CONTRIBUTION TO THEMATIC CONCEPT PAPERS OF THE INTERACTIVE DIALOGS OF UN WATER CONFERENCE

Integrating unconventional water resources to support water-related SDGs

Manzoor Qadir, United Nations University Institute for Water, Environment and Health (UNU-INWEH), Hamilton, Ontario, Canada (E-mail: Manzoor.Qadir@unu.edu)

I. Introduction

Achieving Sustainable Development Goal (SDG) 6 and water-related targets embedded in other SDGs is a grand challenge for the world at large. There is a growing disparity between water resources availability and human population distribution. Increasing competitions among agricultural, domestic, industrial, and energy sectors make water scarcity prominent in areas characterized as water-stressed or expected to become so in the future. Amid climate change impacts, water scarcity has become critical for economic development and improved livelihoods for an increasing number of countries, particularly in the Global South. It is recognized as a potential cause of social unrest, migration, and conflict within and between countries.

To narrow the water demand-supply gap. a range of unconventional water resources can be combined to bring new water sources for human consumption and food production. Such water resources are generated as a by-product of specialized processes or require special technologies to collect and access water. Sources of unconventional water resources range from Earth's seabed to its upper atmosphere and capturing them requires a diverse range of technological interventions and innovations. Harvesting water from the air consists of rain enhancement through cloud seeding and collection of water from fog, while capturing water on the ground addresses micro-scale capture of rainwater where it would otherwise evaporate. All these techniques address local water shortages. On the groundwater front, tapping offshore and onshore deep groundwater and extending sustainable extraction of undeveloped groundwater are important options in areas where there is potential for additional groundwater resources. Reusing water is the key to water conservation and enhancement opportunities which lead to fit-for-purpose use of treated municipal wastewater and agricultural drainage water. Additional opportunities to develop water resources exist in the form of desalinated potable water. Physical transport of water, such as through towed icebergs and ballast water held in tanks and cargo holds of ships, is receiving attention, but corresponding practices remain in infancy.

II. Overview of the challenge, status, and interlinkages

Despite the demonstrated benefits of unconventional water resources, their potential is under-explored by countries that urgently need stable freshwater sources for people and food production. The term "unconventional water resources" has not been mentioned explicitly in any SDG. Still, specific unconventional water resources have been explicitly mentioned, such as water harvesting, desalination, wastewater treatment, recycling, and reuse technologies (SDG 6.a). Wastewater and recycling and safe reuse have also been part of SDG 6.3. Diving deep into the 2030 Sustainable Development Agenda reveals that there are close linkages of unconventional water resources with SDG 6 and its targets and water-related targets in other SDGs:

SDG 6.1: Unconventional water resources such as fog water collection, desalinated water, transportation of water through icebergs, and groundwater confined in deep land-based geological formations or offshore aquifers can provide enough potable water in areas where water is scarce, or the quality of available water resources does not meet drinking water quality standards.

SDG 6.3: Disposal of large volumes of untreated or inadequately treated wastewater to freshwater bodies has deteriorated the quality of water resources in arid regions, where achieving SDG 6.3 via halving the volumes of untreated wastewater by 2030 would help improve water quality and provide a water resource in the form of treated wastewater that could be used in different sectors such as agriculture, aquaculture, agroforestry, aquifer recharge, and environmental flows.

SDG 6.4: The increase in water-use efficiency and water productivity supported by some unconventional water resources in arid regions would help reduce overall water scarcity and the number of people suffering from it. Examples include but are not limited to micro-scale capture of rainwater where it otherwise evaporates, use of drainage water from irrigated areas, and water supply increase by rainfall enhancement via cloud seeding.

SDG 6.5: Efficient use of unconventional water resources can support implementing integrated water resources management in water-scarce countries and transboundary basins and ensure transboundary planning and actions to develop an environment supportive for new approaches harnessing the potential of unconventional water resources.

SDG target 6.a: As explicitly mentioned in this SDG target, there is a need for international cooperation to support capacity-building activities for developing-country professionals in harnessing the potential of unconventional water resources.

SDG 13: As lack of water is the key factor in triggering frequent drought events and its impacts, unconventional water resources could partially offset increased water needs caused by increased temperature and extended periods of drought, and increased frequency of extreme weather events.

Other water-related SDGs where water plays its role ensuring their achievement: SDG 1 on ending poverty, SDG 2 on achieving food security, SDG 3 on ensuring healthy lives and wellbeing, SDG 7 on accessing affordable and sustainable energy for all, SDG 9 on building resilient infrastructure, promoting sustainable industrialization and fostering innovation, SDG 10 on reducing inequalities within and among countries, SDG 11 on making cities inclusive, safe, resilient and sustainable, and SDG 17 on strengthening the means of implementation and revitalizing the global partnership for sustainable development.

III. Overview of opportunities for progress and transformative solutions

Given that most countries are not on track to achieve SDG 6 by the deadline set for 2030, a new water paradigm for water-scarce countries and river basins based on a range of unconventional water resources is crucially important for achieving water-related sustainable development. The policymakers in water-scarce countries need a radical rethinking to integrate the full range of unconventional water resources into water resources planning and policies, public budgets, water pricing and subsidies, and cost recovery mechanisms. The national water agencies and local institutions should effectively cooperate while engaging the private sector actively. Other forward-looking plans and practices are building capacity of institutions and professionals, developing a base of knowledge and best practices, testing water augmentation innovations, and sharing examples of effective use of unconventional water resources for public awareness.

The opportunities for international, regional, transboundary, and country-level collaboration in harnessing the potential of unconventional water resources are crucial in an era when the world at large is not on track to achieve SDG 6 and water-related targets embedded in other SDGs by 2030. The good news is that water professionals and policymakers worldwide have started considering the role of unconventional water resources in building a future where water is recognized and treated as a highly valuable resource and a cornerstone of the circular economy. Social media can also play a major role in promoting the importance of unconventional water resources, especially in dry areas of the world.

1. **Financing**

A major challenge to undertaking the economic analysis of unconventional water resources is the general perception that their development is based on high technology costs. Such seemingly high costs without undertaking comprehensive economic analyses and innovative financing mechanisms restrict the development of certain unconventional water resources and scaling up their use. In fact, these types of economic analyses do not consider the alternate water-supply options such as tankers or long-distance water transportation from wells, including the costs in the form of women’s time and labour, girls missing school days, and poor health of associated communities, particularly women and girls.

With the aim of recycling and reusing water resources, the *circular economy* is a path towards harnessing the potential of some unconventional water resources. For example, vast amounts of valuable energy and agricultural nutrients can be recovered from the municipal wastewater during the treatment process. Brine generated from desalination plants can be used as a source of valuable minerals and rare-earth elements such as lithium, strontium, thorium, and rubidium. These metals are used to fabricate critical components of numerous products, including airplanes, automobiles, smart phones, and biomedical devices. There is a growing realization that the development and implementation of clean-energy technologies and sustainable products, processes, and manufacturing industries will also require large amounts of rare metals and other valuable elements. In such a scenario, recovery of precious metals from brine would offer an additional economic opportunity, while ensuring that the post-recovery brine would be managed in environmentally acceptable protocols.

There is a need to undertake comprehensive economic assessments in given settings of the costs of ignoring needed investments and benefits by introducing innovative financial mechanisms to support and prioritize various types of unconventional water resources. This can be achieved by identifying the full range of potential benefits associated with specific unconventional waters by using approaches that should be credible. The valuation of the benefits of 'action' or, alternatively the valuation of the costs of 'no action', is necessary to make a case for the needed investments in harnessing the potential of unconventional water resources to address water scarcity.

2. **Data and information**

As the research and practice around unconventional water resources have evolved, pertinent data and information on different types of such resources are becoming available. The volumes of some unconventional water resources, such as municipal wastewater (380 km^3) and desalinated water (35 km^3), are known, and there are broader estimates available for deep groundwater volume of 16-30 million km^3. Of this volume, 0.1-5.0 million km^3 is less than 50 years old and renewable, while the remaining nonrenewable but larger volume is embedded in deep geological settings found offshore and onshore. The Earth's atmosphere contains about 13,000 km^3 of water in the vapor phase, the source of which is evaporation from the surface of the oceans, seas, moist soil, and plants. Antarctic ice contains 27 million km^3 of water, of which 2,000 km^3 breaks off annually as icebergs. Seawater stands at 1.335 billion km^3. Accessing even a tiny fraction of such gigantic volumes of deep groundwater, atmospheric water, Antarctic ice, and seawater could significantly reduce water scarcity in arid and semi-arid areas.

3. **Capacity development**

Recent years have witnessed a surge in research and practice related to technical and nontechnical aspects of unconventional water resources. While such research and practice have demonstrated the potential that unconventional water resources can offer, there are gaps in the availability and need for skilled human resources to supports efforts in harnessing the potential of such water resources, particularly in countries in the Global South.

There is critical shortage of skilled human resources to deal with the complexity of the diverse range of technological interventions and innovations in accessing and producing most unconventional water resources, such as municipal wastewater, agricultural drainage water, fog water, weather modification for cloud seeding, ballast water treatment and reuse, icebergs selection and transportation, desalinated water, and offshore deep groundwater.

The assessment of critical capacity gaps is a crucial step to design and implement need-specific capacity development activities. Given current technological developments and access to mobile networks, communication technologies can support capacity-building activities.

4. **Innovation**

With the value of the global water sector estimated to reach $ 1 trillion annually by 2025, the demand for solutions in the water sector is leading developing countries to support both technical and non-technical water-related innovations at various levels. Solutions in the water sector are also required for managing water resources more generally, considering the threats of climate change, conflicts and migration, and bourgeoning demand. Decentralized water management, rainwater harvesting and desalination interventions, wastewater treatment and safe reuse, novel water business models, and water-centric community involvement are just a few of the new technologies and approaches that have been introduced in the water development sector. However, a key question for governments, development actors, and donors remains, i.e., which type of innovation has proven impacts, particularly considering water-scarce communities in the Global South. This question is critically important when these impacts are driven by technological aspects, environmental conditions, and local socioeconomic, institutional, and cultural contexts.

5. **Governance**

Development of effective policies and efficient governance structures are essential to support harnessing the potential of unconventional water resources, with policies and structures being reflective of the regions and countries in which they are situated.

Since water scarcity addresses countries without recognizing political boundaries, it is important to ensure discussion and coordination of national water-related policies and actions with transboundary dialogue and measures in shared basins. This exchange will help identify joint transboundary opportunities and risks and means to share benefits and costs while harnessing the potential of unconventional water resources across political borders. The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) provides a unique global and legal framework for facilitating reasonable and equitable use of transboundary waters, as well as preventing, controlling, and reducing transboundary risks.

In the case of rainfall enhancement through cloud seeding, it is important to consider that artificially altered precipitation would affect the distribution and intensity of atmospheric water and precipitation on the downwind side and may have transboundary impacts. In case of fog water harvesting, there is a lack of national water policies and action plans that consider fog water collection as a means of addressing local water shortages in water-scarce areas with abundant fog. To achieve successful implementation of fog water harvesting projects and their sustainability in the future, it is necessary to integrate the local institutions and associated communities as stakeholders to promote their involvement, commitment, and ownership of the fog collection systems.

In developing countries, municipal wastewater treatment is limited, as investments in treatment facilities have not kept pace with exponential population growth and the resulting increases in wastewater volumes. Thus, much of the municipal wastewater is not treated and released to local water bodies or used by small-scale farmers for irrigation in dry areas with little ability to optimize the volume or quality of the wastewater they receive. Apart from the lack of supportive policies and unclear institutional arrangements, the public budgets in most developing countries for water recycling and reuse are inadequate. In addition, limited economic analysis, lack of reuse cost-recovery mechanisms, no or little value for treated wastewater, lack of awareness about the potential of water recycling and reuse, and inefficient irrigation and water management schemes are constraints to effective water recycling and reuse practices. The policymakers in water-scarce countries need to consider reuse of water reclaimed from wastewater as an essential aspect of strategic planning and management of water resources.

In the context of desalination, the ocean as its source is practically limitless. Desalination is thus drought proof, and it is a good way to deal with drought related climate change risks. It also provides a solid response to exogenous risks such as dependency on other countries for water supply. The stable, efficient supplies of urban and industrial water that desalination provides can help governments manage a range of economic, social, and political risks. As water scarcity grows and with advances in desalination technology and reductions in production cost, policy makers around the world may consider action plans supporting desalination in narrowing the gap between water supply and demand in future years.

IV. Recommendations

Water and climate change are interconnected as climate change increases the likelihood of extreme droughts in dry areas, which are often located in transboundary basins. Despite such interconnectivity, water crisis and climate change are at times addressed in silos, which turn into a major roadblock in the journey to achieve water-related sustainable development amid changing climate in the SDG era and beyond. This is particularly important in arid and semi-arid areas. Harnessing the potential of unconventional water resources and integrating it into water resources management strategies and plans at the transboundary, national, and local levels can go beyond narrowing the water demand-supply gap by developing resilience of water-scarce communities against climate change by diversifying water supply resources.

While the water sector faces diverse challenges, it is making gradual progress towards cost-effective and sustainable water management solutions, which are expected to transform water management and gradually shift its reliance from conventional to unconventional water resources in water-scarce areas. Another encouraging trend is seen in water professionals and policymakers considering the critical role of unconventional water resources in building a water-secure future where water is recognized and treated as a precious resource and as a cornerstone of the circular economy. While recognition is growing in high-income and upper-middle-income countries, this awareness needs to be replicated in low-income and lower-middle-income countries, particularly those where water scarcity and water quality deterioration are prevalent. Such a trend is essentially needed at a time when most countries around the world are not on track in addressing SDG 6 and water-related targets in other SDGs. There is an urgent need to enter a new era of water management where the barriers to efficient water management gradually fade and where water in all its forms is closely monitored, digitized, accounted for, and reused rather than being considered just a simple supply source or a waste product released into the environment without sufficient treatment, as in the case of untreated wastewater.

As global water crises loom and achievement of the SDG 6 and water-related targets in other SDGs grows doubtful, the world must begin to analyse and consider utilization of unconventional water resources individually and collectively. Effective policies and efficient governance structures are essential to support harnessing the potential of unconventional water resources, and such policies and structures may vary across regions and countries. They also need to be coordinated and agreed in transboundary basins for ensuring the most efficient use of unconventional water resources as well as preventing and reducing any potential transboundary impacts out of such use.

International collaboration opportunities across regions and countries in harnessing the potential of unconventional water resources are crucial. Given the importance of unconventional water resources and need for financial resources to harness their potential, the private sector’s involvement needs to be encouraged in investing in projects on unconventional water resources. Beyond private sector, there is a need for a platform to connect the experts, practitioners, young professionals, media, community, and policymakers to exchange literature, ideas, presentations, and capacity development material as well as information on key events and sessions at workshops and conferences addressing one or more unconventional water resources. Such activities are expected to trigger collaboration and implementation of the related activities on the ground. Governments and other agencies that are open to explore alternative water resources should invest in relevant education, training, and capacity building through local, national, and international opportunities. Social media can play a major role in promoting the importance of unconventional water resources in arid and semi-arid regions. The next stages in the development of these resources may benefit from a multi-disciplinary effort that would provide insights and guidance on productive and sustainable use of unconventional water resources.

V. Guiding Questions

What key steps are needed to motivate water-scarce countries to focus beyond conventional water resources in their journey to achievement of water-related SDGs?

What is the potential of unconventional water resources to address increasing global, regional, and local water scarcity under changing climate and what and where, are the barriers to acceptance of unconventional water resources?

What policies, science-based actions and tools are necessary to guide policy makers to support the application of unconventional water resources to achieve water-related SDGs?