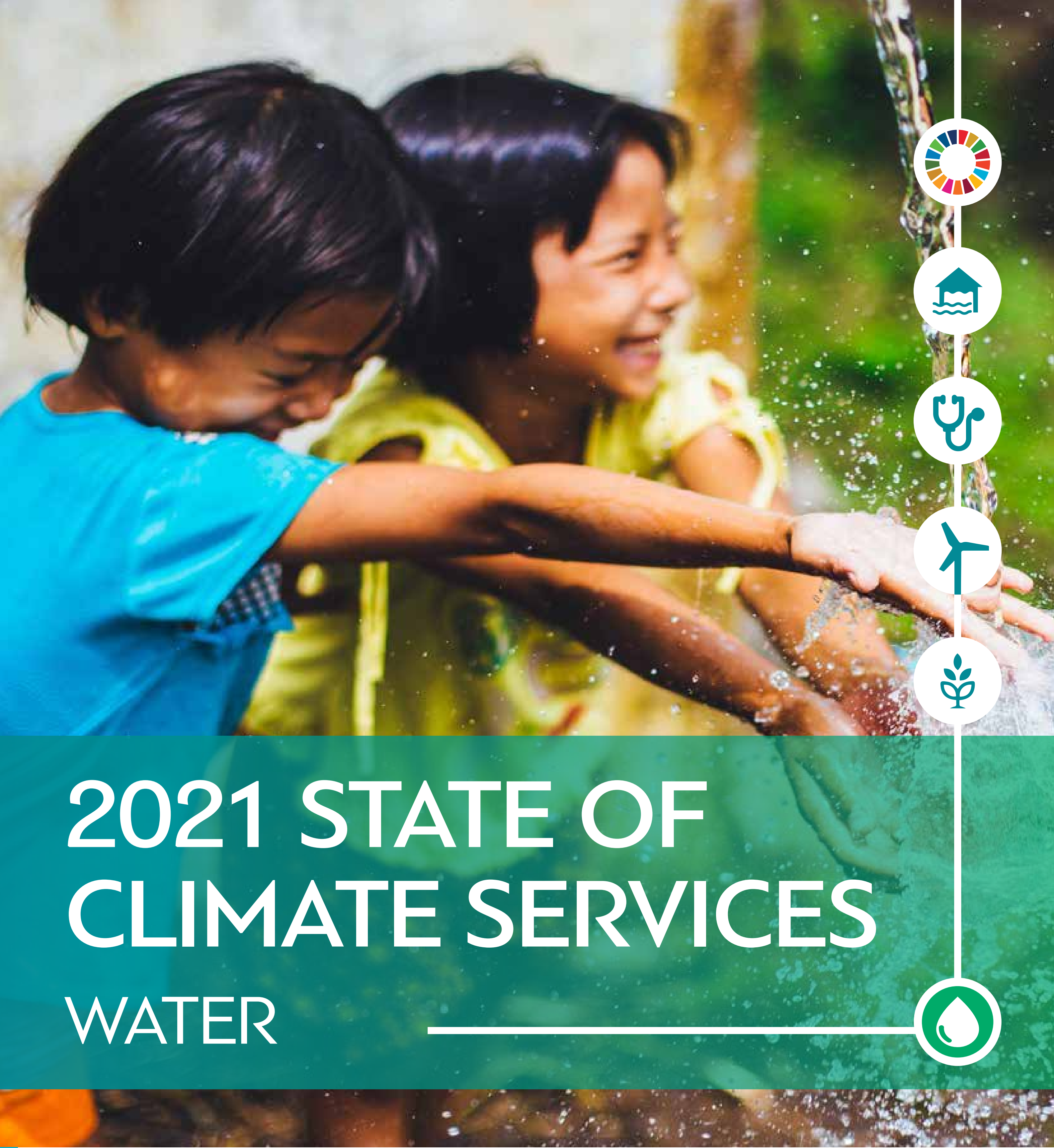

2021 STATE OF CLIMATE SERVICES

WATER

WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

GFCS GLOBAL FRAMEWORK FOR CLIMATE SERVICES

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WMO gratefully acknowledges the financial contributions from Agence Française de Développement and Climate Risk and Early Warning Systems Initiative.

WMO-No. 1278

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ISBN 978-92-63-11278-1

Contents

Photo: Leo Rivas

Since 2019, WMO has issued annual reports on the state of climate services in order to provide scientifically-based information to support climate adaptation.

This 2021 edition of the WMO State of Climate Services report focuses on water, an issue that is of great significance to communities in every corner of the globe, and that affects every economic sector. Water lies at the heart of the global agenda on climate adaptation, sustainable development and disaster risk reduction.

Increasing temperatures are resulting in global and regional precipitation changes, leading to shifts in rainfall patterns and agricultural seasons, with a major impact on food security and human health and well-being.

This past year has seen a continuation of extreme, water-related events. Across Asia, extreme rainfall caused massive flooding in Japan, China, Indonesia, Nepal, Pakistan and India. Millions of people were displaced, and hundreds were killed. But it is not just in the developing world that flooding has led to major disruption. Catastrophic flooding in Europe led to hundreds of deaths and widespread damage.

Lack of water continues to be a major cause of concern for many nations, especially in Africa. More than two billion people live in water-stressed conditions and lack of access to safe drinking water and sanitation. Overall, water-related hazards have been increasing in frequency for the past two decades.

There is good news, however. Most nations are determined to improve the way water is managed, with the United Nations Framework Convention on Climate Change (UNFCCC) reporting that water is a top adaptation priority in the vast majority (79%) of Parties' Nationally Determined Contributions (NDCs) to the Paris Agreement. As we highlight and explore in this report – through data, analysis, and a series of case studies – nations can improve water resource management and reduce the impacts of water-related disasters through better climate services and end-to-end early warning systems – supported by sustainable investments. Towards this end, WMO is a broad-based Water and Climate Coalition to achieve more effective integrated policy-making needed to address growing water and climate-related challenges.

Time is not on our side. The latest Intergovernmental Panel on Climate Change (IPCC) report – the first major review of the science of climate change since 2013 – is a stark reminder that catastrophic heatwaves, droughts and flooding will increase in frequency and severity if we fail to act now. Climate services and early warning systems give us a vital opportunity to prepare and react in a way that can save many lives and protect livelihoods and communities across the world.

Prof. Petteri Taalas,
Secretary-General,
WMO

Executive Summary

In 2018, the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement at the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) called on the World Meteorological Organization (WMO) through its Global Framework for Climate Services (GFCS) to regularly report on the state of climate services with a view to "facilitating the development and application of methodologies for assessing adaptation needs".

Water is a top adaptation priority.

In 2018, 2.3 billion people were living in countries under water stress[1,2] and 3.6 billion people faced inadequate access to water at least one month per year. By 2050, the latter is expected to be more than five billion.[3]

Assuming a constant population, an additional 8% of the world's population in the 2000s will be exposed to new or aggravated water scarcity[4] associated with a 2°C of global warming.[5] Concurrent population growth would further increase this number.

Human- and naturally-induced stressors are increasingly adding pressure on water resources, a key prerequisite for human development. In the past 20 years, terrestrial water storage – the summation of all water on the land surface and in the subsurface, including soil moisture, snow and ice – has been lost at a rate of 1cm per year. The situation is worsening by the fact that only 0.5% of water on Earth is useable and available freshwater.

Integrated Water Resources Management (IWRM) is vital to achieving long-term social, economic and environmental well-being. But, although most countries have advanced their level of IWRM implementation, 107 countries remain off track to hit the goal of sustainably managing their water resources by 2030,[6] as set out in the UN Sustainable Development Goal No. 6 (SDG 6). In 2020, 3.6 billion people lacked safely managed sanitation services, and 2.3 billion lacked basic hygiene services. The current rates of progress need to quadruple in order to reach the global target of universal access by 2030.[7,8]

Meanwhile, water-related hazards have increased in frequency for the past 20 years. Since 2000, flood-related disasters have increased by 134%, compared with the two previous decades.[9] Most of the flood-related deaths and economic losses were recorded in Asia, where end-to-end warning systems for riverine floods require strengthening in many countries. The number and duration of droughts also increased by 29%. Most drought-related deaths occurred in Africa, indicating a need to continue strengthening end-to-end warning systems for drought.

The good news is that nations are determined to improve the situation. According to UNFCCC, water is an adaptation priority in 79% of the Nationally Determined Contributions (NDCs) to the Paris Agreement.[10] And not only is water among the highest priority sectors across all NDCs, it is a cross-cutting factor affecting adaptation in the majority of sectors.

The state of play

To reduce adverse impacts associated with water-related disasters and support water resource management decisions and improved outcomes, climate services and end-to-end early warning systems, as well as sustainable investments, are required but not yet adequate. In the NDCs (submitted as of August 2021), Parties highlighted the need for strengthening the climate services value chain across its constituent components – including observing systems, data and data management, better forecasting, strengthening of weather services, climate scenarios, projections, and climate information systems.

Of the Parties that mention water as a top priority in their updated NDCs, the majority highlight actions that relate to capacity building (57%), forecasting (45%), observing networks (30%), and data collection (28%). However, 60% of National Hydrological Services (NHSs) – the national public agencies mandated to provide basic hydrological information and warning services to the government, the public, and the private sector – lack the full capacities needed to provide climate services for water.

1 FAO and UN-Water. 2021. Progress on Level of Water Stress. Global status and acceleration needs for SDG Indicator 6.4.2, 2021. Rome. https://doi.org/10.4060/cb6241en
2 The level of water stress is defined as the ratio between total freshwater withdrawals by all economic activities and total available freshwater resources, after taking into account environmental flow requirements. Environmental flow requirements are essential to maintaining ecosystem health and resilience. When an area has a level of water stress of 25 per cent or more it is said to be 'water-stressed'.
3 Global Commission on Adaptation, 2019: Adapt Now: A Global Call for Leadership on Climate Resilience.
4 Water scarcity is defined as "an imbalance between supply and demand of freshwater in a specified domain (country, region, catchment, river basin, etc.) as a result of a high rate of demand compared with available supply, under prevailing institutional arrangements (including price) and infrastructural conditions". FAO, 2012: Coping with water scarcity: An action framework for agriculture and food security.
5 Gerten, D. et al., 2013: Asynchronous Exposure to Global Warming: Freshwater Resources and Terrestrial Ecosystems.
6 UNEP-DHI Centre on Water and Environment.
7 UN-Water, 2021: Summary Progress Update 2021 – SDG 6 – water and sanitation for all. Version: July 2021. Geneva.
8 Progress on household drinking water, sanitation and hygiene 2000-2020: Five years into the SDGs. Geneva: World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), 2021.
9 UNDRR, CRED, 2020: The human cost of disasters: an overview of the last 20 years (2000-2019).
10 Nationally Determined Contributions under the Paris Agreement, Synthesis Report, UNFCCC, 2021 (Figure 7).

The WMO assessment in this report found, for WMO Member countries (101) for which data are available, that:

- There is inadequate interaction among climate services providers and information users in 43% of WMO Members;

- Data is not collected for basic hydrological variables in approximately 40% of WMO Members;

- Hydrological data is not made available in 67% of WMO Members;

- End-to-end riverine flood forecasting and warning systems are absent or inadequate in 34% of WMO Members that provided data – with only 44% of Members' existing systems reaching more than two-thirds of the population at risk;

- End-to-end drought forecasting and warning systems are lacking or inadequate in 54% of WMO Members that provided data – with only 27% of Members' existing systems reaching more than two-thirds of the population at risk.

Achieving the adaptation objectives in developing countries' NDCs will require significant additional financial commitments. Yet, several constraints limit countries' capacity to access financing, including low capacities for developing and implementing projects, and difficulties to absorb resources within low-income countries' public financial systems. Despite a 9% increase in financial pledges made to tackle SDG 6, official development assistance (ODA) commitments remained stable at US$ 8.8 billion, despite increased funding needs to meet targets under the SDG6 – between 2015 and 2019.

Recommendations

Based on its findings, the report makes six strategic recommendations to improve the implementation and effectiveness of climate services for water worldwide:

1. Invest in Integrated Resources Water Management as a solution to better manage water stress, especially in Small Island Developing States (SIDS) and Least Developed Countries (LDCs);

2. Invest in end-to-end drought and flood early warning systems in at-risk LDCs, including for drought warning in Africa and flood warning in Asia;

3. Fill the capacity gap in collecting data for basic hydrological variables which underpin climate services and early warning systems;

4. Improve the interaction among national level stakeholders to co-develop and operationalize climate services with information users to better support adaptation in the water sector. There is also a pressing need for better monitoring and evaluation of socio-economic benefits, which will help to showcase best practices;

5. Fill the gaps in data on country capacities for climate services in the water sector, especially for SIDS;

6. Join the Water and Climate Coalition[11] to promote policy development for integrated water and climate assessments, solutions and services, and benefit from a network of partners that develop and implement tangible, practical projects, programs and systems to improve hydroclimate services for resilience and adaptation.

11 http://www.water-climate-coalition.org.

Photo: Daniele Levis Sepuli

Global Status

Water is a key prerequisite for human development, yet only 0.5% of water on Earth is useable and available as freshwater.

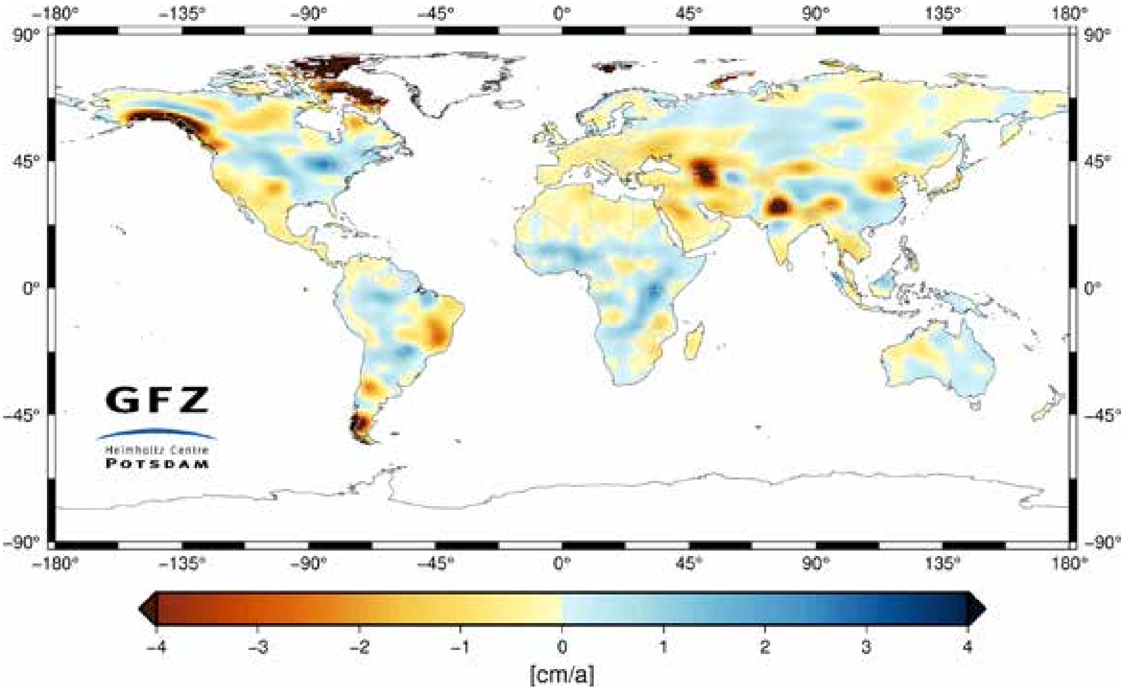

Figure 1: Terrestrial Water Storage (TWS) trends of the past 20 years (2002-2021). The red areas indicate a large water mass loss during the time. These areas are those worst affected by climate change and/or human activity, excluding Greenland and Antarctica, which are not included on the map, as their water mass loss trends are so great that they overshadow the other continental water mass trends. [12]

Water is indispensable and essential to human health, economic development, peace and security. For the past 20 years, the world has experienced terrestrial water storage (TWS) loss of 1cm per year.[13] TWS is the sum of all water on the land surface and in the subsurface, i.e. surface water, soil moisture, snow and ice, and ground water. Although the biggest losses are occurring in Antarctica and Greenland, many highly populated lower latitude locations are experiencing TWS losses (Figure 1). The hotspots of negative TWS trends are visible as red areas in the map.

Human- and naturally-induced stressors are increasingly adding pressure on water resources. Socio-economic factors, such as population growth and urbanization on one hand, and environmental phenomena, such as decreasing freshwater availability and extreme weather events, on the other, are displaying their effects across sectors and regions.

Decision-makers, and public and private stakeholders in climate-sensitive socio-economic sectors need timely and reliable climate data and information to better understand and anticipate the impacts of these trends on water resources.

The more than two billion people currently suffering water stress are expected to increase in number, threatening water resources sustainability and economic and social development.

12 Figure provided by Eva Boergens, GFZ German Research Centre for Geosciences.
13 Based on GRACE/GRACE-FO GFZ RL06 as available from gravis.gfz-potsdam.de (DOI: 10.5880/GFZ.GRAVIS_06_L3_TWS).

Achieving SDG 6 by 2030 will require the current rates of progress to quadruple

Despite good progress over the last decades, UN-Water[14] reports that the world remains off track to achieve SDG 6 by 2030. Achieving universal access to safely managed drinking water and sanitation by 2030 will require a four-fold increase in current rates of progress.[15]

2.3 billion people – or 25% of the global population – are already living in countries under water stress.[16,17] With average global water stress[18] at almost 18%. This number hides regional differences.

Regions with the highest water stress in 2018 were Northern Africa (109%), Central Asia (80%), Southern Asia (78%), and Western Asia (60%). At a country level, 35 countries are experiencing water stress of between 25-75% and 25 countries are considered seriously stressed, with figures above 75%.

Water stress levels rise above 100% in 16 countries, and of these, four are experiencing more than 500% (or even up to 1,000%) water stress. In these four countries – Kuwait, Libya, Saudi Arabia and the United Arab Emirates – the demand for water is largely being met by desalination.

Globally, a quarter of all cities are already water stressed and experience perennial water shortages.[19] Figure 2 shows water stress hotspots based on combining water stress data from FAO[20] and the World Resources Institute.[21]

The IPCC[22] reports that, assuming a constant population in the models used, an additional 8% of the world's population as of the 2000s would be exposed to new or aggravated water scarcity at 2°C of global warming.[23]

Figure 2: Global water stress hotspots. Hotspot areas are those classified by FAO[24] as water scarce and by WRI[25] as areas with high or extremely high-water stress.

14 UN-Water, 2021: Summary Progress Update 2021 – SDG 6 – water and sanitation for all. Version: July 2021. Geneva, Switzerland, data from FAO.
15 Progress on household drinking water, sanitation and hygiene 2000-2020: Five years into the SDGs. Geneva: World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), 2021.
16 FAO and UN-Water. 2021. Progress on Level of Water Stress. Global status and acceleration needs for SDG Indicator 6.4.2, 2021. Rome. https://doi.org/10.4060/cb6241en.
17 UN Water, https://www.unwater.org/water-facts/scarcity.
18 The water stress percentages in the report show the freshwater withdrawal as a proportion of available freshwater resources.
19 GAR Special Report on Drought 2021.
20 FAO's Aquastat.
21 WRI's Aqueduct Water Stress.
22 IPCC, Working Group I of AR5, 2018
23 GAR Special Report on Drought 2021.
24 https://data.apps.fao.org/aquamaps/
25 https://www.wri.org/research/aqueduct-30-updated-decision-relevant-global-water-risk-indicators

IWRM is vital to achieving long-term social, economic and environmental well-being. But, although most countries advanced their level of IWRM implementation between 2017 and 2020, 107 countries are not on track to sustainably manage water resources by 2030. [26]

There is also a strong linkage between increasing drought risk and water scarcity. On the one hand, an increase in drought frequency or severity, or both, can threaten already water-scarce regions and create new, or expand existing, regions suffering from water scarcity. To reduce the threat, regional development planning should allow for timely adaptation to a changing climate. On the other hand, water scarcity significantly increases drought risk, as water-scarce regions lack adequate buffers to cope with droughts. Repeated, prolonged or severe droughts can severely damage the economy, society and natural ecosystems in such regions, potentially leading to land degradation and desertification.[27]

In 2020, more than 20% of the world's river basins had experienced either rapid increases in their surface water area indicative of flooding, a growth in reservoirs and newly inundated land; or rapid declines in surface water area indicating drying up of lakes, reservoirs, wetlands, floodplains and seasonal water bodies. Rapid changes in surface water extent and availability are contributing to elevated disaster risks and potentially negatively affecting water-dependent sectors, e.g. agriculture, energy. More than 80% of wetlands are estimated to have been lost since the pre-industrial era.[28] Despite an average of 58% of countries' transboundary basin areas having an operational arrangement for water cooperation, only 24 countries reported that all their transboundary basins are covered by such.[29] Global Status

Additional SDG6 indicators

When it comes to water-use efficiency (measured as the ratio of dollar gross value added to the volume of water used), data on the change in water-use efficiency, as measured by indicator 6.4.1, from 2015 to 2018 show significant variabilities among countries. Globally, water-use efficiency has increased around 10%. From the 166 countries surveyed[30], water-use efficiency was found to have decreased in 26 countries, however. Looking at water-use efficiency change in the different sectors showed that water-use efficiency globally has increased about 15% in the industrial sector, about 8% in the services sector, and 8% in the agricultural sector from 2015 to 2018. Agriculture continues to be the most water demanding sector (72% of the total demand) contributing to about 2% of the global water-related gross value added.

Participation of users and communities helps ensuring sustainable solutions for all aspects of SDG 6 and contributes to wider reductions in inequality within and among countries, including gender inequalities. In 2019, two-thirds of the 109 reporting countries had community and user participation embedded in laws or policies, but only 14 countries reported high levels of community participation.[31]

Globally, 56% of household wastewater flows was safely treated in 2020, with regional values ranging from 25 to 80%, indicating that progress remains uneven across the globe. Data from 42 countries reporting on the generation and treatment of total wastewater flows indicate that less than a third received at least some treatment in 2015. The situation is similar for industrial wastewater flows, although here data are only available for 14 countries.[32]

In all world regions, and in low-, medium- and high-income countries alike, many water bodies were still in good condition; in 2020, 60% of water bodies assessed in 89 countries had good ambient water quality. However, water quality data are not collected routinely in a majority of countries; especially lower income countries rely on relatively few measurements from relatively few water bodies and lack suitable environmental water quality standards. Therefore, global status and trends cannot be completely assessed.[33]

Water-related hazards have been increasing for the past 20 years

Between 1970 and 2019, 11,072 disasters have been attributed to weather-, water-, and climate-related hazards, involving 2.06 million deaths and US$ 3.6 trillion in economic losses[34]. In this period, droughts and floods were, respectively, the deadliest and most costly hazard events after storms.

Worldwide, 44% of disasters and 31% of economic losses have been associated with floods, with the majority of all flood-related losses occurring in Asia (Figure 3). Drought, on the other hand, claimed lives of around 700,721 people (34% of disaster related deaths from 1970 to 2019), with the majority of deaths recorded in Africa. Globally, drought also contributed to a loss of $US 262 billion, with the largest economic losses occurring in Asia, North America and the Caribbean (Figure 4).

According to WMO analysis of Parties' NDCs, flood, drought and extreme temperature are the hazards of greatest concern for UNFCCC Parties. Water-related hazards have been increasing for the past 20 years. Floods accounted for 44% of all disaster events between 2000 to 2019, affecting 1.6 billion people worldwide.[35] Flood-related disaster events recorded since 2000 increased by 134% compared to the two previous decades.[36] In 2020, there were 23% more floods than the annual average of 163 events, and 18% more flood deaths than the annual average of 5,233 deaths.[37] As compared to 1980-1999, since 2000 drought-related disasters have increased in frequency by 29%[38]. In 2000-2019, drought affected 1.43 billion people.

26 UNEP, 2021: Progress on Integrated Water Resources Management. Tracking SDG 6 series: global indicator 6.5.1 updates and acceleration needs.
27 GAR Special Report on Drought 2021.
28 UNEP, 2021: Progress on Integrated Water Resources Management. Tracking SDG 6 series: global indicator 6.5.1 updates and acceleration needs
29 UNECE and UNESCO, 2021. Progress on Transboundary Water Cooperation Global status of SDG indicator 6.5.2 and acceleration needs.
30 FAO and UN Water. 2021. Progress on change in water-use efficiency. Global status and acceleration needs for SDG indicator 6.4.1, 2021. Rome. https://doi.org/10.4060/cb6413en.
31 National systems to support drinking-water, sanitation and hygiene: global status report 2019. UN-Water global analysis and assessment of sanitation and drinking-water (GLAAS) 2019 report. Geneva: World Health Organization; 2019.
32 UN Habitat and WHO, 2021. Progress on wastewater treatment – Global status and acceleration needs for SDG indicator 6.3.1. Geneva.
33 United Nations Environment Programme (2021). Progress on ambient water quality. Tracking SDG 6 series: global indicator 6.3.2 updates and acceleration needs. Nairobi.
34 The Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019), WMO, 2021.
35 UNDRR, CRED, 2020: The human cost of disasters: an overview of the last 20 years (2000-2019).
36 UNDRR, CRED, 2020: The human cost of disasters: an overview of the last 20 years (2000-2019)
37 CRED, 2020: Disaster Year in Review 2020 Global Trends and Perspectives
38 UNDRR, CRED, 2020: The human cost of disasters: an overview of the last 20 years (2000-2019).

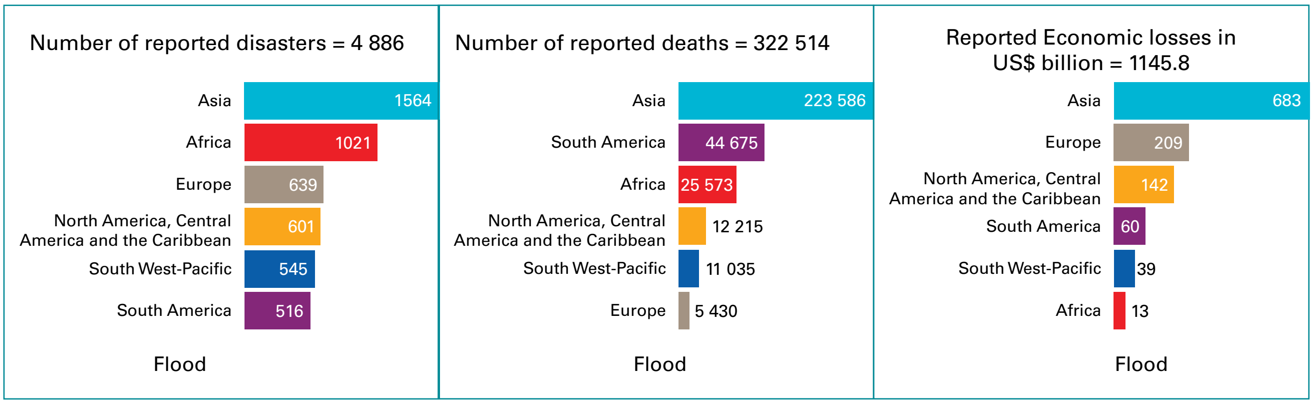

Figure 3: Distributions of flood-related disasters and related losses by region, 1970-2019.[39]

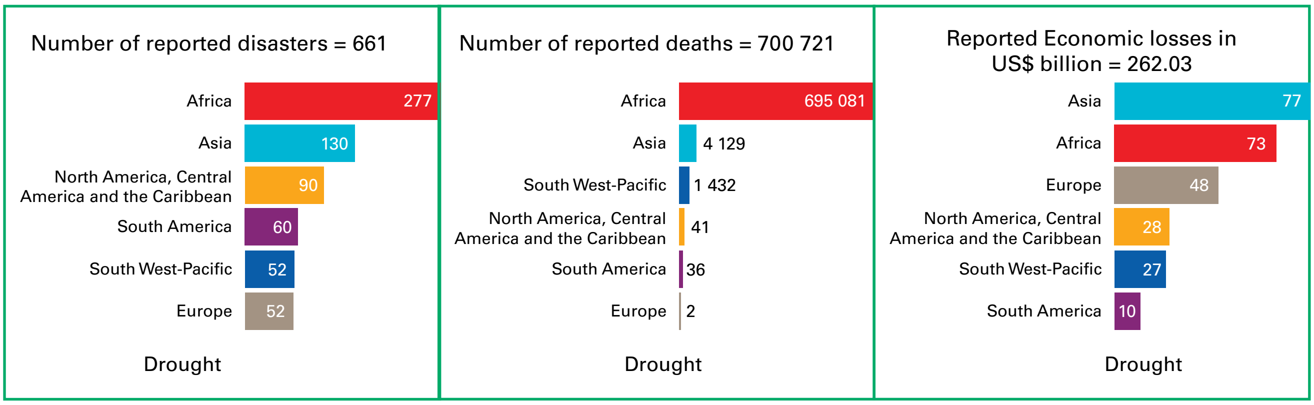

Figure 4: Distributions of drought-related disasters and related losses by region, 1970-2019.[40]

39 WMO analysis of 1970-2019 data from the Emergency Events Database of the Centre for Research on the Epidemiology of Disasters.
40 WMO analysis of 1970-2019 data from the Emergency Events Database of the Centre for Research on the Epidemiology of Disasters.

Value

End-to-end hydrological services

The pursuit of sustainable development and climate adaptation is increasing the demand for weather, climate, water and environmental information and services to help protect lives and livelihoods from hydrometeorological hazards and achieve beneficial socioeconomic and environmental outcomes in weather-, water- and climate-sensitive sectors. The core business of hydrological services is the provision of information about the water cycle and the status, trends, and projections of a country's water resources. This typically focuses on assessing water resources, including drought monitoring and outlooks and flood forecasting and warnings.

Investments in real-time observing networks, weather forecasts, early warnings and climate information make economic sense.[41] They create a triple dividend that includes:

- avoided losses – reliable and accurate early warning systems save lives and assets worth at least 10 times their cost;

- optimized production – the estimated annual benefits of improved economic production through the application of weather and climate prediction forecasting in highly weather/climate-sensitive sectors; and

- improved long-term strategic response to climate change.

The potential benefits of upgrading to developed-country standards for hydrometeorological information production and early warning capacity in all developing countries would reach between US$ 4 and 36 billion per year.[42]

The Global Commission on Adaptation estimates that strategically investing US$ 1.8 trillion[43] between 2020 and 2030 across the globe could generate US$ 7 trillion in total net benefits.[44] High-quality hydro-met services are an essential requisite to realize these benefits.

Photo: Walter Randlehoff

41 WMO, 2021: Hydromet Gap Report.
42 Hallegatte, S. (2012). A Cost Effective Solution to Reduce Disaster Losses in Developing Countries: Hydro-Meteorological Services, Early Warning, and Evacuation. Policy Research Working Paper 6058, World Bank, Washington, DC.
43 Five areas are considered for this estimate by GCA, namely: early warning systems, climate-resilient infrastructure, improved dryland agriculture crop production, global mangrove protection, and investments in making water resources more resilient.
44 The Global Commission on Adaptation (2019) Adapt Now: A Global Call for Leadership on Climate Resilience.

Data and methods

How we collect and analyse the data for this report

WMO collects data from Members based on a framework developed by WMO inter-governmentally appointed experts. This report assesses WMO Members' progress in providing climate services for adaptation in the water sector based on these data sets, which are currently available for 101 WMO Members. The data align with the six components of the value chain for climate services for water (Figure 5).

The data cover 600 hydrology-related capacities and functions, of which 32 are those related to climate services for water and are analyzed in this report (see Annex). Data are currently available for 101 (61%) out of 166 WMO Members with Hydrological Advisors, including 44% of the world's LDCs and 19% of SIDS. The results presented in this report reflect the profiles of the countries which have provided data, and which form the basis for the interpretation of the results for each WMO region.

The data provide a basis for calculating Members' capacities to provide climate services for water in each value chain component area for which data are available, and for categorizing the capacity in each component area as either Inadequate, Basic/Essential, or Full/Advanced. This categorization is based on the percentages of specific constituent functions satisfactorily in place ('functions satisfied') for each value chain component as reflected in the individual questions in the survey, with 0-33% of functions satisfied considered as 'Inadequate,' 34%-66% as 'Basic/Essential' level and 67%-100% as 'Full/Advanced.'

Additional data sources include UN Water on SDG 6, the Food and Agriculture Organization of the United Nation (FAO), and IWRM data from UNEP. Additional data on disasters and related losses for 1970-2019 are from the Emergency Events Database of the Centre for Research on the Epidemiology of Disasters (CRED) and the 2021 WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019).

IWRM data is collected by UNEP through SDG indicator 6.5.1. 186 countries have submitted data during collection rounds in 2017 and 2020, with 172 of these submitting in both rounds, allowing for an assessment of progress towards the target in all regions. The indicator is scored on a scale of 0-100, based on a country survey of 33 questions, including one on management instruments for disaster risk reduction.

The report also includes additional analysis of NDCs to understand UNFCCC Parties' commitments, priorities and needs in relation to climate services and early warnings in the water sector. As of 4 August 2021, a total of 113 Parties have submitted their enhanced NDCs of which 11 are second NDCs, 96 are updated first NDCs, and six are first NDCs. The newly submitted NDCs are unevenly distributed geographically. Out of the 113 Parties, only 20 are from Africa. Our analysis of these NDCs is further complemented by the UNFCCC[45] synthesis report.

Case studies provided by partners highlight how climate information services and early warnings contribute to improved socio-economic outcomes in the water sector. Each case study showcases water-related activities which highlight successful approaches to achieving socio-economic benefits through climate services for the water sector at the national, regional and global level.

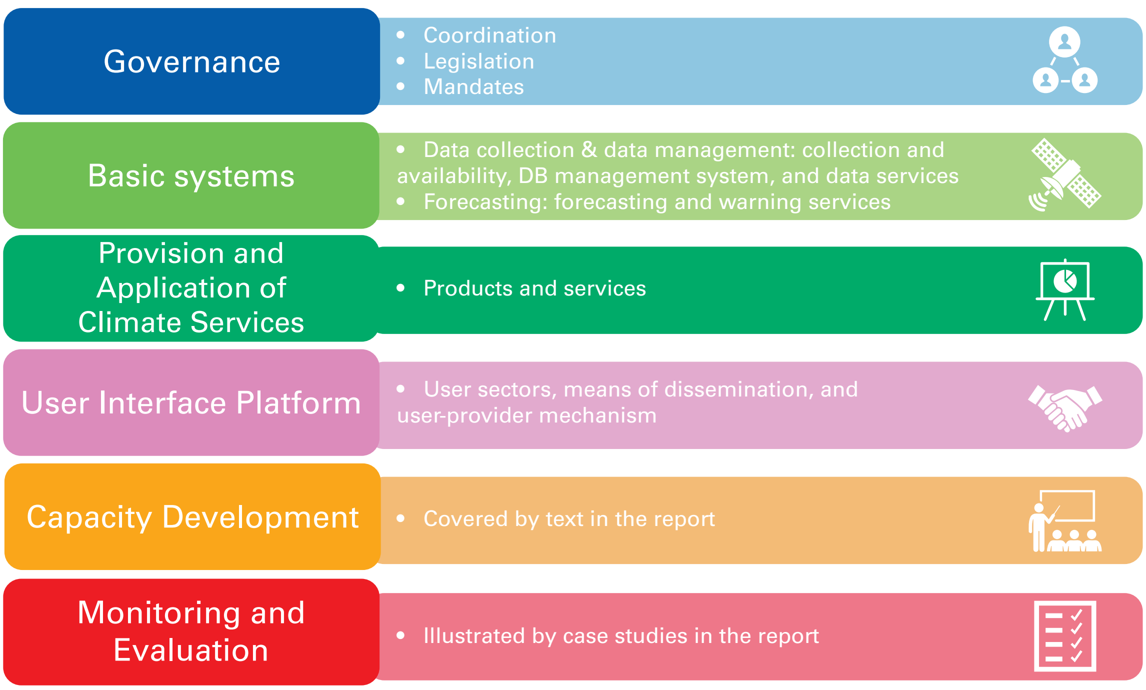

Figure 5: The Hydro survey consists of approximately 600 questions, of which 32 were selected for this report as key indicators of the status of these six value chain components. Note: Capacity development and User Interface Platform are cross-cutting components.

45 UNFCCC, 2021: Nationally Determined Contributions (NDC) under the Paris Agreement, Synthesis report.

Priorities and needs

According to UNFCCC, water is a top adaptation priority in 79% of the Nationally Determined Contributions (NDCs) to the Paris Agreement.

Figure 6: Climate services needs for adaptation in the water sector by region, from UNFCCC Parties NDCs. Only NDCs that indicate water as a top priority were used for this analysis.[46]

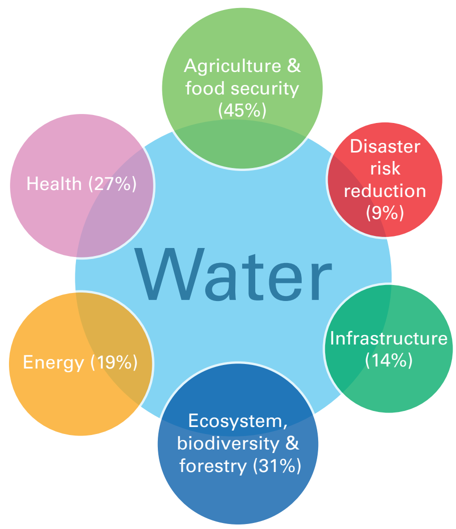

Figure 7: Overview of the Interaction between water and other sectors as indicated in the NDCs.[47]

Water is the ultimate connector in the global commitment towards a sustainable future. The 2030 Agenda for Sustainable Development and its 17 SDGs are highly dependent on improved water management. Within the Sendai Framework for Disaster Risk Reduction, adopted by the United Nations Member States in March 2015, water management is essential for reducing the occurrence and impacts of water-related disasters. Implementation of the Paris Agreement is highly dependent on improved management of water resources.[48]

Water is a top adaptation priority in 79% of UNFCCC Parties' NDCs. In their NDCs, most Parties have mentioned water as an underlying, cross-cutting factor influencing the achievement of adaptation actions in the agriculture and food security sector (45%), ecosystems, biodiversity, and forestry (31%), health (27%) and energy (19%) (Figure 7).

Based on this interaction, and the dependency that other sectors have with the water sector, it is vital to prioritize and integrate water resources management into all climate plans to ensure water is sustainably managed across sectors.

Climate services, in this case for water, help societies to well adapt to climate change, but the required capabilities are still far from being universal, even though proven measures are on the rise and demonstrating their value. From the updated NDCs, around 50% of Parties highlighted climate services as needed in their efforts to adapt to climate change. Of the Parties that mention water as a top priority in their updated NDCs, the majority highlighted actions for attention related to capacity development (57%), forecasting (45%), observing networks (30%), and data collection (28%).[49] Over 70% of LDCs and SIDS highlighted early warning systems (EWS) for hydro-meteorological hazards such as drought and floods in their updated NDCs.

46 NDCs, 2015-August 2021.
47 2021 WMO Analysis of NDCs.
48 UN World Water Development Report, 2020.
49 In their NDCs, Parties highlighted one or multiple areas of need related to climate services for water.

On average, 60% of WMO Members lack the full capacity needed to provide climate services for water.

Data from 101 WMO Members show that, overall, almost 60% of them lack the basic systems, user engagement and service provision capacities needed to respond fully to the growing demand for easily accessible, robust, and timely information needed to support water-related adaptation efforts in their countries. In particular, inadequate interaction with information users is experienced in 43% of WMO Members (Figure 8).

BASIC SYSTEMS

Basic systems capacity refers to observing networks, data collection, data management and forecasting. Observations of the hydrological cycle – producing real-time data, historical time series and aggregated data – are fundamental for delivering climate services for addressing water-related challenges related to floods, droughts, water supply, governance, transboundary sharing, water quality or ecosystems.

There are still important gaps in water data collection and sharing worldwide. Data is not being collected on basic hydrological variables, such as water level and discharge, in, on average, 40% of WMO Members (Figure 9).

Figure 10 (top) shows that the majority of countries did not report data to the WMO Global Runoff Data Center for more than 10 years, and data is being made available in just 33% of WMO Members (Figure 10, bottom).

Members report lacking continuous, automatic sensor-based water level monitoring, as well as data transmission systems, and are unable to guarantee the maintenance, operation and repair of the existing stations, especially in remote areas.

Furthermore, Members report that they still have outdated instruments and equipment, and do not have the human and financial resources to modernize their monitoring networks. They also have challenges in ensuring data validation and quality control. Although 85% of Members have a national database in place, such information systems are still missing in 15 countries from among those providing data, predominantly in central America, Africa and Asia.

Even in cases where data are available, there are challenges in developing data products and disseminating them. Most of these challenges are related to underfunding of the services, lack of human resources, high turnover and a lack of capacity building and training. Some NHSs and National Meteorological and Hydrological Services (NMHSs) have addressed these issues by becoming more customer-focused organizations, adapting their data policy and strategy, and improving communication channels and public awareness.

Gaps also remain in the provision of forecasting and warning services. There is a need to ensure the population at risk receives early warnings and is able to act on them. End-to-end riverine flood forecasting and warning systems are absent or inadequate in 34% of WMO Member countries, however – with only 44% of Members with existing systems reaching more than two-thirds of their at-risk population (Figure 11).

End-to-end drought forecasting and warning systems are absent or inadequate in 54% of WMO Members that provided data – with only 27% of Members with existing systems are reaching more than two-thirds of their at-risk population (Figure 11).

Data show that the number of WMO Members that report being able to provide warnings to the population at risk is insufficient (Figure 11). As WMO's 2020 State of Climate Services report, which focused on risk information and early warning systems, concluded: there is insufficient capacity worldwide to translate early warning into early action, especially in LDCs.

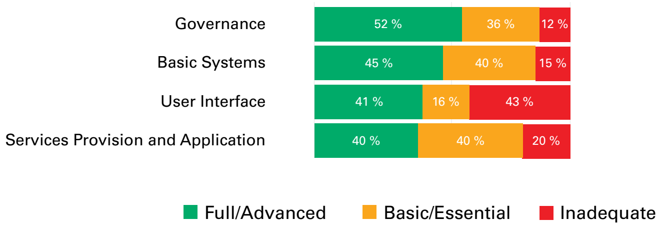

Figure 8: WMO Member capacities across the climate services for water value chain globally divided by component, calculated as a percentage of functions satisfied in each component area, based on data from 101 WMO Members providing data. Capacity levels for each value chain component are categorized as Inadequate (0-33%), Basic/ Essential (34-66%), and Full/ Advanced categories (67-100%) of functions satisfied, respectively.

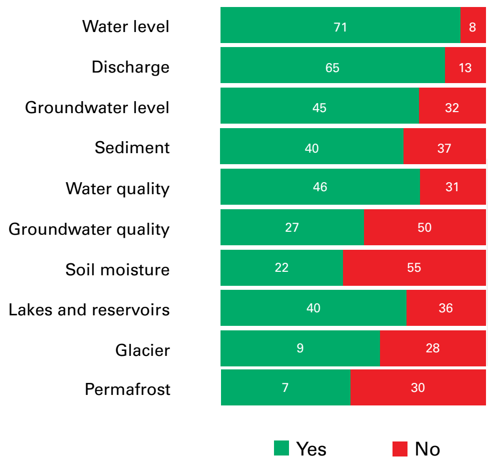

Figure 9: Number of Members collecting hydrological data, by variables. Note: there are an estimated 37 countries with glaciers and permafrost or seasonally frozen ground.

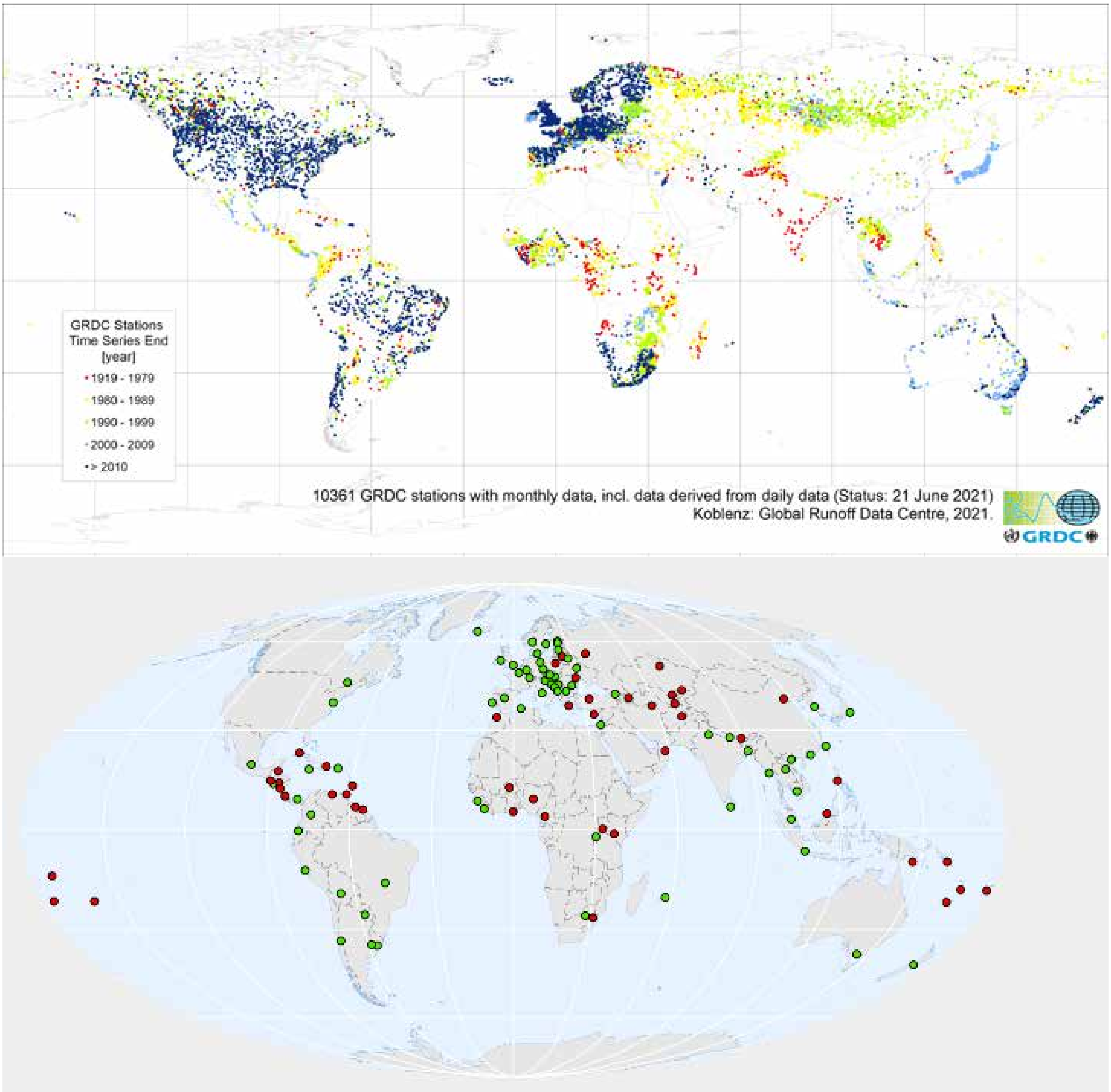

Figure 10: Status of hydrological data availability Top: Monthly hydrological runoff data delivered to the WMO Global Runoff Data Center status as of February 2021. The map shows the stations that last reported in 2020 (blue), in 2009 (light blue), in 1999 (green), in 1989 (yellow), and in 1979 (red). Bottom: Organizations/institutions providing links to data (green) and organizations/institutions collecting data without providing links (red).

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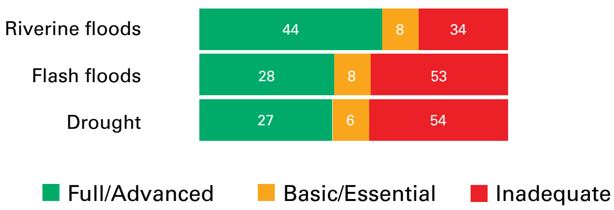


Figure 11: Number of Members with early warnings available to the population at risk, by hazard type, based on data from WMO Members providing data. Member capacities are categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) according to the estimated percentage of the population at risk that receive EW. Note: For each hazard, the category 'Inadequate' includes Members (providing data) reporting that no end-to-end EWS for the hazard is in place, as well as those whose end-to-end EWSs do not reach more than 33% of the at-risk population.

The WMO Hydrological Status and Outlook System (HydroSOS)

Hydrological assessments and predictions are vital for translating data from observations of the hydrological cycle into useful information. Such information is needed for planning and decision-making in water- and climate-sensitive sectors such as agriculture, water management, disaster risk reduction, energy production and even tourism and recreation.

WMO is supporting regional and national efforts towards creating efficient and sustainable water information systems with support for water monitoring networks (WHYCOS and HydroHub [50]), water data sharing and information systems (WHOS[51]), and a Hydrological Status and Outlook System (HydroSOS[52]). Further development of hydrometeorological systems and services can benefit from the new WMO integrated Earth System approach, intending to promote increased efficiency through interoperable systems and integrated services across all domains.

The HydroSOS initiative is working to tie together the efforts on monitoring hydrological data and the delivery of accurate and useful information. HydroSOS is designed to support NHSs in producing and delivering authoritative hydrological information products (sub-seasonal and seasonal outlooks in this case) and upscaling such products to regional and global scales. It will also assist NHSs in tailoring hydrological information products to their users' needs.

At the global level, HydroSOS is assessing the integration of several forecasting systems into one portal to provide hydrological status and outlooks with information from global models. These global models are useful to regional and national applications, as data can be downscaled to support filling in of local timeseries and performing calibration of local models. At the same time, local information from specific regions can also inform global models, rendering them more useful for future predictions in those regions and any other region with similar conditions.

Gender equality and social inclusion in water resources management

While men and women have similar needs for water in their daily life, their roles and responsibilities around water use and access differ due to the socio-cultural factors that influence societies. Women are disproportionately affected by water scarcity and quality, climate change, and natural hazards. Despite these adverse impacts, there are examples of women being powerful catalysts for change. Yet despite women's unique experiences and valuable perspectives, water management policies often fail to address gender inequality. Women and vulnerable groups are frequently absent from the decision-making processes.

According to the World Bank, water sector projects that included women were at least six times more effective than those that did not. By 2014, women made up just 17% of the water, sanitation and hygiene (WASH) labor force on average, and were a fraction of managers, regulators, policy makers, and technical experts. Studies show that women are underrepresented both at community level irrigation water users' associations and in the global processes that influence water and climate decision-making.

To achieve a gender transformative approach, the Global Water Partnership (GWP) suggests four action areas of intervention:[53]

1. Ensuring institutional leadership and commitment to making gender equality and inclusion a major goal for everyone in the water sector;
2. Conducting gender and inclusion analysis at all levels;
3. Adopting a practice of meaningful and inclusive participatory decision-making processes and partnerships; and
4. Creating a level playing field with respect to access and control of resources such as land and water.

50 https://hydrohub.wmo.int/en/world-hydrological-cycle-observing-system-whycos
51 https://public.wmo.int/en/our-mandate/water/whos.
52 https://public.wmo.int/en/our-mandate/what-we-do/application-services/hydrosos.
53 Gender Action Piece, https://www.gwp.org/globalassets/global/about-gwp/publications/gender/gender-action-piece.pdf.

Tracking of socio-economic benefits of climate services is inconsistent

Overall, the tracking and reporting of socio-economic outcomes and benefits achieved through climate services for water is inconsistent and non-standardised.

This point applies to the case studies included in this report – few of which could be obtained that include quantifiable benefits associated with the interventions, and others providing only qualitative results. Although the benefits of early warnings systems are well known and well documented, more systematically collected information is needed on the socio-economic benefits of other aspects of water resource management.

Data from WMO Members show that there is inadequate interaction among climate services providers and information users in 43% of WMO Members (see Figure 8). This translates into the lack of tracking of socio-economic benefits and inconsistent monitoring and evaluation thereof. There is a pressing need for the hydrological community to address this gap and partner with water information users and economists and other social scientists to help demonstrate to society the value of climate services[54] especially in the water sector. Systematic documentation of the socio-economic benefits in hydrometeorological systems and services is essential for sustaining such systems and services, and for attracting the investments needed to support them.

Photo:Eduardo Prim

54 Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services, WMO No.1153, 2015.


Photo: Kayla Kozlowski

Africa

Droughts are the top killer in Africa among weather-, water- and climate-related hazards, claiming more than 695 000 lives in the past 50 years.[55]

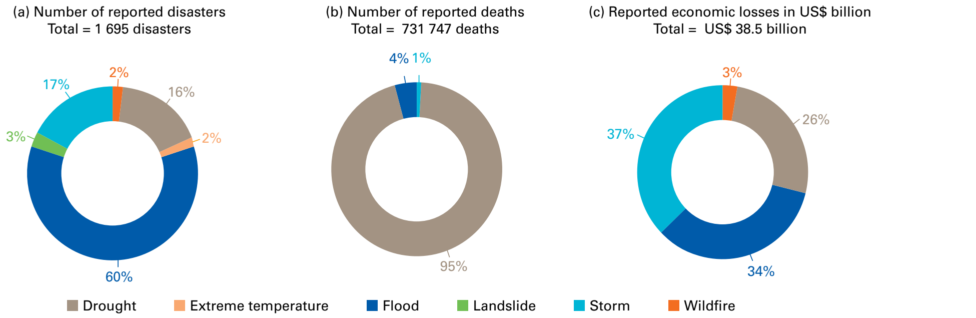


Figure 12: Overview of weather-, water-, and climate-related disasters, deaths and US$ economic losses reported in Africa (1970-2019) .[56]

Africa is one of the regions most affected by climate variability and change.[57] In the past 50 years, Africa recorded a total number of 1,695 disasters associated with weather-, water-, and climate-related events, involving 731,747 deaths and economic losses of US$ 38.5 billion. Droughts accounted for 16% of weather-, water-, and climate- related disasters, 95% of deaths, and 26% of economic losses (Figure 12), and floods 60%, 4%, and 34%, respectively, during this period. Although flood-related disasters were most prevalent, drought has led to the highest number of deaths, accounting for 95% of all lives lost to weather-, water- and climate-related disasters in the region.[58]

In 2020, flood events affected seven million people and flood exposure and vulnerability killed 1,273 people in Africa, the highest figure since 2006.[59] In 2020, drought affected a total of 13.4 million people in Mali, Burkina Faso, and Niger.[60]

According to FAO, Northern Africa is one of the sub-regions with the highest water stress (109%) level globally.[61]

Overview of Hydrological capacities

In their NDCs, most UNFCCC Parties mentioned the need for strengthening climate services – particularly in such areas as data collection and management (mentioned specifically in 42% of African NDCs), followed by, forecasting, observation systems and capacity building in relation to the water sector. For example, Guinea's[62] NDC highlighted substantial gaps in terms of reliable, robust climate data, as well as all statistical data on natural resource management, including for water.

Based on WMO data from 22 countries for which data are available (42% of the region), Africa faces numerous capacity gaps. On average across the full value chain, only 27% provide water-related climate services at a Full/Advanced level. Engagement with users (User interface) and Services provision and application are the weakest links, with the highest percentages of countries in the Inadequate category. There are inadequate interfaces with information users (Figure 13) in 50% of the WMO Africa region Members for which data are available.

Based on IWRM implementation data from 51 African countries in 2020 (SDG 6.5.1), 27 countries have inadequate capacity to effectively implement most IWRM elements, and many activities are undertaken on an ad hoc basis with unsustainable financing.[63] Despite improvements in most countries between 2017 and 2020, raising the average IWRM implementation score from 42 to 47 out of 100 (SDG 6.5.1), four out of five African countries are unlikely to have sustainably managed water resources by 2030 and should therefore focus efforts on accelerating IWRM implementation.[64]

Additionally, 15 WMO Africa region Members out of the 22 providing data report having an inadequate end-to-end drought forecasting/warning services in Africa and, only four Members (Figure 14) are providing those services at a full/ advanced level capacity. This is especially troubling as Africa is the region that has historically been the most affected by drought disasters, as compared to other regions (Figure 4).

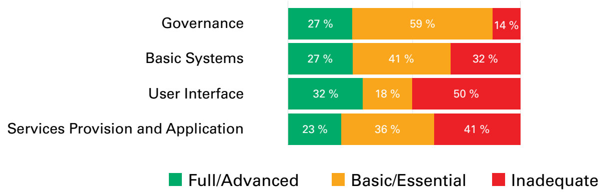


Figure 13: WMO Member capacities across the value chain in Africa, by component, calculated as a percentage of functions satisfied in each component area, across 22 WMO Members providing data, categorized as Inadequate (0-33%), Basic/ Essential (34-66%), and Full/ Advanced categories (67-100%) of functions satisfied, respectively.

Figure 14: Number of WMO Members in Africa with early warnings available to the population at risk, by hazard type, based on data from WMO Members providing data. Member capacities are categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) according to the estimated percentage of the population at risk that receive EW. Note: For each hazard, the category 'Inadequate' includes Members (providing data) reporting that no end-to-end EWS for the hazard is in place, as well as those whose end-to-end EWSs do not reach more than 33% of the at-risk population.

55 Compared to other weather-, water-, and climate- related hazards.
56 The Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019), WMO, 2021
57 Niang et al. 2014, Africa. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability.
58 The Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019), WMO, 2021.
59 CRED, 2020: Disaster Year in Review 2020 Global Trends and Perspectives.
60 CRED, 2020: Disaster Year in Review 2020 Global Trends and Perspectives.
61 FAO and UN-Water. 2021. Progress on Level of Water Stress. Global status and acceleration needs for SDG Indicator 6.4.2, 2021. Rome. https://doi.org/10.4060/cb6241en.
62 Guinea First NDC.
63 Based on data available from http://iwrmdataportal.unepdhi.org.
64 Four out of five countries showing "Limited" or "Moderate" progress between 2017 and 2020, and therefore unlikely to meet Target 6.5 at current rates of implementation, as shown in Figure 3.4 of: UNEP (2021). Progress on Integrated Water Resources Management. Tracking SDG 6 series: global indicator 6.5.1 updates and acceleration needs. IWRM progress report. Report and data available from http://iwrmdataportal.unepdhi.org.

Asia

Photo: Constant Loubier

Asia has continued to face extreme impacts from weather, water and climate compared to other regions, especially from floods.

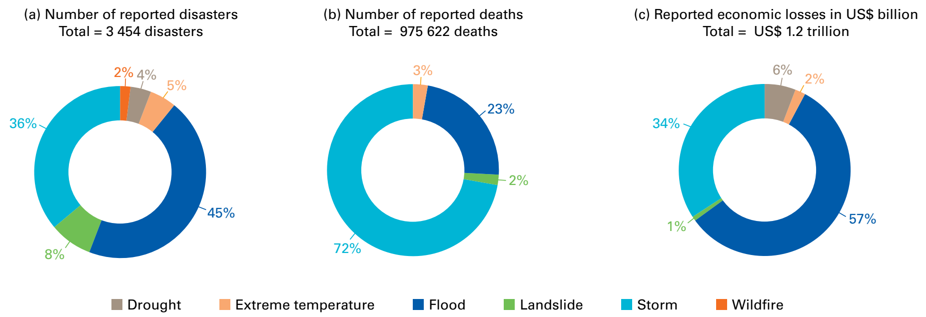


Figure 15: Overview of weather-, water-, and climate-related disasters, deaths and US$ economic losses reported in Asia (1970-2019).[65]

From 1970-2019, Asia recorded 3,454 disasters, almost 1 million lives lost and economic losses of US$ 1.2 trillion associated with weather-, water- and climate-related hazard events. Most of these disasters were associated with floods (45%) and storms (36%). Storms had the highest impacts on life, contributing to 72% of the lives lost, while floods led to the greatest economic losses (57%).[66]

The region suffered the highest economic losses from both floods and droughts compared to other regions in the last 50 years (Figure 3 and Figure 4). In the period of 1970-2019, floods accounted for 45% of disasters, 23% of disaster-related deaths, and 57% of economic losses (Figure 15). Drought accounted for only 4% of disasters and 6% of disaster-related economic losses respectively.

Flooding affected the region particularly badly in 2020. In India, flooding was responsible for the third deadliest event of the year, costing 1,922 lives. China also faced a series of four summer floods across the country that led to the deaths of 397 people, affected 14.3 million people, and contributed to US$ 21.8 billion in economic losses. [67]

According to FAO water stress data, Central Asia (80%), followed by Southern Asia (78%) and Western Asia (60%) suffers from high levels of water stress. Central Asia is one of the sub-regions with the highest water stress globally.

Overview of Hydrological capacities

In their NDCs, most Parties mentioned water-related climate services actions related to forecasting (47%) followed by data collection and management, capacity development and observing systems. For example, Cambodia,[68] mentioned the need to establish an automated nation-wide hydro-met monitoring network and data transmission program, including the collection of climate and hydrological data.

Based on WMO data from 17 countries (50% of the region), Asia is among the regions with the highest level of hydro-services capacity. Governance services in the region are quite high compared to the global average and most Members are providing services at a Full/Advanced capacity level. As in other regions, there is a need to strengthen interaction with users (Figure 16). Service Provision and Application is also lagging in the region, with only 35% of Members providing services at the Full/Advanced capacity level.

Based on IWRM implementation data from 32 Asian countries in 2020 (SDG 6.5.1), 50% of countries generally have inadequate capacity to effectively implement most IWRM elements, while 50% of countries generally having higher capacity, with most IWRM elements generally being implemented under long-term programmes.[69] The regional IWRM implementation average has increased from 47 in 2017 to 54 in 2020 (out of 100), which is positive, though this rate of progress is unlikely to reach SDG target 6.5 by 2030.

Two WMO Members in this region out of the 17 providing data report having inadequate end-to-end riverine flood forecasting services and only nine Members (Figure 17) are providing those services at a Full/Advanced capacity level. Ten Members indicate having inadequate end-to-end drought forecasting systems and four are providing drought warning services at a Full/Advanced capacity level.

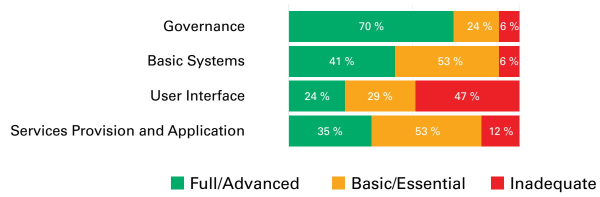


Figure 16: WMO Member capacities across the value chain in Asia, by component, calculated as a percentage of functions satisfied in each component area, across 17 WMO Members providing data, categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) of functions satisfied, respectively.

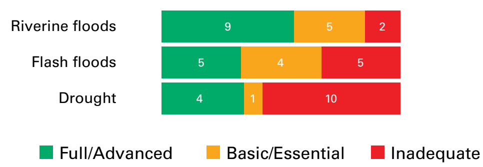


Figure 17: Number of WMO Members in Asia with early warnings available to the population at risk, by hazard type, based on data from WMO Members providing data. Member capacities are categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) according to the estimated percentage of the population at risk that receive EW. Note: For each hazard, the category 'Inadequate' includes Members (providing data) reporting that no end-to-end EWS for the hazard is in place, as well as those whose end-to-end EWSs do not reach more than 33% of the at-risk population.

65 The Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019), WMO, 2021.
66 The Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019), WMO, 2021.
67 CRED, 2020: Disaster Year in Review 2020 Global Trends and Perspectives.
68 Cambodia Updated First NDC.
69 Based on data available from http://iwrmdataportal.unepdhi.org.

South America

77% of weather-, water-, and climate-related deaths in South America from 1970-2019 were associated with floods.

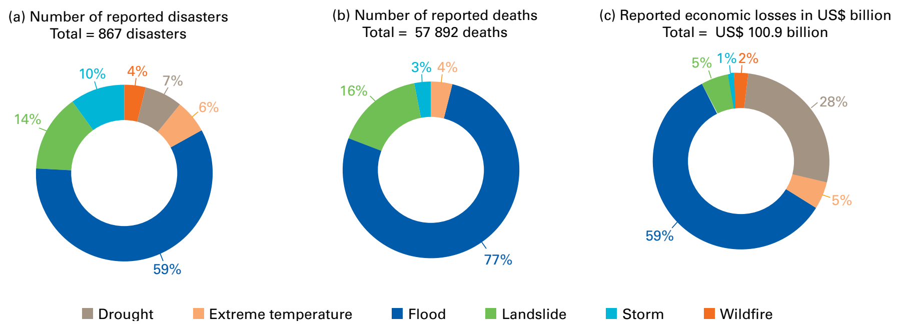


Figure 18: Overview of weather-, water-, and climate-related disasters, deaths and US$ economic losses reported in South America (1970-2019)[70].

From 1970-2019, the region recorded a total of 867 disasters connected to weather-, water-, and climate-related events, resulting to 57,892 deaths and a US$ 100.9 billion economic losses. In the past 50 years, floods have been the most significant hazard, accounting for the most disasters, deaths and economic losses. Floods accounted for 59% of weather-, water-, and climate-related disasters, 77% of deaths, and 59% of economic losses, which totalled around US$ 60 billion.

Drought is also a significant hazard, due to its contribution to significant economic losses in the region. Drought accounted for 7% of disasters, but 28% of economic losses (Figure 18) in the period from 1970-2019. US$ 28 billion was lost due to drought over this period.

South America is the region among all regions with the lowest water stress level, however, according to FAO.

Overview of Hydrological capacities

In their NDCs, UNFCCC Parties in South America have identified various climate services needs in relation to the water sector, including the need to improve forecasting systems (27%), in the region, followed by data collection and management and capacity development. For example, Suriname[71] highlighted the need to enhance data and information collection systems to fully support national and sub-national climate change impacts, vulnerability and adaptation decision-making.

According to the available data from seven countries, representing 32% of WMO Members in the region, interaction with information users is the area of the climate services for water value chain with the highest percentage of Members in both the Full/Advanced and Inadequate categories. On average, from the available data, 47% of Members provide climate services for water at an overall Full/Advanced level (Figure 19).

Based on IWRM implementation data from 10 countries in the region in 2020 (SDG 6.5.1), seven countries generally have inadequate capacity to effectively implement most IWRM elements. The regional average IWRM implementation score has increased from 35 in 2017 to 39 in 2020 (out of 100), which remains the lowest regional average, so the rate of progress needs to significantly accelerate to achieve SDG target 6.5 by 2030.[72]

According to the available data, four WMO Members in the region out of the seven for which data are available report providing riverine flood forecasting/warning services at a Full/Advanced capacity (Figure 20). Three Members report having an inadequate end-to-end riverine flood forecasting/warning system in place. However, only two Members have end-to-end flash flood warning systems capable of reaching over two thirds of the at-risk population (Figure 20). Four Members report having an inadequate end-to-end drought warning system and only three are reaching more than two-thirds of the at-risk population with warnings.

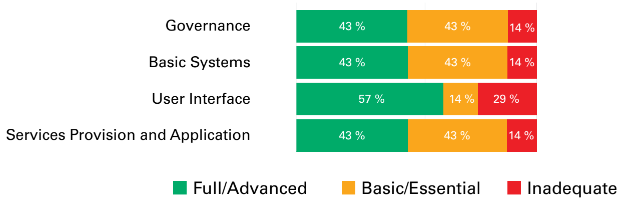


Figure 19: WMO Member capacities across the value chain in Asia, by component, calculated as a percentage of functions satisfied in each component area, across 17 WMO Members providing data, categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) of functions satisfied, respectively.

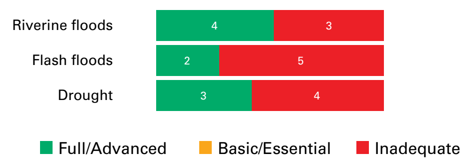


Figure 20: Number of WMO Members in Asia with early warnings available to the population at risk, by hazard type, based on data from WMO Members providing data. Member capacities are categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) according to the estimated percentage of the population at risk that receive EW. Note: For each hazard, the category 'Inadequate' includes Members (providing data) reporting that no end-to-end EWS for the hazard is in place, as well as those whose end-to-end EWSs do not reach more than 33% of the at-risk population.

70 The Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019), WMO, 2021.
71 Suriname second NDC
72 Based on data available from http://iwrmdataportal.unepdhi.org.

Photo: Andy Holmes

North America, Central America and the Caribbean

Floods claimed over 12 000 lives and contributed to a loss of over US$ 150 billion, while drought cost the region almost US$ 70 billion during the period 1970-2019.

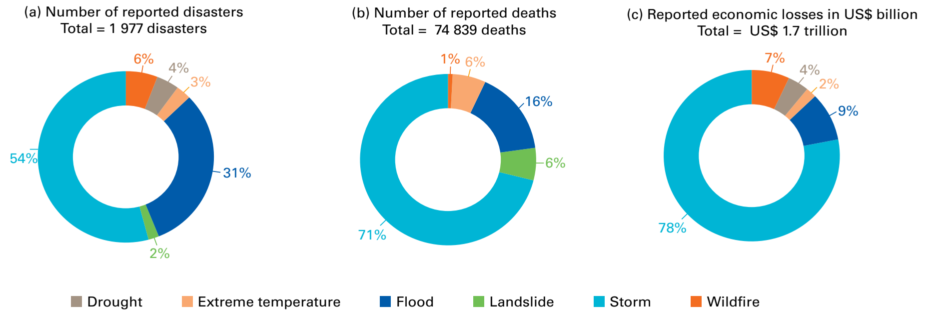


Figure 21: Overview of weather-, water-, and climate-related disasters, deaths and US$ economic losses reported in North America & Caribbean (1970-2019)[73].

The North America, Central America and Caribbean region accounted for 18% of weather-, water-, and climate-related disasters, 4% of associated deaths and 45% of associated economic losses worldwide over the past 50 years from 1970-2019. Over this period the region recorded a total number of 1,977 weather-, water-, and climate-related disasters, events that resulted in 74,839 disaster-deaths, and US$ 1.7 trillion economic losses. Storms and floods were the most prevalent hazards associated with the disasters recorded[74] (Figure 21).

Floods alone resulted in the deaths of almost 12,000 people and contributed to economic losses of US$ 150 billion, while drought cost the region almost US$ 70 billion during the period 1970-2019. In the last 50 years, floods accounted for 31% of weather-, water-, and climate- related disasters, 16% of deaths, and 9% of economic losses, while drought accounted for 4% of disasters and 4% of economic losses in the region (Figure 21).

Overview of Hydrological capacities

In their NDCs, most UNFCCC Parties in the region that mentioned water as a priority and that mentioned climate services indicated a need to improve data and data collection (61%) followed by capacity building and forecasting. For example, Saint Lucia,[75] mentioned the need for improvement and / or creation of open sources of data to more effectively assess increasing climate risks.

Based on WMO data from 14 countries (64% of the region, including six SIDS), the region has a relatively low level of capacity for providing climate services for water. Interaction with users (User interface) is the weakest link in the value chain, with the highest percentage of countries in the Inadequate category (71%) (Figure 22).

Based on IWRM implementation data from 19 countries in 2020 (SDG 6.5.1), 16 countries generally have inadequate capacity to effectively implement most IWRM elements. The regional IWRM implementation average score has increased from 36 in 2017 to 40 in 2020 (out of 100). Therefore, the rate of progress needs to significantly accelerate to meet SDG target 6.5 by 2030.[76]

Four WMO Members out of the 14 for which data are available reported having an inadequate riverine flood forecasting/warning service whereas nine are providing the needed services at a Full/Advanced capacity level (Figure 23). With regards to flash flood forecasting/warning services, only six Members provide the services at a Full/Advanced capacity level, based on the data available. Five Members reported having inadequate drought forecasting/warning services and eight are providing those services at a Full/Advanced level.

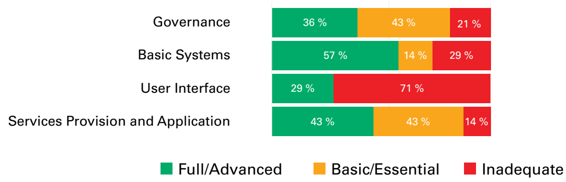


Figure 22: WMO Member capacities across the value chain in North America, Central America and the Caribbean, by component, calculated as a percentage of functions satisfied in each component area, across seven WMO Members providing data, categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) of functions satisfied, respectively.

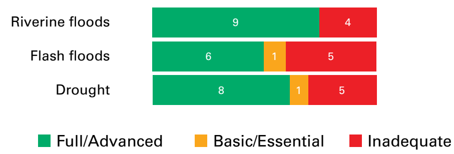


Figure 23: Number of WMO Members in North America, Central America and the Caribbean with early warnings available to the population at risk, by hazard type, based on data from WMO Members providing data. Member capacities are categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) according to the estimated percentage of the population at risk that receive EW. Note: For each hazard, the category 'Inadequate' includes Members (providing data) reporting that no end-to-end EWS for the hazard is in place, as well as those whose end-to-end EWSs do not reach more than 33% of the at-risk population.

73 The Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019), WMO, 2021.
74 The Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019), WMO, 2021.
75 Saint Lucia Updated First NDC.
76 Based on data available from http://iwrmdataportal.unepdhi.org.

South-West Pacific

In 2013, riverine flooding contributed to economic losses of US$ 3.2 billion in Indonesia.

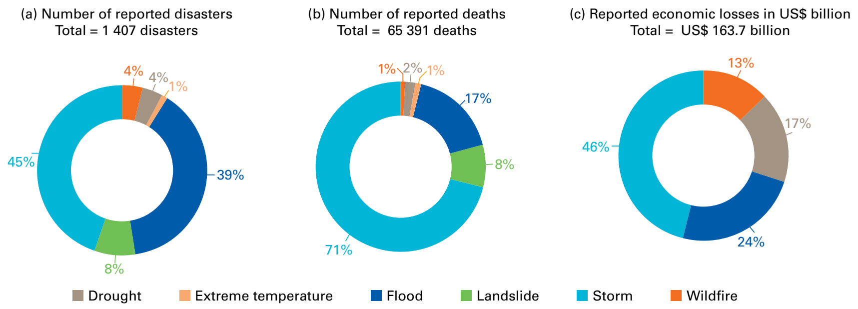


Figure 24: Overview of weather-, water-, and climate-related disasters, deaths and $ economic losses reported in South West Pacific (1970-2019)[77].

In the past 50 years, the South-West Pacific region recorded a total of 1,407 weather-, water-, and climate-related disasters that led to the loss of 65,391 lives and economic losses of US$ 163.7 billion. Most of these disasters were associated with storms and floods. Floods accounted for 39% of weather-, water-, and climate- related disasters, 17% of deaths, and 24% of economic losses. Drought accounted for 4% of disasters, 2% of deaths, and 17% of economic losses (Figure 24)[78].

According to FAO, Oceania has a low level (3%) of water stress.

Overview of Hydrological capacities

In their NDCs, UNFCCC Parties in the region that mentioned water as a priority and that mentioned climate services indicated a need to improve data collection and management (38%). For example, the Republic of the Marshall Islands,[79] highlighted a lack of reliable, high quality and accessible climate data in the country.

According to WMO data from seven countries (32%) in the region, on average, 54% of Members are providing services at a Full/ Advanced capacity level. Basic system capacity in the region is higher compared to the global average. Conversely, the User Interface platform is the weakest link in the value chain for the region, with 43% of Members having inadequate interfaces with information users (Figure 25). More data is needed for SIDS to better understand their capacities, however.

Based on IWRM implementation data from 16 countries in 2020 (SDG 6.5.1), nine countries generally have adequate capacity to effectively implement most IWRM elements, mostly through long-term programmes. The regional IWRM implementation average score has increased from 48 in 2017 to 55 in 2020 (out of 100), which is positive, though this rate of progress is unlikely to reach SDG target 6.5 by 2030. As in all regions, there are significant differences among countries, with national IWRM scores ranging from 14 to 100.[80]

Based on the available data from seven WMO Member countries, three Members reported having an inadequate riverine flood forecasting/warning service and two are providing the needed services at a Full/Advanced capacity level. Five Members in the region reported having inadequate flash flood forecasting/ warning services in their country and just one Member is providing those services in a Full/Advanced level (Figure 26). Three Members reported having inadequate drought forecasting/ warning service and two are providing the needed services at a Full/Advanced capacity level.

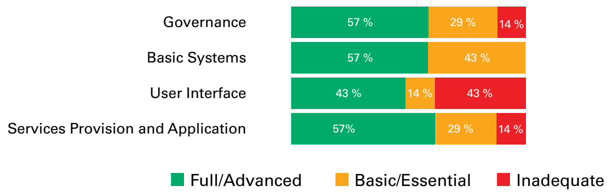


Figure 25: WMO Member capacities across the value chain in South West Pacific and Caribbean, by component, calculated as a percentage of functions satisfied in each component area, across 7 WMO Members providing data, categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) of functions satisfied, respectively.

Figure 26: Number of WMO Members in South-West Pacific with early warnings available to the population at risk, by hazard type, based on data from WMO Members providing data. Member capacities are categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) according to the estimated percentage of the population at risk that receive EW. Note: For each hazard, the category 'Inadequate' includes Members (providing data) reporting that no end-to-end EWS for the hazard is in place, as well as those whose end-to-end EWSs do not reach more than 33% of the at-risk population.

77 The Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019), WMO, 2021.
78 The Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019), WMO, 2021.
79 The Republic of the Marshall Islands Second NDC.
80 Based on data available from http://iwrmdataportal.unepdhi.org.

Europe

Floods and drought accounted for 41% of weather-, water-, and climate-related disasters and 54% of disaster-related economic losses in the region for the past 50 years.

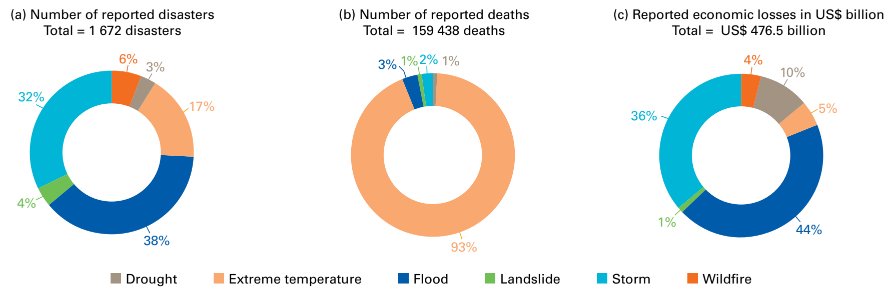


Figure 27: Overview of weather-, water-, and climate-related disasters, deaths and US$ economic losses reported in Europe (1970-2019)[81].

In the past 50 years, from 1970-2019, the region recorded a total of 1,672 weather-, water-, and climate- related disasters, that resulted in 159,438 disaster related deaths, and US$ 476.5 billion in economic losses. Although floods (involved in 38% of disasters) and storms (32%) were the most prevalent hazards, extreme temperatures accounted for the highest number of deaths (93%), with 148 109 lives lost over the 50 years. Floods (36%) and storms (44%) accounted for greatest economic losses in Europe (Figure 27). For example, the 2002 flood in Germany led to US$ 16.48 billion in economic losses and was the costliest event in Europe in the past 50 years.[82]

According to FAO, Europe has a low level of water stress, at 8.2%.

Overview of Hydrological capacities

The majority of the UNFCCC Parties in this region have submitted updated NDCs. A very small number have included an adaptation component, however. Those that mentioned adaptation and that mentioned water as a priority have in particular identified the need for data collection and management. For example, the Republic of Moldova[83] cited a need to establish a national climate change database to ensure periodic assessment of climate risks and associated impacts.

WMO data from 34 countries (68% of the region) show that European nations have an above-average capacity to provide hydrological services. With 61% of Members' User Interface platforms operating at a Full/Advanced level, Europe is the region with highest level of capacity to interact with users, compared to other regions (Figure 28). Additionally, in Europe, the Services Provision and Application capacity is higher than the global average.

Based on IWRM implementation data from all 50 countries in 2020 (SDG 6.5.1), 29 countries are generally meeting IWRM plan and programme objectives, and geographic coverage and stakeholder engagement is generally good. The regional IWRM implementation average score has increased from 66 in 2017 to 70 in 2020 (out of 100), which remains the highest regional average, with this rate of progress likely to reach SDG target 6.5 by 2030.[84]

Seven WMO Members in this region out of the 34 providing data report having inadequate end-to-end riverine flood forecasting services, whereas 16 Members are providing those services at a Full/Advanced capacity level (Figure 29). 13 Members report having inadequate end-to-end flash flood forecasting services. In addition, 17 Members indicate having inadequate end-to-end drought forecasting/warning systems and only six are providing those services at a Full/Advanced capacity level.

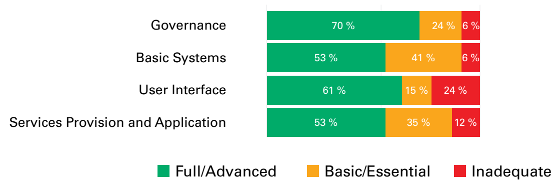


Figure 28 WMO Member capacities across the value chain in Europe, by component, calculated as a percentage of functions satisfied in each component area, across 34 WMO Members providing data, categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) of functions satisfied, respectively.

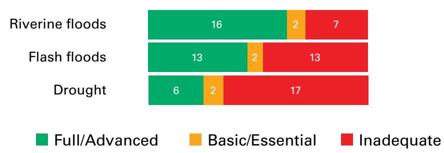


Figure 29: Number of WMO Members in Europe with early warnings available to the population at risk, by hazard type, based on data from WMO Members providing data. Member capacities are categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) according to the estimated percentage of the population at risk that receive EW. Note: For each hazard, the category 'Inadequate' includes Members (providing data) reporting that no end-to-end EWS for the hazard is in place, as well as those whose end-to-end EWSs do not reach more than 33% of the at-risk population.

81 The Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019), WMO, 2021.
82 The Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2019), WMO, 2021.
83 The Republic of Moldova Updated First NDC.
84 Based on data available from http://iwrmdataportal.unepdhi.org.

SIDS

SIDS lost US$ 153 billion due to weather-, water-, and climate-related hazards since 1970 – a very significant amount given that the average GDP for SIDS is US$ 13.7 billion.

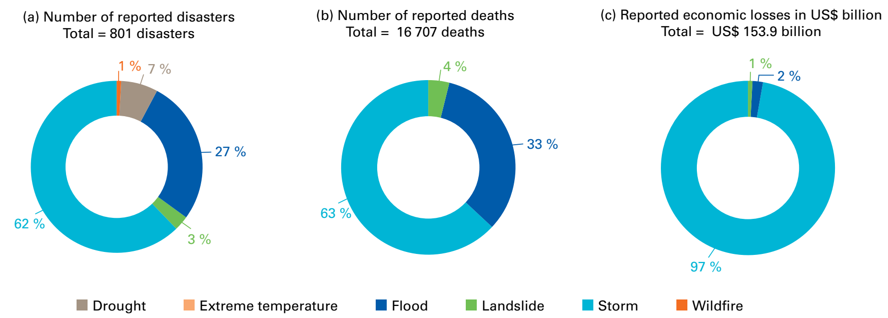


Figure 30: Overview of weather-, water-, and climate-related disasters, deaths and US$ economic losses reported in SIDs (1970-2019).

A total of 801 weather-, water-, and climate-related disasters and 16,707 disaster-related deaths were recorded in the SIDS in the past 50 years from 1970-2019. During this period, storms were by far the deadliest and most costly hazard for SIDS. Floods accounted for 27% of disasters, 33% of deaths and 2% of economic losses while drought accounted for 7% of disasters and 1% of economic losses (Figure 30)[85].

Overview of Hydrological capacities

As of August 2021, 17 SIDS have submitted updated NDCs, 12 of which mention water as a top priority, and eight specifically mention climate services, with a specific mention to data collection and management. For example, Suriname[86] indicated the importance of climate data and information for supporting the planning of climate change adaptation measures at local and national levels.

WMO data are available for 11 SIDS (19% of all SIDS[87]), including advanced and less advanced countries, the latter often possessing very minimal capacities. Overall, SIDS have the lowest level of hydrological capacity compared to the global average. On average, only 21% of the Members are providing hydrological services at a Full/Advanced level, with the majority of Members' (64%) having an Inadequate level of interaction with information users (Figure 31). Services Provision and Application, as well as Basic Systems capacities are also lagging among SIDS. More data are needed to clearly understand the hydrological services gaps that SIDS face, however.

Based on IWRM implementation data from 35 SIDS in 2020 (SDG 6.5.1), 28 countries (80%) generally have inadequate capacity to effectively implement most IWRM elements. The IWRM implementation average score for SIDS has only increased from 38 in 2017 to 40 in 2020 (out of 100), so the rate of progress needs to significantly accelerate to achieve SDG target 6.5 by 2030.[88]

The available data identify considerable gaps in forecasting and warning services for SIDS, and further work is needed. Most of the SIDS that provided data report having inadequate forecasting/warning services in place for riverine floods, flash floods, and drought. For example, nine SIDs out of the 11 providing data to WMO reported having inadequate flash flood forecasting/warning services and only one SIDS (Figure 32) reported providing those services at a Full/Advanced level capacity.

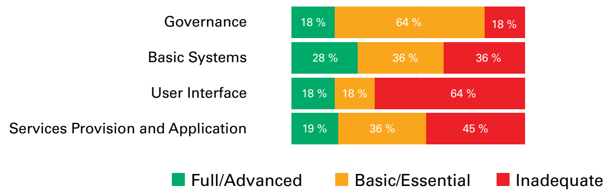


Figure 31: WMO Member capacities across the value chain in SIDS, by component, calculated as a percentage of functions satisfied in each component area, across 11 WMO Members providing data, categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) of functions satisfied, respectively.

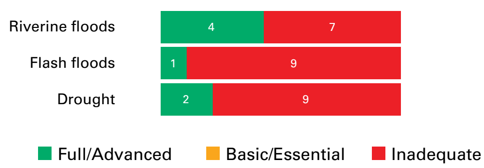
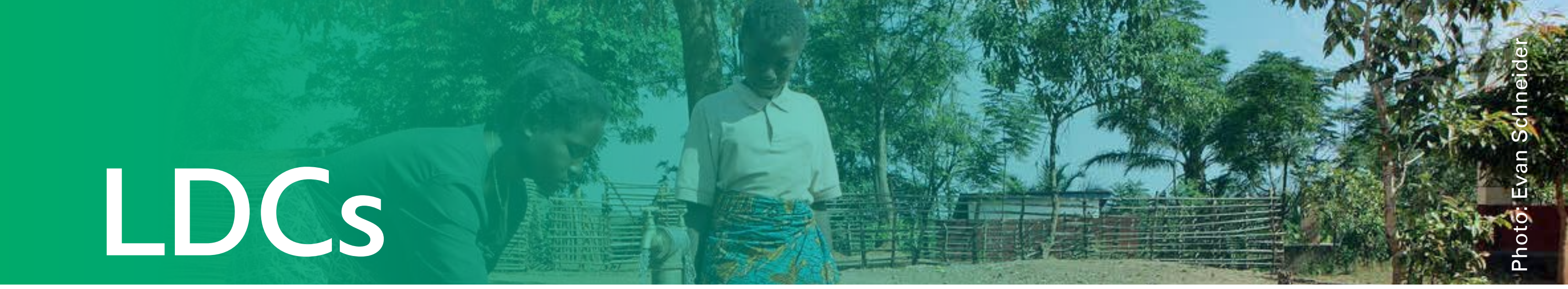


Figure 32: Number of WMO SIDS Members with early warnings available to the population at risk, by hazard type, based on data from WMO Members providing data. Member capacities are categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) according to the estimated percentage of the population at risk that receive EW. Note: For each hazard, the category 'Inadequate' includes Members (providing data) reporting that no end-to-end EWS for the hazard is in place, as well as those whose end-to-end EWSs do not reach more than 33% of the at-risk population.

85 2020 State of Climate Services report, WMO, 2020.
86 Suriname Second NDCs.
87 https://www.un.org/ohrlls/content/list-sids
88 Based on data available from http://iwrmdataportal.unepdhi.org.



LDCs

Around 70% of deaths associated with weather-, water- and climate-related hazards, reported from 1970-2019 occurred in LDCs.

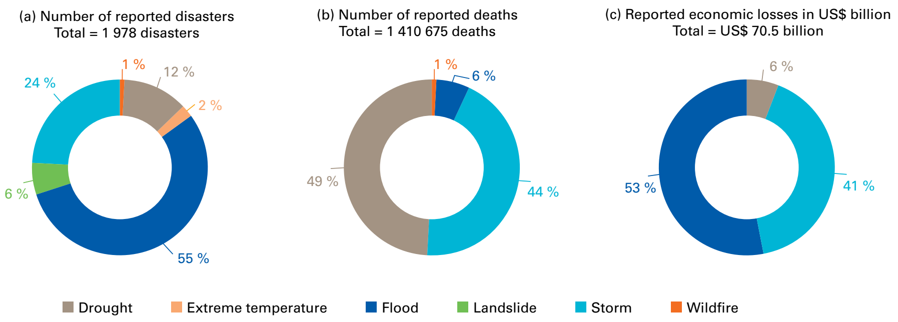


Figure 33: Overview of weather-, water-, and climate-related disasters, deaths and US$ economic losses reported in LDCs (1970-2019).

Around 70% of deaths associated with weather-, water-, and climate-related hazards, reported from 1970-2019 occurred in LDCs – with droughts and floods the deadliest and most costly hazards respectively during that period. The majority of drought-related deaths were recorded in African LDCs and the largest flood-related economic losses occurred in Asian LDCs. Drought accounted for 12% of weather-, water-, and climate-related disasters, 49% of deaths, and 6% of economic losses, and floods 55%, 6%, and 53%, respectively, in the past 50 years (Figure 33)[89].

Overview of Hydrological capacities

Most LDC's NDCs highlight the need for better data collection and management, observing systems, forecasting, capacity development, and user interface platforms to support their adaptation efforts in the water sector.

WMO data from 20 LDCs, representing 44% of LDCs globally[90], show that hydrological capacity in the LDCs is slightly higher than that of SIDS. On average, 35% of LDCs provide hydrological services at a Full/Advanced level. Interaction with users is the weakest link in the value chain, with 40% of Members having Inadequate interactions with information users (Figure 34). Services Provision and Application is also lagging among LDCs with only 25% of Members providing services at a Full/Advanced level.

Based on IWRM implementation data from 43 LDCs in 2020 (SDG 6.5.1), 29 countries generally have inadequate capacity to effectively implement most IWRM elements. The IWRM implementation average score for LDCs has only increased from 37 in 2017 to 42 in 2020 (out of 100). Therefore, the rate of progress needs to significantly accelerate to meet SDG target 6.5 by 2030.[91]

The available data show that LDCs lack adequate forecasting/warning services. Only three LDCs out of the 20 providing data to WMO reported having drought forecasting/warning services that are providing those services at a Full/Advanced level (Figure 35). Given the historical impacts of drought with respect to mortality across all LDCs it is important to strengthen the existing end-to-end drought forecasting/warning systems in countries possessing inadequate levels of capacity to provide those services (Figure 35).

Of the 15 countries providing data, 10 reported having inadequate riverine flood end-to-end forecasting/warning services and only five are providing those services at a Full/Advanced level.

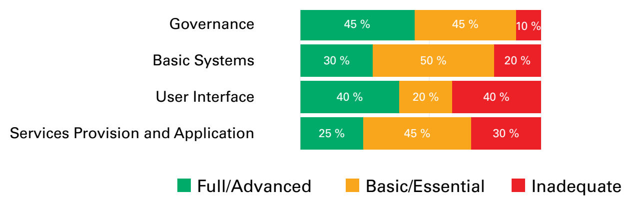


Figure 34: WMO Member capacities across the value chain in LDCs, by component, calculated as a percentage of functions satisfied in each component area, across 20 WMO Members providing data, categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) of functions satisfied, respectively.

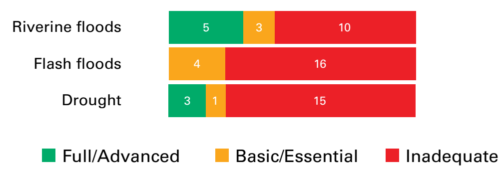


Figure 35: Number of WMO LDC Members with early warnings available to the population at risk, by hazard type, based on data from WMO Members providing data. Member capacities are categorized as Inadequate (0-33%), Basic/Essential (34-66%), and Full/Advanced categories (67-100%) according to the estimated percentage of the population at risk that receive EW. Note: For each hazard, the category 'Inadequate' includes Members (providing data) reporting that no end-to-end EWS for the hazard is in place, as well as those whose end-to-end EWSs do not reach more than 33% of the at-risk population.

89 2020 State of Climate Services report, WMO, 2020.
90 https://unctad.org/topic/least-developed-countries/list
91 Based on data available from http://iwrmdataportal.unepdhi.org.

Photo: Swarnim Prandham

CASE STUDIES
WATER MANAGEMENT

Reliable and actionable information for water management ahead of Hurricanes Eta and Iota in Honduras

The Group on Earth Observations (GEO) Global Water Sustainability (GEOGloWS) Streamflow Forecast service is a worldwide application of the global runoff forecasts from the European Centre for Medium-range Weather Forecasts (ECMWF) that transforms runoff into river discharge forecasts for every river in the world.

CHALLENGE

The Valley of Sula is prone to flooding, mainly during the rainy season and during storms such as Hurricanes Eta and Iota, as it drains more than 22 000 km^2. The only major river control structure in the upper basin is the El Cajón Dam, officially known as Central Hidroeléctrica Francisco Morazán, which controls 39% of the water contribution to the valley. The Honduran state power company, Empresa Nacional de Energía Eléctrica (ENEE), manages this massive hydroelectric dam and is responsible for the generation, distribution, and commercialization of electricity in the country.

With the arrival of the Eta and Iota storms in 2020, the El Cajón Dam reached maximum storage capacity. As of October 30, 2020, when inflow to the reservoir averaged 450 m3 / sec, the reservoir level was 272.60 m above sea level. With Eta's arrival, the water elevation increased by 13.35 m, surpassing the 285 m maximum reservoir level.

APPROACH

With Iota approaching, ENEE accessed available sources of information to ensure the population's safety in the valley and minimize economic losses for the country. Although ENEE had access to forecasted precipitation from the Central America Flash Flood Guidance (CAFFG) system for Central America, the maximum forecast provided (24 hours) was not enough information to estimate the amount of runoff that Iota was to bring 13 days later.

Partners at AmeriGEO, the regional community of the Group on Earth Observations (GEO) for the Americas, informed ENEE about the available 15-day discharge forecast from the GEOGLoWS-ECMWF Streamflow Forecast service provided directly from the web.[92]

ENEE used the discharge forecast to manage the reservoir levels before Iota's arrival. With the priority being to make room and recover reservoir storage capacity, ENEE used the GEOGloWS Streamflow Forecast to define a series of low water releases between the storms, while following the discharge protocols, requiring not to exceed the maximum of 1000 m3/sec discharge. A total of 185.95 million m3 were released before Iota's arrival, creating enough storage in the reservoir for the runoff Iota brought from the upper basin.

RESULT

The use of the GEOGLoWS-ECMWF Streamflow Forecast service avoided severe socio-economic losses in the Sula Valley. Without the controlled water releases prior to Iota, power generation would have been stopped when the level reached 290.20 m above sea level; the reservoir level would have reached 295 m above sea level, and 93.87 million m3 would have been released through the free spillway of the dam, leading to a greater disaster.

Power outage and flooding would have affected the agricultural and industrial productivity of the valley that generates about 65% of national GDP, representing over 50% of the country's exports. Direct and indirect impacts to the roughly two million people (30% of the national population) residing in rural and urban areas within the valley would have been incalculable.

Comparing the economic losses for Hurricane Mitch[93] in 1998 (US$ 3 793.6 million), and Hurricane Eta and Iota in 2020 (US$ 2 171 million), losses were reduced by 40% in 2020.[94] Some of this reduction was due to the implementation of DRR measures and differences in the nature of the hazards. However, considering that El Cajón Dam is the only structure in place capable of controlling the massive amount of runoff to the Sula Valley, the benefits of the use of the GEOGloWS-ECMWF information in ENEE's reservoir management during Hurricanes Eta and Iota were considerable.

Power outage and flooding would have affected the agricultural and industrial productivity of the valley that generates about 65% of GDP.

Partners

GEO, GEOGloWS Initiative, AmeriGEO, and ENEE-Honduras.

92 https://geoglows.ecmwf.int.
93 Economic Commission for Latin American and the Caribbean, 1998.
94 Banco Interamericano de Desarrollo, Comisión Económica para América Latina y el Caribe: Evaluación de los efectos e impactos de la tormenta tropical Eta y el huracán Iota en Honduras.

Photo: Alex Mccarthy

CASE STUDIES
WATER MANAGEMENT

Addressing climate change risks on water resources in Honduras

A wide range of measures have been introduced to protect residents and strengthen the country's climate resilience.

CHALLENGE

Water security and access is a major challenge in many areas of Honduras, with degraded watersheds affected by deforestation and pollution of both surface and ground water. As climate change brings more extreme weather, residents in and around Honduras' capital city of Tegucigalpa increasingly struggle to cope with the deteriorating conditions.

In December 2009, the Water Law[95] and the National Plan Law in Honduras had been recently approved, which represented a unique opportunity to strengthen capacities for mainstreaming climate change into the country's inter-sectoral policy framework. However, despite the country's significant exposure to climate-related hazards and high vulnerability, no provisions had been made for mainstreaming climate change considerations into these norms or into related development planning process.

APPROACH

A UNDP project funded by the Adaptation Fund supported the government to target 13 urban communities in the Tegucigalpa and the upper Choluteca watershed. The aim was to increase resilience to hydro-meteorological hazards among the most vulnerable populations in Honduras via a set of comprehensive interventions.

These targeted interventions ranged from flood protection to adaptive water supply measures, land use and agricultural practices. Activities focused on updating climate-related risk maps, establishing early warning systems, improving forest protection and developing a rainfall management plan for the upper Choluteca watershed. Additional activities involved piloting water pricing and risk transfer/insurance systems, providing training at national and municipal levels on integrating climate adaptation data in decision-making, piloting low-cost water storage facilities, stabilizing landslide areas, and fostering more efficient water use.

Legal frameworks were also harmonized by mainstreaming climate change adaptation issues into the development planning process. The national meteorological network was strengthened which enabled the integration of climate change adaptation into development.[96]

The National Hydrological Balance (NHB) – a vital resource for a range of adaptation options – was also updated to provide an overlay of climate variability (El Niño–Southern Oscillation) and climate change projections over short and medium-term periods. This information is being used to strengthen early warning systems (EWS) and other measures to prevent urban flash floods in Tegucigalpa caused by heavy rains.

RESULT

Honduras has increased its resilience at all levels as a result of this increased capacity. Now, a robust meteorological network, with 46 stations, produces strategic information in real time. The country also now has a set of technical and policy tools aimed at increasing resilience to climate change. These included the establishment of a technical platform that allows the coordination between the different agencies and institutions and strengthens the national meteorological network.

Overall, there have been 119,271 direct and indirect beneficiaries. More than 800 technicians have been trained in climate resilience, 13 000 residents are now covered by four EWS, and five policies have been introduced or adjusted to address climate risks. Elsewhere, 60,000 hectares of forest corridors have been protected, and 3,500 families are benefitting from rainwater harvesting systems.

13 000 residents are now covered by four EWS and supported by 46 meteorological stations across Honduras.

Partners

Adaptation Fund, UNDP and the Secretariat for Natural Resources and Environment (SERNA).

95 In December 2009, Honduras approved a new national Water Law that provides the framework for responding to the challenges faced by this sector. Under the Law, a new Water Authority has the mandate over water resources management, but also, as the Text of the Water Law states: the Water Authority has a mandate over water, ecosystems and their (Natural) Resources.
96 An assessment carried out by WMO in 2005 to define requirements for strengthening the national meteorological network was the basis for detailing investment and equipment needs.

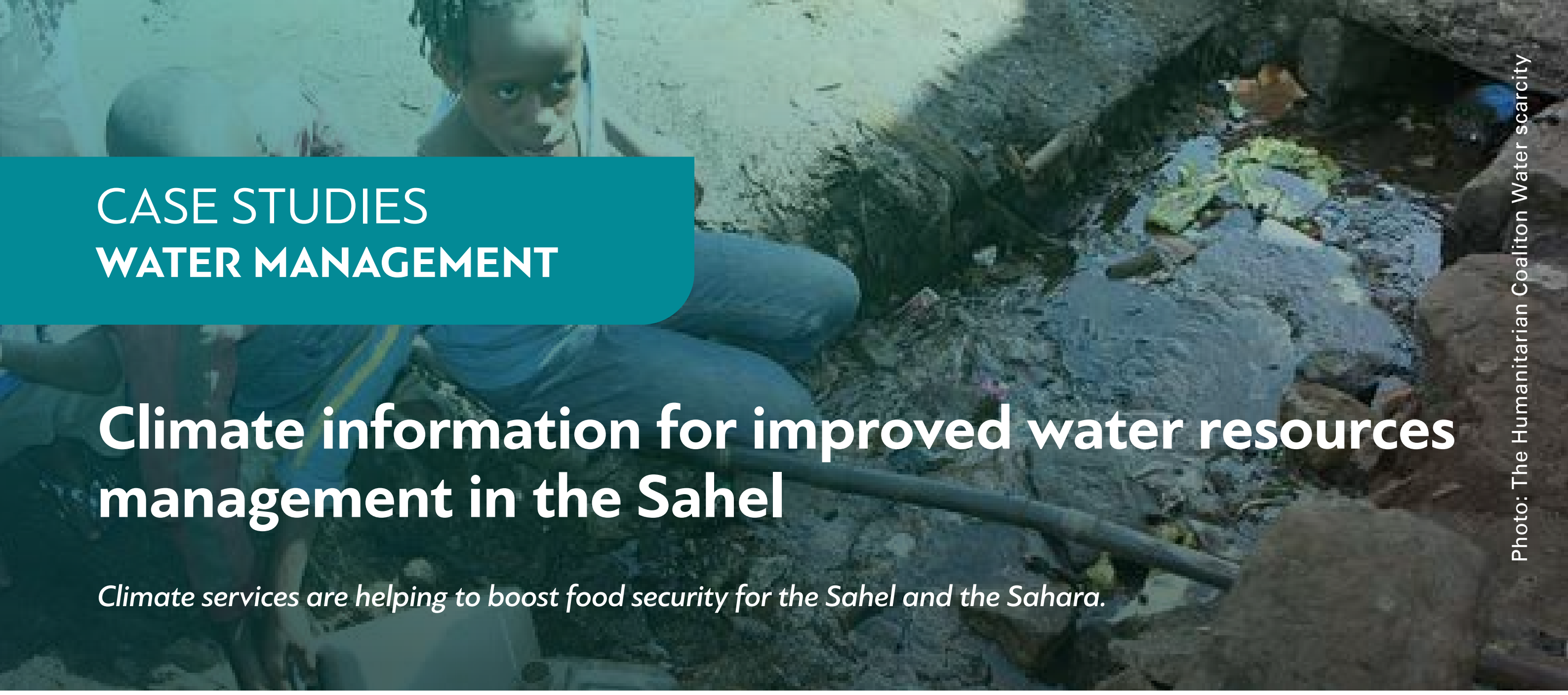


Photo: The Humanitarian Coaliton Water scarcity

CASE STUDIES
WATER MANAGEMENT

Climate information for improved water resources management in the Sahel

Climate services are helping to boost food security for the Sahel and the Sahara.

CHALLENGE

Drought and desertification are a real problem for communities across the Sahel and Sahara. Lack of rain can lead to a very low survival rate of seedlings, the destruction of the cereal crop and disappearance of livestock.

APPROACH

The Great Green Wall Initiative (GGWI) has been conceived as a model to help in the fight against drought and desertification, ensure ecosystem restoration and the development of arid and semi-arid zones in the Sahel.

By 2030, the Great Green Wall aims to sequester 250 million tons of carbon, restore 100 million hectares of currently degraded land, and create 10 million jobs. Twenty countries across the region are now involved in the initiative, supported by a broad set of international partners.

The GGWI of the Sahara is contributing to tackling climate change impacts, including drought, through:

- Energy transition: Boosting local community access to renewable energy for basic household needs as well as communal and production needs;
- Infrastructure, cities and local action: Contributions to low-emission rural infrastructure at scale (irrigation, energy, market access);
- Resilience and adaptation: Building climate risk into a sustainable production of high value drylands products to connect local producers to international markets; and
- Youth and citizen mobilization: A GGW public awareness campaign has been launched to create a global movement targeting global citizens behind a rousing call to 'grow a new world wonder'.

Through the use of climate information, the GGWI is supporting thousands of communities to access food security through land and water restoration and providing training to farmers to access climate resilient technologies.

RESULT

Climate information has played a significant role in improving the management of water resources and making the agriculture sector in the Sahel more resilient. In certain countries, such as Senegal, the establishment of a warning system to cope with climate uncertainties helps to provide advice to farmers on sustainable agricultural practices. For example, innovative practices, such as reviving the roots of plants and trees and digging half-moon pits on the ground to store water and hold moisture more efficiently to enable the percolation of water to the roots, have become more common.

Since the launch of the GGWI in 2007, key results include:

- Ethiopia: 15 million hectares of degraded land restored; land tenure security improved;
- Senegal: 25 000 hectares of degraded land restored; 11.4 million trees planted;
- Nigeria: 5 million hectares of degraded land restored, and 20 000 jobs created;
- Burkina Faso: 3 million hectares of land have been rehabilitated through local practices by community; and
- Niger: 5 million hectares of land restored, delivering 500,000 tons of grain per year enough to feed 2.5 million people.

Climate information has improved the management of water resources and made the agriculture sector in the Sahel more resilient.

Partners

African Union, FAO, GEF, IUCN, The World Bank, CILSS, EU, Royal Botanic Gardens Kew, Sahara and Sahel Observatory, and the UN.

Photo: Saikiran Kesari

Mobilizing communities to manage floods in north-western Thailand

To encourage the development of community-based flood disaster management in northern Thailand, the Global Water Partnership Thailand supported local governments to share knowledge with communities. The region now has a flood early warning system that helps communities to plan ahead and protect themselves.

CHALLENGE

Surrounded by waterfalls, hot springs, and freshwater creeks, and living with rains that last eight months each year, the people in Thailand's lively border town of Mae Sot understand water. Three main creeks flow through the municipality's valley basin before converging to form the Moei River, which marks the border between Thailand and Myanmar. These waterways have always naturally flooded, but as the town has grown, the removal of riverine trees and paving of roads and parking lots has altered water flow courses and decreased seepage into the ground. On top of this, climate change has increased the intensity of rainfall in the region.

Mae Sot suffered its worst flood to date in 2012, when the Mae Sot Reservoir overflowed and, without warning, flooded more than 10 villages along the banks of the Moei River. The Mae Sot municipality was declared an emergency zone. A €2 million concrete levee that had been constructed by the municipality without consulting the community appeared to worsen the flooding. This lowered local communities' trust in the involved government agencies.

APPROACH

In 2014, Global Water Partnership Thailand (GWP Thailand), supported by the Water, Climate and Development Programme (WACDEP), promoted a community-based approach to bridge the gaps between the remits of the state authorities and Mae Sot's 20 local communities. The aim was to implement a sustainable community-based flood management solution and, ultimately, to mitigate flood risk in the town of Mae Sot.

To address a lack of knowledge about the causes of flooding in the region, GWP Thailand began its work in Mae Sot by leading programmes to educate local groups about the basin's natural water sources, flows, and interconnected subsystem ecology. A WACDEP project team-guided site visit led surveys of waterways using a participatory geographic information system, and plotted risk and safe areas on a map. This work consolidated local understanding of different sources of flooding. GWP Thailand also assisted the community in transforming the risk mapping results into risk reduction plans.

The idea to use LINE, a free, mobile phone-based communication application, as the platform for the flood early warning system surfaced during this collaboration. The application provided a means of rapidly sharing community observations and enhancing real-time communication throughout the basin.

RESULT

The discussions between community members and government authorities transformed how water policy is implemented in Mae Sot. Never again would the municipality repeat a project such as the €2 million concrete levee that neglected local inputs on how Mae Sot's water subsystems operate, leading in turn to exacerbated flooding. Since then, the municipality has engaged community members in reviews of water management project proposals, calling on their local knowledge to help shape flood mitigation strategies.

Mae Sot's flood early warning system benefits a population of over 200,000 people. Through WACDEP and GWP Thailand's support, Mae Sot and state authorities have opened up multidirectional flows of knowledge among the region's water stakeholders, ensuring that science at the national and provincial levels will be available to local communities and that local people's knowledge will drive the design of municipal initiatives.

Discussions between community members and government authorities transformed how water policy is implemented in Mae Sot.

Partners

Global Water Partnership Thailand and WACDEP.

CASE STUDIES
DISASTER RISK MANAGEMENT


Photo: Chris Galagher

Flood briefs for the UK Foreign, Commonwealth and Development Office (FCDO)

FCDO has been developing and testing impact-oriented flood early warning advice to international humanitarian actors in advance of, and during, live events.

CHALLENGE

Fluvial and coastal (surge) flooding is one of the most devastating hazards, often featuring multi-hazard events, including strong winds and heavy rainfall. The humanitarian impacts of these events are often long lasting. When driven by tropical cyclones, the devastation can be even larger due to catastrophic wind speeds, with loss of life, loss of livelihoods, and the spread of disease.

Anticipating the likelihood and the potential impacts of flood-related events is scientifically challenging. Impacts result from combined hazards (cyclone, rainfall and flooding), vulnerability and exposure of vulnerable populations.

Climate services by the Copernicus Emergency Management Service Global Flood Awareness System (GloFAS) are freely available and provide relevant information in real-time across the world. GloFAS offers probabilistic forecasts of fluvial flooding and their potential risk category with a lead time of up to 30 days for all major rivers of the world through a dedicated web interface; flood products designed with end-users in mind; and modelled data available in near real-time through data services such as the Copernicus Climate Data Store.

APPROACH

FCDO is piloting further development, and testing service delivery, of impact-oriented flood early warning advice to international humanitarian actors in advance of, and during, flood events. These flood impact forecast briefs build on science innovation and they provide an assessment of likely flooding risk (i.e. hazard, exposure and vulnerability) related to cyclone devastation in LDCs. The flood risk assessments made in the briefs are the result of the work of experts from a consortium of academic, consultancy and operational centres.

The pilot was activated for both cyclones Iota (November 2020, Central America) and Eloise (January 2021, Mozambique). The briefs draw on both fluvial flooding and coastal surge flooding based on the GloFAS climate service for fluvial flood forecasts and additional surge models from HR Wallingford for coastal flooding. Flood inundation and exposure mapping are generated with data from GloFAS, Fathom and the University of Bristol. Background information on weather forecasts (rainfall, wind, tropical cyclone track, etc.) is based on numerical weather predictions (NWP) from the European Centre for Medium-Range Weather Forecasts (ECMWF), consistent with the GloFAS forecasts, and provided as context to the briefs. Post-event satellite imagery is being used to refine exposure mapping and build confidence of the inundation mapping, as well as providing post-event verification.

RESULT

The pilot project has demonstrated feasibility and the success of the methodology, with high interest and feedback for future support from FCDO humanitarian teams, the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), and the Red Cross.

In the context of the support provided to prepare for Tropical Cyclone Idai, 2019, the Head of OCHA's Regional Office for Southern and Eastern Africa, said: "The bulletins were very helpful. They gave us an overview of which rivers were at greatest risk of flooding, and this helped inform where we gave the greatest attention to. We used them to help inform our daily briefings to partners, as well as in our public information products. All of this meant that the humanitarian community had far greater information, in real-time, about flood risks, than we have often had access to in the past."

Flood impact forecasts provide the humanitarian community with targeted information ahead of potential flooding, particularly highlighting where the worst impacts are likely.

Partners

ECMWF, Fathom, University of Bristol, University of Reading, HR Wallingford and FCDO.

Photo: Martin Brechtl

CASE STUDIES
DISASTER RISK MANAGEMENT

Effective drought management in Slovakia

Through a partnership with WMO and the Global Water Partnership Central and Eastern Europe, Slovakia has developed Central Europe's first drought action plan, creating a decision-support system for those with livelihoods on the front line of climate change

CHALLENGE

Slovakia, a country of mountains, lakes, dense forests, and fertile lowlands, would appear to be one of the last places to be concerned about climate change. Yet in the early 2000s, a series of hotter than normal summers raised an alarm among the country's farmers and weather monitoring experts. Rain was still falling, but water evaporated quickly in the hot weather. This left crops dry and reservoirs emptier and groundwater depleted. Drought had come to this normally cool, green country.

And the problem was regional: the whole of the transboundary Danube River basin was affected by the drying conditions. The impact was felt across sectors, from the productivity of vineyards to the movement of shipping barges and tourist river cruises.

APPROACH

In 2013, working with WMO, the Global Water Partnership Central and Eastern Europe (GWP-CEE) leveraged WACDEP funding to establish the Integrated Drought Management Programme in Central and Eastern Europe (IDMP CEE). Its aim was to assist governments to transition from reactive to proactive drought management. In practice this entailed management agencies' moving from focusing on clearing up forest fires and compensating farmers for a season of lost crops as one-off events, to learning how to know when – not if – drought was coming and how to prepare for and reduce its impacts.

Understanding that drought occurs in stages that sometimes go unnoticed, the stakeholders decided that early warning systems were needed. Additional funding from the European Union Interreg Danube Programme and DriDanube project[97] made it possible to set up a platform to collect and share broadly the region's weather, soil, crop, and forestry data in a public online space. IDMP CEE began recruiting a network of observer–reporters among farmers, fruit growers, vineyard keepers, and foresters.

RESULT

IDMP CEE established Drought Watch, a system that makes use of a set of earth observation data from a range of operational remote sensing satellites, data from meteorological stations, and drought impact reports to generate interactive maps of current conditions, providing up-to-date information that helps users of land and water to plan ahead.

With support from the IDMP CEE, in 2017, an inter-ministerial working group that included stakeholders from relevant sectors was tasked to prepare the region's first country-level Drought Action Plan, for Slovakia. The plan's designers looked closely at the preventive, operational, and crisis measures needed. Such measures included identifying drought-resistant tree species, surveying groundwater, designing new irrigation canals, expanding the monitoring network, and developing triage processes for disaster conditions. Having a cross-section of stakeholders engaged in developing the plan meant that the finished product was well understood by those who would be using it.

Focused on anticipation, prevention, and action, the Slovak Drought Action Plan has the potential to lead the way in mitigating the effects of Europe's changing climate.

Partners

WMO and the Global Water Partnership Central and Eastern Europe.

97 http://www.interreg-danube.eu/approved-projects/dridanube.


Photo: Kayla Kozlowski

CASE STUDIES

WATER & DISASTER RISK MANAGEMENT

The co-production of sub-seasonal forecasts across Tropical Africa to improve integrated water management and the resilience of people and economies to weather-related extremes

Sub-seasonal forecasts and advisories are providing new information which is aiding preparedness and disaster risk reduction decisions in key flood- and drought-vulnerable sectors in sub-Saharan Africa.

CHALLENGE

The lives and livelihoods of millions of people across tropical Africa are at risk due to weather-related extremes. Access to reliable, actionable weather information is key to improving the resilience of these populations and economies. However, the uptake and availability of accurate weather information and services, especially at the extended sub-seasonal timescale, remains very low.

Recent scientific advances in sub-seasonal prediction provide potential societal and economic benefits across sub-Saharan Africa. Improved understanding of the sources of sub-seasonal predictability, and their predictive skill across the region, is a necessary process to realize this benefit. However, it is becoming increasingly clear that truly realizing this potential, and translating that to have real societal benefit, requires a more collaborative co-production approach. Such an approach would shift the emphasis away from supply-driven forecast product development to a demand-led process which seeks to better understand and incorporate knowledge from the decision-making context of forecast users. To date, co-producing new forecast products and tools, through this iterative collaboration across a range of stakeholders and disciplines, has typically relied on project-initiated services and resources. However, sustaining such services requires significant continued investment and capacity building of all actors involved.

APPROACH

Through a real-time pilot of the WMO Sub-seasonal to Seasonal Prediction Project, the African-SWIFT and ForPAc projects are running a two-year, sub-seasonal forecasting testbed.[98] Launched in November 2019 in Kenya, the testbed has brought together national meteorological services, universities and forecast users in tropical Africa, to improve the appropriate use of sub-seasonal (1-4 weeks ahead) forecasts through a co-production approach.[99] This testbed has made real-time, sub-seasonal forecast data from the European Centre for Medium-Range Weather Forecasts available to users in a range of sectors, including energy and agriculture, across tropical Africa. Crucially, co-producing forecasts within a testbed shortens the timescale between the development of meteorological research and forecasting knowledge and its application in decision-making.

RESULT

The sub-seasonal testbed has been providing co-produced, tailored forecast products and advisories to weather-sensitive sectors across Africa. Examples here from users in the agricultural sector in Nigeria and energy sector in Kenya exemplify the local application and benefits of new testbed forecast products.

In Kenya, sub-seasonal forecasts co-produced by the Kenya Meteorological Department and KENGEN, a hydropower company, have resulted in improved planning decisions for sustainably including hydropower generation in the national power supply and dam management. Additionally, a Drought Early Warning System (DEWS) that is operated by the National Drought Management Authority (NDMA) has incorporated testbed soil moisture forecasts into the DEWS Kitui County monthly bulletin.

Tailored, co-produced forecast information provided by the Nigerian Meteorological Agency (NiMet) to farmers has improved decision-making, supporting national ambitions to achieve food security for Nigeria's growing population. Prior to the testbed, farmers in Nigeria made their decisions without the support of local weather information. To improve this, the Climate Change Adaptation and Agribusiness Support Programme (CCAASP), now works with NiMet to provide forecasts to 663 village areas and approximately 104 local communities across seven states, supporting more than 10 500 farmers in 2020.

In Kenya, sub-seasonal forecasts have resulted in improved planning decisions for sustainably including hydropower generation in the national power supply and dam management.

Partners

WMO World Weather Research Program.

98 Hirons et al. 2021: Using co-production to improve the appropriate use of sub-seasonal forecasts in Africa.
99 Carter, S., Steynor, A., Waagsaether, K., Vincent, K., Visman, E., 2019: Co-production of African weather and climate services.

Photo: Adrian Infernus

CASE STUDIES

WATER & DISASTER RISK MANAGEMENT

Building capacity and strengthening Early Warning Systems and the integration of climate information in national policies in The Gambia

The Gambia's Climate Change Early Warning Systems is improving resilience, and the country is increasingly integrating climate information into national policies to address impacts in climate sensitive sectors.

CHALLENGE

The Gambia is one of the smallest and most densely populated countries in Africa. It relies heavily on its agriculture sector, which employs three-fourths of the population and accounts for one-fifth of the country's gross domestic product.[100]

Since the late 1960s, The Gambia has experienced increasing temperatures, shorter crop growing seasons, decreasing average annual rainfall, and changing rainfall patterns.[101] Key climate change concerns for The Gambia include drought, wind, coastal erosion, and sea level rise.

The Gambia is highly vulnerable to projected changes in climate and has a low capacity to adapt. This low capacity is due to the relatively low income of The Gambia's citizens and the country's low level of development. Several constraints inhibit the generation of climate risk and adaptation information, including insufficient quantity and quality of climate data collection and monitoring equipment; insufficient computing hardware and software to analyze climate data; and a shortage of qualified personnel to transform data into weather forecasts and early warnings. As a result, The Gambia lacks the ability to effectively predict climate events, assess potential impacts, and deliver short- or long-term warnings.[102]

APPROACH

With support from UNEP and the Least Developed Countries Fund (LDCF) of the GEF, The Gambia began to address climate change adaptation needs identified in The Gambia's National Adaptation Programme of Action (NAPA). The Gambia's hydrometeorological, climate information, and early warning systems (EWSs) was successfully strengthened to enable improved decision-making by the national government, local communities, households, and individuals in the face of climate change. Project activities took place in the Greater Banjul area, the North Bank region, and five other sites.

A number of partners helped to finance and carry out project activities. Primary financial support came from UNEP and the LDCF, with additional support from The Gambia itself.

RESULT

The project achieved success in three separate areas: improving the resources and capability of hydrometeorology personnel; engaging stakeholders to interpret and disseminate information; and integrating climate change into national policies and protocols.

In order to enhance the capacity of hydrometeorological services, the project supported a number of training activities. For example, the project sent three meteorologists to the United Kingdom's Met Office for an initial forecasting course.

The project also worked to improve technologies used by the Hydrometeorology Service. Infrastructure such as synoptic automated weather stations and high-capacity data processing and storage equipment were repaired, upgraded, or installed. An automatic weather station was installed in the Banjul International Airport to monitor wind and air pressure, enhancing the accuracy of measurements for the airport and Greater Banjul area. A new water-level recorder and flow monitor were installed on The Gambia River, marking the first time such flow data were collected.

At the national level, the project facilitated the integration of climate information into policies and decision-making processes. Climate change was considered in policies governing agriculture and natural resources management, such as the Agriculture and Natural Resources (ANR) Policy, the Forestry Sub-Sector Policy (2010–2019), and the Fisheries Strategic Action Plan (2012–2015).[103]

A new water-level recorder and flow monitor were installed on The Gambia River, marking the first time such flow data were collected.

Partners

Department of Agriculture, Government of The Gambia, National Environmental Agency, Government of The Gambia, UNDP, LDCF, UNEP, and Ministry of Water Resources, Fisheries & National Assembly Matters - Government of The Gambia.

100 CIA, Undated.
101 Jaiteh and Sarr, 2011.
102 UNEP-GEF, 2011.
103 Republic of the Gambia, Undated.

Photo: Markus Spiske

CASE STUDIES
AGRICULTURE

Climate services for anticipatory Community Contingency Funds in the Dry Corridor of Central America[104]

A financial mechanism is offering innovative risk protection for farming communities across the region.

CHALLENGE

The climatic conditions of Nicaragua, Honduras, El Salvador and a large part of Guatemala, an area known as Central America's Dry Corridor, are characterized by recurrent droughts and increasing irregular rainfall. Rural livelihoods are affected by significant harvest losses every three out of five production cycles and rural families are often left without enough food. In the area, around 62% of farming families rely on the production of staple grains but harvests rarely cover their nutritional requirements.

APPROACH

FAO, with the support of the Belgian cooperation, implemented an innovative risk protection and financial transferal mechanism, called Community Contingency Funds (CCFs),[105] to provide farm insurance to those families who cannot access the conventional financial system. A producers' association directly manages the resources and provides assistance to its members in emergency situations, such as in the case of sudden extreme climate events (e.g., droughts, hurricanes and floods).

Several activities can be funded through CCFs, once approved by the board of directors, which include coverage of household expenses during emergencies, purchase of supplies for the next agricultural season in the case of crop losses, and the provision of financial means for productive and commercial activities. Interest rates of interest paid by association members vary between 3-5%, while also non-members can apply for CCFs during emergencies at higher rates.

RESULT

In Guatemala, CCFs are activated through the Early Warning System known as Sitio Centinela (sentinel site) by the association's board of directors. Once an assessment is carried out on the availability and access to food and on the management of risk, a decision is taken to declare a state of emergency and the CCF is activated. In Honduras, the responsibility to declare an emergency resides with national-level Permanent Commission for Contingencies (COPECO) once the data provided by the Food Crisis Early Warning System (SATCA) and reported to the Municipal Emergency Committee (CODEM) are evaluated.

Access to CCFs has equipped the associations in both countries with rain gauges and thermometers to register monthly rainfall in millimetres and average temperatures. CCFs have the potential to support rural families with access to low-interest finance to meet nutritional needs compromised by the impacts of climate-related hazards.

> The Community Contingency Funds (CCFs) established in Central America's Dry Corridor allow association members to cover household expenses during drought and flood related emergencies at low interest rates varying between 3-5%.

Partners

FAO, Belgian Development Cooperation, Gobierno de Guatemala, Gobierno de Republica de Honduras.

104 http://www.fao.org/fileadmin/user_upload/emergencies/docs/Corredor_Seco_Breve_EN.pdf.
105 http://www.fao.org/3/i5623e/i5623e.pdf.

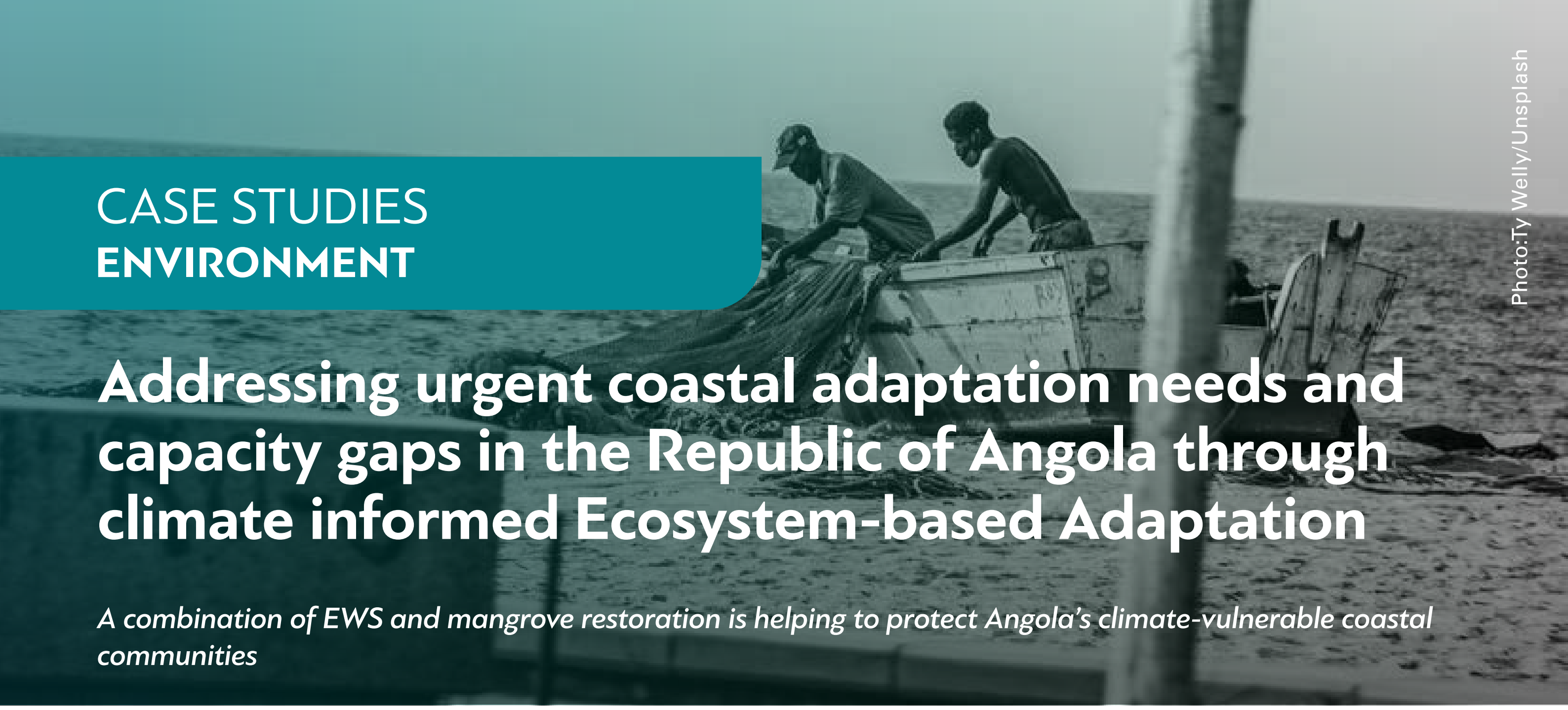


Photo:Ty Welly/Unsplash

CASE STUDIES
ENVIRONMENT

Addressing urgent coastal adaptation needs and capacity gaps in the Republic of Angola through climate informed Ecosystem-based Adaptation

A combination of EWS and mangrove restoration is helping to protect Angola's climate-vulnerable coastal communities

CHALLENGE

The Republic of Angola is the second largest country in sub-Saharan Africa. It has a highly diverse topography, covering flat coastal plains and a mountainous inland region. The coasts are vital for the country's economy, hosting around 50% of the population of 30 million.

In the past two decades, Angola has experienced an increase in the frequency and intensity of extreme climate events such as drought and flooding. The poor living conditions of coastal communities will be exacerbated by rising seas and floods that damage coastal infrastructure and housing.

The fisheries sector is expected to be harmed by climate-related changes to river flows and water temperatures. For the agriculture sector, some climate scenarios project a reduction in crop yields by 2030. Approximately 85% of Angolans are employed in agriculture, which raises serious implications for the economy.

APPROACH

To help climate-vulnerable coastal communities, partners are using ecosystem-based adaptation (EbA) – a type of 'nature-based solution' that uses ecosystem services to reduce the negative impacts of climate change. In Angola the EbA incorporates climate information.

The main approaches used are:

- Establishing an early warning climate forecasting system (EWS) to help people prepare in advance for extreme weather
- Restoring wetlands and mangroves to provide flood defences
- Promoting climate-resilient land management techniques to mitigate the impacts of drought on livelihoods, and
- Integrating adaptation into national policy.

RESULT

A multi-sectoral Climate Vulnerability Assessment is being carried out for Angola's coastal zone. Local climate vulnerability assessments are being produced for each site to inform the EbA activities.

In addition to mangroves, riparian ecosystems are being restored, which includes the clearing of water channels. These interventions provide multiple benefits such as reduced severity of flooding and improved filtration and quality of fresh water. Stabilizing riverbanks with vegetation also lead to increased soil fertility to support agriculture.

Climate-resilient land management techniques are being transferred to coastal communities in four sites. This involves adopting climate-resilient crops, waste management practices, and water quality monitoring. At least 500 people will be trained in EbA and climate-resilient land management to ensure long-term benefits are realised.

The EWS, which is being established in Benguela province, is supported by nine hydrometeorological stations, 20 automatic rainfall stations and one thunderstorm detector.Economic assessments are quantifying the impacts of climate change on Angola's coastal zone, disaggregated by sector. These studies are demonstrating and comparing the cost effectiveness of various adaptation responses. Building on the economic assessments and climate vulnerability assessments, a coastal zone adaptation plan is being developed.

Ecosystem-based Adaptation incorporating climate information and early warning is restoring wetlands and promoting the resilience of coastal communities.

Partners

UNEP, UNDP and GEF.

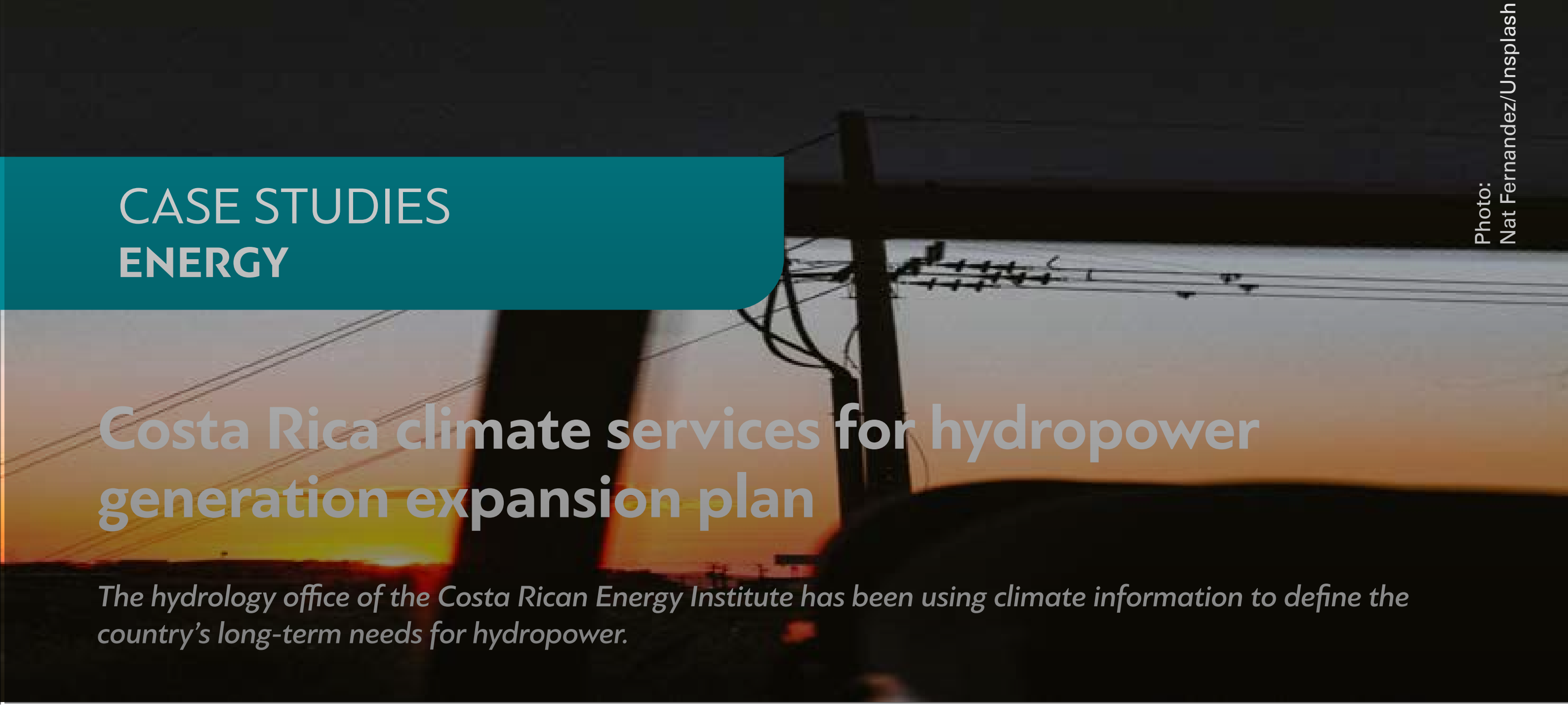


Photo:
Nat Fernandez/Unsplash

CASE STUDIES
ENERGY

Costa Rica climate services for hydropower generation expansion plan

The hydrology office of the Costa Rican Energy Institute has been using climate information to define the country's long-term needs for hydropower.

CHALLENGE

Costa Rica has a long history of hydropower supply based on the country's rich water resource and the proven capacity to exploit it economically and with environmental responsibility. The country's electricity generation in recent years has been almost 100% renewable.

In countries with a predominant dependence on hydroelectric systems, such as Costa Rica (66% of present capacity) it is necessary to count on reliable information regarding the occurrence of dry events, with associated probabilities, and the variability of other renewable sources (solar and wind). In these systems, critical situations are usually associated with water shortages in dry seasons.

Dependence on energy systems based on renewable resources, particularly hydropower, makes countries such as Costa Rica, extremely vulnerable to climate variability and change. To quantify the future availability of renewable energy sources is a complex problem because the past behaviour of the physical variables cannot be relied on in order to forecast possible future energy generation. Globally, by modelling future hydropower over seasonal cycles, a 40% reduction of hydropower generation due to climate variability has been estimated[106].

APPROACH

The hydrology office of the Costa Rican Energy Institute (ICE) was asked to contribute to the Generation Expansion Plan (PEG) to define the optimal investments necessary to satisfy the country's electricity demand. A 55-year record of monthly flow was used to represent the hydrology, corresponding to the historical record for the period 1965-2019. The PEG assumes that the effects of climate change that may occur in the next two decades are within the climate variability already contained in the system modelling for hydroelectric plants, which provide most of the country's generation.

Climate information also reveals that wind energy is a good complement to hydroelectric energy throughout the year, especially during the dry season. El Niño cycles (dry years) are associated to stronger wind patterns, which favour high wind power generation. During La Niña cycles (very rainy years), winds are weaker but there is more hydroelectric generation. This complementarity is also present in the annual horizon because the wind pattern in Costa Rica is stronger during the driest months than in rainy season.

RESULT

The PEG is defined as the reference framework for the medium and long-term planning purposes. This frame of reference informs the main actors of the electricity sector about the electricity development strategies that the country is analysing, the possibilities of the different technological options and the resource needs in the future. As climate change impacts are better quantified, successive revisions of the PEG will consider the inclusion of these effects into their analysis, the scope of which should encompass wind and solar in addition to hydrologic resources.

Costa Rica's energy generation system, composed mostly of variable renewable sources, requires backups to guarantee security in meeting the demand. These backups are provided in a more economically and efficient way by the hydropower plants with reservoirs and regulation capacity.

The scenarios evaluated show that for the period 2020 to 2035 the country will require an increased capacity ranging from 450 to 1255 MW. The cost has been estimated between US$ 390 and US$ 668 million. This considers the inclusion of projects based of different sources, predominantly solar, then wind, hydro and geothermal.

Based on information on climate variability and projected energy demand, for the period 2020 to 2035, Costa Rica will require an increased hydropower capacity ranging from 450 to 1,255 MW.

Partners

ICE, JICA and Interamerican Development Bank.

106 Costa Rican Energy Institute (ICE).

Photo: Matthew Henry/Unsplash

CASE STUDIES
ENERGY

Supporting decision-making across the hydropower sector

Hypeweb.smhi.se is supporting decision-making across the hydropower sector as companies pursue green energy targets.

CHALLENGE

Making the transition from fossil fuels to green energy is one of the main targets many countries face for addressing the mitigation goals of the Paris Agreement. The hydropower industry is one of the sectors with a big role to play, in producing renewable energy, finding new areas for business development and offering social-economic benefits. The required land and water exploitation, however, must also take other considerations into account, such as water regulation and how the building of dams affects ecosystems, communities and water availability for other purposes. New prospects and new regulation routines demand big investments and long-term planning, and hence, high-quality data regarding future water conditions.

APPROACH

Climate Services play a key role by providing hydropower companies the required knowledge to support prospecting, operation, and management decisions or wholesale and distribution market strategies. Hydropower companies mostly ask for past, present and future inflows to reservoirs, as well as snow storage and melt in mountainous catchments. Each drop of water counts for their business, while regulating potential ecological impacts from their operations. When helping with prospecting, future water needs of other societal sectors also matter in calculating potential water access for power production. New sites for hydropower plants are mainly sought for in South America, central Asia and India, while European hydropower plants are mainly concerned with seasonal forecasts for optimal regulation, as well as sediment transport affecting turbines and reservoirs capacity.

The Hypeweb.smhi.se water and climate service has emerged following years of development from a hydrological modelling approach into a global portal for hydrological predictions that support many societal sectors. The design and content of the service is based on experience gained in various R&D projects, through developing web-based static and operational services, with numerous user interactions over the years. Hypeweb.smhi.se provides answers for multiple time horizons for different operational and management approaches. Hypeweb.smhi.se offers two water services: the data delivery service with readily available data on-demand; and the consultancy service with tailored applications or assessments wherever needed.

RESULT

Hypeweb.smhi.se was found useful for decision-making, especially in areas with sparse data coverage. The service is appreciated for the large production chain from global observations, bias adjustment, hydrological modelling and water and climate indicator production – which all these components give a short-cut to scientifically sound data and information. Clients benefit from transparency, integrity and access to hydro-climatic data, metadata, open tools, and qualified support and guidance.

Hypeweb.smhi.se provides answers for multiple time horizons for different hydropower operational and management approaches.

Partners

Swedish Meteorological and Hydrological Institute.

Photo: Jimmy Chang

Investment

Climate finance reached an annual average of US$ 574 billion in 2017 – 2018, an annual increase of 24% compared to 2015-2016 levels. Just 5% of the global climate finance portfolio was allocated for climate adaptation initiatives, however[107]. Annual adaptation finance to the water sector was US$ 10 billion in 2017-2018 on average[108]. A further US$ 0.8 billion was channelled to projects in the water sector targeting both mitigation and adaptation benefits.

In 2020, Multilateral Development Banks (MDBs) provided US$ 16.1 billion in total adaptation funding, out of which US$ 2.7 billion was invested in water and wastewater systems projects, accounting for just 14% of the total MDB investment in adaptation projects in low- and middle-income economies.[109]

Official Development Assistance (ODA) specifically for SDG 6 increased by 9% over the period between 2015 to 2019 in terms of financial commitments[110]. Yet actual ODA disbursements to the water sector remained stable at US$ 8.8 billion, despite increased funding needed to meet SDG 6 targets under the SDG6.[111] Only about 3% of total water sector ODA goes to water resources conservation, encompassing data collection; creation and sharing of water knowledge; conservation and rehabilitation of inland surface waters (rivers, lakes, etc.), ground water and coastal waters; and the prevention of water contamination[112].

While there has been a trend towards increasing concessional loans compared to grants across all countries, loan repayment for low-income countries may pose a higher burden and risk if institutions are weak and measures for cost recovery are not in place in these countries. [113]

Examples of current financing for climate services for water include:

Adaptation Fund (AF)

The AF portfolio consists of a total of US$ 831 million going into 121 projects for adaptation across various sectors (as of April 2021). Of that total, 107 projects, totalling US$ 699 million, have hydro-met components. Those projects are geographically distributed as follows: US$ 286 million in Africa, US$ 99 million in South America, US$ 156 million in Asia, US$ 26 million in Eastern Europe, and US$ 133 million in the Pacific, Central America and the Caribbean. The total invested specifically in hydro-met components is US$ 58 million, of which US$ 30 million is directed to Africa, US$ 8 million to South America, US$ 11 million to Asia, US$ 3 million to Eastern Europe, and US$ 6 million to the Pacific, Central America and the Caribbean.

Agence Française de Développement (AFD)

The AFD portfolio includes 25 projects with hydro-met components, corresponding to €173 million invested in the most vulnerable countries. Most of the invested funds flow to Africa with €123 million invested in hydro-met activities, followed by Southeast Asia, with a total of €44 million invested. Furthermore, a total of €136 million has also been invested to address water-related activities in those projects. Africa dominates the portfolio with a total fund of €87 million going towards water-related activities, followed by Southeast Asia, with €44 million. AFD's portfolio also includes 10 research-focused projects with over €2 million invested in hydro-met-related studies, and €1 million in water-related activities of those studies.

Climate Risk and Early Warning System (CREWS) Initiative

CREWS was established in 2015 as a financial mechanism to save lives and livelihoods through the expansion of early warning systems and services in LDCs and SIDS – the world's most vulnerable countries. As of 2020, 57 countries were being assisted through CREWS projects, and more than a million people are to be better protected from drought, sand and dust storm, and community-based early warning and response mechanisms that were developed, established or piloted. The CREWS portfolio includes 13 regional and country projects of which a total of US$ 49 million has been invested to strengthen climate services and early warning information systems in LDCs and SIDS countries. Africa dominates the portfolio with a total of US$ 29 million followed by the Pacific (US$ 8 million) and the Caribbean (US$ 7 million). More specifically, 92% of the projects focus on flood EWS with an investment of US$ 47 million, while 54% of projects focus on drought EWS with an investment of US$ 22 million, respectively.

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107 Updated View on the Global Landscape of Climate Finance 2019, Climate Policy Initiative (CPI). The Landscape aims to comprehensively track domestic and international investment from both the public and private sectors in activities that address and respond to climate mitigation and adaptation actions.

108 This finance captures water supply and sanitation, wastewater treatment infrastructure projects with primarily adaptation benefits, as well as other policy and capacity building activities, source: CPI.

109 2020 Joint Report on Multilateral Development Banks' Climate Finance.

110 SDG6 indicator 6.a.1 includes the following sectors: Water sector policy and administrative management; Water resources conservation (including data collection); Water supply and sanitation - large systems; Water supply - large systems; Sanitation - large systems; Basic drinking water supply and basic sanitation; Basic drinking water supply; Basic sanitation; River basin development; Waste management/disposal; Education and training in water supply and sanitation; Agricultural water resources; Hydro-electric power plants.

111 UN-Water, 2021: Summary Progress Update 2021 – SDG 6 – water and sanitation for all. Version: July 2021. Geneva, Switzerland.

112 OECD purpose code 14015.

113 UN Water, Summary Progress Update 2021: SDG 6 - water and sanitation for all, March 2021.

European Investment Bank (EIB)

Between 2016 and 2020, the EIB invested €6.4 billion in climate change adaptation activities, of which 78% were in the EU and 22% outside the EU. Projects contributing to adaptation span sectors including bioeconomy, energy, health, transport, urban and regional development, waste management and water, among others. Around half of the investment (€3.4 billion) of adaptation financing stems from the water sector. These investments have supported activities such as flood protection, drought resilience, storm water drainage and water distribution efficiency. In 2020, EIB adaptation finance reached its record high, tripling from 2019 to a total of €2.4 billion and repr senting 10% of total climate action finance. The water sector contributed to half of this amount, totaling €1.2 billion. 37% of these water-related adaptation investments were made outside the EU.

Green Climate Fund (GCF)

Overall, there are 18 approved projects with GCF funding which are exclusively for the water sector. These are worth US$ 635 million. Within the water sector portfolio there are seven approved projects worth US$ 248.87 million in GCF funding which have components related to climate information and early warning (CIEWS). Other sectoral projects that involve water infrastructure, as well as CIEWS, have attracted a total of US$ 1.22 billion in GCF funding. This is a significant proportion of the GCF portfolio. Looking at the total project finance (including co-financing), US$1.5 billion is for water only projects, and just over US$10 billion is for other projects, including water infrastructure. The total of $11.5 billion is more than one-third of all GCF financing to date. However, the majority of these projects are adaptation projects. Most projects are medium, small or micro projects with only one large project in each category. Africa has approximately one-third of the projects in each category, while SIDS are disproportionately over-represented in the water only category. This shows the importance and high vulnerability of drinking water supply in the SIDS.

Global Environment Facility (GEF)

The GEF, through its Least Developed Countries Fund (LDCF) and Special Climate Change Fund (SCCF), has provided nearly US$ 900 million in grant funding for projects which include support for climate information services including early warning systems and hydro-met services. Out of this, approximately US$ 530 million has been channelled to nearly 90 projects that focus on the water sector addressing flooding and/or drought exacerbated by climate change. Most of this funding has been for LDCs. Since its inception, the LDCF and SCCF have financed nearly US$ 2 billion in grant financing and mobilized more than US$13 billion from other sources for more than 400 adaptation projects in 130 countries, including all LDCs and 33 SIDS.

World Bank (WB)

In 2021, World Bank funding that directly supports the strengthening of hydro-met and early-warning services exceeded US$1.1 billion, spread across more than 60 projects. Around US$18.5 million has been allocated by the Global Facility for Disaster and Recovery (GFDRR) as grants to countries for hydro-met/early warning activities. WB has also invested over US$5 billion in the water sector, supporting adaptation, strengthening national capacity for water management, flood preparedness and response, flood early-warning systems, and sustainable water use practices. Significant focus of these investments – within the scope of improving institutional capacity of water management organizations – is on the collection and analysis of hydro-met information and hydrometeorological modelling.

Photo: Fahad Al Rajaan

Funding in West Africa [114]

Data are available for 57 hydro-met related projects across West Africa with a total budget of approximately US$2 billion provided by AF, the World Bank, GCF, GEF, AFD, the European Union, the UK Department for International Development (DFID) and other bi-lateral donors. Around US$363 million of this is invested to address climate services and early warning systems, mainly focused on drought and floods.

34 of the 57 project documents contain enough detail to be analysed as to the extent to which the projects address the climate services value chain components. The results show that much of the funding goes to the climate services information system (Figure 36), the operational core system that supports the climate services value chain, with 88% of projects containing provisions to strengthen climate services information system operations.

The climate services value chain component most frequently addressed in these projects is also climate services information systems, followed by capacity development, due to the cross-cutting nature of these components (Figure 37). Just 26% of the projects have an activity that relates to research modelling and prediction, which is also receiving the least funding as compared to the other components.

Observing systems receive the second-largest amount of funds, but just 38% of the projects analysed provide funding for strengthening observations (Figure 37). Data from WMO Members in West Africa show that observing networks and data represent the most pressing needs for strengthening climate services for adaptation. The percentage of countries failing to satisfy even a Basic level of capacity in observing networks and data and data management is the highest as compared to the other value chain components. Observing systems have also been mentioned most frequently as a priority need in West African countries' NDCs.

Monitoring and evaluation of outcomes and socio-economic benefits of climate services was identified in the preceding analysis as a weak component in the value chain in the region. Monitoring and evaluation receives the second lowest funding in the value chain.

These statistics do not take into account the actual costs of these components, but rather demonstrate that, in principle, it is possible to identify funding allocations in relation to needs for strengthening the various components of the climate services value chain needed to support countries' adaptation priorities. The analysis shows that there is potential to more fully connect the policy, programme, and practice domains so that policies inform and create an enabling environment for programmes. As previously highlighted, there is a need to improve the systematic documentation of socio-economic benefits and outcomes associated with investments, to enable programme results inform policy more systematically.

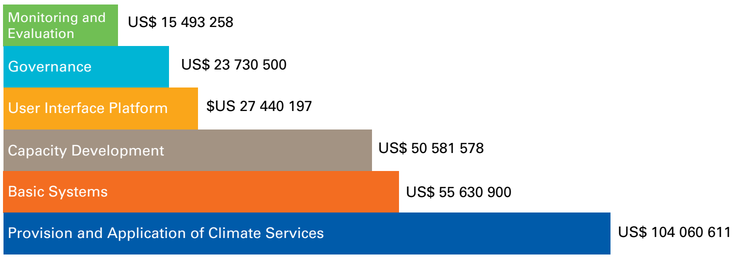

Figure 36: Funding addressing the various climate services value chain components (as identified in the 34 reviewed projects)

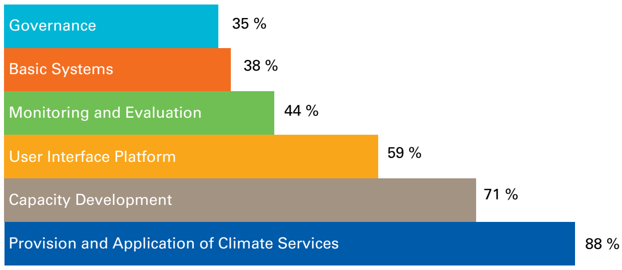

Figure 37: Percentage of projects addressing the various climate services value chain components plus observations (as identified in the 34 reviewed projects).

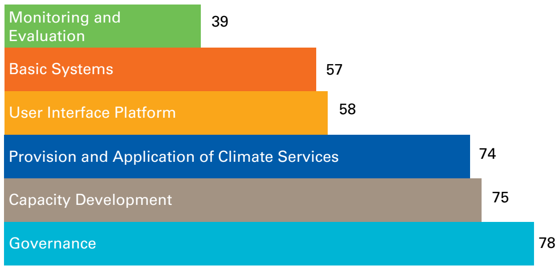

Figure 38: Overview of Climate services capacities in West Africa.

114 Much of the material in this summary, including Figures, is abstracted from: A methodology for assessing climate services' needs: West Africa case study, Veronica F. Grasso, Maxx Dilley, Amir Delju, Nakiete K. Msemo, Climate Services Journal, Elsevier, Volume 23, 100252 (2021).

Gaps

1. FEW COUNTRIES ARE ON TRACK TO HAVE SUSTAINABLY MANAGED WATER RESOURCES

Despite Integrated Water Resources Management (IWRM) being seen as vital to achieving long-term social, economic and environmental well-being, 107 countries will still not have sustainably managed water resources by 2030, according to UNEP.

2. 60% OF WMO MEMBER COUNTRIES DO NOT HAVE A GOOD LEVEL OF SERVICE TO DEAL WITH WATER CHALLENGES

The majority (79%) of NDCs mention water as a top adaptation priority. Yet, 60% of National Hydrological Services (NHSs) – the national public agencies mandated to provide basic hydrological information and warning services to the government, the public, and the private sector – for which data are available do not have a good level of service.

3. CAPACITY FOR EFFECTIVE INTERACTION WITH CLIMATE INFORMATION USERS IN THE WATER SECTOR IS INSUFFICIENT

The WMO assessment found a poor connection with users in the water sector, with only a minority of countries making their data available. There is inadequate interaction among climate service providers and information users in 43% of WMO Member countries. Aside from information on the already well-established benefits of EWS, systematically-collected information on the socio-economic benefits of climate services for the water sector in other aspects of water resource management appears to be practically non-existent.

4. DATA COLLECTION ON KEY VARIABLES IS INADEQUATE

There are significant gaps in water data collection. On average, data is not being collected for basic hydrological variables, such as water level and discharge, in 40% of WMO Member countries surveyed. Many NHSs lack continuous, automatic sensor-based water level monitoring, not to mention data transmission systems. And some NHSs cannot guarantee the maintenance, operation and repair of the existing stations, especially in remote areas. Hydrological data is being made available in just 33% of WMO Member countries.

5. A SMALL PERCENTAGE OF THE POPULATION AT RISK RECEIVES EARLY WARNINGS

Gaps remain in forecasting. End-to-end riverine flood forecasting and warning systems are absent or inadequate in 34% of WMO Members that provided data – with only 44% of Members' existing systems reaching more than two-thirds of the population at risk.

End-to-end drought forecasting and warning systems are lacking or inadequate in 54% of WMO Members that provided data – with only 27% of Members' existing systems reaching more than two-thirds of the population at risk.

6. EFFECTIVE INVESTMENT TO TACKLE WATER CHALLENGES IS NOT INCREASING ENOUGH

Official development assistance (ODA) is a means for implementing all aspects of SDG 6, including through investments in other sectors such as agriculture. Although ODA for the water sector increased between 2015 and 2019, actual ODA disbursements to the water sector remained stable at US$ 8.8 billion, despite increased funding needed to meet targets under the SDG6.

7. MORE DATA IS NEEDED

Data are currently available for 101 (61%) out of 166 WMO Members with Hydrological Advisors, including just 44% of the world's Least Developed Countries (LDCs) and just 19% of Small Island Developing States (SIDS). These data gaps inhibit the efforts of the international community to effectively support these most at-risk countries.

Recommendations

1. INVEST IN IWRM AS A SOLUTION TO BETTER MANAGE WATER STRESS, ESPECIALLY IN SIDS AND LDCS

IWRM is seen as being vital to achieving long-term social, economic and environmental well-being. Sustainable financing is needed to support the 107 countries that remain off track to hit the goal of sustainably managing their water resources by 2030.

2. INVEST IN END-TO-END DROUGHT AND FLOOD EARLY WARNING SYSTEMS IN LDCS, PARTICULARLY FOR DROUGHT EARLY WARNING IN AFRICA AND FLOOD EARLY WARNING IN ASIA

As the data in this report show, there are clear gaps in early warning systems and forecasting worldwide, but especially in LDCs in Africa and Asia, for droughts and floods respectively. Additional investments should be directed to these regions to establish and strengthen end-to-end warning and forecasting systems, enhance preparedness and build systems capacity for dissemination and communication of early warnings.

3. FILL THE CAPACITY GAP IN COLLECTING DATA FOR BASIC HYDROLOGICAL VARIABLES WHICH UNDERPIN CLIMATE SERVICES AND EARLY WARNING SYSTEMS

Observations of the hydrological cycle, producing real-time data, historical time series and aggregated data, are fundamental to deliver climate services for helping solve water challenges such as floods, droughts, water supply, governance, transboundary sharing, water quality or ecosystems. Therefore, Members need support to fill the gaps in the data collection of key hydrological variables.

4. IMPROVE INTERACTION WITH INFORMATION USERS

Co-develop and operationalize climate services to better support adaptation in the water sector. There is also a pressing need for better monitoring and evaluation of socio-economic benefits of climate services, which is critical for sustaining systems and services and attracting investment, and which will help to upscale effective practices.

5. FILL THE GAPS IN DATA ON COUNTRY CAPACITIES FOR CLIMATE SERVICES IN THE WATER SECTOR, ESPECIALLY FOR SIDS

Members' data on climate services for water is missing from 65 WMO Members and particularly from SIDS. Just 19% of SIDS provided data for this report which is insufficient to assess the state of SIDS capacities and climate services needs for water.

6. JOIN THE WATER AND CLIMATE COALITION[115]

in order to: inform policy development for integrated water and climate assessments, solutions and services and benefit from a growing network of partners that develop and implement tangible, practical projects, programs and systems to improve hydroclimate services for resilience and adaptation.

115 http://www.water-climate-coalition.org.

Photo: Marvin Kuhn

Annex

Climate Services Value Chain Components[118]:	Corresponding Functions
Governance	Is there a formal mechanism within your country or territory, to coordinate, on a regular basis, activities between the meteorological and hydrological services?
Governance	Is there any legislation within your country or territory (law, article or subsection thereof, decree or other legislative act) regulating hydrology (or hydrometeorology, or similar discipline)? • Law/Decree/Other
Governance	Does your country or territory have a flood management plan established or under development?
Governance	Is there a national committee or platform within your country or territory, coordinating disaster risk reduction activities with operational hydrology?
Governance	Is there a formal mechanism to coordinate activities with these Organizations/Institutions (responsible for hydro-monitoring) on a regular basis?
Governance	Does your institution/organization have the mandate to carry out the following activities in operational hydrology at the national level? • Hydrological data collection and management • Riverine flood forecasting • Flash flood forecasting • Hydrological forecasting (e.g. drought forecasting, base flow forecasting, water resources assessment) • Hydrological early warnings (not including forecasting)
Governance	Is there a Quality Management System (QMS) for hydrology in use in your country or territory?
Basic systems (Data collection and Data management)	Are discharge data currently collected under the responsibility of the institution?
Basic systems (Data collection and Data management)	Are groundwater level data currently collected under the responsibility of the institution?
Basic systems (Data collection and Data management)	Are water data of inland waters currently collected under the responsibility of the institution?

118 Governance; Basic Systems (Observing networks, Data collection and data management, Monitoring, Forecasting); Provision and Application of climate services; User Interface; Capacity development; and Monitoring and Evaluation.

Climate Services Value Chain Components:	Corresponding Functions
Basic systems (Data collection and Data management)	Please provide the name of the database management system used for hydrological data
Basic System (Forecasting)	Are there forecasting and warning services provided in your country or territory for the following hazards? • Riverine floods
Provision & Application of Climate Services	If applicable, which of the following functions are performed with the stream flow, rainfall and meteorological observations data received by real-time telemetry? • Trigger alerts from water level and/or rainfall at a gauge • Provided to decision support and/or emergency response
Provision & Application of Climate Services	Does your country or territory produce/provide the following services related to water resources assessment? • Assessment of the current availability of water resources/ or Assessment of the future availability of water resources at sub-seasonal to seasonal timeframe
Provision & Application of Climate Services	Does your country use flood hazard, exposure and vulnerability information to carry-out risk assessments at the national, provincial and local levels? • As input into emergency planning and development of warning messages • As input to flood risk reduction strategy development and implementation of risk reduction/prevention measures (e.g. construction of flood levees, dredging, designation of flood plain and land-use practices)
User Interface	What sectors does the institution deliver services to? • Water resources management • Water supply/sanitation • Energy • Agriculture • Disaster risk management • Navigation • Environmental protection
User Interface	How does the institution make its hydrological data available to users/ customers? • Via publications/reports/ Digitally via email • Through website display or download service • Via standardized web-services
User Interface	Is there a mechanism within the institution, to maintain relationships with users of its hydrological data to understand their needs and the levels of satisfaction with services provided? Is there a mechanism to maintain a relationship with users?

Photo: Abigail Keenan/Unsplash

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