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Marginal-quality waters for irrigation in water-scarce areas

Achieving food security for all amid a growing population is a grand challenge for the world at large given increasing global water scarcity. As rainfall, river runoff and snowfall in water-scarce areas are becoming insufficient to meet the water demands, there is a need to consider planned use of waters of marginal quality for irrigation to support sustainable increase in crop production systems.

By Manzoor Qadir

Water-scarce regions and countries must sustainably access and utilise every available option for water resources in order to minimise the pressure that continues to grow on conventional water provisioning approaches relying on snowfall, rainfall and river runoff. Unconventional water resources are an opportunity to narrow the water demand-supply gap in these regions. Some unconventional water resources are of marginal quality but can be effectively used for irrigation. They may need suitable pre-use treatment or require pertinent on-farm management when used for irrigation. In response to growing water scarcity, there are scattered but increasing examples of marginal-quality water resources being used for irrigation.

There are two broader categories of marginal-quality water resources. The first is municipal wastewater, which is generated as a possible combination of domestic effluent consisting of black water from toilets, greywater from kitchen and bathing and other household uses, waste streams from commercial establishments and institutions, industrial effluent where it is discharged into the municipal sewerage systems, and stormwater and other urban runoff ending up in municipal sewerage systems. The second is saline water generated by irrigated agriculture and surface runoff that has passed through the soil profile and entered the drainage system as well as saline groundwater stemming from different sources, such as underlying saline formations, seawater intrusion in coastal areas and infiltration from agricultural drainage and wastewater irrigated areas.

Municipal wastewater – high value, but still underexplored

Once stigmatised as waste, municipal wastewater is increasingly recognised as a valuable source of irrigation water and nutrients. Annual availability of municipal wastewater across the world stands at 380 billion m^3 (1 m^3 = 1,000 l), which is a volume five times that of water passing through the Niagara Falls annually. The potential of irrigation with municipal wastewater is by far under-explored as large volumes of wastewater are not even collected but released into the environment in treated form or even untreated, causing environmental and health impacts.

Where available, the farmers in many water-scarce developing countries tend to opt for wastewater irrigation for a number of reasons. Wastewater is a reliable, if not the only, water source available for irrigation throughout the year. Using it for irrigation often reduces the need for fertiliser application as it is a source of nutrients. Furthermore, wastewater use involves less energy cost even when pumping, if the alternative clean water source is from deep groundwater. Finally, it creates additional benefits such as greater income generation from cultivation and marketing of high-value crops such as vegetables, which provide year-round employment opportunities.

As wastewater irrigation is in most instances part of the informal irrigation sector, authorities face challenges controlling or regulating the practice. The protection of consumer and farmer health and environment are the main concerns. Thus, sustainable use of wastewater must address three major aspects: pertinent policies, regulations and institutional arrangements, wastewater treatment per intended reuse option and risk management practices that eliminate or minimise the health and environmental impacts, particularly when wastewater treatment is limited. The perceived high cost of establishing wastewater collection networks and treatment plants capable of satisfactory wastewater treatment is a major constraint leading to uncertainty in terms of adopting comprehensive wastewater treatment and reuse programmes. Initial improvements in water quality can be achieved in many developing countries by at least primary treatment of wastewater, while secondary treatment can be implemented at a reasonable cost in some areas to standards which can be attained in the local context.

Some countries in dry areas such as Tunisia, Jordan, Israel, and Cyprus have implemented

Municipal wastewater is a valuable source of water and nutrients. Photo: Manzoor Qadir national standards and regulations for water reuse. Policy-makers in these countries consider reuse of reclaimed water as an essential aspect of strategic water and wastewater sector planning and management. For example, the wastewater policy in Jordan has three major considerations: reclaimed water needs to be part of the water budget in the country, water reuse is to be planned on a basin scale, and fees for wastewater treatment are collected from the water users. Water reuse in Jordan occurs through planned direct use within or adjacent to wastewater treatment plants, unplanned reuse of reclaimed water in *wadis* and indirect reuse after mixing with surface water supplies, which is mainly practised in the Jordan Valley where reclaimed wastewater provides about half of the irrigation water used in the valley.

The implementation of research-based technical options for wastewater treatment and reuse in dry areas in developing countries, supported by flexible policy level interventions and pertinent institutions with skilled human resources, offers great promise for environment and health protection as well as livelihoods resilience through agricultural productivity enhancement, although this may not be achieved in the next few years. Therefore, interim measures would be needed to address water recycling and reuse to gradually reach a level when most wastewater in these countries would be collected, treated and used safely and productively in treated form. The good news is that a shift is underway in research and practice supporting collection, treatment and productive use of treated municipal wastewater for irrigation, as the example of Jordan shows.

Three options for the use of saline drainage and groundwater

Saline water from agricultural drainage systems and saline groundwater can be used for pertinent crop production systems and could be a significant contribution to food, feed and renewable energy production. Despite the absence of a comprehensive global assessment of the extent of saline drainage and groundwater resources, broader estimates suggest that their volumes are greater than the volumes of municipal wastewater. Contingent upon the levels and types of salts present, there are three major approaches that involve the use of saline drainage and groundwater for crop production:

The **cyclic strategy** involves the use of saline water and non-saline irrigation water in crop rotations that include both moderately salt-sensitive and salt-tolerant crops. Typically, the non-saline water is also used before planting and during initial growth stages of the salt-tolerant crop, while saline water is usually used after seedling establishment.

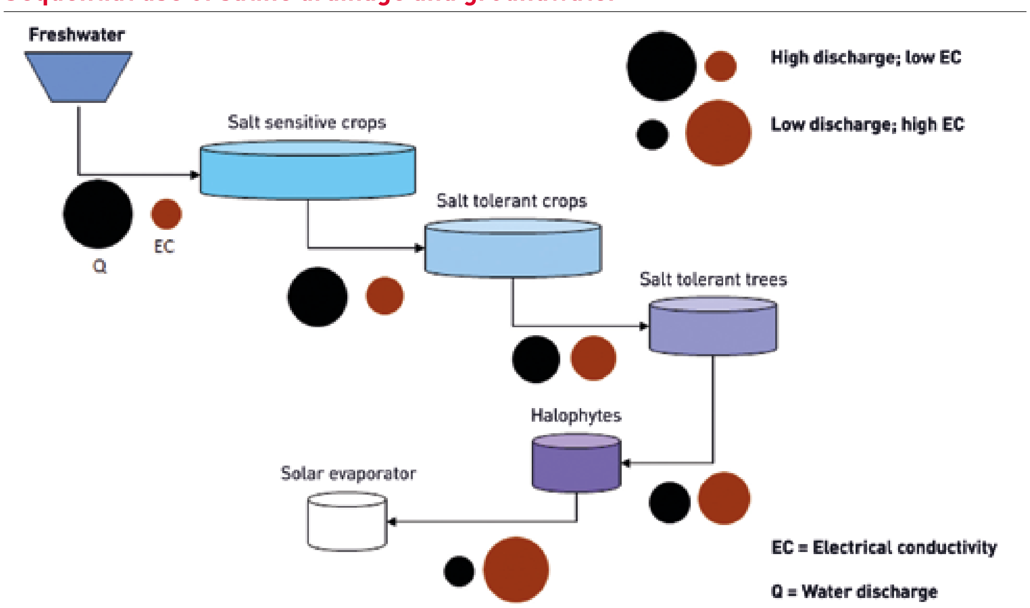
Blending consists of mixing non-saline and saline water supplies before or during irrigation. Drainage water from a drainage sump can be pumped directly into the nearest irrigation canal, or drainage water from a sump on a regional collector, which serves several drainage systems, can be conveyed to a single location and then pumped into a main irrigation canal. In both cases, the amount of drainage water pumped into the canal can be regulated so that target salinity in the blended water can be achieved. Different water qualities are altered according to the availability of individual irrigation water qualities and quantities, between or within an irrigation event.

The **sequential option** (see Figure) involves applying the relatively good-quality water to the crop with the lowest salt tolerance and then using the drainage water from that field – obtained from the subsurface drainage system – to irrigate crops with greater salt tolerance. The simplest management method is to use drainage water on fields located down-slope from those where the drainage water is collected. There is no fixed number of times the cycle can be repeated. It depends on the salinity of drainage water, the volume of water available, and the economic value and the acceptable yield of the crop to be grown.

Saline drainage and groundwater resources are used by the farmers in several river basins in a range of countries such as USA, Spain, India, China, Pakistan, Iraq, Iran, Egypt and most countries in the Central Asian region. For example, in India, saline drainage water has been used to irrigate different crops such as wheat, pearl millet and sorghum in Karnal, Haryana. The salts accumulated in the soil by saline irrigation water were leached by the monsoon rains. At times, pre-sowing irrigation with low-salinity canal water was applied to support the initial, salt-sensitive stage of crop growth.

There is a need for a paradigm shift towards reuse of saline water until it becomes unusable for any economic activity rather than its disposal. In doing so, there are additional gains in the form of mitigating climate change impacts through enhanced soil carbon sequestration. Therefore, saline drainage and groundwater cannot be considered redundant and consequently neglected, especially in areas that are heavily dependent on irrigated agriculture where significant investments have already been made in infrastructure such as water conveyance and delivery systems to supply water for irrigation and food security. There is a need to revisit policies and practices around water resources management in water-scarce countries and place saline waters as a priority in the public policy arena while promoting supportive action plans.

Sequential use of saline drainage and groundwater



Source: Manzoor Qadir

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