

# Transformation of water systems for climate change adaptation and resilience

## The context

Global *warming* is only the start. As climate change warms the atmosphere, the water cycle is intensifying dangerously. More severe, frequent and less predictable floods and droughts, extreme rainfall and changes in soil moisture, along with the melting of ice, reduced snow cover and rising sea levels are dislocating water systems worldwide. The consequences are plain to see. Without action to transform water systems, disruption of the ecological web of life that sustains us will deepen, and development gains will be lost.

## Key messages

- Climate change is water change – too much or too little water, of lower quality than before, and with more risks, uncertainties and unknowns. The IPCC's assessment is clear: anthropogenic alteration of the water cycle has begun and will have devastating consequences for life on Earth. Disadvantaged communities will suffer the most.
- Climate change adaptation starts with managing water better. The race to build resilience is a race to a water-secure world. Climate-resilient water management will help us preserve development gains and thrive despite the shocks and stresses of extreme weather events.

## Climate change is water change

It has never been clearer – human-induced climate change is here, and we are seeing the impacts all over the world, day by day. Floods, fires, tropical cyclones, heat waves, droughts – these disasters are becoming more frequent and severe. Water runs like a thread through all these extremes.

The Intergovernmental Panel on Climate Change (IPCC) warns us in the starkest terms that what we have seen so far is just a warning of what is to come. Under every emissions scenario it has considered, global average temperatures will continue to rise, and water extremes and risks will continue to become more dangerous.

“It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe.”

Sixth Assessment Report (Working Group – the Physical Science Basis), IPCC



Solar-powered pump for irrigating home gardens, Ethiopia (photo: Mulugeta Ayene/WLE).

The warming of the atmosphere is intensifying the water cycle (IPCC 2021; Smith et al. 2019):

- The frequency and intensity of heavy precipitation events have increased since the 1950s; and patterns of tropical monsoon rainfall are changing.
- For each 1°C of global warming, extreme daily precipitation events are projected to intensify by about 7%.
- Flood risks will expand, with three times as many people exposed to the equivalent of a 100-year flood event by the end of this century.
- Surface water flows and availability will become more variable within seasons and from year to year.
- Soil moisture levels will decline in some critical farming areas, challenging rainfed agriculture and increasing irrigation needs.
- Drought has increased over the last five decades and the area of land under drought conditions will double by 2050, with between 0.5 and 3.1 billion more people experiencing conditions of water scarcity.

Water security is becoming harder to achieve because of climate change, yet is more urgent than ever. Climate change adaptation and resilience in agriculture, the energy sector, industry and cities – as well as global ambition for food systems, biodiversity and sustainable development – all depend, as a result, on transforming water systems as the climate changes.

## Water: Too much and not enough

To tackle climate change, we need to let go of our old assumptions: firstly, the notion that we can plan for the future solely by looking to the past. The age-old concept of ‘stationarity’ – viewed in terms of a stable climate with a predictable frequency of disruptions – has long governed human affairs and decision-making. Climate change makes no such promises: we must now plan in a state of ‘deep uncertainty’. This means making robust water management strategies suited to multiple scenarios, and flexible enough to adapt to unexpected events and an emerging understanding of new realities.

The second assumption to discard is the idea that water is a single sector. Water is intrinsic to the climate; it is everywhere, and climate change impacts on water are felt in every sector – from agriculture to sanitation, to energy and to manufacturing and commerce – by all social groups. Climate-resilient water management needs to take into account the cascading impacts of climate change across sectors and at all levels.

## An Action Framework for Climate-Resilient Water Management

The International Water Management Institute (IWMI) has developed an [Action Framework for Climate-Resilient Water Management](#) that builds resilience into decision-making at all levels, across four linked domains for action.

### Governance and participation

Governance is central to climate-resilient water management – but this has to be characterized by participation at all levels, including by vulnerable communities. Multi-level water governance where higher-level institutions empower robust and flexible decisions at lower levels is more likely to account for rights and bring stakeholders together in a collaborative co-creation of solutions.

The IWMI project [Digo Jal Bikas](#) draws on local knowledge to generate a baseline for sustainable water development in western Nepal. This comprehensive exercise in water accounting charts the natural characteristics, ecosystem services, water-related physical infrastructure and modifications of the study area in relation to climate change. It also includes a political economy analysis and assessment of water governance across different levels. The project develops tools and guidelines in consultation with stakeholders at multiple levels to promote best practices that support resilience of local communities and ecosystems.



### GOVERNANCE AND PARTICIPATION

Put in place multi-level water governance to promote participation in decision-making and self-organization. Higher level institutions empower robust and flexible decisions at lower levels.



### INFORMATION AND LEARNING

Ensure data and information is accessible at all levels and that people have the skills to apply it to managing dynamically changing risks. Foster systems thinking and knowledge sharing.



### SYSTEM DIVERSITY AND CONNECTIVITY

Maintain or restore diversity in water-related systems to provide redundancy and fail-safes. Use diversity and connectivity for flexibility in responding to unexpected events and changes.



### INFRASTRUCTURE, TECHNOLOGY AND MANAGEMENT

Reduce vulnerabilities using infrastructure, technologies and water management that will be robust for high-confidence threats but flexible in response to emerging futures.

### Information and learning

Information is power – if it is available to those who most need it, and if they have the skills to use it. Furthermore, this has to be achieved within the dynamic contexts of climate change, where stationarity is breaking down and uncertainty is expanding. This requires more than simply replacing statistical analyses of past weather and climate with the outputs of climate models.

For a number of countries in [Asia](#), Africa and the Middle East, IWMI has developed capabilities across technology, data and policy to respond to droughts and floods. Map-based monitoring systems are being operationalized through country-specific early warning systems, to track drought or flood impacts on irrigated and rainfed agricultural systems. These are linked to risk management and transfer activities to help mitigate and recover from often devastating impacts. For example, [bundled insurance solutions](#) that provide climate information services, seeds and fertilizers, as well as cash payouts, have been developed for India and Bangladesh. While in the [MENAdrought](#) project, vulnerability and impact assessments alongside monitoring have been used in the participatory drafting of action plans that help Jordan, Lebanon and Morocco mitigate climate change and adapt to it.

### System diversity and connectivity

A reluctance to view the Earth as a whole, interconnected system is a fundamental barrier to addressing climate change. But it is water that allows us to maintain a balance across the ecological, economic and social spheres, enabling flexibility in responding to unexpected events and changes.

Wetlands provide an excellent example: long undervalued, particularly around urban settlements, they may provide flood defense for cities at risk from severe weather events, supporting urban municipalities maladapted to such shocks. Colombo's designation as a [Ramsar Wetland City](#), supported by IWMI, recognizes the value of the city's 'natural infrastructure', which helps to reduce flood risks, is ecologically rich, and offers livelihoods to farmers and fishing communities in and around the city.

### Infrastructure, technology and management

Climate-resilient infrastructure and technology for water needs to fit a wide range of credible futures, and should incorporate assessments of suitability for particular vulnerabilities and contexts. A new generation of uncertainty-tolerant approaches helps decision-makers identify options that have a satisfactory performance across scenarios while also retaining the flexibility to adapt according to need.

The [Innovation Lab for Small Scale Irrigation](#) works in Ghana, Ethiopia and Tanzania to improve access to irrigation technologies, accounting for combinations of

water sources, water extraction technologies, application methods and allocation tools. These are set against biophysical and socioeconomic data so the limits of both the environment and the market can be aligned to benefit smallholder farmers.

## Resilience for whom?

Climate change is affecting all of us. But it is already having a disproportionate impact on those least responsible for global emissions, who are also much less able to withstand the shocks of extreme weather events. Any action on mitigation and adaptation must listen to the voices of the marginalized – farmers, women, young people and indigenous peoples – and guarantee their rights. Scientific and local knowledge need to be put on an equal footing if sustainable outcomes are to be achieved; locals need to be heard at the highest levels of decision-making. If well-intentioned, scientifically grounded initiatives for mitigation and adaptation neglect inclusion at the local level, they will be rejected, with their efforts condemned to failure. Grassroots participation within a framework of multi-level governance is fundamental to the success of sustainable water management.

## Financing for water systems transformation

Finance for climate mitigation and adaptation needs to work today, tomorrow and the day after tomorrow. Finance must tackle intensifying water risks under climate change. An 'economics of resilience' will help open up minds (and wallets) to the scale of finance that needs to be mobilized to transform water systems for climate resilience. There are crucial opportunities to be seized not only to include water management in climate finance, but also to ensure that the much larger pool of more general water-related finance is used to build climate resilience.

## Recommendations

Climate change is dislocating water systems and dangerously intensifying the water cycle. The old, static ways we relied on to manage our water resources are no longer enough. Governments, businesses, cities, rural communities and farmers alike need new levers and tools, backed by new evidence and data, to transform water systems for a dynamically changing future. Building on the Action Framework for Climate-Resilient Water Management, IWMI recommends that we:

### Prioritize system-wide action

Support governments and communities to realize their commitments in nationally determined contributions (NDCs) and national adaptation plans (NAPs), where water and agriculture are frequently identified as key areas of risk. This requires water governance developments that operate at multiple levels, a strong evidence base to support analysis of trade-offs and decision-making, technology and infrastructure adapted to non-stationarity, and joined up solutions across food, land and water systems.



### Put the needs of the most vulnerable people first

Enact policies and take actions for climate-resilient water management that are inclusive and advance gender equality, and reduce displacement/migration. Ensure that the development gains of marginalized and climate-vulnerable people are protected and that future pathways out of poverty are privileged.

### Prepare for high-confidence impacts and deep uncertainty

Respond decisively to anticipated impacts in which we have high confidence, but avoid actions that are difficult to undo, modify or adjust over time. This calls for designs of technologies and infrastructure that perform well across a range of climate scenarios, and a decision-making approach that internalizes the principles of robustness and flexibility.

### Invest in water and climate information systems

Advance and invest in the best water and climate information systems available, so decision-makers can prioritize climate-resilient interventions. Ensure this is accompanied by inclusive learning across water users, institutions and wider society.

### Align water and climate finance to accelerate resilience

Financing should be used to accelerate action to build resilience to climate change. Innovative mechanisms such as green bonds, sustainable finance and index-insurance products can help broaden the pool of investors interested in climate resilience.

### Use water as an enabler of adaptation

Leverage action on water to enable adaptation across sectors, and harness the synergies generated to propagate change across water systems. Focus on policy coherence to reconcile the water needs of mitigation and adaptation.

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## Citation

International Water Management Institute (IWMI). 2021. *Transformation of water systems for climate change adaptation and resilience*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 4p. (IWMI Water Issue Brief 18).  
doi: <https://doi.org/10.5337/2021.227>

/ water systems / climate change adaptation / resilience / anthropogenic climate change / global warming / water management / frameworks / hydrological cycle / extreme weather events / flooding / drought / rain / risk / decision making / water security / water governance / participation / policies / technology / information systems / financing / uncertainty / irrigation / infrastructure / communities / vulnerability / diversity /

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