Appendix

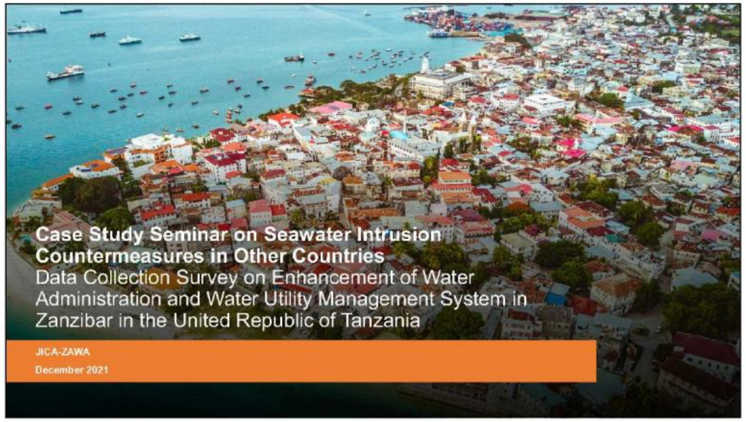
Appendix 1 List of Collected Documents

No	Name of Document	Publisher	Year
A	**Water Administration and Legislation**		
A-01	Water Act, 2006	House of Representatives	2006
A-02	Water Regulations, 2007	Ministry of Water, Construction, Energy and Lands	2007
A-03	Water Regulations (Amendment) of 2008	Ministry of Water, Construction, Energy and Lands	2008
A-04	Charges for Water and Services	Ministry of Lands, Housing, Water and Energy	2013
A-05	ZAWA (2015) Draft Guideline of Simulation on the Proper Tariff	ZAWA	2015
A-06	ZAWA (2020) Draft Customer Charter	ZAWA	2020
A-07	ZAWA Scheme of Service	ZAWA	
A-08	Zanzibar Utilities Regulatory Authority Act, 2013	House of Representatives	2013
A-09	Written Laws (Miscellaneous Amendment) Act 2019, Part Three Amendment of the Zanzibar Utilities Regulatory Authority Act 2013	House of Representatives	2019
A-10	Zanzibar Utilities Regulatory Authority (Rules of Procedure), 2016	ZURA Board of Directors and Ministry of Lands, Water, Energy and Environment	2016
A-11	Financial Regulations, 2018	Ministry of Lands, Housing, Water and Energy	2018
A-12	Consumer Complaints Handling Procedure Regulations, 2018	Ministry of Lands, Housing, Water and Energy	2018
A-13	Water Quality Monitoring Guidelines for Water Utilities (First Edition)	ZURA	2020
A-14	Performance Monitoring of Water Utilities: Key Performance Indicators for Water Supply Services	ZURA	2020
A-15	Inspection Manual for Zanzibar Water Utilities	ZURA	2020
A-16	Public and Environmental Health Act	House of Representatives	2012
A-17	Regional Administration Act, 2014	House of Representatives	2014
A-18	Zanzibar Local Government Authority Act, 2014	House of Representatives	2014
A-19	Miscellaneous Amendment Act 2016, Part Eleven Amendment of the Zanzibar Local Government Authority Act 2014	House of Representatives	2016
A-20	Written Laws (Miscellaneous Amendment) Act 2020, Part Seven Amendment of the Local Government Authority Act 2014	House of Representatives	2020
A-21	Zanzibar Environmental Management Act, 2015	House of Representatives	2015
A-22	Disposal of Unfit and Condemned Products Regulations, 2019	Second Vice President's Office	2019
A-23	Environmental Assessment Regulations, 2019	Second Vice President's Office	2019
A-24	Strategic Environmental Assessment (SEA) Guidelines in Zanzibar	Department of Environment	2019
A-25	Environmental Assessment Guidelines in Zanzibar	Department of Environment	2019
A-26	Ancient Monuments Preservation Act, 2002	House of Representatives	2006
A-27	Stone Town Conservation and Development Act, 2010	House of Representatives	2010
A-28	Forest Resources Management and Conservation Act, 1996	House of Representatives	1997
A-29	Land Tenure Act	House of Representatives	1993
A-30	Land Tenure (Amendment) Act, 2003	House of Representatives	2003

A-31	Land Tenure (Amendment) Act, 2010	House of Representatives	2010
A-32	Act to Amend Various Laws of Land, 2013	House of Representatives	2014
A-33	Municipal and industrial wastewater - General tolerance limit for municipal and wastewater.	Zanzibar Bureau Of Standards	2014
A-34	Potable water - Specification	Zanzibar Bureau Of Standards	2020
A-35	Water quality - Vocabulary	Zanzibar Bureau Of Standards	2020
A-36	Tolerance limits for industrial effluents discharged into inland surface water - Sugar industry	Zanzibar Bureau Of Standards	2020
A-37	Financial Statements for the Year 2019/2020	ZAWA	2020
A-38	Report on Audited Financial Statements of Zanzibar Water Authority for the year ended 30th June, 2019	ZAWA	2019
A-39	Draft Board of Director's Report and Financial Statements for the Year Ended 30th June 2017	ZAWA	2017
B	**Human Resource Development and Organizational Operation**		
B-01	Short Course on Groundwater Exploration, Exploitation and Management	University of Dar es Salaam	
C	**Groundwater Management**		
C-01	Integrated Water Resources Management Action Plan	MoLHWE, ZAWA	2014
C-02	Hydrogeological Map of Zanzibar	Geological Survey of Tanzania	
D	**Water Supply Facility Management**		
D-01	Operation & Maintenance Manual for Borehole Pumps	ZAWA (ZUWSP)	2019
D-02	Operation and Maintenance for Surge Tank	ZAWA (ZUWSP)	2019
D-03	Operation And Maintenance Manual for Transmission Line	ZAWA (ZUWSP)	2019
D-04	Operation Instructions for Chlorination System	ZAWA (ZUWSP)	2019
D-05	Electromagnetic Flow Monitoring System Operation Manual	ZAWA (ZUWSP)	2019
D-06	Capacity Building and Training Manual for Borehole Pump	ZAWA (ZUWSP)	2019
D-07	Garage Equipment for Workshop	ZAWA	2021
D-08	Tools and Equipment for Civil Works	ZAWA	2021
D-09	Draft Project Completion Report (ZUWSP)	ZAWA (ZUWSP)	2019
D-10	Final Detailed Engineering Design Report (RIWSSZ)	MoWEM, ZAWA	2021
D-11	Leakage Report July - Sept'2021	ZAWA	2021

Appendix 2 Material for Seminar and Workshop

2.1 Seminar for Saltwater Intrusion Measures



1

Contents

2

1. Background of the Seminar-1: Challenges

① Periodical groundwater observation (Pumping rate, groundwater level, water quality etc.)
② Collection and management of well specification data
③ Elucidation of Hydrogeological Structure (Groundwater Basin)
④ Groundwater Potential and Permissible Yield*
⑤ Risk Management of Groundwater Pollution (development of multiple aquifer, water shielding treatment)
⑥ Seawater Intrusion
⑦ Groundwater Management Framework

Permissible Yield*: the permissible amount of groundwater pumping from region's residents' point of view, obtained by **comparing** and analyzing **the benefits** resulting from the pumping of groundwater and **the risks** that might arise from it

3

1. Background & Purpose of the Seminar

- In Zanzibar, continued groundwater development has increased groundwater utilization, but the amount of available water resources based on scientific data has not been fully assessed.
- The JICA's advisor pointed out that one of the reason for the insufficient service level was a lack of basic management capability related to water sources.
- Considering the hydrogeology of Zanzibar, excessive groundwater development increases the risk of seawater intrusion into groundwater.

4

2. Purpose of the Seminar

- The purpose of this seminar is to discuss future action for water resources management in Zanzibar by introducing examples of countermeasures against seawater intrusion into groundwater in other countries.

5

3. Selection of a Case, Part 1

For the following reasons, the JICA Survey Team selected a case of Miyako Island (Miyako-Jima City), Okinawa Prefecture in Japan.

- The major countermeasure to prevent the salinization of groundwater in islands such as Zanzibar are only two, one is 1) **Control the amount of pumping rate** so as to maintain the thickness of the freshwater lens, and other one is 2) Construct **underground dam** to physically stop the outflow of groundwater into sea and **prevent seawater intrusion** into the groundwater (freshwater).
- Miyako City have been made both countermeasure such as 1) Control the amount of pumping rate by **setting an ordinance** and 2) construct the **world's first large-scale underground dams** constructed on Miyako Island.

6

3. Selection of a Case, Part 2

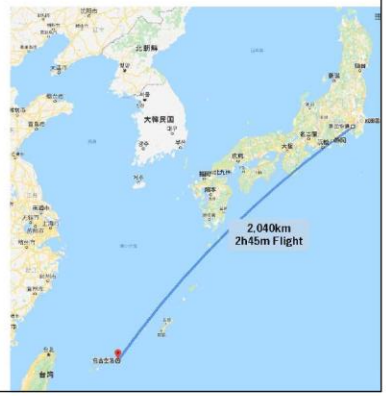
- The constructed underground dam in Miyako Island **maintains the amount of pumping rate**and **also maintains water quality** by raising the groundwater level.
- Both **geological and hydrogeological structure of Miyako Island is similar with that of Zanzibar**, which has a reef limestone aquifer and mudstone basement.
- Miyako Island has **succeeded in seawater intrusion countermeasures on both the soft measure (groundwater management ordinance) and the hard measure (underground dam)**

It is therefore, suitable as an introduction example of the seminar.

7

4. Overview of Miyako Island-1: Location

Miyako Island	
Area	204 km²
Population	52,259 (2021)
Climate	Subtropical Annual rainfall 2,200 mm
Geology	Mudstone (Tertiary) basement and coralline limestone (Quaternary)
Unguja Island	
Area	634 km²
Population	896,721 (2012)
Climate	Tropical Annual rainfall 1,600 mm
Geology	Marls, sancy clays (Tertiary) basement and coralline limestone (Quaternary)



8

4. Overview of Miyako Island-2: Feature

3 bridges connecting Miyako Island to other islands

9

4. Overview of Miyako Island-3: Climate

The average annual temperature is **23 degrees Celsius**. It has a subtropical coastal climate with **80% humidity** and **2,200 mm of precipitation**.

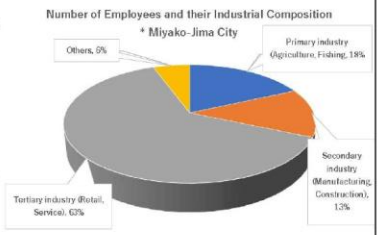
hideClimate data for Miyakojima (1991−2020 normals, extremes 1937−present)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yea
Record high °C (°F)	27.0 (80.6)	27.6 (81.7)	28.6 (83.5)	30.7 (87.3)	33.3 (91.9)	35.1 (95.2)	35.3 (95.5)	34.2 (93.6)	34.2 (93.6)	32.5 (90.5)	30.9 (87.6)	28.8 (83.8)	35. (95.
Average high °C (°F)	20.6 (69.1)	21.1 (70.0)	22.8 (73.0)	25.1 (77.2)	27.7 (81.9)	30.3 (86.5)	31.7 (89.1)	31.3 (88.3)	30.1 (86.2)	27.8 (82.0)	25.3 (77.5)	22.2 (72.0)	26. (79.
Daily mean °C (°F)	18.3 (64.9)	18.6 (65.5)	20.1 (68.2)	22.5 (72.5)	25.0 (77.0)	27.7 (81.9)	28.9 (84.0)	28.6 (83.5)	27.6 (81.7)	25.5 (77.9)	23.1 (73.6)	20.0 (68.0)	23. (74.
Average low °C (°F)	16.3 (61.3)	16.6 (61.9)	17.9 (64.2)	20.4 (68.7)	23.0 (73.4)	25.7 (78.3)	26.8 (80.2)	26.5 (79.7)	25.6 (78.1)	23.8 (74.8)	21.3 (70.3)	18.2 (64.8)	21. (71.
Record low °C (°F)	6.9 (44.4)	7.3 (45.1)	8.6 (47.5)	11.4 (52.5)	15.2 (59.4)	17.4 (63.3)	21.4 (70.5)	21.2 (70.2)	19.7 (67.5)	17.2 (63.0)	12.9 (55.2)	9.6 (49.3)	6.9 (44.
Average precipitation mm (inches)	138.8 (5.46)	119.8 (4.72)	138.7 (5.46)	148.7 (5.85)	222.3 (8.75)	194.7 (7.67)	151.6 (5.97)	257.4 (10.13)	259.3 (10.21)	157.9 (6.22)	139.8 (5.50)	147.2 (5.80)	2,07 (81.
Average snowfall cm (inches)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

10

4. Overview of Miyako Island-4: Industry

1) **Agriculture**: Fruits such as sugar cane, tobacco and mango.
2) **Tourisum**: The clear sea and white sand beaches made of coral are symbolic, and beach resorts and various marine sports are popular.
3) **Brewery**: There are 6 breweries in Miyakojima City
4) **Chemical industry**: Biomass ethanol production from sugar cane



11

5. History of Water Use and Development in Miyako Island

5.1. Before 1960's

- The average annual rainfall on Miyakojima is 2,000 mm or more, which is much higher than the national average in Japan, but due to the **high permeability, 40% of the rainfall infiltrate underground and 50% evaporates**. Since ancient times, it has been an island with very poor water, with no rivers or lakes.
- Water is very valuable on Miyakojima. In addition to using **rainwater** for domestic, it is the job of women and children to draw water from springs along the coastal cliffs called "**Gar**" and natural **cave springs**.
- Regarding agriculture on Miyakojima, the entire cultivated land that occupies most of the island's area is a farming form that **depends only on rainwater**, and although there is abundant rainfall, there are large seasonal variations, and especially in the summer, dry weather often continues. Therefore, it was damaged by **drought once every four years**.

12

5. History of Water Use and Development in Miyako Island
5.1 Before 1960's



Gar springs, along the coastal cliffs


Morika Gar (1939)


Hora Gar (1938)



Natural Cave springs

13

5. History of Water Use and Development in Miyako Island
5.2 From 1960 to 1980

Year	Event
1941 - 1945	The Pacific War
1945 - 1972	Okinawa (including Miyako City) Occupation by the USA
1960	Miyako Sugar Production Company Limited was established
1963	Mr. J.F. Mink (Hydrogeologist) came to Miyako Island from Hawaii (USA) based on the request of Sugar Production Company, and start geological investigation.
1963	Mink Report was submitted and suggested to make full scale hydrogeological study since there is a large potential of groundwater development
neither hydrogeological study nor groundwater development was carried out during the U.S. rule.	
1971	Agriculture was devastated by an unprecedented drought (162mm/185days)
1972	Return of Okinawa to Japan
1972	Okinawa Prefecture started water resources development study on Miyako Island, two development plans were presented by the results of study. 1) Yonaha Bay Artificial Freshwater Lake Development Plan 2) Groundwater development plan in Miyako Main Island

14

5. History of Water Use and Development in Miyako Island
5.2 From 1960 to 1980

1) Yonaha Bay Artificial Freshwater Lake Development Plan

The survey continued from 1972 to 1982, but could not be achieved due to opposition from fishermen around the bay

2) Groundwater development plan in Miyako Main Island

- The idea of Groundwater dam was recommended by the Geological and Hydrogiological investigation carried out from 1973 to 1974.
- In 1977, construction of the Kaifuku underground dam (reservoir capacity 700,000 m^3) has started.
- Kaifuku underground dam was completed in 1979.

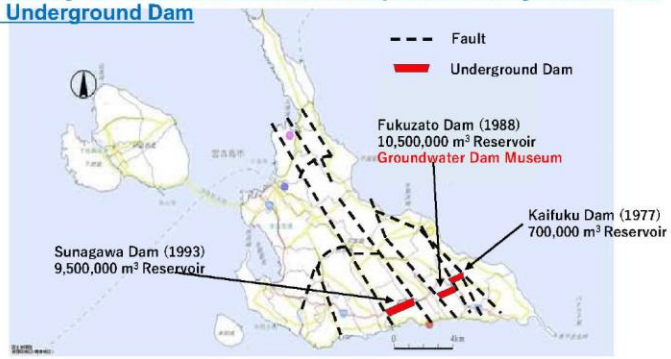
15

5. History of Water Use and Development in Miyako Island
5.3 From 1980 till Now

Year	Event
1987	Miyako area National Irrigation Development Project was started (Project consisting 2 underground dams, 6 farm ponds, 134km pipeline, Wind power generation system)
1988 - 1993	Construction of Sunagawa undergrand dam (reservoir capacity 9,500,000m^3) started on 1988, completed on 1993
1988 - 1998	Construction of Fukazato undergrand dam (reservoir capacity 10,500,000m^3) started on 1988, completed on 1998
2000	Miyako area National Irrigation Development Project was Completed
2009	Issuance of Miyakojima City Groundwater Conservation Ordinance
2009	Completion of Miyakojima City Groundwater Dam Museum
2010	Amendment of Miyakojima City Groundwater Conservation Ordinance
2013	2nd Amendment of Miyakojima City Groundwater Conservation Ordinance
2014	Implementation of Miyakojima City Groundwater Quality Conservation Survey
2014	Formulation of Miyakojima City Groundwater Utilization Basic Plan

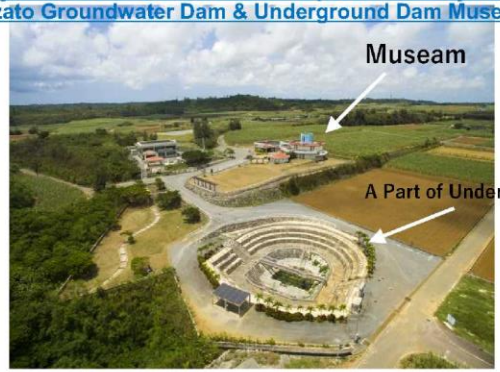
16

5. History of Water Use and Development in Miyako Island
5.4 Underground Dam



17

5. History of Water Use and Development in Miyako Island
5.5 Fukuzato Groundwater Dam & Underground Dam Museam



18

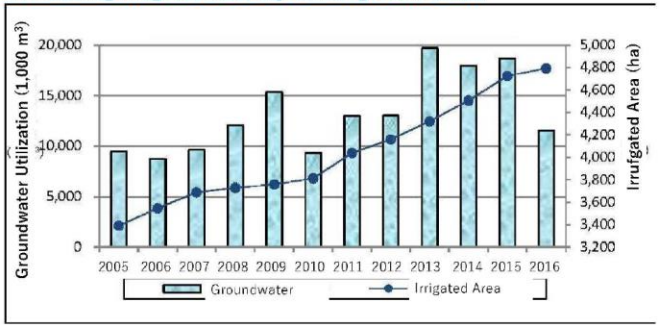
5. History of Water Use and Development in Miyako Island
5.6 Underground Dam Museam

JICA Counterpart Training in Japan (MoW, Tanzania)

Supervisory Control And Data Acquisition system of the Underground Dam

19

5. History of Water Use and Development in Miyako Island
5.7 Increasing irrigated area by Underground Dam



20

5. History of Water Use and Development in Miyako Island

5.8 Miyako Water Festival

Since 2010, the residents of Miyako island have started the "Miyako Water Festival" in order to・・・・・

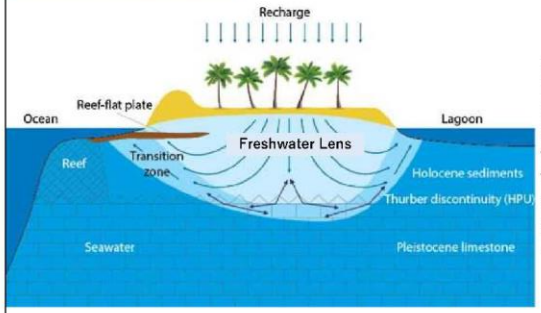
- remember the history of struggling with water
- remember the importance of water
- remember to thank the water

and it is still held every August.

21

6. Mechanism of Seawater Intrusion into Groundwater

6.1 Freshwater Lens

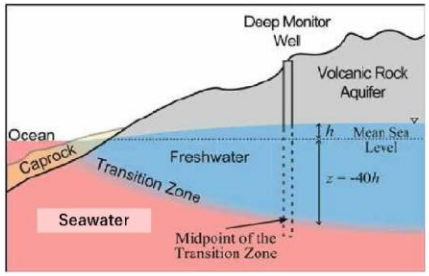


Freshwater lens or **Ghyben-Herzberg lens**, is a convex-shaped layer of fresh groundwater that floats above the denser seawater, usually found on small coral or limestone islands。

22

6. Mechanism of Seawater Intrusion into Groundwater

6.2 Ghyben-Herzberg's Law

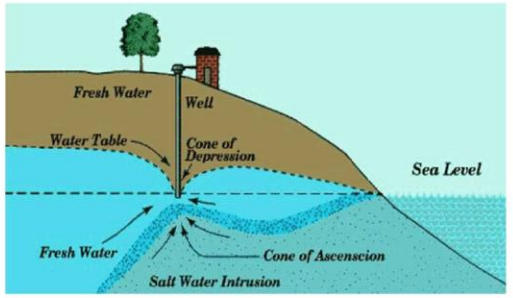


The first physical formulations of saltwater intrusion were made by Willem Badon-Ghijben in 1888 and 1889 as well as Alexander Herzberg in 1901, thus called the Ghyben–Herzberg relation.[14] They derived analytical solutions to approximate the intrusion behavior, which are based on a number of assumptions that do not hold in all field cases.

23

6. Mechanism of Seawater Intrusion into Groundwater

6.3 Relationship between level and invasion of seawater intrusion



When the groundwater level drops due to pumping, the boundary between freshwater and saltwater rises.

24

Appendix-8

6. Mechanism of Seawater Intrusion into Groundwater

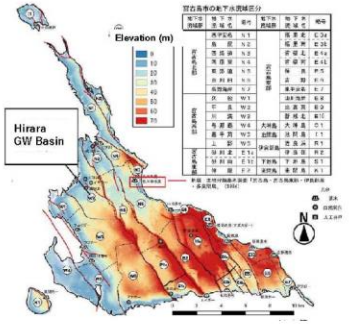
6.3 Relation between groundwater level and seawater intrusion

Lowering groundwater level leads to seawater intrusion

6. Mechanism of Seawater Intrusion into Groundwater

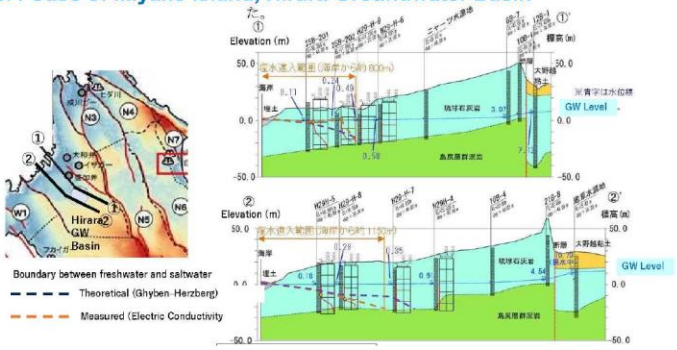
6.4 Case of Miyako Island, Hirara Groundwater Basin

- Theoretically, the lower elevation area is shallower the boundary between freshwater and saltwater (Ghyben–Herzberg relation).
- The low elevation areas are distributed along the coastline, but especially in the western and northern parts (including the Hirara GW basin) of the island.



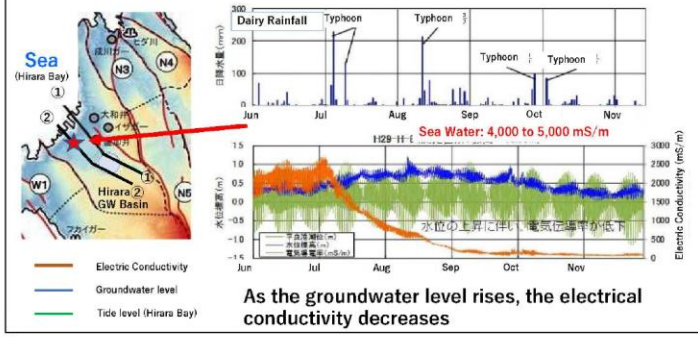
6. Mechanism of Seawater Intrusion into Groundwater

6.4 Case of Miyako Island, Hirara Groundwater Basin



6. Mechanism of Seawater Intrusion into Groundwater

6.4 Case of Miyako Island, Hirara Groundwater Basin



As the groundwater level rises, the electrical conductivity decreases

6. Mechanism of Seawater Intrusion into Groundwater

6.4 Case of Unguja Island

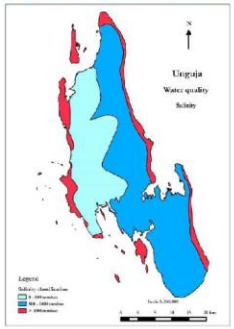
Zone 1: 0 - 500 mmhos
The aquifer is recharging by rainwater. The water is suitable for potable as well as agricultural use.

- **Zone 2: 500 - 1000 mmhos**

The aquifer is recharging by rainwater. The water is in general suitable for potable use and for some agricultural use.

- **Zone 3: More than 1000 mmhos**

This water type has an increased salinity due to local over pumping or the high salinity

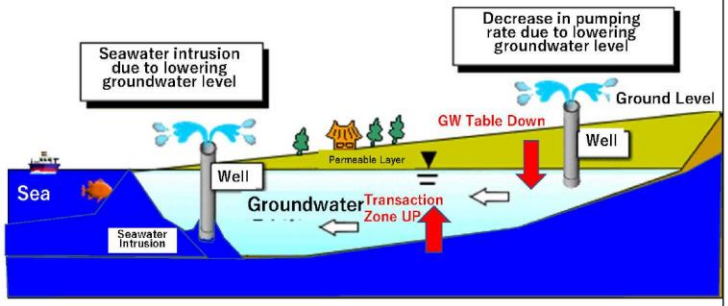


Source: ZAWA (2014) Water Resources Assessment, Zanzibar Water Supply and Sanitation Project,Water Resources Management Component

29

7. Underground Dam

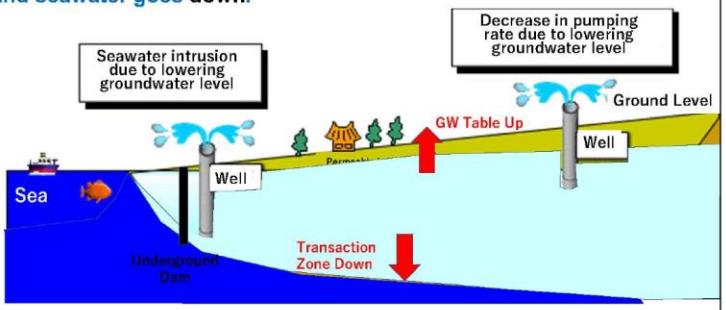
7.1 The risks, caused by over pumping of ground water



30

7. Underground Dam

7.1 As the groundwater level rises, the boundary between freshwater and seawater goes down.



31

7. Underground Dam

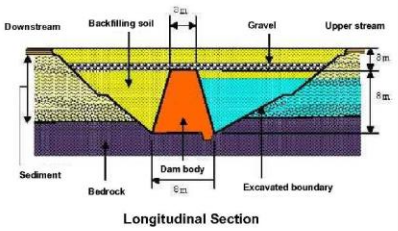
7.3 Construction of the dam: Grouting Method

Application of foundation (soil) improvement method: Inject mortar into the ground through intermittently excavated boring holes

32

7. Underground Dam

7.4 Construction of the dam: Earth dam construction method (Burkina Faso)



Construction method to build a earth dam (clay weir) in underground

33

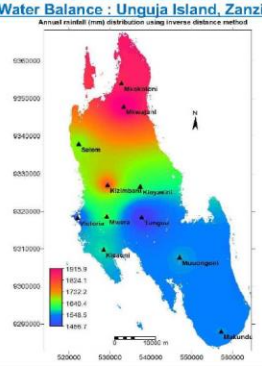
7. Underground Dam

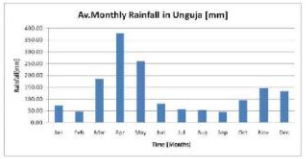
7.5 Advantageous Effect of Underground Dam

34

8. Similarity of Natural Conditions Between Miyako and Unguja Island (Possibility of Underground Dam on Unguja Island)

8.1 Water Balance : Unguja Island, Zanzibar





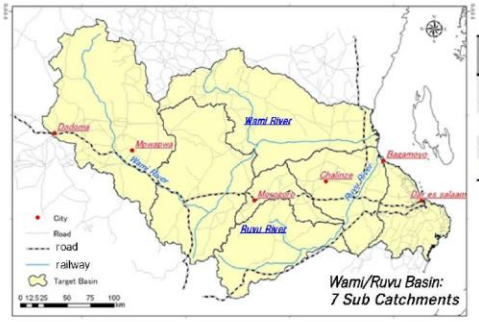
Water Balance of Unguja Island, Zanzibar (1991-2008)	
Rainfall (1,544 mm annual mean)	100%
Evapotranspiration	40%
Surface Runoff	36%
Infiltration	24%

Data Source : Haji Shaaban Haji (2010) Water Balance Assessment in Unguja Island Zanzibar, Tanzania

35

8. Similarity of Natural Conditions Between Miyako and Unguja Island (Possibility of Underground Dam on Unguja Island)

8.2 Water Balance : Wami/Ruve Basin, Tanzania



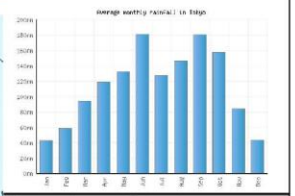
Water Balance of Wami/Ruvu Basin (average of 1969 – 2010)*	
Rainfall (990mm annual mean)	100%
Evapotranspiration	87%
Surface Runoff	6%
Infiltration	7%

Data source: JICA (2013) The study on water resources management and development in Wami/Ruvu basin in the United Republic of Tanzania

36

8. Similarity of Natural Conditions Between Miyako and Unguja Island (Possibility of Underground Dam on Unguja Island)

8.3 Water Balance : Uban Area, Tama River Basin, Tokyo



Water Balance of Tokyo, Japan (1976-2006)	
Rainfall (1,544 mm annual mean)	100%
Evapotranspiration	37%
Surface Runoff	57%
Infiltration	6%

37

8. Similarity of Natural Conditions Between Miyako and Unguja Island (Possibility of Underground Dam on Unguja Island)

8.4 Water Balance : Miyako and Unguja Island

Rainfall (100% both in Miyako and Unguja Island*)

Evapotranspiration

40% : Unguja
50% : Miyako

Infiltration

24% : Unguja
40% : Miyako

Surface Runoff

36% : Unguja
10% : Miyako

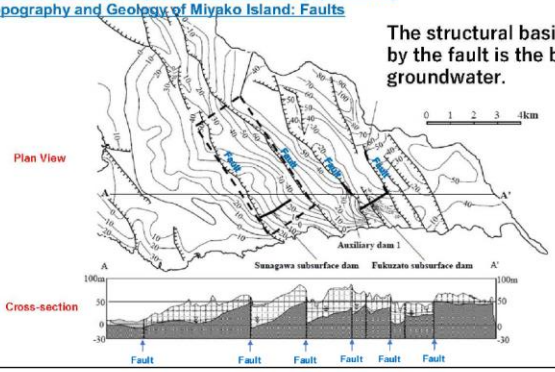
* Haji Shaaban Haji (2010) Water Balance Assessment in Unguja Island Zanzibar, Tanzania

38

8. Similarity of Natural Conditions Between Miyako and Unguja Island (Possibility of Underground Dam on Unguja Island)

8.5 Topography and Geology of Miyako Island: Faults

The structural basin defined by the fault is the basin of groundwater.



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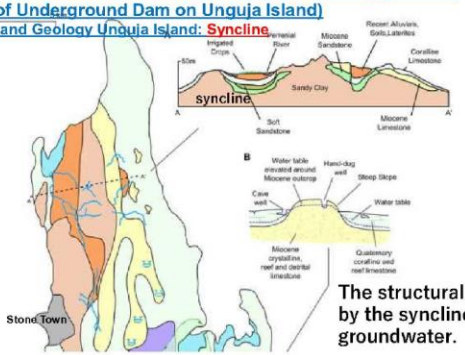
8. Similarity of Natural Conditions Between Miyako and Unguja Island (Possibility of Underground Dam on Unguja Island)

8.6 Topography and Geology Unguja Island: Syncline



The structural basin defined by the syncline is the basin of groundwater.

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

40

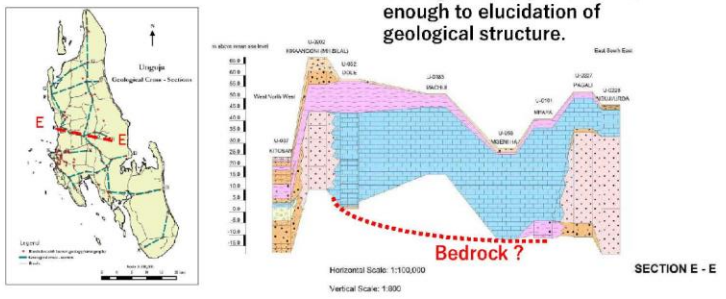
8. Similarity of Natural Conditions Between Miyako and Unguja Island (Possibility of Underground Dam on Unguja Island)

8.6 Topography and Geology Unguja Island: Geologic Fold

41

8. Similarity of Natural Conditions Between Miyako and Unguja Island (Possibility of Underground Dam on Unguja Island)

8.7 Topography and Geology of Unguja Island: Elucidation of Hydrogeological Structure



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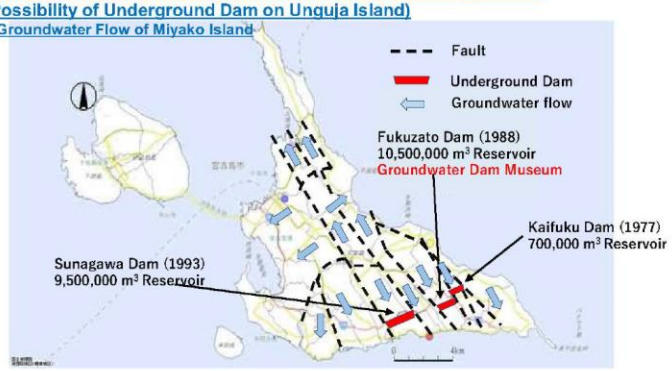
8. Similarity of Natural Conditions Between Miyako and Unguja Island (Possibility of Underground Dam on Unguja Island)

8.8 Groundwater Flow of Miyako Island



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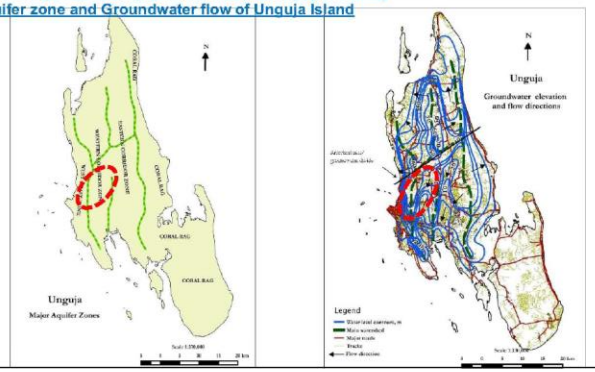
8. Similarity of Natural Conditions Between Miyako and Unguja Island (Possibility of Underground Dam on Unguja Island)

8.9 Aquifer zone and Groundwater flow of Unguja Island



44

8.10 Wrap Up

Conclusion: Unguja Island has high potential for construction of Underground Dam due to following reasons:

1. Large amount of **infiltration** into the Groundwater
2. The **structural basin** is a basin of the groundwater.
3. The buried (underground) valley is **narrow**
4. The foundation rock is **hard rock**

45

9. Miyakojima City Groundwater Conservation Ordinance

Contents of the Ordinance

The ordinance was issued in June 2009 and has been revised in 2010 and 2013.

Chapter 1 General Provisions (Articles 1-7)

Chapter 2 Groundwater Conservation (Articles 8-18)

Chapter 3 Conservation of water sources (Article 19-26)

Chapter 4 Miyakojima City Groundwater Council (Article 27-29)

Chapter 5 Miscellaneous Provisions (Article 30-38)

Chapter 6 Penalties (Article 39-43)

46

9. Miyakojima City Groundwater Conservation Ordinance

Chapter 1 General Provisions (Articles 1-7)

Purpose: to improve the welfare of residents by contributing to the appropriate use of groundwater resources.
Principle: Conservation and utilization of groundwater resources must be carried out properly so that residents can enjoy their benefits.
Mayor's responsibilities: Implement measures related to groundwater conservation
Citizen's responsibilities: Cooperate with the mayor's measures for groundwater conservation
Obligation of the business operator: Take necessary measures for groundwater conservation in view of the impact of the business activities on groundwater
Obligation of commercial groundwater users: Strive for rational groundwater use with the highest priority on public groundwater use

47

9. Miyakojima City Groundwater Conservation Ordinance

Chapter 2 Groundwater Conservation (Articles 8-18)

Area for conservation:
1. The area for conserving groundwater is the entire Miyakojima city.
2. The mayor can designate and/or cancel specific groundwater intake facility as a public groundwater utilization facility, and publicize it.

Miyakojima City Basic Plan on Groundwater Utilization
The mayor must formulate the **Basic Plan on Groundwater Utilization** in order to conserve and effectively use of groundwater.
Groundwater extraction permit and notification:
Anyone who intends to drill a well must obtain permission from the mayor.
Permission and notification of changes:
When changing the pumping rate or the capacity of equipment for which permission has been obtained, the permission of the mayor must be obtained.

48

9. Miyakojima City Groundwater Conservation Ordinance

Chapter 3 Conservation of Water Source(Articles 19-26)

Designation of water source conservation area :

- The mayor can specify, change, or cancel the water source conservation area and drainage water quality.

Business in the water source conservation area:

- Those who intend to implement the target business in the water source conservation area must consult with the mayor in advance.

Prohibition of regulated business establishments:

- No one should set up regulated business establishments in the water source conservation areas.

Conclusion of water source conservation agreement:

- The business operator who intends to establish a specified business establishment shall conclude an agreement with the city that includes the action necessary for the future conservation of the water source.

49

9. Miyakojima City Groundwater Conservation Ordinance

Chapter 4 Miyakojima City Groundwater Council (Articles 27-29)

Miyakojima City Groundwater Council :

- Establish a council to investigate and deliberate important matters concerning groundwater.
- The council can offer an opinion to the mayor on important matters concerning groundwater.

Council organization

- The council is appointed by the mayor from among the heads of relevant administrative agencies, the heads of related organizations, and those who have academic experience in groundwater.

50

9. Miyakojima City Groundwater Conservation Ordinance

Chapter 5 Miscellaneous Provisions (Article 30-38)

Groundwater Monitoring:

- The mayor must monitor the condition of groundwater regularly.
- Investigators appointed by the mayor may enter private land and facilities to investigate or inspect groundwater for monitoring.

Collection of Report

- The mayor can have groundwater users report on structure of the facility, the status of use, the amount of groundwater collected, status of discharged water, etc.

Guidance or Recommendations:

- The mayor warns those who have collected groundwater without permission to immediately stop the pumping.

51

9. Miyakojima City Groundwater Conservation Ordinance

Chapter 5 Miscellaneous Provisions (Article 30-38)

Emergency Measures to Secure the Groundwater Amount:

- The mayor may order groundwater users to limit the pumping of groundwater when there is an urgent need to conserve groundwater.

Emergency Measures to Secure the Groundwater Quality:

- The mayor shall take necessary measures for the conservation of groundwater when it is clearly recognized that the groundwater is contaminated by harmful substances or is likely to be contaminated.

52

9. Miyakojima City Groundwater Conservation Ordinance

Chapter 5 Penalties (Article 39-43)

Cancel of Groundwater Use Permition:

- The mayor may cancel the groundwater use permit or order the suspension of groundwater pumping to those who do not follow the recommendations.

Announcement:

- When the person who received the recommendation does not follow the recommendation, the mayor may announce that fact and the content of the guidance or recommendation.

Penalties:

- Those who violate the ordinance shall be punished by imprisonment for not more than 1 year or a fine of not more than 1 million yen.

53

10. Basic Plan on Groundwater Utilization

Purpose of the Basic Plan

The Basic Plan was formulated in accordance with Article 10 of Miyakojima City Groundwater Conservation Ordinance (Slide No.48)

Contents of the Basic Plan

Chapter 1 General Statement

1.1 Purpose of the Basic Plan
1.2 Groundwater supply and demand plan
1.3 Target year
1.4 Definision
1.5 Basic information of the groundwater in Miyakojima City

Chapter 2 Groundwater Utilization

2.1 Current status of groundwater use
2.2 Groundwater supply and demand plan

54

10. Basic Plan on Groundwater Utilization

Contents of the Basic Plan

Chapter 3 Coordination on utilization and conservation of Groundwater

3.1 Basic policy of the coordination on groundwater utilization

3.2 Public groundwater utilization facilities and their intake areas.

3.3 Permission criteria for groundwater extraction

3.4 Criteria subject to business regulation

3.5 Conservation measures for groundwater quality and quantity

55

10. Basic Plan on Groundwater Utilization

Chapter 3 Coordination on utilization and conservation of Groundwater

3.1 Basic policy of the coordination on groundwater utilization

(1) Target area for coordination on groundwater utilization

(2) Coordination on GW utilization as a measure against drought

- Priority is given to securing water for citizen in Miyakojima City
- Public groundwater use takes precedence over other uses

(3) Coordination on GW use between new groundwater use applications & existing user

- New groundwater use that may interfere with existing public GW use shall not be permitted.
- For applications that may interfere with the other existing GW user, the applicant shall be requested to take care not to cause any obstacles.

(4) Coordination on GW use as a countermeasure against groundwater pollution

- Groundwater use is not permitted if groundwater pollution is likely to occur

56

10. Basic Plan on Groundwater Utilization

Chapter 3 Coordination on utilization and conservation of Groundwater

3.3 Permission criteria for groundwater extraction

Applications that fall under any of the following items shall not be permitted. However, this does not apply if the mayor, after consulting with the Groundwater Council, finds it particularly necessary in view of the public nature of groundwater use

(1) If the GW use does not match the hydrogeological characteristics of the area

(2) When there is a risk of interfering with the use of public GW.

(3) When there is a risk of impairing the quality, storage and flow of GW

(4) When there is an easy means of securing water other than the GW use application

(5) When the flow direction of GW around the planned well drilling point is not clear

(6) When it goes against the purpose of the ordinance

57

10. Basic Plan on Groundwater Utilization

Chapter 3 Coordination on utilization and conservation of Groundwater

3.4 Criteria subject to business regulation

Businesses that fall under any of the following items are subject to regulation

(1) When the effectiveness of the wastewater treatment plan and water source conservation plan are not guaranteed.

(2) When the drainage that infiltrate underground does not meet the drainage water quality standard value

(3) When there is a risk of affecting the quality of the water source

(4) In the livestock industry, when proper management and treatment cannot be performed so that livestock fecal sludge does not become a source of groundwater pollution.

(5) When there is a concern about groundwater pollution in the water source conservation area

58

10. Basic Plan on Groundwater Utilization

Chapter 3 Coordination on utilization and conservation of Groundwater

3.4 Conservation measures for groundwater quality and quantity

(1) The mayor shall operate the ordinance properly in order to conserve of groundwater quality and quantity.

(2) The mayor will carry out the following items as measures related to groundwater conservation.

- Monitoring survey of groundwater quality and groundwater level
- Continuous geological survey to grasp the groundwater flow status, etc.

(3) If the carcass of livestock needs to be incinerated or buried, the mayor shall take groundwater conservation measures.

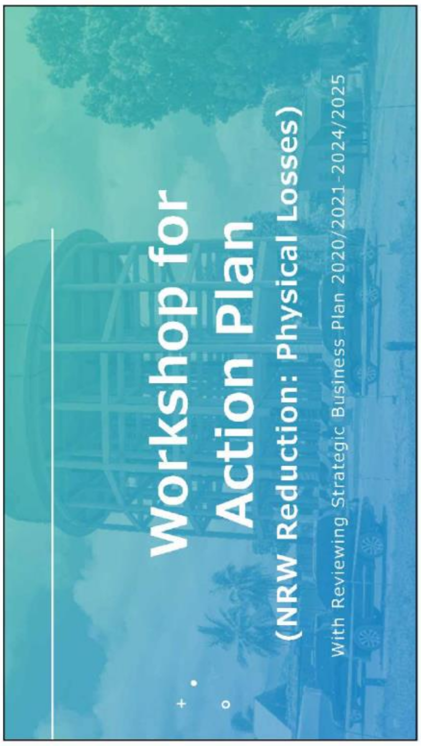
(4) The mayor implements groundwater conservation measures in the event of a livestock infectious disease

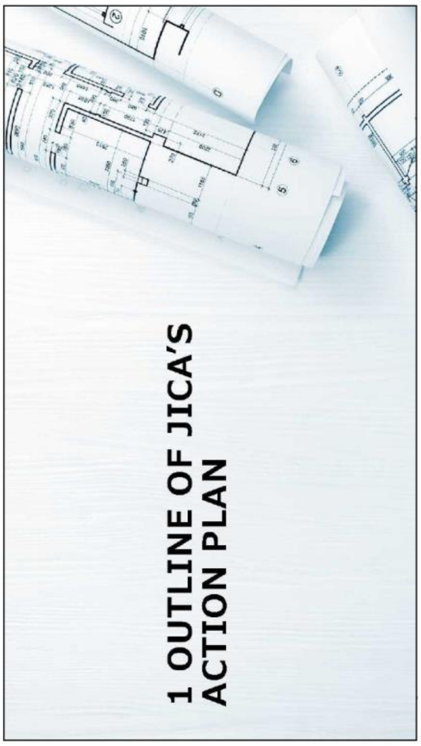
e.c.In the livestock industry, when proper management and treatment cannot be performed so that livestock fecal sludge does not become a source of GW pollution.

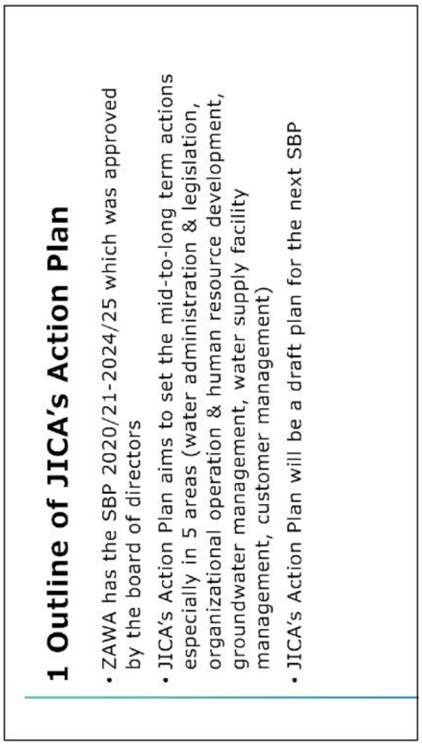
59

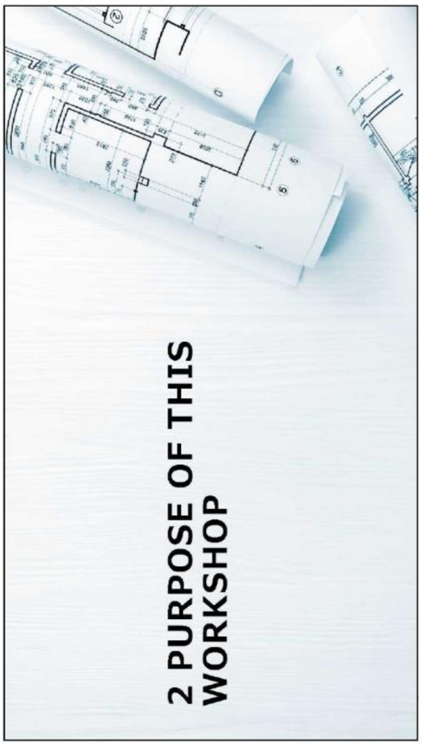
60

2.2 Workshop for NRW Management (Physical Losses)









2 Purpose of this Workshop

- Reviewing basics of NRW
- Review "Actions" (Implementation Matrix) of SBP and their relation to NRW management
- Discuss the Actions that should be addressed by ZAWA to reduce NRW reduction for the mid-to-long terms (actions in the next SBP for NRW management: continuous actions, new actions)

5

3 BASICS OF NRW

6

IWA Water Balance

System Input Volume	Authorized Consumption	Billed Authorized Consumption	Billed Metered Consumption (including water exported)	Revenue Water
			Billed Unmetered Consumption	
		Unbilled Authorized Consumption	Unbilled Metered Consumption	Non-Revenue Water (NRW)
			Unbilled unmetered Consumption	
	Water Loss	Apparent Losses (Commercial Losses)	Unauthorized Consumption	
			Metering Inaccuracies	
		Real Losses (Physical Losses)	Leakage on Transmission and/or Distribution Mains	
			Leakage and Overflows at Utility's Storage Tank	
			Leakage on Service Connections up to the measurement point	

7

NRW calculations

- Formula of NRW calculation

(1) $NRW = \frac{Unbilled\ Authorized\ Consumption + Water\ Loss}{System\ Input\ Volume} \times 100$

(2) $Unbilled\ Authorized\ Consumption + Water\ Loss = System\ Input\ Volume - Revenue\ Water$

(3) $Revenue\ Water = Billed\ Metered\ Consumption + Billed\ Unmetered\ Consumption$

- NRW is calculated from 2 measurable data (system input volume and billed metered consumption) and 1 unmeasurable data (billed unmetered consumption).
- Who is the responsible person for NRW calculations?

8

Data Collection for NRW calculations (a) System input volume

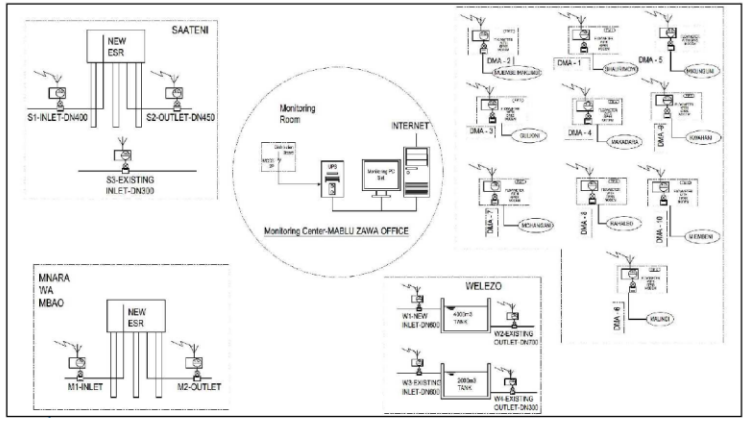
- Decide the system boundary for NRW Calculations
  - Whole ZAWA water supply system
  - Service reservoir wise water supply system (e.g., Welezo system, Saateni system, Dole system, etc.)
  - DMA in water supply system
- Collect the system input volume data
  - Production boreholes
  - Direct pumping production boreholes
  - Outlet flow from service reservoirs
  - DMA inlet flow

9

Data Collection for NRW calculations (a) System input volume

- Measure the various system input flow by flowmeters
  - Install flowmeters at boreholes, reservoirs and DMAs (electromagnetic flow meters are recommended)
  - Record and manage daily, monthly, annual system input flow
  - If you use a SCADA System, measure, record and collect the information easily, automatically in the minimum number of operators.

10



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Data Collection for NRW calculations (b) Billed metered consumption

- Collect the meter reading data (Billed metered consumption)
  - Collect the data of each system for NRW calculation from the billing system
- Estimate the consumption (Billed unmetered consumption)
  - Consumption by flat rate customers
  - Others

12

How to reduce NRW?

- Increase "Revenue Water" = decrease "Non-revenue Water"
- Reduce three items below

(1) "Unbilled Authorized Consumption":
Unbilled metered & unmetered consumption

(2) "Apparent Losses":
Unauthorized consumption and meter inaccuracy

(3) "Real Losses":
Leakage from pipelines, storage tank and service connections, Overflow from storage tanks

13

How to reduce NRW?

System Input Volume	Authorized Consumption	Billed Authorized Consumption	Billed Metered Consumption (including water exported)	Revenue Water
			Billed Unmetered Consumption	
		Unbilled Authorized Consumption	Unbilled Metered Consumption	Non-Revenue Water (NRW)
			Unbilled unmetered Consumption	
	Water Loss	Apparent Losses (Commercial Losses)	Unauthorized Consumption	
			Metering Inaccuracies	
		Real Losses (Physical Losses)	Leakage on Transmission and/or Distribution Mains	
			Leakage and Overflows at Utility's Storage Tank	
			Leakage on Service Connections up to the measurement point	

14

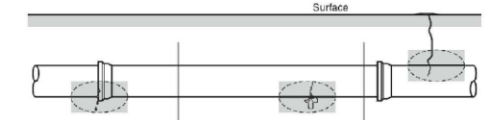
How to reduce NRW?

- The table shows the number of leakage in the first quarter of 2021
- How was the characters of leakage
- Surface or underground?
- Distribution lines, valves or service connection?
- *A leakage record is necessary* to analyze the character of leakage.

DWO	Leakage found	Leakage repaired
North A	24	24
North B	4	4
Central	11	11
Urban	351	351
Urban West A	15	15
Urban West B	80	80
South	24	24
Total	509	509

15

Character of Leakage



Background Leakage
Unreported and undetectable using traditional acoustic equipment

Tools
- Pressure Stabilization
- Pressure Reduction
- Main and Service Replacement
- Reduction in the Number of Joints and Fittings

Unreported Leakage
Often does not surface but is detectable using traditional acoustic equipment

Tools
- Pressure Stabilization
- Pressure Reduction
- Main and Service Replacement
- Reduction in the Number of Joints and Fittings
- Proactive Leak Detection and Repair

Reported Leakage
Often surfaces and is reported by the public or utility workers

Tools
- Pressure Stabilization
- Pressure Reduction
- Main and Service Replacement
- Optimized Repair Time

Source: Water Audits and Loss Control Programs, AWWA

16

4 REVIEW OF ACTIONS RELATED TO REDUCTION OF PHYSICAL LOSSES IN STRATEGIC BUSINESS PLAN

17

4-1 Objectives and Strategies

- Objectives and strategies for water service provision
- Reducing NRW is one of the strategies of SBP.

Objectives	Strategies
Water service provision increased from guesstimated 83% to 95 % by 2023.	i. Enhancing water supply service reliability ii. Reducing non-revenue water iii. Improving Water Infrastructure iv. Enhancing water quality monitoring

18

4-2 Consolidated Performance Targets (Water Service Provision)

Description	Unit	Best Performance	Target (2025)
Volume of water produced	m^3/year	39,417,000	42,321,000
Volume of water sold	m^3/year	14,584,290	26,806,650
Non-Revenue Water	%	63.0	30.0
Water service coverage	%	83.0	97.0
Response time to water leaks and bursts	Hrs.	12	6
Percentage of reported leaks and bursts Repaired	%	70.0	100.0
Percentage samples of supplied water passing bacteriological quality	%	80.0	100.0
Percentage samples of supplied water passing physical chemical quality - turbidity	%	91.0	100.0

19

Consolidated Performance Targets

- To achieve the 30% of NRW target, physical losses should be less than 30% because NRW includes other factors. 30% of the NRW target is the very challenging target.
- Efforts for data management to improve NRW calculation accuracy are required.
- Quick response and repair all found leakage is good for leakage reduction.

20

4-3 Implementation Matrix

• Strategy 1: Enhancing water supply service reliability

	Activities	KPIs	Target	In charge
C1.1	Monitor of water produced	Increase amount of water produced	Water demand	WDD/TOD
C1.2	Install power supply backup	Power supply backup installed	Stable power supply	TOD
C1.3	Monitor water leakage	Reduced leakage	Number of leakage	WDD/TOD
C1.4	Monitor Boreholes	Boreholes performance improved	Number of Boreholes	WDD/TOD
C1.5	Monitor pumping operations	Pump performance improved	Number of Pumps	WRD
C1.6	Scale up alternative sources of power supply	Reduced operation costs	Number of water source	TOD

21

Strategy 1: C1.1

- Monitoring water production volume is the first step of facility operation. It is necessary not only for grasping a system input volume but also for groundwater management. This activity should be continued.
- In Urban West Region, almost all the boreholes will be equipped with electromagnetic flowmeters after the completion of the Projects.
- Currently, ZAWA estimates production volume from design pump capacity and pump operation hours. But measured data should be used for production volume management in the future.
- ZAWA has to change the facility operation method along with the facility improvement.

22

Strategy 1: C1.3

- The stated activity is not clear
- Is this activity monitoring water leakage from wellhead pipe & fittings and transmission main?

23

• Strategy 2: reducing NRW

	Activities	KPIs	Target	In charge
C2.1	Carry out leak scouting for physical leaks, identification and documentation	Number of physical leaks identified	Number of report	TOD
C2.2	Repair all reported and visible leaks within 1 day	Repair all reported and visible leaks within 1 day	Number of leakages	TOD
C2.3	Evaluate the performance of existing pressure zones	Status of existing pressure zone documented	Status report	TOD/WDD
C2.4	Conduct network pressure survey	Network pressure survey conducted	Status report	TOD/WDD
C2.5	Install district meters	Number of district meters installed	All districts have district meters	TOD
C2.6	Record quantity of water	Water recorded	Number of sources	WDD
C2.7	Install and replace bulk meters	Identification of water production		TOD

24

Strategy 2: C2.1

- Is this activity carried out? What is the method for leak scouting?
- In Urban West Region, leakage will shift from surface leakage to underground leakage after the network rehabilitation by the Projects near future.
- DMA system will be established, and flowmeters will be installed to monitor the inlet flow of each DMA by the Projects.
- Leakage scouting methods that ZAWA currently does not use can be applied after the Projects (e.g., minimum night flow measurement, step-testing)

25

Strategy 2: C2.2

- The total amount of water leakage can be calculated by the formula below;
  $$\textit{Total amount of water leakage} = \textit{leaking water rate}(l/day) \times \textit{lapsed time until repair (days)}$$
- Shortening the time until the finish of repair contributes to the reduction of water leakage amount
- Are there obstructions for repairing the leakage within 1 day? What are they? How do you remove the obstructions?

26

Strategy 2

- C2.3: Pressure zones are formed? What are indicators to evaluate the performance of pressure zones?
- C2.4: Is this activity carried out? Minimum dynamic water head in the network is one of the indicators to evaluate the capacity of the network. Do you have water pressure loggers? Pressure survey in zones where water is not supplied 24-hour does not make sense. (ZAWA has to achieve a 24-hour water supply first.)
- C2.6: Record quantity of water is one of the basic activities for the facility operation. Production volume and distribution flow from reservoirs should be recorded. Monitoring and recording the quantity is automated if a SCADA system is introduced.

27

Strategy 2

- C2.5, 7: What is the difference between the district meters and the bulk meters (definition of the meters)?
- The purpose of meter installation is to measure, monitor and record the integrated flow of water.
  ZAWA should consider how to monitor and record the flow before installation of flowmeters.

28

- Strategy 3: Improving Water Infrastructure (excerpt)

	Activities	KPIs	Target	In charge
C3.2	Repair existing water tanks	water loss control	Number of tank repair	TOD
C3.3	Repair existing pump control houses	Water mains repaired on time	Number of pump control houses	TOD
C3.4	Repair existing wellhead	water loss control	Number of wellhead	TOD
C3.5	Rehabilitate the existing pipeline	Pipeline rehabilitated	Number of kilometre	TOD

- Actions of Strategy 3 related to leakage reduction are mainly leakage repaire

29

5 ACTION PLAN

30

5 Discussion for Action Plans

- From now, I'd like all of you to provide your ideas and opinions for actions for physical loss reduction after the current SBP period.
- Items to be discussed are below
  - Target
  - Actions
  - Implementation

31

5-1 Mission & Target of SBP (reference)

- ZAWA's Mission stated in SBP

"To develop and provide potable, adequate, affordable water supply service in a sustainable, environmentally friendly manner and ensuring a reasonable return of water investment"

- Goal of planning period of SBP

"To deliver quality water services to the people living within the ZAWA Service Area while ensuring sound and sustainable water resources management practices"

32

5-2 Discussion Regarding Physical Loss Reduction

- Actions for physical loss reduction should be considered from 3 aspects below

(1) NRW Calculations (data management)

(2) Leakage detection

(3) Leakage repair

33

(1) Planning the Target and Actions for NRW calculations (Data Management)

- Example of Targets
- Utilize bulk meter reading data for operation management
- Manage inlet and outlet flow of reservoirs
- Increase boreholes monitored by a SCADA system
-
-
-

34

(1)Planning the Target and Actions for NRW calculations (Data Management)

- Example of Actions
- Report Water flow data to DoTOD every month
- Collect data for NRW calculation and calculate NRW every month
- Achieve 30% of NRW
-
-

35

(2)Planning the Target and Actions for leakage detection

- Example of Targets
- Enhance capacity for underground leakage detection
- Detect underground leakage
-
-
-
-
-

36

(2)Planning the Target and Actions for leakage detection

●Example of Actions

- Analyze the DMA wise minimum night flow (MNF)
- Carry out a step test in the high-MNF DMA
- Start an underground leakage survey within urban area
- Procure leakage detection equipment
-
-
-

37

(3)Planning the Target and Actions for leakage repair

●Example of Targets

- Reduce surface leakage and underground leakage
- Shorten the repair part supply time
-
-
-
-

38

(3)Planning the Target and Actions for leakage repair

●Example of Actions

- Procure and store repair parts often used
- Manage and refill stored parts
-
-
-
-

39

5-3 Implementation (example)

●Implement leakage reduction activities with donor's support

■Zanzibar Side

- Establish NRW Management Unit
- Secure staff who work for NRW reduction

■Donor Side

- Dispatch experts for ZAWA staff training
- Financial support for procurement of equipment

Please provide your ideas and opinions.

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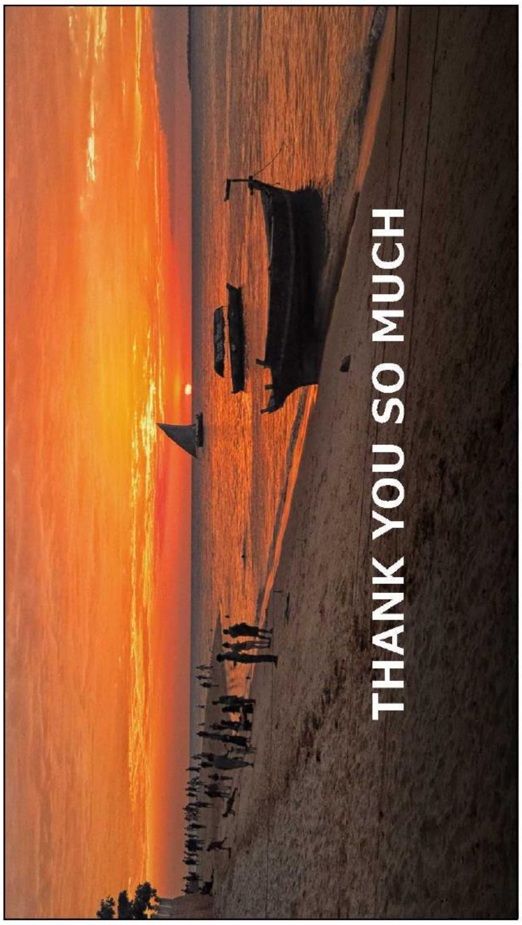

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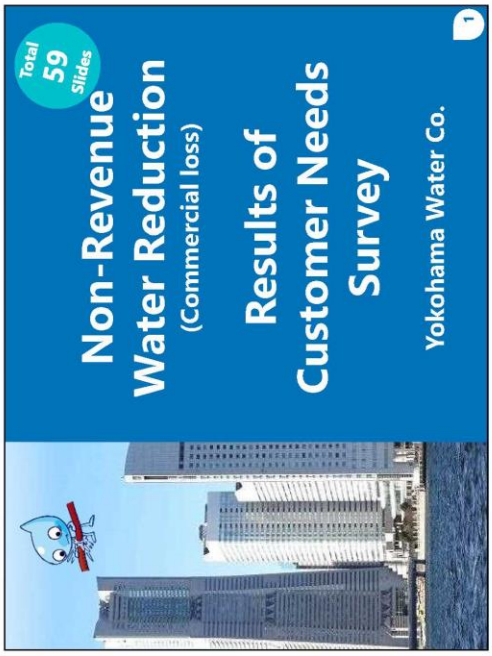
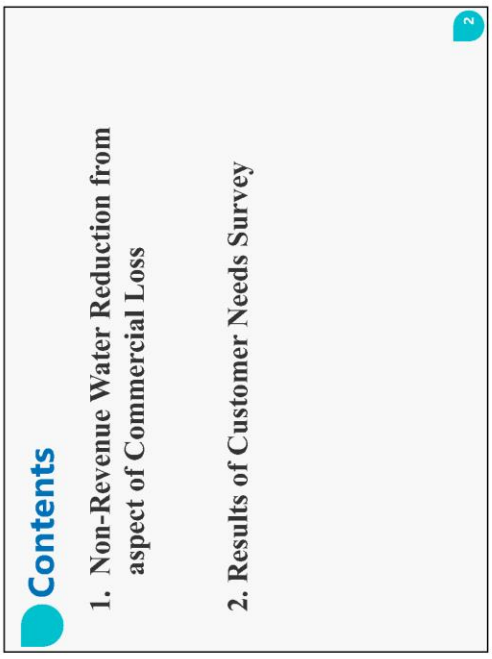
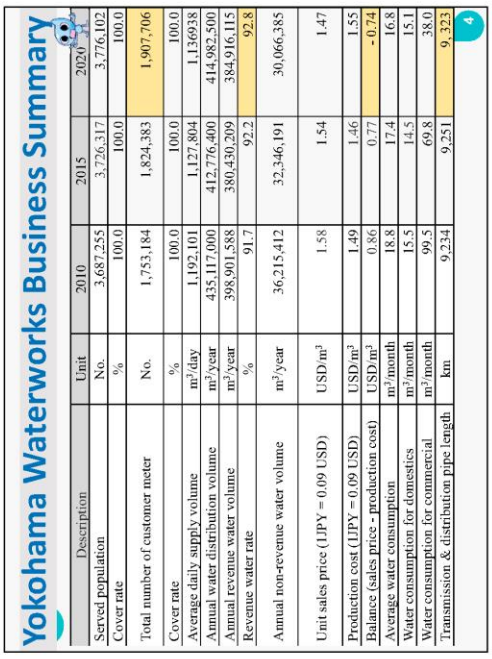
2.3 Workshop for NRW Management (Apparent Losses)







Yokohama Waterworks Business Summary

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

4

Yokohama Waterworks Business Summary

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	238,000 /y 1,907,706
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Water consumption for commercial	m³/month	99.5	69.8	110 km/y
Transmission & distribution pipe length	km	9,234	9,251	9, 323

Water loss:82,400 m3/d, Money loss:121,100 USD/d　Customer meters replace 238,000 no. every year.

5

5

Water Balance Analysis in YWWB

(FY 2019)

System Input Volume (100%)	Revenue Water (92.6 %)	Billed metered consumption (including fire fighting use)	92.6%
		Billed unmetered consumption (compensation for damage)	+0.0%
	Non Revenue Water (7.4%)	Unbilled metered consumption (settlement discount)	0.2%
		Unbilled unmetered consumption (used by utility)	0.3%
		Unauthorized consumption (illegal connection)	+0.0%
		Customer meter inaccuracies	1.9%
		Leakage / Overflow	5.0%

6

6

ZAWA Business Summary

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	m³/day	95,667	107,992	115,948
Volume of Annual water production	m³/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

7

7

Water Balance Analysis

System Input Volume	Revenue Water	Billed metered consumption (metered)
		Billed unmetered consumption (flat-rate, estimated, compensation for damage)
	Non Revenue Water	Unbilled metered consumption (settlement discount, employees' houses, free water stations)
		Unbilled unmetered consumption (used by water utility, excess use of flat-rate, authorized unbilled)
		Unauthorized consumption (illegal connection, unregistered customer, vandalism)
		Customer meter inaccuracies (faulty meter, meter reading error)
		Leakage / Overflow

8

8

Revenue Water

Billed metered consumption

Billed unmetered consumption

- Water charge amount
  (metered, flat-rate, estimated)
- Compensation for damage from other companies
- Others

Q. Does ZAWA collect water tariff in the park?
YWWB: The Bureau that manages the park pays the water tariff.

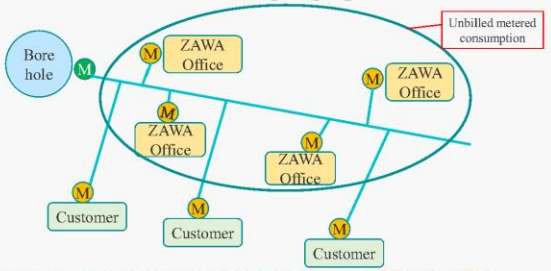
9

9

Non-revenue Water

Unbilled metered consumption

- **ZAWA : Offices such as Headquarter, local offices, etc.**
- **YWWB : Offices, reservoirs, pumping stations, etc.**



- **Customer meters should be installed at ZAWA offices.**
- **Which category does customer usage belong to?**

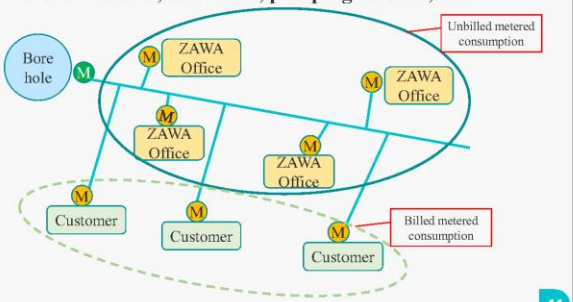
10

10

Non-revenue Water

Unbilled metered consumption

- **ZAWA : Offices such as Headquarter, local offices, etc.**
- **YWWB : Offices, reservoirs, pumping stations, etc.**



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11

Non-revenue Water

Unbilled unmetered consumption

- Settlement discount (when turbid water supplied)
- Used by water utility
  - Water use in the offices of water utilities
  - Pipe washing after pipe installation
  - Water draining turbid water in the pipeline
  - Tank washing, etc.
- Excess use of flat-rate
- Authorized unbilled (Not applicable in Japan)
  - Religious facilities
  - Staff of water utilities
  - The handicapped persons, the poor persons, etc.

12

12

Non-revenue Water

Water draining turbid water in the pipeline

Pipe washing after pipe installation

- **These water use should be measured and recorded.**
- **How do you train to measure such volume?**

13

13

Non-revenue Water

Training to measure these water flow.

Training how to measure this water flow.

Measuring / Calculation
Bottle capacity: 600ml
Measuring time: 30 seconds
0.6 (L) /0.5 (minute) x 60 (minutes) =72 L/h
72 (L) x 24 (hours) / 1000 =1.728 m3/d
→around 52m3/month

Preparation: Plastic bottle (600ml), A watch

14

14

Non-revenue Water

Unauthorized consumption

- Illegal connection, Bypassing
- Stolen water, vandalism
- Unregistered customer, etc.

15

15

Unauthorized consumption

Illegal connection, Bypassing, Stolen water, Vandalism, etc.

How to know and prevent these situation?

16

16

Unauthorized consumption

Patrol by ZAWA staff

Recommended activities

Good Communication with Residents

Distribution of the leaflet at Customer Awareness Meeting

17

17

Unregistered Customer

mil. Rs

	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017
Jul.	27.00	25.58	46.09	47.03	54.61	49.10	68.31
Aug.	53.96	26.54	49.09	53.43	57.98	66.50	84.94
Sep.	25.45	45.89	60.11	55.15	49.19	48.96	71.17
Oct.	50.30	50.14	48.01	54.08	57.83	57.16	88.60
Nov.	24.66	51.26	53.60	49.00	51.19	62.59	73.82
Dec.	52.10	49.32	59.70	52.82	49.15	61.93	74.09
Jan.	31.40	49.99	59.40	58.15	66.11	66.05	87.60
Feb.	63.57	55.25	57.10	48.79	70.00	68.54	88.15
Mar.	22.65	53.45	60.30	54.28	64.29	67.58	83.77
Apr.	42.49	56.72	60.01	64.45	62.00	65.11	84.48
May	35.31	49.30	60.50	51.74	63.42	67.64	88.40
Jun.	55.42	57.83	59.37	60.74	54.74	64.47	78.31
Ave.	40.36	47.61	56.11	54.14	58.38	62.14	80.97

Unregistered Customer were legalized.

Water Supply: **16,332** conn. Sewerage: **49,621** conn.

➔ **90-120 K USD/mon.** of revenue was increased.

18

18

Non-revenue Water

Customer meter inaccuracies

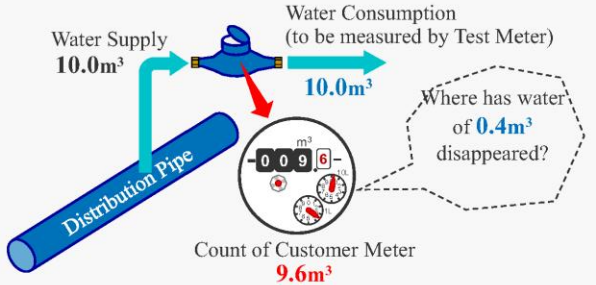
- faulty meter
- meter reading error, etc.

Leakage / Overflow

19

19

Customer meter inaccuracies



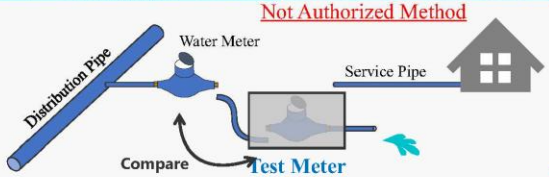
Water Meter Error $= \frac{9.6 - 10.0}{10.0} = -0.4\ m^3\ (-4.0\%)$

20

20

Meter Accuracy Test

Not Authorized Method



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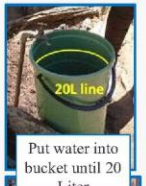
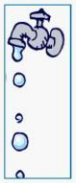
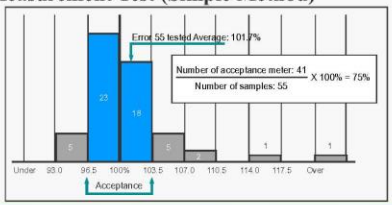
Meter Accuracy Test

Water Meter Measurement Test (Simple Method)



Put water into bucket until 20 Liter





Read water meter before and after 20 Liter use.

- 55 water meters were measured flow volume.
- 41 water meters were acceptable error as meter accuracy (75%).

- 68 households were surveyed as in-house leakage.
- 12 cases of leakage were found (18%).

Not Authorized Method

22

22

Test bench for water meter

Authorized Method

23

23

Comparison of water consumption

Name	Total family member	Meter reading interval	Water consumption (m^3) → (L)	Unit consumption (L/c/d)
Mr. AAAA	5 persons	27 day	16 → 16,000	119
Ms. BBBB	9 persons	34 day	5 → 5,000	16
Mr. CCCC	3 persons	28 day	4 → 4,000	48
Mr. DDDD	7 persons	29 day	23 → 23,000	113
Dr. EEEE	9 persons	31 day	49 → 49,000	176
Ms. FFFF	8 persons	33 day	22 → 22,000	83

- WHO: **50 L/c/d** are needed to ensure for most basic needs
- Yokohama: **220 L/c/d** (average for domestic in 2019)
- ZAWA: **80 L/c/d** (2017)

How to use water consumption data?

24

24

Comparison of water consumption

Effective use of water consumption data

ZAWA: **80 L/c/d** (2017)

- To check the meter reading result.
- To compare the amount of water used by five family members for one month (30 days) with the estimated amount of water.
- As a result of checking, if the amount used is very large compared to the previous meter reading, it is necessary to confirm the reason with the residents at the time of meter reading. If there is no reason, water leakage after the meter is presumed.
- Very low usage suggests meter failure, illegal connections, reduced no. of family, and family's long trips. In this case as well, it is necessary to ask the residents when reading the meter.
- Figures + 30%, - 30% are standard to check the result of meter reading.

25

25

Leakage / Overflow

Judgement of surface water leakage or not

	Residual Chlorine	pH	Conductivity (μS/cm)
Leakage water	Exist	6.7 – 7.5	100 – 300
Rain water	Not	< 6.0	40 – 90
Ground water	Not	6.4 – 7.5	300 – 1000
Sewage water	Not	7.0 <	500 <

Puddle should be suspected of leakage

26

26

Measures for NRW Reduction

NRW Ratio	Focus point	Countermeasures / Methods
40% ~	Reduction of surface leakage and overall apparent losses	Door-to-door survey / meter replacement / citizen education (with human wave tactics)
30% ~ 40%	Reduction of underground leakage and illegal connection	Accurate pipeline map development / DMA setting / Leakage survey training / Introduction of appropriate leakage survey equipment
25% ~ 30%	Prevention of leakage restoration	Aging pipe replacement / Leakage prevention work
15% ~ 25%	Thorough leakage prevention work	Review of leakage prevention work / Acceleration of aging pipe replacement / Introduction of effective leakage survey
~ 15%	Maintaining minimum NRW ratio	Thorough aging pipe replacement and leakage prevention work

What the water utility should do is different at each stage.

27

27

Install Customer Meters

Effectiveness of installing customer meters

Description	Unit	2013	2018	2025 (Plan)
No. of Total Connections	No.	71,990	100,010	132,110
Water supply coverage	%	74	83	97
No. of metered Connections	No.	2,160	11,677 (2020)	118,900
Metering Ratio	%	3	12.2	90
Non-revenue water Ratio	%	85.2	63	30.0

Priority : Installation of meters
(Bulk meters, Customer meters)

How to train new meter readers?

28

28

Water Balance Analysis

System Input Volume	Revenue Water	Billed metered consumption (metered bill)	%
		Billed unmetered consumption (flat-rate bill, estimated bill)	%
	Non Revenue Water	Unbilled metered consumption (settlement discount)	%
		Unbilled unmetered consumption (used by utility, authorized unbilled)	%
		Unauthorized consumption (illegal/unregistered connection)	%
		Customer meter inaccuracies (faulty meter, meter reading error)	%
		Leakage, Overflow	%

Quantitative analysis is required.

29

29

Countermeasures

- Install customer meters
- Detection of illegal connection
- Detection of unregistered customer
- Replacement of faulty meter
- Training of meter reading


Leakage detection


Construction Mag.


Customer meters

30

30

Activities for meter readers/reading


Role playing

Education for meter readers


Role playing


Measuring water quantity


Device

Photo reading


Sharing photo data


Photo reading


Billing

Introduction of photo reading

31

31

Activities for residents

Awareness activities for residents


Customer survey


Customer center


School program

Messages from students

32

32

Customers' awareness activity

Door to door survey

33

33

Evaluation

[NRW Reduction]

- Shifting from flat-rate to metering
- Detection of illegal connection
- Detection of unregistered customer
- Replacement of faulty meter
- Training of meter reading
- Leakage survey and repair
- Pipe replacement
- Installation of PRV

Best per.
63%

After as target value
30.0%

Outcomes can be shown quantitatively.

34

34

Water Balance Analysis

System Input Volume	Revenue	Billed metered consumption (**metered bill**)	%
		Billed unmetered consumption (**flat-rate bill, estimated bill**)	%
	Non Revenue	Unbilled metered consumption (**settlement discount**)	%
		Unbilled unmetered consumption (**used by utility, authorized unbilled**)	%
		Unauthorized consumption (**illegal/unregistered connection**)	%
		Customer meter inaccuracies (**faulty meter, meter reading error**)	%
		Leakage, Overflow	%

Unpaid customers should also be considered in this.

Apparent loss is directly linked to revenue.

Real loss is directly linked to water conservation.

35

35

2. Customer Needs Survey

2-1 Detail of Surveys

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 rate 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 (draft)	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.

The survey was conducted on 500 households and 100 households in each district. The leaflets were distributed at ZUWSP area as educational activities. The contents of the survey were related to water service and **willingness to pay**.

36

36

2. Customer Needs Survey

2-1 Detail number of Surveys

SN	Location description	Number
1	Unguja Urban (ZUWSP / AfDB Project Area)	100
2	Unguja Urban (outside of AfDB Project Area)	100
3	Unguja Rural	100
4	Pemba Urban	100
5	Pemba Rural	100
	Total	500

Sn	Area	District	Shehia	Number
1.	Unguja Urban (ZUWSP / AfDB Project Area)	Mjini	Mkunazini	10
		Mjini	Mwembeladu	10
		Mjini	Muembe Makumbi	10
		Mjini	Shangani	10
		Mjini	Mfundaga	10
		Mjini	Kikwajuni Bondeni	10
		Mjini	Kwasilamshaa	10
		Mjini	Makadara	10
		Mjini	Kiponda	10
		Mjini	Kwasilinato	10
2.	Unguja Urban (outside of AfDB Project Area)	Magharibi B	Tomondo	10
		Magharibi A	Mbopepo	10
		Magharibi A	Pangawe	10
		Magharibi A	Mbweni	10
		Mjini	Kariakana	10
		Magharibi A	Bububu	10
		Magharibi A	Kijichi	10
		Mjini	Sogea	10
		Mjini	Kitonga Chekundu	10
		Mjini	Jangombe	10
3.	Unguja Rural	Kaskazini B	Mahonda	10
		Kaskazini B	Fujoni	10
		Kaskazini A	Mdaniwe	10
		Kaskazini B	Kiwengwa	10
		Kaskazini A	Pongo	10
		Kusini	Makunduchi	10
		Kusini	Pera	10
		Kusini	Muyuni	10
		Kati	Chwaka	10
		Kati	Mtchu	10
4.	Pemba Urban	Chakechake (urban)	1. Sombani	10
			2. Kichungwani	10
			3. Madungu	10
			4. Uwellani	10
		Mkoani (Urban)	5. Mbaoni	10
		Wete (urban)	6. Ngombeni	10
			7. Kiombeni	10
			8. Limbani	10
			9. Bopwe	10
			10. Kipangani	10
5.	Pemba Rural	Mkoani (Rural)	1. Wambaa	10
			2. Chumbageni	10
		Chakechake (Rural)	3. Ndagoni	10
			4. Vitongoji	10
		Wete (Rural)	5. Piki	10
			6. Kambini	10
		Micheweni	7. Maua Magharibi	10
			8. Tondooni	10
			9. Msingaja	10
			10. Kinowe	10
	Total			500

Details of the number of surveys in each district are given in the table.

2. Customer Needs Survey

2-2 Location of Survey Area

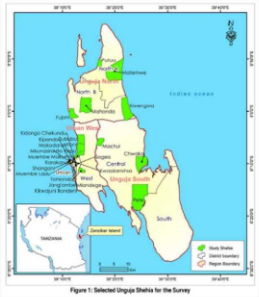


Figure 1: Selected Unguja Shehia for the Survey

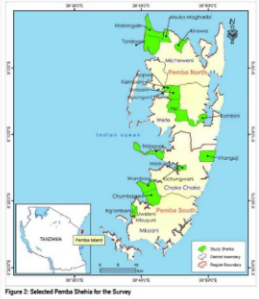


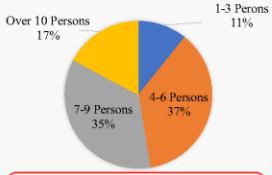
Figure 2: Selected Pemba Shehia for the Survey

Selected survey areas in Unguja and Pemba are shown in green.

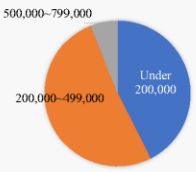
2. Customer Needs Survey

2-3 Customer basic information

NO. OF PEOPLE WITHIN ONE HOUSEHOLD



MONTHLY AVERAGE HOUSEHOLD INCOME



By conducting door-to-door survey and grasping detailed data, it can be used as basic data for water distribution analysis.

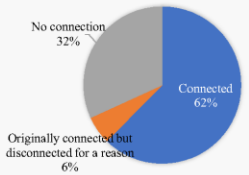
It will be necessary to consider whether consideration is needed for customers in low-income areas (Unguja rural area, ZUWSP area).

The basic policy is to implement water distribution management (water distribution analysis: how much amount is needed in which area) in consideration of the family composition that accounts for 70% of all customers and the amount used per person. ..

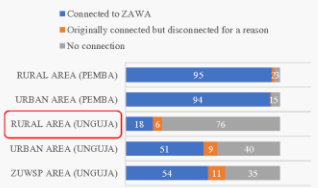
2. Customer Needs Survey

2-4 ZAWA Customer _ Water supply situation

CONNECTION TO ZAWA



CONNECTION TO ZAWA



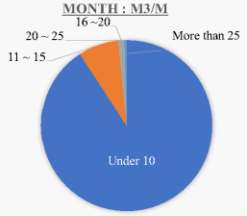
Originally it was connected, but now there are 6% of households that are not connected, so detailed investigation including the reason is necessary.

Measures to connect water supply service in Unguja rural area should be considered.

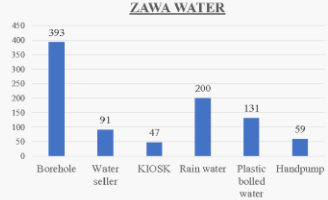
2. Customer Needs Survey

2-4 ZAWA Customer _ Water supply situation

AMOUNT OF WATER USED IN A MONTH : M3/M



WATER SOURCE OTHER THAN ZAWA WATER



Most of the water used per household is 10m3 / month. The increase in usage is due to the timing of irrigation of the crops. A water distribution plan based on timing factors is necessary in consideration of regional characteristics.

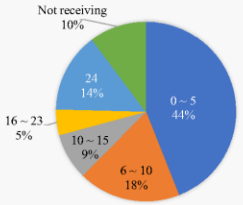
Many households use private bore holes. A survey including water quality is required. The same applies to the use of rainwater.

41

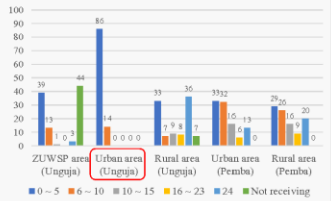
2. Customer Needs Survey

2-4 ZAWA Customer _ Water supply situation

WATER SUPPLY TIME IN A DAY : HOURS



Water supply time in a day : Hours



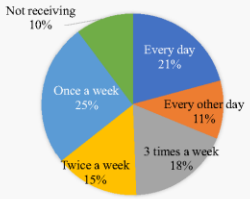
Forty-four percent of the surveyed population have less than five hours of water available per day. It is necessary to improve the distribution pipe network and implement measures for non-revenue water volume to secure the current suppliable water distribution volume.
In the urban areas of Unguja, 86% have less than 5 hours of water per day. It is necessary to consider measures in this area.

42

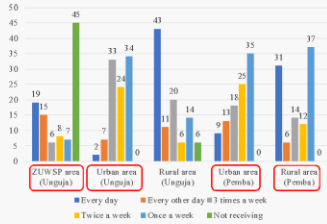
2. Customer Needs Survey

2-4 ZAWA Customer _ Water supply situation

WATER SUPPLY FREQUENCY



Water supply frequency



There is a problem with water supply to 50% of households. Detailed investigation including water pressure (which area becomes a challenge) is required.

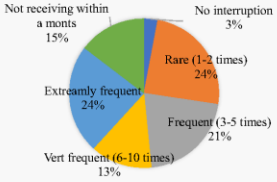
ZAWA is actively working on connections, but ZAWA needs to continue to monitor this type of survey.

43

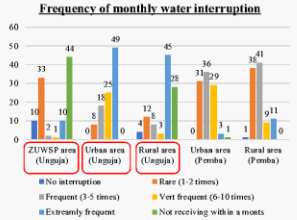
2. Customer Needs Survey

2-4 ZAWA Customer _ Water supply situation

FREQUENCY OF MONTHLY WATER INTERRUPTION



Frequency of monthly water interruption



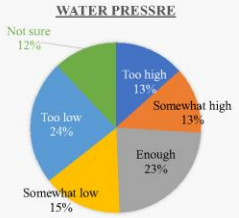
There is a challenge with water supply to 52% of households. Detailed survey including water pressure (which area becomes a challenge) is required.

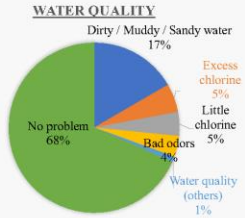
Poor water supply in the Unguja area is becoming more prominent. Further detailed investigation including water pressure (which area has become a challenge) is required. In the ZUWSP area, there are areas where water supply defects have hardly occurred, and the project effect is clear.

44

2. Customer Needs Survey

2-4 ZAWA Customer _ Water supply situation



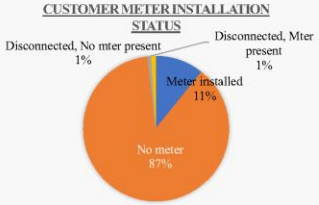


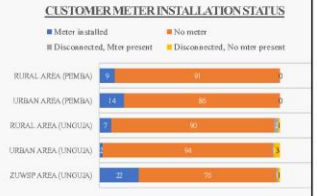
There are some areas where the water pressure is too high or too low. There is a need for proper water pressure management and measures against stagnant water.

What is the cause of water mixed with turbidity, mud and sand?
→ Insufficient cleaning after construction, contamination due to backflow from leaks.

2. Customer Needs Survey

2-5 ZAWA Customer _ Meter Installation

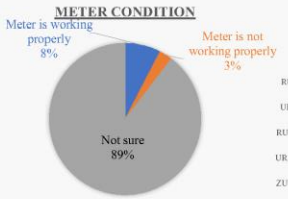


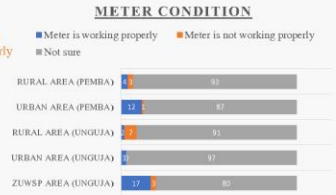


The survey results clarify the reasons for promoting the installation of meters. As a measure against non-revenue water, it is important to increase the number of meters installed in order to improve the amount of water and profits.

2. Customer Needs Survey

2-5 ZAWA Customer _ Meter Condition

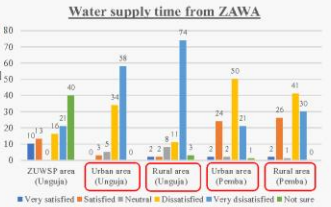




The customer cannot keep track of the status of the meter. It is necessary for the meter reader to grasp the state of the meter. It is necessary to grasp the installation and operation status of the meter by door-to-door survey at all the houses.

2. Customer Needs Survey

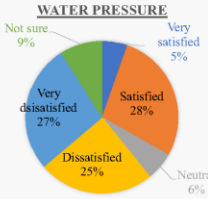
2-6 ZAWA Customer _ Satisfaction Results

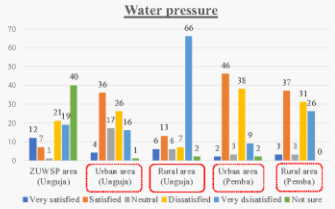


71% of customers are dissatisfied with the water supply time. Compared to other areas, 37% of customers in the ZUWSP area are dissatisfied. It seems that the effect of the countermeasure project is being shown.

2. Customer Needs Survey

2-6 ZAWA Customer _ Satisfaction Results





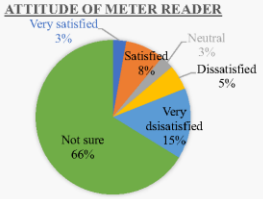
Half of customers have expressed dissatisfaction with water pressure. On the other hand, 33% of customers answered that they were satisfied. As with the measurement of residual chlorine, water pressure control requires fixed-point observation.

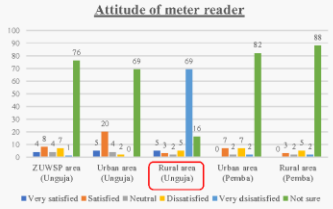
Regarding water pressure, the rural areas of Unguja are complaining about poor water pressure. In the urban area of Unguja, Pemba has a mixture of customers who are satisfied with the water pressure and those who are not. Water pressure management in these areas needs to be verified.

49

2. Customer Needs Survey

2-6 ZAWA Customer _ Satisfaction Results



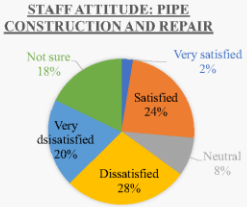


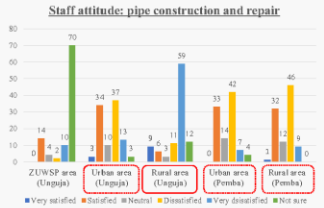
Regarding the attitude of meter readers, customers living in the rural areas of Unguja are highly dissatisfied. A re-investigation of meter readings and meter readers in this area is required.

50

2. Customer Needs Survey

2-6 ZAWA Customer _ Satisfaction Results



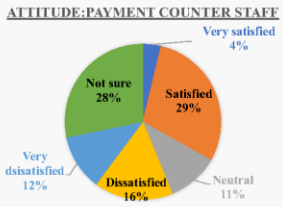


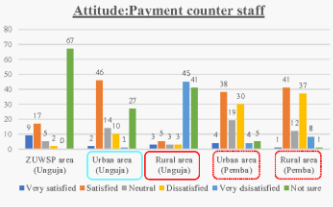
A survey of the attitudes of staff involved in the construction shows that Unguja's rural customers are highly dissatisfied. On the other hand, in Unguja's urban area, Pemba, there are a mixture of customers who are reading and dissatisfied. Detailed investigation is needed.

51

2. Customer Needs Survey

2-6 ZAWA Customer _ Satisfaction Results



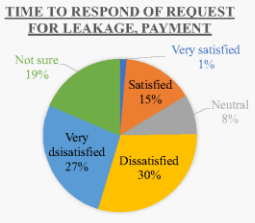


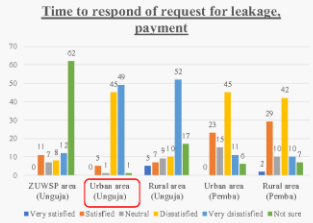
The attitude of payment counter staff is higher for those who are satisfied and those who are not. Unguja urban areas are highly satisfied, and Unguja's rural areas are less satisfied. Pemba has a mix of high and low satisfaction customers in both districts. It is necessary to educate the window staff in areas where satisfaction is low.

52

2. Customer Needs Survey

2-6 ZAWA Customer _ Satisfaction Results



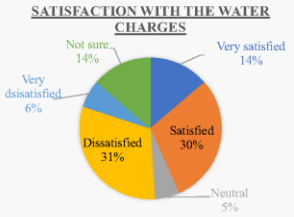


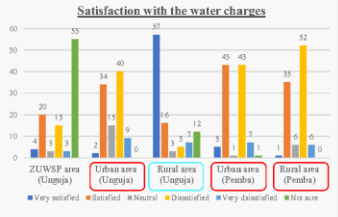
According to a survey on leak repair and payment response, 57% were dissatisfied, and many customers were dissatisfied with ZAWA's response. Unguja's urban customers are very dissatisfied with ZAWA's response to leak repairs and payments. Further investigation will be needed.

53

2. Customer Needs Survey

2-6 ZAWA Customer _ Satisfaction Results



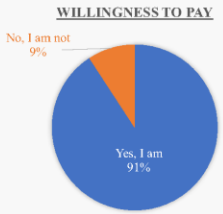


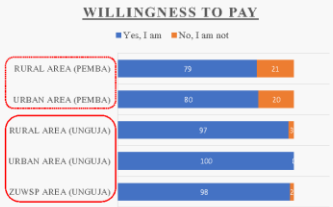
Satisfaction with the water charge is as low as 44%. Urban area (Unguja, Pemba) and Rural area (Pemba) have large numbers. It is desirable to promote installation of customer meters and improve meter reading operations.

54

2. Customer Needs Survey

2-6 ZAWA Customer _ Satisfaction Results





Does the customer be willing to pay the water charge if the water is supplied 24 hours a day and the water pressure is appropriate? About 20% of customers in the Pemba area are less willing to pay. Public relations in this area are needed.

55

2. Customer Needs Survey

2-7 ZAWA Customer _ Suggestions from Customers

Opinions	Frequency	Percent	
• Water should be available 24 hrs.	77	15.4%	• Priority is given to securing the amount of water to be distributed.
• Water service systems should be improved.	214	42.8%	• Priority is given to securing the amount of water to be distributed. Improving water supply rate.
• Reduce water charges	50	10.0%	• PR activities
• Water should be provided / distributed for free.	64	12.8%	• Need to educate customers that water is free.
• ZAWA should improve monitoring and supervision to ensure effectiveness.	46	9.2%	• There is a strict customer eye on ZAWA's water business.
• Null	49	9.8%	
Total	500	100.0%	

What should be prioritized based on customer feedback (requests)?

56

2. Customer Needs Survey

3 Distributed Leaflet -1

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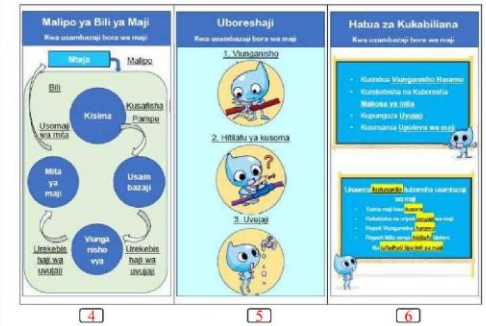
57

2. Customer Needs Survey

3 Distributed Leaflet -2



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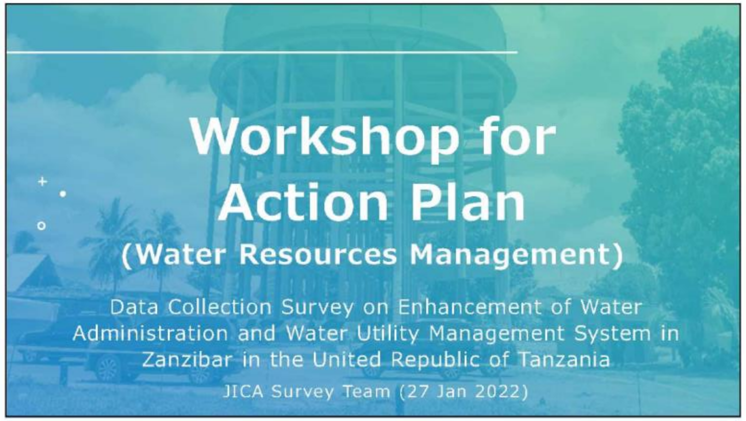
59

2.4 Workshop for Groundwater Management



1

1 OUTLINE OF JICA'S SURVEY AND PURPOSE OF THIS WORKSHOP

2

1 Outline of JICA's Survey

- Japan International Cooperation Agency (JICA) has assisted ZAWA since the establishment of ZAWA (2006)

Name of the Projects	Period
Zanzibar Urban Water Supply Development Project	2006-2008
Zanzibar Urban Water Supply Project Development Phase 2	2009-2010
Needs Assessment Study for the Organization Strengthening of ZAWA	2006-2007
Technical Cooperation Project for Enhancement of Water Supply Management of Zanzibar Water Authority	2008-2010
Technical Cooperation Project for Enhancement of Water Supply Management of Zanzibar Water Authority Phase 2	2011-2016
Preparatory Survey on Zanzibar Urban Water Distribution Facilities Improvement Project	2016-2017

- However, the current water supply service is still not enough (e.g., 60% of leakage ratio, limited supply hours) and financial status is also not good (low bill collection rate). Improvement of NRW is one of the issues.

3

- In Zanzibar, since the population & water demand has been increasing, further water source development is required. However, the amount of available water resources based on scientific data is not sure so far and further water extraction of groundwater may cause drawdown of ground water table and seawater intrusion into groundwater.
- As said above, the water sector in Zanzibar faces many issues.

4

- The purpose of JICA's 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

5

- This survey mainly focuses six areas below.
(1) Water administration and legislation
(2) Human resource development and organizational operation
(3) Groundwater management
(4) Water supply facility management
(5) Customer management
(6) Utilization of knowledge and technologies for above issues of Japanese water utilities and private companies
- In this workshop, we will discuss action plan to improve groundwater resource management.

6

2 REVIEW OF CURRENT STATUS OF GROUNDWATER MANAGEMENT

7

2-1 Framework of Water Resources Management

- The Water Act (2006) granted ZAWA **all water related authority**, including water resource management (every sector).
- ZAWA plays a **conflicting roles** between the **regulator for** water resource management and the water utility that develops the water source.
- The National Water Policy (2004) stipulates the establishment of a **Water Resources Management Board**, but it has not been realized.
- Since water users are not only ZAWA but also agriculture, industry, commerce, etc., it is necessary to control and regulate the use of water resources in **all sectors for comprehensive water resources management** to realize "provision of equitable access to quality, clean and safe water for all water users, whereby fulfilling the needs of expanding social and economic activities while also considering the conservation of nature (MKUZAIII)". It is however, the current framework seems to be insufficient.

8

2-2 Review of planned activities for water resource management on ZAWA's SBP

- ZAWA is planning a strategy at **SBP2020-2025** in the four fields of Institutional capacity, **water resource management**, water service provision and customer management.
- Regarding Water Resource Management, the **following strategies have been established**, and Actions are planned for each strategy.
- (i) **Controlling water abstraction**
  (ii) **Enhancing water resource conservation**
  (iii) **Developing effective mechanism for rainwater harvesting**

9

STRATEGY 1: CONTROLLING WATER ABSTRACTION

10

(i) Actions for Strategy 1

Strategy 1: Controlling water abstraction

	Activities	KPIs	Target	Budget
B1.1	Survey private boreholes	Private borehole documented	Number of borehole	25,000
B1.2	**Control permits** for borehole drilling	Private borehole drilling reduced	Water abstraction not to exceed **33M m^3 / Y**	Nil
B1.3	Conduct study about **water demand** and supply	Baseline for water demand and supply in place	Number of Reports	4,000
B1.4	Re-establish ZAWA journal	ZAWA journal Re-established	Number of Boreholes	1,000
B1.5	Conduct **in-depth study of groundwater**	**Transient ?? study** establish	2 report (steady state, transient)	Not mentioned

11

Discussion: Strategy 1

- The target of 33 Mm^3/Y appears to be based on Annual Acceptable Aquifer Yeild's 339Mm^3/Y in the Water Resources Assessment Report (2014).
- **How credible** or accurate is **Acceptable Yeild** 's 339 Mm^3/Y?
- **How credible** or accurate is Estimated Groundwater Recharge of 686Mm^3/Y?
- Water use in other sector is **larger than water use by ZAWA**
- SBP allows 104 Mm^3 / Y of Estimated Abstraction (71+33 Mm^3/Y), or about 30% of water abstraction, for Acceptable Yeild's 339 m^3/Y. What is the basis for that ratio?

12

Reference 1

ZAWA's SBP 2020-2025

2.3 Water Resources Management

Table 1: Estimated Abstraction and Rainfall (Unit Mm³/Y)

Description	Unguja	Pemba	Total
Average annual Rainfall	2445	1525	3970
Estimated groundwater recharge	565	121	686
Acceptable aquifer yield	293	46	339
Other Sector	60	11	71
Estimated ZAWA abstraction	23	10	33

The value of each description is almost same as the value estimated by Water Resources Assessment Report (2014).

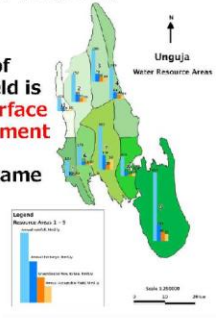
13

Reference 2

Water Resources Assessment (2014)

Estimation of "Acceptable Yield is based on the surface water sub-catchment

This situation is same in Pemba



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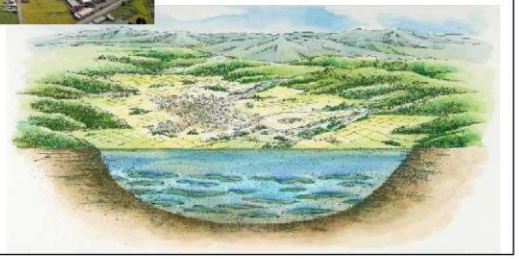
Groundwater Basin



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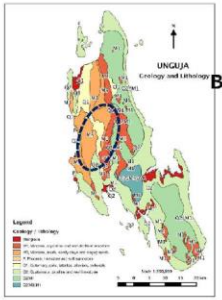
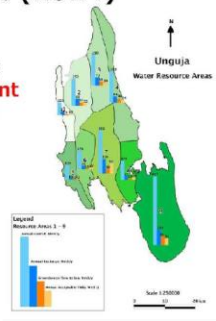
Reference 3

Water Resources Assessment (2014)



Groundwater Basin is different with surface water sub-catchment



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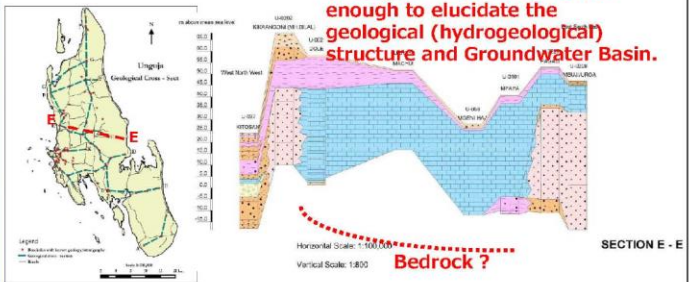
Reference 4

Water Resources Assessment (2014)

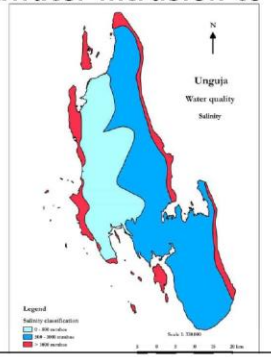


Geological information is not enough to elucidate the geological (hydrogeological) structure and Groundwater Basin.

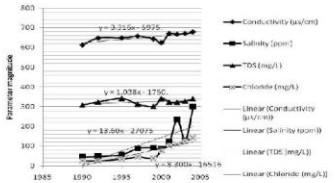
17

Reference 5

Seawater intrusion to the Groundwater



There is a risk of seawater intrusion into groundwater if pumping amout of groundwater over the certain level (seawater intrusion has already begun in coastal areas).



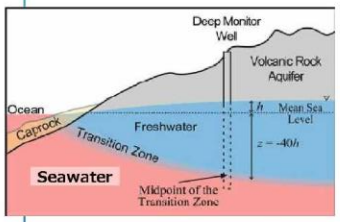
Source: Groundwater Quality degradation due to saltwater intrusion in Zanzibar Municipality

18

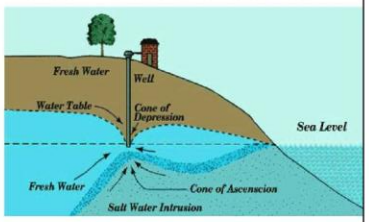
Reference 5

Mechanism of seawater intrusion

Ghyben-Herzberg's Law



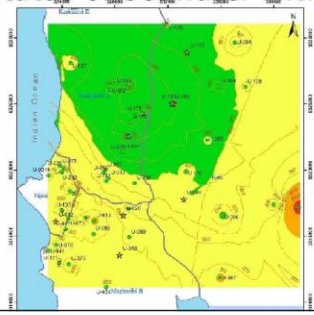
Groundwater level drops (by pumping), the boundary between freshwater and saltwater rises.



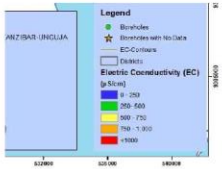
19

Reference 6

Brief of Results of Simplified Survey on the Status of Seawater Intrusion to Groundwater



EC (Electrical Conductivity)
Unit: µs/cm

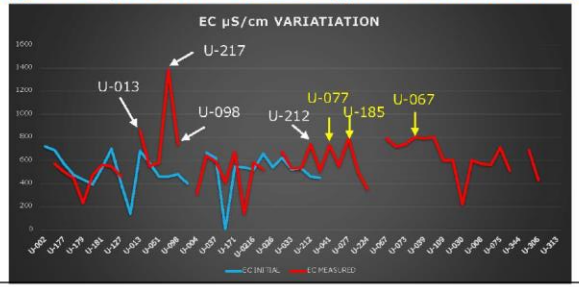


20

Reference 6

Brief of Results of Simplified Survey on the Status of Seawater Intrusion to Groundwater

Change of EC (Electrical Conductivity) Value from 2012 to 2022



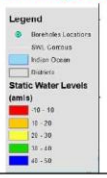
21

Reference 6

Brief of Results of Simplified Survey on the Status of Seawater Intrusion to Groundwater

Relation between SWL and EC

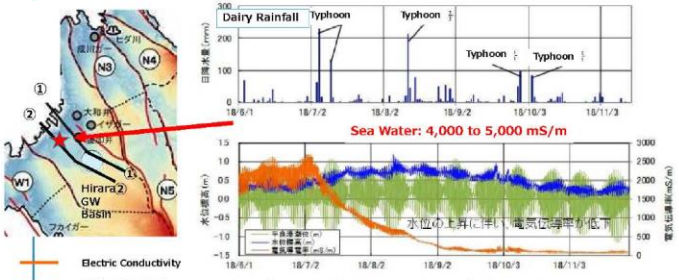
EC value is increasing during recent 10 years in the Low Static Water Level (SEL) Zone



22

Reference 6

Seawater Intrusion, Case of Miyako Island, Japan

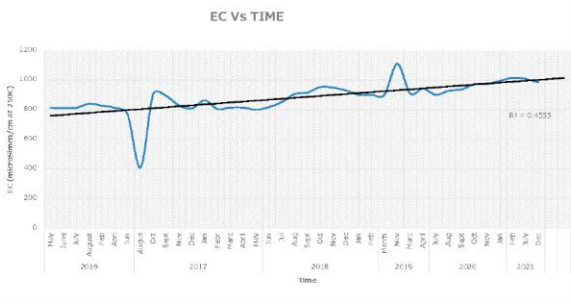


As the Static Water Level rises, the electrical conductivity decreases

23

Reference 6

Seawater Intrusion, Dimani Cave



24

Challenges of Strategy 1: Controlling water abstraction (1/2)

- The target water volume (33Mm³/Y) for water abstraction control is a volume estimated from the water balance of each sub-surface water chatchment and is not the extractable amount of groundwater (permissible yield) that can be developed.
- Since a comprehensive hydrogeological survey has not been conducted, the hydrogeological mechanism and groundwater basin structure have not been elucidated. Therefore, in the current situation, it is impossible to estimate the total potential and extractable amount of groundwater.

25

Challenges of Strategy 1: Controlling water abstraction (2/2)

- The provisions for controlling water abstraction in the Water Act and Water Regulations are not enforced properly as observed in the following status:
  - Legal requirements of the application for borehole drilling permits and water abstraction permits are not adequately followed by those who abstract water for different uses.
  - The rate and quantity of water abstraction is not set in the water abstraction permits.
  - The water abstraction volume at water sources for different uses other than the ZAWA's water supply services is not monitored.
- The aquifer developing as a water source is mainly limestone, and there is a risk of seawater intrusion into groundwater if pumping amount of groundwater over the certain level (see evidence)

26

Discussion 1: Activity in SBP and Challenges

	Activities in SBP	Target
B1.1	Survey private boreholes	Number of borehole
B1.2	Control permits for borehole drilling	Water abstraction not to exceed 33M m³/Y
B1.3	Conduct study about water demand and supply	Number of Reports
B1.4	Re-establish ZAWA journal	Number of Boreholes
B1.5	Conduct in-depth study of groundwater	2 report (steady state, transient)

	Challenges	Action to be taken
1	The target water is not the extractable amount of groundwater	Set appropriate target water volume (??Mm³ / Y) for groundwater abstraction control
2	It is impossible to estimate the total potential and extractable amount of groundwater	Implement the comprehensive hydrogeological survey
3	The provisions for controlling water abstraction in the Water Act and its regulations are not properly enforced	• Awareness raising of water users and policy-making institutions on the purpose of water resources management, establishment of law enforcement mechanism • Set the rate and quantity of water abstraction in the permit • Monitor the water abstraction
4	There is a risk of seawater intrusion into the groundwater	Elucidate permissible yield* **Permissible Yield***: the permissible amount of groundwater abstraction, obtained by comparing the benefits resulting from the

27

Discussion 2: Priority Action

	Challenges	Action to be taken
1	The target water is not the extractable amount of groundwater	Set appropriate target water volume (??Mm³ / Y) for groundwater abstraction control
2	It is impossible to estimate the total potential and extractable amount of groundwater	Implement the comprehensive hydrogeological survey
3	The provisions for controlling water abstraction in the Water Act and its regulations are not properly enforced	• Awareness raising of water users and policy-making institutions on the purpose of water resources management, establishment of law enforcement mechanism • Set the rate and quantity of water abstraction in the permit • Monitor the water abstraction
4	There is a risk of seawater intrusion into the groundwater	Elucidate permissible yield*

Note

No.2 is the basis of other activities

To what quantity

28

Discussion 3: Commencement of Action and Required Period

	Challenges	Action to be taken [responsible organization]
1	The target water is not the extractable amount of groundwater	Set appropriate target water volume (??Mm³ / Y) for groundwater abstraction control [a new unit in MoWEM? Water Resources Management Board?]
2	It is impossible to estimate the total potential and extractable amount of groundwater	Implement the comprehensive hydrogeological survey [MoWEM]
3	The provisions for controlling water abstraction in the Water Act and its regulations are not properly enforced	• Awareness raising of water users and policy-making institutions on the purpose of water resources management, establishment of law enforcement mechanism • Set the rate and quantity of water abstraction in the permit • Monitor the water abstraction
4	There is a risk of seawater intrusion into the groundwater	Elucidate permissible yield*

Note

- Required tool: Act to govern water resources management
- No.1:need multi-sectoral coordination & cooperation
- MoWEM to start with a unit/section in the Ministry for WRM, which will be

29

Discussion 4: Necessary measures for implementation

	Challenges	Action to be taken
1	The target water is not the extractable amount of groundwater	Set appropriate target water volume (??Mm³ / Y) for groundwater abstraction control
2	It is impossible to estimate the total potential and extractable amount of groundwater	Implement the comprehensive hydrogeological survey
3	The provisions for controlling water abstraction in the Water Act and its regulations are not properly enforced	• Awareness raising of water users and policy-making institutions on the purpose of water resources management, establishment of law enforcement mechanism • Set the rate and quantity of water abstraction in the permit • Monitor the water abstraction
4	There is a risk of seawater intrusion into the groundwater	Elucidate permissible yield*

Note

30

STRATEGY 2: ENHANCING WATER RESOURCES CONSERVATION

31

(ii) Actions for Strategy 2

Strategy 2: Enhancing water resources conservation

	Activities	KPIs	Target	Budget
B2.1	Fencing of the catchment areas	Protection of the Catchment	Number of catchment area	20,000
B2.2	Afforestation of the areas	Number of survivals planted trees		4,500
B2.3	Survey the catchment areas	Reduced encroachment		6,000
B2.4	Seek for title deeds for gazette catchments	Title deeds secured		2,000
B2.5	Prepare proposal for the **water resources tribunal (WRT)**	Tribunal in place	Proposed draft	5,000
B2.9	Institutionalize the WRT	WRT established	WRT in place	Nil

32

Discussion: Strategy 2

- What is the meaning of catchment area ?

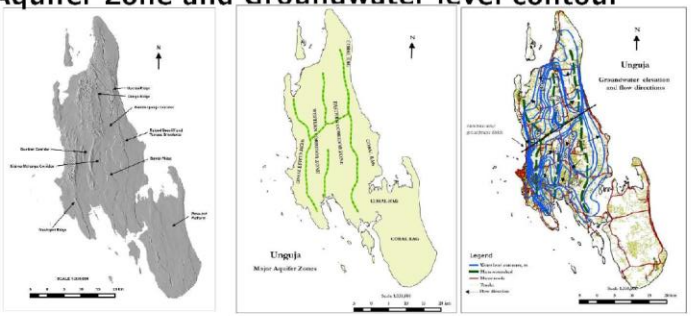
(the area from which rainfall flows into a river, lake, or reservoir)

- Catchment Area, definition by ZAWA is **The area where water source (Borehole) situated**
- Is it **not necessary to conserve the groundwater recharge area**?
- Is the **groundwater recharge area the same as ZAWA's Catchment Area**?

33

Reference 1

Aquifer Zone and Groundwater level contour

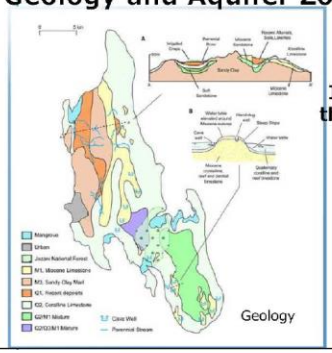


Topography　Aquifer Zone　Groundwater Level

34

Reference 2

Geology and Aquifer Zone



Geology

Identification of the recharge area is not easy considering complicated geological structure

Aquifer Zone

35

Reference 3 Laws and Regulations
(1) Water Act (2004)

5. Function of the Authority

(1) (a) **to control, manage and protect all catchments areas and shall have mandate to take legal actions against any person or body of persons in violation of, or disturbing or encroaching the catchments areas.**

*"catchment area": any area of land or of water delimited by the Minister, which its water contributes to the supply of any waterworks

*"waterworks": all gathering grounds, reservoirs, dams, weirs, tanks, cisterns, tunnels, filters beds, conduits, aqueducts, mains, pipes, meters, fountains, sluices, valves, hydrants, pumps, prime movers and all other structures or appliances used for regulation of water, which are used or have been constructed by or on behalf of the Authority

36

Reference 3 Laws and Regulations
(1) Water Act (2004)

39. Batching or washing in waterworks

Any person who:

(a) **washes or bathes in any part of the waterworks or catchment's area or in any vessel used by the Authority for supplying water** from any public standpipe;

(b) washes, throws or causes or permits to enter **in any part of the waterworks or catchment's area or into any vessel used by the Authority for supplying water** from any public standpipe, any animal, clothing, material or thing;

(C) wrongfully opens or closes any lock, valve, sluice or manhole belonging to the waterworks;

shall be guilty of an offence and upon conviction shall be liable to a fine not less than three hundred thousand shillings or an imprisonment for a period of six months or to both such fine and imprisonment.

37

Reference 3 Laws and Regulations
(2) Water Regulations (2007)

- 13. Protection of water sources

  (1) **The Authority shall be responsible to protect all water sources which are the basic sources for supplying water in Zanzibar for safeguarding in order to provide safe and clean water**.

  (2) Trees shall be planted on the water sources areas or fencing as a protecting measure.

  (3) Every well shall have a cover on top to prevent entrance of any material which may causes pollution.

- 86. Unlawful grazing of animals

  Any person who unlawfully or negligently grazes animals, applies chemical fertilizer, pesticides and other chemicals, cuts trees or clear shrubs, dispose of all kinds of waste or conduct any construction activities on **water sources area within 200 metres from the source**, shall be guilty of an offence and be liable to a fine equivalent to not less than fifty American Dollars.

38

Reference 3 Laws and Regulations
(3) Environmental Management Act (2015)

65. Conservation of Water Resources

(1)A person shall not destroy or pollute by any means water resources and catchment.

(2)A person who contravenes the provision of this section commits an offence and upon conviction shall be liable to a fine of not less than one million shillings and not exceeding thirty million shillings or imprisonment for a term of not less than six months and not exceeding ten years or both such fine and imprisonment.

The Water Act and Water Regulations put more focus on protection of water sources for waterworks. There are no specific provisions regarding the enactment of protected areas for the conservation of recharge areas for water resources (groundwater) which are used for different purposes.

39

Reference 4
National Water Policy (2004), (2021, Draft)

- The National Water Policy (2004) indicates the necessity to establish an independent "Water Resources Management Board (WRMB)" as one of the measures for water resources management.
  - ✓ Be the sole institution to give authorization (permit, license or right) to ground and surface water abstraction and provide necessary conditions attached thereto.
  - ✓ Ensure safe yields based on scientific survey and monitoring.
  - ✓ Protect aquifers from depreciation of water tables, pollution and from sea water intrusion in coastal areas.
  - ✓ Control all water resources development activities
- ZAWA suggests in the proposed revisions of the Water Policy and Water Act:
  - ✓ Formulation of the Water Resources Management Act for the establishment of WRMB
  - ✓ Establishment of the Water Resources Tribunal

40

Challenges of Strategy 2: Enhancing water resources conservation

- The catchment area based on the groundwater basin structure has not been clarified (the catchment area to be targeted has not been confirmed).
- There are no specific provisions regarding the enactment of protected areas for the conservation of recharge areas for water resources (groundwater) which are used for different purposes.
- A roadmap for the establishment of the "Water Resources Management Board", one of the measures indicated in the National Water Policy, has not been formulated.

41

Discussion 1: Activity in SBP and Challenges

	Activities	KPIs	Target	Budget
B2.1	Fencing of the catchment areas	Protection of the Catchment	Number of catchment area	20,000
B2.2	Afforestation of the areas	Number of survivals planted trees		4,500
B2.3	Survey the catchment areas	Reduced encroachment		6,000
B2.4	Seek for title deeds for gazette catchments	Title deeds secured		2,000
B2.5	Prepare proposal for the water resources tribunal	Tribunal in place	Proposed draft	5,000
B2.9	Institutionalize the WRT	WRT established	WRT in place	Nil

	Challenges	Action to be taken
1	The catchment area based on the GW basin structure has not been clarified	Implement the comprehensive hydrogeological survey (**same as Strategy 1**)
2	No stipulation regarding the enactment of protected areas for the conservation of recharge areas for water resources (groundwater)	Set the stipulation for enactment protected areas for the conservation of groundwater recharges
3	Establishment of the "Water Resources Management Board"	Provision of roadmap for the establishment of the "Water Resources Management Board"
	Coordination of stakeholders in water resources	Coordination of stakeholder by WRMB (IWRM

42

Discussion 2: Priority Action

	Challenges	Action to be taken [responsible org.]
1	The catchment area based on the GW basin structure has not been clarified	Implement the comprehensive hydrogeological survey (**same as Strategy 1**)
2	No stipulation regarding the enactment of protected areas for the conservation of recharge areas for water resources (groundwater)	Set the stipulation for enactment protected areas for the conservation of groundwater recharges [MoWEM & ZAWA] (to coordinate with other stakeholders, such as ZEMA, MoAINR)
3	Establishment of the "Water Resources Management Board"	Provision of roadmap for the establishment of the "Water Resources Management Board" [MoWEM]
4	Coordination of stakeholders in water resources management	Coordination of stakeholder by WRMB (IWRM Manner) [MoWEM]

43

Discussion 3: Commencement of Action and Required Period)

	Challenges	Action to be taken
1	The catchment area based on the GW basin structure has not been clarified	Implement the comprehensive hydrogeological survey (**same as Strategy 1**)
2	No stipulation regarding the enactment of protected areas for the conservation of recharge areas for water resources (groundwater)	Set the stipulation for enactment protected areas for the conservation of groundwater recharges
3	Establishment of the "Water Resources Management Board"	Provision of roadmap for the establishment of the "Water Resources Management Board"
4	Coordination of stakeholders in water resources management	Coordination of stakeholder by WRMB (IWRM Manner)

Note

44

Discussion 4: Necessary measures for implementation

	Challenges	Action to be taken
1	The catchment area based on the GW basin structure has not been clarified	Implement the comprehensive hydrogeological survey (**same as Strategy 1**)
2	No stipulation regarding the enactment of protected areas for the conservation of recharge areas for water resources (groundwater)	Set the stipulation for enactment protected areas for the conservation of groundwater recharges
3	Establishment of the "Water Resources Management Board"	Provision of roadmap for the establishment of the "Water Resources Management Board"
4	Coordination of stakeholders in water resources management	Coordination of stakeholder by WRMB (IWRM Manner)

Note

45

STRATEGY 3: DEVELOPING THE EFFECTIVE MECHANISM FOR RAINWATER HARVESTING

46

(iii) Actions for Strategy 3

Strategy 3: Developing the effective mechanism for rainwater harvesting

	Activities	KPIs	Target	Budget
B3.1	Manage the existing rainwater projects	Rainwater projects implemented	Number of Project	15,000
B3.2	Implement new rainwater projects	Water production improved	Number of Project	550,000
B3.3	Improve Springwater infrastructure		Number of Spring	Not mentioned

47

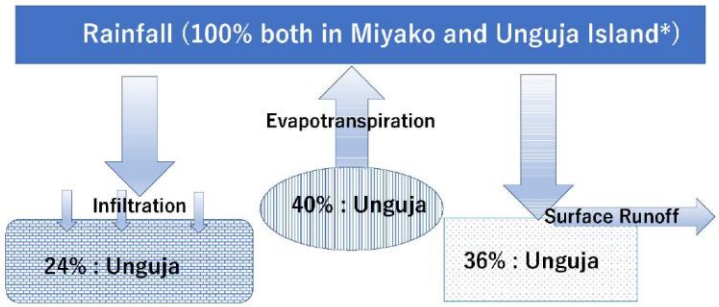
Discussion: Strategy 3

- Is **rainwater** harvesting sufficient?
- Zanzibar's **surface runoff is 36%** of total annual rainfall, which is equivalent to 880 Mm^3.

48

8. Similarity of Natural Conditions Between Miyako and Unguja Island (Possibility of Underground Dam on Unguja Island)

8.4 Water Balance : Miyako and Unguja Island

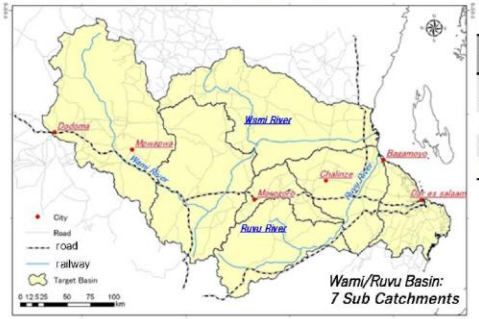


* Haji Shaaban Haji (2010) Water Balance Assessment in Unguja Island Zanzibar, Tanzania

49

8. Similarity of Natural Conditions Between Miyako and Unguja Island (Possibility of Underground Dam on Unguja Island)

8.2 Water Balance : Wami/Ruve Basin, Tanzania



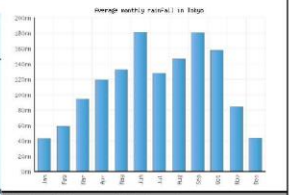
Water Balance of Wami/Ruvu Basin (average of 1969 – 2010)*	
Rainfall (990mm annual mean)	100%
Evapotranspiration	87%
Surface Runoff	6%
Infiltration	7%

Data source: JICA (2013) The study on water resources management and development in Wami/Ruvu basin in the United Republic of Tanzania

50

8. Similarity of Natural Conditions Between Miyako and Unguja Island (Possibility of Underground Dam on Unguja Island)

8.3 Water Balance : Uban Area, Tama River Basin, Tokyo

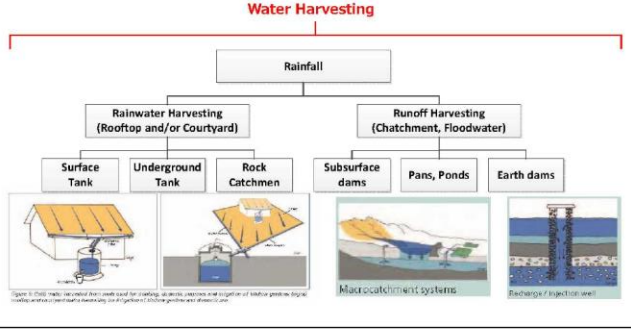


Water Balance of Tokyo, Japan (1976-2006)	
Rainfall (1,544 mm annual mean)	100%
Evapotranspiration	37%
Surface Runoff	57%
Infiltration	6%

51

Reference 1

Idea of Water Harvesting (WH)



52

Challenges of Strategy 3: Developing the effective mechanism for rainwater harvesting

- In recent years, the mainstream of water resource storage is the concept of **Water Harvesting** (comprehensive storage of both rainwater and runoff) based on the concept of IWRM (Integrated Water Resources Plan),
- ZAWA's strategy is concentrated **only on "rainwater** storage"
- Considering the water balance and hydrogeological structure of Zanzibar, it is more suitable and efficient for widespread area **runoff storage including groundwater recharge** than the development of local "rainwater storage" facilities.

53

Discussion 1: Activity in SBP and Challenges

	Activities	KPIs	Target	Budget
B3.1	Manage the existing rainwater projects	Rainwater projects implemented	Number of Project	15,000
B3.2	Implement new rainwater projects	Water production improved	Number of Project	550,000
B3.3	Improve Springwater infrastructure		Number of Spring	Not mentioned

	Challenges	Action to be taken
1	ZAWA's strategy is concentrated only on "rainwater storage"	Implement the comprehensive hydrogeological survey (**same as Strategy 1**)
2	Widespread area runoff storage including groundwater recharge is more suitable and efficient than the development of local "rainwater storage" facilities.	Formulation of an optimal Water Harvesting plan for each catchment area specified in the Strategy 2 action plan

54

Discussion 2: Priority Action

	Challenges	Action to be taken
1	ZAWA's strategy is concentrated only on "rainwater storage"	Implement the comprehensive hydrogeological survey (**same as Strategy 1**)
2	Widespread area runoff storage including groundwater recharge is more suitable and efficient than the development of local "rainwater storage" facilities.	Formulation of an optimal Water Harvesting plan for each recharge area specified in the Strategy 2 action plan

Note

- No.2 :
  - Rainwater harvesting is a cross cutting issue.(ZAWA, communities, Agriculture, Industries, hotels, municipal water, ect.)
  - Why no use of rainwater in Zanzibar?: myth/belief prevents some communities using rainwater for drinking & domestic water (=> need awareness, community sensitization)
  - Construction of two dams & boreholes for rice production,
  - Boreholes for vegetable production

55

Discussion 3: Commencement of Action and Required Period)

	Challenges	Action to be taken
1	ZAWA's strategy is concentrated only on "rainwater storage"	Implement the comprehensive hydrogeological survey (**same as Strategy 1**)
2	Widespread area runoff storage including groundwater recharge is more suitable and efficient than the development of local "rainwater storage" facilities.	Formulation of an optimal Water Harvesting plan for each catchment area specified in the Strategy 2 action plan

Note

56

Discussion 4: Necessary measures for implementation

	Challenges	Action to be taken
1	ZAWA's strategy is concentrated only on "rainwater storage"	Implement the comprehensive hydrogeological survey (**same as Strategy 1**)
2	Widespread area runoff storage including groundwater recharge is more suitable and efficient than the development of local "rainwater storage" facilities.	Formulation of an optimal Water Harvesting plan for each catchment area specified in the Strategy 2 action plan

Note

57

58

Strategy 1: Controlling water abstraction

	Action to be taken
1	Set appropriate **target water volume** (??Mm^3 / Y) for groundwater abstraction control
2	Implement the comprehensive **hydrogeological survey**
3	• Set the water intake volume in **permit** • **Monitor** the water abstraction
4	Elucidate **permissible yield**

Baseline/Preparation	Implementation of Water Resource Management
Hydrogeological Mechanism **Hydrogeological Survey**	**Permissible Yield** **Target Water Volume**
Legal System **Permit**	**Monitoring**

59

Strategy 2: Enhancing water resources conservation

	Action to be taken
1	Implement the comprehensive **hydrogeological survey** (**same as Strategy 1**)
2	Set the stipulation for **enactment protected areas** for the conservation of groundwater recharges
3	Provision of **roadmap** for the establishment of the "**Water Resources Management Board**"

Baseline	Implementation of Water Resource Management
Hydrogeological Mechanism **Hydrogeological Survey**	**Enactment Protected Area**
Governing Structure **Roadmap**	**Water Resources Management Board**

60

Strategy 3: Developing the effective mechanism for rainwater harvesting

	Action to be taken
1	Implement the comprehensive **hydrogeological survey** (**same as Strategy 1**)
2	Formulation of an optimal **Water Harvesting Plan** for each **catchment area** specified in the Strategy 2 action plan

Baseline/Preparation	Implementation of Water Resource Management
Hydrogeological Mechanism **Hydrogeological Survey**	**Recharge Area** **Planning of Water Harvest** **Water Harvesting**

61

Action Plan

Baseline/Preparation	Implementation of Water Resource Management
Hydrogeological Mechanism **Hydrogeological Survey**	**Target Water Volume** **Enactment Protected Area** **Permissible Yield** **Water Harvesting**
Legal System **Permit**	**Monitoring**
Governing Structure **Roadmap**	**Water Resources Management Board**

62

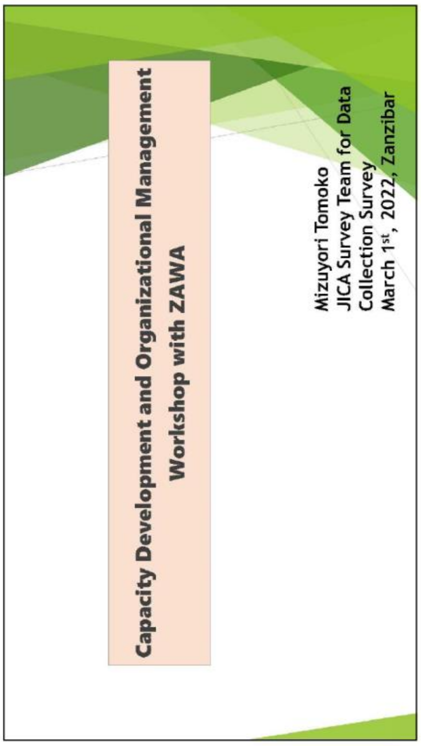
Discussion

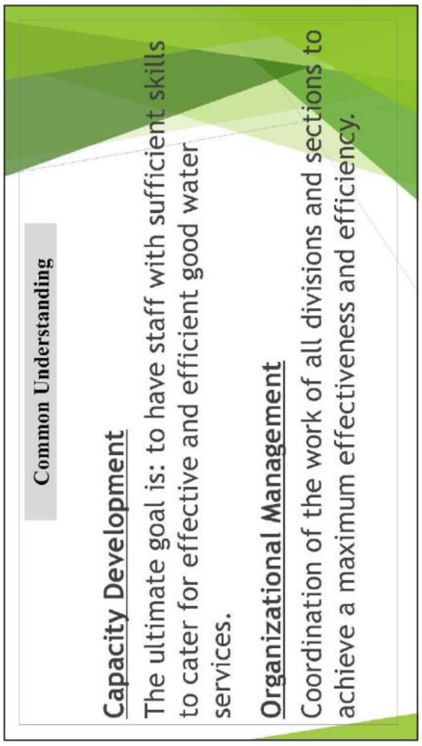
- The action plan should include a review of the Water Act on relevance/adequacy of provisions on the water abstraction permit.
- How are different actors involved in WRM in the case of Mainland? (MoWEM-Zanzibar & MoW-Mainland have signed a MoU)
- Multisectoral cooperation should be considered in WRM.
- How will MoWEM proceed with the hydrogeological survey?
  - Gaps in human resources in hydrogeology
- What if salinity of groundwater increases? how much does it cost in worse situation? = the value of WRM should be understood by policy makers.
- Separation of power between WRM and water supply should be considered in revision of the Water Act.
- Collection of stormwater to contribute to the recharge of groundwater should also be considered.

63

64

2.5 Workshop for Human Resource Development and Organizational Operation





1. Questionnaire Result (continued)

(4) Method : Questionnaire survey

Questions in four categories of work were asked to see the perceptions and attitudes towards work

The questions were classified into the following four groups.

Group A: Situation understanding

Group B: Planning

Group C: Implementation

Group D: Data handling/ recording

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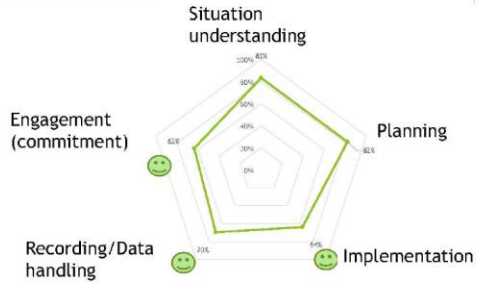
Results summary



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Results Summary

Category	Competency Analysis
Situation understanding	◆Slight weakness on finding issues related to work and grasping the situation ◆Slight weakness on understanding of the frame of work itself
Planning	◆High sense of awareness for the importance of planning ◆Slight weakness for work planning at the personal level ◆Tendencies to leave it untouched if there is a breakdown or malfunction is found ◆There is a delay in the implementation of the activity plan
Implementation	◆High sense of responsibility for work ◆Slight anxiety about carrying out the given work efficiently
Recording/Data handling	◆Weak IT-related mechanism for a recording system ◆Slight weakness on information recording and management
Engagement Motivation, commitment for work	◆Thinking that it's more efficient if others do the job ◆Feeling of no personal good gain from working hard ◆Habit of giving up easily

7

2. SWOT Analysis

Category	Analysis results	Future action
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	
	☐ We can carry out pipe repair work	
	☐ Project movement and monitoring	
	☐ Making follow ups on activities	
	☐ We do repair activities, and we have land ownership	
	☐ With the establishment of the ZAWA Training Center, knowledge and skills can be improved.	
	☐ We have motivated staff	
	☐ We have sufficient water resource	

8

2. SWOT Analysis

Category	Analysis results	Future action
Weakness	There is a discrepancy in the legal framework of water supply	
	No bulk meter installed on the network	
	Not enough water supply quantity	
	Insufficient parts supply	
	Old pipes and other parts	
	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 labor market itself, and highly skilled human resources cannot be hired.	
	Aging facilities and frequent pump failures	

9

2. SWOT Analysis

Category	Analysis results	Future action
Opportunities	There are opportunities for training	
	Brick is used for repairing tanks, pump rooms, etc. (durable)	
	Zanzibar, Tanzanian Government Support and Development Partner Support	
	Being the only service provider in the water supply sector	

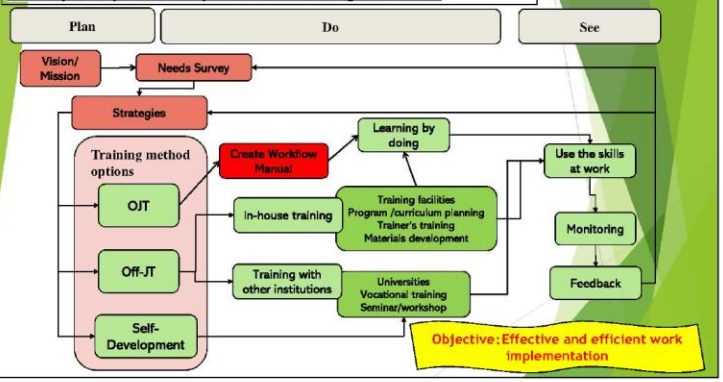
10

2. SWOT Analysis

Category	Analysis results	Future action
Threat	The only water source is groundwater	
	Infiltration 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	

11

3. Capacity Development Training Process



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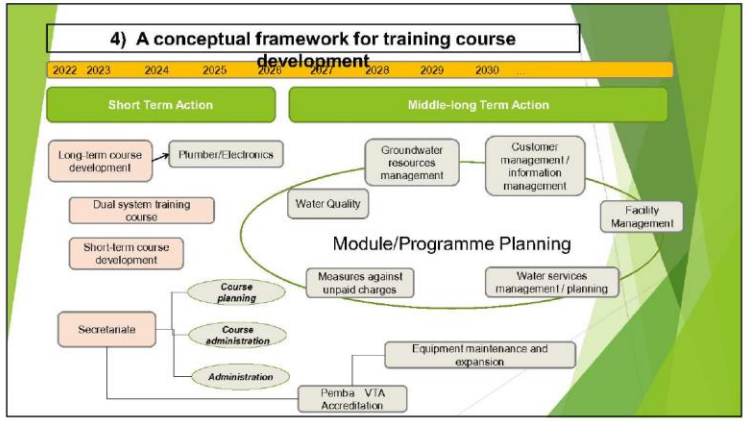

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5) Training Themes Brain Storming

Theme	What can be the training themes?
Plumbing	Leakage repair, connection works, piping materials, mathematics, computer
Electro-mechanics	Pump operation
Customer management / information management	
Facility Management	
Water quality management	

14

5) Training Themes Brain Storming

Theme	What can be the training themes?
Groundwater resource management	
Non-Revenue Water management	
Measures against unpaid charges	
Water services management / planning	

15

(6) Workflow Monitoring for improvement of work implementation

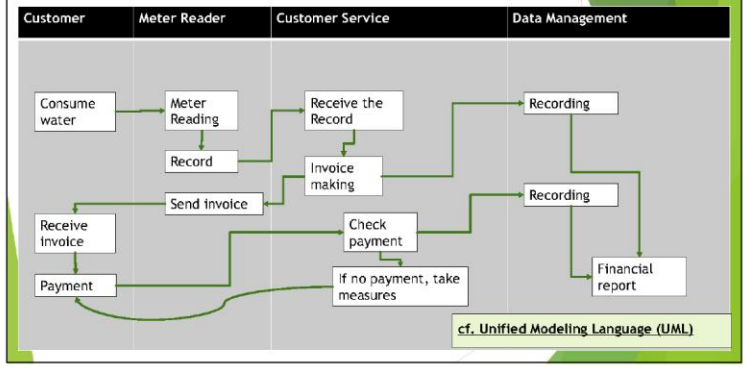
1) Workflow modelling

For a proper implementation of work, workflow modelling is an important task of managers.

2) According to the workflow of daily/monthly work, an effective monitoring of work can be conducted and delays of work may be rectified.

16

Workflow Manual Visual Model (Example: Payment Process)



17

Process definitions (Example: Leakage repair)

Theme	Middle category	Action	Who	Next step	Output
Leakage repairs	Identify leakage	Prepare recording sheets	Network operation	Give to meter readers	Report sheets
		Report from meter readers	Meter reader	Return to network op.	Report sheets
		Prepare a visiting plan	Network operation	Workorder to personnel	Plan
		Regular leakage checkup	Network operation	Visits	Report sheets
	Leakage repair	Initial quick-fix repair	Network operation	Report to supervisor	Report sheets
		Prepare materials list	Network operation	Give to store manager	List
		Contact store manager	Network operation	Arrange with store manager	
		Repair works	Network operation	Visits	
		Cost calculation	Network operation	Cost report to supervisor	Cost report

18

(6) Merits and purpose of Process Modelling

1) Anyone can understand the business

2) Problems will be visible (mistakes, mistakes, troubles)

3) Prevent problems from occurring in advance

4) Respond timely to changes and happenings

5) Eliminate differences in measures to take depending on individuals (personal dependency)=>systematization

19

Thank you for your time

20

2.6 Explanation Meeting for Action Plan

Outline of the Survey Result

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

22 February 2022

1

Contents

1. History and Current Status of JICA's Assistance for Zanzibar Water Sector
2. Outline of the Survey
3. Current situation and Issues
4. Urgent Issues
5. Action Plan
6. Exchange of Opinions

2

1. History and Current Status of JICA's Assistance for Zanzibar Water Sector

3

History of JICA's Assistance for Zanzibar Water Sector

Period	Outline of the Assistance
2006-2008	**The Project for Zanzibar Urban Water Supply Development (Phase 1 & 2)** - Grant Project - Construction of water supply facilities
2008 – 2016	**Project for Enhancement of Water Supply Management of Zanzibar Water Authority (Phase 1 & 2)** - Technical Cooperation Project - **Phase 1**: Business mindset, Customer administration system (SBM), Water tariff setting, CB on Billing, bill collection and claim handling, Water consumption monitoring - **Phase 2**: CB on information management (MIS to ABP), Human resource management (Scheme of Service), Customer management (registration to the system), Planning and implementation of leakage reduction activities
2016-2017	**Zanzibar Urban Water Distribution Facilities Improvement Project (ODA loan)** - Preparatory Survey
2019 – 2021	**Zanzibar Water Advisor**

4

Current Status of JICA's Assistance

- Following projects are planned as JICA's future projects.
  1. Zanzibar Urban Water Distribution Facilities Improvement Project (ODA Loan) (E/N and L/A were signed on 4 Feb 2022.)
  2. Project for the Management of Groundwater Resources in Zanzibar (Technical Cooperation Project)
- ODA loan project was halted due to the taxation issues raised by Ministry of Finance and Planning, Mainland. Thus, the ODA loan project and its associated technical cooperation project have been delayed accordingly.
- During the delay, the environment surrounding the water sector in Zanzibar has been changed (e.g., publishment of ZDV 2050, changes of competent ministry on water administration and reallocations of officers at the ministry and ZAWA).
- Since JICA has a will to keep a relationship with the Zanzibar water sector, JICA hired the consultant team to carry out this survey to collect the latest information for the study of future assistance through planning necessary actions for the improvement of the water sector.

5

2. Outline of the Survey

6

Purpose of the Survey

- The purpose is to collect the latest information related to 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
  3. Study of possible support under the present conditions
  4. Study of JICA's mid-to-long-term assistances in addition to the planned projects such as the yen-loan project
- The output of the survey aims to be
  1. utilized for operation and management of the water sector in Zanzibar
  2. material for the study of JICA's future assistance plans

7

Focused Key Areas of the Survey

Key Area	Key Point
Water Administration and Legislation	• Legislation regarding the establishment of an autonomous water resource management organization and introduction of prepaid system • Revision of discrepancy of laws (e.g., Water Act. and ZURA Act.)
Organizational Management and Human Resource Development	• Restructuring the organizations considering the establishment of the organization for WRM and introduction of prepaid system • Recruitment and human resource development • Motivation improvement measures
Ground Water Management	• Development of groundwater management system • Prevention of seawater intrusion • Regular monitoring of groundwater table and production volume to collect data for water resource assessment

8

Key Area	Key Point
Water Supply Facility Management	• Improvement of water supply facility operation & maintenance • Leakage reduction in ZUWSP area • Improvement of management skills for donor's projects
Customer Management	• Development of a system for prepaid system • Improvement of water bill collection from postpaid customers
Cooperation Program with Japan	• Possibility of utilizing technologies of Japanese private companies to implementation of the Action Plan • Possibility of cooperation with Japanese water utilities • Planning the invitation to Japan for introducing efforts for the above 5 Key Areas in Japan to promote the implementation of the Action Plan

9

3. Current Situation and Issues

10

(1) Water Administration

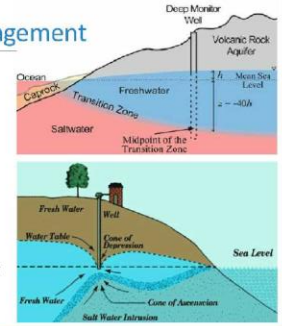
- Framework of water administration

Category	Latest Version	Status
National Policy	Zanzibar Development Vision 2050	2020 published
	Zanzibar Poverty Reduction Plan III 2016-2020	2017 published
	Roadmap to SDGs in Zanzibar 2020-2030	2020 published
Sector Policy	National Water Policy 2004	In revision
Legal System	Water Act. (2006)	Revision planned
	ZURA Act. (2013)	2013 enacted
Strategy/Master Plan	Zanzibar Urban Water Development Plan 1991-2015	1991 published
Business Plan	ZAWA Strategic Business Plan 2020-2025	2020 published
	ZURA Strategic Business Plan 2017-2022	2017 published

11

(2) Issues for Water Resource Management

- Water resource in Zanzibar depends on groundwater, and seawater intrusion is one of the concerns.
- Seawater intrusion is accelerated by the drawdown of the groundwater table.
- Groundwater abstraction should be controlled within the permissible yield.
- High EC at low groundwater level area were observed in the southern part of Unguja Island.



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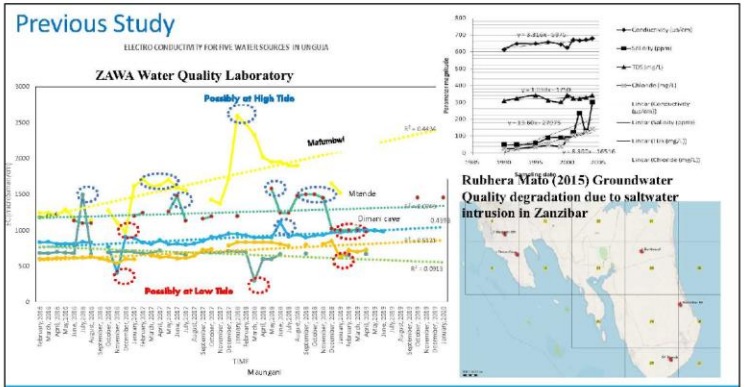
Previous Study

ELECTRO CONDUCTIVITY FOR FIVE WATER SOURCES IN UNGUJA



Rubhera Mato (2015) Groundwater Quality degradation due to saltwater intrusion in Zanzibar

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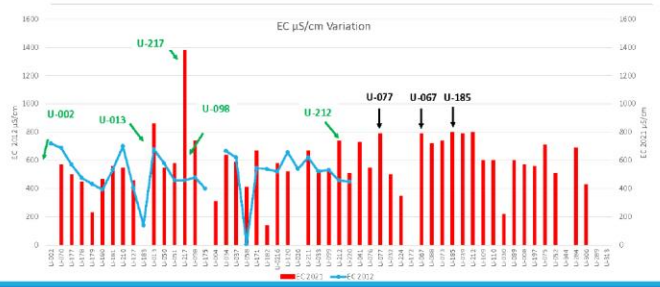
Brief of Results of Simplified Survey on the Status of Seawater Intrusion to Groundwater

Change of EC (μS/cm) Value from 2012 to 2022



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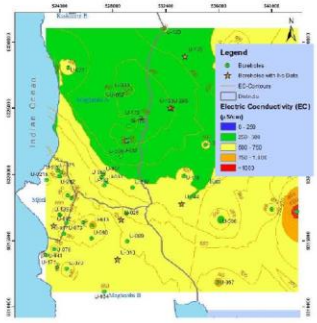
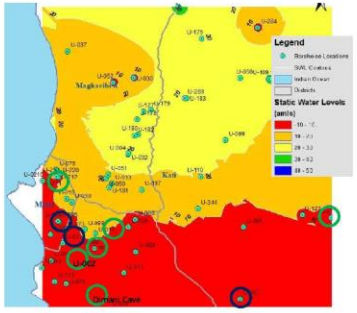


EC (Electrical Conductivity) (µs/cm)



SWL (Static Water Level) (m)

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- The abstraction of groundwater should be controlled based on a permissible yield estimated from scientific data, but the volume is not clear.
- Although various sectors (agriculture, commercial, industry, private) use groundwater, the abstraction volume of other sectors has not been managed sufficiently.
- ZAWA is the water service authority that develops and use water resources as well as the water resources management authority that regulates the development and usage of water resources (conflicting functions).

16

16

(3) Issues for Water Utility Operation

- Revenue cannot cover the cost of water utility operation.
- Following items are general business resources for water utilities. It is the reason for the financial difficulty that the quantity and quality of current resources of the Zanzibar water sector are not sufficient.
  a. **Facility/equipment**: This resource is to provide water supply service and get service charges.
  b. **Financial Resources**: This resource is to develop and maintain facilities/ equipment and operate water supply facilities.
  c. **Information**: This resource is to be used for facility O&M and business decisions.
  d. **Human Resources**: This resource is for the management and operation of water utility

17

17

a. Water Supply Facilities/equipment

Item	2008	2013	2018
Annual Yield (,000m3/year)	33,017	34,922	39,417
Annual Consumption (,000m3/year)	3,058	5,168	14,584
Rate of Water Losses	91%	85.2%	63%

Supply Hours	ZUWSP Area	Unguja Urban	Unguja Rural	Pemba Urban	Pemba Rural	Total
0-5	39.0 %	86.0 %	33.0 %	33.0 %	29.0 %	44.0 %
6-10	13.0 %	14.0 %	7.0 %	32.0 %	26.0 %	18.4 %
10-15	1.0 %	0.0 %	9.0 %	16.0 %	16.0 %	8.4 %
16-23	0.0 %	0.0 %	8.0 %	6.0 %	9.0 %	4.6 %
24	3.0 %	0.0 %	36.0 %	13.0 %	20.0 %	14.4 %
Not Receiving	44.0 %	0.0 %	7.0 %	0.0 %	0.0 %	10.2 %

18

18

a. Water Supply Facilities/equipment

- Water losses have been reduced but it is still high.
- Percentage of 0-5 hours water supply is the highest.
- 44% of the ZUWSP area do not receive water from ZAWA.
- Water leakage is expected as the reason for the above (Aged pipelines (e.g., 190 km of AC pipes) are remaining according to GIS data).
- Since water leakage is expected, implementation of NRW management and NRW component analysis is recommended.
- Reduction of water leakage in ZUWSP area is one of the urgent issues. (Many users in the area don't use ZAWA's water due to the insufficient service.)

19

19

b. Financial Resource (Fund/budget)

Income (mil TZS) (2019/20)		Expenditure (mil TZS) (2019/20)	
Sales, Service charge, etc.	3,396.0 (33.7%)		
Subsidies, Grants	6,687.1 (66.3%)	OPEX	9,901.2
Total	10,083.1 (100%)		

Status of meter installation	ZUWSP	Unguja Urban	Unguja Rural	Pemba Urban	Pemba Rural	Total
Meter installed	22.0 %	2.0 %	7.0 %	14.0 %	9.0 %	10.8%
No meter	76.0 %	94.0 %	90.0 %	86.0 %	91.0 %	87.4 %
Disconnected, meter present	1.0 %	1.0 %	2.0 %	0.0 %	0.0 %	0.8 %
Disconnected, no meter	1.0 %	3.0 %	1.0 %	0.0 %	0.0 %	1.0 %

Willingness to pay	ZUWSP	Unguja Urban	Unguja Rural	Pemba Urban	Pemba Rural	Total
Yes	98.0 %	100.0 %	97.0 %	80.0 %	79.0 %	90.8%
No	2.0 %	0.0 %	3.0 %	20.0 %	21.0 %	9.2 %

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b. Financial Resource (Fund/budget)

- ZAWA's finance relies on government subsidies and grants, and water sales are approximately 34% of OPEX.
- Following items are conceivable as the reason for insufficient revenue.
  1. Worse of the service
  2. Small number of metered customers
  3. Insufficient meter reading (lack of meter readers)
  4. Insufficient billing (SMS billing system was introduced but the number of registration is not enough [35,000 registered/120,000 customers]).
  5. Existence of authorized unbilled customers
  6. Too long average collection period (913 days).

21

21

- To increase revenue, water supply service and customer management should be improved at the same time.
- Raising awareness in Pemba is required to improve willingness to pay.
- Besides, ZAWA is going to introduce a prepaid meter system for 350 large users as a trial. If ZAWA expands the system, the following items should be addressed.
  1. Set the tariff for prepaid meter users.
  2. How to develop and maintain the central system for prepaid meter operation (tentatively prepaid meter manufacturer will provide the system during the trial.)

22

22

c. Information

- It is hard to get facility operation information (amount of water production and supply, pressure, etc.) because of the lack of instrumentation equipment. Monitoring equipment should be installed when facilities are developed.
- Start from KPIs calculation using "Performance Monitoring of Water Utilities (2020)" that ZURA published is recommended.
- Formulation of data collection and management procedure should be developed through the KPIs calculation.

23

23

d. Human resource/organization

- The importance of groundwater management is increasing from the viewpoint of sustainable groundwater use but there are almost no human resources who have knowledge about hydrogeology.
- Although it may be due to a shortage of human resources, the establishment of the Water Resources Management Organization itself is not currently proceeded.

24

24

4. Urgent Issues

25

25

Urgent Issues

- There two urgent issues from the current situation.
  1. Leakage reduction in the ZUWSP area
  2. Prepaid meter system operation (water tariff and voucher sales)

26

1. Leakage reduction in the ZUWSP area

- There are two reasons that the water supply services were not improved in the area.
  1. Existing old pipelines that should be disconnected still exist because service connections are branched from old pipelines.
  2. Some water flows out to the adjacent area until the completion of the Japanese ODA project area.
- No.1 is an urgent issue.

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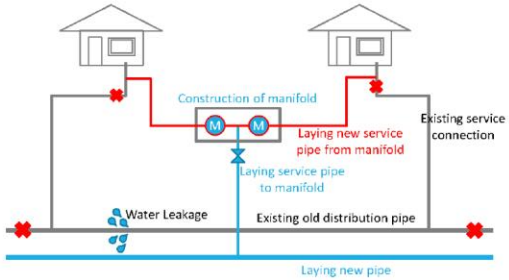


- Cannot supply water from new pipelines
- Supply water from new pipelines and disconnect old pipelines

28

28

- As shown in the schematic figure, the procedure to disconnect old pipelines (reduce leakage from old pipelines) is below.
  1. Complete the installation of service connections from manifolds.
  2. Disconnect old pipelines from the network.
- Responsible department is Commercial and Customer Service Department of ZAWA
- The total length of old pipelines that can be disconnected in the area is estimated at 12.7 km from as-built drawings.
- According to the technician of Customer Service Department, disconnection work in 5 shehias (Kikuwajuni Bondeni, Kikuwajuni Juu, Kwaalinatoo, Kwahani and Kisiwandui) was completed.
- Unfortunately, this procedure can be applied only outside of Stone Town.

29

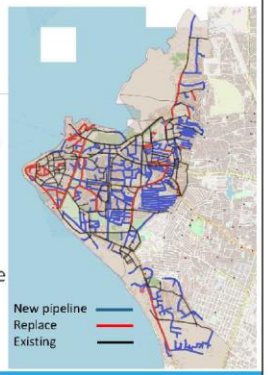
Problem 1: Manifold in Stone Town

- The right photo shows a manifold in Stone Town. The lid is too heavy to open for meter readers. (Manifolds cannot be used.)
- Therefore, it needs to be planned how to replace the service connections in Stone Town. (It seems that the conventional connection method without manifold is suitable in Stone Town.)

30

Problem 2: Existing Old Pipelines

- 33.6 km of existing old pipelines (including AC pipelines) will remain even if the disconnection of 12.7km pipelines are completed.
- There is a possibility that water pressure does not increase due to the leakage from existing old pipelines.
- Replacement of existing old pipelines should be carried out after the completion of the disconnection work.



31

Conclusion

- Need to promote water meter installation and disconnect removable old existing pipelines outside of Stone Town (securing budget).
- Regarding Stone Town, need to start with a survey and detailed design again.
- Need to continue leakage repair and/or replacement for remaining existing old pipelines.

32

2. Prepaid meter system operation (water tariff and voucher sales)

- Prepaid meters will be introduced by RIWSSZ as a trial.
- Expected completion of RIWSSZ is October 2022 for Lot 2 & 3, January 2023 for Lot 1.
- Less than 1 year is left until the commencement of operation of the prepaid meter system.
- Water tariff for prepaid meter users and voucher sales procedure should be decided immediately (discussion between ZAWA and ZURA is necessary).

33

33

5. Action Plan

34

34

5-1. Outline of Action Plan

35

35

Outline of Action Plan

- In this survey, the survey team proposes strategies, measures and actions as an action plan based on the current issues of water administration, legal system, water resource management, facilities and customer management, and human resource development in the water sector of Zanzibar.
- The survey team will also propose the recommended med-to-long-term assistance by JICA considering the resources such as personnel and budget of executing agencies for the implementation of the action plan.

36

36

5-2. Targets and Basic Policy of Action Plan

37

37

Targets of Action Plan

- The summary of targets of national policies is shown below.
  1. Sustainable and efficient use and distribution of water resources, and management, conservation and protection
  2. In consideration of poverty, gender, environment, all people can be able to sustainably access safe water at appropriate prices
- Considering the above, targets of the action plan was set.
  - 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

38

38

Basic Policy for Target 1

- There is a possibility that groundwater abstraction exceeding water resource capacity causes saltwater intrusion.
- To allocate water resources and regulate groundwater abstraction properly, it would be better to prepare a water resources management M/P and water users from all sectors should be involved in water resources management activities.
- Current personnel allocation is not sufficient for IWRM (integrated water resource management).
- ZAWA should not have conflicting functions that developing and using water resources as a water utility and regulating the development and usage of water resources as a water resources management authority.

39

39

- From the above situation, preparation is necessary for the implementation of IWRM.

  - Basic Policy 1 for Target 1:
    Establishment of a system for Integrated Water Resources Management (IWRM) and formulation and implementation of IWRM plan

40

40

Basic Policy for Target 2

- Because of the financial difficulties, water service is not enough (Replacement of aged facilities/equipment and maintenance does not proceed well.)
- Although in the difficult financial conditions, continuous increase in population and water demand is expected in Zanzibar and investment for future water demand is necessary.
- For the sustainable provision of water supply service, improvement of ZAWA's financial situation is necessary.
- For the provision of equitable water supply at an affordable price to all residents including poverty groups, water utility should be operated efficiently.

41

41

- From the above situation, directions are decided as shown below.

- Basic Policy 2 for Target 2:
  Improvement of the financial situation of ZAWA for sustainable and stable water supply
- Basic Policy 3 for Target 2:
  Operation of water utility for the provision of equitable water supply at an affordable price

42

42

5-3. Strategies and Measures for Basic Policy

43

43

Planned Strategies and Measures

Basic Policy 1 for Target 1: Preparation for and implementation of IWRM	4 Strategies, 16 Measures
Basic Policy 2 for Target 2: Improvement of the financial situation of ZAWA for sustainable and stable water supply	8 Strategies, 12 Measures
Basic Policy 3 for Target 2: Operation of water utility for the provision of equitable water supply at the proper price	7 Strategies, 13 Measures

44

44

(1) Strategy and Measures for Basic Policy 1 (1)

Strategy	Measures	Way of thinking
Revision of Policies and Laws	Revision of National Water Policy (2004)	Revision considering changes in the sector environment is required.
	Enactment of Water Resources Management Act.	To establish a water resources management body, the enactment of an act which stipulates the purpose and principles of water resources management, and institutional/legal framework is required.
	Revision of Water Act and ZURA Act.	The current Water Act needs to be revised to a law governing water supply services with the formulation of the Water Resources Management Act.
Establishment of Water Resources Management Board	Establishment of WRMB	An independent organization which executes water resource management and regulation is required.
	Establishment of a coordination/collaboration mechanism (e.g., water users association)	A multi-stakeholder coordination/collaboration mechanism is required to facilitate problem-solving related to water resources based on social consensus building with sharing recognition of issues and scientific data.
	Capacity development of WRMB and the associations	Capacity development for execution of required functions of each party is required.

45

(1) Strategy and Measures for Basic Policy 1 (2)

Strategy	Measures	Way of thinking
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 evaluate the amount of available water resources and permissible yield, find out the groundwater flow mechanism by simulating the groundwater flow model, and to do so, investigation of groundwater basin is required.
	Grasp and estimate current and future water demand	Evaluation of water balance between water demand and permissible yield in each sector and groundwater basin is required.
	Formulation of water resources allocation plan	Adjustment of water balance by seasons, purposes, and areas
	Coordination of water resources development plans	Formulation and implementation of harmonized water resources development plans among sectors within each groundwater basin in line with water resources allocation plan

46

(1) Strategy and Measures for Basic Policy 1 (3)

Strategy	Measures	Way of thinking
Formulation of a water resources management master plan (M/P) for improving efficient water use and ensuring sustainable groundwater abstraction	Efficient water use and saving	Promote more efficient water use in sectors where future water demand is expected to increase significantly
	Appropriate management of water abstraction and use	Management/regulation of water abstraction and use based on related laws and regulations, promotion of organized water use
	Conservation of water resources	Prevention of deterioration of water quality and quantity of water resources in the groundwater basin

47

(1) Strategy and Measures for Basic Policy 1 (4)

Strategy	Measures	Way of thinking
Introduction of IWRM approach	Development of information management system related to water resources and water use	Identification of the basic information and data necessary for formulating and implementing a water resource management plan, and to establish a system for monitoring and management are required.
	Raise awareness and promote participation of citizens and the private sector in water resources management	Promotion of interest of the citizens and the private sectors in the water cycle mechanisms and current and future scenarios of water resources and their active involvement in the conservation and proper use of water resources is required.
	Formulation and trial implementation of IWRM plan for each groundwater basin	Formulation of an IWRM plan by WRMB and the water user council for catchment areas where there are concerns about saltwater intrusion and conflicts of interest over water use.
		Considering how to proceed with water resources management with the IWRM approach through the process of pilot activities

48

(2) Strategy and Measures for Basic Policy 2 (1)

Strategy	Measures	Way of thinking
Formulation of strategy for improvement of financial situation	Grasp and analyze water supply service and current OPEX in each water supply scheme	To improve the current account balance, grasping and analyzing the current quality of service and the account balance in each water supply scheme are required.
	Examination of water revenue improvement strategy based on analysis results	Examination of account balance improvement strategy based on the character of water supply scheme (service quality and revenue situation) is required.
		Examination of direction of future water utility operation (e.g., division of ZAWA) is required.
Examination of appropriate water tariff	Review of unit price of current water tariff	Validation of the current water tariff is required.

49

(2) Strategy and Measures for Basic Policy 2 (2)

Strategy	Measures	Way of thinking
Increase the number of metered customers	Promotion of meter installation to flat rate customers	To improve the current account balance, grasping and analyzing the current quality of service and the account balance in each water supply scheme are required.
Improvement of billing and collection	Billing and collection from current unbilled customers	Collection as much as possible from users who have not been billed for various reasons (NRW reduction)
	Promotion of customer information registration especially mobile phone numbers	Customer information (mobile phone number) information is required for effective use of various systems (distribution of invoices by SMS, payment service by mobile phone).
	Increase meter readers according to the number of meters installed	If the meter reading functions well, it is expected that the billing and collection will be improved in combination with SBM and various systems.

50

(2) Strategy and Measures for Basic Policy 2 (3)

Strategy	Measures	Way of thinking
Survey of customer satisfaction	Implementation of periodical customer satisfaction survey by meter readers	Regular customer satisfaction surveys are required to understand the status of water services and obtain information for improvement.
Improvement of follow-up activity for unpaid bills	Execute follow-up to unpaid customers	Reminder to unpaid customers to pay is required (consideration for poverty is necessary)
Evaluation of trial prepaid meter introduction	Evaluation of prepaid meter operation introduced by RIWSSZ and feasibility of expansion	Evaluation of the effects and problems of the prepaid meter system based on the regional characteristics of Zanzibar is required.
		Confirmation of problems related to system operation and maintenance is required before expansion of prepaid system.

51

(2) Strategy and Measures for Basic Policy 2 (4)

Strategy	Measures	Way of thinking
Evaluation of trial prepaid meter introduction	Examine the water tariff for prepaid customers	Although it is a trial introduction, it is necessary to set a tariff for operation
Improvement of efficiency of customer management by system update	Implement integrated customer management with SBM updates	There are links between systems, but SBM, SMS system, and charge collection system are separate systems.
		About 10 years have passed since the introduction of SBM, and the software has become old (the current version is packaged with billing, payment, unpaid management, complaint management, and meter management functions).

52

(3) Strategy and Measures for Basic Policy 3 (1)

Strategy	Measures	Way of thinking
Formulation of facility development strategy to meet future water demand	Formulation of water M/P (facility development and replacement plan)	Future water demand that will be the basis of future water supply facility development plans and water resource management plans are required.
		Investigation and understanding the status of existing facilities and grasping the demand for facility renewal is required.
		Formulation of the facility development and renewal plans to improve water services is required for water utility operation.
Enhancement of NRW reduction	Establishment of NRW management team	Since NRW is related to multiple departments, an organization in charge of NRW management is required.
	Analysis of NRW status and formulation and implementation of NRW improvement plans	For efficient NRW reduction, analysis and understanding the status of each element of NRW (unbilled, apparent losses, real losses) is required.
		NRW reduction plan based on the analysis result, implementation management and evaluation of NRW reduction activities are required.

53

53

(3) Strategy and Measures for Basic Policy 3 (2)

Strategy	Measures	Way of thinking
Improvement of facility maintenance	Formulation of a maintenance plan that incorporates the idea of preventive maintenance	Shifting to preventive maintenance as much as possible by conducting daily and regular inspections is required.
Enhancement of project management using external funds	Accumulation of experience through the management of Japanese ODA loan project	Enhancement of project management and improvement of management ability based on the issues and lessons learned from previous project management are required.
Improvement of work processes	Visualize the process of work and understand and organize them accordingly	Work manuals that maintains the quality of work, to avoid missing procedures or low quality of work is required.
		Functioning a monitoring system in which management monitors and confirms the work status using KPI is required.

54

54

(3) Strategy and Measures for Basic Policy 3 (3)

Strategy	Measures	Way of thinking
Enhancement of information management	Sort out information items required for utility management and facility operation/maintenance	Sorting out the items of information that the water utility should grasp for the operation is required.
	Confirmation of status such as data acquisition method, procedure, necessary equipment and system for data acquisition	Confirmation of the development status of SOPs and manuals for information management and the status of equipment and systems for information acquisition and management are required.
	Implementation of information collection, management and reporting as a daily operation	Formulating procedures for information collection and management and implementation as a daily operation is required to improve information management.
		Establishment of procedures for reporting to MoWEM and ZURA (items, frequency, timing, etc.) is required.

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(3) Strategy and Measures for Basic Policy 3 (4)

Strategy	Measures	Way of thinking
Enhancement of human resource management	Examination of organizational management policy for water utility operation	Reviewing organizational management policies (work allocation to Pemba branch and District Offices, management processes, utilization of online communications) is required considering future business environment (increase of water meters, strengthening information management, etc.).
	Human resource allocation plan based on the reviewed organizational management policy	Staff allocation plan to each office (plumbers, meter readers, pump operators, etc.) is required for formulation of recruit plan
	Formulation of recruit plan	Recruit plan according to the facility development and water meter installation plan is required.

56

56

(3) Strategy and Measures for Basic Policy 3 (5)

Strategy	Measures	Way of thinking
Enhancement of human resource management	Enhancement of ZTC for capacity building of new employees and existing employees of ZAWA	ZTC should be not only a vocational training institution but also an internal training institution of ZAWA.
		Development of short course programs for internal capacity building, development of training materials, training of trainers, expansion of facilities, incentives for capacity building, etc. need to be considered.
		Plan for utilization of external training institution such as WI should be considered for capacity improvement of staff in the water sector.

57

57

5-4. Planned Actions

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58

Planned Actions

- Basic Policy 1: Preparation for and implementation of IWRM → 4 Strategies, 16 Measures → 37 Actions
- Basic Policy 2: Improvement of the financial situation of ZAWA for sustainable and stable water supply → 8 Strategies, 12 Measures → 24 Actions
- Basic Policy 3: Operation of water utility for the provision of equitable water supply at the proper price → 7 Strategies, 13 Measures → 22 Actions

59

59

(1) Actions for Basic Policy 1 (1)

Strategy	Measures	Actions
Revision of Policies and Laws	Revision of National Water Policy (2004)	1101: Revision of National Water Policy
	Enactment of Water Resource Management Act.	1102: Legislation required for water resources management
	Revision of Water Act and ZURA Act.	1103: Revision of Water Act and ZURA Act along with the Water Resources Management Act.

60

(1) Actions for Basic Policy 1 (2)

Strategy	Measures	Actions
Establishment of Water Resource Management Body	Establishment of WRMB	1104: Preparation for establishment (planning of organizational structure, division of duties in each department, staff allocation, procurement, budget, etc.) 1105: Appointment of board members 1106: Assignment of engineers, professional staff, clerical staff 1107: Preparation of office and necessary equipment
	Establishment of a council mechanism (water user association)	1108: Discussion with stakeholders (organizational structure of the coordination/collaboration body, legal status, roles, area of jurisdiction of each water users association, regulation/ constitution) 1109: Promote the formation of the water users association in areas where there are concerns about conflicts in water use
	Capacity building of WRMB and the council	1110: Implementation of capacity development program

61

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(1) Actions for Basic Policy 1 (3)

Strategy	Measures	Way of thinking
Formulation of a water resources management master plan (M/P) for improving efficient water use and ensuring sustainable groundwater abstraction	Evaluation of available water resource amount	1111: Implementation of hydrogeological survey for finding out groundwater basin structure and groundwater flow mechanism 1112: Groundwater modeling and simulation using the model 1113: Evaluation of the amount of available groundwater resources and permissible 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 permissible yield
	Water resource allocation plan	1117: Study of options for water resources development 1118: Formulation of water resources allocation plan by usage and groundwater basin

62

62

(1) Actions for Basic Policy 1 (4)

Strategy	Measures	Way of thinking
Formulation of a water resources management master plan (M/P) for improving efficient water use and ensuring sustainable groundwater abstraction	Adjustment of water source development plan	1119: Coordination of sectoral water resources development plans from the viewpoint of water resources management 1120: Formulation of appropriate water harvesting plan in each groundwater basin
	Efficient water use and saving	1121: Advising of sectoral water use plan from the viewpoint of water resources management
	Appropriate management of water yield and use	1122: Formulation of regulations and standard procedures for permit issuance 1123: Consolidation of data/information of permits (well owner construction permit & water abstraction agreement) already issued and determination of permitted volume of abstraction in the permits 1124: Review of tariff structure of various charges for water abstraction and fee collection methods 1125: Formulation of water abstraction monitoring plan 1126: Cooperation with the ministry responsible for water and water utility to secure availability of alternative water sources for borehole owners

63

63

(1) Actions for Basic Policy 1 (5)

Strategy	Measures	Way of thinking
Introduction of IWRM approach	Conservation of water resource	1127: Designation of conservation area at groundwater recharge areas and main water sources, and execution of conservation activities 1128: Designation of groundwater controlled area 1129: Formulation of groundwater basin conservation plan 1130: Cooperation with authorities that implement conservation activities for forest and water sources
	Development of information, data collection, management system related to water resources and water use	1131: Development of information management system for decision making and planning 1132: Formulation of a plan for water resources observation and monitoring, and establishment of implementation system 1133: Collection and analysis of natural and social scientific data related to water resources 1134: sharing information among related institutions and stakeholders

64

64

(1) Actions for Basic Policy 1 (6)

Strategy	Measures	Way of thinking
Introduction of IWRM approach	Raise awareness and promote participation in water resource management for citizens and the private sector	1135: Formulation of communication plan 1136: Awareness program with social, schools and private companies
	Formulation and trial implementation of IWRM plan	1137: Formulation of IWRM plan for each groundwater basin

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(2) Actions for Basic Policy 2 (1)

Strategy	Measures	Way of thinking
Formulation of strategy for improvement of financial situation	Grasp and analyze water supply service and current account balance 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 account balance (Note: water supply scheme (or area) wise)
	Examination of current account balance improvement strategy based on analysis results	2204: Categorizing of water supply schemes by service situation and account balance (service○balance○, service○balance×, service×balance○, service×balance×) 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

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(2) Actions for Basic Policy 2 (2)

Strategy	Measures	Way of thinking
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) 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 number registration	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 2215: Securing meter readers according to the plan (recruit or outsource)

67

67

(2) Strategy and Measures for Basic Policy 2 (3)

Strategy	Measures	Way of thinking
Survey of customer satisfaction	Implementation of periodical customer satisfaction survey be 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 trial prepaid meter introduction	Evaluation of prepaid meter operation introduced by RIWSSZ and feasibility of expansion	2219: Evaluation of prepaid meter system operation 2220: Feasibility study for the expansion of prepaid meter introduction

68

68

(2) Strategy and Measures for Basic Policy 2 (4)

Strategy	Measures	Way of thinking
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 2224: Update of the billing management system

69

69

(3) Actions for Basic Policy 3 (1)

Strategy	Measures	Way of thinking
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
Enhancement of NRW reduction	Establishment of NRW management team	2302: Formulation of NRW management system 2303: Establishment of NRW management team
	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

70

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(3) Actions for Basic Policy 3 (2)

Strategy	Measures	Way of thinking
Improvement of facility maintenance	Formulation of a maintenance plan that incorporates the idea of preventive maintenance	2306: Formulation of maintenance plan 2307: Implementation of maintenance according to the plan and monitoring of implementation
Enhancement of project management using external funds	Enhancement of project management of Japanese ODA loan	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.

71

71

(3) Strategy and Measures for Basic Policy 3 (3)

Strategy	Measures	Way of thinking
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, designation of responsible Department and system development (if necessary)
	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

72

72

(3) Strategy and Measures for Basic Policy 3 (4)

Strategy	Measures	Way of thinking
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 plan for training

73

73

5-5. Implementation Plan

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74

Implementation Plan

- Implementation period is proposed in 3 periods.
  1. 1st Period: 2022 to 2024
  2. 2nd Period: 2025 to 2027
  3. 3rd Period: After 2028
- Importance of measures (priority), procedure of related measures, required time for implementation are considered for planning of the implementation period.
- The proposed implementation period is shown after the next slide.

75

75

(1) Strategy and Measures for Basic Policy 1

Strategy	Measure	Implementation Period		
		Short	Midium	Long
Revision of Policies and Laws	Revision of National Water Policy (2004)	○		
	Enactment of Water Resource Management Act,	○		
	Revision of Water Act and ZURA Act.	○		
Establishment of Water Resource Management Body	Establishment of WRMB		○	
	Establishment of a council mechanism (water user council)		○	
	Capacity building of WRMB and the council		○	○
Groundwater resource management M/P for efficient water usage and ensuring sustainable water yield	Evaluation of available water resource amount	○	○	
	Grasp and estimate current and future water demand	○	○	
	Water resource allocation plan		○	
	Adjustment of water source development plan		○	○
	Efficient water use and saving			○
	Appropriate management of water yield and use		○	○
Introduction of IWRM approach	Conservation of water resource		○	○
	Development of information, data collection, management system related to water resources and water use	○	○	○
	Raise awareness and promote participation in water resource management for citizens and the private sector			○
	Formulation and trial implementation of IWRM plan			○

76

76

(2) Strategy and Measures for Basic Policy 2

Strategy	Measure	Implementation Period		
		Short	Midium	Long
Formulation of strategy for improvement of financial situation	Grasp and analyze water supply service and current account balance in each water supply scheme	○		
	Examination of current account balance improvement strategy based on analysis results	○		
Examination of appropriate water tariff	Review of unit price of current water tariff	○		
Increase the number of metered customers	Promotion of meter installation to flat rate customers	○	○	○
Decrease the unbilled customers	Billing and collection from current unbilled customers	○	○	○
Enhancement of customer information management	Promotion of customer information registration especially mobile phone number registration	○	○	○
Enhancement of meter reading	Increase meter readers according to the number of meters installed	○	○	○
Survey of customer satisfaction	Implementation of periodical customer satisfaction survey be meter readers	○	○	○
Improvement of follow-up activity for unpaid bills	Execute follow-up to unpaid customers	○	○	○
Evaluation of trial prepaid meter introduction	Evaluation of prepaid meter operation introduced by RNWSSZ and feasibility of expansion		○	
Tariff setting for prepaid customers	Examine the water tariff for prepaid customers	○	○	
Improvement of efficiency of customer management by system update	Implement integrated customer management with SBM updates	○		

77

77

(3) Strategy and Measures for Basic Policy 3

Strategy	Measure	Implementation Period		
		Short	Midium	Long
Formulation of facility development strategy to meet future water demand	Formulation of water M/P (facility development and replacement plan)	○		
Enhancement of NRW reduction	Establishment of NRW management team	○		
	Analysis of NRW status and formulation and implementation of NRW improvement plans		○	○
Improvement of facility maintenance	Formulation of a maintenance plan that incorporates the idea of preventive maintenance	○	○	○
Enhancement of project management using external funds	Enhancement of project management of Japanese ODA loan	○	○	
Improvement of work process	Visualize the process of work and understand and organize them accordingly	○		
Enhancement of information management	Sort out information items required for utility management and facility operation/ maintenance	○		
	Confirmation of status such as data acquisition method, procedure, necessary equipment and person for data acquisition	○		
	Implementation of information collection, management and reporting as a daily operation		○	○
Enhancement of human resource management	Examination of organizational management policy for water utility operation	○		
	Human resource allocation plan based on the reviewed organizational management policy	○	○	○
	Formulation of recruit plan	○	○	○
	Enhancement of ZTC for capacity building of new employees and existing employees of ZAWA	○	○	○

78

78

6. Exchange of Opinions

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79

(1) Current Main Issues

- The survey team recognized the following items as the issues through the survey.

1. Addressing Water Resources Management
   - establish of WRMB, implementation of IWRM
2. Improvement of the financial situation of the water utility operation
   - enhancement of customer management for water revenue increase
3. Improvement of the water supply service
   - addressing measures for water supply service improvement (formulation of water M/P, leakage reduction through NRW management, improvement of O&M)

80

80

(2) Urgent Issues

- How to address the urgent issues?

1. Leakage reduction in the ZUWSP area
   - Outside of Stone Town (meter installation and disconnection of unnecessary pipelines)
   - In Stone Town (survey, design, and construction)
2. Trial operation of the prepaid meter system
   - Tariff setting for prepaid meter users
   - O&M (voucher sale, system operation, maintenance of meters and the system)

81

81

(3) Proposed Action Plan

- Utilize the action plan

1. Will this action plan be referred to and used in the operation & management of the water sector?
2. Which areas in the action plan would you like to focus on especially?
3. Do you need the support of experts for the implementation?
   - Which fields?

82

82

Thank you so much

83

83

Appendix 3 Minutes of Meeting for Action Plan Explanation

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

With reference to the above-captioned Data Collection Survey conducted by a survey team dispatched by the Japan International Cooperation Agency (hereinafter referred to as "JICA survey team"), Ministry of Water, Energy & Minerals (hereinafter referred to as "MoWEM"), Zanzibar Utilities Regulatory Authority (hereinafter referred to as "ZURA"), Zanzibar Water Authority (hereinafter referred to as "ZAWA") and the JICA survey team made discussions and confirmed the results of discussions.

As a result of the discussions, both sides acknowledged on the main items described in the attached sheets.

Zanzibar, 22nd February 2022

Mr. Toshiaki OOKA
Survey Team Leader

Survey Team, Japan International Cooperation Agency, Japan

Mr. Mudrik Fadhil Abass
Director, Water Development

Ministry of Water, Energy & Minerals, Zanzibar, Tanzania

ATTACHEMENT

1. Positioning of the survey

JICA dispatched the JICA survey team to carry out the Data Collection Survey to collect the latest information to identify the relevant themes and actions for the future of the water sector in Zanzibar as well as the direction of assistance from Japan.

The JICA survey team will submit the survey report to JICA and subsequently be shared with MoWEM, ZURA and ZAWA.

2. Purpose of the Data Collection Survey

The purpose is to collect information related to the following 6 key areas that contributes to the enhancement of the Zanzibar Water Administration and Water Utility Management System.

1) Water Administration and Legislation
2) Organizational Management and Human Resource Development
3) Groundwater Management
4) Water Supply Facility Management
5) Customer Management
6) Potential for Cooperation Program with Japan

The survey purposes covered the following four items.

1) Study of countermeasures 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 organizational operation, human resource development and legal system
3) Study of possible support under the present conditions for the implementation of above measures and actions
4) Study of JICA's mid-to-long-term assistances in addition to the planned projects such as the yen-loan project and Management of Groundwater Resources.

3. Results of the discussions

Both sides acknowledged that the results of the survey were presented, and discussions were made. Both sides acknowledged that the following points of discussions are mutually understood.

(1) Current Issues

Both parties confirmed that the issues shown below presented by the survey team are the current fundamental issues for the water sector in Zanzibar.

1. Improvement of water resources management for prevention of seawater intrusion and sustainable use of water resource
2. Improvement of the financial status of ZAWA for sustainable provision of water supply service
3. Improvement of the water supply service for provision of equitable water supply to all uses at the affordable price

(2) Water Resources Management

DG of ZURA questioned ZAWA on how they are going to deal with the conflicting functions that are regulating, developing and using water resources.

ZAWA Legal Officer responded that ZAWA proposed the separation of the functions (establishment of water resource management board, hereinafter referred to as "WRMB") in the draft National Water Policy drafted by ZAWA. The draft was already submitted to MoWEM, and it will be finalized by MoWEM.

Director of Water Development of MoWEM explained that the National Water Policy is under review and a consultant will be hired to review and finalize the policy. The procurement process of the consultant has already started. Department of Planning and Policy and Department of Water is working for it.

Principal of ZAWA Training Center mentioned that the new National Water Policy should address the issue of separation of conflicting functions of water supply and water resources management. MoWEM should consider starting something what they can do rather than waiting for the revision of the water policy. For example, the State University of Zanzibar (SUZA) has researchers on water resources management. These experts may be consulted to exchange ideas to proceed with the institutional reform and policy formulation for water resources management.

(2) Urgent Issues

Zanzibar side understood the urgent issues raised in the meeting.

(a) Leakage reduction in ZUWSP area

Director of Technical Operation mentioned that ZAWA has started to address this issue

and has a plan to proceed the replacement of the old pipelines with new pipelines installation in the area.

Principal of ZAWA Training Center questioned the survey team whether the manifolds in Stone Town can be used or not if the problem is only the weight of concrete covers of manifolds.

Team leader of the survey team explained that using existing manifolds is one of the options. However, it is necessary to discuss with the authority responsible for urban planning of Stone Town about the materials, design, and construction methods in accordance with their regulations. At first, a survey to examine appropriate way of replacement of service connections should be executed.

(b) Water tariff setting for prepaid meter users

Team leader of the survey team questioned about the procedure of the process to set a new tariff structure for prepaid meter users.

DG of ZURA explained that ZAWA is to propose tariff and ZURA is to review and approve or, ZURA can also propose tariffs.

ZAWA Legal Officer explained that Commercial Dept and Legal Unit are responsible for preparing a tariff proposal of ZAWA.

Principal of ZAWA Training Center mentioned that ZAWA and ZURA will discuss and decide the tariff before the commencement of prepaid meter service.

(3) Action Plan

ZAWA Legal Officer questioned if all of these activities would be financed by JICA project and how to access to request for support of JICA for implementation of the action plans.

JICA Tanzania Office explained that the official window of Japanese ODA is Embassy of Japan and Ministry of Finance and Planning of Tanzania mainland is the window of Tanzanian Side. For this particular survey, the proposed contents are not necessarily to be implemented by JICA. This is a data collection survey to grasp the current situation of the water sector in Zanzibar. For a request of a project assistance, the relevant authorities of Zanzibar side need to discuss whether they are going to align with these proposed action plans or not, in all parts or partial actions.

Both parties acknowledged that this action plan is a road map and would be referred to

and used in the Water Administration of the water sector in Zanzibar.

Zanzibar side expressed their will that the proposed actions would be discussed among the MoWEM, ZURA and ZAWA, and who would do what, when, how and necessity of external support would be discussed by referring to the proposed actions.

End of the Attachment

Appendix 4 Data Sheet for Brief Saltwater Intrusion Survey

Survey data		1	2	3	4	5
Source description	Source_no	U-002	U-070	U-177	U-178	U-179
	Source_name	Kaburi Kikombe	Kiembe Samaki Airport	N6- Machui	N7-Kianga	N8- Machui
	Source_type	BH	BH	BH	BH	BH
	Photo taken					
1. Operational Status	Funtionality	Not functioning	Functioning	Functioning	Functioning	Not functioning
	Not functional	Yes	NA	NA	NA	Yes/Pump not installed
	Abandoned/Reason	Yes/collapsed	NA	NA	NA	NA
2. Location	Latitude	06°11.220'	06°12.974'	06°06.865'	06°07.183'	06°06.790'
	Longitude	039°12.715'	039°13.317'	039°16.067'	039°15.832'	039°16.313'
	Coord_X	523515	524533	529626	529195	530082
	Coord_Y	9316123	9312888	9324138	9323649	9324279
	GL (above sea level) (m)	22	18	34	38	34
3. Borehole structure (data from ZAWA water resources section)	Drilled depth (m)	27.6	37.28	69	60	70.75
	Diameter of borehole (inch)	12	12	16	16	16
	Diameter of casing (inch)	10	9	10	10	10
	Top of screen pipe (m)	16.4	12	31.43	25.32	30.29
	Bottom of screen length (m)	26.3	35.28	63.22	51.33	64.97
	Aquifer geology	Sand/clay	clay/calcareous sand	Clay/limestone	Sand/clay/limestone	clay with sand/limestone
4. Pump	Model	NA	SAER	SAER	SAER	NA
	Model number	NA	no records	no record	AT3-E_SAER 01_00	NA
	Setting depth(m)	NA	No data	no record	Not measured	NA
	Dia. of raiser pipe (inch)	No pump	5	5	5	NA
	Pressure (Mpa)	not measured	not measured	not measured	not measured	NA
	Flow rate (m3/hr)	not measured	not measured	not measured	Not measured	NA
5. Hydrogeological information (data from ZAWA water resources and operations sections)	Startic water level (m)	15.9	10.3	5.57	7.8	7.4
	Dynamic water level (m)	17.17	13.76	no records/not measured	20.57	NA
	Borehole yield (m^3/h)	8	30	no records	40	77
	Pumping hours/day	No records	19	no records	19	NA
6. On site water quality measurements	Electric conductivity (µS/cm)	Not measured	570	500	450	230
	Salinity (mg/l)	Not measured	250	200	220	100
	pH	Not measured	7.3	7.4	7.2	6.2
	Water temperature (^{0}C)	Not measured	30	28.7	28	28.4
7. Previous water quality measurement (ZAWA database)	Electric conductivity (µS/cm)	720	688	570	458	494
	Salinity (mg/l)	No records	250	200	220	100
	pH	No records	7.3	7.4	7.2	6.2
	Water temperature (^{0}C)	No records	30	28.7	28	28.4
8. Water use	Purpose of the use	Domestic	Domestic	Domestic	Domestic	Domestic
	Appropriateness of current water quality for the purpose	NA	Appropriate	Appropriate	appropriate	NA
	Appropriateness of the current yield for the use	NA	Appropriate	Appropriate	appropriate	Appropriate
	Water treatment facility	no facility	no facility	no facility	no facility	no facility

Survey data		6	7	8	9	10
Source description	Source_no	U-180	U-181	U-210	U-127	U-183
	Source_name	N9-Kianga Chemani	N13- Mwembe mchomeke	Sebleni	Chwaka Jendele(CJ-PBH 1)	Machui
	Source_type	BH	BH	BH	BH	BH
	Photo taken					
1. Operational Status	Funtionality	Functioning	Functioning	Not functioning	Functioning	Not functioning
	Not functional	NA	NA	Yes/faulty pump	NA	yes
	Abandoned/Reason	NA	NA	NA	NA	yes/high drawdown
2. Location	Latitude	06°07.666'	06°09.560'	06°09.964'	06°10.524'	06°06.377'
	Longitude	039°15.872'	039°14.842'	039°13.332'	039°21.718'	039°17.594'
	Coord_X	529268	527371	524584	540046	532446
	Coord_Y	9322662	9319175	9318434	9317393	9325039
	GL (above sea level) (m)	31	44	25	26	45
3. Borehole structure (data from ZAWA water resources section)	Drilled depth (m)	63.9	70	44.06	58.08	24.1
	Diameter of borehole (inch)	16	16	12	12	12
	Diameter of casing (inch)	10	10	10	8	10
	Top of screen pipe (m)	25.15	31.43	14.7	24	no records
	Bottom of screen length (m)	59.83	63.22	44.7	54	no information
	Aquifer geology	clay/sand/limestone	clay/limestone	sand	Corolline Limestone	clay/sand/limestone
4. Pump	Model	SAER	no information	no information	Grundfos	NA
	Model number	no information	no information	no information	SP 60-11	NA
	Setting depth(m)	no informatio	no information	NA	no information	NA
	Dia. of raiser pipe (inch)	5	5	1.5	4	NA
	Pressure (Mpa)	not measured	not measured	NA	not measured	NA
	Flow rate (m3/hr)	not measured	not measured	NA	not measured	NA
5. Hydrogeological information (data from ZAWA water resources and operations sections)	Startic water level (m)	6.6	23.02	4.23	17.9	not measured
	Dynamic water level (m)	30.14	36.36	no records/not measured	records/not measured	no records/not measured
	Borehole yield (m^3/h)	55	95	8	50	NA
	Pumping hours/day	24	no information	NA	19	NA
6. On site water quality measurements	Electric conductivity (µS/cm)	470	560	550	460	not measured
	Salinity (mg/l)	240	230	200	300	not measured
	pH	7.2	6.9	7	7.4	not measured
	Water temperature (^0C)	28.3	28	30.5	28.8	not measured
7. Previous water quality measurement (ZAWA database)	Electric conductivity (µS/cm)	453	413	700	485	140
	Salinity (mg/l)	240	230	200	200	no records
	pH	7.2	6.9	7	7.5	no records
	Water temperature (^0C)	28.3	28	30.5	30.9	no records
8. Water use	Purpose of the use	Domestic	Domestic	Domestic	Domestic	Domestic
	Appropriateness of current water quality for the purpose	appropriate	appropriate	not appropriate	appropriate	NA
	Appropriateness of the current yield for the use	appropriate	appropriate	not appropriate	appropriate	not appropriate
	Water treatment facility	no facility	no facility	no facility	no facility	no facility

Survey data		11	12	13	14	15
Source description	Source_no	U-013	U-050	U-051	U-217	U-098
	Source_name	Kijito Upele	Mwembe Mchomeke	Mwembe Mchomeke	Chwaka	Kwarara
	Source_type	BH	BH	BH	BH	BH
	Photo taken					
1. Operational Status	Funtionality	Functioning	functioning	functioning	functioning	functioning
	Not functional	NA	NA	NA	NA	NA
	Abandoned/Reason	NA	NA	NA	NA	NA
2. Location	Latitude	06°11.190'	06°09.233'	06°09.100'	06°10.627'	06°11.723'
	Longitude	039°14.351'	039°14.722'	039°14.808'	039°22.748'	039°14.328'
	Coord_X	526462	527147	527306	541945	526419
	Coord_Y	9316173	9319779	9320023	9317202	9315192
	GL (above sea level) (m)	24	52	39	23	14
3. Borehole structure (data from ZAWA water resources section)	Drilled depth (m)	25.1	62.13	69	38.07	58
	Diameter of borehole (inch)	16	12	16	12	12
	Diameter of casing (inch)	12	8	10	10	8
	Top of screen pipe (m)	8.8	28.66	5	20.76	39.16
	Bottom of screen length (m)	24.8	61.66	67	35.57	61
	Aquifer geology	limestone	limestone	limestone	limestone	clay/calcareous sand
4. Pump	Model	Grundfos	SAER	SAER	Grundfos	Grundfos
	Model number	SP 8A-21	no information	no information	SP 30-9	SP 17-11
	Setting depth(m)	20.8	40	45.3	26	49
	Dia. of raiser pipe (inch)	2	4	4	5	3
	Pressure (Mpa)	not measured	not measured	not measured	not measured	not measured
	Flow rate (m3/hr)	not measured	not measured	not measured	not measured	not measured
5. Hydrogeological information (data from ZAWA water resources and operations sections)	Startic water level (m)	2.4	29.96	21.37	18.2	16
	Dynamic water level (m)	4.47	61.66	no records/not measured	no records/not measured	no records/not measured
	Borehole yield (m^3/h)	17	60	130	30	17
	Pumping hours/day	24	19	18	18	24
6. On site water quality measurements	Electric conductivity (µS/cm)	860	550	580	1380	740
	Salinity (mg/l)	400	230	260	790	390
	pH	7.4	7	7.4	7.5	7
	Water temperature (^0C)	28	27.8	27.8	27.8	29.8
7. Previous water quality measurement (ZAWA database)	Electric conductivity (µS/cm)	836	593	616	1129	708
	Salinity (mg/l)	400	200	300	500	300
	pH	6.8	6.9	7.1	7.6	6.8
	Water temperature (^0C)	27.6	27.5	27.3	30.9	30.8
8. Water use	Purpose of the use	Domestic	Domestic	Domestic	Domestic	Domestic
	Appropriateness of current water quality for the purpose	appropriate	appropriate	appropriate	not appropriate	appropriate
	Appropriateness of the current yield for the use	appropriate	appropriate	appropriate	not appropriate	appropriate
	Water treatment facility	No facility	No facility	No facility	No facility	No facility

Survey data		16	17	18	19	20
Source desription	Source_no	U-175	U-004	U-034	U-037	U-058
	Source_name	Kiboje	Kianga	Maungani	Kitosani	Mgeni Haji
	Source_type	BH	BH	BH	BH	BH
	Photo taken					
1. Operational Status	Funtionallty	not functioning	Not functioning	functioning	functioning	functioning
	Not functional	yes(pump uninstalled)	yes/pump uninstalled	NA	NA	NA
	Abandoned/Reason	yes/no recharge	NA	NA	NA	NA
2. Location	Latitude	06°04.262'	06°08.383'	06°13.917'	06°04.721'	06°05.665'
	Longitude	039°18.145'	039°15.508'	039°14.850'	039°13.366'	039°19.495'
	Coord_X	533436	528594	527379	524651	535953
	Coord_Y	9328934	9321341	9311148	9328094	9326347
	GL (above sea level) (m)	55	48	20	24	33
3. Borehole structure (data from ZAWA water resources section)	Drilled depth (m)	63.3	37.08	30	40	38
	Diameter of borehole (inch)	12	12	10	10	10
	Diameter of casing (inch)	8	8	8	8	7
	Top of screen pipe (m)	27	13.65	10	26	no records
	Bottom of screen length (m)	60	27.02	27.5	38	no records
	Aquifer geology	limestone/clay	limestone	Sandy clay /marl	clayey sand	clay/calcareous sand
4. Pump	Model	NA	NA	Grundfos	Grundfos	Grundfos
	Model number	NA	NA	SP 46-11	SP 46-13	SP 30-9
	Setting depth(m)	55	NA	no records	no records	no records
	Dia. of raiser pipe (inch)	not known	NA	4	4	3
	Pressure (Mpa)	not measured	NA	not measured	not measured	not measured
	Flow rate (m3/hr)	not measured	NA	not measured	not measured	not measured
5. Hydrogeological information (data from ZAWA water resources and operations sections)	Startic water level (m)	22.54	11.62	15	7.5	7.6
	Dynamic water level (m)	no records/not measured	NA	records/not measured	no records/not measured	records/not measured
	Borehole yield (m^3/h)	8	60	48	48	65
	Pumping hours/day	NA	NA	19	19	24
6. On site water quality measurements	Electric conductivity (µS/cm)	not measured	310	640	590	410
	Salinity (mg/l)	not measured	150	330	270	240
	pH	not measured	7.5	6.7	6.7	7.5
	Water temperature (°C)	not measured	27.6	28.9	27.8	27.7
7. Previous water quality measurement (ZAWA database)	Electric conductivity (µS/cm)	400	546	718	619	667
	Salinity (mg/l)	no records	200	300	300	300
	pH	no records	7.3	7.1	7.3	7
	Water temperature (°C)	no records	27.4	27.6	29	29
8. Water use	Purpose of the use	Domestic	Domestic	Domestic	Domestic	Domestic
	Appropriateness of current water quality for the purpose	not appropriate	appropriate	appropriate	appropriate	appropriate
	Appropriateness of the current yield for the use	not appropriate	appropriate	not appropriate	not appropriate	appropriate
	Water treatment facility	No facility	No facility	No facility	No facility	No facility

Survey data		21	22	23	24	25
Source desription	Source_no	U-171	U-182	U-0216	U-120	U-026
	Source_name	Kiembe Samaki (Masum)	N9-2-Kianga Mkadini	Saateni Pumping Station	Bumbwi Sudi	Chunga
	Source_type	BH	BH	BH	BH	BH
	Photo taken					
1. Operational Status	Funtionality	functioning	not functioning	not funtioning	not functioning	not functioning
	Not functional	NA	yes/pump uninstalled	yes	yes/pump uninstalled	yes
	Abandoned/Reason	NA	NA	yes/contaminated by oil	NA	yes/blockage
2. Location	Latitude	06°12.912'	06 °07.725'	06°09.329'	06°03.123'	06°10.964'
	Longitude	039°12.917'	039°15.750'	039°12.476'	039°17.318'	039°15.523'
	Coord_X	523815	529043	523006	531937	528625
	Coord_Y	9313003	9322556	9319603	9331032	9316591
	GL (above sea level) (m)	20	32	8	58	13
3. Borehole structure (data from ZAWA water resources section)	Drilled depth (m)	265	60	30.5	49.95	44.3
	Diameter of borehole (inch)	12	16	10	12	10
	Diameter of casing (inch)	8	10	8	8	8
	Top of screen pipe (m)	no records	30.29	11.6	18.76	12
	Bottom of screen length (m)	no records	64.97	29.6	45.76	42
	Aquifer geology	sand/limestone	clay/limestone	sand	Corolline limestone	clay/sand/limestone
4. Pump	Model	GENVIK	no pump	no pump	NA	NA
	Model number	no records	NA	NA	NA	NA
	Setting depth(m)	no records	NA	NA	NA	NA
	Dia. of raiser pipe (inch)	3	NA	NA	NA	NA
	Pressure (Mpa)	not measured	not measured	not measured	not measured	not measured
	Flow rate (m3/hr)	not measured	not measured	no measured	not measured	not measured
5. Hydrogeological information (data from ZAWA water resources and operations sections)	Startic water level (m)	14.74	7.3	5.8	17.51	not measured
	Dynamic water level (m)	no records/not measured	no records/not measured	no records/not measured	no records/not measured	NA
	Borehole yield (m^3/h)	30	77	18	60	30
	Pumping hours/day	24	NA	NA	NA	NA
6. On site water quality measurements	Electric conductivity (µS/cm)	670	140	580	520	not measured
	Salinity (mg/l)	340	70	200	210	not measured
	pH	7.4	6.4	7.2	7.9	not measured
	Water temperature (°C)	29	28.2	28.6	28.1	not measured
7. Previous water quality measurement (ZAWA database)	Electric conductivity (µS/cm)	692	507	520	646	540
	Salinity (mg/l)	300	no records	no records	300	no records
	pH	7.2	7.3	no records	7	no records
	Water temperature (°C)	30.3	no records	no records	26.7	no records
8. Water use	Purpose of the use	Domestic	Domestic	Domestic	Domestic	Domestic
	Appropriateness of current water quality for the purpose	appropriate	appropriate	not appropriate	appropriate	appropriate
	Appropriateness of the current yield for the use	appropriate	appropriate	NA	appropriate	not appropriate
	Water treatment facility	No facility	No facility	No facility	No facility	No facility

Survey data		26	27	28	29	30
Source desription	Source_no	U-211	U-033	U-099	U-212	U-220
	Source_name	Chumbuni-1	Mchomekee	Dunga (S.S. Mehta)	Chumbuni-2	Chumbuni-Mbunge
	Source_type	BH	BH	BH	BH	BH
	Photo taken					
1. Operational Status	Funtionality	not functioning	functioning	functioning	not functioning	not functioning
	Not functional	yes/pump uninstalled	NA	NA	yes/no pump	no/pump at rest
	Abandoned/ Reason	NA	NA	NA	NA	NA
2. Location	Latitude	06°09.204'	06°09.427'	06°07.873'	06°09.205'	06°09.031'
	Longitude	039°13.030'	039°14.934'	039°18.977'	039°13.030'	039°13.080'
	Coord_X	524027	527538	534994	524027	524119
	Coord_Y	9319837	9319421	9322279	9319832	9320155
	GL (above sea level) (m)	22	36	34	18	22
3. Borehole structure (data from ZAWA water resources section)	Drilled depth (m)	52.22	52.97	33.23	52.8	72
	Diameter of borehole (inch)	12	12	10	10	8
	Diameter of casing (inch)	10	8	8	8	6
	Top of screen pipe (m)	14.65	17	11.3	no records	no records
	Bottom of screen length (m)	49.8	50	32.3	no records	no records
	Aquifer geology	clay/limestone/sandstone	clay/sand	limestone	Sand Clay/Marl	Sand Clay/Marl
4. Pump	Model	NA	SAER	Grundfos	NA	ATX
	Model number	NA	no records	SP 46-10	NA	no information
	Setting depth(m)	NA	no records	no records	NA	no data
	Dia. of raiser pipe (inch)	NA	4	3	NA	2
	Pressure (Mpa)	not measured	not measured	no measured	not measured	not measured
	Flow rate (m3/hr)	not measured	not measured	no measured	not measured	not measured
5. Hydrogeological information (data from ZAWA water resources and operations sections)	Startic water level (m)	8.17	23.2	11.2	19.88	11.32
	Dynamic water level (m)	no records/not measured	no records/not measured	no records/not measured	no records/not measured	no records/not measured
	Borehole yield (m^3/h)	27	60	48	22	14
	Pumping hours/day	NA	18	18	NA	12
6. On site water quality measurements	Electric conductivity (µS/cm)	670	530	530	740	510
	Salinity (mg/l)	300	200	250	350	200
	pH	7.2	7	7.2	7.1	7.2
	Water temperature (^{0}C)	28.9	28	27.7	28.6	29
7. Previous water quality measurement (ZAWA database)	Electric conductivity (µS/cm)	655	568	524	824	524
	Salinity (mg/l)	300	300	200	400	200
	pH	7.1	7.2	7	7.2	7.1
	Water temperature (^{0}C)	27.9	29	30.1	29.9	29.3
8. Water use	Purpose of the use	Domestic	Domestic	Domestic	Domestic	Domestic
	Appropriateness of current water quality for the purpose	appropriate	appropriate	appropriate	appropriate	appropriate
	Appropriateness of the current yield for the use	appropriate	appropriate	appropriate	appropriate	appropriate
	Water treatment facility	No facility	No facility	No facility	No facility	No facility

Survey data		31	32	33	34	35
Source desription	Source_no	U-041	U-076	U-077	U-032	U-224
	Source_name	Mbweni	Kiembe Samaki(Ali Yussuf)	Mombasa (Office)	Kianga	Bint Amran
	Source_type	BH	BH	BH	BH	BH
	Photo taken					
1. Operational Status	Funtionality	funtioning	not functioning	funtioning	not functioning	not functioning
	Not functional	NA	yes/no pump	NA	yes/power & pump problems	yes/pump uninstalled
	Abandoned/Reason	NA	NA	NA	NA	NA
2. Location	Latitude	06°12.421'	06°12.174'	06°11.538'	06°08.346'	06°10.769'
	Longitude	039°12.453'	039°12.796'	039°13.187'	039°15.534'	039°13.035'
	Coord_X	522961	523592	524314	528645	524035
	Coord_Y	9313906	9314362	9315537	9321414	9316949
	GL (above sea level) (m)	24	23	24	39	21
3. Borehole structure (data from ZAWA water resources section)	Drilled depth (m)	22	41.73	47.65	49	78
	Diameter of borehole (inch)	12	10	10	12	8
	Diameter of casing (inch)	8	8	8	8	6
	Top of screen pipe (m)	12.64	12.26	26	8	no records
	Bottom of screen length (m)	24.64	40.73	44	50	no records
	Aquifer geology	limestone	sand/limestone	sand/limestone	Limestone	Sand clay/Marl
4. Pump	Model	GRUNDFOS	NA	CRI	MAXISU	NA
	Model number	SP 60-10	NA	no information	no information	NA
	Setting depth(m)	no records	NA	no information	no information	NA
	Dia. of raiser pipe (inch)	5	NA	3	5	NA
	Pressure (Mpa)	2.25	not measured	2	not measured	NA
	Flow rate (m3/hr)	not measured	not measured	not measured	not measured	NA
5. Hydrogeological information (data from ZAWA water resources and operations sections)	Startic water level (m)	13.07	16.85	18.99	10.7	18.91
	Dynamic water level (m)	no records/not measured	no records/not measured	28.37	no records/not measured	no records/not measured
	Borehole yield (m^3/h)	30	no records	30	30	18
	Pumping hours/day	24	NA	24	18	NA
6. On site water quality measurements	Electric conductivity (µS/cm)	730	550	790	500	350
	Salinity (mg/l)	370	240	360	210	140
	pH	7.2	7	7	7.2	6.6
	Water temperature (^0C)	29	29.6	29	28.1	30.8
7. Previous water quality measurement (ZAWA database)	Electric conductivity (µS/cm)	707	no records	794	513	no records
	Salinity (mg/l)	300	240	300	200	no records
	pH	7	no records	7.1	6.8	no records
	Water temperature (^0C)	29.6	no records	28.9	26.5	no records
8. Water use	Purpose of the use	Domestic	Domestic	Domestic	domestic	Domestic
	Appropriateness of current water quality for the purpose	appropriate	appropriate	appropriate	appropriate	appropriate
	Appropriateness of the current yield for the use	appropriate	appropriate	appropriate	appropriate	inappropriate
	Water treatment facility	No facility	No facility	No facility	No facility	No facility

Survey data		36	37	38	39	40
Source desription	Source_no	U-172	U-067	U-088	U-073	U-185
	Source_name	Chukwani (Hali ya Hewa	Kibefe	Masumbani	Mombasa (Kwa Mchina)	Bint amran
	Source_type	BH	BH	BH	BH	BH
	Photo taken					
1. Operational Status	Funtionality	functioning	functioning	operating	operating	not functioning
	Not functional	NA	NA	NA	NA	yes
	Abandoned/Reason	NA	NA	NA	NA	yes /damaged by road works
2. Location	Latitude	06°13.271'	06°13.522'	06°11.057'	06°11.091'	06°10.757'
	Longitude	039°13.064'	039°19.498'	039°13.985'	039°13.282'	039°13.019'
	Coord_X	0524088	535954	525786	524487	524006
	Coord_Y	09312338	9311866	9316418	9316356	9316973
	GL (above sea level) (m)	22	18	25	23	21
3. Borehole structure (data from ZAWA water resources section)	Drilled depth (m)	22.9	29.82	53.61	33	40
	Diameter of borehole (inch)	10	12	8	12	8
	Diameter of casing (inch)	8	8	6	8	6
	Top of screen pipe (m)	no records	no records	19.89	no records	no records
	Bottom of screen length (m)	no records	no records	50.8	no records	no records
	Aquifer geology	clay/calcareous sand	Corolline Limeatone	coarse calcareous sand/clay	clay/sand/limestone	Sand clay/Marl
4. Pump	Model	SAER	Grundfos	GENVIK	Grundfos	no pump
	Model number	AT3-E/30	SP 30-13	no records	SP 17-6	NA
	Setting depth(m)	no information	no information	no information	no information	NA
	Dia. of raiser pipe (inch)	3	3	2	2	NA
	Pressure (Mpa)	0.7	not measured	not measured	not measured	not measured
	Flow rate (m3/hr)	45.08	not measured	not measured	not measured	not measured
5. Hydrogeological information (data from ZAWA water resources and operations sections)	Startic water level (m)	13.35	13.3	9.6	19.5	19.37
	Dynamic water level (m)	no records /not measured	not measured	no records	25.17	not measured
	Borehole yield (m^3/h)	30	30	8	17	8
	Pumping hours/day	19	24	24	12	NA
6. On site water quality measurements	Electric conductivity (µS/cm)	735	790	720	740	800
	Salinity (mg/l)	370	350	320	360	120
	pH	7.1	7.6	7.4	7.1	7.4
	Water temperature (°C)	28.9	28.4	30.1	28.9	29.5
7. Previous water quality measurement (ZAWA database)	Electric conductivity (µS/cm)	no records	1082	773	718	no records
	Salinity (mg/l)	no records	400	250	300	no records
	pH	no records	7.2	7.35	7.4	no records
	Water temperature (°C)	no records	29	29.2	29.1	no records
8. Water use	Purpose of the use	Domestic	Domestic	Domestic	Domestic	Domestic
	Appropriateness of current water quality for the purpose	appropriate	appropriate	appropriate	appropriate	not appropriate
	Appropriateness of the current yield for the use	appropriate	appropriate	appropriate	appropriate	not appropriate
	Water treatment facility	No facility	No facility	No facility	No facility	No facility

Survey data		41	42	43	44	45
Source desription	Source_no	U-039	U-215	U-109	U-110	U-030
	Source_name	Semuso	Chumbuni-3	Mpapa chemchem	Ubago	Kizimbani
	Source_type	BH	BH(private)	SPRING WELL	BH	BH
	Photo taken					
1. Operational Status	Funtionality	not functioning	operating (private)	not functioning	not functioning	operating
	Not functional	yes/pump uninstalled	NA	yes/pump uninstalled	yes/pump uninstalled	NA
	Abandoned/ Reason	NA	yes by ZAWA/low yielding	NA	NA	NA
2. Location	Latitude	06°10.075'	06°09.176'	06°05.690'	06°09.166'	06°05.661'
	Longitude	039°13.512'	039°12.982'	039°20.542'	039°18.100'	039°15.716'
	Coord_X	524915	523939	537883	533375	528983
	Coord_Y	9318227	9319885	9326300	9319899	9326358
	GL (above sea level) (m)	33	26	51	32	52
3. Borehole structure (data from ZAWA water resources section)	Drilled depth (m)	37.87	51.9	NA	50.99	40
	Diameter of borehole (inch)	16	10	NA	9	12
	Diameter of casing (inch)	10	8	NA	6	8
	Top of screen pipe (m)	6.87	9.7	NA	12	3
	Bottom of screen length (m)	34.87	49.9	NA	48	16
	Aquifer geology	clay/sand	clay/limestone/sandstone	corollinelimestone	sandstone/limestone	clay/sand
4. Pump	Model	NA	no information	no pump	pump uninstalled	GENVIK
	Model number	NA	no information	NA	NA	no records
	Setting depth(m)	NA	no information	NA	NA	no records
	Dia. of raiser pipe (inch)	NA	no information	NA	3	3
	Pressure (Mpa)	NA	not measured	not measured	not measured	not measured
	Flow rate (m3/hr)	NA	not measured	not measured	not measured	not measured
5. Hydrogeological information (data from ZAWA water resources and operations sections)	Startic water level (m)	12.27	11.03	15.52	11	not measured
	Dynamic water level (m)	26.48	no records	no records	no records	12.92
	Borehole yield (m^3/h)	10	18	10	17	17
	Pumping hours/day	NA		NA	NA	19
6. On site water quality measurements	Electric conductivity (µS/cm)	790	800	600	600	220
	Salinity (mg/l)	330	400	300	300	110
	pH	6.1	7.8	7.1	7.2	6.7
	Water temperature (°C)	30.1	28.7	28	27.2	30.4
7. Previous water quality measurement (ZAWA database)	Electric conductivity (µS/cm)	627	757	no records	no records	219
	Salinity (mg/l)	300	300	no records	no records	100
	pH	6.9	7	no records	no records	7
	Water temperature (°C)	28.8	28.8	no records	no records	27.1
8. Water use	Purpose of the use	Domestic	Domestic	Domestic	Domestic	Domestic
	Appropriateness of current water quality for the purpose	appropriate	not appropriate	appropriate	appropriate	appropriate
	Appropriateness of the current yield for the use	not appropriate	not appropriate	appropriate	appropriate	appropriate
	Water treatment facility	No facility	No facility	No facility	No facility	No facility

Survey data		46	47	48	49	50
Source desription	Source_no	U-089	U-008	U-197	U-075	U-052
	Source_name	Fuoni	Chunga	Msikiti Mzuri N_10	Mwembe Makumbi	Dole
	Source_type	BH	BH	BH	BH	BH
	Photo taken					
1. Operational Status	Funtionality	not functioning	functioning	functioning	functioning	functioning
	Not functional	yes/power supply problems	NA	NA	NA	NA
	Abandoned/ Reason	NA	NA	NA	NA	NA
2. Location	Latitude	06°11.853'	06°10.698'	06°09.634'	06°08.943'	06°05.814'
	Longitude	039°15.786'	039°15.765'	039°16.005'	039°12.951'	039°14.992'
	Coord_X	529107	529069	529513	523881	527649
	Coord_Y	9314951	9317080	9319039	9320314	9326074
	GL (above sea level) (m)	19	18	30	26	59
3. Borehole structure (data from ZAWA water resources section)	Drilled depth (m)	35.5	45.2	72.5	58	56
	Diameter of borehole (inch)	12	12	16	12	10
	Diameter of casing (inch)	8	8	10	8	7
	Top of screen pipe (m)	13.15	7.7	no records	22.34	28.2
	Bottom of screen length (m)	34.5	42	no records	56.98	53.58
	Aquifer geology	Sand Clay /mari	limestone/clay with gravel	Sand Clay/Mari	sand/limestone/clay	sand/clay
4. Pump	Model	GENVIK	Grundfos	Grundfos	SAER	Grundfos
	Model number	no records	SP 125-5	SP 77-5	AT3-E/30	SP 30-11
	Setting depth(m)	no records	no records	no records	no records	no records
	Dia. of raiser pipe (inch)	3	5	5	2	3
	Pressure (Mpa)	not measured	not measured	not measured	2.7	not measured
	Flow rate (m3/hr)	not measured	not measured	not measured	16.7	not measured
5. Hydrogeological information (data from ZAWA water resources and operations sections)	Startic water level (m)	10	16.57	20.94	11.57	3
	Dynamic water level (m)	no records	not measured	31.74	37.48	not measured
	Borehole yield (m^3/h)	30	125	95	30	30
	Pumping hours/day	NA	24	19	24	18
6. On site water quality measurements	Electric conductivity (µS/cm)	600	570	560	710	510
	Salinity (mg/l)	310	240	240	300	220
	pH	7.3	7	7.1	7.3	7.2
	Water temperature (°C)	28.8	29.3	28.7	29.1	27.1
7. Previous water quality measurement (ZAWA database)	Electric conductivity (µS/cm)	653	592		701	512
	Salinity (mg/l)	300	200	no records	300	200
	pH	7.2	6.9	no records	7.1	7.4
	Water temperature (°C)	29.8	29.1	no records	29.4	28.1
8. Water use	Purpose of the use	Domestic	Domestic	Domestic	Domestic	Domestic
	Appropriateness of current water quality for the purpose	appropriate	appropriate	appropriate	appropriate	appropriate
	Appropriateness of the current yield for the use	appropriate	appropriate	appropriate	not appropriate	appropriate
	Water treatment facility	No facility	No facility	No facility	No facility	No facility

Appendix 5 Financial Statements (Statement of Cash Flow)

Statement of Cash Flow

	For the year ended 30th June		
	2019/20	2018/19	2017/18
Cash flow from Operating Activities:	**TZS**	**TZS**	**TZS**
RECEIPTS			
Water Sales	2,799,196,832	3,137,452,685	2,635,805,974
Service Charges	97,342,507	91,876,424	61,912,940
Other Income	499,508,122	1,176,776,706	435,595,961
Subsidies From Government	3,611,076,004	4,007,375,007	2,499,999,996
Total Receipts	**7,007,123,465**	**8,413,480,822**	**5,633,314,871**
Payment			
Personnel Emoluments	(3,901,064,440)	(4,069,689,856)	(3,273,558,570)
Supplies Goods, Works and Services	-	-	-
Other Payments	(2,772,086,186)	(2,580,432,362)	(2,134,286,697)
Total Payments	**(6,673,150,626)**	**(6,650,122,218)**	**(5,407,845,267)**
Net Cash flow from Operating Activities	**333,972,839**	**1,763,358,604**	**225,469,604**
Cash flow from Investing Activities:			
Purchase of Assets	(3,228,003,374)	(12,828,046,285)	(7,833,773,664)
Net Cash flow from Investing Activities:	**(3,228,003,374)**	**(12,828,046,285)**	**(7,833,773,664)**
Cash flow from Financing Activities:			
RGoZ Grants	2,895,720,928	5,425,636,860	2,751,000,000
Other Grants	180,309,900	435,400,000	9,991,115,985
Net Cash flow from Financing Activities:	**3,076,030,828**	**5,861,036,860**	**12,742,115,985**
Net Increase/Decrease in cash	182,000,293	(5,203,650,821)	5,133,811,925
Cash at the beginning of the year	199,025,981	5,402,676,802	268,864,877
Cash at the end of the period	**381,026,274**	**199,025,981**	**5,402,676,802**