Water Supply Management of the Sulaimanyah City

A Paper Submitted to the Kurdistan Union Engineers – As a partial fulfillment for the step of consultant

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Abstract

Sulaimaniya city is supplied with potable water by two main sources, they are: Sarchinar and Doukan water projects. In addition to that, some of residences depend on the ground water from their private wells which are drilled illegally, because of the absence of drinking water distribution system in their quarters. In the past, springs and (galleries) kahrezs were the major sources of water supply in the city, but now these sources are used for irrigation of public gardens or connected to the sewerage system, because of contamination as a result of the expansion of residential area of the city.

In current time SWSD faces the problem of disability to provide required potable water for residences in most area of the city. Although water production capacity of SWSD is estimated as16,900 m^3/hr, it is more than the required demand in 2027 due to results of this study. Also questionnaire results show that about 87% of the residents don't obtain sufficient amount of water,34% of them get water from main network just 3-5 hr/weekly, and 45% don't use water from network for drinking .

From (SWOT Analyses) table and analyzing both environmental (internal & external) of SWSD were done. The weaknesses were explained from internal environmental, and the threats from external environmental.

Thus both infrastructures and incentive system were major weaknesses from internal environment, where as technical beside legal & economical were the major threats from external environment.

Table of Contents

List of Abbreviation

SWSD	Sulaimanyah Water Supply Directorate
SSD	Sulaimanyah Statistic Directorate
SFDD	Sulaimanyah Food Distribution Directorate
GDWS	General Directorate of Water and Sewerage.
MMT	Ministry of Municipality and Tourism .
PRV	Pressure Reduce Valve
KRG	Kurdistan region government
KP	Kurdistan parliament
I.D.	Iraqi dinar

List of Tables

List of Figures

1. Introduction

The city of Sulaimaniya is the culture capital and second main city of Iraqi Kurdistan Region. Geographically, Sulaimaniya is located between E45º 20' and E45º 30' / N35 30' and N35º 36'. The altitude is between 750m and 1100m. It has a surface area of about 470 $km^2$and the maximum width and length are 15 and 32 km respectively

In 1820, the population of Sulaimaniya city was about 10,000 capita [(1)]. In 1957 the water consumption was estimated to be 6280 cubic meter/day based on 57 liter/capita/day for the whole city. In 2006 water consumption was based on 220 liter/capita/day for the whole city, and since 2010 (SWSD) estimated water consumption is 250 liter/capita/day [(2) & (3)].

A comparison between water consumption of 1957 and 2010 shows that there is an overmuch increase in using water, because of the changes that happened in the life style, education level, increasing needs for population, and increase different activities of the city from economic side, tourism, and an industry.

Politic situations of the region led to an irregular migration from suburbs, towns, and villages around the city to the center of the city, which started since 80s of the last century, and after 2003 the stable security conditions in the city led to the increase and continuous migration to the region.

The absence of the plan to relocate residents on a regular basis led to the exploitation of agricultural lands by using them for constructing the horizontal housing for citizens. This development in the process of construction as well as the population growth by this amount has led to the increasing demand for water. Figure (1) explain the rate of Sulaimanyah expansion from (1925 to 2027) [(4)].

Figure (1) Rate of Sulaimanyah expansions from (1925 to 2027), (Annual calendar work of Sulaimanyah municipality,2011)

2. Sulaimanyah Population Forecasting

After 1987 no real census has taken place in Kurdistan Region, therefore SSD depends on the data provided by SFDD which is known as food coupon.

The SSD population data of Sulaimanyah city from 1977 to 2009 are shown in the table (1):-

(Table 1) Population Growth according to the SSD [5]

year	Population
1977	162877
1987	364096
2002	569123
2009	571507

It is worth mentioning that after 2003 as mentioned before, the rapid growth happened in cities of Kurdistan as a result of stable security condition, economic activities, and investments, but records show that population growth from 2002 to 2009 was as much as 2384 capita. Thus one cannot depend on it, and instead the data from census of 1987 are taken as reference.

Using exponential growth equation for predicted population of the city as:-

$P=Po\ e^{rt}$ (6)

Where:

- P_0 is the starting population.
- P is the population after a certain time, t.
- r is the rate of natural increase expressed as a percentage (birth rate - death rate).
- e is the constant which is equal to 2.71828... (The base of natural logarithms).

The Population growth in Iraq was last reported at 2.87% in 2011, according to a World Bank report published in 2012 [7]. According to the October 1987 census, the annual population growth rate was 3.1% [8]. The average growth rate can be taken 3% to predict the expected future population.

Table (2) shows the population forecast of Sulaimanyah city till 2032, calculated according to the equation mentioned before.

Table (2) Population forecasting (1987-2032) calculated by exponential growth equation

year	Population
1987	364096
2002	571016
2012	770791
2017	895531
2022	1040459
2027	1208840
2032	1404472

3. Water demand for Sulaimanya city

As mentioned before, the changes in life style, educational levels, and the increase of different activities in the city, and others change rate use of water per capita. According to the standard for water demand of SWSD which is (250 liter/capita/day) for domestic use, the table (3) shows water demand estimation for Sulaimanyah.

Then total demand at 2032 = 250 x 1404472

=351,118,000 liter/day or 14629.9m^3/hr

Considering that 30% of total demand of water as non-review water and for other uses [9],[10 & 11].

Then the total demand is (325 liter/capita/day)

Total required water demand for whole city in 2032 = 325 x 1404472

=456453400 liter/capita/day

=19020m^3/hr

Table (3) Water demand estimation for Sulaimanyah

year	population	Domestic demand m^3/hr (250 liter/capita/day)	Total demand m^3/hr (325 liter/capita/day)
1987	364096	3792.67	4930.47
2002	571016	5948.08	7732.51
2012	770791	8029.07	10437.79
2017	895531	9328.45	12126.98
2022	1040459	10838.11	14089.54
2027	1208840	12592.09	16369.71
2032	**1404472**	**14629.92**	**19018.89**

4. Sulaimanyah water sources

The existing water sources for Sulaimanyah city are four, some of them are near the city, while the others are 60 km far from the city center.

4-1. Gallery (Kahrez) and wells

i. The history of water supply in Sulaimanyah goes back to (1933), depending on galleries water, which is regarded as one of the underground water resources. The

morphology of Sulaimaniya city is suitable to construct kahrez, because it is situated on foot zones of Goyzhe and Azmar Mountains. Because of that, the residents had constructed more than 16 kahrezes, most of them being situated in traditional regions, that give water to residents, mosques, and bathrooms of the city. (Arabic heritage regenerating center, 1989, pp 112) as cited in (Abbas, 2009) [12].

Galleries supplied water by closed channel which were made of rocks and clay. Most of those channels are damaged and water is polluted now because of the expansion of the city. Therefore today some of those galleries are used for irrigation of public garden in the city, and others are connected to the sewerage system for decreasing density ratio of contaminators in Tanjero River, which sewerage of the city fall into it without treatment.

ii. Wells: there are 31 wells in Sulaimanyah that belong to Water Supply Directorate, and 11wells are in operation for supplying water by tanker delivery process for those districts that don't have water networks which are about %4 of the city [2].

Also there are large numbers of private wells which were drilled illegally by residences in their houses distributed in the different places of the city, and there are no real records and information about them. These wells are used by residences without any control from SWSD.

4-2. Sarchenar project

Sarchnar is a natural spring located at the north west of the Sulaimanyah city, about (5 km) from the city center. This spring is considered as a major source of water for Sulaimanyah till now, and it was the only source of water supply for the city from 1950 to 1982, but since 1982 first Doukan project operated which is considered as a strategic project for the city, but Sarchnar project remain an important source till now.

Sarchnars spring discharge is about 70 million m^3/year [13], and its capacity changing during the year depending on precipitation rate and climate change. SWSD supplied water to the city from Sarchnar spring about (3000 m^3/hr min) to (9000 m^3/hr max) [12] SWSD depended until 2004 just on Sarchenar source from September to June, but now SWSD has to provide the city with this water during the whole of the year.

In Sarchnar project there is also a boosting station which contains 10 halls for boosting water to different, quarters, as well as the reservoirs, and it looks like the midpoint between (1st & 2nd Doukan projects) and distribution network of the city. Receiving water from Sherkuzh collecting tanks, the storage capacity of the first one is about 2800 m^3, while the capacity of the second is about 20,000 m^3. These two tanks receive water from Doukan projects. Then water is distributed by two transmission lines, the diameter of first line is900 mm, while the second line diameter is 1200 mm. Figure (3-2) shows Sarchnar project [14].

4-3.Doukan Projects

Doukan projects are two projects (first and second), those names refer to Doukan town where the intakes are located. Doukan town is located about 2.5 km downstream of Doukan Dam and 65km western of Sulaimanyah, which is constructed on the Lower Zab River.

4-3-1. First Doukan Project

First Doukan Project was established in 1980, and in 1982 supplying water started with a capacity of 3200m^3/hr. Its intake is located on Qashqoly River (downstream of the Doukan dam) approximately 3 km downstream Doukan town, and it's about 65 km west of Sulaimanyah city.

Currently SWSD is working to extend the project and making its capacity 6400 m^3/hr, and according to the time table extension, work will finish in the next Oct.

4-3-2. Second Doukan Project

Second Doukan project established during 2008 to 2010 with the capacity of 8000 m^3/hr. Its intake is located near the intake of the first project on Qashqoly River. Now SWSD has extended the project and its capacity is 12000m^3/hr.

From previous data about capacity of sources the total minimum produced capacity (in summer and autumn) is about18200 m^3/hr at the beginning of 2013 (as

planned from SWSD, and according to the timetable of executor companies). SWSD supply capacity during paper preparation it more than 12126.98 m3/h which expected on 2017 as shown in table 3, even though residents get drinking water just 2 hour every 48 hours!

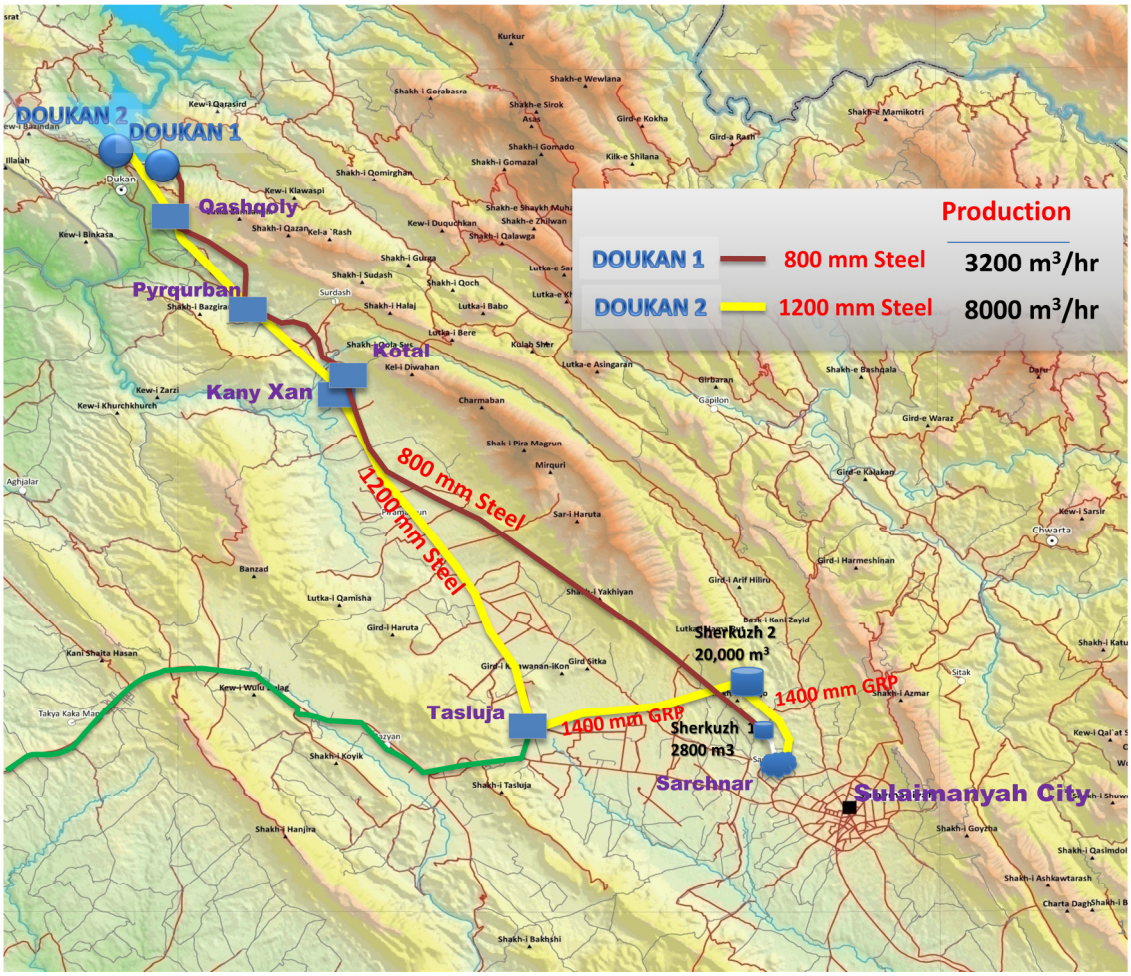

Fig (2) Both Doukan projects, “source- SWSD”

5. Existing Situation of the Water Supply System in Sulaimanyah

5-1. Sulaimanyah water source capacity

As mentioned before the minimum rate of potable water that SWSD should provide Sulaimanayh from Sarchenar and Doukan projects is about 18,200 m^3/hr, about 16,900 m^3/hr is for Sulaimanyah city, and this rate is supposed to increase to **21,400m^3/hr** next year.

5-2. SWSD's abilities

5-2-1 Staff of SWSD

Table below shows the classification of SWSD's staff according to their educational degrees, this data refers to year 2012 as recorded in archive of SWSD.

Table (4) Staff of SWSD according to their educational degrees, "source- SWSD/Statistic department"

Item No.	Education degree	Number	Ratio %
1	B.SC	106	10
2	Diploma	126	12
3	Secondary School	43	4
4	Secondary Industrial School	179	17
5	Secondary Commercial School	42	4
6	Intermediate School	116	11
7	Primary School	263	25
8	Anti Illiteracy	21	2
9	Illiteracy	158	15
		1054	100%

5-2-2. Reservoirs and Tanks

SWSD has 49(with rectangular and cylindrical shape) tanks for distributing and collecting water with total storage capacity of 75,012.1m^3, most of them made of concrete and others of steel [15]. Reservoirs are all connected to Sarchnar boosting station. Also topography of Sulaimanyah is suitable for supplying water from existing reservoirs to the network by gravity, as well as for building more tanks (Collection or Distribution tanks).

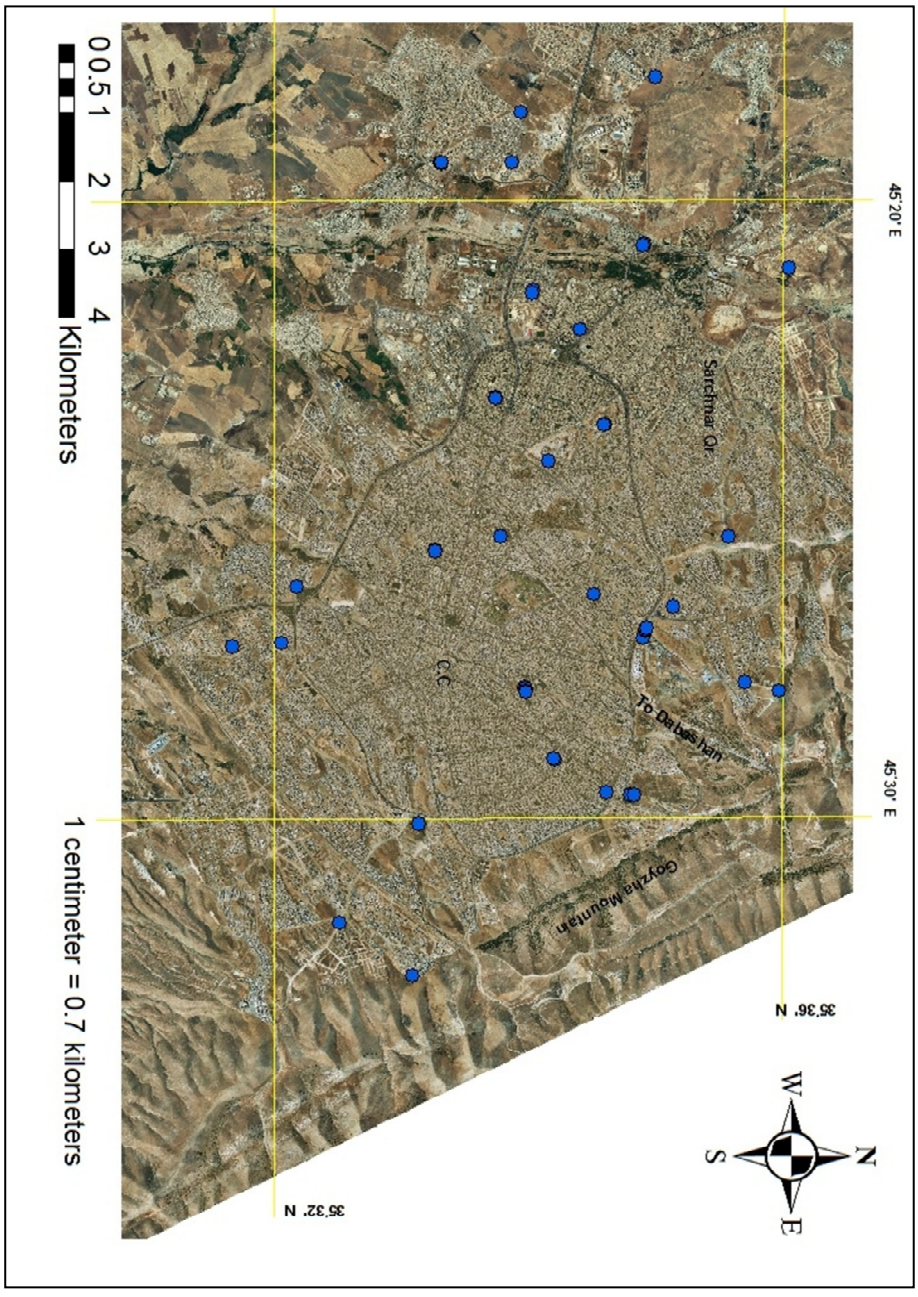

Figure (3) Location of reservoirs in Sulaimanyah city

5-2-3. Distribution Network

The distribution network covered more than 96% (in operation) of the city, and there is continues expansion. 4% of the network is not in operation because they didn't connect to the supply sources (reservoir). Most parts of the network are connected to the tanks except some places which were connected to the transmission pipe lines directly.

Operation of the network is a partial-time operation, and in the best situation residents can get drinking water just 2 hours every 48 hours especially during May to October (period of water crisis). Controlling of this operation is done manually; therefore this controlling may face some mistakes.

The absence of water meters in the networks leads to disability of predicting the real quantity of water from SWSD, and losses amount (leakage) in the network.

5-2-4. Water Cost

The department that has the responsibility of collecting water cost in SWSD is Revenue department, in this department water cost bills are prepared for each consumer in the city. According to information from this department, water cost estimated as (250 ID/ m^3 of water).

From September 2012 and according to the formal litter from GDW the rate of water cost depend on area of the unit, which is 50 I.D. /m^2/ months, take as monthly water cost without any consideration for the real amount of water used [16] . This cost system causes because of absence better alternative.

5-3. Existing situations from view of residences:

For explaining the existing situation from resident's point of view need to depend on questionnaire. The questionnaire covered 60 random families in different areas of the city and that was through:-

Firstly, field visiting to define contributed families' locations by using GPS.

Then, dividing questionnaire forms to the families and collecting them after two days.

Finally, analyzing families' answers were by using a special statistic's soft ware to explain the results.

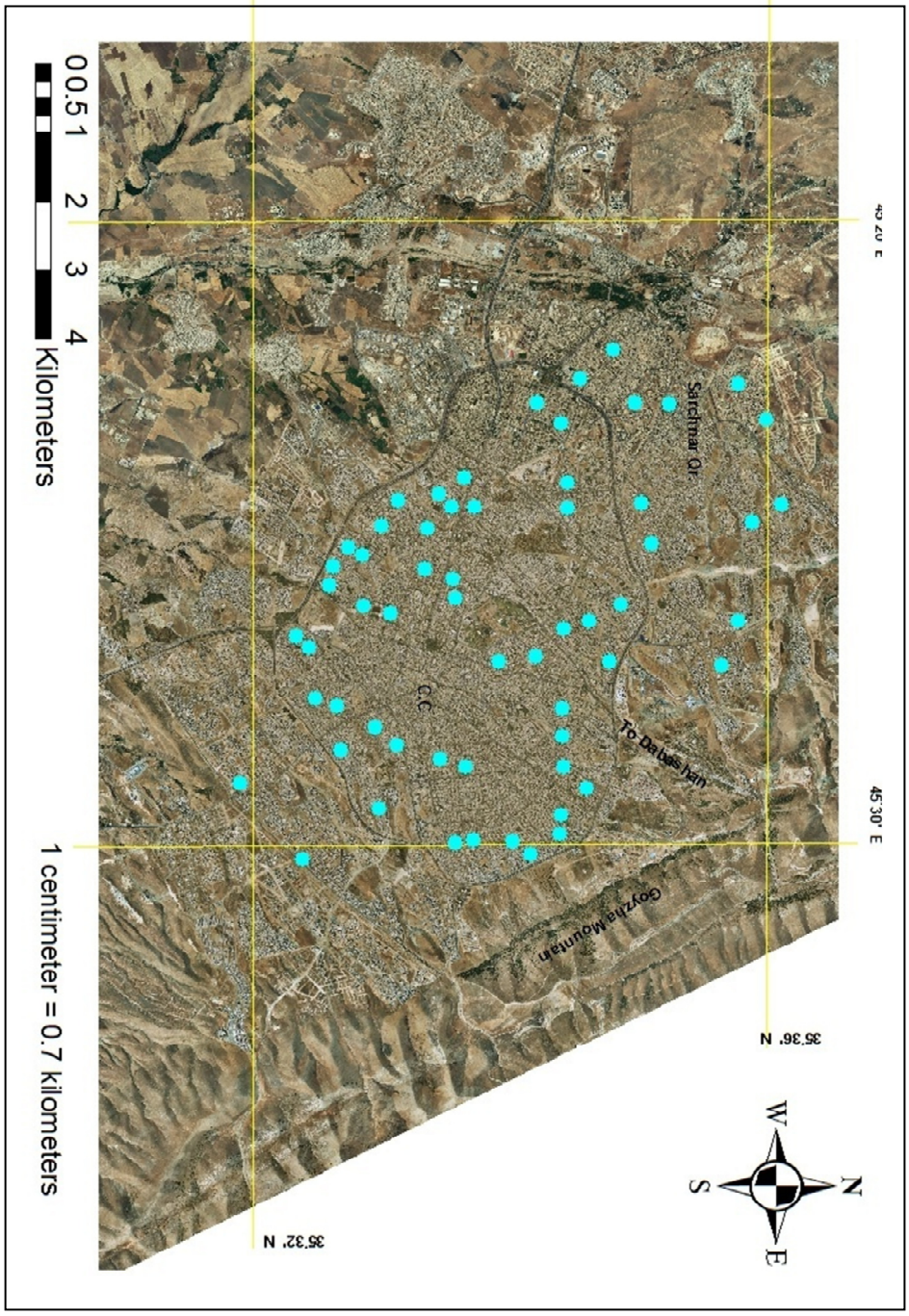

Figure (4) Participated families' locations

5-3-1. Analyzing questionnaire answers

5-3-1-1. Water source

Figure (5) shows water source for the participated families, 3.3% of families use only their own wells, 20% use their own wells with network supply system, and (76.7%) of them just depend on network.

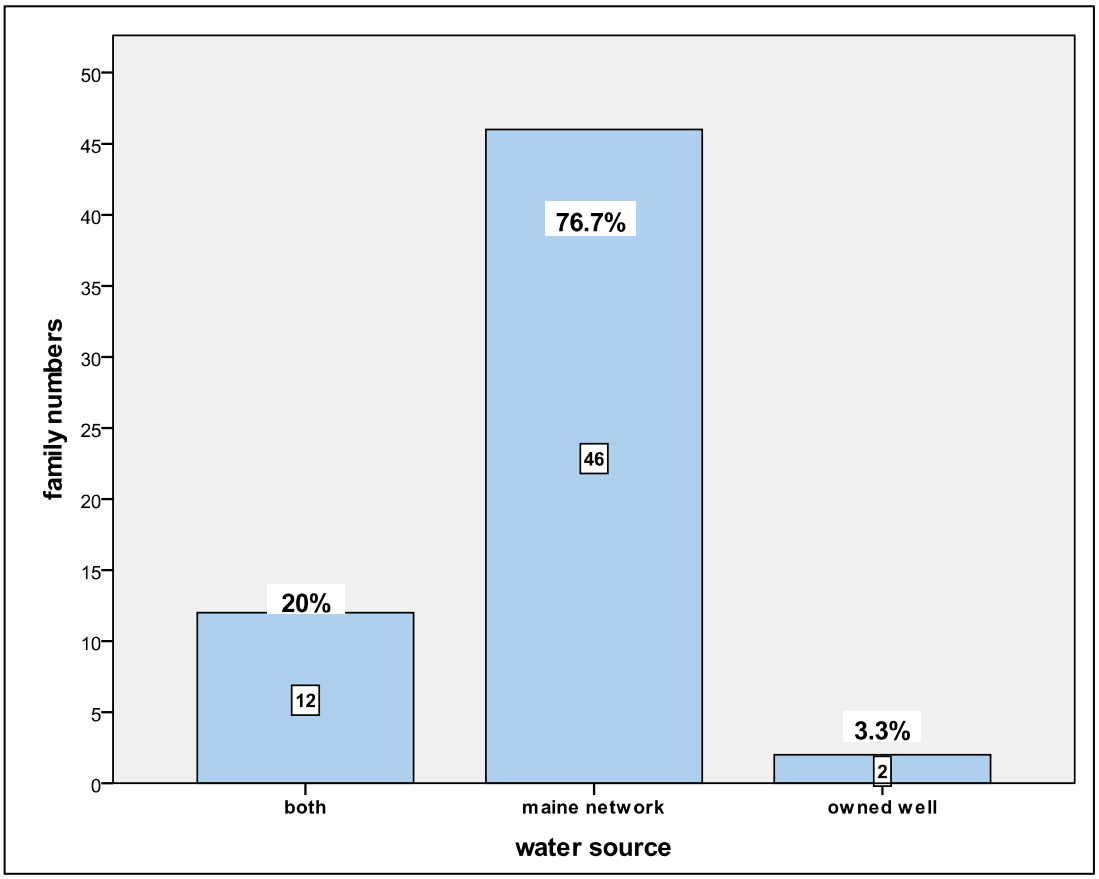

Figure (5) Ratio of water source for participated families

5-3-1-2. Water quantity

Th quantiies complain by the users was 86.7% insufficient while 13.3% sufficient quantities of water reserved as shown in figure (6).

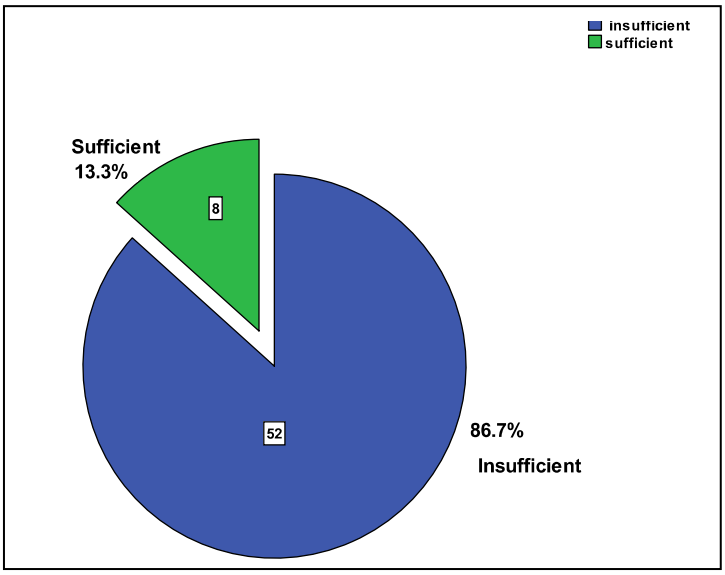

Figure (6) Situation of water quantity received from the main network

5-3-1-3. Water quality

Water quality from residents views are explained in figures (7), it's found that about 45% of the contributed families didn't use water from the main network for drinking because of its color and odor in a ratio of (26.67% and 18.33%) respectively

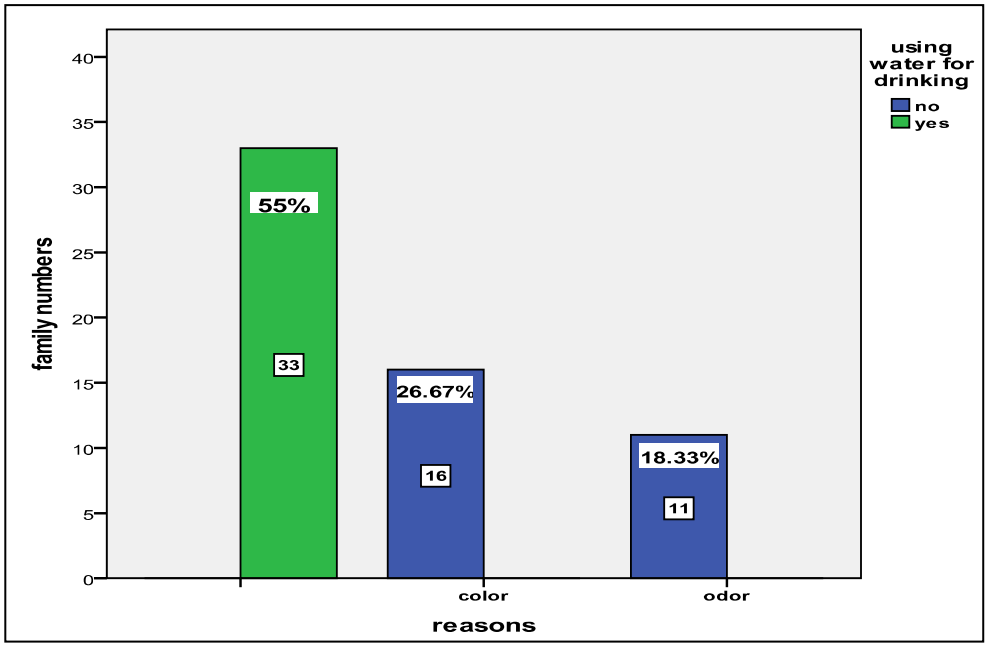

Figure (7) Water usage for drinking

6. SWOT Analyzing

In order to focus on water supply capacity of SWSD and management the following analysis is adopted .It will identify the strengths, weaknesses, threat and opportunities that are necessary for future development of the SWSD supply capacity[17].

To evaluate components of SWOT that affect on SWSD's activities, this paper depended on the questionnaire which covered 30 engineers from different departments of SWSD. Then analyzing results of it, and SWOT components were as follow:-

6-1.Strengths and weaknesses (Internal environment):

	Strengths	weaknesses
communication	▪Suitable communication system between leaders and various levels of SWSD. ▪Existing communication facilities affected positively on the whole system. ▪Communication forms between SWSD and consumers.	▪Media activities of SWSD not affected positively on the whole system.
Infrastructure	▪Required treatment plants exist. ▪Existing network covered most parts of the city. ▪Existing water quality control system ability.	▪Disability to operate existing network with peak demand. ▪Existing technical abilities (staff) of SWSD not as required. ▪Existing collecting water tasks system not effective. ▪Water quality control system ability. ▪Connection of some parts of networks to main transmission lines affected negatively on the system. ▪There are some old parts in the city networks. ▪Disappearing of water meters. ▪Operation of the system manually affected negatively on the system. ▪Disappearing enough water storage tanks.
Incentive system	▪Incentive system for the staff.	▪Salary system for the staff. ▪Absence of practical evaluations for financial supporting.

	Strengths	weaknesses
Training and development	▪Existing training system leads to development	▪Absence of required training for the staff. ▪Existing trainings didn't cover various departments of SWSD. ▪Absence of scientific evaluations for participation in the trainings.
Human resource	▪Required skills in SWSD.	▪Required man power in SWSD. ▪Divisions of the responsibilities aren't according to efficient evaluation.

6-2. Opportunities and Threats (External environment):

	Opportunities	Threats
Environme	▪Existing sources having enough capacity. ▪Topography of the city act positively on the system. ▪Monitoring from health sectors of the water quality has good effects on the system.	▪Raw water of Qashqoly rivers quality. ▪Rapid growth of the city.
Technical & Legally	▪Supporting water sector from governance helpful for the system	▪Motivation from MMT to improve the system ▪Dividing responsibilities of water management between MMT and MAWR. ▪Neglecting the trespassing on the networks from domestics. ▪Disappearance of punishment against trespassers.
Economic		▪Disappearance of water tariff. ▪lacking of required sufficient budget from MMT
Social		▪Preparations from NGOs to cooperate with SWSD. ▪Lack of population awareness.

7. Development planning

7-1 VISION

Sulaimanyah is an example of a comfortable city from water supply servicing in Iraq

7-2 MISSION

The SWSD is an institution that provides drinking water for Sulaimanyah city.

SWSD works to obtain a moderate supplying system to provide continuous supply with high water quality according to Iraqi standards.

That's through increasing storage capacity, decreasing leakage, and pollution. The purpose is reaching water security, saving water sources, and decreasing financial losses by supporting water taxes by the government.

7-3 GOALS

1. Improving communication system in SWSD.
2. Developing the infrastructure for water supply system.
3. Improving incentive system to support SWSD staff.
4. Improving training system for staff of SWSD.
5. Satisfying consumers.
6. Improving water quality from source.
7. Technical and legal development.
8. Economical Development
9. Social edification

7-4 Objectives

1 Improving SWSD's media activities.

2-a Increasing required abilities (especially technicians).

2-b Improving water task collecting system, by utilizing foreign experiences in this field.

2-c Improving water quality system by increasing monitoring system besides controlling.

2-d Redesigning for parts of the network, which are connected directly to the transmission lines.

2-e Providing water meters for the whole system (consumers unites and network)

2-f Changing system operation from manual to auto, by using new techniques.

2-g Building more storage tanks, for increasing storage capacity at least to the half of daily demands of the city.

3-a Changing the system of the salaries can obtain a balance with staff efforts and their responsibilities.

3-b Putting practical evaluations for financial supports.

4-a Making required trainings for staff in order to develop their abilities, and has to cover various departments of SWSD.

4-b Making scientific evaluations for participations in trainings.

5-a Supply required water quality and quantity.

5-b Increasing supplement hours (which must be suitable for consumers).

6 Building sewerage treatment plants for Doukan town before falling to Qashqoly River, which is a source for Doukan water projects.

7-a Establishing general directorate for water supply in Sulaimanyah by MMT as established for municipalities and tourism.

7-b Referring responsibility of water managements to MMT, or establishing Water Ministry by KRG.

7-c Putting required laws and regulations for punishing trespassers by MMT, and increasing monitories for the network.

8-a KRG and KP have to recognize scientific water tariff.

8-b MMT have to increase a financial budget for water sector.

9-a Participating NGO's with media department from SWSD to edification consumers about water saving.

9-b Rising media activities to increase population awareness.

7-5 Scenarios

7-5-1 White scenario

- Sulaimanyah residents will obtain potable water according to international standards, and they haven't spent extra costs for water.
- SWSD will depend on its staff abilities, and doesn't need extra technicians (locally or foregone) for carrying out its duties.
- Any leakages in the system will be detected.
- Collecting water task system will be more effective and will participate in decreasing the financial losses.
- Securing social justices from side of water supply, and balancing in water pressures that reach consumers will be implemented.
- Quantity of produced water and distributed water will be detected, that help to predict any trespassing on the system.
- System will be operated continuously, and residents wouldn't need to use storage tanks.

- Spreading disease from water can be controlled easily, that leads to save financial costs which are spent by health directorate for this purpose.
- Required skills will intend SWSD, when salary systems for the staff become better.
- SWSD staff will compete on honesty in work.
- Human building capacity in SWSD will grow.
- Financial and administration authority of SWSD will be suitable with its duties considering continuous growth of the city.
- Water resources will be protected and managed more effectively.
- Trespassing and illegal behavior will decrease.
- Losses in financial cost which is spent on supporting water sectors by KRG will decrease.
- At near future residents will assimilate SWSD's message *saving water is saving life,* and the efforts of media department of SWSD will not go to scatter.
- Water security will be obtained for all of consumers in the city.

7-5-2 Black scenario

However the situation remains as it is besides rapid growth of the city. Also if SWSD doesn't take care about mentioned goals, then the black scenario will appear as:

- Sulaimanyah residences cannot obtain potable water for their daily use, and they have to spend a lot costs for water.
- SWSD stays depending on extra skills, and cannot carry out its duties without spending high costs.
- Large amount of produced water will be lost by leakages.
- Collecting water tasks remain ineffective, and disabled to be done which participate in decreasing the financial losses.
- Unbalancing in water pressure will remain, and most of consumers have to connect their own pumps directly to the network.

- The quantity of lost water by leakage and trespassing cannot be predicted.
- System stays to use partial-time and residents have to use their storage tanks, which are considered a source of pollution in most times.
- Spreading diseases from water stay to appear every year, and health sectors have to spend high costs and abilities for controlling it.
- Most of the staff and important skills in SWSD will escape to other sectors, when salary system stay as it is.
- Competing on honesty in work in SWSD will disappear.
- Building human capacity in SWSD will decay.
- SWSD cannot follow city growth and present required services for consumers.
- Water resource protection and management will disappear.
- Trespassing and illegal behavior well increase.
- Losses in financial cost which are spent on supporting water sectors by KRG will increase.
- Residents never take care of SWSD's massages, and efforts of media department of SWSD will be scattered.
- Water security cannot be obtained.

8. Conclusions

1. Public drinking water does not meet the demand of residents neither quantitatively nor qualitatively.
2. Large amount of produced water is being wasted because of leakages, and SWSD cannot predict this amount because of the absence of meters on the system.
3. SWSD could not obtain residents' satisfactions, from side of distribution potable water and task system.
4. Most of the problems and difficulties which are faced by SWSD and related directorates are managerial problems rather than scientific problems.

5. Lack of reservoirs and distribution tanks in the city, that's led to water shortage in parts of the city without water during maintenance on the transmission lines.
6. Contamination of raw water from sources especially during summer season.
7. Absence of laws against trespassers on the network.
8. Absence of required technical staff in SWSD especially for maintenance work, which pushed SWSD to depend on extra skills.
9. There are unbalancing pressures detected in the network, due to the topographic nature of the area and bad design.

9. Recommendations

1. Supporting media department of SWSD from local media institutions, and cooperating with NGOs to edification consumers for saving water.
2. Improving SWSD staffs' abilities through raising their technical levels by required training, and their living standards by increasing financial support and incentive system.
3. Building more storage tanks, for increasing storage capacity at least to half the daily demands of the city, renovate old parts of the network, and redesigning system to be operated automatically.
4. Using water meters on the network by SWSD for detecting water losses in the system, also will be helpful for controlling water quality and detecting pollution.
5. Recognizing required laws and regulations for water tariff, trespassing punishments, and using water meter to consumers for measuring water tasks.
6. Using new technicians for balancing water pressure in the network.
7. Building sewerage treatment plants for Doukan town before falling to Qashqoly River and controlling pollutions during tourism seasons by tourists on both banks of it.

8. Establishing general directorate for water supply in Sulaimanyah by MMT to reduce managerial and financial routines and spend more abilities of SWSD for scientific and technical operations.
9. KRG have to adopt water resource management policy, formulate it, and KP has to recognize and put laws and regulations for it.
10. KRG has to attend more water sector by increasing its budget annually, and put regulations for participating private sectors to involve same departments of SWSD like (maintenance, and task collection)

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