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Reuse of Treated Sewage Effluent (TSE) in Qatar

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ABSTRACT

Qatar has one of the fastest growing and funded water sectors in the GCC region, with significant government funds being focused into water supply and sanitation. However, it is anticipated that there will be an increase in the demand on desalinated water supply due to increase in urban population and expansion of industrial and agriculture activities. This is expected to cause water shortages and a serious need for new water sources. There is a critical need to evaluate the efficacy of applying certain advanced technologies to improve the quality of Treated Sewage Effluent (TSE) for reuse in more applications in the industrial and agriculture sectors to reduce the demand on desalinated water. Treated sewage effluent (TSE) and wastewater have tremendous potential in supplementing the ever-growing water demand. It can be effectively recycled for both potable and non-potable purposes, provided it meets specific water quality requirement and type of application. Generation of treated wastewater is also cheaper and consumes lower energy when compared to desalinated water. Nevertheless, wastewater effluent contains a wide range of pathogens and other pollutants including chemicals of emerging concerns and heavy metals. Many studies have confirmed the abundance presence of pharmaceuticals, personal care products (PPCPs) and endocrine disrupting chemicals (EDCs) in wastewater that could pose a severe threat to public health. Therefore, it is essential that wastewater effluents are adequately treated and monitored to ensure a safe supply and reuse of treated effluents.

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1. Introduction

Qatar's only natural freshwater resources are precipitation and groundwater. In the years 2008–2012, the total precipitation (monitored at Doha International Airport) was lower than the long-term average precipitation (1962–1992). In the year 2012 the total precipitation was 32% of the long term average. According to the Environment Statistics Annual Report 2013 by Ministry of Development Planning and Statistics State of Qatar, the exploitable groundwater volume is 47.5 million m^3 per year [1]. However the current groundwater abstractions are about 250 million m^3 per year, this would lead to aquifers depletion and increase salinity. The depletion of its groundwater aquifers represents one of the major challenges for water systems management in Qatar [1].

Water scarcity is a grappling issue that plagues the Middle East and North Africa (MENA) region where it has been reported that more than two-thirds of the world's top 20 water-deficit countries are located in this region [2]. Another source [3] revealed that at least 12 countries in the Arab and Western Asia region have less

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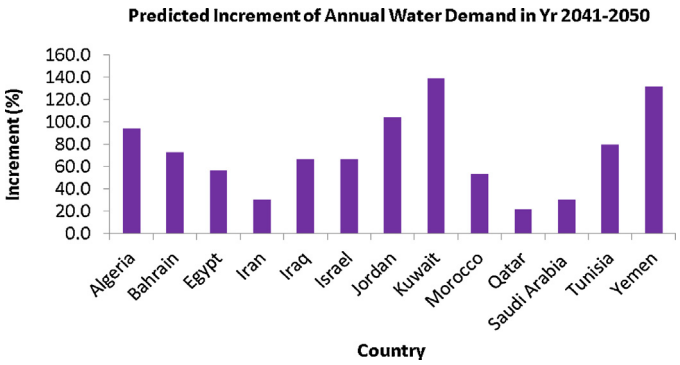

Fig. 1. Annual water demand in MENA Region by 2050 (calculated based on Droogers et al. [4].

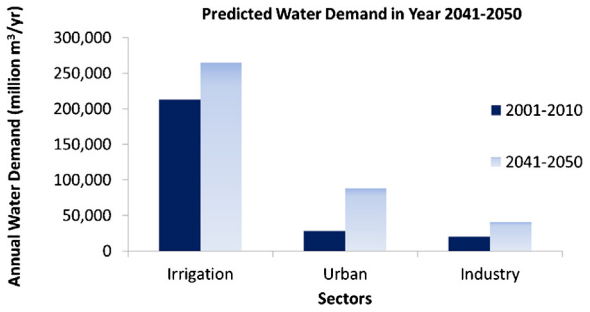

Fig. 2. Water demand by sector in MENA Region [4].

than 500 m^3/capita/yr of renewable water resources. Droogers et al. [4] projected that water shortage in MENA region would increase approximately by 290% in 2041–2050 compared to actual shortage of 42,000 million m^3/yr in 2001–2010. By taking into account the average detrimental effect of climate change, it was predicted that MENA's water discrepancy would be approximately four folds or higher in 2041–2050 [2,4,5]. Increase in annual water demand by 2050 according to different MENA countries and sectors are shown in Figs. 1 and 2 respectively. It is evident from Fig. 2 and numerous publications [2,3,6] that the agricultural sector is and will be the largest water consumer for next few decades. In comparison to global water usage of 70% for agricultural purposes, some of the countries in MENA region, especially Iran, Yemen, and Sudan are consuming over 90% of its total water withdrawal for agricultural activities [5]. Despite its relatively lower demand in comparison to agriculture sector, water demand for urban and industry sectors are expected to surge to 88,000 million m^3/yr and 41,000 million m^3/yr respectively by 2050 [4].

Presently, water demand in MENA region has already exceeded its natural water supply by 20% where this shortage is currently being met using groundwater reserves and desalinated water [2]. It is indisputable that limited ground water resources and high desalination cost would not be able to sufficiently address the water shortage in this region. A more sustainable and reliable water resource is required to satisfy the ever-growing demand in irrigation, urban and industrial activities that are further exacerbated by climate change and increase of population.

Treated sewage effluent (TSE) and industrial wastewater could potentially play a significant role in supplementing the water demand of Arab countries as it has been reported that only 60% of the generated wastewater volume of 10,900 million m^3/yr were treated [7]. Of this treated volume, only one third of the volume was actually reused. These figures clearly reveal that up to 80% of the total wastewater generated could potentially be reused to address the water shortage in the region.

2. Reuse of treated wastewater

Due to global water scarcity, the reuse of treated wastewater has become a necessity and is widely recognized as a valuable water resource. Many countries have successfully recycled their wastewater resources to complement their overall water demand. For instance, Singapore is currently meeting 30% of its water need by reclaiming wastewater and aiming to increase the reuse rate to 55% by 2060 [8]. Bennett et al. [8] also highlighted the wastewater reuse rate in Israel where over 80% of domestic household wastewater are recycled. To harness the benefits of reusing treated wastewater, the MENA countries have executed significant efforts and plans. By 2040, Saudi Arabia has targeted an increase in their water-recycling rate by more than 90%. Water reuse in Saudi Arabia's agriculture sector is expected to increase by almost 1.3 folds in 2035 compared to the reported amount of 540 million m^3/yr in 2012. Similar increase is also predicted in the landscaping sector where the reuse amount in 2035 is approximated at 560 million m^3/yr. Apart from these two sectors, water reuse for industrial sectors is predicted to constitute about 13% of overall water reuse of 2130 million m^3/yr in 2035 [9]. Egypt's National Water Resources Plan is targeting to reuse 2400 million m^3/yr of the treated wastewater for agriculture irrigation to partially fulfill its anticipated total water requirement of more than 90,000 million m^3 by 2017 [10]. In Tunisia, long-term goals were set to irrigate over 25,000 ha and recharge aquifers with 30 million m^3 of treated wastewater [7]. In Abu Dhabi, its Environment Vision 2030 targets to recycle 100% of its treated wastewater by 2030.

Similarly, Qatar is making a major headway in reusing its wastewater resources. Due to limited rainfall and depleting ground water sources, TSE has been recognized as one of the vital water resources that could play a key role in meeting Qatar's water demand. TSE generation in Qatar has augmented more than 3.4 times over the past seven years to 108 million m^3 in 2011. This constitutes 14% of 771 million m^3 volume of water that was potentially available for usage in Qatar in 2011. The agriculture sector is the primary user of TSE in Qatar. Almost 42 million m^3 of TSE (equivalent to 39% of TSE production in 2011) were used to meet agricultural sector's total water demand of the 270 million m^3. TSE generation has further increased to 117 million m^3 in 2012 (Fig. 3) where nearly two third were reuse for agriculture and landscaping [1].

Apart from supplementing the huge water demand of the agriculture and irrigation sectors, TSE is expected to play a prominent role in Qatar's district cooling industries. It is estimated that these industries will consume nearly 73 million m^3 of TSE which represents 17% of total TSE demand in 2020 [11]. As per the approved directive of Water Resources Committee (PWRC) in 2014, usage of potable water for cooling purposes is forbidden in Qatar. As TSE is an excellent alternative to potable water, nearly 39 million m^3/yr of potable water can be saved by the district cooling industries in 2023 [12]. Other possible usage of TSE in Qatar are for the following applications:- (i) make-up water for fire-fighting training exercise [13] (ii) non-potable use in construction field (e.g. concrete mixing) and road works [14] (iii) sanitary flushing [11] and (iv) sand washing [11].

Besides TSE, industrial wastewater is also being widely treated and reused in Qatar. Qatar's Ministry of Environment issued a directive that requires energy and industry sectors in Qatar to work towards Zero Liquid Discharge (ZLD) of process wastewater by December 2016. In 2013, these sectors recycled 24.5 million m^3 of water [15]. Qatar Fertilizer Company (QAFCO) has laid out plans to reuse 90% of its process wastewater irrigation or other purposes [16]. Qatar Gas, the world's largest liquefied natural gas company, has embarked on various engineering projects to increase its wastewater recycle rate to 70% [17]. Qatar Fuel (WOQOD), a downstream oil storage, distribution, and marketing company, has