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Editorial

Managing Water, the Mother of Resources: Thoughts on World Water Day 2024

Cite This: *ACS Sustainable Resour. Manage.* 2024, 1, 368–369

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While several nations of the world are going through wars to affirm their territorial boundaries, wars of another kind are being fought everyday by millions around their neighborhood: **the war for access to water, a basic human right**. This latter war is intensifying due to climate catastrophes and indiscriminate development, particularly evident in the developing world. The theme of World Water Day 2024 is *Water for Peace*.[1] We know that sharing water resources equitably can bring peace to any region, and the opposite can nucleate or propagate conflicts. Water can bring prosperity, food security, reduced mass migration, quality education, and all-around growth of the young, ultimately leading to harmony and stability of nations. Water can indeed bring joy in the long run!

Water is central to all aspects of life and development; thus, it is also a reason for conflicts at the local and national levels due to several factors. The factors may be broadly grouped as (a) 60% of global fresh water resources are trans-national involving 153 countries of which only 24 have cooperative agreements, (b) ~5 billion people experience water scarcity at least once a year, (c) over 2 billion people live without reliable and safe water supply and face major health consequences, such as over 500,000 diarrheal deaths per year due to microbial contamination,[2] and (d) rising inequality continues to exert pressure on the available water bodies that are shrinking in size and with reduced water quality. We realize that the central problem is associated with resource management, which is the theme of *ACS Sustainable Resource Management*.

Water resources of the planet are constant. We have just about 1.14×10^{45} molecules of water, with minor changes in the numbers over time due to anthropological activities. The sugar molecules which are components of cellulose—which eventually made petroleum, and coal—are derived from CO_2 and H_2O via photosynthesis through a quantitative reaction. Combustion then transforms these compounds back into the same starting molecules. Thus, from a planetary sense, "water for all" is a management problem.

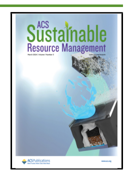
We obtain water from rain and snow, and the availability of these resources has been constant over millennia, with local variations, particularly exacerbated due to climate change. The annual renewable water resource (ARWR) for the planet was ~5400 m^3 per person in 2020.[3] However, by 2050, the ARWR of 87 out of 180 countries will be less than 1700 m^3 per person, and 45 of the 87 countries will face absolute water scarcity, i.e., 500 m^3 per year.[4] Water, being a dense molecule, poses another significant challenge in society: its transportation across and within nations to address this resource scarcity is also an energy problem due to the large volumes required by humanity. Although technologies as exotic as transporting detached icebergs across the oceans has been considered,[5] new science is essential to address and manage this important resource at the magnitude needed.

Sadly, water scarcity is a problem of the poor. Data suggest that the ratio of ARWR (per capita) for high-income to low income countries was 2.3 times (in 2015), and the disparity was expected to worsen to 5.8 times by 2050.[4] New technological inputs are needed for water-efficient agriculture, energy production, and manufacturing, while water harvesting, recycling, and reuse must become standard practices to guarantee a safe planet.

What can be done by the scientific community? Sustainable water management must be practiced at the personal, institutional, and community levels. All good things must begin from the individual, each one of us. For this, our personal choices of food, clothing, personal care, transportation, housing, work, etc. must be evaluated, and sensible decisions must be taken, not necessarily on financial considerations alone. In the laboratory and workplace, sustainable water management practices need to be followed. For example, every liter of water used in the laboratory for various purposes goes through a series of purification processes, with losses at each step. A study[6] showed that the loss can be as large as 75% when producing ultra-high purity water. Of course, water recovery and recycling may be practiced for wastewater. New science and technology are essential for efficient water management at the personal, institutional, and community levels.

Our research must find new ways to reduce water consumption in products, processes, and services. For instance, agricultural processes consume large amounts of water—up to 70%−90% of the water resources on planet earth—and new ways of efficient water management will be essential for humanity. Likewise, delivering fertilizers without runoff into bodies of water will reduce eutrophication. Precision pesticides and novel delivery mechanisms will reduce their load on water bodies and reduce their residues in agricultural produce.

Published: March 19, 2024



https://doi.org/10.1021/acssusresmgt.4c00096
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Efficient storage and transportation and reduced product loss at every stage will avoid excess cultivation, enhance profits, and make more quality time available with family and community. Much effort and advances are happening in each of the areas, and more are welcome.

For any ubiquitous substance, perceiving the importance of management is difficult—taps are kept open for longer periods than needed, and groundwater pumps run continuously causing paddy fields to flood. For the same reason, the use of solar pumps in the name of carbon credits poses a new risk for water resources.[7] Therefore, **the key to resource management is social awareness and responsibility**. Coupled with it, technologies for rapid assessment of quality, quantity, and utilization along with strict enforcement are critical to ensure that water resources are not threatened. Creating credible, open access water data is necessary with advanced and affordable sensors and remote sensing, along with appropriate education and training. Academic institutions, through partnerships, can help build "People's Water Data" by empowering human resources in any part of the world, taking advantage of digital education and access that was catapulted by the COVID-19 pandemic.[8] Multi-institutional and trans-national cooperations can build big data on water, and artificial intelligence can expand the scope that allows the prediction of the distribution of water resources and preventive measures necessary to ensure that the planetary boundaries are not breached.

***ACS Sustainable Resource Management* welcomes papers that are related to the management of this precious resource, our life-giving fluid.** We look forward to receiving your manuscripts for publication and to serve you in advancing science for the benefit of humankind and disseminating your discoveries to our communities.

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Notes

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https://doi.org/10.1021/acssusresmgt.4c00096
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