ORIGINAL ARTICLE

BRIDGING THE GAP BETWEEN DRINKING WATER AVAILABILITY AND DEMAND BY REDUCING LOSSES IN BANIAS WATER NETWORK

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ABSTRACT

Background: The severe shortage of water sources is one of the most important challenges facing the Middle East region in general and Syria in particular. The continuous increase in population, economic activity and great development causes great pressure on the water resources in this region; on the other hand, a large proportion of this water is wasted from distribution networks, causing losses of money and energy. **Objectives**: This research aims to assess the current and future water needs of the city of Baniyas from drinking water, in addition to studying the possibility of bridging the gap between need and supply, depending on reducing the rate of losses. **Methods:** The study relied on conducting field measurements, determining the amount of water produced as well as collecting data related to authorize consumption of bills and others, and then relying on the WEAP21 program for modeling different scenarios. **Results**: This research finds that the percentage of losses in the Banias water network, reaching 65%, and the best scenario was that the losses were reduced to 30%. **Conclusions:** The study reveals that if the current situation persists in the presence of the same quantities of water, the gap between the amounts of supply and demand will widen, in addition to that the third scenario (reducing the percentage of losses by leaks) is an appropriate solution to cover the needs of drinking water in the city of Banias.

Keywords: *Water need, water losses, weap21.*

1. INTRODUCTION

Considering the importance and necessity of securing water as the basis of life, many researchers have analyzed the current state of available water resources to find out quantities of conventional and unconventional water and the needs for different sectors, to clarify the magnitude of the water problems expected in the near future of water resources and predict the extent of their ability to meet the demand for them and the extent of the emergence of future water deficit. In this case, appropriate solutions must be found to confront this deficit and secure water for all [1]. With regard to Syria, it is expected that the demand for domestic and irrigation will increase, due to the increase in the population and the increase in the demand for industrial water as a result of its development [2]. On the other hand, before searching for new alternatives to supply water, it is worth to reduce wasted quantities of water, especially since there are huge quantities of wasted networks, called unaccounted for water (losses), which represent the difference between produced and consumed water. Water losses may be either real or apparent, and, in developing countries, it may reach significant proportion. Therefore, many researchers focused their attention to studying the problem of losses, knowing their causes and determining their quantity as they constitute the most prominent challenges facing water institutions. [3,4,5,6,7,8,9]

2. MATERIALS AND METHODS

2.1 Study site

The research area is located in Syria, the city of Baniyas. The main network consists of Ductile iron pipes, with a length of 27 km, put into service in 1994, and Polyethylene pipes of 64 km were put into service in 2006.

2.2 Field measurements stage:

In this research, measurements were made using the ultrasound machine. The results of the measurements were shown in table 1.

Table 1: The table presents the abundance of feeding branches for Banias.

abundance of feeding branches for Banias(m^3/hour)						
Taleb1	**Taleb2**	**Ras ALNABEH**	**Fareed Naddah**	**Masaken Almosfat**	**Main Banias Tank**	**Total**
15	10	135	180	160	350	**850**

2.3 The data collection stage

In this research, the necessary data was collected for the study, namely:
The estimated population of Baniyas city is 75,000 individuals.
The quantity of produced water: (7446000 m^3).

Authorized consumption includes: The amount of water consumed and obtained from the institution's records of bills and represents the amount of water measured and billed in addition to other components shown in table2:

Table 2: The amount of authorized consumption for the year 2018.

billed metered (m^3/hour)	billed unmetered (m^3/hour)	unbilled metered (m^3/hour)	unbilled unmetered (m^3/hour)	Total (m^3/hour)
2474606	22600	27500	93075	**2617781**

2.4 Calculation of water losses

There are many terms that express losses in water networks, including unaccounted for water (UFW), non-revenue water (NRW), and the most common term is water losses. Each of them expresses the difference between water produced and authorized consumption [5].

$$Ql = Qs - Qa \quad \textbf{(1)}$$ [4]

Ql: amount of wasted water (m^3)
Qs: amount of water produced (m^3)
Qa: amount of authorized consumption

$$Ql\% = 100*(1 - Qa/Qs) \quad \textbf{(2)}$$

$$\text{Total water losses} = \text{amount of water produced} - \text{authorized consumption} \quad \textbf{(3)}$$

$$\text{Total water losses} = 7446000 - 2617781 = 4828219\ m^3 \quad \textbf{(4)}$$

$$\text{percentage of losses} = 4828219 / 7446000 = 65\% \quad \textbf{(5)}$$

<u>Calculate leakage based on Minimum Night Flow (MNF):</u>

Minimum night flow: It is the lowest flow that feeds an isolated hydraulic area during the night, where the night consumption is the lowest possible between (2 and 4) in the morning and thus the pressure is as high as possible, meaning that the largest part of the MNF leaks [10].

For the Banias water network, we measured the overnight flow and the lowest value was 408 m^3 / h.

Night consumption is related to the number of consumers at night and depends on the day of the week, social habits .... etc. Experience in different regions of the world showed that 6% of the population is effective during the MNF period, as consumption is given per person 10 liters / person / hour, and this value varies from one region to another [11]. By subtracting the night consumption from the smallest night flow, we get the night leakage rate.

Baniyas active population during the night = 75,000 * 0.06 = 4,500 people.
Night consumption = 0.01 * 4500 = 45 m^3 / h.
Leakage rate = minimum night flow - minimum night consumption.
Leakage rate = 408-45 = 363m^3 / h = 363 * 24 * 365 = 3179880 m^3.
Real losses ratio = (3179880/7446000) = 43%
Thus, the percentage of apparent losses is = 65% -43% = 22%.

2.5 Building a model for the city of Baniyas within a WEAP21 software

The Water Evaluation and Planning program is one of the most popular software used in water resource planning and management and was designed at the Stockholm environment institute. It can be used as a multi-functional program with the aim of linking available water resources with hydrological processes, future demand including the population, the evolution of the individual's need for water, and improving the efficiency of using these resources in drinking water, domestic use, the agricultural and the industrial sector [12]. It is an effective prediction tool as it simulates the need, supply, flow, storage, source of pollution, treatment, and discharge. It is also an analysis and evaluation tool for management options, and takes into account the multiple and competitive uses of water systems [13].

Initially, a schematic model was built within the WEAP 21 that includes the city of Baniyas and the water sources that feed it as shown in figure 1, where the city of Baniyas feeds from the Alsen-Tartous line by:

-Direct branching.
- Al Quoz tank with a capacity of 5000 m^3.
Then we developed several different scenarios and discussed their results, these scenarios include possible management options in order to meet future water needs.

Figure 1: A model diagram of the city of Baniyas.

4. DISCUSSION

4.1 The first scenario:

After calculating the first scenario that simulates the current water situation of drinking water within the city of Banias, where supply and demand for water has been modeled, as well as the gap between need and supply, starting from the current study year 2018 and for 25 years, that is until 2043. Population growth rate was assumed to be about 1.7%. Domestic water demand is assumed at $130\ l\ /\ cap\ /\ d$ per person, that is, about 47.45m^3 / year per person. The results show that the water requirement for the city of Baniyas from drinking water is constantly increasing from 2018 as it reached 3558750 m^3 until 2043, when it will reach 5424020 m^3, as a result of the continuous increase in the population, as shown in Figure (2).

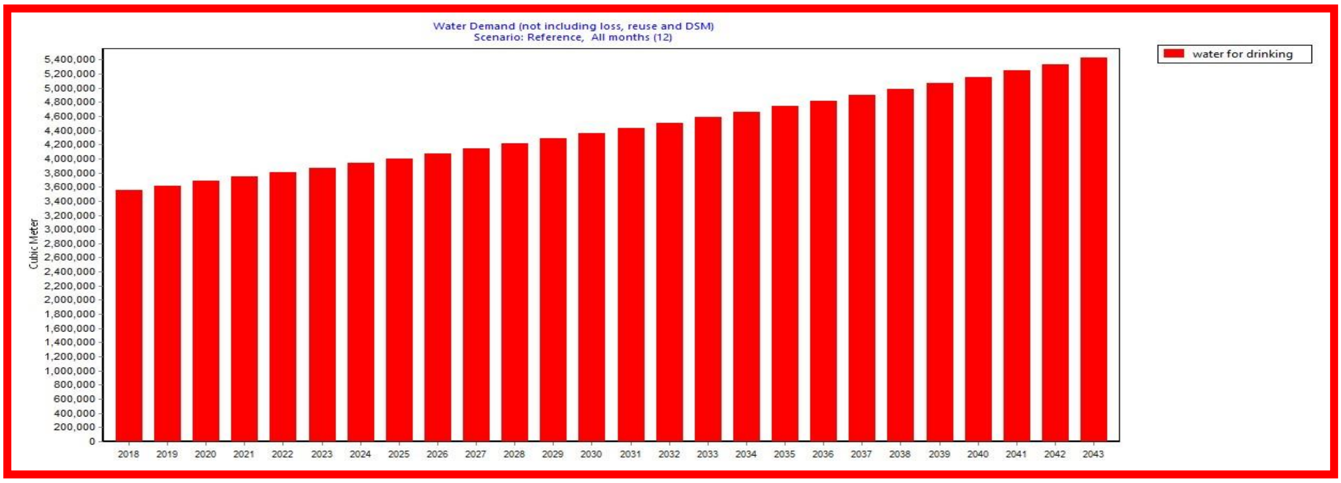

Figure 2: Annual need changed over 25 years.

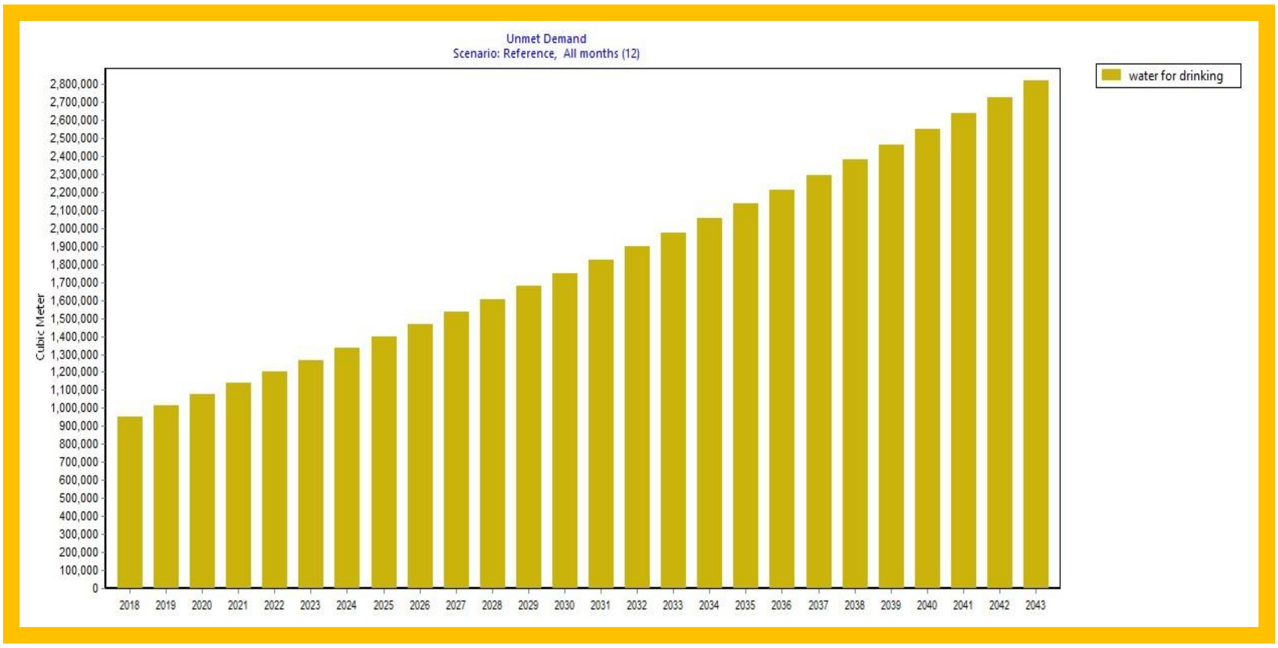

Figure 3: The gap between need and supply from 2018 to 2043.

Thus it is clear to us through this scenario, which clarifies the current water situation of the city of Baniyas, where the per capita share was *130l / cap / d* per person, and with the presence of this large proportion of losses, which amounted to 65%, that there is a gap between the need and supply even in the current study year 2018 This means that the Per capita water l that actually reaches consumers is less than.

4.1 Second scenario

In this scenario, we will change Per capita water to 95 *l / cap / d*, while maintaining all previous entries.

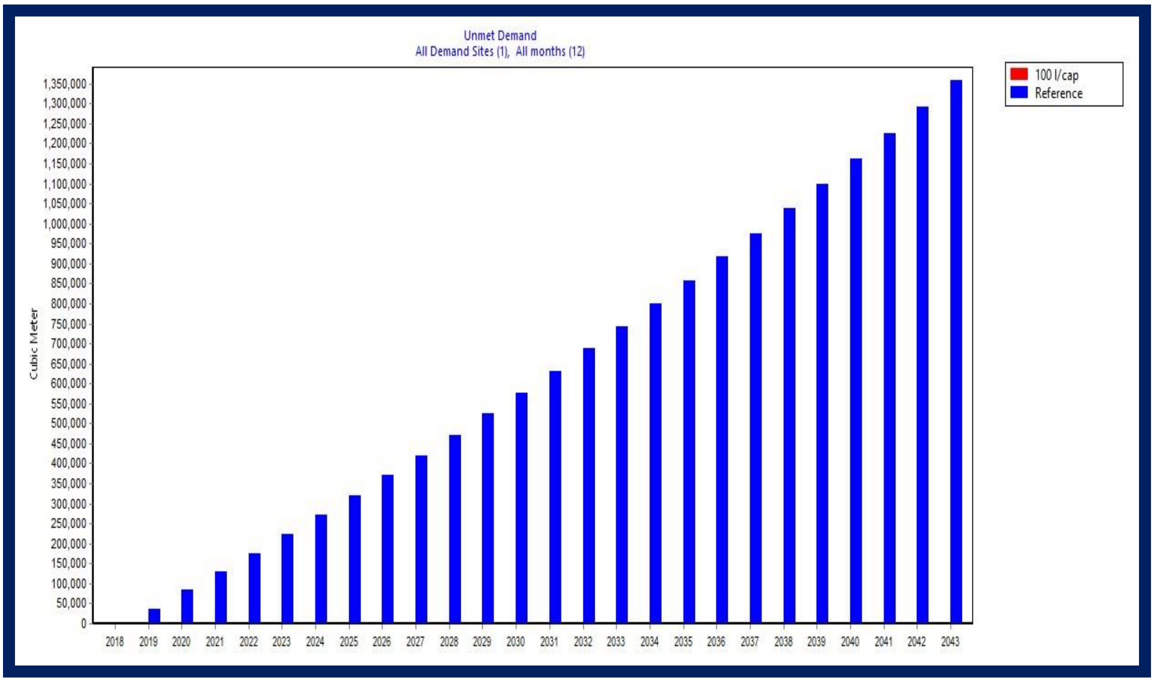

Figure 4: The gap between need and supply from 2018 to 2043.

From previous figure (which shows the gap between need and supply in case that the Per capita water is *95 l/cap/d)*, we conclude that the supply in this case covers the need for the reference study year 2018. In other words, it can be said that the large losses in the Banias water network have reduced the Per capita water under these poor network conditions to *95 l/cap/d*.

4.1 Third scenario:

There is no doubt that improving the efficiency of water use in the narrow sense of word means increasing the ratio between beneficial use and withdrawal of water. Usually, distribution networks in cities lose large quantities of water and among 23 countries on the Mediterranean Sea an estimated 25% of the water is lost in urban networks and therefore, saving water by reducing losses is an important issue in the field of water demand management, but it can only be determined by defining water accounting procedures.

In this scenario, we will model the water situation in the city of Baniyas on the assumption that we have reduced the percentage of total losses in the network, which amounts to 65% to 35%, and a value of 130 *l / cap / d*. The goal of this scenario is to define the percentage of loss reduction, which can meet the bridging gap between need and supply, as it is an important step in the waste management phase of this network and its integration with the energy of available resources (existing) currently only.

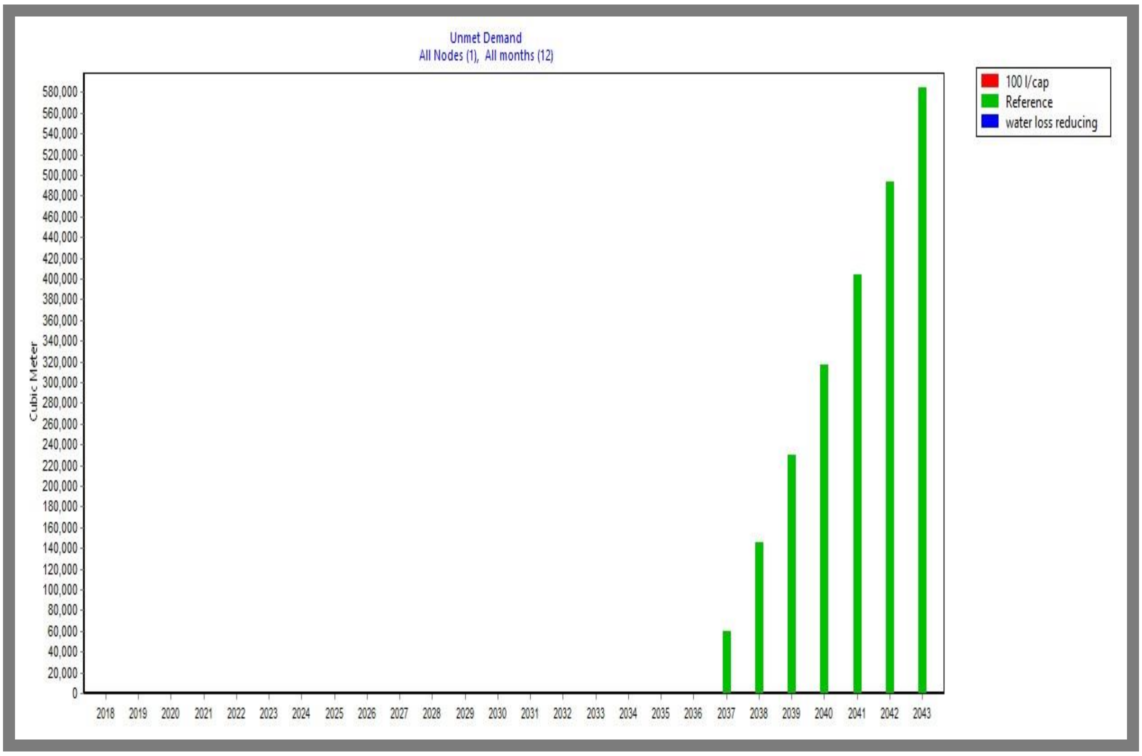

Figure 5: The gap between need and supply from 2018 to 2043.

This scenario demonstrates that reducing the percentage of losses to 35% will contribute to bridging the gap and covering the need for drinking water from Baniyas from 2018 to 2037, i.e. for about 20 upcoming years without the need to search for new resources and invest them. In order to reduce the percentage of losses to 35%, the institution must implement strategies to reduce losses, and given that the largest percentage of these losses are real losses, where their value is about 43%, the organization should detect all leaks in the network and work to repair them, which contributes to recovering the amount of water Waste resulting from leaks and making use of them to bridge the gap between need and supply.

5. CONCLUSION

In the research area, the demand for water increases with the increase in the population over the years of study, and if the current situation continues to exist with the same quantities of water, the gap between the amount of supply and demand will widen. The total losses in the Banias water network is 65%, and this percentage of losses due to leakage in the Banias water network reached 43%. The current situation in Baniyas indicates that the daily per capita water consumption is *95l / cap / d*. In light of the limited water resources and the increasing population, the third scenario (reducing the percentage of losses due to leaks) represents a suitable solution to cover the needs of drinking water in the city of Baniyas.

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