Don’t Tread Water

How We Can Measure Effective Climate Resilience Through Water Resources

AGWA

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About the Report

The UK's Foreign, Commonwealth & Development Office (FCDO) is dedicated to water and climate programming that is transformational — facilitating shifts from one state to another - and for this transformation to be sustainable. In the context of water, this transformation would result in a more water secure world for the billions facing water insecurity, particularly the poorest and most vulnerable, in the face of a changing climate com- pounded by economic and population growth. However, no existing effort to review and revise indicators for water and climate resilience to support this transformational change has been undertaken. Early analysis suggests that targeting and tracking progress against water security and resilience will require clear indicators to measure progress against water security effectively and to align FCDO with core partners for expanded impact (e.g., MDBs, GCF, other peer aid agencies), as well as with global frameworks such as the UNFCCC Paris Agreement (e.g., NDCs, the Global Goal on Adaptation).

Against this backdrop, the Alliance for Global Water Adaptation (AGWA) was commissioned by FCDO to analyze the current state of play around water security and resilience indicators and ultimately propose a framework by which the FCDO — and potentially many others more broadly — can monitor and track impacts around water and/or climate security in a period of rapid global change.

The following report represents the outcomes of this research, beginning with establishing shared definitions of adaptation and resilience, proposing four categories of climate resilience, surveying some prominent indicator frameworks, and closing with a summary of "good" water and climate resilience indicators. While the report was written with FCDO as the nominal audience, the framing around water security and resilience indicators is applicable to anyone working with water stewardship standards, corporate disclosures, national investment guidance, ODA spending, adaptation planning and evaluation, trade measures accounting for water footprint, and far more.

Introduction: Integrating Climate Resilience and Water

Like many aid agencies, FCDO has had a "water" program and a "climate program" as parallel tracks. Traditionally, water work in FCDO has prioritized projects such as rural water supply and sanitation, moving more broadly to water "security" issues, while climate investment has been more oriented towards energy and emissions projects with a slow shift towards adaptation and resilience or combined mitigation-adaptation projects. Internal indicators of progress, success, and failure have also been segregated into separate channels.

Beginning in 2021, with the advent of a small FCDO grant, FCDO funded an external program called the Water Tracker for National Climate Planning. The Water Tracker takes a new view of water as both a sector and as a medium for resilience, intended to strengthen the efficacy and coherence of national climate teams such as NDC focal points and NAP teams. Neither FCDO's climate nor water indicators are especially useful to evaluate the ongoing quality of the program. Beginning in mid 2024, the Water Tracker will be part of a larger FCDO funding package called the Just Transitions for Water Security (JTWS), which will include two other teams as well.

Breaking away from more traditional, siloed, and sector-based approaches also means that measuring the success of these projects must look different from the past. Targeting and tracking progress against new qualities requires new or at least additional indicators. Ideally, these indicators would be aligned across core partners for expanded impact (e.g., MDBs, there GEF and GCF, other peer aid agencies), as well as with global frameworks such as the UNFCCC Paris Agreement (e.g., the national climate commitments of target countries or the Global Goal on Adaptation).

This report is an attempt to braid these threads into a single strand, in order to guide several distinct audiences that are listed here in rough order of priority:

- The Just Transitions for Water Security Programme, implemented through the Water Tracker, Resilient Water Accelerator, and Fair Water Footprint teams, which is anticipated to begin in mid 2024.

- National country partners enrolled in the Water Tracker, Fair Water Footprints, and Resilient Water Accelerator programs. Currently, the Water Tracker is working with 13 countries, with another dozen ready for onboarding.
- Negotiations for the UNFCCC's Global Goal on Adaptation (GGA) process, extending through 2026.
- As relevant, the revision of International Climate Fund (ICF) indicators for FCDO program tracking, to integrate resilience into water security funding and non-stationary water management into resilience funding.

By engaging members of the climate and water communities spanning investment, implementation, and policy, we have tried to synthesize insights and to propose a set of indicators that can align programs working in both spaces. The approach contained herein intends to describe the landscape as we see it now and to capture a layered framework for identifying and putting forward integrated water security and resilience indicators. Through these modalities, we also see other diverse and transformational influence, such as for water stewardship standards, corporate disclosures, national investment guidebooks, adaptation planning and evaluation, and trade measures accounting for water footprint.

What Are We Measuring?

Compared to climate adaptation, resilience is a relatively new word in the climate change policy and practitioner space, not becoming widespread prior to 2018 in UNFCCC circles. Today, the word seems as ubiquitous as it is fast evolving, undefined, and — perhaps purposefully — unclear despite the best intentions of groups such as the IPCC. A cluster of associated terms, such as robustness, flexibility, and resistance, also circulate in the same contexts, often with more technical and refined implications.

Clear, shared definitions are vital but ambiguity has its purposes. Indeed, in some cases universal definitions may be unnecessary or even stifling for creativity and exploration for issues that continue to rapidly evolve through policy, science, finance, engineering, and practice. However, several larger trends are driving a convergence for more broadly agreed upon terms:

- A shift in funding and policy attention towards reducing climate risk (that is, avoiding and mitigating bad impacts and outcomes) and/or promoting resilience (that is, encouraging positive outcomes rather than just reducing the intensity of negative outcomes)
- "Paris Alignment" as an accelerating process for making sure that ODA, finance, and investment support national adaptation and resilience goals and targets as outlined in NDCs and NAPs.
- The Global Goal on Adaptation (GGA) as a global policy mechanism intended to define, measure, and align adaptation outcomes and investments by COP30 in 2026, serving as an additional layer of specificity to Paris Alignment
- Groups working on adaptation and resilience, such as aid agencies, philanthropies, finance institutions, ministries, NGOs, and national and sub-national governments, which are also trying to track, finance, and prioritize adaptation and resilience actions.

In contrast to adaptation and resilience, climate mitigation is relatively clear in terms of what to track. The need to assess and coordinate adaptation and resilience activities is much more problematic. Should we measure climate risk in an absolute manner, the way we might measure temperature or humidity? at a local level? at a regional or ecological or economic system level? in terms of relative tradeoffs? should we consider taking advantage of opportunities as well as threats and hazards? These questions have been answered variously by quite different groups since the practice of adaptation began recognizably around the year 2000. Even within single institutions, these questions can provoke profound disagreements festering into crises of management, prioritization, emphasis, strategy, and sequencing. Moreover, measuring efficacy for adaptation and resilience is even less clear. Many social, economic, and ecological indicators reported for adaptation and resilience were originally developed with an assumption of a stationary climate, such as water quantity and quality, water use efficiency, or service delivery reliability. Proposing new or additional indicators has proven to be an active challenge for many institutions.

Water resources run like a blue thread through adaptation and resilience discussions. Water is widely seen as the medium for negative climate impacts (Sadoff & Muller 2009), but water resources are also increasingly being seen as a mechanism to promote coherence and efficacy in a wide range of climate adaptation projects (IPCC AR6, Matthews 2023). The water community was an early advocate for using freshwater resources and the water cycle as a new lens for viewing adaptation, primarily for four reasons:

1. The widespread use of rigid long-lived water infrastructure and governance-legal systems (lasting decades to centuries) makes most water decision making sensitive to even modest climate shifts (Milly et al. 2008).
2. Traditional water resources decision making assumes that the recent past is a reasonable predictor of future states and conditions ("stationary" climate conditions) and tend to discount or ignore uncertainty in climate projections, and these decision making approaches are difficult to dislodge or adjust (Milly et al. 2008).
3. The water cycle is both very sensitive to climate change while also being hard to project in Earth System Models (ESMs) with sufficient confidence for planning, operations, and design cycles, especially at temporal and spatial scales relevant to most projects and management decisions (World Bank 2014). Freshwater cycle parameters are associated with even higher levels of uncertainty than, say, for air temperatures. In many regions, projections are unable to distinguish between the likelihood of much wetter versus much drier conditions over the operational or finance lifetime of new investments, a state referred to as "deep uncertainty" by infrastructure investors (Hallegatte et al. 2012).
4. Water is a shared and critical resource across many projects, administrative and national boundaries, and sectors, but water sharing planning and governance normally do not consider climate shifts and tend to treat water as a fixed economic input in energy, agriculture, and management rather than a dynamic and hard to predict flow (Matthews et al. in press). The role of water as both a distinct economic sector and a resilience "connector" between other sectors is a new insight.

The climate policy world has followed a different trajectory around water resources. Until about 2015 or 2016, the UNFCCC and the climate community viewed water as a "sector,[1]" on par with other sectors such as energy, forests, and oceans. Like the water community, the climate community has been slowly identifying water as both a climate hazard and as a medium for connecting diverse sectors and projects. In AR6 in 2022, the IPCC promoted the concept of "water-based adaptation," and the use of terms like "water resilience" in meetings began appearing about COP26 in 2021 and was widespread by COP28 in 2023. These terms seem intended to describe water-sensitive or water-focused adaptation and resilience even when working on projects that are not targeting the water sector. A more significant role for water resources has been slowly developing, however. As stated in one recent publication, if climate change is a threat multiplier, then water can function as a resilience multiplier (Matthews et al. 2022).

The GGA framework negotiated at COP28 in Dubai reflects the ongoing tension for water resources to need specific adaptation and resilience attention and for a more cross-cutting role for water resilience across other sectors. The GGA is arguably the most important piece of adaptation and resilience policy to rise through the COP process to date. An effective set of adaptation and resilience indicators is needed to guide the evaluation of national climate planning, ambitions, and implementation, and to serve as an effective scorecard for "Paris Alignment.[2]" The GGA holds the promise of creating a shared definition and basket of indicators for adaptation and resilience that will bring shared meaning to implementation.

[1] The water sector has various definitions. Perhaps the most common is institutions engaged in the treatment, transport, and storage of water (e.g., water utilities). In some contexts the water sector also focuses on rural water supply, waste management, and hygiene (e.g., WASH as practiced by groups such as WaterAid and UNICEF), which is often embedded in public health policies and programs. The water "community," at least as used in this document, refers to those who are involved in all aspects of water resource management, which includes the groups above as well as institutions working on topics such as water stewardship, freshwater ecological conservation, agriculture (especially irrigation), and water and energy connections (e.g., thermal turbine energy systems, biofuels, and hydropower).

[2] Paris Alignment refers to the ongoing process of ensuring that ODA, regional and national planning, and multilateral investment are fully in accord with the 2015 Paris Agreement's intent for mitigation and adaptation. In practice, Paris Alignment often means ensuring that planning and finance reference specific issues, goals, and outcomes in NDCs.

Defining Climate Resilience

Resilience is the central issue of this study. Historically, the concept of resilience has been malleable and shifted over time. Resilience emerged as a term in the climate community in the late 2010s as an elegant, warmer variation for adaptation. Prior to 2020, the two terms are often not clearly distinguished, and since definitions vary in practice it can still be a challenge to determine what is meant by resilience vis a vis adaptation.

"Official" Definitions of Adaptation and Resilience

The Intergovernmental Panel on Climate Change (IPCC) plays a special role in the climate community more broadly and with the United Nations Framework Convention on Climate Change (UNFCCC) in particular in how words are used and defined, though the IPCC is often tracking change in usage as much as other groups. The IPCC definition of resilience is:

> The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions. (IPCC, 2022).

The IPCC also distinguishes between resilience and adaptation. Adaptation for the IPCC refers to the process of adjusting to the current or expected climate and its effects and involves recognizing the changes that are occurring or projected to occur due to climate change and taking measures to minimize the negative impacts or exploit any opportunities that may arise. Adaptation can encompass a wide range of actions, including changes in practices, policies, technologies, and behaviors to reduce vulnerability and increase resilience to climate change impacts.

Resilience, on the other hand, refers to the capacity of a system, whether a community, ecosystem, or socio-economic system, to absorb and recover from disturbances, including but not limited to those caused by climate change. Resilience goes beyond adaptation in that it not only involves preparing for and adapting to changes but also focuses on building the inherent capacity of systems to withstand shocks and stresses while maintaining essential functions and structures.

Another relevant definition is the United Nations Office for Disaster Reduction (UNISDR), who defines resilience as "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the efforts of a hazard in a timely and efficient manner." The resilience of a community in respect to potential hazard or events is determined by the degree to which the community has the necessary resources and is capable of organizing itself both prior to and during times of need" (UNISDR, 2009).

According to the Stockholm Resilience Centre, "resilience is the capacity of a system, be it an individual, a forest, a city or an economy, to deal with change and continue to develop. It is about how humans and nature can use shocks and disturbances like a financial crisis or climate change to spur renewal and innovative thinking" (Stockholm Resilience Centre, 2015).

The City Resilience Index (CRI) defines urban resilience as "the capacity of cities to function so that the people living and working in cities—particularly the poor and vulnerable—survive and thrive no matter what stresses or shocks they encounter."

Understanding these definitions of resilience, and the breadth of approaches that they envelop, provide important context and history for how resilience has been viewed and used in the past.

Four Categories of Climate Resilience

Adaptation and resilience taxonomies, classification schemes, definitions, and programs are rapidly proliferating. We created a table of some of the notable systems we have run across, especially those that make use of indicators as part of the work (Table 1), but we have chosen to focus on a subset of systems.

We have also tried to develop categories that describe in practice how resilience is currently being used and defined (Figure 1). We have identified four categories of climate resilience that are relevant to the scope of this report:

- *Rebound resilience*. Following longstanding English language usage, resilience here refers to the ability to "bounce back," rebound, or recover from an adverse incident or impact. Analytically, this definition of resilience is the return to homeostasis. Measuring traditional resilience is relatively straightforward, and could include recovery time as well as the reduction of the severity of anticipated impacts. Actors working in the mainstream of water security and water resources management tend to focus on this definition, as well as some humanitarian and disaster relief groups that reference work on climate change but largely work on known, non-stationary hazards. Rebound resilience assumes a relatively fixed set of conditions and drivers ("stationary" conditions), and that rebuilding or reconstruction to pre-crisis conditions/functions is the ideal.
- *Resilience as an ethical framework for climate equity, justice, reparations, and/or representation*. Climate justice has been an important strain of thought and policy in climate policy for more than thirty years. It is arguably embedded in all four definitions described here, but simultaneously it stands out as a unique approach in a way that demands its own definition. As an ethical framework that is motivating policy and investment, this approach to resilience focuses on programs such as the UNFCCC loss and damage policy program that emphasize the attribution of damage to highly vulnerable or sensitive groups from climate impacts. LDCs, indigenous groups, ethnic minorities, and less-represented groups such as the urban poor, subsistence farmers, or women and girls may be the primary targets for resilience as an ethical framework: "resilience" is needed because these populations have been excluded from the benefits of a carbon-based economy and received inordinate harm from climate impacts. In the case of the current loss and damage framework, compensation is in the form of funds disbursed without a requirement that they be used to support adaptation actions. A restorative or reparations approach is advocated in some contexts, such as for indigenous groups or current/former colonized groups. Other efforts to achieve climate justice similarly tend to focus on damage that has occurred in the past and helping these groups "catch up" or "level up" to the state of current impacts rather than how to anticipate future impacts. "Resilience" as remediating injustice and inequity can be heavily oriented to the past, such as the loss of fisheries or extreme water scarcity. A more forward-looking approach might treat justice and equity as non-stationary qualities per se (i.e., will new inequities appear or existing inequities go through significant changes? how do we address disparities in access to future climate conditions?), which would prepare for these new circumstances. Measurements for resilience in these cases may be in the return of access to lost resources, financial support, and changes in wealth.
- *Resilience as an end-state*. Resilience is often referred to as a state or condition reached following a risk assessment and reduction process. Resilience in this context follows successful adaptation, and adaptation itself is exclusively (or mostly) about reducing negative climate impacts. In practice, this definition of resilience assumes that climate change impacts are largely incremental rather than preparing for ecological transformation. Thus, at its most basic, adaptation is a de-risking process. For many institutions, de-risking is well established already, so that adaptation means accounting for climate among a pre-existing set of other potential hazards that might range from seismic threats, loss of key personnel, or insufficient insurance coverage. Climate-related hazards are just another set of risks to consider rather than a fundamentally new or different type of risk. For much of the finance and investment community, climate de-risking "resilience" typically considers a handful of direct climate risks, often only for physical assets, such as sea-level rise, fire, and extreme heat. Climate is not considered as a systemic threat (or a systemic opportunity!). In some cases, such as for the Asian Development Bank, climate de-risking is distinguished from other approaches by the level of analytical intensity; projects are initially classified as having a primary goal of addressing climate change (type 2 projects) or not primarily addressing climate impacts (type 1 projects), and those in the latter case go through a streamlined de-risking evaluation process (Watkiss et al. 2020). Type 2 projects intended to directly address climate adaptation challenges are held to a higher standard of attribution and evaluation. These projects can then be reported outside of the ADB to demonstrate "additionality," potentially attracting supplemental funding from groups such as the Green Climate Fund that only support climate additionality.

- *Resilience as an ongoing and continuous process*. Seeing resilience/adaptation as a continuous process has deep roots, arguably the ecologist Buzz Holling lineage of resilience (dating back to the late 1960s and well predating any concern with current climate change issues) is in this vein. Holling famously viewed resilience as existing in multiple potentially stable ("resilient") states for a system, and resilience was way of understanding both what kept that system of interest in a particular stable state and what might lead to a transition to another stable state (e.g., 1973). A forest is a system that can transform — rapidly or slowly — into a wetland or a desert, or even into a different type of forest. All four (or more) resilience states tend to be stable and self-stabilizing within certain limits. A major disruption or a combination of drivers (invasive species, fire, overharvesting, shifts in precipitation) could trigger the initial forest to transition into another state. The concept of transformation is embedded into the concept of resilience as a continual process. In the 1970s and 1980s, some of these concepts blended into natural resource management as "adaptive management" (tracking ecological and natural resource change over time, and making adjustments in both management systems and in what ultimate targets may be viable. Adaptive management has proven hard to implement in practice, but at least theoretically might include guiding a forest already in a state of transition into a wetland rather than a desert). Some of the foundational essays in climate adaptation in particular (e.g,. Wilby & Dessai 2010) describe adaptation as a circular process, a concept that has been adopted by many institutions in principle if not in practice. More recently (and after the integration of resilience as a term into a climate change context), the climate policy sphere has also fully embraced Holling's concept of multiple stable states by expressing concern over what the UNFCCC refers to as "transformational adaptation": the climate change driven restructuring of ecological landscapes, such as parts of Greenland or the Himalayas moving from deep ice fields to tundra to alpine and even woody vegetative conditions in a handful of decades.

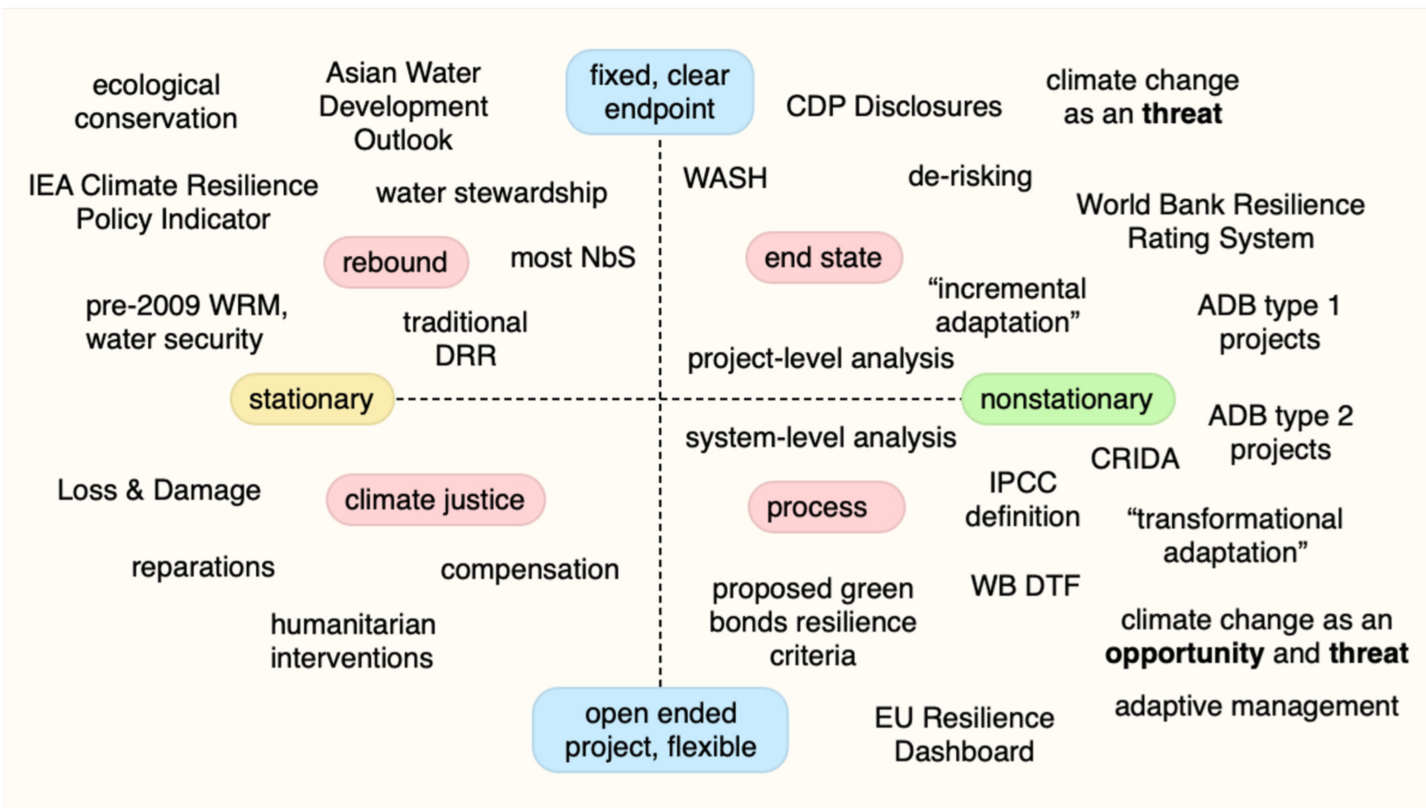

Figure 1. An analytical framework for categorizing climate resilience definitions.

The attribution of climate change to particular objectives is certainly shared across these four definitions, usually through an analytical process. Climate justice is often embedded within all four, at least as a motivation for decisive action. However, whether we view resilience as state or process or essentially stationary (fixed) or non-stationary (ongoing) is hard to reconcile across these four definitions (Figure 1).

The contrast between incremental and more systemic approaches is also important, even if they share an assessment that climate change is an issue with non-stationarity. As suggested above, the IPCC's definition at least implies a process-based approach to managing a system, including for the potential reorganization and fundamental transformation of that system (2022), and resilience might increase or decrease over time. Key additional insights of resilience as a process include (a) assumptions that resilience addresses non-stationary change; (b) these processes can include economic, technological, and social change; (c) resilience may also include the reorganization of an system, such as an institution, economic or political system, or ecosystem; (d) resilience may encompass shifts in long-term goals; and (e) that resilience is a process of looking for new opportunities as much as addressing or removing hazards.

Water-Based Adaptation and Resilience

The IPCC's AR6 called for the widespread use of a new approach: "water-based adaptation." This concept recognizes that freshwater resources are both an important and widespread climate-sensitive hazard (Sadoff and Muller 2009) and a potential way of ensuring adaptation efficacy and coherence across adaptation actions and projects (Timboe et al. 2019, Matthews 2023). A related term, "water resilience," has been widely adopted in the water community, both in the context of WASH and water policy and water resources management, with the implication being that water is central to effective climate resilience programs.

Water resilience emphasizes integrated human and natural systems to adapt and respond to realized and potential shifts in eco-hydrological systems, including the ability to reorganize and shift goals, indicators, and strategies in response to and in advance of systemic changes that support the integrity, health, and prosperity of those systems for future generations.

A Survey of Existing Water and Climate Resilience Indicator Systems

This section serves as a literature review of some of the most prominent indicator frameworks that have been published to date addressing water security and/or resilience. The paragraphs below are intended to summarize the key components of these existing models, including how they are defining resilience, what the structure of the indicators is, types of data sources used, and why they may or may not fall short of current needs and trends in measuring adaptation and resilience. Additional systems can be found listed in Table 1.

United Kingdom International Climate Finance, KPI4: Number of people whose resilience has been improved as a result of ICF

KPI4 is focused on measuring "people who are made more resilient" through the investments of UK Government ICF. KPI4 acknowledges the complexity of measuring climate resilience, and that changes are context specific and multidimensional. For this KPI, the UK draws on the definition of climate resilience from the IPCC definition, focusing on the ability to maintain essential function with capacity for adaptation, as well as the Disaster Risk Reduction definition from the former DFID office, which emphasizes the "ability to manage change by maintaining or transforming living standards in the face of shocks or stresses without compromising long-term prospects."

KPI4 looks at the number of people which a change in resilience at an outcome level and changes in climate resilience that have been "positively influenced" by the ICF funds. The methodology for tracking resilience under this KPI includes the use of household level surveys. The indicators, "assumes that the program… interacts directly with the beneficiary population" and thus one "would struggle to apply the methodology if the program primarily addresses the climate resilience of infrastructure, institutions, or governments."

The KPI4 methodology recommends the use of the "3As" for assessing resilience, as documented in the report, "The 3As: Tracking Resilience Across BRACED" (Bahadur et al. 2015). This methodology focuses on Adaptive, Anticipatory, and Absorptive capacities. It includes language around transformation: "an approach to holistically and fundamentally build, reshape, and enhance people's capacity to adapt to, anticipate, and absorb shocks and stresses." Adaptive capacity includes individual access to assets and income, relevant climate information and the ability to take deliberate and planned decisions based on that information, and basic services. Anticipatory capacity includes the existence of early warning systems, planning for DRR and DRM, tracking the number of people who feel like they have ability to cope with and adapt to climate hazards, community level capacity, and the assessment of how community led groups use risk data collection and disaster risk mapping. Absorptive capacity trends to the community or even national level, and looks at access to tangible and intangible assets to survive intensive shocks, existence and availability of microfinance, disaster finance, and relevant insurance; and diversity of income and nutrition streams available.

The components of resilience in this methodology are relevant, however, by focusing at the individual household level using a self-diagnostic process, it misses the critical institutional and governance components of resilience that facilitate true, longer-term transformation and resilience in line with the definition presented above. Further, self-reporting and survey data also will not really be able to include a meaningful measurement of the role or attribution of climate change impacts, or a long-term perspective on trends over time. As a stress measurement, these methods may be better at detecting weather related but not climate related impacts and adaptation. KPI4 approaches resilience with an end-state mindset, and records changes in states of "absolute" resilience.

DFID International Water Stewardship Programme (IWaSP) Monitoring Framework

The IWaSP monitoring framework is a detailed programme-level logframe used to evaluate the Water Security Programme (WSP). The WSP stated goals are to increase investment in the information and evidence, institutions, and infrastructure necessary to improve water security and climate resilience, though the latter term and issue disappears following the introduction. The framework assesses progress at the impact and outcome levels. The focus on the IWaSP is on water security across four broad categories: economic activities and development, drinking water and human well-being, ecosystems, and water-related hazards and climate change (although again non-stationarity is not present in any significance in the WSP). The indicators selected to assess progress are targeted at both direct and indirect program beneficiaries.

IWaSP uses the definition of water security as the "capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socioeconomic development, for ensuring protection against water risks, and for preserving ecosystems in a climate and peace and political stability." This definition is by definition for a fixed, unchanging climate. The IWaSP framework also defines capacity as a critical component measuring progress, under the definition, "Adaptive Capacity is the ability to avoid harm from water risks and/or take advantage of opportunity by having the skills, resources, and flexibility to adjust a course of action and prevail in light of changing conditions." Resilience is considered a component of adaptive capacity and is defined as "ability to absorb or bounce back to your original state." Coping is also considered an element of capacity: "the ability to manage water risks or stresses but not necessarily bounce back."

The IWaSP framework is comprehensive for traditional approaches to water security but does not capture resilience in the way that is relevant to the JWST program. Direct program impacts are primarily captured through household surveys and include measures such as physical improvements to water access, changes in household income, households with improved livelihoods, and those trained in stationary risk management.

World Bank Group Resilience Rating System (RRS)

The World Bank Resilience Rating System (RRS) is targeted towards the project or investment level and seeks to inform decision makers, investors, and other stakeholders of progress against targets. By increasing transparency and disclosure, the RRS aims to create incentives for climate adaptation and guide a project developer or manager to manage risk and improve project quality. The framework also facilitates the identification of best practices to allow for proven lessons on resilience to be scaled up across sectors and countries.

The RRS defines resilience as "the ability of individuals, communities, institutions, and systems within a country to anticipate, absorb, recover from, and adapt to adverse impacts caused by climate variability and change, natural disasters, and other shocks and stresses, in order to reduce vulnerability and promote sustainable development." This framework emphasizes the importance of strengthening resilience at multiple levels, including the household, community, subnational, national, and regional levels, through integrated and coordinated actions across sectors.

The RRS provides guidance and specific criteria to assess resilience along two complementary dimensions:

- "Resilience *of* the project" is a measure of confidence that the expected investment outcomes will be achieved based on whether a project has considered climate and disaster risk in design, incorporated adaptation measures, and demonstrated economic viability despite climate risks.
- "Resilience *through* the project" explores the project's contribution to adaptive development pathways based on whether investments are targeted at increasing climate resilience in the broader community or sector.

The RRS includes numerous examples of climate and disaster indices, resilience attributes, and climate adaptation indicators, but the RRS is not prescriptive about indicators or methodology. However, the RRS describes and rates a number of climate risk assessment and reduction systems, and the highest ranking methodologies encourage / require the development of specific project- and stakeholder-driven performance metrics related to adaptation and resilience. The analysis and collection of these indicators are consistent with the approach provided within this document, and thus the RRS may be a complementary approach applicable at the project level.

Asian Development Bank Water Development Outlook (AWDO)

This Asian Water Development Outlook (AWDO) is a five-year periodic assessment for the Asia-Pacific region led by the Asian Development Bank. AWDO identifies water security as the availability of sufficient water to ensure safe and affordable water supply, inclusive sanitation for all, improved livelihoods, and healthy ecosystems, with reduced water-related risks toward supporting sustainable and resilient rural-urban economies in the Asia and Pacific region.[3] The AWDO follows the five principles of the Strategic Directions for Water 2023 from ADB: (i) building resilience and adaptive capacity, (II) promoting inclusiveness, (iii) embracing sustainability, (iv) improving governance, and (v) fostering innovation.

The AWDO tracks water security improvement along five key dimensions:

- Rural household water security (water and sanitation)
- Economic water security (water to sustainably satisfy economic growth)
- Urban water security (water and sanitation and flood management)
- Environmental water security (catchment and aquatic health and environmental governance)
- Water-related disaster security (resilience against droughts, floods, and storms)

The AWDO defines resilience in the context of water resources management as the capacity of water systems, communities, and institutions to anticipate, withstand, and recover from shocks and stresses while maintaining essential functions, structures, and identity. Shocks are defined in the methodology as "caused by extreme or catastrophic water-related events, such as droughts, floods, and landslides." In this sense, this framework uses a risk-reduction approach to resilience that is in line with the rebound quadrant of the resilience grid.

The AWDO framework tracking waters security is easy to apply and understand. The indicators themselves extend beyond the water "sector," but focus heavily on issues that are critical to ensuring water security and equal access for poor and vulnerable groups. The framework is climate-stationary and relies on metrics through global data sets or national information. As a result, data quality is not homogeneous or interoperable across countries. The AWDO framework is an evolving and adaptive methodology, which has the aspiration to provide more granular indicators and metrics.

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3 https://www.adb.org/publications/series/asian-water-development-outlook

Water Insecurity Experiences (WISE) Index

The Water Insecurity Experiences (WISE) Scales constitute a recently developed survey-based instrument for monitoring household water access across physical, emotional, and financial dimensions.[4] The WISE indicator was designed to assess progress towards equitable realization of the human right to water using metrics aligned with user experiences. By tracking household water deprivation beyond infrastructure provisions, developers sought to account for service delivery gaps, climate vulnerabilities, and disproportionate burdens faced by marginalized and underserved groups.

Climate-related resilience is not explicitly defined by the WISE scales, and the household unit of analysis is not attached to water system variables, such as a utility district or watershed. Moreover, WISE examines self-reported and self-assessed conditions rather than, for instance, independently metered delivery of how much water is piped or carried to a household. The WISE scale is composed of twelve questions spanning water access, reliability, adequacy, and stress domains. The outcomes have been used primarily in academic research to date, investigating linkages between household water insecurity and health outcomes. The research has demonstrated the sensitivity of WISE measures to capture issues like health risks and weather (but not climate) conditions. In the 2023 UNICEF/WHO Joint Monitoring Program report on SDG 6 monitoring, WISE data were featured across 35 countries to demonstrate significant inequities in water security experiences based on wealth, education level, and other demographics that static measures like "access to basic services" do not reveal. The report concluded WISE questions can strengthen monitoring by connecting infrastructure delivery to true realization of rights for vulnerable groups (UNICEF & WHO, 2023).

The WISE scales are a more responsive metric compared to static water access measures and have successfully captured household water security fluctuations resulting from climate variability and extremes in a novel way. However, the WISE scales are focused only on perceptions of water security, and do not reflect water's role in resilience writ larger at a system-level scale (e.g., a watershed or a water allocation system), or provide tools to assess resilience more broadly. As such, the WISE data focuses on climate justice and equity issues in a climate stationary context.

International Energy Agency Climate Resilience Policy Indicator

The origins of the IEA Climate Resilience Policy Indicator can be traced to the Agency's January 2021 report titled "Climate Resilience: Policy Indicator Prototype Framework," which first introduced this metric aiming to quantify national policy preparedness for climate change threats to energy infrastructure. IEA projects that 1.6 billion people could face climate-related energy access issues by 2040, and the report frames robust policy evaluation as "the first step to enhancing climate resilience" across interconnected electricity assets (IEA, 2021a).

The IEA defines resilience as the "ability to anticipate, absorb, accommodate and recover from the effects of a potentially hazardous event related to climate change," which most directly describes rebound resilience. The focus of the IEA framework is on energy infrastructure, and and the risk of climate impacts to the energy sector. However, the Climate Policy Indicator has a broader focus on promoting social and economic goals and protecting the welfare of citizen as key components of resilience.

Specifically, the IEA anchored formulation of this new indicator in the learnings from its prior Energy Policy Progress Index, which has tracked country-level reforms across energy access, efficiency, affordability, and environmental sustainability domains since 2015. While highlighting crossovers, the Agency makes a case for dedicating tailored attention to climate resilience policy gaps commonly neglected within broader energy sector assessments. The presented prototype framework encompassing awareness, capacity and action pillars across adaptation, transition, and overall planning was also informed by a literature review on existing climate-related measurement methodologies worldwide (IEA 2021a; IEA 2015).

The IEA indicator was initially used to benchmark climate resilience policy preparedness across 27 countries. The evaluation entailed IEA country teams assigning indicator scores from 1 (nascent efforts) to 5 (advanced strategic planning) across the three preparedness pillars of awareness, capacity, and action as outlined previously. For each national context, resilience policy gaps were scored along the spectrum of progress

[4] https://www.ipr.northwestern.edu/wise-scales/

towards scientific and socioeconomic resilience. Radar plots depict preparedness variations across the framework dimensions (IEA, 2022), and comparative insights sought to highlight potential peer exchange opportunities and prod action in states lagging regional leaders. The authors noted method limitations like dependence on singular expert viewpoints per country, uneven publicly available policy details between geographies, and inherent subjectivity in interpreting preparedness.

The policy preparedness component of the Climate Resilience Policy Indicator examines the extent to which countries have integrated climate resilience measures into their national energy and climate plans. This assessment highlights the varying levels of preparedness among countries and underscores the importance of comprehensive planning in safeguarding energy systems against climate-induced disruptions.

CDP Disclosures Framework

Two relevant CDP questionnaires were reviewed to inform the development of the resilience indicators, the CDP Cities, States, and Regions framework, and the Corporate and Financial Sector Water Questionnaire. The questionnaires include reporting on water-related risks (i.e., water stress, water demand, urban flooding, river flooding, coastal flooding, water supply, sewerage, and waste management), as well as reporting of climate mitigation and adaptation goals. The questionnaires do not explicitly mention or define water resilience. The motives for reporting are also not clear. Would companies benefit from reporting climate change related risks? Should specific assessment methodologies be referenced?

Within the corporate water questionnaire, lines of inquiry for business strategies and planning include creating internal water policies, water scenario planning, and internal water pricing. Climate change interactions with the water cycle are not called out or explored, though climate variability is loosely described. Similarly, the financial sector water questionnaire also includes assessments of risks and the identification of water opportunities, which are intended to lead to the incorporation of water into business strategy and internal policies. Some stakeholder interaction is included.

These questionnaires are limited to self-reported data, and not all responders answer all of the questions. There is no requirement to report on the scale of a water system or a watershed, and non-stationary analysis is encouraged or required. As such, we infer that the CDP framework assumes a rebound resilience approach.

The European Union's approach to water resilience

The European Union (EU) approaches water and climate issues through two existing frameworks. The first is the EU's approach to climate adaptation via the Green Deal policy framework. A second is via the EU's water policy, which includes water resource management and environmental protection.

As part of the EU's Green Deal action plan, the EU's Strategy on Adaptation to Climate Change (European Commission, 2021) aims to minimize vulnerability to the impacts of climate change. The Strategy aims to build a climate resilient society by improving knowledge of climate impacts and adaptation solutions, stepping up adaptation planning and climate risk assessments, accelerating adaptation action, and helping to strengthen climate resilience globally. The new EU Adaptation Strategy development was based on the evaluation of the 2013 EU strategy on adaptation to climate change (European Commission, 2018). The evaluation included an "adaptation preparedness scoreboard" for measuring EU member states' level of readiness based on qualitative, process-based indicators.

The European Commission's resilience dashboards describe resilience as "the ability to make progress towards policy objectives amidst challenges." Resilience in this context is defined as "the ability not only to withstand and cope with challenges but also to undergo transitions, in a sustainable, fair, and democratic manner." Non-stationary conditions are assumed, with an implicit recognition of transformational adaptation.

The resilience dashboards aim to provide a holistic assessment of resilience in the EU in relation to ongoing societal transformations and challenges ahead. The dashboard features 124 quantitative indicators across four dimensions (economic, green, digital, and geopolitical), derived from publicly available data sources and selected in coherence with other monitoring tools. The methodology identifies vulnerabilities (defined as features that can exacerbate the negative impact of crises and transitions, or obstacles that may hinder the achievement of long-term strategic goals) and capacities (enablers or abilities to cope with crises and structural changes and to manage the transitions.). These capacities and vulnerabilities do not depict the dynamic reaction to a challenge but refer to some underlying features that can enable or hinder a country's responses and preparations.

In order to select the most relevant indicators for the resilience dashboard, the following criteria were used:

- Holistic view: covering as many and as multidisciplinary aspects as possible, while balancing indicators across areas and keeping their number contained at around 30.
- Representativeness: what and how much the indicator tells us about the considered area.
- Relevance and value added: how much the indicator is linked to resilience, whether it describes a specific vulnerability or a resilience capacity, and whether it adds value compared with standard progress indicators such as GDP.
- Coherence with other existing monitoring frameworks, to ensure alignment and avoid duplication.
- Forward-looking perspective: how much the indicator brings in forward-looking aspects.
- Clarity: how clear is the interpretation of the direction of change of the indicator (the higher the better or vice versa), and whether it has a clear and intuitive meaning.
- Comparability: how much the indicator ensures meaningful cross-country comparisons, considering specific features of the country (e.g., area, economy, population).
- Data quality and availability: whether the indicator comes from official statistics. Priority was given to Eurostat, data from European Commission services, and data from international institutions like the OECD and the World Bank.
- Granularity: whether data cover all countries and span at least five years, to assess the evolution over time.

The principles of just resilience and "leaving no one behind" are also introduced as key elements in recent EU policies related to climate adaptation, including the European Green Deal and related policy instruments, such as the Just Transition Mechanism (EU, 2021c), the EU Strategy on Climate Adaptation (EC, 2021b), and the EU Mission on Adaptation to Climate Change (EC, 2022b). The EU is expected to announce a non-legislative initiative on Water Resilience in the first quarter of 2024.

Water Infrastructure Criteria for the Climate Bonds Initiative Standard

Beginning in 2015, the Climate Bonds Initiative (CBI) in partnership with Ceres, CDP, and WRI approached AGWA to develop a set of adaptation criteria for water sector investments. The criteria were crowd-sourced through the AGWA network and published in stages, beginning with gray infrastructure but eventually including sections for hybrid and nature-based solutions, hydropower, and desalinization facilities.[5]

The criteria were designed to demonstrate to potential bond issuers risk assessment expectations as well as to potential investors that a particular bond had been climate proofed. In this case, effective resilience was defined as managing both facility and systemic risks and developing long-term flexible management plans to handle ongoing, uncertain risks. Criteria sections cover topics such as sophistication and richness of climate change information used in the design and assessment process for the investment, as well as an evaluation of the relevant water allocation and governance systems' complexity. As such, the criteria are an unusual blending of infrastructure, climate science, and institutional adaptation and resilience issues. The methodology is expressed as a checklist with binary answers and a minimum basic score. Final scores must be certified before issuance, and a reporting and auditing mechanism ensures that the bond was applied as intended.

The criteria were published initially in 2016, with the first application the San Francisco, USA, Public Utility Commission (SFPUC) for about 500 million USD, with more than 2 billion USD issued by SFPUC to date. Issuances continue to the present day across six continents and many countries. Other notable issuances include a highly publicized 2018 certified bond from Cape Town to address water system enhancement during

[5] https://www.climatebonds.net/standard/water

the Day Zero crisis, and a 2019 issuance from the Dutch government for an NbS flood control project that was the largest green bond in European history at that time (almost 6 billion euros).

Table 1: Additional climate adaptation and resilience measurement and taxonomy systems. Note: Taxonomies and measurement systems appear to be rapidly proliferating right now, often for specialized needs and audiences. These are a small sampling of current and forthcoming systems. Source: Climate Bonds Initiative, 2024.

Metrics

- Oxford University systemic risk metrics
- Adaptation Metrics Mapping Evaluation Framework (AMME)
- Race to Resilience Metrics Framework
- UNEP Land Use Impact Hub KPIs

Infrastructure

- Fast Infra
- Blue Dot Network
- Physical Climate Risk Assessment Framework (PCRAM)
- Global Infrastructure Hub

Regional/National Taxonomies

- EU Taxonomy
- LAC Taxonomy Framework
- Panama Taxonomy
- Finance Tracking
- MDB Paris Alignment methodology
- E3G Public Bank Climate Tracker Matrix
- Adaptation Strategy Valuation (ASV)

Forthcoming

- Standard Chartered / UNDRR Adaptation Finance Guide
- ClimateWorks/Tailwind's Taxonomy

Additional Categories of Water Assessment Frameworks

Historically, water-related investments have targeted water supply and sanitation projects, such as expanding the reach and reliability of water urban utilities and access in rural and periurban populations. Such investments emphasize the water “sector” rather than water as a cross-sectoral resource. These goals remain important and aligned with SDG 6, which also has a primary focus on WASH: safe, reliable water supply and sanitation access for the most poor and vulnerable populations. Past programs targeting WASH have often had a grounding in public health policy rather than water resources management and disciplines such as planning, engineering, hydrology, or natural resource management. Indicators for success have typically described households served, delivery of water volume per capita (or waste treated per capita), the prevalence of water-borne diseases, or more indirectly the mean age of girls enrolled in school. None of these types of indicators describe the water management system’s efficacy, reliability, sustainability, or interaction with other sectors, much less its climate risks/opportunities.

Water security as a concept, of course, is broader than SDG 6, extending to choices about the use of water resources to engage with or influence economic development and sustainability issues beyond the water “sector.” Water security in this view means a shared, coherent integration of water resources with and between economic sectors and between human and ecological needs. In essence, water security is a sustainability framework for connecting sectors and ecosystems and setting and achieving development priorities. Beginning in the mid 20th century, new analytical approaches balanced hydrology, economics, and engineering to maximize the economic value of water resources. Economics remains an essential orientation for evaluating water use and value.

The water stewardship movement began in the late 2000s and though at a highest level focuses the private sector as a good partner with other water users (including the environment), in practice water stewardship tends to measure water use efficiency, water conservation, and “offsets” (i.e., searching for water savings in one part of a supply chain or facility that are credited somewhere else, often outside of the basin where the savings occurred). These are not measures of climate resilience and arguably are even in some tension with concepts like redundancy and flexibility. The concept of non-stationarity is still quite new in this area.

Ecological conservation efforts look at measurements such as the size of areas that are “protected,” the amount of habitat or natural resources that are restored to a pre-disturbance states, or natural resources that are managed in line with some ecological standard. For water resources, indicators might include source water restoration, flow regime management, and species health and population size. Climate adaptation and resilience are also in some tension with conservation, given that conservation targets are often defined by a past state (which existed in a past climate).

Additional Categories of Climate Adaptation and Resilience Assessment Frameworks

Climate adaptation and resilience, unlike water resources management or WASH, have never been embedded within a discrete number of technical disciplines. Compared to centuries of accrued technical knowledge in water management, adaptation and resilience have also only existed as a practical and technical discipline for about 25 years.

Measurements of efficacy tend to emphasize how well specific realized or potential impacts are addressed (e.g., loss of life from tropical cyclones, flood damage, mean agricultural productivity), reflecting a view of adaptation and resilience as essentially project- and context-dependent and local. Even quite sophisticated approaches endorsed by the RRS and the Green Climate Fund, such as the World Bank’s Decision Tree Framework (Ray & Brown 2015) or UNESCO’s Climate Risk Informed Decision Analysis (CRIDA; Mendoza et al. 2018), include the development of indicators as a specific step early in the project design, planning, and assessment cycle.

Defining “Good” Water and Climate Resilience Indicators

We have prepared a supplemental document with proposed Water Tracker indicators. Targets and indicators can define concepts in operational terms, which in turn can guide program strategy. In some cases, explicit definitions of adaptation and resilience may not clearly match what is being monitored. Ideally, definitions and targets complement one another. A key assumption in this report is that most climate resilience programs will require some water-based indicators, and that most water programs will require some climate risk- and resilience-based indicators. How we define risk, opportunity, resilience, and water security in practice is important for the success of the JWST and the Water Tracker in particular.

The Water Tracker currently fits soundly into a process-based and non-stationary approach to resilience. Moreover, the Water Tracker promotes users to be aware of how a particular program, policy, agreement, framework, or investment interacts with other systems and sectors; “water” in the Water Tracker is a medium for both climate risks and coherence policy standards. In other words, is a particular program, policy, investment, or project embedded in a larger network, such as a watershed or a water supply and treatment system? Are water and climate impacts embedded in energy systems? Do agriculture and cities share water resources in ways that can adjust for shifts in seasonality and extremes? Can disaster response systems anticipate novel types of hazards? Are resource management systems forcing nature-based solutions and ecosystems to remain “fixed” even as climate change reorganizes and transforms them?

In most cases, the Water Tracker does not promote a single answer to any issue or question but prompts an awareness that tradeoffs and choices exist despite uncertainties in future water conditions, that systems are interacting, and that water is embedded (and often hidden) in many tangible and intangible aspects of our institutions, products, services, and ecosystems. In other words, a stationary response (or policy or plan) to a non-stationary problem should be an explicit decision rather than an accident. We have proposed a set of indicators that span a variety of broad categories, which are also contrasted with stationary or traditional evaluation measures.

For purposes of an accountable grant through FCDO, indicators should provide a sense of how the Water Tracker is influencing decisions, programs, projects, and policies on timescales that both improve the application of the Water Tracker and inform FCDO about the efficacy of the program as a whole. Is a particular country engagement making progress? Following an election and change of government, has progress been maintained? Are some modalities of the Water Tracking more progress than others?

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