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Perspective

## Global water security: A shining star in the dark sky of achieving the sustainable development goals

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## ABSTRACT

The COVID-19 pandemic has already triggered global health, economic, and social crises, clouding the sky of achieving the 2030 Agenda for Sustainable Development adopted by the United Nations (UN) in 2015 to improve human lives while protecting nature. Water, vital for all forms of life, is essential to public health and human well-being and smooth the path of ending poverty through food and energy security. Hence, we argued that global water security can serve as a shining star to guide policymakers through the overwhelming task of achieving the UN 2030 Agenda for Sustainable Development, currently hindered by the coronavirus outbreak. To quickly attain global water security while taking the accelerators of Sustainable Development Goal 6 (SDG6 “Clean Water and Sanitation”) into account, this study proposed different water-related interventions. To successfully implement the UN 2030 Agenda for Sustainable Development after the coronavirus pandemic, we call for immediate and sustainable interventions to act rapidly towards achieving water security and SDG6 worldwide and support the constant battle against the ongoing fight with COVID-19 and prepare for possible future pandemics.

## Poverty: a key driver and consequence of pandemics

The COVID-19 pandemic has already (29 November 2021) killed over 5.2 million humans worldwide, exceeding 260.8 million positive cases (WHO, 2021). This multipronged global crisis may hamper achieving two-thirds of the Sustainable Development Goals (SDGs) (Naidoo and Fisher, 2020) adopted by the United Nations (UN) in 2015 (United Nations, 2015). These 17 SDGs include 169 target areas aim to simultaneously improve human lives and ecosystems by 2030. However, the greatest challenge facing the UN’s policy agenda by 2030 has always been alleviating pervasive and extreme poverty (United Nations, 2015), both as a key driver and, now, as part of the economic consequences of COVID-19’s rapid spread around the world.

Overall, socioeconomic disparities play a vital role in the dramatic transmission and mortality rates of pandemics like COVID-19 (Brown and Ravallion, 2020). While global economic inequality has recently decreased between countries (Bourguignon, 2015), increasing income inequality within nations has likely contributed to more COVID-19 positive cases and deaths (Clarke and Whiteley, 2020). To stem the tide of coronavirus infections, governments have urged both public preventative (e.g. isolation and physical distancing) and personal protective (e.g. regular hand-washing and wearing masks) behaviors (Habersaat et al., 2020). However, individuals earning

lower wages are more likely to work in occupations that increase their exposure to others and limit their ability to practice physical distancing (Papageorge et al., 2020). For example, workers in the gig economy (e.g., food-delivery bikers) must continue working during the COVID-19 pandemic, as they provide essential services to society (Stabile et al., 2020). Poverty also induces further social inequalities resulting in limited access to safe water, sanitation, and hygiene (WASH) services (Bavel et al., 2020), which are crucial for protecting human health in the fight against infectious diseases (WHO-UNICEF, 2020). WASH services insecurity can lead to a higher risk of adverse health consequences among women and children who bear the burden of water collection in low- and middle-income countries (LMICs), people living with physical and mental disabilities, and those residing in rural/remote areas, or in overcrowded residences (e.g. refugee camps) (Subbaraman, 2020), especially during a pandemic. In higher-income nations, significant socioeconomic inequality makes access to WASH unaffordable for many poorer residents (Food & Water Watch, 2018). In all countries, the ongoing pattern of water-related natural and conflict disasters such as the extremely intense Atlantic hurricane season and unrest in Syria have exposed gaps in our disaster risk response and management approaches that may increase exposure and transmission of COVID-19, a topic that has been a critical focus for the intergovernmental High-level Experts and Leaders Panel on Water and Disasters (HELP) (<https://www.wateranddisaster.org/the-international-online-conference-to-address-water-related-disaster-risk-reduction-drr-under-the-covid-19-pandemic/>). The intersection of water-related economic

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and social risks with a broader pandemic is a perfect storm, elevating the uncertainties and challenges of already tricky work.

### Post-COVID-19 era: the dark sky of SDGs

The coronavirus has unleashed an unprecedented global economic crisis, reversing decades of progress on monetary poverty in only a short timeframe (United Nations, 2020). The world's economy will lose an estimated US\$8.5 trillion in output over the next two years because of the COVID-19 pandemic (United Nations, 2020). About 34.4 million additional people are expected to fall below the extreme poverty level (living on less than US\$1.25 per day) in 2020, with over 130 million living in extreme poverty by 2030 (primarily in African countries) (United Nations, 2020). In both present- and post-COVID-19 periods, industrialized countries struggle to support their residents, with no serious concerns about the bankrolling of other nations' development. Decreases in international aid financing will likely influence the implementation of the UN 2030 Agenda for Sustainable Development. Even before the global coronavirus outbreak, financial supports for the UN 2030 SDGs were US\$2.5 trillion short (Naidoo and Fisher, 2020), calling to question the sustainability of the UN 2030 Agenda for Sustainable Development. Indeed, the COVID-19 pandemic presents an additional barrier to sustained global economic growth and positive social development for achieving the UN 2030 SDGs.

The currently perceived SDGs can be challenged by a global stressor like the coronavirus (Naidoo and Fisher, 2020). This has already opened a controversial debate about revising the scope and timeline of the UN 2030 Agenda for Sustainable Development. Some scientists are calling for scaling back the SDGs now (Nature Editorial, 2020), while others persist that all original SDGs remain affordable and achievable (Sachs et al., 2020) through a flexible aggregate approach allowing for trade-offs among and prioritizing different SDGs (Schaubroeck, 2020). The latter group believes that: (i) the COVID-19 pandemic reinforces why the SDGs were established after conscientious 3-year diplomatic negotiations among 193 nations: to guarantee long-term future for humanity on Earth (Bhattacharya et al., 2020); (ii) the ambitious SDGs foster scientific, technological, social, and institutional innovations to drive down costs and speed up progress (Sachs et al., 2020), like tremendous advances in infection control that once seemed impossible (Sachs and Schmidt-Traub, 2017); (iii) if the SDGs had been heeded sooner, adjusting their progress would be faster and more effective today (Sachs et al., 2020); and (iv) this moment requires absolute clarity about what is needed to achieve the UN 2030 SDGs in various scenarios (Bhattacharya et al., 2020), such as lockdowns versus reopening (Schaubroeck, 2020). Even with imperfections, the original SDGs are more essential now, but it is unrealistic to consider them equally crucial for post-COVID-19 economic, social, and environmental recovery.

In the complex crisis of today's world, the dark sky of SDGs needs a shining star to guide policymakers through the overwhelming task of achieving the UN 2030 Agenda for Sustainable Development. As the SDGs and their targets are closely interlinked, this shining star should primarily address fundamental problems, including those directly linked to the fight against the spreading coronavirus, which can lead to the realistic attainment of more progressive SDGs worldwide.

### Water: A shining star

Water is the most essential component of life on Earth. It is an essential enabler for food and energy security, human health and wellbeing, and ending hunger and poverty (United Nations, 2018), and some groups have argued that water is the critical tool for coherent climate adaptation as well (Smith et al., 2019; Timboe et al., 2020). In the UN 2030 Agenda, SDG6 "Clean Water and Sanitation" includes six targets related to the social (equitable access), economic (integrated water resources management), and environmental (protect and restore water-

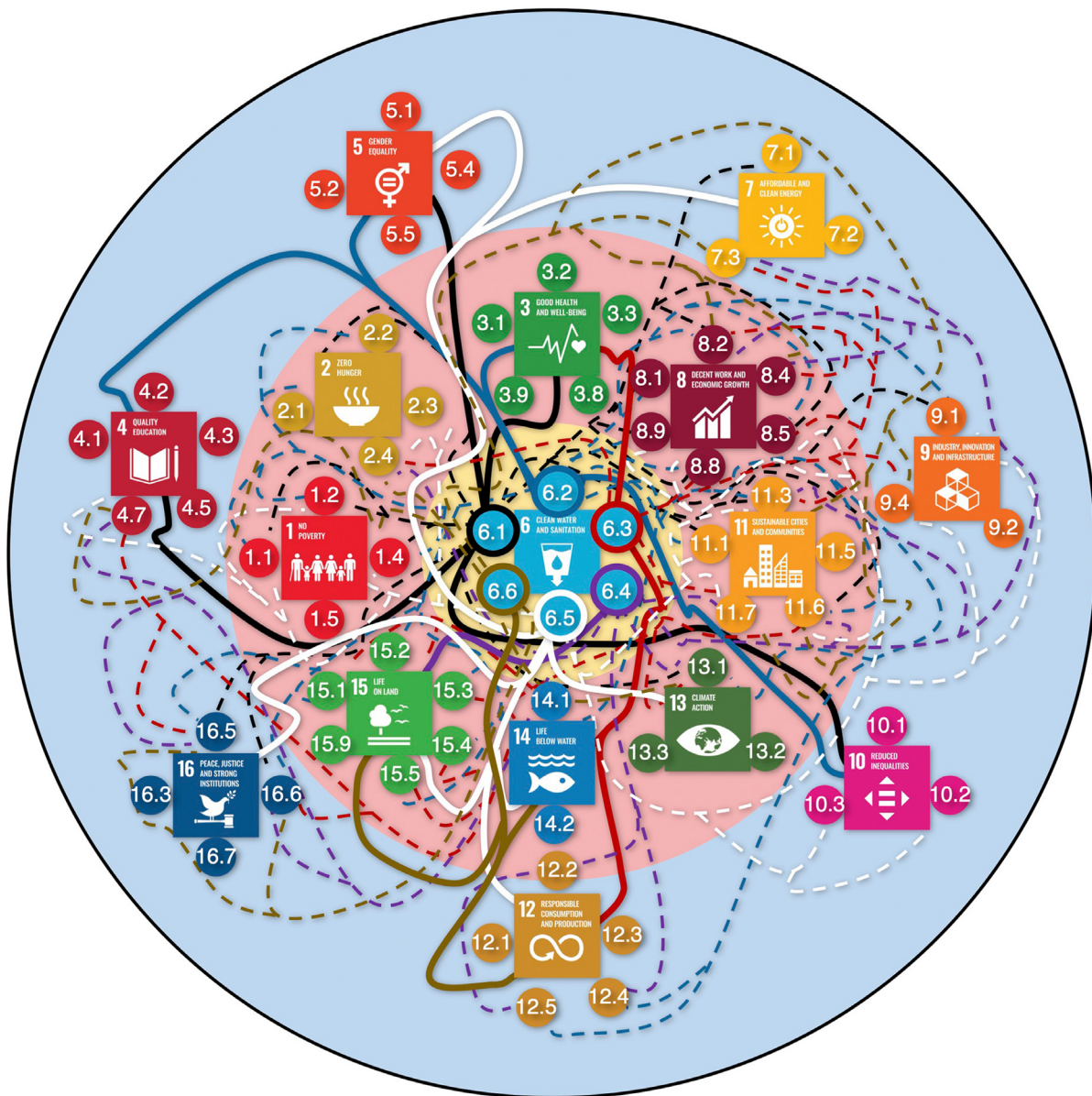
related ecosystems) dimensions of sustainable development. Using systems thinking approaches allows us to prioritize and explain the solid web-like interconnections (Liu et al., 2019) between SDG6 and other identified SDGs (United Nations-Water, 2016). Accordingly, the SDG6 is an essential prerequisite for moving forward 62 out of 163 targets of all other SDGs (Fig. 1). "Clean Water and Sanitation" strongly supports: (i) the society through SDGs 1, 2, 3, 4, 5, 7, 8, 10, 11, and 16; (ii) the economy through the SDGs 2, 7, 8, 9, 10, 11, and 12; and (iii) the environment through SDGs 2, 7, 8, 11, 12, 13, 14, and 15 (United Nations-Water, 2016). From a systems lens, SDG6 can today be considered the heart of sustainable development worldwide. Hence, global water security through SDG6 can be a shining star in the dark sky of progress towards achieving the SDGs, moving through and beyond the coronavirus pandemic.

Additionally, the 4<sup>th</sup> target of SDG6 explicitly addresses freshwater scarcity (available surface and groundwater resources for human use) to ensure adequate freshwater resources for humans and ecosystems. However, water resources for agricultural usage (root-zone soil moisture) have not received enough attention in SDGs and their action plans, even though the root-zone soil moisture is the water source for 65% of global crop production (Schyns et al., 2019). This will exacerbate the global water security issue because of the unsustainable use of freshwater resources for irrigation purposes.

Global water security is defined as the capacity for humans to have continuous access to adequate water of acceptable quality to maintain livelihoods, well-being, and socio-economic development with sustaining the limited freshwater resources and ensuring peace among nations (Grey and Sadoff, 2007). To achieve global water security, humanity is facing three grand challenges:

- Adequate water availability – Earth is 70% covered by water. Still, only 2.5% of the total world water storage is freshwater, of which about two-thirds is ice, snow, or unavailable for human use. On the other hand, the Spatio-temporal distribution of such limited available freshwater is unequal around the world, inducing "severe water scarcity" for at least one month per year to an estimated 4 billion people (particularly in India and China) (Mekonnen and Hoekstra, 2016).
- Acceptable water quality – Both water shortage (e.g. drought) and abundant (e.g. flood) can contaminate the quality of water by multiple biological and chemical pollutants (e.g. bacteria, viruses, pathogens, and protozoa). Discharges from industry, agriculture, wastewater, and human waste may also deteriorate freshwater environments. In general, poor water quality is inappropriate for consumption and/or hygiene, presenting immediate risks to human health. For example, the annual 525,000 deaths of children under five years old around the world are unfortunately related to diarrheal disease, which could be due to contaminated water (WHO, 2017).
- Sustainable water accessibility – Even physically available, water can be inaccessible due to different reasons; such as high cost, poor water infrastructure, mismanagement, inefficient water governance, etc. In our world today, over 2.2 billion people, half of the schools, and one-quarter of healthcare facilities lack access to safely managed clean water (United Nations, 2018). Besides, about 4.2 and 3 billion people do not have access to basic sanitation and handwashing facilities, respectively (World Health Organization & United Nations Children's Fund, 2019).

Even with the tremendous progress in geosciences, the COVID-19 pandemic is a grim reminder that our world is currently nowhere near achieving each facet of global water security (availability, acceptable quality, and accessibility), and therefore, SDG6 (Naidoo and Fisher, 2020). It is critical to acknowledge that population growth, urbanization, climate change, and land use-land cover alterations are increasing global water demand, stress, and scarcity, and thereby threatening water security around the world (particularly in developing coun-



**Fig. 1.** The web-like interlinkages between SDG6 “Clean Water and Sanitation” and other SDGs based on the UN-Water Report (United Nations, 2018). The larger and smaller circles represent the SDG and its targets, respectively. The solid (dashed) lines denote the connections between the specific targets of SDG6 and all (the specific) targets of other SDGs shown.

tries) (United Nations-Water, 2019). These drivers may also increase zoonotic diseases outbreaks, with the high potential for more frequent pandemics in the coming years (Lee et al., 2020). In this context, immediately working on mid-term measures can play an essential role in strengthening global water security, sustaining access to WASH services, combatting future pandemics (Cooper, 2020), and consequently increasing momentum towards the UN 2030 SDGs during the post-COVID-19 era.

### Interventions: a global water security shortcut

In 2020, the United Nations launched the SDG6 Global Acceleration Framework to dramatically improve progress on safe water and sanitation for all by 2030 (United Nations-Water, 2020). This framework includes four action pillars: engage, align, accelerate, and account. In the accelerate pillar, the framework defined five accelerators for SDG6: (i) optimized financing; (ii) improved data and information; (iii) capacity development; (iv) innovation; and (v) governance. These accelera-

tors were developed to primarily solve the water and sanitation crisis at the national/country scale (United Nations-Water, 2020). However, prioritizing and targeting interventions directed at water-related factors can simultaneously: (i) aid global health, economic and social recovery from the COVID-19 pandemic; (ii) play the role of shortcut to the global water security; (iii) accelerate movement towards the SDG6; and (iv) make the UN 2030 Agenda for Sustainable Development achievable (Cooper, 2020). Hence, to quickly attain global water security while taking the accelerators of SDG6 into account, we propose different interventions in water-related factors, aimed at providing:

- Adequate water with acceptable quality – A combination of gray and green water infrastructures (e.g. reservoirs or pipe networks with watersheds or wetlands conservation) (Palmer et al., 2015), nature-based solutions (e.g. protecting wetlands), and wastewater treatment (e.g. reusable water recovered through treatment processes) (Huang et al., 2020) can significantly increase water availability and improve water quality. Different interventions to watersheds (e.g. restoration and protection) (Menberu et al., 2016) and groundwater

(e.g. managed aquifer recharge through improving soil infiltration) (WWAP (United Nations World Water Assessment Programme)/UN-Water, 2018) can also increase and save limited available freshwater resources on Earth. Combining different sustainable irrigation deficit practices with sustainable irrigation expansion strategies (Rosa et al., 2019; Rosa et al., 2020a) cannot only contribute to progress towards achieving the SDG6 (“Clean Water and Sanitation”) by ensuring adequate water resources for humans (rights to water) and ecosystems (rights of waters) (Rosa et al., 2020b; Jenkins et al., 2021) but also the SDG1 (“No Poverty”) by increasing agricultural production, the SDG2 (“Zero Hunger”) by improving global food security, and the SDG15 (“Life on Land”) by impeding biodiversity loss. Moreover, employing new sanitation infrastructure and approaches (e.g. urine diversion dry toilets, latrines, or septic tanks), source water protection measures (e.g. wetlands degradation upstream of hydropower plants), and urban sanitation and sewers (e.g. building communal and public toilets) can lead to water quality improvements (Cooper, 2020).

- Sustainable water accessibility – Integrated water resources management is key to ensuring sustainable access to adequate and clean water in different parts of the world. Accordingly, the mid-term interventions should consider: climate-resilient infrastructures and methodologies (e.g. building “sponge cities”) (Huang et al., 2020; Nik et al., 2020); good water governance (e.g. enforcing environmental regulations like water pollution control standards) (OECD, 2018); stakeholder participation (e.g. addressing water data gaps that can strengthen monitoring of water use) (Browder et al., 2019); systems and institutional improvements (e.g. employing qualified human resources and capacity to manage clean water accessibility) (WWAP (United Nations World Water Assessment Programme)/UN-Water, 2018); moving beyond sectoral thinking (e.g. understanding the links between public health and urban water supply can improve coordinated responses to future pandemics) (Cooper, 2020); and reliable data and information (e.g. collecting data by water accounting tools) (WWAP (United Nations World Water Assessment Programme)/UN-Water, 2018).

Although these interventions can hasten global water security, different actions towards SDG6 must also include affordable WASH services. We offer four examples of actionable recommendations regarding such affordability. First, we should provide financial support for infrastructure, systems, plans, institutions, policies, and capacity to ensure sustainable WASH services. Second, we can extend efficient urban services, such as access to low-cost piped water at home. Third, make water affordable for low-income consumers by subsidizing water or through flexible payment arrangements. Lastly, help to support service delivery using different digital tools, which combine prepaid water meters, billing software, and an easy payment mobile model to save water resources and users’ time paying water bills.

### A call for action

The target for the SDGs is now less than a decade away. The COVID-19 pandemic highlights a program for short-term actions to achieve global water security. To secure water availability, quality, and accessibility around the world, we must ensure (i) creation of adequate legislation, institutions, infrastructure, and capacity, (ii) availability of innovative and reliable funding sources and investments by public and private sectors, and (iii) mitigation of potential sources of conflict (e.g. decline in water quantity and quality, disparate access to water resources). For the UN 2030 Agenda for Sustainable Development to remain a reality after the coronavirus pandemic, there is an urgent need to achieve SDG6 “Clean Water and Sanitation” by supporting mid-term measures, which can significantly and rapidly improve global water security. Hence, this commentary strongly encourages the global financial community, political leaders, policy-makers, international agencies, and research in-

stitutes to immediately and sustainably tackle the water security issue around the world to support the ongoing fight against COVID-19 and prepare for possible future pandemics (Hannah et al., 2020) while striving to fulfill the UN 2030 SDGs.

### Declaration of Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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**Professor Junguo Liu** Dr. Junguo Liu is a Chair Professor of Southern University of Science and Technology, Academician of European Academy of Sciences, Deputy Dean of School of Environmental Science and Engineering, Senior Visiting Researcher of International Society for Applied Systems Analysis in Austria, and Chairman of Beijing Ecological Restoration Society. Winner of the National Science Fund for Distinguished Young Scholars, and a young and middle-aged scientific and technological innovation leader of the Ministry of Science and Technology. He is also a Fellow of the Royal Geographical Society and a Fellow of the Royal Meteorological Society.

Professor Liu carries out in-depth research and practical exploration on the temporal and spatial evolution of water resources, water quality-based water scarcity assessment and river ecological restoration. He has created the theory of progressive ecological restoration and the theory of three-dimensional water shortage, and his research work has had an important impact on the field of water resources at home and abroad. He published more than 240 academic articles, including 7 monographs and approximately 20 articles in *Nature*, *Science*, *Proceedings of the National Academy of Sciences*, *Nature Climate Change*, *Nature Sustainability*, *Nature Communication*, *Nature Food*, *Science Advances*. Published articles have been cited more than 11,000 times (Google Scholar).