Assessment the Status of Treated and Ground Water Production in Selected Provinces in Iraq

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Abstract

The objective of this work was to evaluate the usage and production of water in selected provinces in Iraq for the period from 2016-2018. Thus, the procedure consists of collecting the data and analyze these data statistically in order to find the general trend of the water production and consuming in Iraq. Five provinces were selected to evaluate their status in terms of drinking waters production. The key associated findings with respect to the drinking waters is that there is no province within the selected provinces has increased the design capacity to be compatible with the increasing in their populations. In addition, Kirkuk has a significant reduction in the actual production of drinking waters while the drinking water production in Missan is higher that the planned production. Moreover, the losses in drinking waters were reduced in Kirkuk comparing to other provinces unless that due to the decline in the actual production. The other findings with respect to the ground waters is that although there is an increasing in the number of constructed wells and that mean to the increase to the water demand, however, low rate of production in some areas within the selected study areas. Finally, the ground waters quality is classified between slightly saline to moderately saline. More monitoring and evaluation studies needs to be undertaken to the other provinces in order to diagnose and overcome the problems.

Keywords: Drinking water, Raw water, Water quantity, Groundwater Pollution, Iraq.

1 Introduction

Around the world, the fast growth in the population, and the industrial development with an increasing economy, there is a urgent need to clean waters. The main source of drinking water supply is surface water. In addition to the surface waters, ground waters are used in in some cases as a source of the domestic use after treated with some effective treatments. The surface waters can be represented by different pictures such as: oceans, lakes, reservoirs, and rivers which they are usually contaminated by wastes and surface runoff [1]. Water quality from rivers has a significant importance for the reason that these water resources are commonly used for several things like: irrigation, transportation, potable water and for industrial and commercial issues[2]. The primary cause of river pollution come from the agriculture, domestics and industrial activities as these three categories are normally located along the streams and therefore most of their activities are disposed to the rivers [3].
Although the enhancements in water treatment techniques, however, access to good quality drinking water remains a critical issue and that is supported by the World Health Organization that approximates that around the world nearly 10% of the population do not have access to good quality potable water [4].

Groundwater is a reasonable source for its sustainable use. Because of the natural filtration via soil and sediments which will make the ground water free from organic matters[5]. However, many factors may affect the quality of the ground water quality like the land use methods regional geology, and geochemically process and consequently influenced their consumptions [6, 7]. Therefore, Groundwater quantity and quality is deteriorating at a very fast due to human activities. Universally and locally, many studies have been performed to study the quality of groundwater and the sources of pollution with their impacts[8-10].

Removing microbial and chemical contaminants from the raw water in addition to the undesirable physical elements such as odor and taste are crucial to provide water safe for human use[11]. Therefore, the main goal of water treatment is to make raw water safe and palatable to drink. Moreover, the other target for water treatment is to make the finished water fit for domestic and commercial uses. In several countries, despite drinking water quality is observed and controlled, increasing information leads to review these standards and guidelines for the new contaminants and the regulated one[12].

In this study, an evaluation to the water production for five selected provinces in Iraq were performed.

2 Methodology

Five provinces were selected in order to evaluate their status in terms of the drinking water and ground water production during the period from 2016-2018. The provinces are Kirkuk, Salah Al-Din, Karbala, Al-Qadisiyah, and Missan. The Iraqi map which shows the selected provinces are shown in Figure 1. The climate of the selected provinces has almost the same conditions which is hot, dry climate characterized by long, hot, dry summers and short, cool winters [13]. The data used for this cross-sectional study from the Central Statistical Organization, Ministry of Planning, Iraq were analyzed in order to get better understanding for the situation of the water production within these provinces [14].

Figure 1. Map of Iraq [adopted from [15]].
Table 1. Some information for the Selected Provinces[16].

| Province          | Population (2012) |
|-------------------|-------------------|
| Kirkuk            | 1,432,74          |
| Salah Al-Din      | 1,441,266         |
| Karbala           | 1,094,281         |
| Al-Qadisiyah      | 1,162,48          |
| Missan            | 997,410           |

3 Results

3.1 Drinking Water comparison

3.1.1 Design and Available Capacity

The design and available capacity for the water treatment plants projects within the selected provinces for the period from 2016-2018 are shown in Table 2.

Table 2. Values of Design and Available Capacities for the Water Treatment Plants in the Selected Provinces.

| Province            | Year | Design Capacity $m^3*10^6$ | available Capacity $m^3*10^6$ |
|---------------------|------|----------------------------|-------------------------------|
| Kirkuk              | 2016 | 560                        | 533                           |
|                     | 2017 | 560                        | 186                           |
|                     | 2018 | 517                        | 186                           |
| Salah Al-Din        | 2016 | 428                        | 407                           |
|                     | 2017 | 428                        | 360                           |
|                     | 2018 | 428                        | 360                           |
| Karbala             | 2016 | 545                        | 427                           |
|                     | 2017 | 545                        | 321                           |
|                     | 2018 | 545                        | 321                           |
| Al-Qadisiyah        | 2016 | 494                        | 345                           |
|                     | 2017 | 494                        | 300                           |
|                     | 2018 | 494                        | 300                           |
| Missan              | 2016 | 184                        | 138                           |
|                     | 2017 | 184                        | 176                           |
|                     | 2018 | 184                        | 176                           |

It can be seen from Figure 2, that a clear drop in the available capacity in Kirkuk Province from 2016 and 2017 and that might be due to the rehabilitation of some water projects during that year that make the decrease in the available capacity. In same time, a relatively small reduction in the available capacities for the Salah Al-Din, Karbala, and Al-Qadisiyah provinces were noted. On the other hand, there was an increase in the available capacity for producing the treated drinking waters in Missan province from 2016 and 2017 although there was no increase with its design capacity. Moreover, during that period, the figure shows that there was no construction for any water treatment plant within these provinces to increase the design capacity of the province as the design capacities were kept in the same level.
3.1.2 Planned Production and Actual production

The planned and actual production for the water treatment plants projects within the selected provinces for the period from 2016-2018 are shown in Table 3.

Table 3. Values of Planned and Actual production for the water treatment plants in the selected provinces.

| Province       | Year | Planned Production ($m^{*}10^6$) | Available Capacity ($m^{*}10^6$) |
|----------------|------|----------------------------------|----------------------------------|
| Kirkuk         | 2016 | 523                              | 498                              |
|                | 2017 | 183                              | 174                              |
|                | 2018 | 183                              | 174                              |
| Salah Al-Din   | 2016 | 400                              | 381                              |
|                | 2017 | 353                              | 336                              |
|                | 2018 | 353                              | 336                              |
| Karbala        | 2016 | 419                              | 399                              |
|                | 2017 | 315                              | 300                              |
|                | 2018 | 315                              | 300                              |
| Al-Qadisiyah   | 2016 | 338                              | 322                              |
|                | 2017 | 294                              | 280                              |
|                | 2018 | 294                              | 280                              |
| Missan         | 2016 | 131                              | 140                              |
|                | 2017 | 172                              | 169                              |
|                | 2018 | 172                              | 169                              |

It can be noted from Figure 3, that most of the actual production of the treated water is very close to the planned production (more than 90% of the planned production) for the period from 2016-2018. Interestingly, during the 2016 there was an increasing for the actual production than the planned production in Missan province and that might be due to the
climate change and the weather or due to any other social activities the make higher demand than expected. Moreover, it can be seen that the planned production for the year 2016 was higher than those of 2017 and 2018 except in Missan was the opposite.

![Drinking Water Planned and Actual Production](image)

**Figure 3.** Planed and Actual Production of Drinking Water.

### 3.1.3 Losses in Drinking Waters

The losses in the drinking waters from the water treatment plants projects within the selected provinces for the period from 2016-2018 are shown in Table 4.

| Province     | Year | Losses Production (m$^3*10^6$) |
|--------------|------|-------------------------------|
| Kirkuk       | 2016 | 50                            |
|              | 2017 | 17                            |
|              | 2018 | 17                            |
| Salah Al-Din | 2016 | 38                            |
|              | 2017 | 34                            |
|              | 2018 | 34                            |
| Karbala      | 2016 | 40                            |
|              | 2017 | 30                            |
|              | 2018 | 30                            |
| Al-Qadisiyah | 2016 | 32                            |
|              | 2017 | 28                            |
|              | 2018 | 28                            |
| Missan       | 2016 | 14                            |
|              | 2017 | 17                            |
|              | 2018 | 17                            |

From Figure 4, there is a clear reduction in the losses in Kirkuk Province from 50 to 17 m$^3*10^6$. This drop should be explained heather due the rehabilitation in the main pipes and the
network in the province or due the decrease of the actual produced drinking waters at the years 2016 and 2017. In addition, no significant difference between the losses within the same province and for the most of the other provinces apart of Missan which shows an increase in the losses during 2016 comparing to (2017 and 2018) and that might be either the leakage might had happened or due it is relatively increase with the actual produced drinking waters.

![Figure 4. Losses in Drinking Water.](image)

3.2 **Ground Water Comparison**

3.2.1 **Number of Wells**

Table 5, shows the number of constructed wells in the selected provinces for the period from 2016-2018.

| Province      | Year | Number of Wells |
|---------------|------|-----------------|
| Kirkuk        | 2016 | 8               |
|               | 2017 | 6               |
|               | 2018 | 11              |
| Salah Al-Din  | 2016 | 4               |
|               | 2017 | 29              |
|               | 2018 | 57              |
| Karbala       | 2016 | 32              |
|               | 2017 | 73              |
|               | 2018 | 19              |
| Al-Qadisiyah  | 2016 | 7               |
|               | 2017 | 27              |
|               | 2018 | 137             |
| Missan        | 2016 | 19              |
|               | 2017 | 31              |
From the figure 5, the number of constructed wells in Kirkuk and Missan were kept at the same level during the three years. An increase had in the number of wells had occurred in Salah Al-Din during the three years where it increased from 4 to 57 wells and that might be due to the increasing demand to the water to be used for domestic uses. on the other scenario, Karbala have increased their number if well and then decreased it. while Al-Qadisiyah has jumped from 7 wells in 2016 to 137 in 2018 and that might be either to the climate change impact or due the increasing demand to the water or clean waters.

![Figure 5. Number of wells constructed.](image)

### 3.2.2 Rate of Ground Waters

The rate of produced waters from the constructed ground water wells in (l/sec) within the selected provinces for the period from 2016-2018 are shown in Table 6.

#### Table 6. Rate of produced ground waters in the selected provinces.

| Province     | Year | Rate l/Sec |
|--------------|------|------------|
| Kirkuk       | 2016 | 6          |
|              | 2017 | 6          |
|              | 2018 | 6          |
| Salah Al-Din | 2016 | 5          |
|              | 2017 | 5          |
|              | 2018 | 3          |
| Karbala      | 2016 | 6          |
|              | 2017 | 6          |
|              | 2018 | 6          |
| Al-Qadisiyah | 2016 | 4          |
|              | 2017 | 4          |
|              | 2018 | 3          |
| Missan       | 2016 | 5          |
|              | 2017 | 5          |
|              | 2018 | 5          |
It can be seen from figure 6 that the rate of producing the ground water is almost the same for Kirkuk, Karbala, and Missan. However, there is a reduction in the rate of Salah Al-Din in the last year of the study and that might be due to the number of constructed wells or due to the distances between the wells themselves. In Al-Qadisiyah an addition decline in the rate of producing the ground water although it was the lowest among the selected provinces and also that might be due the number of wells that constructed in 2018 which 137 well.

![Figure 6. Rate of produced ground waters.](image)

**3.2.3 Salinity of Produced water**

The average salinity of the ground water from the wells that were constructed within the selected provinces for the period from 2016-2018 are shown in Table 7.

**Table 7. Salinity of the ground water in the selected provinces.**

| Province       | Year | Salinity (mg/l) |
|----------------|------|-----------------|
| Kirkuk         | 2016 | 2500            |
|                | 2017 | 2500            |
|                | 2018 | 2500            |
| Salah Al-Din   | 2016 | 4500            |
|                | 2017 | 4500            |
|                | 2018 | 2500            |
| Karbala        | 2016 | 3250            |
|                | 2017 | 3250            |
|                | 2018 | 2500            |
| Al-Qadisiyah   | 2016 | 5000            |
|                | 2017 | 5000            |
|                | 2018 | 5000            |
| Missan         | 2016 | 5000            |
|                | 2017 | 5000            |
The average salinity of ground water for the chosen provinces are illustrated in figure 7. According to table 8 which shows the standards classification of water salinity [17], it can be noted that salinity of the ground water in Kirkuk can be considered as a slightly saline, while the other province is between slightly saline to moderately saline. Moreover, Al-Qadisiyah province has the highest concentration among the selected provinces although it has the lowest rate of ground water production.

Table 8. Classification of water salinity adopted from [17].

| Concentration (mg/l) |    |
|----------------------|----|
| Slightly Saline      | 1,000 - 3,000 |
| Moderately Saline    | 3,000 - 10,000 |
| Very Saline          | 10,000 - 35,000 |
| Brine                | More than 35,000 |

Figure 7. Salinity of the ground water.

4 Conclusion

The evaluation of water production (treated and ground) waters in five provinces for the period from 2016-2018 within in Iraq was undertaken. The main related conclusions with respect to the drinking waters is that there is no province within the selected provinces has increased the design capacity to be compatible with the increasing in their populations. In addition, Kirkuk has a significant reduction in the actual production of drinking waters while
the drinking water production in Missan is higher than the planned production. Moreover, the losses in drinking waters were reduced in Kirkuk comparing to other provinces unless that due to the decline in the actual production.

The other conclusions with respect to the ground waters is that there is an increasing in the number of constructed wells and that mean to the increase to the water demand in spite of low rate of production in some areas within the selected study areas. Finally, the quality of ground waters is classified between slightly saline to moderately saline.

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