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An Evaluation of Water Resources in Tobruk, Libya: To Aware Consumers and Support Decision Making

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Abstract: ***This paper is aimed at the looming water crisis in Tobruk. Growing population, rapid urbanisation and industrial and commercial activities have significantly increased the water demand. The depletion of groundwater resources and the deterioration of their quality have resulted in a sever water deficit which has a tremendous influence in the agricultural production in the region. For the water shortage to be compensated, water consumers exert large pressure on Tobruk's desalination plant. Public water sector is suffering from deficient management and planning. This can be seen from the deteriorating water distribution networks and the lack of distribution reservoirs. Samples show that water produced by the desalination plant does not meet neither the Libyan standards for drinking water nor the WHO guidelines; this undoubtedly can pose a threat to public health. Inhabitants, in order to cope with water shortage, they resorting to water resources of poor quality and adopting unsafe practices regarding water transfer and storage. Therefore, water consumers and decision makers in Tobruk have to be aware of the adverse consequences of the increasing water shortage in their community.***

Keywords: Water resources, water scarcity, Tobruk, Libya

1. Introduction

In arid zones water resources management is essential in order to maintain and improve the water resources crops and quality and also in maintaining a balance between supply and demand (Zereini and Hötzl 2008; Pereira 2009). The absence of surface waters, low rainfall and the deteriorating of groundwater quality, increasing population and rapid urbanization make Tobruka severely water - stressed region. Knowing that the annual average of water consumption in Tobruk varies from only 29 to 36 m³/person/year (Tahani et al.2012) was the major motive for this work to be conducted to aware Tobruk society of the looming water crisis. Water scarcity and misuse can pose a serious and growing threat to food security and result in detrimental impacts on human health and well - being, industrial development and the ecosystem. Moreover, scarcity or poor quality can have significant adverse consequences not only on agricultural production, but on all aspects of daily life (Kay 1999).

Tobruk locates on the Mediterranean, in the northern - east of Libya. It is one of the major cities in Libya and, owing to its distinctive geographical location (Figure 1), it can play a major role for the development and the enhancement of the country's economy. Tobruk has an excellent naturally protected harbour imparts it an economic importance in addition to historical sites – II world war ruins for instances – and beautiful beaches which can make it a destination for tourists from all over the world. However, due to the lack of sufficient water resources, Tobruk region import its vegetable and fruits either from Egypt or from other Libyan cities. There is a concern, that water scarcity might hinder the urban, agricultural industrial and industrial development in the region.

Figure 1: Location map of Tobruk in the globe (*Source*; Google Earth)

During the past four decades, where poor management and negligence prevailed, water resources in Tobruk were not paid sufficient attention by government and those limited water resources have been left without managing. The results are the depletion of the groundwater and a considerable deterioration of its quality, a dramatic decrease in the agricultural production and sharp deficitin water budget. Because of the previously mentioned factors the desalinated water is now intensively used as the major source of potable water in Tobruk and its suburbs. However, based on economical and environmental aspects, desalinated water could undermine efforts for sustainable development in Tobruk region. The goals of this paper are to draw the attention of Tobruk's population to the threat of water crisis looms over the region and also to support decision making by creating a database – like from which information on water situation can be obtained.

2. Water situation in Tobruk

Due to its location in the Middle East and North Africa (MENA), Tobruk is characterised by water scarcity (Nasr 1999). According to Pereira et al. (2009) who sate that the threshold of 2000 m^3/person/year is considered to indicate that a region is water stressed, the water situation in Tobruk – where the portion of domestic water consumption is only 29 to 36 m^3/person/year – can be described as a serious.

2.1 Conventional water resources

2.1.1 Groundwater resources

Groundwater was a major resource of water in Tobruk region for all purposes, especially for agricultural purposes. Nevertheless, owing to the population growth, rapid urbanisation, to urban migration by rural people and the imbalance between recharge and abstraction, groundwater resources is no more sufficiently exploited. Figure 2 is a satellite image photograph demonstrates the effect of water shortage on the arable farming lands in the city suburban areas.

Figure 2: The effect of water shortage on agriculture and arable landsin Tobruk (*Source*; Google Earth)

Sadly, it can be said that groundwater resources in Tobruk are no more reliable. Field studies included sampling, personal interviews with well owners, groundwater users and farmers, haves shown that groundwater resources in Tobruk are significantly impacted in terms of both quantity and quality. Diminishing natural recharge, over exploitation have led to dramatic decrease in groundwater levels. And ground water quality, due to sea water intrusion, is adversely affected. In the highly urbanised areas, near city centre for example, samples have revealed a number of chemical and biological pollutants, in addition to excessive levels of total dissolved solids (Table 1). The use of groundwater in Tobruk nowadays is almost limited to private industrial and construction sectors where quality is not of high importance.

Table 1: Physicochemical parameters of a groundwater sample taken from a well in an urban area

Parameter	Value/measured amount
Well depth in (m)	40 approx.
Distance from sea in (m)	400
pH	7.4
Total hardness (mg/l)	228
Electrical Conductivity (µS/cm)	2542
Nitrate (mg/l)	40
Microbial & chemical contaminants	positive

Source; Tahani et al. (2012)

2.1.2 Surface waters

As it previously mentioned, due to its geographical location and the limited rainfall (less than 50 mm / year), Tobruk is an arid zone and there are no surface water bodies, such as lakes, rivers or streams. However, it is worth mentioning that rainfalls in winter provide considerable quantities of

water for rural areas whose residents are entirely rainwater - dependent (Figure 3). Rainwater harvesting was practiced by the urban population as well during the past two decades, before the construction of Tobruk's seawater desalination plant – phase III in 2002. Before that time, inhabitants had to cope with water scarcity and quality problems by collecting rainwater from their houses and store it in canisters to be used to make tea or coffee in particular.

In his work in rainwater harvesting in Tobruk, Abdulla (2010) states that about 15 % of Tobruk's water demand can be provided by rainwater harvesting. And large - scale rainwater harvesting is feasible; nevertheless, it requires diligent and continuous efforts of studies and research funded by the government in order to create efficient methods and techniques of rainwater collection, storing and developing the existing ones.

Figure 3: A Roman - style canister used for rainwater storage in a suburb area around Tobruk (*Photo by*; Abdulla, 2010).

2.2 Non - conventional water resources

2.2.1 Desalinated water

Desalination, a process that converts seawater or highly brackish groundwater into potable freshwater, has been practiced for several decades. The scarcity of freshwater has provided a driving force for the use of this approach in arid and semi - arid regions and in countries bordering seas or salt lakes. The production of freshwater from seawater is widely common the Middle Eastern countries. However, seawater desalination is not limited to the arid and semi - arid countries; there several other countries had to adopt this approach because their conventional water resources being either inadequate or becoming unfit for consumption (Qadir et al.2007).

The total amount of freshwater water produced from Tobruk's desalination plant is about 40, 000 m³/day. This amount of water is almost the sole resource of water for the city and its suburbs. It is used for all purposes; including industrial processes and agricultural irrigation Sample analysis (Tahani et. al 2012) have shown that water produced from Tobruk's desalination plant is free from any pollution. Nevertheless, the sample has shown that the water does not comply with the Libyan standards NO.82 for drinking water or with the WHO guidelines (Table 2), however, there are no reported accidents or issues regarding the water quality. The plant uses MED - TVC technology (Multi - effect Desalination - Thermo Vapour Compressor) and operated by heavy oil.

Despite the fact that Tobruk's desalination plant represents the major source of water for the city, there is significant proportion of houses which are unsewered and not connected to the public water network. People who are involved in water and wastewater sector estimate that proportion of 40 %. This claim is supported by the measurements of sewage influent entering Tobruk' sewage treatment plant. This situation deprives about half of the population from their water rights, and also it has led them to buy potable water from private water suppliers. This involves bad practices that are discussed in (section 3).

This pattern of water production raises concerns about environmental issues and sustainable development. However, it has been argued that seawater desalination is a very attractive resource of water because of the low cost of energy, since Libya is an oil - rich state, unlimited source of clean raw water (nearly 1900 km coast on the Mediterranean) and well designed desalination plants emissions and wastes are not environmental issues (Elhassadi 2008).

2.2.2 Treated wastewater

There is a newly constructed and a modern sewage treatment plant (STP). This plant design capacity is 20, 000 m^3/day, however, due to the over estimation of domestic water consumption per capita and also due to the fact that about 40 % of premises in Tobruk are unsewered, the STP receives only 7000 – 9000 meters per day of sewage. Abdulla and Ouki (2013) conducted a study on the potential of wastewater re - use for agricultural purposes in Tobruk.

They have concluded that Tobruk' STP produces about 7, 000 cubic meters per day of suitable effluent for agricultural irrigation and safe discharge. This proportion is worth twice as much as the water being currently used for irrigation in Tobruk region. Therefore, with well planning and management, treated wastewater reuse schemes, in addition to their economical and environmental benefits, can be an efficient mechanism to alleviate water shortage problem and reducing the increasing pressure placed on the desalination plant.

3. Water quality and public health aspects

As it is discussed in (section 2.1.1) desalinated water produced from Tobruk's plant does not meet the Libyan standards of drinking water quality. This raises fears of people, especially concerning the bottle - fed infants who are much more sensitive to quality issues than others. Another problem with water supply in Tobruk is that, supply is intermittent; water is supplied to consumer's premises for 24 hours or less every two or three weeks. This has led to the widespread of private water storage tanks in the city (Figure 4). Most of these water containers are improperly constructed and exposed to pollution. In the new residential areas – lacking of infrastructures – make it even worse, as many residents, due to economical aspects, have to dig Roman - style water storage wells adjacently to permeable cesspits. Such practices, with no doubt, constitute a danger to public health.

Water quality issues have led to the widespread of bottled water trade names. It is not concealed that, bottled water market in Libya is not submitted to the national water directives. Some, if not most, of these trade names sources are known, their suitability and safety for drinking are questionable. Ironically, the taste of some local bottled water trademarks changes according to the taste of water provided by public water supply.

Table 2: A comparison between the Libyan standards for drinking water and the specifications of drinking water produced by Tobruk's desalination plant

Standards	Libyan standards NO.82 for drinking water*		Specification of drinking water produced by Tobruk's desalination plant. **
	Minimum acceptable concentration	Maximum acceptable concentration	Value/measured amount
Natural characteristics			
Colour (colour unit)	5	15	none
Temperature (C°)	22	25	20
Turbidity (NTU)	1	5	0
Taste and odour	acceptable	acceptable	none
pH	6.5	8.5	6.08
Electrical Conductivity (µS/cm)	750	1200	116
Chemical compounds standards (in mg/l)			
Total hardness	200	500	40
Total dissolved solids	500	1000	70
Sulphates	200	400	4.0
Chloride	200	250	18
Sodium	20	200	10
Calcium	75	200	10
Magnesium	30	150	4
Potassium	10	40	-
Zinc	5	15	-
Fluoride	1	1.5	0.1
Iron	0.1	0.3	0
Manganese	0.05	0.1	0
Chemical compounds hazardous to health (in mg/l)			
Phosphates	0	0	0
Nitrate	0	45	6
Ammonia	0	0.05	0

* General Desalination Company of Libya. Date of sampling: 24.01.2012
** Tahani et. al.2012.

4. Conclusions and recommendations

- Water authorities in Tobruk are recommended to assign highly qualified water specialist, international pioneer water companies for instances, to evaluate the water situation in Tobruk region.
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- Developing the public water and sewerage networks and constructing of service and distribution water reservoir for consumers to avoid bad practises in water storage and transfer.
- It is quiet common to see pools of potable water in Tobruk's streets and residential areas caused by leakages and water misuse. Thus, public awareness is necessary for the contribution of water saving and hence a reduction in its production cost.

- Encouraging of rainwater harvesting and wastewater reuse as they seem viable resources to be used within integrated water resources schemes.
- Enacting groundwater abstraction laws by public authorities.
- Control and periodical monitoring of bottled water factories. Such business must be constrained by licences issued by water and public health authorities.
- Water researchers in Libya are arguing that water desalination is a viable and economically efficient. That is because the abundance of oil in the country. However, we should not ignore that the oil used for the operating of desalination plants has a financial value can be spent on other sectors. The question now is; how long will we depend on desalination plants to provide us of water? The answer to this question leads to the fact that we must spend a portion of oil income on researches of water resources, especially seawater distillation using solar energy. Indeed we receive enormous amounts of sun radiation which can make distillation a feasible option, but on the other hand, it is well known that researches require large funding that might not be available once the oil has been depleted.

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