EXECUTIVE SUMMARY

1. BACKGROUND OF THE STUDY

In Sana'a Basin, where the capital of Yemen is situated, development of deeper aquifer has been greatly increased to meet the dual demands of domestic water supply and irrigation. As a result, the water shortage has become worse, and is now being accelerated by continued imbalance between annual recharge and the growing water demand.

Sana'a Basin was designated to be "Water Protection Zone" by the Cabinet Decree No. (344) in 2002, and was designated as the one of the five critical basins. Then, the National Water Resources Authority Sana'a Branch (NWRA-SB) was established in 2003 to implement activities related to water resources management for Sana'a Basin. Additionally, the Sana'a Basin Commission (SBC) was organized with the technical secretariat NWRA-SB to execute management of water resources in Sana'a Basin. Comprehensive water resources studies inside Sana'a Basin have been conducted since 1970s; however, NWRA-SB has faced difficulties in implementing water resources management effectively. In this context, the Government of Yemen requested the Government of Japan to execute the technical cooperation plan, to formulate water resources management action plan for Sana'a Basin, based on the existing data and information.

2. FUTURE SCENARIOS BASED ON SOCIO-ECONOMY AND WATER DEMAND IN SANA'A BASIN

(1) Future Water Balance

The projected future water demand is gradually increased from 269.3 MCM in 2005, to 349.6 MCM in 2020. As the same time, renewable groundwater resources were estimated to be only 50.7 MCM/year. The balance, between renewable resources and demand is estimated to be minus 298.9 MCM in 2020, if the recharge amount is not changed. The implication of these numbers is that non-renewable water resources will continue to decrease. Additionally, the estimated amount of usable groundwater in the existing data is 5,212 MCM. Therefore, if the water consumption is continued in accordance with the projected future water demand, usable groundwater would not be able to meet the demand in the year of 2021, as shown in *Figure 1*.

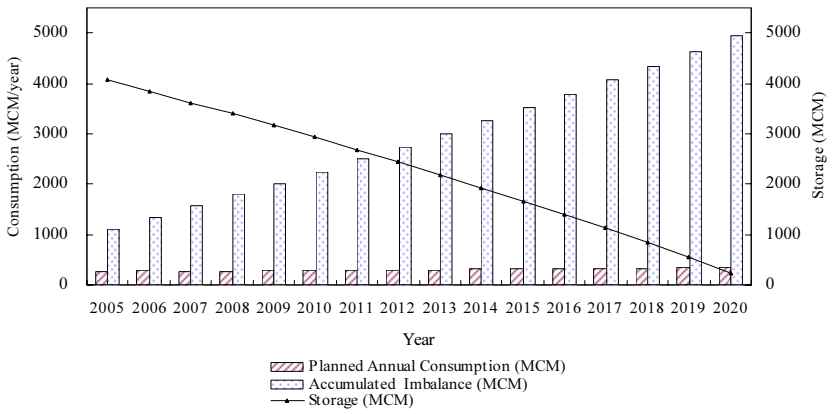

Figure 1 Decreasing of Storage with Planned Future Demand

(2) Future Scenarios

In order to keep sustainability of water resources in the Basin, all irrigation activities should be stopped and water to be supplied for urban areas should be nearly two thirds. However it is unrealistic way considering that economic activities rely on the agriculture sector. Therefore, all stakeholders are strongly required to reduce water consumption by 2020 at the very latest so as to obtain the opportunity to approach the next steps, in accordance with the scenario showing the direction towards reducing water consumption. In this study, from the view point of this, the scenarios for water demand were considered. Considered scenarios with a target figure in the year of 2020 are summarized in *Table 1* and shown in *Figure 2*. These four scenarios are prepared in combination with scenarios of five sectors. Condition of setting for each scenario is as follows.

- Scenario 1: The values for less contribution to reduction of water consumption in each sector such as higher growth rate and lower irrigation efficiency, which are set in the existing plan and set by the Study team, are applied.

- Scenario 2: The values for the most possible reduction of water consumption set by the Study team for urban area water supply and irrigation use that account for large portion of total water consumption are applied.

- Scenario 3: The values for the most possible reduction of water consumption set by the Study team are applied to not only urban area water supply and irrigation use but also industrial and touristic use.

- Scenario 4: The values for the most possible reduction of water consumption set by the Study team are applied to urban area water supply, industrial use and touristic use. For irrigation use, reduction of water consumption to 50 MCM is applied taking into consideration the reuse of treated wastewater in the year 2020.

Table 1 Summarized Scenario of Water Demand

	Urban Area Water Supply (Domestic and Institutional)	Domestic Use in Rural Area	Industrial Use	Touristic Use	Irrigation Use	Total[*8)] Consumption
Scenario 1	Population: 3,198,573 LPGR[*1)] Physical Loss: 14.6 MCM (20%)[*2)] Unit water consumption : 35 l/c/d[*3)]	Population: 437,532[*5)] Unit water consumption: 20 l/c/d[*5)]	Historical growth rate, DPPR[*6)]	Based on DPPR	No expansion of irrigated area since 2005 IE: 60%[*7)] Actual requirement: 83.68 MCM/year	***232.3***
MCM/year	**73**	**3.2**	**9.5**	**7.1**	**139.5**	
Scenario 2	Population: 3,198,573 LPGR Physical Loss: 10.3 MCM (15%)[*4)] Unit water consumption: 35 l/c/d	Population: 437,532 Unit water consumption: 20 l/c/d	Historical growth rate, DPPR	Based on DPPR	No expansion of irrigated area since 2005 IE: 70% Actual requirement: 83.68 MCM/year	***208***
MCM/year	**68.7**	**3.2**	**9.5**	**7.1**	**119.5**	
Scenario 3	Population: 3,198,573 LPGR Physical Loss: 10.3 MCM (15%) Unit water consumption: 35 l/c/d	Population: 437,532 Unit water consumption: 20 l/c/d	No growth in Industry inside the Basin since 2005	No growth in Tourism inside the Basin since 2005	No expansion of irrigated area since 2005 IE: 70% Actual requirement: 83.68 MCM/year	***196.6***
MCM/year	**68.7**	**3.2**	**4.8**	**0.4**	**119.5**	
Scenario 4	Population: 3,198,573 LPGR Physical Loss: 10.3 MCM (15%) Unit water consumption: 35 l/c/d	Population: 437,532 Unit water consumption: 20 l/c/d	No growth in Industry inside the Basin since 2005	No growth in Tourism inside the Basin since 2005	Reduce 11,111 ha of irrigated area out of 18,954 ha Install improved irrigation system for 7,843 ha	***127.1***
MCM/year	**68.7**	**3.2**	**4.8**	**0.4**	**50**	

*1) LPGR: Limited Population Growth Rate set in Sana'a Water Supply and Sanitation Project (SWSSP)

*2) Physical Loss, 20% is set in SWSSP

*3) Option 1 set in SWSSP, Minimum option, water is supplied of entire city population

*4) Physical Loss, 15% is set by the Study team

*5) Population growth rate in rural area: 2.5%adopted by GARWSP and unit water consumption, 20 l/c/d: adopted by NWRA.

*6) Calculated value based on the Socio-economic development plan for poverty reduction (DPPR, 2006-2010)

*7) Irrigation efficiency

*8) Total consumption includes loss of water supply and overuse in irrigation

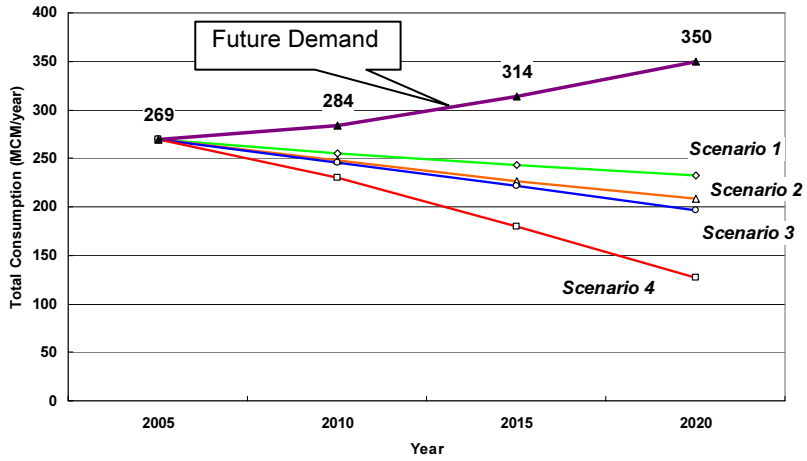

Figure 2 Scenarios for Water Demand (2005 – 2020)

(3) Future Scenario towards Maximum Sustainability

Four scenarios aiming at reducing consumption of water resources set are evaluated taking into consideration the difficult condition of water resources, in order to select most reasonable scenario. Result of evaluation of each scenario is as follows.

- Scenario 1: Though the irrigation efficiency is set at 60%, there is a possibility of further improvement of the efficiency by installing pipes for water conveyance. In addition, physical loss in urban water supply is set at 20%. However, the percentage of physical loss is able to be reduced by introducing the technology of water leakage detector for invisible leakage from the ground. Therefore, it can be concluded that there is a possibility of further reduction of water consumption in this scenario.

- Scenario 2: Reduction of water consumption in irrigation use and urban area water supply sectors which account for large portion of total water consumption, is the largest as much as possible. While no measure to reduce water consumption in industrial and touristic use is taken. Therefore, it can be concluded that there is a possibility of further reduction of water consumption in this scenario.

- Scenario 3: Reduction of water consumption in irrigation use and urban area water supply sectors which account for large portion of total water consumption, is the largest as much as possible. In addition, control of the growth of water demand in industrial and touristic sectors is set in this scenario. Therefore it is concerned that economic activities would be affected if further measures are taken to reduce water consumption.