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WORLD METEOROLOGICAL ORGANIZATION

TECHNICAL GUIDANCE ON APPLICATION OF CLIMATE INFORMATION FOR COMPREHENSIVE RISK MANAGEMENT

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For additional information, please contact:
United Nations Office for Disaster Risk Reduction (UNDRR)
7bis Avenue de la Paix, CH1211 Geneva 2, Switzerland, Tel: +41 22 917 89 08

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Contents

List of acronyms and abbreviations

CADRI	Capacity for Disaster Reduction Initiative
CCA	Climate change adaptation
CDD	Consecutive Dry Days
CMIP	Coupled Model Intercomparison Project
CMIP6	Coupled Model Intercomparison Project Phase 6
CPC	Climate Prediction Center
CRM	Comprehensive risk management
DRR	Disaster risk reduction
DRRM	Disaster Risk Reduction and Management
ECMWF	European Centre for Medium-Range Weather Forecasts
ENSO	El Niño-Southern Oscillation
ETCCD	Expert Team on Climate Change Detection and Indices
ET-SCI	Expert Team on Sector-Specific Climate Indices
EWS	Early warning systems
GCF	Green Climate Fund
GFCS	Global Framework for Climate Services
GHG	Greenhouse gas
GPC	Global Producing Centre
IBF	Impact-based forecast
IGAD	Intergovernmental Authority on Development
IPCC WGI	Intergovernmental Panel on Climate Change Working Group I
IPCC WGII	Intergovernmental Panel on Climate Change Working Group II
IPCC	Intergovernmental Panel on Climate Change
M&E	Monitoring and evaluation
MHEWS	Multi-hazard Early Warning System
NAP	National adaptation plan
NDC	Nationally determined contribution
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration
RCC	Regional Climate Centre
RCP	Representative Concentration Pathway
RiX	Risk Information Exchange
SDGs	Sustainable Development Goals
SFDRR	Sendai Framework for Disaster Risk Reduction
SMHI	Swedish Meteorological and Hydrological Institute
SPI	Standardized Precipitation Index
SSP	Shared Socioeconomic Pathway
UNDRR	United Nations Office for Disaster Risk Reduction
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization

01

INTRODUCTION

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1.1. Rationale for the guidance

Climate change is driving an increase in the frequency, duration, spatial extent, timing and intensity of climate extremes, which are consequently increasing the number of disasters.[1] For the purposes of this guidance, climate change is the change in the climate's state that can be identified by changes in the mean of its properties that persists for an extended period, typically decades or longer.[2] These persistent changes are affecting how disasters manifest, for the worst, in human, economic and natural systems. The imperative for climate and climate change data and information in disaster risk reduction (DRR) and integrating planning (including climate change adaptation [CCA]) is evident.

While there is now more scientific data and information on climate change than ever, there remains uncertainty in the information and in how best to translate it into effective planning, including for DRR. The longer the planning term, the greater the uncertainty. Climate change detected for the whole planet can also be traceable for a given locality. For the past and present, climate analyses are mainly based on observed climate variables, whereas for the future, climate projections derived from climate models are used. Both of these methods carry uncertainties. Most areas of application of climate information are multi-hazard in nature and comprehend various scales in both space and time, as in the case of DRR. Thus, a tailored approach is necessary to obtain, use and apply climate information to DRR and integrated planning.

This guidance aims to complement United Nations Office for Disaster Risk Reduction (UNDRR)-/co-led guidance and tools on comprehensive risk management (CRM),[3] for instance:

1. technical guidance on comprehensive risk assessment and planning in the context of climate change;[4]
2. guidance on promoting synergy and alignment between CCA and DRR in the context of national adaptation plans (NAPs);[5]
3. the Words into Action guide on developing national DRR strategies;[6]
4. the implementation guide for local DRR and resilience strategies.[7]

These guidelines and tools provide the necessary know-how to develop and strengthen a policy basis for DRR and risk-informed development. The present guidance provides pathways for climate information that is scientifically sound and publicly available. Ultimately, by accessing the best available up-to-date climate information, planners, risk managers and decision makers will be empowered to develop their strategies and plans, taking into account multiple climate-related hazards at different levels of uncertainty.

Current challenges for disaster and climate risk management require research, operations, implementation and policymaking communities, including state and non-state actors, to come together. Specific needs from the DRR community imply major challenges for climate information providers: to provide real-time climate data, which are required to support the implementation of EWS, early actions and monitoring-based decision-making, and to deliver timely, reliable and usable forecasts, predictions and projections for planning and strategy development. All available information should then be bridged into climate information systems to ultimately offer stakeholders the data that meet their needs. Such climate information production and delivery is the goal of the Global Framework for Climate Services.

1 IPCC, *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Valérie Masson-Delmotte and others, eds. (Cambridge, United Kingdom and New York, Cambridge University Press, 2021).
2 IPCC, "Annex I: Glossary", in *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Priyadarshi R. Shukla and others, eds. (Cambridge, United Kingdom and New York, Cambridge University Press, 2022).
3 UNDRR, "Comprehensive Disaster and Climate Risk Management". Available from https://www.undrr.org/climate-action-and-disaster-risk-reduction/comprehensive-disaster-and-climate-risk-management (accessed on 27 September 2023).
4 UNDRR, *Technical Guidance on Comprehensive Risk Assessment and Planning in the Context of Climate Change* (Geneva, 2022).
5 UNDRR, *Promoting Synergy and Alignment Between Climate Change Adaptation and Disaster Risk Reduction in the Context of National Adaptation Plans: A Supplement to the UNFCCC NAP Technical Guidelines* (Geneva, 2021).
6 UNDRR, *Words into Action Guidelines: Developing National Disaster Risk Reduction Strategies* (Geneva, 2019).
7 UNDRR, *Words into Action Guidelines: Implementation Guide for Local Disaster Risk Reduction and Resilience Strategies* (Geneva, 2019).

Presently available climate information comes in a wide range of formats, the use of which requires various levels of skills or competences. The emergence of climate information platforms and portals has made it possible to access a vast amount of climate information, spanning from historical records to future projections. However, using such information to develop climate risk management, NAPs and DRR strategies is not a straightforward process; it requires correct interpretation and periodic updates as our knowledge and understanding of climate change-driven hazards and their inherent risks evolve.

This guidance relies on programmes and initiatives developed by various partners within the United Nations system, including the partnership between the World Meteorological Organization (WMO) and UNDRR. The individual entities and the collective work towards the common goal of taking adequate climate change action, enabling society to reduce climate-related disasters while supporting the implementation of the Sendai Framework for Disaster Risk Reduction (SFDRR), the Paris Agreement and the 2030 Agenda for Sustainable Development, providing planners and decision makers with the most up-to-date climate information for their plans and strategies. This will also enhance implementation of initiatives such as Early Warnings for All, launched in November 2022 by the Secretary-General of the United Nations.[8] The success of this initiative in providing multi-hazard early warnings to reduce and avoid loss of life and livelihoods is dependent on data. This includes historic and current climate data that will determine the thresholds for triggers of EWS.

1.2. Intended audience

This guidance is primarily intended for national and subnational DRR focal points as well as planners, policymakers and strategy designers, and other DRR planning and policy experts who may not be specialists in the scientific aspects of climate change information or who are not necessarily familiar with use of climate information from multiple sources. It is also a resource for climate experts as key stakeholders and contributors to the development and updating of DRR plans.

1.3. Objectives

- To provide a general overview of the publicly available climate information and its use, scope and limitations, specifically for risk policymakers and planners
- To establish a framework for applying climate information for short-, medium- and long-term DRR planning purposes
- To outline and review existing climate products, data sources and tools to support the integration of climate information into DRR and short-term adaptation planning

1.4. How to use this guidance

The document has a continuous flow. **Section 2** describes fundamental climate concepts. **Section 3** explores spatial and temporal timescales and climate information sources. **Section 4**, where the analytical framework is formulated, provides an examination of how climatic and non-climatic information is intended to be integrated into planning. The annexes provide examples of available climate information that could be used with minor technical assistance.

8 The Early Warnings for All initiative was launched at the twenty-seventh session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC COP 27) held in Sharm el-Shiekh. For more information, see https://www.undrr.org/early-warnings-for-all.

02

KEY CONCEPTS

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This section uses specific examples to define climate and risk concepts. Insights on climate indices (which can be used to represent the status and variation of specific climate features, including changes in extremes in recent decades) are provided and a general view of climate change is discussed in the context of DRR.

2.1. Climate

For climate risk management, establishing the difference between weather and climate is essential. The climate is, in a sense, the statistics of weather; for example, the long-term mean of weather conditions in any given location. This is framed by a quote attributed to Mark Twain: "Climate is what you expect, weather is what you get." When statistically seen across time, weather variations result in what is known as climate. Whether climate is regarded as the statistics of meteorological variables or the long-term expectation in the occurrence of weather phenomena, it refers to the most probable set of events that will happen in a location in a specific period (a month, a season, a year or longer). Thus, two examples of climate are: (1) the mean daily maximum temperature of January in Taza, Morocco (15°C) and; (2) the annual average number of tropical cyclones in the North Atlantic basin between 1970 and 2010 (15 events). When observing the climate, occurrence of extreme events is normal; a complete description of the climate in each location includes both the mean conditions and the extremes.

Disasters resulting from weather-related hazards are most likely when they are extreme events, for instance, a tropical cyclone that produces extreme winds and precipitation values, causing damage to infrastructure and economic assets. If no preventive measures or early actions are in place to cope with such extremes, there can be costly impacts, such as loss of lives and assets.

By knowing the climate in geographic regions (such as in the examples of the mean daily maximum temperature in a month or the average expected number of tropical cyclones), it is possible to have a baseline that accounts for climate-related hazards.

As another example, the average frequency of hail observed over many years in a region would give a sense of the potential hazards for life and assets in terms of that specific weather phenomenon. Hence, historical records of the observed climate conform to a knowledge base of what usually happens, and precise variations around that baseline are then complemented by real-time predictions.

Each of the world's regions has a set of characteristic weather events, as well as specific behaviour in terms of climate variables. Such periodically observed events constitute what is considered normal and, within that normality, extremes will occasionally occur. However, such normality is what climate change is modifying; climate change is altering the frequency, intensity and duration of individual events in a trend expected to show major changes in the future. Therefore, the first step is to have an understanding of the climate in any region, before recognizing the climate normal, as a reference.

2.2. Climate normals

When the term "climate normal" is used, reference is made to the long-term mean of any climate variable, typically over a minimum of 30 years of data. According to WMO, climate normals are used for two principal purposes: (1) as a benchmark against which recent or current observations can be compared, including providing a basis for many anomaly-based climate data sets (for example, global mean temperatures); and (2) implicitly or explicitly, to predict the conditions most likely to be experienced in a given location. Such thirty-year periods constitute a climatological "normal standard period". For climate change studies, the "normal reference period" (1961–1990) has been recommended permanently, since it is considered a stable period.[9] For climatological normals in contexts other than climate change, averages for the last three decades are used (e.g., 1991–2020 for the latest normal period). Climate normals may be presented in graphical form depicting the most measured climate variables, temperature and precipitation (Figures 1 and 2).

9 WMO, *Guide to Climatological Practices* (Geneva, 2018).

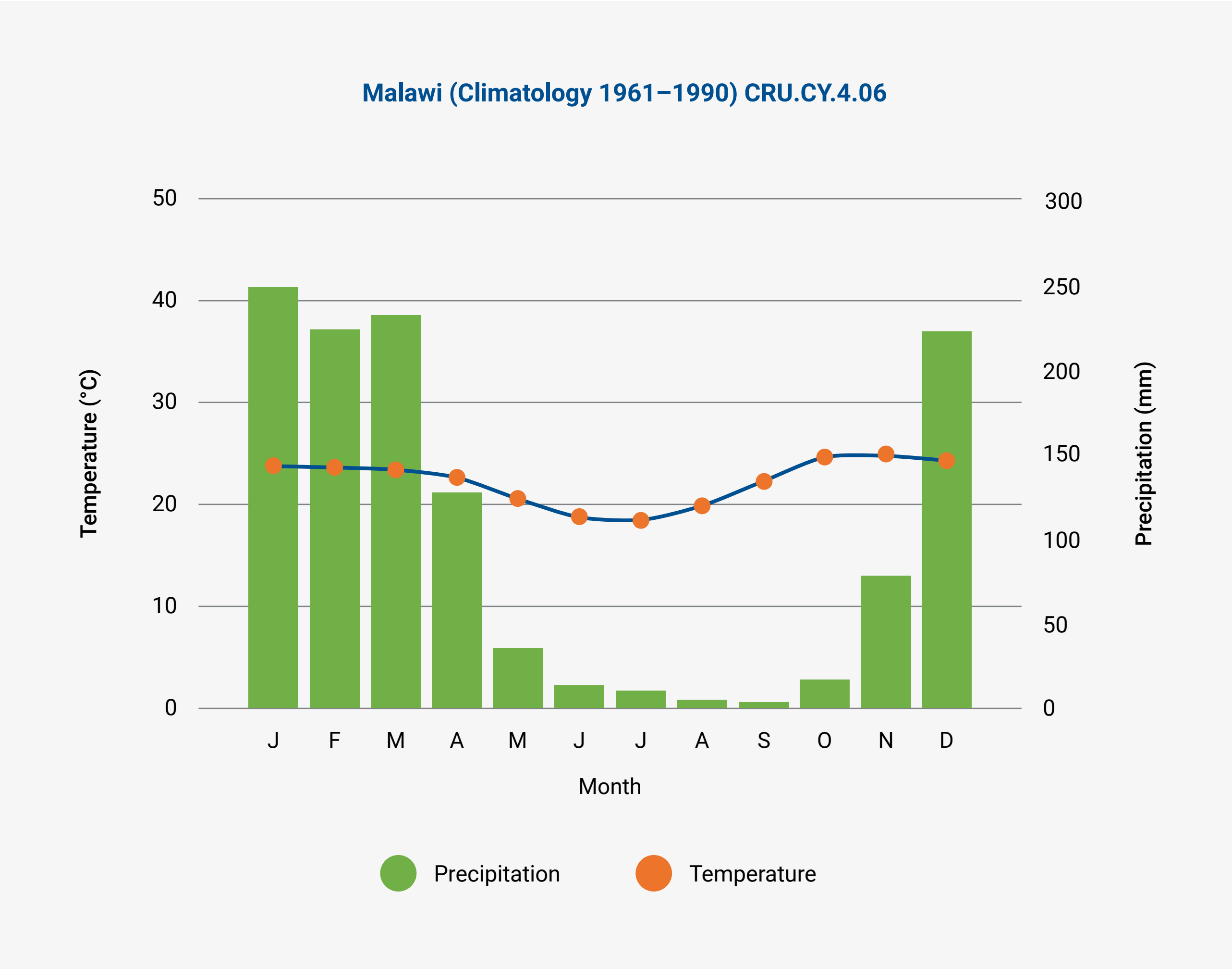


Figure 1. Climogram of normal precipitation (bars) and temperature (line) in Malawi 1961–1990 for the climate change reference period.

Source: CRU TS Version 4.06, Climatic Research Unit; see https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_4.06/.

It should be noted that the examples above contain data for the most commonly measured climate variables (precipitation and temperature). However, climatological normals are much more comprehensive and can be produced for many more climate variables (including maximum temperature, minimum temperature, snow, humidity, pressure and frequency of specific weather events). A compilation of WMO climate normals for locations all over the world is available from the National Oceanic and Atmospheric Administration (NOAA)'s National Centers for Environmental Information for easy reference. The primary source for climatological normals, including counts of weather events that only pertain to a specific region, should be the National Meteorological and Hydrological Service (NMHS) of each country. Once the normal climate information is determined, an analysis of deviations from it can be made using the concept of climate anomalies.

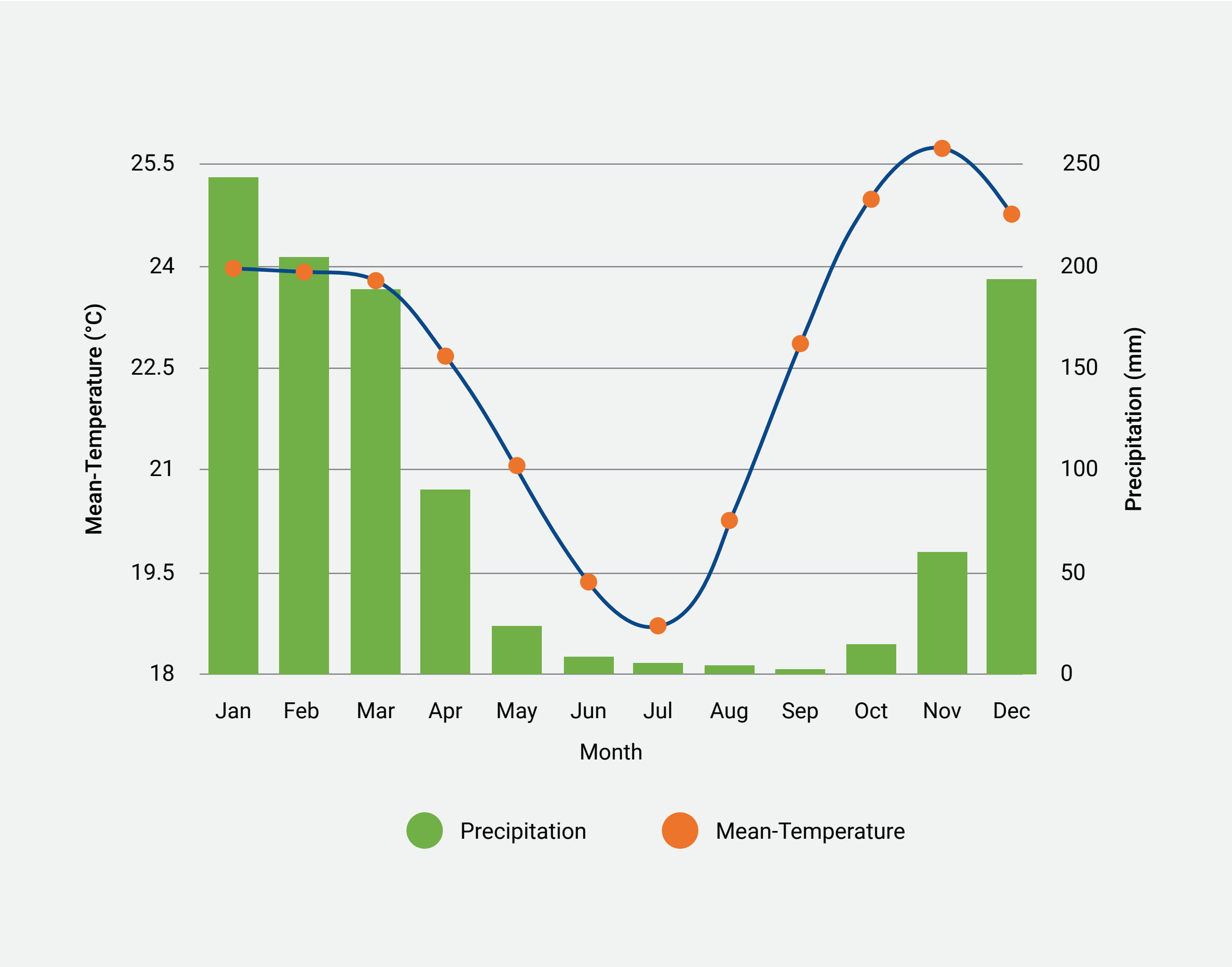


Figure 2. Climogram of normal precipitation (bars) and temperature (line) in Malawi 1991–2020 for the most recent "normal" standard period.

Source: Climate Change Knowledge Portal, World Bank; see https://climateknowledgeportal.worldbank.org/.

2.3. Climate anomalies

Although the climate normal gives us an overall expectancy of what might happen, it will exhibit variations across time; information on how the climate in a specific period (i.e., a specific month, season or year) differs from normal is required. This difference is known as an "anomaly", which is most simply obtained by subtracting the value of the long-term mean from the value of the specific period of interest for any climate variable. The use of anomalies allows the identification of deviations above or below the typical behaviour in climate variables.

Such deviations are not evident through direct analysis of climate variables. For example, in Figure 3, the mean temperature anomalies in Malawi reveal which periods have been colder or warmer than the reference mean (1961–1990) and in what magnitude. The figure shows that starting in 1990, all years have had higher temperatures than normal on a continuous basis.

More complex anomalies (such as standardized anomalies) can be calculated but, in all cases, they serve the purpose of identifying changes in relation to a selected period of reference (1961 to 1990 for climate change studies). When using climate anomalies, it is important to always specify the reference or "normal" period used for anomaly calculation.

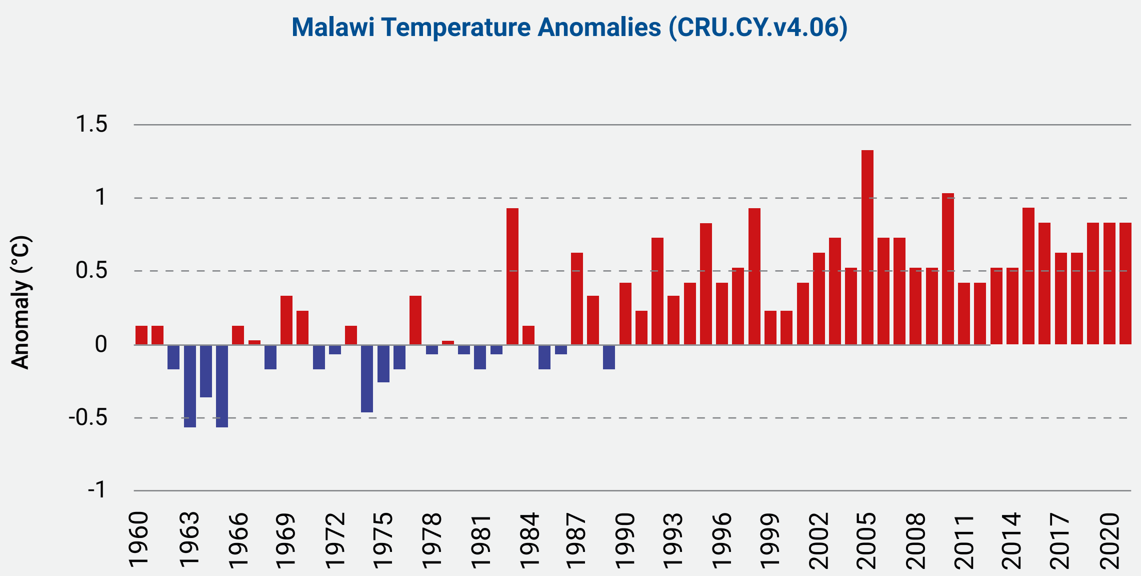


Figure 3. Annual temperature anomalies in Malawi from 1960 to 2020 in reference to the base period 1961–1990.

Source: CRU TS Version 4.06, Climatic Research Unit; see https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_4.06/.

In the examples above for both climate normals and anomalies, the values shown consist of averages at the country level (Malawi). Countrywide averages are commonly provided or included in policy-related documents since actions and policies are designed nationally. However, it should be noted that nationwide climate values may differ from reality depending on the territorial extension of a specific country and that a large territory may in fact comprise various climate regimes at the subnational level. Thus, specific sectors or locations may require a refinement of the country-level analysis to properly address climate-related risks. Climate anomalies are a type of climate index, and many more climate indices have been designed for better understanding of climate variations. Since climate indices are an essential component of the CRM framework, they are described next.

2.4. Climate indices

An index is a re-expression of data, commonly in a time series. Indices highlight specific features of the variable they re-express that are not evident through direct analysis of the data they derive from. An example is given in the previous section, where the re-expression of observed temperature data as temperature anomalies highlights warmer or colder episodes in relation to a period of reference. While the anomaly time series is one type of index, many other climate indices have been designed to identify specific climate variations. A large number of climate indices is available since each research group can define its indices according to its objectives.

However, for the purpose of intercomparison across multiple countries and regions, WMO technical commissions expert teams have defined standard sets of climate indices that are consistently calculated and presented everywhere, specifically a set of 27 core climate change indices known as the Expert Team on Climate Change Detection and Indices (ETCCDI)[10] indices (shown in Table 1) as well as an extended set of 60+ sector-specific climate indices known as the Expert Team on Sector-Specific Climate Indices (ET-SCI)[11] indices, also known as the "Climpact indices" since they are calculated using the Climpact[12] software.[13]

Since their inception, both the ETCCDI and ET-SCI climate indices have been part of the Intergovernmental Panel on Climate Change (IPCC) assessment reports and key elements in the evaluation of observed changes in the climate extremes derived from daily weather data. The main advantages of these climate indices are that they allow analyses of climate variability and trends that are globally comparable and provide a climate information basis for analysis of impacts through identification of their relationships with sectoral data, including DRR. Index definitions, software and more information are available on the Climpact website.

Table 1. A summary of the 27 basic climate change indices of ETCCDI.

Number	Short name	Long name
1	FD	Frost days
2	ID	Ice days
3	SU	Summer days
4	TR	Tropical nights
5	GSL	Growing season length
6	TXx	Maximum value of daily maximum temperatures
7	TNn	Minimum value of daily minimum temperatures
8	WSDI	Warm spell duration indicator
9	CSDI	Cold spell duration indicator
10	CDD	Consecutive dry days
11	PRCPTOT	Annual total wet-day precipitation
12	DTR	Daily temperature range
13	TNx	Maximum value of minimum temperatures
14	TXn	Minimum value of maximum temperatures

10 ETCCDI is of the former WMO Commission for Climatology.
11 Expert Team on Sector-specific Climate Indices (ET-SCI), a successor group to the ETCCDI in the WMO Commission for Climatology.
12 Climpact is a freely available R package for the calculation of ETCCDI and ET-SCI climate indices. It is developed and maintained by the University of New South Wales.
13 It should be noted that the ETCCDI indices are now a subset of the ET-SCI indices.

Number	Short name	Long name
15	TX10p	Number of cool days
16	TX90p	Number of hot days
17	TN10p	Number of cold nights
18	TN90p	Number of warm nights
19	CWD	Consecutive wet days
20	R10mm	Number of heavy rain days
21	R20mm	Number of very heavy rain days
22	Rnnmm	Number of customized rain days
23	SDII	Simple daily precipitation intensity
24	R95p	Total annual precipitation from heavy rain days
25	R99p	Total annual precipitation very heavy rain days
26	Rx1day	Maximum one-day precipitation
27	Rx5day	Maximum five-day precipitation

Although extreme events can be defined in many ways, they are generally events with low probabilities of occurrence as part of the normal behaviour of a given variable. When extremes happen, the observed values in the variable exceed a threshold or critical value. Extreme events can be due to multiple factors and are part of a normal climate. However, one of the main impacts of climate change is the modification of how extreme events happen. The ETCCDI and ET-SCI indices enable analysis of multiple climate-related hazards, including assessment of variations in extreme heat, drought, cold temperatures, warm spells and heavy rainfall, and general detection of ongoing changes in climate extremes. Their correct calculation and usability are subject to climate data availability (long-term records of daily maximum temperature, daily minimum temperature and daily precipitation).

2.5. Climate information variations across countries and regions

Availability of climate information varies across different regions worldwide. In general, climate observations are not equal in terms of length of record, completeness and continuity from one country or community to another. These differences are due to different levels of development, the historical circumstances of specific territories and the presence or absence of human settlements. Technically, without instrumental climate observations, it is possible to use proxy data or estimations to depict historical changes in climate, though historical climate indices might still be calculated. In contrast, information for the future produced using climate models can be provided for any location, but at different levels of uncertainty. In both cases, for historical and future climate information, caution must be taken regarding the actual degree of correspondence with reality when estimations are used. Climate observations are means to assess climate-related hazards in recent decades. Such information, along with climate projections for the future, is necessary in climate risk assessments.

2.6. Climate information for the future: forecasts, outlooks and scenarios

Two of the main pillars of the Global Framework for Climate Services are 1) observations and monitoring; and 2) research, modelling and prediction. While monitoring of climate variations is essential to identify current climate anomalies, modelling and prediction are necessary to provide insights about the expected evolution of climate variables for various timescales in the future.

A range of prediction information products are available: forecasts, outlooks and scenarios. Clarity on the differences among them is relevant for planning and decision-making. In all cases, it is expected that the shorter the term, the higher the probability of accuracy. A more detailed set of terms and definitions is available from the IPCC Data Distribution Centre. Here, some simplified definitions are provided.

A **forecast** is typically issued for weather timescales (from the next few hours up to the next 14 days). Most weather forecasts are produced as a result of numerical model runs or in-depth analysis of atmospheric circulation carried out by operational meteorologists. A (weather) forecast includes information for the short-term future on the evolution of many atmospheric or hydrological variables. Its accuracy is highly reliable for at least the next seven days.[14,15,16]

A **prediction** (a term synonymous with the forecast but mostly used in the timescale of climate variability) is used to refer to the future state of the climate for monthly or seasonal timescales. Climate predictions are produced using climate models, either dynamical (based on physics equations) or statistical (based on regression or other statistical methods). Although climate predictions are commonly expressed in anomalies, they can also be expressed as probabilities in some cases.[17,18,19]

An **outlook** is made up of a prediction or set of predictions that, having passed through expert analysis, is adjusted based on expert consensus. It is similar to a prediction in terms of timescale and format, but has the added value of containing expert insights. Outlooks are usually available for a country or group of countries (a region) and are a key product of the Regional Climate Outlook Forums, a concept developed by WMO and sustained since its inception three decades ago (see https://public.wmo.int/en/our-mandate/climate/regional-climate-outlook-products) to provide stakeholders with future climate information in the short term.[20,21,22,23,24]

For the long-term future, a set of **climate scenarios** have been made available. Climate scenarios are neither forecasts nor predictions, but probable futures that may only happen when other given conditions occur. Therefore, scenarios do not contain a unique possible future but various possible futures whose materialization depends on fulfilment of a given condition. When scenarios of climate change for future horizons are created, they are conditioned by changes in greenhouse gas (GHG) concentrations in the atmosphere and more recently by the potential development pathways of societies in the world, among other factors.[25]

14 Tiruvalam N. Krishnamurti and Lahouari Bounoua, *An Introduction to Numerical Weather Prediction Techniques* (Boca Raton, CRC Press, 2018).
15 National Oceanic and Atmospheric Administration, "Weather forecasts versus climate outlooks: what's the difference?", Climate.gov, 20 November 2013.
16 Tim Palmer and Renate Hagedorn, eds., *Predictability of Weather and Climate* (Cambridge, United Kingdom, Cambridge University Press, 2006).
17 National Oceanic and Atmospheric Administration, "National Weather Service Glossary". Available from https://w1.weather.gov/glossary/ (accessed on 27 September 2023).
18 Huug van den Dool, *Empirical Methods in Short-Term Climate Prediction* (Oxford, Oxford University Press, 2007).
19 Daniel Wilks, *Statistical Methods in the Atmospheric Sciences*, 4th ed. (Amsterdam, Elsevier, 2019), e-book.
20 Cambridge Dictionary, "Outlook". Available from https://dictionary.cambridge.org/dictionary/english/outlook (accessed on 27 September 2023).
21 National Oceanic and Atmospheric Administration, "National Weather Service Glossary". Available from https://w1.weather.gov/glossary/ (accessed on 27 September 2023).
22 National Oceanic and Atmospheric Administration, "Outlook Maps, Graphs and Tables" Available from https://www.cpc.ncep.noaa.gov/products/forecasts/ (accessed on 29 September 2023).
23 National Oceanic and Atmospheric Administration, "Weather forecasts versus climate outlooks: what's the difference?", *Climate.gov*., 20 November 2013.
24 International Research Institute for Climate and Society, "ENSO Forecast, Nov 2022 Quick Look". Available from https://iri.columbia.edu/our-expertise/climate/forecasts/enso/2022-November-quick-look/ (accessed on 28 November 2023).
25 Intergovernmental Panel on Climate Change, "Future Global Climate: Scenario-Based Projections and Near-Term Information", in *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Valérie Masson-Delmotte and others, eds. (Cambridge, United Kingdom and New York: Cambridge University Press, 2021).

IPCC has reported three sets of climate change scenarios:

1. The Special Report on Emission Scenarios published in 2000 consisted of four families of scenarios (A1, B1, A2 and B2) and considered the potential evolution of GHG in the atmosphere. However, it did not include actions based on international agreements for climate change mitigation (i.e., emission reduction activities).
2. The IPCC Fifth Assessment Report published in 2013 delivered scenarios known as Representative Concentration Pathways (RCPs), where changes in radiative forcing on Earth were projected considering GHG concentrations up to the year 2100. These scenarios were grouped according to expected changes in radiative forcing by the year 2100, denoted by a number after the letters RCP-: RCP 2.6, emissions peak then decrease; RCP 4.5, stable emissions; RCP 6.0, stable emissions; and RCP 8.5, increasing emissions.
3. The IPCC Sixth Assessment Report published in 2021 included a new set of scenarios, the so-called Shared Socioeconomic Pathways (SSPs), which provided new future pathways of societal development from demographic and economic drivers as well as projected changes in land use and GHG emissions. As suggested by their name, the SSPs included various pathways that societies might follow: SSP1, sustainability; SSP2, middle of the road; SSP3, regional rivalry; SSP4, inequality; and SSP5, fossil fuel development. The combination of changes in RCPs and SSPs produced key information on projections for the future (Table 2). Access to the latest climate change scenarios is available from the IPCC Working Group I Interactive Atlas though the advanced interface.

Table 2. A selection of the latest climate change scenarios (SSP and RCP) that provide key information for the future.

Scenario	Future socioeconomic developments	2100 forcing level (W/m^2)	Challenge for mitigation and adaptation
SSP1-1.9	Increasing towards a more sustainable path, investment in the education and health sector, increased emphasis on human welfare and less inequality	1.9 W/m^2 (low)	Low
SSP2-4.5	Current social, economic and technological trends continue their historical patterns	4.5 W/m^2 (medium)	Medium
SSP3-7.0	Less investment in the education and health sectors, slow economic development, increased inequality and severe environmental degradation	7.0 W/m^2 (high)	High
SSP5-8.5	Dependence on fossil fuels, high emissions, high human development and rapid economic growth	8.5 W/m^2 (high)	High for mitigation and low for adaptation

Sources: O'Neill, Brian C. and others. The scenario model intercomparison project (ScenarioMIP) for CMIP6. *Geoscientific Model Development*, vol. 9, No. 9 (September 2016); Riahi, Keywan R. and others. The shared socio-economic pathways and their energy, land use and greenhouse gas emissions implications: An overview. *Global Environmental Change*, vol. 42 (January 2017).

It is important to note that projected changes in scenarios realistically contemplate potential changes in land use, GHG emissions and, ultimately, future pathways of how societies may develop. Such projections, in combination with the use of several climate models, result in the best scientific projections of climate change. As part of this process, Coupled Model Intercomparison Projects (CMIPs) are carried out by the scientific community (Coupled Model Intercomparison Project Phase 3 with the Special Report on Emission Scenarios; Coupled Model Intercomparison Project Phase 5 with RCPs; and Coupled Model Intercomparison Project Phase 6 with SSPs). Nevertheless, it should be remembered that scenarios are not predictions and the longer the term in the future they project, the greater their uncertainty.

2.7. Uncertainty

Uncertainty is the degree to which the likelihood of an event happening is unknown. Informed decisions rely on accurate data describing the elements that are involved as part of them and reduce uncertainties to the extent possible. When the climate is one of these elements, it is often described quantitatively using values of climatic variables. Such variables can be observations from the past or present, or they can be forecasts, predictions, outlooks or projections for the future.

Any information for the future, regardless of the timescale it covers, contains uncertainty. Since none of the available products regarding future climate states is entirely certain (forecasts, predictions, outlooks and scenarios all carry on a certain degree of uncertainty), developing a plan or a strategy to respond to climate-related hazards requires full consideration of uncertainty.

In general, for all types of climate products for the future, it is assumed that **the longer the lead time, the larger the uncertainty**, whereas in terms of the spatial coverage of each product, **the more localized the analysis, the larger the uncertainty**. Other factors intervene to conform to the degree of uncertainty for a decision maker; these may include, but are not limited to, how probabilities are used, the degree of sectoral climate sensitivity and specification of thresholds, risk tolerance and non-climatic factors.

An example of uncertainty in climate change information is depicted in Figure 4, where projected changes in annual mean temperature for Kinshasa in the Congo for three future horizons (2011–2040; 2041–2070; 2071–2100) from several climate models are shown in boxplots. Each boxplot is based on outputs of 18 different climate models. While the median of the projected changes is the expected value to be observed, the value could be within the interval given by the box or even the whiskers. The larger box for 2071–2100 indicates greater uncertainty in comparison with the shorter box for 2011–2049. On the other hand, the pie chart in Figure 5 shows that for this specific variable, site and projection, all 18 climate models agree on an expected increase in annual mean temperature change. Therefore, two types of uncertainty are provided. The first relates to the amount of change expected in temperature and the second relates to the number of models in (dis) agreement; in this specific case, since all models agree, the projected changes have lower uncertainty.

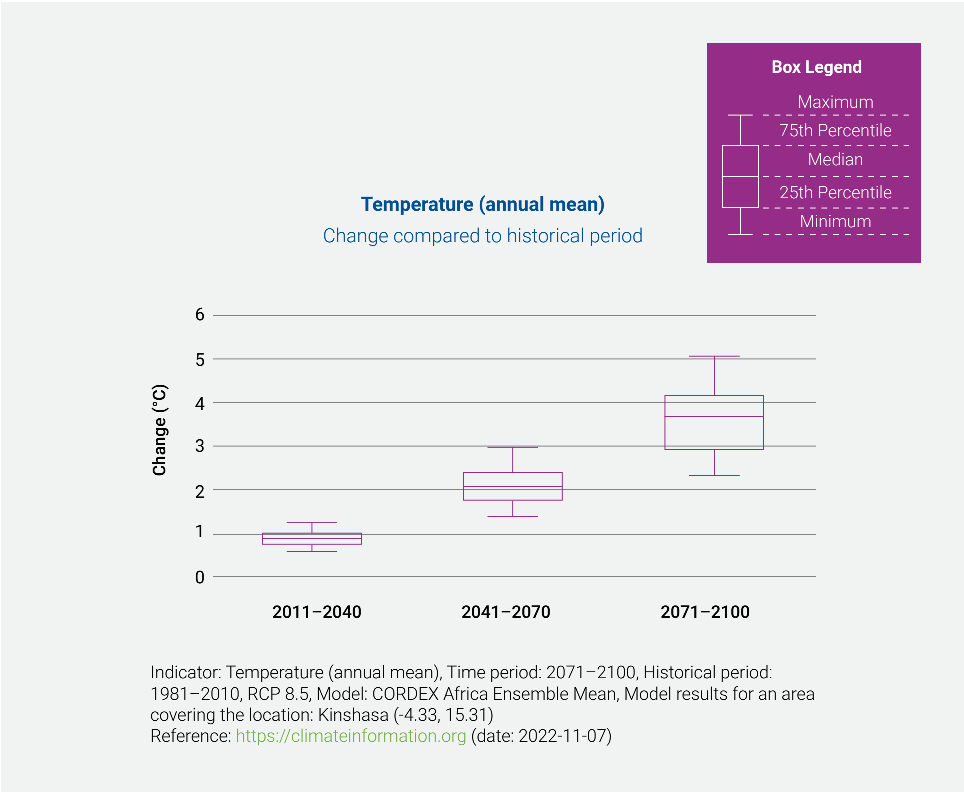
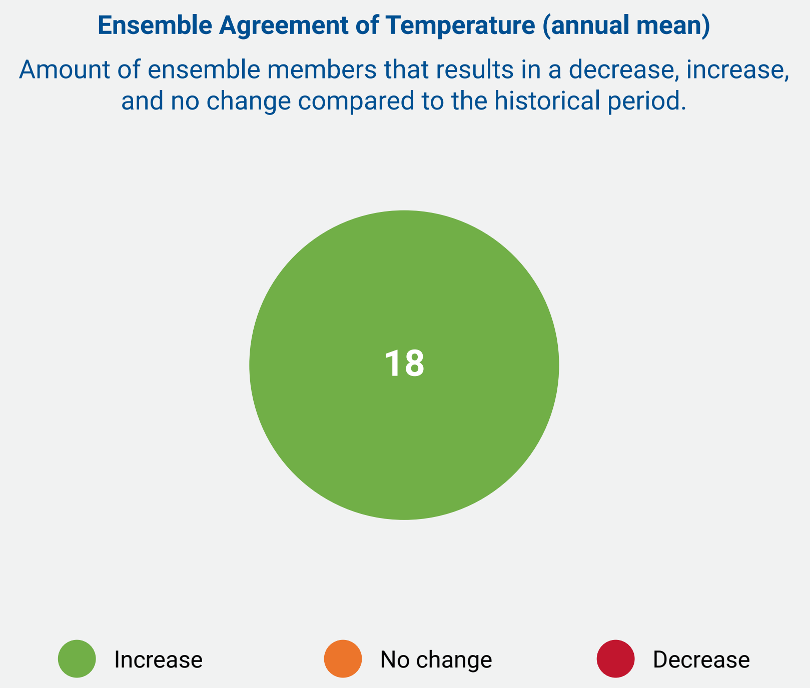


Figure 4. Projected changes in annual mean temperature for Kinshasa in the Congo for three future horizons.

Source: CORDEX Africa model ensemble, Climate Information Platform, Swedish Meteorological and Hydrological Institute; see https://climateinformation.org/.



Indicator: Temperature (annual mean), Time period: 2071–2100, Historical period: 1981–2010, RCP 8.5, Model: CORDEX Africa Ensemble Mean, Model results for an area covering the location: Kinshasa (-4.33, 15.31)
Reference: https://climateinformation.org (date: 2022-11-06)

Figure 5. Agreement of climate models for projected changes in annual mean temperature for Kinshasa in the Congo in Figure 4.

Source: Climate Information Platform, Swedish Meteorological and Hydrological Institute; see https://climateinformation.org/.

It should be noted that climate change projections only contain changes in the mean values since forecasts are only possible for a few days in the future. A long-term projection does not include information on future changes in extreme events since this type of information would have very high uncertainty.

Many weather, climate and water products are prepared by the NMHSs or by other agencies in the public and the private sector in such a way that uncertainty can be quantified, or at least qualitatively assessed, before the information is used. How explicitly uncertainty is described varies from one product to another.

Figure 6, for example, shows the official five-day track forecast for Hurricane Ida of the Atlantic Ocean (starting on 26 August 2021). The forecasted track of the storm's centre is plotted in the middle. As lead time increases, a white cone surrounding the track line increases in size. This area, known as the uncertainty cone, denotes the areas where the actual cyclone track might occur. NOAA's National Hurricane Center provides guidance on how to use the cone graphic in both a video and a web page so that the best decisions are made taking forecast information into account.

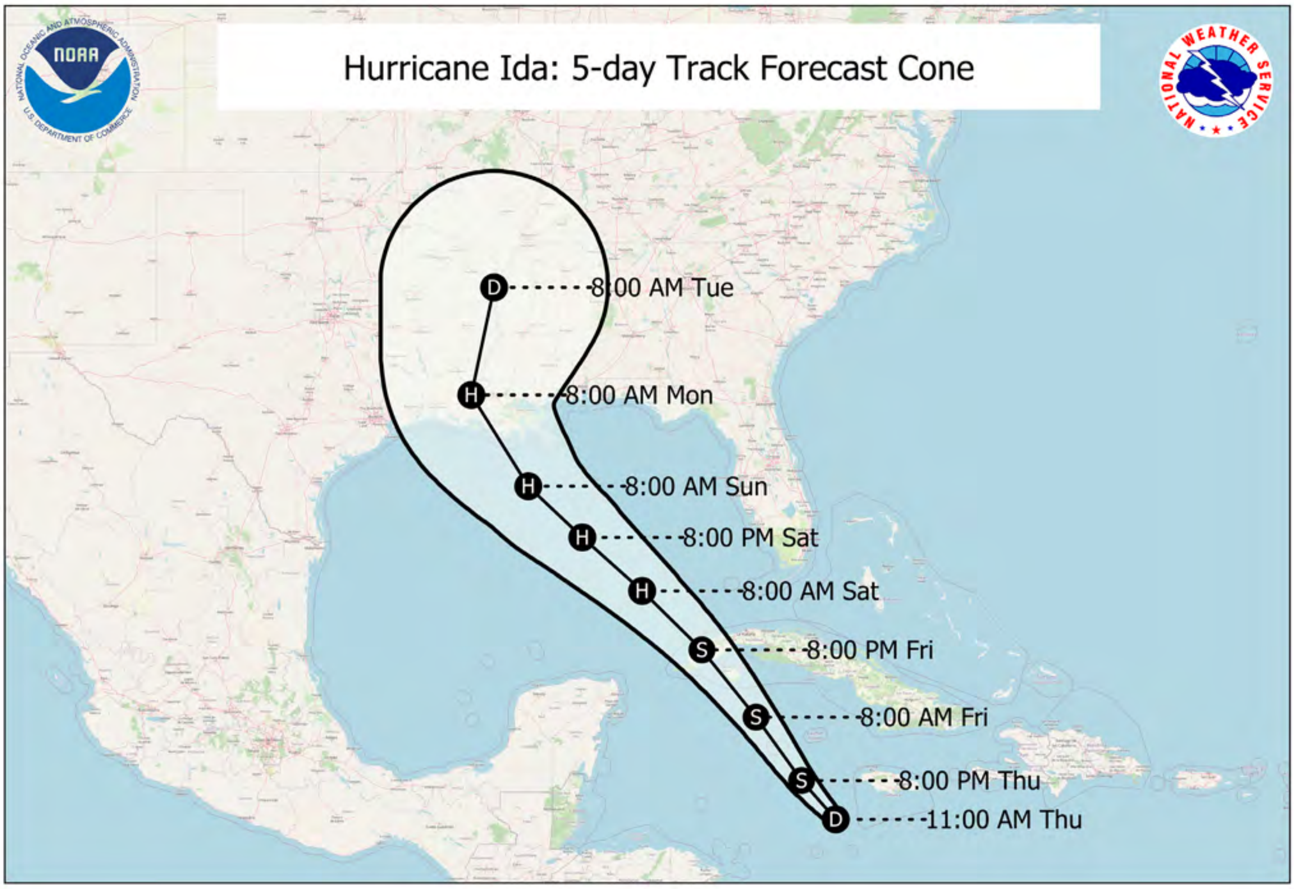


Figure 6. Five-day track forecast for tropical cyclone Ida, including the uncertainty cone. The initial forecast is for 26 August 2021.

Source: National Hurricane Center and Central Pacific Hurricane Center, National Oceanic and Atmospheric Administration; see https://www.nhc.noaa.gov/gis/.

2.8. Understanding disaster risk in the context of climate change

Disaster risk is the "potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period, determined probabilistically as a function of hazard, exposure, vulnerability and capacity"[26,27] (Figure 7). Global efforts to address this issue are guided by the SFDRR that seeks to "prevent new and reduce existing disaster" through various measures that prevent and reduce hazard exposure and vulnerability to disaster. Risk assessments require a thorough understanding of each element of risk, particularly in the context of climate change.

With the gradual evolution of thinking, as reflected in the 2019 and 2022 Global Assessment Reports on Disaster Risk Reduction, the risk is known to be systemic in nature, also exhibiting compound, interconnected and cascading impacts. The IPCC is now shifting from a static framing of risks as a function of hazard, exposure, and vulnerability towards a more dynamic framing in which reactions to risks with potential side effects and links between risks are strongly considered.

26 A/71/644.
27 For more information, see https://www.undrr.org/terminology/disaster-risk.

Figure 7. (Disaster) risk as a compound event of hazards, vulnerability and exposure. Adapted from IPCC SPM_Fig1.

Source: Intergovernmental Panel on Climate Change, SPM_Fig1; see https://www.ipcc.ch/report/managing-the-risks-of-extreme-events-and-disasters-to-advance-climate-change-adaptation/summary-for-policymakers/spm_fig1/.

Assessments of climate-related risks require evidence-based information on climate-related hazards, vulnerability and exposure to enhance understanding of the interactions between climate processes and other related systems. Physical observations of the climate system and its elements, along with predictions and projections of its evolution, are means to characterize climate-related hazards. Highlights of an in-depth analysis of all risk components benefit from a detailed description of determinant thresholds and resistance and resilience capacities.

2.9. Thresholds, resistance and resilience

Even with climate variations in the normal range (i.e. considering climate variability alone, with no climate change), climate-sensitive sectors are subjected to impacts triggered by observation of critical values in climate variables. Such critical values, known as "thresholds", are values that will have an impact on a natural, societal or economic system if exceeded.

Figure 8 shows three critical values for daily maximum temperature calculated based on percentiles. The daily maximum temperatures of 39°C, 39.5°C and 41.5°C correspond to the ninetieth, ninety-fifth and ninety-ninth percentiles, respectively. Assuming a hypothetical example, in which persons from three different age groups (the elderly, young adults and children) are exposed to maximum temperatures exceeding the highest threshold on a given day, the health of the most vulnerable group (the elderly) may be impacted, since their bodies are less resistant to extreme temperatures of about 41.5°C and higher. The temperature may have a medium impact on the group of young adults, since their bodies are in a stage of development that can resist extreme temperatures, and they would recover after a certain time.

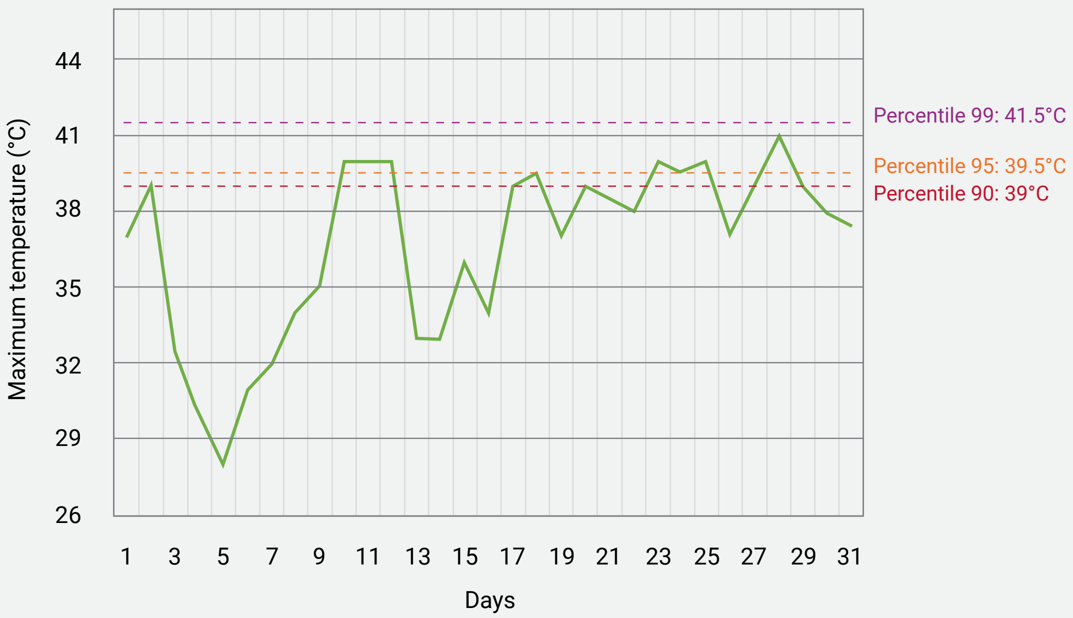


Figure 8. Examples of three different percentile-based thresholds in daily maximum temperature.

Source: Public data, National Meteorological Service of Mexico.

Another example of the concepts of thresholds (critical values), resistance (capacity to not be impacted even if a threshold is exceeded) and resilience (capacity of a quick recovery after being impacted) is provided in Figure 9 for the case of crop response to maximum temperature thresholds. The figure schematically illustrates how crop failure is directly related to exceedance in increasing daily maximum temperatures.

All three quantities – thresholds, resistance and resilience – are **context dependent**. They will not be the same for all sectors, regions, countries, communities or systems, nor they will be equal for different climate-related hazards. DRR implies that thresholds are accurately determined at the local level, including resistance capacities, and that resilience is built through the implementation of necessary actions. This context implies that vulnerability and risk assessments have been carefully conducted.

All of the above can be produced based on recent past and present climates. However, with the changing climate, due consideration to future climate projections across different time horizons will be required. This will inform prevention and disaster mitigation strategies, particularly for coping with climate-related risks.

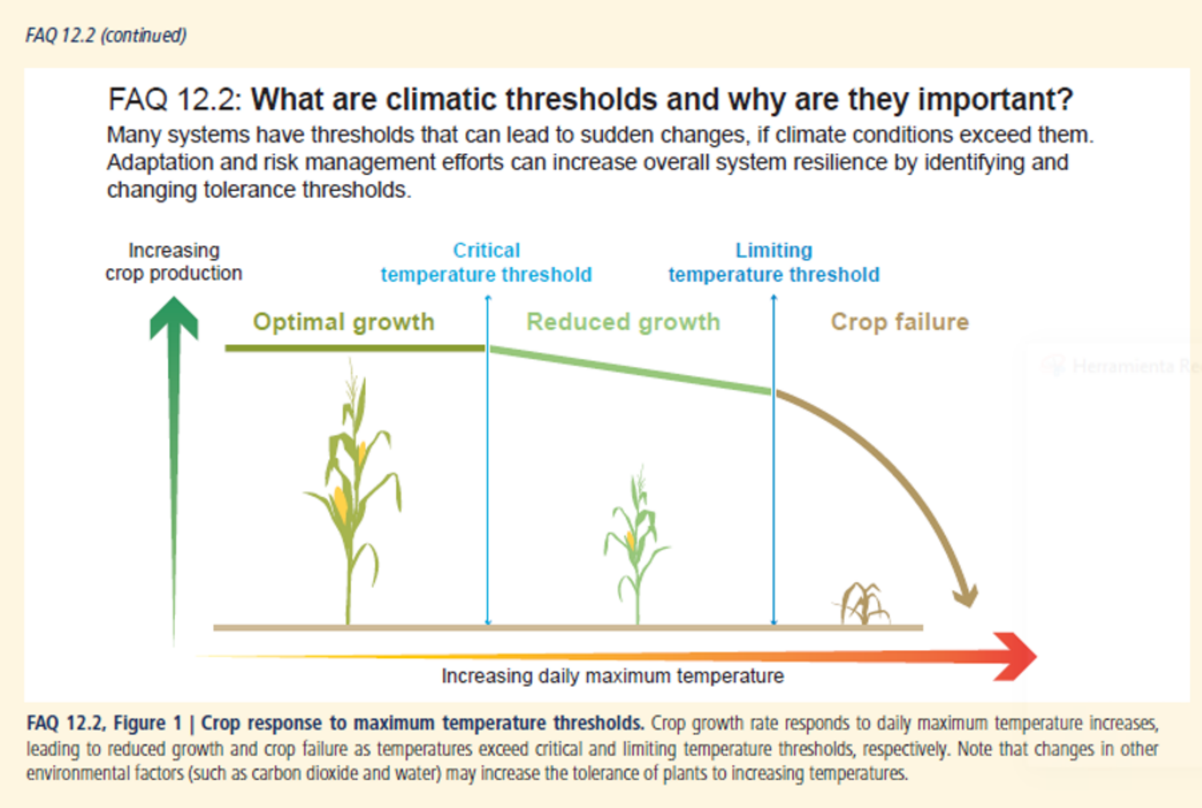


Figure 9. Crop response to maximum temperature thresholds.

Source: Intergovernmental Panel on Climate Change. Climate Change Information for Regional Impact and for Risk Assessment. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Valérie Masson-Delmotte and others, eds. Cambridge, United Kingdom and New York: Cambridge University Press, 2021.

2.10. Climate change in the context of disaster risk reduction

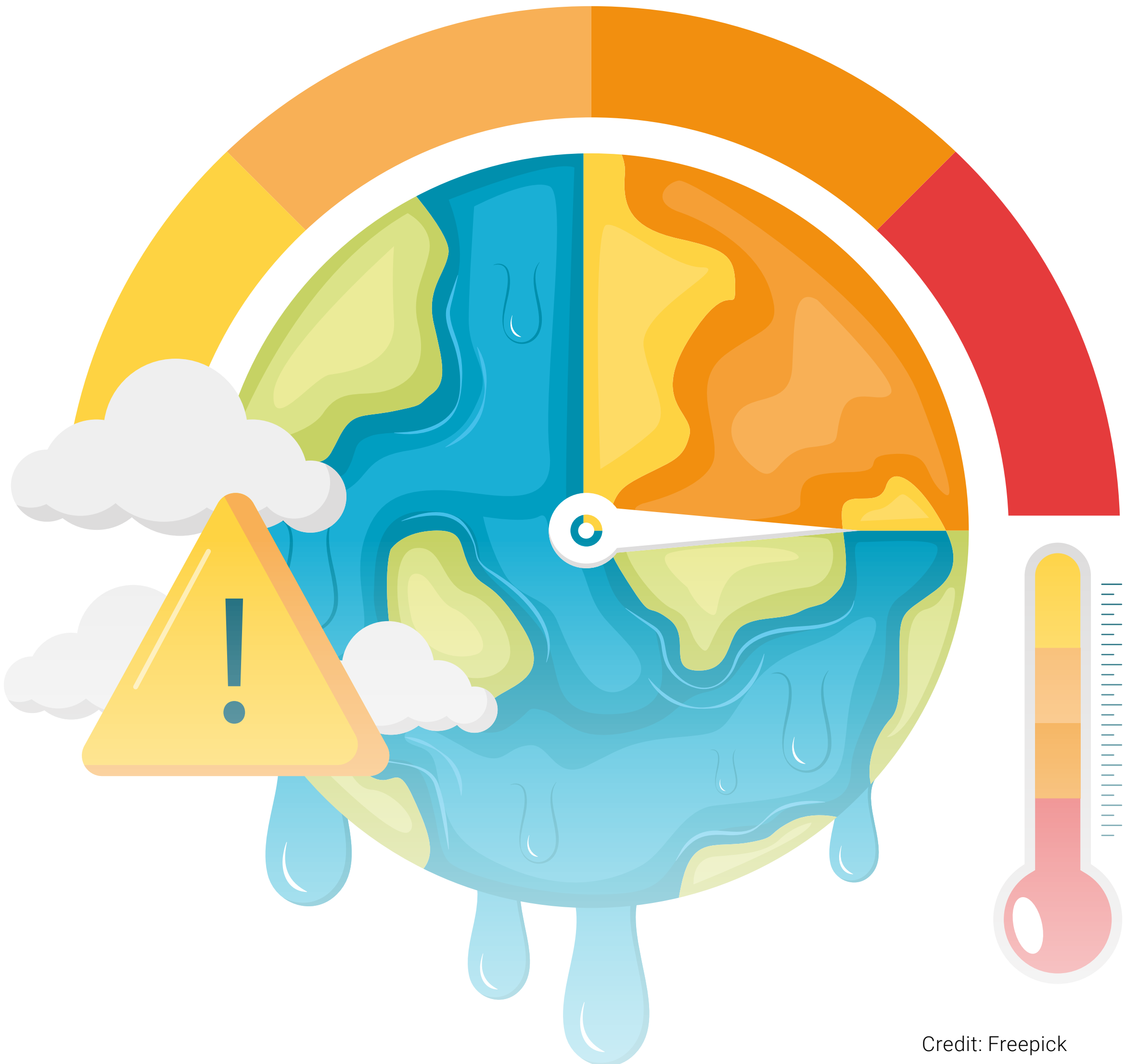
Climate change is the underlying driver for acceleration of and increases in climate risks. However, climate variability and changes occurred in the past before global warming was detected and the acceleration of GHG emissions took place. It should be noted that global warming does not mean a constant, permanent and omnipresent increase in temperatures everywhere. Its actual meaning is that the Earth's climate system will have to enhance its hydrological cycle to maintain the energy balance of the planet and an increase in mass and energy-exchanging mechanisms will consequently take place. This implies an increase in extreme weather, climate and water events, with a more frequent rate of exceedance in thresholds.

In lieu of the inherent uncertainty linked to the exact implications of climate change (at present, it is impossible to know exactly when and where impacts will take place), current capacities in climate risk assessment and management for all scales in space and time must be strengthened. This is most urgent for countries and communities already being affected by climate-related disasters, where climate change has been detected based on observational evidence.

It is known that if global warming goes beyond the global thresholds of 1.5°C or 2°C above pre-industrial average temperatures, more abrupt and unexpected changes in the climate system will occur, with associated catastrophic impacts. Addressing of these concerns in national and subnational policy development, including the integration of climate information into risk management strategies, is needed urgently.

03

CLIMATE SCALES AND INFORMATION SOURCES



Credit: Freepick

Building resilience against the negative effects of climate change and harnessing the benefits of favourable conditions will necessitate development and execution of effective climate risk assessment and management techniques. This requires availability of relevant climate information to support comprehensive risk assessment and risk-informed decision-making processes. Appropriate use of this information requires proper understanding of what information is accessible and how it can be used. This section aims to discuss the availability of climate information in terms of scale and highlight various sources that can be used to obtain the required information and climatic indicators.

Presently, many sources for climate data are available worldwide from governments, academic institutions, private companies and non-governmental organizations. The amount of available information may be overwhelming for the precise needs of DRR, planning or national and subnational policymaking. With variations in the data available from one country to another, use of official sources could be essential in climate risk assessment and management. At the same time, unofficial sources of climate information can prove valuable in building resilience to climate-related risks. For example, official observations from a National Weather Service may be complemented by observations from other unofficial networks implemented by sectoral communities or the private sector.

Ideally, all climatic information should be systematically consistent across scales of space and time where climate risks occur. For this purpose, WMO has set up a tailored chain for the operational provision of climate information where global sources (Global Producing Centres [GPCs] for long-range forecasts) feed into regional sources (Regional Climate Centres [RCCs]), which in turn feed into national ones (NMHSs), that ultimately provide usable information at the local scale (Figure 10; Table 3). Climate information scales in space and time are discussed in Figure 10.

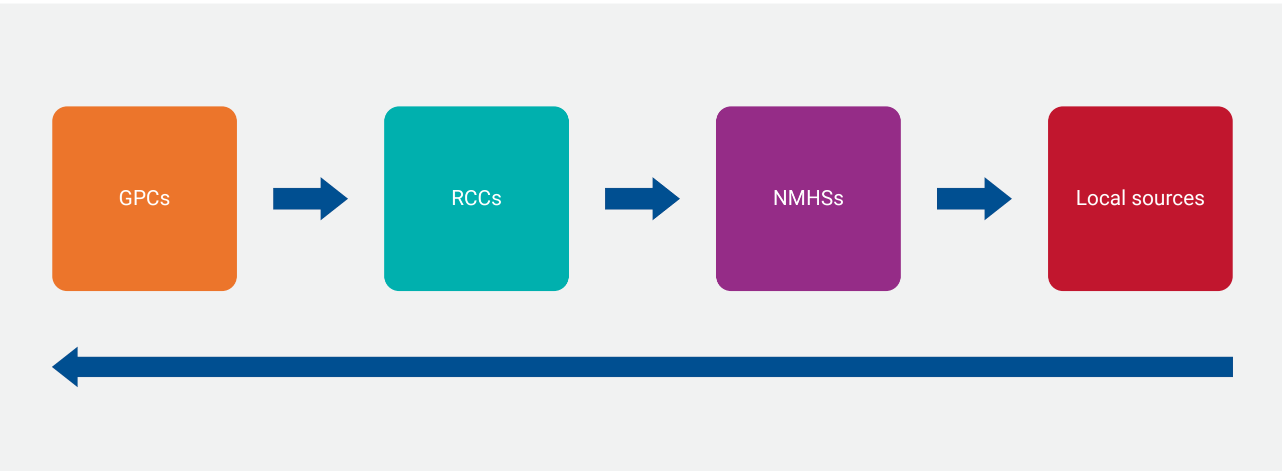


Figure 10. The flow of climate information in the top-down scheme used by WMO. Prepared by the authors. Note that the local sources are served by the NMHSs or in some countries may correspond to regional or local NMHS branches.

Source: World Meteorological Organization; see https://public.wmo.int/en.

Table 3. The tailored flow of climate information from the global to the local scale for seasonal outlooks.

GPCs	RCCs	NMHSs	Local sources
In its GPC role, NOAA issues monthly and seasonal predictions based on global climate models that run in its computing facilities.	RCCs are responsible for intake of global seasonal predictions produced by the GPC as inputs for the Climate Outlook Forum and production of a consensus-based seasonal outlook.	NMHSs are responsible for intake of the consensus-based seasonal outlook produced by the RCC and adding value based on their knowledge of national needs and capacities.	Local sources consult NMHS-tailored information to take action and make informed decisions at the local level.

3.1. Spatial scales

Although global warming, an unprecedented increase in the planetary mean temperature, has been detected in recent decades, temperature increase is just one of several climate change indicators. While the warming signal has been detected at the global scale, it is also detectable at lower spatial scales, such as the regional and local ones. However, when the spatial scale is smaller, the global signal may not be as evident due to influence of local factors.

Climate variations occur in well-defined scales in spaces where specific patterns or phenomena are observed. For example, the El Niño-Southern Oscillation phenomenon is identified by temperature anomalies across a large area of the tropical Pacific. Since it causes change in the general circulation of the atmosphere, altering the normal climate everywhere, it is considered a climate modulator at the global scale. In the case of monsoons, they are observed in specific areas of the planet (such as parts of Asia and northern South America) and are typical phenomena of the regional scale; similarly, the transition of air masses and development of cyclones are observed in specific regions. On the other hand, climate variations induced by changes in land use, such as urban heat islands, or those related to the presence of water bodies and mountains, such as breezes or nocturnal winds, are phenomena of the local scale. All climate variations at different scales are fully interconnected since, by its physical nature, climate does not meet frontiers. It is often the case that climate variability and change information must be adjusted to meet societal and economic boundaries, such as political or sectoral boundaries. The main characteristics and information sources for the various spatial scales are described in the next section.

3.1.1. Global scale

The global scale covers both hemispheres and is directly related to the general circulation of the atmosphere and the influence of global climate modulators such as the El Niño phenomenon. The most recent state of climate at the global scale is usually monitored and described as part of periodical publications such as the assessment reports of IPCC and the WMO Global State of Climate.[28] Global warming is one of the most known climate variations on the global scale.

Various agencies and centres around the world keep track of global climate records, mainly for temperature (e.g., the International Research Institute for Climate and Society and the NASA Goddard Institute for Space Studies in the United States of America; the Met Office Hadley Centre and the Climatic Research Unit in the United Kingdom; the Japanese Meteorological Agency in Japan; and the Asia-Pacific Economic Cooperation Climate Center in the Republic of Korea). Climate change indices (ETCCDI) and their trends at the global scale are available from the Climdex data portal provided by the University of New South Wales, Australia (Figure 11).

28 World Meteorological Organization, “State of the Global Climate in 2022”. Available from https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate (accessed on 28 September 2023).

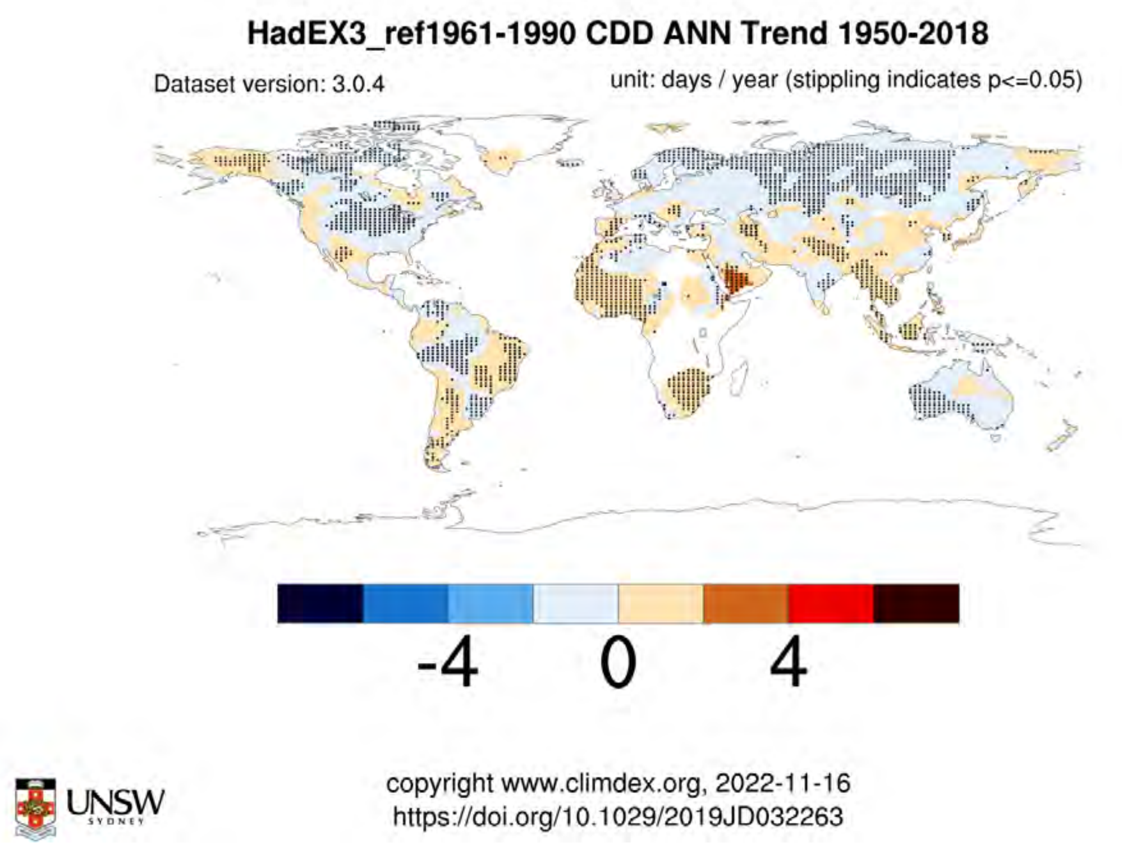


Figure 11. Trends in CDD index 1950–2018 at the global scale for continental areas. Retrieved in November 2022.

Source: Climdex data portal, University of New South Wales; see www.climdex.org.

Operationally, 13 centres for climate monitoring and prediction at the global scale have been established by WMO: the China Meteorological Administration and Beijing Climate Center in Beijing; the Center for Weather Forecasts and Climate Studies and the National Institute for Space Research in Brazil; the European Centre for Medium-Range Weather Forecasts (ECMWF) in the United Kingdom, Italy and Germany; the Met Office in Exeter in the United Kingdom; the Bureau of Meteorology in Melbourne, Australia; the Meteorological Service of Canada in Montreal; the Hydrometeorological Centre of Russia and the North Eurasia Climate Centre in the Russian Federation; the Deutscher Wetterdienst in Offenbach, Germany; the South African Weather Service in Pretoria, South Africa; the Korea Meteorological Administration in Seoul, Republic of Korea; the Japan Meteorological Agency and the Tokyo Climate Center in Tokyo, Japan; the Météo France in Toulouse, France; and the Climate Prediction Center (CPC) in Maryland and NOAA in Washington, D.C., United States of America.

All of these centres, known as "Global Producing Centres for Long-Range Forecasts",[29] have the mission of monitoring and predicting climate variability, mainly at monthly and seasonal timescales. They make climate information and products available on a global scale but keep focus on the regions where they are established. Two examples of the type of information these centres produce are El Niño-Southern Oscillation (ENSO) monitoring and prediction (Figure 12a) and seasonal predictions from multi-model ensembles (Figure 12b).

29 World Meteorological Organization, "Global Producing Centres for Long-Range Forecasts". Available from https://community.wmo.int/en/global-producing-centres-long-range-forecasts (accessed on 27 September 2023).

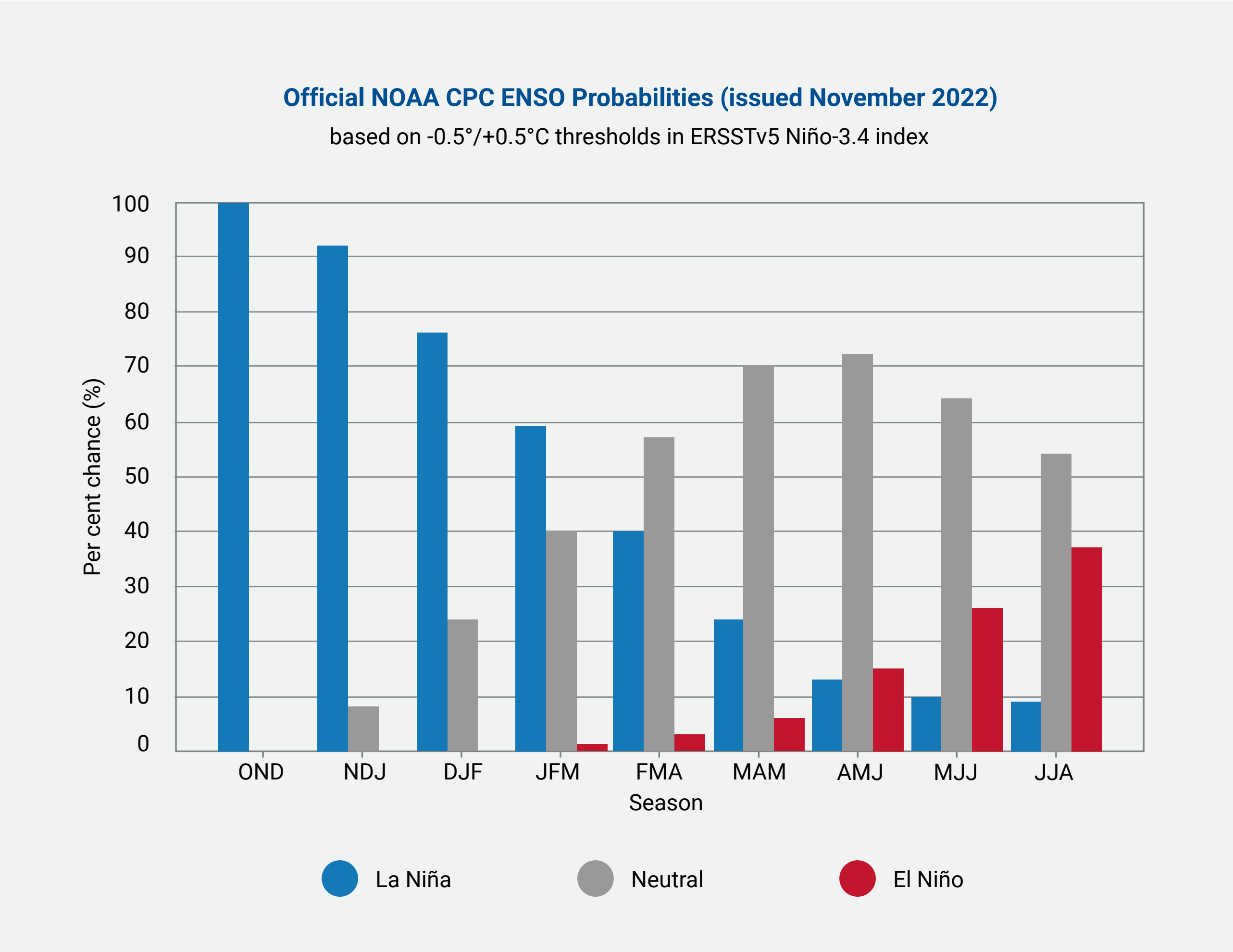


Figure 12a. Official NOAA CPC ENSO probabilities, issued in November 2022. The bars show the probability of an El Niño (El Niño, Neutral or La Niña) phase for the next nine quarters.

Source: ENSO Forecast, November 2022 Quick Look, International Research Institute for Climate and Society; see https://iri.columbia.edu/our-expertise/climate/forecasts/enso/2022-November-quick-look/.

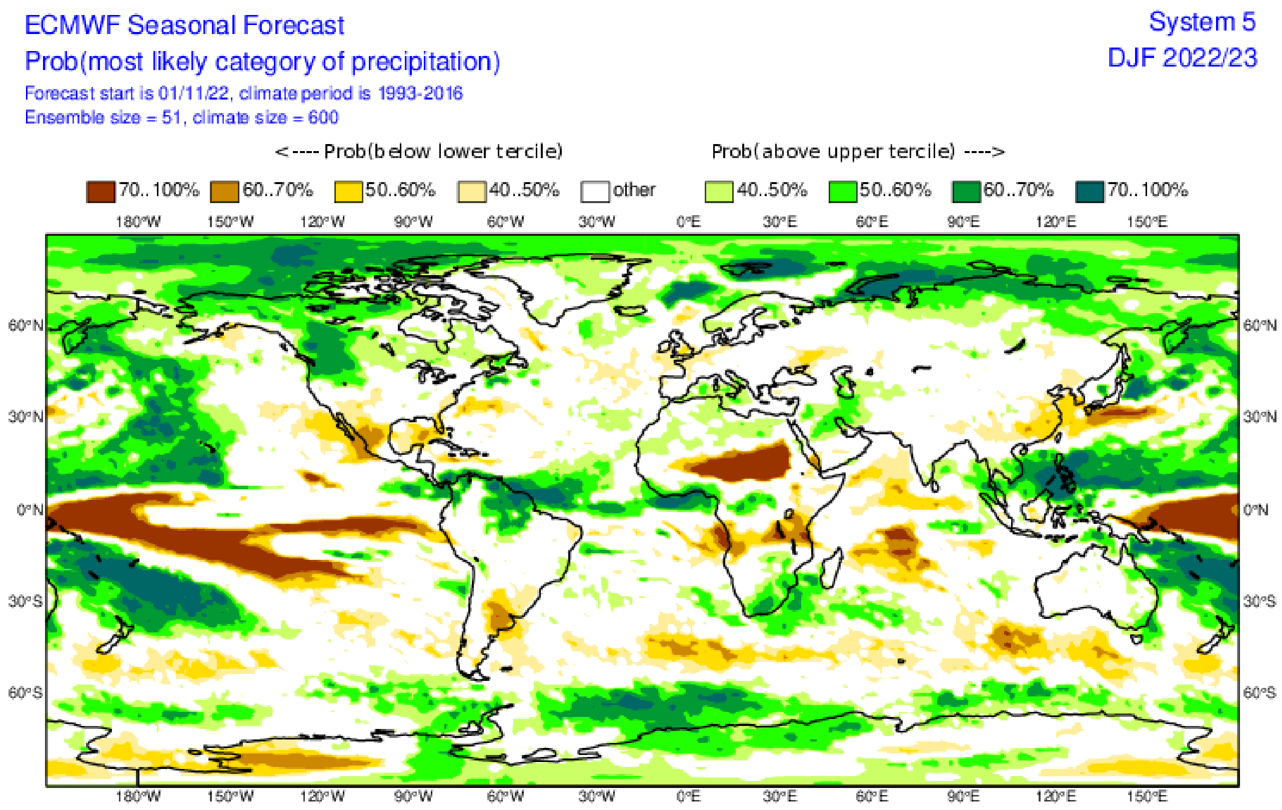


Figure 12b. ECMWF precipitation seasonal forecast for the quarter December-January-February 2022/2023, issued in November 2022. The map shows the probabilities of the most likely category of precipitation.

Source: European Centre for Medium-Range Weather Forecasts; see https://charts.ecmwf.int/products/seasonal_system5_standard_rain?area=GLOB&base_time=202309010000&stats=tsum&valid_time=202310020000.

Using the product of Figure 12a, a planner can use the probabilities of occurrence of ENSO phases (El Niño, Neutral, La Niña) to inform decisions that require knowledge about a potential change in climate patterns for a given quarter of the year (assuming that climate in the planner's region of interest is sensitive to ENSO and that ENSO-related changes in precipitation are known). For example, from previous years, it is well known that during La Niña winters, precipitation deficits are observed in northern Mexico. By knowing that the probability of La Niña is higher than 90 per cent for the quarter November-December-January, a planner will know that winter precipitation in north-western Mexico would be expected to be lower than normal. Similarly, El Niño conditions are associated with increased rainfall in East Africa and drought conditions in the Indian subcontinent.

In a similar way, the product in Figure 12b shows in a global map the probabilities of quarterly precipitation (for the quarter December-January-February 2022/2023) happening in one of three categories (terciles): below normal (in brown tones), normal (white) or above normal (in green tones). By looking at the map, planners would know how the forthcoming quarterly precipitation is expected to be in any area of the world which may be of interest to their sector.

3.1.2. Regional scale

The definition of the region is not unique, but contextual. This context may be economic, political, sectoral, geographical or climatic. The climate system, due to its physical nature, results in several regions in the world that do not coincide with regions defined by other non-climatic contexts. An economic region may encompass one or more climatic regions, as may also be the case for countries (defined by political boundaries) and other delimitations.

In a climatic context, the regional scale has boundaries, covering areas of the world that exhibit similar patterns in climate variations. For practical purposes, when reference is made in this guidance to the regional scale, this means a group of neighbouring countries in the same area of the world.

Climate Outlook Forums are periodic meetings intended to provide consensus-based climate outlooks for the seasonal timescale. There are several Regional Climate Outlook Forums:

- The Central American region, as it is defined by the Central American Integration System, includes seven countries (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama) which are the target regions for analysing climate variations (Figure 13) in the Central American Climate Outlook Forum, even though the region is not climatically defined.
- The Greater Horn of Africa Climate Outlook Forum[30] covers 11 countries that are members of the Intergovernmental Authority on Development (IGAD) and the East African Community.
- The Southern African Development Community, with a membership of 16 countries, is treated as a region in the Southern Africa Regional Climate Outlook Forum.[31]

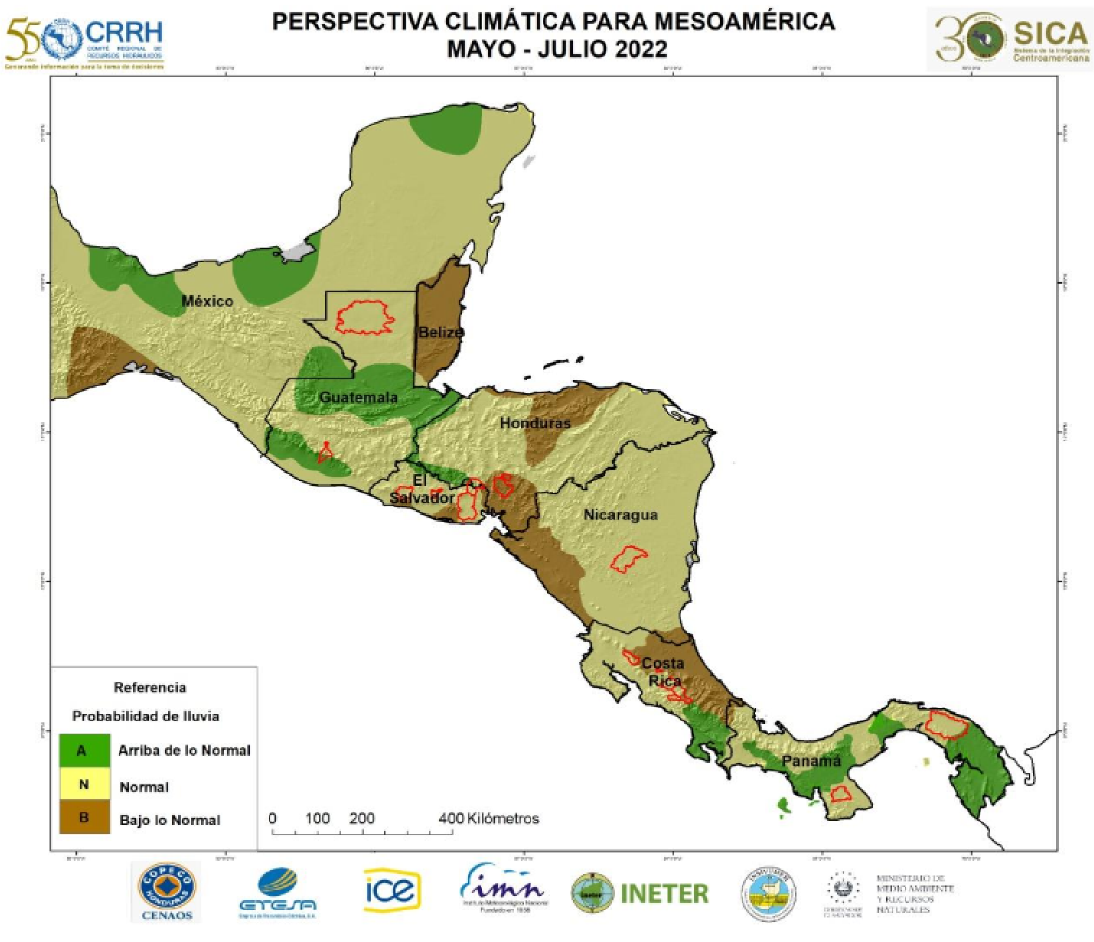


Figure 13. Climate Outlook for Central America from May to July 2022, produced at the Central American Climate Outlook Forum. Retrieved in November 2022.

Source: Central American Integration System; see https://www.sica.int/documentos/informe-lxviii-foro-climatico-de-america-central-perspectiva-del-clima-para-el-periodo-mayo-a-julio-2022_1_129899.html.

30 Intergovernmental Authority on Development Climate Prediction and Application Centre, "Climate Outlook Forums. Theme: Greater Horn of Africa Climate Outlook Forum (GHACOF)". Available from https://www.icpac.net/climate-outlook-forums/ (accessed on 27 September 2023).
31 Southern African Development Community, "Member States". Available from https://www.sadc.int/member-states (accessed on 27 September 2023).

Regional Climate Outlook Forums are usually organized by the WMO RCCs.[32] WMO designates RCCs as the second tier of climate information provision after GPCs. RCCs comply with mandatory functions in at least four areas: operational long-range predictions, operational climate monitoring, operational climate data management and training in the use of their products and services. Designation of RCCs can happen for a single centre or a network. They can only be designated by WMO and should follow guidance from WMO technical commissions.

Box 1. Designated RCCs

RCC-Africa: the African Centre of Meteorological Applications for Development in Niger; IGAD RCC: the IGAD Climate Prediction and Applications Centre in Kenya; the North African RCC-Network: the Direction de la Météorologie Nationale in Morocco, the Institut National de la Météorologie in Tunisia, the National Meteorological Office in Algeria, the Egyptian Meteorological Authority in Egypt and the National Meteorological Centre in Libya; RCC-Beijing: the Beijing Climate Center in China; RCC-Tokyo: the Tokyo Climate Center in Japan; RCC-Moscow: North EurAsia Climate Centre in the Russian Federation; RCC-Pune: the India Meteorological Department in India; RCC for Western and South America: Centro Internacional para la Investigación del Fenómeno de El Niño in Ecuador; RCC Network for Southern South America: the Regional Climate Center Network for Southern South America (RCC-SSA) in Brazil/Argentina; RCC-Caribbean: the Caribbean Institute for Meteorology and Hydrology in Barbados; United States of America Regional Climate Centre: CPC in the United States of America; Southeast Asia RCC Network: Meteorological Service Singapore in Singapore, Philippine Atmospheric, Geophysical and Astronomical Services Administration in the Philippines and Meteorology, Climatology, and Geophysical Agency in Indonesia; Pacific RCC Network: National Institute of Water and Atmospheric Research in New Zealand; Regional Association VI RCC Network: Deutscher Wetterdienst in Germany.

An example of a monitoring product from the Caribbean Institute for Meteorology and Hydrology (the Caribbean RCC) can be seen in Figure 14, where the Standardized Precipitation Index (SPI) is shown for September 2022. SPI facilitates the identification of wet (index values above zero) or dry (index values below zero) episodes. Identification of SPI index values in the map is described in the colour scale at the bottom left corner and a summary describing the map is also provided (not shown). By accessing this regional product, a planner can gain knowledge of recent precipitation conditions and decide whether action is needed for risk reduction. Very wet conditions could saturate soils, contributing to potential landslides or dam overflow, whereas very dry conditions could affect crop yields or water supplies to human settlements.

32 World Meteorological Organization, "WMO Regional Climate Centres". Available from https://public.wmo.int/en/our-mandate/climate/regional-climate-centres (accessed on 27 September 2023).

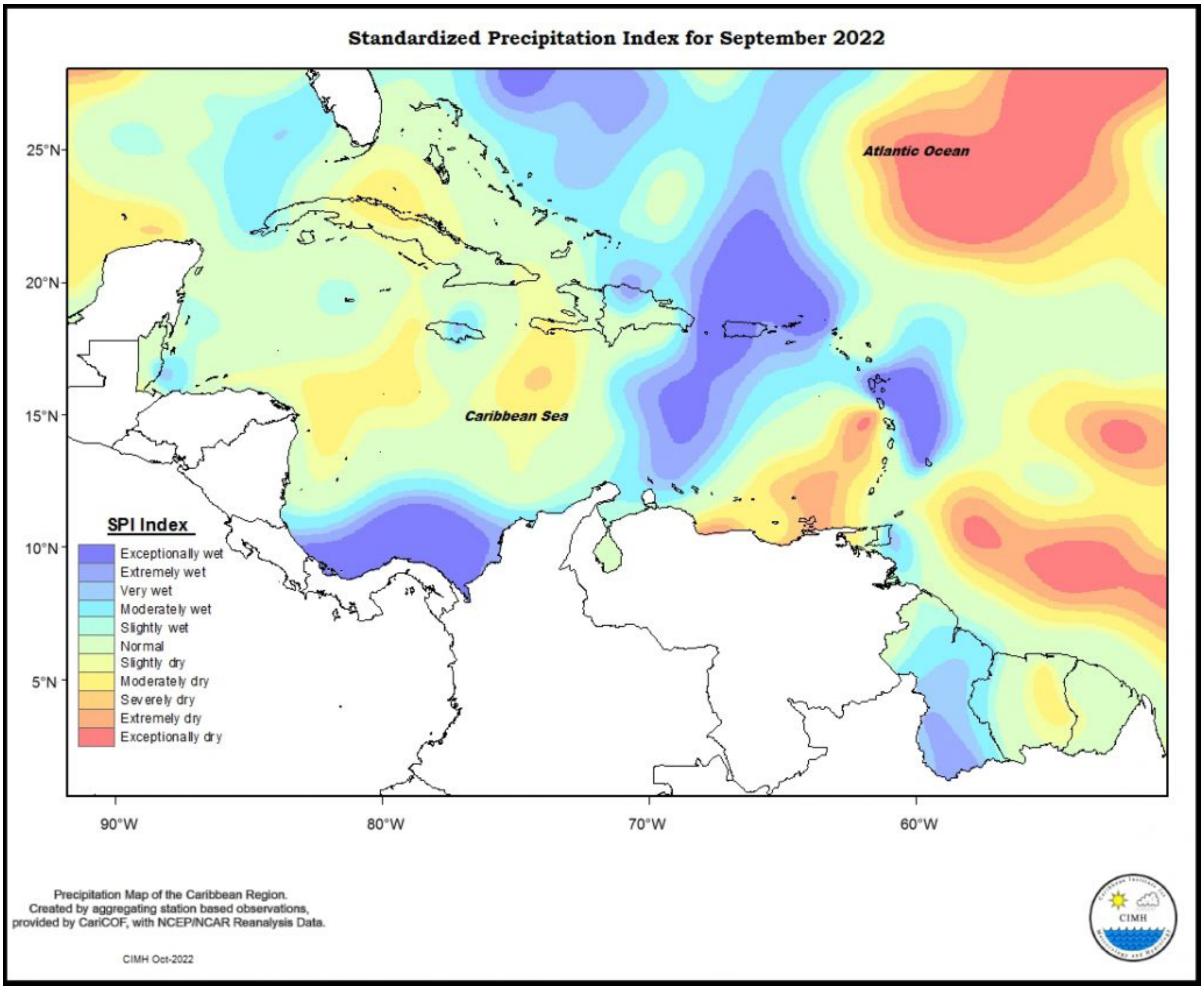


Figure 14. SPI for the Caribbean region during September 2022. Produced at the Caribbean RCC. Retrieved in November 2022.

Source: Caribbean Institute for Meteorology and Hydrology, Caribbean Regional Climate Center; see https://rcc.cimh.edu.bb/spi-monitor-september-2022/.

3.1.3. National scale

The national scale is not climatic in nature. It results from the political, societal and economic structures of countries. National territories exhibit wide variations in their extension around the world. Nations with large territorial extensions are likely to be exposed to various climate types. In contrast, a nation with a small territory may have a similar climate to adjacent areas. While there is no exact rule for climate types, adaptation and risk reduction strategies, as well as official communications of climate information for the population, happen at the national scale, where decisions are made in response to climate hazards.

NMHSs are the official sources of climate information at the national level. A list of all NMHSs is available from the WMO country profile database,[33] a repository listing the main constitution of each NMHS including links to corresponding websites. The capacities of each

33 World Meteorological Oragnization, "Members/Partners". Available from https://community.wmo.int/en/members (accessed on 27 September 2023).

NMHS vary in terms of technical and human resources. While most NMHSs belong to a specific government sector or ministry, they are the official sources of weather and climate information in each country. A few NMHSs are non-governmental, including being operated by the private sector. After RCCs and GPCs, NMHs are the third tier in the top-down approach of climate information production.

Since most NMHSs are part of the structure of a particular socioeconomic sector, their information products might be designed to better serve the sector they belong to, which results in additional challenges for generation of information dedicated to reduction of climate-related risks. In some cases, the meteorological and hydrological services are part of the same institution, although this is not always the case.

An NMHS carries out activities related to observation, monitoring and prediction of climate variations at all scales. Figure 15 shows an example of monsoon precipitation monitoring from the India Meteorological Department. Three maps are included for rainfall on 21 November: daily rainfall (21 November 2022), normal precipitation (1971 to 2020) and anomalies (current minus normal). By consulting this product, a planner can see that daily rainfall is below what normally occurs.

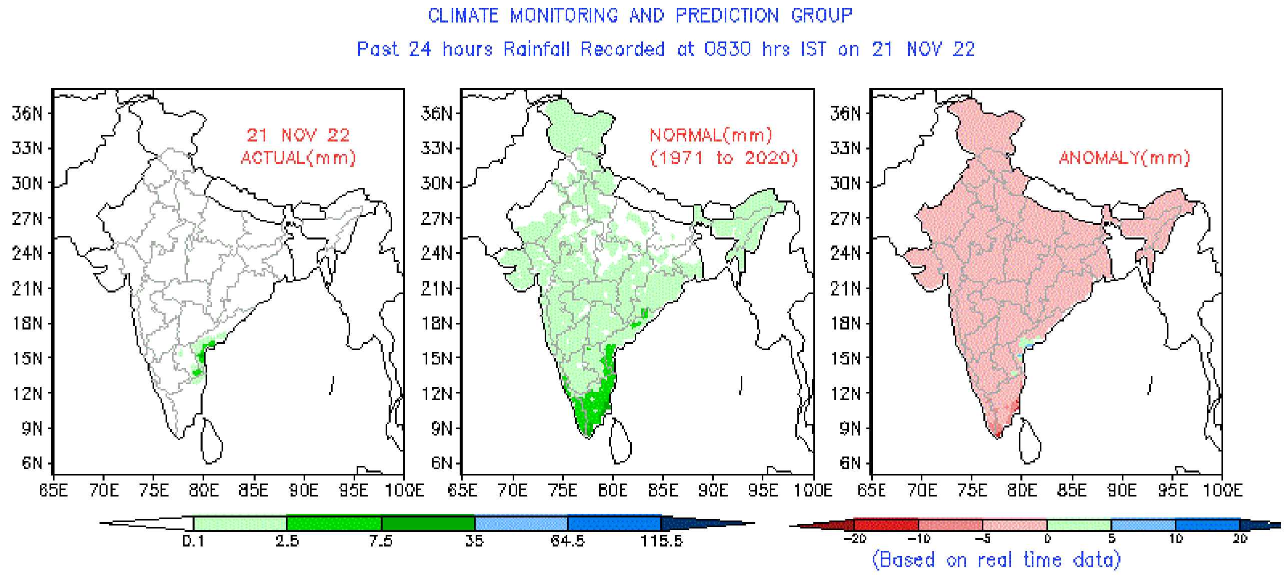


Figure 15. Daily map of monsoon activity published by the India Meteorological Department, Ministry of Earth Sciences, Government of India. Retrieved in November 2022. (The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.)

Source: India Meteorological Department; see https://mausam.imd.gov.in/imd_latest/contents/daily_activity_map.php.

3.1.4. Local scale

Any area with similar characteristics different from those of other surrounding areas is defined as a local area. In this sense, a local area is expected to be subjected to the same climate type. In general, a city, village or any other type of human settlement such as a valley, a mountain or a coastal area would typically be part of a local-scale climatic area. Climate change will alter the climate of all localities globally in a cascading effect. However, specific changes for each locality depend on many other local factors. For example, urban localities where the local impact of land use has given place to an urban heat island might see exacerbations in that phenomenon, whereas local rural areas could experience changes in temperature, precipitation and evaporation rates. The former is related to risks for the at-risk population (children, the unwell and the elderly) and the latter is related to risks for crop yields, conservation and rural-to-urban migration.

Changes in climate at the local scale are detectable from long-term instrumental observations at localities. Observed variables reported by meteorological, climatological or hydrological stations in a specific locality also contain information on extreme values. For example, in tropical regions, hurricanes are a major weather hazard, as in the case of Hurricane Dean, which impacted eastern Mexico in August 2007 (Figure 16) and caused daily precipitation values as high as 193 mm per day, the highest daily precipitation in the 1981–2010 period and much more than the monthly total but recorded in one single day (Table 4).

Figure 16. Satellite image of the final landfall of Hurricane Dean in Mexico on 22 August, 2007. Retrieved in November 2022.

Source: National Aeronautics and Space Administration; see https://earthobservatory.nasa.gov/images/18895/hurricane-dean.

Table 4. Daily rainfall, maximum temperature and minimum temperature observed in a locality of central-eastern Mexico (15 to 26 August 2007) during the trajectory and impact of Hurricane Dean. Extreme values were observed on 22 August, which had the highest daily rainfall and the lowest daily maximum temperature.

Year	Month	Day	Daily rain (mm)	Daily Tmax (◦C)	Daily Tmin (◦C)
2007	8	13	0	19	5
2007	8	14	5	22	5
2007	8	15	9	18	6
2007	8	16	8	19	3
2007	8	17	4	21	4
2007	8	18	0	19	6
2007	8	19	21	20	4
2007	8	20	7	19	5
2007	8	21	16	18	6
2007	**8**	**22**	**193**	**13**	**4**
2007	8	23	3	16	3
2007	8	24	6	17	4

Source: National Meteorological Service of Mexico; see https://smn.conagua.gob.mx.

Some advantages are inherent to climate information at the local scale. On the one hand, small communities or even individuals could possess historical information on climate variations that is not necessarily contained in official sources. On the other hand, specific projects or non-governmental organizations could also have climate records that, despite not being of an extensive length, might help evaluate extreme events, climate hazards and their impacts.

The generation of climate information at the local level has constantly been a challenging practice since, in most regions of the world, the number of observation sites has diminished in recent decades. However, monitoring through actual observations is what produces real/time inputs that feed into DRR strategies such as EWS. Therefore, the importance of promoting continuous and sustained local observations should be emphasized to the extent possible.

3.2. Timescales

This section documents how long each timescale lasts, and which diagnostic and prediction products are usually available for climate risk management. At present, information products are available for all timescales. These products contain observations and predictions of weather and climate hazards, which can contribute to informing risk management processes. Although no best source exists as such, some are more usable than others. Climate change spans all timescales (Figure 17).

In fact, the perception of climate change has associated it with the middle or the end of the twenty-first century, since most climate scenarios refer to the year 2050 or 2100. However, as has been described in section 2.10 of this guidance, since global warming is only a driver of changes in the physics of climate, climate change means a different behaviour in atmospheric circulation and exchanges of energy with the ocean, among other effects.

The more the planet warms, the more its climate physics changes. Therefore, climate change implies changes in weather and climate phenomena across all timescales, including but not limited to: more intense precipitation and droughts, more extreme temperatures, stronger exchanges between the poles and the tropics (different patterns in frontal passages, cyclones, atmospheric and oceanic waves). Hence, changes in the climate variables normally observed during the occurrence of weather and climate phenomena are expected as a result, but the exact moment when such changes will manifest is uncertain.

Only by developing current capacities in monitoring and prediction, as well as in associated mechanisms in the DRR value chain, can there be improvements in managing climate risk. Here, all timescales are described at a glance.

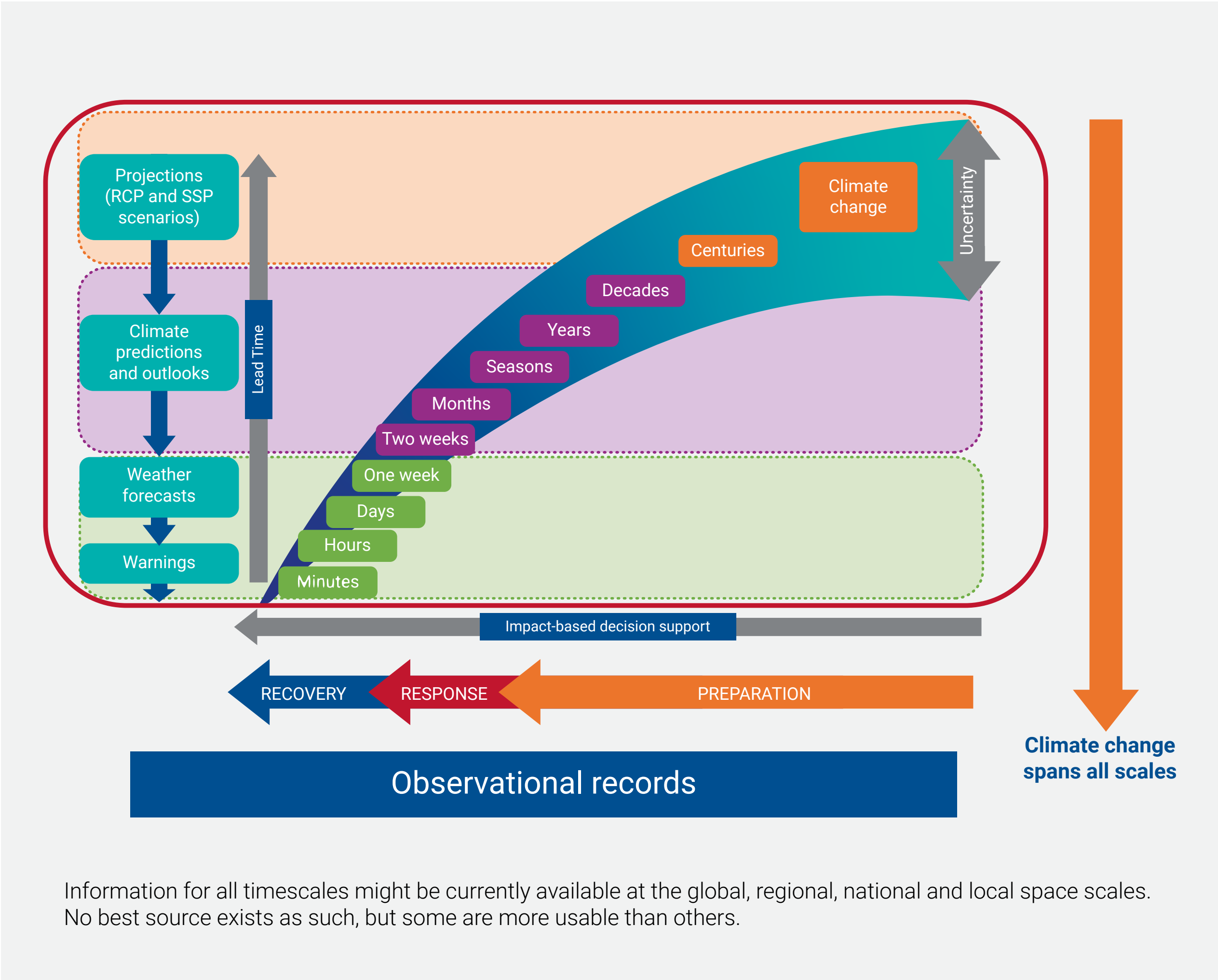


Figure 17. Timescales of weather and climate information for DRR planning. Climate change spans all scales.

Source: National Oceanic and Atmospheric Administration, 2023.

3.2.1. Weather scale

The weather timescale spans from a few minutes to a maximum of 14 days. Many meteorological phenomena are observed in this timescale, including turbulence, dust devils, tornadoes, storms, local convective systems, winds, hail, snow, extreme temperatures, frosts, heatwaves, frontal passages, cyclones and storm surges, among others. Hazards related to weather phenomena require real-time monitoring and forecasting, usually carried out by the NMHS.

Some weather phenomena occur suddenly, within minutes to hours, as in the case of tornadoes, limiting the amount of time for issuing a forecast, giving place to the issuance of warnings instead. In such cases, the approach known as "nowcasting" is used instead of forecasting. It consists of a very short-term warning based on monitoring and requires installed response capacities in each one of the vulnerable systems for prompt action.

At present, near-term numerical weather forecasts are reasonably accurate, in most cases for the next one to five days; after this, the forecast accuracy gradually decreases. For the purpose of DRR, weather forecasts are a key piece of information on short-term hazards; weather forecasts are operationally available from global (GPCs), regional (RCCs) and national (NMHSs) sources and should ideally be tailored accordingly.

With the increase in computing power in recent years, many prediction centres use supercomputing facilities to run numerical weather prediction models. This means that weather forecasts are performed under the modality known as "**ensemble forecasting**". An ensembled forecast is the most probable forecast of several performed for the same target time. If ensemble forecasts are available for an area of interest, their use is highly recommended since they are probability-based and account for uncertainty.

Enhanced capacities for the use of weather forecasting have been developed over time. Weather forecasts have been combined with impact information in what is known as "impact-based forecasts (IBFs)"; in this way, forecasts and warnings are addressed under a multi-hazard impact-based approach. Additional resources on IBFs include the WMO guidelines on multi-hazard IBF and warning services and a freely available introductory course.

Regardless of which type of weather forecast a planner uses, these resources are essential for the development and operation of MHEWSs, which in turn are a key element of DRR adopted by the SFDRR 2015–2030 (global target G).

It should be noted that between weather and seasonal timescales, there is an intermediate timescale known as the subseasonal to seasonal timescale (S2S). It covers phenomena that occur between 14 days and three months. However, it remains an area with low predictability and a matter for research.

3.2.2. Seasonal scale

Spring, summer, autumn and winter are the year's seasons as determined astronomically, but not climatically. When it comes to climatology, a marked difference from one to another of those four seasons is more evident around mid-latitudes. However, such differences vanish around the equator, giving place to climate regimes that exhibit relatively minor contrasts throughout the year. In between, other regions have only two well identified seasons, one dry and cold and another warm and humid. In contrast, at the poles, half the year happens in light and the other half in darkness. For areas of the planet where most of socioeconomic activities take place, a good knowledge of the seasonal climate is highly relevant to DRR-related strategies.

3.2.3. Inter-annual scale

Climate naturally varies from year to year. Not all years are equal in terms of mean temperature or total precipitation. Thus, wetter and drier and warmer and colder years alternate. When seen as climate anomalies, it is normal to see these alternates. Nonetheless, recent decades have been characterized by mostly warming in relation to a stable period of reference (1961–1990). Using different and more recent periods of reference may slightly mask the overall warming signal and reveal patterns of inter-annual variability. In many regions, quasi-cyclical climatic variations in the inter-annual scale exist, related to any of the various climate modulators influencing climate. The most known of these are those related to the presence of El Niño or La Niña phenomena, which are the two oceanic phases of the coupled ocean-atmosphere system known as ENSO. Therefore, knowing if the climate in a particular region of interest has direct impacts on ENSO is key to understanding inter-annual variations.

3.2.4. Decadal scale

Some climate variations can occur at the decadal scale. These are known as low-frequency oscillations, meaning that climate variables may follow a specific pattern for one decade or group of decades before shifting to a different one in the next decade or group of decades. These types of climate variations are related to changes in the ocean, such as the Pacific Decadal Oscillation or the Atlantic Multidecadal Oscillation. However, not all areas of the world show this type of variation and the impact of climate change will still accompany decadal variations.

3.2.5. Climate change

Future horizons for climate change extend to the end of the twenty-first century. Climate change scenarios cover an extended period up to the year 2100. In practice, three future horizons are used in thirty-year periods known as the near-term future (2011–2040), the medium-term future (2041–2070) and the long-term future (2071–2100). In addition, the year 2050 is often used as a reference for reviewing accomplishment of climate action goals.

3.3. Other climate information sources

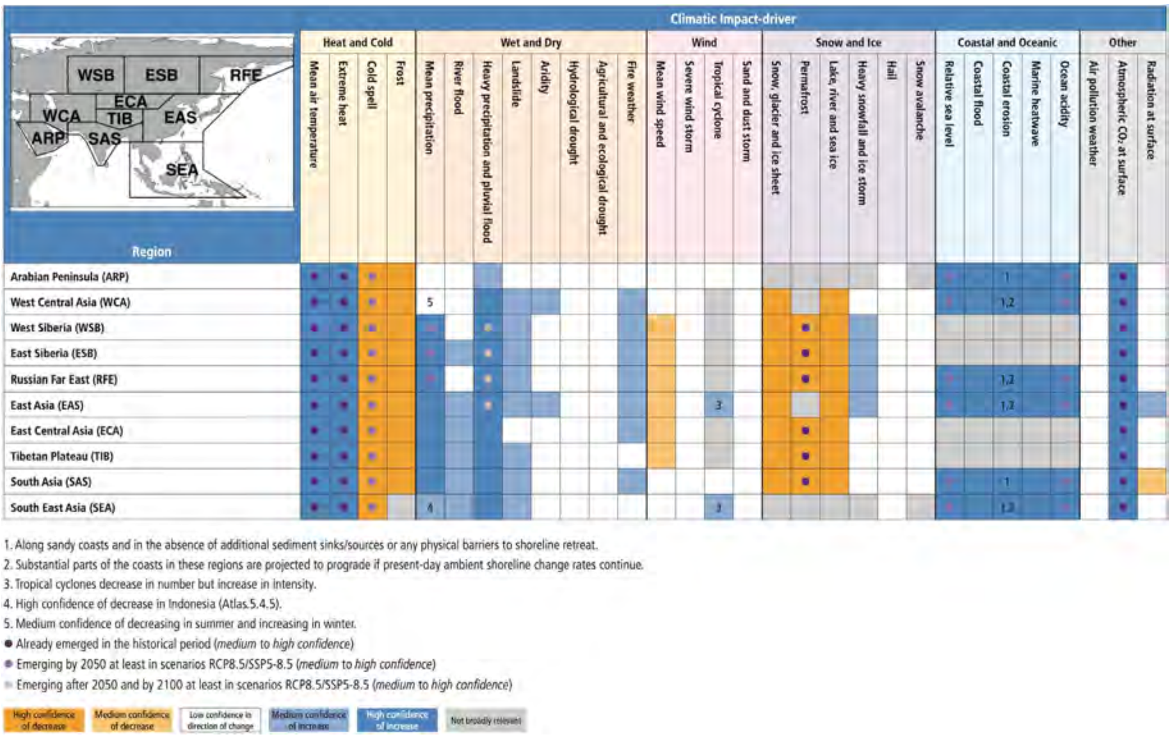
3.3.1. Intergovernmental Panel on Climate Change assessment reports

The IPCC, a body of the United Nations in charge of conducting periodical assessments on climate change, produces periodical assessment reports on three aspects of climate change: the physical science basis (WGI); vulnerability, adaptation and impacts (Working Group II [WGII]); and mitigation of climate change (Working Group III). Among them is the Sixth Assessment Report with contributions from WGI, published in 2021. The IPCC has also produced special reports on topics related to climate change, such as emission scenarios, climate extremes, GHG inventories and global warming of 1.5°C above pre-industrial levels.

The IPCC conducts assessments of the latest scientific knowledge that has been published in peer-reviewed literature, by consensus of all the Parties (member countries). Since the assessment reports are produced by consensus, they are the authoritative voice on the latest knowledge regarding climate change. However, summaries for policymakers, synthesis reports and all plots and tables are publicly available and easily accessible on the IPCC website.

An example of the type of climate information that can be used in DRR plans is given in Table 5, which shows Table 12.4 from the Sixth Assessment Report of IPCC WGI, where a summary of changes in climatic impact-drivers in Asia is provided at the regional level.

Table 5. Table 12.4 of the Sixth Assessment Report. Summary of confidence in direction of projected change in climatic impact-drivers in Asia.



Source: Working Group I, Intergovernmental Panel on Climate Change; see https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-12/#12.4.

As an example, a risk management strategy might take from Table 5, for the region of South-East Asia (the "SEA" area depicted in the map and the row at the bottom of the table) the following insights on climate-related hazards:

- Extreme heat already emerged in the historical period (medium to high confidence).
- Hazards from cold spells, relative sea level and ocean acidity will be emerging by 2050 at least in high emission scenarios (medium to high confidence).
- A mean precipitation decrease is expected in Indonesia (high confidence).
- Tropical cyclones in the region are to decrease in number but increase in intensity.
- There is a coastal erosion hazard along sandy coasts and in the absence of additional sediment sink/sources or any physical barriers to shoreline retreat.
- Substantial parts of the coasts in these regions are projected to prograde if present-day ambient shoreline change rates continue.
- Hazards due to atmospheric carbon dioxide at the surface already emerged in the historical period (medium to high confidence).

Although such insights may not be punctual in specific locations, the IPCC regions provide a good idea of changes in the climate system that have been already detected and specific changes that are expected and the related uncertainty or confidence level. Similar tables for the rest of the world are available in Chapter 12 of the Sixth Assessment Report of IPCC WGI. In-depth consultation of the IPCC reports by risk planners and risk managers is an essential aspect of DRR strategy development.

3.3.2. Risk information exchange

The Risk Information Exchange (RiX) is UNDRR's living repository of open-source global, regional and national risk data and information to improve risk knowledge, risk literacy and risk analytics. Contributing to country-led efforts to strengthen their national risk data ecosystems, including for early warning and DRR, RiX was launched in 2022, with new features added quarterly. As a UNDRR-led platform, RiX seeks to aggregate risk information to facilitate risk analysis by government, United Nations, private and other actors for risk-informed decision-making and resilience building.

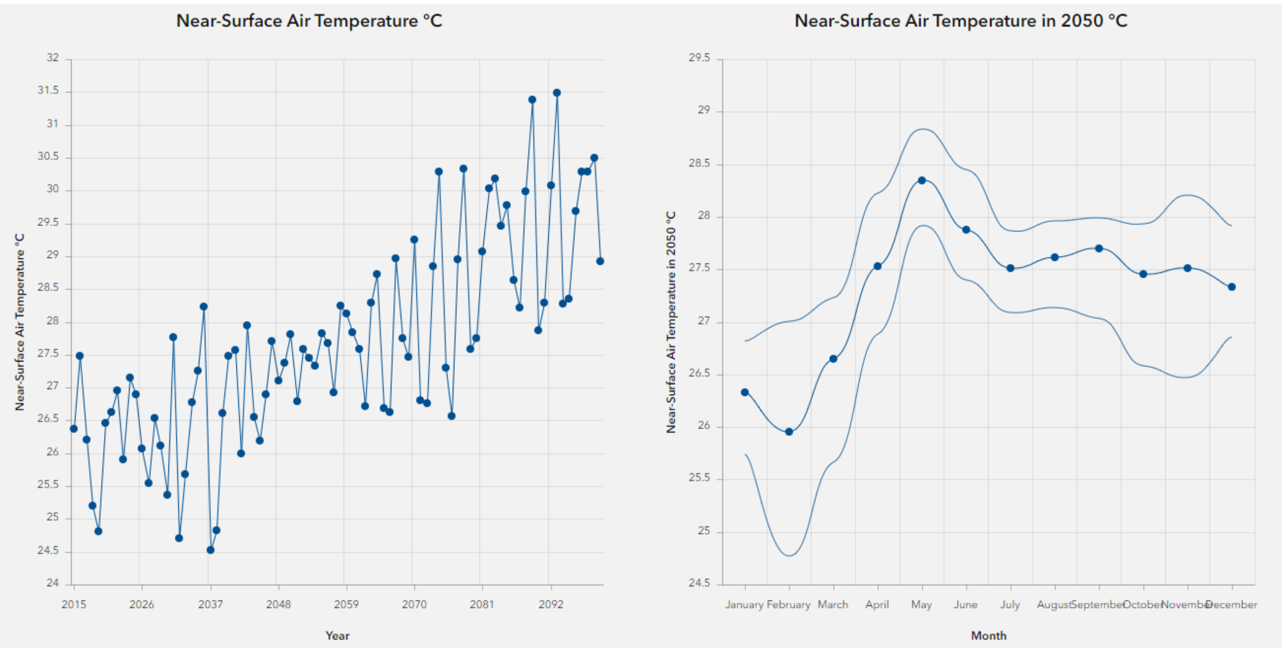


Figure 18. RiX platform-generated climate statistics for the Maldives.

3.3.3. Climate information platforms

Constant evolving capacities in information technologies have enabled the development of various climate information platforms intended to provide easy access to a wide range of users. In most cases, as described in the Appendices, climate centres at the global, regional and national levels provide specific types of climate data, usually for operational purposes to serve information needs for weather, seasonal and inter-annual timescales (see annex I). Examples of different types of information are provided in annex VII.

In terms of climate change, information from both the recent past/present and the future is needed in order to evaluate related hazards. In most cases, climate change scenarios might require different levels of skills or expertise to be accessed and visualized efficiently. Hence, recently emerged climate information platforms intend to provide users from all sectors with straightforward access to such information. Since these platforms are not designed for specific sectors, they provide overall information on observed temperature and precipitation and their future projections under different scenarios. Some of them include additional climate indicators.

At the time of producing this guidance, many platforms have been developed, at least five of which are suggested here. These are:

- IPCC WGI Interactive Atlas (annex II)
- SMHI Climate Information Platform (annex III)
- University of New South Wales Climdex portal (annex IV)
- National Aeronautics and Space Administration /IPCC Sea Level Projection Tool (annex V)
- World Bank Climate Change Knowledge Portal (annex VI)

Examples of each platform's usage are given in the annexes, albeit for illustrative purposes and with no intention of replacing the tutorials of each platform, which can be found on their respective websites.

04

APPLYING CLIMATE INFORMATION FOR PLANNING AND IMPLEMENTATION

Credit: Shutterstock/aappp

Disaster and climate risk management benefit from using climate information on all scales, including those referenced in the previous sections. While DRR offers an important opportunity to adapt to current climate variability, in order to be successful, DRR efforts must also consider changing climate-related risks in the medium to long term. Countries are increasingly appreciating the value of integrated approaches and a shared understanding of risk, and a joint approach to manage it at different timescales offers a concrete basis for breaking down the often artificial silos in governance and management of disaster risk and climate change.

Depending on its timeliness and accuracy, climate information improves the characterization of multiple hazards, so that in combination with vulnerability and exposure assessments, it contributes to the formulation and implementation of DRR and CCA plans. The type of climate information for a specific temporal or spatial scale is directly related to the dimension of the hazards to be addressed. Identifying the correct climate information products for each hazard is essential since it reduces inherent limitations and uncertainties.

4.1. Considerations for integrated disaster risk reduction-climate change adaptation plans

Understanding and identifying the climate change data and information, as outlined in the preceding sections, are essential in conducting risks assessments and applying an analytical framework that sufficiently integrates CCA and DRR in national or local-level planning. However, there are other critical areas that will facilitate a holistic approach and greater sustainability; a stepwise approach (below) builds on these areas.

Table 6: Key Considerations for CRM planning

Key areas for consideration	Parameters
Governance instruments (plans, policies, programmes, legislation and regulation, etc.)	• Conduct a stocktake of existing DRR and adaptation instruments (such as plans, strategies and policies) and their status (outdated, in the draft stage, being developed or being implemented). • Identify other relevant instruments to which integrated DRR plans must be aligned, such as national development plans and natural resources management plans.
Repositories and sources of climate change data and information (as outlined in the previous sections)	• Identify relevant sources of data and information as available and applicable for the country, taking into account the geographic scope and the parameters referenced in previous sections. • Identify existing and relevant climate-centric risk assessments such as climate change projections, hazard and exposure maps, vulnerability assessments and impact assessments covering multiple sectors, populations, social services and economic considerations.
Level of climate change consideration	• Evaluate (if applicable) the extent to which the DRR plans have considered weather and climate variability and change.

Key areas for consideration	Parameters
Key stakeholders and partners	• Conduct a stakeholder mapping exercise to identify the entities essential to the process of integrating climate information in DRR plans. These include data providers, researchers, climate change specialists, funding entities, at-risk populations, etc.
Coordination mechanisms	• Identify any existing or planned coordination mechanisms that aim to facilitate risk management and/or climate change action (e.g., councils, thematic working groups, committees, boards, etc.). • Evaluate whether the existing coordination mechanisms are fit for purpose or can be adjusted to support integrated planning.
Finance and budget	• Evaluate ways in which existing or planned budgetary allocations can be scoped to support enhanced integrated planning, e.g., creating budget line items for integrated climate change and DRR activities. • Identify opportunities for integrated approaches to be funded, such as NAP funding under the GCF Readiness Support Programme and allocations under the Global Environment Facility.
Gap assessment	• Determine where gaps exist, based on the key areas for consideration above. This includes technological, financial, data and human resource gaps. • Develop a plan to address these gaps, with special attention given to priority issues (essential activities that will catalyse the integration process).

There are several resources available that can complement or be used to add value to DRR plans. Of note is the Words into Action[34] guide on developing national DRR strategies and the implementation guide for local DRR and resilience strategies.

Another useful resource is the NAP technical guidelines. These provide elements and steps of the NAP process, along with some key questions associated with each step. Various supplementary materials for NAPs are also available. These include guidelines relating to engaging with NAPs, biodiversity, alignment with budget and development planning, a stocktaking tool and developing a climate science basis for climate action. Of direct relevance to this guidance is the NAP supplement on promoting synergy and alignment between CCA and DRR in the context of NAPs. The steps proposed in the section below will highlight ways in which these technical resources can be applied.

4.2. Framework for climate-informed planning

A simplistic analytical framework is proposed for developing integrated DRR-CCA plans. This consists of: climate information; impact, vulnerability and exposure; and DRR plans and interrelated strategies. See Figure 19 below.

34 For the full series of guides, see https://www.undrr.org/words-action.

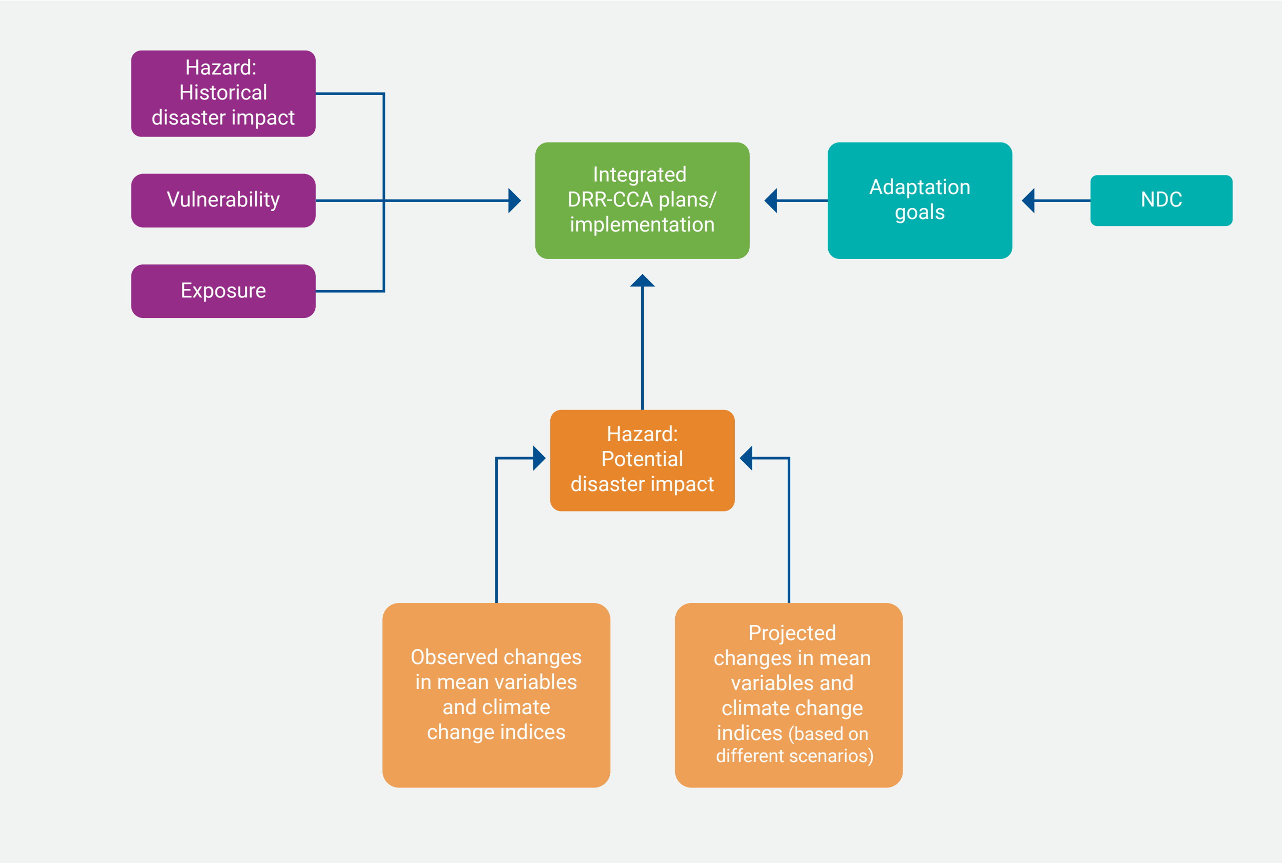


Figure 19. An analytical framework for integration of climate information into DRR strategies.

Pillar 1: Impacts (historical and potential), vulnerability and exposure data

The ultimate goal of an integrated approach is to reduce the risk and impact of hazardous events. Without data on past impact, it would be more challenging to project future impact. However, the precautionary principle should apply, where lack of or insufficient data does not deter efforts in reducing future impact.

Impact data are available from databases intended to monitor and inform implementation of the SFDRR The online Sendai Framework Monitor, especially targets A to D, provides disaster impact information. The tracking system on disaster impacts and losses and damages (see www.desinventar.net) provides national and subnational information.[35] Other relevant impact information includes EM-DAT. However, information at the local and national levels should be thoroughly sought in sectoral databases or information systems, as well as in individual records of extreme weather or climate events recorded by specific societies. See Box 1 as an example of good practice.

35 The tracking system has been in operation since 1994 and currently being used by 110 countries. The system is currently being revamped. See https://www.undrr.org/disaster-losses-and-damages-tracking-system.

Box 2. Good practice – Use of disaster loss databases and data as an entry point for better collaboration on DRR and climate action in Cambodia

Cambodia has adapted the DesInventar database to Cambi, the national equivalent, which is also aligned to the SFDRR, and used the information to inform multiple planning processes, including the NDC and the Cambodia Disaster Risk Reduction Framework and National Action Plan 2019–2023, as well as for NDC budgeting. It improved the database by strengthening the climate and disaster information system: installing and using installed climate and hydrological stations (data availability); carrying out an evaluation of existing compiled and monitored data within the relevant ministries as well as their climate and disaster information needs (access to data and information and capacity to use it) in order to improve data and information delivery (key informant).

Vulnerability and exposure assessments, including socioeconomic variables, may need to be completed for given areas or sectors of interest. Insights on vulnerability in various regions of the world are available in the IPCC WGII Sixth Assessment Report. Climate change is dynamic, in that improvements in data collection and science provide more up-to-date evidence of climatic changes and their subsequent impacts on human, natural and economic systems. It is therefore imperative that DRR planning remains flexible and adjusts to accommodate new and emerging vulnerability, exposure and impact information.

Pillar 2: Climate information (observed and projected changes in mean variables and climate indices)

Integration of climate change in the planning processes must be undergirded by climate data and information. For the specific purpose of addressing climate change as part of integrated DRR-CCA strategies, initial information on observed and projected changes in mean climate variables and climate indices should suffice as data on the normal climate, climate anomalies and observed changes and trends in climate indices. Similarly, information for future horizons can be obtained from the different climate change scenarios available in climate information platforms or other local sources.

Expert opinions should be sought on the implication of changing climate variables and indices for potential impact. Where possible, national- and local-level DRR tracking and monitoring databases and systems should integrate or be connected to climate databases. This could assist in streamlining the use of climate data in DRR decision processes. It would also support analyses relating to the contribution of weather and climate phenomena to disasters and provide the impetus and justification for further integrating CCA and DRR.

Recording and tracking of disasters, impacts and potential impacts should follow available data standards. For instance, the SFDRR Framework terminology, hazard classification and hazard information profiles help use a common taxonomy across time and space to enable comparisons across the scale.

Pillar 3: DRR plans and interrelated strategies (including but not limited to national adaptation plans and nationally determined contributions)

DRR plans are most effective and sustainable when aligned with other plans, particularly climate change plans. It is therefore necessary to take stock of what exists with a view to identifying areas of synergy, and how climate change and DRR planning can be integrated. Tools to consider in this regard include NAPs, nationally determined contributions (NDCs), low-carbon, climate resilient long-term development strategies and national development plans, etc. Box 3 provides information regarding NAPs. It is also useful to identify ongoing and planned climate change projects and programmes, including funding by regional and international entities such as the Green Climate Fund (GCF). This provides for two-way integration opportunities, whereby DRR can be more fulsomely taken into account in funded initiatives and vice versa.

A well-structured coordination mechanism will enhance the effectiveness of integrated DRR-CCA planning. Such a mechanism pulls expertise and buy-in from key stakeholders and strategic partnerships to, inter alia: provide data; guidance; tools and methodologies; financial and human resources; and other resources as required. The mechanism should be inclusive, with the engagement of at-risk populations, as well as gender, to leave no one behind. Options for such a mechanism include committees, working groups and boards. Existing options, where not fit for purpose, could be retooled and reconfigured accordingly. New mechanisms should be designed to be responsive and not add undue burden where capacities are constrained.

Additional mechanisms that may play a role in CRM and be investigated to establish a liaison with integrated DRR-CCA strategies include instruments for risk transfers to the international market, traditional and parametric insurance and communal trust funds; such mechanisms often require operational weather or climate information at the local level and might be a source of documentation for impacts or vulnerability.

A relevant aspect of climate change is the requirement of historical data to establish a “reference period”, preferably with a record length of at least 30 years, ideally in the period from 1961 to 1990.

National integrated plans and strategies face the challenges of:

- Determining potential impacts at the national and regional levels from climate change projections. Since projections only document potential changes in hazards driven by climate change, their translation into potential impacts can only be derived from historical impacts.
- Designing effective actions for disaster reduction and climate risk management (or adaptation) based on a progressive approach, noting that short- and medium-term goals contribute to long-term sustainable capacity-building and risk-informed planning.

Box 3. Climate information for NAPs

Both the twenty-first session of UNFCCC COP and the Paris Agreement stressed the significance of accelerated implementation of NAPs. As of 11 April 2023, 45 Parties have submitted NAPs to the UNFCCC.[1] Furthermore, an estimated 194 NDCs[2] have been submitted to the UNFCCC, 150 of which included adaptation.[3]

Successful implementation of NAPs requires credible, relevant, usable and timely climate information to support evidence-based climate risk management decision-making. Enhancement of climate-related adaptation planning should ideally include a wide range of information on the past, present and future climate, which is necessary to support understanding of climate risk and its effects on natural and human systems. In this regard, NAPs have synergies with DRR strategies as both aim to reduce risks brought by climate-related hazards.

UNDRR has conducted reviews of NAPs and NDCs (see Promoting Synergy and Alignment Between Climate Change Adaptation and Disaster Risk Reduction in the Context of National Adaptation Plans) and continues to review submitted NAPs to analyse their quality and how well climate change information was featured within them. At present, this is a continued process intended to support the development and inception of NAPs.

These reviews reveal that, despite the inclusion of a substantial amount of climate change data and information in the development of NAPs, several limitations exist:

- Availability of data for complete and continuous observational climate records remains a major issue. In many countries, the climate data record extends to as few as 10 years. However, it has been observed that many data, in developing and least developed countries, exist in paper format. Hence, digitization of climate data is urgently needed to facilitate access, exchange and use.
- In many cases, observed data exhibit problems of record intermittency and incompleteness, making it difficult to conduct thorough data analyses of climate trends. These challenges impose severe constraints on assessing the normal climate at specific locations, evaluating their observed changes and limiting the design of the most effective adaptation and climate risk management solutions.
- Without high-quality observation records, climate model validation is also constrained, increasing uncertainty in the development of plans such as NAPs and DRR strategies.
- In addition, it has been observed that some specific territories, such as the small island developing states, lacked access to reliable, long-term data due to the limited number of measurements and studies on climate change parameters. For example, in the case of tropical small island developing States, where cyclonic activity and ocean surge dynamics have led to high impacts, with no possibility of accurate determination of climate-related hazards due to loss of data from hydrometric stations.

Therefore, concerted efforts are needed to rescue observed climate data to facilitate more robust design and development of concrete climate actions. Such data support the development and application of climate model validations that in turn will reduce uncertainty in long-term projections that will ultimately enable development of actionable DRR and adaptation plans at the national level.

1 For more information, see https://www.napcentral.org/submitted-naps.
2 NDCs are primarily for reporting on mitigation, particularly emissions reductions targets; however, countries can also use them for reporting on adaptation priorities, needs and action.
3 Data calculated from https://www.climatewatchdata.org/ndcs-explore?category=adaptation&indicator=adaptation on 14 February 2023.

4.3. Steps for integration of climate information into disaster risk reduction plans

The following steps, while not exhaustive, are designed to support the design and development of climate-informed DRR and integrated plans.

Figure 20. Non-exhaustive steps for designing a climate-informed DRR or integrated plan.

Step 1: Take stock of what exists

This first step is designed to identify what exists: climate data and information; climate change and DRR plans and policies; and coordination and governance mechanisms. With respect to climate data and information, it will be important to identify national and subnational data repositories and types of data available. Useful data and information may also be contained in various reports, including national reports under the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, or special reports prepared at the national or regional levels.

Examples include the State of the Jamaican Climate reports (produced for 2012, 2015 and 2019) and the State of the Caribbean Climate Report 2020.[36] Various international sources also exist (refer to section 3.3). These sources will be instrumental in mapping changes in weather and climate, including seasonal, extreme and slow-onset events/patterns.

An integrated approach must also identify various planning instruments being implemented or programmed in the draft stage. In this way, opportunities for synergies and alignment increase, as does efficiency in use of resources (human and finance, inter alia). Consideration should be given to NAPs, NDCs, low-carbon, climate resilient long-term development strategies and so on. Local-level instruments, where they exist, should also be included.

Coordinating mechanisms are comprised of entities and persons that facilitate action in pre-determined areas, whether these are thematic (such as DRR or climate change) or geographic. They will become a critical element of how climate change is integrated into DRR plans, and a stocktaking exercise would identify where they exist and their role. The Words into Action guide on national and local platforms offers some steps to strengthen coordination in countries. See Box 4 for an example of country-level coordination.

This step aligns with the first phase of the NAP process of laying the groundwork and addressing gaps, as well as the first of the 10-step approach to developing a DRR strategy. The information collected during the stocktaking exercise will dovetail into the understanding of risk, subsequently framing the vision and outcome expected in the integrated DRR plan. The stocktake is also essential in identifying commonalities between DRR and CCA and enhancing the picture of risk across different timescales.

Box 4. National coordination in Jamaica

Jamaica has established several mechanisms for integrating CCA and DRR. A thematic working group for hazard risk reduction and CCA was established to foster strategic-level, multidisciplinary input in the implementation of Vision 2030 Jamaica – National Development Plan. The Climate Change Policy Framework for Jamaica (2015) also established a Climate Change Council with representatives from various backgrounds, and from state and non-state entities; members are nominated by the Cabinet on the recommendation of the minister with climate change responsibility. Another mechanism is the Climate Change Focal Point Network, comprising representatives from government ministries, departments and entities, including those responsible for disaster management. Local-level DRR focal points have received training in climate change to facilitate integrated planning.

In addition to the questions in section 4.1 above, the following reflects some key questions to move this step forward, pulling from the DRR and CCA/NAP guides referred to above:

- What data and knowledge (for varied timescales) are available for both DRR and CCA? (This includes historic data and projections for future climate.)
- What are the hazards to which the country or community is exposed?
- What risks assessments have been conducted, what was the focus and scale, and when were they completed?
- Who are the owners and managers of these data and how can they be accessed?
- Are there linkages and synergies among the CCA and DRR data sets?
- What are the reporting arrangements with respect to these data?

36 Climate Studies Group Mona (eds.), *The State of the Caribbean Climate* (Mona, 2020).

- How can the existing and planned resources and capacities for CCA and DRR be streamlined to support the integrated approach?
- Who are the key stakeholders that would ensure an inclusive approach to integrated planning?
- What current mechanisms exist to facilitate the collaboration and coherence in DRR and CCA systems and stakeholders?
- What are the governance systems in place?
- What are the key development goals in the short to long term that govern or align with DRR and CCA?
- What are the national- and local-level contexts? (e.g., population dynamics, geography, climate, etc.)
- What are the global multilateral agreements being pursued and implemented nationally and locally, and what are the priority targets?
- What agencies and actors are involved in CCA and DRR and to what degree?

An outcome of this step may include a stocktaking report. Alternatively, there may be several reports relating to the areas for which information is collected. Regardless of the route taken, the stocktaking activities must form the basis for understanding risk, the next step.

Step 2: Understand the risk

Risk assessments give an idea of the impact that can happen as a result of various types of hazards, including climate hazards. Assessments of hazards (including exposure to them) and vulnerability, as the components of risk, must likewise account for climate change. With respect to hazards, the previous sections gave an overview of the different types; local and national hazard assessments and mapping provide the best sources for this type of information. It is best to utilize multi-hazard assessments for a holistic outcome, one that also builds coherence across the DRR and climate change landscapes. With the use of information from Step 1, patterns and trends relating to national or local climates will emerge; this will have direct application for change in risk and potential impact. Note also the information in Box 3 regarding the use and application of climate information. Further guidance on risk assessments is available at Words into Action guidelines on national disaster risk assessment and technical guidance on comprehensive risk assessment and planning in the context of climate change.

The vulnerability and impact of climate hazards on at-risk populations have been and still are increasing. Assessments in this regard should therefore be climate-sensitive. Impact assessments, where available, can complement vulnerability assessments and improve understanding of overall risks being addressed in DRR plans. Translating potential impact from hazards to inform DRR plans is not necessarily a scientific exercise, especially where limitations exist. In this regard, experts and experience can be used to give an indication of the projected impact and can guide the interventions to follow (see Step 4).

Box 5. Climate-specific activities towards an integrated plan

Identify the weather/climate/water phenomenon or variables that constitute hazards whose occurrence have in the past or might in the future result in disaster risk. Make a prioritized list. Examples: cold fronts, tropical cyclones, heatwaves, floods, frosts, hail, tornadoes, drought.

1. Determine the scales and projected timelines for the occurrence of selected hazard(s). This is valuable in determining whether capacities are installed for their correct monitoring and prediction (for example: a global hazard is the occurrence of El Niño or La Niña; if it has clear impacts on the region of interest, then its monitoring and prediction is performed by WMO GPCs, though impacts should be assessed at the national or local level; in a second example, if a local hazard such as a flood is the priority, then observed and projected extreme precipitation indices and their trends must be assessed and the implementation of correct observation networks, weather prediction schemes, impact based forecasts and EWS should be part of the strategy).
2. Identify available sources of information on selected hazard(s) for the scales determined in the previous step and analyse whether information is available for historical observations and future projections.
3. Evaluate what monitoring and prediction capacities are in place for the selected hazard; begin with operational agencies such as NMHSs. Check whether an MHEWS is in place.
4. Confirm that specific thresholds have been determined in relevant weather/climate/water variables for the sector or area of interest. If they are not available, establish a route for their determination.
5. If specific thresholds are available, verify whether they correspond to any of the climate change indices or sector-specific climate indices recommended by WMO; if not, include in the strategy the need of technically assessing the thresholds. For example, if floods are the prioritized hazard, they could originate from precipitation (pluvial floods) or from runoff (fluvial floods). Climate change indices may only include a pluvial index; if so, the selected hazard is fluvial floods, and calculation of projected thresholds would be needed because strategies for specific risk management would depend on them.
6. Analyse how thresholds are projected to change in the future by consulting any of the available climate information platforms for at least two different climate change scenarios. For example, assume the selected hazard is pluvial flooding and that a threshold has been locally determined in terms of the largest one-day precipitation. For the area of Medellín City, under SSP5-8.5, the average projected largest one-day precipitation anomaly for 2010–2039 is 15.63 mm, whereas the same projection for 2070–2099 is 68.17 mm. This would give an idea of the average increase in hazards from maximum daily precipitation and the potential increases in impacts. It should be noted that climate change scenarios only can provide changes in terms of long-term averages.
7. Consider the uncertainty level in the analysed projections and make inferences on how changes in mean temperature or precipitation (or changes in specific thresholds) might cause changes in the analysed hazard.

This second step is related to several elements of the DRR guide, Phases I and II in particular, and likewise, the NAP technical guides and supplements. The stocktake (which must be considered iterative) will determine the risk information available along with data to assess and understand risk.

Risk assessments give clarity to past impact as well as potential future impact. They can show, to varying degrees of certainty: possible new and emerging threats; the evolving nature and scale of hazards; and the location and scale of the potential impact on people, infrastructure, nature, the economy and sociocultural systems, among others. The past, present and projected impact on lives, health, livelihoods, sectors (such as tourism, agriculture and water), communities, migration (including forced displacement), economic growth and national security should become more evident through these assessments. This information then feeds into the identification of appropriate and integrated actions that will be captured in the DRR plan (Step 3).

Some guiding questions to note:

- How has risk evolved, particularly as a result of climate change?
- How will risk further evolve with the onset of more frequent, intense and extreme climate hazards?
- What is considered an acceptable risk with respect to human, natural and economic systems?

Step 3: Determine where gaps exist

In conducting stocktaking exercises (Step 1) and risk assessments (Step 2), gaps will become evident. These may be gaps in climate data (time series, parameters, scale, etc.), risk assessments or financing and human capacity. Gaps may also exist in the policy and planning landscape and in the regulatory framework to support or facilitate an integrated planning approach. Coordination mechanisms may exist but may have limitations in relation to representation (membership), scope or resources available, to name a few. Capacity constraints in key entities should also be identified, as this will have implications for the development and implementation of integrated plans.

Questions to ask:

- Were climate data available and easily accessible?
- Was there data to provide trend analyses?
- What assessments were not conducted or not available that would significantly enhance the quality of integrated plans?
- What were the limitations identified in the conduct of risk assessments, such as coverage of compounding, cascading and systemic risks from climate change?
- Was expertise available to support the development of risk assessments?
- Were there sufficient resources?
- Was there support for or buy-in of leaders or other key stakeholders?
- What, if any, were capacity gaps common to DRR and CCA planning?
- What capacity support is lacking in DRR and climate change institutions?
- What capacity-building exercises would be required for the development and implementation of an integrated plan (bearing in mind the risk assessments from Step 2)?

The 10-step DRR strategy provides a basis for identifying capacity needs. Capacity typologies listed are listed and should cover DRR and CCA: functional capacity (leadership, resource management, etc.); technical capacity (expertise and knowledge); hard capacities (organizational structures and procedures, etc.); and soft capacities (social skills, organizational culture, flexibility, etc.).

Step 4: Produce an integrated plan

The goal of an integrated plan is to reduce risk and vulnerability and strengthen resilience, more than would be possible in a siloed approach. This involves collaboration with climate change actors and could benefit from good practices in other jurisdictions. Resources such as PreventionWeb and weADAPT are freely available for use in this regard. Furthermore, several tools and methodologies have been produced that can assist in different aspects of the plan.

Among them are the Words into Action guide series referenced previously. Other complementary tools include the Technical Guidance on Comprehensive Risk Assessment and Planning in the Context of Climate Change and the DRR4NAPs (Promoting synergy and alignment: between Climate Change Adaptation and Disaster Risk Reduction in the context of National Adaptation Plans).

The production of the integrated should build on the previous steps and complement any prescribed format that may be required nationally or locally. With climate risks integrated into DRR plans, there is likely to be the potential to leverage political momentum, including ongoing debates under the UNFCCC and Paris Agreement. Similarly, many donors and funding entities are aligning their programmes with climate change targets of international agreements, which would bode well for access to financing.

Crucial in the integrated plans are the anticipated outcomes and associated activities and inputs. These should be aligned with past and present impacts from climate-related events and disasters, as well as projected risks. The activities should also address the gaps identified in Step 3, in particular, those gaps that are fundamental to understanding the most urgent needs of the country or community or are potentially catalytic in driving funding or other forms of support.

Communicating risks as identified (Step 2) coupled with knowledge management can help to reach a wider audience and strengthen collaboration with CC and development communities of practice at all levels. It is also beneficial for transparency and accountability and, importantly, providing knowledge as a first step in reducing vulnerability.

Monitoring and reporting is the only way to reliably demonstrate the extent to which the goals and objectives of integrated plans were achieved. To the extent possible, the integrated plan should consider how to streamline the monitoring system for both DRR and CCA. It may prove beneficial to take advantage of similar timelines for updating the DRR strategy and relevant climate change and national development strategies. This could reduce the data-collection and reporting burden, while optimizing lessons learned and revisions of corresponding policies and implementation plans.

A summary of some important climate elements of an integrated plan is as follows:

- Sources of data and information
- Past, present and projected climate
- Impact assessment, including the past and potential impact
- Assessment of risks from climate-related hazards
- Gaps in developing an integrated plan
- Activities and inputs to reduce the identified risks and potential impact
- Communication of risks and related activities to be taken
- Key stakeholders and actors
- Resource requirements (technological, human, financial)
- Monitoring and reporting

The DRR guide and the 10-step approach provide some concrete and useful activities for the DRR plan:

- **Defining the objectives and vision of the DRR plan**: This must bridge the DRR and CCA landscapes, taking into consideration the risk assessments in Step 2 and any identified gaps that may constrain progress from Step 3; a cohesive DRR plan also ensures alignment and synergies with national development goals and objectives and international commitments.

- **Defining stakeholder and institutional coordinating mechanisms**: This involved a stakeholder mapping exercise that builds on the list from Step 1 (stocktaking activities) and creates or modifies mechanisms that would help in developing and implementing an integrated DRR plan. This multisectoral and multi-stakeholder mechanism should be inclusive, have a broad range of representation and be endorsed at the highest level. More information is provided in the cross-cutting steps.

- **Identifying actions to reduce risks over various timescales**: The plan should seek to consolidate risk assessments in a comprehensive and cohesive way, with the objective of providing the evidence basis for action to be taken.

  Climate change information, inclusive of projections relating to future hazards, is necessary for an integrated plan. The risks assessment outlined in Step 2 should therefore not be blind to this type of risk, but instead be a basis on which all relevant assessments are conducted. Where there is a dearth of such information, the DRR plan could consider conducting assessments of this nature and amend the plan as necessary. See Box 6 for questions that can help identify these measures.

- **Creating a budget and finance strategy**: The plan should be adequately resourced, which necessitates development of a budget. Relevant stakeholders, including ministries responsible for finance, DRR and climate change can provide the required information. Any shortfall identified will be instrumental in engaging potential donors and financiers. The global momentum around climate change can be leveraged, particularly as many multilateral organizations and donors are aligning their funding programmes with the Paris Agreement. Box 7 shares examples of different approaches relating to financing.

- **Developing a monitoring and evaluation (M&E) mechanism**: The only way to accurately determine the effectiveness of the integrated DRR plan is through an M&E mechanism. Some activities will be implemented over a short- or medium-term period and are therefore easier to track for course correction. Others, especially when taking into account the longtime lags of climate change, may be more challenging. However, including these types of data and information in the M&E system allows for a baseline to be established and for future decisions to be evidence-based. Alignment with any existing climate change M&E systems should be explored as this will maximize efficiency. To the extent possible, the monitoring system should capture and store the information from the stocktaking exercise and decide on the periodicity for updating it.

Box 6. Key questions to identify integrated measures

- **Hazard-disaster relationship**: What has been the relationship between hazards (including climate- and weather-related ones) and disasters? How will hazards evolve due to climate change and what is the likely scale of future disasters in a business-as-usual scenario? What would be necessary to reduce the impact of hazards, even with greater frequency and/or intensity?
- **Vulnerability**: What are the key vulnerabilities at the sectoral, sub-national and national levels? How will hazards, including climate-related ones, exacerbate these vulnerabilities?
- **Development context**: What are the hazard-related impediments to achieving the development goals? How are these likely to evolve in the context of climate change? What are the required skills, tools and other resources that will lower risks to these development goals?
- **SFDRR**: How will the plan practically and feasibly facilitate the implementation of the SFDRR? Consider the targets: to reduce mortality, the number of people affected, economic loss, and damage to critical infrastructure and basic services, and to increase risk reduction strategies (such as DRR plans), enhance international cooperation and increase MHEWSs.
- **Climate change agreements**: How will the plan support national and sub-national implementation of the UNFCCC and Paris Agreement objectives? How will it align with the global goal on adaptation of the Paris Agreement to enhance adaptive capacity, strengthen resilience and reduce vulnerability? How will the plan avert, minimize and address loss and damage associated with the adverse effects of climate change, including in relation to slow onset events, irreversible and permanent loss and damage, risk insurance, risk pooling and other insurance solutions?
- **Other multilateral agreements**: What will be the role of the integrated DRR plan vis-à-vis relevant goals and targets of multilateral agreements such as the United Nations Convention on Biodiversity, the United Nations Convention to Combat Desertification and the 2030 Agenda for Sustainable Development?

Cross-cutting steps

The success or failure of developing and implementing an integrated plan depends on inclusive stakeholder engagement. A broad range of expertise is required in fields including climate science, meteorology and hydrology, and impact research. Additionally, it is necessary to have the support of various state and non-state entities, as well as representatives from at-risk populations. It is good practice to adopt early engagement of stakeholders, the benefits of which include efficiency in the process, additional resources and better streamlining of activities.

A stakeholder engagement strategy is a useful element of an integrated plan. It will assist in identifying actors with climate data and information (including projections), expertise in risk assessments, political clout and financial and other resources. It is also a necessary part of monitoring and reporting and bodes well for communication of risk. Stakeholder engagement also bodes well for transparency, particularly to show integrity in the process that in turn can increase buy-in and support from a wider cross section of stakeholders. The private sector should be considered among the identified actors, as they can be important repositories of information (including insurance and impact data).

There should be a drive to proactively strengthen systems that facilitate collaboration and coherence across sectors, including at the local level. This includes the various mechanisms that exist or need to be established that can better streamline linkages with CCA and DRR institutions and actors. Tools such as the Disaster Resilience Scorecard for Cities can help local governments better prioritize climate actions. Training programmes are available to support such collaboration across sectors. The systems should facilitate, as much as possible, the ability of networks and partnerships to participate in the planning and implementation processes. As an example, United Nations issue-based coalitions are available to identify and promote synergies between CCA and DRR in order to foster internal coherence on the topic and adopt a harmonized engagement approach. Issue-based coalitions act as regional task forces to facilitate improved cooperation between different United Nations agencies and their partners. These broad, multi-partner coalitions are led by one or several agencies, coordinate the United Nations response to cross-cutting challenges in the region, help realize synergies among related areas of work of different United Nations entities and serve as platforms to reach out to non-United Nations stakeholders.

The budgeting process affects all steps of the process. It is therefore necessary to engage relevant ministries and entities at the outset. Budget officers are likely very useful (and even required) for flexible, integrated budgeting to be pursued and ultimately approved. It is also important to utilize the entire risk financing spectrum. This may include using a broader range of available policy and financial instruments including subsidies, taxes, grants, bonds, border adjustments (e.g., tariffs) and targeted microfinance that have been used to help integrate risks into planning.

Communication is a crucial element of the DRR plan. It begins with the stocktaking exercise and continues to implementation, and monitoring and reporting. It is a tool that keeps stakeholders informed of risks and associated actions, as well as progress with respect to the development of the plan. The buy-in and engagement of stakeholders must also be attained.

Box 7. Good practices – Three different approaches to financing DRR and CCA

Philippines: In 2010, the Philippines introduced the Disaster Risk Reduction and Management (DRRM) Act (Republic Act 10121). As a result, the National Disaster Risk Reduction and Management Fund was created; 30 per cent of this fund was set aside in a Quick Response Fund for relief and response and 70 per cent was set aside for broader risk reduction. It requires local governments to establish local DRRM funds and set aside 5 per cent of their usual budget allocation towards this fund. Local DRRM funds are used to implement CCA, ultimately supporting broader DRR objectives. The law also attributes a budget for the Office of Civil Defense and allocations for each line ministry for DRRM projects (survey, interview, UNDRR, 2019a, p.351).

Bangladesh: Bangladesh carried out a Climate Public Expenditure and Institutional Review to review budgets and expenditure on climate change. Throughout the process, it was highlighted that adaptation expenditures often contribute to multiple outcomes, including DRR and overall resilience (DRR4NAPs). It also has a Climate Change Trust Fund with funds being used for DRR, addressing extreme climatic events such as floods and cyclones. Opportunities for joint local DRR and CCA activities through international aid funds are also being pursued (e.g. with the Global Climate Fund) (survey).

Peru: Peru has a supporting regulatory framework with measures to manage contingent fiscal risks such as evaluating, reducing and managing disaster-related fiscal risk in order to preserve the macroeconomic stability and sustainability of fiscal policy during disasters. Climate and disaster risks are included in appraisal guidelines for all public investments. Over two thirds of all disaster management funds go to ex ante financing (see Peru: A Comprehensive Strategy for Financial Protection Against Natural Disasters).

05

CONCLUSION

Climate science contributes to a better understanding of the susceptibility of socioecological systems to climate change. When acted upon, climate science can help to safeguard economic and human development and the environment from adverse climate impacts and reduce risks of disasters. Such information can be used to plan and design investments that increase the adaptive capacity and resilience of vulnerable populations. The value of climate science for decision-making in DRR depends on the use of the best available data for characterizing the climate system and dealing with uncertainties. Reliable, high-resolution and timely climate information is, therefore, a crucial input for decisions intended to promote DRR and CCA and avoid or minimize impacts on societies.

There is a plethora of sources for climate information, which are created to meet the needs of different user communities or are classified according to a range of various sectors, locations and utilities. Context-specific climate information can generate more effective results at the local level, increasing the effectiveness of actions taken. By clearly establishing relationships between climatic and non-climatic contributing factors and their impacts and between climate actions and their outcomes, the use of climate information in the design and development of DRR plans results in more effective implementation. It also increases the likelihood of actions achieving their intended results. In interpreting this information, expert judgment needs to be applied to assess the relevance of each factor to the analysis. Information on climatic averages and statistics of variability for future periods is important for strategic decisions and those involving long-term commitments. Stakeholders should be aware of the limitations of climate change projections but still be informed by them in creating responsive DRR plans.

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ANNEXES

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Annex I. Catalogue of climate information sources

Table 7: Catalogue of available climate information for disaster risk reduction planning (v 1.0)

Timescale	Description	Main sources	Access links
Climate change (recent past/present climate observations)			
Observed changes and trends	Global temperature record/climatologies Global Historical Climatology Network daily Climate change and sector-specific climate indices	Climatic Research Unit, University of East Anglia NOAA National Centers for Environmental Information NMHSs Climdex/Climpact, University of New South Wales	https://www.uea.ac.uk/web/groups-and-centres/climatic-research-unit/data https://www.ncei.noaa.gov/products/land-based-station/global-historical-climatology-network-daily https://community.wmo.int/members/profiles https://www.climdex.org https://www.climpact-sci.org
ERA-5 reanalysis	A combination of climate models and observations, intended as a proxy for temperature (secondary source) only where no other data exist	Climate Data Store, Copernicus Climate Change Service	https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-singlelevels?tab=overview
Climate change (projections)			
Projected changes	Projected changes for future horizons under different emission scenarios derived from models at the global (CMIP6) and regional (CORDEX) scales Sea level projections	IPCC WGI Interactive Atlas SMHI Climate Information Platform World Bank Climate Change Knowledge Portal IPCC Sea Level Projection Tool	https://interactive-atlas.ipcc.ch/ https://climateinformation.org/ https://climateknowledgeportal.worldbank.org/ https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6 https://cordex.org https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool

Timescale	Description	Main sources	Access links
Weather			
Forecast of atmospheric variables for 1–14 days	Outputs of numerical weather prediction models (single or ensembled). For better confidence, verification of forecasts or data assimilation schemes is required.	Global modelling systems Visualization interfaces developed by other agencies or companies enable quick consultation of weather models (such as the Global Forecast System and ECMWF).	https://www.ncei.noaa.gov/products/weather-climate-models/global-ensemble-forecast https://www.windy.com
Seasonal			
Observed anomalies	Climate variations at different timescales in relation to a base period are usually due to climate variability.	WMO RCCs NMHSs Universities	https://public.wmo.int/en/our-mandate/climate/regional-climate-centres https://community.wmo.int/members/profiles
Seasonal predictions	Seasonal prediction from multi-model ensembles produces at global centres Seasonal Outlooks produced at Regional Climate Outlook Forums	WMO GPCs or similar centres Regional Climate Outlook Forums	https://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/ https://public.wmo.int/en/our-mandate/climate/regional-climate-outlook-products
Inter-annual			
ENSO monitoring	El Niño and La Niña status and predictions (requires regional/local identification of ENSO-related climate anomalies)	WMO GPCs e.g., CPC/International Research Institute for Climate and Society ENSO Outlook	https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/

This table summarizes a list of sources of climate information that can be used as inputs for DRR planning. Given the changing nature of the climate system, the information to be considered must be comprehensive, attempting to cover all scales in time and space, provided that different strategies are feasible to implement for DRR, including response and prevention. Although only primary or the most used sources are listed here, other sources at the regional and local scales may be available. Some products from the list have already been included in recent NAPs. The main assumption is that climate change spans all timescales, making it necessary to build capacities using a multi-scale tailored approach.

Annex II. Intergovernmental Panel on Climate Change Working Group I Interactive Atlas

Click the link https://interactive-atlas.ipcc.ch/ to go to the IPCC WGI Interactive Atlas. The page in Figure II.1 should be displayed. Many options will be shown. Please select the Advanced Regional Information section to enter the interactive map.

Figure II.1. IPCCWGI Interactive Atlas home page.

There are several customization options. Firstly, we can see a menu with four options:

DATASET: There is a total of 41 data sets divided into four data set groups: model projections, model historical, observations and paleoclimate.
VARIABLE: There are 28 variables divided into the categories of **Atmosphere**, **Ocean** and **Others**. Among these variables, there are also indices for temperature and precipitation.
QUANTITY & SCENARIO: This option allows us to choose the desired future period, scenario and baseline for the data.
SEASON: Here, you can choose whether the whole year or only a certain part of it should be considered for the data. If the desired range is not listed, it can be customized.

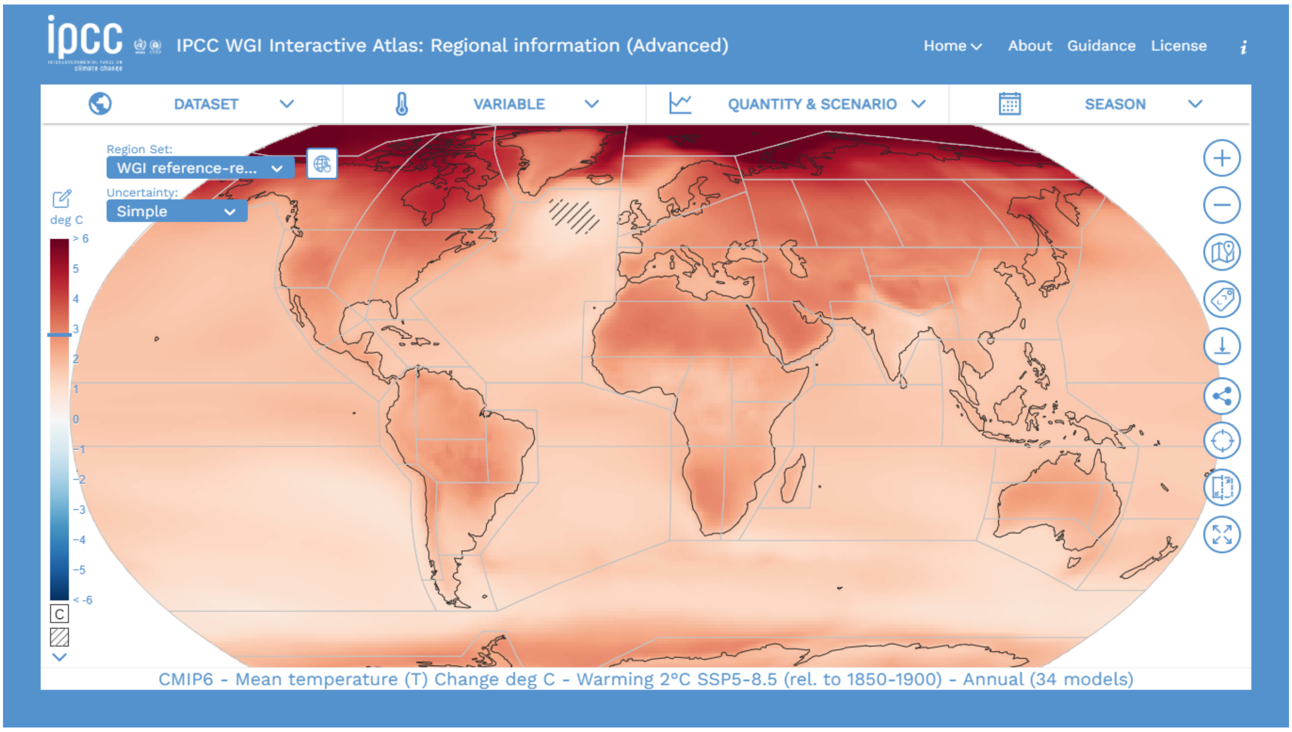


Figure II.2. IPCC WGI Interactive Atlas map display.

In addition to the menu, there are more customization options. You can change the map lines, the uncertainty, zoom in and out, change the map projection and add graticules.

You can also find information, visualization and sharing options as metadata information for data processing, point information, duplicated map view, full-screen view, social media sharing and downloading.

To download data from this Atlas, you should first adjust the options listed above to the desired parameters. Once you have made these changes, select the **Download** option; this will allow you to download the current view of the data as a NetCDF, PNG or GeoTIFF file.

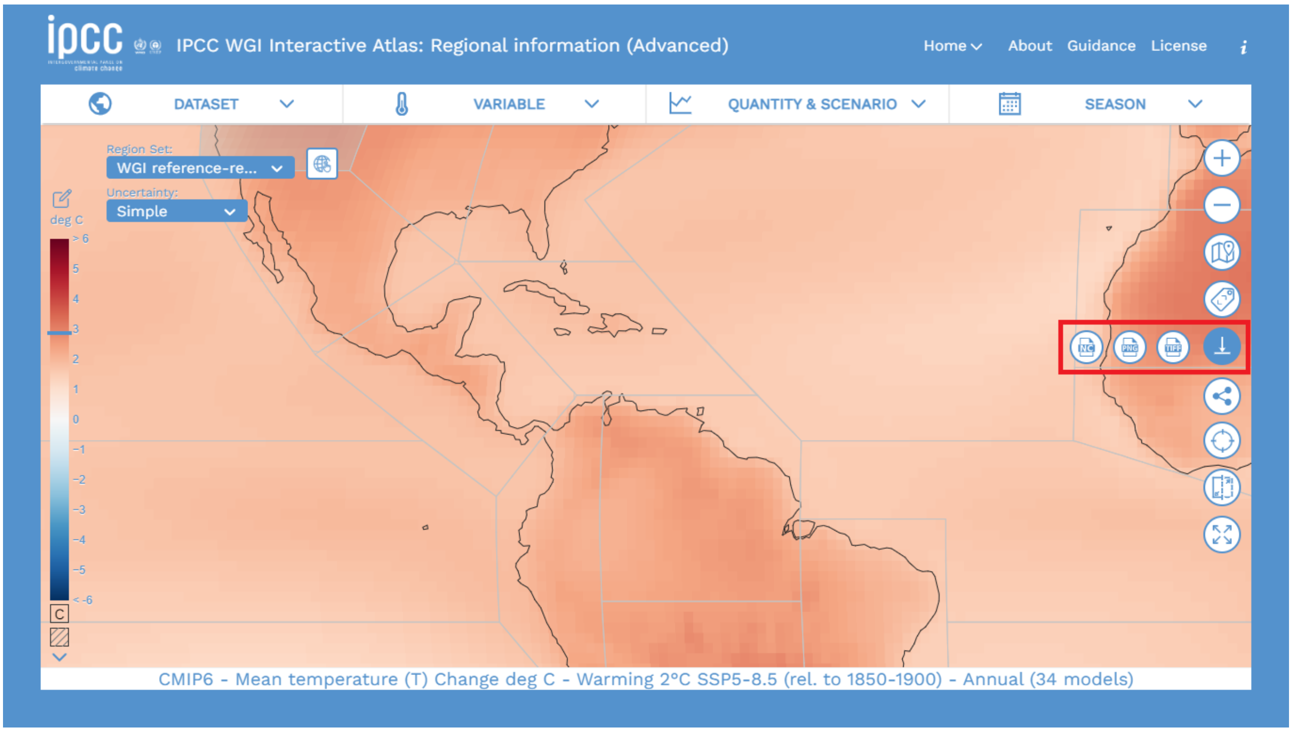


Figure II.3. IPCC WGI Interactive Atlas map display ready to download.

In this example, we only changed the period to Medium Term (2041–2060) and the baseline to 1981–2010. We also readjusted the map area to centre Trinidad and Tobago. The result is shown in Figure II.4.

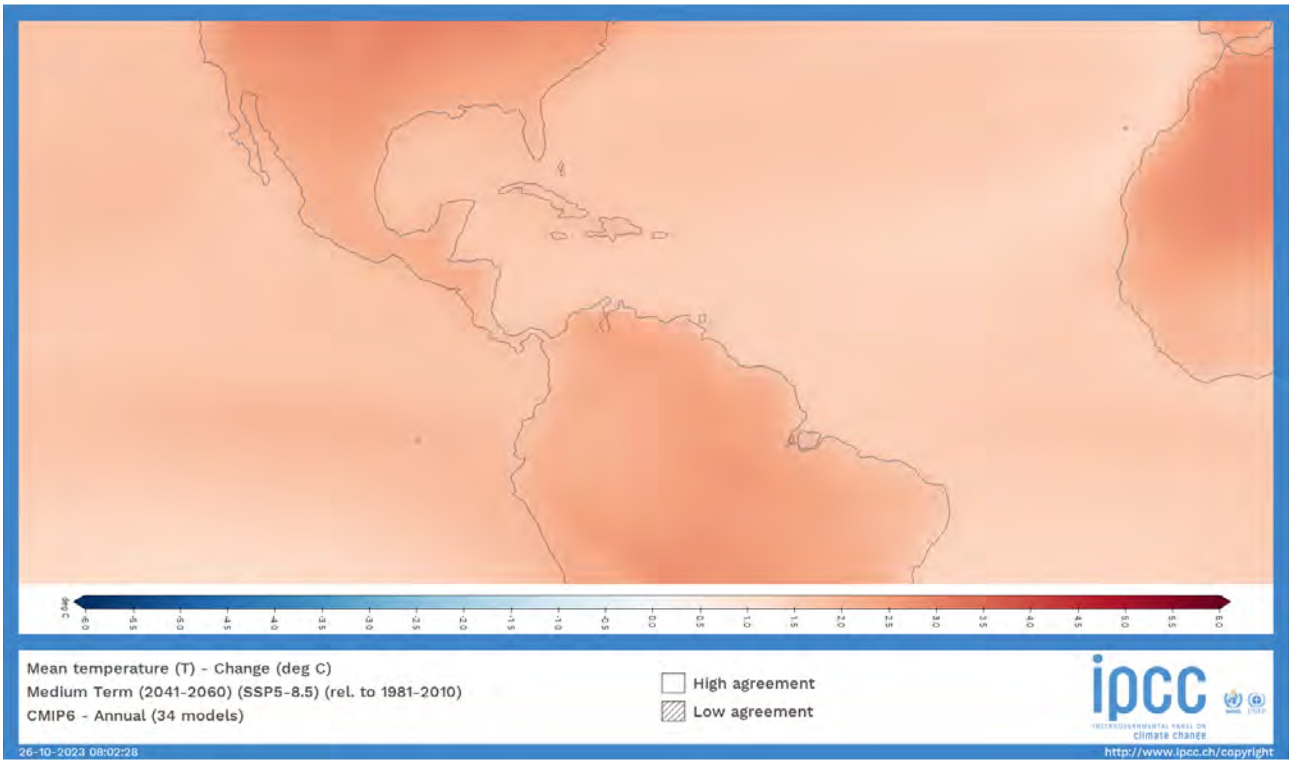


Figure II.4. PNG file of the data selected in the IPCC WGI Interactive Atlas.

Annex III. Swedish Meteorological and Hydrological Institute Climate Information Platform

Click https://climateinformation.org/ to go to the Climate Information Portal. Developed and hosted by SMHI as part of the WMO-GCF partnership, the Climate Information Platform enable users to get an instant climate change overview for any location in the world, download precalculated climate indicators and explore interactive maps and graphs.

For an instant climate change overview for any location worldwide, select the **Site-specific report** option.

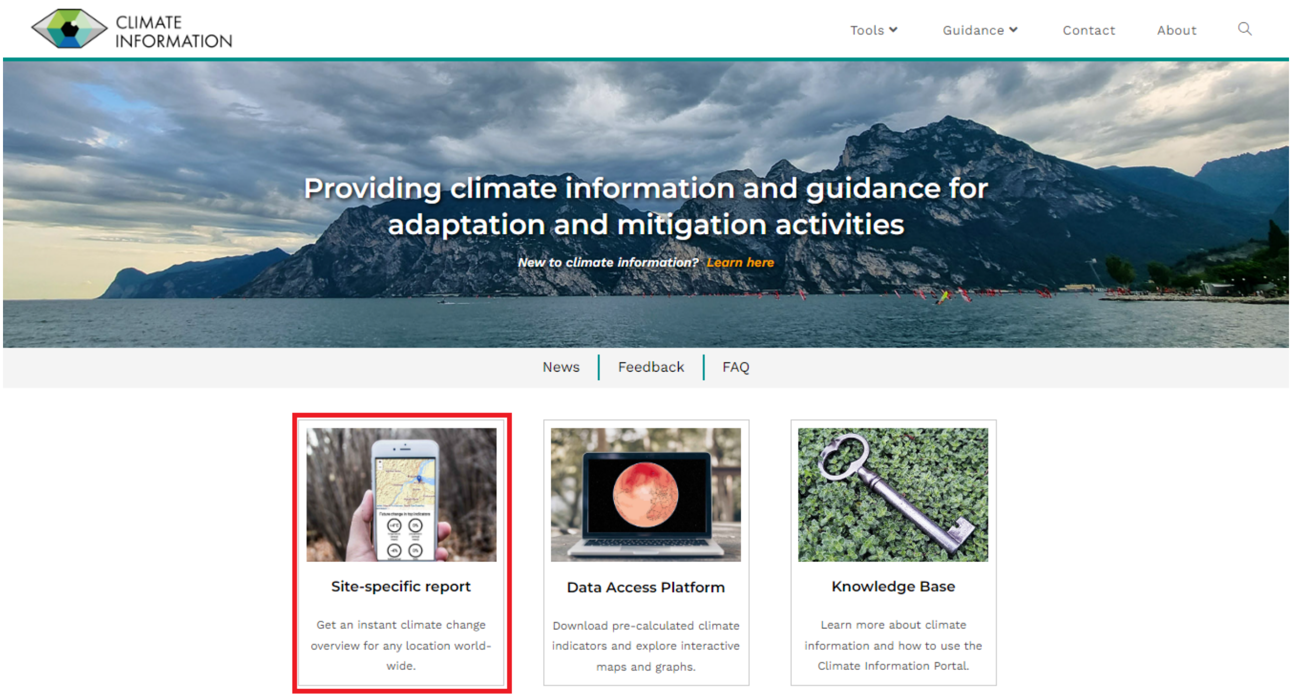


Figure III.1. Climate Information site home page with Site-specific report selected.

Now, in this view, select an area of interest (this can be any city you wish), a scenario and a time period to obtain the site report. Once you have set the parameters, select **Generate overview**.

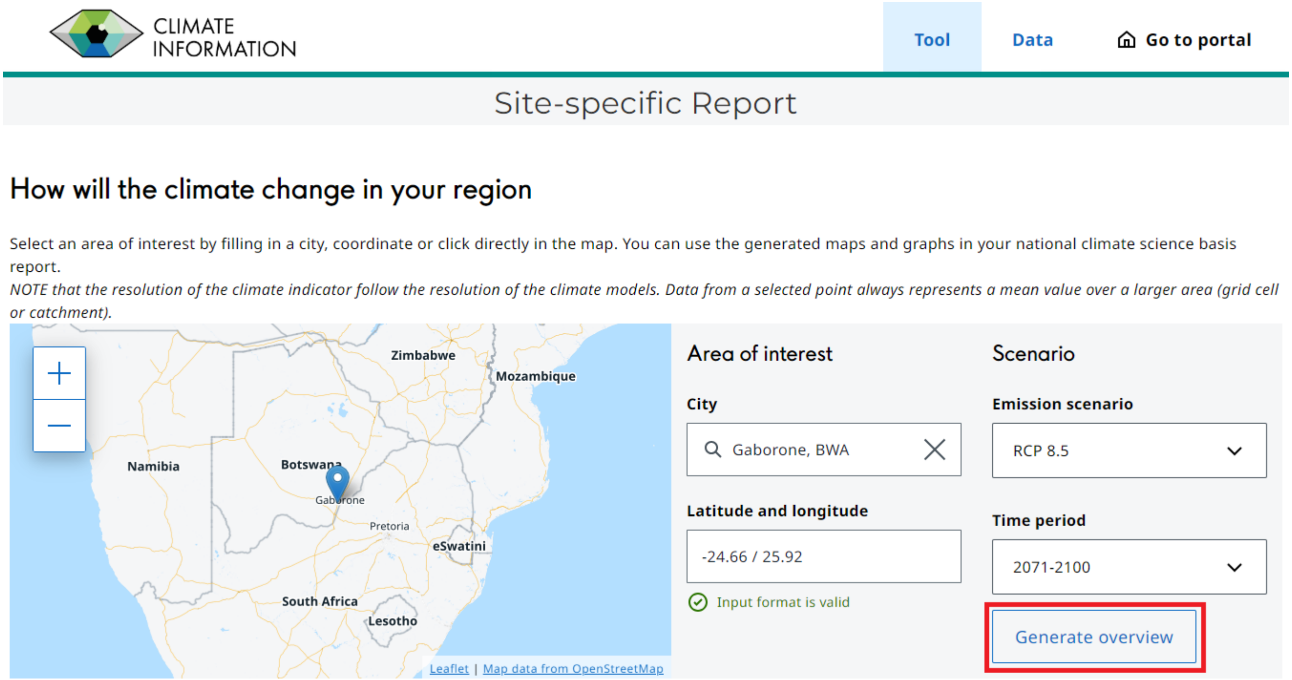


Figure III.2. Site-specific Report display.

This will generate and display information and a large list of indicators. The first section contains the top six indicators for future changes, followed by the details of each indicator. You can also read about how to interpret the change levels used on the site.

Here, you can see how the Climate Information site should be cited.

For this example, we will select the first indicator listed, **Aridity actual**.

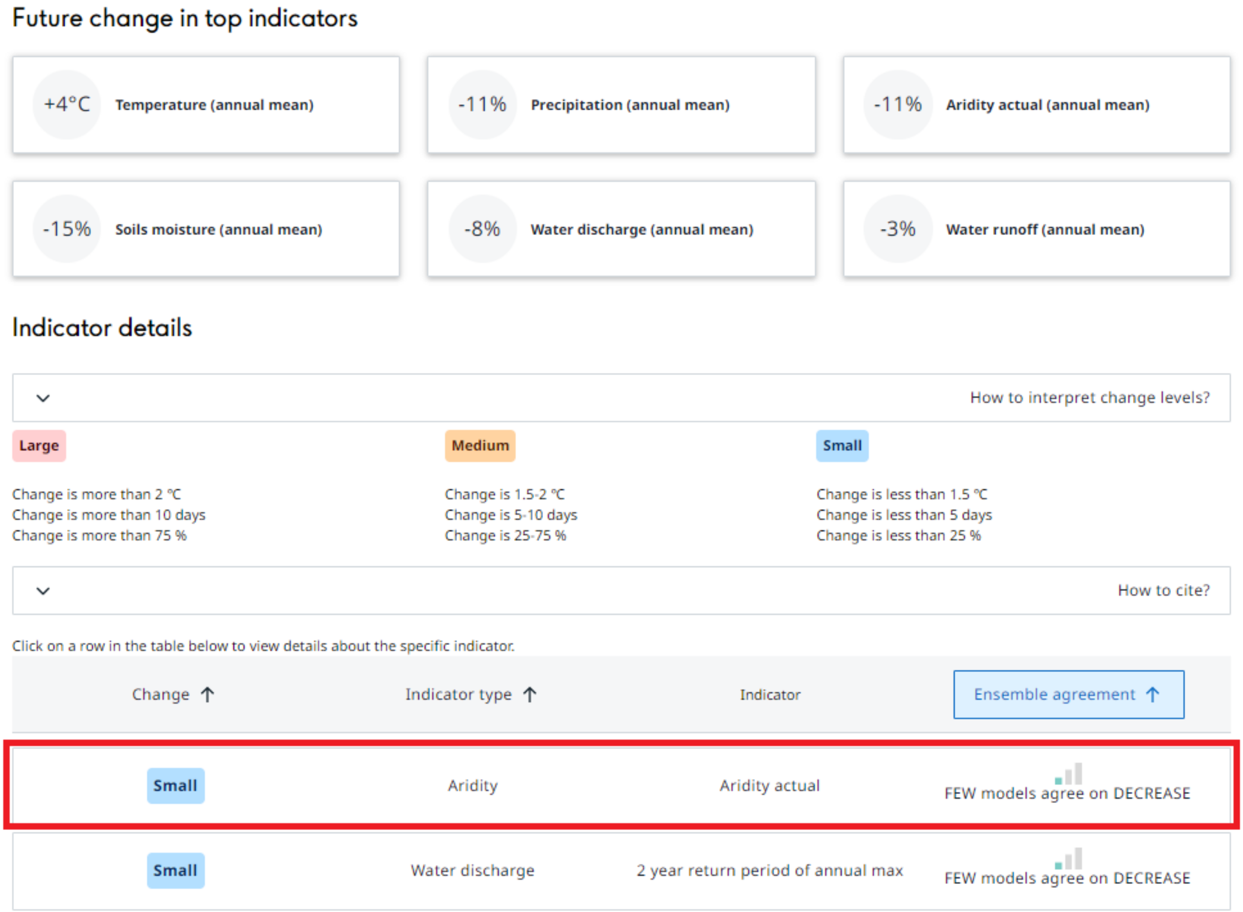


Figure III.3. Site-specific Report overview results.

Once selected, a tab should be displayed. This tab contains information on the point previously chosen, shown as maps and graphics. There will also be plots for annual and monthly lapses.

Aridity actual

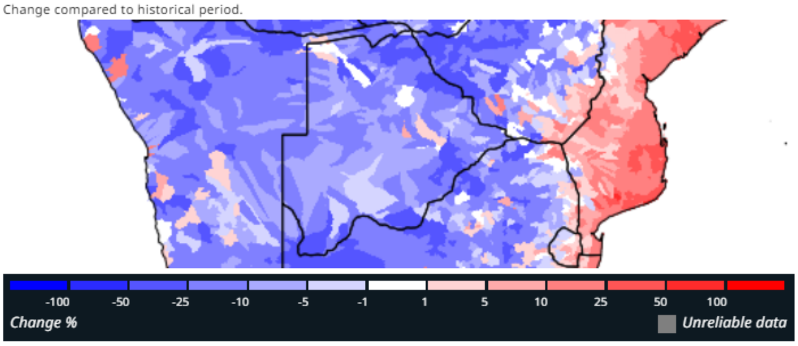
Annual   Metadata

Indicator description Aridity actual (annual mean)

Calculated as mean annual values of the ratio between actual evapotranspiration and precipitation for a 30 years period. This index is given as a relative change (100*(future period - reference period)/ reference period). Here the median ensemble value is given, calculated over the models listed in model attribute.

Aridity actual (annual mean) for Botswana

Change compared to historical period.



Indicator: Aridity actual (annual mean), Time period: 2071–2100, Historical period: 1981–2010, Model: CORDEX Africa - WWHYPE Ensemble Mean, Model results for Botswana.

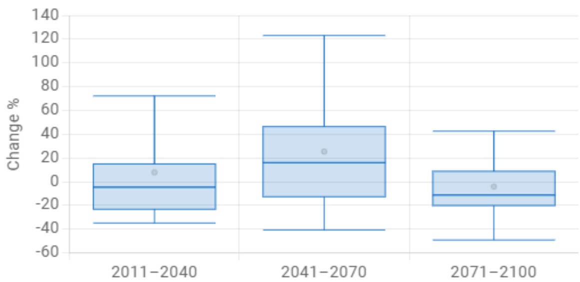
Reference: https://climateinformation.org (date: 2023-10-26)

Download figure: Aridity actual (annual mean) for Botswana

Aridity actual (annual mean)

Change compared to historical period.

Legend



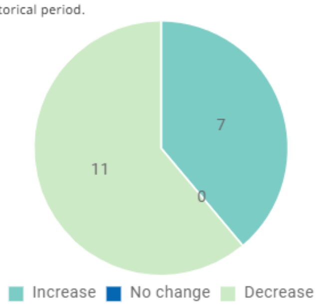
Indicator: Aridity actual (annual mean), Time periods: 2011–2040, 2041–2070 & 2071–2100, Historical period: 1981–2010, RCP 8.5, Model: CORDEX Africa - WWHYPE Ensemble Mean, Model results for an area covering the location: Gaborone (-24.66, 25.92)

Reference: https://climateinformation.org (date: 2023-10-26)

Download figure: Aridity actual (annual mean)

Ensemble Agreement of Aridity actual (annual mean)

Amount of ensemble members that results in a decrease, increase, and no change compared to the historical period.



Indicator: Aridity actual (annual mean), Time period: 2071–2100, Historical period: 1981–2010, RCP 8.5, Model: CORDEX Africa - WWHYPE Ensemble Mean, Model results for an area covering the location: Gaborone (-24.66, 25.92)

Reference: https://climateinformation.org (date: 2023-10-26)

Download figure: Ensemble Agreement of Aridity actual (annual mean)

Key message for Aridity actual (annual mean)

For the time period 2071–2100 compared to 1981–2010 (RCP 8.5)

- Median change is -11% (ensemble mean)
- 50% of the ensemble members (interquartile range) agree that the change lies between -20% and 8.7%

Figure III.4. Annual plots.

Figure III.5. Monthly plot.

Now, you can download the figures generated for the indicator, point, scenario and time period selected.

To download precalculated climate indicators and explore interactive maps and graphs, select the **Data Access Platform**.

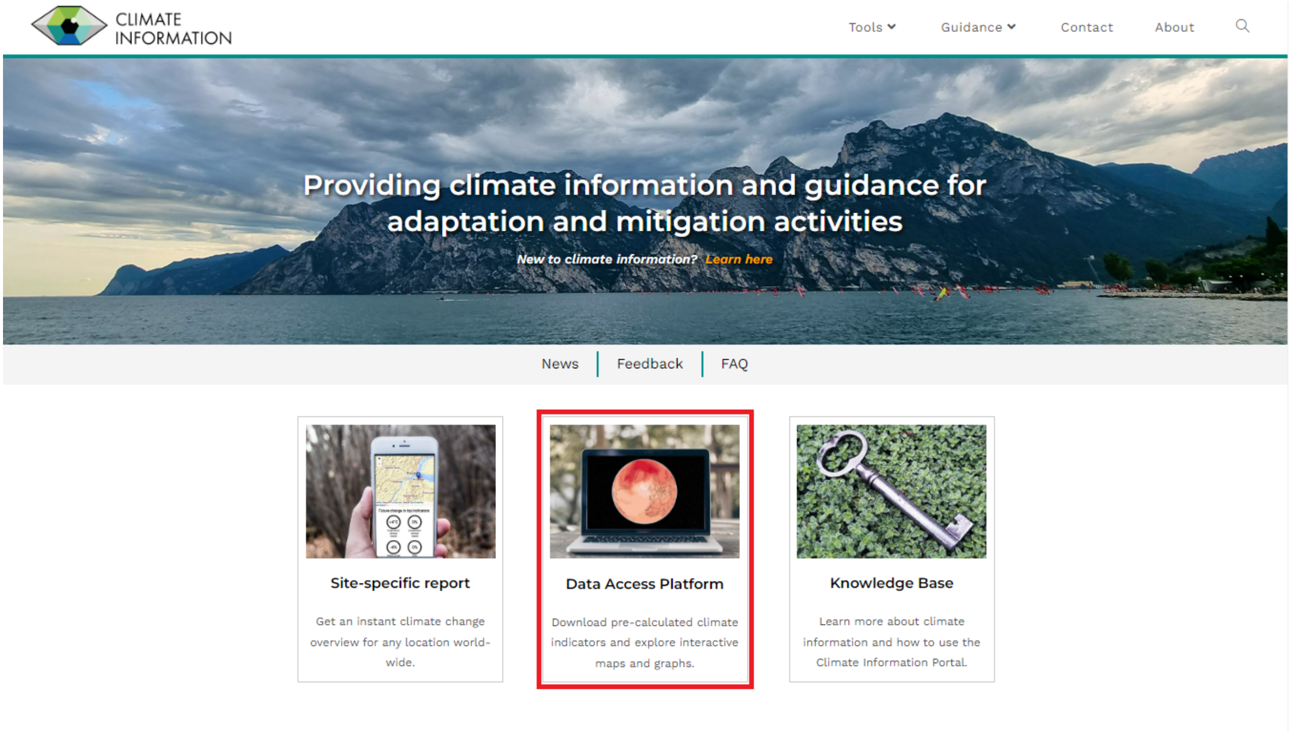


Figure III.6. Climate Information site home page with Data Access Platform selected.

As this display is similar to those of many other interactive maps, the tool is rather intuitive. To download the data, first choose a place using the **Area of interest** tool.

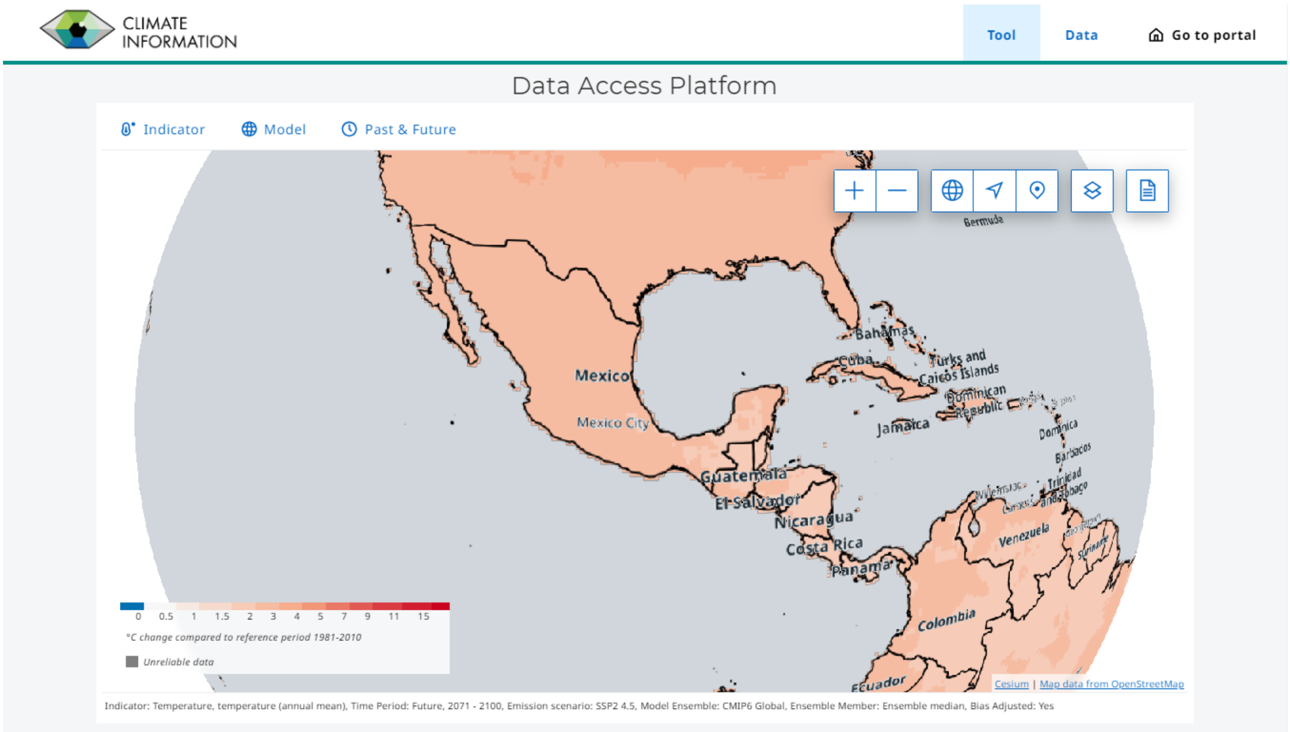


Figure III.7. Data Access Platform display.

For this example, we will select the same place and the same parameters as in the **Site-specific report**.

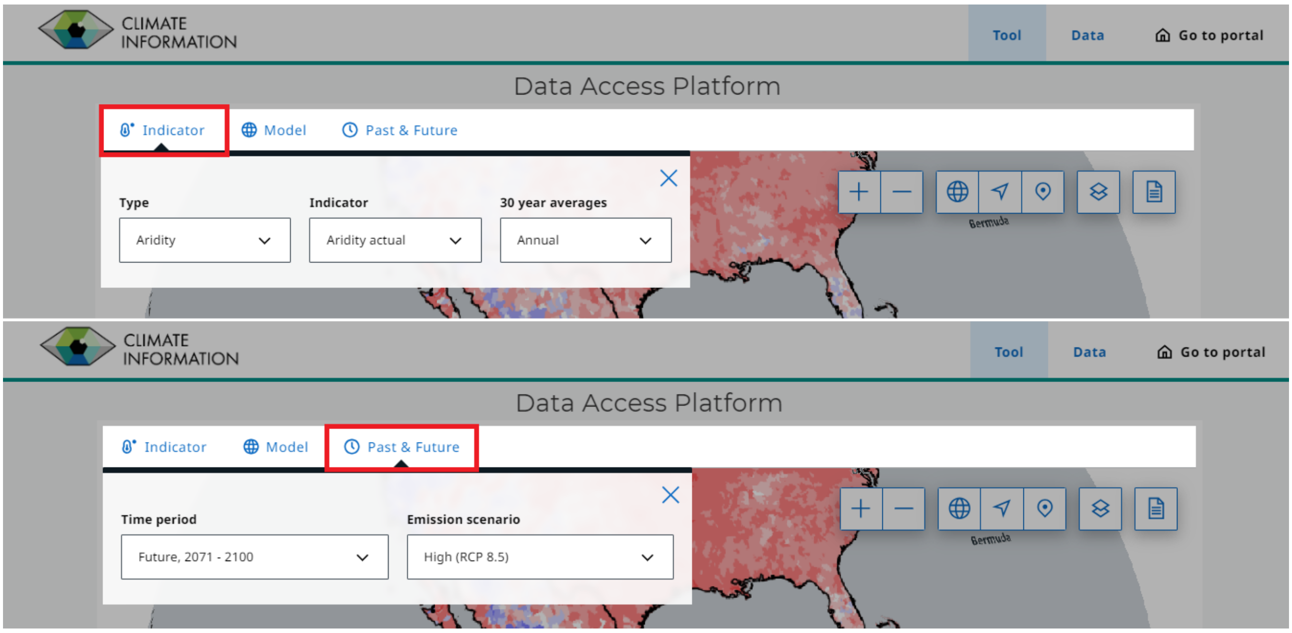


Figure III.8. Selection of parameters.

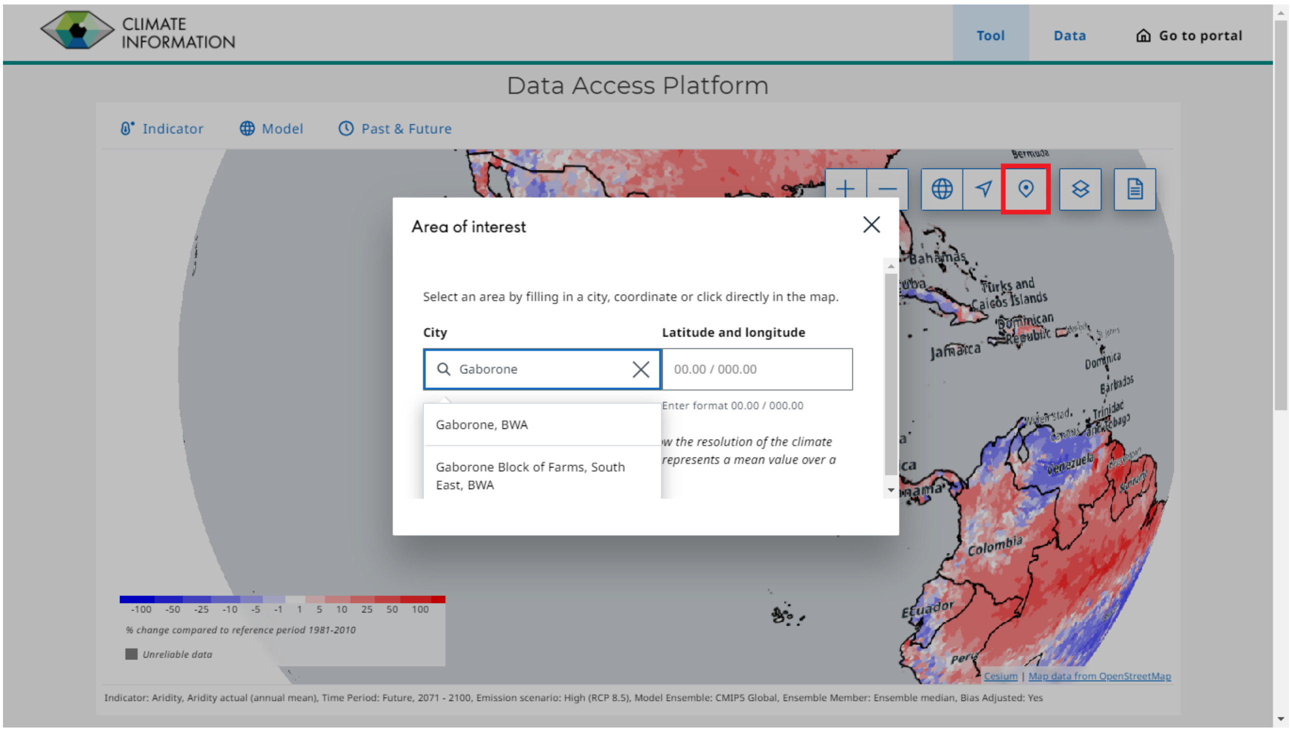


Figure III.9. Location selection.

The **Graph ❶**, **Table ❷** and **Download ❸** options should be shown. You should also be available to download the graph. You can choose whether to only select the area of interest or to also add a radius of 50, 100 or 200 km. Data can be downloaded as a spreadsheet or a NetCDF file.

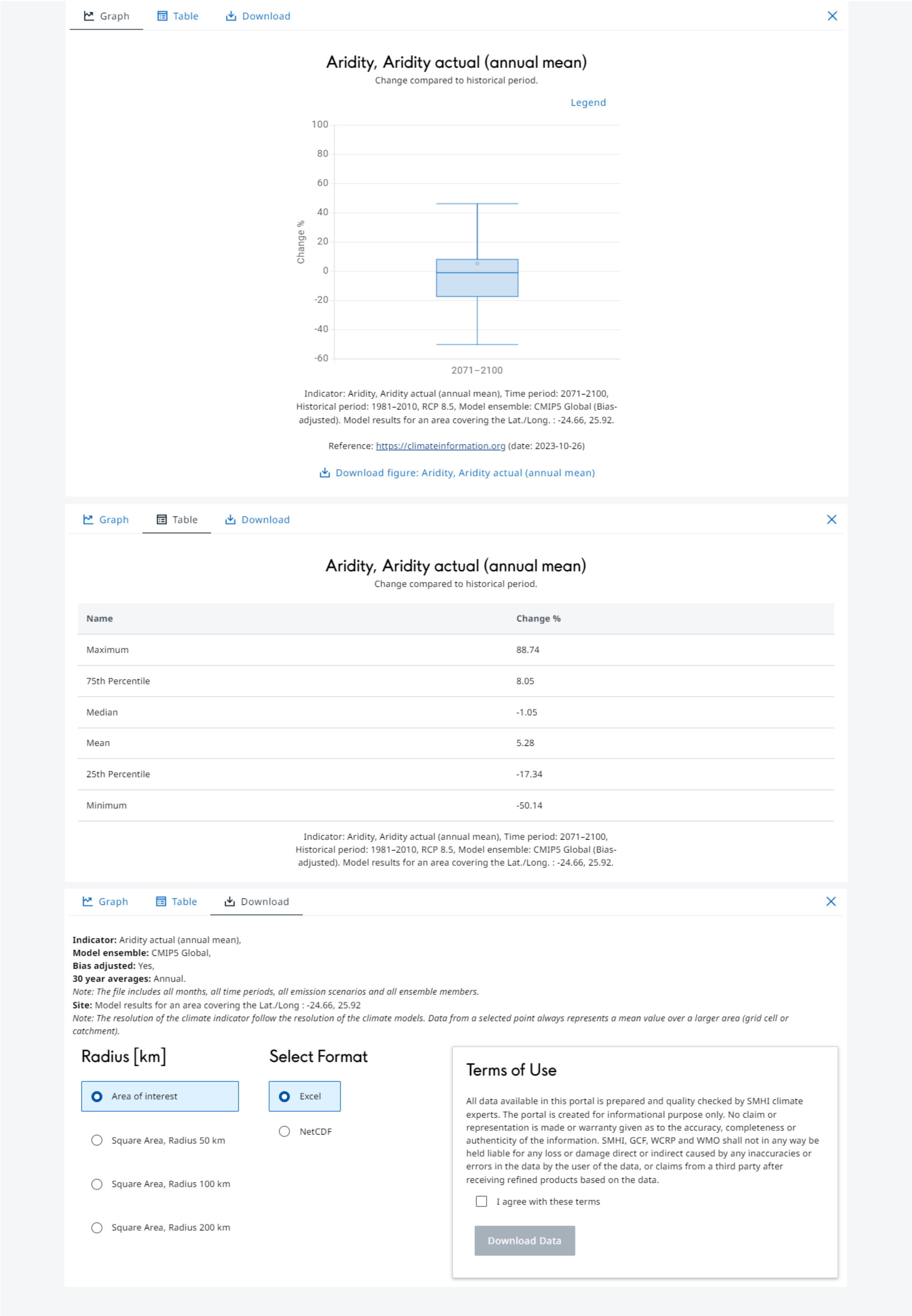


Figure III.10. Final results and Download option.

Annex IV. University of New South Wales Climdex portal

Click https://www.climdex.org/ to go to the Climdex home page.

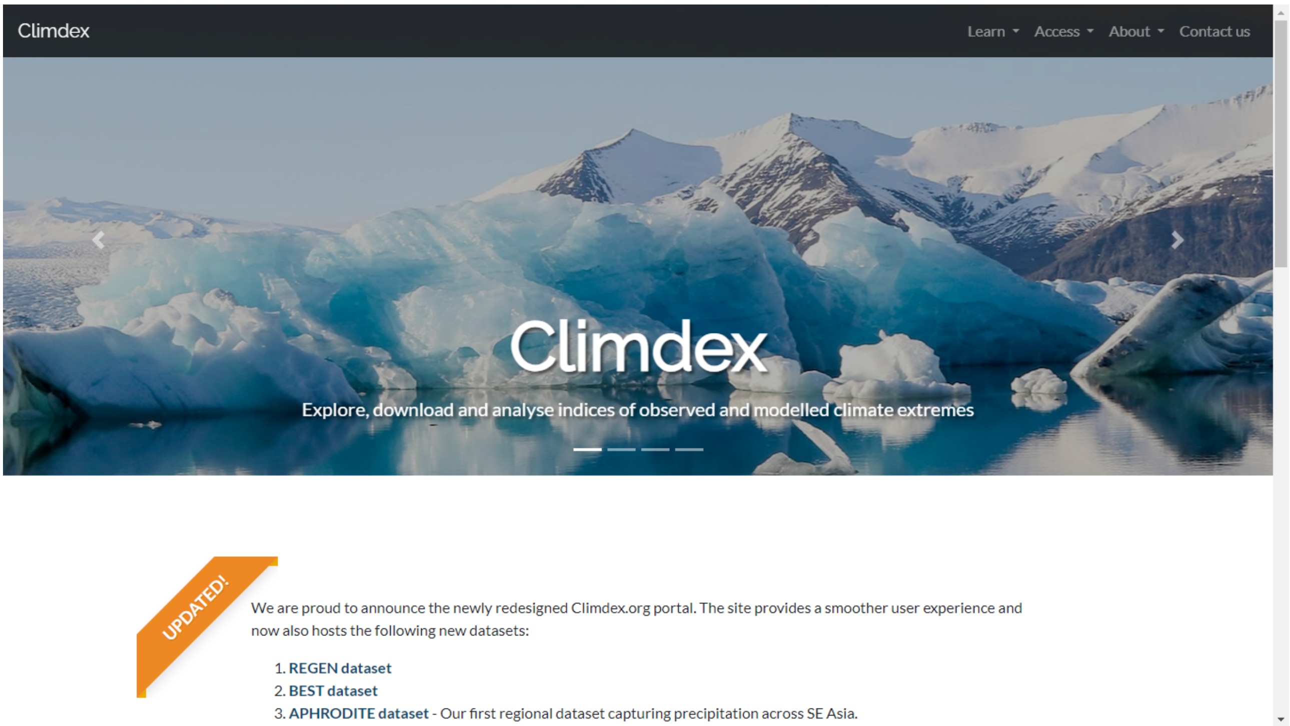


Figure IV.1. Climdex home page.

To access the data, select **Gridded and station data** from the **Access** option in the top-right menu.

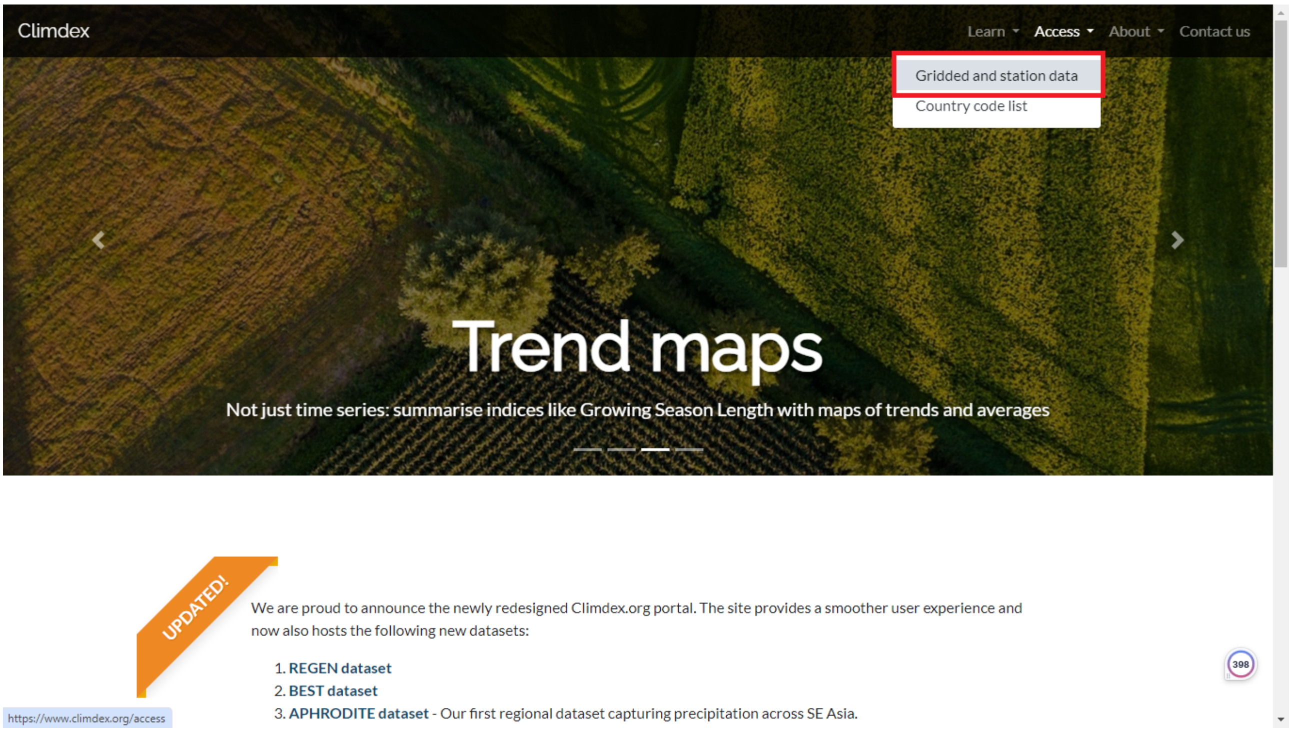


Figure IV.2. Menu options.

Now, choose a data set. You have three options: GHCNDEX uses stations from the Global Historical Climatology Network (GHCN)-Daily data set, HadEX2 uses high-quality stations over the 1901–2010 period, and HadEX3 uses stations for temperature and precipitation using two reference periods 1961–1990 (version 1) and 1981–2010 (version 2). For more information, see https://www.climdex.org/learn/datasets/.

In this example, we will select the **HadEX3_ref1961-1990** data set.

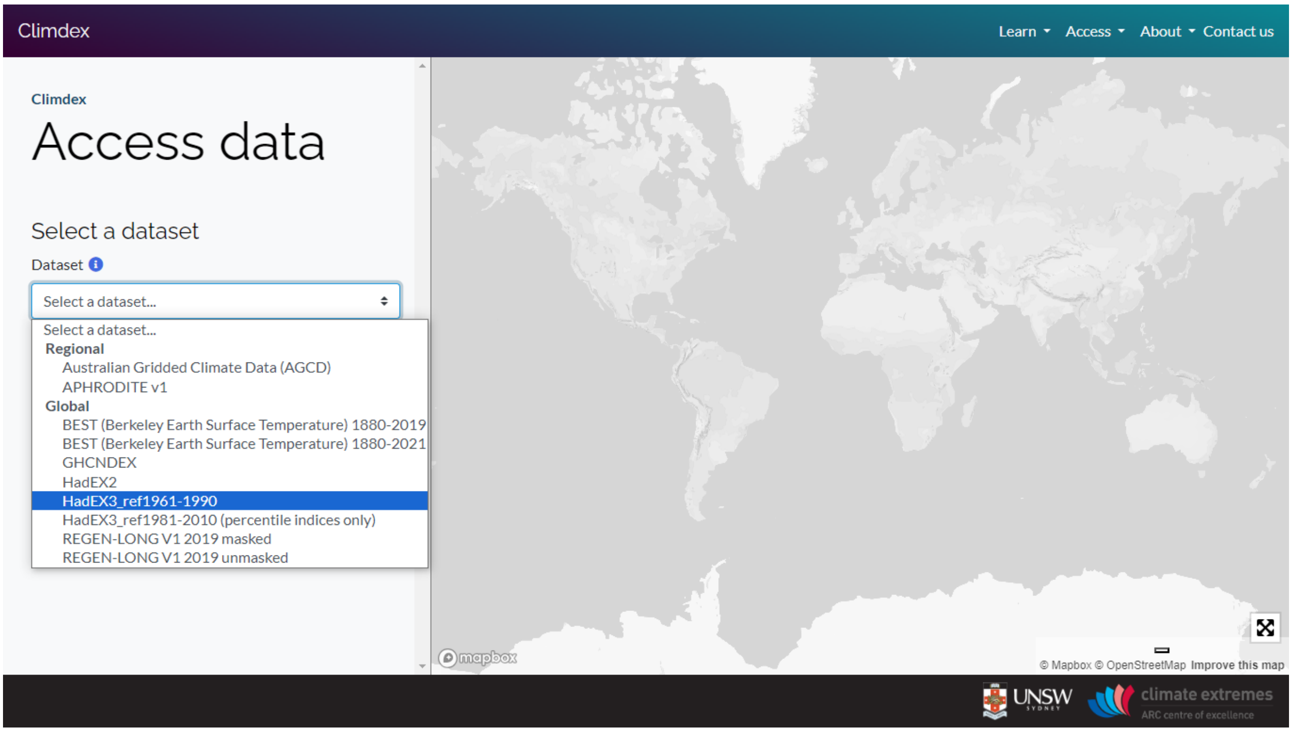


Figure IV.3. Access data.

The HadEX3 data set is available for individual **Stations** (Case A) or **Gridded** across regions (Case B). In both cases, you can download climate indices for the entire data set. This example shows Cases A and B for Ecuador.

Case A: Stations. Select **Get a single station** ❶, apply the third filter and write *EC* ❷(for the country code list, see https://www.climdex.org/access/countries/). Next, filter the stations. Select station ECH30000071, choose the annual TX90p index for the period indicated by default and download the three outputs ❸.

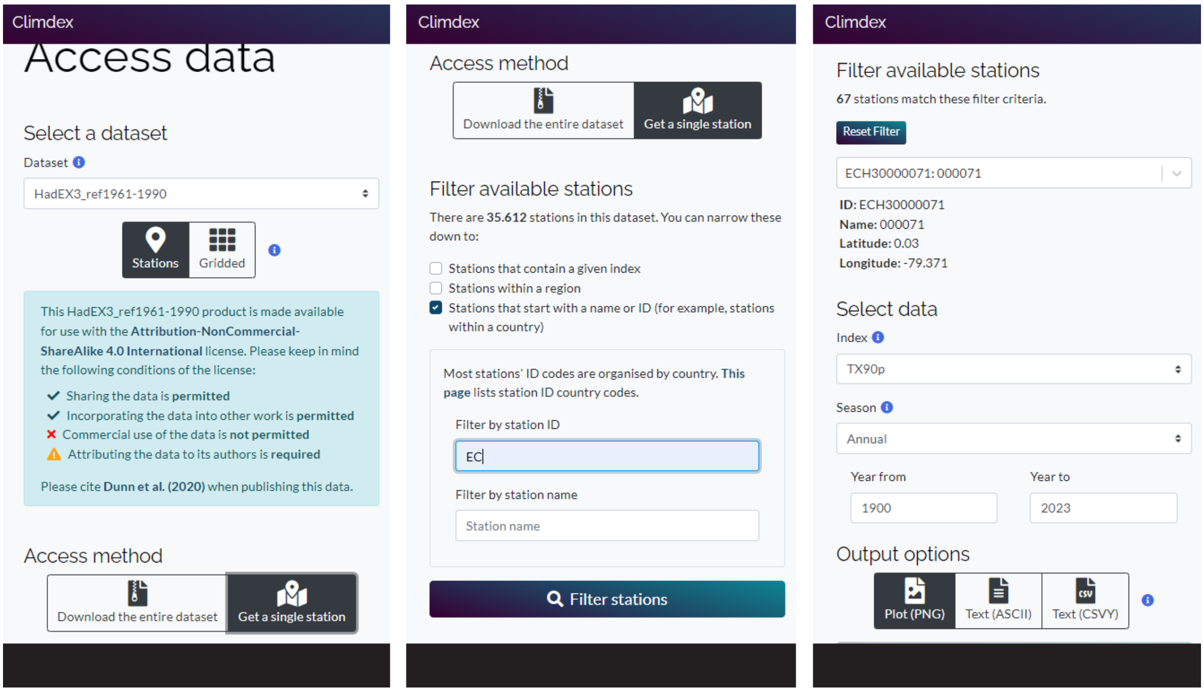


Figure IV.4. Case A steps.

Output **Plot (PNG)** shows the plot of the percentage of days when the maximum temperature exceeded the ninetieth percentile. To manipulate the data, select **TEXT (ASCII)** to download it in ASCII format or select **Text (CSV)** to download it in comma delimited text.

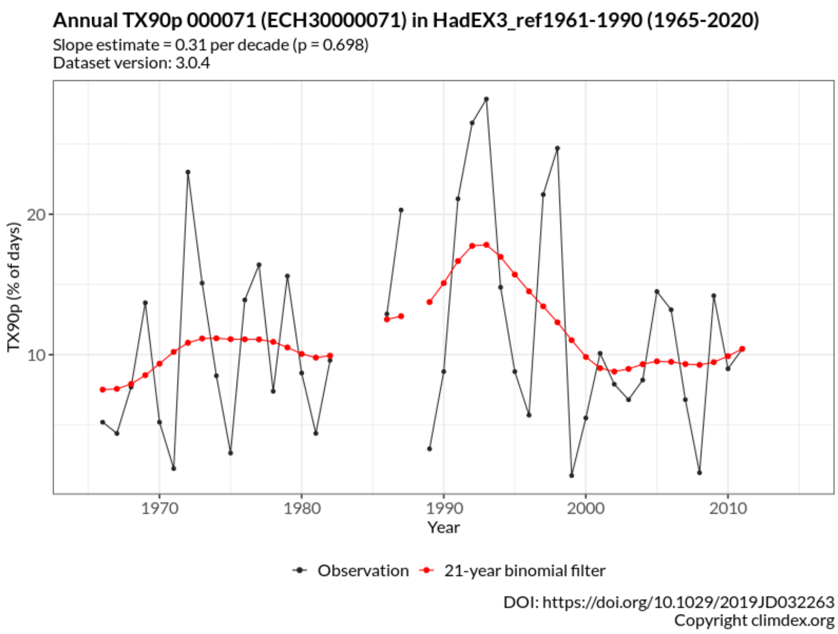


Figure IV.5. Outputs of Case A.

Case B: Gridded: Select **Get a single variable** ❶, indicate the coordinates of the region of interest or select it on the map (e.g. Ecuador). Subsequently, apply the same options in **Select data** as in Case A ❷.

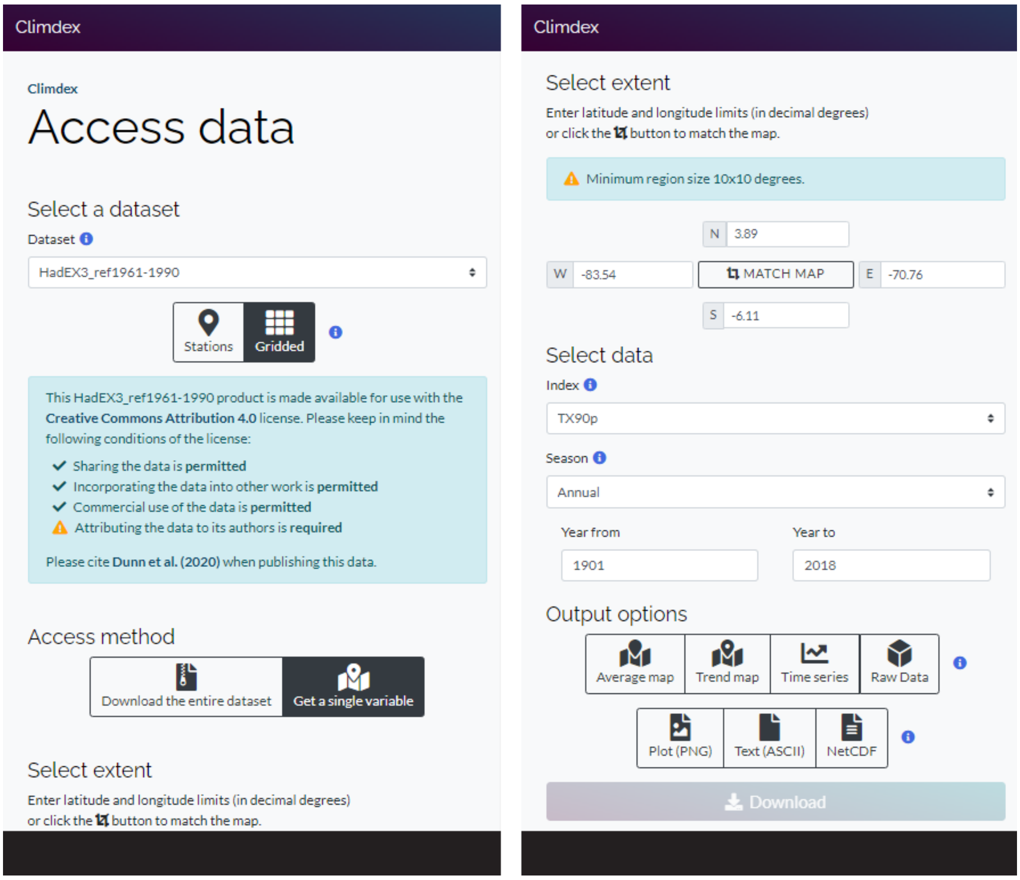


Figure IV.6. Case B steps.

Here you have the same download options as in Case A. However, in this case, you can download some additional output options, such as **Trend map** in PNG, ASCII or NetCDF format. Please note that the title designs of some plots may contain errors.

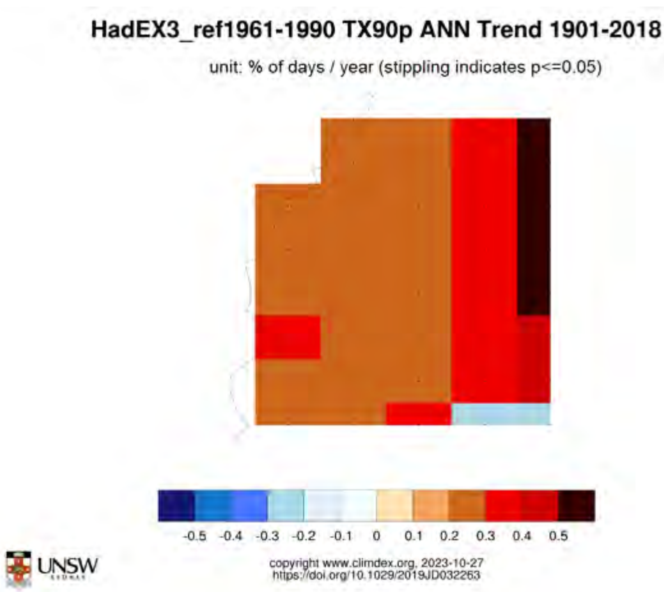


Figure IV.7. Trend maps of TX90p index for Ecuador.

Annex V. National Aeronautics and Space Administration/ Intergovernmental Panel on Climate Change Sea Level Projection Tool

In this annex, examples are shown for sea level rise projections from different climate change scenarios (SSPs, see section 2.6, Table 2 of this guidance). Sea level projections can be obtained from the tool available at https://sealevel.nasa.gov/data_tools/17 . The tool has been part of the IPCC VI assessment report (AR6). Figures V.1, V.2 and V.3 show examples of sea level rise projections for the coasts of Trinidad and Tobago and Guyana for 2030, 2040 and 2100, respectively, based on a medium scenario (SSP2-4.5).

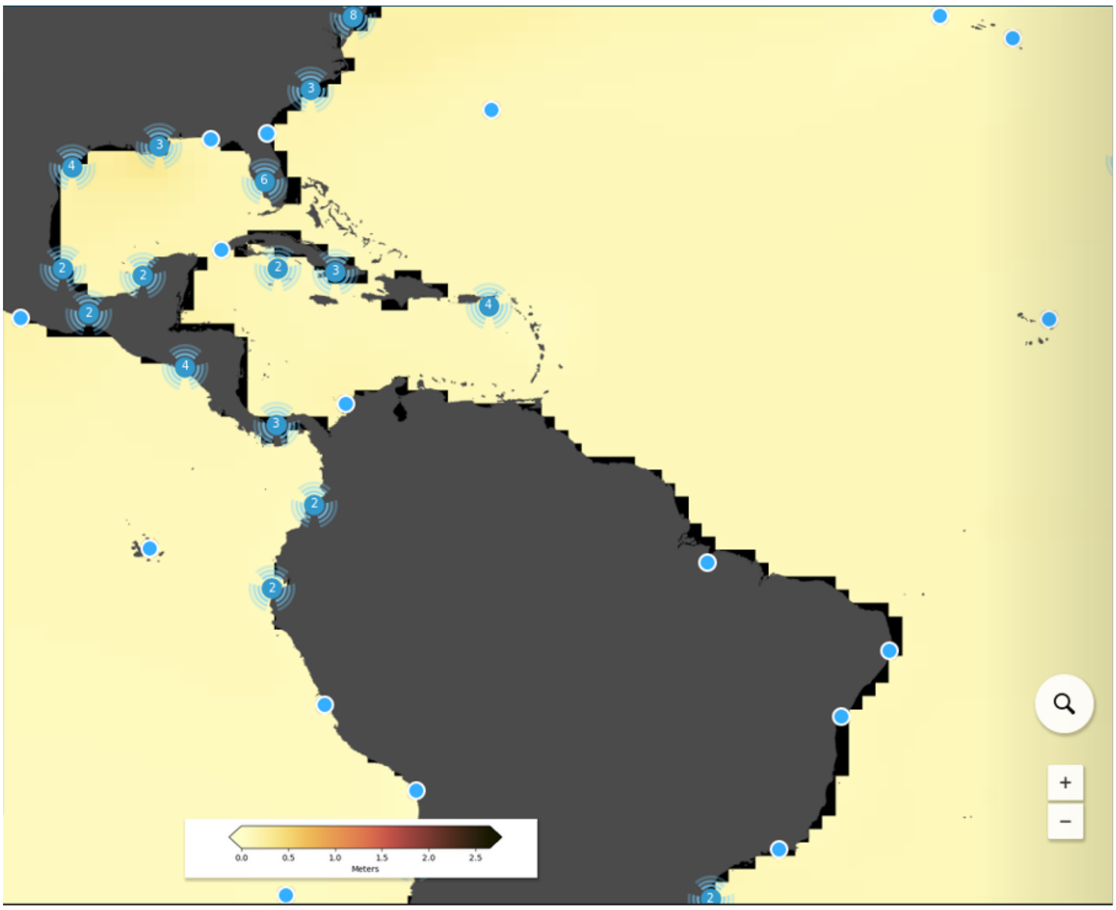


Figure V.1. SSP2-4.5, 2030. The sea level rise in Trinidad and Tobago coasts is expected to be 0.11 m, similar to the coast of Guyana.

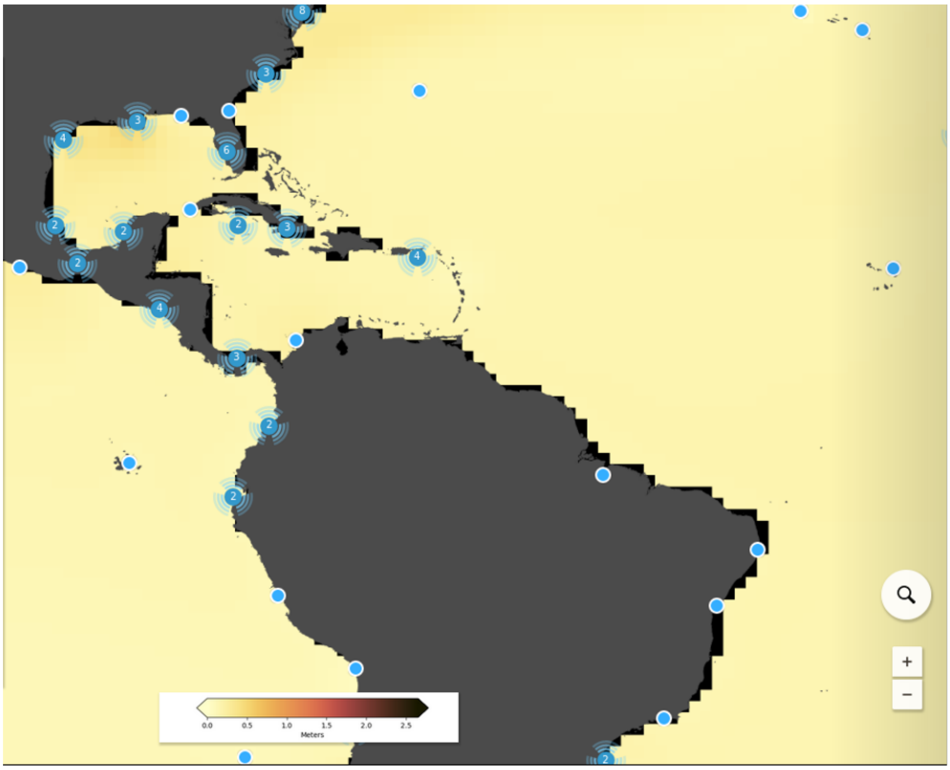


Figure V.2. SSP2-4.5, 2040. The sea level rise in Trinidad and Tobago coasts is expected to be 0.17 m, similar to the coast of Guyana.

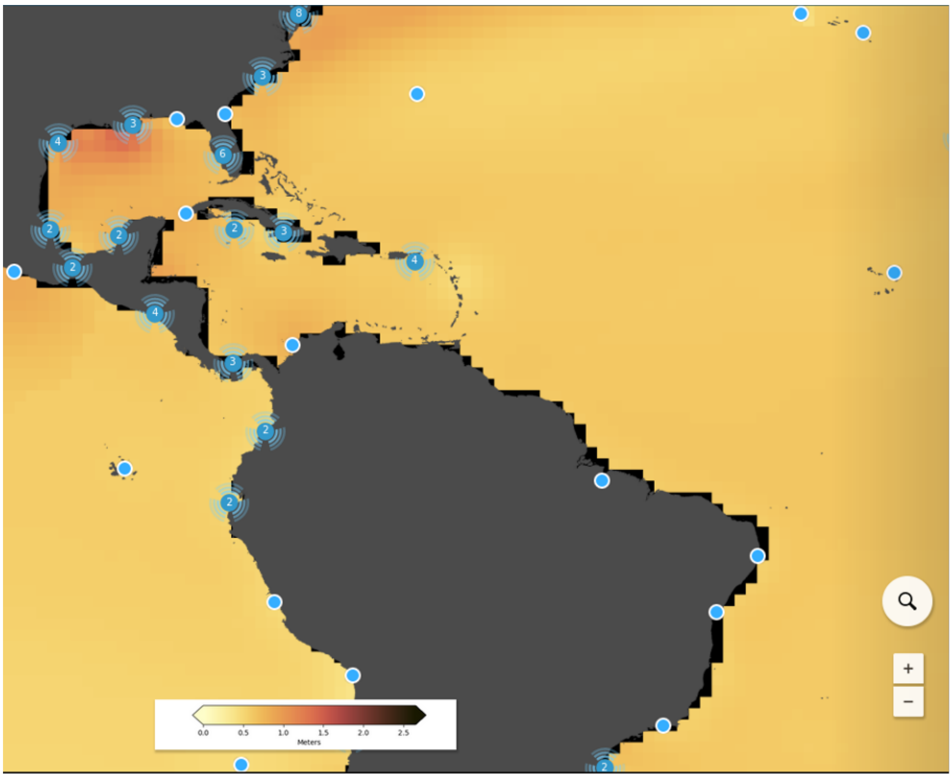


Figure V.3. SSP2-4.5, 2100. The sea level rise in Trinidad and Tobago coasts is expected to be 0.62 m, similar to the coast of Guyana.

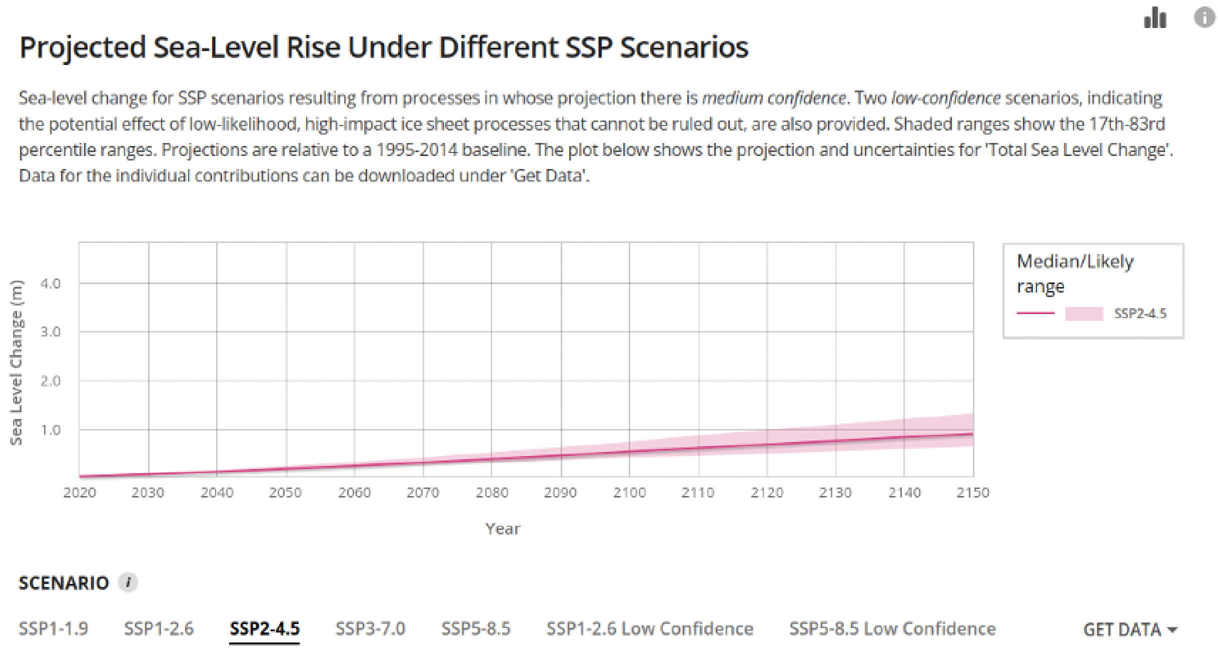


Figure V.4. SSP2-4.5. Projection and uncertainties for total sea level change in Trinidad and Tobago and Guyana in reference to 1995–2014.

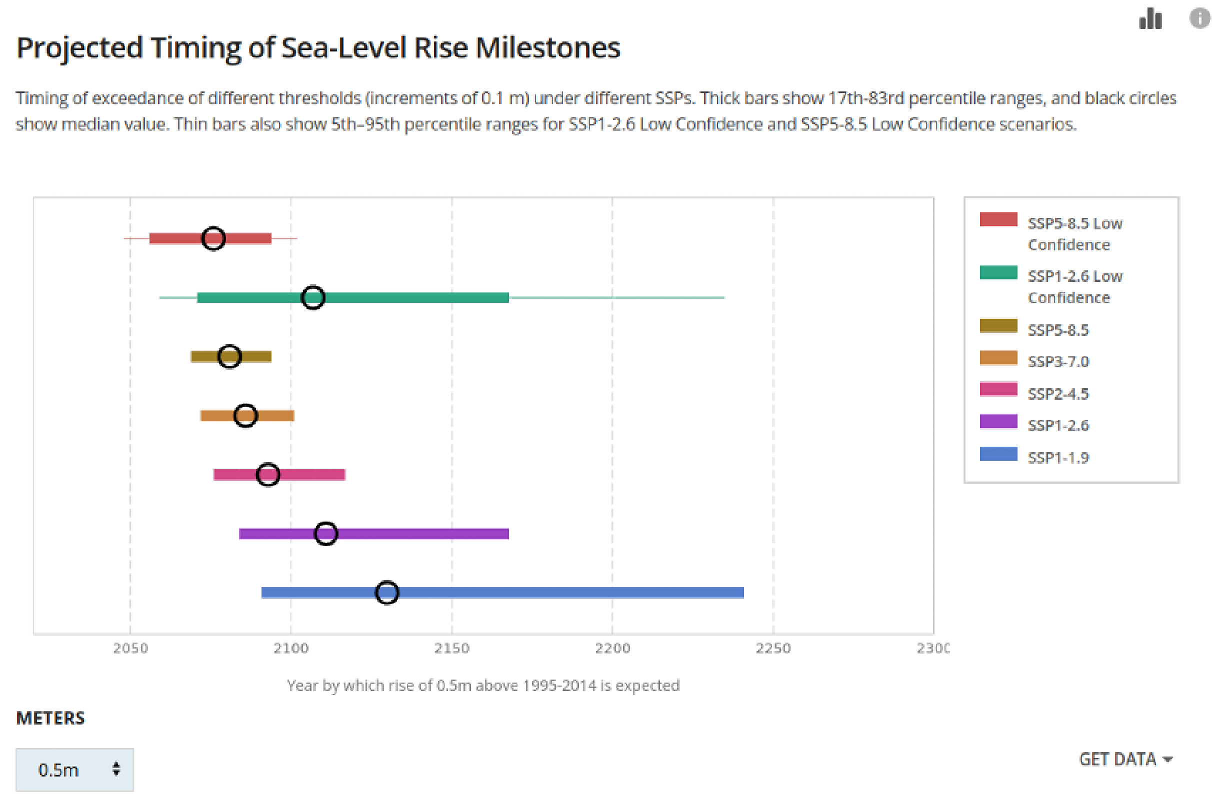


Figure V.5. Sea level exceedance of thresholds in Trinidad and Tobago and Guyana for different SSPs.

Annex VI. World Bank Climate Change Knowledge Portal

This portal provides climate, vulnerability and historical and future global data. We can easily explore the data by country and hydrographic basins to obtain detailed information about climate risks and adaptation options.

Click https://climateknowledgeportal.worldbank.org/ to access the site's home page.

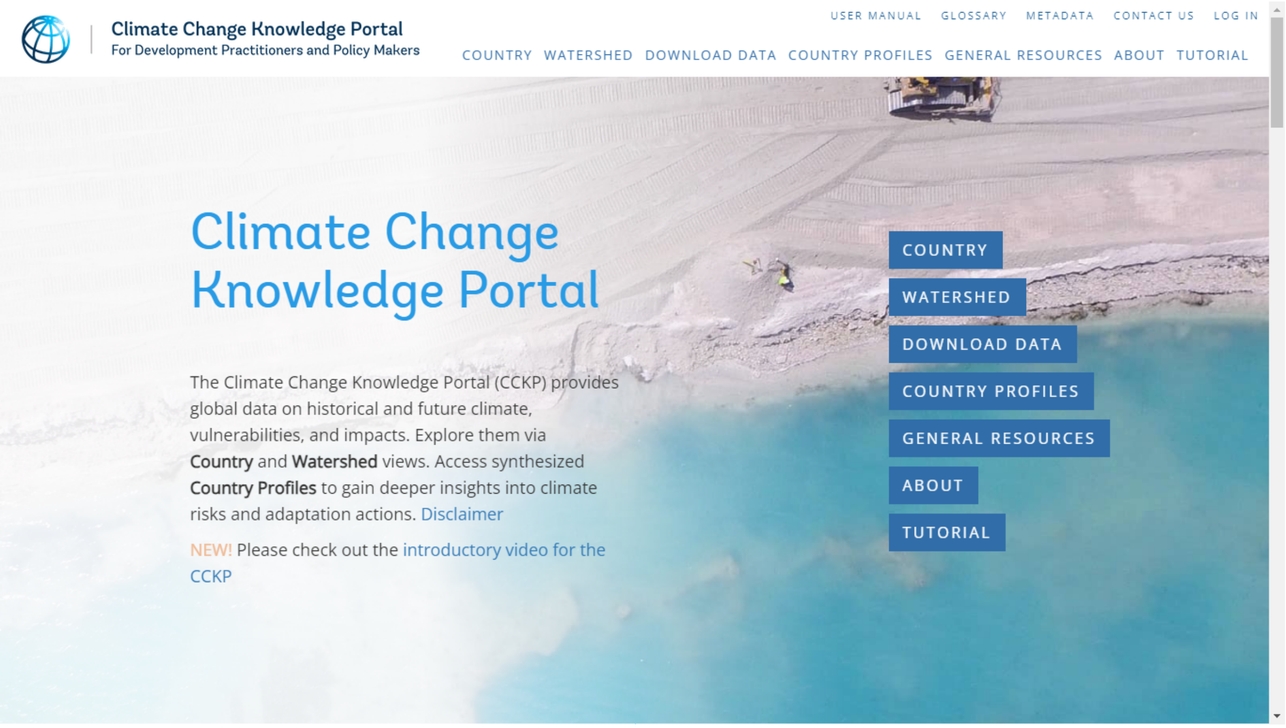


Figure VI.1. Climate Change Knowledge Portal home page.

Select your area of interest to visualize the information. In this case, we have selected the **COUNTRY** option. We can now select the desired location. Here, we have the option of choosing the country by selecting it from the map or from an alphabetically organized list.

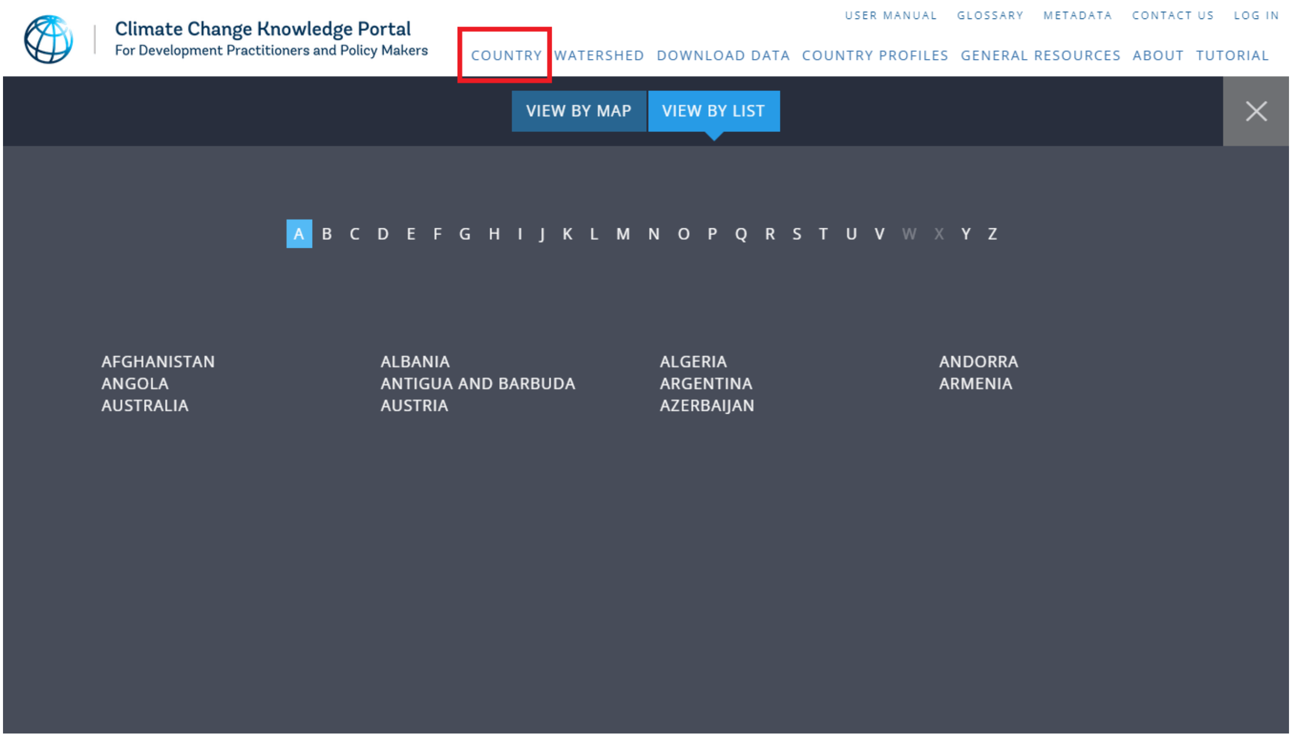


Figure VI.2. Country selection by alphabetical list.

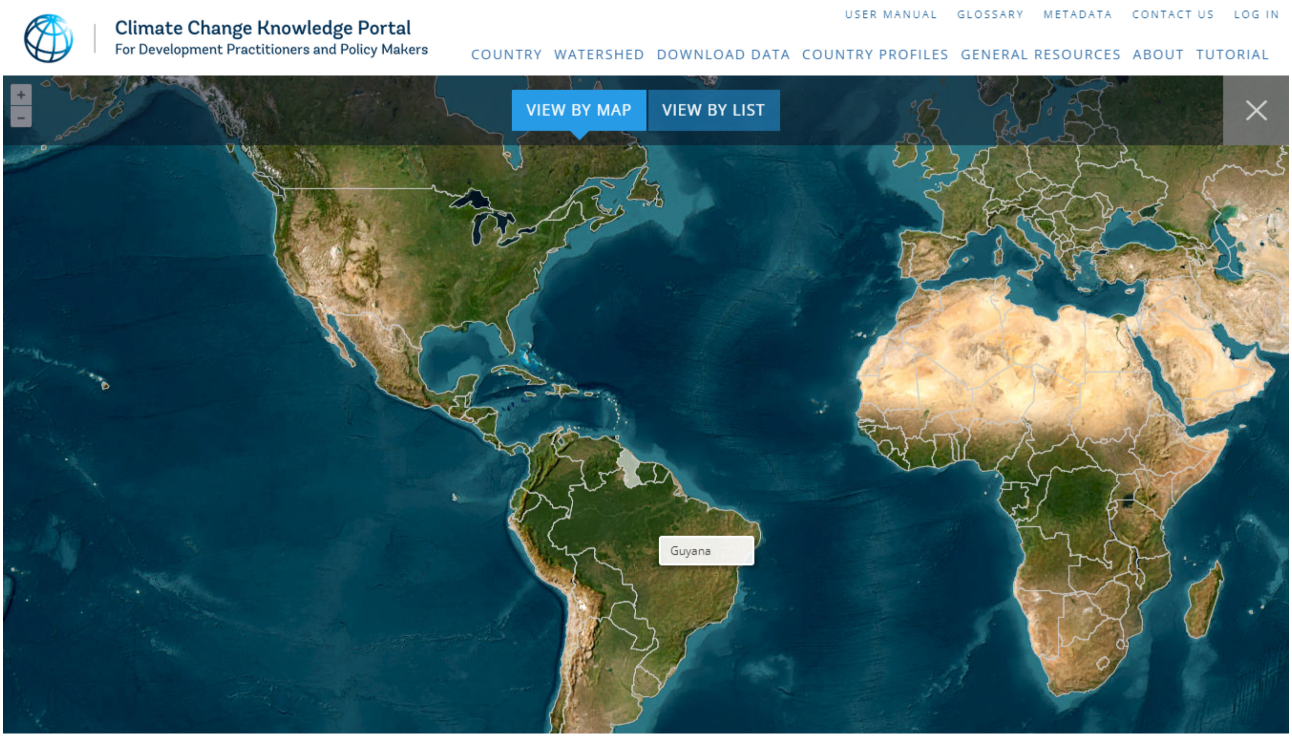


Figure VI.3. Country selection by map.

For example, if we select Guyana, the site will redirect us to the page shown in **Figure VI.4.**

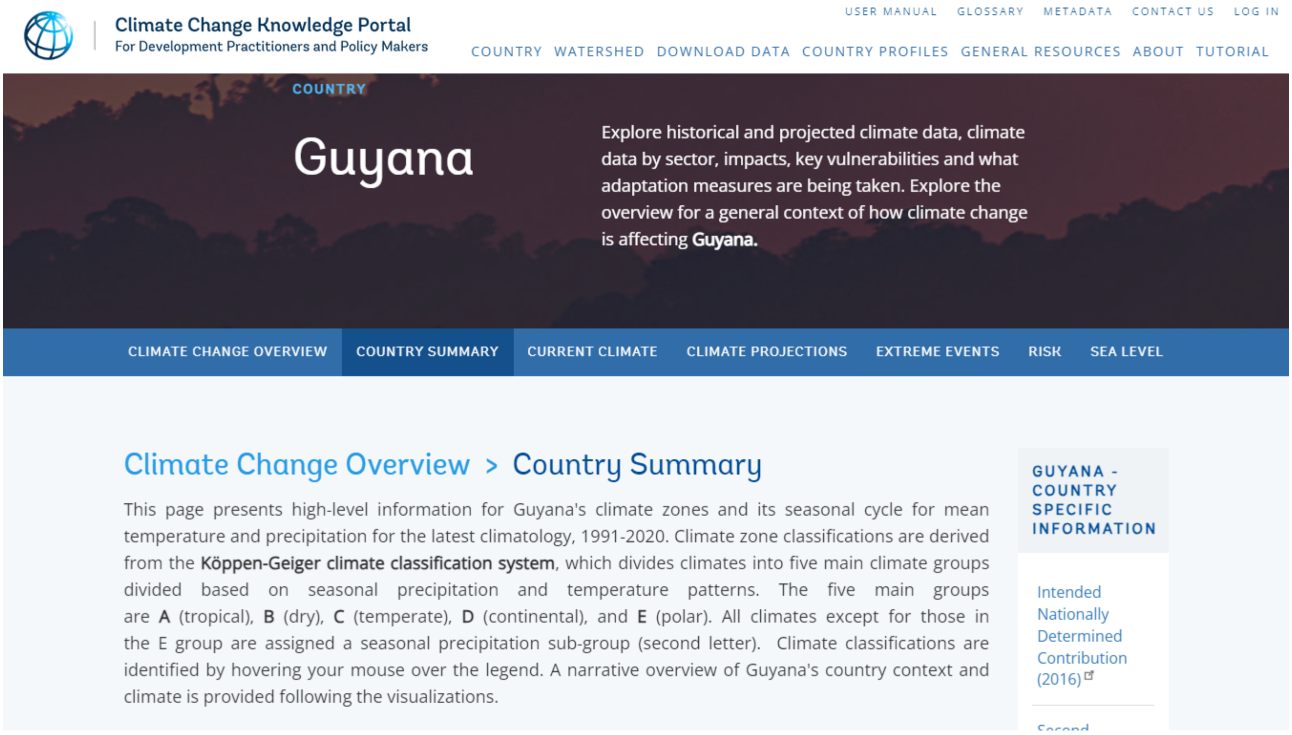


Figure VI.4. Climate Change Knowledge Portal Guyana site.

We can explore historical and projected climate data by sector, as well as by impacts, vulnerabilities and adaptation options being applied. We also have an overview to understand the context of how climate change is affecting Guyana.

The **Country Summary** section contains a general description of climate change. The climatic classification is presented on the caption.

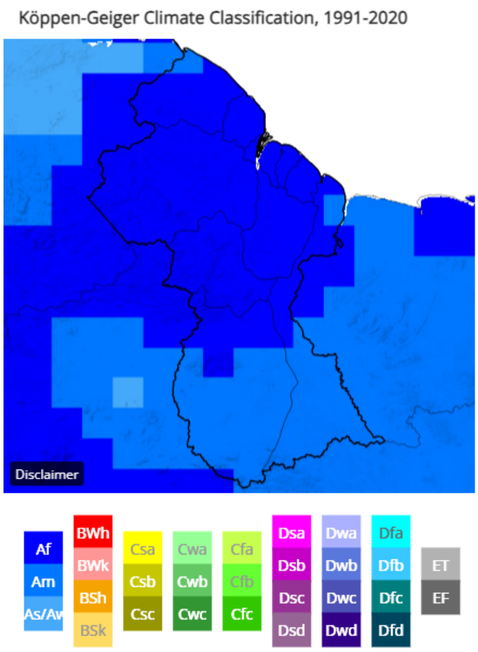


Figure VI.5. Köppen-Geiger climate classification, 1991–2020.

You can scroll down to see more graphs showing climatological information.

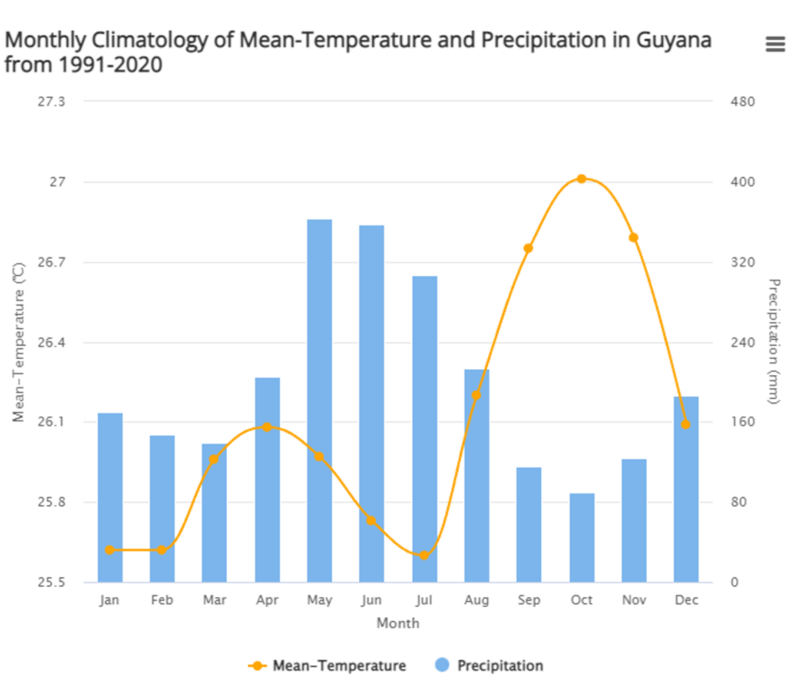


Figure VI.6. Monthly climatology of mean temperature and precipitation for Guyana, 1991–2020.

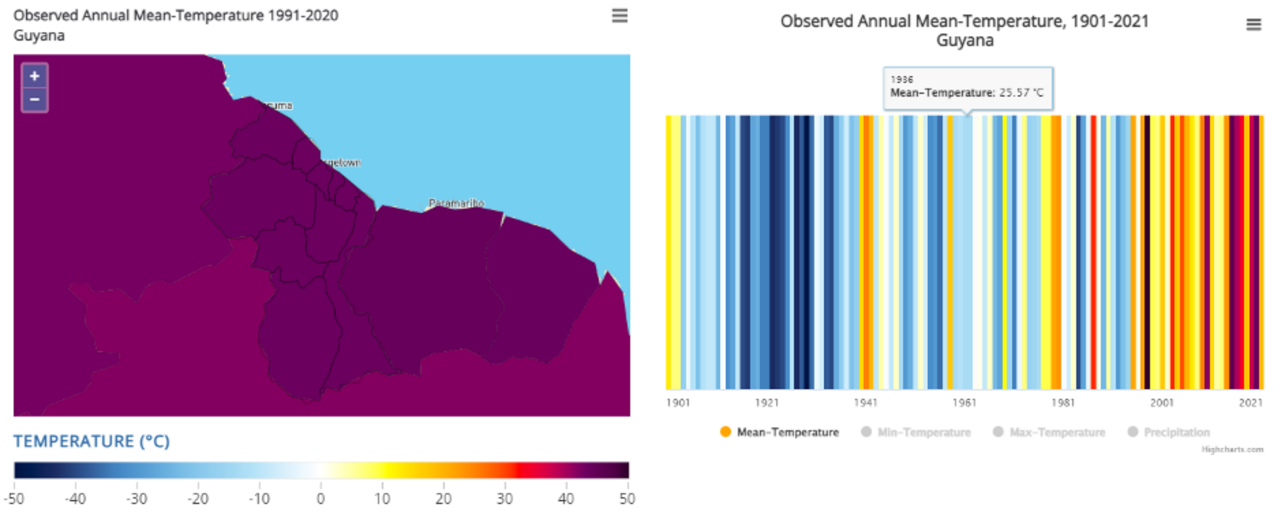


Figure VI.7. Observed annual mean temperature, 1901–2021.

All of these graphs and maps are interactive. You can change the variable displayed by selecting a different one from below the bar plot.

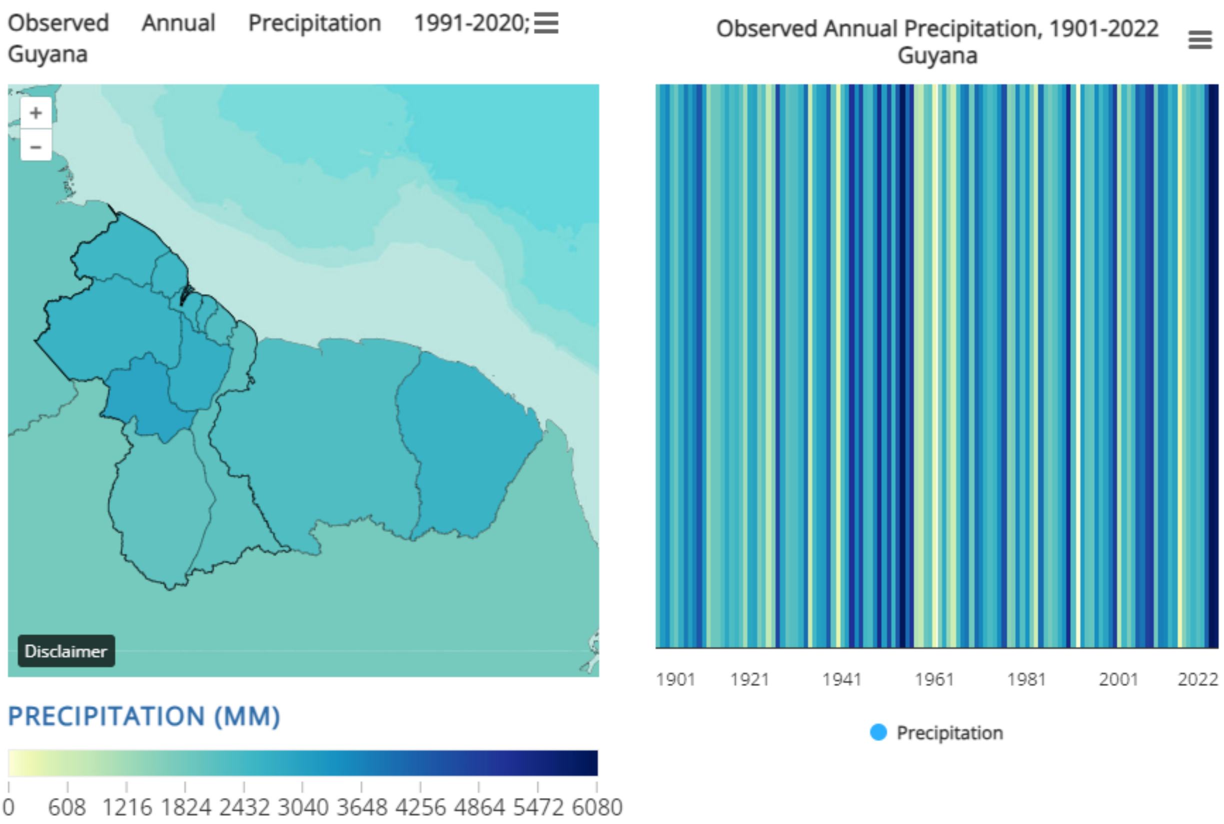
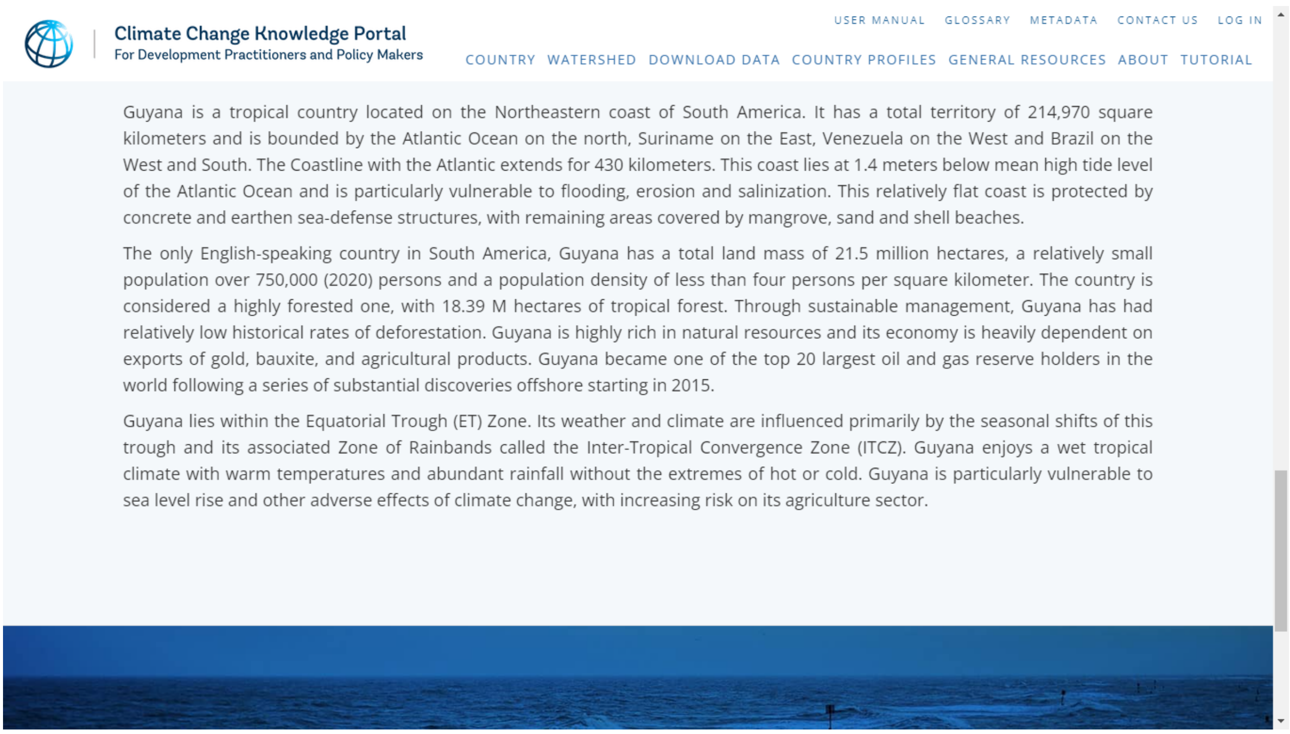


Figure VI.8. Observed mean precipitation, 1991–2020.

We can also find a general summary of the chosen country, as shown in Figure VI.9.



Guyana is a tropical country located on the Northeastern coast of South America. It has a total territory of 214,970 square kilometers and is bounded by the Atlantic Ocean on the north, Suriname on the East, Venezuela on the West and Brazil on the West and South. The Coastline with the Atlantic extends for 430 kilometers. This coast lies at 1.4 meters below mean high tide level of the Atlantic Ocean and is particularly vulnerable to flooding, erosion and salinization. This relatively flat coast is protected by concrete and earthen sea-defense structures, with remaining areas covered by mangrove, sand and shell beaches.

The only English-speaking country in South America, Guyana has a total land mass of 21.5 million hectares, a relatively small population over 750,000 (2020) persons and a population density of less than four persons per square kilometer. The country is considered a highly forested one, with 18.39 M hectares of tropical forest. Through sustainable management, Guyana has had relatively low historical rates of deforestation. Guyana is highly rich in natural resources and its economy is heavily dependent on exports of gold, bauxite, and agricultural products. Guyana became one of the top 20 largest oil and gas reserve holders in the world following a series of substantial discoveries offshore starting in 2015.

Guyana lies within the Equatorial Trough (ET) Zone. Its weather and climate are influenced primarily by the seasonal shifts of this trough and its associated Zone of Rainbands called the Inter-Tropical Convergence Zone (ITCZ). Guyana enjoys a wet tropical climate with warm temperatures and abundant rainfall without the extremes of hot or cold. Guyana is particularly vulnerable to sea level rise and other adverse effects of climate change, with increasing risk on its agriculture sector.

Figure VI.9. Country Summary

Now, select the **Current Climate** option. Here, there are two options: **Climatology** and **Trends & Variability**.

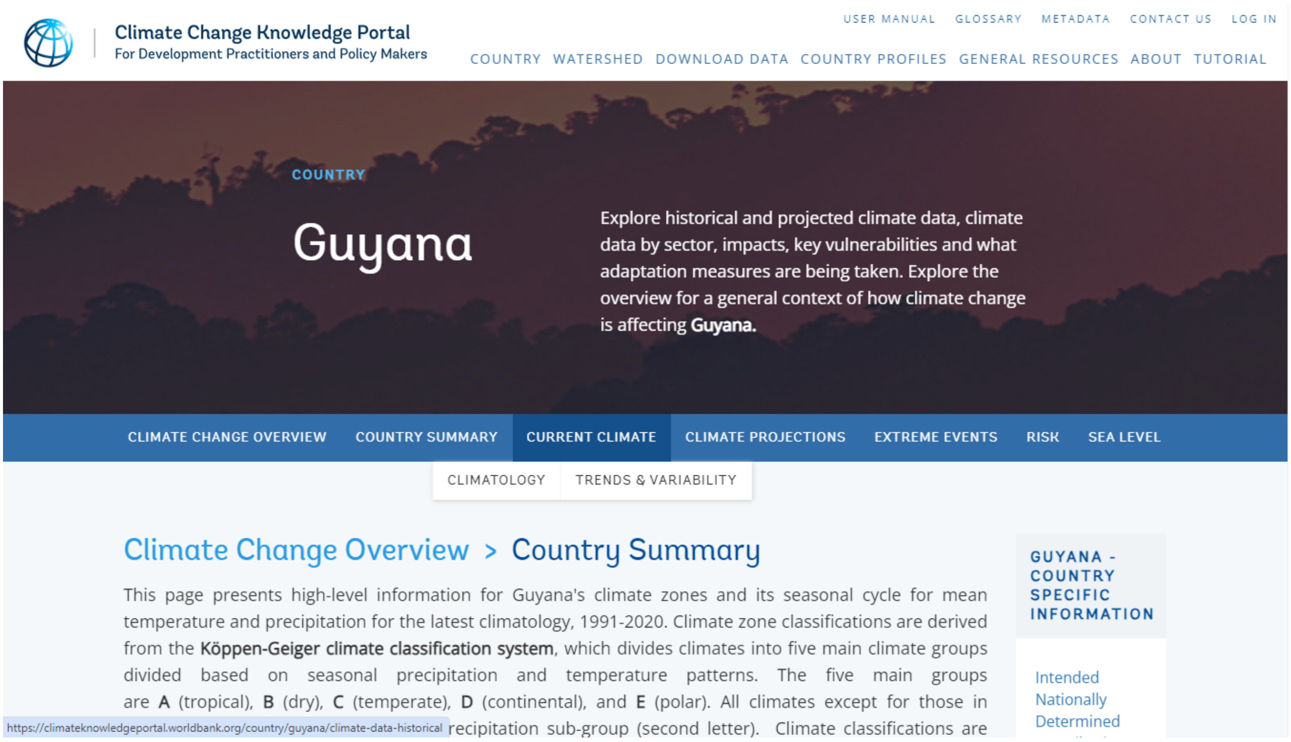


Figure VI.10. Current Climate.

The first option shows a summary of what we can find in this section. Again, there are interactive graphs and maps.

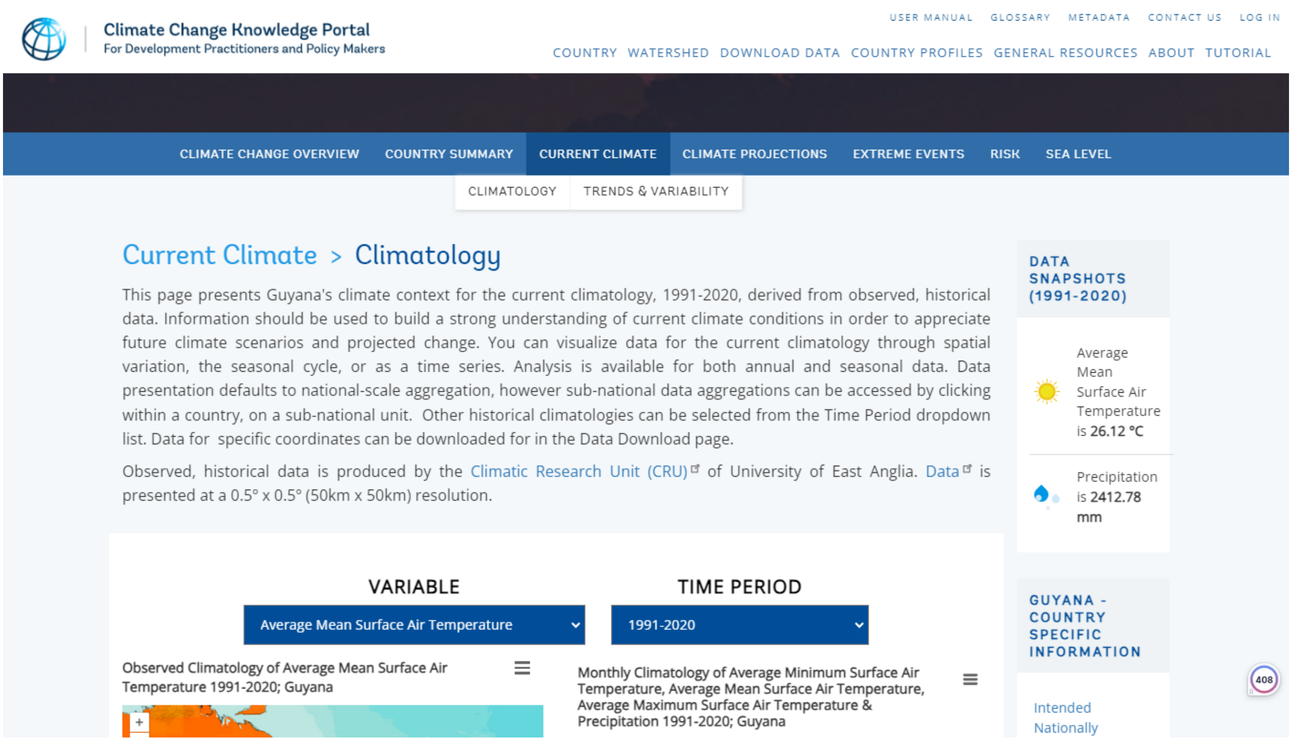


Figure VI.11. Current Climate, Climatology view.

The **Trends & Variability** option contains a section on **Trends and Significant Changes against Natural**

Vulnerability.

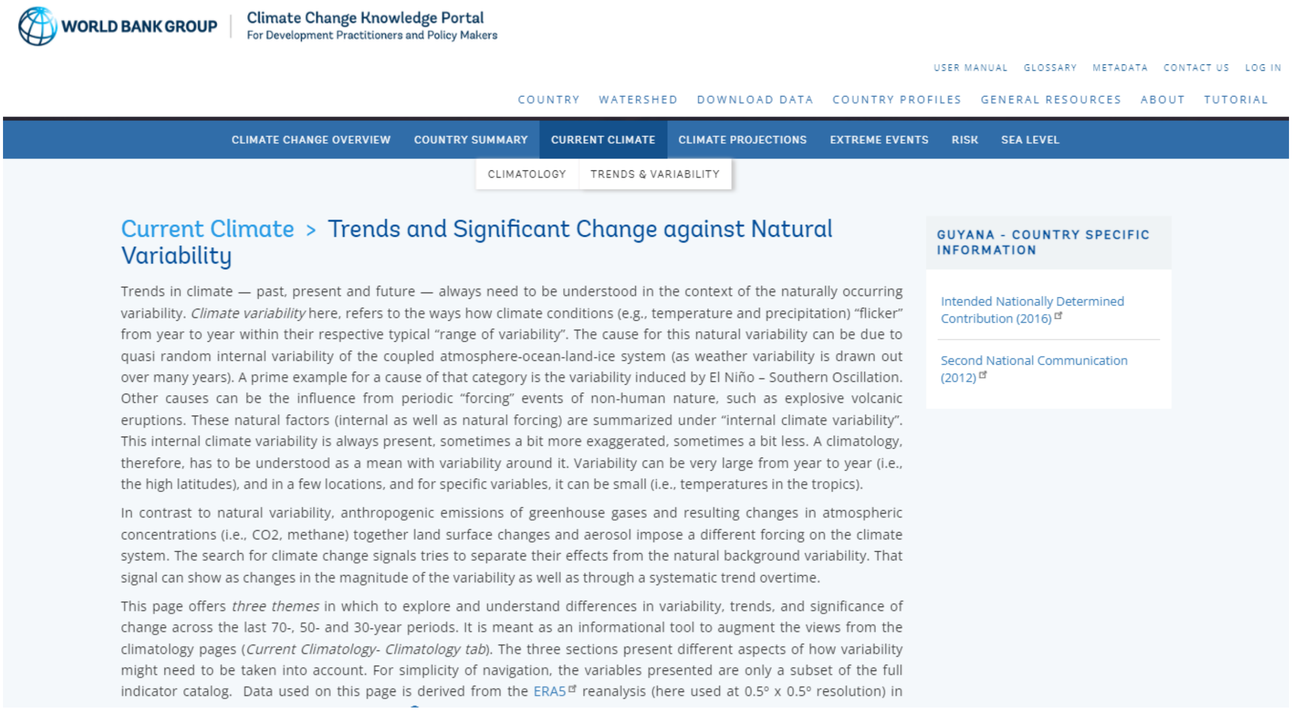


Figure VI.12. Current Climate, Trends and Significant Changes against Natural Vulnerability view.

The graphs and maps are also interactive. In this case, we change the variable and choose the main temperature to display the information in Figure VI.13.

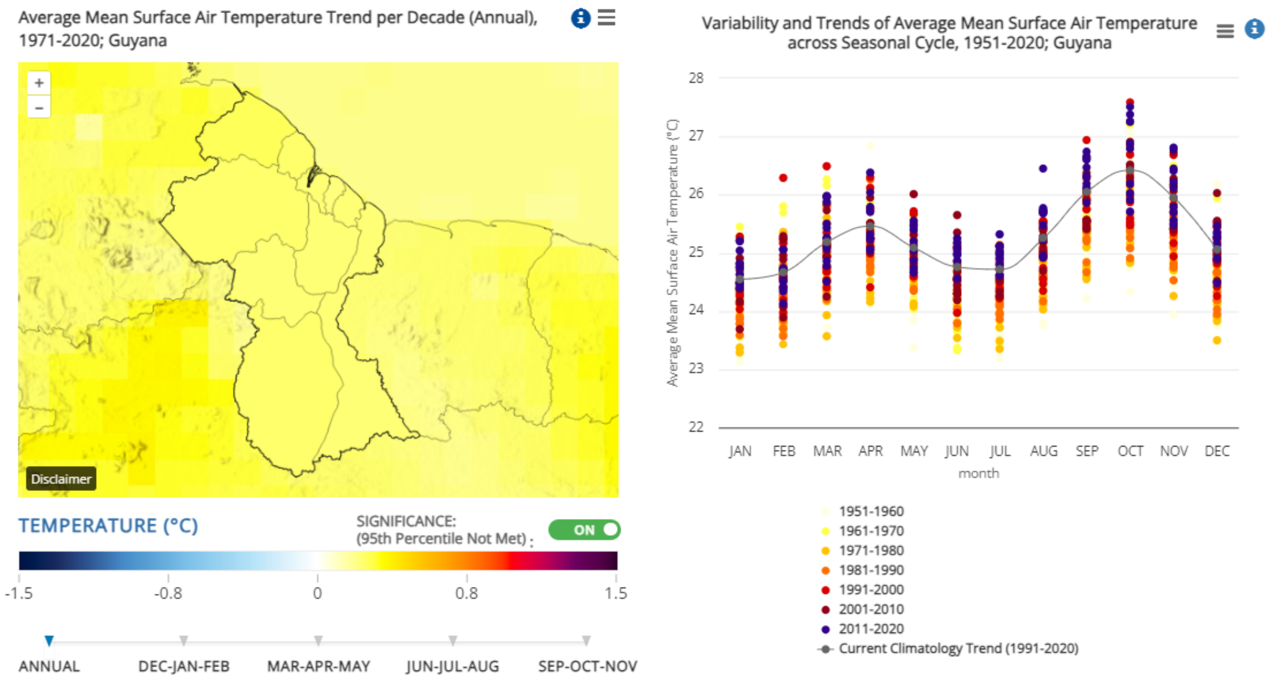


Figure VI.13. Trends and variability plots.

Here, we can select different variables for each graph submenu.

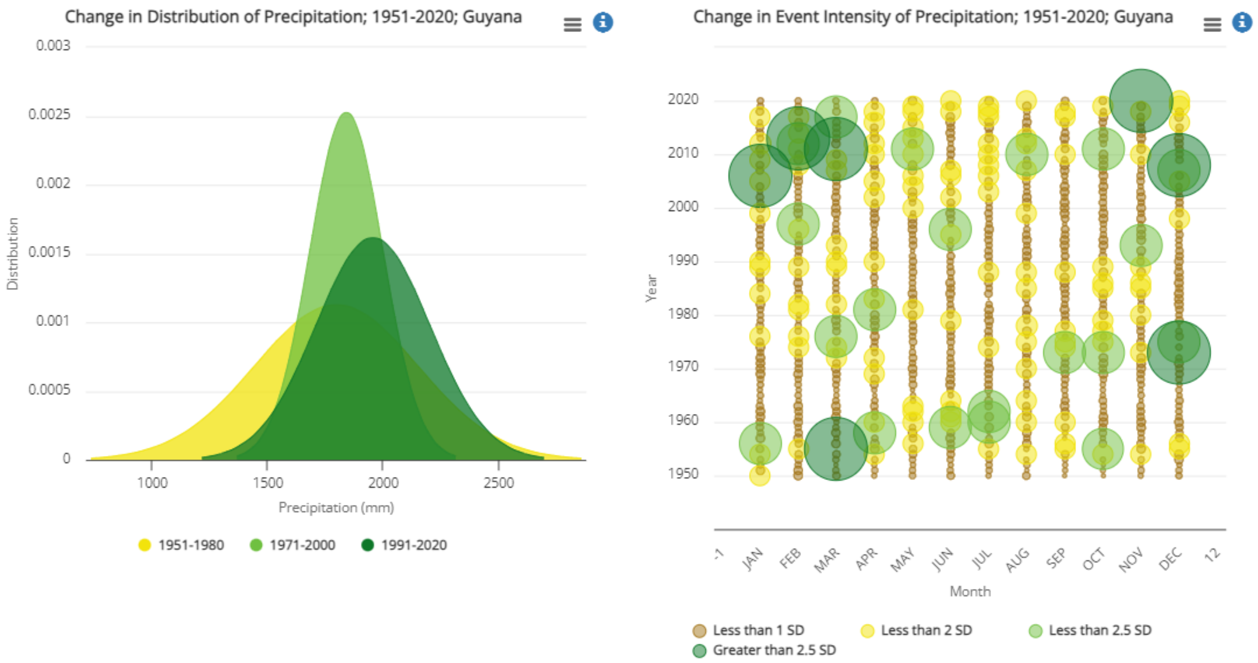


Figure VI.14. Trends and variability, precipitation graphs.

The **Climate Projections** section contains the projected climate for the chosen country (in this case, Guyana). This page offers a complete set of Climate Change Knowledge Portal indices for deep analysis of future climate scenarios and potential risks due to climate change.

Figure VI.15. Climate Projections web page.

We can change and select the variable, period, scenario and model for the following graph. For this example, we chose the maximum temperature for 2020–2039 and SSP5-8.5 scenario for a multi-model ensemble.

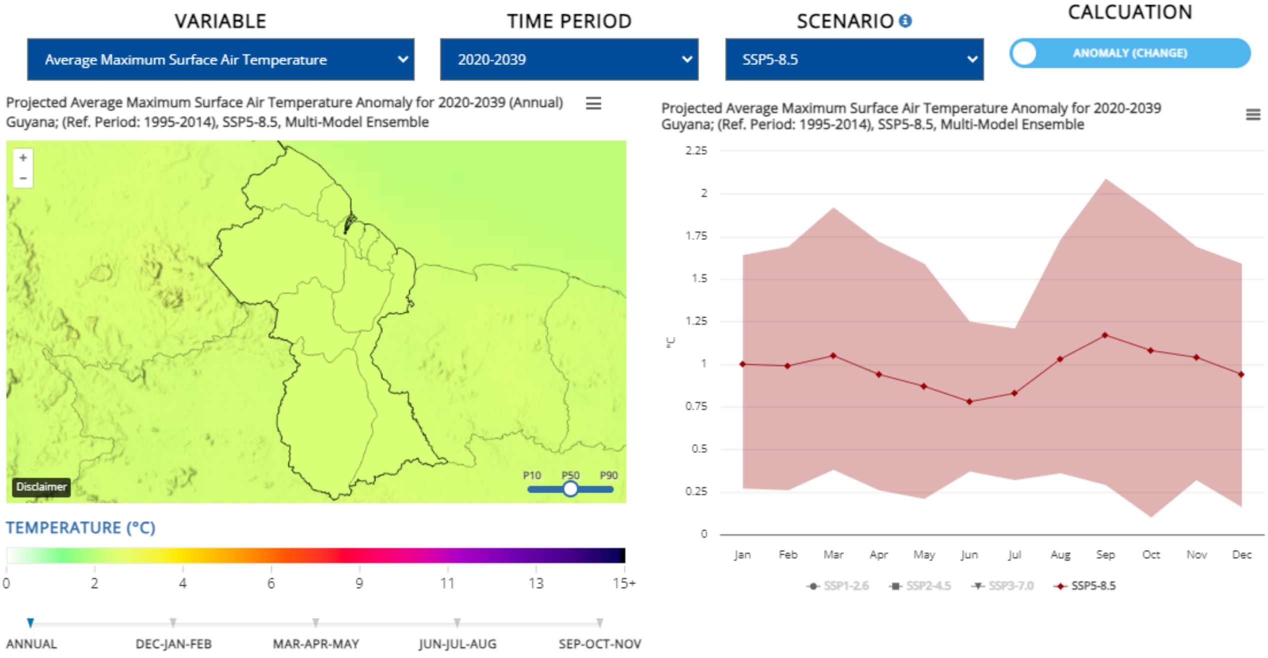


Figure VI.16. Climate projection of maximum temperature plot.

Annex VII. Examples of climate information

Climate change (recent past/present climate observations)

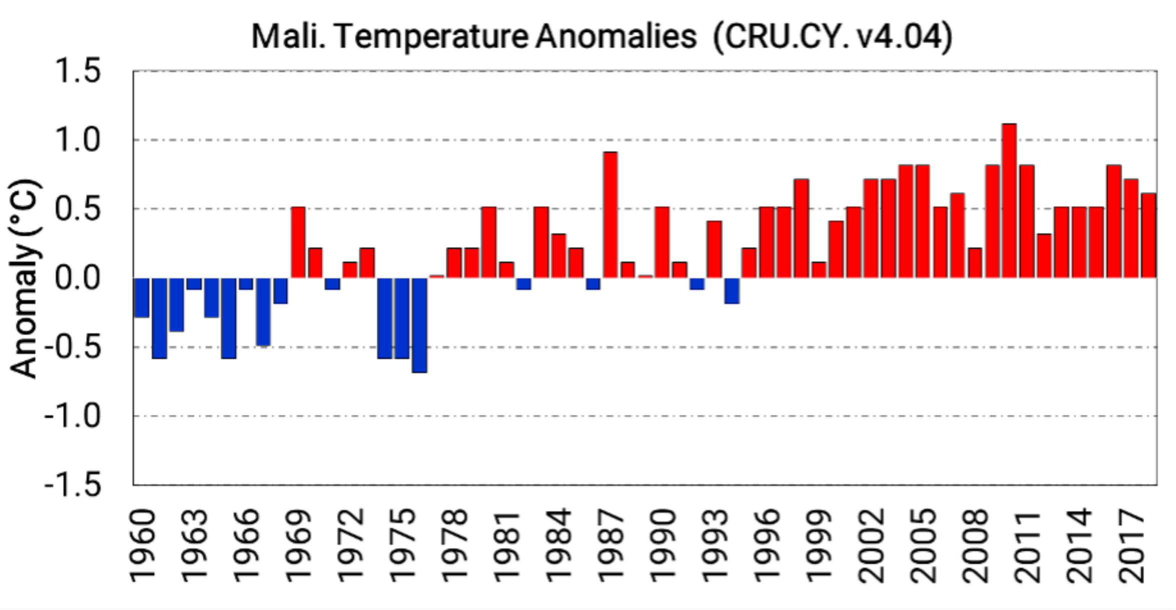


Figure VII.1. Annual temperature anomalies of Mali from 1960 to 2018 (base period 1961–1990).

Source: Data Sets, Climatic Research Institute; see https://www.uea.ac.uk/web/groups-and-centres/climatic-research-unit/data.

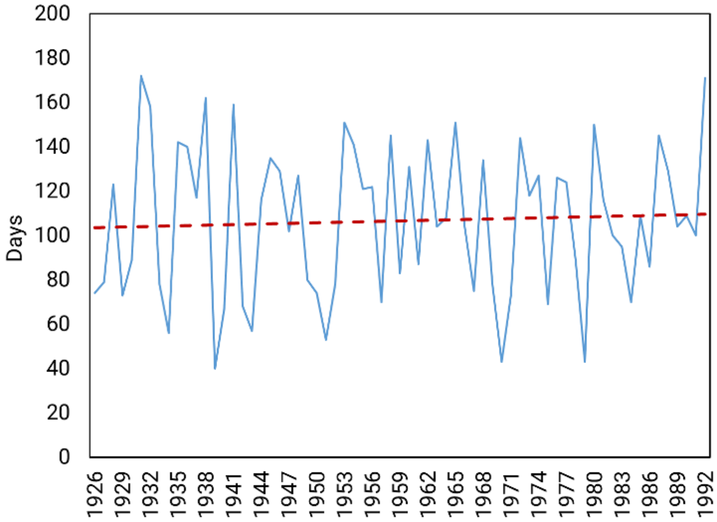


Figure VII.2. CDD index for Gaborone, Botswana from 1926 to 1992 (base period 1961–1990).

Source: Global Historical Climatology Network daily; see https://www.ncei.noaa.gov/products/land-based-station/global-historical-climatology-network-daily.

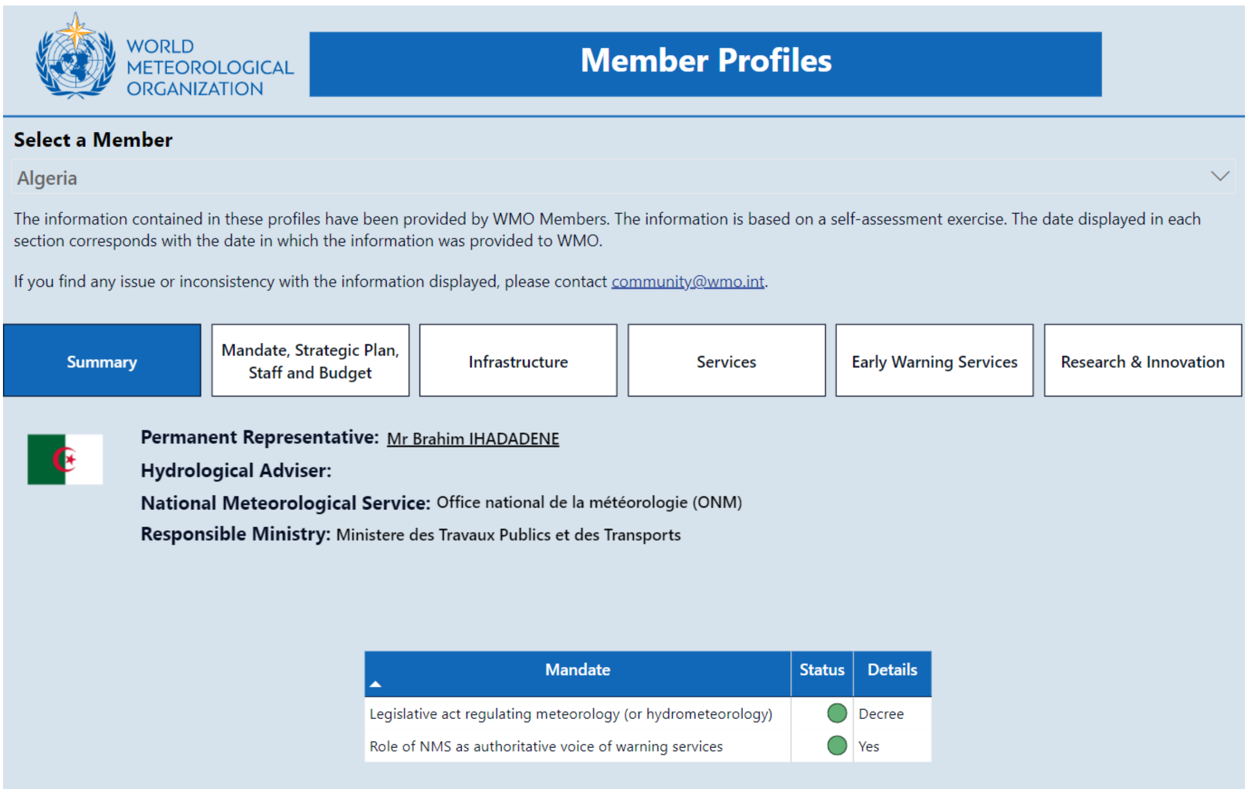


Figure VII.3. Cabo Verde profile providing key information on the National Institute of Meteorology and Geophysics.

Source: Member Profiles, World Meteorological Organization; see https://community.wmo.int/members/profiles.

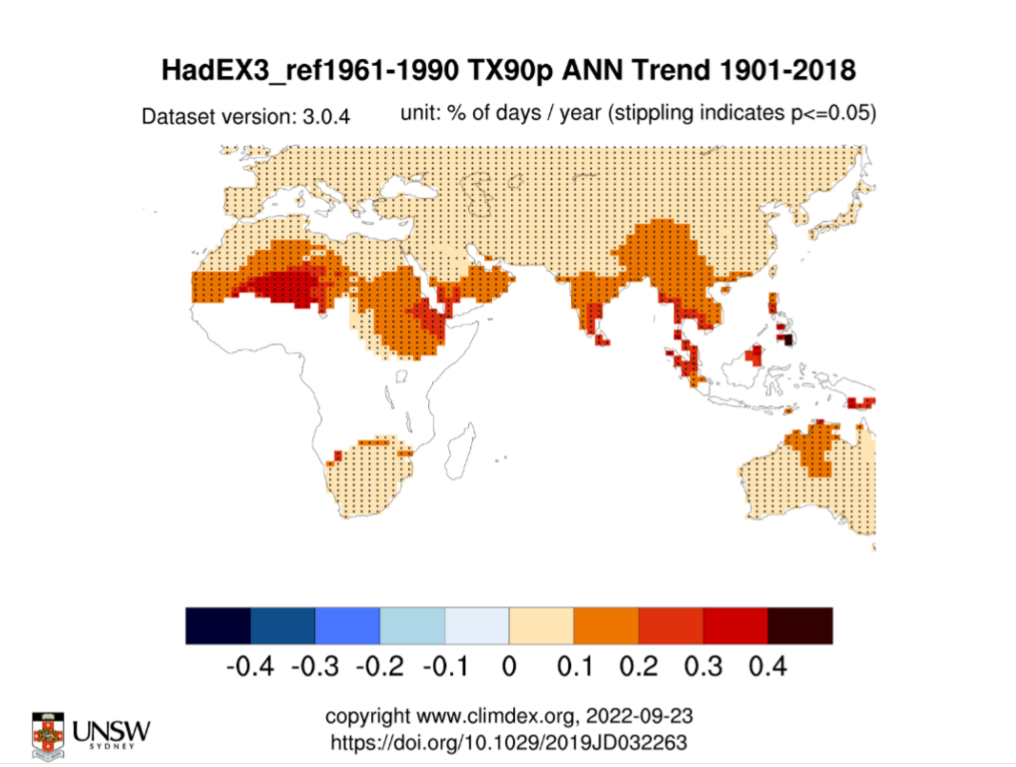


Figure VII.4. Map trend of the number of hot days (TX90p) index from 1901 to 2018 (base period 1961–1990).

Source: Climdex data portal, University of New South Wales; see https://www.climdex.org.

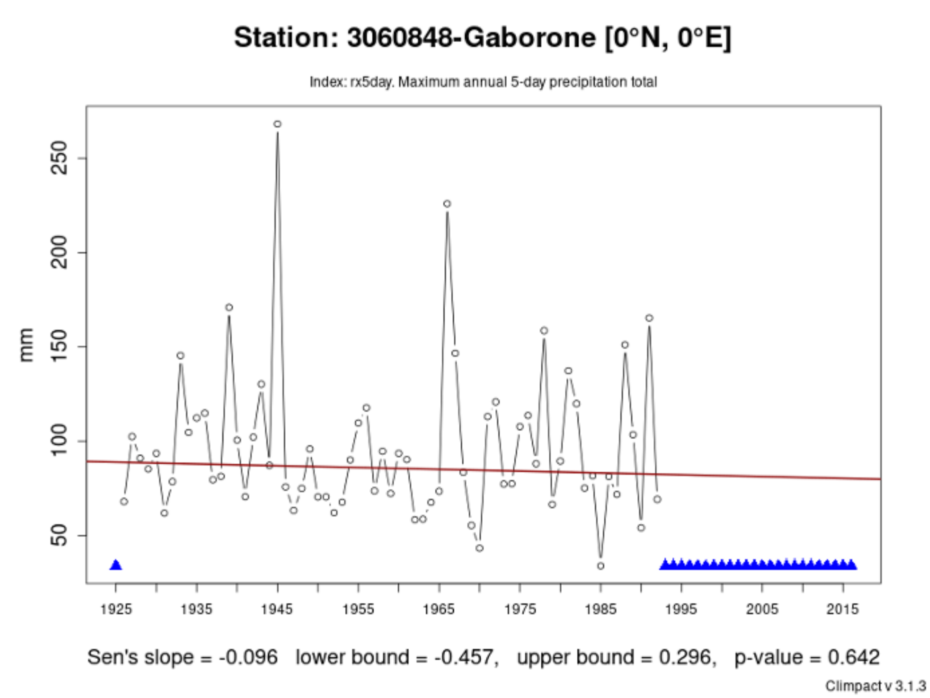


Figure VII.5. Maximum annual five-day precipitation total (rx5day) index for Gaborone, Botswana from 1926 to 1992 (base period 1961–1990).

Source: Climpact, Expert Team on Sector-Specific Climate Indices; see https://www.climpact-sci.org.

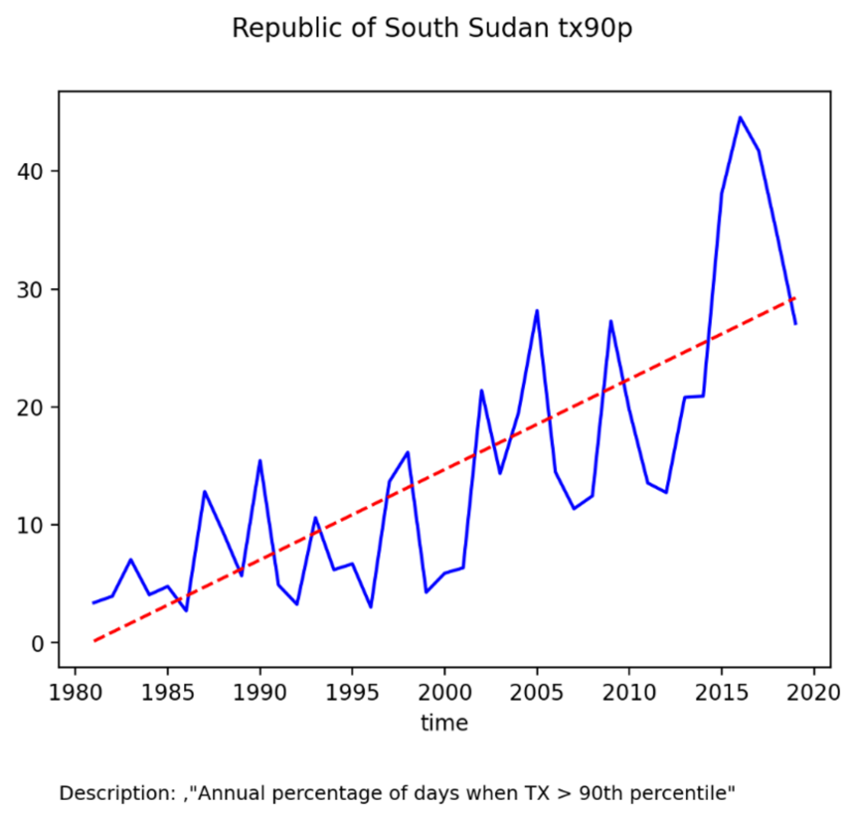


Figure VII.6. Regional time series of amount of hot days (TX90p) index for South Sudan from 1979 to 2019 (base period 1961–1990).

Source: Climate Data Store, Copernicus Climate Change Service; see https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels?tab=overview.

Climate change (projections)

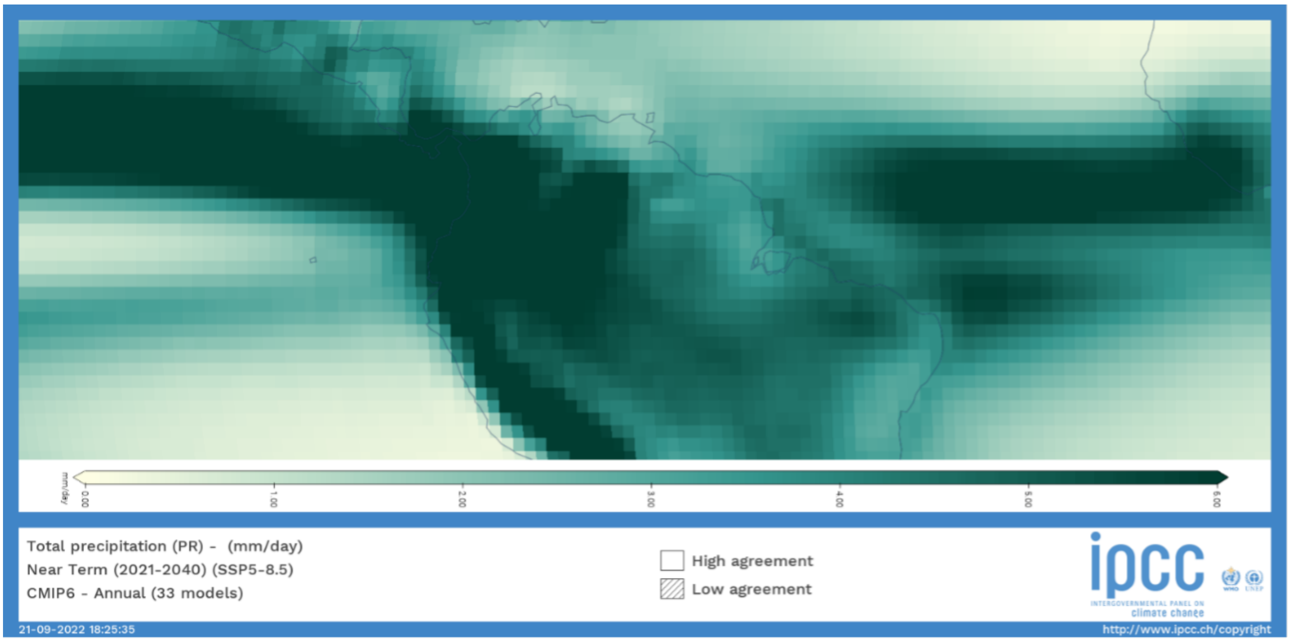


Figure VII.7. Total precipitation (mm/day) for Central and South America Region from 2021 to 2040 (base period 1961-1990) for SSP5-8.5 scenario (CMIP6 model ensemble).

Source: Interactive Atlas, Intergovernmental Panel on Climate Change Working Group I; see https://interactive-atlas.ipcc.ch/.

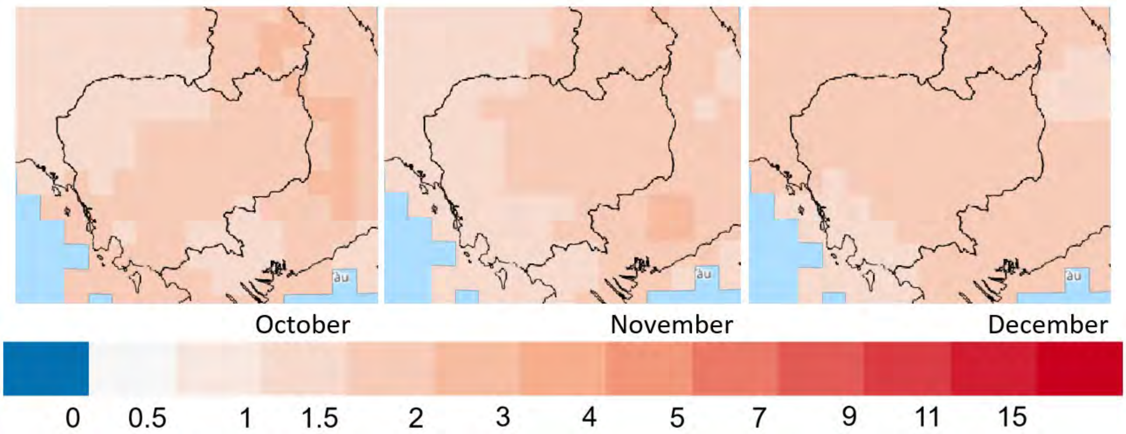


Figure VII.8. Temperature (monthly mean) for Cambodia from 2041 to 2070 for the high emissions scenario (RCP 8.5) (base period 1981–2010). CORDEX South Asia.

Source: Climate Information Portal, Swedish Meteorological and Hydrological Institute; see https://climateinformation.org/.

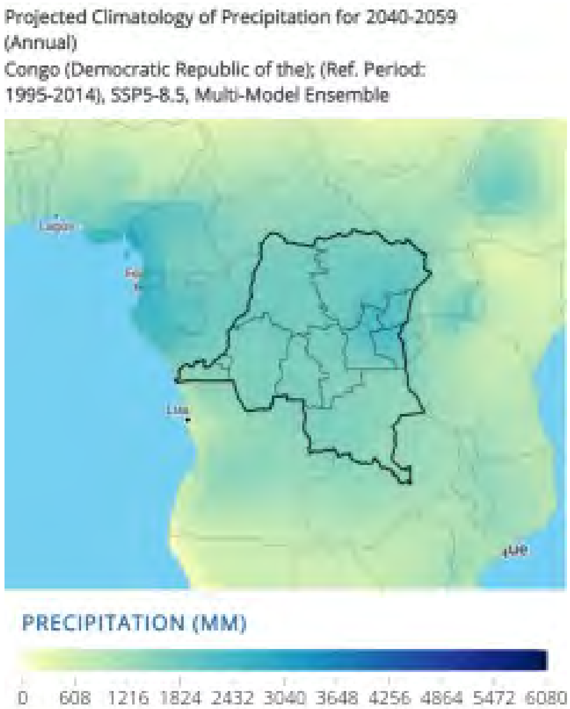


Figure VII.9. Precipitation (mm) for Democratic Republic of the Congo from 2040 to 2059 (base period 1995–2014) for SSP5-8.5 scenario (CMIP6 model ensemble).

Source: Climate Change Knowledge Portal, World Bank; see https://climateknowledgeportal.worldbank.org/.

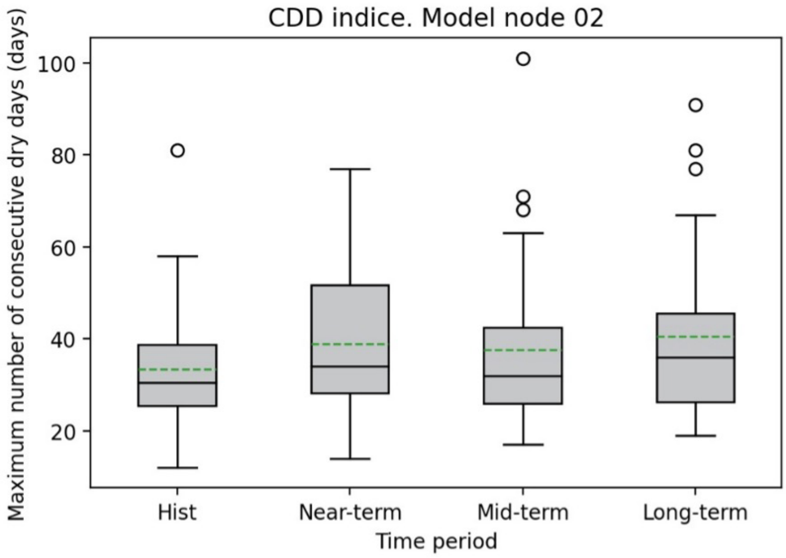


Figure VII.10. Box plot of CDD index for Malé, the Maldives, for four periods: 1850–2015 (hist), 2011–2040 (near-term), 2041–2070 (mid-term) and 2071–2100 (long-term) (base period 1981–2010) for SSP5-8.5 scenario (Max Planck Institute Earth System Model, CMIP6).

Source: CMIP Phase 6; see https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6.

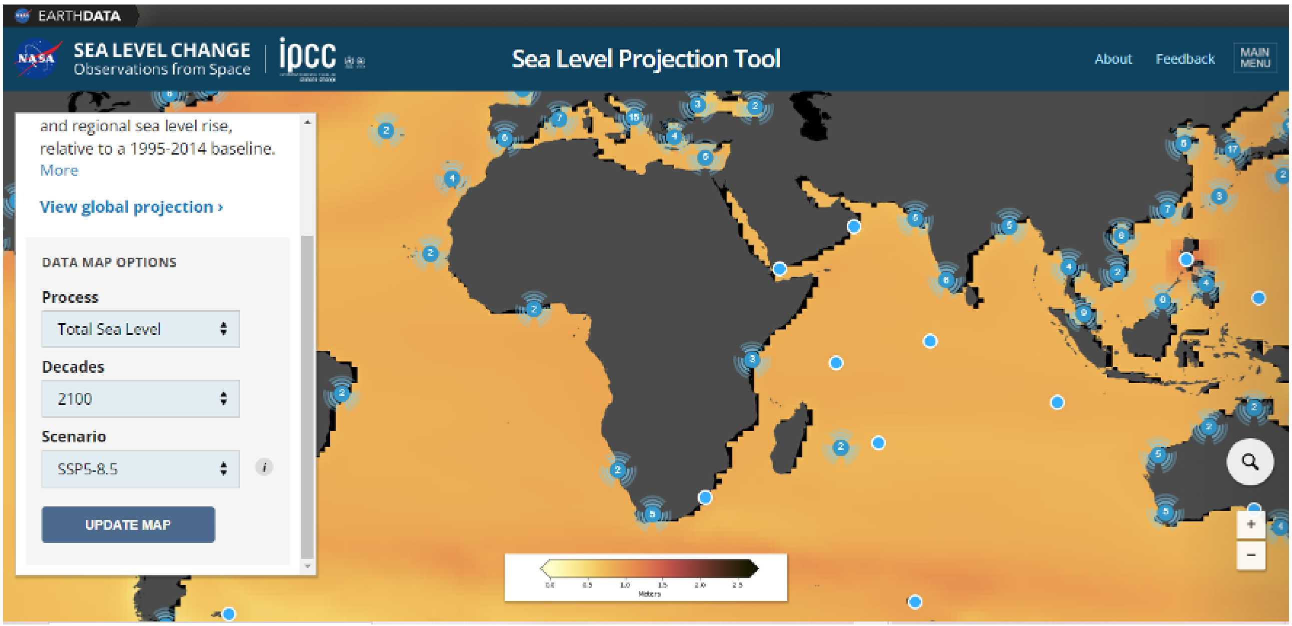


Figure VII.11. Total sea level for Africa in 2100 for SSP5-8.5 scenario (base period 1995–2014).

Source: Sea Level Projection Tool, National Aeronautics and Space Administration; see https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool.

Weather

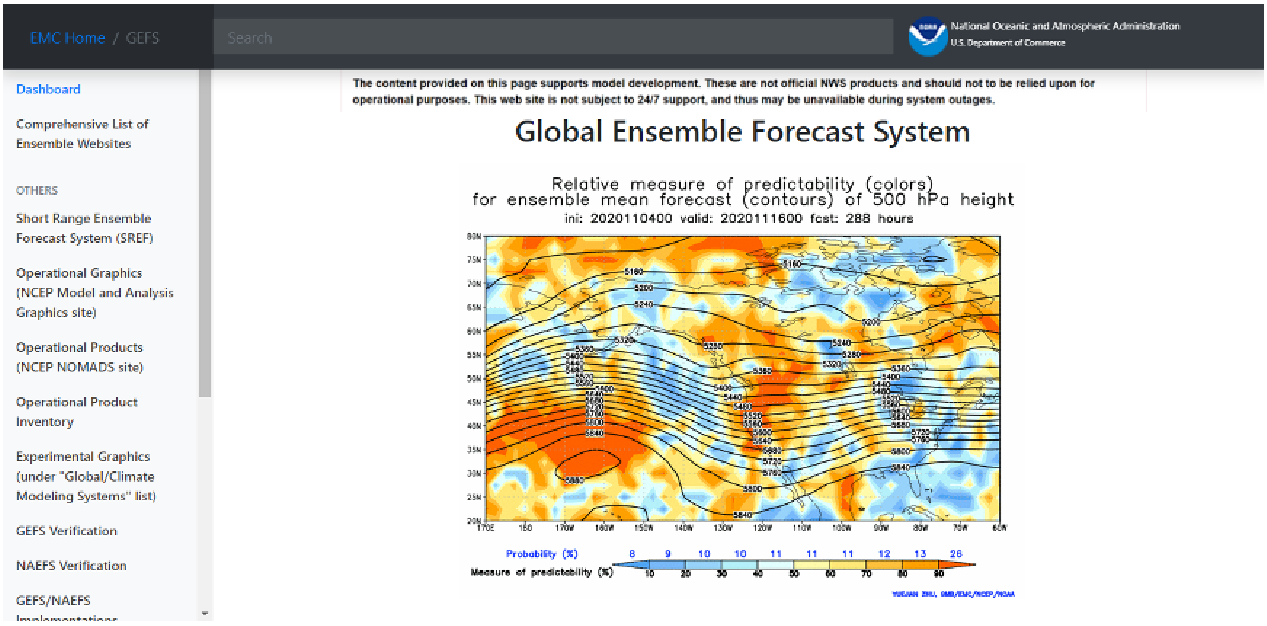


Figure VII.12.

Source: Global Ensemble Forecast System; see https://www.ncei.noaa.gov/products/weather-climate-models/global-ensemble-forecast.

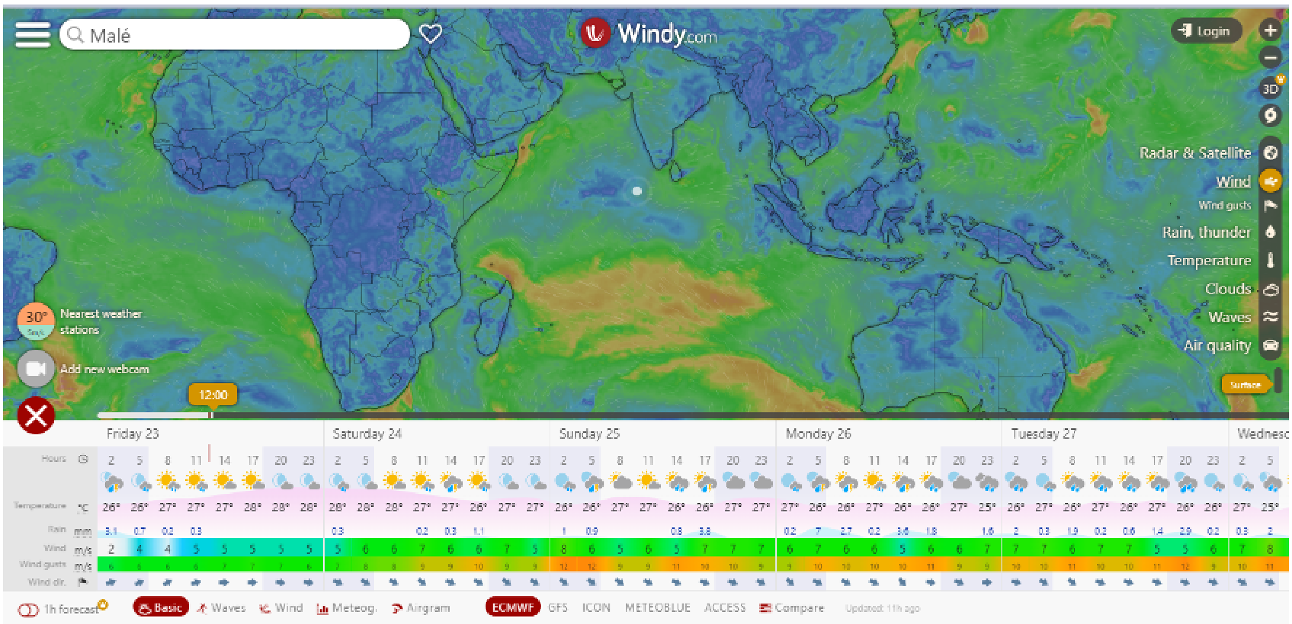


Figure VII.13.

Source: Windy; see https://www.windy.com.

Seasonal

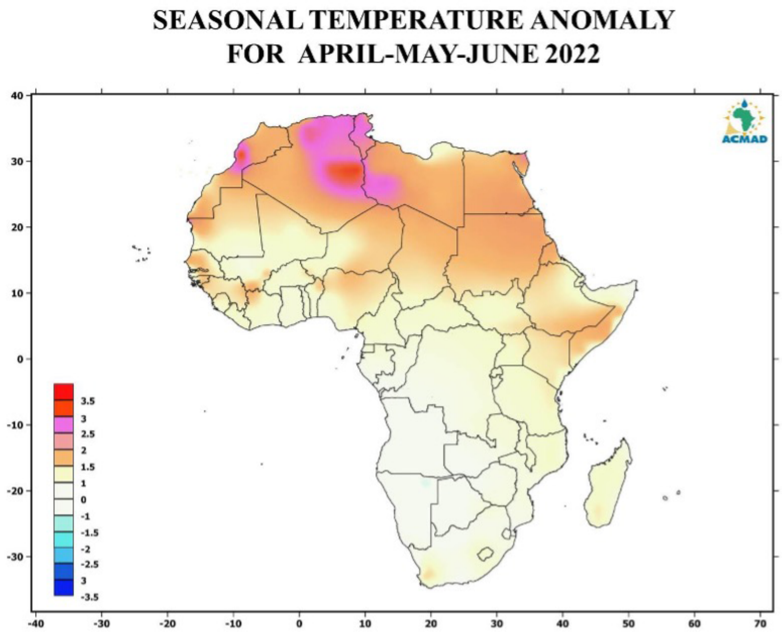


Figure VII.14.

Source: Regional Climate Centres, World Meteorological Organization; see https://public.wmo.int/en/our-mandate/climate/regional-climate-centres.

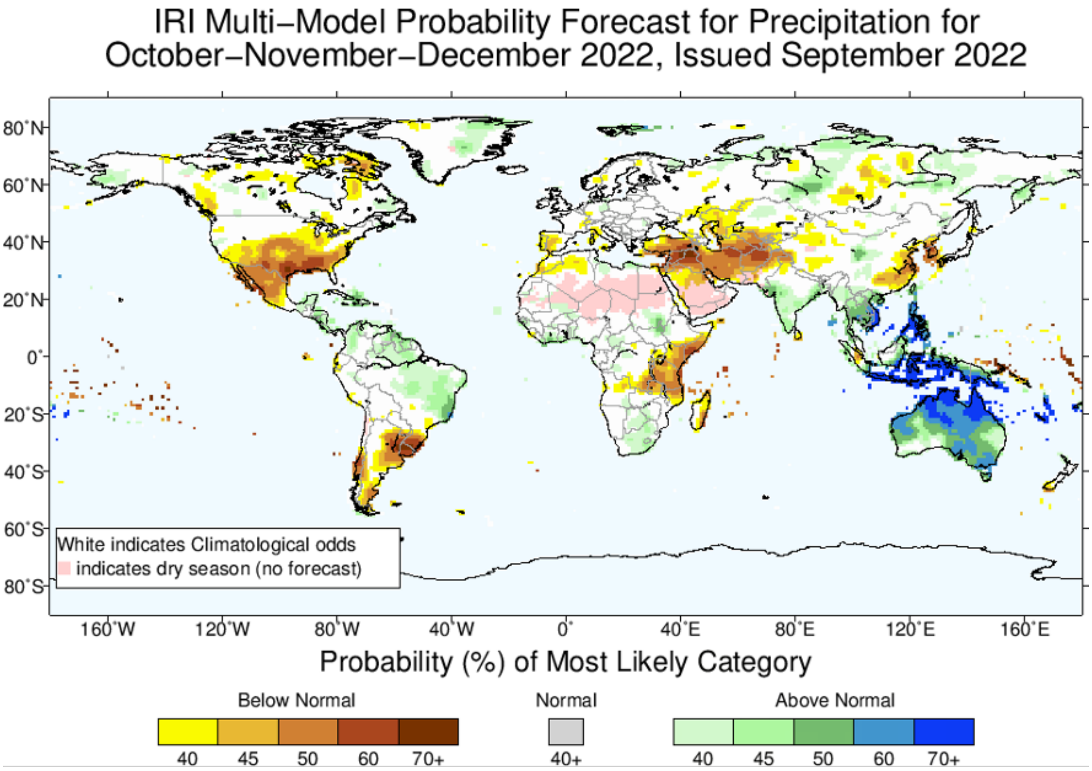


Figure VII.15.

Source: Seasonal Climate Forecast, International Research Institute for Climate and Society; see https://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate- forecasts/.

Figure VII.16.

Source: Regional Climate Outlook Forums, World Meteorological Organization; see https://public.wmo.int/en/our-mandate/climate/regional-climate-outlook-products.

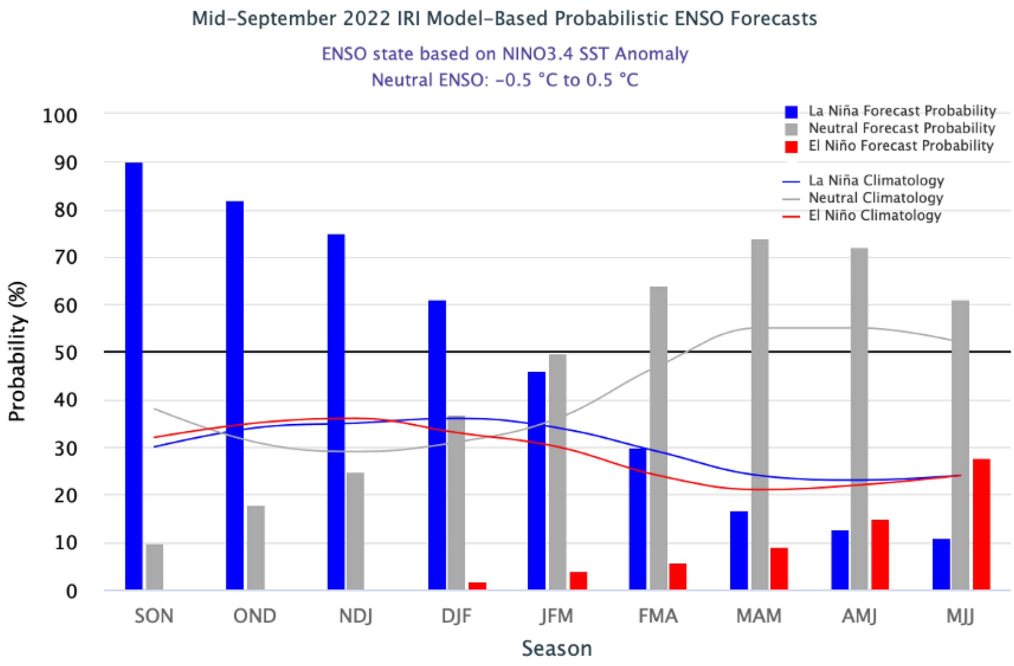


Figure VII.17.

Source: ENSO Forecast, International Research Institute for Climate and Society; see https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/.

Annex VIII: Resources and tools

Relevant resources and tools have been categorized by step. This list of existing resources is not exhaustive and there are repetitions since many resources are relevant. The user is invited to use this supplement in conjunction with other resources as needed.

Table 8: United Nations Office for Disaster Risk Reduction technical resources

Publication year	Title	Main focus (key messages)	Source (link)
2022	Technical guidance on comprehensive risk assessment and planning in the context of climate change	The document offers a framework on how to apply comprehensive risk assessment and planning. It acknowledges that risks in the context of climate change are complex and systemic due to non-linear interactions among system components and the need for improved risk governance. The guidance can be contextualized to national and local needs.	https://www.undrr.org/publication/technical-guidance-comprehensive-risk-assessment-and-planning-context-climate-change
2021	**Promoting Synergy and Alignment:** Between Climate Change Adaptation and Disaster Risk Reduction in the Context of National Adaptation Plans	This publication is a supplement to the UNFCCC NAP Technical Guidelines. The supplement focuses particularly on the opportunities that the NAP process provides to national authorities and stakeholders for integrating risk-centred approaches and in creating synergies and effective connections with DRR efforts. It should be used in conjunction with the NAP guidelines as it uses the four elements outlined in that document as its basis.	https://bit.ly/DRR4NAP
2019	**Words into Action Guidelines:** Developing National Disaster Risk Reduction Strategies	These guidelines are designed to support countries in developing a national DRR strategy that is aligned with the SFDRR. They complement the "Words into Action implementation guide for local DRR and resilience strategies". Together, these documents they form the basis for achievement of target E, which calls to substantially increase the number of countries with national and local DRR strategies. It also contains a practical 10-step approach to the development or revision of an inclusive national DRR strategy that is adaptable to country-specific contexts.	https://www.undrr.org/publication/words-action-guidelines-developing-national-disaster-risk-reduction-strategies

Publication year	Title	Main focus (key messages)	Source (link)
2019	**Words into Action guidelines:** Implementation guide for local disaster risk reduction and resilience strategies	The aim of this guidebook is to advise local governments (authorities, planners and managers at the city or other subnational levels) on developing and implementing a holistic and integrated local DRR strategy that contributes to building resilience at the local scale and that accommodates national strategies whenever they are in place. It outlines what a local DRR and resilience strategy should look like and what is needed to create and implement one. Local strategies, while aligned with their national counterparts, are generally more specific. They reflect the local context and hazard profile and tend to concentrate on the planning and implementation phases, clearly assigning roles and responsibilities at the subnational level.	https://www.undrr.org/publication/words-action-guidelines-implementation-guide-local-disaster-risk-reduction-and
2021	**Words into Action:** Nature-based solutions for disaster risk reduction	Cheap, effective and scalable, nature-based solutions can help governments address the growing challenges of climate change, biodiversity loss, increased frequency of extreme weather and natural hazards, as well as other human-made environmental disasters. The guide offers practical, expert-informed guidance on setting up and implementing nature-based solutions, especially for DRR, but also for CCA.	https://www.undrr.org/words-action-nature-based-solutions-disaster-risk-reduction
2020	**Integrating Disaster Risk Reduction and Climate Change Adaptation in the UN Sustainable Development Cooperation Framework:** Guidance Note on Using Climate and Disaster Risk Management to Help Build Resilient Societies	This document helps United Nations Country Teams in formulating and implementing cooperation frameworks that support countries, communities and people in using climate and disaster risk management approaches to build disaster resilience. It outlines the impacts of climate and disaster risks on progress towards achieving the Sustainable Development Goals (SDGs) and suggests appropriate actions for each phase in the United Nations Sustainable Development Cooperation Framework lifecycle to make them risk-informed.	https://www.undrr.org/publication/integrating-disaster-risk-reduction-and-climate-change-adaptation-un-sustainable

Publication year	Title	Main focus (key messages)	Source (link)
2017	**Words into Action guidelines:** National Risk Assessment	These guidelines focus on SFDRR's first Priority for Action: Understanding Disaster Risk. The Guidelines are intended to: (a) Motivate and guide countries in establishing a national system for understanding disaster risk that would act as the central repository of all publicly available risk information. This national system would lead the implementation and updates of national disaster risk assessment for use in disaster risk management, including for risk-informed DRR strategies and development plans; (b) Encourage national disaster risk assessment leaders and implementing entities to aim for holistic assessments that would provide an understanding of the many different dimensions of disaster risk (hazards, exposures, vulnerabilities, capacities). The assessments would include diverse types of direct and indirect impacts of disaster – such as physical, social, economic, environmental and institutional. They would also provide information on the underlying drivers of risk – such as climate change, poverty, inequality, weak governance and unchecked urban expansion.	https://www.preventionweb.net/publications/view/52828
2020	Guidance Note on Using the Probabilistic Country Risk Profiles for Disaster Risk Management	The country risk profiles improve the understanding of risk at the national and subnational levels by providing quantifiable data on economic and population disaster impacts. They can be an important tool for informing disaster management actions already in place or, used as a first step towards designing new actions to curb the deadly cost of disasters." This guidance "outlines a number of practical applications, aiming to promote the use of probabilistic risk information.	https://www.undrr.org/publication/guidance-note-using-probabilistic-country-risk-profiles-disaster-risk-management
2017	**Words into Action Guidelines:** National focal points for disaster risk reduction, national platforms for disaster risk reduction, local platforms for disaster risk reduction	This document provides guidance on National Focal Points for the SFDRR 2015–2030 and on the establishment or strengthening of National and Local Platforms for DRR. It also describes the link between global, national, regional and local Platforms for DRR.	https://www.undrr.org/publication/words-action-guidelines-national-focal-points-disaster-risk-reduction-national

Table 9: Technical resources from other organizations

Organization	Publication year	Title	Main focus (key messages)	Source (link)
NAP Global Network			The NAP Global Network facilitates sustained peer learning and exchange on the NAP process and NAP implementation through activities such as targeted topics forums, peer learning summits and a South-South peer exchange programme.	https://napglobalnetwork.org/activities/
Capacity for Disaster Reduction Initiative (CADRI)		CADRI Tool	The CADRI Tool, which is being updated to encompass climate and disaster risks, facilitates development of national plans for capacity development in DRR; accelerate legislative, institutional and policy change; enhance awareness of DRR and CCA across sectors; and increase coherence in United Nations programmes.	https://www.cadri.net/
CGIAR		CGIAR Research Program on Climate Change, Agriculture and Food Security	Lessons learned from the CGIAR programme "Climate information services in agriculture".	https://ccafs.cgiar.org/
WMO		Climate Information Portal		https://climateinformation.org/
Red Cross/ Red Crescent Climate Centre	2013	Minimum Standards for local climate-smart disaster risk reduction (Red Cross/ Red Crescent Climate Centre, The Hague, The Netherlands)	The Minimum Standards are intended to be a bridge between national climate policy and local capacity for DRR. They are practical approaches, achievable by communities with relatively few external resources, and national actors can use them to incorporate community action into national-level adaptation. The guidance is also available in Arabic, French and Spanish. "Interactive posters" to apply the Minimum Standards in workshops are available here.	https://www.climatecentre.org/wp-content/uploads/Minimum-Standards-for-climate-smart-DRR-2.0-NOV-2013.pdf

Organization	Publication year	Title	Main focus (key messages)	Source (link)
Global Network of Civil Society Organisations for Disaster Recuction	2019	**Coherence cookbook:** Building resilience in an integrated way	This cookbook presents a series of recipes for building coherence, and highlights the important role civil society organizations play in this process. The recipes are adapted from case studies from a wide range of localities around the world. It is packed with key ingredients and recipes for coherent action in DRR, CCA and sustainable development.	https://reliefweb.int/report/world/coherence-cookbook-building-resilience-integrated-way
European Union	2010	**European Union Commission Staff Working Paper: R**isk Assessment and Mapping Guidelines for Disaster Management	The guidelines are mainly addressed to national authorities and other actors interested in the elaboration of national risk assessments, including regional and local authorities involved in cross border cooperation. The focus of these guidelines is on the processes and methods of national risk assessments and mapping in the prevention, preparedness and planning stages, as carried out within the broader framework of disaster risk management. They are based on a multi-hazard and multi-risk approach. They cover in principle all natural and man-made disasters both within and outside the European Union, but excluding armed conflicts and threat assessments on terrorism and other malicious threats.	https://climate-adapt.eea.europa.eu/metadata/guidances/eu-commission-staff-working-paper-risk-assessment-and-mapping-guidelines-for-disaster-management
Deutsche Gesellschaft für Internationale Zusammenarbeit	2017	**Climate Change Policy Brief:** Synergies in monitoring the implementation of the Paris Agreement, the SDGs and the Sendai Framework	Opportunities and limits of connecting the monitoring of the implementation of the Paris Agreement, the SDGs and the SFDRR are explored. The policy brief provides recommendations for complementary national and lobal monitoring and reporting towards their objectives in regard to adaptation to climate change.	https://www.adaptationcommunity.net/wp-content/uploads/2017/11/giz2017-en-cc-policy-brief-synergies-PA_SDG_SF.pdf

Organization	Publication year	Title	Main focus (key messages)	Source (link)
Organization for Economic Cooperation and Development	2020	**Common Ground Between the Paris Agreement and the Sendai Framework:** Climate Change Adaptation and Disaster Risk Reduction	Countries are faced with the growing challenge of managing increasing risks from climate change and climate variability, putting development and the achievement of the SDGs at risk. The adoption in 2015 of the SFDRR and the Paris Agreement on climate change provides a clear mandate for increased coherence in countries' approaches to climate and DRR. Countries increasingly recognize the benefits of improved coherence between the two policy areas, exemplified by the number of countries that either have developed joint strategies or put in place processes that facilitate coordination. Informed by the country approaches of Ghana, Peru and the Philippines, in addition to a review of relevant literature, this report examines the potential for increased coherence in approaches to CCA and DRR across levels of government and sectors. It identifies ways in which government officials, development cooperation and other stakeholders can support efforts to further enhance coherence between the two policy areas, not only in the three case study countries, but also those in other countries as well as providers of development cooperation.	https://www.oecd-ilibrary.org/sites/3edc8d09-en/index.html?itemId=/content/publication/3edc8d09-en
United Nations Development Programme	2021	Risk-Informed Development: A Strategy Tool for Integrating Disaster Risk Reduction and Climate Change Adaptation into Development	This strategy tool addresses repeated calls for practical guidance on integrating both disaster and climate-related risks into development, and an approach that helps overcome policy silos and fosters joined-up implementation and localization. It is a contribution to risk-informing the 2030 Agenda and risk-proofing development investments in United Nations Development Programme countries. The tool emphasized the importance to establish links to other types of risks, thus acknowledging the multi-dimensionality of risk.	https://www.undp.org/publications/risk-informed-development-strategy-tool-integrating-disaster-risk-reduction-and-climate-change-adaptation-development

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