

## Challenges and prospects of using treated wastewater to manage water scarcity crises in the Gulf Cooperation Council countries

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### ABSTRACT

The Gulf Cooperation Council (GCC) countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates) are facing severe water shortages, which jeopardize sustainable development and restrict human, industrial, and agricultural expansion. Rapid urbanization and increasing living standards have further exacerbated the problem. Although arable land in GCC countries is averaging only 4.3% of the total land area, average water use for agriculture is 70% of the renewable water resources and is even higher in Saudi Arabia, UAE, and Oman. Despite this water use, the average contribution of agriculture to the gross domestic product (GDP) is only 0.8%. However, massive oil and gas reserves in the region compensate for the scarcity of land and water resources in GCC countries.

The increasing demand for water by domestic and industrial sectors is threatening the ecosystem services, food security, and the environment. The annual per capita water uses in the GCC countries is 560 L/d compared to the world average of 180 L/d. This four-fold increase in water consumption over the last two decades is caused by a rising population and unplanned agricultural expansion. Therefore, improving the productivity of marginal land and water resources in GCC countries is imperative to increase the food supply and avoid the adverse environmental effects of land degradation. The marginal water resources such as poor-quality saline water, treated wastewater, and produced water from the oil industry are now successfully used for agricultural crop production and aquaculture in many countries. Currently, an estimated 380  $\text{bm}^3$  of wastewater is collected annually across the globe and expected to reach 574  $\text{bm}^3$  by 2050. Currently, about 36 million ha are irrigated with the wastewater, of which 29 million ha are using untreated wastewater. Farmers in urban and peri-urban areas of nearly all developing countries are using untreated wastewater for irrigation.

The treated and untreated municipal wastewater is used for agriculture in several parts of the world because it supplies additional nutrients and improvements in crop production during the dry season. During the last two decades, the use of treated wastewater for agriculture has also increased in the GCC countries. The GCC countries are in the driest part of the world with an annual per capita water availability of 500  $\text{m}^3$  compared to the world average of 6000  $\text{m}^3$ . Agricultural water demand, which is more than 80% of the total water consumption, is primarily met through the massive exploitation of groundwater. The imbalance between groundwater discharge (27.8  $\text{bm}^3$ ) and recharge (5.3  $\text{bm}^3$ ) is causing the excessive lowering of groundwater levels. Therefore, GCC countries are investing heavily in the production of nonconventional water resources such as desalination of seawater and treated wastewater (TWW).

Currently, 439 desalination plants are annually producing 5.75  $\text{bm}^3$  of desalinated water in the GCC countries. The annual wastewater collection is about 4.0  $\text{bm}^3$ , of which 73% is treated with the help of 300 wastewater treatment plants. Despite extreme water poverty, only 39% of the treated wastewater is reused, and the remaining is discharged into the sea. Currently, more than one-third of the available TWW is used to irrigate nonedible crops and fodder. However, TWW use is primarily restricted to landscaping, gardens, and road ornamentals. The use of TWW to irrigate food crops is minimal due to health, environment, social, and religious concerns. Farmers are hesitant to grow food crops using TWW due to the fear of losing customers for their products.

In all GCC countries, the gap between water supply and agricultural water demand is met through extensive groundwater exploitation. Uncontrolled and unregulated groundwater abstraction has resulted in excessive lowering of groundwater levels, degradation of groundwater quality, salt-water intrusion into freshwater aquifers, and rising pumping costs. The current trends of groundwater exploitation are not sustainable and immediate action is required to put a brake on groundwater abstraction to protect this vital natural resource to ensure potable water supply to urban and rural communities.

The TWW represents one of the most promising alternatives to meet agricultural water demand and make more fresh water available for domestic and industrial uses. The use of TWW in agriculture can contribute positively to improve the socio-economic conditions in the GCC countries. This is very important considering that large volumes of TWW will become available in the future due to population increase and the expansion of urban sewage networks in the large cities of the GCC countries. Therefore, robust plans need to be developed for the sustainable use of TWW; otherwise, vast quantities will have to be discharged into the sea. Since water is the key driver in achieving Sustainable Development Goals (SDGs), developing a global vision on wastewater use is needed to improve the effectiveness of national policies.

This paper reviews the status of available water resources in the GCC countries. It considers the future water demands and discusses the challenges and opportunities to use the TWW in GCC countries to bridge the gap between supply and demand. The increased use of TWW is also vital for this region because groundwater is fast depleting due to overexploitation, which will have direct consequences for the food security of this region. To increase TWW use for agriculture, a comprehensive awareness campaign needs to be initiated to address the social and religious concerns of farming communities and consumers. Several internal and external risks can jeopardize the sustainable use of treated wastewater in the GCC countries. These include climate change, increasing costs, technological and market-driven changes, and regional security issues. Therefore, effective response mechanisms should be developed to mitigate future risks and threats. For this purpose, an integrated approach involving all concerned local and regional stakeholders needs to be adopted.

*Keywords:* Wastewater reuse; Agriculture; Desalinated water; Heavy metals; Water scarcity

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