode quickly and have a high rate of leakage from joints, the possibility of leakage can be reduced by installation this type of joints by persons who have acquired the appropriate tools and techniques. *Coping therapy and does not lead to fundamental solutions
15	Leakage prevention by construction methods and materials	Corrugated stainless steel pipe for water supply	Less susceptible to corrosion and less prone to leakage. Even when there is not much piping space in the buried part, the shape can be changed freely, and workability is improved. *Expensive.
16	Leakage prevention by construction method and materials	Drill for service pipe branch	Accurate drilling is possible due to uninterrupted water supply when branching service water pipes, reducing the possibility of leakage. *Equipment is not limited to those made in Japan.
17	Leakage prevention by construction method and materials	Submersible pumps / Drainage pumps	Installation of pumps that are less prone to breakdowns enables a stable water supply and reduces maintenance costs. * Expensive initial investment.
18	Leakage prevention by construction methods and materials	Valves and flow control valves	Centralized control of divider valves and flow control butterfly valves, leading to energy savings and leakage reduction through appropriate water flow and water pressure *System construction is required to collect information on each device, which is expensive.
19	Flow measurement	Smart meter	Centralized management of customer information and water consumption. Reduces labour costs for meter readers, etc., and prevents meter reading errors. *Manufactured in other countries are more popular in Africa than those made in Japan. *Maintenance of the meter itself is also necessary but is often neglected.
20	A system reduces non-revenue water	Accurate flow meters and a rate system based on them	Electromagnetic flow meters and household electromagnetic flow meters are used to accurate water volume and to improve the payment ratio through fair fee collection. *System construction is required to collect information on each device, which is expensive.
21	Flow velocity and water level measurement	Ultrasonic flowmeter that can be installed in conjunction with or after pipeline installation	Appropriate management of water storage and distribution using water level gauges contribute water resource and energy saving. Flow measurement can be installed without suspension of the water supply. *How to use the collected data is important.
22	Drawings Management	Drawings management using GIS Pipe network data managed by the systems that can be used for design and hydraulic calculations.	Electronic data management for drawings Mainly manages information on facilities such as water purification plants and pumping stations, pipelines and manages all assets that can be used for maintenance, renewal, and investment planning. *Manufactured in other countries are more popular in Africa than those made in Japan.

Source: JICA Survey Team

Japanese technologies can be introduced if the conditions are met but are often considered to be expensive although of high quality. It is necessary to adopt appropriate technology contributing to resource conservation, business management, and the benefit of the recipient country while properly understanding the character of the technology.

2.6.4 Survey to Japanese Water Utilities

(1) Selection of Water Utilities

As mentioned before, since only the Yokohama City has a cooperation record with Zanzibar, the Survey Team expanded the survey target to entities with the track records in other countries in African region, in Pacific Island countries from the similarity with Zanzibar and of JICA Partnership Program. In addition, some cities were selected for the reason of similarity with Zanzibar in which it totally relies on groundwater and supplies water to similar served population.

(2) Questionnaire to the Water Utilities

Survey items in the questionnaire are the record of international cooperation, the possibility of support or cooperation in the field of customer management, and human resource development. As for the cooperation scheme with JICA, items such as acceptance of training participants, providing trainers, or dispatch of its staff members were surveyed because formulating an original support project was considered difficult for local government independently.

(3) Result of the Questionnaire

Some water utilities responded that there is a possibility of collaboration with Zanzibar, while there are few pessimistic responses too, such as "Consider response upon request" and "No plans for collaboration". However, when the persons from Zanzibar come to Japan, it may be possible to visit these water utilities as places for sight inspection.

2.6.5 Invitation Plan to Japan

Based on the issues of the water sector in Zanzibar, the Survey Team planned to invite person from Zanzibar water sector to Japan. The invitation to Japan planned here is based on the premise that if a project such as a technical cooperation project is implemented with the support of JICA in the future, it will be one of the activities in that project.

(1) Theme of invitation to Japan

As mentioned in 2.4, The water sector in Zanzibar faces various challenges such as improving and strengthening water resources management, NRW reduction measures, billing and collection. Additionally, legislation and securing and developing human resources to implement the above-mentioned challenges are required. In this context, the following themes are identified.

- Water resource management, such as legal framework and implementation and monitoring
- Countermeasures to reduce NRW, such as distribution management, water leakage countermeasures, customer data management and financial improvement
- Human resource development, training mechanism, technology inheritance, and know-how sharing

Since the opportunity to visit Japan is scarce for the persons invited, matching programs with Japanese companies and/or conducting opinion exchanges with water utilities are expected to be initiated.

(2) Target Persons to be Invited

For Zanzibar's water sector to continue to address these issues, it will require the involvement of senior officials such as the Permanent Secretary of MoWEM and Director General of ZAWA. Therefore, inviting people like them is considered to be very effective. It is also considered effective to invite directors at the department manager level who are actually in charge of water supply management and human resource development. Based on the above, Study Team proposes the following invitees.

- Senior Administrative Officer (e.g., Permanent Secretary of MoWEM, DG of ZAWA)
- Directors (general manager class) involved in water supply management and human resource development

It is also possible to invite staff-level managers who manage direct and actual work under the director. Since it will be considered in future projects, training that is close to practical work, and long-term training to improve the effect will be recommended. Therefore, we propose to take opportunities other than invitations to Japan, such as participation in topic-based training.

(3) Draft Invitation Plan to Japan

Table 2.148 shows the plan for invitation.

When planning and implementing an actual invitation, it is not simple because various organizations such as the government and water supply companies, as well as specialized occupations and ranks, are targeted. In addition, due to the ideas of the recipient organization and restrictions on the receiving organization, it is necessary to carefully consider the target person, content, and period before making a decision.

Table 2.148 Invitation Plan to Japan (Draft)

Item	Subjects	Background to the Proposal
Theme for Invitees	Groundwater resource management	-While the amount of water that can be pumped based on scientific evidence is unknown. Despite such a situation water source development and water utilization are being carried out, management is inadequate, and there are concerns about saltwater intrusion into groundwater. - It is difficult to manage water distribution by various water sources including wells. And problems such as insufficient water supply service due to insufficient water pressure are likely to occur in areas with poor hydraulic conditions. - Since there are a large number of water sources, distribution reservoirs, and elevated water tanks and pipelines, it has become an issue occurrence of frequent water leaks due to the deterioration of water supply facilities.
	Management of NRW	-High NRW is the highest issue strain on water supply business management, therefore exchange opinions with related parties while introducing improvement cases in Japan (assuming Yokohama City and Tokyo). -Customers are feeling unfair due to poor water supply services due to the shift from flat-rate to pay-as-you-go services. -Learn about the cases of cities that have achieved self-supporting systems in business operations.
	Human resource development	-Regarding water sources, it is important to work on improving the current situation by first gaining the necessary knowledge. -The level of staff ability in each job varies, and a certain level of quality is not maintained. To enhance ZAWA's training program, consider the themes and training contents necessary for capacity improvement and the scale of the program.
Details of implementation	Water services in general	- Introduction to the division of responsibilities of administrative organizations, design of laws, regulations, and institutions, organizational reform, groundwater management, technical standards, etc. -Through the development of the vision for water supply, introducing points to note in water services administration.
	Introduction of water resource management	-In response to the issues (groundwater management) that emerge from this survey, exchanging opinions with related parties while introducing improvement cases in Japan (assuming site introductions in Miyakojima City and Kumamoto City).
	Introduction of NRW countermeasure	- Focusing on measures against NRW, introduce examples of how to improve by taking examples of problems that have occurred in the past (assuming a site visit in Yokohama City).
	Human resources development Introduction of water services administration	-In response to the issues that emerge from this survey (insufficient human resources development system), we will exchange opinions with related parties while introducing improvement cases in Japan (assuming Yokohama City and Tokyo). -Introduce Japanese cases and conduct site visits (assuming Yokohama City), keeping in mind that they can be reflected in the training system of Zanzibar. -Consider how to train trainers within the organization and how to improve motivation by qualifying trainers.
	Case study through the field	-Support for introducing private company products and hearing about local conditions by providing matching opportunities for trainees when they visit Japan.
		-Consider only if they are highly interested in seawater desalination facilities -Introduce the achievements from companies with achievements in the island area (assuming private companies (Hitachi, Japanese membrane manufacturers, etc.). -On-site inspection (assuming Fukuoka City and Okinawa Prefectural Enterprise Bureau) will also be considered necessary. -Effective use of water sources through mutual communication of small dams (Okinawa Prefectural Enterprise Bureau, Ishigaki City is assumed)
		-Introduce municipalities (Miyakojima City, Kumamoto City, Hiroshima City, Tokyo) that promote the use of groundwater, and conduct site visits.
Period of Acceptance	About 10 to 14 days including facility tours	-Since it is difficult for executives to leave the organization for a long period, consider the period with a program that emphasizes discussions based on themes even for a short period.
	About 3 weeks (when conducting staff-level training)	- In addition to lectures and facility inspection, consider the period as a program that incorporates hands-on experience (sharing the state of activities even if it is not possible for trainees to experience it in the field).

Source: JICA Survey Team

Chapter 3 Urgent Issues to be Addressed

3.1 Urgent Issues to be Addressed

As for ZUWSP area, water service has not been improved despite the completion of the project. In the Japanese ODA loan project, water transmission to Saateni reservoir located in the ZUSP area is planned. If water leakage in the ZUWSP area exceeds the expected amount, it will affect the facility operation and water balance in the Japanese project area located upstream of the ZUWSP area. Therefore, urgent improvement is required.

In addition, ongoing RIWSSZ is going to install prepaid meters for large consumers as a trial. The system required to operate the prepaid meters will be provided by the water meter manufacturer, but the water tariff has not yet been set. Since RIWSSZ is scheduled to complete two lots in October 2022 and one lot in January 2023, it is necessary to set the water tariff for prepaid uses immediately.

3.2 Measures for Urgent Issue in ZUWSP Area

(1) Issues in ZUWSP Area

As noted in 2.2.4, the following issues are considered urgent for ZUWSP area based on the results of the current study.

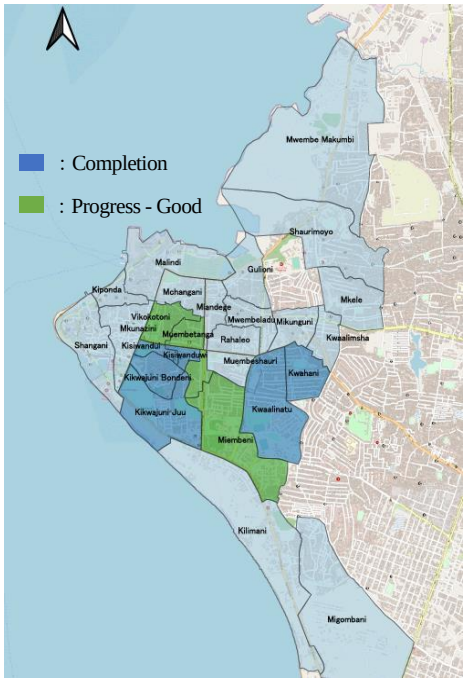
- Issue 1: Implementation of service connection replacement and disconnection of removable existing pipelines.
- Issue 2: Planning methods for service connections within Stone Town.
- Issue 3: Repair or replace inoperative flowmeters at the reservoirs and DMAs

(2) Measures for Issue 1 (Disconnection of removable pipelines)

(i) Replacement of service connections

As noted in 2.2.4, 6,900 replacement of service connections were planned in the ZUWSP area, of which 3,450 were completed and 3,450 were not yet completed.

Progress of the replacement varies from shehia to shehia. According to a technician of Customer Service Department, the replacement and disconnection of removable pipelines were completed in the 5 shehias in the southern part of the Saateni zone (Kikwajuni Bondeni, Kikuwajuni Juu, Kwaalinatoo, Kwahani, and Kisiwandui). Figure 3.1 shows the progress of water supply reconnection.



Source: JICA Survey Team

Figure 3.1 Progress of Service Connection Installation

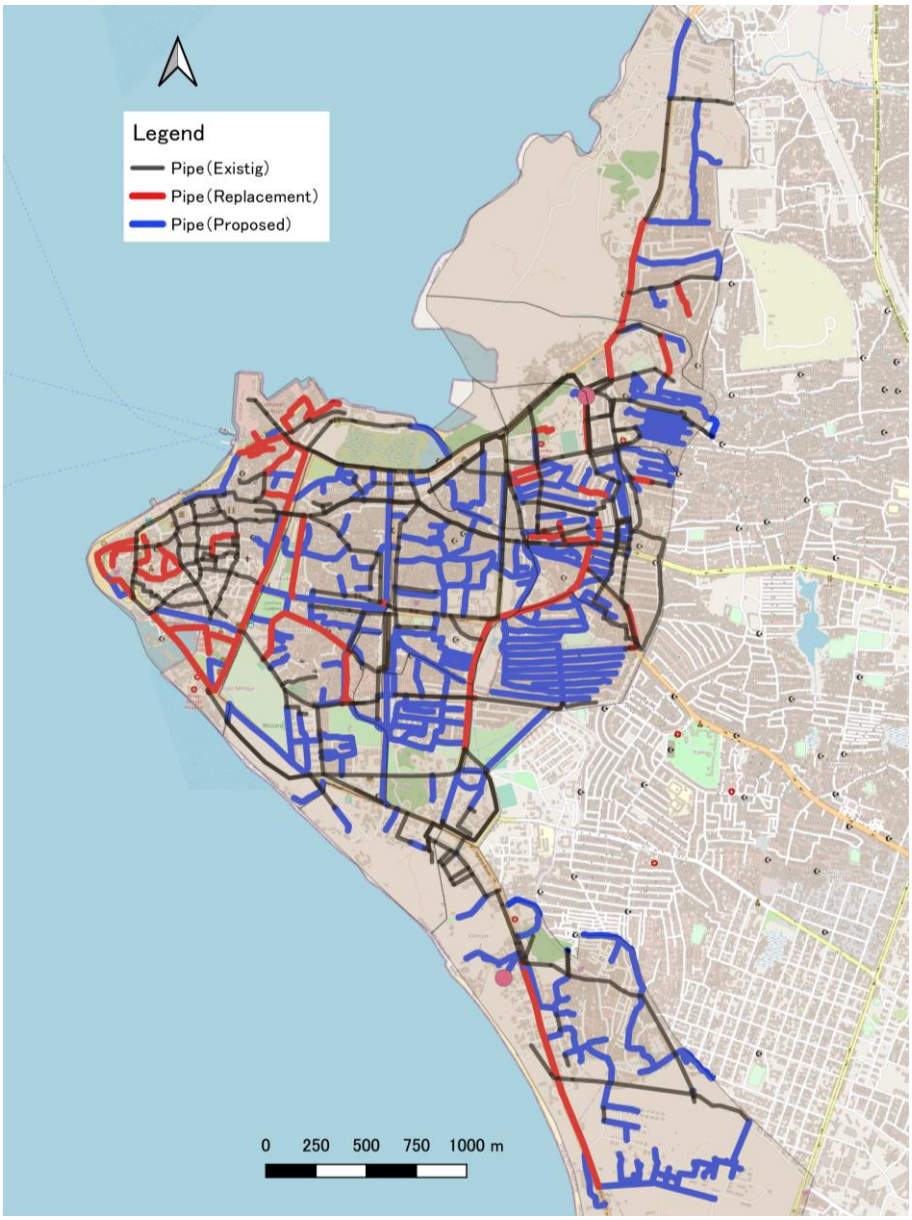
(ii) Identification of removable existing pipelines

In ZUWSP, laying new pipelines and replacing aged pipelines were planned and implemented. On the planned pipeline

replacement routes, new pipelines were installed along the existing pipelines, but the existing pipelines still existed and supplied water to customers due to the delayed installation of service connections. Therefore, removable pipelines are on the planned routes of pipeline replacement. Additionally, the pipelines in the routes where new pipelines were laid near of along with existing pipelines may be removal. Consequently, existing pipes are classified in the following categories to identify the removable existing pipelines.

- Pipe (Replacement): Both newly laid pipe and removable old existing pipe exist
- Pipe (Proposed): Newly installed pipe
- Pipe (Existing): Existing pipe not being the target of replacement (including pipes excluded from the replacement target due to the reduction of the scope of work of ZUWSP)

Pipeline Map of ZUWSP area is shown in Figure 3.2, and removable existing pipelines by material and diameter is shown in Table 3.1. In total, there are approximately 12.7 km removable pipelines in the area.



Source: JICA Survey Team Based on ZUWSP As-Built Data

Figure 3.2 Pipeline Map of ZUWSP Area

Table 3.1 Removable Existing Pipelines by Material and Diameter

Diameter(mm)	Pipe Type	Pipe Length(m)	Diameter(mm)	Pipe Type	Pipe Length(m)
75	AC	0	180	AC	0
	DI	0		DI	0
	PE	288		PE	1,801
90	AC	0	205	AC	0
	DI	0		DI	0
	PE	1,277		PE	128
110	AC	0	250	AC	0
	DI	0		DI	0
	PE	2,421		PE	1,351
115	AC	0	300	AC	0
	DI	0		DI	412
	PE	97		PE	0
140	AC	0	315	AC	0
	DI	0		DI	0
	PE	3,090		PE	1,235
150	AC	248	350	AC	0
	DI	0		DI	284
	PE	0		PE	84
			Total		**12,717**

Source: JICA Survey Team

(iii) Method for disconnection removable existing pipelines from the network

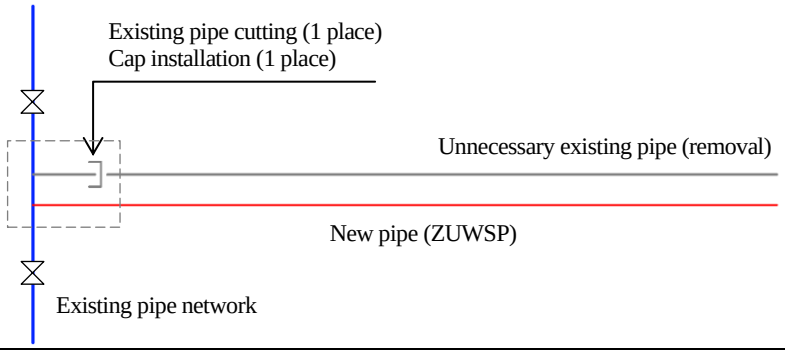
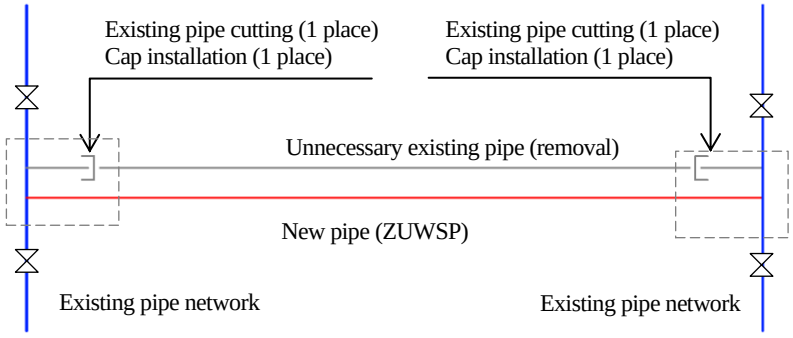
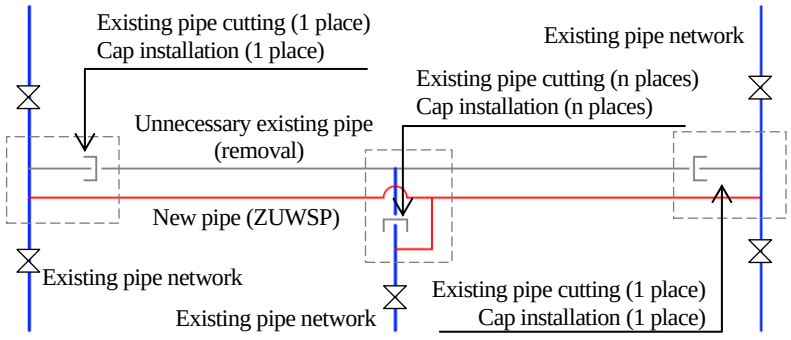
The removal existing pipelines can be classified into the following three types.

- Type 1: Connecting to the network at only one point
- Type 2: Connecting to the network at two points (start and end points)
- Type 3: Connecting to the network at three or more points (start and end points, and points between the start and end points)

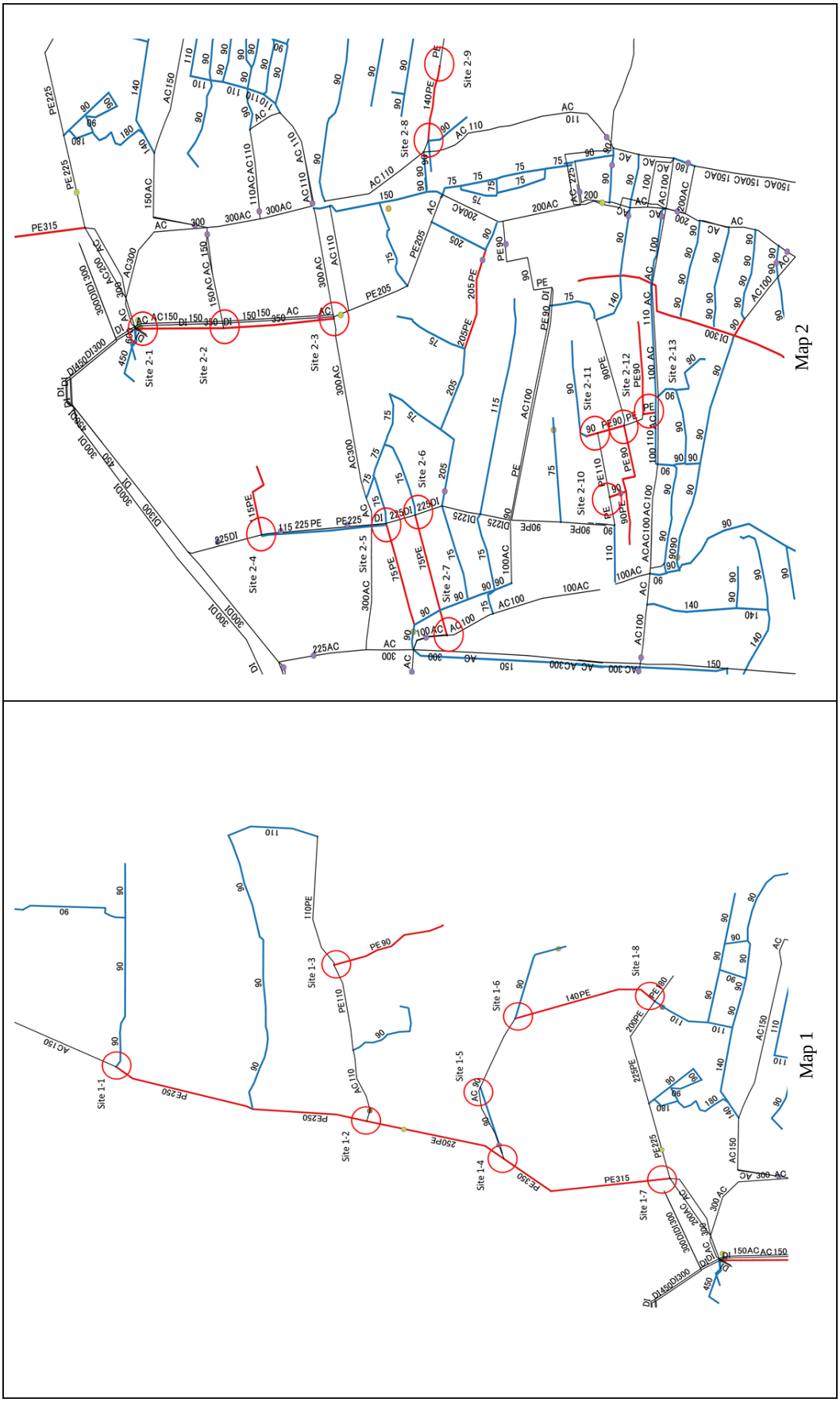
Table 3.2 shows the method of unnecessary pipe disconnection. Location map for disconnection work is shown in Figure 3.3 through Figure 3.6, and estimated bill of quantities are shown in Table 3.3 through Table 3.9.

Before procuring materials and implementing the work, it is necessary to plan the work method and procedures considering the situation of pipeline connections checked at the sites.

Table 3.2 Method of Unnecessary Existing Pipe Disconnection

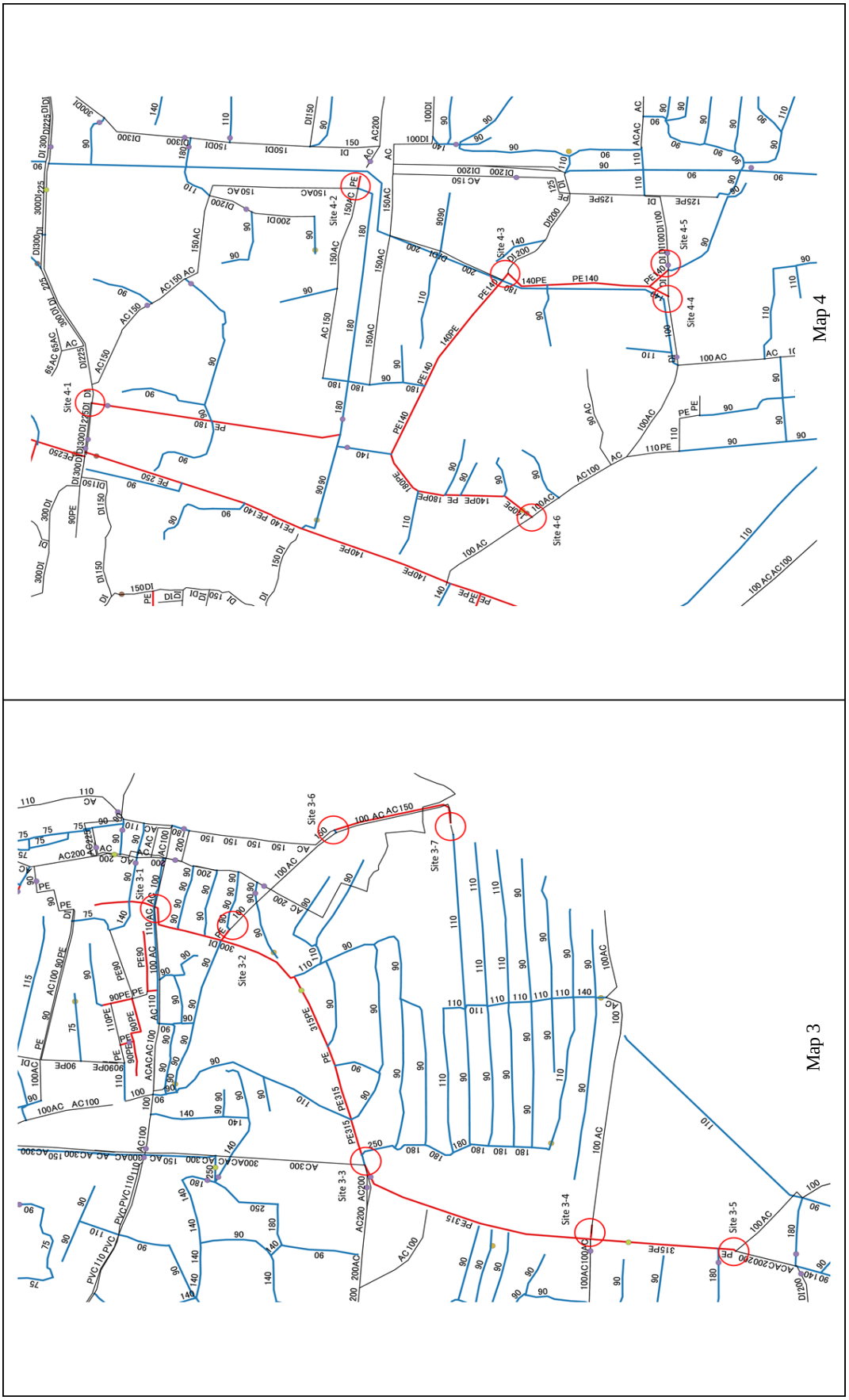
Category	Item	Contents
Type 1	Outline	Unnecessary existing pipelines connecting to the network at only one point
	Schematic Diagram	
	Construction method	1 Completion of installation of service connections from new pipes (start water supply from new pipes) 2 Test Pit (if required) (check the buried pipe situation such as location, material, and diameter) 3 Existing pipe disconnection work (preparation for the work (e.g., valve operation); excavation & backfill: 1 place; existing pipe cutting: 1 place; cap installation: 1 place; existing pipe removal)
	Points to be noted	If the existing pipes are asbestos pipes, handling it should be careful.
Type 2	Outline	Unnecessary existing pipelines connecting to the network at two points (start and end points)
	Schematic Diagram	
	Construction method	1 Completion of installation of service connections from new pipes (start water supply from new pipes) 2 Test Pit (if required) (check the buried pipe situation such as location, material, and diameter) 3 Existing pipe disconnection work (preparation for the work (e.g., valve operation), excavation & backfill: 2 places; existing pipe cutting: 2 places; cap installation: 2 places; existing pipe removal)
	Points to be noted	・Temporary water supply suspension area by the work should be confirmed before the work. ・If the existing pipes are asbestos pipes, handling it should be careful.
Type 3	Outline	Unnecessary existing pipelines connecting to the network at three or more points (start and end points, and points between the start and end points)
	Schematic Diagram	
	Construction method	1 Completion of installation of service connections from new pipes (start water supply from new pipes) 2 Test Pit (if required) (check the buried pipe situation such as location, material, and diameter) 3 Existing pipe disconnection work (preparation for the work (e.g., valve operation), excavation & backfill, existing pipe cutting, cap installation, removal of existing pipe)
	Points to be noted	・Temporary water supply suspension area by the work should be confirmed before the work. ・Need to check the situation of connections among buried pipelines. ・If the existing pipes are asbestos pipes, handling it should be careful.

Source: JICA Survey Team



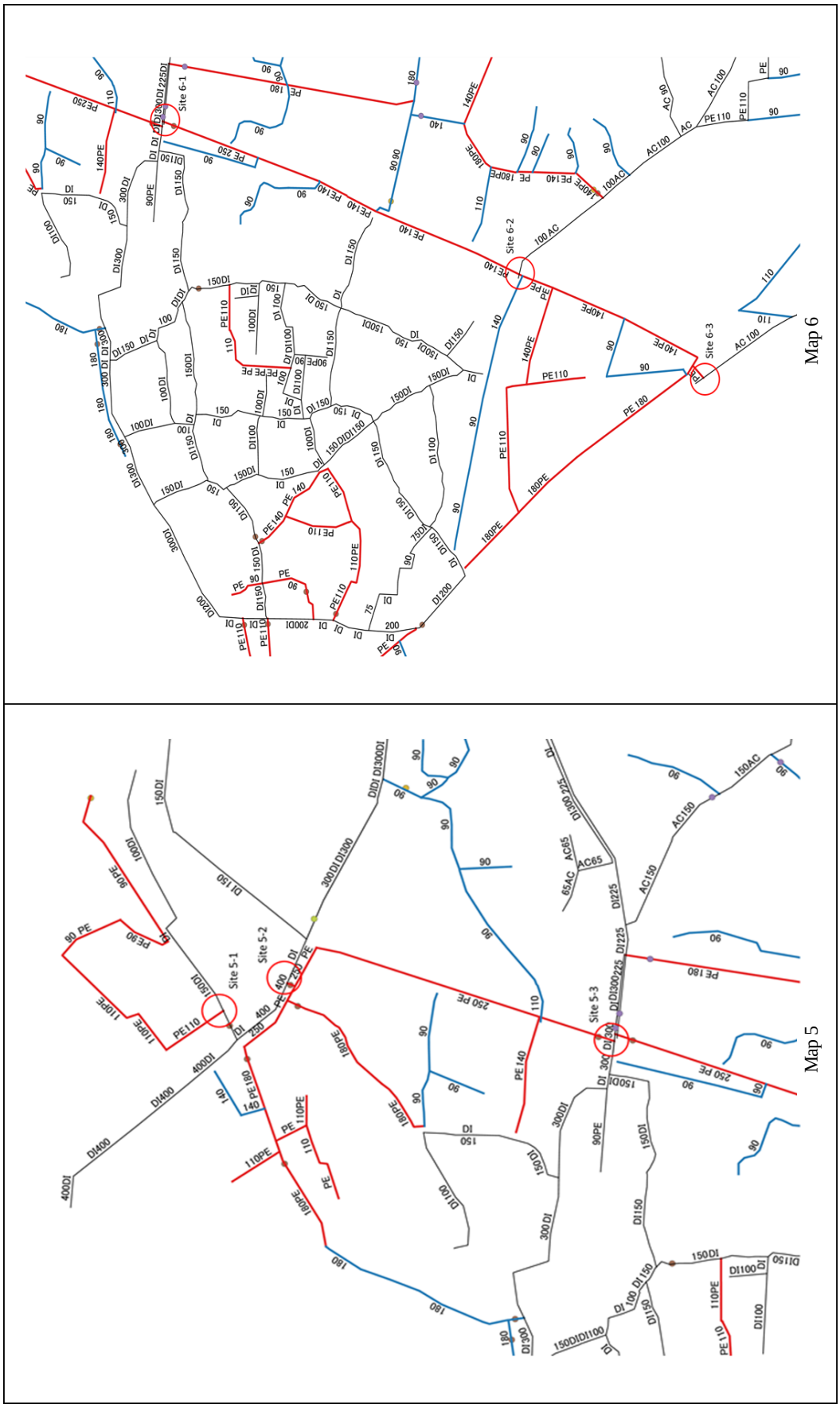
Source: JICA Survey Team

Figure 3.3 Location Map for Disconnection Work (1)



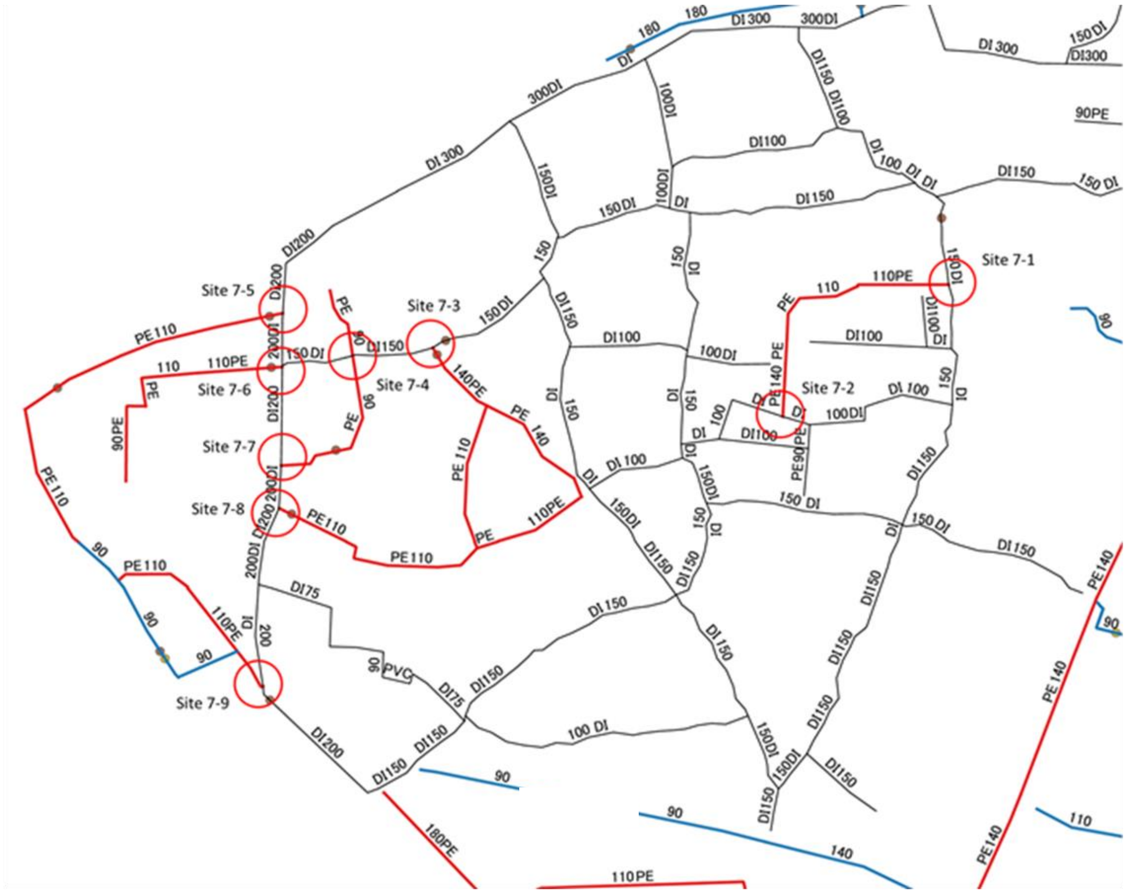
Source: JICA Survey Team

Figure 3.4 Location Map for Disconnection Work (2)



Source: JICA Survey Team

Figure 3.5 Location Map for Disconnection Work (3)



Map 7

Source: JICA Survey Team

Figure 3.6 Location Map for Disconnection Work (4)

Table 3.3 Estimated Bill of Quantities (Location Map 1)

Category	Type of Work	Location	Specification	Unit	Amount
Materials	Cap	Site 1-1	PE250	No.	1
		Site 1-2	AC110	No.	1
		Site 1-3	PE90	No.	1
		Site 1-4	PE90	No.	1
		Site 1-5	PE90	No.	1
		Site 1-6	PE140	No.	1
		Site 1-7	PE315	No.	1
		Site 1-8	PE180	No.	1
Earthworks	Man-Powered Excavation Backfilling	Site 1-1	1.0m×1.0m×1.4m	m3	1.4
		Site 1-2	1.0m×1.0m×1.3m	m3	1.3
		Site 1-3	1.0m×1.0m×1.2m	m3	1.2
		Site 1-4	1.0m×1.0m×1.2m	m3	1.2
		Site 1-5	1.0m×1.0m×1.2m	m3	1.2
		Site 1-6	1.0m×1.0m×1.3m	m3	1.3
		Site 1-7	1.0m×1.0m×1.5m	m3	1.5
		Site 1-8	1.0m×1.0m×1.3m	m3	1.3
Pipeworks	Cutting Work of Existing Pipes	Site 1-1	PE250	Place	1
		Site 1-2	AC110	Place	1
		Site 1-3	PE90	Place	1
		Site 1-4	PE90	Place	1
		Site 1-5	PE90	Place	1
		Site 1-6	PE140	Place	1
		Site 1-7	PE315	Place	1
		Site 1-8	PE180	Place	1
	Cap Installation	Site 1-1	PE250	Place	1
		Site 1-2	AC110	Place	1
		Site 1-3	PE90	Place	1
		Site 1-4	PE90	Place	1
		Site 1-5	PE90	Place	1
		Site 1-6	PE140	Place	1
		Site 1-7	PE315	Place	1
		Site 1-8	PE180	Place	1

Source: JICA Survey Team

Table 3.4 Estimated Bill of Quantities (Location Map 2)

Category	Type of Work	Location	Specification	Unit	Amount
Materials	Cap	Site 2-1	DI350	No.	1
		Site 2-2	AC150	No.	1
		Site 2-3	DI350	No.	1
		Site 2-4	PE115	No.	1
		Site 2-5	PE75	No.	1
		Site 2-6	PE75	No.	1
		Site 2-7	PE75	No.	1
		Site 2-8	PE140	No.	1
		Site 2-9	PE140	No.	1
		Site 2-10	PE90	No.	1
		Site 2-11	PE110	No.	1
		Site 2-12	PE90	No.	2
		Site 2-13	PE90	No.	2
Earthworks	Man-Powered Excavation Backfilling	Site 2-1	1.0m×1.0m×1.5m	m3	1.5
		Site 2-2	1.0m×1.0m×1.3m	m3	1.3
		Site 2-3	1.0m×1.0m×1.5m	m3	1.5
		Site 2-4	1.0m×1.0m×1.3m	m3	1.3
		Site 2-5	1.0m×1.0m×1.2m	m3	1.2
		Site 2-6	1.0m×1.0m×1.2m	m3	1.2
		Site 2-7	1.0m×1.0m×1.2m	m3	1.2
		Site 2-8	1.0m×1.0m×1.3m	m3	1.3
		Site 2-9	1.0m×1.0m×1.3m	m3	1.3
		Site 2-10	1.0m×1.0m×1.2m	m3	1.2
		Site 2-11	1.0m×1.0m×1.3m	m3	1.3
		Site 2-12	1.0m×1.0m×1.2m×2 Spots	m3	2.4
		Site 2-13	1.0m×1.0m×1.2m×2 Spots	m3	2.4
Pipeworks	Cutting Work of Existing Pipes	Site 2-1	DI350	Place	1
		Site 2-2	AC150	Place	1
		Site 2-3	DI350	Place	1
		Site 2-4	PE115	Place	1
		Site 2-5	PE75	Place	1
		Site 2-6	PE75	Place	1
		Site 2-7	PE75	Place	1
		Site 2-8	PE140	Place	1
		Site 2-9	PE140	Place	1
		Site 2-10	PE90	Place	1
		Site 2-11	PE110	Place	1
		Site 2-12	PE90	Place	2
		Site 2-13	PE90	Place	2
	Cap Installation	Site 2-1	DI350	Place	1
		Site 2-2	AC150	Place	1
		Site 2-3	DI350	Place	1
		Site 2-4	PE115	Place	1
		Site 2-5	PE75	Place	1
		Site 2-6	PE75	Place	1
		Site 2-7	PE75	Place	1
		Site 2-8	PE140	Place	1
		Site 2-9	PE140	Place	1
		Site 2-10	PE90	Place	1
		Site 2-11	PE110	Place	1
		Site 2-12	PE90	Place	2
		Site 2-13	PE90	Place	2

Source: JICA Survey Team

Table 3.5 Estimated Bill of Quantities (Location Map 3)

Category	Type of Work	Location	Specification	Unit	Amount
Materials	Cap	Site 3-1	AC110	No.	2
		Site 3-2	AC100	No.	1
		Site 3-3	AC300	No.	1
			AC200	No.	1
		Site 3-4	AC100	No.	2
		Site 3-5	AC200	No.	1
			AC100	No.	1
			PE315	No.	1
		Site 3-6	AC150	No.	1
		Site 3-7	AC100	No.	1
Earthworks	Man-Powered Excavation Backfilling	Site 3-1	1.0m×1.0m×1.2m×2Place	m3	2.4
		Site 3-2	1.0m×1.0m×1.2m	m3	1.2
		Site 3-3	1.0m×1.0m×1.4m	m3	1.4
			1.0m×1.0m×1.3m	m3	1.3
		Site 3-4	1.0m×1.0m×1.2m×2Place	m3	2.4
		Site 3-5	1.0m×1.0m×1.3m	m3	1.3
			1.0m×1.0m×1.2m	m3	1.2
			1.0m×1.0m×1.5m	m3	15
		Site 3-6	1.0m×1.0m×1.3m	m3	1.3
		Site 3-7	1.0m×1.0m×1.2m	m3	1.2
Pipeworks	Cutting Work of Existing Pipes	Site 3-1	AC110	Place	2
		Site 3-2	AC100	Place	1
		Site 3-3	AC300	Place	1
			AC200	Place	1
		Site 3-4	AC100	Place	2
		Site 3-5	AC200	Place	1
			AC100	Place	1
			PE315	Place	1
		Site 3-6	AC150	Place	1
		Site 3-7	AC100	Place	1
	Cap Installation	Site 3-1	AC110	Place	2
		Site 3-2	AC100	Place	1
		Site 3-3	AC300	Place	1
			AC200	Place	1
		Site 3-4	AC100	Place	2
		Site 3-5	AC200	Place	1
			AC100	Place	1
			PE315	Place	1
		Site 3-6	AC150	Place	1
		Site 3-7	AC100	Place	1

Source: JICA Survey Team

Table 3.6 Estimated Bill of Quantities (Location Map 4)

Category	Type of Work	Location	Specification	Unit	Amount
Materials	Cap	Site 4-1	PE180	No.	1
		Site 4-2	PE250	No.	1
		Site 4-3	PE140	No.	2
			DI200	No.	1
		Site 4-4	PE140	No.	1
		Site 4-5	PE140	No.	1
		Site 4-6	PE140	No.	1
Earthworks	Man-Powered Excavation Backfilling	Site 4-1	1.0m×1.0m×1.3m	m3	1.3
		Site 4-2	1.0m×1.0m×1.4m	m3	1.4
		Site 4-3	1.0m×1.0m×1.3m	m3	1.3
			1.0m×1.0m×1.3m	m3	1.3
		Site 4-4	1.0m×1.0m×1.3m	m3	1.3
		Site 4-5	1.0m×1.0m×1.3m	m3	1.3
		Site 4-6	1.0m×1.0m×1.3m	m3	1.3
Pipeworks	Cutting Work of Existing Pipes	Site 4-1	PE180	Place	1
		Site 4-2	PE250	Place	1
		Site 4-3	PE140	Place	2
			DI200	Place	1
		Site 4-4	PE140	Place	1
		Site 4-5	PE140	Place	1
		Site 4-6	PE140	Place	1
	Cap Installation	Site 4-1	PE180	Place	1
		Site 4-2	PE250	Place	1
		Site 4-3	PE140	Place	2
			DI200	Place	1
		Site 4-4	PE140	Place	1
		Site 4-5	PE140	Place	1
		Site 4-6	PE140	Place	1

Source: JICA Survey Team

Table 3.7 Estimated Bill of Quantities (Location Map 5)

Category	Type of Work	Location	Specification	Unit	Amount
Materials	Cap	Site 5-1	PE110	No.	1
		Site 5-2	PE250	No.	1
		Site 5-3	PE250	No.	1
Earthworks	Man-Powered Excavation Backfilling	Site 5-1	1.0m×1.0m×1.3m	m3	1.3
		Site 5-2	1.0m×1.0m×1.4m	m3	1.4
		Site 5-3	1.0m×1.0m×1.4m	m3	1.4
Pipeworks	Cutting Work of Existing Pipes	Site 5-1	PE110	Place	1
		Site 5-2	PE250	Place	1
		Site 5-3	PE250	Place	1
	Cap Installation	Site 5-1	PE110	Place	1
		Site 5-2	PE250	Place	1
		Site 5-3	PE250	Place	1

Source: JICA Survey Team

Table 3.8 Estimated Bill of Quantities (Location Map 6)

Category	Type of Work	Location	Specification	Unit	Amount
Materials	Cap	Site 6-1	PE250	No.	1
		Site 6-2	AC100	No.	1
		Site 6-3	PE140	No.	1
Earthworks	Man-Powered Excavation Backfilling	Site 6-1	1.0m×1.0m×1.4m	m3	1.4
		Site 6-2	1.0m×1.0m×1.2m	m3	1.2
		Site 6-3	1.0m×1.0m×1.3m	m3	1.3
Pipeworks	Cutting Work of Existing Pipes	Site 6-1	PE250	Place	1
		Site 6-2	AC100	Place	1
		Site 6-3	PE140	Place	1
	Cap Installation	Site 6-1	PE250	Place	1
		Site 6-2	AC100	Place	1
		Site 6-3	PE140	Place	1

Source: JICA Survey Team

Table 3.9 Quantity of Existing Pipe Disconnection Work (Location Map 7)

Category	Type of Work	Location	Specification	Unit	Amount
Materials	Cap	Site 7-1	PE110	No.	1
		Site 7-2	PE140	No.	1
		Site 7-3	PE140	No.	1
		Site 7-4	PE90	No.	2
		Site 7-5	PE110	No.	1
		Site 7-6	PE110	No.	1
		Site 7-7	PE90	No.	1
		Site 7-8	PE110	No.	1
		Site 7-9	PE110	No.	1
Earthworks	Man-Powered Excavation Backfilling	Site 7-1	1.0m×1.0m×1.3m	m3	1.3
		Site 7-2	1.0m×1.0m×1.3m	m3	1.3
		Site 7-3	1.0m×1.0m×1.3m	m3	1.3
		Site 7-4	1.0m×1.0m×1.2m	m3	1.2
		Site 7-5	1.0m×1.0m×1.3m	m3	1.3
		Site 7-6	1.0m×1.0m×1.3m	m3	1.3
		Site 7-7	1.0m×1.0m×1.2m	m3	1.2
		Site 7-8	1.0m×1.0m×1.3m	m3	1.3
		Site 7-9	1.0m×1.0m×1.3m	m3	1.3
Pipeworks	Cutting Work of Existing Pipes	Site 7-1	PE110	Place	1
		Site 7-2	PE140	Place	1
		Site 7-3	PE140	Place	1
		Site 7-4	PE90	Place	1
		Site 7-5	PE110	Place	1
		Site 7-6	PE110	Place	1
		Site 7-7	PE90	Place	1
		Site 7-8	PE110	Place	1
		Site 7-9	PE110	Place	1
	Cap Installation	Site 7-1	PE110	Place	1
		Site 7-2	PE140	Place	1
		Site 7-3	PE140	Place	1
		Site 7-4	PE90	Place	1
		Site 7-5	PE110	Place	1
		Site 7-6	PE110	Place	1
		Site 7-7	PE90	Place	1
		Site 7-8	PE110	Place	1
		Site 7-9	PE110	Place	1

Source: JICA Survey Team

(3) Measures for Issue 2 (Service Connections in Stone Town)

(a) Situation of buildings in Stone Town

To disconnect unnecessary existing pipes, starting water supply from new pipelines is required. And to do so, completion of the service connection installation is necessary. However, as shown in Photo 3.1, there are many multi-story tall buildings in Stone Town. In addition, as shown in Photo 3.2, many buildings have tanks on their rooftops for water supply to the buildings.

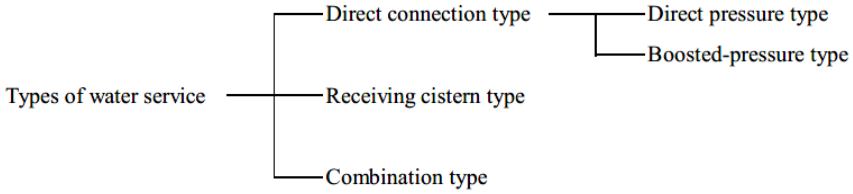
Therefore, it may be difficult to supply water simply by reconnecting service connections, and a plan for water supply methods for multi-story buildings is needed.

Photo 3.1 Photo of Inside Stone Town

Photo 3.2 Photo of Multi-level Building in Stone Town

(b) Water supply system for multi-story buildings

A typical water supply system is shown in Figure 3.7. The Japanese design criteria specify 15 m of minimum effective water head for supplying water directly to two-story buildings. When the direct pressure system is not feasible for water supply to buildings of three or more stories due to the pressure conditions, the boosted pressure system, receiving tank system, or combination system are generally used.



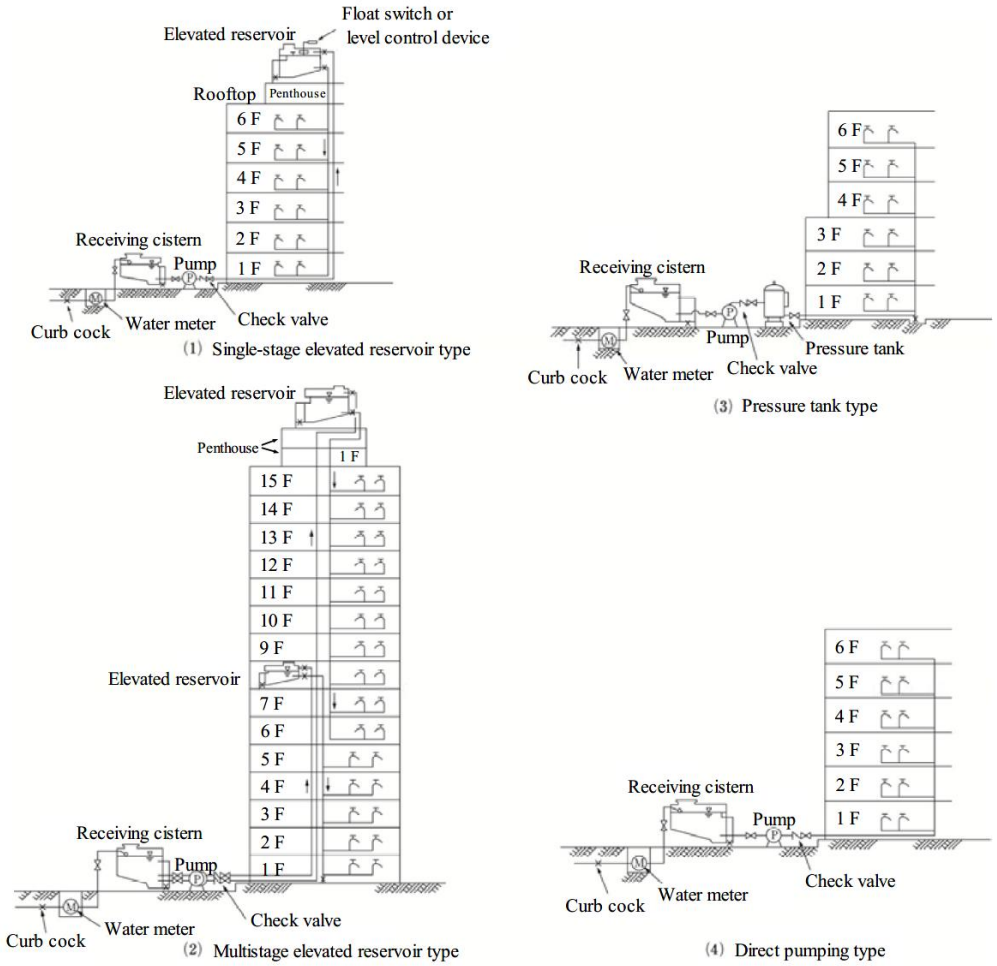
Source: Design Criteria for Water Supply Facilities (2012), Japan Water Works Association (JWWA)

Figure 3.7 Water Supply System

In principle, boosted pressure systems (direct connection of a booster pump) are not permitted under the Water Regulations because it causes low pressure on the surrounding pipelines. Therefore, the receiving tank system and/or the combination system are applicable in Zanzibar.

Source: Design Criteria for Water Supply Facilities (2012), Japan Water Works Association (JWWA)

Figure 3.8 shows a general diagram of the receiving tank system. Incidentally, the combination system supplies water to low-story floors by direct pressure and high-story floors by receiving tank system.



Source: Design Criteria for Water Supply Facilities (2012), Japan Water Works Association (JWWA)

Figure 3.8 General Diagram of Receiving Tank System

(c) Issues on water supply in Stone Town

・Securing sites for installation of receiving tanks: In case of the receiving tank system, a water tank must be installed at the basement level, and pump equipment must be provided to lift water from the tank to the rooftop tank or to supply water to the building. However, as shown in Photo 3.3, many of the alleys in Stone Town are narrow, and it is not easy to secure sites for the tanks. In addition, as Stone Town is registered as a World Heritage Site, consultation with the Stone Town Conservation and Development Authority (STCDA) is required before installing the facilities.

Photo 3.3 Alley in Stone Town

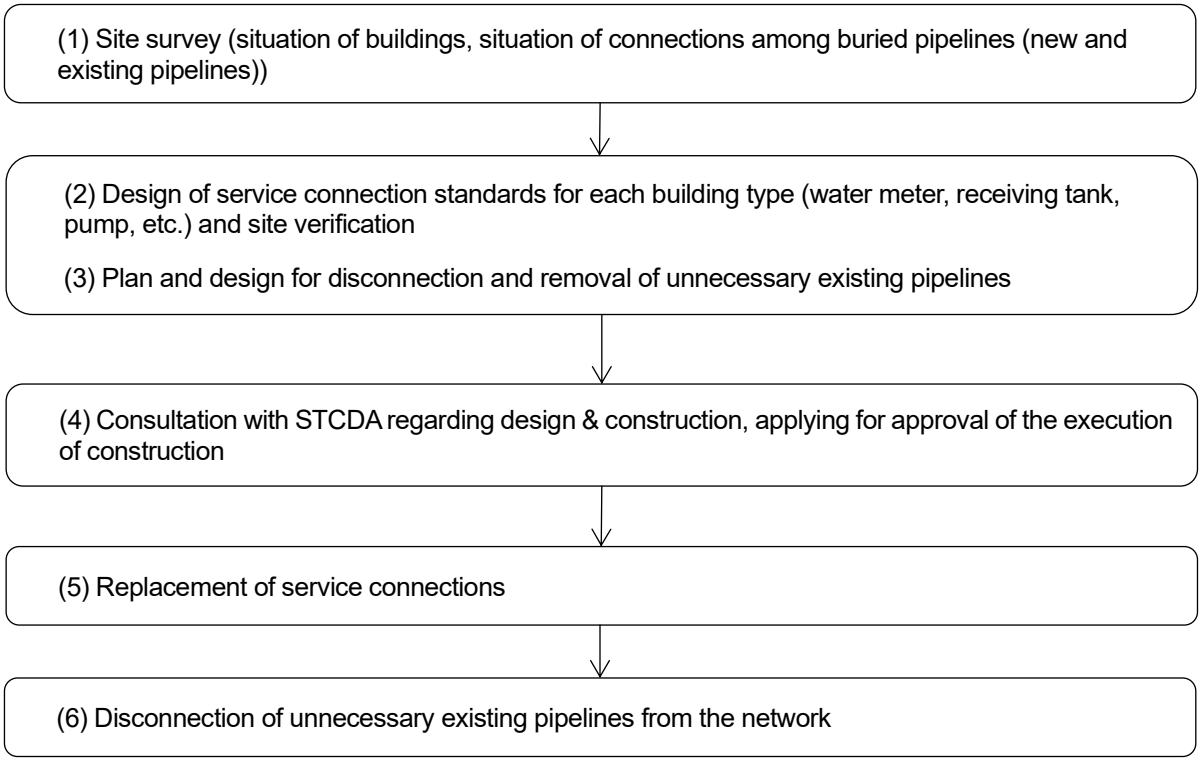
・Installation of water meters: In the case of multiple dwelling buildings, the place of meters to be installed

and the number of water meters depend on whether billing to the building owner or each household. Before connecting the water supply, it is necessary to confirm the billing address and user information for each building in cooperation with the Customer Service Department and reflect this information in the design.

- Handling of manifolds constructed by ZUWSP: As noted in 2.2.4, the manifolds in Stone Town constructed by ZUWSP are difficult to utilize. Either replacing the lids with the lightweight ones that can be opened and closed by meter readers or reconstructing manifolds are required. In either case, this should proceed in consultation with the Stone Town Conservation and Development Authority.

(d) Procedures for implementing water supply connections in Stone Town.

The following procedures are proposed for the implementation of water supply connection work in Stone Town.



Source: JICA Survey Team

Figure 3.9 Procedure for Replacement of Service Connections in Stone Town

(4) Measures for Issue 3 (Repair or Replace of Malfunction Flowmeters)

(a) Measures for electromagnetic flowmeters

Flowmeters at the service reservoirs and DMA boundaries can be used to manage water flow volume and estimate leakage volume in the DMAs in the ZUWSP area. Currently, 13 electromagnetic flowmeters are out of service as shown in Table 3.10 .

Table 3.10 Status of Electromagnetic Flowmeters Installed at ZUWSP

Location	Type of Flowmeters	Diameter	No.	Remarks
Saateni Reservoir	Inflow Flowmeters	ϕ 400	1	
	Water Distribution Flowmeters	ϕ 450	1	
Mnarawambao Reservoir	Inflow Flowmeters	ϕ 250	1	working
	Water Distribution Flowmeters	ϕ 300	1	
Pipeline Network	DMA Flowmeters	ϕ 300	1	
	DMA Flowmeters	ϕ 200	2	
	DMA Flowmeters	ϕ 150	6	
	DMA Flowmeters	ϕ 100	1	
Total			**14**	
Same as above Breakdown	Operative Flowmeter	ϕ 250	1	
	Inoperative Flowmeter	ϕ 450	1	
		ϕ 400	1	
		ϕ 300	2	
		ϕ 250	1	
		ϕ 200	2	
		ϕ 150	6	
		ϕ 100	1	
		Total	**13**	

Source: Prepared by JICA Survey Team Based on ZUWSP's Completion Books

Because the contractor did not satisfactorily complete the work, many of these flowmeters were not functional from the time of installation. In addition, proper information on the flowmeters (e.g., specifications and name of supplier) was not provided, making it difficult to conduct an investigation into the cause of the non-functioning installed flowmeters. Based on the above, replacement of the electromagnetic flowmeters are proposed.

(b) Flowmeter specifications

Currently, there is no monitoring equipment to remotely monitor flow rates at service reservoirs and DMAs. Therefore, it is proposed to install a small indicator panel containing a data logger that can check flow rates on site and collect data to manage flow rates. In the future, when a remote monitoring facility is installed, the small indicator panel will be equipped with a GPRS modem that can be added to enable data communication.

(5) Reference Cost for Urgent Issue in ZUWSP Area

(a) Implementation plan

(i) Measures for Issue 1

The main task is the installation of water meters and the disconnection of existing pipelines that are no longer needed from the pipe network. These implementations are currently handled by the Customer Service Department and can be handled by ZAWA itself.

Therefore, propose that the Customer Service Department be responsible for the installation of water meters and the Technical Operations Department, and the Customer Service Department be responsible for the disconnection of unnecessary pipelines.

(ii) Measures for Issue 2

Although this is a water supply reconnection in Stone Town, the process will require a survey of the pipeline and water supply situation in Stone Town, building survey, design of the water supply system according to the conditions of the building. Since these surveys, planning, and design require specialized skills related to water supply and are difficult to be conducted solely by ZAWA staff, it is proposed that the survey be outsourced to a consultant. The construction work is assumed to be carried out by ZAWA.

(iii) Measures for Issue 3

Since this is not a simple replacement of the electromagnetic flowmeter and requires ancillary work such as the installation of an indicator panel, it will be difficult for ZAWA staff to handle the work. Therefore, the replacement work by outsourcing is proposed.

(b) Estimated cost

This section provides an approximate reference cost associated with the construction.

Issue 1 requires the cost for water supply reconnection work and unnecessary pipeline disconnection work including procurement of pipe fittings (caps), labour costs. Since the installation is assumed to be performed by ZAWA, this section shows reference costs for reconnection of service connections and pipe fittings.

Issue 2 requires the cost for the survey and the construction in Stone Town. Since the cost for the construction in Stone Town cannot be estimated without the implementation of the survey, the cost is omitted here.

Issue 3 requires the cost of procurement and installation of an electromagnetic flowmeter and indicating panel to replace the electromagnetic flowmeters. This section provides reference costs for replacement of the electromagnetic flowmeter.

Table 3.11 Reference Cost for Issue Response

Item	Outline	Unit	No.	Unit Price (TZS)	Amount (,000TZS)	Remarks
Water Supply Reconnection		No.	3,450	120,000	414,000	
Pipe Material (Cap)	AC, PE, DI、59 caps	Set	1		26,210	
Electromagnetic flowmeter	13	Set	1		1,468,630	
Instruction Panel	12	Set	1		227,400	Reservoir-2, DMA-10
Installation costs, etc.		Set	1		508,810	Including overheads
Total					2,645,050	

Source: JICA Survey Team

3.3 Measures for Urgent Issues Related to the Prepaid Meter Introduction

As a result of the survey, it is noticed that 350 prepaid meters will be introduced for large users. This section explains how to pay prepaid water tariff (tokens), how to sell them, and how to set water tariffs.

(1) Sale of Prepaid Tokens

Since the system related to the operation of prepaid meters, including the handling of prepaid charges, is expected to be provided by the water meter manufacturer, and short-term support and cooperation are not considered necessary. As a reference, it is showed that how to sell tokens from Zanzibar Electricity Corporation (ZECO), which has introduced the prepaid method in advance, and Lilongwe City, Malawi.

(a) ZECO

In Zanzibar, ZECO has already introduced prepaid meters in 2016 as an improvement in the payment method in the electrical field.

ZECO tokens can be purchased on smartphones, and they are also sold at ZECO sales offices and token sales offices for customers those do not have smartphones. It is also possible to purchase from a token seller entrusted by ZECO. The tariff is set by adding the service charge to the normal electricity usage. Figure 3.10 shows ZECO's tariffs. Customers are subject to Z1 and are charged according to the purchase amount. The amount including the service charge will be deducted.

ZECO TARIFFS

NO	TARIFFNAMES	TARIFF CATEGORIES	UNIT RANGES	PRICE PER kWh	PRICE PER KVA	SERVICE CHARGE
1	Z0	Life Line	1---50	79		2,100
			51---ALL	480		
2	Z1	General Services	1---1,500	766		2,100
			1,501----ALL	788		
3	Z2	Small Industries	1---ALL	206	16000	10500
4	Z3	Large Industries	1---ALL	169	16000	150500
5	Z4	Street Lights	ALL Units	266	16,000	150500

Source: ZECO Web Page

Figure 3.10 ZECO Tariffs

(b) Lilongwe, Malawi

As an example, in another country, Figure 3.11 shows the payment screen (Access your Prepaid Tokens) used by prepaid customers from the Lilongwe Waterboard in Malawi to purchase water. When the customer number and purchase amount are set from the smartphone, the charge is displayed on the smartphone and the charge according to the purchase amount is deducted from the customer's account. The customer sets the meter number and purchase period.

Source: LWB Web Page

Figure 3.11 Purchase Screen for Prepaid

(c) ZAWA prepaid payment method

The payment through the prepaid method will depend on the system provided, and a method like ZECO, which is easy for users to understand and is familiar with, is desired.

(2) Water Tariffs Setting for Prepaid Meter Customer

(a) Procedure of tariff setting

Water tariff is stipulated in the Water Regulation, but no prepaid water tariff is stipulated at this point of time. Currently, ZAWA prepares a draft and ZURA approves the procedure for setting water tariff. Since the introduction of the prepaid meter this time is a trial introduction, it is expected that ZAWA and ZURA will discuss the necessity of revising the Water Regulation as well as the price plan. No short-term support or cooperation is considered necessary. This section considers the average unit price based on the current price.

(b) Concept of charges based on current water tariffs

Since the prepaid meter planned by ZAWA is aimed at large customers (hotels, etc.), it will be possible to install a charge terminal at a hotel, etc., purchase from the terminal and use a convenient payment method. The tariff system is based on the current water tariff, and it is conceivable to add a service charge like electricity and allocate it to maintenance costs. Table 3.12shows the current water tariffs table.

Table 3.12 ZAWA Water Tariffs

Tariff Code	Description	Band	Start Unit	End Unit	Rate
					TZs
P-A2013		1	0.00	50.00	718.80
P-A2013		2	50.00	200.00	872.83
P-A2013		3	200.00	0.00	1026.85
P-C2013		1	0.00	15.00	821.48
P-C2013		2	15.00	30.00	924.17
P-C2013		3	30.00	50.00	1026.85
P-C2013		4	50.00	100.00	1232.22
P-C2013		5	100.00	0.00	1437.60
P-D2013		1	0.00	8.00	667.45
P-D2013	Domestic	2	8.00	12.00	821.48
P-D2013		3	12.00	15.00	1026.85
P-D2013		4	15.00	17.00	1232.22
P-D2013		5	17.00	0.00	1540.28
P-H2013		1	0.00	15.00	1129.54
P-H2013		2	15.00	30.00	1437.60
P-H2013		3	30.00	50.00	1848.34
P-H2013		4	50.00	100.00	3080.56
P-H2013		5	100.00	250.00	4107.42
P-H2013		6	250.00	500.00	5647.70
P-H2013		7	500.00	1000.00	6161.12
P-H2013		8	1000.00	0.00	7167.98
P-I2013		1	0.00	15.00	924.17
P-I2013		2	15.00	30.00	1026.85
P-I2013	Institution	3	30.00	50.00	1129.54
P-I2013		4	50.00	100.00	1232.22
P-I2013		5	100.00	250.00	1437.60
P-I2013		6	250.00	500.00	1642.97
P-I2013		7	500.00	1000.00	1951.02
P-I2013		8	1000.00	0.00	2259.08
P-K2013		1	0.00	0.00	750.00
P-W2013		1	0.00	0.00	750.00

Source: Water Regulation

Water tariff for large customers is applied per the price list for Bands 1-8 of Domestic P-H2013. For example, when purchasing 250m3, bands 1 to 6 of the price list P-H2013 are applied. Calculation example

1129.54 (0~15.00m^3) × 15 (m^3) +1437.60 (15.00~30.00m^3) × 15 (m^3)+1848.34 (30.00~50.00m^3) × 20 (m^3)+3,080.56 (50.00~100.00m^3)×50 (m^3) + 4,107.42 (100.00~250.00m3) ×150(m3) = 845,614.9 (TZS)

The water charge paid by the customer in advance is the sum of the service charge (depending on the setting of ZAWA).

(c) Tariff setting for prepaid meter

Regarding the tariff setting of prepaid meters, it is necessary to consider that the tariff has not been revised since 2013. The tariff will be decided through discussions between ZAWA and ZURA. It is possible to calculate the unit price of water supply revenue and water supply amount for large customers, by calculating

the charge based on it, and determining the charge by adding the maintenance cost. In addition, to obtain stable tariff income from large customers, it is considered building a tariff system that encourages consumption from the direction of curbing water usage. The prepaid system by prepaid meters is a reliable revenue source for ZAWA. It is no longer necessary to spend long-time in collecting tariffs as in the past, which will contribute to management improvement.

Chapter 4 Mid-to-Long Term Action Plan for Zanzibar Water Sector

4.1 Outline of Action Plan

Based on the current status of water administration & legislation, water resources management, facilities and customer management related to water services, and human resource development in the water sector in Zanzibar, the actions needed to contribute to strengthen the Zanzibar water administration and water services management system were planned in this survey. Then, mid-to-long term actions will be proposed, taking into account the priority of the issues and the necessary steps. In addition, an action plan and implementation plan will be proposed, taking into account the importance of the measures and actions, the procedures, the required timeframe, and the responsible departments.

4.2 Setting Targets of Action Plan

In planning the Action Plan, targets need to be set and these goals need to be aligned with water sector policies. Review the water sector policy and planning framework, their goals, and set the goals of the Action Plan.

4.2.1 Policy Objectives for the Water Sector in Zanzibar

(1) Water Sector Policy and Planning Framework

Table 4.1 lists policies and major plans related to the water sector.

The current status of each policy and plan is described in Table 4.1. At this point of time, MKUZA IV of the national policies has not been updated, and the National Water Policy, a policy for the water supply sector, is in the process of the revision. Related to the sector development plans for the realization of the policies, a feasibility study supported by KfW is commenced.

Table 4.1 Policies and Major Plans Related to the Water Sector

.	Current Latest Version	Remarks
National Policy	Zanzibar Development Vision 2050	Publication in 2020
	Zanzibar Strategy for Growth and Poverty Reduction III (2016-2020)	Not updated
	Zanzibar SDGs Roadmap 2020-2030	Publication in 2020
Water Sector Policy	National Water Policy 2004	Under Revision
Water Supply Master Plan	Zanzibar Urban Water Supply Development Plan 1991-2015	Schedule to be formulated
Water Supply Business Plan	ZAWA Strategic Business Plan 2020-2025	Publication in 2020
Plans pertaining to utility regulation	ZURA Strategic Business Plan 2017-2022	Publication in 2017

Source: JICA Survey Team

(2) Policy Objectives for the Water Sector

In the ZDV 2050, the national policy for all sectors in Zanzibar, strengthening water resources management to ensure safe and equitable access to water (e.g., integrated water resources management, policy development and legislation for management/protection/conservation, formulation of water resources management master plan), water resource development other than groundwater, water supply management for socio-economic activities in Zanzibar, development of water supply infrastructure and its maintenance are raised as the goals for the water sector as shown in Table 4.2.

Table 4.2 Goals for the Water Sector in National Policy

Policy	Objectives	Activities etc.
ZDV2050	・Sustainable access to safe and clean drinking water facilitated by an effective water resources management master plan and related strategies with an emphasis on integrated water resources management ・Diversified sources of drinking water, including seawater desalination, undersea freshwater development, and the use of rainwater storage and reuse technologies ・Optimal water supply management for agriculture, tourism, industry, and other economic activities, supported by research and development on sustainable water sources	
MKUZA III	・Achieve equitable access by all water users to high quality, safe water, taking into consideration both the needs of expanding social and economic activities and the preservation of the natural environment	
SDGs Roadmap	・Achieve adequate and equitable access to safe and affordable water supply and sanitation and wastewater services for all people by 2030	・Formulate and implement water policies and enforce laws and regulations for the management, protection and conservation of water resources ・Development and maintenance of water supply facilities on Unguja and Pemba islands ・Provide capacity building training on rainwater harvesting, seawater desalination, efficient water use, and wastewater treatment, reclamation, and reuse technologies

Source: JICA Survey Team

Following the publication of ZDV 2050, the National Water Policy is currently undergoing a revision process. The points of revised policy drafted by ZAWA is shown below.

- Organize responsibilities of ZAWA, ZURA, ZEMA, local governments and other relevant agencies
- Enactment of the Water Resources Management Act to establish the WRMB
- Responsible for both water supply and sanitation services by ZAWA

Although still in the draft, the goals and principles of the draft National Water Policy are shown in Table 4.3.

Table 4.3 Objectives of the National Water Policy (Revised)

Item	Contents
Objective	1. Ensure access to water for all, including the poor and disadvantaged, and take into account the specific needs of women and children 2. Promote efficient and effective use, conservation and protection of water resources for sustainable use 3. Promote private sector participation in water resources development, management, and service delivery 4. Clarify the role of government agencies for water matters and stakeholders in the water sector 5. Achieve sustainable provision of water supply and sanitation services that are equitably accessible to all for socio-economic development at affordable costs 6. Ensure environmental sustainability and gender considerations in all aspects of water development and management
Principle	1. Water is a national asset and resource common to all and its use is under government control 2. Managing the quantity, quality, and reliability of the nation's water resources is intended to achieve optimal, long-term, environmentally sustainable social and economic benefits for society 3. Water pollution control adopts the "polluter pays" principle to ensure the responsibility of water users 4. Water resources are optimally, equitably and reasonably allocated and regulated in a transparent and accountable manner to ensure sustainable and optimal economic benefits and social upliftment 5. The protection and use of water resources for domestic water supply is given top priority over other uses 6. Treat water as an economic benefit as well as a social benefit 7. The government, in consultation with other stakeholders, regulates the pricing of water services 8. Water regulation is based on reliable and ongoing data collection, management, and analysis to ensure accurate assessment of water resources and dissemination of information for effective planning of water resource development 9. All people have access to drinking water and sanitation services to reduce the incidence of waterborne diseases

Source: Zanzibar National Water Policy (Draft)

4.2.2 Goal Setting for the Action Plan

The main goals common in the national policies are as follows

- Implement the sustainable, efficient use and distribution of water resources that are fundamental to Zanzibar's socio-economic infrastructure, as well as the management, conservation and protection
- Ensure sustainable access to safe water at a reasonable price for all people, taking into account the poor, gender and the environment

In order to realize these goals, development of water administration system and legislation required to manage and conserve water resources in Zanzibar in coordination with stake holders using water resources not only water supply but an agriculture sector, strengthening of ZAWA's financial base to enhance water utility operation and management capability and ensure sustainability, enhancement of monitoring and tightening of regulations for water utility's services and charges, human resource development to implement the above mentioned actions in each organization, are required.

Based on the above, the targets of this Action Plan are set as shown below.

- Target 1: Sustainable and well-managed use of water resources without adversely affecting the environment
- Target 2 : Provision of equitable access to the safe, stable and sustainable water supply to support socio-economic activities considering poverty, gender and environment

4.3 Basic Policies and Strategies Based on the Current State of the Water Sector

4.3.1 Current Status of Zanzibar Water Sector and Direction of Basic Policies

(1) Basic Policy on Target 1

Zanzibar has no rivers flowing through the year because of the extremely high underground infiltration rate of 24% of total precipitation (Unguja Island, see Figure 2.45) and the characteristics of the highly permeable aquifer composed of reef-like limestone, and thus depends on groundwater from springs and boreholes for all its water sources. On the other hand, groundwater (freshwater) floats above saltwater (seawater) as a freshwater lens formed by the density difference and pressure balance between freshwater and saltwater, so that if its pressure is reduced by excessive pumping, the saltwater boundary rises and there may be a potential for saltwater intrusion into groundwater. In the event of seawater intrusion, it could have a significant impact on socio-economic activities in Zanzibar. Therefore, groundwater must be used in a properly managed manner.

Integrated water resource management is indispensable not only for ZAWA, which uses water for water supply, but also for other water users such as agriculture, hotels, factories, and private. In addition, coordination with sectors other than water users, such as environmental considerations, is necessary. Currently, the Water Resources Management Division, Water Resources Department of ZAWA is responsible for water resources management, issuing licenses to borehole drillers, permitting construction, registering

boreholes, and observing groundwater in observation boreholes. However, there is no organized system that enables integrated water resources management (IWRM) in cooperation with various water users, the environment, and other related parties. Furthermore, ZAWA, as a water utility, currently has the conflicting functions of a water user who develops water sources and a regulator who manages and regulates water resources, which is not a preferable situation.

Based on the above, the basic policy for Target 1 is as shown below.

- Basic Policy 1: Establishment of a system for Integrated Water Resources Management (IWRM) and formulation and implementation of IWRM plan

(2) Basic Policy for Goal 2

Approximately 60% of ZAWA's revenues are subsidized by the government and continuing the situation which cannot cover the operating expenditures by the water revenue. This severe financial situation has a negative influence on water supply services because it makes ZAWA face difficulty to replace aged facilities and equipment and repairing failed equipment. On the other hand, the population of Zanzibar continues to grow and water demand is expected to increase accordingly, Hence, investment in future increases in water demand is also necessary. Improving ZAWA's financial condition is essential to continue to invest in the repair/replacement of existing facilities and the development of new facilities with due consideration for Zanzibar's natural environment, and to ensure sustainable access to water supply in the future.

In addition, in order to achieve equitable access to all people, including the poor and other socially vulnerable groups, water rates must be affordable, and for this reason, water utilities must be operated efficiently.

Based on the above, the basic policy for Target 2 and 3 are as shown below.

- Basic Policy 2: Improvement of the financial situation of ZAWA for sustainable and stable water supply
- Basic Policy 3: Operation of water utility for the provision of equitable water supply at an affordable price

4.3.2 Strategies and Measures for the Basic Policy

Proposed measures for each of the basic policies are shown below. Figure 4.1 shows the framework of the proposed strategies and measures for improving Zanzibar water sector.

(1) Basic Policy 1: Establishment of a System for Integrated Water Resources Management (IWRM) and Formulation and Implementation of IWRM plan

Under the circumstances where seawater intrusion into groundwater is a concern, integrated water resource management, which manages the allocation and use of water resources for water users from various sectors, should be promoted as soon as possible. Due to restriction of human resources, the current water resource management by ZAWA has limitations, and it should aim to establish a dedicated organization for the implementation of integrated water resource management.

After the establishment of the organization, a master plan should be formulated for the implementation of

integrated water resources management. For the formulation of the plan, surveys are required to obtain necessary information for the management such as the amount of available water resources and permissible yield in each groundwater basin. In addition, the implementation of the plan will require the establishment of a water users' association that coordinates among the water users.

The proposed measures for Basic Policy 1 are shown in Table 4.4.

Table 4.4 Proposed Measures for Basic Policy 1

Strategy	Measure	Concept of Proposed Measures
Revision of policies and laws	Revise National Water Policy (2004)	The Policy needs to be revised to take into account changes in the sector environment
	Enactment of Water Resources Management Act	The current Water Act (2006) is the basis for the establishment of ZAWA and provides for water resource management by ZAWA and water supply services. In order to establish a water resource management entity, separate from ZAWA, it is necessary to enact a law that defines the rationale, objectives and principles of water resource management, and the institutional and legal framework.
	Revision of Water Act and ZURA Act.	Revise the current Water Act to a law governing water supply services in accordance with the enactment of the Water Resources Management Law.
Establishment of water resource management board	Establishment of WRMB	An independent organization will be needed to be responsible for water resource management and regulatory enforcement
	Establishment of a coordination/collaboration mechanism (e.g., water users associations)	It is necessary to establish a mechanism to promote recognition of problems and issues by various parties involved in the use and management of water resources in the region and to share scientific data and information on water resources, in order to promote solutions based on social consensus building.
	Capacity building of WRMB and the associations	Capacity building is needed to ensure that each organization can properly perform the required functions and responsibilities.
Formulation of a water resources management master plan (M/P) for improving efficient water use and ensuring sustainable groundwater abstraction	Evaluation of groundwater potential and permissible yield.	To achieve the ultimate goal of evaluating water resource availability and permitted pumping capacity, it is necessary to construct a groundwater model and conduct simulations.
	Grasp and estimate current and future water demand	To achieve efficient water use and sustainable water yield, it is necessary to assess water demand by sector and groundwater basin and to determine the water balance by comparing it with the permissible yield that can be developed.
	Formulation of water resources allocation plan	It will be necessary to adjust for excesses and deficiencies in water resources that vary by season, purpose, and groundwater basin
	Coordination of water resources development plans	Promote the formulation and implementation of a harmonized water resources development plan among sectors in each groundwater basin in line with the water resources allocation plan.
	Efficient water use and saving	Promote water use efficiency and conservation planning in sectors where significant increases in water demand are expected in the future.
	Appropriate management of water	Water yield management and regulation, promotion of planned

	abstraction and use	water use in accordance with relevant laws and regulations.
	Conservation of water resources	Conservation and Protection of water quality and quantity of water resources within each groundwater basins
Introduction of IWRM approach	Development of information management system related to water resources and water use	It is necessary to identify basic information and data needed to develop and implement a water resources management master plan, and establish a system for collection, management, and utilization.
	Raise awareness and promote participation of citizens and the private sector in water resources management	It is necessary to promote the interest in water cycle mechanisms in groundwater basins by citizens and private sector, and proactive involvement in conservation and proper use of water resources.
	Formulation and trial implementation of IWRM plan for each groundwater basin	Develop IWRM plans for groundwater basins where saltwater intrusion and conflicts of interest over water use are of concern by the WRMB and local water users' councils and other consultative bodies. Then, from the process of implementing priority projects, examine how to proceed with IWRM approach to water resources management

Source: JICA Survey Team

(2) Basic Policy 2: Improvement of the Financial Situation of ZAWA for Sustainable and Stable Water Supply

In order to provide continuous and stable water services for the socio-economic activities in Zanzibar, ZAWA's management (financial base) needs to be stable, reduce dependence on government subsidies and aim to increase the percentage of ZAWA's water service operating costs covered by water supply revenues. In order to implement these strategies, it is desirable to understand in as much detail as possible the current water service situation and the current balance of payments, and then develop and implement strategies to improve water supply revenues. The proposed measures for Basic Policy 2 are shown in Table 4.5 and Table 4.6.

Table 4.5 Proposed Measures for Basic Policy 2 (Water Utility Management)

Strategy	Measure	Concept of Proposed Measures
Formulation of strategy for improvement of financial situation	Grasp and analyse water supply service and current OPEX in each water supply scheme	・In order to improve the financial situation, it is necessary to understand the current service situation (water scheme wise, district office wise) and the current financial situation, and analyse the problems.
	Examination of water revenue improvement strategy based on analysis results	・Consideration of effective financial improvement strategies based on the characteristics of the water scheme and district (situation of service and revenues) ・Consideration of the future direction of the water administration (ZAWA's exclusive water supply over the Zanzibar, division of ZAWA, etc.)
Examination of appropriate water tariff	Review of current water rates	・It is necessary to confirm the appropriateness of current water tariff levels.

Source: JICA Survey Team

Table 4.6 Proposed measures for Basic Policy 2 (Customer Management)

Strategy	Measure	Concept of Proposed Measures
Increase the number of metered customers	Promotion of meter installation to flat rate customers	・For the same service, flat-rate customers' rates are lower and more inequitable than those of metered customers (for residential customers, 4,000 TZS of flat-rate is equivalent to 4.5 m^3/month of metered usage).
Improvement of billing and collection	Billing and collection from current unbilled customers	・It is necessary to distribute bills as much as possible to reduce NRW, even from users who have not been billed for various reasons
	Promotion of customer information registration especially mobile phone numbers	・Customer information (cell phone number) is necessary for effective use of various systems (bill distribution via SMS, payment service via cell phone)
	Increase meter readers according to the number of meters installed	・If the meter reading operation works, it is expected to improve billing and collection operations in addition to SBM and various systems.
Survey of customer satisfaction	Implementation of periodical customer satisfaction survey by meter readers	・Periodic customer satisfaction surveys will enable us to obtain information useful for service improvement, such as the current status of water service and problems.
Improvement of follow-up activity for unpaid bills	Execute follow-up to unpaid customers	・Reminders are needed to encourage unpaid customers to pay (consideration must be given to the poor).
Evaluation of trial prepaid meter introduction	Evaluation of prepaid meter operation introduced by RIWSSZ and feasibility of expansion	・Prepaid meters need to be operated, and evaluated for effectiveness and problems based on Zanzibar's regional characteristics. ・It is necessary to confirm issues related to maintenance when the system is fully implemented (the manufacturer will provide the system free of charge when the system is installed on a trial basis)
	Examine the water tariff for prepaid customers	・Wate tariff needs to be set for operation although this is a pilot implementation,
Improvement of efficiency of customer management by system update	Implement integrated customer management with SBM updates	・Systems are linked, but SBM, SMS system, and fee collection system are separate systems ・Software is obsolete after approximately 10 years of SBM implementation (current version is packaged with billing, payment, non-payment management, complaint management, and meter management functions)

Source: JICA Survey Team

(3) Basic Policy 3: Management of Water Services That are Fairly Accessible to all at Reasonable Rates

In order to provide water services that are equitably accessible to all people at all times and in all places, including homes and stand posts, it is necessary to manage water resources and operate a water utility, including maintenance and operation of water facilities, routine and periodic inspections and repair of broken facilities, and replace of aging facilities and equipment.

In order to plan, implement, and manage water utility operations, it is necessary to focus on the management resources of the water utility (facilities and equipment, funds, information, and human resources), and to maintain these resources at an adequate level in terms of quantity and quality. However, the current water sector in Zanzibar is lacking in the quality of resources.

- **Facilities and Equipment:** Resources needed to pump, disinfect, and distribute water and obtain payment for services.
- **Funds:** Resources required for operation and maintenance of the water supply system, renewal of aging facilities, and improvement of facilities considering future water demand increases and

operation of the water utility.

- **Information:** Internal information required for water utility operation management in decision-making such as information related to water supply service (yield volume, supply volume, water pressure, water quality), information related to water utility operation (number of connections, number of customer meters, annual production volume, annual billed water volume, operational expenses, water revenue), key performance indicators. And external information such as new technologies, practices related to water supply.
- **Human Resources:** Human resources that formulate policies and business plans, determine the allocation of various resources, and manage the operational status of water utility in accordance with the business objectives and plans.

Regarding facilities and equipment, it is necessary to develop strategies and formulate and carry out a master plan for developing water supply infrastructure considering future water demand and capacity/situation of existing facilities and equipment. In existing facilities, since water leakage from ageing pipelines and service connections is one of the concerns, it is necessary to promote NRW reduction including water leakage control. In addition, improvement of maintenance (e.g., securing budget, spare parts, staff, tools & equipment) is required to shorten the repair time of failed equipment.

Regarding funds, there are internal and external funds. In terms of internal funds, it is difficult to improve the situation significantly until ZAWA's utility operation is headed in the right direction and the balance between revenue and expenditure improves. In terms of external funds from donor's, utilization of the fund is the opportunity to obtain facilities and equipment for water supply and monitoring. To improve the water supply service and financial situation of ZAWA, external funds need to be utilized efficiently.

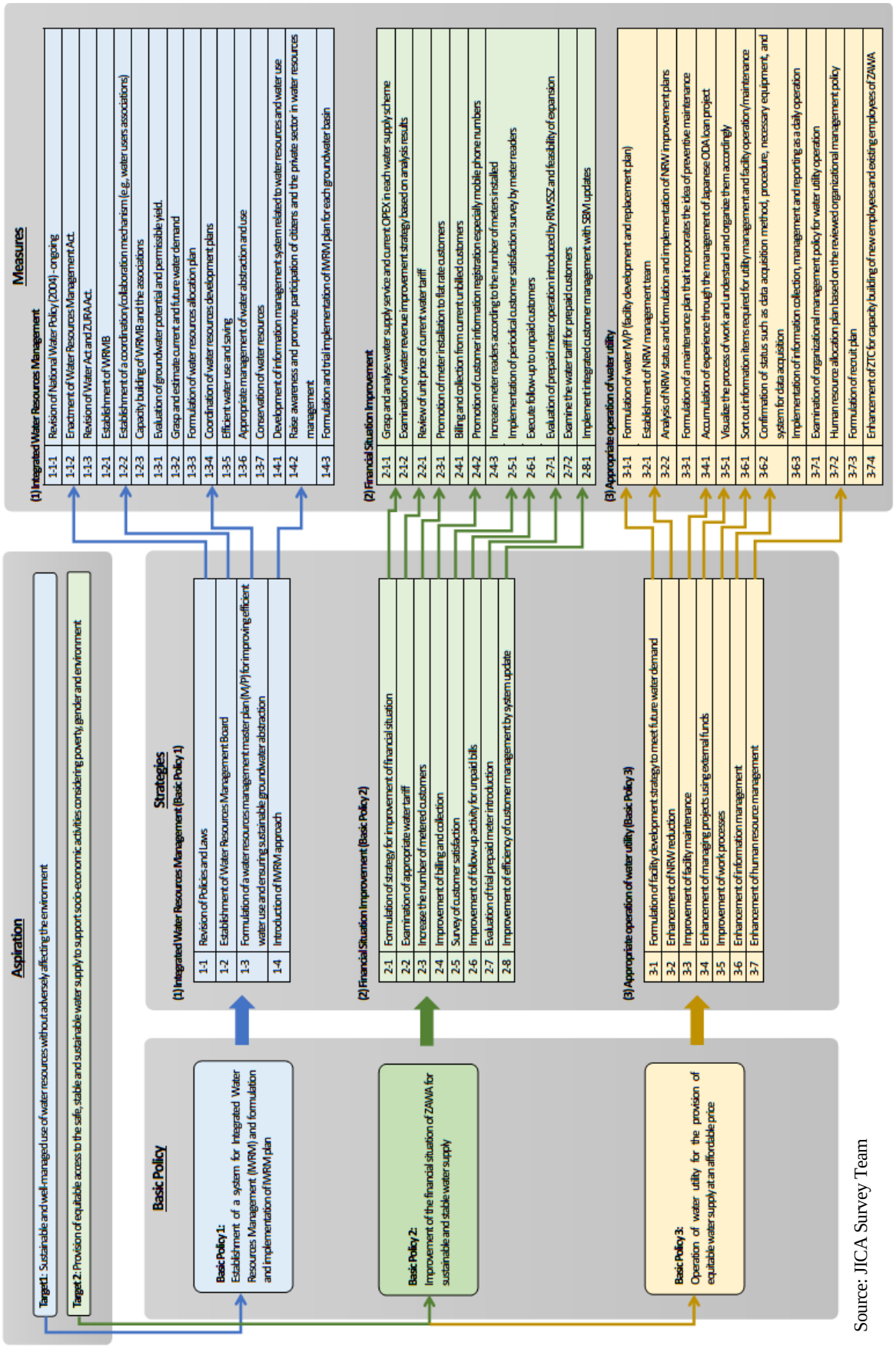
Regarding information, there is internal and external information. The way collecting and accumulating of internal information related to facility operation and maintenance and utility operation is a self-help effort. Collecting and accumulating information need to be daily routine work by developing required monitoring equipment and establishing procedures for information management. Regarding the utilization of internal information for water utility operation management, it is necessary to share information with MoWEM and ZURA, and to promote management together. It is required efforts to incorporate external information on trends in water sectors in the mainland and overseas, as well as new technologies related to water supply.

Human resources need to be secured by self-help efforts since external resources cannot be used. As for human resource development, it is possible to utilize external funds and resources in addition to the self-help efforts. Since human resources, especially in the area of water resources management, are insufficient in Zanzibar, it should consider building cooperative relationships with the water sector and universities in the mainland to develop the capacity of human resources.

Table 4.7 Proposed Measures for Basic Policy 3

Strategy	Measure	Concept of Proposed Measures
Formulation of facility development strategy to meet future water demand	Formulation of water M/P (facility development and replacement plan)	・It is necessary to estimate future water demand as the basis for future water supply facility development plans and water resource management plans. ・It is necessary to survey and assess the ageing status of existing facilities and identify demand for facility renewal. ・It is necessary to understand the facility maintenance and renewal required to improve water supply services through the improvement of water supply facilities and equipment.
Enhancement of NRW reduction	Establish NRW management team	・Since NRW is related to multiple departments, including water distribution volume information and customer information, an organization is needed to oversee the entire process.
	Analysis of NRW status and formulation and implementation of NRW improvement plans	・Effective NRW reduction requires analysis and understanding of the current status of each NRW element (unbilled, apparent losses, and real losses). ・Plan efficient measures according to the status of NRW elements based on the results of the current situation analysis. ・Manage plans, check implementation results (effectiveness), and review improvement plans.
Improvement of facility maintenance	Formulation of a maintenance plan that incorporates the idea of preventive maintenance	・Shift to preventive maintenance for prevention of failure as much as possible by conducting daily and periodic inspections.
Enhancement of managing projects using external funds	Accumulation of experience through the management of Japanese ODA loan project	・Based on the challenges and lessons learned in the previous project management, it is necessary to strengthen a project management capacity.
Improvement of work processes	Visualize the process of work and understand and organize them accordingly	・Visualising work processes to understand duties of each staff and improve the efficiency of the work
Enhancement of information management	Sort out information items required for utility management and facility operation/maintenance	・It is necessary to clarify the items of information that should be managed by the water utility
	Confirmation of status such as data acquisition method, procedure, necessary equipment, and system for data acquisition	・It is necessary to check the status of SOPs and manuals for current information management, and the status of equipment and systems for obtaining and managing information.
	Implementation of information collection, management and reporting as a daily operation	・Based on the necessary information items, it is necessary to establish information collection and management procedures to improve the current information acquisition and management situation and establish them in daily operations. ・It is necessary to establish procedures for reporting to MoWEM and ZURA (items, frequency, timing, etc.) for sharing information.
Enhancement of human resource management	Examination of organizational management policy for water utility operation	・Review of organizational management policies, including the division of duties (facility operation and maintenance, meter reading, billing, and collection management, etc.) among ZAWA HQ, Pemba branch and district offices, review of business processes, and using online communications, in light of future changes of business environment (increase in the number of water meters, enhanced information management, etc.)
	Human resource allocation plan based on the reviewed organizational management policy	・The planning process requires a plan for future staffing needs (plumbers, meter readers, pump operators, etc.) for ZAWA HQ and district offices.
	Formulation of recruit plan	・It is necessary to develop an annual recruit plan in accordance with facility development and water meter installation plans ・Consider hiring graduates of ZAWA training centre (plumbers, pump operators, etc.)
	Enhancement of ZTC for capacity building of new employees and existing employees of ZAWA	・ZTC needs to be strengthened as an internal training institute of ZAWA, not just a vocational training school. ・It is necessary to consider development of short course programs for internal training to Zanzibar water sector, development of teaching materials, training of trainers, expansion of facilities, capacity building incentives, etc. ・Considering utilization of training institutions in mainland such as WI for capacity development of ZAWA staff.

Source: JICA Survey Team



Source: JICA Survey Team

Figure 4.1 Framework for Draft Strategies and Measures to Improve Zanzibar Water Sector

4.4 Action Plan

Planed actions based on the basic policy, strategies and measures are shown below.

4.4.1 Action on Basic Policy 1

Strategies, measures, and actions for Basic Policy 1 are shown in Table 4.8.

Table 4.8 Strategies, Measures, and Actions for Basic Policy 1

Goal 1: Sustainable and well-managed use of water resources		
Basic Policy 1: Establishment of a system for Integrated Water Resource Management (IRWM) and formulation and implementation of IWRM plan		
Strategy	Measure	Action
Revision of Policies and Laws	Revision of National Water Policy (2004)	1101 : Revision of National Water Policy - Coordinate with relevant policies, identification of relevant water sector agencies and clarification of functions and responsibilities - Update water resource management and water supply policy issues, measures and implementation strategies - Direct policies and implementation systems for improving sanitation facilities
	Enactment of Water Resource Management Act.	1102 : Legislation required for water resources management - Objectives and principles of water resources management - Ownership and administrator of water resources - Water resources management structure, ministry in charge, establishment of Water Resources Management Board (WRMB) and stakeholder consultative bodies, functions and responsibilities, and method of operation, etc. - Develop an integrated water resources management plan, protection of water resources, permits for water withdrawal and water use, water use fees and permit application fees, penalties and legal proceedings, etc.
	Revision of Water Act.	1103 : Revision of Water Act. based on the Water Resources Management Act. - Water resources management excluded from ZAWA's purview - Review of ZAWA's provisions pertaining to water supply services and Harmonization with the ZURA Act - Positioning of water supply projects by entities other than ZAWA
Establishment of Water Resources Management Board	Establishment of WRMB	1104 : Preparation for establishment (planning of organizational structure, division of duties in each department, staff allocation, procurement, budget, etc.) 1105 : Selection of board members 1106 : Assignment of engineers, professional staff, general staff 1107 : Preparation of office and necessary equipment
	Establishment of a coordination/collaboration mechanism (e.g., water users association)	1108 : Discussion among related sectors (structure of the association, rolls, covered area of each association, managerial regulation) 1109 : Promote the formation of the association in areas where there are concerns about conflicts in water use
	Capacity development of WRMB and the associations	1110 : Implementation of management ability improvement program - Board members and executive staff of water resource management organizations: management and practical skills in water resources management - Water users' associations and other councils: Ability to design and manage processes to lead to consensus building

Formulation of a water resources management master plan (M/P) for improving efficient water use and ensuring sustainable groundwater abstraction	Evaluation of groundwater potential and permissible yield.	1111 : Implementation of hydrogeological survey for finding out groundwater basin structure and groundwater flow mechanism 1112 : Groundwater modelling and simulation using the model 1113 : Evaluation of the amount of available groundwater resources and acceptable yield
	Grasp and estimate current and future water demand	1114 : Evaluation of current and future water demand by sectors and groundwater basin 1115 : Setting priority for water use by purpose 1116 : Evaluation of water balance comparing demand and acceptable yield
	Water resources allocation plan	1117 : Study of options for water resources development 1118 : Formulation of water resources allocation plan by usage and groundwater basin
	Coordination of water resources development plans	1119 : Adjustment and advice of sectoral water source development plan from the viewpoint of water resources management 1120 : Formulation of appropriate water harvesting plan in each groundwater basin
	Efficient water use and saving	1119 : Advice of sectoral water source development plan from the viewpoint of water resources management
	Appropriate management of water abstraction and use	1121 : Formulation of regulations for permit issuance and standardization of procedure 1122 : Information management of issued permission and setting of permit quantity of water yield 1123 : Review of permission fee and correction 1124 : Formulation of groundwater yield monitoring plan 1125 : Cooperation with the ministry and water utility for promotion of alternative water source development
Introduction of an integrated water resources management approach	Conservation of water resource	1126 : Designation of conservation area at recharge areas and main water sources and execution of conservation activities 1127 : Designation of regulated area for water source development 1128 : Formulation of groundwater and groundwater basin conservation plan 1129 : Cooperation with authorities that implement conservation activities for water resource
	Development of information management system related to water resources and water use	1130 : Development of information management system for decision making and planning 1131 : Formulation of a plan for water resources observation and monitoring, and establishment of implementation system 1132 : Collection and analysis of natural and social scientific data related to water resources 1133 : Sharing information among related institutions and stakeholders
	Raise awareness and promote participation of citizens and the private sector in water resources management	1134 : Formulation of communication plan 1135 : Awareness program with social, schools and private companies
	Formulation and trial implementation of IWRM plan for each groundwater basin	1136 : Formulation of integrated water resource management plan for each groundwater basin - Clarification of current status and issues related to water resources in groundwater basins (watersheds) - Identify stakeholders in the issue - Set goals and objectives - Scenario study of countermeasures - Build social consensus to set goals for resolution - Prioritize projects/programs - Investment plan - Climate change considerations (water source selection,

		watershed conservation, land use policies, groundwater conservation and recharge, strengthening community resilience)

Source: JICA Survey Team

4.4.2 Action on Basic Policy 2

Strategies, measures, and actions for Basic Policy 2 are shown in Table 4.9

Table 4.9 Strategies, Measures, and Actions for Basic Policy 2

Goal 2 : Achieve equitable access to safe, stable, and sustainable water supply systems that are pro-poor, gender and environmentally sensitive and support sustainable socio-economic activities		
Basic Policy 2: Improvement of the financial situation of ZAWA for sustainable and stable water supply		
Strategy	Measure	Action
Formulation of strategy for improvement of financial situation	Grasp and analyse water supply service and current OPEX in each water supply scheme	2201 : Basic information survey (number of customers by categories, annual yield, annual billed water volume, etc.) 2202 : Survey for supply costs and water revenue 2203 : Analysis of quality of service and OPEX
	Examination of water revenue improvement strategy based on analysis results	2204 : Categorizing of water supply schemes by service situation and OPEX 2205 : Formulation of financial improvement strategy by category
Examination of appropriate water tariff	Review of unit price of current water tariff	2206 : Estimation coverable cost by water revenue under assumption
Increase the number of metered customers	Promotion of meter installation to flat rate customers	2207 : Formulation of annual water meter installation plan (number of meters by shehia) 2208 : Budget securing based on the plan 2209 : Installation of meters and implementation management
Improvement of billing and collection	Billing and collection from current unbilled customers	2210 : Preparation of list of unbilled customers (name and reason for unbilled) 2211 : Dialogue with unbilled customers and start billing and collection
	Promotion of customer information registration especially mobile phone numbers	2212 : Formulation of customer survey plan and securing survey budget 2213 : Survey implementation and registration of collected information into systems (SBM, SMS, GIS)
	Increase meter readers according to the number of meters installed	2214 : Formulation of meter reading plan - Metering management system (organizational structure, system, etc.) - Meter reader assignment, employment, and training plan based on the Water Meter Installation Plan (2207) - Meter reading plan (meter reading area, handling of meter reading data, meter reading management method, etc.) 2215 : Securing meter readers according to the plan (recruit or outsource)
Survey of customer satisfaction	Implementation of periodical customer satisfaction survey by meter readers	2216 : Preparation of customer satisfaction survey form 2217 : Periodical implementation of the survey and report the result to the management
Improvement of follow-up activity for unpaid bills	Execute follow-up to unpaid customers	2218 : Formulation of follow-up procedures for unpaid customers, and implementation of follow-up according to the procedure
	Evaluation of prepaid meter operation introduced by RIWSSZ and feasibility of expansion	2219 : Evaluation of prepaid meter system operation - Meter function, durability, maintainability - Prepaid operation system - Operation of voucher sales, etc.

		- Effects of system introduction 2220 : Feasibility study for the expansion of prepaid meter introduction - Installation costs (meters, systems) - Revision of the system (owner classification, fees) - Establishment of operation and maintenance management organization system, etc.
Evaluation of trial prepaid meter introduction	Examine the water tariff for prepaid customers	2221 : Preparation of draft water tariff for prepaid meter users 2222 : Discussion and adjustment of water tariff with ZURA
Improvement of efficiency of customer management by system update	Implement integrated customer management with SBM updates	2223 : Survey and selection of a billing management system - Survey of system usage by mainland water utilities - System functions and features - Installation cost including maintenance - Data transferability, etc. 2224 : Update of the billing management system

Source: JICA Survey Team

4.4.3 Action on Basic Policy 3

Strategies, measures, and actions for Basic Policy 3 are shown in Table 4.10

Table 4.10 Strategies, Measures, and Actions for Basic Policy 3

Policy 3: Appropriate operation of water utility for the provision of equitable water supply at an affordable price		
Strategy	Measure	Action
Formulation of facility development strategy to meet future water demand	Formulation of water M/P (facility development and replacement plan)	2301 : Formulation of water master plan - Current water services and survey of facility maintenance status - Estimation of planned water demand and water resource planning - Study of facility planning (new development and facility renewal) - Estimated project cost and selection of priority projects, etc.
Enhancement of NRW reduction	Establishment of NRW management team	2302 : Formulation of NRW management system - Establishment of NRW management system study team and management and staffing plan by team - Develop NRW management work content, including related departments - Plan for NRW-related data management flow 2303 : Establishment of NRW management team - Assign staff to NRW management team - Procurement of necessary equipment, etc.
	Analysis of NRW status and formulation and implementation of NRW improvement plans	2304 : Calculation of NRW (whole of ZAWA, each water supply scheme, each area, each DMA) 2305 : Analysis of NRW components and examination and report the NRW reduction measures
Improvement of facility maintenance	Formulation of a maintenance plan that incorporates the idea of preventive maintenance	2306 : Formulation of maintenance plan - Develop facility-specific daily and periodic inspection plans - Develop consumable parts and spare parts management plan - Develop a maintenance and management system plan (personnel, tools, etc.) 2307 : Implementation of maintenance according to the plan and monitoring of implementation
Enhancement of project management	Accumulation of experience through the management of Japanese ODA loan project	2308 : Strengthening of partnership with consultant providing the services

Improvement of work processes	Visualize the process of work and understand and organize them accordingly	2309 : Create a process of work manual that maintains the quality of work, to avoid missing procedures or low quality of work, and perform reliable work based on the procedure manual. 2310 : Construction of a monitoring system in which management monitors and confirms the work status using key performance indicators, etc.
Enhancement of information management	Sort out information items required for utility management and facility operation/ maintenance	2311 : Extraction of information items that are used for utility operation management (utilization of ZURA manual) 2312 : Extraction of information items that are used for facility operation and maintenance
	Confirmation of status such as data acquisition method, procedure, necessary equipment, and system for data acquisition	2313 : Planning of methods for information collection and procedure, and designation of responsible Department
	Implementation of information collection, management and reporting as a daily operation	2314 : Implementation of information management and sharing collected information to internal of ZAWA and ZURA
Enhancement of human resource management	Examination of organizational management policy for water utility operation	2315 : Review of roles of ZAWA HQ, Pemba branch and district offices for efficiency improvement of water utility operation
	Human resource allocation plan based on the reviewed organizational management policy	2316 : Formulation of staff allocation plan according to the review result
	Formulation of recruit plan	2317 : Formulation of recruit plan according to the staff allocation plan
	Enhancement of ZTC for capacity building of new employees and existing employees of ZAWA	2318 : Selection of internal training menu from needs 2319 : Development of internal training modules 2320 : Collection of existing manuals (ZURA and ZAWA) 2321 : Development of training material 2322 : Formulation of a facility and equipment plan for training and installation

Source: JICA Survey Team

4.5 Implementation Plan for Action Plan

The implementation plan of the actions was prepared in a bar chart considering the importance of measures and actions, procedures, required timeframe, responsible departments by the category of each basic policy.

4.5.1 Concept of Implementation Procedure

(1) Actions related to Basic Policy 1 of Target 1

The importance of integrated water resources management has been recognized because of the need to achieve the goal of sustainable, properly managed, and environmentally sound use of water resources in the face of the expected continued increase in water demand and the risk of saltwater intrusion. In order to put this into practice, integrated water resources management needs to be formally positioned as a water sector policy in the National Water Policy and the necessary legislation needs to be put in place.

In order to implement integrated water resources management practices, it is necessary to establish a water resources management system, formulate a master plan for water resources (water resources capacity, water demand of each sector, and water resources development plan), and develop an integrated water resources management plan. The first step is to conduct surveys to evaluate the water resource capacity and permissible

yield (survey for groundwater basin structure and groundwater flow mechanism) and to estimate the water demand of each sector. Based on the results, an integrated water resources management approach will be introduced, after addressing the formulation of water resources allocation plans, the formulation and coordination of water resources development plans, water resources management and water resources conservation and protection practices.

(2) Actions related to Basic Policy 2 of Target 2

Further increase in water demand is expected in the future although water supply service is insufficient even in the situation of current water demand.

In order to improve ZAWA's financial situation by providing services that satisfy users and obtaining water revenue, it should be investigated the current situation such as water supply facilities, services and water revenue, and analysed the causes of insufficient revenue. Based on this analysis, it would be effective to plan and implement measures to increase revenue from water supply. It would be efficient to conduct this status survey as part of the water master plan planned in action (3).

On the other hand, with regard to customer management, which will lead to higher water supply revenues, it is desirable to immediately implement the proposed actions, such as promoting the shift to metered customers, improving meter reading, billing and collection, and strengthening billing to unbilled customers. ZAWA has introduced the SMS-based bill distribution system, a cell phone payment system, and a payment management system based on data communication between district offices and ZAWA HQ. It is required to strengthen customer information management (especially information related to cell phone numbers) and meter reading so that these systems can be used effectively. In addition, RIWSSZ is going to introduce prepaid meters on a trial basis. Prepaid meters require a relatively advanced IT management system and maintenance system. Thus, their full introduction is not easy under the current circumstances. However, since this technology can contribute to improving water supply revenues, it is necessary to evaluate the results of several-year operation after the trial introduction and assess the potential for future use.

Since the current billing management system, SBM 2, has been in place for about 10 years and a more advanced and user-friendly system is expected to be developed, it is desirable to conduct a survey on currently available billing management systems in order to improve the efficiency of billing management through the introduction of a new system.

(3) Actions related to Basic Policy 3 of Target 2

Currently, there is no master plan for water supply. A master plan is required to ensure efficient operation of the water sector in the future. The master plan should not only plan for the development of water supply facilities, but also provide direction on how water supply administration should be (e.g., the division of water supply services between Unguja and Pemba or urban and rural areas, and the separation of facility development and operation).

In addition, to efficiently utilize limited water resources, leakage reduction in the water supply system is one of the important issues, and it is necessary to establish an NRW management team that will play a central role in the implementation of NRW management activities.

In order to reduce water supply suspension due to failure of facilities and/or equipment as much as possible, it is desirable to shift to the maintenance method that incorporates the concept of preventive maintenance, and to formulate a maintenance plan and implement maintenance in accordance with the plan.

Currently, the system of information collection and management is weak for the purpose of utilizing the information for water utility operation and O&M, and information management needs to be strengthened, including improvement of work processes.

Since recruiting and developing human resources, which form the basis of water utility operations, is also an important issue, strengthening the function of ZTC as an internal training provider is also an important task.

All of these issues should be initiated at an early stage.

4.5.2 Responsible Department and Implementation Schedule for Action Plan

Table 4.11 shows the proposed responsible departments and the implementation schedule.

Table 4.11 Responsible Department and Implementation Schedule for Action Plan

Basic Policy	Strategies	Measures		Action	Responsible	Year 1	2	3	4	5	6	7	8	9	10
Establishment of a system for Integrated Water Resource Management (IRWM) and formulation and implementation of IWRM plan	Revision of Policies and Laws	Revision of National Water Policy (2004)	1101	Revision of National Water Policy	MoWEM										
		Enactment of Water Resource Management Act.	1102	Legislation required for water resources management	MoWEM, ZAWA										
		Revision of Water Act.	1103	Revision of Water Act. based on the Water Resources Management Act.	MoWEM, ZAWA										
	Establishment of Water Resources Management Board	Establishment of WRMB	1104	Preparation for establishment (planning of organizational structure, division of duties in each department, staff allocation, procurement, budget, etc.)	MoWEM										
			1105	Selection of board members	MoWEM										
			1106	Assignment of engineers, professional staff, general staff	MoWEM										
			1107	Preparation of office and necessary equipment	WRMB										
		Establishment of a coordination/collaboration mechanism (e.g., water users association)	1108	Discussion among related sectors (structure of the association, rolls, covered area of each association, managerial regulation)	WRMB										
			1109	Promote the formation of the association in areas where there are concerns about conflicts in water use	WRMB										
		Capacity development of WRMB and the associations	1110	Implementation of management ability improvement program	WRMB										
	Formulation of a water resources management master plan (M/P) for improving efficient water use and ensuring sustainable groundwater abstraction	Evaluation of groundwater potential and permissible yield	1111	Implementation of hydrogeological survey for finding out groundwater basin structure and groundwater flow mechanism	MoWEM, ZAWA										
			1112	Groundwater modelling and simulation using the model	WRMB										
			1113	Evaluation of the amount of available groundwater resources and acceptable yield	WRMB										
		Grasp and estimate current and future water demand	1114	Evaluation of current and future water demand by sectors and groundwater basin	MoWEM, ZAWA										
			1115	Setting priority for water use by purpose	WRMB										
			1116	Evaluation of water balance comparing demand and acceptable yield	WRMB										
		Water resources allocation plan	1117	Study of options for water resources development	WRMB										
			1118	Formulation of water resources allocation plan by usage and groundwater basin	WRMB										
		Coordination of water resources development plans	1119	Adjustment and advice of sectoral water source development plan from the viewpoint of water resources management	WRMB										
			1120	Formulation of appropriate water harvesting plan in each groundwater basin	WRMB										
		Efficient water use and saving	1119	Advice of sectoral water source development plan from the viewpoint of water resources management	WRMB										
		Appropriate management of water abstraction and use	1121	Formulation of regulations for permit issuance and standardization of procedure	WRMB										
			1122	Information management of issued permission and setting of permit quantity of water yield	WRMB										
			1123	Review of permission fee and correction	WRMB										
			1124	Formulation of groundwater yield monitoring plan	WRMB										
			1125	Cooperation with the ministry and water utility for promotion of alternative water source development	WRMB										
	Introduction of IWRM approach	Conservation of water resource	1126	Designation of conservation area at recharge areas and main water sources and execution of conservation activities	WRMB										
			1127	Designation of regulated area for water source development	WRMB										
			1128	Formulation of groundwater and groundwater basin conservation plan	WRMB										
			1129	Cooperation with authorities that implement conservation activities for water resource	WRMB										
		Development of information management system related to water resources and water use	1130	Development of information management system for decision making and planning	WRMB										
			1131	Formulation of a plan for water resources observation and monitoring, and establishment of implementation system	WRMB										
			1132	Collection and analysis of natural and social scientific data related to water resources	WRMB										
			1133	sharing information among related institutions and stakeholders	WRMB										
		Raise awareness and promote participation of citizens and the private sector in water resources management	1134	Formulation of communication plan	WRMB										
			1135	Awareness program with social, schools and private companies	WRMB										
		Formulation and trial implementation of IWRM plan for each groundwater basin	1136	Formulation of integrated water resource management plan for each groundwater basin	WRMB										
Improvement of the financial situation of ZAWA for sustainable and stable water supply	Formulation of strategy for improvement of financial situation	Grasp and analyse water supply service and current OPEX in each water supply scheme	2201	Basic information survey (number of customers by categories, annual yield, annual billed water volume, etc.)	ZAWA										
			2202	Survey for supply costs and water revenue	ZAWA, ZURA										
			2203	Analysis of quality of service and OPEX	ZAWA, ZURA										
		Examination of water revenue improvement strategy based on analysis results	2204	Categorizing of water supply schemes by service situation and OPEX	ZAWA										
			2205	Formulation of financial improvement strategy by category	ZAWA										
	Examination of appropriate water tariff	Review of unit price of current water tariff	2206	Estimation coverable cost by water revenue under assumption	FP										
	Increase the number of metered customers	Promotion of meter installation to flat rate customers	2207	Formulation of annual water meter installation plan (number of meters by shahia)	CS										
			2208	Budget securing based on the plan	CS										
			2209	Installation of meters and implementation management	CS										
	Improvement of billing and collection	Billing and collection from current unbilled customers	2210	Preparation of list of unbilled customers (name and reason for unbilled)	CS										
			2211	Dialogue with unbilled customers and start billing and collection	CS										
		Promotion of customer information registration especially mobile phone numbers	2212	Formulation of customer survey plan and securing survey budget	CS										
			2213	Survey implementation and registration of collected information into systems (SBM, SMS, GIS)	CS, ICT										
		Increase meter readers according to the number of meters installed	2214	Formulation of meter reading plan	CS										
			2215	Securing meter readers according to the plan (recruit or outsource)	CS, HR										
	Survey of customer satisfaction	Implementation of periodical customer satisfaction survey by meter readers	2216	Preparation of customer satisfaction survey form	CS										
			2217	Periodical implementation of the survey and report the result to the management	CS										
	Improvement of follow-up activity for unpaid bills	Execute follow-up to unpaid customers	2218	Formulation of follow-up procedures for unpaid customers, and implementation of follow-up according to the procedure	CS										
		Evaluation of prepaid meter operation introduced by RIWSSZ and feasibility of expansion	2219	Evaluation of prepaid meter system operation	ZAWA										
			2220	Feasibility study for the expansion of prepaid meter introduction	ZURA, ZAWA										
	Evaluation of trial prepaid meter introduction	Examine the water tariff for prepaid customers	2221	Preparation of draft water tariff for prepaid meter users	ZURA, ZAWA										
			2222	Discussion and adjustment of water tariff with ZURA	ZURA, ZAWA										
	Improvement of efficiency of customer management by system	Implement integrated customer management with SBM updates	2223	Survey and selection of a billing management system	CS, ICT										
			2224	Update of the billing management system	CS, ICT										
Appropriate operation of water utility for the provision of equitable water supply at an affordable price	Formulation of facility development strategy to meet future water demand	Formulation of water M/P (facility development and replacement plan)	2301	Formulation of water master plan	ZAWA										
	Enhancement of NRW reduction	Establishment of NRW management team	2302	Formulation of NRW management system	TO										
			2303	Establishment of NRW management team	TO, HR										
		Analysis of NRW status and formulation and implementation of NRW improvement plans	2304	Calculation of NRW (whole of ZAWA, each water supply scheme, each area, each DMA)	NRW Team										
			2305	Analysis of NRW components and examination and report the NRW reduction measures	NRW Team										
	Improvement of facility maintenance	Formulation of a maintenance plan that incorporates the idea of preventive maintenance	2306	Formulation of maintenance plan	TO										
			2307	Implementation of maintenance according to the plan and monitoring of implementation	TO										
	Enhancement of project management	Accumulation of experience through the management of Japanese ODA loan project	2308	Strengthening of partnership with consultant providing the services	MoWEM, ZAWA, PMU										
	Improvement of work processes	Visualize the process of work and understand and organize them accordingly	2309	Create a process of work manual that maintains the quality of work, to avoid missing procedures or low quality of work, and perform reliable work based on the procedure manual.	ZAWA										
			2310	Construction of a monitoring system in which management monitors and confirms the work status using key performance indicators, etc.	ZAWA										
	Enhancement of information management	Sort out information items required for utility management and facility operation/ maintenance	2311	Extraction of information items that are used for utility operation management (utilization of ZURA manual)	ZAWA										
			2312	Extraction of information items that are used for facility operation and maintenance	TO										
		Confirmation of status such as data acquisition method, procedure, necessary equipment, and system for data acquisition	2313	Planning of methods for information collection and procedure, and designation of responsible Department	ZAWA										
		Implementation of information collection, management and reporting as a daily operation	2314	Implementation of information management and sharing collected information to internal of ZAWA and ZURA	TO, CS										
	Enhancement of human resource management	Examination of organizational management policy for water utility operation	2315	Review of roles of ZAWA HQ, Pemba branch and district offices for efficiency improvement of water utility operation	FP										
		Human resource allocation plan based on the reviewed organizational management policy	2316	Formulation of staff allocation plan according to the review result	FP, HR										
		Formulation of recruit plan	2317	Formulation of recruit plan according to the staff allocation plan	HR										
		Enhancement of ZTC for capacity building of new employees and existing employees of ZAWA	2318	Selection of internal training menu from needs	ZTC										
			2319	Development of internal training modules	ZTC										
			2320	Collection of existing manuals (ZURA and ZAWA)	ZTC										
			2321	Development of training material	ZTC										
			2322	Formulation of a facility and equipment plan for training and installation	ZTC										

※Legend : FP: Financial Planning Department, CS: Customer Service Department, ICT: ICT Unit, HR: Human Resources and General Affairs Department, TO: Technical Operations Department, PMU: Project Management Unit

Source: JICA Survey Team