TOWARDS A SUSTAINABLE DOMESTIC WATER USE RATE IN LIBYA

Khaled A. Rashed

Department of Civil Engineering, University of Tripoli, Libya.
Email: k65rashed@yahoo.co.uk

الملخص

تعتمد ليبيا على المياه الجوفية المحلية والمياه الجوفية المنقولة ومياه التحلية لتزويد المناطق الحضرية بالمياه. حيث توفر المصادر الثلاثة 600 مليون متر مكعب سنوياً. معدل التغطية لشبكات المياه في ليبيا ليست معروفة بالشكل الصحيح ولكن التقديرات تشير إلى 65% مما أدى إلى تقدير معدل استعمال المياه بحوالي 420 لتر للشخص الواحد في اليوم (يعتبر عالي جداً بالمقارنة مع البلدان المجاورة). ولكي نقلل من معدل استعمال المياه العالي يقترح إنجاز المهمتين التاليتين: المهمة الأولى: وقد كانت موضوع نشر ورقة علمية سابقة وتتضمن تقييم الوضع القائم فيما يخص العرض والطلب والبنية التحتية والجانب المالي والجانب الاداري. أما ما يخص المهمة الثانية وهي موضوع هذه الدراسة فتتضمن اقتراح خطة طويلة الأمد لتخفيض الاستعمال اليومي والحفاظ على الموارد المائية. وضعية الطلب المستقبلي للمياه تم دراستها من جانبين هما طلب مياه غير مقيد وطلب مياه مقيد. تم اقتراح سيناريوهن إثنين لكل جانب والنتائج أشارت إلى أن وضعية طلب المياه الغير مقيد ستزيد من ضياع الموارد المائية وزيادة صرفها. أما طلب المياه المقيد مع اقتراح برنامج ادارة مائية متكاملة فسيقلل من ضياع الموارد المائية ويجعل معدل استعمال ليبيا من المياه قريباً من معدلات الدول المجاورة.

ABSTRACT

Libya relies on local groundwater, transported groundwater and desalination for urban water supply. Yearly, these three sources provide a total of $600x10^6$ m^3. Libya's water network coverage rates are not known but estimates put a national average of around 65%, which leads to an average national supply per capita estimate of 420 l/c/d. Supply per capita seems high even when compared to countries with similar adjusted wealth. In order to reduce wastage and achieve a more reasonable per capita consumption figure, two tasks need to be done. The first task, which was the main focus of a previous published paper, is to assess the current situation in terms of supply/demand, asset, financial and organizational levels. The second task, which is the main focus of this paper, is to propose a proactive plan that is required in the long-run to bring supply per capita down and preserve water resources. Future water demands have been studied with two main cases; uncontrolled water demand case and controlled water demand case. Two scenarios within each case have been proposed and analyzed with different assumptions. The main findings are: (1) Uncontrolled demand will result in increased wastage of

financial and water resources; (2) With the consumption management program in place, Libya's supply per capita is expected to go down gradually to a level comparable to similar countries in the region.

KEYWORDS: Per Capita Consumption; Water Demand; Consumption Management.

INTRODUCTION

According to the United Nations, about one third of the world's population already lives in countries considered "water stressed" that is, where consumption exceeds 10 % of total supply [1]. These countries, which Libya is one of them, are using more fresh water than they have or at least have in the form of renewable resources. The withdrawal of groundwater in quantities greater than nature's ability to renew it is widespread in Libya [2]. This situation is not sustainable given that the index of renewable water resources in Libya is well below scarcity level. Figure (1) shows water scarcity levels for some countries in the Middle East [3]. Results from the first task showed a high national supply per capita estimate of 420 l/c/d. This figure of water consumption, which includes domestic and non-domestic consumption and unaccounted for water, was confirmed using the Down-Top approach and the Top-Down approach [4]. This paper focuses on proposing a proactive plan that is required in the long-run to bring supply per capita down and preserve water resources.

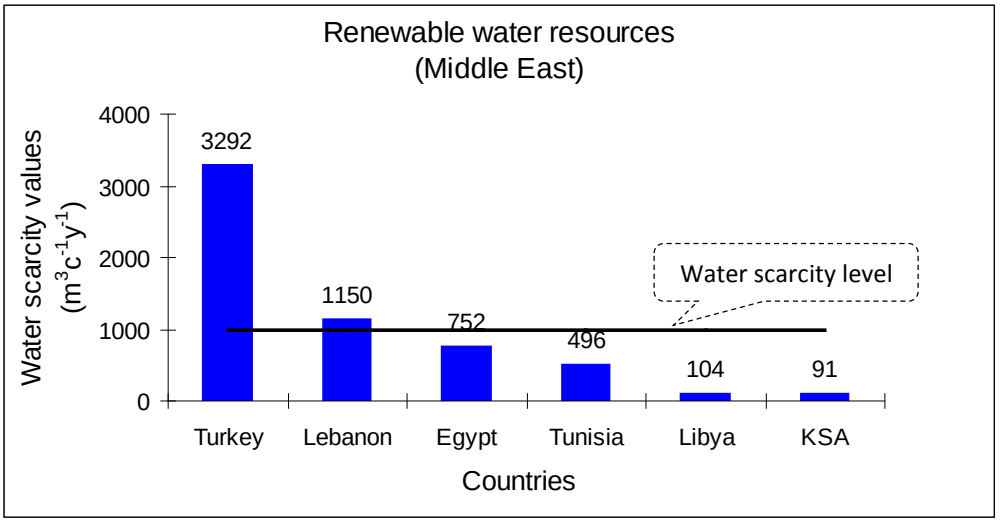


Figure 1: Water scarcity values for some countries in the Middle East.

BACKGROUND

This mission needs to be achieved in the context of the main findings regarding the first task [4], a summary of these findings are as follows:

- In supply/demand dimension, data on coverage rates across Libya is not available, per capita consumption figure (420 l/c/d) is high for Libyan standards of wealth and water scarcity, significant waste of fresh water in domestic sector, water use habits are related to availability, and quality and reliability of water supply are below internal standards;
- In asset dimension, aging assets across the value chain are in poor condition, preventive maintenance is not implemented, leakage in distribution system is a

serious concern that is neither understood nor systematically addressed, and underutilisation of supply assets is not cost effective;

- In financial dimension, very low water tariffs do not at all allow recovery of investment and operating cost, low bill collection rates and metering penetration, low awareness of real operating costs, and no accountability for financial performance;
- In organizational dimension, frequent reorganisations in recent years with pressing overstaffing, unclear interfaces between key players, water allocation decisions are not taken by one body, and overlap, fragmentation and duplication of institutional and asset-related functions in entities.

CURRENT SUPPLY AND DEMAND

Libya's average supply per capita is estimated at 420 l/c/d (for the connected population) with significant variations across regions implying a high correlation between consumption and water availability. In fact, there is a wide regional variation in water supply. According to the population density, the country can be divided into four regions. Table (1) shows details about supply per capita in these regions. It is clear that Supply per capita in Libya seems high even when compared to countries with similar adjusted wealth as it can be seen in Table (2) [3].

Table 1: Supply per capita by region

Regions	**Eastern region**	**Central region**	**Western region**	**Southen region**
Supply ($\times 10^6$ m^3 per year)	170	153	222	55
Population connected (millions)*	0.9	0.85	1.75	0.4
Supply per capita (l/c/d)	518	493	348	377

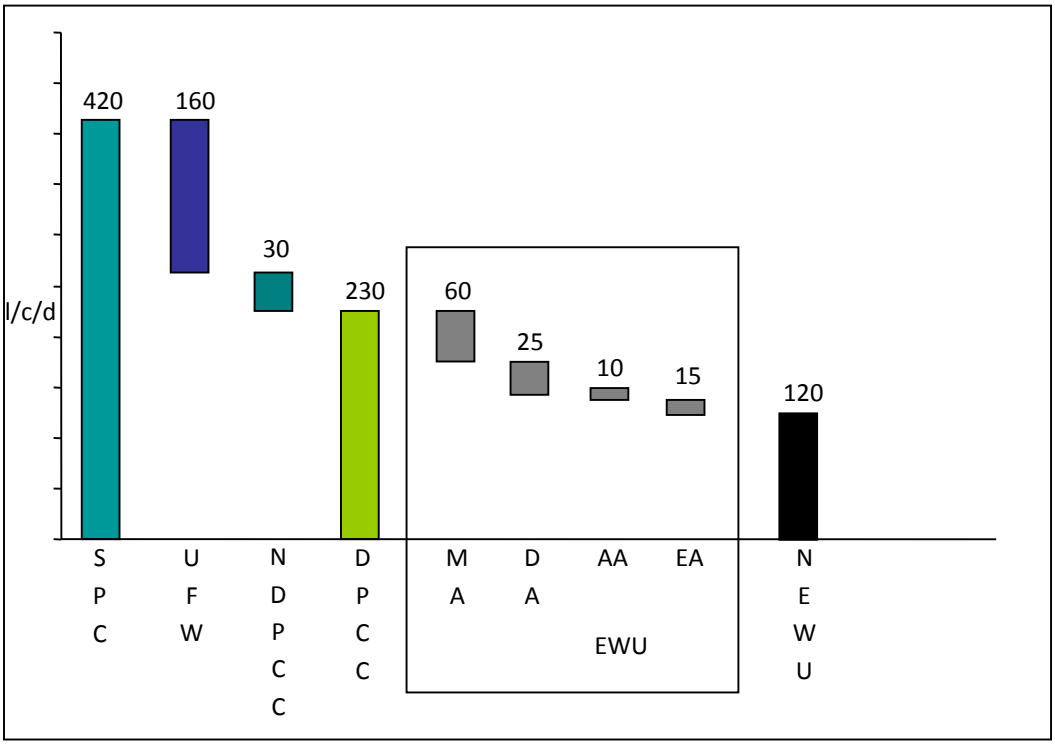
* Population figures based on an average growth rate of 1.8% published by the National Information Authority (NIA) with an average coverage rate of 65%, [5].

Table 2: Water consumption (selected countries with similar adjusted wealth)

Countries	**Libya**	**Lebanon**	**KSA**	**Jordan**	**Morocco**	**Oman**
Consumption per capita (l/c/d)	420	360	250	190	185	110

Figure (2) shows supply per capita breakdown to different components. Down-Top approach based on Libyan living conditions shows that domestic water needs are around 120 l/c/d. This is in line with consumption levels in developed countries (Tripoli example). Based on our estimate current domestic consumption levels are at an average of 230 l/c/d. This figure could be grouped into two main groups; (1) essential water use (110 l/c/d) and (2) non-essential water use (120 l/c/d), which includes among others Wastage, such as spraying in front of residence, leaving the tap running unnecessarily, and inefficient plumbing in household. It is clear that each person is using double the

amount they need daily. This situation is driven by a widespread perception that water is free and by the belief that water is an infinite resource, which has been reinforced by the existence of the Man-Made River, which has been financed through indirect taxes.



SPC	Supply per capita	**MA**	Morning activities
UFW	Unaccounted for water	**DA**	Day activities
NDPCC	Non-domestic per capita consumption	**AA**	Afternoon activities
DPCC	Domestic per capita consumption	**EA**	Evening activities
EWU	Essential water use	**NEWU**	Non-essential water use

Figure 2: Supply per capita breakdown

FUTURE SUPPLY DEMAND

Two cases of future water demands have been proposed and analyzed; (1) Uncontrolled water demand and (2) Controlled water demand. Both cases cover a forecast period from 2015 to 2025 and the year 2010 is used as a base year.

Uncontrolled water demand

Two scenarios of uncontrolled water demand have been proposed, with the following assumptions; (1) population grows at an average growth rate of 1.8%, (2) connectivity is assumed to grow at a rate of 2% per year, and unaccounted for water is assumed to remain constant at 40% over the forecast period.

Scenario-I (constant supply per capita)

In this scenario, a constant supply per capita of 420 l/c/d is assumed to be continued during the forecast period. A summary of calculations and water demand forecasts of this scenario are presented in Table (3) and Figure (3).

Table 3: Water demand forecasts (constant supply per capita)

years	2010	2015	2020	2025
Population (millions)	6.0	6.6	7.2	7.9
Connectivity (%)	65	71	78	86
Water demand ($\times 10^6$ m^3/ year)	600	720	860	1040

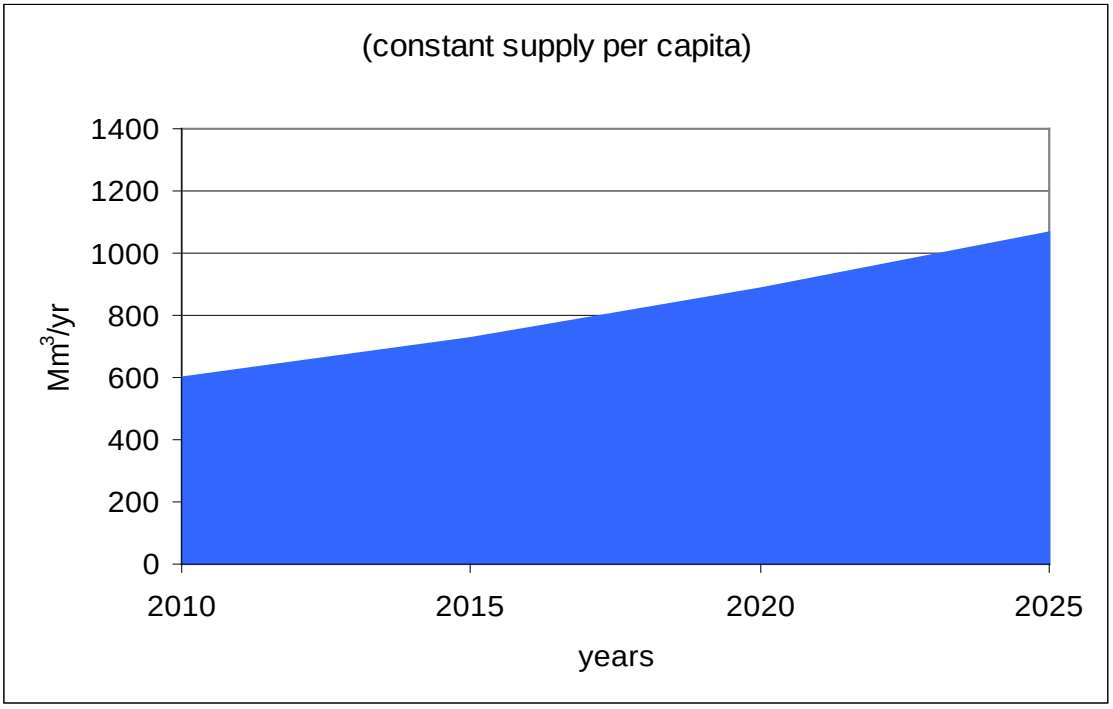


Figure 3: Water demand forecast (constant supply per capita)

Scenario-II (increasing supply per capita)

Increasing supply per capita scenario assumes that supply per capita increases gradually by 20% reaching 500 l/c/d by 2025. A summary of calculations and water demand forecasts of this scenario are presented in Table (4) and Figure (4).

Table 4: Water demand forecasts (increasing supply per capita)

Years	2010	2015	2020	2025
Population (millions)	6.0	6.6	7.2	7.9
Connectivity (%)	65	71	78	86
Water demand ($\times 10^6$ m^3/ year)	600	780	1010	1270

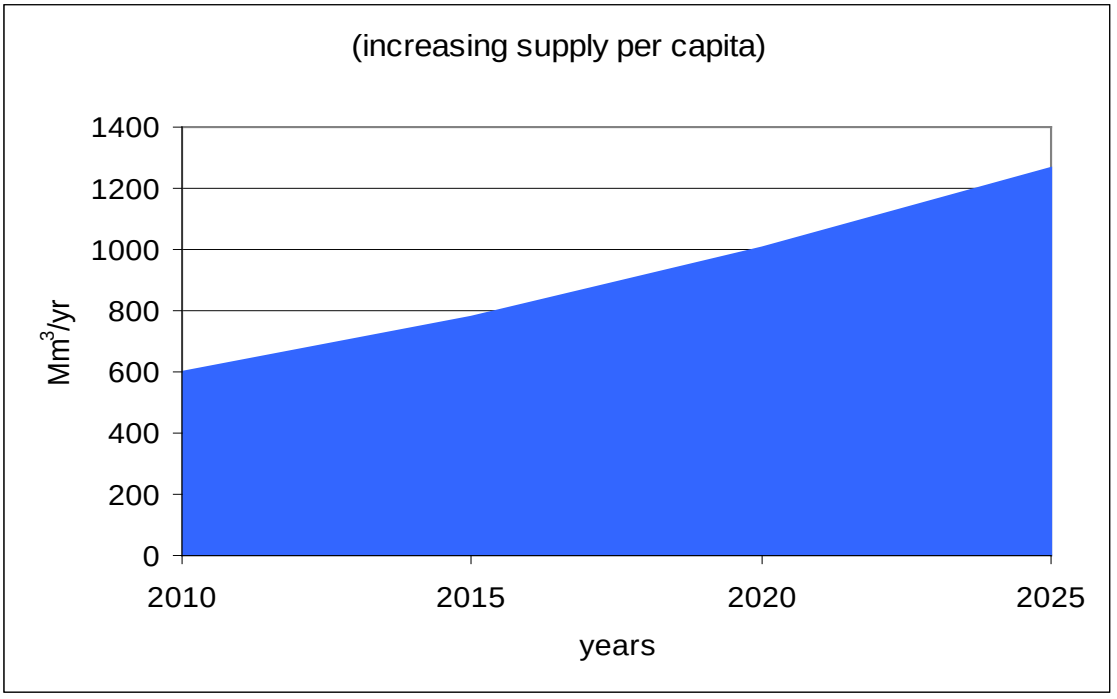


Figure 4: Water demand forecast (increasing supply per capita)

Controlled water demand

Two scenarios of controlled water demand have been proposed, with the following assumptions; (1) population grows at an average growth rate of 1.8%, and (2) connectivity is assumed to grow at a rate of 2% per year.

Scenario-III (eliminating non-essential water use)

In this scenario, supply per capita decreases gradually by 30% reaching 300 l/c/d by 2025 (in other words eliminating the non-essential water use, which is estimated at around 120 l/c/d). This will be achieved by introducing a consumption management program that will put in place the levers to control consumption through water tariffs giving consumers financial incentives to reduce wastage. In this scenario, unaccounted for water is assumed to remain constant at 40% over the forecast period. A summary of calculations and water demand forecasts of this scenario are presented in Table (5) and Figure (5).

Table 5: Water demand forecasts (eliminating non-essential water use)

Years	**2010**	**2015**	**2020**	**2025**
Population (millions)	6.0	6.6	7.2	7.9
Connectivity (%)	65	71	78	86
Water demand ($\times 10^6$ m^3/ year)	600	650	700	745

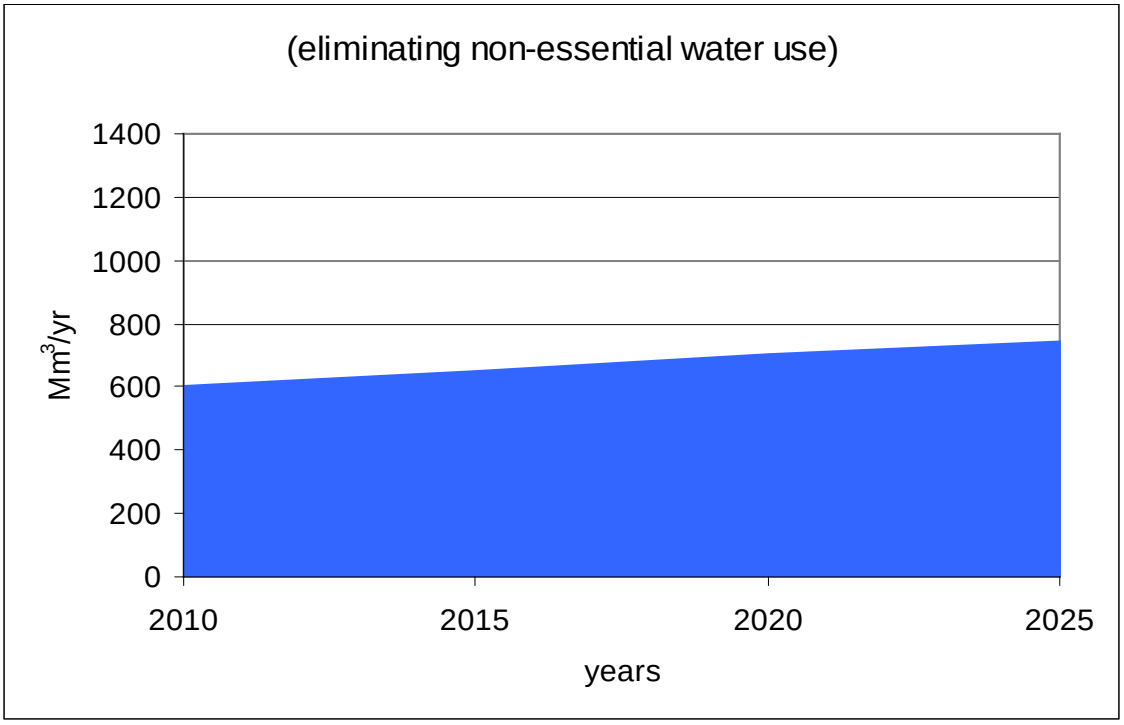


Figure 5: Water demand forecast (eliminating non-essential water use)

Scenario-IV (eliminating non-essential water use & reducing unaccounted for water)

In this scenario, supply per capita decreases gradually through two mechanisms; (1) Eliminating non-essential water use, as presented in scenario III. (2) Reducing unaccounted for water (UFW) from current level of 40% to a level of 25% by year 2025. A summary of calculations and water demand forecasts of this scenario are presented in Table (6) and Figure (6).

Table 6: Water demand forecasts (eliminating non-essential water use & reducing unaccounted for water)

Years	**2010**	**2015**	**2020**	**2025**
Population (millions)	6.0	6.6	7.2	7.9
Connectivity (%)	65	71	78	86
Water demand ($\times 10^6$ m^3/ year)	600	15	615	595

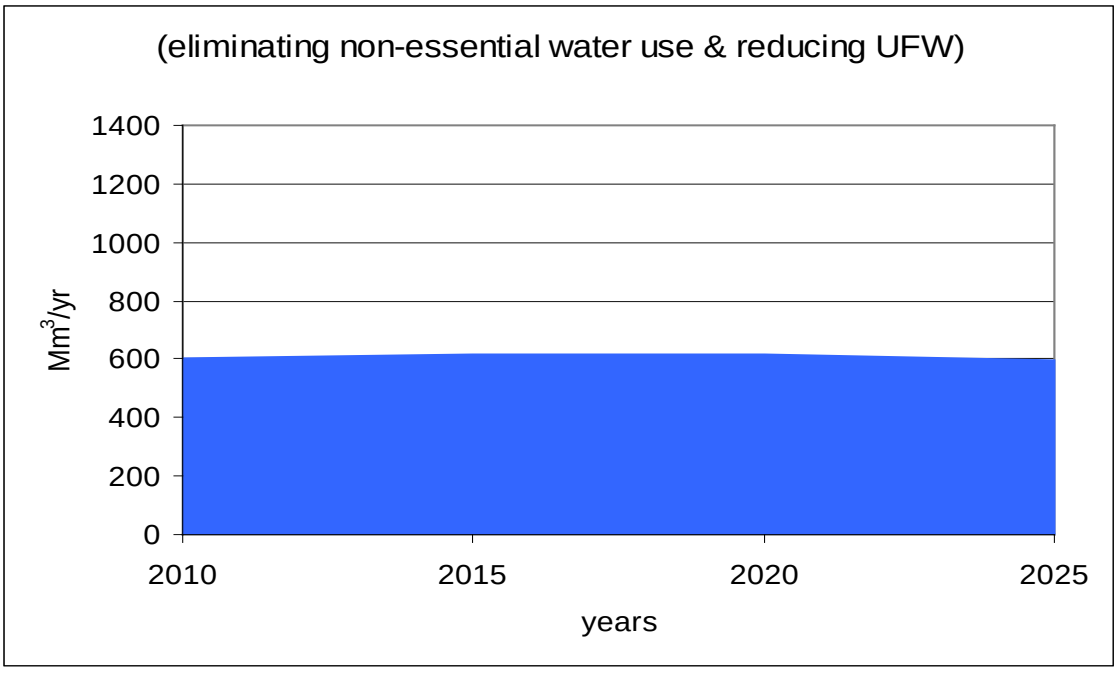


Figure 6: Water demand forecasts (eliminating non-essential water use & reducing unaccounted for water)

DISCUSSION

The uncontrolled water demand case will necessitate a costly expansion of desalination and transported water capacity while continuing to strain wells. It will result in increased wastage of financial and water resources; additional desalination investments; increased system costs (depreciation and operating costs); increased use of transported water; additional withdrawals from depleting wells. In addition, this situation will encourage use of unnecessary water and sustain the belief that water is free and abundant. This will put Libya out of step with other countries in the regions and with the world wide trends to use water more efficiently. If no measures are taken today, it will be difficult to adjust course in the future when reliability and connectivity improves. Therefore a proactive water consumption management program is required in the long-run to bring supply per capita down, mitigate capital investments in desalination and preserve water resources. Water consumption management will be used to eliminate non essential water use and to reduce unaccounted for water. This will be achieved by giving consumers financial incentives to reduce wastage and by introducing a plan to fix and replace broken pipes respectively. The consumption management program is based on five key elements (Table 7). Successful consumption management depends on putting in place the levers to control consumption through water tariffs, metering, bill collection, water conservation campaigns and unaccounted for water reduction. If the consumption management program is, implemented yearly water savings can reach 450×10^6 m^3/Year, which is equivalent to 10 average size desalination plants. With the Consumption Management Program in place, Libya's supply per capita is expected to go down gradually to a level comparable to similar countries in the region (Figure 7).

Table 7: Key elements of water consumption management program in Libya

years	Current situation	Consumption management target
Bill collection	Average bill collection is around 20%	Bill collection to be increased gradually reaching 90% in 2025
Metering	Average meter penetration at about 14% of the connected population	Meter penetration to be increased gradually reaching around 90% in 2025
Water tariff	Water tariff at 0.25 LYD/ m^3 No real tariff enforcement	Two proposed tariff changes in 2015 and 2020 to reach a water tariff of 1 LYD/ m^3
Water conservation campaign	No effective water conservation campaigns are currently being conducted to curb consumption	Water conservation campaigns can bring down consumption of all the consumers
UFW control	No effective water saving plan is currently being conducted	Pipe replacing and fixing can bring down water losses due to leakage

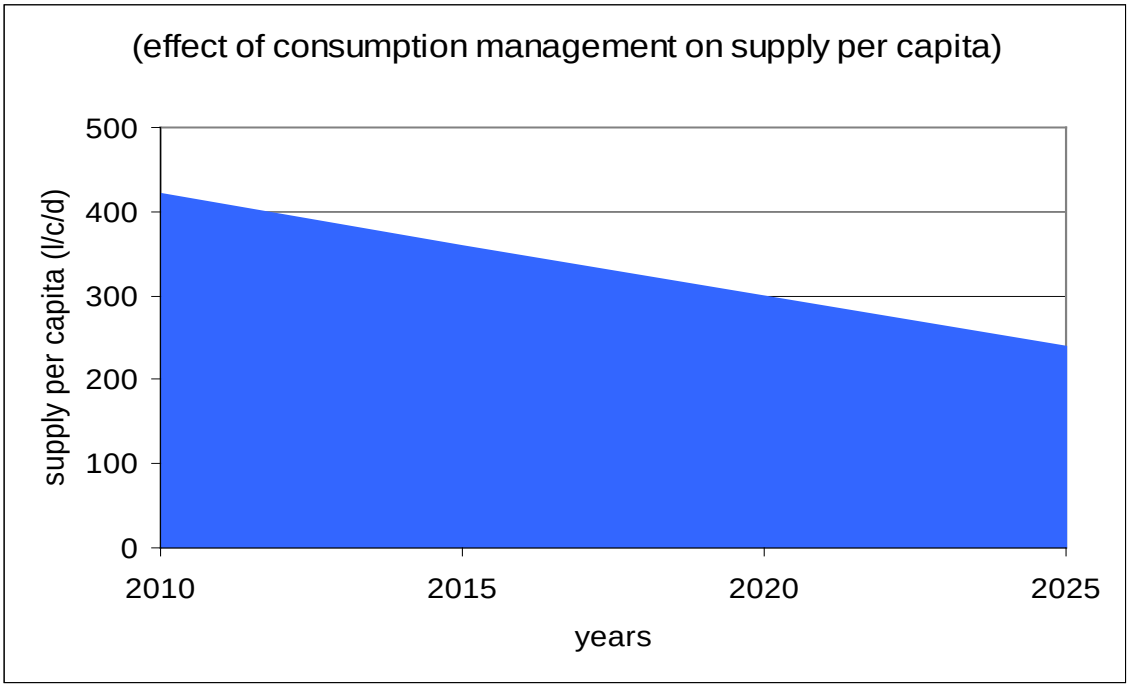


Figure 7: Effect of water consumption management program on supply per capita

CONCLUSION

In Libya, the average national supply per capita estimate of 420 l/c/d is a high figure due to the fact that the country is using more fresh water than it has or at least has in the form of renewable resources. The main goal of this paper is to propose a proactive plan that is required in the long-run to bring supply per capita down and preserve water resources. Future water demands have been studied with two main cases; uncontrolled water demand case and controlled water demand case. Two scenarios within each case have been proposed and analyzed with different assumptions. In the first case, the supply per capita could reach as high as 500 l/c/d by year 2025. In the second case, the supply per capita is expected to go down to reach as low as 240 l/c/d by year 2025.

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