INFORMATION SOURCES
TO SUPPORT ADB CLIMATE
RISK ASSESSMENTS
AND MANAGEMENT

TECHNICAL NOTE

SEPTEMBER 2018
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## Abbreviations

| Abbreviation | Description |
|--------------|-------------|
| CCKP         | Climate Change Knowledge Portal (of the World Bank) |
| CMIP         | Coupled Model Intercomparison Project (number that follows is the phase) |
| CORDEX       | Coordinated Regional Climate Downscaling Experiment |
| CRA          | climate risk assessment |
| CRMF         | Climate Risk Management Framework |
| EM-DAT       | Emergency Events Database |
| ENSO         | El Niño Southern Oscillation |
| ESRL         | Earth System Research Laboratory |
| GCM          | Global Climate Model |
| GDP          | gross domestic product |
| GHG          | greenhouse gas |
| GIS          | geographic information system |
| GSOD         | Global Summary of the Day |
| IPCC         | Intergovernmental Panel on Climate Change |
| km           | kilometer |
| M&E          | monitoring and evaluation |
| NCEP         | National Centers for Environmental Prediction |
| NDC          | Nationally Determined Contribution |
| ND-GAIN      | Notre Dame Global Adaptation Initiative |
| PET          | potential evapotranspiration |
| RCCAP        | Regional Climate Consortium for Asia and the Pacific |
| RCM          | Regional Climate Model |
| SDG          | Sustainable Development Goal |
| SDSM         | Statistical Downscaling Model |
| SST          | sea surface temperature |
| TRMM         | Tropical Rainfall Monitoring Mission |
| USAID        | United States Agency for International Development |
| WASH         | water, sanitation, and hygiene |
| WMO          | World Meteorological Organization |
Executive Summary

This technical note is intended to support climate risk assessment (CRA) experts, in particular, those undertaking the early stages of project development. Time and resources could be saved by attaching this document to terms of reference issued to CRA consultants. However, there is a limit to which globally accessible, open source data can meet the detailed information needs of local adaptation projects. This note supplements rather than replaces efforts to gather relevant climate information from government agencies and counterparts, especially during the project concept phase.

About 70 sources of public information have been compiled for the Asia and Pacific region, including data on historical and future climate, climate-related disasters, indicators of national vulnerability, and preparedness to adapt. Additional resources produced by ADB are also incorporated. This is a living document—appendixes should be periodically refreshed as new information is located and quality assured. Data sources are collated in four appendixes that broadly map to successive phases of the ADB Climate Risk Management Framework. The appendixes cover:

(i) national emissions, climate vulnerability, risks, and impacts;
(ii) historic weather, climate, and environmental change;
(iii) multidecadal, regional climate change projections; and
(iv) climate change impacts and adaptation.

Most of the data identified are contextual—they provide high-level information about present and future climate risks at national and/or sector levels. Additional capacity development may be required in specialist “gatekeeping” skills, such as geographic information systems, data homogeneity testing, post-processing research data formats (e.g., NetCDF), regional climate downscaling, and impact assessment. By growing these technical capabilities, more data could be accessed from the same public platforms or combined in ways that add value to the CRA.

As well as strengthening the technical capacities of local consultants and CRA experts, access to existing research-grade data stores should be improved through closer cooperation with scientific programs. For example, new interfaces could be developed to open research archives to a broader user base. In particular, there is an urgent need to widen access to the daily and sub-daily climate information needed for economic analysis, engineering design standards, stress-testing adaptation options, and other aspects of project design.
Large parts of the Asia and Pacific region are scarce in both the climate and socioeconomic information required for robust CRA—in particular, for high-elevation and physically remote locations. Remotely-sensed and reanalysis products certainly improve coverage, but the accuracy of these assets ultimately depends on high-quality observing networks. Therefore, ADB, other multilateral development banks, and partner agencies should continue to invest in programs that strengthen national monitoring systems for climate and environmental change. Open access to such long-term records is invaluable for detecting emergent risks and devising, then implementing, effective adaptation measures.
Introduction

The Asia and Pacific region is vulnerable to temperature extremes, and flooding by heavy rainfall, sea level rise, and tropical cyclones (Asian Development Bank [ADB] 2017). Risks from climate change are further amplified by the pace of population growth and rapid development of urban areas. Both trends are concentrating people and assets in places that are potentially exposed to climate threats. Climate change also has implications for food, water, and energy security; migration; and the stability of trade networks in the region.

To counter these risks, ADB has made a commitment to provide $6 billion of climate financing per year by 2020, of which $2 billion will be allocated for adaptation.

Due diligence requires that adaptation finance is invested in projects that deliver intended benefits at the least cost. The Midterm Review of Strategy 2020 (ADB, 2014a) sets out a vision for mainstreaming adaptation and climate resilience in development planning, project design, and implementation. Subsequently, the ADB Strategy, Policy, and Review Department introduced mandatory screening of ADB infrastructure projects to identify those at high or medium risk of being adversely affected by climate change. At-risk projects must be “climate-proofed” to make them resilient to identified climate change impacts.

The process of adapting to climate change can be highly data-intensive (IPCC-TGICA 2007; Weaver et al. 2013; Wilby et al. 2009). Contextual information is needed for preliminary risk screening and to identify socioeconomic factors that define adaptive capacities. Site-level data are required to establish baseline conditions for referencing climate change impacts and avoided damages, as well as for project monitoring and evaluation. Climate change scenarios are used with sector-specific impacts models to quantify expected risks and to evaluate the efficacy of adaptation measures. Alternative adaptation options must be prioritized based on their benefits and costs, as well as other criteria agreed with project partners.

Limited availability of contextual and climate information can present significant obstacles to climate risk assessments (CRAs). This bottleneck is particularly acute in data-sparse regions where even information about past climate trends and impacts may be difficult to obtain. However, improved access to remotely sensed (satellite) products, global climate (gridded) data, reanalysis products, and platforms for accessing country data help to fill some information gaps.

This technical note provides a compendium of open access resources that could assist experts carrying out CRAs. Where feasible, identified resources are mapped to the information needs of specific tasks within the CRA process.
Aims and Overall Approach

Four sector groupings account for the majority of ADB adaptation finance. These are:

(i) water and wastewater systems;
(ii) energy, transport, and other built environment infrastructure;
(iii) crop and food production; and
(iv) coastal and riverine infrastructure.

With these sectors in mind, this technical note aims to provide:

(i) tables of reputable sources of public data on climate, sea level, and historical climate-related disasters for the Asia and Pacific region, which could be accessed by experts carrying out CRAs (especially those working in data-sparse regions); and
(ii) commentary on the points at which these data might be brought into the ADB Climate Risk Management Framework (CRMF) (ADB 2014b) and economic analysis (ADB 2015).

The above aims were addressed by systematically appraising the information needs of CRA experts following all 20 steps of the ADB CRMF. Potential sources of data were assigned to one of four categories:

(i) contextual information about historic greenhouse gas (GHG) emissions, climate vulnerability, risks, and impacts;
(ii) historic information on climate variability and change;
(iii) projections of multidecadal climate change;
(iv) information about future climate change impacts and major completed or ongoing adaptation projects.

In each case, a brief description is provided along with an outline of the advantages and disadvantages of the information.

This technical note begins with a list of some ADB resources that support CRAs, then an overview of the key entry points for data input within the ADB CRMF. These elements are followed by sections on each of the four categories of information, including example resources and their application. The note closes with a few suggestions for strengthening ADB’s capacities in data retrieval and analysis.
ADB Resources to Support Climate Risk Assessments

ADB has developed a range of guidelines to raise awareness of climate hazards and to improve the climate resilience of projects (Table 1). The complete ADB archive is searchable by publication type, country, subject, language, and publication date. Climate-related sector guidelines are available for agriculture, energy, transport, and water. Cross-sector guidance is provided for economic analysis of adaptation options, strengthening resilience through social protection programs, evaluation of natural hazards, and disaster risk assessment.

In addition to the resources listed in Table 1, ADB (ADB 2016a) provides a catalog of other climate-related publications up to 2016. This includes case studies of climate change impacts and options for increasing resilience of water infrastructure (ADB 2011; ADB 2013a); a review of the vulnerability and adaptation options available to the electric power sector (ADB 2012); country and sector studies of the economic costs and benefits of actions on climate change in South Asia (Ahmed and Suphachalasai 2014); a methodology and lessons learned from an assessment of vulnerability and adaptation options in the Greater Mekong Subregion (ADB 2014c); and examples of technologies that can be used to address climate change across six sectors (agriculture, coastal resources, human health, transportation, water resources, and disaster risk management) (ADB 2014d).

ADB technical assistance reports may also provide useful contextual information and examples of economic analysis of climate change adaptation. These documents are also available through the ADB archive.
### Table 1: ADB Guidance Relevant to Climate Risk Assessment for Project Preparation

| Resource                                                                 | Description                                                                                                                                                                                                            |
|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| **Strengthening Resilience through Social Protection Programs: Guidance Note. March 2018.** | Underscores the importance of strengthening climate change and disaster resilience through social protection programs and proposes a working framework for social protection programs to deliver on resilience outcomes |
| **Disaster Risk Management and Country Partnership Strategies: A Practical Guide. November 2017.** | Provides technical advice on the integration of disaster risk management considerations in ADB country partnership strategy preparation                                                                                   |
| **Disaster Risk Assessment for Project Preparation: A Practical Guide. November 2017.** | Provides technical advice on disaster risk assessment to facilitate the consideration of disaster risks in the design of development projects                                                                                 |
| **Natural Hazard Data: A Practical Guide. November 2017.** | Assists ADB project officers in understanding natural hazards, hazard mapping, disaster risk assessments, and in taking disaster risk into account in project design                                                       |
| **Guidelines for Climate Proofing Investment in the Water Sector: Water Supply and Sanitation. December 2016.** | Assists project teams in managing climate change risk in the context of water supply and sanitation investment projects                                                                                            |
| **Economic Analysis of Climate-Proofing Investment Projects. September 2015.** | Describes the conduct of cost–benefit analysis of climate-proofing investment projects                                                                                                                                  |
| **Climate-Proofing ADB Investment in the Transport Sector: Initial Experience. December 2014.** | Describes investments in the transport sector vulnerable to increased sea level and expected changes in the frequency and intensity of extreme weather events                                                                     |
| **Guidelines for Climate-Proofing Investment in the Energy Sector. May 2013.** | Provides a step-by-step methodological approach to help project teams assess climate change adaptation measures to energy investment projects                                                                               |
| **Guidelines for Climate-Proofing Investment in Agriculture, Rural Development, and Food Security. November 2012.** | Provides a methodological approach to assist project teams in assessing and incorporating climate change adaptation measures into investment projects in agriculture, rural development, and food security |
| **Climate-Proofing ADB Investments in the Transport Sector: Road Infrastructure Projects. October 2011.** | Provides a step-by-step methodological approach to assist project teams to incorporate climate change adaptation measures into transport sector investment projects                                                                |

Source: ADB archive.
The ADB CRMF helps to identify climate-related risks to investments in the early stages of project development, and to thereby incorporate cost-effective countermeasures in the final project design. This is a top-down, scenario-led, 20-step process with five phases of activity: (i) climate risk screening, (ii) climate risk assessment, (iii) adaptation assessment, (iv) implementation arrangements, and (v) monitoring and evaluation (Figure 1). All phases require data with the exception of implementation arrangements (although even in this case, there may be planned activities to strengthen the information base as an outcome of the project). The following sections outline how the information requirements of these phases may be met (in part) by public data sources (Table 2). More specific examples of resources are given in later sections.

**Climate risk screening (steps 1 to 5).** For this, there is a need for up-to-date contextual information on existing climate hazards and climate change parameters most relevant to the project development and operational lifetime. International databases on climate-related disasters or hazards, along with national indicators of climate vulnerability and human development, or national plans of action can all set the scene (Appendix 1). Global gridded climate data sets can help to fill gaps in national coverage (Appendix 2). Background data on specific climate-related threats (e.g., floods, fires, drought, and dust) can be gathered too. Time and resources could be saved by attaching lists of approved information sources (e.g., Appendixes 1 to 4 of this technical note) to the terms of reference issued to CRA consultants (step 5).
Figure 1: Steps in the Climate Risk Management of Investment Projects

| Project Concept Phase | Project Preparation Phase | Project Implementation Phase | Monitoring and Evaluation |
|-----------------------|---------------------------|-----------------------------|--------------------------|
| **CLIMATE RISK SCREENING** | **CLIMATE RISK ASSESSMENT** | **IMPLEMENTATION ARRANGEMENTS** | **MONITORING AND EVALUATION** |
| STEP 1: Preliminary climate risk screening | STEP 6: Identify climatic vulnerability of project components | STEP 17: Establish arrangements for implementation | STEP 19: Design monitoring and evaluation plan, including suitable performance indicators |
| STEP 2: Detailed climate risk screening | STEP 7: Identify biophysical drivers of vulnerability | STEP 18: Identify needs for technical and capacity building | STEP 20: Feedback into policy-making and knowledge management processes |
| STEP 3: Survey existing information and knowledge | STEP 8: Identify socioeconomic drivers of vulnerability | | |
| STEP 4: Identify data needs and required expertise | STEP 9: Develop appropriate climate change scenarios | | |
| STEP 5: Prepare terms of reference for CRVA | STEP 10: Estimate future biophysical impacts | | |
| | STEP 11: Assess impacts on investment project | | |
| | | | |
| | **ADAPTATION ASSESSMENT** | | |
| | STEP 12: Establish the adaptation objective | | |
| | STEP 13: Identify all potential adaptation options | | |
| | STEP 14: Conduct consultation | | |
| | STEP 15: Conduct economic analysis of adaptation options | | |
| | STEP 16: Prioritize and select adaptation option(s) | | |
| | | | |
| | **IMPLEMENTATION ARRANGEMENTS** | | |
| | STEP 17: Establish arrangements for implementation | | |
| | STEP 18: Identify needs for technical and capacity building | | |
| | | | |
| | **MONITORING AND EVALUATION** | | |
| | STEP 19: Design monitoring and evaluation plan, including suitable performance indicators | | |
| | STEP 20: Feedback into policy-making and knowledge management processes | | |

CRVA = climate risk and vulnerability assessment.

Source: ADB. 2015. Economic Analysis of Climate-Proofing Investment Projects. Manila, Philippines.
Climate risk assessment (steps 6 to 11). This phase requires project-specific data to determine the vulnerability of project components to changing climate conditions (step 6). However, national indicators (with their constituent scores) can help to situate the project alongside long-term socioeconomic drivers of climate vulnerability and readiness to adapt (e.g., Notre Dame Global Adaptation Initiative [ND-GAIN] Country Index, Appendix 1). Development of appropriate climate change scenarios can be extremely time-consuming and data-intensive depending on the level of detail needed to evaluate potential biophysical impacts and economic costs and benefits. Bespoke scenarios may be created for the project via a range of statistical downscaling techniques fit to available climatic data (Appendix 2). Alternatively, existing high-resolution climate change scenarios can be accessed via online weather generators (e.g., MarkSim), regional (e.g., Coordinated Regional Climate Downscaling Experiment [CORDEX], Regional Climate Consortium for Asia and the Pacific [RCCAP]), or global (e.g., Intergovernmental Panel on Climate Change [IPCC]) model archives (Appendix 3). With all these scenarios, care should always be taken to avoid mistaking increased precision for accuracy.

### Table 2: Tasks and Resources Required to Complete Each Step in the ADB Climate Risk Management Framework

| Step | Tasks | Requirements | Resources |
|------|-------|--------------|-----------|
| 1    | Preliminary risk screening | “...expert opinion and judgment, based on awareness and knowledge of climate change and hazards” (p. 17) | Appendix 1 |
| 2    | Detailed risk screening | “Projects identified to be at medium or high risk undergo a further and more detailed screening” (p. 20) | AWARE™ for projects |
| 3    | Survey existing information and knowledge | “Identifying existing available information can help to avoid duplication and ensure that coordination efforts within countries and between donors are being supported” (p. 23) | NAPAs, NDCs, Appendix 1 |
| 4    | Identify data needs and required expertise | “A preliminary identification of all climate change parameters most relevant to the project should be initiated during the project concept phase” (p. 25) | Appendix 2 |
| 5    | Prepare terms of reference for the CRA | “Collect all relevant climate change data from government ministries and international and community organizations... [and analyze] raw and observational data of current practices to compensate for vulnerability” (pp. 95–98) | Attach Appendixes 1 to 4 |
| 6    | Identify vulnerability of project components | “...information gathered during a vulnerability assessment may include local experiences related to shifting precipitation patterns and water availability, effects of warming on vegetative health, incidence of extreme climate events, such as floods, and melting of permafrost” (p. 33) | Project-specific data |

continued on next page
| Step | Tasks                                      | Requirements                                                                 | Resources          |
|------|--------------------------------------------|-----------------------------------------------------------------------------|--------------------|
| 7    | Identify biophysical drivers of vulnerability | “Using geographic information system (GIS), it is possible to map areas that are particularly vulnerable to a combination of local conditions and climate variability” (p. 34) | Remotely sensed data |
| 8    | Identify socioeconomic drivers of vulnerability | “It is useful at this stage to identify those socioeconomic factors that influence adaptive capacities” (p. 34) | Appendix 1         |
| 9    | Develop appropriate climate change scenarios | “The construction of climate change scenarios begins with an understanding of which climate variables are likely to affect the project, including both the integrity of project components and project outputs” (p. 36) | Appendix 2         |
|      |                                            | “…analysis of historical data helps to identify trends in the main climate variables and also allows for the ground-truthing of the simulation results from climate models” (p. 38) | Appendix 3         |
| 10   | Estimate future biophysical impacts         | “Once climate change scenarios have been constructed, key relationships between changes in climate parameters—such as average temperature, average precipitation, temperature and precipitation extremes, sea-level rise, and storm surges—and impacts… must be quantified” (p. 48) | Impact models      |
| 11   | Assess impacts on investment projects      | “Provide information on the impacts of projected climate change on the project’s performance and outputs, and, where appropriate, to transform the quantification of these impacts into economic costs and/or benefits” (p. 49) | Project-specific economic data Appendix 3 |
| 12   | Establish the adaptation objective         | “The adaptation-related activities should seek to minimize the potential negative effects” (p. 51) | Partner consultations |
| 13   | Identify all potential adaptation options  | “Based on an understanding of the project’s vulnerability to climate change, the project team will have to identify a range of technically feasible adaptation options to reduce climate risk to the project” (p. 51) | Partner consultations Appendix 4 |

*Table 2 continued on next page*
| Step | Tasks | Requirements | Resources |
|------|-------|--------------|-----------|
| 14   | Conduct consultations | “Conducting roundtable consultations provides useful input for identifying and appraising the whole range of adaptation options... Options must be scientifically sound, socially beneficial, and economically viable” (p. 52) | Partner consultations Appendix 4 |
| 15   | Conduct economic analysis | “…the costs and benefits of the climate-proofing options must be assessed by identifying and quantifying the climate change impacts along two scenarios: Scenario without climate proofing... Scenario with climate proofing” (p. 53) | Discount rate Incremental costs of adaptation options Appendix 3 |
| 16   | Prioritize and select adaptation options | “…prioritization can be based on an assessment of their technical feasibility, their benefits and costs, their social acceptability, and the opportunities they may offer for synergies with national priorities” (p. 60) | Partner consultations Multicriteria analysis |
| 17   | Establishing arrangements for implementation | “A lead organization should be selected to implement the adaptation measures” (p. 64) | M&E framework |
| 18   | Identify needs for technical support and capacity building | “Provisions for training and capacity building will likely be needed for executing agencies, partner institutes, local communities, project management units, and contractors” (p. 65) | Needs assessment |
| 19   | Design monitoring and evaluation plan including suitable performance indicators | “There are some challenges in developing M&E indicators, including the long-term nature of actual climate change, the need to acquire appropriate baseline data and metrics for measuring vulnerability, and isolating vulnerability to climate change from other sources of pressure” (p. 67) | Indicators of project impacts, outcomes, and outputs Appendix 1 Appendix 2 |
| 20   | Feedback into policy-making and knowledge management processes | “Lessons from adaptation measures undertaken at a project level should inform policy makers about appropriate approaches at the sector and/or national levels” (p. 68) | Institutional frameworks and processes |

M&E = monitoring and evaluation, NAPA = National Adaptation Programme of Action, NDC = Nationally Determined Contribution.

Source: ADB. 2016. *Guidelines for Climate-Proofing Investment in the Water Sector: Water Supply and Sanitation*. Manila, Philippines.
Adaptation assessment (steps 12 to 16). The value added by this phase of activity largely rests on the quality of consultation and level of engagement with project partners when identifying potential adaptation options. Lessons about “successful adaptation” processes can be exchanged through knowledge sharing platforms, regional networks, and case study catalogs (e.g., Asia-Pacific Network for Global Change Research, Appendix 4). However, adaptation outcomes may not be realized for decades and, even then, reliable counterfactuals may be hard to find (Moser and Boykoff, 2013). Nonetheless, the ADB CRMF requires that incremental benefits and costs of various adaptation options are established through economic analysis (step 15). Hence, climate scenarios are needed to assess the economic consequences of the project with or without climate change and with or without adaptations.

Monitoring and evaluation (steps 19 to 20). Reliable baseline data and long-term, post-project monitoring are needed to evaluate investment impacts, outcomes, and outputs. Scope for developing meaningful performance indicators is partly constrained by available baseline socioeconomic and climate information (Appendixes 1 and 2). The recurrent costs of long-term data collection must also be considered when setting up monitoring and evaluation frameworks. Ultimately, the intention is to use such evidence to share learning about what mix of adaptation measures work best, where, and when. Monitoring may also be needed to trigger measures at various points along planned adaptation pathways (e.g., rising sea levels as a stimulus for progressive raising and/or relocating of port infrastructure). Haasnoot et al. (2013) and Ranger et al. (2013) have other examples of adaptation pathways.
Appendix 1 provides various sources of contextual information, including for existing climate-related hazards, disaster impacts, development indicators, socioeconomic vulnerability, and readiness to adapt to climate change.

Many of the global databases listed provide national annual statistics; hence, any regional and/or sub-annual variations can be obscured. For example, the Emergency Events Database (EM-DAT) is a global archive of mass disasters since 1900, searchable by country, cause, and impact (Figure 2). National summary sheets and dashboards of climate risks are also widely available (e.g., World Bank Climate Change Knowledge Portal), but generic outputs should always be sanity-checked using local knowledge. In Figure 3, Tajikistan is entirely landlocked, so cannot be at a “very low” risk of coastal flooding, whereas Metropolitan Manila has more than a “very low” risk of coastal flooding. Other sources give data on individual disaster losses and areas affected (e.g., DesInventar Sedai, or Dartmouth Flood Observatory), but the precise definition of events may not always be clear.

Aqua Monitor gives a global view of land-to-water and water-to-land conversions over the period 1985–2016 (Donchyts et al. 2016).
Figure 2: National Exposures to Drought and Extreme Temperatures 1986–2015

Source: Centre for Research on the Epidemiology of Disasters. Emergency Events Database.
Figure 3: Need for Careful Use of Hazards Dashboards Shown by Outputs for Tajikistan and Metropolitan Manila, Philippines

Source: ThinkHazard.
National socioeconomic and composite vulnerability indicators are widely available as raw annual statistics that can be downloaded for post-processing and analysis (Figure 4). Much information is collected and distributed via the agencies of the United Nations, including for reporting against Sustainable Development Goals (e.g., Joint Monitoring Programme) or emissions targets (e.g., ClimateWatch). Some indicators give useful contextual information on underlying drivers of climate risk, such as high dependency on imported food (Figure 4) (d’Amour et al., 2016). Project-level information on low-carbon development and monitoring is available through the database of the Clean Development Mechanism.

Remotely sensed physical features and hazards are increasingly available, both historically and in near real-time at subnational scales. For instance, the World Glacier Monitoring Service issues periodic bulletins on changing ice thickness, area, length and mass balance (Figure 5). Terra/MODIS satellite imagery shows distributions of wildfires (Figure 6, left, at 1-kilometer [km] resolution) and dust storms (Figure 6, right, at 2 km resolution). In Figure 6, Terra/MODIS thermal imagery shows extensive forest fires across Borneo and Indonesia on 23 October 2015 at 15:05–15:10 UTC (left). The path of the satellite and central points of tiles are also shown. Terra/MODIS aerosol optical depth reveals the severe dust storms that impacted Beijing and northern People’s Republic of China on 4 May 2017 (right). Satellite
data are available in a range of formats that can be interrogated by GIS to extract local information relevant to the project. Historic data—whether on the properties of glaciers or climate-related hazards (such as fires and dust storms)—provide baselines for evaluating future threats to a project.

**Figure 5: Changes in the Front and Mass Balance of the Abramov Glacier, Kyrgyz Republic**

![Figure 5: Changes in the Front and Mass Balance of the Abramov Glacier, Kyrgyz Republic](image)

Source: World Glacier Monitoring Service.

**Figure 6: Terra/MODIS Satellite Imagery Showing Distributions of Wildfires and Dust Storms**

![Figure 6: Terra/MODIS Satellite Imagery Showing Distributions of Wildfires and Dust Storms](image)

Source: Terra/MODIS.
Appendix 2 lists sources of historic climate information for standard meteorological variables (such as temperature and precipitation over land areas), seasonal teleconnection patterns (such as for El Niño Southern Oscillation [ENSO]), remotely sensed variables (such as snow and ice cover), derived products (such as gridded weather data or reanalysis variables), and climate effects (on drought, food security, fire, and human health indicators). In each case, users should consider the temporal and spatial resolution of the various data sources in relation to the accuracy and precision required for the intended application.

Historic weather and climate data can be expensive to acquire or may be subject to strict licensing conditions. Sub-daily and daily hydrometeorological data are especially difficult to obtain from open sources and options may be particularly limited in data-sparse regions. The Global Summary of the Day (GSOD) is a searchable archive that provides access to daily variables for World Meteorological Organization (WMO) stations. However, records may be incomplete or contain unresolved quality issues so should always be checked carefully (Wilby et al. 2017). Sources of sub-daily weather data for selected sites in the Asia and Pacific region include RCCAP, Planet OS, and Weather Underground.

Other sub-daily and daily precipitation estimates can be obtained via the Giovanni portal for instruments, such as the Tropical Rainfall Monitoring Mission (TRMM). However, TRMM and other satellite-based precipitation estimates may be unreliable in mountainous, snow-covered regions, or near large water bodies, and where there are few land-based data for calibration (Karaseva et al. 2012; Yong et al. 2012; Dixon and Wilby 2016). A comprehensive evaluation of 30 global precipitation products showed that satellites tend to underestimate monsoon precipitation at high elevations in South Asia, and struggle to replicate observed frequencies of light and heavy rainfall in East Asia (Sun et al. 2018). Maps from the study show regional variations in systematic and random errors for satellite data.

Proxy daily weather variables can also be sourced from global reanalysis products, such as National Centers for Environmental Prediction (NCEP). These are essentially observed data from land, ocean, and satellite observations that have been assimilated by a climate model to create global coverage on a regular grid. Raw data are typically in NetCDF format, but some portals issue selected variables as TXT files from 1940s onward (e.g., SDSM).
Monthly precipitation and temperature series are readily available from several sources (e.g., Earth System Research Laboratory [ESRL], and The Royal Netherlands Meteorological Institute [KNMI] Climate Explorer). The CRU Google Earth Interface is an interactive tool for locating nearest weather stations or interpolated data at 0.5° grid resolution for the period 1901–2014 (as in Figure 7). Although the underlying station data have been quality assured, reliability of the interpolated estimates decreases in data-sparse and complex terrain (Harris et al. 2014). Accuracy and coverage also diminishes for earlier decades, with much lower station densities before the 1950s (Figure 8). More recent political instability and conflict can lead to gaps in data too (e.g., Aich et al. 2017).

**Figure 7: Annual Mean Temperature and Annual Precipitation Totals for the 0.5° Grid Nearest Bandar Seri Begawan, Brunei Darussalam (4.75°N, 114.75°E)**

Source: I. Harris et al. 2014. Updated High-Resolution Grids of Monthly Climatic Observations – the CRU TS3.10 Dataset. *International Journal of Climatology*. 34.

**Figure 8: Density of Active Weather Stations in June 1921**

Source: Global Climate Monitor.
The KNMI Climate Explorer gives access to a variety of gridded, monthly weather variables from land-based observations and reanalysis products (Table 3). The portal can aggregate data by country, point location, or user-specified domain and season. Output is available as TXT files, time-series plots, or maps (showing change between chosen periods, or as anomalies and averages over time, Figure 9). When selecting data, one product might be preferred over another depending on the amount of interpolation applied, spatial resolution or period covered.

Table 3: Monthly Variables Available through the KNMI Climate Explorer

| Variable            | Description                                                                                                                                 |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| GISTEMP 1200        | Relatively low-resolution (1,200 km interpolated) temperature data set, more accurate over large spatial (more than 1,000 km) and temporal (annual and longer) scales |
| NCDC MOST           | Less interpolated temperature data set with other homogeneities, 5° resolution                                                              |
| HadCRUT 4.2.0.0     | Temperature data set with most gaps, but with advanced sea surface temperature (SST) corrections; area averages are less accurate due to the missing data |
| CRU TS 4.00         | Fully interpolated temperature and precipitation data set with high resolution (0.5°); in areas without observations it gives climatology            |
| GPCCV7              | High-resolution reconstruction of precipitation; in areas without observations it gives climatology                                           |
| NCDC anomalies      | Low-resolution (5°) analysis with missing data                                                                                            |
| UCAR ds010          | Subjective reconstruction of mean sea level pressure based on old weather maps, Northern Hemisphere only                                      |
| HadSLP2r            | Low-resolution (5°) reconstruction of mean sea level pressure                                                                               |
| ERA-Interim         | Reanalysis of the state of the atmosphere over the satellite era, from 1979 to the present; uses all information available to reconstruct the weather and propagates this information using a high-resolution (~0.7°) weather model |
| ERA-20C             | Reanalysis of the state of the atmosphere over the period 1900–2010 at 125 km resolution; based only on SST and air pressure observations to make it as homogeneous as possible; fidelity to the historical weather depends on the number of observations in an area |
| 20C reanalysis      | As above but for the period 1871–2012 at 200 km resolution                                                                                  |

km = kilometer, KNMI = The Royal Netherlands Meteorological Institute. Source: KNMI Climate Explorer.
Other sources of monthly climate and environmental series include river flow, drought, and water balance indexes (e.g., CAWater-Info, Global Climate Monitor, Palmer Drought Severity Index, Gravity Recovery and Climate Experiment); snow, ice, and glacier properties (e.g., National Snow and Ice Data Center); long-term sea levels (e.g., Permanent Service for Mean Sea Level); wind and sea surface temperature (SST) indexes (e.g., NOAA Climate Prediction Center). Global layers of monthly climate and bioclimatic 30-year means are available via WorldClim.

The ESRL correlation portal is a versatile tool for identifying significant teleconnections between various SST and atmospheric indexes, and remote responses in regional climate variables—the basis for seasonal forecasting. The tool is also useful for extracting and interpreting signatures of seasonal climate variability in long-term climate records. For example, Figure 10 shows the well-known teleconnection between Pacific SSTs in autumn and precipitation in winter across Southeast Asia. When the Niño3.4 index is strongly positive, there is increased likelihood of drought in the region. Some assert that developing a seasonal forecasting capability is one way of strengthening capacity to adapt to extreme weather both now and in the future (e.g., Washington et al. 2006).

The IRI Climate and Society Map Room is a library of graphics and data that monitors climate conditions at global and regional scales, along with metrics of climate effects on society (including food and water security, or human health). Many records are updated in near real-time and provide historic information, including trends and analysis of climate extremes. For example, Figure 11 shows the distribution of the 3-month Standardized Precipitation Index across Asia at the start of 2018 and the monthly time-series of this drought index for a site in India. Such information could be helpful as part of the preliminary evaluation of climate risks and in benchmarking climate change scenarios.
Information Sources to Support ADB Climate Risk Assessment and Management

Figure 10: Spatial Variations in the Correlation between ENSO (Niño3.4 Index) in Autumn (September–November) and Precipitation the Following Winter (December–February)

ESRL = Earth System Research Laboratory, ENSO = El Niño–Southern Oscillation
Source: ESRL Teleconnection Tool.

Figure 11: Three-Month Standardized Precipitation Index for Asia in January 2018 and for the Indian State of Madhya Pradesh since 2008

Source: IRI Global Drought Analysis Tool.
APPENDIX 3 provides sources of information about future climate based on Global Climate Model (GCM) and downscaled regional climate scenarios. Even in an era of rapidly expanding climate services, access to high-resolution scenarios is more limited than might be expected. For instance, most portals offering daily climate model information (e.g., CORDEX, IPCC) are intended for use by the research community—with assumed expertise in handling NetCDF files or ability to assemble complex command sequences to access subsets of data from large archives.

The KNMI Climate Explorer and World Bank Climate Change Knowledge Portal (CCKP) are more user-friendly. They give access to climate change projections from the Coupled Model Intercomparison Project Phase 3 (CMIP3) and Phase 5 (CMIP5). Example output is provided for each in Figures 12 (KNMI) and 13 (CCKP). Both portals are highly versatile in terms of the domain, time period, key sector indicators, and outputs that can be retrieved. However, the most accessible data are only available as monthly, annual, or multidecadal means at the native grid-resolution of the GCM; downscaled and daily data are available, but in NetCDF format (CCKP) or only for Europe (KNMI). In Figure 12, changes in precipitation for Thailand by 2080–2099 are compared with 1986–2005. On the left of the figure is the 97.5 percentile of CMIP5 (Representative Concentration Pathways [RCP]8.5) ensemble annual mean; on the right is the annual ensemble mean of CMIP5 (RCP2.6 and RCP8.5) during 1900–2100. Figure 13 shows the change in the number of days with rainfall exceeding 50 millimeters per day in Thailand by 2080–2099, compared with 1986–2005 (based on the CMIP5 ensemble and a projection by HadGEM2-CC under RCP8.5).
**Figure 12: Projected Changes in Precipitation for Thailand**

Source: KNMI Climate Explorer.

**Figure 13: Change in Number of Days with Rainfall Exceeding 50 mm/day in Thailand by 2080–2099 versus 1986–2005**

Source: World Bank Climate Change Knowledge Portal.

mm/day = millimeter per day, CMIP = Coupled Model Intercomparison Project, SRES = Special Report on Emissions Scenarios
The World Bank Water Anchor also produced scenarios (including mean air temperature, annual precipitation, a flood and a drought indicator) for major river basins. For example, Figure 14 shows climate changes (%) in the Chao Phraya river basin, Thailand by the 2050s based on CMIP3 output under SRES A2, A1b, and B1 emissions. However, the CCKP makes it clear that these data are not intended for use in any design study.

![Figure 14: Climate Changes in the Chao Phraya River Basin, Thailand by the 2050s based on Coupled Model Intercomparison Project 3; SRES = Special Report Emissions Scenario3 Output under Special Report Emissions Scenario A2, A1b, and B1 Emissions (%)](image)

**Note:**
The bars are mean annual water runoff; annual high flow (10%); annual low flow (90%); groundwater (Gndwtr); basin yield/water availability (Stor); crop water deficit (Irr. Def); mean annual precipitation (Precip); annual potential evapotranspiration (PET); average change of mean temperature (Δ Temp); and climate moisture index (Δ CMIX(x10)).

Source: World Bank Water Anchor.

Climate model outputs are most readily available as monthly scenarios. This implies that their likely use within CRAs will be as change factors applied to higher resolution baseline data (IPCC-TGICA 2007). For example, the upper bound (97.5 percentile) ensemble projection for annual precipitation changes in the vicinity of Bangkok is 40%–50% (Figure 12). In this case, a multiplier (change factor) of 1.4 to 1.5 would be applied to observed daily or sub-daily precipitation series for the city during the baseline period (1986–2005). Sensitivity testing of options within the economic analysis might scale across the ensemble range (0.9 to 1.5 for Bangkok) to represent the climate scenario uncertainty. Return period estimates can also be recomputed from the scaled series. However, in these types of application, a questionable assumption is typically made that all time-intervals (whether sub-daily, daily, monthly, or annual) scale by the same factor.
A limited amount of daily CMIP5 Regional Climate Model (RCM) output is available for Asia and the Pacific through the RCCAP portal. For example, the CSIRO RCM was used to downscale output from six CMIP5 GCMs (ACCESS1-0, CCSM4, CNRM-CM5, GFDL-CM3, MPI-ESM-LR, and NorESM1-M) to 10 km resolution for Thailand. Some of these scenarios were used to quantify crop water demand and rice yields in the Nam Oon Irrigation Project (Shrestha et al. 2017). Other RCMs, such as the PRECIS system, have been applied in the lower Mekong Basin (e.g., Mainuddin et al. 2013). A limited selection of outputs may be accessed via the Southeast Asia START Regional Center (SEA START RC) Data Distribution System and Analysis Tool (Figure 15).

Figure 15: Changes in Precipitation Projected for the 2070s by the PRECIS System under SRES A2 Emissions, (mm)

Site-specific and bespoke climate change scenarios can be created by weather generators and statistical downscaling tools (IPCC-TGICA 2004). The latter may be calibrated using daily meteorological data from open sources, such as GSOD combined with reanalysis products from various portals. For example, the Statistical Downscaling Model (SDSM) has been applied in about 500 studies covering at least 25 countries in Asia and the Pacific region. The bibliography of SDSM research provides a starting point for developing high-resolution climate change scenarios for a range of sectors. Although the majority of studies focus on scenario creation for impact assessment, the latest version of the tool was intentionally designed to stress-test adaptation options (Wilby et al. 2014). The tool

mm = millimeter, PRECIS = Providing Regional Climates for Impacts Studies, SRES = Special Report on Emissions Scenarios.
Source: SEA START RC.
can also be used to reconstruct missing meteorological data within the period 1948–2017 (Figure 16).

**Figure 16: Reconstructed Wet-Day Frequencies and Annual Precipitation Totals for Changwu, People’s Republic of China**

Reconstructed wet-day frequencies

Annual precipitation totals

Note:
Black lines are reconstructed, grey dashed lines are model confidence intervals, red lines are observations.

Source: Wilby et al. 2014. The Statistical Downscaling Model–Decision Centric (SDSM–DC): Conceptual Basis and Applications. *Climate Research*, 61. pp. 259–276.

mm = millimeter.

Online weather generators (e.g., MarkClim) may deliver site-specific simulations of daily variables, intended for agricultural and hydrological impact assessments. Both types of downscaled product offer high-resolution scenarios conditional on coarser resolution climate model experiments and choice of emissions scenario. However, when applying such climate change information, care should always be taken to avoid mistaking increased precision for accuracy. Just because a particular tool or data set offers daily (or even sub-daily) climate scenarios at a point does not necessarily mean that the projected changes are credible (Racherla et al. 2012). Ideally, indicators of climate model skill—that are relevant to the intended application—are evaluated as part of the scenario development process (e.g., Ekström et al. 2018; Wilby 2010).
Appendix 4 lists sources of information on climate change impacts (mainly for the water sector), programs of research and development with an adaptation dimension, as well as several knowledge platforms for exchanging intelligence and insights on adaptation (using case studies, project archives, and technical materials).

Some portals provide global risk assessments based on climate model scenarios and impact models. Archives of preformulated results are typically interrogated via mapping and visualization tools. For example, the Aqueduct Water Risk Atlas plots indicators of future water supply and demand under contrasting emissions scenarios (Figure 17). Likewise, the DARA Climate Vulnerability Monitor (2012) gives national indicators of climate impacts and economic costs for 2030 compared with 2010 (Figure 18). Care must be taken when interpreting such output because much is based on macro impact models applied at coarse scales with unspecified uncertainties. The information may be helpful for rapid appraisal of key climate threats and policy development, but unsuitable for detailed project design.

Figure 17: Projected Changes in Global Water Supply by 2040 Assuming a Business as Usual (RCP8.5) Climate Change Scenario

RCP = Representative Concentration Pathways
Source: Aqueduct Water Risk Atlas.
The DARA Climate Vulnerability Monitor and other agencies (e.g., Climate Service Center Germany [GERICS], United States Agency for International Development [USAID], World Health Organization [WHO], World Bank CCKP) offer national “fact sheets,” “dashboards,” or “country profiles” of sector-specific climate vulnerabilities and impacts. For example, the country profile in Figure 19 shows sector-level vulnerability levels, climate-related economic costs, and mortality, as well as the size of the affected population for Tajikistan in 2010 and 2030. This highlights acute vulnerability of the country to drought, flood, and landslides. Loss of hydro-energy is evidently the most significant economic vulnerability.
Fact sheets are intended to raise awareness within government and civil society of the underlying risk factors that increase vulnerability to emergent climate threats. They also enable risk screening and comparative analysis between different countries to inform investment decisions or resource allocation at programmatic levels. Indicative social and economic costs of climate impacts can demonstrate scope for avoided damages through adaptation investments. Some resources like the USAID Fact Sheets provide helpful links to documents on national strategies and plans, as well as tables of donor funded programs related to climate adaptation.

Knowledge platforms with searchable archives can widen access to information about adaptation projects across the Asia and Pacific region. Some specialize in key sectors (e.g., Asian Cities Climate Change Resilience Network) or regions (e.g., Climate Himalaya). However, web-based content can sometimes be dated or have broken links. Nonetheless, libraries enable shared learning from established impact case studies and adaptation projects. Such knowledge can inform the design, monitoring, and evaluation process of the ADB project implementation phase.
Peer-reviewed scientific articles on regional climate change, impacts, and adaptation can also yield useful links to open access data. Increasingly, publishers are requiring that research teams place their data and algorithms in the public domain, with unique identifiers (e.g., Pritchard 2017, Huss and Hock 2018).
Concluding Remarks

This technical note is intended to support CRA experts, particularly those involved in the early stages of project development. Time and resources could be saved by attaching this document to terms of reference issued to CRA consultants. However, there is a limit to which globally accessible, open source data can meet the specific information needs of local adaptation projects. Hence, this note supplements rather than replaces efforts to gather relevant climate information from government agencies and counterparts, especially during the project concept phase.

This technical note compiles about 70 sources of public information for the Asia and Pacific region, including data on historical and future climate, climate-related disasters, indicators of national vulnerability, and preparedness to adapt. Additional sources will no doubt come to light so this is a living document—appendixes should be periodically refreshed as new information is located and quality assessed.

Most of the public data identified are contextual—providing high-level information about present and future climate risks at national and/or sector levels. Additional capacity development may be required in specialist “gatekeeping” skills, such as GIS, data homogeneity testing, post-processing research data formats (e.g., NetCDF), regional climate downscaling, and impact assessment. By growing these technical capabilities, more data could be accessed from the same public platforms or combined in ways that add value to the CRA.

As well as strengthening the technical capacities of local consultants and CRA experts, access to existing research-grade data stores should be improved through closer cooperation with scientific programs. For example, new interfaces could be developed to open research archives (e.g., CORDEX) to a broader user base. In particular, there is an urgent need to widen access to the daily and sub-daily climate information needed for economic analysis, engineering design standards, stress-testing adaptation options, and other aspects of project design.

Parts of the Asia and Pacific region are scarce of both the climate and socioeconomic information required for robust CRA. High elevation and remote environments are particularly problematic for data gathering, yet these locations have some of the most climate vulnerable communities and resources. Remotely-sensed and reanalysis products certainly improve coverage, but the accuracy of these assets ultimately depends on high-quality observing networks. Therefore, ADB, other multilateral development banks, and partner agencies should continue to invest in programs that strengthen national monitoring systems for climate and environmental change. Open access to such long-term records is invaluable for detecting emergent risks and devising, then implementing, effective adaptation measures.
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Appendixes

Appendix 1: Sources of Information on Historic Greenhouse Gas Emissions, Climate Vulnerability, Risks, and Impacts

| Description                                      | Advantages                                                                                                                                  | Disadvantages                                                                                       | Source                        |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-------------------------------|
| Surface water changes                           | Global-scale analysis at 30 m resolution of water-to-land and land-to-water conversions in 1985–2016 based on satellite imagery from multiple Landsat missions; reveals documented and undocumented conversions due to natural variability, human interventions and climate change | Only shows compound effects of natural variability, human interventions and climate change so more local information is needed to attribute changes; processed data behind the maps are not openly available | Aqua Monitor                  |
| Emission-reduction projects in developing countries | Archive of CDM projects searchable by sector scope, scale of emission reductions, host country                                                                 | Marginal relevance of CDM project design and monitoring documentation to the specific information needs of CRA | Clean Development Mechanism   |
| Greenhouse gas (GHG) emissions, nationally determined contributions (NDCs), emissions pathways | Platform to visualize and compare national emissions, climate commitments, and performance; national summaries of climate vulnerability and readiness, climate risk index (Germanwatch), and associations between NDCs and Sustainable Development Goals (SDGs) | Some features are still under development (e.g., sector-level analysis, emission pathways); data begin in 1990 | ClimateWatch                  |
| Large flood events                              | Global near real-time archive of large flood events based on news, government, surface, and satellite sources; available as online table or downloaded as a spreadsheet file; each entry includes country or area affected, main causes, number of fatalities and/or displaced, and severity score | No data prior to 1985; unclear what criteria are applied for inclusion or rating of flood severity | Dartmouth Flood Observatory    |

*continued on next page*
| Description                                              | Advantages                                                                                                                                                                                                 | Disadvantages                                                                                                                                                                                                 | Source                      |
|---------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| Disaster loss data for 89 countries                     | Covers all disaster types (including non-climatic) occurring in the period 1970–2013; raw data are accessible in a spreadsheet file; searchable archives                                                                 | Incomplete coverage of the Asia and Pacific region                                                                                                                                                          | DesInventar, Sedai           |
| International disaster database for vulnerability assessment and priority setting | Core data on the occurrence and impacts of more than 22,000 mass disasters since 1900; archive searchable by period, country, disaster type, and impact; climate-related disasters include wildfire, drought, mass movement, landslide, flood, fog, extreme temperature, storm; output as reference maps, CSV files, time series plots | Registration required; country-level and continental-scale data base; priority given to United Nations and government data, but quality of entries reflects sources | Emergency: Events Database (EM-DAT) |
| Fires and thermal anomalies                             | Thermal anomalies (day and night) at 1-kilometer (km) resolution, approximately twice daily; global coverage                                                                                             | Data format HDF; registration required; data begin in 2012; image time and location depends on path of satellite orbit; other sources of thermal anomalies include volcanic eruptions and gas flares | EOSDIS Worldview            |
| Atmospheric aerosols                                    | Aerosol optical depths at 2 km resolution, approximately daily; global coverage                                                                                                                             | Data format HDF; registration required; data begin in 2000; image time and location depends on path of satellite orbit; algorithm is not applied over sun glint ocean or bright desert; sources of aerosols include industrial emissions, fire smoke, dust storms, sea salt, volcanic ash, and smog | EOSDIS Worldview            |
| Storm surface runoff and groundwater-baseflow           | Gridded products based on satellite observations and land surface modeling; available at 0.25° (2000 onward) and 1° (1948 onward) resolution, 3-hourly or monthly                                                                 | Requires offline routing algorithm to aggregate and pass river flow between neighboring cells; large uncertainty in precipitation inputs to model                                                                 | Global Land Data Assimilation System (GLDAS) |

continued on next page
## Description Advantages Disadvantages Source

**Global data on risk from natural hazards, including floods, droughts, storm surges, fires, and landslides**

- Based on spatial hazard data from the Global Assessment Report on Disaster Risk Reduction versions 2009, 2011, and 2013; zoom, pan, and layering capabilities to create bespoke maps; various backgrounds to highlight vulnerability, such as population distribution, gross domestic product (GDP) per capita, elevation, land cover; online visualization, data and map downloads; various data formats, including shape files and text
- Contextual layers have missing features (such as some major rivers); pixelated output depends on the grid-resolution of the data used for hazard modeling

**Source:** Global Risk Data Platform

**Global data on drinking water, sanitation, and hygiene (WASH)**

- Annual country-level indicators showing status and trends toward SDGs on WASH; standard classification and estimation methods applied across countries; downloadable country files with graphics and raw data; searchable by rural or urban, socioeconomic and service level
- National statistics may conceal regional variations in WASH; data cover 2000–2015

**Source:** Joint Monitoring Programme (JMP)

**National indexes of climate vulnerability and readiness to adapt**

- 45 indicators of climate change related vulnerability and readiness for 192 UN countries since 1995; vulnerability scores for water, agriculture, health, infrastructure, food and ecosystems; component scores for climate exposure, sensitivity and adaptive capacity; readiness scores based on economic, governance and social indicators; GDP adjusted scores for ND-GAIN index
- Some interpolation used to fill in missing values; national indicators may conceal marked regional variations; international climate threats to local economies are not considered

**Source:** Notre Dame Global Adaptation Initiative (ND-GAIN) Country Index

**Glacier outlines**

- A global inventory of glacier outlines (ice covered areas) at the beginning of the 21st century; includes topographic and hypsometric attributes for most glaciers; data available as ESRI shapefile or KML
- A “snapshot” of outlines not intended for measurement of glacier-specific rates of area change; substantial range of survey dates as priority was completeness of coverage

**Source:** Randolph Glacier Inventory (RGI)

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*continued on next page*
| Description | Advantages | Disadvantages | Source |
|-------------|------------|---------------|--------|
| Inventories of river and urban flooding, earthquake, landslide, wildfire, water scarcity, extreme heat, coastal flood, cyclone, tsunami, volcano | General view of hazards, for a given location, intended for project design and implementation to promote disaster and climate resilience; national summary sheets with links to supporting materials on each hazard type | Some rated hazards are nonsensical (e.g., very low risk of coastal flood in Tajikistan and Manila); qualitative assessment of how each hazard could change in the future due to climate change | ThinkHazard |
| National disaster risk profiles and loss estimates | Country statistics alongside nationally and internationally reported losses (mortality, economic); probable maximum loss estimates by hazard for return periods of 20 to 1,500 years; overall national INFORM risk index (based on hazard, vulnerability and coping capacity); draws on EM-DAT, UNISDR, and DesInventar | Contains some spurious information (e.g., three volcanoes identified for the United Kingdom, whereas probable maximum losses from wind and storm surge are allegedly zero); methods of risk estimation could be more transparent | UNISDR PreventionWeb |
| GHG and socioeconomic data (various) | Portal providing links to 20 external sources of primary data covering emissions, development indicators, energy production and prices, sector and environmental indicators | National statistics may conceal regional variations | United Nations Climate Change portal |
| Human Development Indicators (HDIs) | Archive searchable by dimension (health, education, income, inequality, gender, poverty, work, human security, trade and finance, mobility and communication, environmental sustainability, and demography), indicator, year and country; visualize data as bar charts, trends and maps; download as spreadsheet files | Data cover period 1990–2015; national statistics may conceal significant regional variations | United Nations Development Programme (UNDP) |

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Appendix 1  continued

| Description                                                                 | Advantages                                                                 | Disadvantages                                                                                           | Source                                      |
|----------------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|---------------------------------------------|
| Global international trade, national accounts, energy, industry, environment, demographic, and social statistics | Includes annual country and regional indicators of SDGs, monthly bulletin of statistics online (from 2000 onward), gender and disability statistics | National statistics may conceal regional variations; some data begin in 1990s, most in 2000; incomplete data for some indicators and countries | United Nations Statistics Division (UNSD)    |
| National sector-level indicators of climate impacts and vulnerabilities since 2000 | 38 climate impact indicators for agricultural, natural hazards, water and coastal zone; range of socioeconomic and demographic vulnerability metrics | Country- and sector-level statistics may conceal regional variations; future downscaled scenarios are only available for SRES emissions in NetCDF format | World Bank Climate Change Knowledge Portal |
| Glacier locations and properties                                           | Basic information about 130,000 glaciers, including location, area, length, orientation, elevation, and classification; data available in TXT and CSV format | Snapshot of glacier distribution in the second half of the 20th century mainly based on aerial photographs | World Glacier Inventory                     |
| Glacier fluctuations and events                                           | Standardized observations of changes in glacier mass, volume, snout position, area, and length; statistical information on the distribution of perennial surface ice in space (World Glacier Inventory); data on events, such as surges, calving, rock falls, lake outbursts, ice avalanches, eruptions of glacier-covered volcanoes; global glacier change bulletin now published every 2 years, 5-yearly reports since 1959 | Some records are short or broken; some regions are underrepresented or require integration of onsite measurements with remote sensing and modeling | World Glacier Monitoring Service Fluctuations of Glaciers (FOG) database |

CDM = Clean Development Mechanism, CRA = Climate Risk Analysis, CSV = comma separated values, HDF = Hierarchal Data Format, EOSDIS = Earth Observing System Data and Information System, ESRI = Environmental Systems Research Institute, INFORM = Index For Risk Management, KML = Keyhole Markup Language, m = meter, NetCDF = Network Common Data Form, SRES = Special Report on Emissions Scenarios, UN = United Nations, UNISDR = United Nations International Strategy for Disaster Reduction.

Sources: ADB and other sources in the rightmost column.
## Appendix 2: Sources of Information on Historic Weather, Climate Variability, and Change (by timescale)

| Description                                                                 | Advantages                                                                                                                                                                                                 | Disadvantages                                                                                                                                                                                                 | Source                                                                                     |
|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| Sub-daily, daily, monthly, and annual precipitation estimates                | Various remotely-sensed precipitation products with spatial resolutions of 0.04° (2003–present) and 0.25° (1983–2017) for the domain 60°S to 60°N; online data visualization tool and FTP download. | Daily version may not record some intense, short-lived events; based on complex algorithms to convert infrared measurements into precipitation rates; not quite global coverage; partly dependent on other precipitation products, such as GPCP. | Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks (PERSIANN) |
| Sub-daily, daily, monthly, and annual precipitation and temperature data    | Searchable repository for the Asia-Pacific region providing links to resources (e.g., APHRODITE, SACA&D, PERSIANN); data accessible for points and areas; easily downloaded. | Registration required to access data; some data held as NetCDF or BIN format; some links pass to other portals (e.g., reanalysis, TRMM, CRU); filters sort by the number of data sets (not alphabetically). | Regional Climate Consortium for Asia and the Pacific (RCCAP)                                |
| Sub-daily, daily and monthly precipitation for the tropics                  | Searchable archive by domain, date range, spatial, and temporal resolution; output as maps, time series, and other formats.                                                                                   | Finest grid resolution is 0.25°; earliest data from 1998 onward; registration required to download some output.                                                                                           | Tropical Rainfall Monitoring Mission (TRMM)                                               |
| Sub-daily and daily weather variables in point and grid format              | User interface with searchable map providing access to forecast, model, radar, reanalysis, and station weather variables.                                                                                   | Registration required to access data; easier to search by country and date range to identify available open and commercial data sets first (rather specify variable[s] of interest).                         | Planet OS                                                                                 |
| Sub-daily, daily, weekly, and monthly summaries of standard weather variables | Searchable archive by city, state, zip code, or airport; coverage tends to be post-2000; variables include maximum, minimum, and mean daily air temperature, dew point temperature, relative humidity, air pressure, visibility and wind speed, precipitation, cloud cover, and wind direction; data up to date. | Bias toward WMO-reporting stations; time-consuming to build a complete multivariate series from screen output; data interspersed with advertising.                                                        | Weather Underground                                                                       |

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| Description                                      | Advantages                                                                 | Disadvantages                                                                                                                                   | Source                                                                                   |
|--------------------------------------------------|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Daily precipitation for Asia                     | High density and quality rain gauge network covering the period 1950–2011    | Station network changes with time and season; no homogenization of data so potentially susceptible to discontinuities; limited coverage for India, Indonesia, and Papua New Guinea; record discontinued and data download links broken (RCCAP) | Asian Precipitation – Highly Resolved Observational Data Integration Towards Evaluation of Water Resources (APHRODITE) |
| Daily, monthly, and seasonal reanalysis products (including precipitation rate, air temperature, zonal wind, sea level pressure) | Versatile tools to extract raw data, monthly or seasonal series and maps from global reanalysis fields; nearly 30 products available; downloadable as TXT, CSV, or NetCDF | NCEP/NCAR reanalysis and derived variables (i.e., these are quasi-data, not actual observations); earliest output is from 1979 onward | Earth System Research Laboratory (ESRL)                                                  |
| Daily data for standard meteorological variables | Global archive searchable by country, station, date; data downloadable as TXT file | Incomplete records and quality issues must be resolved on a site by site basis; missing dates are not shown, so post-processing of files is required to fill blocks with these missing values; all units are US imperial | Global Summary of the Day (GSOD)                                                        |
| Daily and monthly weather variables (including maximum and minimum temperature, total precipitation, snowfall, and snow depth) for land surface stations | Searchable archive of 100,000 stations in 180 countries; data subjected to a standard set of quality checks; observations can be selected by data set, date range, station name, and/or user defined search terms; supplied in various formats, including CSV | The total number of stations and spatial coverage varies with time; missing dates are not shown, so post-processing of files is required to fill blocks with these missing values | Global Historical Climate Network (GHCN)                                                 |

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## Appendix 2 continued

| Description | Advantages | Disadvantages | Source |
|-------------|------------|---------------|--------|
| Daily and monthly teleconnection indexes | Various indexes describing historic and current teleconnections, including ENSO, AAO, AO, NAO, and PNA; diagnostic and attribution tools to interrogate El Niño indexes; forecasts and bulletins for each index in real time | Bias toward Northern Hemisphere teleconnection patterns; some maps will not display in Internet Explorer10 (use Chrome instead); earliest data available for some indexes is from 1979 onward | NOAA Climate Prediction Center |
| Daily atmospheric predictor variables (for downscaling) | Archive holds more than 30 predictor variables describing atmospheric stability, airflow strength, pressure, vorticity, wind direction, humidity, temperature, and precipitation; interface locates nearest NCEP reanalysis data based on latitude and longitude; available as TXT format | Coarse grid resolution 2.5°, only available from 1948 onward; most predictors are normalized (i.e., z-values); records end in 2017; vorticity and airflow indexes cannot be derived for equatorial regions | SDSM portal |
| Weekly and monthly water and environmental data for Central Asia | Various data sets for accounting land and water resources in the Aral Sea basin | Earliest data begin in 1980; registration required for some data sets | CAWater-Info |
| Monthly mean temperature and precipitation | Interactive Google Earth interface to locate monthly or annual mean precipitation and temperature series for the period 1901–2016; graphical and TXT output of gridded data at 0.5° resolution | Based on gridded (i.e., area-average) rather station (i.e., point) meteorological information interpolated from nearest stations; larger uncertainty in estimated values for data-sparse regions | CRU TS Version 4.01 Google Earth Interface |
| Monthly Palmer Drought Severity Index for global land areas | Gridded Palmer Drought Severity Index from 1850 to 2012 at 2.5° resolution for the domain 58.75°S to 76.25°N | Data are provided for all global land areas by month (in NetCDF and TXT); subsets of the data have to be extracted from global fields offline | Earth System Research Laboratory (ESRL) |
| Monthly rainfall, temperature, and potential evapotranspiration (PET) | Map interface for interrogating monthly or annual climate series since 1901; options include climate anomaly and trend analysis for points and areas; enables comparison of annual temperatures at two points | Site under development; charting option only gives temperature series; trends are for three fixed periods; PET data are not available beyond 2012 | Global Climate Monitor |

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| Description                                                        | Advantages                                                                 | Disadvantages                                                                 | Source                                                                 |
|-------------------------------------------------------------------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Monthly ocean, ice, and hydrology equivalent water height          | Global water storage anomalies relative to time-mean of monthly mass, applicable to ocean, ice and hydrology; expressed as equivalent water thickness (centimeter); 0.25° grid resolution | Data begin in 2002; individual ASCII files must be downloaded for each month (but also available as NetCDF) | Gravity Recovery and Climate Experiment                                 |
| Monthly precipitation, temperature, and air pressure              | Global archive searchable by domain, country or point for specified seasons from various sources (e.g., CRU, GIS, GPCC, Hadley Centre, NCDC, UCAR); raw data available in TXT format; versatile and downloadable maps and time series | Finest temporal resolution is monthly | KNMI Climate Explorer                                                   |
| Monthly wind and sea surface temperature (SST) indexes            | Standard teleconnection and pressure indexes available from the 1880s onward; weekly and monthly SST series available from the 1980s and 1950s, respectively, upper atmosphere temperature and radiation fields from the 1980s; graphical and TXT data formats | Earliest wind indexes available from 1979 | NOAA Climate Prediction Center                                           |
| Monthly and annual sea levels                                     | Stations sortable by name, ID, latitude and longitude, and country code; detailed station metainformation on known quality issues (e.g., sedimentation, subsidence); shows nearest neighbor stations; graphical and TXT formats | Station data are presented as a single table not easily searched; some records end as early as 1980 | Permanent Service for Mean Sea Level                                    |
| Mean monthly climate and bioclimatic data                        | Global layers at 1 square kilometer (km²) to 340 km² resolution for the period 1970–2000; downloaded as a “zip” file containing GeoTiff (.tif) files | Fixed period, mean monthly values | WorldClim Version2                                                      |
Appendix 2  continued

| Description                                                                 | Advantages                                                                                                                                                                                                                                                                                                                                 | Disadvantages                                                                                                                                                                                                 | Source                                                                                          |
|-----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Seasonal teleconnection patterns                                            | Tool for analyzing seasonal mean correlation fields for NCEP reanalysis variables versus specified teleconnection and ocean indexes; enables exploration of coincident and lagged relationships; possible to import user-created time series; versatile plotting options                                                                                                             | Earliest records begin in 1948                                                                                                                                                                                        | **Earth System Research Laboratory (ESRL)**                                                  |
| Various time scales of remotely sensed Earth observations for aerosols,   | Global archive searchable by domain, date range, scientific discipline, instrument, spatial and temporal resolution, wavelengths, depths; nearly 2000 data sets available; output as maps, time series, and other formats                                                                                                                         | Remote processing times for data can be long depending on domain, sampling interval and output type; earliest output available from 1948                                                                  | **Giovanni**                                                                                     |
| atmospheric chemistry, atmospheric dynamics, cryosphere, hydrosphere,     |                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                 |                                                                                                |
| ocean biology, oceanography, water and energy cycles                       |                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                 |                                                                                                |
| Various timescales for map collections of present and recent past climate  | Maps covering wide range of climate variables, indicators of food security, agriculture, teleconnection indexes, human health, fire risk, water management; data can be downloaded for user-specified domains, time periods, and formats; interactive maps to plot time series of indexes at selected locations                                                                 | Not all raw data can be downloaded; large volume and variety of resources can be difficult to navigate                                                                                                 | **IRI Climate and Society Map Room**                                                           |
| and societal impacts                                                        |                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                 |                                                                                                |
| Various timescales for snow and ice cover, glacier, permafrost, sea ice    | Global archive searchable by domain, date range, parameter, sensor, spatial and temporal resolution, data format, scientific program; more than 400 data sets available; output as maps, time series, and other formats                                                                                                                                                 | Only seven data sets pertain to Asia: two precipitation, three DEMs, one short permafrost record for Central Asia and Mongolia, one snow survey for Central Asia                                                                 | **National Snow and Ice Data Center**                                                         |
| and soil moisture                                                           |                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                 |                                                                                                |

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Appendix 2

### Description Advantages Disadvantages Source

| Global weather and climate extremes archive | Record weather extremes with dates and locations for global, hemispheric, and WMO regions; background notes and supporting information (e.g., on instrumentation issues) | Records are not searchable by country | World Meteorological Organization (WMO) |

AAO = Antarctic oscillation, AO = Arctic Oscillation, ASCII = Annual climate indices, BIN = non-text binary file format, CAWater = Portal of Knowledge for Water and Environmental Issues in Central Asia, CRU = Climatic Research Unit, CSV = comma separated values, DEM = Digital Elevation Model, ENSO = El Niño Southern Oscillation, FTP = File Transfer Protocol, GIS = geographic information system, GPCC = Global Precipitation Climatology Centre, GPCP = Global Precipitation Climatology Project, IRI = International Research Institute for Climate and Society, KNMI = Royal Netherlands Meteorological Institute, NAO = North Atlantic oscillation, NCDC = National Climatic Data Center, NCEP = National Centers for Environmental Prediction, NetCDF = Network Common Data Form, NOAA = National Oceanic and Atmospheric Administration, PNA = Pacific/North American teleconnection pattern, SACA&D = Southeast Asian Climate Assessment & Dataset, SDSM = Statistical DownScaling Model, TRMM = Tropical Rainfall Measuring Mission, TXT = text file, UCAR = University Corporation for Atmospheric Research, WMO = World Meteorological Organization.

Sources: ADB and other sources in the rightmost column.
### Appendix 3: Sources of Information on Multidecadal Climate Change Projections (by timescale)

| Description | Advantages | Disadvantages | Source |
|-------------|------------|---------------|--------|
| Hourly to seasonal regional climate model output (14 domains) | Historical runs available for South Asia (SAS); East Asia (EAS); Central Asia; Southeast Asia (SEA); and Australasia (AUS); large number of meteorological variables at multiple atmospheric levels; hourly to seasonal output | Registration required to access data; NetCDF format; limited number of RCP runs to 2050s only for AUS, EAS, and SEA | Coordinated Regional Climate Downscaling Experiment (CORDEX) |
| Daily bioclimatic, precipitation, solar radiation, and temperature variables | Bias-corrected and spatially downscaled data derived from CMIP3 and CMIP5 output, available at spatial resolutions of 30 seconds to 20 minutes; intended for agricultural applications, but may have wider utility | Data download in ASCII format, but for large regions and monthly time-slices; unsuitable for transient climate change analysis | Climate Change, Agriculture and Food Security (CCAFS) |
| Daily weather generator of precipitation, solar radiation, maximum and minimum temperature | Site specific synthetic data obtained by entering location name or coordinates; simulations are conditioned by CMIP5 model(s) and RCPs for target years in the period 2010–2095; variables are intended for agricultural applications, but may have wider utility; outputs provided as text file, histogram, or polar charts | The model outputs data for 1 year per simulation and Global Climate Model (GCM) ensemble, so analysis of transient changes would be time-consuming; the weather-typing algorithm and attendant regression equations are assumed to be valid for hitherto unseen climate states | MarkSim Weather Generator |
| Daily bias corrected precipitation, maximum and minimum temperature | High-resolution (~25 km) global historic and climate change scenarios for 21 GCMs, RCP4.5 and RCP8.5 for the period 1950–2100 | NetCDF format; files accessed from THREDDS catalog via URL | NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP) |
| Daily meteorological variables (rainfall, temperature, humidity, solar radiation, wind) | Searchable repository for the Asia-Pacific region providing links to Regional Climate Model output for historical, RCP4.5 and RCP8.5 (e.g., CCAM, CORDEX); data accessible for points, areas and individual Regional Climate Models (RCMs); easily downloaded; supporting guidance on climate model information | Registration required to access data; some data only as NetCDF format; CMIP5 GCM output only available for the Philippines and Thailand; filters sort by number of data sets (not alphabet) | Regional Climate Consortium for Asia and the Pacific (RCCAP) |

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| Description | Advantages | Disadvantages | Source |
|-------------|------------|---------------|--------|
| Daily weather as well as exotic variables (such as storm surge, air quality and heat island indexes) | Globally applicable statistical downscaling model that can reconstruct and synthesize site specific weather series and exotic variables based on reanalysis predictors covering the period 1948–present; useful for infilling missing data or generating synthetic scenarios for stress-testing impact models and adaptation options | Future downscaled scenarios are not explicitly tied to any given GCM; depends on sufficient daily data (for the required variable[s]) for model calibration; multisite and multivariate applications can be time-consuming to undertake; some training or expertise in downscaling is recommended prior to calibrating the model and applying outputs | Statistical DownScaling Model – Decision Centric (SDSM-DC) |
| Monthly global climate model output (various) | Historic and CMIP experiments; produces maps and time series; searchable by domain, country, point; output for standard climate variables; raw data available in TXT format | Finest temporal resolution is monthly | KNMI Climate Explorer |
| Decadal precipitation, maximum and minimum temperature | Decadal mean projections and changes in precipitation, maximum and minimum temperature for Southeast Asia from 2010s to 2090s | Outputs are only for one GCM (ECHAM4) and one RCM (PRECIS) under two SRES emissions scenarios (A2 and B2) | SEA START RC Data Distribution System |
| Global climate model output (CMIP3 and CMIP5) | Snap-shots of the Coupled Model Intercomparison Projects that underpinned IPCC AR5; archive of 952 simulations provided by 58 models from 24 institutes | NetCDF format; data intended for use by the research community | IPCC Data Distribution Centre |
### Description

| Description                                                                 | Advantages                                                                 | Disadvantages                                                                                                                                                                                                 | Source                  |
|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| Global climate model projections (CMIP5)                                    | An atlas of global and regional climate projections from the IPCC Fifth Assessment Report; a point of reference for projected seasonal and annual precipitation and temperature changes relative to 1986–2005; maps show the 25th, 50th, and 75th percentiles of the ensemble for 2016–2035, 2046–2065, and 2081–2100; maps cover SREX regions as well as the Caribbean, Indian Ocean, and Pacific island states and land and sea areas of the two polar areas; hatching denotes areas with weak signals relative to model variability | Seasonal and annual climate changes are based on the unweighted ensemble, averaged across large regions (i.e., regional climate change signals may be obscured); note that the underlying climate model output can be accessed by the KNMI Climate Explorer (see above) | IPCC AR5, Annex 1       |
| Global climate model change factors (CMIP3, CMIP5) and downscaled scenarios (CMIP3) | CMIP3 (SRES A2, B1) and CMIP5 (RCP 2.6, 4.5, 6, 8.5) projections for standard and sector specific climate indicators (e.g., days with heavy rain, hot and cold days, days below freezing) for 2020–2039, 2040–2059, 2060–2079, and 2080–2099; change factors available as spreadsheet files; downscaled global daily scenarios for some CMIP3 models and climate indexes | Country-level, change factors based on 20-year blocks (i.e., not time-series output); downscaled data only for SRES and subset of CMIP3 models in NetCDF format | World Bank Climate Change Knowledge Portal |

ASCII = Annual climate indices, CMIP = Coupled Model Intercomparison Project, ECHAM4 = An atmospheric general circulation model developed at the Max Planck Institute for Meteorology, IPCC AR5 = Intergovernmental Panel on Climate Change Fifth Assessment Report, km = kilometer, KNMI = Royal Netherlands Meteorological Institute, NetCDF = Network Common Data Form, PRECIS = Providing Regional Climates for Impacts Studies, RCP = Representative Concentration Pathway, SRES = Special Report on Emissions Scenarios, SREX = Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, THREDDS = Thematic Real-time Environmental Distributed Data Service, TXT = text file, URL = Uniform Resource Locator.

Sources: ADB and other sources in the rightmost column.
### Appendix 4: Sources of Information on Future Climate Change Impacts and Adaptation Projects

| Description                                                                 | Advantages                                                                                                                                  | Disadvantages                                                                                                                                                                                                 | Source                                      |
|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| Flood risk under current and future climate                                  | Assesses flood risks by country, river basin scale, state or city (120) by population, GDP or urban damage; evaluates risks for 2010 and 2030 under three scenarios (RCP 4.5 with SSP2, RCP8.5 with SSP2 and RCP 8.5 with SSP3) | Only simulates large-scale river flooding (does not include coastal, pluvial or flash flooding); hazard maps show situations with no flood protection; assumes a globally applicable flood depth–damage relationships; projections are based on five unspecified climate models | Aqueduct, Global Flood Analyzer            |
| Maps of water-related risk                                                   | Global to local coverage for current and future (next 30 years) climate conditions under three emissions scenarios; indicators cover water stress, seasonal variability, water supply and demand | Download via ESRI Geodatabase files; decadal and annual means conceal sub-annual variations in risk and opportunities                                                                                   | Aqueduct Water Risk Atlas                  |
| Regional network connecting professionals and communities to build urban climate resilience | Searchable archives of news stories, case studies, technical reports, policy briefs, media                                                                                                                      | Some search fields are not populated                                                                                           | Asian Cities Climate Change Resilience Network |
| Knowledge platform for enhancing institutional capacity and implementing adaptation | Searchable archive by theme, country, project status                                                                                                                                                         | Some content quite dated or project details missing                                                                                      | Asia-Pacific Adaptation Network            |
| E-library of sector- and country-level impact case studies                   | Searchable archive by theme, country, program, framework, key terms, technical reports                                                                                                                         | No access to underpinning data                                                                                                          | Asia-Pacific Network for Global Change Research |

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| Description                                                                 | Advantages                                                                 | Disadvantages                                                                 | Source                                                                                     |
|----------------------------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Knowledge platform for information and networking on climate impacts on the Himalayan Mountains | Searchable archive of news stories, case studies and opinions covering 2010–2015 | Content now dated                                                              | Climate Himalaya                                                                          |
| National indicators of climate impacts and vulnerability                  | National vulnerability levels shown for 2010 and 2030 with indicative economic costs; results in tabular and map format | Weblinks to national summaries broken; national means conceal regional variations and sub-annual differences in risk and opportunities | DARA Climate Vulnerability Monitor                                                        |
| Knowledge platform for sharing information and networking on climate change in Nepal | Searchable archives of maps, data bases, journal articles                  | Some content quite dated or irrelevant                                          | Nepal Climate Change and Development Portal                                                |
| Global explorer on climate change adaptation projects                     | Searchable by country, hazard type, thematic area, level of intervention; detailed project-level information | Some content now dated                                                          | United Nations Development Programme                                                       |
| Regional and country-specific climate risk profiles                      | High-level summaries of expected sector impacts for agriculture, water energy, coastal ecosystems, infrastructure and human health; useful links to supporting information on institutional context, national strategies, key reports, and donor programs; annexes contain forms of language for sector contracts | Historical and future climate summaries are very high-level, rather qualitative and unattributed; some Asian countries are not covered | United States Agency for International Development (USAID) Fact Sheets                     |

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### Appendix 4  
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| Description                                                                 | Advantages                                                                                      | Disadvantages                                                                                     | Source                                                                                   |
|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Portal for accessing agriculture, water, energy, and health sector climate indexes | 38 climate variables accessed by the Climate for Sectors Dashboard; available in graphical and Excel formats, by Global Climate Model (GCM) and emissions scenario, for CMIP3 and CMIP5; some future downscaled scenarios | Most output provided as national, multidecadal mean changes for specified time periods (2020–2039, 2040–2059, 2060–2079, 2080–2099); downscaled output only available for SRES emissions; some links broken | [World Bank Climate Change Knowledge Portal](https://www.worldbank.org) |
| Country-specific evaluations of present and future climate impacts on human health | First round (2015) profiles cover 40 countries, second set (2019) will expand to ~80 countries; each shows burden of climate change on human health, with opportunities for health co-benefits from climate mitigation actions, and analysis of policy responses at national level | National statistics conceal significant variations in group exposure, sensitivity, and ability to adapt to climate hazards; some of the global opportunities for health co-benefits from mitigation policies may not be priorities at national scales | [World Health Organization Climate and Health Country Profiles](https://www.who.int) |

ESRI = Environmental Systems Research Institute, GDP = gross domestic product, RCP = Representative Concentration Pathway, SRES = Special Report on Emissions Scenarios, SSP = Shared Socioeconomic Pathway.

Sources: ADB and other sources in the rightmost column.
Information Sources to Support ADB Climate Risk Assessments and Management

Technical Note

The Asia and Pacific region is vulnerable to extreme temperatures, flooding by heavy rainfall, sea level rise, coastal erosion, and damage by tropical cyclones. This technical note provides information that supports climate risk assessment experts undertaking early stages of project development in the region. The information is grouped into four major categories: inventories of national emissions, climate risks, vulnerability, and impacts; historic weather, climate, and environmental change; regional climate change projections; and climate change impacts and adaptation. The note also identifies opportunities for capacity development in key skills such as geospatial analysis, data testing and post-processing, regional climate downscaling, and impact assessment.

About the Asian Development Bank

ADB is committed to achieving a prosperous, inclusive, resilient, and sustainable Asia and the Pacific, while sustaining its efforts to eradicate extreme poverty. Established in 1966, it is owned by 67 members—48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.