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EDITORIAL

Drinking Water Problem in the Dry Zone of Sri Lanka – a Paradigm Shift

The abundance of clean water is a wealth of a nation. Water is vital in all aspects of life. However, the clean water supply on Earth is finite and under stress. Benedek (2008) designates *"water as new "oil" or more precious than oil. The oil can substitute for other energy forms but not water. However, oil is not recoverable, but water does*." Approximately 50% of the consumed water by us will never be replaced! The rainfall and infiltration are not sufficient to replenish this treasured resource!

UNSDG goals and Sri Lankan Perspectives

The United Nations (UN) declared a Sustainable Development Goal (UNSDG 6) dedicated to `Clean Water and Sanitation for all by 2030'. However, recent reports show that the world is off-track in fulfilling UNSDG goals (Nature Editorial, 2020). Achieving UNSDG 6 is vital for the success of all other UN goals. The Government of Sri Lanka has taken steps to accelerate the UNSDG 6 by declaring the provision of safe drinking water to the entire nation by 2025 under its *Water for All* program. Can Sri Lankan Government achieve this ambitious target? With nearly 22 million population, Sri Lanka is not a water-scarce nation! However, the distribution of water resources is uneven in Sri Lanka (as in other parts of the world), where potable water occurs in places where it is not needed.

Therefore, implementing an effective water management plan is critical in preventing drinking water shortages. Presently, 44% of the Sri Lankan population has access to pipe-borne water, 3% has access to hand-pumped tube wells, 36% have access to protected dug wells, and 1% of the population uses rainwater harvesting systems. The remaining 16% of the population does not have access to safe water sources (Fan, 2015). The majority of the water-related health issues have become dominant in the dry zone that covered approximately two-thirds of the country's total land area. Except in urban areas, the majority of the people (~85%) in the dry zone use groundwater for drinking, at their own risk. The lack of safe drinking water is a poverty indicator in a country! The villages in the dry zone are remotely located; thus, the people cannot access the national water supply grid. However, the authorities require developing community-based schemes with a localized network of pipe-borne water to minimize the widening disparity between urban and rural populations in supplying safe water.

Water salination

Dry zone groundwater resources are characterized by high total dissolved solids (TDS), hardness, fluoride, nitrate, and iron. Except for nitrate, other substances have a lithogenic origin. However, chemical data related to pesticides and other organic contaminants in drinking water is sporadic or unavailable. Good practices can prevent pollution from anthropogenic sources, while the effect of lithogenic constituents can be minimized by selecting water sources judiciously. Salinity in drinking water is the most acute problem experienced in the dry zone. The high content of fluorides in drinking water (2.0-3.0 mg/L) causes severe dental and bone-related issues. High salinity renders water unpalatable resulting inadequate water consumption by the people. Most water quality issues and related health problems in the dry zone of Sri Lanka emerged over the past four decades. This period coincides with resettlements under the accelerated Mahaweli Project and the commencement of installing tube wells. The unsystematic drilling for groundwater extraction and construction of agricultural wells seem to result in high salinity in water. Generally, the dry zone groundwater treats to remove excess fluorides but still renders it unpalatable. Treatment order of contaminants in polluted water is important. For example, when the excess salinity is removed, other ions present in water are also removed automatically, modifying the charge balance. Therefore, water desalination should be the first step to improve palatability followed by checking for the availability of other trace ions such as fluorides before introducing additional treatments, if needed.

State and Private Organizations have introduced several interim measures to resolve this pressing drinking water issue, but with limited success. Bowser-driven water distribution is one of the unsustainable options in operation. Several rainwater harvesting projects have been implemented, but the direct consumption of rainwater is not recommended due to the deficiency of required solutes. In ancient Sri Lanka, large-scale reservoirs were used to harvest rainwater to recharge groundwater and for other uses. These surface bodies are not efficiently utilized today in resolving the current crisis in potable water. Due to the lack of potable water, the consumption of bottled water has also increased over the years. However, bottled-water manufacturers' adherence to regulations is questionable, raising concerns about the quality of their products. The safety of household water filters also needs proper scrutiny.

Water desalination and pressure driven membranes

In the dry zone (Sri Lanka), several treatment methods such as electrocoagulation, adsorption, etc. were introduced to control excess fluoride levels in groundwater, though these methods are not effective in water desalination. Most of these treatment plants are not used at present. All these methods generate

https://orcid.org/0000-0002-0509-5307

excess sludge often causing other environmental issues. However, the removal of water salinity is not easy as defluoridation. Pressure-driven membrane technologies such as reverse osmosis (RO) or nanofiltration membranes (NF) are proven methods in water desalination (Sedlak, 2019). However, in Sri Lanka, this technology shows limited success due to inappropriate use. In Sri Lanka, the seawater RO membranes (SWRO) are frequently used in freshwater desalination (most membrane treatment plants are installed without characterizing the salinity of input water). Except in the Northern part of Sri Lanka, where TDS levels in water are > 8,000 mg/L, the TDS levels are always < than 3,000 mg/L. Also, SWRO membranes require high energy input (1.1 $kWh.m^{-3}$, recommended water TDS > 10,000 mg L^{-1}). Thus, they desalinate freshwater, eventually resulting with extremely low solute levels. In such situations, artificial salts are added to maintain the required water-electrolyte balance, which often results in a peculiar taste. Natural water contains minerals that come from dissolving geological material in minute concentrations. Therefore, the quality of the natural water is hard to achieve through RO-treated water. As a precaution, tunable membranes have been developed in recent times to regulate solute levels at desired concentrations (Liu *et al*., 2021). Such technologies are still at an experimental stage. However, a topological network of RO and NF membranes can mimic the role of tunable membranes to generate treated water with desired TDS (NRC, 2016). Further, the wastes generated by RO and NF can lead to soil salinization. Presently, a majority of water treatment plants are managed by villagers as a community service. Therefore, the required technical expertise is often lacking among these villagers. If these problems are not addressed urgently, the membrane-based technologies will continue to show limited success in Sri Lanka.

Misconceptions among communities

In providing safe water, public awareness programs are essential to address some of the misconceptions of the communities. Currently, a majority believe that natural water is not safe for drinking, as they think that rainwater requires treatments before consumption. As a result, most natural wells have been abandoned, and in some instances, use them as dumping sites, causing additional threats of polluting aquifers. Studies also noted that the groundwater is of good quality in some locations (i.e. Kebitigollawa, Sri Lanka) and requires a simple treatment to improve its clarity. However, people are reluctant to accept these findings and demand installing treatment plants. Therefore, resolving deeply-rooted community misconceptions about water is another challenge for policymakers and experts. The villagers should provide reliable information through programs with experts from universities, research institutes, and state agencies to resolve their misconceptions and improve knowledge.

Final inference

In saline environments, water has a peculiar behaviour that cannot be explained successfully by its deceptively simple chemical structure (Fayer, 2011). As a result, the water treatment methods used so far are not effective and sustainable. In 2003, the World Health Organization introduced Water Safety Plans to protect water resources against pollution (WHO, 2003). To ensure the sustainability of life on the Earth, the protection of water resources is of utmost importance!

Rohan Weerasooriya
Water Quality Research Centre,
National Institute of Fundamental Studies, Sri Lanka.
China-Sri Lanka Joint Research Centre for Water
Research and Demonstration Technology, Sri Lanka.
Email: rohan.we@nifs.ac.lk

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