

## CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

### 6.1 CONCLUSIONS

- (1) Re-evaluation of water resources in Sana'a Basin was carried out and warned that if the projected future water demand is tried to be satisfied, usable groundwater resources is estimated to be depleted before the year 2020. Even if the present water consumption that is 270 MCM/year is continued, it is estimated to be depleted before the year 2024. It became cleared that the reduction of water consumption is fundamental things towards sustainability of water resources in Sana'a Basin
- (2) Reduction of water consumption to the amount of renewable water resources that is from 220 MCM in 2005 to 50 MCM in the year 2020 is the ultimate but unrealistic scenario. Therefore, four scenarios for future water demand are considered based on the existing programs and possibility of the implementation of contents of scenarios. Consequently, from the view point of utmost possibility, the one scenario to be in line with is selected which is aiming at reducing water consumption from 352.8 MCM to 199.8 MCM in the year 2020. Then, it makes possible to mitigate severe condition of water resource as much as possible and to extend the period of depletion of water resources until the year 2036 that is around 30 years later from 2007.
- (3) Water Resources Management Action Plan for Sana'a Basin, which presents the actions to be taken to achieve the goal of selected scenario, is formulated. Action Plan is composed of two categories that is "Action Plan" and "Action to be taken for Further Progress" considering the effectiveness. The former, which is composed of eight actions, is the action to be taken immediately, and the latter, which is composed of three actions, is to aim at obtaining better achievement of water resources management.
- (4) The Action Plan focuses on reducing overuse in water consumption, securing domestic water and development of institution and organization. Total amount of water to be reduced by 2020 is estimated to be 153 MCM/year in 2020 mainly composed of the improvement of irrigation efficiency, reducing physical loss of urban water supply and reuse of treated wastewater.
- (5) Difference of water imbalance among sub-basins which implies future possibility of conflict caused by deficit of water, will be mitigated by using treated wastewater and reallocation of water resources consumed in irrigation purpose.
- (6) Alternative water sources for Sana'a city were concluded to be not feasible from the view point of financial evaluation for the operation and maintenance, even if the adverse impacts on social and economic aspects are mitigated. These alternatives will become feasible when the restriction of financial aspect including investment cost is solved.

### 6.2 RECOMMENDATIONS

#### (1) Budget Allocation

In order to smoothly and effectively implement the water resources management action plan presented in this study, NWRA SB is advised to allocate enough budget considering the investment program set forth in NWSSIP.

**(2) Periodical Monitoring and Modification**

Action plan presented in this reports should be monitored and modified periodically in accordance with the progress of each action and current conditions by SBC with its technical secretariat NWRA-SB.

**(3) To commence the actions immediately**

Considering the critical water resources conditions inside Sana'a Basin, under the initiative of SBC and its technical secretariat NWRA SB, and other organizations concerned are strongly required to launch towards achievement of the Action Plan immediately.

**(4) Acceleration of finalization of Executive Regulation and bylaw**

It is strongly recommended that finalization of Executive Regulation and development of Sana'a Basin Bylaw be achieved considering that groundwater metering and groundwater charge levying shall be one of the most indispensable prescriptions to address the issues of over-consumption for water-demanding cash crop and excessive water loss.

**(5) Incorporation of Local Council**

Considering the limited staff of NWRA SB and responsibility of Local Council for basin level water resources management, there is a significant need to develop mechanism on field monitoring network in collaboration with local authorities.

**(6) Close Cooperation among Organization Concerned**

The improvement of irrigation efficiency which should be applied to all farmlands is the essential for the achievement of the water resources management action plan for Sana'a Basin. As it has been reported in existing documents related to SBWMP, the progress of dissemination of improved irrigation system was in behind. Therefore, all organizations concerned especially MAI, NWRA-SB and WUAs are strongly recommended to carry forward this action in close cooperation.

**(7) Acceptance of Water Users in Sana'a City on Reducing Unit Consumption**

As it is mentioned in Chapter 2 "Present Situation of Water Resources and Water Use in Sana'a Basin", designed unit water consumption for urban area and rural area are 35 l/c/d and 40 l/c/d, respectively. Since the responsible organization for urban water supply, SWSLC has set 35 l/c/d as unit water consumption considering the condition of water resources, the responsible organization for rural water supply GARWSP is recommended to set reliable amount for rural water supply through the discussion with organizations concerned especially NWRA-SB and SWSLC from the view point of water resources management.

**6.3 FUTURE CONSIDERATION**

It was elucidated that the groundwater resources inside Sana'a Basin will be depleted by the year of 2020 if the water demand is increased in accordance with existing scenarios and tendency in each sector. Therefore, the most feasible scenario is prepared in this study considering the utmost possibility of the implementation of scenario of each sector and maximum effect on reducing water consumption. By implementing the prepared scenario with saving water resources of 153 MCM in 2020, such severe condition of water resources will be mitigated as much as possible, and the period for the depletion of water resources will be expanded until the year of 2036 that is around 30 years later from 2007.

However, the limited groundwater resources will be finally depleted. Then irrigation is forced to be quitted and those who are living inside the Basin will not be supplied domestic water. Consequently, all economic activities will not be able to be continued. Even before the groundwater is completely depleted inside Sana'a Basin, the conflict among people must be broken out due to regional depletion of groundwater resources. Therefore, before encountering such unacceptable situation, all stakeholders are strongly required to prepare further countermeasures to overcome it.

In case any countermeasures are not effectively implemented before the groundwater is depleted, socio-economic activities inside Sana'a Basin will be severely damaged and not be recovered. However, by implementing the Action Plan presented in the report, the foundation for water resources management such as awareness of stakeholders, institutional and organizational conditions and skills will be consolidated by the year of 2020 with the achievement of saving water resources and be definitely ready towards further sustainability of water resources for next generation.

Therefore, during the implementation period of the Action Plan, the Government of Yemen is also required to prepare further countermeasures and to make a decision towards further sustainability of water resources inside Sana'a Basin where the Capital city of Sana'a is situated.