

Ministerial roundtable III –
Taking Forward the Results of the Summit of the Future

Earth Water Futures:

A Big Science Initiative to Advance Next-Generation Water
Solutions for Future Generations

Junguo Liu

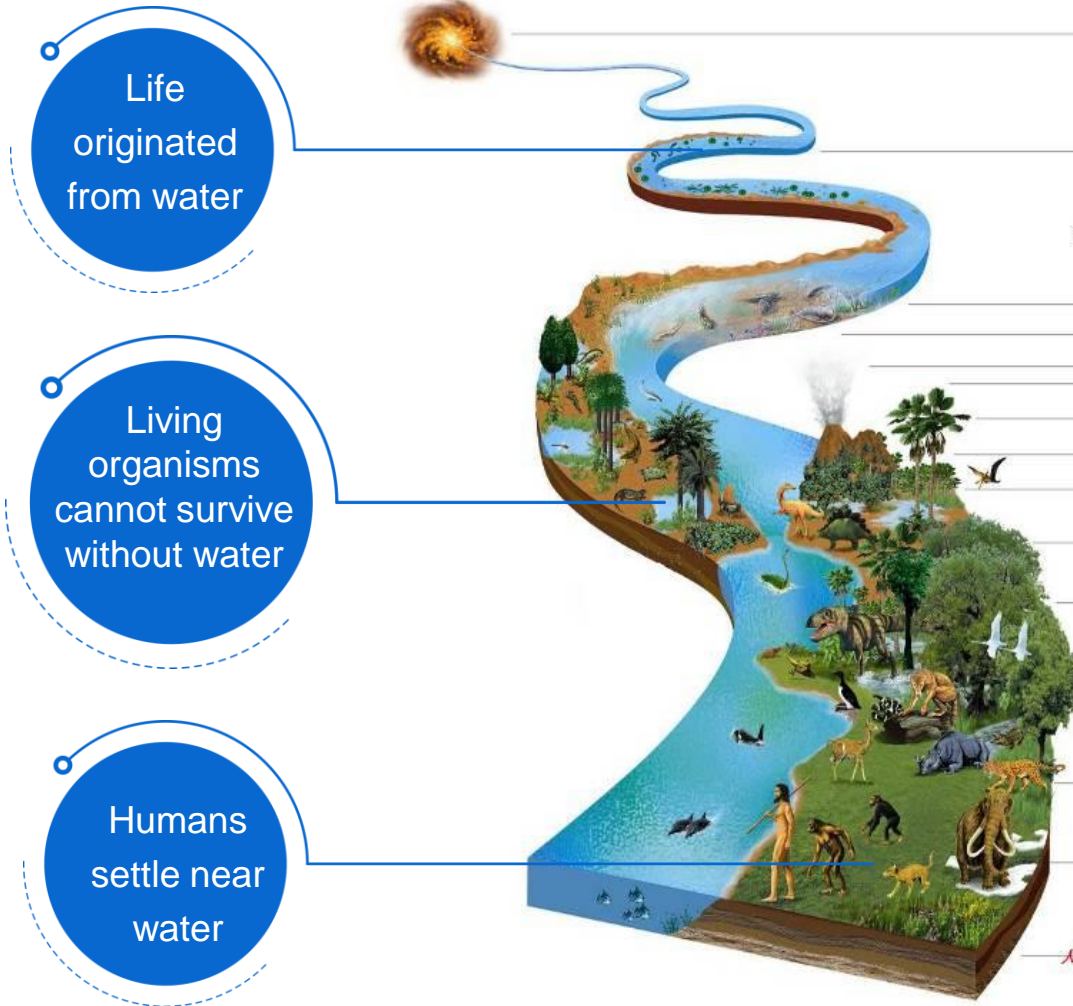
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Water and Civilization



Without water, there is no life



Sumerian Civilization Mayan Civilization

Civilizations collapse with water crisis



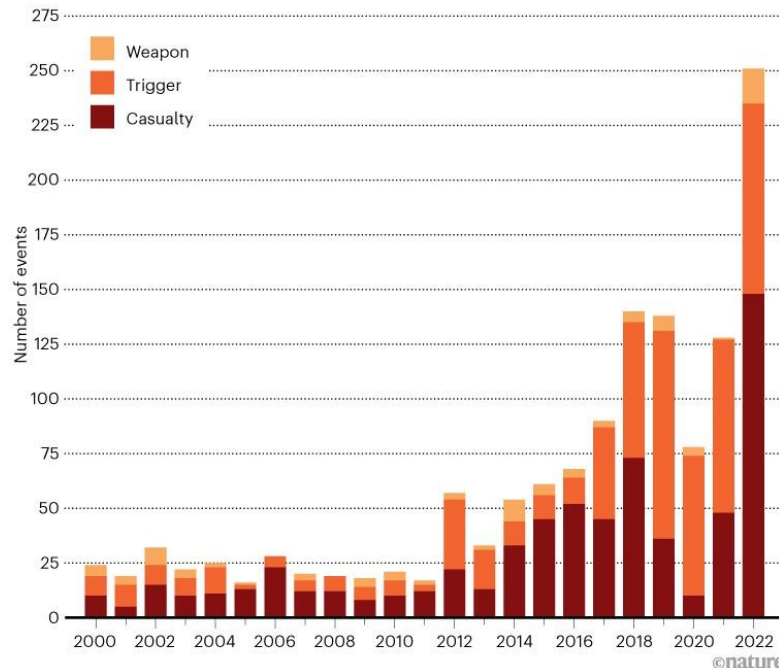
On December 14, 2023, **Nature** organized a special issue themed on **water** to look ahead into the future.

Water: a Source of Life and Strife

Water can cause conflict, expose people to pollution and put communities at risk in the form of flooding.

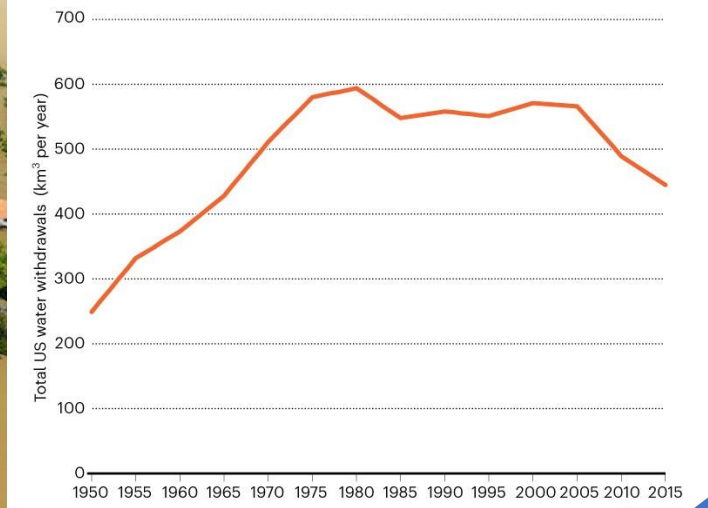
WARRING OVER WATER

Globally, the number of water-related events during conflicts has been rising since 2000. Access to water can trigger violence; water can be used as a weapon; and water systems can be a casualty of war.

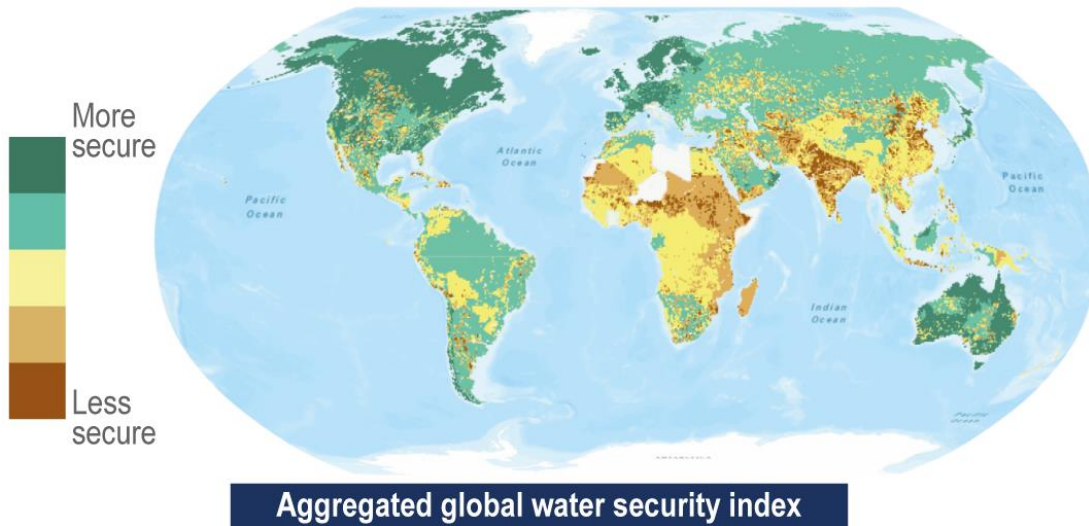


A DIP IN USE

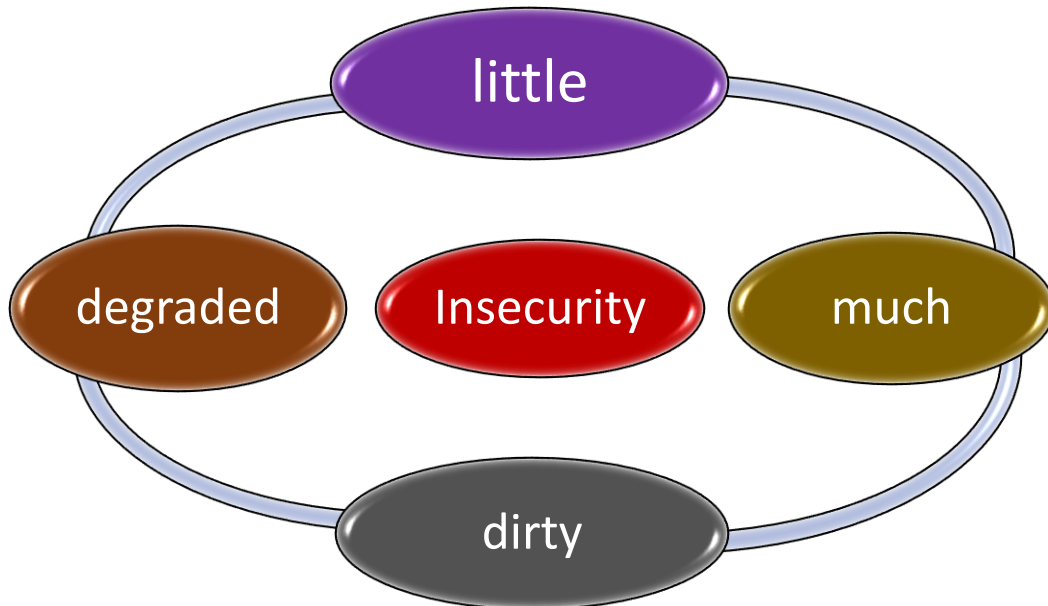
After a period of rapid increase in the decades after the Second World War, the use of water in the United States stabilized and has now even started to decline.



Water Insecurity: A Threat to Sustainable Development



Intensification of the hydrological cycle due to human-induced climate change is affecting physical aspects of **water security** (*high confidence*), thereby exacerbating existing water-related vulnerabilities caused by other socioeconomic factors



Caretta...**Liu**... et al., 2022. Water. 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** [H.-O. Pörtner, et al. (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 551-712, doi:10.1017/9781009325844.006.

Water Insecurity: water scarcity (too little)



INSIGHTS
PERSPECTIVES

Check for updates

ENVIRONMENTAL SCIENCE

Water scarcity is exacerbated in the south

The Southern Hemisphere has experienced a 20% drop in water availability in 20 years

By Günter Blösch¹ and Pedro L. B. Chiffre²

Water availability—the difference between precipitation and evaporation—is expected to decrease in many regions of the world because climate change has modified the water cycle, more water will be abstracted by the growing population, and water pollution will continue to limit clean water (2). Estimates of changes in water availability are uncertain at continental and global scales because measurements of precipitation and evaporation tend to be indirect or only locally representative (2). On page 570 of this issue, Zhang *et al.* (3) report a study that combines streamflow observations of large river basins of the world with terrestrial precipitation data and satellite measurements of evaporation and water storage to show that water availability in the Southern Hemisphere has substantially decreased from 2001 to 2020. With their approach, the authors have improved the reliability of water availability estimates, which could help improve long-term water management.

Zhang *et al.* used a consistent method to validate monthly or seasonal evaporation (ENET) estimates. For the Northern Hemisphere, these changes are predominantly related to increased evaporation, whereas in humid regions in the south, they are mainly related to decreased precipitation. Both trends and the year-to-year variability of water availability are aligned with climate model (long-term variations of the climate that are related to ocean processes), such as the Intergovernmental Panel on Climate Change (IPCC) and the National Oceanic and Atmospheric Administration (NOAA). For example, in the Southern Hemisphere, the authors find that the Southern Hemisphere suffered floods decreased by 70 mm per year over the past two decades suggest future water management challenges in the Southern Hemisphere. Long-term water availability as reflected in streamflow and groundwater recharge, is the base value against which to

Human activities, including crop and livestock production, manufacturing of goods, power generation and domestic activities, rely on the availability of water in both adequate quantities and of acceptable quality for the intended use⁽¹⁾. However, geographic and temporal mismatches between clean water availability and demands occur across different world regions and at certain times⁽²⁾. The inability to meet our clean water demands, both now and in the future, is considered to be one of the major threats to humankind both in terms of likelihood and potential impacts—and is increasingly perceived as a global systemic risk⁽³⁾. Recognizing the importance of addressing this risk, the United Nations established Sustainable Development Goal (SDG) 6 to “substantially reduce the number of people suffering from water scarcity⁽⁴⁾”.

Global water scarcity assessments have sought to identify areas susceptible to water scarcity based on the aim of raising awareness, assessing the state and trends of sub-regional to global water scarcity targets and guiding regional to national scale water management measures in adaptive water scarcity responses (5). However, these assessments have largely overlooked the role of changing water quality in the end-of-the-century, accounting for multiple pollutants, sector-specific water quality requirements, and seasonality.

The inadequate availability of clean water presents systemic risks to human health, food production, energy generation and ecosystem functioning. Here we evaluate population exposure to current and future water scarcity (both excluding and including water quality) using a coupled global hydrological and surface water quality model. We find that 55% of the global population are currently exposed to clean water scarcity at least one month per year, compared with 47% considering water quantity aspects only. Exposure to clean water scarcity at least one month per year increases to 56–66% by the end of the century. Increases in future exposure are typically largest in developing countries—particularly in sub-Saharan Africa—driven by a combination of water quantity and quality aspects. Strong reductions in both anthropogenic water use and pollution are therefore necessary to minimize the impact of future clean water scarcity on humans and the environment.

Check for updates

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Article <https://doi.org/10.1038/s41558-024-0270-0>

Current and future global water scarcity intensifies when accounting for surface water quality

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Timing the first emergence and disappearance of global water scarcity

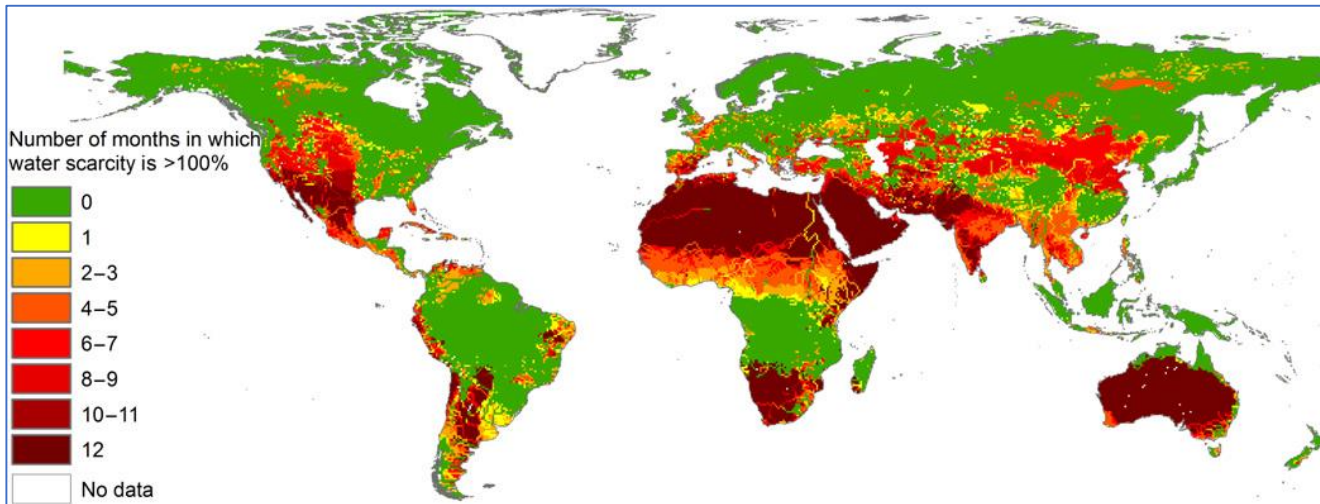
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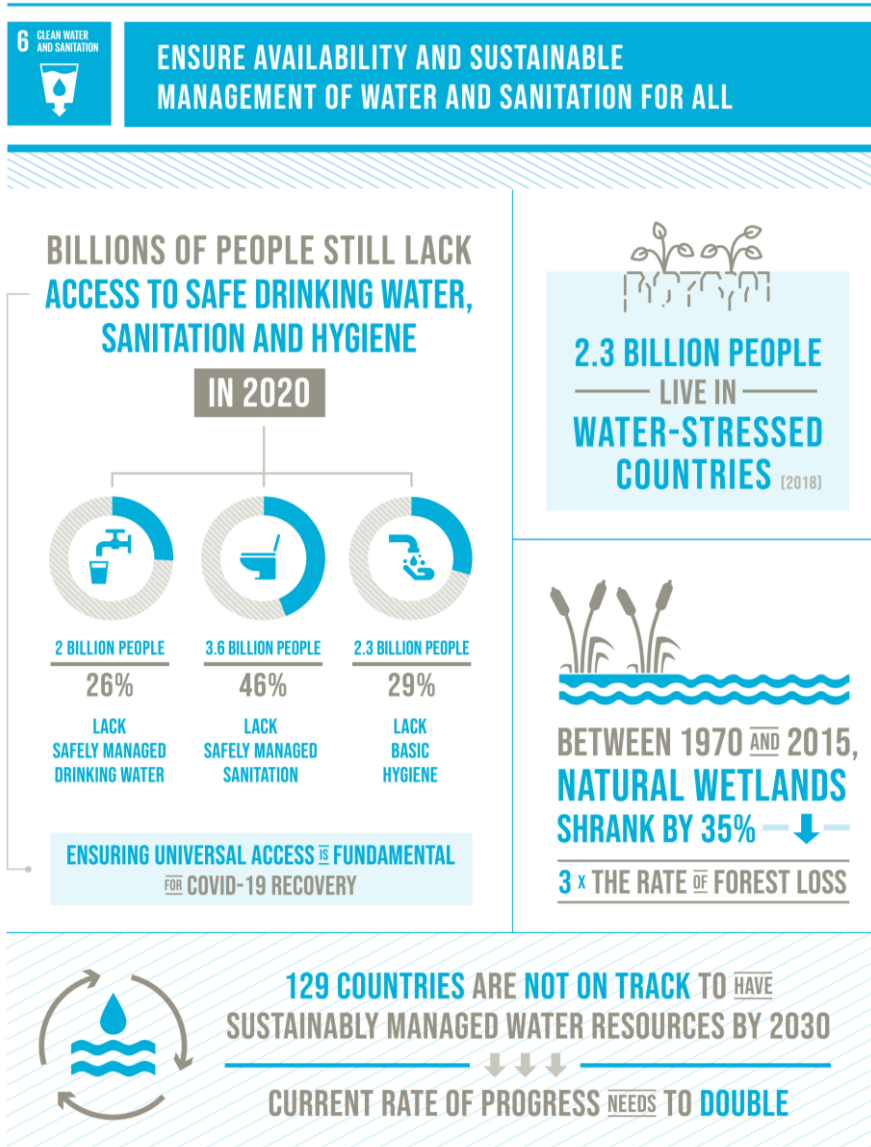
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Currently, ~4 billion people are estimated to experience severe water scarcity for at least one month per year (medium confidence)(IPCC,2022)

Water Insecurity: water scarcity (too little)



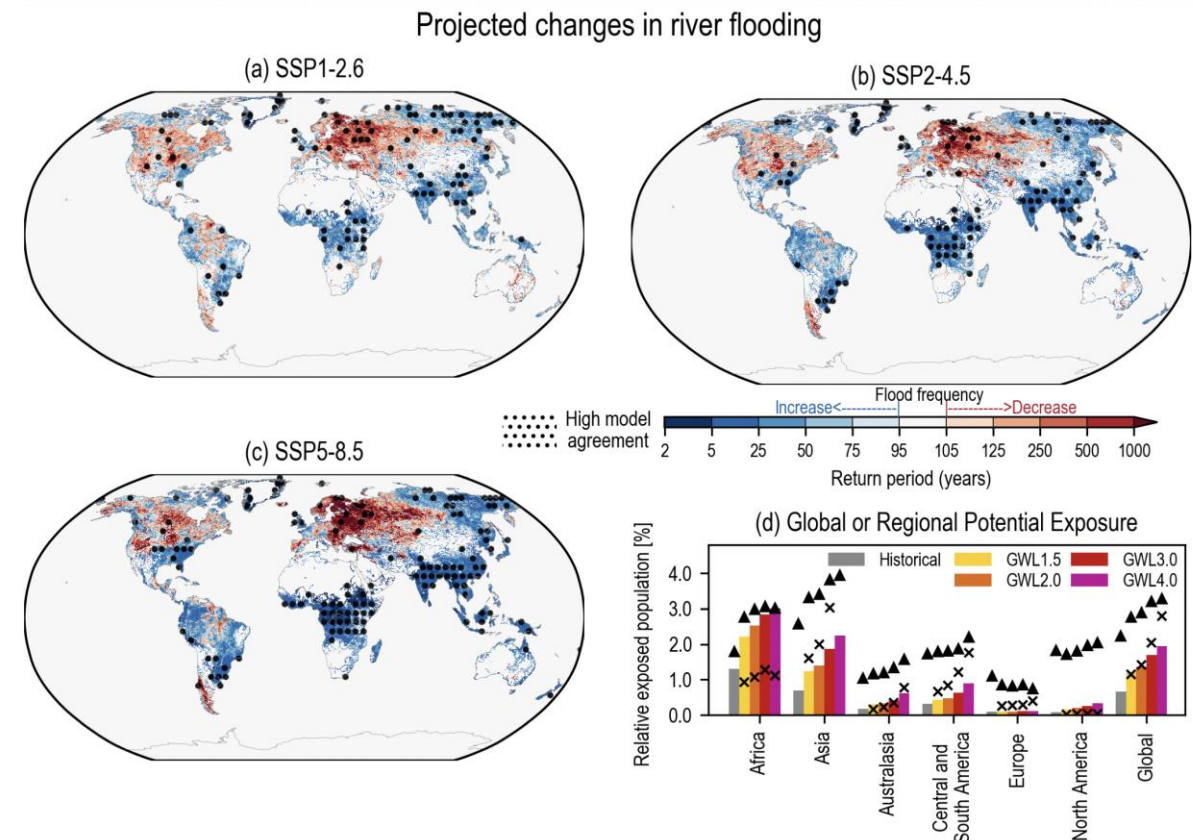
Target 6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address **water scarcity** and substantially reduce the number of people suffering from **water scarcity**

Water Insecurity: flood (too much)

Flood **risks and societal damages** are projected to **increase with every degree of global warming** (medium confidence)

- Direct flood damages will **increase by 4 to 5 times** at 4 °C compared to 1.5 °C
- At 4 °C GWL by the end of the century, **10%** of the global land area is projected to face simultaneously increasing high extreme streamflow and decreasing low extreme streamflow, affecting roughly **over 2.1 billion people**

Changes in river flooding under various scenarios





2021 Zhengzhou



2022 Pakistan

Flood



2022 Germany



2024 Spain

Water Insecurity: pollution (too dirty)



FACTS

- More than 80% of wastewater resulting from human activities is discharged into rivers or sea without any pollution removal
- Coastal waters are deteriorating due to pollution and eutrophication
- Roughly 80% of marine and coastal pollution originates on land

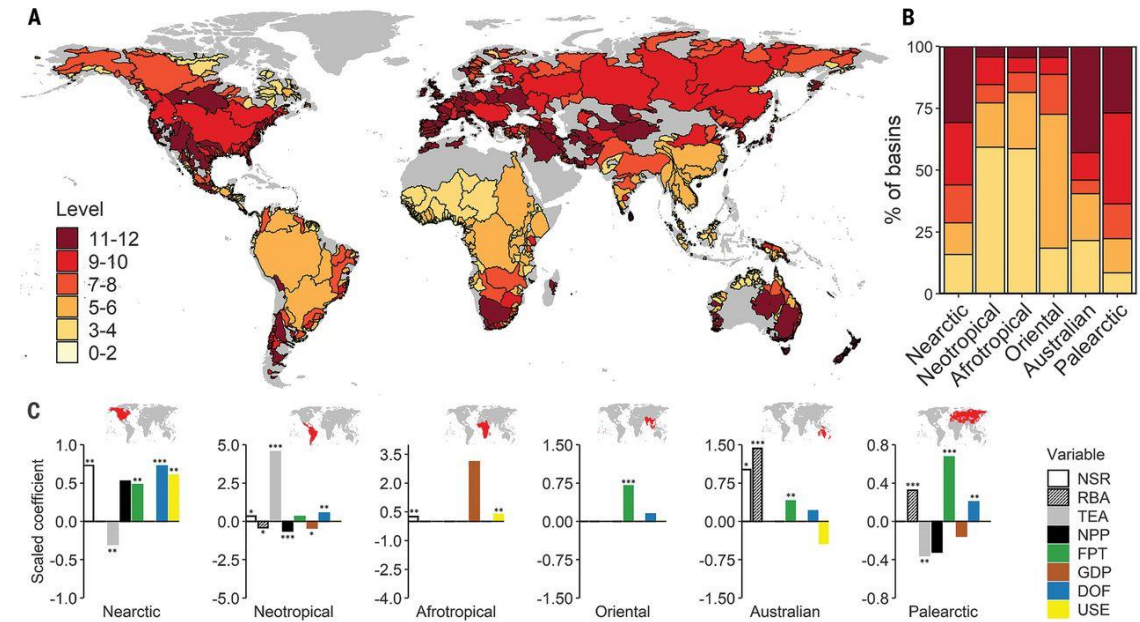
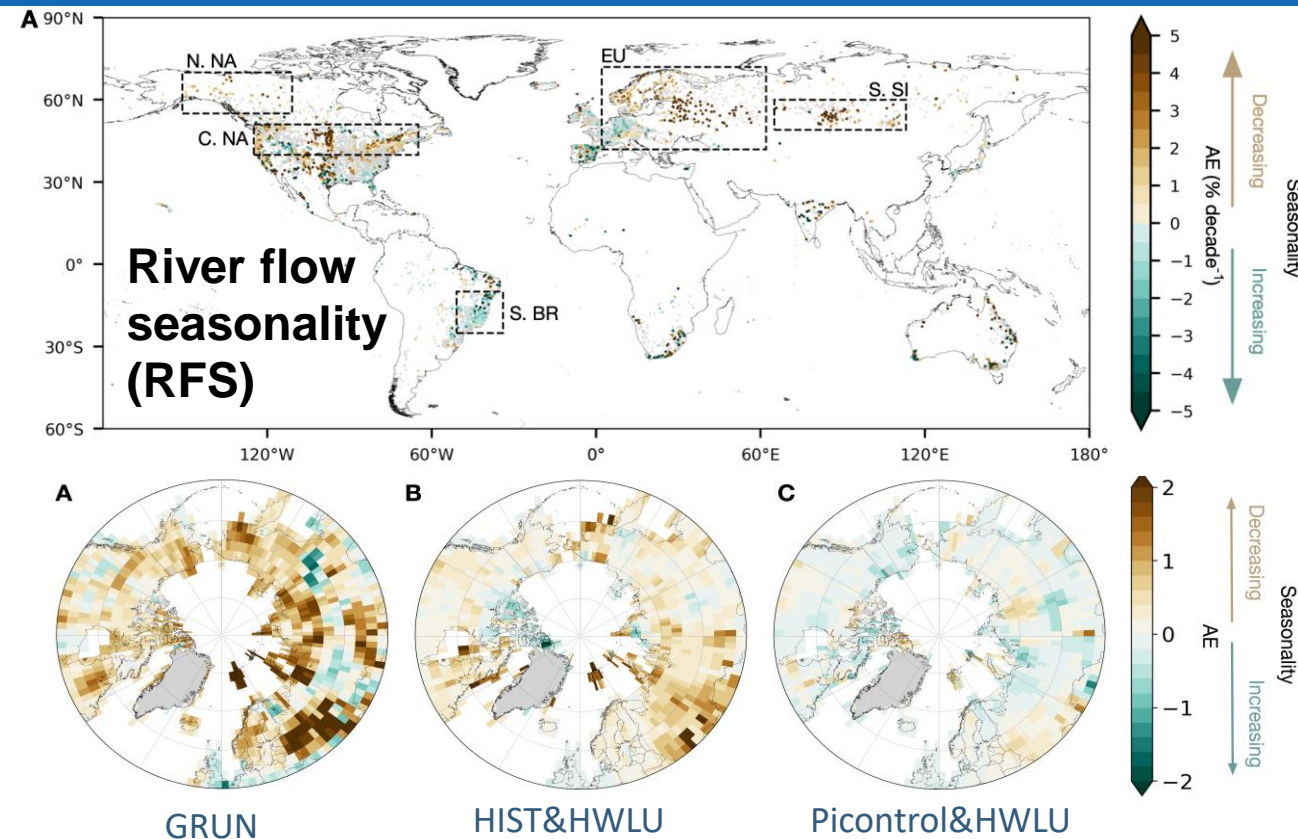
TARGETS

- **6.3** By 2030, improve **water quality** ... , halving the proportion of untreated wastewater ...
- **14.1** By 2025, prevent and significantly reduce marine **pollution** of all kinds, in particular from land-based activities



SUSTAINABLE DEVELOPMENT GOALS

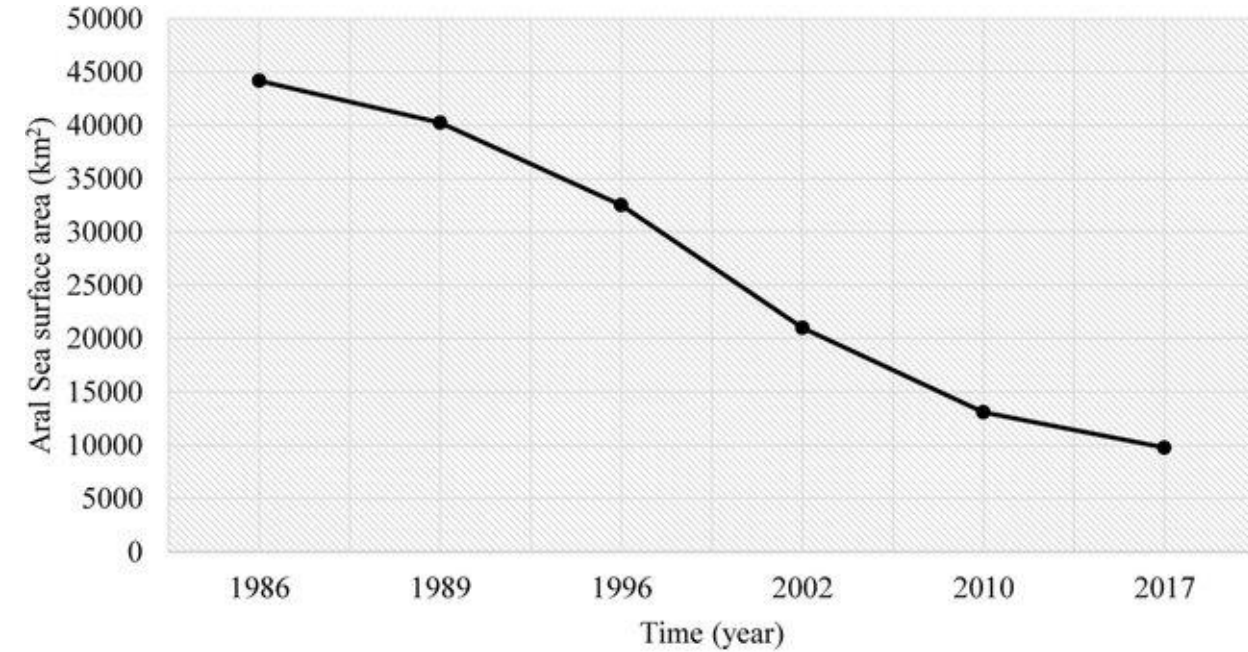
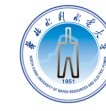
Water Insecurity: eco-collapse (too degraded)



~**21%** of gauging stations exhibit significant changes in river flow seasonality. **Weakening of RFS** in northern high latitudes is linked to anthropogenic climate change

>**50%** of rivers have experienced significant changes in biodiversity, affecting >**40%** of continental area and >**37%** of river lengths

Water Insecurity: eco-collapse (too degraded)



The sea has lost 60,000 km², or **90%** of its size, over half a century

[Aral Sea Drying Up](#)

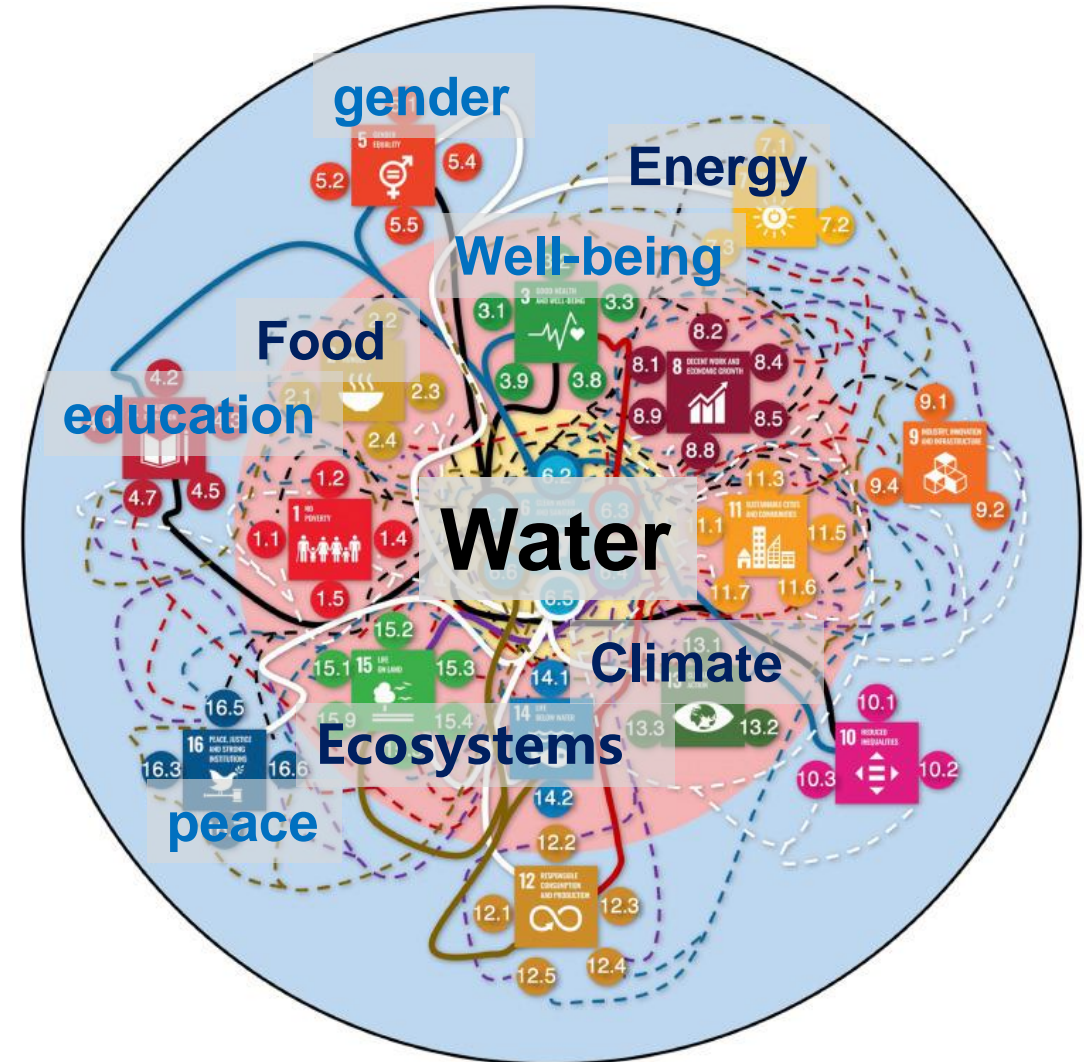


At the Summit of the Future on 22 September 2024, world leaders adopted the **Pact for the Future** and its annexes: the Global Digital Compact and Declaration on Future Generations.

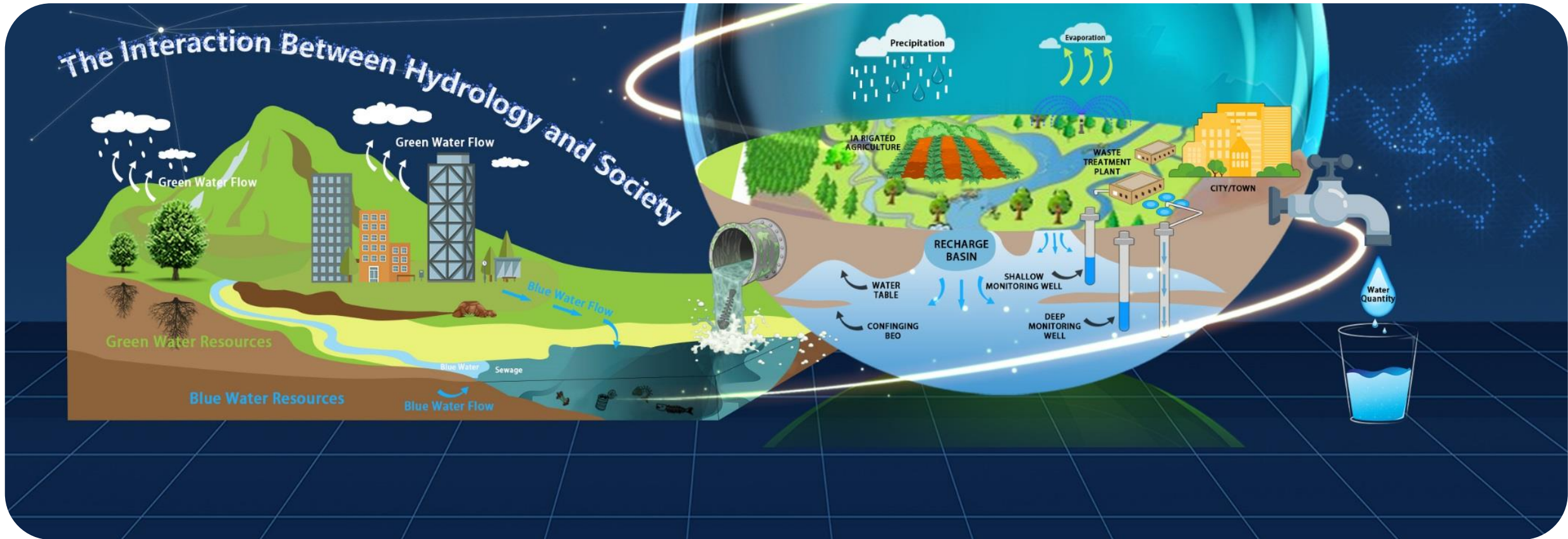
- Clear commitments and deliverables on
- sustainable development and financing
 - peace and security
 - STI and digital cooperation
 - youth and future generations
 - global governance

Global water security: A shining star in the dark sky of achieving the sustainable development goals and all deliveries of the Pact for the Future

- sustainable development and financing
- peace and security
- STI and digital cooperation
- youth and future generations
- global governance



International Big Science Initiative



Earth Water Futures

advancing next-generation solutions to water crisis for next generations

Goals of Earth Water Futures

GOALS

1

Data Sharing and Collaboration: Create global databases and information platform for water crisis and promote joint research efforts

2

Sustainable Management: Develop innovative tools and practices for efficient water use and conservation

3

Capacity Building: Provide training and support to countries lacking expertise in water technologies

4

Integrated Solutions: Address Water-Energy-Food Nexus with integrated green-blue-gray solutions

Potential Projects

A dynamic, AI-powered tool providing real-time data on water crisis worldwide

Global Water Atlas

Understanding aquatic ecosystems for pollution mitigation and stepwise ecological restoration

Water Genome Project

Develop climate-resilient green infrastructure for managing water systems and disasters

Climate-resilient Solutions

Earth Water Futures Initiative



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North China University of Water Resources and Electric Power



WORLD SCIENCE FORUM
BUDAPEST

By integrating **Earth Water Futures into the **Pact for the Future**,
we can collectively build a world where water sustains life,
development, and peace for generations to come.**

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