

The Republic of the Sudan

FY2016 Ex-Post Evaluation of Japanese Grant Aid Project

“The Project for Urgent Improvement of Water Supply Facilities at Kassala City” and  
“The Project for Improvement of Water Supply System at Kassala City”

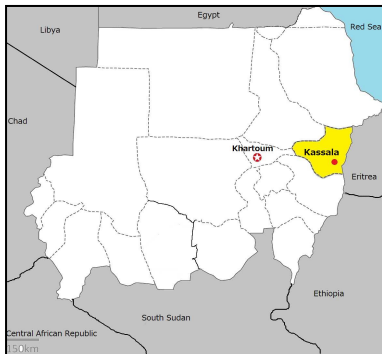
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## **0. Summary**

The projects were implemented in Kassala city located in the eastern part of Sudan, where its population has been growing, with the aim of improving the safe and stable water supply to the residents through the rehabilitation of the existing water treatment plant (hereinafter WTP) in the East and West Districts and through the construction of a new WTP in the East District, thereby contributing to improvements in the residents' basic human needs. The projects' implementation was consistent with Sudanese development policy and needs as well as Japan's ODA policy. Therefore, the relevance of the projects is high. Although there were minor modifications from the plan with regard to the construction and soft component (technical guidance), the projects implementation and their cost were almost as planned. However, as the projects period exceeded the plan, the efficiency of the projects is fair. The projects contributed to the improvement of water supply and water quality in Kassala East District and to the water quality in Kassala West District where its outputs had been limited. The positive effects by those contributions were also confirmed. In addition, the risk of bursting of the reservoirs was reduced by upgrading old Fiber Reinforced Plastics (hereinafter FRP) reservoirs to reinforced concrete reservoirs through the rehabilitation of existing WTPs in the East and West Districts of Kassala city. This led to the reduced future risk of people being affected by the reservoir bursting. However, the people receiving positive effects through the project are limited, as many people are still unable to receive water supply service because the replacement of the distribution pipes and the water supply pipes by the Sudanese side, although it is outside of the project scope, has been delayed, and also because of the population increase. Therefore, the effectiveness and impact of the projects are fair. Some minor problems have been observed in terms of the technical and financial aspects of Operation and Maintenance (O&M). Therefore, sustainability of the project effects is fair.

In light of the above, the projects are evaluated to be partially satisfactory.

## 1. Project Description



Project Location



Mahta Water Treatment Plant<sup>1</sup>

### 1.1 Background

Kassala city, the capital of the Kassala state located in the eastern part of Sudan, is near the borders of Eritrea and Ethiopia, and has received refugees from those countries for many years. In addition, the long-term domestic conflict since the 1980s brought Internally Displaced Persons (IDPs) from west and south Sudan to Kassala city. Owing to the population increase by receiving the refugees and the IDPs, the water supply was not able to meet residents' demand. In such a situation, in 2005, the Sudanese government requested that the Japanese government implement the Grant Aid Project in order to develop new water resources, expand water supply facilities, and install new water supply pipes in East District, Kassala city.

During the preparatory survey of the project, it was confirmed that existing WTPs were deteriorated as the reservoir of the Mahta WTP in East District of Kassala city that was constructed in 1986 by the Grant Aid Project of Japan had burst. Thereupon, it was decided to implement the "The Project for Urgent Improvement of Water Supply Facilities at Kassala City (hereinafter Rehabilitation Project)" in order to rehabilitate the Mahta WTP urgently as well as the Garb WTP in West District, Kassala city that was constructed as same year as the Mahta WTP. After the implementation of the Rehabilitation Project, the Khatmia WTP was newly constructed by "The Project for Improvement of Water Supply System at Kassala City (hereinafter Expansion Project)" according to the initial request to develop new water resources, to expand water supply facilities, and to install new water supply pipes in East District, Kassala city.

Therefore, this ex-post evaluation assessed both the Rehabilitation Project and the Expansion Project.

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<sup>1</sup> Front building is a distribution pump building and the back one is a reservoir. Three WTPs have the same design though the capacities of the facilities are different.

## 1.2 Project Outline

The objective of this project is to improve the safe and stable water supply to the residents of Kassala city by the rehabilitation of existing WTPs and the construction of new receiving wells and reservoirs (through “Rehabilitation Project”), and by the construction of a new WTP (through “Expansion Project”), thereby contributing to the improvement of the basic human needs of the local residents in Kassala city.

<Grant Aid Project>

|  |   |  |
|--|---|--|
| Project Name                                 | The Project for Urgent Improvement of Water Supply Facilities at Kassala City   | The Project for Improvement of Water Supply System at Kassala City   |
| G/A Grant Amount / Actual Grant Amount       | 1,086 million yen / 1,086 million yen   | Detailed Design:<br>96 million yen / 95 million yen<br>Construction work:<br>1,790 million yen / 1,488 million yen |
| Exchange of Notes Date /Grant Agreement Date | April, 2011 / April, 2011   | Detailed Design:<br>August, 2011 / August 2011<br>Construction work:<br>October, 2012 / October, 2012              |
| Executing Agency                             | Kassala Sate Water Corporation (Kassala SWC)  |  |
| Project Completion                           | October, 2013   | July, 2014   |
| Main Contractor(s)                           | Konoike Construction Co., Ltd.  |  |
| Main Consultant(s)                           | Tokyo Engineering Consultants Co., Ltd.   | TEC International Co., Ltd. <sup>2</sup>   |
| Basic Design                                 | February, 2010 – June, 2011   |  |
| Related Projects                             | Technical Corporation:<br>-Human Resources Development for Water Supply (2008-2011)<br>-Human Resources Development for Water Supply in Phase 2 (2011-2015)<br>-Capacity Development Project for the Provision of Services for Basic Human Needs in Kassala (2011-2015)<br>-The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations (2016-2020) |  |

<sup>2</sup> In October, 2012, Tokyo Engineering Consultants Co., Ltd. split up its overseas division and established TEC International Co., Ltd. as an affiliated company of Tokyo Engineering Consultants Co., Ltd.

|  |   |
|--|---|
|  | <p>Grant Aid:</p> <p>-Water Supply Project related to International Conference on Assistance to Refugees in Africa (ICARA) II (1986)</p> <p>Others:</p> <p>-WASH Program (2012-2016) UNICEF</p> |
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## 2. Outline of the Evaluation Study

### 2.1 External Evaluator

Mayumi Hamada, Foundation for Advanced Studies on International Development

Chiho Ikeda, Foundation for Advanced Studies on International Development

### 2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule:

Duration of the Study: November, 2016 – March, 2018

Duration of the Field Study: February 18, 2017 – March 7, 2017

July 15, 2017 – July 24, 2017

## 3. Results of the Evaluation (Overall Rating: C<sup>3</sup>)

### 3.1 Relevance (Rating: ③<sup>4</sup>)

#### 3.1.1 Consistency with the Development Plan of Sudan

The *25-Years Strategic Plan for Water Sector (2003-2027)* that was enacted in 2003 is the highest water sector policy in Sudan. One of the targets in this policy was “To be able to supply sufficient and safe water in all urban and rural areas by 2017” and to set the indicators of the water supply as 150 liter/capita/day in urban areas and as 50 liter/capita/day in rural areas. The increase in the number of people who can access the urban water supply is also stated in the *Water Supply and Environmental Sanitation Policy (2010)* and *Water, Sanitation and Hygiene National Strategic Plan (2012-2016)*, which were made in order to practise the *25-Years Strategic Plan for Water Sector (2003-2027)*. *Kassala State Water, Sanitation and Hygiene Sector Strategic Plan (2012-2016)*, which followed the above national-level policies, mentioned the improvement of access to safe water up to 100% by 2016 in urban areas with adequate capacity to provide 90 liters per capita per day within 100-meters from a dwelling by 2016. According to the Kassala SWC, those policies and plans are still valid at the time of ex-post evaluation, and strategic plans from 2017 are still under preparation.

Therefore, this project aimed to improve the city water supply in Kassala state has been consistent with the Sudanese development policy both at the time of planning and the ex-post evaluation.

<sup>3</sup> A: Highly satisfactory; B: Satisfactory; C: Partially satisfactory; D: Unsatisfactory

<sup>4</sup> ③: High, ②: Fair, ①: Low

### 3.1.2 Consistency with the Development Needs of Sudan

At the planning stage of the projects, the water supply was not able to meet the water demand in Kassala city because of the population increase due to receiving refugees and IDPs for a long time. Under such a situation, in 2005, the Sudanese government requested the Japanese government's support to expand the water supply in Kassala East District. During the preparatory survey for the request, the reservoir of the Mahta WTP in Kassala East District burst in 2009. As the result, the necessity of urgent rehabilitation for the Mahta WTP was recognized as well as the need for rehabilitation of the Garb WTP in West District that was constructed the same year as the Mahta WTP in order to reduce the future risk of bursting. Thus it can be judged as reasonable that a new WTP was constructed by the "Expansion Project" after existing WTPs in East District had been rehabilitated by the "Rehabilitation Project."

At the time of ex-post evaluation, the population of Kassala city has been increasing. According to the estimation of the Central Bureau of Statistics (CBS) Kassala branch, the population in 2016 was 218,144 in East District and 175,503 in West District, which was an increase of 32% (about 95,000) compared with the census of 2008. Thus water demand of the residents is considered to be rising as well.

Therefore, the project which newly constructed water supply facilities in East District after rehabilitating existing water supply facilities for the purpose of improving water supply in Kassala city, has been highly consistent with Sudanese development needs from the time of planning to the time of ex-post evaluation.

### 3.1.3 Consistency with Japan's ODA Policy

The project was positioned as Japan's assistance priority area "Basic human needs support" and development subject "water and sanitation support program" of country assistance policy for Sudan. Japan also expressed support for African countries' efforts on water and sanitation and agriculture (irrigation) at the Fourth Tokyo International Conference on African Development (TICAD IV) in 2008. Thus, the project aiming to improve water supply in a provincial city in Sudan is equivalent to that support. Therefore, the project is consistent with Japan's ODA policy.

### 3.1.4 Appropriateness of the Project Plan and Approach

Eastern Sudan including the project target area was a conflict-affected area where domestic conflict continued until the signing of the peace agreement in 2006<sup>5</sup>. The project target

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<sup>5</sup> In eastern Sudan (Red Sea state, Kassala state and Al Gedaref state), the Eastern Front was formed after the anti-government forces of the local tribes led by the Beja tribe formed an armed uprising in 1994 from the government dissatisfaction with development delay, and the conflict between anti-government forces and government forces intensified since 2005. The Eastern Sudan Peace Agreement (ESPA) was concluded between the Sudanese government and the Eastern Front by Eritrea's mediation on 14 October 2006, and the conflict was settled. (Refer to the Japanese version of "Terminal Evaluation Report on the Capacity Development Project for the Provision

beneficiary was all residents of Kassala city regardless of ethnicity. The case of promoting the conflict by the project implementation between the period of planning and ex-post evaluation was not confirmed. Thus the selection of the project area and target beneficiary group was appropriate.

As stated above, this project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore its relevance is high.

### 3.2 Efficiency (Rating: ②)

#### 3.2.1 Project Outputs

Table 1 shows the planned and actual outputs of the project. As for the Japanese side, by implementing the "Rehabilitation Project" for the existing WTPs, which are the Mahta WTP in Kassala East and the Garb WTP in Kassala West, the receiving wells were newly constructed and reinforced concrete reservoirs were installed as the existing reservoirs of FRP had deteriorated<sup>6</sup>. In addition, the distribution pump facilities and chlorine-dosing facilities of the Mahta WTP were also rehabilitated<sup>7</sup>. Although there were minor changes in the number and size of reinforcement, it was constructed and installed as planned.

By implementing the "Expansion Project," the water treatment plant, water intake facilities, water conveyance facility and water distribution facility were constructed in Kassala East. The selection of the wells was modified based on the result of pumping tests for existing wells and the new wells after the new wells had been drilled during the detailed design survey. The number of wells<sup>8</sup> and the conveyance pipe route were also changed according to the modification of the wells' selection. However, those modifications were appropriate because it was necessary for meeting the planned water supply.

The responsible works of the Sudan side were also done as planned without delay.

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of Services for Basic Human Needs in Kassala (2014)," p. 2)

<sup>6</sup> The lifespan of the reinforced concrete is about 60 years though the life span of the FRP is about 20 years. (Refer to the "Preparatory Survey Report on the Projects for Improvement of Water Supply Facilities at Kassala City (2011)," p. 2-23)

<sup>7</sup> The rehabilitation of the chlorine-dosing facilities and the distribution pump facilities in Garb WTP were not planned because it had been designed to utilize existing ones.

<sup>8</sup> Among the ten existing wells, three wells with low water production were changed to two wells with higher water production. Thus the number of existing wells changed from 10 to 9. Regarding the new wells, planned wells were changed to wells with higher water production.

Table 1 Planned and actual output

<Japanese side>

| Project Name           | Name of Facility      | Plan                                  | Actual (Reason for change)    |            |
|------------------------|-----------------------|---------------------------------------|-------------------------------|------------|
| Rehabilitation Project | Mahta WTP             | Receiving well (with roof)            | 2 wells                       | As planned |
|                        |                       | Reservoir                             | 2 reservoirs                  |            |
|                        |                       | Distribution pump building            | 1 building                    |            |
|                        |                       | Piping in the premise                 | 1 set                         |            |
|                        |                       | Maintenance within premises           | 1 set                         |            |
|                        |                       | Distribution pump equipment           | 5 units (of which 1 is spare) |            |
|                        |                       | Chlorine dosing equipment             | 1 set                         |            |
|                        |                       | Electric facility and instrumentation | 1 set                         |            |
|                        | Garb WTP              | Emergency power generator             | 1 unit                        | As planned |
|                        |                       | Receiving well (with roof)            | 2 wells                       |            |
|                        | Reservoir             | 2 reservoirs                          |                               |            |
|                        | Piping in the premise | 1 set                                 |                               |            |

| Project Name      | Name of Facility          | Plan                                   | Actual (Reason for change)    |   |
|-------------------|---------------------------|--|-------------------------------|---|
| Expansion Project | Khatmia WTP               | Receiving well (with roof)             | 2 wells                       | As planned  |
|                   |                           | Reservoir                              | 2 reservoirs                  |   |
|                   |                           | Distribution pump building             | 1 building                    |   |
|                   |                           | Piping in the premise                  | 1 set                         |   |
|                   |                           | Maintenance within premises            | 1 set                         |   |
|                   |                           | Distribution pump equipment            | 5 units (of which 1 is spare) |   |
|                   |                           | Chlorine dosing equipment              | 1 set                         |   |
|                   |                           | Electric facility and instrumentation  | 1 set                         |   |
|                   |                           | Emergency power generator              | 1 set                         |   |
|                   | Water intake facilities   | Existing wells (improvement)           | 10 wells                      | 9 wells<br>(Changed the number of wells to 9 based on the pumping test conducted in the detailed design survey) |
|                   |                           | New wells (converted from test wells)  | 4 wells                       | As planned  |
|                   |                           | New wells                              | 7 wells                       | As planned  |
|                   |                           | Existing well facilities (improvement) | 10 facilities                 | 9 locations<br>(Change according to the modification of the number of wells)                                    |
|                   |                           | New well facilities                    | 11 facilities                 | As planned  |
|                   | Water conveyance facility | Conveyance pipe                        | 12.11km                       | 11.07 km<br>(Change according to the modification of the number of wells)                                       |
|                   | Distribution main         | Distribution pipe                      | 6.3km                         | As planned  |

Source: Preparatory Survey Report on the Projects for Improvement of Water Supply Facilities at Kassala City (2011) (p.vi-vii) and Completion Report of the project

<Sudanese side>

| Project Name           | Plan   | Actual     |
|------------------------|--|------------|
| Rehabilitation Project | <ul style="list-style-type: none"> <li>• Provision of temporary yard (partial area of construction land for south WTP)</li> <li>• Secure lands for facilities including construction lands and access roads.</li> <li>• Removal of trees and existing structures, Land leveling inside the construction area</li> <li>• Disposal area for surplus soil from the work</li> <li>• Provision of the electric power line to the project area (415V)</li> <li>• Removal and disposal of old facilities</li> <li>• Cooperation of the project implementation when shifting to the new facilities from old facilities (e.g., Construction attendance, suspension of water supply and announcement to the residents)</li> <li>• Construction of the fence and gate (Mahta WTP)</li> <li>• Water supply for leakage test</li> <li>• Allocation of project implementation personnel</li> </ul> | As Planned |

| Project Name      | Plan  | Actual     |
|-------------------|---|------------|
| Expansion Project | <p>&lt;WTP&gt;</p> <ul style="list-style-type: none"> <li>• Ensuring site</li> <li>• Land leveling of site, Relocation of trees, etc.</li> <li>• Installation of fences and gates</li> <li>• Replacement of power equipment of power receiving on the primary side (existing wells)</li> <li>• Cabling works for power supply and installing power equipment of power receiving on the primary side (new wells and WTP)</li> <li>• Emergency generator equipment (existing wells)</li> <li>• Provision of temporary sites for work</li> <li>• Access road</li> <li>• Provision of water for water-filling tests</li> </ul> <p>&lt;Conveyance pipes and distribution mains&gt;</p> <ul style="list-style-type: none"> <li>• Cooperation related to request for exclusive use of roads and rivers</li> <li>• Pruning and removing trees, shrubs, etc., in roads</li> <li>• Clearing objects on the road</li> <li>• Suspension of water supply because of new pipe and existing pipe connections</li> </ul> <p>&lt;Others&gt;</p> <ul style="list-style-type: none"> <li>• Disposal area for surplus soil from the work</li> <li>• Cooperation for the project implementation</li> </ul> | As Planned |

Source: Preparatory Survey Report on the Projects for Improvement of Water Supply Facilities at Kassala City (2011) (Japanese version) (p.3-44~p.3-45) and interview with Kassala SWC

In addition, workshops and on-the-job-training (OJT)<sup>9</sup> were provided to the O&M staff of Khatmia WTP (engineers and operators) and to the staff of the related departments of Kassala SWC under the technical guidance (soft component) of the “Expansion Project.” The attendees of the workshops are shown in Table 2. According to the interviews with the operators who attended the workshops, although teaching materials and lectures were in English, they could understand well through the English-Arabic interpreter. However, at the ex-post evaluation, it was confirmed that one of the three staff of laboratory who attended the workshop on the choline-dosing facilities had left the job, and the remaining two staff only attended the part of the workshop.

<sup>9</sup> In OJT, practical training such as operation method, adjustment of valves, measurement of pumped water volume and input of check sheets was carried out using actual equipment such as water distribution pump, chlorine-dosing equipment and well facilities.



Table 2 Contents of the workshops conducted through the technical guidance and attendees

| Contents of the Workshop (WS)                       | Target staff and number of attendees of SWC staff                                 |
|---|---|
| WS1 Brief Overview/<br>Orientation                  | Operators and SWC staff of related departments Total: 20 staffs                   |
| WS2 Chlorine-Dosing Equipment                       | Staffs of Laboratory for Water Quality Total: 3 staff                             |
| WS3 WTP & Wells Facilities<br>Management            | Director general and executive staff Total: 3 staff                               |
| WS4 Distribution Pump & Well Facilities             | Operators and Engineers of WTP Total: 14 staff                                    |
| WS5 Maintenance                                     | Executive staff, staff of related departments, Engineers of WTP Total: 5 staff    |
| WS6 Comprehensive Workshop (Summary of<br>WS1-W5)   | Director general, Engineer of WTP and Staff of related department Total: 13 staff |
| Total (no double counts on attendees of<br>WS1~WS6) | Total: 51 staff   |

Source: Final Report on Management Guidance (p.2)

### 3.2.2 Project Inputs

#### 3.2.2.1 Project Cost

The planned and actual cost covered by the Japanese side is shown in Table 3.

Table 3 Planned and actual cost covered by Japanese side

|                        | Planned   | Actual   | Comparison |
|------------------------|---|--|------------|
| Rehabilitation Project | 1,086 million yen   | 1,086 million yen  | 100%       |
| Expansion Project      | 1,886million yen<br>(Detailed design: 96million yen,<br>Construction: 1,790million yen) | 1,583 million yen<br>(Detailed design: 95million yen,<br>Construction: 1,488million yen) | 84%        |

The planned and actual cost of the “Rehabilitation Project” was both 1,086 million yen as planned. The actual cost of the “Expansion Project” was lower than planned; whereas the planned cost was 1,886 million yen (details design: 96 million yen, construction 1,790 million yen), the actual cost was 1,583 million yen (details design: 95 million yen, construction 1,488 million yen). The amount of 298 million yen, which was included in the planned cost as a contingencies<sup>10</sup>, was not disbursed due to the construction work being implemented as planned. The cost covered by the Sudanese side was not confirmed.

#### 3.2.2.2 Project Period

The planned and actual period of the project is shown in Table 4. The actual period of the “Rehabilitation Project” exceeded the plan; the actual period was 30 months whereas the

<sup>10</sup> “Contingencies” is applied when the contract amount is exceeded due to design change, expenses incurred due to an increase in the unit price of materials, or additional expenses for security and natural disasters. The payment of the contingencies is limited only when the executing agency of the partner country, consultant, and contractor agree, and the Japanese government and JICA approve (document provided by JICA).

planned period was 23 months<sup>11</sup>. During the project, the project contract was extended twice. The reason of the first extension was delay of customs clearance of equipment and the shortage of labour as the skilled personnel returned to South Sudan due to the separation of Sudan. The second extension was owed to the delay of the construction work because the concrete batcher plant<sup>12</sup>broke down<sup>13</sup>.

The actual period of the “Expansion Project” also exceeded the plan; the actual period was 36 months whereas the planned period was 32 months. This is because more time was required in details design because the pumping test of the well was done twice at the month of significant decline of the groundwater level.

Table 4 Planned and actual period of the project

| Project Name           | Planned<br>(Preparatory survey report)  | Actual<br>(Completion report)   | Comparison/Reason for extension  |
|------------------------|---|---|--|
| Rehabilitation Project | Total: 23 months<br>【Breakdown】<br>Details design: 4 months<br>Others (tender, etc.): 3 months<br>Construction: 16 months                             | May 2011-October 2013 (Total: 30 months)<br>【Breakdown】<br>Details design: 4 months<br>Others (tender, etc.): 3 months<br>Construction: 22 months                                   | 130%<br>· Delay of customs clearance of equipment and outflow of skilled personnel due to the separation of Sudan ( 6-month delay)<br>· Malfunction of concrete batcher plant(1-month delay) |
| Expansion Project      | Total: 32 months<br>【Breakdown】<br>Details design: 9 months<br>Others (tender, etc.): 4 months<br>Construction: 19 months<br>Soft component: 3 months | September 2011- August 2014 (Total 36 months)<br>【Breakdown】<br>Details design: 12 months<br>Others (tender, etc.): 3 months<br>Construction: 19 months<br>Soft component: 3 months | 113%<br>· Required time for detailed design survey (4-month delay)   |

As stated above, although the project cost was almost as planned, the project period exceeded the plan. Therefore, efficiency of the project is fair.

### 3.3 Effectiveness<sup>14</sup> (Rating: ②)

The project implemented was aimed at “the improvement of safe and stable water supply” in Kassala city. At the time of planning, the existing WTPs did not have sufficient capacity to cover the water demand due to aging. Furthermore, there was a risk that it would not be able to supply stable water in the future as the reservoir of the Mahta WTP had burst.

At the time of the ex-post evaluation, “how much water supply to the city has increased by the project implementation” (water distribution volume from each WTP) was examined as a quantitative effect of the “improvement of stable water supply.” And as a qualitative effect of

<sup>11</sup> Since the starting point of the project period described in the ex-ante evaluation was not clear, it was set as the starting month of the detailed design (starting month of consultant contract) based on the process chart planned in the preparatory survey report.

<sup>12</sup> Equipment for mixing concrete at a predetermined ratio to make appropriate materials.

<sup>13</sup> Interview with the consultant, and refer to the document provided by JICA.

<sup>14</sup> Sub-rating for Effectiveness is to be put with consideration of Impact.

“improvement of safe water supply,” the question “what kinds of improvement has there been on the operation of WTPs compared to the situation before project implementation” was asked to operators in WTPs. In addition, the beneficiary survey was conducted to the residents who received water supply service in order to examine the improvement of service before and after the project.

The water supply system of Kassala city is divided into east and west at the Gash River, and water supply service is provided to the East and West districts, respectively. Water in East District is supplied from the Mahta WTP that was rehabilitated by the “Rehabilitation Project,” the Khatmia WTP that was newly constructed by the “Expansion Project,” and several wells connected directly to the water supply network. Water in West District is supplied from the Garb WTP that was rehabilitated by the “Rehabilitation Project” and several wells connected directly to the water supply piping network<sup>15</sup> like in East District.

### 3.3.1 Quantitative Effects (Operation and Effect Indicators)

#### (1) Water distribution volume in each WTP (Operation indicators)

At the time of planning, water distribution volume of the Mahta WTP in 2014 was only set as a quantitative indicator of the “Rehabilitation Project.” However, it is crucial to examine the change of water distribution volume of the other WTPs in order to measure the effectiveness of the project as the project’s aim was the improvement of stable water supply in Kassala city. Thus, comparison between estimated and actual figures of the water distribution volumes of Garb and Khatmia WTPs were also examined at the ex-post evaluation. The daily maximum water distribution volume<sup>16</sup> was set as a target and estimated indicators at the time of the planning. However, as for Mahta WTP and Khatmia WTP, the achievement of daily maximum water distribution volume in October-November that are the month with high groundwater level, and the achievement of the daily average water distribution volumes<sup>17</sup> of other months were examined at the ex-post evaluation while considering the special condition of water resource in Kassala city<sup>18</sup> as well as the calculation manner for water distribution volume at the planning.

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<sup>15</sup> The proportion of the wells connected directly to the water supply piping networks is 33% (31 wells) in the East District and 74% (25 wells) in the West District. (Document provided by “The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations.”) The beneficiary survey was conducted to residents who were supposed to receive water from the WTPs after confirming the water supply areas by the staff of WTPs and the residents.

<sup>16</sup> Daily maximum water distribution volume is the daily average water distribution volume divided by the load ratio (daily average water distribution volume / daily maximum water distribution volume), which is the maximum figure of the daily water distribution throughout the year. In this project, the adoption figure of Japan’s Grant Aid Project in 1984 and the Japanese standard 0.7692 were applied as the load ratios.

<sup>17</sup> Daily average water distribution is the daily average water consumption (designed daily water consumption × design served population) divided by the effective water ratio (1 - water leakage ratio, ratio of water effectively used among water produced in the WTPs).

<sup>18</sup> The water source of Kassala city relies on the groundwater recharged in the Gash River. The Gash River is a wadi (seasonal river) where water flows only during the rainy season, and underground water is recharged from June to September when water flows. Thus, the groundwater level rises from about September when recharging is over and

Daily average water distribution volume was calculated based on the daily maximum water distribution volume of East District (Refer to Figure 1, A and B) that was calculated at the planning.

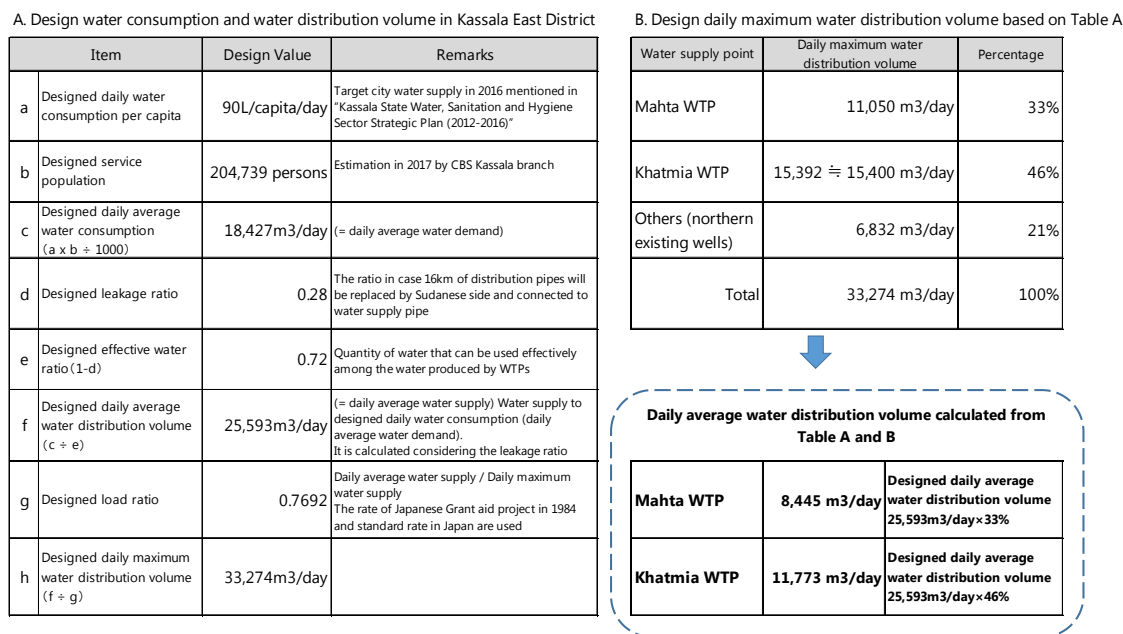


Figure 1 Calculation of the designed daily maximum water distribution volume and daily average water distribution volume calculated from Table A and B<sup>19</sup>

- ♦ Mahta WTP 【Daily maximum water distribution volume: Baseline 9,200 m<sup>3</sup>/day (2010) → Target 11,050 m<sup>3</sup>/day (2014)】

As shown in Table 5, the actual daily average water distribution volume except October-November 2015 was less than the target daily maximum water distribution volume. However, actual daily average water distribution volume per month was generally more than the baseline figure (9,200 m<sup>3</sup>/day) before the project implementation and target daily average water distribution volume (8,445 m<sup>3</sup>/day). Although the seasonal fluctuation exists, it can be said that water distribution volume was increased due to 24-hour water collection from the wells by expanding the capacity of the reservoir through the project.

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reaches its maximum around November, gradually declining and becoming the lowest around June of the following year. Therefore, the water pumping volume of groundwater is also changing throughout the year according to the groundwater level. (Interview with main consultant)

<sup>19</sup> Refer to Japanese preparatory survey report p. 3-14

Table 5 Daily average water distribution volume in Mahta WTP

(Unit: m<sup>3</sup>/day)

| Month   | Baseline     | Target   | Actual                   |                   |                          |                   |                          |                   |
|---------|--------------|--|--------------------------|-------------------|--------------------------|-------------------|--------------------------|-------------------|
|         | 2010         | 2014   | 2015                     | Achievement ratio | 2016                     | Achievement ratio | 2017                     | Achievement ratio |
|         | Planned Year | 1 Year After Completion  | 2 Years After Completion |                   | 3 Years After Completion |                   | 4 Years After Completion |                   |
| Jan     | 9,200        | Designed daily maximum water distribution volume (October-November):<br><br>11,050 | -                        | -                 | 10,654                   | 126%              | 9,074                    | 107%              |
| Feb     |              |  | -                        | -                 | 10,100                   | 120%              | 8,803                    | 104%              |
| Mar     |              |  | -                        | -                 | 7,656                    | 91%               | 9,840                    | 117%              |
| Apr     |              |  | -                        | -                 | 8,937                    | 106%              | 10,083                   | 119%              |
| May     |              |  | -                        | -                 | 8,745                    | 104%              | 9,475                    | 112%              |
| Jun     |              |  | -                        | -                 | 7,362                    | 87%               | 8,604                    | 102%              |
| Jul     |              | -  | -                        | 8,052             | 95%                      | -                 | -                        |                   |
| Aug     |              | -  | -                        | 9,706             | 115%                     | -                 | -                        |                   |
| Sep     |              | -  | -                        | 9,696             | 115%                     | -                 | -                        |                   |
| Oct     |              | 8,445  | 11,799                   | 107%              | 9,907                    | 90%               | -                        | -                 |
| Nov     |              |  | 11,867                   | 107%              | 10,054                   | 91%               | -                        | -                 |
| Dec     |              |  | 10,930                   | 129%              | 10,503                   | 124%              | -                        | -                 |
| Average |              |  | 11,532                   | 115%              | 9,163                    | 105%              | 9,313                    | 110%              |

Source: Calculated monthly average from the water distribution record in Mahta WTP

- ♦ Garb WTP 【Daily maximum water distribution volume: Baseline 5,200 m<sup>3</sup>/day (2010) → Estimation 5,200 m<sup>3</sup>/day (2014)】

Water distribution volume was not recorded for the Garb WTP because the rehabilitation of the project was limited to construction of receiving well and replacement of reservoir, and had not installed a flow meter. Thus, actual figures of Table 6 were calculated from estimated water production of the well by interviews with the staff of the Garb WTP. According to the interviews, the water distribution volume decreased<sup>20</sup> as the number of wells that can intake the water was decreased to 9 wells from 14 wells because some wells had dried up since 2016.

<sup>20</sup> According to the interview at the Garb WTP during the field survey in July 2017, the water distribution volume has been increased from June 2017 because two wells were newly developed.

Table 6 Daily average water distribution volume in Garb WTP

(Unit: m<sup>3</sup>/day)

| Baseline     | Estimation              | Actual                  |                          |                          |                          |
|--------------|-------------------------|-------------------------|--------------------------|--------------------------|--------------------------|
|              |                         | 2014                    | 2015                     | 2016                     | 2017                     |
| Planned Year | 1 Year After Completion | 1 Year After Completion | 2 Years After Completion | 3 Years After Completion | 4 Years After Completion |
| 5,200        | 5,200                   | 5,040                   | 5,040                    | 3,240                    | 3,240                    |
| Achievement  |                         | 97%                     | 97%                      | 62%                      | 62%                      |

Source: Interview with the staff of Garb WTP

Note: Calculation of actual figure: Water production (m<sup>3</sup>/hour) × Number of wells × pumping hour (hours) = 15 m<sup>3</sup> × 14 wells × 24 hours (2014-2015); 15 m<sup>3</sup> × 9 wells × 24 hours (2016-2017)

- ♦ Khatmia WTP 【Daily maximum water distribution volume: Estimation 15,400 m<sup>3</sup>/day (2014)】

As shown in Table 7, actual figures of daily average water distribution volume as well as daily maximum water distribution volume have been less than the expected daily average water distribution and daily maximum water distribution.

This is because the water production of the wells was less than expected<sup>21</sup>. Although the water production fluctuated each year, only 70% was achieved particularly in 2016. However, it has been increased since the first half of the year 2017, and 80% was achieved on average. According to the response from the Groundwater and Wadis Kassala branch<sup>22</sup>, it is supposed that inter-annual decline of the groundwater level due to the over pumping of agriculture wells near the Khatmia WTP wells, mutual interference between the agriculture wells and WTP wells owing to the close interval, and a poor aquifer in the location of the WTP wells are regarded to be the causes of the reduced water production.

<sup>21</sup> From the analysis of the monthly water intake data from the wells that was obtained, the number of wells that exceeded the planned water production volume on average was only five (four existing wells and one new well) among twenty (nine existing wells and eleven new wells).

<sup>22</sup> The Department of Groundwater and Wadis is a department belonging to the Ministry of Water Resources, Irrigation and Electricity. It carries out the groundwater monitoring, hydraulic geological survey, aquifer evaluation, and database management of the groundwater and wadi. It has offices in 15 states, one of which is the Kassala branch. (Refer to the “Detailed Design Survey Report of the Project for Enhancement of Integrated Water Resources Management in the Republic of the Sudan” (Japanese version) p. 18.)

Table 7 Daily average water distribution volume in Khatmia WTP

(Unit: m<sup>3</sup>/day)

| Month   | Estimation  | Actual          |                   |                         |                   |                          |                   |                          |                   |
|---------|---|-----------------|-------------------|-------------------------|-------------------|--------------------------|-------------------|--------------------------|-------------------|
|         | 2014  | 2014            |                   | 2015                    |                   | 2016                     |                   | 2017                     |                   |
|         | Completion Year   | Completion Year | Achievement ratio | 1 Year After Completion | Achievement ratio | 2 Years After Completion | Achievement ratio | 3 Years After Completion | Achievement ratio |
| Jan     | Designed daily maximum water distribution volume (October-November):<br><br>15,400<br><br>Designed daily average water distribution volume (except October-November):<br><br>11,773 | -               | -                 | 11,817                  | 100%              | 8,780                    | 75%               | 10,393                   | 88%               |
| Feb     |   | -               | -                 | 10,795                  | 92%               | 9,111                    | 77%               | 9,887                    | 84%               |
| Mar     |   | -               | -                 | 10,711                  | 91%               | 9,148                    | 78%               | 9,906                    | 84%               |
| Apr     |   | -               | -                 | 11,231                  | 95%               | 9,126                    | 78%               | 9,833                    | 84%               |
| May     |   | -               | -                 | 10,809                  | 92%               | 7,659                    | 65%               | 9,534                    | 81%               |
| Jun     |   | -               | -                 | 8,945                   | 76%               | 7,163                    | 61%               | 9,044                    | 77%               |
| Jul     |   | -               | -                 | 7,451                   | 63%               | 6,622                    | 56%               | -                        | -                 |
| Aug     |   | 9,740           | 83%               | 9,549                   | 81%               | 7,645                    | 65%               | -                        | -                 |
| Sep     |   | 10,943          | 93%               | 11,366                  | 97%               | 9,600                    | 82%               | -                        | -                 |
| Oct     |   | 11,708          | 76%               | 11,306                  | 73%               | 9,844                    | 64%               | -                        | -                 |
| Nov     |   | 11,957          | 78%               | 10,659                  | 69%               | 9,886                    | 64%               | -                        | -                 |
| Dec     |   | 11,622          | 99%               | 9,687                   | 82%               | 10,382                   | 88%               | -                        | -                 |
| Average |   | 11,194          | 86%               | 10,361                  | 84%               | 8,747                    | 71%               | 9,766                    | 83%               |

Source: Calculated monthly average from the water distribution record in Khatmia WTP

♦ East District (The total water distribution volume of Mahta WTP and Khatmia WTP<sup>23</sup>)

It was expected that the water supply volume in East District would be improved by the rehabilitation of the existing WTPs through the “Rehabilitation Project” and by the construction of a new WTP through the “Expansion Project.” Thus, in addition to the achievement of the target of each WTP, it was also examined how much water supply to East District (i.e., total water distribution volume of Mahta and Khatmia WTPs) has been achieved compared to the expected water distribution volume (refer to Table 8).

Before the implementation of the “Expansion Project,” the water in East District was supplied from the Mahta WTP and several wells connected directly to the water supply network. Existing southern wells that were among the wells that were connected directly to the water supply network were utilized as a part of the Khatmia WTP wells. The baseline data was set at 16,736 m<sup>3</sup>/day including the water supply volume of 9,200 m<sup>3</sup>/day of the Mahta WTP since the water production of existing southern wells was 7,536 m<sup>3</sup>/day before the Khatmia WTP construction. Although the actual figure fluctuated by months, average water distribution volume has been more than expected, and overall, it achieved 80-90% of the estimated figure.

<sup>23</sup> The water supplied to the East District is from the Mahta WTP, the Khatmia WTP, and the wells connected directly to the water distribution piping network. But the water from wells connected directly to the water distribution piping network were excluded from the analysis in order to examine the pure effect of the project.

Table 8 Daily average water distribution volume in East District (Mahta and Khatmia WTPs)

(Unit: m3/day)

| Month   | Baseline     | Estimation  | Actual                  |                   |                          |                   |                          |                   |
|---------|--------------|---|-------------------------|-------------------|--------------------------|-------------------|--------------------------|-------------------|
|         | 2010         | 2014  | 2015                    | Achievement ratio | 2016                     | Achievement ratio | 2017                     | Achievement ratio |
|         | Planned Year | Completion Year   | 1 Year After Completion |                   | 2 Years After Completion |                   | 3 Years After Completion |                   |
| Jan     | 16,736       | Designed daily maximum water distribution volume (October-November):<br><br>26,450<br><br>Designed daily average water distribution volume (except October-November):<br><br>20,218 | -                       | -                 | 19,434                   | 96%               | 19,467                   | 96%               |
| Feb     |              |   | -                       | -                 | 19,211                   | 95%               | 18,690                   | 92%               |
| Mar     |              |   | -                       | -                 | 16,804                   | 83%               | 19,746                   | 98%               |
| Apr     |              |   | -                       | -                 | 18,063                   | 89%               | 19,916                   | 99%               |
| May     |              |   | -                       | -                 | 16,404                   | 81%               | 19,009                   | 94%               |
| Jun     |              |   | -                       | -                 | 14,525                   | 72%               | 17,648                   | 87%               |
| Jul     |              |   | -                       | -                 | 14,674                   | 73%               | -                        | -                 |
| Aug     |              |   | -                       | -                 | 17,351                   | 86%               | -                        | -                 |
| Sep     |              |   | -                       | -                 | 19,296                   | 95%               | -                        | -                 |
| Oct     |              |   | 23,105                  | 87%               | 19,751                   | 75%               | -                        | -                 |
| Nov     |              |   | 22,526                  | 85%               | 19,940                   | 75%               | -                        | -                 |
| Dec     |              |   | 20,617                  | 102%              | 20,885                   | 103%              | -                        | -                 |
| Average |              |   | 22,083                  | 91%               | 18,028                   | 85%               | 19,079                   | 94%               |

Source: Calculated monthly average from the water distribution record in Mahta and Khatmia WTPs

### 3.3.2 Qualitative Effects (Other Effects)

At the time of planning, the project's effects described in Table 9 were expected as qualitative effects. Those effects were analyzed with the information through the interviews with operators in each WTP as well as the beneficiary survey for the residents who had been receiving the water supply service conducted during the ex-post evaluation survey<sup>24</sup>. As mentioned above, in the East District, Khatmia WTP was newly constructed by the "Expansion Project" after the rehabilitation of the existing Mahta WTP by the "Rehabilitation Project"; thus, the project's expected effects in the East District were high. On the other hand, the effect of the project was limited in the West District compared with the East District, as it was only part of the rehabilitation of Garb WTP in the "Rehabilitation Project." The results of the beneficiary survey were analyzed considering that point.

<sup>24</sup> The zoning method by which the entire service area is divided into smaller areas for each water supply point has not been adopted in Kassala city. In addition, not all well water is collected in the WTP and then sent to the water distribution pipe; some wells are directly connected to the water distribution piping network. Thus, the distribution area by water supply point cannot be clearly identified. But considering the fact that the water supply was not enough due to the problem of water volume and water pressure in the northern and southern parts of the East District (mountain side) away from the Mahta WTP before the project, it was presumed that the area affected by the water distribution of each WTP was its service area, and we conducted a door-to-door survey of the residents. On the survey, the residents were asked about the water supply situation before compared to after the project. Regarding the sample size, see footnote 26.



Table 9 Qualitative effects that were expected at the time of planning

| Rehabilitation Project   |          | Expansion Project   |
|--|----------|---|
| Mahta WTP  | Garb WTP | Khatmia WTP   |
| <ul style="list-style-type: none"> <li>- To ensure disinfection of water by the construction of receiving wells in order to enable chlorine dosing</li> <li>- To improve O&amp;M of the WTPs by using a design that considered flood prevention</li> <li>- To provide a better sense of security about water supply service to the residents by reducing the risk of bursting the reservoir</li> </ul> |          | <ul style="list-style-type: none"> <li>- To improve the shortage of water supply, and to reduce the water suspension areas</li> <li>- To improve the sense of trust of the residents about water supply service by increasing the percentage of chlorine-dosed water</li> <li>- To improve the management of water sources and the control of water distribution by installation of the flowmeters</li> </ul> |

Source: Preparatory Survey Report on the Projects for Improvement of Water Supply Facilities at Kassala City (2011)

(1) Results of the interviews with the operators in WTPs<sup>25</sup>

During the interviews with operators in each WTP to see if there were any problems with specifications and how to handle the facilities and equipment that were rehabilitated or newly constructed in this project, all operators answered that there were no problems. In addition, the operators of the Mahta and Garb WTPs were questioned regarding the changes before/after the project involving “chlorine injection,” “risk of flooding,” and “risk of bursting the reservoir.” The results of the interviews are shown in Table 10. It can be said that the risk of flooding and the risk of bursting the reservoir were reduced as compared with before this project, and it became possible to efficiently operate the WTP.

Table 10 Results of the interviews with the operators in WTPs

| Rehabilitation Project   |   | Expansion Project  |
|--|---|--|
| Mahta WTP  | Garb WTP  | Khatmia WTP  |
| <ul style="list-style-type: none"> <li>- Risk of bursting reservoir was reduced because the concrete reservoir that was installed is more durable compared to the former FRP reservoir.</li> <li>- Risk of flooding was reduced due to the new reservoir being constructed at a higher place. However, there was no comment that O&amp;M was improved by that.</li> <li>- Reliable chlorine injection became possible by installation of receiving well and chlorine dosing facilities. (However, there was a period of malfunction)</li> <li>- Checking and cleaning of facilities became easier due to the good design.</li> <li>- Water intake volume and water distribution volume can be managed collectively by distribution pump building (administration building) due to the installation of a flow meter.</li> </ul> | <ul style="list-style-type: none"> <li>- Risk of bursting reservoir was reduced because the concrete reservoir that was installed is more durable compared to the former FRP reservoir.</li> <li>- Risk of flooding was reduced due to the new reservoir being constructed at a higher place. Risk of flooding was reduced due to the new reservoir being constructed at a higher place. However, there was no comment that O&amp;M was improved by that.</li> <li>- Due to the installation of a receiving well, the impurities were surely removed in sedimentation tank, and the chlorine powder was mixed well due to the fact that the flow was also made.</li> <li>- Checking and cleaning of facilities became easier due to the good design.</li> </ul> | <ul style="list-style-type: none"> <li>- It is easy to operate the facilities as the water intake volume and water distribution volume can be managed collectively in the distribution pump building (administration building).</li> <li>- Cleaning of the facilities is easy due to the good design.</li> <li>- It became possible to supply water to the northern part of Kassala city and the southern part (mountain side) where water supply situation was not good.</li> </ul> |

Source: Interviews with operators in each WTP

(2) Results of the beneficiary survey<sup>26</sup>

Figure 2 shows the results of the beneficiary survey. Many residents living in each WTP covered area responded that the water supply service has been improved as compared with

<sup>25</sup> Separate interviews were conducted for 6 staff in each WTP.

<sup>26</sup> The sample size of the beneficiary survey was 49 households (respondents: 6 men, 43 women) in the Mahta WTP covered area (center of the city in East District), 43 households (9 men, 34 females) of the Garb WTP (West District), and 51 households (respondents: 6 men, 45 women) in the Khatmia WTP covered area (mountain side of the East District). The interview survey using questionnaires was carried out especially targeting women, who mainly use water at home. For the method of sampling, see footnote 24.

before. Especially, most of the residents in the East District, where the rehabilitation of the existing WTP and the construction of the new WTP were carried out, responded that they are “very satisfied” or “satisfied.” Thus, it is supposed that the reliability of the water supply service of the residents who has been receiving water supply service has been generally improved as compared with before the project. In addition, the survey results show that the residents of the Khatmia WTP covered area, where the water supply situation was not good before this project, think that the water supply service has been improved greatly with respect to the amount of water<sup>27</sup>. On the other hand, in the West District (covered area of Garb WTP), where the project implemented only the rehabilitation of the existing WTP, many residents felt that the quality of water has been improved, but about half of the respondents responded that the amount of water was “not changed” or “worse.” Thus, the satisfaction of the residents in the West District is not as high as in the East District<sup>28</sup>.

(Unit: %)



Source: Results of the beneficiary survey

Figure 2 Results of the beneficiary survey in relation to the project's effectiveness

As stated above, although the water distribution volume of the Mahta WTP has generally achieved the target volume, the Garb WTP and the Khatmia WTP have not achieved the estimated volume because the water production of their wells is lower than expected. However,

<sup>27</sup> Some of the residents in the East District feel that the situation of the water supply has become worse. According to the interviews with the residents, the water supply volume and water pressure to the areas away from the WTPs are limited, as many people living near the WTPs, where the situation of the water supply was not bad even before, use more water than before due to the improvement of the water supply service. In addition, the number of households using water pumps has increased compared to before. However, it is considered that many residents in areas where the water supply situation was not good before the project think the water supply in their area has been improved because they can obtain more water compared to before.

<sup>28</sup> In addition to that, it is supposed that the high percentage of the wells connected directly to the water supply piping network is another reason for reducing the residents' satisfaction.

the combined water volume of the Mahta WTP and Khatmia WTP has achieved 80% of the total target water volume in the East District. Regarding the situation in the East District, certain effects are observed. The amount of water supply has increased due to the construction of the Khatmia WTP, and the residents in the areas where the water did not reach due to the low water pressure before the project have been able to receive water thanks to improved water pressure due to the increase of the proportion of water sent by the distribution pump. Thus, the objective of this project has been generally achieved with regard to the “improvement of safe and stable water supply.” As for the water quality, the proportion of chlorine disinfection of the water supplied to the East District has been increased due to the installation of the chlorine dosing facilities and the receiving well. As a result, many residents pointed out the improvement of water quality during the beneficiary survey. In addition, the risk of bursting the reservoirs of the Mahta and Garb WTPs was reduced by replacing the FRP reservoirs with reinforced concrete reservoirs through the project implemented as urgent support. This means that the risk of damage to the residents, who are assumed would suffer from the burst of the old reservoirs in the future, was reduced. Therefore, the effectiveness of the project is high.

### 3.4 Impacts

#### 3.4.1 Intended Impacts

Improvement of the water supply situation in Kassala city by the implementation of the project was expected to contribute to improvement of the basic living environment of the residents. Therefore, at the time of ex-post evaluation, it was examined that how many residents receiving the water supply service led to improvement of basic living (quantitative effect) and what kind of changes in terms of living environment occurred by improving the water supply service among residents receiving water supply service (qualitative effect).

(1) Percentage of the households receiving the water supply service, population receiving the water supply service, and daily water use per capita in the East District (quantitative effects)

At the time of the planning, the water distribution pipe renewal work and water supply pipe connection work by the Sudanese side, which were planned outside of the scope of the project, were regarded as necessary work of the partner country in order to achieve the project effect and were indispensable for the effective use of the facilities constructed by the project. Therefore, the percentage of households receiving the water supply service, population receiving the water supply service, and daily water supply per capita<sup>29</sup> in the East District were set as effect

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<sup>29</sup> Daily water supply per capita, which was set as an indicator at the planning stage, means daily water use per capita.

indicators of the project on the premise that those works by the Sudanese side would be completed<sup>30</sup>.

As shown in Table 11, the number of households receiving the water supply service in the East District has been increasing year by year. Especially in the completion year of the “Expansion Project” (2014), the number of households increased significantly compared to other years. Thus, the project contributed to some extent to the increased number of households receiving water supply service in the East District.

Table 11 Number of households receiving the water supply service (East District)

|  | 2010   | 2011   | 2012   | 2013                                      | 2014                                 | 2015   | 2016   | 2017   |
|--|--------|--------|--------|---|--------------------------------------|--------|--------|--------|
|  |        |        |        | Completion year of Rehabilitation Project | Completion year of Expansion Project |        |        |        |
| Kassala East                             | 19,237 | 20,520 | 21,671 | 22,824                                    | 24,484                               | 25,008 | 25,607 | 26,235 |
| <i>Increase in number from last year</i> | -      | 1,283  | 1,151  | 1,153                                     | 1,660                                | 524    | 599    | 628    |
| <i>Increase rate</i>                     | -      | 107%   | 106%   | 105%                                      | 107%                                 | 102%   | 102%   | 102%   |

Source: Kassala SWC Financial Department

The achievement of the indicators (percentage of households receiving household water supply, population receiving the water supply service, and daily water use per capita, set at the planning stage) at the time of the ex-post evaluation was analyzed via the number of households receiving the water supply service (Table 11) and the information provided by the related organization<sup>31</sup>. The results of the analysis are shown in Table 12, and the indicators (percentage of households receiving household water supply and population receiving the water supply service) have not been achieved at present.

However, the population receiving water supply service has increased compared to 2009. It can be said that the expansion of the water supply volume in the East District through the project contributed to some extent to the increase of the population receiving the water supply service. Regarding the amount of water use per capita per day, the target has been achieved, taking into account that the leakage rate is set to 28% and divided simply by the population figures. As a result of the beneficiary survey, it is supposed that some residents who had been receiving water supply service before the project can use more water than before as a result of the project. However, it is thought that there are still 30% of the residents in the East District who cannot receive water supply service because the water supply pipes are not connected to their household. In other words, it would have been ideal if the water supply volume per day

<sup>30</sup> Although these indicators were set as quantitative effects at the time of planning, they are considered to be the effect brought about by the increase in the water distribution volume, which is a quantitative indicator of effectiveness. Thus, they were reset as indicators of impact at the time of the ex-post evaluation. Although the target year was mentioned as 2016 in the preparatory survey report, it was reset to 2017 in the ex-post evaluation because the indicator of the quantitative effect 3 years after the project completion was set as a target figure.

<sup>31</sup> The estimated population (218,144 people) and estimated number of households (38,102 households) in the East District in 2016 were provided by CBS Kassala branch. And the number of households receiving the water supply service in the East District in 2016 (25,607 households) was provided by Kassala SWC.

that was increased by the project were allocated for those 30% of people, but currently it is thought that it has been allocated for the residents who receive water supply service.

Table 12 Status of achievement of the impact indicators which were set at the planning stage

| Indicators   | Baseline   | Target  | Actual       |  |
|--|------------|---|--------------|--|
|  | 2009       | 2017  | 2016         | Remarks  |
| Percentage of households receiving water supply services | 73%        | 100%  | 67%          | 25,607 households ( number of households in East District receiving the water supply service ) ÷ 38,102 households ( Estimated total households in East District ) × 100 |
| Population receiving water supply services               | 125,479    | 204,739<br>(Total population in Kassala East estimated by CBS Kassala branch at the planning stage) | 146,600      | 5.725 persons/household × 25,607 households ( number of households in East District receiving the water supply service ) *Note1  |
| Water use per capita per day (L/capita)                  | 62L/capita | 90L/capita  | 90.2L/capita | 19,634m <sup>3</sup> /day ( Daily average water consumption [=daily average water demand] / 218,114 persons ( Estimated population in East District ) × 1000 *Note2      |

Source: Analysis by evaluator

Note1: The number of persons per household was determined by dividing 218,144 people (estimated population in the East District in 2016) by 38,102 households (estimated number of households in 2016).

Note2: The daily average water consumption was calculated by taking the daily average water distribution volume in the East

District (27,270 m<sup>3</sup>), that is, the average daily water distribution from Mahta WTP (9,163 m<sup>3</sup>) + from Khatmia WTP (8,747 m<sup>3</sup>) + from others (9,360 m<sup>3</sup>), minus the same water leakage rate as planned (28%). Others refers to the estimated water production of the wells connected directly to the distribution pipe network according to the interview with Kassala SWC. As for the water leakage rate, the same water leakage rate as planned, as shown in Figure 1, was applied since the exact leakage rate was unknown.

Factors that led to not being able to achieve the indicators at the time of ex-post evaluation include population increase and delay in construction work of the renewal distribution pipes by the Sudanese side<sup>32</sup>. Water distribution pipe renewal work was started in January 2014<sup>33</sup>. According to the Kassala SWC, the renewal work of the water distribution pipes was completed in both the East District and West District in July 2017. In order to switch the water supply to the new water distribution pipe, some households whose water supply pipe is connected to the old water distribution pipe will require replacement work of the water supply pipe to the new distribution pipe. The replacement work has been started with the agreement that the Kassala SWC will bear the material cost of the water supply pipe and the installation cost will be borne

<sup>32</sup> If considering the target population in 2017 as the total population of the East District estimated in the planning stage (204,739 people), the population receiving the water supply service (146,600 people) in 2016 that was calculated by the analysis covered 72% of the target population. However, the total population of the East District in 2016 estimated at the time of ex-post evaluation is 218,144 people, which is more than the estimation in the planning stage due to the increase in the number of people in Kassala city. Therefore, the coverage is 67% of the target population. Thus, it can be said that the increase in the population in Kassala city affected the achievement of the target indicator together with the delay of work by the Sudanese side.

<sup>33</sup> Making a renewal plan for the water distribution pipe was supported by the water cluster of the “Capacity Development Project for the Provision of Services for Basic Human Needs in Kassala” (2011-2015).

by the residents<sup>34</sup>. It is expected that the leakage of water from the pipes will be reduced if the connection work between the water supply pipe and new water distribution pipe is carried out appropriately and completed. Moreover, if the water supply pipe is connected to the 30% of households to which the water supply pipe is not yet connected, it is expected that the achievement of the indicators will improve in the future, but it will be difficult to achieve the figure of the target year 2017.

## (2) Changes of residents' living environment (Qualitative effects)

It was expected that the improvement of the residents' basic living environment in the target area would be an indirect effect of the project. Thus, at the time of the ex-post evaluation, an interview survey of the residents with questionnaires about "what changes occurred in their lives due to the changes in water supply conditions" was conducted. Also, question about "the amount of water purchased from a water vendor due to improvement of the water supply situation" was asked the residents in order to see the change in the cost of water. The results are shown in Table 13.

Table 13 Results of the beneficiary survey in relation to the project's impact<sup>35</sup>

| Changes due to improvement of water supply situation (multiple answers)          |       |      |         |       |   |
|--|-------|------|---------|-------|---|
|  | Mahta | Garb | Khatmia | Total | Percentage of total households surveyed |
| Number of households surveyed  | 49    | 43   | 51      | 143   | -                                       |
| Number of households that responded the water supply situation had improved      | 41    | 33   | 43      | 117   | 82%                                     |
| Time of collecting water has decreased   | 22    | 13   | 21      | 56    | 39%                                     |
| The frequency of diarrhea (especially children) has decreased                    | 22    | 18   | 9       | 49    | 34%                                     |
| The work of drawing water for women and children has been reduced                | 16    | 8    | 25      | 49    | 34%                                     |
| Life became comfortable  | 13    | 9    | 26      | 48    | 34%                                     |
| Frequency of collecting water has been reduced                                   | 17    | 4    | 22      | 43    | 30%                                     |
| Became possible to secure sufficient water for cleaning and washing              | 19    | 1    | 10      | 30    | 21%                                     |
| Became possible to do housework without worrying about the water collection time | 3     | 3    | 9       | 15    | 10%                                     |
| Cost of purchasing water has been reduced  | 8     | 1    | 3       | 12    | 8%                                      |
| Became possible to grow plants in a garden                                       | 3     | 3    | 7       | 13    | 9%                                      |
| Became possible to secure sufficient water for showering                         | 8     | 0    | 3       | 11    | 8%                                      |
| Became possible to save money  | 6     | 1    | 3       | 10    | 7%                                      |
| Became possible to sprinkle the garden with water                                | 0     | 1    | 3       | 4     | 3%                                      |
| Sub total  | 137   | 62   | 141     | 340   |   |

| Changes due to deterioration of water supply situation (multiple answers)       |       |      |         |       |   |
|---|-------|------|---------|-------|---|
|   | Mahta | Garb | Khatmia | Total | Percentage of total households surveyed |
| Number of households surveyed   | 49    | 43   | 51      | 143   | -                                       |
| Number of households that responded the water supply situation had deteriorated | 8     | 10   | 5       | 23    | 16%                                     |
| Time of collecting water has increased  | 8     | 9    | 6       | 23    | 16%                                     |
| Frequency of collecting water has increased                                     | 6     | 7    | 6       | 19    | 13%                                     |
| The work of drawing water for women and children has increased                  | 5     | 10   | 4       | 19    | 13%                                     |
| Cost of purchasing water has increased  | 0     | 6    | 1       | 7     | 5%                                      |
| The distance to draw water has increased  | 0     | 0    | 2       | 2     | 1%                                      |
| The frequency of diarrhea has increased   | 1     | 0    | 0       | 1     | 1%                                      |
| Sub total   | 20    | 32   | 19      | 71    |   |

| Has the amount of water purchased from the water vendor changed? |       |      |         |       |   |
|--|-------|------|---------|-------|---|
|  | Mahta | Garb | Khatmia | Total | Percentage of total households surveyed |
| It has decreased compared to before                              | 12    | 9    | 33      | 54    | 38%                                     |
| It has increased compared to before                              | 3     | 13   | 7       | 23    | 16%                                     |
| Never purchased from water vendor                                | 31    | 21   | 7       | 59    | 41%                                     |
| No response  | 3     | 0    | 4       | 7     | 5%                                      |
| Sub total  | 49    | 43   | 51      | 143   |   |

Source: Results of beneficiary survey

Although there was a negative answer from the residents of the Garb WTP covered area where the output of the project was limited in the West District as well as the part of the East

<sup>34</sup> Information provided by "The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations" (October, 2017).

<sup>35</sup> The sample size of the beneficiary survey is referred to in footnote 26. "Time and frequency of collecting water" means that water is collected in the early morning or at night in case sufficient water cannot be obtained from the household water tap. Some households collect water by using the water pump during times of low water pressure. "Drawing water" is drawing water from the household tap and moving the water to a container to keep it.

District where the water supply situation was not good even after the project, the positive effect was generally confirmed. Regarding the amount of water purchased from a water vendor, many respondents, except for the water supply area of the Garb WTP, responded that it has been decreased. Especially in the water supply area of the Khatmia WTP, it is regarded to have improved remarkably. Thus, the project contributed to saving the cost of residents' water purchases in the East District<sup>36</sup>.

#### 3.4.2 Other Positive and Negative Impacts

At the planning stage of the project, it was concerned that the project would cause "economic difficulty due to the reduction/loss of sales activities of water vendors" and "the decrease of the groundwater level" at the operation stage, and it was expected that necessary measures would be taken. The status of those effects and measures taken by the Kassala SWC at the time of the ex-post evaluation are mentioned below (1)-(3). According to the interview at the Kassala SWC, there was no land acquisition and resident resettlement due to the "Rehabilitation project", as the land for the project was within the premises of the existing WTP. And the land for the "Expansion project" was agricultural land, and it was obtained by Kassala state government through compensating alternative land to the owner before the start of the project<sup>37</sup>. Regarding the other impacts that were concerned would occur during the construction stage of the project, such as air pollution and noise, planned measures such as arrangement of staff for traffic control, construction of a protective fence, and establishment of an information desk for receiving the residents' complaints were taken, and the negative impact of the project during the construction stage was not identified.

##### (1) Economic difficulty of water vendors by reduction and loss of water vendors' sales activities

The sufficient information about the number of water vendors and their sales activities was not obtained. According to the interviews with the currently active water vendors (3 people), they purchased water from the public water taps of the Kassala SWC (about 25 places) by around 2011. But currently all places are closed, and they purchase the water from private water trucks. Regarding the customers, they previously sold to households, but currently they sell at

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<sup>36</sup> According to the interview with water vendors, they sell two barrels of water (same as 400 liters) at SDG30. Most of the households receiving the water supply service are categorized as "Residential 3" in their contract water fee categories, and they pay SDG32 per month. For example, assuming that 62 liters, which is the daily water consumption per capita of 2009, is bought from the water vendor, the necessary amount of water per month will be 1,860 liters, which costs about SDG140. If there are five family members, it costs about SDG700. Compared with purchasing the water from water vendors, the water supply service, whose monthly water fee is fixed at SDG32/household, is very cheap.

<sup>37</sup> The land acquisition and resident resettlement by the project were not planned during the planning stage. Although there was no resident resettlement, in fact, land acquisition occurred for the "Expansion Project." The background and process of obtaining the land were not identified. But there was no negative impact up to the time of the ex-post evaluation (Interview with Kassala SWC and Main consultant).

construction sites. Their income has decreased as compared with before. However, one water vendor out of three said that he still sells to previous customers, and there was no change in his income. Although the enough information about the loss of their jobs was not obtained, from their interviews, the vendors said that many water vendors have engaged in other jobs after quitting as water vendors.

## (2) Decline of the groundwater level

In Kassala city, decline of the groundwater level has been pointed out for many years. The data of the observation well observed by Groundwater and Wadis Kassala branch also shows that the groundwater level has declined with the passage of time. The pumping volume of the wells in the WTPs constructed by the project has also tended to decrease, and it seems that it is influenced by the groundwater level decreasing to some extent. Factors influencing the decrease of the groundwater level are considered to be over pumping of agricultural wells, installation of the wells in close intervals, propagation of plants called mesquite, etc. However, the evidence to prove those factors was not obtained because the exact data have not been recorded. Regarding whether the project has affected the decreasing of the groundwater level, it is considered that the negative impact of the project is not much as compared with the number of agricultural wells (although the accurate number is unknown, there are about 3,000 wells according to the related person of farmers union) and the number of wells for drinking water (136 wells<sup>38</sup>). On the contrary, the over pumping of the agricultural wells is considered to have a negative effect on the reduction of the pumping volume of the WTPs' wells. To see the current situation of the decreasing groundwater level, the Kassala SWC has begun monitoring activities since November 2016, and 15 observation wells were being monitored twice a week at the time of ex-post evaluation<sup>39</sup>. Through the accumulation and analysis of those data in the future, it is expected to see the exact current situation based on the data<sup>40</sup>.

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<sup>38</sup> Document provided by "The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations."

<sup>39</sup> The monitoring activities are also supported by "The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations."

<sup>40</sup> Among the observation wells being monitored, one well with a large fluctuation range of one day has been confirmed. The agricultural wells are adjacent to the observation wells within 50m, and the decrease in the groundwater level of the observation wells is nearly consistent with the pumping time of the agricultural wells every day. Thus, it is considered that the fluctuation of the water level is due to the interference of the water pumping of each other (interview with the expert of "The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations").



(3) Contribution to the increased number of households receiving the water supply service in West District

As Table 14 shows, the number of households receiving the water supply service in the West District is increasing year by year. The certain contribution of the project has been observed, as the number has increased in the completion year of the “Rehabilitation Project.”

Table 14 Number of households receiving the water supply service (West District)

|  | 2010   | 2011   | 2012   | 2013                                      | 2014                                 | 2015   | 2016   | 2017   |
|--|--------|--------|--------|---|--------------------------------------|--------|--------|--------|
|  |        |        |        | Completion year of Rehabilitation Project | Completion year of Expansion Project |        |        |        |
| Kassala West                             | 11,919 | 12,802 | 14,079 | 15,015                                    | 16,113                               | 16,481 | 16,853 | 17,161 |
| <i>Increase in number from last year</i> | -      | 883    | 1,277  | 936                                       | 1,098                                | 368    | 372    | 308    |
| <i>Increase rate</i>                     | -      | 107%   | 110%   | 107%                                      | 107%                                 | 102%   | 102%   | 102%   |

Source: Kassala SWC Financial Department

As described above, with regard to the impact of this project, the quantitative indicators that were set at the planning stage had not been achieved at the time of ex-post evaluation. This was because external factors such as delay in construction on the part of Sudanese work were an impediment to the achievement of the goal, by separating the Sudanese side work, which was indispensable for realizing the effect, to be outside of the scope of this project. Although the population receiving the water supply service is increasing in the East District, there are still many people who cannot receive water supply service because the population in Kassala city is also increasing year by year. In the future, improvement of indicators will be expected by proceeding with renewal work of the water distribution pipes and replacement work of the water supply pipe connected to each household by the Sudanese side. But achievement in the target year of 2017 is difficult. Regarding the qualitative effects (improvement of basic living environment for the residents in the target areas) that were set at the time of planning, it was confirmed that many residents feel that the water supply situation has been improved according to the beneficiary survey, although there is a difference in results according to area. It is also assumed that there were many positive impacts on their living environment. Although sufficient information was not collected about the “economic difficulty on water vendors by losing/decreasing their sales activities,” which was a concern as a negative effect at the time of planning, several water vendors who were interviewed at the ex-post evaluation survey said that most of their colleagues have already shifted their job from water vendor. As for the “decline of groundwater level,” it is supposed that it is not caused by the project but caused by over pumping of agricultural wells, etc. Thus, the impact of the project is fair<sup>41</sup>.

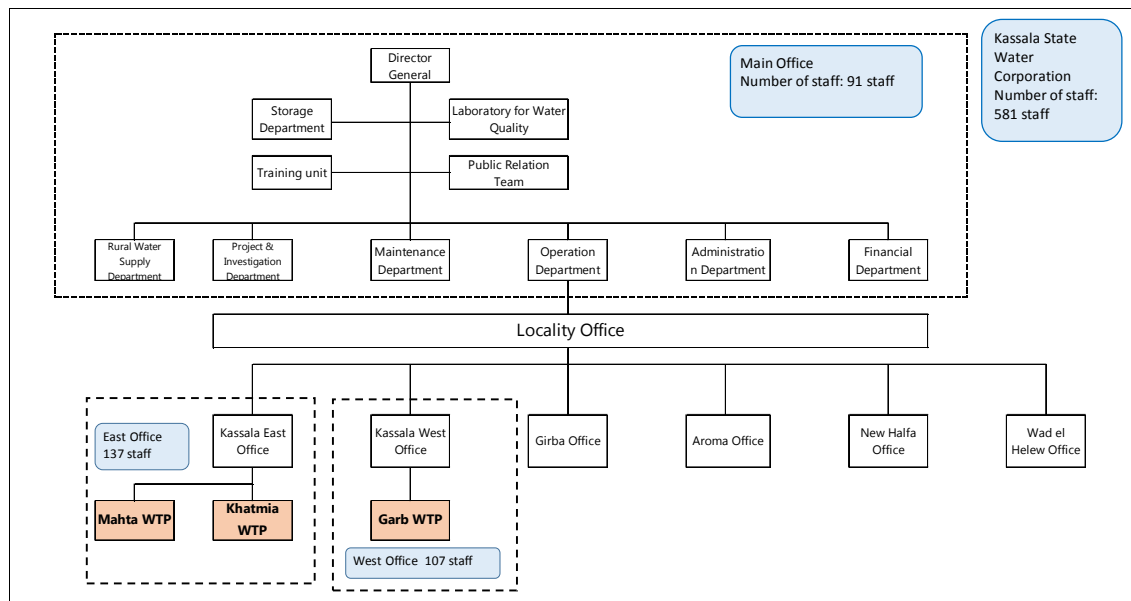
<sup>41</sup> The timing of ex-post evaluation of the Grant Aid Project is the timing at which the project’s outcome is expected. Thus, when evaluating the project’s impact at the time of ex-post evaluation, it is general to assess the impact with taking into consideration the added value that can be seen at the time of ex-post evaluation (refer to FY2016 External ex-post evaluation reference). However, because this project set the quantitative indicators (percentage of households receiving the water supply service, population receiving the water supply service, and daily water use per capita) on the premise that the Sudanese side work, which was outside the project scope, would be completed, as stated in footnote 30, those indicators were determined as impact indicators at the time of ex-post evaluation. In

As stated above, this project has achieved its objectives to some extent, and the effectiveness and impact of the project are fair.

### 3.5 Sustainability (Rating: ②)

#### 3.5.1 Institutional Aspects of Operation and Maintenance

Kassala SWC has the authority to decide the issue about water supply in Kassala State. Figure 3 is the organizational chart of Kassala SWC. There has been no big change from the time of the planning.



Source: Refer to the document provided by “The “Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations””

Figure 3 Organizational chart of Kassala State Water Corporation

The daily operation of the WTPs is carried out by full-time operators belonging to each WTP<sup>42</sup>. In case the operators find trouble of the facilities, they inform the shift leader, and the shift leader contacts the engineer. When the engineer judges that repair is necessary after checking the facilities, he requests the maintenance department to repair the facilities. If the maintenance department cannot manage to repair the trouble, the repair is outsourced by the maintenance department. According to the interviews at the WTPs, the number of O&M staff in each WTP is as shown in Table 15, and the sufficient number of O&M staff is secured.

addition, the work conducted by the Sudanese side, which was implemented outside of the project scope, was recognized as a factor of the development of the project effect, and the target year was set at the time of ex-post evaluation (2017). Therefore, this project was assessed with more emphasis on the impact compared with general ex-post evaluation because the project impact had been expected to be confirmed at the time of ex-post evaluation as planned. It is considered that the plan based on the premise of the Sudanese side work completion, which was implemented outside of the project scope, involved risk.

<sup>42</sup> The four-rotating-shift is applied to each WTP. One shift team in the Mahta WTP and the Khatmia WTP consists of 3 operators (one of them is the shift leader), and the team in Garb WTP consists of 2 operators.

Table 15 Number of staff in WTPs

|             | Mahta WTP | Garb WTP | Khatmia WTP |
|-------------|-----------|----------|-------------|
| Engineer    | 1         | 1        | 1           |
| Operator    | 16        | 13       | 12          |
| Other staff | 3         | 0        | 3           |
| Total       | 20        | 14       | 16          |

Source: Interviews at the WTPs

Therefore, there are no big challenges in the institutional aspect of O&M.

Although the training unit has been established since 2012 at the Kassala SWC, and technical training has been implemented, the activities of the training unit have been stagnant recently. Currently, it has been attempted to revitalize its activities through “The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations”<sup>43</sup>.

### 3.5.2 Technical Aspects of Operation and Maintenance

Operators who received OJTs in the “Rehabilitation Project” and who attended workshops and OJTs of the technical guidance in “Expansion Project” belong to each WTP<sup>44</sup>. It is assumed that there are no big challenges in daily operation as the experienced operator supervises the other operators as a shift leader. However, the chlorine dosing facilities in both the Mahta and Khatmia WTPs that were installed by the project broke down for over the one year. According to the interview with the laboratory staff, the cause was leakage of chlorine gas, and the joint of the changeover corroded due to the fact that its repair was done improperly. Although the training related to the O&M of the chlorine dosing facilities was conducted by the technical guidance of the project, it is considered that proper O&M was not done because one of the three staff members in the laboratory who attended the training quit the job, and the other two only partially attended the training. Subsequently, it was repaired by an expert of “The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations” in November 2016, and it was operating at the time of the ex-post evaluation. For Kassala SWC to maintain the facilities by itself in the future, technical support under the guidance of the expert of “The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations” has been implemented. It is assumed that there are minor challenges with WTP’s O&M as a result of the scoring based on the work achievement sheet in the O&M of WTP and mini tests for the maintenance team conducted by “The Project for Strengthening Capacity of Institutional Management, Operation and

<sup>43</sup> The draft of the business plan developed by Kassala SWC through “The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations” describes revitalization of the training unit.

<sup>44</sup> Not less than 70% of the staff of the Kassala SWC who attended workshops hosted by the technical guidance of the project have worked at the time of the ex-post evaluation.

Maintenance in State Water Corporations” in October 2016<sup>45</sup>. Thus O&M in WTPs is aimed to improve by the activities of “The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations” in the future. Therefore, some minor problems have been observed in the technical aspect of O&M.

### 3.5.3 Financial Aspects of Operation and Maintenance

All the necessary expenses for the O&M of the Kassala SWC, including the WTPs, are covered by the water fees collected from the customers. The water fees in Kassala city are fixed rates. According to the Kassala SWC, the collection rate has been not less than 80% since the start of entrusting the fee collection to the Electricity Corporation in late 2012<sup>46</sup>. As shown in Table 16, the water fees structure are regularly reviewed, and the income is increasing year by year with the increasing number of customers<sup>47</sup>.

Table 16 Monthly water fees by the customer categories<sup>48</sup>

(Unit: SDG)

|                 | 2012 | 2013 | 2014 | 2015  | 2016  |
|-----------------|------|------|------|-------|-------|
| Residential -1  | 40   | 40   | 45   | 50    | 60    |
| Residential -2  | 35   | 35   | 40   | 45    | 55    |
| Residential -3  | 20   | 20   | 20   | 30    | 32    |
| Commercial-A    | 280  | 280  | 350  | 450   | 600   |
| Commercial-B    | 80   | 80   | 120  | 200   | 250   |
| Commercial-C    | 45   | 45   | 65   | 100   | 150   |
| Commercial-D    | N/A  | N/A  | 801  | 1,000 | 1,500 |
| Commercial-E    | N/A  | N/A  | 250  | 350   | 500   |
| Governmental -A | 80   | 80   | 100  | 150   | 200   |
| Governmental -B | 45   | 45   | 55   | 60    | 70    |

Source: Kassala SWC Financial Department

To see the financial document provided by the financial department, there was no year in which the expenditure greatly exceeded its income (refer to Table 17).

<sup>45</sup> On the work achievement sheet, the scoring was conducted for 16 items related to well management, WTP management, procurement, and inventory management. The average score was 23.5 points out of 100 points. Mini tests were conducted on the basic knowledge of water quality and chlorine treatment, and calculation of the chemical injection volume was conducted for 16 maintenance team members from the operation department, maintenance department (electricity section and machinery section), and laboratory. The average score of the mini test was 20.1 points out of 100 points (Document provided by “The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations”).

<sup>46</sup> Regarding the collection of water fees, 77% of customers’ water fee collections are entrusted to the Electricity Corporation, and the remaining 23% customers who do not use electricity are collected by the Kassala SWC.

<sup>47</sup> Revision of water fees and categories was supported by the water cluster of the “Capacity Development Project for the Provision of Services for Basic Human Needs in Kassala (K-TOP), and it was revised since 2014.

<sup>48</sup> There are ten categories (eight categories until 2013) of water fee. The category of “Residential” is household, “Commercial” is restaurant, farm, and factory, and “Governmental” is public institution and schools.

Table 17 Annual income and expenditure of Kassala SWC

(Unit: Thousand SDG)

|                                       | 2012       | 2013       | 2014       | 2015       | 2016       |
|---------------------------------------|------------|------------|------------|------------|------------|
| <b>Total revenue (fee collection)</b> | 14,404,545 | 14,915,700 | 18,424,428 | 23,161,095 | 29,502,108 |
| Residential -1                        | 246,960    | 245,520    | 222,345    | 250,200    | 303,480    |
| Residential -2                        | 1,378,755  | 1,374,345  | 1,562,040  | 1,777,545  | 2,198,790  |
| Residential -3                        | 10,790,280 | 11,281,860 | 13,034,475 | 15,952,230 | 20,003,238 |
| Governmental -A                       | 360,000    | 386,640    | 514,800    | 776,250    | 1,063,800  |
| Governmental -B                       | 133,245    | 131,220    | 115,560    | 106,920    | 141,750    |
| Commercial-A                          | 292,320    | 322,560    | 872,550    | 793,800    | 1,042,200  |
| Commercial-B                          | 669,600    | 678,240    | 1,245,240  | 2,147,400  | 2,704,500  |
| Commercial-C                          | 533,385    | 495,315    | 628,560    | 1,049,400  | 1,594,350  |
| Commercial-D                          | N/A        | N/A        | 72,000     | 90,000     | 108,000    |
| Commercial-E                          | N/A        | N/A        | 156,858    | 217,350    | 342,000    |
| <b>Total expenditure</b>              | 10,926,902 | 13,807,484 | 13,700,233 | 23,204,475 | 18,973,582 |
| Salaries                              | 6,247,864  | 6,858,995  | 7,545,818  | 12,107,198 | 9,955,021  |
| Electricity                           | 2,069,095  | 2,097,532  | 2,510,733  | 2,872,972  | 2,182,541  |
| Fuel                                  | 737,705    | 859,749    | 1,126,495  | 1,371,216  | 960,332    |
| Maintenance (materials, tools, etc.)  | 568,166    | 798,346    | 535,648    | 366,813    | 1,097,412  |
| Others                                | 1,304,072  | 3,192,862  | 1,981,539  | 6,486,276  | 4,778,276  |

Source: Kassala SWC Financial Department

Note: Commercial-D and Commercial-E are the categories introduced since 2014

However, according to the interview with the director general of Kassala SWC, there are some expenses that are not reflected in the total expenditure of Table 17. In fact, the funds are insufficient, and the costs of developing new wells and new facilities are difficult to cover with the income of the customers' fee. Therefore, Kassala SWC depends upon subsidies from federal and state governments as well as through support from donors. Although Kassala SWC manages to develop new wells, the chlorine dosing facilities and distribution pump in Garb WTP, which had been installed in the 1980s by the Japanese Grant Aid Project, have not yet been replaced. As a result, chlorine powder is manually placed in the receiving wells, and only two distribution pumps among three are working<sup>49</sup>. In addition, accurate water distribution volume has not been recorded in Garb WTP, as the flow meter was not installed due to the shortage of funds.

Thus, the financial aspect of O&M has minor problems.

<sup>49</sup> Two out of three of Garb WTP's water distribution pumps, which were procured in the 1980s, were out of work in February 2017. But after repair work done by Kassala SWC, two pumps were working in July 2017.

### 3.5.4 Current Status of Operation and Maintenance

#### (1) Current status of O&M in each WTP

The status of O&M in each WTP at the time of ex-post evaluation is shown in Table 18.

Table 18 Status of O&M at the time of ex-post evaluation (July 2017)

|                      | Mahta WTP  | Garb WTP  | Khatmia WTP   |
|----------------------|--|---|---|
| Operation Records    | <ul style="list-style-type: none"> <li>•The chlorine-dosing facility and distribution pumps are checked and operation records are recorded every day.</li> <li>•Water distribution volume is recorded every hour.</li> </ul>   | <ul style="list-style-type: none"> <li>•No operation record because flow meter was not installed as the project's output of Garb WTP was limited and distribution pump building was not rehabilitated like Mahta and Khatmia WTPs. However, the time of water distribution is recorded.</li> </ul>  | <ul style="list-style-type: none"> <li>•The chlorine-dosing facility and distribution pumps are checked and operation records are recorded every day.</li> <li>•Water distribution volume is recorded every hour.</li> <li>•Engineer can check the water intake and distribution anywhere by using the remote monitoring system.</li> </ul>   |
| Facility Maintenance | <ul style="list-style-type: none"> <li>•Although the chlorine-dosing facility was out of use for a year, it is currently working after the repair by the technical cooperation project.</li> <li>•One of the distribution pumps is not operating due to the high temperature during its operation. (but it is not a big problem at present as one of the distribution pumps is installed as a spare.)</li> </ul> | <ul style="list-style-type: none"> <li>•The facilities rehabilitated by the project are operating without any problem.</li> <li>&lt;The followings are the malfunction of the facilities provided by the Grant Aid Project in the 1980s. &gt;</li> <li>•Only two distribution pumps among three are operating.</li> <li>•Chlorine-dosing facility was out of order since 2011.</li> </ul> | <ul style="list-style-type: none"> <li>•Although the chlorine-dosing facility was out of use for a year, it is currently working without any problem after the repair by the technical cooperation project.</li> <li>•Operator has to adjust the water distribution pump valve manually to control the water flow every time water is conveyed because no screw of the valve for flow adjustment meets its specifications.</li> </ul> |

Source: Observation at the time of ex-post evaluation

Although there are minor challenges in the Mahta and Khatmia WTPs in terms of the current status, their facilities are generally managed well. In the Garb WTP, where the outputs of the project is limited, the existing facilities that have been utilized since the 1980s, such as the chlorine-dosing facility and distribution pumps, are not utilized partially due to deterioration, However, the facilities rehabilitated by the project are managed well.

Thus, generally, there are no challenges in terms of the current situation of O&M.

As stated above, some minor problems have been observed in terms of the technical aspect and financial aspect. Therefore, the sustainability of the project effects is fair.

Column: Negative factors concerning the sustainability of the project effect

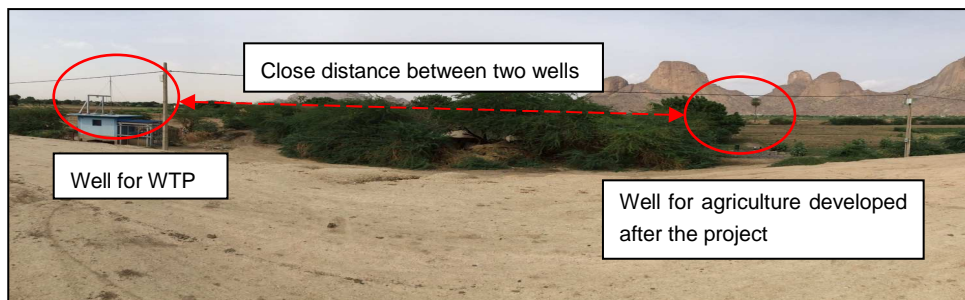
As stated in the section on effectiveness, the water distribution volume and water pumping volume of each WTP tend to decrease. According to the director of the Groundwater and Wadis Kassala branch, it is assumed that over pumping as well as the overdevelopment of agriculture wells due to the expansion of the agriculture lands, mutual interference of wells located within a close distance, and effect of the plant called mesquite (\*1), are causes of the decrease of the groundwater level. However, a clear reason has not been specified at the moment, as the detailed investigation has not been conducted. Kassala SWC has begun periodic monitoring of several wells in the city since November 2016 in order to grasp the current situation of the decline of the groundwater level. A block meeting with the residents to discuss effective water use has also started. (\*2) In addition, new wells for drinking water are being developed by Kassala SWC to increase the water distribution volume. But those efforts require time to take effect, and it is unknown how much they can mitigate the decrease in water distribution due to the decline of the groundwater level.

In July 2017, the Kassala state government established the local act (No.58 and No.59) concerning the management of groundwater, and the coordination and supervising of the groundwater resources management in Kassala state was to be carried out by the Groundwater and Wadis Kassala branch. In addition, the restriction is imposed for future expansion of farmlands and for excavating new wells due to the necessity of approval by the committee chaired by the Groundwater and Wadis Kassala branch. (\*3)

\*1 Mesquite is an exotic species brought in to prevent the desertification. According to the director of the Groundwater and Wadis Kassala branch, it is thought to be a cause of groundwater decline because of its high reproductive potential and deep underground rooting, and, as a result, it hinders the recharge of groundwater.

\*2 Those activities are supported by “The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations.”

\*3 The committee members consist of the Groundwater and Wadis Kassala branch (chair), Kassala SWC (vice chair), Farmers Union, Gash River Training Unit, and Law Administration (Interview with the director of Groundwater and Wadis Kassala branch). It is also assumed that the 3<sup>rd</sup> Joint Coordination Committee (JCC) of “The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations”(2016-2020) held in 27 April 2017 contributed to the establishment of the committee. This is because about 60 stakeholders such as the officers of Kassala SWC, Kassala State government, related ministries, farmers, NGOs, and the residents of Kassala could share the information and discuss groundwater management at this JCC.



(Example of close interval between the well of WTP and agricultural well)

## **4. Conclusion, Lessons Learned and Recommendations**

### 4.1 Conclusion

The projects were implemented in Kassala city located in the eastern part of Sudan, where its population has been growing, with the aim of improving the safe and stable water supply to the residents through the rehabilitation of the existing WTP in the East and West Districts and through the construction of a new WTP in the East District, thereby contributing to improvements in the residents' basic human needs. The projects' implementation was consistent with Sudanese development policy and needs as well as Japan's ODA policy. Therefore, the relevance of the projects is high. Although there were minor modifications from the plan with regard to the construction and soft component (technical guidance), the projects implementation and their cost were almost as planned. However, as the projects period exceeded the plan, the efficiency of the projects is fair. The projects contributed to the improvement of water supply and water quality in Kassala East District and to the water quality in Kassala West District where its outputs had been limited. The positive effects by those contributions were also confirmed. In addition, the risk of bursting of the reservoirs was reduced by upgrading old FRP reservoirs to reinforced concrete reservoirs through the rehabilitation of existing WTPs in the East and West Districts of Kassala city. This led to the reduced future risk of people being affected by the reservoir bursting. However, the people receiving positive effects through the project are limited, as many people are still unable to receive water supply service because the replacement of the distribution pipes and the water supply pipes by the Sudanese side, although it is outside of the projects scope, has been delayed, and also because of the population increase. Therefore, the effectiveness and impact of the projects are fair. Some minor problems have been observed in terms of the technical and financial aspects of O&M. Therefore, sustainability of the projects effects is fair.

In light of the above, the projects are evaluated to be partially satisfactory.

### 4.2 Recommendations

#### 4.2.1 Recommendations to the Executing Agency

(1) Completion of the replacement of a new distribution pipe and water service pipe for the customer

When considering how to effectively deliver water from limited water resources to more residents, while also considering the current situation of Kassala city's water supply, the most effective way is to increase water supply volume by decreasing the water leakage rate. In order to decrease the water leakage rate, it is recommended for Kassala SWC to complete the replacement of a new distribution pipe steadily through close communication with the contractors. In addition, Kassala SWC needs to monitor sufficiently the process of replacing the water supply pipes for existing customers whose installation costs are covered by the customers



so that their installation will be properly completed.

(2) Strengthen cooperation with Groundwater and Wadis Kassala branch

It can be said that Kassala SWC and Groundwater and Wadis Kassala branch will be able to cooperate more easily than ever before through the establishment of the local act related to the management of the groundwater resource from the state government. Kassala SWC has great knowledge about the water supply system, and Groundwater and Wadis has great knowledge about groundwater resources. In order to continuously supply stable water to residents, water supply and water resource management cannot be considered separately. It is significant for Kassala SWC to monitor the fluctuation of the groundwater level periodically and consider the proper water resource management as well as the water supply management in the future in cooperation with the Groundwater and Wadis Kassala branch.

(3) Making sure to keep the O&M record

Although the operation records such as check records of the facilities and water intake/water distribution are taken on a daily basis in the Mahta WTP and Khatmia WTP, maintenance records such as engine oil change logs of the generator are not taken. For efficient O&M in the future, it is recommended to take a maintenance record in addition to the daily operation records. Regarding the Garb WTP, it is desirable to take records of water intake/water distribution together with the installation of the flow meter, since it is not even possible to record the intake and distribution as there is no flow meter installed.

(4) Providing the training opportunities for the operator of WTP

Many operators requested training related to maintenance during the interview with the operators. Although the training for operators is being conducted by “The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations,” it is recommended that the training unit of the Kassala SWC takes initiative to provide more training for the staff. Kassala SWC has personnel to conduct the maintenance training and OJT for operators, as some staff members were dispatched to receive training at the Drinking Water and Sanitation Training Center (DWST), and the staff members who have taken the TOT (Training of Trainers) at the DWST can conduct the training as trainers. Thus, it is important for the Kassala SWC to secure the cost of training proactively and promote the capacity building of the staff by itself to enhance the sustainability of the project’s effect.

(5) Promoting water conservation among residents

In the beneficiary survey, there are many residents who responded that their living environment became comfortable due to an increase in water supply, but some residents responded that the situation of water supply worsened. One of the reason for worsened water

supply situation for some residents is considered that the residents in areas close to the WTPs, where the water supply situation was relatively good before the project, used water more than before due to the improvement of the water supply situation, and as a result, the water volume and water pressure in areas far from the WTPs were restricted. It was pointed out that residents wasted water because the monthly water fee in Kassala city is a fixed rate and is not proportional to the water usage<sup>50</sup>. The demand for water use is expected to increase in the future because the population in Kassala city tends to increase. To provide water supply service to all residents equally, it is important for the Kassala SWC to continue educational activities on efficient water usage. Although it is considered that the future excavation of new wells is restricted by the establishment of a local act, it is recommended that Kassala SWC persistently educate the farmers about the over pumping of existing agricultural wells.

#### 4.2.2 Recommendations to JICA

(1) Enhancing the improvement of water supply service through the continuous support of the JICA technical cooperation project

It is very crucial to manage the groundwater in order to provide water supply service that continuously meets customer demands in the future. Also, an indispensable issue for improving future water supply service is how to effectively use limited water resources for water supply service. For that purpose, JICA is implementing the capacity development of the water supply service of Kassala SWC, including the water leakage control and the water supply system monitoring, through “The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations.” Regarding groundwater resource management, it is recommended to support strengthening capacity of the Groundwater and Wadis Kassala branch and educating the residents and farmers about the effective water use of limited water resources through the activities of the “Project for Enhancement of Integrated Water Resources Management.”

#### 4.3 Lessons Learned

##### Making the plan to enhance the sustainability of the Grant Aid Project

Collaboration with technical cooperation projects during and after the project implementation has contributed greatly to the effectiveness, impact, and sustainability of the project. Firstly, during the implementation of the project, renewal work of the water distribution piping network

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<sup>50</sup> Introduction of the water meter system is the most effective way to prevent wasteful water use. But the main collection system of the water fee in Sudan is the flat rate system. Thus, it is assumed that it requires considerable time and continuous support such as securing a budget, building the system, and human resource development to shift the water meter system from the flat rate system. By taking a step, it is desirable to gradually introduce the water meter system after strengthening the management capacity of Kassala SWC to operate and maintain the system

by the Sudanese side advanced by supporting the management of pipe network facilities of Kassala SWC through the water cluster of “Capacity Development Project for the Provision of Services for Basic Human Needs in Kassala (K-TOP) (2011-2015).” In addition, the water fee that had not been revised for many years was revised with the support of K-TOP and thereby improved the financial situation of Kassala SWC. Furthermore, K-TOP also contributed to the launch of the training unit, which provided the foundation of the current O&M knowledge of Kassala SWC staff, and various technical trainings were conducted under the training unit during the implementation of K-TOP<sup>51</sup>.

Secondly, after the project, the chlorine dosing equipment provided by the project was repaired with the support of “The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations (2016-2020).” In addition, continuous advice in terms of maintenance method is also provided by “The Project for Strengthening Capacity of Institutional Management, Operation and Maintenance in State Water Corporations.” Although the technical training of O&M of the facilities was conducted during the project through the so-called “Soft Component,” it is difficult to practically learn facility repair at the time of provision because the facilities are new. In this manner, it is very effective to make a plan from a program perspective, in which technical cooperation projects implement technical support during and after the grant aid, to improve the sustainability of the project.

#### Including the work to be implemented by the partner country in the project scope to enhance the project effect

At the time of the project planning, it was recognized that completion of the water distribution pipe renewal work and water supply pipe connection work conducted by the Sudanese side was indispensable for the project’s effectiveness, and the indicator of the quantitative effect of the project was set based on that assumption. However, as a result of the work on the Sudanese side not being included in the project scope as a necessary work covered by the partner country and implemented outside of the project scope, the project’s effectiveness was affected by external factors such as delayed work on the Sudanese side. In this manner, to prevent external factors from hindering the development of the aimed effect of the project, in the case that difficulty is foreseen in the feasibility, after recognizing the technical, institutional, and financial capacity of the partner country with regard to components indispensable for the project effect, it is desirable to include it within the project scope as part of the work to be borne by the partner country and to manage the progress while also sharing progress with the partner country to enhance the project effect.

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<sup>51</sup> The training unit is reducing its activities at the time of the ex-post evaluation. Thus, the revitalization of the training unit is included in the recommendation to the Kassala SWC.