Watering the NDCs: National Climate Planning for 2020 and Beyond

How water-aware climate policies can strengthen climate change mitigation & adaptation goals

About the Author

This document is a product of the Alliance for Global Water Adaptation (AGWA) network, an international members-based non-governmental organization (NGO) comprised of regional and global development banks, government agencies and ministries, utilities, diverse NGOs, academics, and the private sector working across technical and policy programs to mainstream resilient water resources management, focusing on the connections between water resources and climate adaptation and mitigation.

A Living Document

This report is designed to serve as a living document. Its contents will be updated over time as new resources and tools become available. To be sure you have the most updated version of this living policy paper, visit www.wateringthendcs.org.

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Foreword

This paper is intended primarily for national staff, decision makers, and consultants involved in crafting and / or implementing national climate policy, planning, and outreach, including National Adaptation Plans (NAPs), Nationally Determined Contributions (NDCs), and National Communications. AGWA worked with many dozens of national adaptation focal points and their teams to prepare this guidance, which is also relevant to climate mitigation activities. At a basic level, this document makes a connection between resilient water management and climate adaptation and mitigation policies. While this document concentrates on the mechanisms outlined within the UNFCCC Paris Agreement, the lessons are equally applicable to the 2030 Agenda and the Sendai Framework for Disaster Risk Reduction.

In 2020, Parties to the Paris Agreement are invited to communicate their mid-century, long-term low greenhouse gas emission development strategies (Long-Term Strategies or LTSs).[a] They will outline how they plan to achieve these objectives successively in their Nationally Determined Contributions also due in 2020 and every five years onward. Parties are encouraged to use the principles, recommendations, and resources included in this document to augment their 2020 climate plans (both NDCS and LTSs) and to inform subsequent climate activities such as their National Adaptation Plans (NAPs).

The guiding principles and recommendations enumerated here are a starting place to incorporate water into national climate planning; detailed resources for implementation are available and listed in the Resources and Examples section. This paper is designed to be a living document—routinely updated to incorporate new insights, case studies and resources—and to center a global movement around climate-resilient water management for adaptation and mitigation, which we are calling the “Watering the NDCs” movement.

If you have any feedback, questions or if you would like to join the “Watering the NDCs” movement, you can email us at: policy@alliance4water.org.

Sincerely,

Ingrid Timboe
Policy Director
Alliance for Global Water Adaptation

a — in accordance with Article 4, paragraph 19, of the Paris Agreement.

Introduction

In 2015 the world joined together in Paris to address the real and increasing threats and opportunities associated with the global climate crisis. The resulting ambitious framework of the Paris Agreement recognizes the urgent need for worldwide action to limit global temperature rise to well below 2°C above pre-industrial levels while strengthening humanity's ability to respond and adapt to both increasing variability and systemic changes in the world's climate. As outlined in their Long-Term Strategies (LTSs), Nationally Determined Contributions (NDCs), and National Adaptation Plans (NAPs), Parties' national commitments lay out how each will contribute to reaching the targets of the Paris Agreement. Box 1 explains how these aspects of the Paris Agreement fit with resilient water management. Now Parties must begin to implement existing commitments and increase national ambitions for the future. Water resources are fundamental to both tasks.

The impacts of climate change are primarily felt through water systems (see Box 2), and water resource needs are implicitly imbedded in most climate mitigation and adaptation strategies. Climate change is expected to increase global water demand, potentially intensifying competition for water resources even as the timing, quantity, and quality of available water becomes less predictable and more variable.[1] Trade-offs between water users are likely to become increasingly difficult: for example, choosing between water for electricity or food production during the dry season. Already these tradeoffs are difficult choices and could become even more stark if freshwater resources are not explicitly considered throughout countries' climate plans and actions. Absent these considerations, we risk not only failing to meet the Paris Agreement targets but intensifying persistent or permanent water stress, leading to social and economic disruption and profound ecological damage.

BOX 1: Why Water in NDCs, NAPs, and LTSs?

For signatories to the Paris Agreement, 2020 is the first year they are invited to communicate their mid-century greenhouse gas emission development strategies (Long-Term Strategies, or LTSs). LTSs encompass both adaptation and mitigation. Starting in 2020 and every five years thereafter, Parties are also requested to submit Nationally Determined Contributions (NDCs), which outline how they will successfully meet these Long-Term Strategies in the near-term. Additionally, implementing those objectives through subsequent climate activities may include developing National Adaptation Plans (NAPs).

Access to a reliable water supply is critical to nearly all sectors working to combat climate change. That means water is a fundamental, cross-sectoral component of all national climate planning and implementation, including the LTSs, the NDCs, and the NAPs. Water considerations throughout planning mean thinking about water insecurity—where people have too much, too little, and/or too dirty water—which is already a significant problem in many parts of the world. Because water is cross-sectoral and tied to economic prosperity and development, national climate change planning is strengthened when all aspects of it are based on resilient water management.

There are two critical components of resilient water management:

Robustness—the ability to withstand anticipated vulnerabilities
Flexibility—the ability to change as needed when climate futures' anticipated outcomes shift.[2]

The purpose of this brief is to assist Parties in improving the effectiveness and success of their national climate plans and actions (e.g., LTSs, NDCs, and NAPs) by ensuring they address freshwater resources throughout all national climate planning and implementation processes in ways that can both withstand climate impacts that have already occurred or are highly likely to occur, as well as potential impacts that are less well understood in their timing, severity, form or when models and scenarios show widely divergent types of impacts. By adopting resilient and low carbon water management approaches that combine robustness (able to withstand anticipated vulnerabilities)[2] and flexibility (able to change as needed when climate futures' anticipated outcomes shift)[2] to address both known and uncertain impacts, Parties can fulfill NDC commitments and ensure that climate policies and actions foster synergies rather than conflict. This brief provides evidence, examples, and tools to manage water as an asset for achieving the goals of the Paris Agreement, along with a set of principles and recommendations for Parties to use during the process of updating and implementing their national climate plans.

BOX 2: Water-Related Climate Risks

Observed climate impacts have been linked as a result to changing precipitation patterns, intensity and extremes, and changes in runoff to rivers, lakes, and wetlands, in addition to reduced snow cover and melting of ice. In 2015, the World Economic Forum (WEF) listed water as the top global threat to the planet given the chances of increased climate variability and with it floods and droughts, the chance of failure to adapt to climate change, and the significant potential economic impacts of water insecurity at the national, regional, and global levels.[3] It has remained in the WEF's top five global threats annually ever since. Water-scarce regions could see their growth rates decline by as much as 6% of GDP by 2050 due to water-related impacts on agriculture, health, and incomes.[4] The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)[5] assesses hydrological impacts due to climate change and provides the most comprehensive information available on observed and projected hydrological changes due to climate change, including:

- Climate change is negatively affecting freshwater ecosystems by fundamentally altering streamflow and water quality, posing risks to drinking water and sanitation even with conventional treatment.
- Increased warming amplifies the exposure of small islands, low-lying coastal areas, and deltas to the risks associated with sea-level rise and saltwater intrusion into freshwater systems.
- Disasters—including those exacerbated by climate change—are overwhelmingly water-based (90%) and are becoming more frequent and intense.[6] The annual economic losses from weather-related disasters are USD 250–300 billion.[7] In 2018, 57.5 million people were affected by storms, droughts, or floods—a "quiet" year for the 21st Century, which has averaged 179.5 million people affected annually.[8]
- Climate change is likely to increase the frequency of meteorological droughts (less rainfall) and agricultural droughts (less soil moisture) in several currently dry regions in coming decades, which is likely to increase the frequency of short or "flash" hydrological droughts (less surface and groundwater) in these regions.
- Rates of groundwater replenishment will be affected by altered precipitation regimes. Rainfall from increasingly short and/or intense events may not reach the groundwater table. At the same time, regions with a surplus of rainfall could be threatened by groundwater flooding.
- Human exposure to flooding is increasing due to more frequent and intense rainfall events, including the associated risk of damage and contamination to both urban and rural domestic water and sanitation services.

Guiding Principles

Creating climate-resilient societies requires sufficient, clean, and accessible water. Parties working to meet the long-term goal of net zero emissions must reduce the carbon emissions of water-intensive sectors—particularly energy and agriculture. Simultaneously, Parties must reduce the carbon emissions of water and wastewater extraction, transport, supply, and treatment processes as well. Thus, acknowledging the role of water in national climate planning is important, but not sufficient. Instead, new, risk-based approaches to water management—herein referred to as resilient water management—are warranted.[9] Water resources are explicitly referred to in roughly 90% of the intended NDCs (INDCs) from 2015 that include an adaptation component.[10] However, virtually none of the INDCs reference the need for resilient water management and policy approaches. This oversight is problematic because of the high potential for water conflict among NDC commitments, especially those with implicit water components. For example, given a limited water supply, there may not be enough water for the activities that sectors (e.g., cities, energy, agriculture) deem necessary to meet NDC goals. These risks for conflict are not well recognized in the INDCs and need to be accounted for in the forthcoming NDCs.

While many intended NDCs address water in the context of adaptation, only a few parties include GHG emission reductions through activities in the water sector, for instance through improving the energy efficiency of public utilities. Water utilities often rely on inefficient pumping systems and are a major user of fossil energy especially in developing countries, resulting in substantial potential to reduce GHG emissions. In addition, Parties' current mitigation strategies largely fail to acknowledge their implicit water commitments, or the need for cross-sectoral water integration within their strategies. For example, Parties that prioritize hydropower or biofuels for energy production must consider the water requirements of these activities and the impacts on other water users such as agriculture, urban supply and sanitation, and forestry. We can no longer assume that the water will be available when, where, and in the right quality we need, even in places that have not previously experienced water insecurity. At the same time, Parties should also recognize the potential benefits for water from reduced reliance on thermal power generation in terms of both quality and quantity of water for other uses.

BOX 3: Tools and Approaches for Resilient Water Management

- Deutsches Institut fur Entwicklungspolitik (DIE) / Geodateninfrastruktur Deutschland (GDI-DE) NDC Explorer
- Deltares: Adaptation Pathways
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH: NDC Adaptation Toolbox
- Climate Resilient Infrastructure Development Facility (CRIDF) Resource Center
- *For a more complete list and further information, see the Resources and Examples section of this document.*

Resilient water management for mitigation and adaptation dates back to roughly 2007 and is crucial to effective, coherent national climate planning. It has two key elements: developing robust approaches to address climate impacts that have a high likelihood of occurring (especially over the short term) and developing flexible solutions and approaches to address high uncertainty issues.[9]

Water is becoming increasingly variable,[5] often requiring more energy-intensive management for irrigation, flood management, water supply, and treatment in order to be usable when and where it is needed.[11] Increased competition for limited water resources will also result in further constraints on future adaptation and mitigation options if water demand and availability is not factored into climate adaptation and mitigation plans today. Resilient water management can assist in this endeavor.

The guiding principles for resilient water management outlined below are critical to building and maintaining climate-resilient societies and ecosystems and should be considered for adoption by Parties looking to strengthen their national climate plans.

1. **Climate Change Uncertainties Mean Water Uncertainties.** *Climate change will continue to fundamentally alter the hydrological cycle for decades, which requires the systematic inclusion of resilience into water decision making.* Water managers, engineers, and planners have traditionally made predictions about future water availability based on historical water trends or baselines. Warming temperatures and systemic changes in other climate variables affect all aspects of the hydrologic cycle.[12] These changes mean historical baselines are, in many cases, no longer a reliable indicator of future water supply. Even with increasingly sophisticated Global Circulation Models (GCMs), signiricant levels of uncertainty exist around how water conditions will shift in the future. These uncertainties make planning, regulations, and infrastructure design and operations much more difficult than in the past, so widespread standard practices have a high likelihood of leading to inaction or mal-adaptation.[13,14] Adopting risk-based approaches to resource and service management can address climate change uncertainty because it involves preparing for a range of possible climate futures by taking actions now that can withstand greater climate and hydrological variability and by calibrating the level of confidence in future projections with the level of certainty needed. For example, a governance agreement between irrigation and energy users for water allocation can address greater uncertainty and flexibility using proportions instead of fixed volumes. When traditionally building an irrigation or energy generation facility, the design and operation required confidence in future levels of water and energy availability. If that level of confidence in future availability does not exist, the facility may need to be designed in a new way—one that it can be adjusted over time to increase adaptability in the face of the unknown. Such flexible and modular approaches can be applied to a range of climate change mitigation and adaptation decisions (see Box 3).

2. **Robustness and Flexibility Are the Best Strategies to Address Uncertainties within and between Sectors.** *Given ongoing changes to water demand and availability, trade-offs between water uses must be addressed with robustness and flexibility when determining the how, where, and when of water allocation.* Water is inherently cross-sectoral, supporting almost all aspects of the economy, natural environment, and society. A small proportion of water always needs to be protected and reserved for domestic use, a principle that underpins most national water management strategies. When water is limited, more water allocated for agriculture can mean less water for industry, household consumption, and ecosystems. Ecosystem degradation (including water loss) further constrains water supply and quality while potentially increasing GHG emissions. Historically water has been largely managed with limited coordination or accountability across sectors; this siloed approach has resulted in fragmented development and governance for water resources.[13] Siloed management matters less when water is abundant—although remains important for managing risks associated with flooding—but as the world faces increasing uncertainty around water resources, an uncoordinated approach is no longer viable for creating resilient societies. Water must be systematically accounted for, managed, monitored, and adjusted across all sectors and levels of governance to weigh trade-offs that can prevent over-allocation, protect essential supplies, and manage long-term stressors such as climate change.

Water is inherently cross-sectoral, supporting almost all aspects of the economy, natural environment, and society.

3. **Meeting Climate Change Mitigation and Adaption Goals Demands Cross-sectoral Water Management.** *Resilient water management can provide coherence within and across sectoral, regional, and institutional goals.*[15] Because water is a necessary component of most mitigation and adaptation activities, it is intricately linked in every sector related to and affected by climate change. For these reasons water must be systematically evaluated throughout national climate change plans, so that water availability and demand can be holistically monitored and balanced over time. One specific cross-sectoral example is given in Box 4 on water and energy. If decision makers plan in a more integrated manner, they can ensure the robustness of the water supply for different water users, thus maximizing the value of each sector's infrastructure investments.

4. **Robust and Flexible Management Solutions Enable Economic Growth.** *Resilient water management implemented across sectors can provide an "adaptation dividend," ensuring resilient economic growth even as the climate continues to shift.* Water savings programs, important for adapting to increased variability of the local water cycle, can also provide mitigation benefits in the form of a reduced need for energy-intensive pumped irrigation or treatment, thus saving money and resources. In Comoros, where 80% of the rural population relies on rainfed agriculture, new resilient water management methods will be applied to address insufficient storage by strengthening both groundwater management and environmental monitoring and by integrating local stakeholders into water resource management.[16] These efforts can help ensure that agricultural products continue to provide economic growth for communities despite uncertainties related to climate change and water supply. Groundwater infiltration and actively managing aquifers for water storage from high magnitude flows is another method to help cope with climate change as implemented in Texas and California, USA.[17] In many areas, increasing water storage options in underground reservoirs or tanks can improve drought resilience and potentially diminish costs related to disaster recovery. Efforts to combine traditional grey infrastructure with green and blue Nature-based Solutions (NbS) are becoming more widespread as these so-called "blended" solutions may offer cost savings over their operational lifetime.[18,19] As the regional climate changes, NbS infrastructure is more easily adjustable and flexible than gray infrastructure.

BOX 4: Water Is Cross-Sectoral

Water's connection with energy is a good example of how cross-sectoral water is. Population and economic growth are projected to increase the energy sector's water needs roughly 27% by 2040.[20] More water for energy will compete with growing water needs in other sectors; agriculture will likely need more water while urban drinking supply and sanitation may find it difficult to meet water quality objectives during times of water stress. Many renewable energy resources such as biofuels or hydropower have significant water needs[11] though implementation methods and geographic and socioeconomic context do impact the exact amount. For example, hydropower reservoirs use more water than run-of-river dams. Additionally, methods of displacing CO_2 from coal and gas-fired power stations, such as carbon capture and storage (CCS), increase the water footprint of energy production.[21] At the same time, being aware of this exchange between water and energy can result in a net water-positive plan. For example, with thermal energy generation using less water, that water can be "given" to renewable energy resources without the total amount of energy going up or infringing on the water needs of other sectors.

These four guiding principles for managing water under an uncertain climate future underpin water-smart climate policy and should be incorporated into NDCs, LTSs, NAPs, and other climate implementation plans where appropriate. Resilient water management tools and approaches (see Boxes 3 & 5 and Resources and Examples) based on safeguarding and incorporating sustainable ecosystem function can help improve the overall climate resilience of communities and ecosystems while increasing the likelihood of success for mitigation and adaptation strategies.

Recommendations for Water-Resilient LTSs, NDCs, & NAPs

The following six recommendations demonstrate how Parties can operationalize the four guiding principles at local, national, and regional levels. Given the complexity and context specific nature of water management, no one-size-fits-all solutions exist, so each Party will need to determine which recommendations work best for their situation. Regardless of the situation, applying the concept of resilient water management will help make national climate planning more effective. Institutions, regulations, and infrastructure that are adaptive (i.e., can learn from experiences and change as needed) are key and should be incorporated into all climate planning and implementation. Resources and Examples offers additional information and illustrative examples of these actions in practice.

1. **Analyze explicit and implicit water commitments across and within sectors at the national level and determine how to systematically evaluate water consumption, allocation, and tradeoffs.** This analysis can help those drafting NAPs and NDCs understand where surface and ground water is currently budgeted nationally and where it might need to be shifted to support climate change mitigation and adaptation activities. Where might there be seeds of conflict among users? Opportunities for collaboration? Are there clear operational rules and policies regarding essential life-line services for domestic supply? Are there operating rules to guide decision-making during resource shortages? Are allocation and governance agreements flexible enough to adjust if novel climate events occur, such as extreme floods or droughts? This evaluation is particularly critical in regions facing increasing water scarcity or flooding, which disrupts rather than helps water availability and may cause long-term damage to water infrastructure.

   National level cross-sectoral water governance mechanisms could come in the form of a regulatory framework or a ministry responsible for inter-agency dialogue tied to the national climate authority (i.e., focal point) that can track and analyze the total volume of water being withdrawn and either consumed or returned to the hydrological system (i.e., water allocation, baseline monitoring, and prioritization). Such arrangements assume the evaluation group has the ability to determine how much water is available and to agree upon sustainable water use thresholds to stop water usage at unacceptable levels that would trigger water stress for a given community or ecosystem. . For this reason, surface and ground water monitoring networks are needed to provide data for determining water budgets and allocations. India has worked towards this by combining the Ministry of Water Resources, River Development, & Ganga Rejuvenation and the Ministry of Drinking Water and Sanitation into the Ministry of Jal Shakti to better respond to its water challenges.[22]

2. **Invest in design and management policies and systems for water-intensive energy infrastructure that enable energy system resilience.** Energy infrastructure is designed to last for decades and is critical to economic growth. Many types of energy systems—thermal, nuclear, coal and natural gas, biogas, even many types of solar, hydropower, and biofuels—are deeply dependent on water supplies (see Box 4). For thermal energy production, energy systems may also be dependent on cool water supplies. Thus, planning, designing, and managing energy systems should take future water risks into account by including climate change impacts (water quantities and temperature) and future competing water demands across sectors. Decisions for the energy sector are significant: which energy extraction facilities to develop and where, which power plants to build, which to retire, and which energy or cooling technologies to deploy and develop. Conventional plans to expand water storage to protect against drought and to build dams to protect against floods are no longer enough. New insights into water-intensive energy assets are currently being developed and refined and can be used to evaluate the resilience of such systems over time.[9,23] Decision makers should incorporate robustness and flexibility across a wide range of credible future projections for climate change impacts on water supply into their energy plans and designs.

3. **Integrate basin-level mechanisms to evaluate the robustness and flexibility of water commitments within and between catchments.** River, lakes, and groundwater aquifers can be contained within part of a single country or across countries (i.e., transboundary). Regardless of the geographical or political layout, the entire basin must be considered when it comes to water allocation. Due to uncertainty around future demand and availability of freshwater, we need water allocation mechanisms and infrastructure that can be successfully adjusted as conditions change while also withstanding such changes that could impact their efficiency and effectiveness. In systems facing increased inter-annual variability, allocations systems based on proportions of available water rather than fixed volumes should be considered. Co-managing surface and groundwater resources (so called conjunctive management) can further contribute to water security. Regardless, adaptation measures in upstream regions or recharge areas of transboundary aquifers should be designed in a manner that will not jeopardize water users further downstream.

   For example, a basin-level mechanism could evaluate whether agricultural or industrial water and its associated infrastructure could be shifted to other uses or locations while maintaining both ecosystem integrity and essential household services during water scarcity or surplus. For how long? At what cost? What is the resulting benefit and for whom? These considerations are essential to ensuring that water systems can continue to support communities, economies, and the environment under increasing climate uncertainty.

4. **Introduce measures to monitor and manage water demands and to buffer increased unpredictability in water availability due to climate change.** These measures will typically include new water storage, distribution, and treatment infrastructure and methods (e.g., increased use of natural systems for these purposes) and measures for water demand reduction like price-based reductions in major cities. When thoroughly studied and managed, aquifers can be developed as strategic water buffers for times of drought. Focus is needed to ensure that building water infrastructure increases societal—as well as climate—resilience. Improved water sector governance may be necessary to implement these kinds of reforms and to attract more private financing into water infrastructure and services.

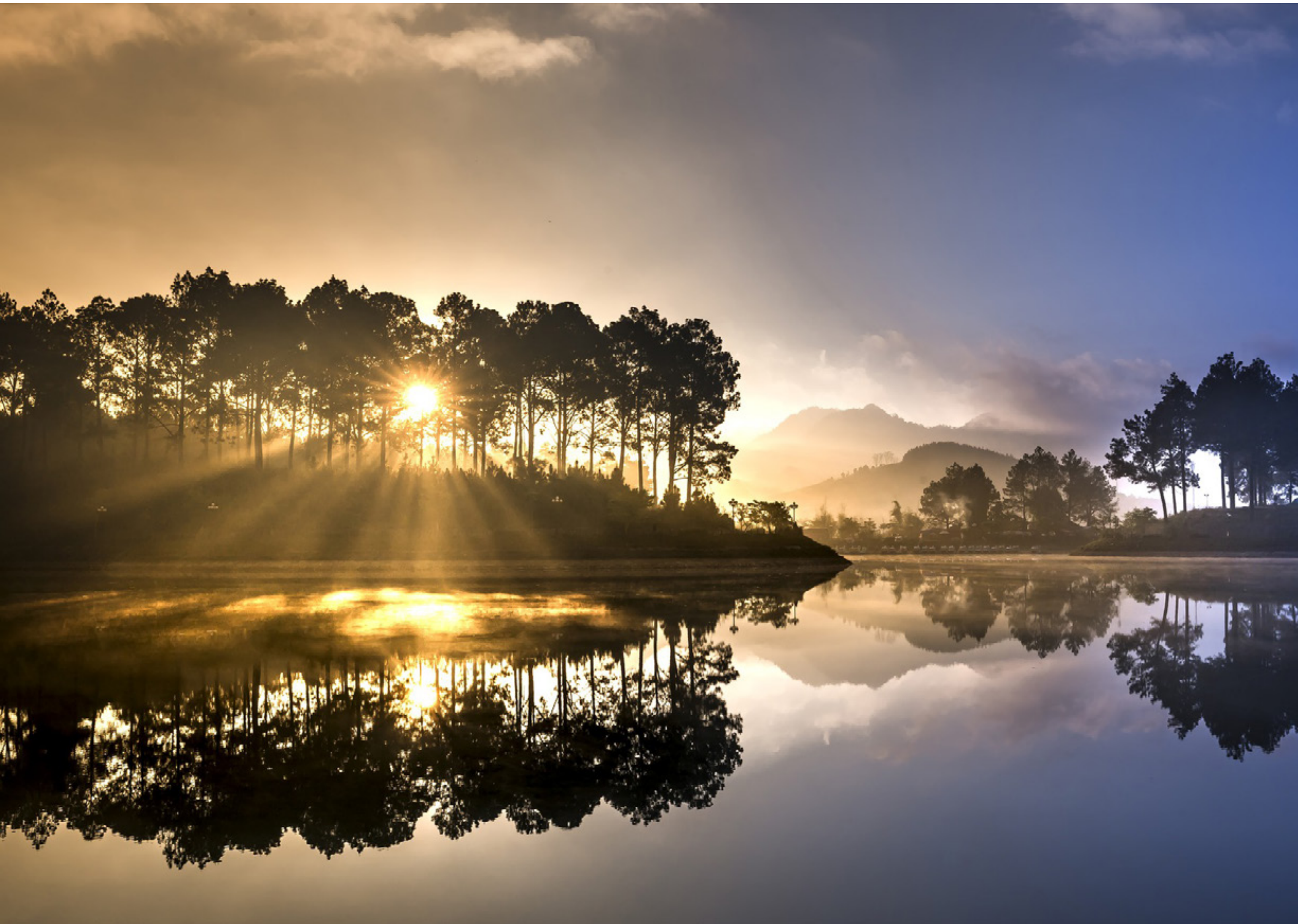
5. **Respect and enhance integrated ecosystems, particularly for vulnerable populations most of whom are directly dependent on ecosystem services for livelihoods.** Vulnerable populations are often dependent on ecosystem services for their livelihoods—fishing for example—but are not in a position to ensure those ecosystems are integrated nationally. Globally, freshwater ecosystems (including wetlands, peatlands, lakes, rivers, and aquifers) are among the ecosystems most impacted by human development and climate change,[24] which together have caused freshwater biodiversity to decline by over 80% since 1970.[25] Further fragmentation, degradation, and the loss of freshwater ecosystems is a direct and urgent threat to achieving the climate change goals outlined in the Paris Agreement and sustainable development more broadly. Freshwater ecosystem services are an asset to national climate planning because they provide several climate regulating services, such as providing significant carbon storage (sequestration) and regulating and purifying water flow. Furthermore, these ecosystem services provision and support other services such as water supply, food, raw materials (fuel, fiber, bio-energy), and nutrient cycling, all of which form the backbone of successful climate change adaptation and mitigation.[26] These ecosystems foster biodiversity and increase human well-being by raising the ability of communities to respond and recover from shocks and stressors. Serious, sustained, and coordinated effort and investment are needed—from local to international levels—to restore and safeguard essential ecosystem services, notably in the context of water retention (storage capacity) to mitigate downstream droughts and floods and to protect and purify water sources. Such efforts are often labeled as part of ecosystem-based adaptation (EbA) or ecosystem-based management (EbM).

Freshwater ecosystem services are an asset to national climate planning.

6. **Enforce sustainable and cooperative water allocation within and across basins.** Water management issues often arise from the mismatch between various individual decisions and the current and projected state of water resources within a given hydrogeologic or administrative unit. Basin decision support systems and councils should be strengthened, adequately resourced, and empowered to determine optimal basin-scale water allocation both within and beyond a single basin—including the multi-basin governance scale. For example, this can be done by determining conditional operating rules to better account for drought and high-flow periods and explicitly considering sustainability criteria in the decision support system aimed at achieving a better efficiency in basin-scale water allocation. These considerations should not be limited to the scale of hydrologic basins but should also apply to so-called "management basins," which can vary widely in scale from small sub-river administrative units to complex networks of basins based on how water is defined and managed in a given context. Water boundaries exist not only between countries but within them; greater coordination and cooperation is needed at all levels.

BOX 5: Continued Reading

- Global Commission on Adaptation (2019) Adapt Now: A Global Call for Leadership on Climate Resilience
- UN-Water (2019) Climate Change & Water Policy Brief
- The Nature Conservancy (2019) Wellspring: Source Water Resilience and Climate Adaptation
- *For a more complete reading list, see the Resources and Examples section of this document.*



RESOURCES AND EXAMPLES

This document is intended as a primer for Parties introducing why and how to integrate water more centrally within national climate planning and implementation. There are many additional resources out there that go into further detail and offer guidance for Parties looking to implement the principles and recommendations outlined here. Below are a few examples of such resources. In addition, we've included some positive examples from the intended NDCs (INDCs) that demonstrate how Parties might augment their own plans to link water in climate change adaptation and mitigation strategies. More details about these resources are also available on our website: www.wateringthendcs.org. If you are looking for guidance on a specific aspect of resilient water management but aren't finding it in this list, please reach out to us directly.

Our intention is for this to be a living document, meaning that this list will be updated as new resources are made available and new case studies are provided. If you have examples or studies to add to this list, please contact us at: policy@alliance4water.org.

Reports and Guidance

- UN-Water (2020) UN World Water Development Report—Water and Climate Change
- Harou JJ, Matthews JH, Smith DM et al. (2020) Water at COP25: Resilience enables climate change adaptation through better planning, governance and finance
- Grantham, T. E., Matthews, J. H., & Bledsoe, B. P. (2019) Shifting currents: Managing freshwater systems for ecological resilience in a changing climate
- Boltz, F., Poff, N. L., Folke, C., et al. (2019) Water is a master variable: solving for resilience in the modern era
- Keys, P. W., Porkka, M., Wang-Erlandsson, L., et al. (2019) Invisible water security: Moisture recycling and water resilience
- Voisin, N., Tidwell, V., Kintner-Meyer, M., & Boltz, F. (2019) Planning for sustained water-electricity resilience over the US: Persistence of current water-electricity operations and long-term transformative plans
- Global Commission on Adaptation (2019) Adapt Now: A Global Call for Leadership on Climate Resilience
- International Association of Hydrogeologists (2019) Strategic Overview Series Climate Change Adaptation and Groundwater
- UN-Water (2019) Climate Change & Water Policy Brief
- The Nature Conservancy (2019) Wellspring: Source Water Resilience and Climate Adaptation
- OECD (2018) Water Governance report
- Global Water Partnership (2018) Preparing to Adapt: The untold story of water in climate change adaptation processes
- French Water Partnership (2015) Review of the Integration of Water Within the Intended Nationally Determined Contributions (INDCs) for COP21

- IUCN (2015) Water and Climate Change: Building climate change resilience through water management and ecosystems
- World Bank. (2013) Thirsty Energy

Tools and Frameworks

- Deutsches Institut fur Entwicklungspolitik (DIE) / Geodateninfrastruktur Deutschland (GDI-DE): NDC Explorer tool
- World Wildlife Fund (WWF-US) & U.S. Agency for International Development (USAID): Natural and Nature-Based Flood management: A green guide plus additional resources
- Deltares: Adaptation Pathways
- Water and Wastewater Companies for Climate Mitigation (WaCCliM): Energy Performance and Carbon Emissions Assessment and Monitoring (ECAM) tool
- Water and Wastewater Companies for Climate Mitigation (WaCCliM): Roadmap to a Low Carbon Urban Water Utility
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH:
    - NDC Adaptation Toolbox
    - Climate Risk Assessment for EbA
    - Voluntary guidelines for the design and effective implementation of ecosystem-based approaches to climate change adaptation and disaster risk reduction and supplementary information (2019)
    - Valuing the Benefits, Costs and Impacts of EbA
- Climate Resilient Infrastructure Development Facility (CRIDF): Resource Center
- International Water Management Institute (IWMI): E-Flow Calculator
- Global Water Partnership (2019) Addressing Water in National Adaptation Plans: Water Supplement to the UNFCCC NAP Technical Guidelines, 2nd Edition
- Sustainable Sanitation Alliance (SuSanA) (2019) Opportunities for sustainable sanitation in climate action - Factsheet of Working Group 3
- Cremades, R., et al. (2019) Ten principles to integrate the water-energy-land nexus with climate services for co-producing local and regional integrated assessments
- UNESCO and ICIWaRM (2018) Climate Risk Informed Decision Analysis (CRIDA)
- World Health Organization (WHO) (2017) Climate Resilient Water Safety Plans
- UNECE, INBO (2015) Water and Climate Change Adaptation in Transboundary Basins: Lessons Learned and Good Practices
- The World Bank Group (2015) The Decision Tree Framework
- Wetlands International (2013) Ramsar Briefing Note 6: Wise Use of Urban and Peri-Urban Wetlands

Examples from the INDCs

This section is not meant to serve as an exhaustive list of resilient water management in the INDCs but rather as a small sample to give an idea of the types of activities that Parties have included.

Egypt: Egypt is currently one of the few Parties to include transboundary water considerations in their INDC. Why might transboundary waters be important for climate change adaptation? There are over 300 river basins shared by two or more countries worldwide,[27] which means that managing shared water resources and joint planning for future uncertainty around regional climate and precipitation patterns are essential to sound adaptation planning. Activities such as data sharing, joint monitoring of river basins, and flexible water sharing agreements can be implemented to improve transboundary adaptation outcomes.

Mexico: The adaptation component of Mexico's 2015 INDC is one of the few to highlight both the critical role of ecosystems in buffering communities from the worst effects of climate change and the role ecosystems play in providing essential services for adaptation, including additional water storage and coastal protection against storms and sea level rise. Green infrastructure, ecosystem-based adaptation (EbA), and integrated water resources management (IWRM) are prioritized in Mexico's NDC. Finally, Mexico also prioritizes the integration of climate change criteria into the design, construction, financing, and maintenance of critical water infrastructure, thus ensuring that plans to retrofit, relocate, or build new infrastructure are climate-resilient.

Solomon Islands: In their 2016 NDC, the Solomon Islands included adaptation activities around community-based adaptation planning and risk-reduction. These bottom-up approaches to risk-management, linked to top-down national plans, are a systematic way to address the climate adaptation challenges that many small island developing nations face: extreme floods, drought, sea-level rise, and increasingly strong and frequent tropical cyclones. These countries have, in many cases, been facing these challenges for decades, if not centuries, and have some of the best developed coping strategies across the globe. They are a great example of how local knowledge can drive local solutions that can be piloted and scaled up where appropriate. Given that many of their climate risks are directly water-related, the national government of the Solomon Islands is also working on implementing a national IWRM plan.

Uganda: Uganda is one of the few Parties to include water in their first NDC mitigation plan, with a particular focus on wetland protection, restoration, and management. These activities include a national inventory and assessment of all wetlands found within the country, the development of Ramsar-designated "Wetlands of International Importance" for the purposes of wetland research, conservation, education, and eco-tourism; the design and implementation of local wetland action plans; the identification and protection of 20 "critical and vital" wetland systems; achieving a net increase in total wetland land cover by 2030; and the strengthening of wetland management institutions and governance at both the national and local levels.

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