Comment

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People in Satkhira, Bangladesh, cross a flooded road in the aftermath of Cyclone Amphan in May 2020.

As the UN meets, make water central to climate action

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Managing water and climate in tandem would protect water resources, reduce disaster risks, lower greenhouse-gas emissions and assure equitable access.

This week in New York City, the United Nations is holding its second global Water Conference — after a gap of 46 years. At the first meeting in 1977, climate change was not even on the agenda. Today, there is stark evidence that the world is warming and that greenhouse gases from fossil fuels are to blame[1,2]. At the same time, the global water cycle has been wrecked by decades of mismanagement and intensified by climate change. As a result, 1.5 billion to 2.5 billion people live in areas where water is scarce for at least part of the year[1] — and those numbers could double by 2050. Strategies for governing water and addressing climate change in tandem must be higher on the political agenda.

This matters for three reasons. First, water is the primary medium through which people experience climate change. Three-quarters of all disasters are water-related[3]. In the past year alone, massive floods have affected at least two-thirds of Pakistan's districts; extreme drought has devastated the Horn of Africa; and Europe, the western United States, Australia and parts of Latin America have experienced both extremes. Many of these events have a clear climate-change fingerprint. Along coasts and in deltas, rising seas increase flood risks and bring salt water further inland; at the poles and in the mountains, glaciers and ice sheets are thawing; and, in the tropics, monsoons, heavy rains and droughts are intensifying[1].

Second, development and rapid urbanization are increasing global demand for water. By 2050, such demand is projected to increase by 20–30% above the 2010 level (of 4,600 cubic kilometres annually). Even greater rises are expected in Africa (60%), South America (50%) and Asia (30%)[4]. Coupled with higher temperatures and altered precipitation patterns owing to climate change, 3 billion people would be exposed to water scarcity by 2050 if the world warms by 2 °C relative to pre-industrial levels[1]. People who are struggling to find clean drinking water, rear livestock and grow crops, or to escape sea-level rise and storm surges, could be forced to move. In 2020, floods and storms displaced 29 million people globally[5]; the World Bank estimates that, by 2050, 216 million people will need to relocate within their own countries[6]. Some places will become uninhabitable – by 2050, billions of people might struggle to live in regions that are too hot, too dry or too regularly inundated[7]. As with climate change, vulnerable groups – including women and girls, Indigenous communities and the poorest sections of society – are disproportionately affected. Regions such as sub-Saharan Africa, East Asia and the Pacific, and South Asia will be hit hardest, with some economies crippled by water shortages or floods.

Third, managing water effectively is an essential part of adapting to climate change. Measures will be needed to respond to more-frequent and intense droughts, floods and storms. Efficient irrigation systems, rainwater harvesting, ways to conserve soil moisture and drought- and flood-resilient crop varieties will also be required.

Yet, water's role in tackling climate change is not being recognized in international climate agreements. This is creating a mismatch between local and national needs on the one hand, and international pledges on the other. Whereas climate mitigation and biodiversity conservation are seen as global issues, water is widely regarded as a national or local concern. The majority of countries (around 80%) that signed up to the Paris climate agreement list water as an adaptation priority in their national pledges (see go.nature.com/3ypgivq), yet the agreement makes no mention of water management. Although water did make it into the implementation plan issued last year at the 27th UN Conference of the Parties (COP27) climate summit in Sharm el-Sheikh, Egypt, the text said little about links between water, climate and societal impacts.

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A community works to create a reservoir near Binga, Zimbabwe.

The gap between articulation and action urgently needs to be bridged, by incorporating water into climate action in the following four ways.

Manage water for climate resilience

Climate change is making the frequency, scale and impacts of floods and droughts more uncertain. For example, between 1985 and 2015, the rate of floods in the tropics and at northern mid-latitudes quadrupled and more than doubled, respectively[1]. Global warming is increasing the amount of moisture held in the atmosphere (by 2–3% per 1 °C rise in temperature) and is causing drier summers in regions such as the Mediterranean, southwestern Australia, southwestern South America, South Africa and western North America[1]. Yet, water managers almost everywhere continue to devise policies and design infrastructure (such as drainage canals, storm sewers, dams and levees) on the basis of historical records, such as the time elapsed between floods of a certain magnitude. In a changing climate, the past is no longer a reliable predictor of the future.

Instead, water managers and policymakers should develop resilient approaches suited to a changing climate. This entails broad collaboration[7] and drawing together various approaches and forms of evidence (modelling, Indigenous knowledge, lived experience) to project the likely variation in the availability and distribution of water. Water professionals, local communities, businesses and policymakers must find ways to manage water that are robust (that function under all reasonable climate projections) and flexible (that can be modified as situations evolve). For example, increasing the safety margins would ensure that dams, reservoirs, wells and wetlands retain their functionality under a range of climatic conditions. Hydrological baselines (for precipitation, temperature, streamflow, evaporation and sediment flow, for example) and risks should be reassessed regularly.

A 'safe to fail' rather than 'fail-safe' mindset should be adopted[8]. Combinations of 'grey' (engineered structures such as dams and sea walls) and 'green' (natural systems including forests and soils) infrastructures should be deployed to offer more ways to withstand extreme events. For example, as part of the Dutch government's Room for the River programme, which ran from 2007 to 2018 to improve flood protection around rivers, a dyke near the village of Lent on the

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River Waal was moved 350 metres inland, and nearby farmland was set aside for recreation and to provide a vegetated buffer to forestall catastrophic flooding elsewhere[9]. By contrast, static engineered structures often fail when conditions change. In May 2020, for example, the Sanford dam in central Michigan collapsed after intense rainfall, forcing the evacuation of 11,000 people. Responses must also be implemented with regard for cultural, political, socio-economic and geographical circumstances, rather than as universal solutions. For example, a more sensitive approach to flood schemes and community consultation might have avoided the displacement of thousands of residents of informal neighbourhoods in cities such as Jakarta and Manila (ref. 8 and go.nature.com/3fi5t5r).

Include water considerations in climate mitigation

Reducing emissions of greenhouse gases is the focus of most climate action. It's less well recognized that water management can also help to reduce emissions. For example, irrigation techniques that require less water are being promoted for rice production in South Asia, southeast Asia and parts of Africa. Such methods include 'alternate wetting and drying', in which rice fields are flooded, then allowed to partly dry out, then reflooded. This system uses 30% less water than continuous flooding, cuts methane emissions by 48% without reducing yield, and increases farmers' profits by lowering water-pumping costs (see go.nature.com/3kmcin9). Solar-powered irrigation is also beneficial. In Ethiopia, for example, it could be used to increase crop production and farmers' incomes in 18% of the agricultural land that is now rainfed[3].

Improving the treatment of water and wastewater saves water and cuts emissions, too. Treatment using fossil-fuel-based energy accounts for 3–7% of emissions, and that's not counting those associated with discharging untreated sewage[3] — more than 80% of waste water globally is released untreated into the environment. Treatment before disposal, or processing waste to produce fertilizers and biogas, would not only cut emissions but also lower pollution risks[3].

As the climate warms, mismanaging water will exacerbate water or food crises[1,10]. Planting forests in dry regions diverts water from streams and soils, lowering its availability as well as increasing salinity and acidity[11]. Similarly, taking land and water away from food production to produce biofuels from crops such as maize (corn), sugar cane, soya bean, switchgrass or sorghum could inflate local food prices[10]. Trade-offs between decarbonization and increased water use need to be explored[12].

> **"Water-based adaptation must fit local contexts, or else exacerbate the risks it is meant to allay."**

Invest more in water-based adaptation

As climate impacts soar, adaptation is not only essential but also makes sound economic sense. On average, every US$1 invested in adaptation generates a net economic benefit of $2–$10 (ref. 13). For example, following a 2007 flood in Mexico's Tabasco state that cost $3 billion in damages, the federal and state governments invested $750 million in creating embankments, early-warning systems and flood risk maps. These helped to avert $2 billion in damages and losses during a bigger flood in 2010 (ref. 14). In sub-Saharan Africa, the cost of investing in adaptive water management — involving irrigation, drought- and flood-resilient seeds and improved weather forecasts — is less than one-tenth of that predicted for inaction (paying for lost crops, disaster relief and recovery after floods and droughts): $6 billion versus $90 billion per year, respectively[15].

Yet adaptation as a whole is not receiving finance at the scale needed. In 2018, more than 90% of global climate funding (of $746 billion) went to mitigation, leaving just $34 billion for adaptation. And the water sector has been receiving a mere 3% of total climate funds (see go.nature.com/3j8prwn). Adaptation is estimated to cost $140 billion to $300 billion per year by 2030. Achieving the UN Sustainable Development Goal of 'universal and equitable access to safe and affordable drinking water for all' by 2030 would cost about $1.7 trillion[16], or triple the current level of investment. And much more is needed: projected costs for water infrastructure range from $6.7 trillion by 2030 to $22.6 trillion by 2050 (see go.nature.com/3t9bi59).

Where could the funding come from? First, wealthy countries need to fulfil their commitment, made at COP15 in Copenhagen in 2009, of contributing $100 billion annually for climate finance by 2020. And more money must go to low- and middle-income nations through grants instead of loans. Between 2000 and 2018, low-income countries received only 18% of international public climate finance for water; an even smaller share (14%) was provided as grants[17]. Approval processes must be simplified to enable local communities to access funds quickly. The loss and damage fund established at COP27 in Sharm el-Sheikh needs to be quickly put into operation.

Foster justice, equity and inclusion in water and climate actions

Water is also a vehicle through which climate injustice propagates. Climate-change impacts and unequal access to water are experienced differently by people depending on gender, caste, sexuality, class, race and location[1,18]. For example, in 2017, Hurricane Harvey caused catastrophic flooding in Texas and Louisiana and inflicted $125 billion in damage. Neighbourhoods with larger Black and Hispanic populations were disproportionately affected owing to existing vulnerabilities, including poorer infrastructure and access to health care[1]. Sixty per cent of the global population living below the poverty line of $2.15 in 2019 were in sub-Saharan Africa (389 million

Flood waters breach a weir on the River Waal in the Netherlands in February 2021.

ROBIN VAN LONKHUIJSEN/EPA-EFE/SHUTTERSTOCK

FADEL SENNA/AFP VIA GETTY

Cracked ground at Morocco's al-Massira dam in August 2022, during an extended drought.

people), which has the highest concentration of extreme poverty and few resources to overcome climatic shocks. Coping strategies, such as emigrating or selling valuable assets such as livestock, might lead to permanent losses in income and livelihoods, and further impoverishment.

Water-based adaptation must fit local contexts, or else exacerbate the risks it is meant to allay. For example, in coastal areas of Bangladesh in the 1960s, international experts put in embankments and sluice gates to provide flood protection and boost agriculture in the Ganges Delta. They did so without considering the massive sediment flows that meandering rivers bring, traditional water systems such as 'aushtomashi bandhs' (temporary earthen levees that prevent saltwater incursion in the dry season), fishing and agricultural livelihoods, and the inability of local communities to maintain engineered flood-control structures[10,19]. The consequences have been dire – worse floods and waterlogging, sinking of land and filling up of riverbeds, increased soil and water salinity, and degraded food and livelihood security[19]. Many men from the region have migrated in search of jobs, increasing women's household burdens and insecurity.

Such problems stem from either failing to understand or ignoring the root causes of vulnerability, which are often historical. For example, in Cape Town, South Africa, measures to cut water demand, such as tariff increases, fines and the withdrawal of 'free basic' provision, were imposed in response to prolonged drought from 2015 to 2018. As a result, poor and working-class households faced severe shortages, whereas affluent households were able to store bottled water or install rainwater harvesting tanks and boreholes[20].

Going forward, local communities must have a voice in shaping and determining their futures and, where appropriate, must lead the decision-making process. For instance, in 2021, the district council in Rangamati, Bangladesh, worked closely with local women to combat water shortages in this drought- and landslide-prone hilly region. The women chose to install a solar-powered well and tank to pump, store and supply water, and took the lead in project design, implementation and follow-up, to ensure success. Such community-led projects need to become the norm.

As water and climate crises collide, the UN meeting offers a chance for the world to capitalize on this moment and put water at the heart of climate action.

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1. Caretta, M. A. *et al.* in *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (eds Pörtner, H.-O. *et al.*) Ch. 4 (Cambridge Univ. Press, 2022).
2. Douville, H. *et al.* in *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (eds Masson-Delmotte, V. *et al.*) Ch.8 (Cambridge Univ. Press, 2021).
3. UNESCO World Water Assessment Programme. *United Nations World Water Development Report 2020: Water and Climate Change* (UNESCO, 2020).
4. Burek, P. *et al.* IIASA Working Paper WP-16-006 (International Institute for Applied Systems Analysis, 2016).
5. IDMC. *Global Report on Internal Displacement 2021* (Internal Displacement Monitoring Centre, 2021).
6. Clement, V. *et al. Groundswell Part II: Acting on Internal Climate Migration* (World Bank, 2021).
7. PBL. *The Geography of Future Water Challenges: Bending The Trend* (PBL Netherlands Environmental Assessment Agency, 2023).
8. Kim, Y., Chester, M. V., Eisenberg, D. A. & Redman, C. L. *Earth's Future* **7**, 704–717 (2019).
9. Yu, S., Brand, A. D. & Berke, P. *J. Am. Planning Assoc.* **86**, 417–430 (2020).
10. Mukherji, A. *Nature* **605**, 195 (2022).
11. Jackson, R. B. *et al. Science* **310**, 1944–1947 (2005).
12. Miralles-Wilhelm, F. *Nature Clim. Change* **12**, 110–112 (2022).
13. Global Commission on Adaptation. *Adapt Now: A Global Call For Leadership On Climate Resilience* (Global Center on Adaptation, 2019).
14. Ishizawa, O. A., Miranda, J. J., Paredes, M., de Haro, I. & Pedrozo, A. *Analysis of the Impact of Investments in Disaster Risk Reduction and Prevention in Mexico: Case Study Of Tabasco between 2007 and 2011* (World Bank, 2017).
15. GCA. *State and Trends in Adaptation Report 2021: How Adaptation Can Make Africa Safer, Greener and More Prosperous in a Warming World* (Global Center on Adaptation, 2021).
16. Hutton, G. & Varughese, M. *The Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water, Sanitation, and Hygiene* (World Bank, 2016).
17. Mason, N., Pickard, S., Watson, C., Klanten, B. & Calow, R. *Just Add Water: A Landscape Analysis of Climate Finance for Water* (WaterAid, 2020).
18. Srivastava, S., Mehta, L. & Naess, L. O. *Nature Clim. Change* **12**, 113–114 (2022).
19. Dewan, C. *Misreading the Bengal Delta: Climate Change, Development, and Livelihoods in Coastal Bangladesh* (Univ. Washington Press, 2022).
20. Rusca, M., Savelli, E., Di Baldassarre, G., Biza, A. & Messori, G. *Nature Clim. Change* **13**, 98–105 (2023).

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