

CHAPTER 5 WATER RESOURCES MANAGEMENT ACTION PLAN FOR SANA'A BASIN

5.1 DIRECTION OF ACTION PLAN

In order to mitigate critical situation of water resources and to secure future of next generation, action plan to be taken immediately are formulated as listed in *Table 5.1*, considering the present condition of water resources and future scenarios of socio-economy as described in the previous chapters. Water resources management action plan is composed of two categories considering the effectiveness as shown in *Table 5.1*. "Action Plan" is the action to be taken immediately in order to achieve the Scenario 3 as mentioned in section 4.5 in Chapter 4. The consideration of each activity of actions is described. Then the proposed schedule for each activity is presented considering on-going projects. "Action to be taken for Further Progress" is to aim at obtaining better achievement of water resources management.

Table 5.1 Actions to be Taken

No.	Contents of Water Resources Management Action Plan for Sana'a Basin	Section No.
<i>Action plan</i>		
1	Reduce of water consumption for irrigation purpose	5.2.1
2	Reduce of physical loss of urban water supply	5.2.2
3	Assuring reuse of treated waste water	5.2.3
4	Constant consumption of industrial use	5.2.4
5	Constant consumption of touristic use	5.2.5
6	Institutional development	5.2.6
7	Organizational development	5.2.7
<i>Actions to be taken for Further Progress</i>		
1	Protection of groundwater resources from contamination	5.3.1
2	Effective use of recharge system	5.3.2
3	Optimization of water supply covered by private supplier in Sana'a city	5.3.3
4	Inter-Regional and Sectoral Reallocation of Water Resources	5.3.4

By implementing the action plan until the year 2020, around 150 MCM/year of water resources can be saved comparing the water demand based on the present conditions in the year of 2020, and limited water resources can be utilized until the year 2036 which is around 30 years later from 2007. During this expanded period, all stakeholders are seriously required for future another generation to consider next actions towards sustainability of water resources.

Detailed contents of action plan are described in following sections.

5.2 ACTION PLAN

5.2.1 REDUCE OF WATER CONSUMPTION FOR IRRIGATION PURPOSE

Purpose

To save the amount of 90 MCM of water consumption for irrigation purpose by the year of 2020 by improving the irrigation efficiency from 40% to 70%

To reduce the water consumption for irrigation purpose by means of improvement of irrigation efficiency from 40% to 70% should be implemented so as to save 90 MCM/year of limited water resources by the year of 2020 comparing present water consumption of irrigation that is 209 MCM. Therefore, consumption for irrigation purpose will be reduce to 119 MCM/year in 2020. The action should be carefully carried out not to support extension of their irrigated land, which might be easily happened by transferring saved water.

Activities

(1) *Increasing the farmers' perception of effectiveness of improved irrigation system*

Although the substantial improvement such as less water consumption, increase of crop yield, less fertilizer and less fuel consumption have been observed at pilot farms through the introduction of improved irrigation system as one of the components of SBWMP, dissemination of this methods is still remained insufficient. Improved irrigation system has been installed in irrigated land with the area of 211 ha by SBWMP, which is less than 5% of the project target of 4,000 ha. Though the progress of installation is remained slow, it should be addressed by developing successful program accompanied with improvement of the capability of WUAs by conducting activities mentioned in section 4.2.5 4).

Thus, the promotion activity as a part of raising awareness activity shall be enhanced with close cooperation with Local Council, WUA and WUG, showing those positive results effectively to other farmers and the period of cost recovery to investment using the results obtained through SBWMP.

(2) *Convincing farmers not to expand their own farmland*

Control of expansion is also one of the activities to minimize water consumption. This activity, however, shall be simultaneously executed with raising awareness of farmers, incentives and enforcement of regulation.

(3) *Installation of improved irrigation system*

Annual amount to be saved, accumulated saved amount and total consumption of irrigation use are graphed in *Figure 5.1*. In order to save the amount of 1.0 MCM, 0.0047 MCM/ha with the improvement of irrigation efficiency from 40% to 70% should be achieved at irrigated land of 212 ha, which corresponds to around 62 farm lands. This area is calculated by adopting 40% of irrigation efficiency for present condition and weighted arithmetic mean of the actual evapotranspiration of each crop that is 0.0044 MCM/ha. Therefore, the consumed water in 1.0 ha at present is estimated at 0.011 MCM.

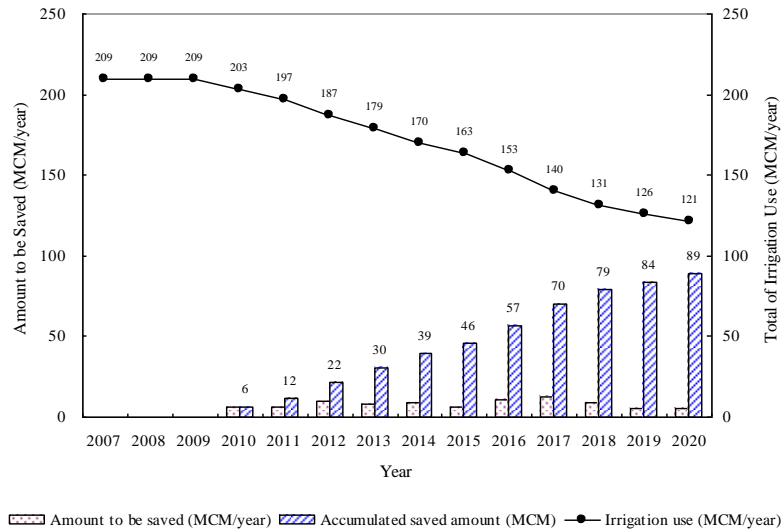


Figure 5.1 Scenario for Reducing Water Consumption for Irrigation Purpose

Improvement of irrigation efficiency should be carried out by sub-basin and addressed first the large water imbalanced sub-basins. Table 5.2 shows the detailed schedule for annual reduce of water consumption by the improvement of irrigation efficiency for sub-basin until the year of 2020.

For the implementation, “Wadi Al Huqqah”, “Wadi Bani Huwat”, “Wadi As Sirr”, “Wadi Al Furs” and “Wadi Al Mawrid” shall be addressed first in the year of 2010. Then other sub-basin should be gradually addressed. Finally, 90 MCM of overuse water can be reduced by the year 2020.

Cost for installation of improved irrigation system is estimated to be between 3,600 and 4,800 US\$/ha depending on the conveyance system and irrigation system to be applied (Ministry of Water and Environment). Then total cost for system is estimated to be between 68 million US\$ and 91 million US\$ in 11 years from 2009 to 2020 (from 6.2 to 8.3 million US\$/year in average) for 18,955 ha. According to NWSSIP, from 5 to 6.5 million US\$/years from 2005 to 2009 are scheduled to allocate for Sana’a Basin Water Management Project for the part of irrigation and watershed management. Difference of cost and the cost from 2010 should be allocated.

(4) *Introducing watering control system with installation of water flow meter*

Introducing watering and fertilizing control system including installation of water flow meter, which is one of the most important factors to reduce overuse of water and maximize productivity, shall be considered with technical support from experts so as to keep or improve effectiveness of modern irrigation technique.

(5) *Improvement of capability of NWRA-SB or staff in charge of irrigation activities*

As mentioned in section 3.2.6 in Chapter 3, it is also necessary to establish the effective training course with experienced trainer to develop capability of the organizations related to installation, operation and maintenance of improved irrigation system in the early stage of the above schedule, that is, from the year of 2008 to 2011.

Table 5.2 Schedule for Reduce of Irrigation Water Consumption

Year		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020		
Amount to be reduced by year		0.0	0.0	0.0	6.00	6.00	9.82	8.52	9.00	6.53	10.99	12.90	9.06	5.17	5.10		
1	Wadi Al Mashamini	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.6	0.6	0.6	0.6	
													0.32				0.3
		69											68				68
2	Wadi Al Madini	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	3.5	2.9	2.9	2.9	2.9	
												1.0	0.7				1.7
		352										213	138				351
3	Wadi Al Kharid	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	1.9	1.9	1.9	1.9	
												1.0	0.1				1.1
		238										213	26				238
4	Wadi Al Ma'adi	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	0.8	0.8	0.8	0.8	0.8	
												0.5					0.5
		100										100					100
5	Wadi A'sir	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	6.6	5.6	4.9	4.9	4.9	4.9	
											1.0	1.0	0.79				3
		593									213	213	168				594
6	Wadi Khulaqah	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	
												0.85					0.9
		181										181					181
7	Wadi Qasabah	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	1.5	
																0.87	0.9
		186													185		185
8	Wadi Al Huqqah	14.5	14.5	14.5	13.5	12.5	11.5	10.5	9.5	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
					1.0	1.0	1.0	1.0	1.0	0.53							
		1176			213	213	213	213	213	113							1177
9	Wadi Bani Huwat	48.7	48.7	48.7	46.7	44.7	42.7	40.7	38.7	36.7	33.7	30.2	26.0	26.0	26.0	26.0	
					2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.5	4.18				22.7
		4826			426	426	426	426	426	426	638	745	889				4826
10	Wadi Thumah	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	0.7	
																0.59	0.6
		126													126		126
11	Wadi As Sirr	24.7	24.7	24.7	23.7	22.7	21.7	20.7	18.7	16.7	14.7	12.5	12.5	12.5	12.5	12.5	
					1.0	1.0	1.0	1.0	2.0	2.0	2.04	2.20					12.2
		2603			213	213	213	213	426	426	434	468					2604
12	Wadi Al Furs	8.6	8.6	8.6	7.6	6.6	5.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	
					1.0	1.0	1.0	1.0									4.0
		856			213	213	213	217									855
13	Wadi Al Iqbal	19.7	19.7	19.7	19.7	19.7	18.7	17.7	16.7	15.7	14.2	12.4	12.4	12.4	12.4	12.4	
							1.0	1.0	1.0	1.0	1.5	1.73					7.2
		1538					213	213	213	213	319	368					1538
14	Wadi Zahr & Al Ghayl	16.3	16.3	16.3	16.3	16.3	15.3	14.3	13.3	12.3	10.2	10.2	10.2	10.2	10.2	10.2	
							1.0	1.0	1.0	1.0	2.1						6.1
		1297					213	213	213	213	447						1298
15	Wadi Hamdan	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	9.2	7.7	6.5	6.5	6.5	
												1.0	1.5	1.21			3.7
		789									213	319	257				789
16	Wadi Al Mawrid	8.8	8.8	8.8	7.8	6.8	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	
					1.0	1.0	1.47										3.5
		739			213	213	313										738
17	Wadi Sa'wan	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	9.6	8.6	7.1	5.1	5.1	
												0.5	1.0	1.5	1.96		5.0
		1055									106	213	319	417			1055
18	Wadi Shahik	10.3	10.3	10.3	10.3	10.3	9.0	7.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	
							1.35	1.5	2.0								4.9
		1032					287	319	426								1032
19	Wadi Ghayman	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4.5	3.0	3.0	
														1.0	1.5		2.5
		533											213	319			532
20	Wadi Al Mulaikhy	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	2.5	2.2	2.2	
														1.0	0.3		1.3
		269											213	57			270
21	Wadi Hizyaz	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	1.7	
																1.0	1.0
		206													206		206
22	Wadi Akhwar	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	1.6	
																0.9	0.9
		191													191		191

unit : million cubic meter

above : Annual water consumption in sub-basin in accordance with plan

middle : Amount of water to be reduced in sub-basin

below : Areas in hectare where improved irrigation system should be installed

Note : Figures in below cell on the left side is the present irrigated area in hectare, Noman and Mulat (2007)

Alternatives to reduce water consumption for irrigation purpose

(1) Introducing the less water consumption crops

In addition to installation of improved irrigation system, introduction of less water consumption crops also contributes to reduce consumption of water. However, trial for diversion of crops has been just started under the SBWMP and the result of the trial has not been reported yet. Therefore, it is necessary to understand detailed information including effectiveness first by conducting pilot scheme.

In case the introduction of less water consumption crops is concluded to be effective, it is required for governmental body in early stage, to create the market for introduced crops so as to secure stable income generation of farmers.

(2) Reduce of irrigated land

Reduce of irrigated land also contributes to save water. For this activity, compensation system for farmers should be established in advance.

Responsibilities

Related organizations and their responsibilities are described in *Table 5.3*.

Table 5.3 Responsibility for Improvement of Water Use Efficiency for Irrigation Use

Organizations	Responsibility
MAI	Execution organization
WUA, WUG	Dissemination of improved irrigation system for others
Local Council	Support for increasing awareness of farmers and dissemination
NWRA-SB	Increasing awareness of farmers

Under the initiative of NWRA-SB, this action shall be taken by MAI, Local Council and WUA. NWRA-SB will be a responsible for increasing awareness of farmers and monitoring water consumption for irrigation use.

5.2.2 REDUCE OF PHYSICAL LOSS OF URBAN WATER SUPPLY

Purpose

To save the amount of 9.9 MCM of water consumption for urban water supply by the year of 2020 by reducing physical water loss from 30% (inferred figure) to 15%.

To reduce overuse of urban water supply network operated by SWSLC should be implemented to save water with the amount of 9.9 MCM comparing the projected future water demand that is 78.6 MCM in 2020 by reducing physical water loss from 30% to 15%.

Activities

(1) *Persuading water users in Sana'a city to accept the reduce of unit water consumption*

According to SWSLC's water supply plan, unit water consumption of 35 l/c/d is designed aiming at supplying water entire population in Sana'a city. Since the actual per capita consumption in 2005 was 50.8 litter/day, if the designed unit consumption is applied, per capita consumption should be reduced around 30% of present consumption. Therefore, SWSLC is required to take necessary actions to persuade water users in Sana'a city to accept the reduced consumption in parallel with reducing physical loss.

(2) *Improvement of the capability of leakage detection*

In order to effectively reduce water leakage, improvement of capability of leakage detection is the one of the key factors. Therefore, SWSLC is required to prepare detailed schedule to reduce leakage to 15% in the year 2015 and to improve the capability including the investigation of leakage, the introduction of leakage detector together with technology transfer by well-experienced experts and investment program for the investigation and renewable or repair of damaged distribution pipes, taken into consideration of the progress of on-going project of replacement of distribution pipes funded by World Bank. In addition, the schedule for the periodical replacement or calibration of house connection meters and meters installed on production wells should be also included in the schedule.

Assuming that leakage of 30% is reduced to 15% based on the actual production amount of 2004, saved amount of water is converted to between 1.35 and 1.74 million US\$/year depending on the consumption amount in household and institutions.

(3) *Monitoring of production amount and progress of improvement of losses*

NWRA SB is required to periodically collect the information about production amount of urban water supply and the progress of improvement of losses such as leakage of transmission and distribution mains, storage tanks and connections which are carried out by SWSLC so as to manage water resources properly.

Responsibilities

Related organizations and their responsibilities are described in *Table 5.4*.

Table 5.4 Responsibility for Improvement of Water Use Efficiency for Urban Water Supply Covered by SWSLC

Organizations	Responsibility
SWSLC, Municipality	-Persuading water users to accept reduced per capita consumption. -Preparing the detail schedule for reducing losses
NWRA-SB	Monitoring of production amount and improvement of leakage

5.2.3 ASSURING REUSE OF TREATED WASTEWATER

Purpose

To reuse of treated wastewater with the amount of 50 MCM for irrigation purpose by the year 2020 so as to save water consumption for irrigation purpose.

As mentioned in section 3.6.3 in Chapter 3, SWSLC has already launched the expansion of capacity of the wastewater treatment plant (WWTP) with the capacity of 105,000 m³/day and aimed at utilizing for the irrigation purpose. Total capacity will become 155,000 m³/day by the year 2020. Assuming that around 90% of the effluent with sufficient quality is regarded as usable, the amount of available water resources is estimated at 50 MCM/year. Then water consumption for irrigation purpose can be saved 50 MCM/year from the year 2020. Therefore, it is necessary for SWSLC, NWRA-SB and WUA to assure the reuse of treated wastewater for irrigation purpose by the year of 2020 by conducting activities mentioned below.

Activities

(1) Assuring the improvement of existing WWTP and new construction of WWTP

Procedures of rehabilitation on existing WWTP with capacity of 50,000 m³/day, and construction of new WWTP with capacity of 105,000 m³/day and the treatment facility for sewage on cesspit should be properly managed by SWSLC.

(2) Planning for distribution of treated wastewater

Though it seems to be most feasible way to distribute treated wastewater by gravity to the farm lands situated down stream, the organizations concerned especially MAI and SWSLC are required to consider the feasibility for distribution of the treated wastewater to other sites where the balance between recharge and abstraction inside sub-basin will be still remained in large minus as of the year 2020. Since there will not be enough demand of irrigation to consume the treated wastewater at the area of downstream, it is necessary to consider proper way to use the limited water resources as much as possible.

Proposed areas for distribution of treated wastewater are “Wadi Al Huqqah”, “Wadi Bani Huwat”, “Wadi Al Furs” and “Wadi Al Mawrid” as listed in *Table 5.5*. These proposed areas are selected considering the balance between abstraction amount and recharge amount, and geographical distribution. It is noted that “Wadi Al Mawrid” includes main part of the capital city of Sana'a and main part of water abstraction is for domestic purpose. That is the reason why the rate of “abstraction/recharge, with reuse” is still being high, even if the irrigation demand is fully covered by reuse of treated wastewater.

Table 5.5 Proposed Sub-Basins for Distribution of Treated Wastewater

	Sub-Basin	Consumption of Irrigation				Recharge	Abstraction / Recharge		Proposed Sub-Basin
		2007	2010	2015	2020		wihout Reuse	with Reuse	
1	Wadi Al Mashamini	0.9	0.9	0.9	0.6	0.90	0.64		
2	Wadi Al Madini	4.5	4.5	4.5	2.9	2.73	1.06		
3	Wadi Al Kharid	3.0	3.0	3.0	1.9	1.76	1.27		
4	Wadi Al Ma'adi	1.3	1.3	1.3	0.8	1.71	1.29		
5	Wadi A'sir	7.6	7.6	7.6	4.9	4.27	1.14		
6	Wadi Khulaqah	2.3	2.3	2.3	2.3	1.54	1.51		
7	Wadi Qasabah	2.4	2.4	2.4	1.5	0.83	1.84		
8	Wadi Al Huqqah	14.5	13.5	9.0	9.0	1.36	8.70	2.12	⊙
9	Wadi Bani Huwat	48.7	46.7	36.7	26.0	5.58	6.84	2.19	⊙
10	Wadi Thumah	1.3	1.3	1.3	0.7	1.00	2.66		
11	Wadi As Sirr	24.7	23.7	16.7	12.5	3.81	7.04		
12	Wadi Al Furs	8.6	7.6	4.6	4.6	0.79	12.13	6.32	⊙
13	Wadi Al Iqbal	19.7	19.7	15.7	12.4	2.31	5.39		
14	Wadi Zahr & Al Ghayl	16.3	16.3	12.3	10.2	7.11	1.46		
15	Wadi Hamdan	10.2	10.2	10.2	6.5	0.82	7.87		
16	Wadi Al Mawrid*	8.8	7.8	5.3	5.3	1.54	20.73	17.30	⊙
17	Wadi Sa'wan	10.1	10.1	10.1	5.1	1.41	3.61		
18	Wadi Shahik	10.3	10.3	5.5	5.5	4.12	1.35		
19	Wadi Ghayman	5.5	5.5	5.5	3.0	1.24	2.42		
20	Wadi Al Mulaikhy	3.5	3.5	3.5	2.2	1.66	1.33		
21	Wadi Hizyaz	2.6	2.6	2.6	1.7	1.92	1.15		
22	Wadi Akhwar	2.5	2.5	2.5	1.6	2.32	3.25		

*: Main part of Capital city of Sana'a is located in this Sub-basin

(3) Convincing farmers of use of treated wastewater with demonstration of using treated wastewater

Since NWRA-SB has started to convince farmers not to use insufficient treated wastewater in order to avoid negative influence on their animals, themselves and productivity of crops in the year 2007 as a part of SBWMP, activity of convincing them to use adequately treated wastewater for irrigation purpose should be included in combination with demonstration of farming with treated wastewater.

Since the improvement of existing WWTP is planned to be completed by 2015 prior to the construction of another large capacity WWTP, arrangement for the demonstration of farming with treated wastewater should be started in 2013 targeting farmers who possess their own farmland along the wadi in north of WWTP involving WUAs.

In addition, acceptance of farmers to be charged for consuming treated wastewater, which may not be readily, shall be also considered so as to save the limited water resources.

(4) Monitoring of water quality

Monitoring of quality of the effluent should be carried out by SWSLC and the results should be submitted to MAI and NWRA-SB in order to control the water quality for securing water use for irrigation. The result of monitoring shall be open to the public especially for the farmers.

Responsibilities

Related organization and their responsibilities are described in *Table 5.6*.

Table 5.6 Responsibility for Assuring Reuse of Treated Wastewater

Organizations	Responsibility
SWSLC, Sana'a Municipality	Execution organization
MAI	Execution organization, Farmers' acceptance for use of treated wastewater and tariff
WUA	Farmers' acceptance
NWRA-SB	Monitoring of quality and quantity of effluent, Increasing awareness of farmers' acceptance

5.2.4 CONSTANT CONSUMPTION OF INDUSTRIAL USE

Purpose

To control water consumption of industrial use in order to prevent acceleration of depletion of water resources

In order to prevent the depletion of limited water resources, it is necessary to establish the control system of water consumption of industrial use.

Activities

(1) Preparation of inventory of existing water sources used in factories

NWRA SB in cooperation with Ministry of Industry is required at first to carry out inventory survey to understand actual condition of water usage in industrial use. Since most of water sources are reported to be private wells and located inside the factory, actual water consumption has been estimated by using indirect factors. Therefore, inventory survey is the fundamental to control water consumption in proper way.

(2) Persuading owners of factories not to expand their activities inside Sana'a Basin

No expansion of factories is one of the ways not to increase water consumption in industrial sector. Therefore, NWRA SB and Ministry of Industry should persuade owners of factories not expand their factories that bring into increase of water consumption.

(3) Reduce of overuse of water in factories and reuse of water inside factories

In order to save the limited water resources, factories required to reduce overuse of water and reuse of used water as much as possible.

(5) Preparation of master plan for industrial sector taken into consideration water resources condition

Ministry of Industry and authorities concerned are strongly required to prepare the sector development program considering the present condition of water resources in consultation with NWRA-SB, in order to mitigate such severe condition of water resources.

If the development of industrial sector inside Sana'a Basin is demanded, discussion with authorities related to agriculture sector should be carried out in order to arrange reallocation of water from irrigation to industry.

Responsibilities

Related organization and their responsibilities are described in *Table 5.7*.

Table 5.7 Responsibility for Constant Consumption of Industrial Use

Organizations	Responsibility
Ministry of Industry	Preparation of sector development plan considering water resources
NWRA-SB	Inventory survey, Persuading factory owners not to expand their activities

5.2.5 CONSTANT CONSUMPTION OF TOURISTIC USE

Purpose

To control water consumption of Tourist use in order to prevent acceleration of depletion of water resources

In order to prevent the depletion of limited water resources, it is necessary to establish the control system of water consumption of touristic use.

Activities

(1) Preparation of inventory of water sources used for touristic purpose

NWRA SB in cooperation with Ministry of Tourism is required at first to carry out inventory survey to understand actual condition of water usage in touristic purpose.

(2) Persuading owners of hotels not to expand their activities that brings about increase of water consumption

NWRA SB and Ministry of Tourism are required to persuade hotels not to expand their activities that make increase of water consumption.

(3) Preparation of sector development plan taken into consideration water resources condition

Ministry of Tourism and authorities concerned are strongly required to prepare the sector development program considering the present condition of water resources in consultation with NWRA-SB, in order to mitigate such severe condition of water resources.

If the development of tourism sector is demanded, discussion with authorities related to agriculture sector should be carried out in order to arrange reallocation of water from irrigation to tourism.

Responsibilities

Related organization and their responsibilities are described in *Table 5.8*.

Table 5.8 Responsibility for Constant Consumption of Touristic Use

Organizations	Responsibility
Ministry of Tourism	Preparation of sector development plan considering water resources
NWRA-SB	Inventory survey, Persuading hotels not to expand their activities

5.2.6 INSTITUTIONAL DEVELOPMENT

1) Finalization of the Executive Regulation to the Water Law of 2002, and Development of Decree for Water Protection Zone of Sana'a Basin

Purpose

To finalize Executive Regulation and develop Sana'a Basin's Bylaw in order to implement the Action Plan effectively.

For the purpose of effective implementation of the Action Plan of Sana'a Branch Office of NWRA, finalization of Executive Regulation and development of Sana'a Basin's Bylaw should be achieved by conducting activities mentioned below, 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 typical in Sana'a Basin,

Considering time factors to increase social acceptance, thus, the bylaws for the "protection zones" of Sana'a Basin should have the objective of gradually and over time limiting abstraction (over five to ten years) to the annual natural recharge as a priority. They should include; 1) a ban on well drilling for agricultural and irrigation use, 2) licensing of all wells, irrespective of depth, 3) mandatory water abstraction metering, and 4) a provision that may allow over time levying water charges for agricultural and irrigation use.

Activities

The following package of action shall be implemented for finalization of Executive Regulation and development of Sana'a Basin's Bylaw;

- Review the Water Law of 2002, its amendment Law of 2007, Draft Executive Regulation of the Water Law, and relevant decrees.
- Identify shortcomings in the relevant laws, decrees, and bylaws particularly in Sana'a Basin water resource management as "protected area".
- Assess the negative impacts and social costs if these shortcomings are not amended.
- Prepare additional and necessary principles and strategies for Draft Executive Regulation of the Water Law, such as mandatory groundwater abstraction metering and groundwater charge levying.
- Prepare Draft Bylaw and Regulation for Sana'a Basin as "protected area".
- Initiate consultative meetings with stakeholders in preparation of Draft Bylaw and Regulation for Sana'a Basin, and build consensus.
- Determine strategy and time frame to introduce groundwater abstraction metering and

- groundwater charge levying for irrigation purpose
- Receive legal consultation for finalization of the Draft Bylaw and Regulation for Sana'a Basin.
 - Submit the final draft of Bylaw and Regulation for Sana'a Basin to the Cabinet and Parliament for approval.

Responsibilities

Prime responsibility for development of Bylaw and Regulation for Sana'a Basin rests with NWRA-SB with support from NWRA Headquarters. Working group shall be established under NWRA-SB or SBC. Where convenient and feasible, cooperation with other Basin Office defined as "protected area" shall be concerned to share the problems and experiences for development of the bylaw particularly for the protected area.

2) Advocacy of Water Resource Management for Public and Political Leaders

Purpose

To increase public awareness and establish consensus for water resources management gradually in order to change political attitude and further increase political willingness towards water resources management

In order to duly change political attitude and further increase political willingness towards water resources management, increasing public awareness and gradual establishment of consensus for water resources management shall be undertaken. Thus, current efforts for public awareness campaign, shall be further concentrated with informing the seriousness of the water crisis in a first places by conducting activities mentioned below.

Activities

The awareness campaign shall be extended to the authorities, corporations, and companies involved in the water development sector whether they are at central or local, and governmental or private for compliance of the relevant laws and regulations.

Moreover, a package of public awareness campaign shall be developed and implemented suitable for the country's unique socio-culture of "tribalism". Inheritance of their tribal land of prosperity to the next generation over the generation shall be one of the most important concerns for them so as to water on and under the ground which is regarded as servitude to the land in their custom. The lost opportunity cost in the land productivity incurred to the next generations, when the barren land due to overexploitation of groundwater by them is inherited, shall be fully recognized. Also, education and information network for tribal authorities may be established. As far as possible, inter-tribal coordination system for the conciliation of their interests shall be identified and utilized to ease the current competitions of over-development and over-abstraction of groundwater.

Provision of reliable information on the water crisis to the political entities shall be also significant. Along with the awareness campaign for the public in general, the "right" political decisions based on reliable evidence on the water crisis in future shall increase public support with "vote".

In addition, the following activities shall be undertaken for advocacy on IWRM for public and political leaders;

- Review the existing Information and Public Awareness Campaign (IPAC) and assess its impact in groundwater preservation/control particularly in the rural area where tribal autonomy is strongly observed.
- Study the system, value and autonomy of tribal communities in water resource management.
- Develop the most effective and suitable options of IPAC for tribal communities.
- Set program for all kinds of awareness raising activities for the public; designing and disseminating posters and brochures, workshop, informative meetings in the field, messages at schools and mosques, radio and TV messages, etc.
- Intensify and scale-up the IPAC program developed as above.
- Develop comprehensive sets of information to help progressive political decision making in water resource management for the parliament members and local politicians.
- Organize consultative meetings for parliament members and local politicians to provide right information for right political decision making in the basin-level water resource management.

Responsibilities

Prime responsibility for development of Bylaw and Regulation for Sana'a Basin rests with NWRA-SB. However, for involvement of parliament members and local politician shall be facilitated with support from NWRA Headquarters.

3) Respect on Traditional and Tribal System

Purposes

To include “tribes” or “tribal system” in Local institutions, not as formal but rather significant in their socio-culture, in order to enforce regulations by decentralized local institutions and communities effectively.

Decentralized framework of local institution and administration introduced by the Water Law and other relevant laws and bylaws, however, seems to lack effective mechanism to enhance active participation of “tribes” and “tribal system” in decision making and execution for improved water resource management. Therefore, Local institutions, not as formal but rather significant in their socio-culture, should include “tribes” or “tribal system”, which can not be ignored and, in fact, can be regarded as the most governing institution particularly in highland area of the country including areas of Sana'a Basin.

One of significant principles in institutional and administrative framework employed in the Water Law of 2000 is to delegate authorities in management of water resources and enforcement of regulations to decentralized local institutions and communities, in which self-regulating mechanism for water resource management is enforced. Thus, improved participation of local institutions and communities in all the process of water resource management in decision making, execution and regulation and monitoring, becomes the most important determinant for the success of self-regulating mechanism for water

management.

With the present severe water condition, grade of impact on water resources will be different among sub basins which will be a cause of water conflict among tribes. Therefore, establishment of effective mechanism to enhance active participation of “tribes” and “tribal system” in decision making and execution for improved water resource management is necessary to prevent such conflicts related to water.

Activities

Channels and network to connect tribes and tribal system shall be identified and developed as it is possible. “Tribal system” herein refers to interrelationship among tribes, and it can be defined as the fora for groups of tribes to conciliate their interests, dispute, and conflict. In this line, involvement of tribal authorities in Basin Commission could be also considered. Sana'a Basin Commission has been established in accordance to the Water Law and relevant Decrees, of which function has two-folded characteristics that one served as decision making body for the Basin water management, while one functioned as regulatory body. An active participation of tribal authorities in such decision making and regulation, if supports granted, could be a backstopping institutional support for enhancement of self-regulating mechanism in water resource management.

It shall be also emphasized that, the stakeholders involved in decision making process for the water resource management either at central, local, and community level, shall take account of and apply where possible the traditionally and generally accepted principles and considerations. Thus, tribal rules and customs developed over generation require respect, and can be often a sound and practical basis for cooperation between water users and resolution of conflicts in water management.

The following activities shall be considered for incorporation of traditional and tribal system in IWRM.

- Study norms, value, autonomy, and conflict resolution system of the tribal communities in water resource management.
- Identify and develop channels and network to involve tribal communities in decision making and enforcement of regulations in IWRM, as well as in settlement of the conflicts.
- Review the membership of SBC, and include traditional leaders influential on the traditional communities in water resource management.

Responsibility

Prime responsibility for development of Bylaw and Regulation for Sana'a Basin rests with NWRA-SB with support from NWRA Headquarters.

4) Improvement in Decentralized Framework of Local Administration and Organization

Purpose

To improve current institutional structure in order to involve local institutions particularly Governorate Local Council and District in improved water resources management

In order to involve local institutions particularly Governorate Local Council and District in execution, enforcement, and regulation and monitoring of the Water Law and program related to management in improved water resources management, and to improve decentralized framework, the current institutional structure should be improved by implementing the activities mentioned below.

Activities

The following activities shall be undertaken for improvement of decentralized framework of local administration and organization

- Review the Water Law of 2002, Local Authority Law of 2000, and their relevant bylaws and regulations to comprehend legislative framework for local administration and institutional settings in IWRM and basin-level water resource management.
- Consult with Local Councils and Ministry of Local Administration to improve local administrative and organizational framework in IWRM and the basin-level water resource management.
- Facilitate and support Local Councils to establish their executive organ for basin-level water resource management.
- Establish mechanism to cooperate with Local Councils in the basin-level water resource management, in particular, in monitoring and enforcement of the regulations and rules set forth in the Water Law and its Executive Regulation.

Responsibility

Prime responsibility for development of Bylaw and Regulation for Sana'a Basin rests with NWRA-SB with support from NWRA Headquarters.

5.2.7 ORGANIZATIONAL DEVELOPMENT

IWRM in the country could be successful only if basin-level management is properly and effectively carried out by the relevant local authorities and user communities. Indeed, administrative and institutional framework as well as organizational structure set forth for IWRM in the Water Law and governmental decrees put great emphasis on delegation of power in water management to the lowest appropriate levels. In decentralized organizational framework determined for the State's IWRM and the basin-level water resource management in Sana'a Basin, the following organizations take leading roles and responsibilities, namely, NWRA-SB and Local Council as local authorities, SBC as stakeholders' platform for decision making in the basin management, as well as WUA as user community organization. In this section, key organizational capacity areas to be developed for each of these organizations are discussed, as well as actions to be undertaken for the improvement.

1) NWRA Sana'a Branch (NWRA-SB)

(1) Development of Organizational Structure

Purpose

To finalize NWRA-SB's organizational bylaws and job-description, in order to ensure the organizational operation and management.

In order to ensure the organizational operation and management, such as mutual understandings, decision making process, system for giving and monitoring orders, and interdepartmental coordination/cooperation in NWRA-SB, finalization of their organizational bylaws and job-description based on tasks and duties allocated for them should be achieved by executing the activities mentioned below.

Activities

The following activities shall be undertaken for improvement of NWRA-SB's organizational structure:

- Review the Water Law of 2002, and its related executive regulation and decree, to comprehend the tasks and duties assigned to NWRA-SB.
- Review and revise the draft organizational bylaws based on the assessment above.
- Prepare organizational structure and job-description for each department/section of NWRA-SB, putting emphasis on proper planning, monitoring, and decision making process.
- Facilitate approval on the prepared bylaws, organizational structure, and job-descriptions for each department/section.

Responsibility

Prime responsibility for development of organizational bylaws and structure rests with NWRA-SB with support from NWRA Headquarters.

(2) Human Resource Development

Purpose

To enhance NWRA-SB's technical capacity, in order to be a relevant and responsible local authority for Sana'a Basin

In order for NWRA-SB to be a relevant and responsible local authority for Sana'a Basin water resources management, enhancement of the authority's technical capacity identified as priority such as groundwater modeling, legal framework, regulation and enforcement, user participation in the basin management should be carried out.

Activities

The following activities shall be undertaken for improvement of NWRA-SB's human resources:

- Identify the training needs according to the capacity gaps assessed with re-defined tasks and duties in above.
- Prepare strategic training program with budget setting.
- Identify competent training providers in the country and abroad for the identified capacity development area.
- Implement the training program and evaluate the impact.
- Review staff remuneration/salary and introduce an improved incentive mechanism through pay rises and promotion based on performance-based staff evaluation system.

Responsibility

Prime responsibility for development of Bylaw and Regulation for Sana'a Basin rests with NWRA-SB with support from NWRA Headquarters.

(3) Improved Financial Management

Purpose

To improve the capability of financial management in NWRA-SB, in order to undertake water resources management properly.

Improvement of the capability of financial management should be addressed by implementation of activities mentioned below so as to properly undertake the planned water resources management.

Activity

The following activities shall be undertaken for improvement of NWRA-SB's financial management:

- Study the development and investment needs in the basin management according to the re-defined duties and tasks above.
- Prepare middle and longer term (i.e. five-years and ten-years) development and investment plan according to the development and investment needs identified above.

Responsibility

Prime responsibility for development of Bylaw and Regulation for Sana'a Basin rests with NWRA-SB with support from NWRA Headquarters.

(4) Improved Regulation and Monitoring Mechanism

Purpose

To develop mechanism of field monitoring network, in order to accelerate the progress of well registration and licensing.

In order to accelerate the progress of well registration and licensing, development of the mechanism of field monitoring network, in collaboration with other local authorities, especially with Local Councils, should be addressed by conducting activities mentioned below.

Activity

The following activities shall be undertaken for improvement of NWRA-SB's monitoring and regulation.

- Facilitate to develop bylaws and regulation particularly for Sana'a Basin as "protected area"

- Intensify the current registration and licensing program.
- Develop local administrative and organizational framework for enforcement and monitoring with Local Councils.

Responsibility

Prime responsibility for development of Bylaw and Regulation for Sana'a Basin rests with NWRA-SB with support from NWRA Headquarters.

2) Local Councils

Purpose

To incorporate Local Councils in the local organizational framework of basin-level water resources management.

Local Councils, of which tasks and duties are supervision and enforcement of rules and regulations, shall be further utilized and incorporated in the local organizational framework for the basin-level water resources management by the activities mentioned below.

Activity and Responsibility

Activities and responsibilities necessitated to improve local administrative and organizational coordination with Local Councils can be referred in section 5.2.7 4) "Improvement in Decentralized Framework of Local Administration and Organization".

3) Sana'a Basin Commission (SBC)

Purpose

To involve traditional leaders and tribal institution in order to ensure the institutional arrangement, and relevant supporting organizations in order to strengthen regulatory and monitoring system

In order to ensure the institutional arrangement to improve water resources management by means of participatory water resources management approach, and a public information and awareness program, it is required for SBC to involve traditional leaders and tribal institution in decision making, enforcement of self-regulating water management mechanism by implementing the activities mentioned below.

Furthermore, in order to strengthen regulatory and monitoring system, relevant supporting organizations such as the Ministry of Interior, Ministry of Local Administration, and Ministry of Justice to enforce water regulations, seems to be involved in SBC for its purpose.

Activity and Responsibility

Activities and responsibilities necessitated to improve SBC's coordination with tribal system can be referred in section 5.2.6 3) "Respect on Traditional and Tribal System".

4) Water User Association (WUA)

Purpose

To improve awareness of WUAs and WUGs in order to save water consumption for irrigation use.

The key issue over longer term, herein, is the improved awareness of WUAs and WUGs. It is they that are going to handle the bulk of the regulation of water usage by the group and by each farmer through adoption of improved technologies with irrigation efficiency. If this is done, and farmers simply use the water saved for higher application levels or expand irrigated area, the entire point of this component – water saving – is lost. Thus, the quality of WUAs/WUGs is a key need, and is more fundamentally important than the project's achievement in terms of the number of WUGs and number of hectares. In essence, it is more important to develop successful program than to achieve targets that are not replicable or of demonstration value because they have not succeeded. In the assessment for the WUAs and WUGs that have already been formed, their quality, in terms of social mobilization and training is not yet sufficient.

Accompanied with this, there is limited training for WUAs/WUGs in agronomic practices that will result in water saving. Beneficiaries should be acquainted with appropriate cropping patterns in order to adopt to growing less water consuming crops. Training programs for the staff should emphasize efficient water use through proper knowledge of crop water requirements, irrigation scheduling and water saving, leading ultimately to increased productivity. Thus, farmers' extension services should focus on the aspects of operation and maintenance of improved irrigation equipment and agronomic practices. Also, they should be convinced not to expand to more crop area as a result of water saving through the modern irrigation systems. Additionally, the tripartite agreement between farmers, the community organization and the NWRA-SB should be endorsed, and especially, the role of WUAs should be fully activated.

Activity

The following activities shall be undertaken for improvement of WUA in self-regulating water resource management:

- Review the current methodologies and approaches to establish WUA, and assess its effectiveness in self-regulating water resource management.
- Develop self-regulatory mandates for WUA in basin-level water resource management, and monitor its compliance.
- Introduce monitoring system among Local Councils, NWRA-SB, and WUA for compliance of the self-regulatory mandates.

Responsibility

Prime responsibility for development of Bylaw and Regulation for Sana'a Basin rests with NWRA-SB with support from NWRA Headquarters.

5.3 CONSIDERATION OF ACTION PLAN

Since the institutional development is the basis for all actions, relationship among actions are summarized in *Table 5.9*. Then the responsible organization for each activity of Action Plan and situation of activities are tabled in *Table 5.9*.

In the columns of "Situation of Activities", three kinds of situations are listed. In the column of "Effectiveness", the saving amount by each action is mentioned. Since the total amount of present water use for irrigation purpose is quite huge, the contribution to saving is larger than others. In the column of "State", the status of the listed activities, whether it is already addressed by other projects or not, is mentioned. Some activities have been already addressed by SBWMP, SWSCCL and Government of Yemen. Then considering the progress of these activities and urgency, the activities to be accelerated are listed.

Since these seven actions in *Table 5.9* are set to achieve the Scenario 3 as mentioned in section 4.5.2 in Chapter 4, it is required to address all actions.

Table 5.9 Consideration and Responsible Organizations of Action Plan

Actions to be Taken			Relation to Institutional Development				Responsible Organization							Situation of Activities					
			Finalization of the executive regulation to the Water Law of 2002, and development of decree for water protection zone of Sana'a basin	Advocacy of water resources management for public and political leaders	Respect on traditional and tribal system	Improvement in decentralized framework of local administration and organization	NWRA Sana'a branch office	Sanna basin commission (SBC)	Ministry of Agriculture and Irrigation (MAI)	Local Council (Governorate and District)	Sana'a Water and Sanitation Local Corporation (SWSLC)	Ministry of Industry, Sana'a Branch	Ministry of Tourism, Sana'a Branch	Water user association (WUA)	Effectiveness (Saving Amount, MCM in 2020)	Status (already addressed in other projects or not yet)	Actively to be accelerated		
5.2.1	Reduce of Water Consumption for Irrigation Purpose	Increasing the farmers' perception of effectiveness of improved irrigation system	○	○			○		⊗	○				⊗	125	SBWMP ¹	○		
		Convincing farmers not to expand their own farmland	○	○			○		⊗	○				⊗			○		
		Installation of improved irrigation system	○	○			○		⊗					⊗			SBWMP	○	
		Introducing watering control system with installation of water flow meter	○				○		⊗										
		Improvement of capability of NWRA-SB or staff in charge of irrigation activities	○				⊗		⊗									SBWMP	○
5.2.2	Reduce of Physical Loss of Urban Water Supply	Persuading water users in Sana'a city to accept the reduce of unit water consumption	○	○			○								10		○		
		Improvement of the capability of leakage detection	○														SWSLC ²		
		Monitoring of production amount and progress of improvement of losses	○				⊗												
5.2.3	Assuring Reuse of Treated Wastewater	Assuring the improvement of existing WWTP and new construction of using treated wastewater	○				○							⊗	50				
		Planning for distribution of treated wastewater	○		○		○	○	○				○				SWSLC		
		Convincing farmers of use of treated wastewater with demonstration of using treated wastewater	○	○			○		⊗	○				○					
		Monitoring of water quality	○			○	⊗												
5.2.4	Constant Consumption of Industrial Use	Preparation of inventory of existing water source used in factories	○				⊗								11				
		Persuading owners of factories not to expand their activities inside Sana'a Basin	○	○			⊗												
		Reduce of overuse of water in factories and reuse of water inside factories	○	○			⊗												
		Preparation of master plan for industrial sector taken into consideration water resources condition	○				○	○						⊗					
5.2.5	Constant Consumption of Touristic Use	Preparation of inventory of existing water source used for touristic purpose	○				⊗								7				
		Persuading owners of hotels not to expand their activities that brings about increase of water consumption	○	○			⊗						○						
		Preparation of sector development plan taken into consideration water resources condition	○				○	○					⊗						
5.2.6	Institutional Development	Finalization of the executive regulation to the Water Law of 2002, and development of decree for water protection zone of Sana'a basin					⊗	○							-	Gov. ³	○		
		Advocacy of water resources management for public and political leaders	○				⊗	○											
		Respect on traditional and tribal system	○				○	⊗		○									
		Improvement in decentralized framework of local administration and organization	○				○	⊗		○				○					○
5.2.7	Organizational Development	NWRA Sana'a branch office	○				⊗	○							-	SBWMP	○		
		Local council	○			○	⊗												
		Sanna' basin commission (SBC)	○		○												SBWMP		
		Water user association (WUA)	○				⊗		⊗	○							SBWMP	○	

*1 : Sana'a Basin Water Resources Management Project, SBWMP, *2 : Sana'a Water and Sanitation Local Corporation, SWSLC, *3 : Government of Yemen

5.4 IMPLEMENTATION SCHEDULE FOR ACTION PLAN

Table 5.10 shows the proposed implementation schedule for Action Plan. This schedule is prepared in consideration of the ongoing projects such as SBWMP and rehabilitation of WWTP, and is required to be re-scheduled considering the progress of each activity and in conformity with actual conditions under the initiative of NWRA-SB together with relevant organizations.

Table 5.10 Proposed Schedule for Action Plan (1/2)

Action to be Taken		Status*	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
5.2.1	Reduce of Water Consumption for Irrigation Purpose	Increasing the farmers' perception of effectiveness of improved irrigation system	SBWMP	▨													
			Action plan		■	■	■										
		Convincing farmers not to expand their own farmland	Action plan		■	■	■	■	■	■	■	■	■	■	■	■	■
		Installation of improved irrigation system	SBWMP	▨													
			Action plan			■	■	■	■	■	■	■	■	■	■	■	■
		Introducing watering control system with installation of water flow meter	Action plan				■	■	■	■	■	■	■	■	■	■	■
	Improvement of capability of NWRA-SB or staff in charge of irrigation activities	SBWMP	▨														
		Action plan		■	■	■	■										
5.2.2	Reduce of Physical Loss of Urban Water Supply	Persuading water users in Sana'a city to accept the reduce of unit water consumption	Action plan		■	■											
		Improvement of the capability of leakage detection	SWSLC	▨													
			Action plan			■	■	■	■	■	■	■	■	■	■	■	■
	Monitoring of production amount and progress of improvement of losses	Action plan															
5.2.3	Assuring Reuse of Treated Wastewater	Assuring the improvement of existing WWTP and new construction of using treated wastewater	SWSLC	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	
			Action plan		■	■	■	■	■	■	■	■	■	■	■	■	■
		Planning for distribution of treated wastewater	SWSLC	▨													
			Action plan		■	■											
		Convincing farmers of use of treated wastewater with demonstration of using treated wastewater	Action plan							■	■	■	■	■	■	■	■
	Monitoring of water quality	Action plan												■	■	■	
5.2.4	Constant Consumption of Industrial Use	Preparation of inventory of existing water source used in factories	Action plan		■												
		Persuading owners of factories not to expand their activities inside Sana'a Basin	Action plan				■	■	■	■	■	■	■	■	■	■	
		Reduce of overuse of water in factories and reuse of water inside factories	Action plan							■	■	■	■	■	■	■	■
		Preparation of master plan for industrial sector taken into consideration water resources condition	Action plan			■											

Table 5.10 Proposed Schedule for Action Plan (2/2)

Action to be Taken			Status*	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
5.2.5	Constant Consumption of Touristic Use	Preparation of inventory of existing water source used for touristic purpose	Action plan		■													
		Persuading owners of hotels not to expand their activities that brings about increase of water consumption	Action plan				■	■	■	■	■	■	■	■	■	■	■	■
		Preparation of sector development plan taken into consideration water resources condition	Action plan			■	■	■	■	■	■	■	■	■	■	■	■	■
5.2.6	Institutional Development	Finalization of the executive regulation to the Water Law of 2002, and development of decree for water protection zone of Sana'a basin	SBWMP	▨	▨													
			Action plan		■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Advocacy of water resources management for public and political leaders	Action plan		■	■	■	■	■	■								
		Respect on traditional and tribal system	Action plan		■	■	■	■	■	■	■	■	■	■	■			
		Improvement in decentralized framework of local administration and organization	Action plan		■	■	■	■	■	■								
5.2.7	Organizational Development	NWRA Sana'a branch office	Action plan		■	■	■	■										
		Local council	Action plan			■	■	■	■									
		Sanna' basin comission (SBC)	Action plan			■	■	■	■									
		Water user association (WUA)	SBWMP	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
			Action plan		■	■	■	■	■	■	■	■	■	■	■	■	■	■

*) : "SBWMP" means that Sana'a Basin Water Management Pjobject has already addressed .
 "SWSLC" means that Sana'a Water Supply and Sanitation Local Corporation has already addressed.
 "Action Plan" means that the schedule proposed in this JICA

5.5 ACTIONS TO BE TAKEN FOR FURTHER PROGRESS

5.5.1 PROTECTION OF GROUNDWATER RESOURCES FROM CONTAMINATION

(1) Control of Contamination caused by Effluent from Factories

Purpose

To control disposal of industrial waste in order to avoid the groundwater contamination/pollution

It was reported that infiltration of untreated effluent from factories and oil and lubricant from small shops are resulted in the contamination of groundwater. Since the improvement of sewage system will be completed more than 10 years later, it is required for organizations concerned to take necessary action as soon as possible so as to protect limited groundwater from pollution.

Activity

(1) *Preparation of inventory of possible source for groundwater contamination*

Since there is a few available information about effluent from factories and small shops which deal with oil and lubricant, it is necessary first to understand present status of possible source of contamination.

(2) *Increasing awareness of owners of factories and small shops*

NWRA-SB in collaboration with SBWMP and EPA, has to carry out increasing awareness of owners of factories and small shops to minimize the adverse impact caused by the infiltration of untreated effluent, oil and lubricant.

(3) *Enforcement of Article (54) of Water Law and preparing its Executive Bylaw*

Article (54) of Water Law stipulating protection of water from contamination/pollution should be enforced by Ministry of Water and Environment properly. And its Executive Bylaw should be developed immediately.

(4) *Preparation of collection system for disposal of industrial waste*

Before the completion of expansion of WWTP in the year 2020, collection system for disposal of industrial waste should be considered and started in parallel with increasing awareness and enforcement of Water Law, in order to stop groundwater contamination as soon as possible.

Responsibility

Organizations related to these approaches and their responsibilities are described in *Table 5.11*. NWRA-SB is responsible for increasing awareness of owners of factories and small shops.

Table 5.11 Responsibility for Control of Contamination

Organization	Responsibility
MWE	Development of executive bylaw
NWRA-SB	Increasing awareness of owners of factories and small shops

(2) Control of Over Utilization of Chemical Fertilizer and Pesticides

Purpose

To reduce over utilization of chemical fertilizers and pesticide in order to prevent groundwater contamination

Purpose of the control of over utilization of chemical fertilizer and pesticide is to protect groundwater from contamination. Since the cultivation of cash crops has started, the farmers have applied much chemical fertilizer and pesticides to more benefit. Sometimes, they have used dangerous pesticide which causes cancer.

Activities

NWRA-SB has already addressed to this issue in cooperation with General Department of Plant Protection as one of the component of SBWMP. Therefore, following activities shall be enhanced.

- Persuading farmers not to use these chemical fertilizer and pesticide through enhanced awareness campaign, in cooperation with WUA.

Responsibilities

Organizations related to these approaches and their responsibilities are described in *Table 5.12*. NWRA-SB is responsible for increasing awareness of farmers and the monitoring of water quality.

Table 5.12 Responsibility for Control of Over Utilization of Chemical Fertilizer and Pesticides

Organizations	Responsibility
General Department for Plant Protection	Increasing awareness of farmers on overuse of chemical fertilizer and pesticides
WUA	Increasing awareness of farmers
NWRA-SB	Increasing awareness of farmers, Monitoring of water quality

5.5.2 EFFECTIVE USE OF RECHARGE SYSTEM

(1) Effective Use of Water Harvesting

Purpose

To utilize water harvesting structures as much as possible in order to mitigate the depletion of groundwater

In order to mitigate the depletion of groundwater, rain water shall be utilized as much as possible by means of water harvesting methods which has been used for a long time in the country such as cistern, pond, terrace, rooftop and diversion of floods and so on.

Activities

(1) Preparation of inventory for existing water harvesting methods

Prior to persuade farmers to use water harvesting system properly, it is necessary to prepare the inventory for existing water harvesting methods so as to understand present status of these methods and to formulate the plan of activities followed.

(2) Persuading farmers to use water harvesting system properly

Based on the inventory prepared, program for the increasing awareness of farmers on using water harvesting methods should be prepared, then this activity should be commenced and supported under the initiative of WUAs and Local Councils.

Responsibilities

Organizations related to these approaches and their responsibilities are described in *Table 5.13*. NWRA-SB will be responsible for the evaluation of recharge and monitoring.

Table 5.13 Responsibility for Effective Use of Water Harvesting

Organizations	Responsibility
MAI	Support for maintenance of these method
WUA, WUG	Maintenace and operation
Local Council	Support for maintenace
NWRA-SB	Increasing awareness of farmers on necessity of water harvesting

(2) Consideration of Recharge and Sub-Surface Dams

Purpose

To consider the most effective way in order to optimize the recharge to groundwater through surface and/or subsurface dam

Purpose of this activity is to consider the right way to optimize the recharge to groundwater through surface and/or subsurface dams. Inside Sana'a Basin, so far, 38 dams, of which 13 dams are also used for irrigation and drinking purpose, have constructed, and other three dams are under construction for the purpose of recharge to groundwater. According to the information from SBWMP, the good result, that is, recovering the groundwater level at shallow wells were observed, but insufficient results were also observed in some cases. Thus, the necessity of comprehensive study for optimizing the recharge function of these structures has been discussed among organizations concerned.

Activities

(1) Monitoring and evaluation of on-going activities related to recharge improvement

NWRA-SB in collaboration with MAI should monitor and evaluate the results of rehabilitation and construction of dams which will be conducted in SBWMP from the view point of effectiveness.

(2) Consideration of integrated approach towards appropriate management of recharge system

Based on the results of evaluation of activities of SBWMP related to the enhancement of recharge, comprehensive plan to improve effectiveness of recharge to groundwater should be considered.

Responsibilities

Organizations related to these approaches and their responsibilities are described in *Table 5.14*. NWRA-SB will be responsible for the evaluation of the results of activities carried out in SBWMP.

Table 5.14 Responsibility for Consideration of Dams

Organizations	Responsibility
MAI	Execution agency
WUA	In charge of operation and maintenance
EPA	Evaluation of the results of social and environmental considerations
NWRA-SB	Evaluation of the results of dam rehabilitation and construction

5.5.3 OPTIMIZATION OF WATER SUPPLY COVERED BY PRIVATE SUPPLIER IN SANA'A CITY

Purpose

To optimize water supply condition covered by private supplier in order to save overuse amount of water

Uncovered population by public network, which is around 64% of population of Sana'a city, have obtained water from private suppliers by means of tankers and small networks with rather high tariff and unsecured water quality. No monitoring system for private water supply has been established, therefore, efficiency of private water supply has not been cleared yet. As observed inside the city, water tankers has moved having leakage of water.

In fact, since the public water supply does not have enough capacity to supply water for increasing demand caused by rapid population growth in Sana'a city, the private suppliers has had functions to fulfill the demand. However, from the view points of reducing water loss and securing water quality, monitoring system for private supplier shall be established

so as to manage water resources.

Activities

- Comprehension present situation of private water supply and establishment of database
- Increasing awareness of private supplier on water saving
- Consideration of introduction of meter for monitoring purpose

For these activities, following consideration should be taken:

- incentives and regulation for private supplier
- coordination with SWSLC
- compensation for private supplier which might be caused by the expansion of public network

Responsibilities

Related organizations and their responsibilities are described in *Table 5.15*.

Table 5.15 Responsibility for Improvement of Water Use Efficiency for Urban Water Supply Covered by Private Suppliers

Organizations	Responsibility
SWSLC, Municipality	Coordination with private supplier
NWRA-SB	Increasing awareness of private supplier on saving water, Monitoring of quantity

NWRA-SB is responsible for the increasing awareness of private supplier on saving water, and monitoring of their water use situation.

5.5.4 INTER-REGIONAL AND SECTORAL REALLOCATION OF WATER RESOURCES

Purpose

To reallocate water resources from sub-basin to sub-basin and irrigation use to domestic use in order to make the period to depletion of water in sub-basin even as much as possible by reducing irrigated area

In order to make the period of depletion of sub-basin even as much as possible, it is required to reallocate water resources among sub-basins and from irrigation purpose to urban domestic purpose. Around 20 MCM of groundwater has to be transferred to “Wadi Al Mawrid” where capital city of Sana’a is located from other neighbor sub-basins in the year 2020 by reducing irrigated area.

Activities

(1) *Reallocation of water from irrigation purpose to urban domestic purpose*

Around 20 MCM of groundwater should be transferred to “Wadi Al Mawrid” for urban

Chapter 5: Water Resources Management Action Plan for Sana'a Basin

water supply from other neighboring sub-basins in the year 2020. Then the period to depletion of water resources of each sub-basin could be nearly even and source of urban water supply can be secured. In addition, water conflict among tribes which might be happened can be reduced. Sub-basins where water resources can be transferred are selected from the view points of followings.

- Consumption of irrigation is high
- Location of sub-basin is relatively close to capital city of Sana'a

(2) Persuading the tribes to transfer water from their own land to other places, and to across the transmissions

The success of this activity is recognized as the most important and difficult one. The activity should be properly addressed early stage, since without their understanding and cooperation, the transferring water would not be successfully implemented. Therefore, considering the sensitivity of “tribes”, this activity should be addressed in accordance with the activity mentioned in the section 5.2.6 3) “Respect on Traditional and Tribal System” in this Chapter.

Responsibilities

Related organizations and their responsibilities are mentioned in *Table 5.16*.

Table 5.16 Responsibility for Improvement of Reallocation of Water for Urban Water Supply

Organizations		Responsibility
1	Sana'a Water Supply and Sanitation Local Corporation (SWSLC), Sana'a Municipality	Execution organization
2	Ministry of Agriculture and Irrigation (MAI)	Execution organization
3	WUA	Raising public awareness of people
4	General Authority for Rural Water Supply Projects (GARWSP)	Execution agency
5	Local Council	Coordination among villages in the district
6	NWRA-SB	Analysis of available water resources, Propose relevant reallocation plan, Raising public awareness on water transfer

Under the initiative of NWRA-SB, increasing awareness of farmers on improvement of water use efficiency, incentive or compensation to be given, coordination among Local Councils and WUAs and implementation of water reallocation shall be conducted.

REFERENCES

Ministry of Water and Environment (2006), Baseline Survey for Future Impact Evaluation, Sana'a Basin Water Management Project, MWE, 107p.

Ministry of Water and Environment (), Demand Management and Irrigation Improvement Component, Sana'a Basin Water Management Project, MWE, 67p.