

# Implementation of Integrated Water Resources Management for Sana'a Basin



Water and  
*Environment Centre*

Sana'a university

A short course with support of:



# OUTLINE

- 1) **Introduction**
- 2) **Acronyms**
- 3) **Institutional Issues of Sana'a Basin Project**
- 4) **2. Legal Framework for Sana'a Basin Management**
- 5) **3. Policy Issues of Sana'a Basin Project**
- 6) **Technical Issues of Sana'a Basin Project**
- 7) **Social Issues of Sana'a Basin Project**
- 8) **Environmental Issues of Sana'a Basin Project**
- 9) **Economical and Financial Issues of Sana'a Basin Project**

# INTRODUCTION

**Objective of the course:** raising the capacity building of water sector trainees on the implementation of IWRM for Sana'a Basin for applying the IWRM concept and indicators .

**Description of the course:** attendees of the short course will be able to:

- Mobilize, activate, discuss the IWRM for the Sana'a basin
- Introduce the IWRM Process
- Understand the IWRM concept and the importance of applying IWRM to manage Sana'a basin.,
- Be aware of the need for all other Yemen water basins in applying IWRM in comparison with Sana'a basin.,
- Know problems generated from the absence of applying IWRM to the Sana'a.,
- Recognize the performance indicators which reflect proper application of IWRM In Sana'a basin.,
- Understand factors affecting the proper application of IWRM for Sana'a basin.,
- Identify existing situation of the Sana'a basin and discuss other ways to overcome its related problems.

# ACRONYMS

<b>NWRA</b>	<b>National Water Resources Authority</b>
<b>SB</b>	<b>Sana'a Basin</b>
<b>IWRM</b>	<b>Integrated Water Resources Management</b>
<b>BC</b>	<b>Basin Committee</b>
<b>SWSLC</b>	<b>Sana'a Water &amp; Sanitation Local Corporation</b>
<b>LC</b>	<b>Local Council</b>
<b>WUA</b>	<b>Water Users Association</b>
<b>GARWSP</b>	<b>General Authority for Rural Water Supply Projects</b>
<b>WSLC</b>	<b>Water Suppliers Local Council</b>
<b>WC</b>	<b>Water Committee</b>
<b>WWTP</b>	<b>Wastewater Treatment Plant</b>
<b>SBWMP</b>	<b>Sana'a Basin Water Management Project</b>
<b>MAI</b>	<b>Ministry of Agriculture and Irrigation</b>
<b>NWSA</b>	<b>National Water &amp; Sanitation Authority</b>
<b>WEC</b>	<b>Water &amp; Environment Center</b>
<b>MWE</b>	<b>Ministry of Water &amp; Environment</b>
<b>GS</b>	<b>Geological Survey</b>
<b>GIS</b>	<b>Geographical Information System</b>
<b>ESIA</b>	<b>Environmental &amp; Social Impact Assessment</b>
<b>WSSP</b>	<b>Water Sector Support Program</b>



# **1. INSTITUTIONAL ISSUES OF SANA'A BASIN PROJECT**

# 1.1. COMPONENTS AND OBJECTIVES OF SANA'A BASIN PROJECT (SB)

In 2003, Yemen took over the term Integrated Water Resources Management(IWRM) of the Sana'a Basin on a long term basis.

15 years was set as a time limit to confront this crisis in 3 stages.

The project works within the scope of eight directorates in Sana'a Governorate

1. Bani Hushaish Directorate
2. Hamdan
3. Sanhan and Bani Bahlool
4. Arhab and Nihm
5. Bani Al-Harith
6. Part of Khawlan Al-Tial
7. Part of Bani Matar
8. Amanat Al-Asemah

# 1.2. SANA'A BASIN PROJECT GOALS

- Reducing the excessive depletion of ground water
- Supporting the economic infrastructure
- Strengthening ground water recharge
- Delay the date for the need to transfer water to Sana'a Basin from the adjacent basins
- Increasing water efficiency
- Strengthening the institutional & legal framework

# 1.3. COMPONENTS OF SANA'A BASIN PROJECT

- Water demand management and irrigation efficiency improvement;
- Supply management and recharge improvement – Dams Unit;
- Developing institutional and social infrastructure;
- Implementation of a media awareness campaigns.

## **Environmental management plan including the following:**

- Providing fresh groundwater for drinking;
- Check the safety of the dams by conducting periodic inspections;
- Preparation and implementation of integrated pest management of grapefruit and Qat in order to reduce the excessive use of pesticides and protection of groundwater from pollution;
- To combat the spread of schistosomiasis in dams lakes and water resources;
- Work on improving and monitoring the wastewater treatment plant for reuse in agriculture and in the irrigation of gardens and islands on the streets

# 1.4. IMPORTANCE OF IWRM FOR SB

Prior to the intervention of the Integrated Water Resources Management System in the Sana'a basin, water governance and institutions in the basin suffered from the following weaknesses:

Random drilling of wells with groundwater pumping,

Inadequate amounts of water pumped into urban areas for drinking,

Lack of equality, effectiveness and sustainability of the water allocation systems,

Demand for water is much higher than renewable quantities,

The wastewater discharged from the treatment plant is estimated at  $16M^3$ /year, however, farmers downstream the treatment plant use the effluent to irrigate their crops.

The local corporation faced many problems due to the unsustainable sources The agriculture sector consumes the largest water in the basin by more than 80% of the extracted water while the other sectors consume less than 20% of the extracted water.

# 1.5. ESTABLISHMENT OF NWRA-SB

The Sana'a branch was divided into several departments and serve the Institutional arrangement as follows:

- Branch management,
- Water control and decision support system,
- Management of licensing and user rights,
- Monitoring and evaluation management,
- Services management
- The role of NWRA-SB
- Tasks required from the branch:

## **1.5. ESTABLISHMENT OF THE BASIN COMMITTEE (BC)**

The Committee's functions are:

- Approval of annual water plans and development projects
- Review and implement the basin management strategy.

In accordance with the Basin Conservation Decree, it requires the following from the Committee:

- Approval of withdrawals water, projects & water allocation and control water balance
- Monitor the draw down and intervene to stop over-pumping;

## **1.6. INVOLVEMENT OF LOCAL COUNCILS (LCS):**

- 1) Have the right of general supervision on the WUAs (as stipulated in the local authority law), coordination with the WUAs in the preparation of plans for local management of water resources at the level of directorates.
- 2) In negotiating with local councils, the role of local councils in water governance is determined (so that this role is in line with the Water Law and Local Councils Law) as an intermediate level between the Basin Committee and the WUAs.



## **2. LEGAL FRAMEWORK FOR SANA'A BASIN MANAGEMENT**

# 2.1. WATER LAW AND REGULATIONS AND DECREES

Article No.	its position in the Law	content of the article
2	Definitions	Definition of water policies, water regulation, water area, depletion, water rights,
3	Objectives and principles	The aim of the law is to regulate, manage, develop and rationalize the exploitation of water resources and protect them from depletion and pollution and raise the efficiency of the transfer and distribution of their uses ... and involve users in their development, investment, protection and conservation
7	Organizing and management of water resources	To mandate the Commission to propose water strategies and policies for the management, development and regulation of water resources
12		To commission the Authority to assess the volume of demand for water and quantities that can be exploited for different sectors and take measures to ensure equitable use of available water and protect them from depletion and pollution through monitoring and evaluation and conducting studies and others
22	Control handling of water use	To mandate the Authority to prepare regulations and health requirements and to issue licenses for sold drinking water and treated and accepted tanks and networks and others

Article No.	its position in the Law	content of the article
34-27	Water rights	The Authority has been charged with the registration of water use rights, the maintenance of its records and the monitoring of compliance with registration requirements and non-compliance
42	Licenses	To commission the Authority to issue licenses for the practice of drilling wells, drilling for water, distribution of water directly from wells or through drinking water networks or by filling them
46	General technical standards and specifications	Submitting the means of transport and distribution of water for drinking purposes to the system of standards and general technical specifications and other rules and procedures implementing the provisions of this article
48	Preserve water resources from depletion and rationalize their uses	To instruct the Ministry and relevant authorities to provide the necessary support and facilitation to farmers to encourage them to use modern irrigation and technologies to provide water and increase their production, and to support and encourage the participation of popular efforts to contribute to the management of water resources.
76	General and final provisions	To mandate the Commission to propose fees for the development of water resources and protection from depletion and pollution and to achieve the objectives of the law

# LIST OF REGISTRATION FEES FOR WATER RIGHTS

Part III: Water resources management and planning	Chapter 1.	Organization and management of water resources
	Chapter 2.	Controls handling of the used water
	Chapter 3.	Sectoral uses of water
Part 5: Water Rights and Licenses and Conditions of Water Registration System	Chapter 1.	Water rights
	Chapter 2.	The rules and conditions of water rights registration system
Part 8. Fees	Different fees for issuing licenses of various kinds	

# EXECUTIVE REGULATIONS OF WATER LAW

Part III: Water resources management and planning	Chapter 1.	Organization and management of water resources
	Chapter 2.	Controls handling of the used water
	Chapter 3.	Sectoral uses of water
Part 5: Water Rights and Licenses and Conditions of Water Registration System	Chapter 1.	Water rights
	Chapter 2.	The rules and conditions of water rights registration system
Part 8. Fees	Different fees for issuing licenses of various kinds	

## 2.3. DEVELOPMENT OF GOVERNANCE STRUCTURE

Activating the water law

Delegating the responsibilities of water management to the triangle of institutional composition

Make the basin committee more comprehensive

Strengthening and integration to enable the three components of governance

Enable water user associations as managers in front line of water resources

## 2.4. PROTECTED AREAS AND RANDOM DRILLING AT SANA'A BASIN:

The southern side of the basin must be a protected area;

Control of the random drilling shall be (a) from bottom to top, (b) from top to bottom;

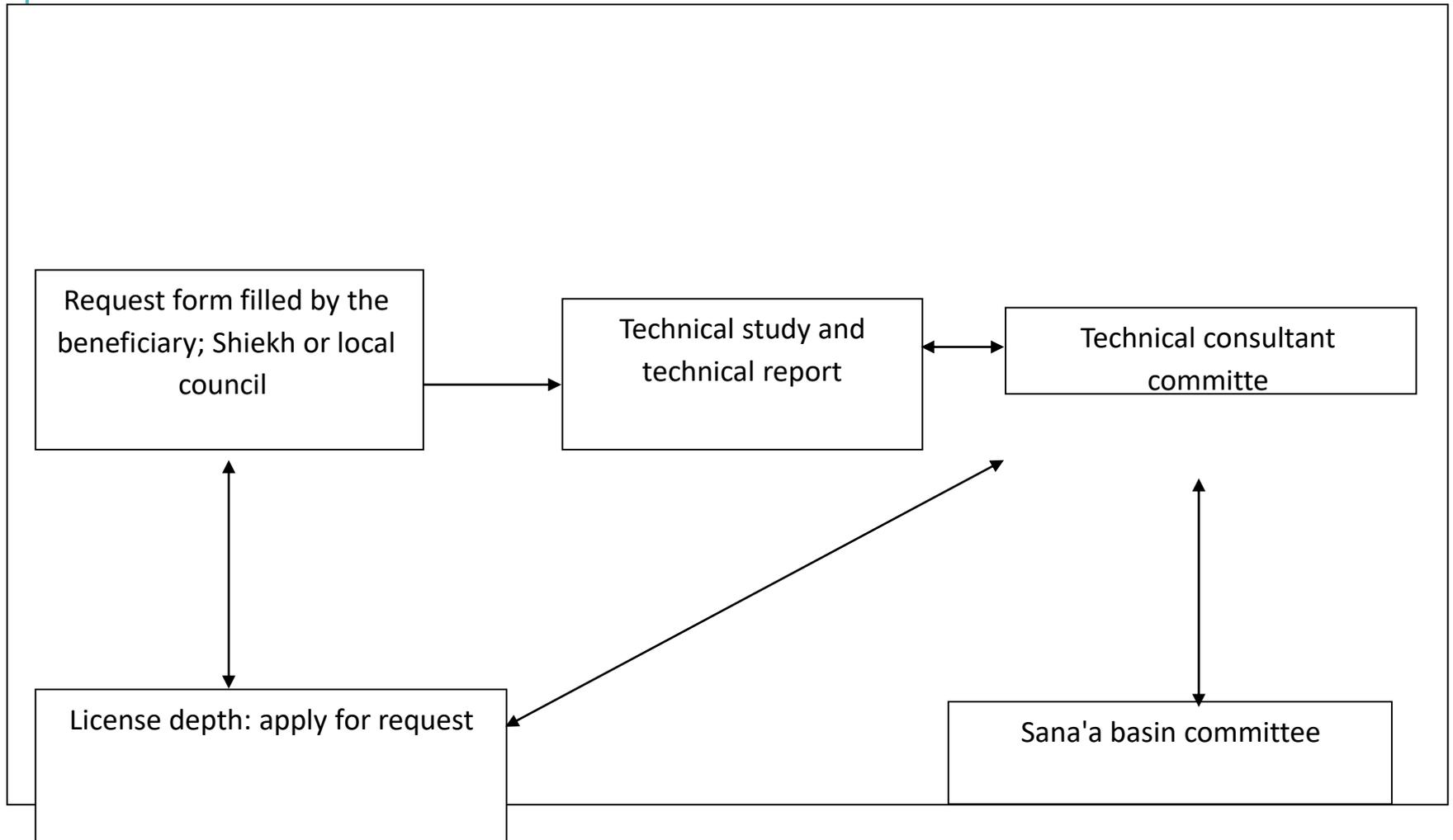
Implementing a socio-economic program

Among the legal conditions contained in the decree are as follows:

(1) Legal action

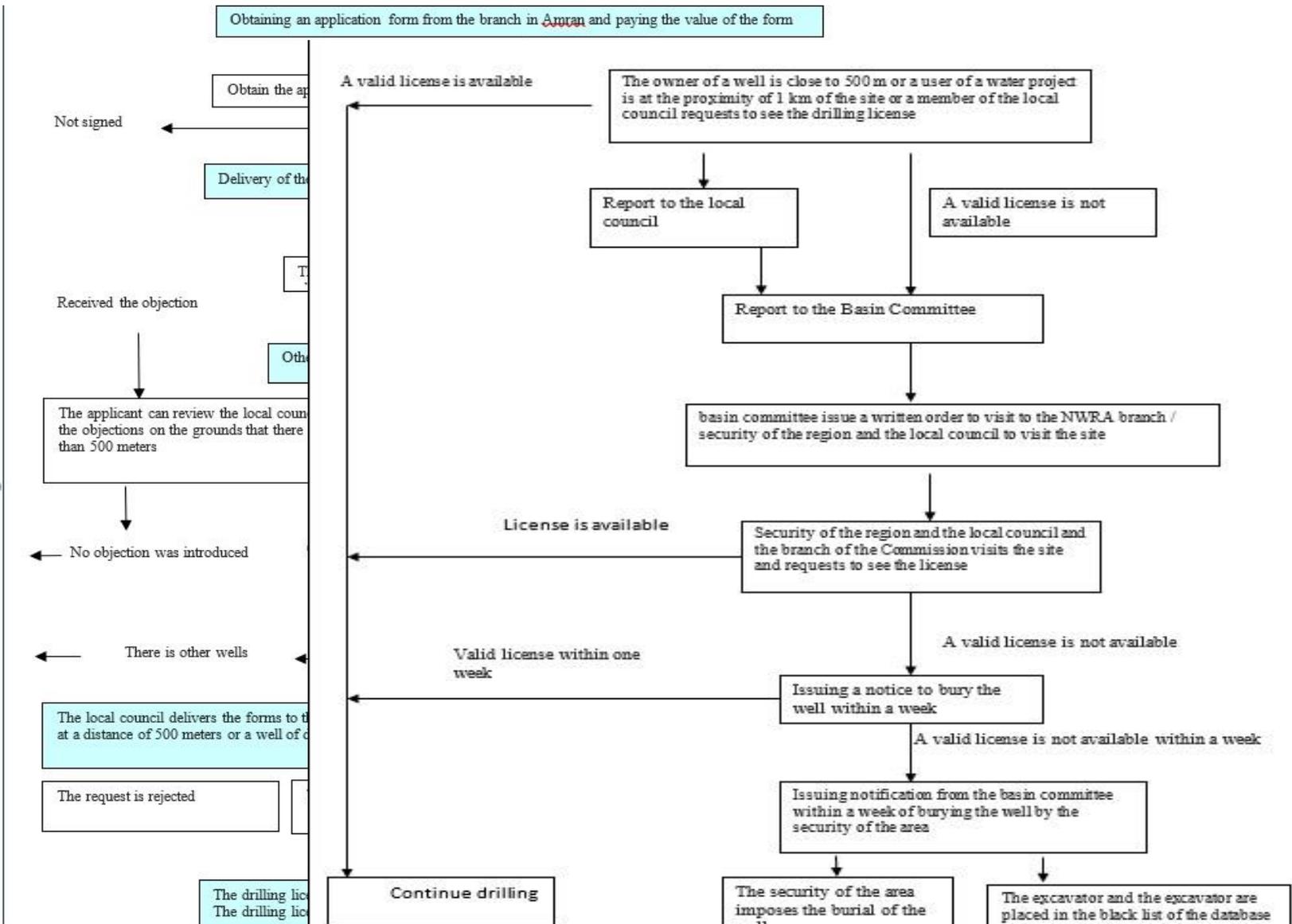
(2) Institutional Action

## 2.5. LICENSING SYSTEM OF WELL DRILLING



# 2.6. LEGAL PROCEDURE:

mechanism for Requesting a Well Drilling Permit (Amran Model) & mechanism for Requesting a Well Drilling Permit



## 2.7. WATER RIGHTS

### Legal recommendation:

- Ensure that any transfer of water between different uses is carried out on the basis of profit for all parties, with no uncompensated harm to any party.
- Conduct pilot programs to establish means to determine water rights;

### Discussion:

- Basically, the Amran basin adopted a general decision-making approach to water rights.
- The plan looks at the well as a water right, and encourages the owners of wells to determine their rights.
- This practical approach avoids NWRA from legal, practical and moral difficulties in determining and imposing rights.



### **3. POLICY ISSUES OF SANA'A BASIN PROJECT**

### **3.1. Water monitoring at sub - basin level:**

- Ensure sustainable revenue from agriculture
- Transfer of water among different uses

### **3.2. Treated wastewater**

Water demand needs to be managed in a practical way on the basis of the principle of benefit to all parties. Water must be maintained for high-yield urban uses but at the same time without harming farmers' returns.

### **3.3. NWRA -SB and WSLCs Exchange their Information with the NWRA**

- Encouraging private sector suppliers to form a specialized, self-regulatory organization,
- Encourage the establishment of private supply networks, especially in the areas located within the city,
- Control the rigs that can reach the deep sandstone.

# 3.4. Regarding the Aquifer

- Classification of sub-basin group on the basis of the following different characteristics:
- Located on the deep reservoir,
- Deep groundwater reservoir must be kept for drinking water,
- Green Belt / Agricultural Zone.
- Technical recommendation: Keep the deep sandstone aquifer specific for drinking water,

## **With regard to plans and databases:**

Policy recommendation: Adopt the 20-25 years, the five-year plan and yearly plan, as a general framework for planning, and create a mechanism for monitoring and evaluation in light of this policy.

## **Alternatives solutions are applied for water resources**

Finalize and legalize water quality policy



## **4- TECHNICAL ISSUES OF SANA'A BASIN PROJECT**

# 4.1. WATER RESOURCES EXISTING CONDITIONS

## Classification of sub-basins

<b>Sub-basin Group</b>	<b>Priorities and objectives</b>
<b>Urban</b>	<b>Protection of the groundwater aquifer</b>
<b>Urbanized (Edge of Cities)</b>	<b>Integration of water and sewage supply planning into urban planning</b> <b>- Transitional planning for farmers on the basis of benefit for all</b>
<b>Above the deep sandstone aquifer</b>	<b>Protection of the deep aquifer:</b> <b>- Prevent deep drilling</b> <b>- Stimulation and regulation of revenue protection for surface aquifer users</b>
<b>Green Belt / Agricultural Area</b>	<b>Sustainable management of resources</b> <b>Increase farmers' returns</b> <b>environment protection.</b>

# THE CURRENT STATE OF EACH SUB-BASIN AND THE EXPECTED DIRECTION

Sub-basin No.	sub-basin name	Water balance (million cubic meters) by traditional irrigation system	What will happen if there is no change?
1	Wadi Al-Mashamini	0.04 -	Limestone aquifer, inability to supply drinking water
2	Wadi Al-Mudaini	2.36 -	Volcanic aquifer Deficiency, Continuous drawdown
3	Wadi Al-Kharid	1.51 -	Limestone aquifer, problems with water quality, lack of drinking water supply
4	Wadi Al-Maadi	0.00	Currently there is a shortage of drinking water supplies
5	Wadi Aaser	0.18 -	Limestone, sandstone, continuous drop in groundwater levels.
6	Wadi Khalaqah	0.77 -	Limestone, water shortage
7	Wadi Qasabah	2.57 -	Volcanoes, water shortage, continuous decline of water levels
8	Wadi Al-Huqah	13.24 -	Dry sandstone in 2020
9	Wadi Bani Howat	52.20 -	Water quality problem, high pressure water supply and irrigation
10	Wadi Thomah	0.52 -	Limestone, water shortage, high precipitation
11	Wadi Al-Sir	24.59 -	Dry sandstone in 2020

# THE CURRENT STATE OF EACH SUB-BASIN AND THE EXPECTED DIRECTION

Sub-basin No.	sub-basin name	Water balance (million cubic meters) by traditional irrigation system	What will happen if there is no change?
12	Wadi Al-Furs	9.49 -	Dry sandstone in 2020
13	Wadi Al-Iqbal	19.32 -	Dry sandstone in 2020
14	Wadi zahr Al-Khail	7.46 -	High drop in water level, transfer of water to qat irrigation
15	Wadi Hamdan	2.90 -	Dry sandstone
16	Wadi Al-Mawred	34.00 -	Dry sandstone, water quality problems, shortage of drinking water supply, high pressure on the deep sandstone aquifer
17	Wadi Sawan	10.26 -	Dry sandstone in 2020
18	Wadi Shaheq	3.64 -	Volcanic inertia, sandstone deepening, water transfer
19	Wadi Ghaiman	2.87 -	deficiency of the volcanoes, deepening into sandstone, transferring water to qat irrigation
20	Wadi Al-Malekah	2.83 -	deficiency of the volcanoes, deepening into sandstone, transferring water to qat irrigation
21	Wadi Hiziaz	1.57 -	Increase pressure on the aquifer due to drinking water supply, water transfer to qat irrigation, and to drink
22	Wadi Ahwar	0.40 -	deficiency of the volcanoes, deepening into sandstone, transferring water to qat irrigation
	<b>total water balance</b>	<b>192.7 -</b>	

## 4.2. WATER BALANCE:

Component of water balance	Average
Pumping of groundwater for agriculture	212
Pumping of groundwater for domestic use	58
total pumping	270
Recharge from rain and torrents	57
Return from irrigation	20
Return from domestic use	2
total recharge	79
Balance = extract from groundwater stock	191

## DRAW DOWN IN GROUNDWATER LEVEL

Aquifer type	average drawdown (m)	period (since)
Alluvials aquifer	3.4	1973
volcanics aquifer	51.2	1985
sandstone layer aquifer	141	1993

# WATER BALANCE FOR EACH SUB-BASIN

sub-basin no.	sub-basin name	Water balance (Mm3) Traditional/ available irrigation system	Water balance (Mm3) Modern irrigation system
1	Wadi Al-Mashamine	-0.04	0.0
2	Wadi Al-Madani	-2.36	- 0.5
3	Wadi Al-Kharid	-1.51	- 0.3
4	Wadi Al-Ma'adi	0.0	0.0
5	Wadi Sir	- 0.18	- 0.1
6	Wadi Khalkah	- 0.77	- 0.2
7	Wadi Qasabah	- 2.57	- 1.5
8	Wadi Al-Hukah	- 13.24	- 7.0
9	Wadi Bani Hwat	- 52.2	- 32.5
10	Wadi Thoomah	- 0.52	0.0
11	Wadi Al-Sir	- 24.59	- 13.6
12	Wadi Al-Furs	- 9.49	- 5.7
13	Wadi Al-Eqbal	- 19.32	- 10.7
14	Wadi Dhar Al-Ghail	- 7.46	- 0.9
15	Wadi Hamdan	- 2.90	- 2.1
16	Wadi Al-Mawrid	- 34.00	- 30.4
17	Wadi Sa'awan	- 10.26	- 5.9
18	Wadi Shaheq	- 3.64	- 0.2
19	Wadi Ghaiman	- 2.87	- 0.6
20	Wadi Al-Mulaiki	- 2.83	- 1.4
21	Wadi Heziaz	- 1.57	- 0.5
22	Wadi Ahwar	- 0.40	- 0.1
	<b>total</b>	<b>- 192.7</b>	<b>- 114.2</b>

## 4.3. WATER SAVING TECHNOLOGY BY MODERN IRRIGATION SYSTEMS

- Introduction of modern irrigation system,
- Calculation of water savings and installation of meters,
- Rainwater Irrigation,
- Improving irrigation at the sub-basin level,
- Reduce irrigation water use,
- Monitor the irrigation systems meters in areas irrigated by modern irrigation systems,
- Protection of the surface water sources from pollution

# 4.4 DAMS, CHECK DAMS AND

## GROUNDWATER RECHARGE

- The effect of dams depend heavily on cleaning. Cleaning of the dam from sediments is essential to increase groundwater recharge from the dam.
- Groundwater monitoring
- Check dams are a choice for groundwater recharge in some wadis

## 4.5. WASTEWATER TREATMENT

- The wastewater discharged from the WWTP is estimated at about 16 million cubic meters per year, which is currently considered poor and unsafe for reuse.
- Implementation of NWRA-SB and in cooperation with the Sana'a Basin Water Management Project to implement a pilot campaign and awareness to stop the use of effluent wastewater in the irrigation of some crops consumed by humans and animals directly.

### **Effluent water quality improvement Industries and factories adopt treatment plants**

- Prepare vulnerability map of the contamination of basins
- Implement program on industrial wastes treatment

## 4.6. Reuse of Wastewater:

- Prepare extension programs on the safe uses of the treated waste & grey water
- Field visits for the farmers who use the treated waste water in Bani Al-Harith
- NWRA should plan with the WSLC and the Ministry of Agriculture and Irrigation to reuse the wastewater treatment and associated regulations.

## 4.7. Rainwater Harvesting:

It is proposed to start quickly with the economic assessment of the rainwater harvesting system from the roofs of houses.

## 4.8. Irrigation Development

The Sana'a basin water management project contracted specialists to train in the field of agricultural extension, and ten of them worked with the Sana'a basin water management project.

Modern irrigation allowed farmers to use 40% less water while increasing yields by 10%. Sana'a basin water management project has enhanced knowledge on the irrigated agriculture side of the basin

## 4.9. Urban Water Supply

Sana'a is the third largest city in the world in terms of rapid growth. SWSLC supplies only half of the city with its water needs. Although network connectivity is the most cost-effective model to address poverty, the SWSLC is slow to provide the network due to its high cost and limited water resources.

The technical problem: The SWSLC faced many problems in the side of unsustainable sources

Work to coordinate with NWSA & LCs to reduce the network water loses

Prepare & implement pilot programs to expand water saving devices

Make sure of the "dry wells" closed by the SWSLC that the problem is dry aquifer and not a problem associated with the damage of the well protection pipes or the collapse of the walls of the well.

Farm wells provide urban areas located on the borders of the city as well as tankers traded water.

## 4.10. Databases

## 4.11. Planning and studies consultant

- Water use is improved & regulated
- Sources of water pollution map are identified
- EIA strengthened and adapted
- Alternatives of water use priorities are identified



## **5. SOCIAL ISSUES OF SANA'A BASIN PROJECT**

# 5.1. Formation of WUAs

- Water user associations are formed in a typical manner and can play a major role in the front line as water managers,
- Institutional measures

Activities	WUAs formed	WUAs closed	WUAs effective	WUAs continue
irrigation	52	6	46	33
Recharge	13	3	12	11
Total	67	9	58	44

## 5.2. Monitoring and Control of Groundwater

Activities could affect on groundwater that can be monitored and controlled by water user associations

## 5.3. Gender Issue

- Percentage increase of women in decision –making levels
- Involving women through forming WUAs

## 5.4. Control of Random Drilling

- The Government enables WUAs (through a decree) to play their role in controlling the random drilling.
- Water Users Association or any individual may object via the "Water Committee" in the Directorate

## **5.5. WASTEWATER TREATMENT**

Implementation of NWRA-SB and in cooperation with the Sana'a Basin Water Management Project to implement a pilot campaign and awareness to stop the use of effluent wastewater in the irrigation of some crops consumed by humans and animals directly.

## **5.6. PLANS AND DATABASES**

## **5.7. DAMS, CHECK DAMS AND GROUNDWATER RECHARGE**



## **6. ENVIRONMENTAL ISSUES OF SANA'A BASIN PROJECT**

A plan to reserve specific areas and depths in Al-Taweelah sand stone basin for urban water supply,

Implementing a socio-economic program to ensure that there is no undue damage,

Establishment of legalization for water quality standards

Discussing Environmental water requirement studies carried out  
Public users are aware of sustainable water management and sustainable environment

Environmental management plan including the following:

- Check the safety of the dams by conducting periodic inspections
- Preparation and implementation of integrated pest management of grapefruit and Qat



## **7. ECONOMICAL AND FINANCIAL ISSUES OF SANA'A BASIN PROJECT**

# 7.1. A SPECIAL BUDGET ALLOCATION FOR IWRM

Funding by the National Water Sector Support Program (WSSP);  
Digital indicators in the documents of the National Water Sector Support Program (WSSP)

The budget of the Sana'a branch (NWRA-SB) of the Water Sector Support Program (WSSP) 2010 is as follows Table 9):

Item	*1000 (US \$)
Capacity building	87.9
Data Bank (NWRIS)	27.6
Sana'a basin plan	20.0
groundwater monitoring	5
Sana'a Basin Committee	10
Social Motivation	7.5
Pilot program for water conservation equipment	5
Awareness Campaign	10
<b>Total</b>	<b>173.0</b>

## 7.2. SOURCES OF FINANCING THE PROJECT

- Funding through a single integrated project (WSSP).
- Provision of water monitoring and regulation equipment for the NWRA-SB

## 7.3. BASIN PLAN

- Decision-making regarding the basin plan and the allocation of financial resources.
- Implementation and funding, which translate the plans into reality facts on the ground
- Elements of this structure are available - or can be readily available - in Sana'a Basin

## 7.4. INCENTIVE FRAMEWORK

- Economic-financial-social recommendation: Incentive framework is identified & adjusted for water consumption in agriculture and urban area.
- Prepare action plan for the outcomes of the economic incentives study