# Resilience Rating System

A methodology for building and tracking resilience to climate change

WORLD BANK GROUP

February 2021

Cover design by Brad Amburn.

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# Acknowledgments

This methodological note for the Resilience Rating System was prepared by Stephane Hallegatte, Viviane Clement, Sundus Siddiqi, and Michelle Winglee. Economic analyses that include disaster and climate risks were performed by Rubaina Anjum, Paolo Avner, Ammara Shariq, and Michelle Winglee. The review and mapping of existing sectoral methodology was done by Elham Shabahat and Viviane Clement.

This methodology is based on the work of a working group on the Resilience Rating System, which is led by Stephane Hallegatte, Veronique Morin, and Vladimir Stenek, and includes input from experts from the sectors considered in this note: Suzana Abbott, Rubaina Anjum, Margaret Arnold, Fatima Arroyo, Paolo Avner, Simone Balog-Way, Fatima Barry, Garo Batmanian, Anush Bezhanyan, Christian Borja-Vega, Greg Browder, Ana Bucher, Jack Campbell, Karan Capoor, Debabrata Chattopadhyay, Narae Choi, Viviane Clement, Fiona Collin, Mark Deinert, Caroline Devadason, Stephen Dorey, Nathan Engle, Xavier Espinet, Gregory Felter, Erick Fernandes, Marc Forni, Ugo Gentilini, Christine Heumesser, Oscar Ishizawa, Anders Jensen, Pravin Karki, Oceane Keou, Nalin Kishor, Fabian Koehrer, Patricia Kristjanson, Ashok Kumar, Lisa Lau, Friederike Mikulcak, Ayah Mahgoub, Erkin Mamadaliev, Shomik Mehndiratta, Aurelio Menendez, Veronique Morin, Robert Mutyaba, Sean Nelson, Philippe Neves, Claire Nicolas, Samuel Oguah, Ninan Oommen, Angelica Parada, Karen Peffley, Leela Raina, Patrick Ray, Jun Rentschler, Kanta Rigaud, Julie Rozenberg, Ommid Saberi, Amy Schweikert, Sachin Shahria, Ammara Shariq, Manu Sharma, Sundus Siddiqi, Natalya Stankevich, Ioannis Vasileiou, Michelle Winglee, Yi Xu, Daniela Zingler, and Nkulumo Zinyengere.

Previous iterations of the methodology have benefited from comments from Timothy H. Brown, Barbara Buchner, June Choi, Joyce Coffee, Sarah Coll-Black, Fiona Collin, Mark Deinert, Willem Janssen, Ashok Kumar, Anne Kuriakose, Robert Lempert, Angelica Ospina Parada, Ujala Qadir, Kanta Kumari Rigaud, Jennifer Solotaroff, Asmita Tiwari, and the members of the Adaptation and Resilience Expert Group convened by the Climate Bonds Initiative.

As peer reviewers, Eric Dickson, Nathan Engle, Kulwinder Singh Rao, and Iain Shuker provided invaluable suggestions and comments.

Lucy Southwood was the production editor. Brad Amburn designed the report.

The report and underlying work benefited from the guidance of John Roome and Bernice Van Bronkhorst, directors of the World Bank Climate Change Group.

# Table of Acronyms

| | |
|---|---|
| **AF** | Additional Financing |
| **ATAAS** | Agricultural Technology and Agribusiness Advisory Services |
| **BCR** | benefit-cost ratio |
| **CCFF** | Climate Change Financing Framework |
| **CAPEX** | capital expenditures |
| **CCKP** | Climate Change Knowledge Portal |
| **CIAT** | International Center for Tropical Agriculture |
| **CMIP** | Coupled Model Intercomparison Project |
| **CSA** | climate-smart agriculture |
| **CRIDA** | Climate Risk Informed Decision Analysis |
| **DMDU** | decision making under deep uncertainty |
| **DPF** | Development Policy Financing |
| **DMU** | decision making under uncertainty |
| **EFA** | economic financial analysis |
| **ESF** | Environmental and Social Framework |
| **ESS** | Environmental and Social Standard |
| **FCV** | fragile, conflict and violence |
| **FHWA** | (US) Federal and Highway Administration |
| **GHG** | greenhouse gas |
| **GP** | Global Practice |
| **IBRD** | International Bank for Reconstruction and Development |
| **IDA** | International Development Association |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **IPF** | Investment Project Financing |
| **IRR** | internal rate of return |
| **M&E** | monitoring and evaluation |
| **MDB** | multilateral development bank |
| **MPA** | Multiphase Programmatic Approach |
| **NA** | not applicable |
| **NDC** | Nationally Determined Contributions |
| **NPV** | net present value |
| **NNRFC** | National Natural Resources and Fiscal Commission |
| **NR** | not rated |
| **OPEX** | operational expenditures |
| **PA** | prior action |
| **PDO** | project development objectives |
| **PAD** | Project Appraisal Document |
| **PforR** | Program for Results |
| **RCP** | representative concentration pathway |
| **RRS** | Resilience Rating System |
| **RDM** | Robust Decision Making |
| **SPEI** | Standardized Precipitation-Evapotranspiration |
| **TFP** | total factor productivity |
| **UNFCCC** | United Nations Framework Convention on Climate Change |

*All dollar amounts are US dollars unless otherwise indicated.*

# Introduction and objectives of the Resilience Rating System

Climate change and natural hazards cause economic losses that threaten development and long-term growth. Severe rainfall can cause mudslides and road washouts, while floods can contaminate water supplies. Higher temperatures can reduce the efficiency of electricity transmission and distribution, and place stress on grid networks from increased cooling demands. Droughts can harm livestock and crop productivity, while changes in rainfall patterns increase the risk of crop pest infestations that threaten food security. Resilience is the capacity to prepare for these types of disruption, recover from shocks, and grow from a disruptive experience.[1] Development agencies have committed to do more to boost the resilience of countries around the world. With the increase in attention to and investments in disaster risk management and climate change adaptation,[2] it becomes more important to track performance, progress, and development outcomes for resilience.

To better monitor adaptation and resilience-related action, the World Bank Action Plan on Climate Change and Resilience committed to create a Resilience Rating System (RRS) to complement existing methodologies on tracking climate-related finance[3] and increase ambition for climate-aligned development. The main objectives of the RRS are to:

» **Better inform decision makers, client countries, and other stakeholders.** The RRS provides specific assessment and reporting criteria that can be used to track resilience, either by how a project is designed or how it provides the tools, institutions, and infrastructure needed to cope with climate change impacts and natural disasters. The RRS methodology can be applied to any investment, including private sector projects.

» **Create incentives for more and better climate adaptation.** Enhanced transparency and standardized reporting can create financial incentives. Effectively communicating a project's climate resilience to potential investors can attract finance towards projects that are climate resilient or support climate resilience objectives.

» **Identify best practice.** The rating system can help identify best practice, allowing quicker and better learning to be scaled up from the best projects and practices across sectors and countries, within and outside the World Bank Group.

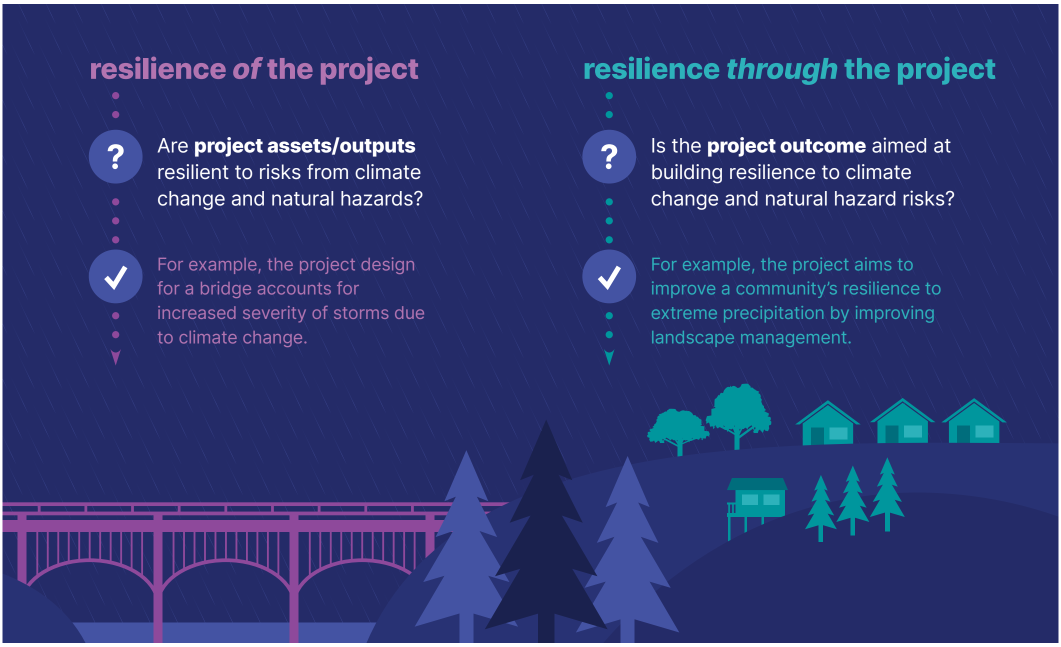
- » **Provide guidance.** The RRS provides guidance on ways to incorporate appropriate risk reduction measures into project design and improve the quality of development projects. It also accommodates flexibility for different sectoral and country contexts.[4]

The RRS does not attempt to solve all challenges related to tracking and monitoring climate change action. Rather, it aims to guide institutions, private sector participants, and project developers—especially in sectors that do not traditionally incorporate climate risk—that are looking to improve climate resilience in project design and outcomes. In parallel, the RRS helps streamline World Bank Group corporate climate commitments related to adaptation and resilience under one process.[5] Specific implementation guidance for World Bank Group operations will be part of a separate note, and sector-specific versions of this methodology will be developed over time.

Beyond the World Bank Group, other financial actors and development institutions can apply the RRS as an input in decisions to finance and implement projects, or to monitor (and report on) how they include climate change in their decision making. The RRS can also be a building block for rating portfolios, companies, and countries—for example, by aggregating project ratings in a portfolio. There are, however, different ways of aggregating ratings and this question is not treated in this document.

This introduction provides an overview of the rating criteria, a summary of the two dimensions for rating resilience, and examples of sector methodologies that correspond to certain ratings. The rest of the note and its appendixes offer more details on key principles, in-depth reporting criteria, project examples, and useful further resources. Developers can also use the note to guide them through the steps and processes needed to ensure their project is resilient to climate and disaster risks, or contributes to the population's resilience.

**FIGURE I.1** • Resilience *of* the project and resilience *through* the project




## How is resilience rated?

The RRS evaluates the resilience of the project design and resilience through project outcomes (figure I.1). Resilience *of* the project design (or simply, **resilience *of* the project**) is the extent to which a project's assets have considered climate and disaster risks in their design. This includes incorporating appropriate adaptation measures—for example, a road with improved drainage designed to prevent washouts—and accounting for climate and disaster risks in the economic and financial analysis demonstrating the viability and value of the project.

Resilience *of* the project can help characterize the confidence that investment outcomes will be achieved despite possible climate risks. Since acceptable risk levels vary across projects, sectors, and contexts, the resilience of project design does not provide a judgment on whether residual risks are acceptable. Instead, it measures how climate and disaster risks have been included in the assessment of the project value and performance.

Resilience *through* project outcomes (or simply, **resilience *through* the project**) reflects whether a project's objective is to enhance the targeted sector's and beneficiaries' climate resilience through its interventions—for example, project activities aimed at improving watershed management in a flood or drought-prone area.

While the lines between these two dimensions cross, the distinction is important for monitoring a portfolio of investments. All projects should be designed to manage climate risk and prevent maladaptation (resilience *of* the project). However, not every project needs to have activities or objectives aimed at increasing people's climate resilience (resilience *through* the project), as there are many other valid objectives.

The two dimensions are consistent with the concept of "double materiality", a concept for reporting on sustainability in the private sector. This combines the effects of environmental, social, and governance considerations on profitability and value creation with the additional non-financial societal value these considerations bring.[6]

**FIGURE I.2** • The Resilience Rating System: an overview

# Rating overview

This section provides an overview of the criteria for rating the resilience *of* and *through* a project (figure I.2). A project may be rated under both criteria.

## Resilience *of* the project

Resilience *of* the project is the first dimension of the RRS. This rating, expressed in letter grades A+ to C, characterizes the confidence in the project's ability to avoid financial, environmental, and social underperformance (compared with what is expected). A high rating denotes higher confidence that an investment will achieve its expected rate of return and the project will remain beneficial, despite any possible negative impacts of climate change. A low rating means that possible impacts of disasters and climate change on project performance have not been fully explored, and the project may be at higher risk of underperformance or failing to achieve its development outcomes.

This metric provides guidance to ensure that the decision to proceed with the project has considered, reported, and accounted for climate risks.[7] A high rating does not mean that a project does not face climate and disaster risks. Rather, it means that risks have been robustly assessed or addressed and do not threaten the project's viability and value. Note that a project may have significant risk and still be attractive and receive a high rating if the potential benefits are high enough, the residual risk is manageable or does not threaten the project's net gain, or the investor or decision maker considers the risk acceptable.[8]

The rating levels are defined below and depicted in figure I.3. Note that ratings build upon each other—for example, an A rating depends on meeting the criteria below it. See the "Reporting in project documents" sections in Chapters 1–4 for greater specifics and guidance. Table I.1 contains some examples of rating the resilience of project design.

**C** The project has conducted a basic climate and disaster risk screening. It has identified relevant short and long-term climate and disaster risks over its lifetime and provided a qualitative estimate of residual risks (high, moderate, or low) and a justification.[9] All World Bank projects are at least here through their fulfillment of the corporate commitment on climate and disaster risk screening.

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**B** The project has conducted a multi-model risk assessment[10] and identified, assessed, and considered adaptation options such as reinforced structures and improved maintenance. It also reports on identified threats, a qualitative level of residual risk, and on a rationale for including or rejecting possible adaptation options.

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**A** The project's economic and financial analysis incorporates a stress test on the residual disaster and climate risks and reports on how these risks do not make the project economically or financially unviable.[11] The project reports identified threats to project performance, considering uncertainty around disaster risks and future climate change and scenarios that can make the project uneconomical (if any). It also incorporates risk management measures where necessary or provides a rationale for why residual risk may be acceptable.

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**+** The project explicitly discusses the possibility of unexpected impacts based on a systematic analysis of uncertainties and risks that informs contingent planning. The + provides additional confidence for an investor or decision maker that a project will remain economically beneficial despite the possibility of negative shocks. Projects can achieve the + rating if preparation and design follow sector best practice guidance in terms of climate change resilience and decision making under deep uncertainty (DMDU).[12] The + can be added to both the B and A ratings.[13]

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**Special circumstances:** The rating system is to be applied even where data and models are not available—for example, in fragile, conflict and violence (FCV) contexts—which can lead to lower ratings. In these instances, decision makers may choose to accept a lower rating—for example, requiring a C rather than a B project rating. Other special ratings include:

**NA** **NA (not applicable):** The project is not exposed to climate change risks or a resilience rating is not relevant based on the nature of project activities or types of outcome.

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**NR** **NR (not rated):** The project is possibly exposed to climate change and disaster risks, but no information is available, or the risks are unmanageable and threaten the project's economic viability.

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## Implementation arrangements

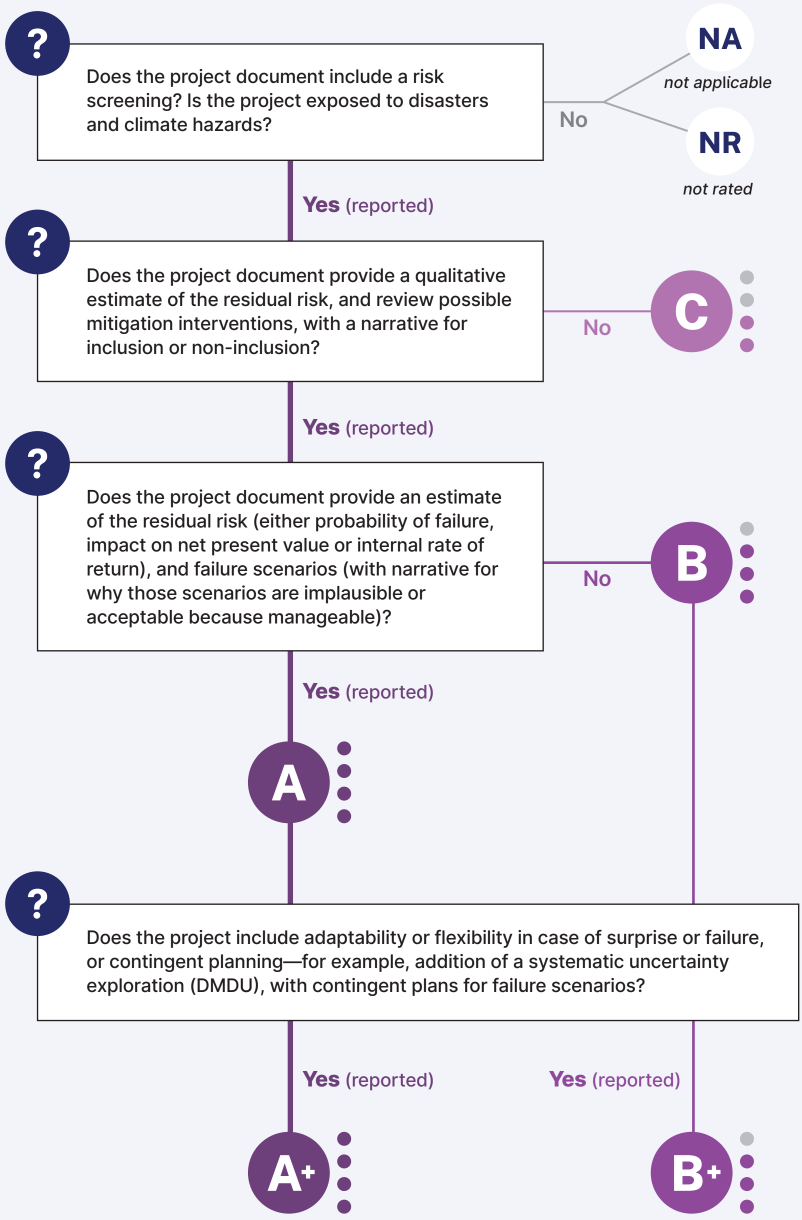
The steps required to achieve ratings C, B, or A can correspond to different stages in the project development cycle:[14]

» **Screening (rating C)** is best conducted at an early stage of project design (corresponding to the World Bank Group's "concept note" stage), so its results inform the project's development.

» **Assessment and adaptation options (rating B)** correspond to activities and negotiations taking place during project preparation (for the World Bank Group, at the "project preparation and appraisal" stage).

» **Residual risk stress testing (rating A)** can be performed before a decision is made to implement the project (at the World Bank Group, before the project goes to the Board of Executive Directors for approval, with disclosure in the appraisal documents).

**FIGURE I.3** • Decision tree for rating the resilience *of* the project



Although incorporating climate change and natural hazards into project design can correspond to basic stages in the project cycle, the process of identifying key risks, including adaption measures, stress testing, and revising project activities is an iterative one.

Some changes to the project during implementation—such as dropping a resilience-related activity or cancelling a planned risk analysis—can lead to a lower rating; others could lead to a rating increase. As the RRS primarily aims to support decision making, the rating is based on the information available when the decision to proceed with the project is made (for the World Bank Group, this is at Board level). However, given unexpected changes during project implementation and to better track resilience-building activities, ratings can be reviewed during implementation—for example, in the mid-term review—and at a project's close.

**TABLE I.1** • Examples of rating resilience *of* the project

| Sector | Project examples | Rating |
|---|---|---|
| **Transport** | Project developers identify vulnerability to extreme precipitation, incorporate appropriate hydrological analysis (considering watershed management) into road design, and take natural and engineered measures to revegetate/stabilize slopes. | B |
| **Water** | Project developers identify vulnerability to drought at the project location and conduct a detailed assessment of precipitation patterns, surface water, and impacts of reduced water availability on the project. The task team incorporates water use efficiency at facilities, such as gray water recycling, and aquifer recharge to reduce risks from water scarcity. | B |
| **Agriculture** | Project developers identify risks from pest outbreaks, flooding and shifts in seasonal patterns on crop yields based on a multi-model risk assessment. The team conducts an economic analysis that incorporates a climate and disaster risk stress test to determine whether measures for pest and landscape management are enough to make the project economically viable, even in a worst-case scenario. | A |
| **Transport** | Project developers identify the key risks to the project location—namely, floods and cyclones—and use flood likelihood maps to identify priority areas for enhancing road access and rehabilitation. The project's economic analysis uses DMDU methodology to capture different factors that may affect investment performance. Cost of failure and impacts on end users determine risk management measures, such as cleaning and repairing bridges and upgrading road culverts. The team creates a Geospatial Climate Resilience Tool to monitor changing climate conditions on roads and inform an adaptable implementation plan. | A+ |

## Resilience *through* the project

Resilience *through* the project is the second dimension of the RRS. This rating, also expressed in grades A+ to C, characterizes the extent to which projects explicitly contribute to the resilience of beneficiaries, communities, asset networks, or even countries. Such projects are intentionally designed with the objective or subobjective for improving resilience. The distinction between this and the first dimension is important, because not all development projects seek to improve resilience more broadly beyond the individual investments themselves being resilient to impacts from climate and natural hazards. Thus, this dimension helps prioritize and promote investments that support transformation towards resilient development pathways as they relate to current and long-term climate impacts.

The rating levels are defined below and depicted in figure I.4. Note that ratings build upon each other. An A rating depends on meeting the criteria below it. See the "Reporting in project documents" sections of Chapters 6–8 for greater specifics and guidance. Table I.2 contains some examples of rating resilience through project outcomes.

C The project is a standard development project that increases local income, reduces poverty, or provides beneficiaries with infrastructure or financial services that boost socioeconomic resilience. A C rating is based on the idea that lower poverty, higher income, and better access to infrastructure and financial services, health care and social protection increase resilience. All projects with development objectives (including World Bank Group projects) are rated at least C.

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B The project targets resilience building through specific activities and investments—that is, by helping people manage shocks brought on or exacerbated by climate and disaster risks. These activities are intentionally designed to contribute to resilience building by reducing identified vulnerabilities of beneficiaries, asset networks, or wider systems. At the World Bank Group, all projects with adaptation co-benefits will be at this level at least.

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A The project is transformational in improving resilience, influencing resilience or adaptation beyond direct outputs by affecting institutions, policies, incentives, capacities, and so on. For example, an A-rated project might affect upstream policies, country-level strategic plans or frameworks, system-level change, cross-sectoral collaboration or technology and data enhancements. Local ownership and high-level political buy-in are important for capacity building, empowerment, and lasting impacts.

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\+ As well as increasing the resilience of beneficiaries, the project uses at least one climate indicator to monitor the progress of those resilience-building activities and/or outcomes. Climate indicators that reflect resilience measures are thoroughly embedded in the project's overall theory of change or road map for achieving long-term goals, as part of its monitoring and evaluation strategy. The + rating can be added to both the B and A ratings.

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NR As with the first dimension, an NR rating is for special circumstances where a project may not report on its contribution to development, growth, poverty reduction, or resilience.

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## Implementation arrangements

The steps required to achieve B, B+, A, or A+ ratings correspond to different stages of project development:

- Identifying an intent to **build the resilience of the wider community, asset network or resource system**—a key part of establishing resilience *through* the project—can begin at an early stage of project design (for example, during the concept stage at the World Bank) and be informed by stakeholder dialogues. Identifying initial resilience-building components and activities (to achieve a **B rating**) can therefore be described in project concept notes.

- Projects aiming for **transformational development outcomes** should try to achieve the **A rating** criteria as early as possible in project design, embedding these development outcomes into the project's theory of change.

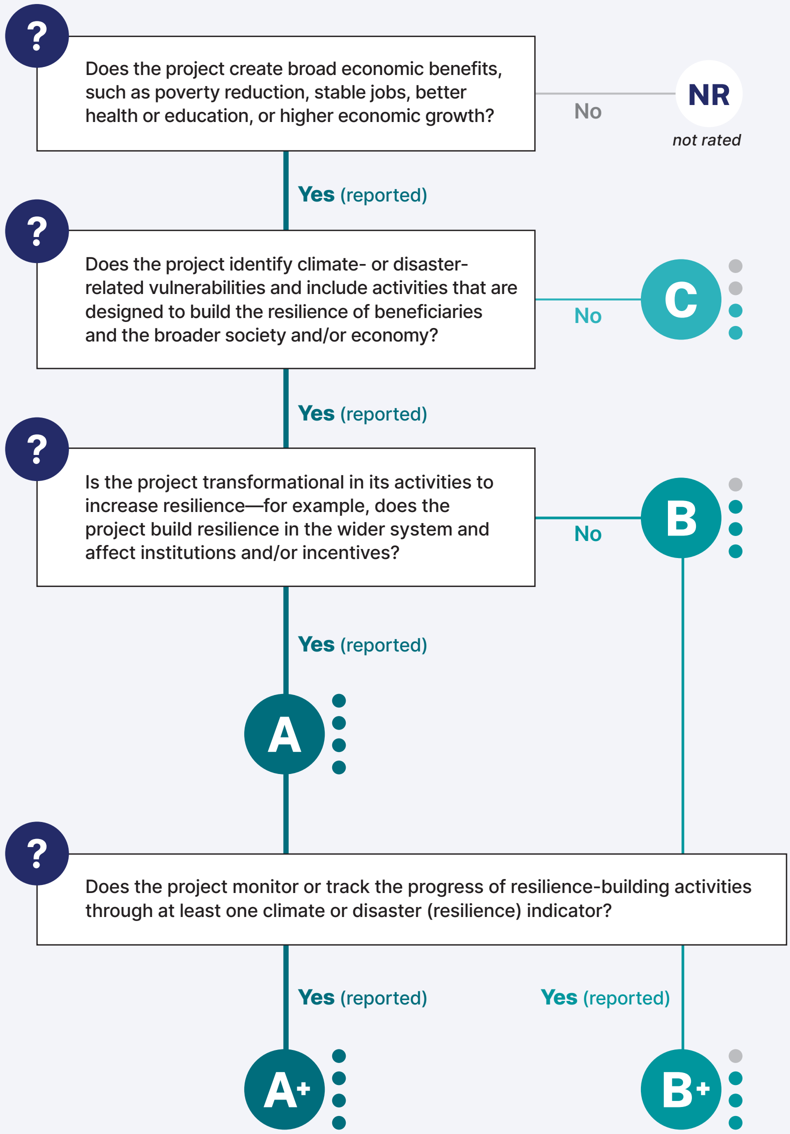
- Including **at least one indicator** to achieve a **B+ or A+ rating** can be solidified as the monitoring and evaluation strategy is developed during project preparation.

As with resilience *of* the project, ratings will be attributed when the implementation decision is made (for the World Bank Group, this is at Board level). But the rating can be adjusted according to project implementation to enhance project monitoring and ensure outcomes.

**TABLE I.2** • Examples of rating resilience *through* the project

| Sector | Project examples | Rating |
|---|---|---|
| **Agriculture** | The project team incorporates a project component that supports research on the impacts of climate change on crop varieties and climate-smart agriculture practices, such as crop diversification, to mitigate risks of crop failure. | B |
| **Transport** | The project integrates disaster risk management criteria into codes and zoning laws to make sure new roads, assets, and future developments are not built in a flood plain. Developing a disaster risk management plan ensures that the population can be quickly evacuated by road in case of extreme events. The project is considered transformational because the improved codes and laws will also improve the resilience of future projects and investments. | A |
| **Environment** | The project objective supports resilience through community-led watershed and landscape management by investing in green infrastructure. This includes rehabilitating degraded forest, pasture, and woodlands; strengthening land tenure security; and enhancing institutional decision making to support resilient landscapes. A climate indicator tracks the hectares of land implementing climate-smart agriculture practices. | A+ |

**FIGURE I.4** • Decision tree for rating resilience *through* the project



# Link with existing methodologies and approaches

This section provides an overview of sector methodologies that correspond to certain ratings. The other chapters and appendixes provide links to data and methodological resources that can help teams incorporate climate and disaster risk considerations in their project design[15] (see box I.1 for common principles of risk assessments that can be applied across the ratings). Another guidance document, *Integrating Climate Change and Natural Disasters in the Economic Analysis of Projects*, has also been developed for achieving an A rating for resilience *of* the project; and there are other, sector-specific documents on applying the RRS methodology to forest plantations, road projects, and urban projects.[16]

Of course, project developers—at the World Bank Group and elsewhere—already use guidance and other approved methodologies to incorporate resilience into their project designs, and the RRS is not meant to replace those. Instead, the RRS can be used to attribute a rating to these methodologies, which can then be transferred to projects that apply them. For example, projects following the World Bank's Water Global Practice guidelines—which help project developers build resilience of water supply and sanitation services by identifying vulnerabilities through stress-testing possible future scenarios and considering risk management in project design—would automatically gain an A+ rating. Table I.3 and Appendix 1 provide examples of where the (documented) use of sector methodology is enough for projects to receive a given rating.

**TABLE I.3 • Existing methodologies mapped to the Resilience Rating System**

*Some of these methodologies contain different levels of analysis that correspond to different resilience ratings.*

| Sector | Publication details | Rating |
|---|---|---|
| **Dimension 1: Resilience *of* the project methodologies** | | |
| **Water** | *Building the Resilience of WSS Utilities to Climate Change and Other Threats: A Road Map.* World Bank Group 2018. http://hdl.handle.net/10986/31090 | A+ |
| **Water** | *Resilient Water Infrastructure Design Brief.* World Bank Group 2020. http://hdl.handle.net/10986/34448 | A+ |
| **Water** | *Confronting Climate Uncertainty in Water Resources Planning and Project Design: The Decision Tree Framework.* World Bank Group 2015. http://hdl.handle.net/10986/22544 | A+ |
| **Water** | *Climate Risk Informed Decision Analysis (CRIDA): Collaborative Water Resources Planning for an Uncertain Future.* UNESCO and ICIWaRM Press 2018. https://agwaguide.org/about/CRIDA/ | A+ |
| **Water** | *Incorporating Climate Change Adaptation in Infrastructure Planning and Design: Overarching Guide.* USAID 2015. https://www.climatelinks.org/resources/incorporating-climate-change-adaptation-infrastructure-planning-and-design-overarching | B |
| **Water** | *Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans and Online Companion Tool for Vulnerability Assessment Reports.* US Environmental Protection Agency 2014. https://www.epa.gov/cre/being-prepared-climate-change-workbook-developing-risk-based-adaptation-plans | B |

| Sector | Publication details | Rating |
|---|---|---|
| **Dimension 1: Resilience *of* the project methodologies** | | |
| **Transport** | *Addressing Climate Change in Transport (Volume 2): Volume 2: Pathway to Resilient Transport.* World Bank 2019. http://hdl.handle.net/10986/32412 | A+ |
| **Transport** | *Supporting Road Network Vulnerability Assessments in Pacific Island Countries.* World Bank Group 2018. http://hdl.handle.net/10986/29691 | A |
| **Transport** | *FHWA Vulnerability Assessment and Adaptation Framework.* Federal and Highway Administration 2018. https://www.adaptationclearinghouse.org/resources/fhwa-vulnerability-assessment-and-adaptation-framework.html | A |
| **Transport** | *Climate Adaptation: Risk Management and Resilience Optimisation for Vulnerable Road Access in Africa—Climate Adaptation Options Report.* Paige-Green, P, Verhaeghe, B, and Head, M 2016. https://www.gov.uk/research-for-development-outputs/climate-adaptation-risk-management-and-resilience-optimisation-for-vulnerable-road-access-in-africa | B |
| **Transport** | *Climate Adaptation: Risk Management and Resilience Optimisation for Vulnerable Road Access in Africa - Climate Risk and Vulnerability Assessment Guidelines.* Le Roux, A, Makhanya, S., Arnold, K., Roux, M. Council for Scientific and Industrial Research, Paige-Green Consulting Ltd, and St Helens Consulting Ltd 2019. https://www.research4cap.org/ral/CSIR-PGC-StHelens-ClimateAdaptation-RiskVulnerabilityGuideline-AfCAP-GEN2014C-190926-compressed.pdf | B |
| **Hydropower** | *Hydropower Sector Climate Resilience Guide.* International Hydropower Association 2019. https://www.hydropower.org/publications/hydropower-sector-climate-resilience-guide | B to A+ |
| **Energy** | *The Good Practice Note for Energy Sector Adaptation.* World Bank 2020. [World Bank internal resource] https://worldbankgroup.sharepoint.com/sites/energy/Documents/Energy%20Resilience%20Good%20Practice%20Note/Energy%20Resilience%20Good%20Practice%20Note_Feb2020.pdf | A+ |
| **Energy** | *Guidelines for Climate Proofing Investment in the Energy Sector.* Asian Development Bank 2013. https://www.adb.org/sites/default/files/institutional-document/33896/files/guidelines-climate-proofing-investment-energy-sector.pdf | A |
| **Energy** | *Hands-on Energy Adaptation Toolkit (HEAT).* Energy Sector Management Assistant Program (ESMAP) 2010. https://www.esmap.org/node/312 | B |
| **Agriculture** | *Reducing the Vulnerability of Azerbaijan's Agricultural Systems to Climate Change: Impact Assessment and Adaptation Options.* World Bank 2014. http://hdl.handle.net/10986/18239 | A |
| **Agriculture** | *Agricultural Sector Risk Assessment: Methodological Guidance for Practitioners.* Agriculture global practice discussion paper, no. 10. World Bank 2016. http://hdl.handle.net/10986/23778 | B |
| **Agriculture** | *ARCC Vulnerability Assessments in Africa.* USAID. https://www.climatelinks.org/content/arcc/va/africa | B |
| **Forestry** | *Overview of a four-step approach to building climate resilience in plantation forestry projects.* World Bank, forthcoming.[16] | C to A |
| **Buildings** | *Building Resilience Index.* IFC 2020. https://www.resilienceindex.org | C to A |
| **General** | *Robust Decision Making.* RAND Corporation. https://www.rand.org/topics/robust-decision-making.html | A+ |
| **General** | *Real Option Analysis: Where are the Emperor's Clothes?* Borston, A 2003. http://www.realoptions.org/abstracts/abstracts03.html | A+ |
| **Dimension 2: Resilience *through* the project methodologies** | | |
| **Health** | *Protecting health from climate change: vulnerability and adaptation assessment.* WHO 2013. https://www.who.int/globalchange/publications/vulnerability-adaptation/en/ | A+ |
| **Health** | *Methodological Guidance: Climate Change and Health Diagnostic. A Country-Based Approach for Assessing Risks and Investing in Climate-Smart Health Systems.* World Bank 2018. http://documents1.worldbank.org/curated/en/552631515568426482/pdf/122328-WP-PUBLIC-WorldBankClimateChangeandHealthDiagnosticMethodologyJan.pdf | A |
| **Health** | *Assessing Health Vulnerability to Climate Change: A Guide for Health Departments.* CDC 2019. https://www.cdc.gov/climateandhealth/pubs/assessinghealthvulnerabilitytoclimatechange.pdf | B |

BOX I.1

# Common principles for risk assessments

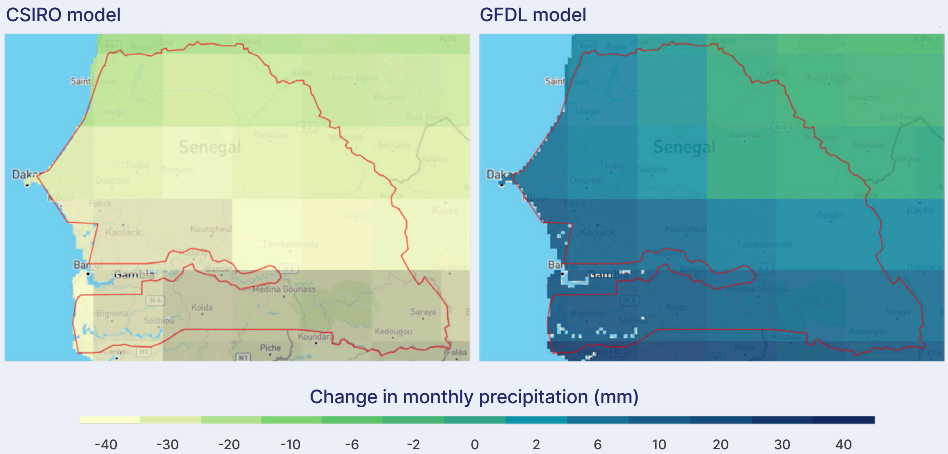
**Use climate indices to evaluate exposure and impacts.** When considering historical and projected trends in extreme weather—including temperature, precipitation, flooding, and drought—consulting relevant climate indices will provide a better understanding of the intensity, frequency, and duration of these events. For example, energy projects might consider projected changes in heating or cooling degree days that might affect peak demand; agriculture projects might consider rainfall seasonality changes or drought indicators; and transport projects might consider heat thresholds that may affect workers and pedestrians. See Appendix 2 for sectoral examples of climate indices and relevance to sector projects.

**Use multiple climate scenarios and data sources to manage uncertainty.** Future climate projections hold tremendous uncertainty, given the challenge of modeling complex earth systems. However, relying on historical weather and climate data may not be enough for designing climate-sensitive investments that may be highly vulnerable to changes in future risks. Acknowledging and managing uncertainty is important for creating robust project design, especially for projects with long lifetimes. Using multiple climate scenarios and data sources can help. For example, considering a high-emission representative concentration pathway (RCP) 6.0 (or even RCP 8.5, depending on the context,) as one scenario, and a low-emission RCP 2.6 as the other, can help cover the range of possible global climate change magnitude. Using multiple climate models is also essential to cover the range of climate sensitivities and local changes. This is because, for the same level of warming, models can have very different projections for rainfall (figure BI.1.1). The choice of climate scenarios depends on the context: the higher the stakes (in terms of lives at risk and economic impacts), the more important it is to consider the possibility of pessimistic "worst case" scenarios. See Appendix 4 for more information on managing uncertainty and climate scenarios. Trends based on models can be complemented by other sources, such as those derived from weather generators and statistical downscaling, as well as stakeholder consultations on recent weather/climate observations and expert opinions.

**Take into account relevant timescales for the project.** Developers should choose the timescales at which they consider climate indices and hazards to reflect the expected lifespan of the assets or systems covered by the project. Note that this lifetime tends to be longer than the time horizon of a World Bank project (which mostly cover design, implementation and construction) or even the time horizon of the contracting (for example, in a private-public partnership). The project timescale will inform whether the assessment focuses on longer-term climate change—or shorter-term climate variability. Climate change is particularly relevant over longer timescales—for example, 20- or 30-year trends—while climate variability may be more relevant over shorter timescales. The consideration of extreme events is relevant for both timescales.

**Go beyond monetary outcomes.** Like any project appraisal and assessment, it is critical to consider all outcomes, including those that are not naturally expressed in monetary form. In particular, climate risks from a project may materialize in the form of costs to health and well-being. For example, climate change may increase the impact of a water reservoir on malaria incidence in the area, and such an outcome needs to be part of the analysis, since it can potentially make a project undesirable. Depending on the methodology used, this can be done by either valuing the impact (that is, attributing a monetary value to the impact) or using multiple metrics—for example, combining monetary and non-monetary metrics to measure outcomes.

**FIGURE BI.1.1** • Precipitation change over Senegal in 2080–2099 (RCP 8.5 scenario), according to two state-of-the-art climate models, ranges from a substantial decline to a large increase




*Source:* World Bank's Climate Change Knowledge Portal.[17]
*Note:* CSIRO is Australia's Commonwealth Scientific and Industrial Research Organisation; GFDL is the Geophysical Fluid Dynamics Laboratory in the US.

# I. Resilience *of* the project

Resilience of the project design (or simply, **resilience *of* the project**), expressed in letter grades A+ to C, characterizes the confidence in the avoidance of financial, environmental, and social underperformance, compared with what is expected. A high rating denotes higher confidence that an investment will achieve its expected rate of return and the project will remain beneficial, despite the impacts of climate change. A low rating indicates that the project has not fully explored the impacts of disasters and climate change on its performance, so may be at higher risk of underperforming or failing to achieve its development objectives.

Ratings reflect a project's assessment of risks to assets and outcomes, not the risk profile of the project itself. A project may receive a high rating, despite significant risk, and still be beneficial if the payoffs are high enough. The purpose of the rating system is to help ensure that residual risks are transparent to decision makers, do not threaten the net gain of the project,[18] and are appropriately managed.[19]

**TABLE 1.1** • Resilience *of* the project: overview of ratings

**NR: not rated**

- The project is possibly exposed to climate change and disaster risks, but no information is available, or the risks are unmanageable and threaten the project's economic viability

**NA: not applicable**

- *Threats from natural hazards and climate change impacts are considered, resulting in no identified threat, or a narrative is produced on why the project is not exposed and a screening is not applicable, based on the nature of project activities or type of outputs and outcomes*

### C — Risk screening

- Threats from natural hazards and climate change impacts are considered
- Climate and disaster risk screening or similar sectoral guidance is applied
- *Identified threats and a qualitative estimate of risk are reported*

*Note: For each level, additional requirements are in italic.*

### B — Risk assessment and adaptation options

- Threats from natural hazards and climate change impacts are considered
- *A risk assessment is used or sectoral guidance on managing climate and disaster risk is followed*
- *Rationale for including or not including risk reduction and adaptation options is reported*
- Identified threats and a qualitative level of residual risk are reported

### A — Residual risk exploration and stress testing

- Threats from natural hazards and climate change impacts are considered
- Rationale for including or not including risk reduction and adaptation options is reported
- *After mitigation measures are included, a range of plausible residual risk and plausible impacts on the project benefits and costs are estimated through a stress test and reported in project documents*
- *A "failure scenario" is identified (what disaster or climate change scenario would make the project a bad investment), and a rationale of why this vulnerability is acceptable is reported*

### B+ / A+ — Contingent planning

Same as B or A, plus:

- *Uncertainties and risks over the lifetime of the asset/project—including the interaction of multiple risks and potential for risk compounding—are systematically explored, and the project's ability to monitor and adjust in case of unexpected conditions is reported*

# 1. Resilience *of* the project, C and NA ratings: risk screening

## 1.1 • Rating overview

A C rating is achieved when a project has completed a climate and disaster risk screening and identified relevant short and long-term risks over the lifetime of its assets or outputs. The project should report on identified threats and on a qualitative level of residual risk. Screening for climate and disaster risks is a key step to building resilience. Identifying risks at an early stage of project design can help inform climate-resilient project design by including appropriate measures to manage these risks.

## 1.2 • Key principles

Risk identification starts with an understanding of a project's location, components, and outcomes. Key principles for a C rating risk screening include considering:

» **Exposure.** Evaluate the extent to which the project location is exposed to hazards related to climate change and disasters, looking at both current and future climate conditions. A screening should consider historical and projected trends in: temperature and precipitation; sea level rise; extreme events, such as flooding, drought, wildfires, cyclones, storm surge; and geophysical hazards, such as volcanic eruptions and landslides that are relevant to the project location.

» **Impact.** Assess how climate change and disasters might affect the project through impacts on physical assets, beneficiaries, or outcomes. A screening should consider impacts on: physical infrastructure and assets, such as roads, hospitals, energy facilities; key beneficiaries, including vulnerable groups, such as women, children, the elderly, people with disabilities, migrants and displaced populations; and project outcomes, such as creating access to transport routes, providing clean water and sanitation, or strengthening food security.

» **Sector and development context.** Consider the sector, policy and socioeconomic context of the project. Institutional capacity and readiness at local, national, and sectoral levels can help reduce climate and disaster risks to a project, whereas low capacity and standards, weak policy and regulatory frameworks, and a lack of transparency can hamper a project's ability to effectively respond to identified threats.

**NA or NR ratings:** Considering these steps can also help project developers determine whether climate and disaster risks are not threatening the project. If the screening concludes that the project is not exposed to climate change risks or a resilience rating is not relevant based on the nature of project activities or types of outcome, it is rated NA. If there is not enough information for the screening, then an NR rating applies.

Screenings (and ratings) can be updated as more information becomes available. This could be further details on project location or activities, or access to locational studies. If a project identifies moderate or high risks related to even one hazard, or a currently low risk hazard is expected to become higher in the future, project developers are encouraged to follow the criteria for a B, A, or B/A+ level rating (table 1.1).

## 1.3 • Tools and guidance

The World Bank's Climate and Disaster Risk Screening Tools can help guide project developers through the key principles for a C rating.[20] Project developers can also follow sector-developed guidance where available (see Appendixes 1 and 3).

## 1.4 • Suggested timing in the World Bank project cycle

Ideally, screening should take place at an early stage of the project cycle and be discussed with relevant project stakeholders. For the World Bank, a screening can take place during the concept stage, to identify risks and use them to enhance the resilience of project design. Screening good practices for World Bank project teams include early engagement with sectoral and regional climate focal points, incorporating key findings from the screening in the project concept note, and discussing screening results at the project concept note review meeting.

## 1.5 • Reporting in project documents

For a C rating, project developers are required to report identified threats based on a qualitative estimate of risk. An NA rating should follow the same steps as a risk screening or include a narrative for why a risk screening is not applicable. The main goal is for project developers to understand the project's exposure to climate change and disasters, the potential impacts of this exposure, and how the broader development context could reduce or exacerbate these impacts.

Reporting requirements for a C rating include:

» Providing a qualitative estimate of risks in project documents. The screening should be as location-specific as possible, though country-level narratives may be used if localized information is not available. World Bank project documents can include the screening results in the "country context," "sectoral and institutional context" and/or "key risks" sections of project documents.

» Considering past and projected trends in temperature and precipitation and the occurrence, frequency, and severity of key hazards.

» Including a qualitative estimate and justification for determining risks as high, moderate, or low, including sources for climate data and scenarios, and the rationale used to determine the risk levels.

A basic understanding of the level of risk to a project should be based on information from quality-controlled sources such as:

- **ThinkHazard!** for identifying key hazards and understanding whether risks to a project location (at the country and subnational unit level) may be high, medium, or low.[21]

- The **Climate Change Knowledge Portal** (CCKP)[22] for information on historic and projected climate trends, vulnerabilities, and sectoral indicators for all countries (with country profiles and subnational data that can help identify the key threats to a project location).[23]

- **National meteorological agencies** for more localized climate information, accessed via the World Meteorological Organization's member resource page.[24]

- Client country Nationally Determined Contributions (NDCs),[25] National Adaptation Programmes of Action,[26] and National Communications to the United Nations Framework Convention on Climate Change (UNFCCC)[27] for outlines of sectoral priorities, needs and knowledge gaps.

See case study box 1 for an example of a C-rated project.

## 1.6 • Links with other World Bank climate change commitments

All World Bank International Bank for Reconstruction and Development (IBRD) and International Development Association (IDA) lending operations must be screened for climate and disaster risks during preparation.[28] This includes Investment Project Financing (IPF) and Development Policy Financing (DPF) and Program-for-Result (PforR) operations, including Additional Financing (AF), Multiphase Programmatic Approach (MPA), Emergency Operations, and Guarantees. Projects can achieve a C rating by fulfilling the World Bank's climate and disaster risk screening climate corporate commitment.

The analysis required for a C rating also has direct linkages with climate co-benefits, particularly for adaptation.[29] Adaptation co-benefits are assigned to project activities when the project document:

1. Sets out the project's climate change vulnerability context.

2. Makes an explicit statement of intent to address the identified climate vulnerabilities as part of the project.

3. Articulates a clear and direct link between specific project activities and the project's objective to reduce vulnerability to climate change.

To receive adaptation co-benefits, the project document must reflect these three key steps.[30]

The risk identification undertaken for a C rating can help project developers establish a project's climate vulnerability context. This is the first required step for achieving adaptation co-benefits, according to the multilateral development banks' (MDB) *Joint Methodology for Tracking Climate Adaptation Finance.*

The analysis required for a C rating can also inform a project's Environmental Social Framework (ESF), a World Bank requirement that applies to IPFs (including technical assistance projects) and IPF components of PforRs. The ESF requires borrowers to comply with 10 Environmental and Social Standards (ESSs), some of which have direct linkages to climate risk screening.[31] For example, if the risk screening identifies an increased risk of flooding, which could then impact occupational health and workers' safety, these results should be shared with environmental and social specialists.

CASE STUDY BOX 1

# A C-rated project: risk screening in project documents

| | |
|---|---|
| Country: | Yemen |
| Project name: | Third Additional Financing of the Emergency Health and Nutrition Project for Yemen |
| Project number: | P167195 |

This project contributes to basic health, essential nutrition, water and sanitation services provision to the population of Yemen, an FCV country. In the project paper, the task team identifies historical and projected climate change risks and the implications for food security, water scarcity, and health—key aspects of project interventions—as well as risk to vulnerable populations. It cites rising temperatures, drought, flooding, and extreme weather events that will exacerbate existing disease outbreak, malnutrition, and water security challenges. The project qualitatively assesses the country's vulnerability to climate risks based on information sources including CCKP, World Bank publications, and external references such the Notre Dame-Global Adaptation Index (ND-GAIN) Country Index. Note that for a C rating, project documents should also include a qualitative (low, medium or high) estimate of any risks. See excerpts from the project paper below and refer to the full project paper for more information and reference details.

**Excerpts from project paper *Appraisal Section* that fulfill C rating criteria (risk screening)**

**Climate change threatens food security in Yemen.** Average annual temperatures in the project area, already 1.4ºC above pre-industrial levels, are projected to rise by 3.3ºC by 2060 and 5.7 ºC by 2100. Recently observed drought-induced crop failure has caused starvation among farmers, and deeper food insecurity for women and children in both rural and urban areas. Agricultural output, which is below levels achieved half a century ago, could fall further at a time when over 80 percent of cereal grains are imported but not distributed due to blockades (FAO 2018). Small-scale artisanal fisheries, another vital source of nutrition and income in vulnerable communities, are rapidly declining as fish stocks plummet from climate-induced ocean acidification, deoxygenation, and habitat destruction. As food supply drops, prices rise further impairing the ability of the poor to adapt. The UN calls "the devastating food insecurity" in Yemen the world's worst humanitarian crisis since the institution was founded in 1945.

**Rising temperatures will also exacerbate water scarcity and natural disaster risk.** Yemen's limited surface water supplies evaporate faster in hotter weather, while its ground aquifers, already among the most stressed in the world, struggle to replenish amid arid conditions (World Resources Institute Aqueduct and World Bank 2018). Groundwater tables are declining between two and seven meters annually (Republic of Yemen 2015), and further depletion of water resources is expected to reduce agricultural output by 40 percent (World Bank 2010). When land, already severely degraded by conflict, refugees, and poverty, is exposed to higher temperatures and climate-induced variable precipitation, the results are catastrophic. Denuded biomass speeds the expansion of desertification, and flood damages consequently increase with the lack of vegetation to absorb rainfall. By 2050, water shortages are expected to reduce GDP in Middle East and North Africa countries by 6 to 14 percent (World Bank 2018). In ND-GAIN's rankings of countries' vulnerability and readiness to improve resilience, Yemen is one of the most vulnerable and least ready, ranking 167 out of 181 nations.

**Public health will suffer from climate change as well.** Nutritional deficits stemming from climate-induced food insecurity are projected to dramatically increase childhood stunting within coming decades. Livelihood disruption from extreme weather will aggravate mental health problems. Mortality and morbidity from heat-related illnesses, such as skin cancer, heat stroke, and cardiovascular disease, are also forecasted to rise as heat waves move from a current baseline of less than 10 days per year to 30 days per year by 2030 and 150 days per year by 2100. Premature deaths among the elderly could increase by 1,400 percent by the end of the century (WHO and UNFCCC 2015). More frequent storms and flooding are expected to amplify the incidence of infectious disease such as cholera, diphtheria, and dengue, which spread along water and mosquito-borne vectors. The warmer and wetter conditions forecasted in Yemen as well as greater water salinity from sea level rise promote the growth of vibrio cholerae bacteria. Flash floods, moreover, could contaminate water supplies with fecal matter and expand existing cholera outbreaks. Experts also predict a rise in schistosomiasis, lymphatic filariasis, scabies, and malaria cases.

Finally, more extreme weather, coupled with water scarcity and higher temperatures, will impair the ability of Yemen's health system to respond to the challenges above. Essential medical supplies and personnel may be unavailable after natural disasters thus limiting treatment options for cholera, diphtheria, and dengue—diseases that can be cured or prevented with antibiotics, freshwater (rehydration), vaccinations, and comfortable bedrest.

**Negative climate impacts will disproportionately affect Yemen's vulnerable populations.** Low income groups lack the resources to withstand higher temperatures, sea level rise, erratic rainfall, and other natural disasters (Hallegatte 2016; Wooden 2016; Verner 2013), and poor Yemenis make up half of the country's population. In 2016, Yemen's GDP per capita was US$660.28. Hence, citizens not only lack sufficient financial wherewithal to cope with climate shocks, but research also demonstrates that the bottom 40 percent in MENA [Middle East and North Africa] suffer the highest economic losses from extreme weather (Wooden, World Bank 2014). Climate-induced shocks, which reduce food security, water supply, and income levels, can be catastrophic for the vulnerable. In the short term, extreme weather contributes to injuries, household food insecurity, disease and disability, increased population displacement, and economic insecurity. In the medium term, Yemen's economy is expected to contract up to 24 percent by 2050 due to climate change (Verner, World Bank 2013).

# 2. Resilience *of* the project, B rating: risk assessment and adaptation options

## 2.1 • Rating overview

A B rating is achieved when a project conducts a risk assessment and identifies, assesses, and considers adaptation options. A risk assessment goes beyond a screening in that it evaluates a project's sensitivity to climate and natural hazards based on specific assets and applies a more in-depth analysis based on climate indices and models. Undertaking a deeper risk assessment, integrating considerations on climate change and disaster risks, and embedding measures to manage those risks can help ensure projects achieve expected outcomes. The B rating builds on the risk screening from the C rating to integrate adaptation options during project design.

## 2.2 • Key principles

Adaptation options will vary across sectors, regions, and the level of identified risk. Key principles to address identified risks include:

» **Proactively consider climate change and natural hazards when determining project location.** Projects should integrate information on historical and projected climate change trends and disasters when deciding on a project location. This includes changes in temperature and precipitation; sea level rise; extreme events such as flooding, drought, wildfires, cyclones, storm surge; and geophysical hazards such as volcanic eruptions and landslides. For example, project developers may want to build infrastructure away from flood-prone areas, consider relocating infrastructure (perhaps moving a road to higher ground), or identify hotspot areas that are particularly vulnerable to climate and disasters to ensure that project design can withstand heightened risks. Careful selection of the project location is often the most cost-effective way of reducing climate and disaster risks, but those risks need to be considered early in the project design (Hallegatte, Rentschler and Rozenberg 2019).

» **Adapt the project engineering design or technology.** Depending on the location, project developers can design assets to better withstand risks through natural or engineered protective measures. They can also increase resilience by:

- Incorporating materials, such as heat-resistant paving, or other flexible or expandable material investments
- Incorporating design features, such as safeguards for water and sewage systems, a dike around a power plant, or underground electric lines
- Adopting new technologies, such as crop varieties with better tolerance to extreme weather conditions and/or changing weather patterns, or electronic payment for social protection systems.

- **Consider the role of the project within the system and cross-sectoral solutions.** In many instances, projects integrate into a larger system. This is the case for network infrastructure—for example, the value of a bridge depends on the whole transport system around it. It is also the case for most economic development projects—for example, the value of agricultural production depends on upstream and downstream supply and value chains, which are affected by the transport, water, and energy sectors. Project developers should therefore consider risk management measures from a systems approach and look for cross-sectoral solutions.

- **Work with nature.** Natural infrastructure such as riparian buffer zones or revegetating unstable slopes can help to control water runoff and prevent damages to assets or roads during extreme precipitation. A transport project can be made more resilient—and avoid potentially high costs of rebuilding—by adding an afforestation and slope management component. Nature-based solutions can also create co-benefits in climate change mitigation.

- **Introduce adaptive management.** Resilient projects should allow investments to respond adaptively to newly emerging conditions and information. For example, a project may want to develop budgeting processes that account for higher maintenance costs to cover damages from hazards, increase the frequency of repair schedules, or implement changes in maintenance protocols. Projects should also consider flexible and dynamic approaches and avoid locking infrastructure into a location that is considered highly exposed.

- **Boost emergency preparedness and response capacity.** Projects may also establish emergency protocols to increase preparedness for extreme events—such as tropical cyclones—or support the development of early warning systems. For example, projects can help set up rapid emergency repair teams to restore damaged facilities more quickly, and install backup energy generation—in hospitals, schools, and so on—to accommodate disruptions in service. Establishing or expanding contingency budget reserves will also help address unexpected disruptions.

- **Use community engagement.** Engaging the broader community can help build project resilience. Conducting local stakeholder consultations and dialogues, and incorporating the feedback from these can enhance resilience and improve project outcomes. For example, partnering with local communities to ensure effective road maintenance can avoid heavy costs associated with further rehabilitation and reconstruction.

## 2.3 • Tools and guidance

There are multiple documents to inform teams on adaptation options in various sectors. Appendixes 1 and 3 contain a short selection of sector-specific resources that support risk assessments and the consideration of risk management measures (focusing on World Bank Group and other development partners' guidance notes).

The World Bank's Climate and Disaster Risk Screening Tools, "in-depth assessment" option also provides guiding questions that can help project developers through a detailed consideration of relevant hazards to start thinking through resilience options.[32]

Useful tools for this rating include hazard mapping or an in-depth vulnerability and climate and disaster risk assessment.

## 2.4 • Suggested timing in the World Bank project cycle

A risk assessment and identification of adaptation options can take place alongside other project preparation activities. World Bank project developers should engage with sector and regional focal points and discuss options for integrating climate and disaster risk considerations into project design. The project team can discuss risk assessment results and identified adaptation options in the appraisal stage project documents.

## 2.5 • Reporting in project documents

For a B rating, project developers are required to report on identified threats and include a qualitative estimate of risk level to the project. They should also include a rationale for including or rejecting possible adaptation options—for example, going through the seven key principles outlined in Section 2.2. Such options should be based on identified climate impacts for the project itself and context-specific knowledge of climate vulnerabilities, based on factors such as location, beneficiaries, and sector. For example, an adaptation option for a project that may be impacted by increased flooding may not be valid for another project that may be impacted by more severe drought.

Reporting requirements for a B rating include:

» Providing a qualitative estimate of risks in project documents and justification for determining risks as high, moderate, or low. This should include more detailed information from the risk assessment and assessment methodology—for example, from sector guidance. World Bank project documents can include the screening results in the "country context," "sectoral and institutional context" and/or "key risks" sections.

» Risk assessments must: consider relevant climate indices (see Appendix 2 for examples) to evaluate the frequency and severity of identified hazards to the project location; include multiple climate scenarios to account for different climate futures; and use the timescale relevant for the project outputs and assets built (box I.1). For threats identified as high or moderate, the assessment must consider possible adaptation options (for example, in the seven categories listed in Section 2.2) to manage risks and provide a rationale for inclusion or exclusion. World Bank project documents can include these discussions in the "project description," "key risks," or other relevant sections.

See the case study box 2 for an example of a B-rated project.

CASE STUDY BOX 2

CASE STUDY: B-RATED PROJECT

# A B-rated project: integrating resilience measures in project documents

| | |
|---|---|
| Country: | Sierra Leone |
| Project name: | Integrated and Resilient Urban Mobility Project |
| Project number: | P164353 |

This project aims to improve the quality of public transport, address climate resilience, enhance institutional capacity, and improve road safety in selected parts of Sierra Leone's Western Area. The project appraisal document identifies climate and disaster risks to the project in the "country context," "sector context" and "technical" sections, and includes a sector-specific assessment. It also integrates risk management measures in the project design under the "project description" section. The project's multi-hazard risk assessment highlights particularly vulnerable locations and incorporates resilient road design features based on sectoral guidance notes. Note that for a B rating, project documents should also include a qualitative (low, medium, or high) estimate of residual climate risks. See excerpts from the project appraisal document (PAD) below and refer to the full PAD for more information and reference details.

### Excerpt from *PAD Country Context Section* that fulfills C rating criteria (risk screening)

The fragile socioeconomic recovery of Sierra Leone and Western Area has been hindered by frequent impacts of climate and natural disasters in coastal and southern areas. Sierra Leone has a tropical climate with a rainy season from May to October and a dry season from November to April. Mean annual rainfall for the entire country is around 2,500 mm, the eleventh highest in the world and the second highest in Africa, just behind São Tome and Príncipe. Coastal and southern areas, including Western Area of Sierra Leone, experience severe rainfall patterns with annual precipitation between 3,000 and 5,000 mm per year, peaking to more than 800 mm of rainfall monthly in July and August. These torrential storms often disrupt communications and transportation nationwide, damage people's homes and agricultural production, and cause erosion. From 1998 to 2018, natural disasters related to intense rainfalls killed more than 1,200 people and affected more than 50,000. Climate change is projected to increase the frequency of heavy rainfall events during the rainy season and the projected sea-level rise may exacerbate flooding events, especially in coastal areas and Western Area.

### Excerpt from *PAD Sectoral and Institutional Context Section* that fulfills C rating criteria (risk screening)

Western Area's transport system is highly exposed and vulnerable to climate change and natural disasters, especially to flash floods and landslides. The city's geography causes transport services and infrastructure to be highly exposed to climate change risks and natural disasters. The many waterways

## CASE STUDY BOX 2
*continued*

that cross the city's poorly engineered and constructed roads drain runoff from hilly areas. Moreover, many roads are exposed to rainfall-induced landslides due to the steep, unstable slopes in the central highlands. Climate change will aggravate this risk: projections indicate an increase in maximum one- and five-day rainfall, especially from July to September. This risk was evidenced by the August 2017 landslides and floods that resulted in the need for an estimated US$5.4 million for transport sector recovery alone.

### Excerpt from *PAD Project Description Section* that fulfills B rating criteria (risk assessment and adaptation options)

Investments follow two strategic pillars: integrated corridor management and resilience accessibility improvement. Interventions under the first pillar aim to improve accessibility and road safety with specific engineering design to mitigate climate change impacts. The objective of the second pillar is to adapt the urban mobility to the impacts of climate change and therefore target the most climate vulnerable areas in the city. Civil works will focus on: (a) improving road conditions and rehabilitating key road sections; (b) improving drainage capacity; (c) slope stability interventions; (d) traffic management, signalization, parking, and intersection improvements; (e) pedestrian infrastructure; and (f) constructing off-street transit terminals and markets.

The project considers climate adaptation and resilience throughout its life cycle, including planning, engineering, operations, contingency planning, and overall capacity building, as emphasized by the recent Transport Global Practice (GP) World Bank Guidance Note.[33] This project includes in its design the lessons learned from said Guidance Note and best practices in each of the life-cycle phases. Through technical assistance, the project has used network science to evaluate the impact of natural hazards (for current and climate-change projections) on urban mobility. This analysis has served to provide recommendations on enhancing climate resilience in project design. The project also proposes several activities to address the lack of awareness and capacity to deal with climate-change impacts in the transport sector.

### Excerpt from *PAD Technical Section* that fulfills B rating criteria (risk assessment and adaptation options)

The project has built an innovative region-wide spatial analysis to prioritize mobility services. The prioritization framework integrates the following criteria: (a) actual and potential access to economic opportunities (i.e., jobs, access to key sectors for economic diversification such as tourism, port); (b) access to social opportunities (i.e., education, health); (c) climate-related impacts (floods and landslides, based on the multi-hazard and risk assessment); and (d) socioeconomic data, including data on poverty, gender and disabilities. The accessibility analysis will assess who is actually benefiting from the interventions and make it possible to prioritize those interventions that benefit excluded groups (for instance, low-income residents, women, and people with disabilities). The prioritized project area is chosen following close collaboration and coordination with ongoing and planned development projects in

CASE STUDY:
B-RATED PROJECT

the Western Area (tourism, health, education, urban, etc.). Annex 1 [an annex in the PAD] details the methodological framework to prioritize mobility services and infrastructure.

All interventions were screened through a double climate-resilience technical assessment: resilience of the interventions and resilience through the interventions. The technical assessment included a multi-hazard and risk assessment to prioritize interventions that will bring overall resilience to the mobility of people in Western Area through the interventions. This included the use of climate projections and state-of-the-art network resilience analysis to ensure that the project design can accommodate climate network disruption of other parts of the city and enhance resilience of the urban transport system *through* the project itself. Once these interventions were selected, a risk assessment was used to identify mitigation measures to enhance the resilience of the intervention itself in order to adapt and mitigate future damage from climate-related impacts (floods, costal erosion and landslides). The list of climate adaptation measures [in an annex of the PAD] was then shared with the local technical consulting team preparing the bidding documents for project interventions [under Sub-component 2.1 of that project].

## 2.6 • Links with other World Bank climate change commitments

The analysis required for a B rating has direct linkages with climate adaptation co-benefits. As with the C rating, information from the B rating can help inform a project's climate vulnerability context. This is the first required step for achieving adaptation co-benefits. Including adaptation options and accompanying rationale can also help inform the project's intent to address climate vulnerabilities and articulate the direct link between specific project activities and identified vulnerabilities, the other two requisite steps according to the MDBs' *Joint Methodology for Tracking Climate Change Adaptation Finance* (African Development Bank et al. 2020).

As with the C rating, the analysis required for a B rating can also inform a project's ESF, a World Bank requirement which applies to IPFs (including technical assistance projects) and IPF components of PforRs. The ESF requires borrowers to comply with 10 ESSs, some of which have direct linkages to climate risk screening.[34] For example, if the risk screening identifies an increased risk of flooding, which could then impact occupational health and workers' safety, these results should be shared with the environmental and social specialists.

# 3. Resilience *of* the project, A rating: residual risk exploration and stress testing

## 3.1 • Rating overview

A project moves from a B to an A rating when project developers also incorporate a climate and disaster risk stress test in the project's economic and financial analysis and report on how, after risk reduction measures are included, residual risks do not make the project economically or financially unviable. In most cases, uncertainty is too large to provide a precise estimate of residual climate risk, and such an estimate is not required. Instead, project developers can perform a stress test on the residual risk and report on whether a project is robust or the consequences remain acceptable, given low probabilities, limited consequences, or inclusion of risk mitigation measures.

## 3.2 • Key principles

There are multiple ways to quantify climate impacts, and an A rating does not require a specific methodology to be applied. However, there are key principles for a robust methodology and requirements on the information that is disclosed. They include:

» **Assess impacts from changing average climate conditions and extreme events.** Project developers should consider how:

- The change in average climate conditions can affect the costs and the benefits of the project, including capital and operational expenditures, (CAPEX and OPEX) as well as non-market benefits such as ecosystem services
- Extreme events and natural hazards (floods, droughts, etc.) affect project costs and benefits
- Climate change can affect the likelihood and intensity of those hazards.

  Project developers should use recent literature, historical observation, and databases such as ThinkHazard! or CCKP[35] to identify the range of different hazards affecting the project, such as extreme temperature, flooding, cyclones, and so on. They should evaluate changes in climate conditions at a seasonal as well as annual basis to account for arid/wet extremes. See Appendix 3 for further resources.

» **Apply ranges to properly account for uncertainties.** The assessment should not try to predict future climate change or disaster impacts; rather, it should explore whether plausible scenarios can make the project fail. To do so, developers can consider no/low-impact and high-impact scenarios to account for uncertainty around climate change projections. When a project can fail catastrophically, it is better to identify low-probability risks than to miss important vulnerabilities. An economic or financial analysis based on a single model or scenario is insufficient. See Appendix 4 for guidance on managing uncertainty.

» **Stress test and establish a threshold.** Since it is often impossible to predict future impacts precisely, it is useful to identify "switching scenarios"—that is, scenarios in which the project does not bring significant benefit—or thresholds above which project outcomes are still acceptable, but below which a project should consider redesigning to include further resilience measures. For example, a drainage system is beneficial, unless precipitation increases by more than 25 percent in the area. Project developers are also encouraged to consider how climate change may interact with or exacerbate non-climate development challenges: if projects are viable even under very pessimistic scenarios, they can be considered robust and further analysis is not needed.

## 3.3 • Tools and guidance

Detailed guidance on how to include disaster and climate risks into an economic analysis is provided in the forthcoming *Guidance Note on Integrating Climate Change and Natural Disasters in the Economic Analysis of Projects*, with examples from three different sectors.[36] The World Bank team developed a simple tool—the *Risk Stress Testing Tool* (RiST)—to help project developers include climate change impacts and natural disasters into a project's economic analysis and produce the information needed to achieve an A rating. However, the RRS does not require the use of a specific tool or methodology, and Appendixes 1 and 3 provide examples of other sector methodologies that fulfil the A requirement.

## 3.4 • Suggested timing in the World Bank project cycle

To achieve an A rating, project developers should perform a residual risk quantification before a decision is made to implement the project. At the World Bank Group, this is before the project goes through to Board approval. The disclosure of residual risks should be included in the Board approval stage project documents. Fulfilling the C-rating risk screening criteria and considering B-rating risk management measures can help inform the criteria needed for an A rating.

As outlined in box 3.1, if the technical information required for this analysis is not available at Board approval stage, the assessment should be based on the likely design, existing norms and regulations in the country, and project operation manuals, with the option of revising the rating once the design is available.

BOX 3.1

# What if project design is not finalized? Or if the design is simply based on existing standards?

There are cases in which the exact technical design of a project is not available at the time when a project is rated and before the decision to approve or a reject a project is made (for example, for World Bank framework projects). It is also often the case that projects are approved before all the technical and engineering studies have been done. In other cases, the project design follows existing industry practice—for example, on the dimensions of a drainage system—without specific additional analysis for the project.

In these cases, the resilience rating attributed at the time of decision making should be based on the intended design, existing norms and regulations in the country, and project operation manuals. At the World Bank Group, this decision occurs when the project goes to the Board of Executive Directors for approval. Two cases are possible:

**Design methodology.** The project can be rated A, B, or C if the intended design is to be determined with a methodology that is consistent with an A, B, or C rating. In that case, the project needs to report on the process in place to ensure that the methodology will be implemented as intended. Ratings can be revised during implementation or at project completion, if the design has deviated from what was originally planned.

**Industry standard.** The project can be rated A or B if it follows an industry standard or local norms or regulations that are consistent with an A or B rating. In the case of an A rating, it means that the standard or regulation is based on the quantified assessment of a residual risk that incorporates current and future climate change and natural hazard impacts as projected by multiple models. In these cases, project documents must report how the standard fulfills the reporting requirements of the rating. Without further analysis and disclosure, following an industry standard or the local regulations, is not in itself enough for a B or A rating.

## 3.5 • Reporting in project documents

Reporting requirements for an A rating include:

- » Reporting on the selection of climate change scenarios and the rationale behind hazards considered in the analysis. Since localized studies may not be available, it is acceptable to use regional estimates, values from countries with similar climate conditions, or expert estimates.

- » Presenting results of the analysis as a range, covering possibilities of low and high climate impacts, and optimistic and pessimistic project scenarios due to non-climate related factors, such as possibility of project delays, elite capture, low uptake, and so on. Results can use various metrics, depending on the project sector and context, including traditional net present value (NPV) or benefit-cost ratios (BCRs), possibly complemented by non-market indicators, such as distributional impacts.

- » If the analysis suggests that the project could fail in at least one scenario (for example, if the NPV or the BCR fall below a given threshold), then the project document should identify at least one scenario that makes the project fail and provide a narrative for why this identified risk is acceptable—for example, low plausibility, manageable consequences of failure, or acceptable risk, considering the magnitude of the benefits in other scenarios. Failing that, it should consider revising the project design to manage residual risks.

See case study box 3 and box 3.2 for examples of an A-rating project and a template for reporting disaster and climate risk in project documents.

CASE STUDY BOX 3

# A-rated projects: residual risk exploration and stress testing in project documents

Review of existing World Bank projects did not identify any that include the information needed to achieve a rating A in their project documents. However, tests on a few World Bank projects showed that it is possible and easy to add a stress test to their existing economic analysis to explore residual disaster and climate change risks. The examples included in this section use the *Guidance Note on Integrating Climate Change and Natural Disasters in the Economic Analysis of Projects*,[39] and the associated RiST Excel tool, to ensure that even high-impact climate change scenarios cannot threaten the project economics.

| | |
|---|---|
| **Country:** | **Uganda** |
| **Project name:** | **Agricultural Technology and Agribusiness Advisory Services (ATAAS) Project** |
| **Project number:** | **P109224** |

This project, which closed in 2018, built on previous World Bank engagement to increase the agricultural productivity and incomes of participating farmers. The project focused on strengthening agricultural research and extension systems for improved technologies and advisory services. However, changing rainfall patterns, drought, pest outbreaks, and flooding—challenges exacerbated by climate change—threatened to put project development objectives of increasing crop yields and farmer incomes at risk. Meanwhile, actions to mitigate climate impacts, such as setting up irrigation systems or rehabilitating storage facilities, would have increased project costs. When combined with other non-climate risks such as implementation delays and government turnover, these challenges could have resulted in a reduction of project benefits, increase in project costs, and significant project underperformance. The inclusion of activities to manage the agriculture sector's high sensitivity to climate change and disasters enabled the project to be more resilient—potentially increasing the net benefits of the project under climate and disaster scenarios. This sample write-up of the results from a hypothetical climate and disaster risk stress test are based on the project's economic analysis. The estimates used are based on the project's economic financial analysis (EFA), a literature review, climate data sources, and other approximations. Best practice entails engagement with the task team and on-the-ground expertise for more accurate estimates.

**Hypothetical excerpts from PAD *Economic Analysis Section* that fulfill A rating criteria (risk stress testing)**

**Under a high climate impact scenario, the project is robust.** A stress test was conducted on the project's economic analysis that accounted for the impacts of changes in average climate conditions as well as disaster shocks. Impacts due to change in average climate conditions were assessed based on effects on crop yields, prices, and increases in cost over the project's lifetime, evaluated from 2010–2030.[40] The disaster shocks considered included droughts/change in rainfall patterns, pest outbreaks, and flooding.[41] The analysis used RCP 2.6 and RCP 8.5 emission pathways[42] to assess the low and high range of impacts.[43] The results show that, even when considering high climate impacts and pessimistic project performance,[44] project performance remains at an NPV above zero and a BCR above one (table CSB3.1). The project NPV remains above zero despite a relatively high discount rate—12 percent compared to the typical 6 percent (figure CSB3.1)—which further suggests robustness. This is largely due to the incorporation of risk management measures, which enhance the value of the benefits with the project scenario as compared to without the project in the event of climate shocks. Under a worst-case scenario—where no total factor productivity (TFP) spillovers occur

**TABLE CSB3.1** • Results under four extreme scenarios (climate impact and baseline pessimism)

| Adjusted NPVs and BCRs | | |
|---|---|---|
| Baseline scenario: | Optimistic | Pessimistic |
| **No/low climate impact:** | | |
| NPV ($, millions) | 767.22 | 140.59 |
| BCR | 2.13 | 1.21 |
| **High climate impact:** | | |
| NPV ($, millions) | 632.65 | 130.61 |
| BCR | 1.57 | 1.12 |

*Note:* The numbers in blue indicate that, in both low and high climate impact scenarios and optimistic and pessimistic project scenarios, the NPV and BCR remain above an acceptable threshold (NPV>0 and BCR>1).

to farmers not receiving inputs is coupled with high climate impacts—climate impacts would need to be 60 percent more than current high estimates to cause the NPV to be zero. However, under a worst case scenario, the BCR is close to the "switching scenario", in which the project may fall below an acceptable level of performance (a BCR of 1.12).

**Sensitivity analysis of climate impacts:** The results of the sensitivity analysis reveal that impacts of non-climate events on the project baseline—such as low technology adoption by farmers—may have the largest effect on the project NPV. However, of the impacts related to climate change in a worst-case scenario, the magnitude of extreme events and their change in frequency are key risk areas (figure CSB3.2). Impacts from the magnitude of extreme events reflect hazards such as flooding, pests, and droughts/change in rainfall patterns, which can have devastating outcomes. While project activities mitigate these risks, the analysis suggests that investing in early warning systems or ensuring social safety nets for farmers in the event of extreme disasters could help to boost project resilience.

**Analysis baseline:** The starting point of the analysis is based on the project's economic financial analysis, where costs reflect project investment costs and benefits were calculated as the net of "with project" and "without project" interventions over the project's 20-year lifetime. "With project" benefits were assumed as gains from:

- Increased yields from growth in TFP

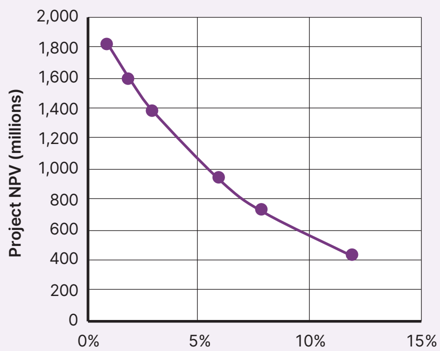
## CASE STUDY BOX 3
*continued*

- Increased yields from more intensive use of inputs
- Shifts in the enterprise mix to more profitable commodities
- Marketing yielding higher farm-gate prices as a share of wholesale prices arising from stronger agribusiness and great integration of smallholders in the value chain.

In addition to this project baseline, the analysis considers another "pessimistic" scenario, in which benefit and cost streams are adjusted under a scenario where the project fails to induce TFP spillovers to farmers not receiving inputs.

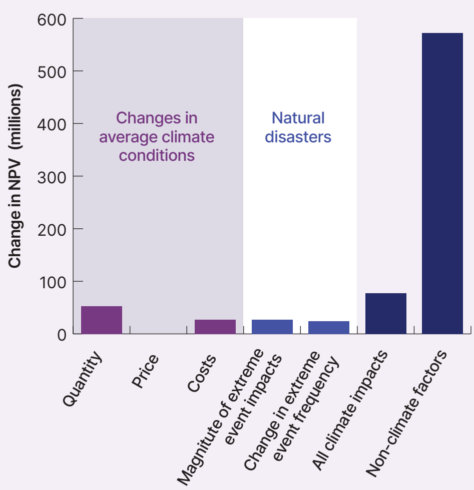
**Incorporating the impacts of a change in average climate conditions:** This analysis accounts for possible impacts on expected project benefits in terms of yields and prices due to changes in average climate conditions. The analysis assesses a range of low to high impacts based on the 13 priority crops identified in the project and the average yield impact across crops.[45] Changes in price are assumed to remain the same in the event of yield increases or decreases—for example, a drop in yields might not reflect a subsequent increase in price due to trade, lag in price responsiveness to changes in supply, and farmers' lack of bargaining power to set prices. Data from Hallegatte et al. (2015) and the RegioCrop online platform[46] highlight that cassava, Irish potato, and groundnut may be among the crops most affected by climate change.[47] Given that the project also identified cassava and groundnut as two of the three highest value-added enterprise crops to shift towards, the project benefits from making this switch are at risk. However, crop diversity in the project does allow farmers to adapt to less climate-sensitive crops. The analysis also considers additional costs from fuel/transport.[48]

**FIGURE CSB3.1** • Impact of the discount rate on project NPV




*Note:* Even with a higher discount rate, the project NPV remains viable (above zero).

**FIGURE CSB3.2** • Sensitivity analysis



**Incorporating the impacts of disasters:** The three disasters considered in the climate and disaster stress test analysis include impacts from drought/change in rainfall patterns, pests, and storms/flooding. Negative impacts of disasters on yields with and without the project were differentiated. Estimation of impacts on "without project" yields is based on a literature review from past extreme events in Uganda and East Africa (Mubiru et al. 2018; Leng and Hall 2019; FAO 1997; FAO 2008). As the project includes a focus on developing drought-resistant seeds, the impacts of drought/change in rainfall patterns are greater without the project than with it.[49] Estimated additional costs associated with drought are estimated based on labor costs (for example, setting up additional irrigation mechanisms, time gathering water supplies, and so on).[50] Similarly, the impact of "with project" pest outbreaks on crop yields compared "without project" is mitigated by pest management techniques for Fall Army Worm, and crop varieties that are better able to withstand Cassava Mosaic, Brown Streak and banana wilt diseases established *through* the project.[51] The estimate of additional costs from a pest outbreak were based on the increased need for inputs.[52] Project interventions for sustainable land management practices also help mitigate the impacts of flooding.[53] The costs associated with storm and flood events is based on increased labor and/or infrastructure costs that could result from introducing drainage, replanting, new storage facilities, increased transport costs from washed out roads, and so on.[54]

The results of the analysis show that mitigating the impact of major floods, and thus including sustainable land management practices—such as terracing, grass bunding, low-till conservation agriculture, rehabilitating or reclaiming degraded watersheds, agroforestry woodlots, and so on—to control floods may offer high returns on risk management.

**Incorporating the impacts of a change in disaster frequency and severity:** Droughts/change in rainfall patterns, pest outbreaks, and flooding events are all projected to increase during the project lifetime.

**Droughts:** Estimated changes in drought/rainfall pattern frequency are based on CCKP projections for Uganda (see figure CSB3.3 for RCP 8.5 scenario). Projections contain a high degree of uncertainty. Under projected trends using both RCP 8.5 and RCP 2.6 scenarios, there is a slight increase in the projected range of change in annual severe drought likelihood  while the median or minimum projected change is negligible.[55] Increased average temperatures—especially during Uganda's dry season from June-August—may also exacerbate drought and impact the growing season duration.

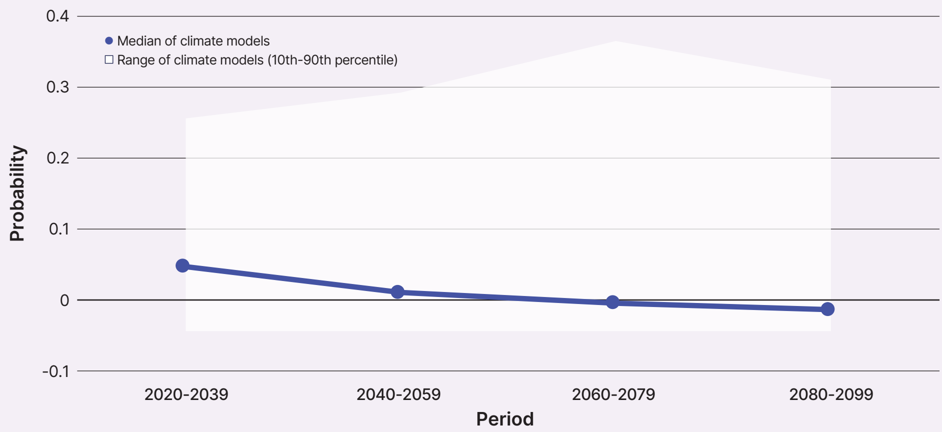
**Pests:** Estimated changes in the projected frequency of pest outbreaks are based on internal calculations and a literature review. East Africa's severe locust outbreak of 2019–2020 is similar to the one which occurred in 1956. Because two major outbreaks occurred in the last century, we estimate a 1-in-50 likelihood of such a pest outbreak each year, in current conditions. Other studies have shown that locust breeding may have been affected by the Indian Ocean Dipole, which has led to wetter conditions and improved locust breeding grounds (WMO 2020).

Projections suggest that the situation that may have led to the latest pest outbreak could double in frequency in the future (Cai et al. 2018); so the pessimistic scenario assumes almost a doubling in the frequency of locust outbreak; the frequency remains unchanged in the optimistic case.

**Flooding:** Estimated changes in the projected frequency of flooding events is based on CCKP data for Uganda (figure CSB3.4). The future change in rainfall of very wet days—defined as the top 5 percent of precipitation events—reflects a range of outcomes and uncertainty. This analysis assumes a maximum increase in frequency of around 40 percent under a high-impact RCP 8.5 scenario in the 2030 timeframe,[56] and at minimum, remaining relatively unchanged. RCP 2.6 projections reflect a similar range. The projected changes in very wet days by month (figure CSB3.5) show the greatest increases will overlap during Uganda's rainy seasons—April through May and August through October—which could further exacerbate flooding events.

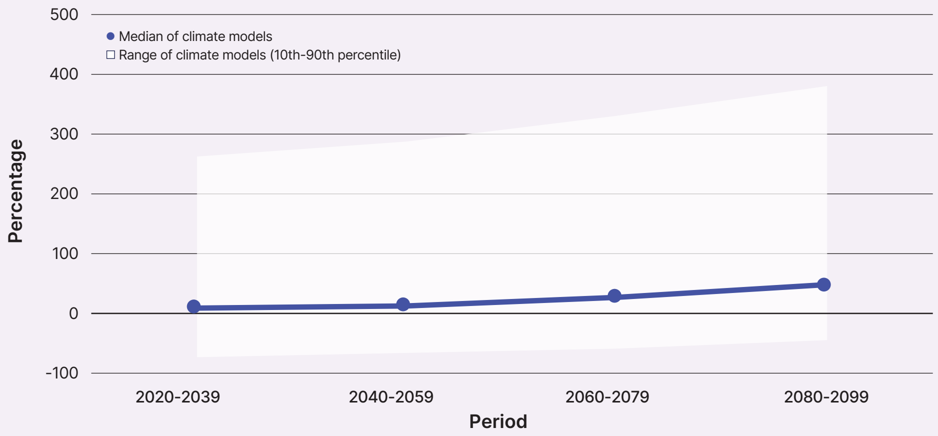
**Summary:** The incorporation of resilience measures to climate change and disasters enhance project robustness—however, given the extreme sensitivity of agriculture to climate risks, more may be needed. The incorporation of risk management measures enhances the value of "with project" benefits as compared to "without project" in the event of climate shocks. That said, the analysis is based on assumptions about the effectiveness of the project's drought-resistant seed varieties, pest management strategies, and sustainable land management practices. During implementation, a similar project may wish to explore further contingency measures that promote early warning systems, adaptive management, and a plan to assist farmers in the event of a disaster.

**FIGURE CSB3.3** • Projected change in annual severe drought likelihood for Uganda under an RCP 8.5 scenario



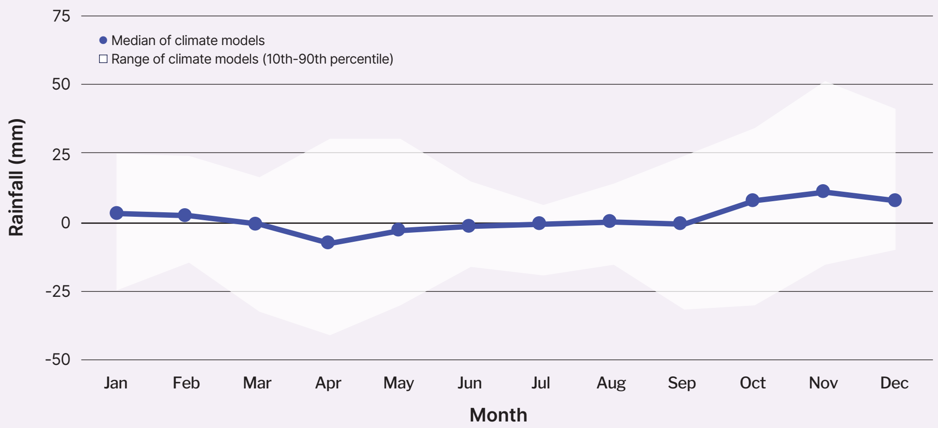

*Source:* World Bank's Climate Change Knowledge Portal
*Note:* The blue line represents the median of models; the shaded white area represents the range.

**FIGURE CSB3.4** • Projected change in rainfall of very wet days for Uganda under an RCP 8.5 scenario




*Source:* World Bank's Climate Change Knowledge Portal
*Note:* The blue line represents the median of models; the shaded white area represents the range.

**FIGURE CSB3.5** • Projected change in monthly precipitation for Uganda under an RCP 8.5 scenario, 2020–2039




*Source:* World Bank's Climate Change Knowledge Portal
*Note:* The blue line represents the median of models; the shaded white area represents the range.

## CASE STUDY BOX 3

*continued*

| | |
|---|---|
| **Country:** | **Honduras** |
| **Project name:** | **Water security in the dry corridor of Honduras** |
| **Project number:** | **P169901** |

This project aims to improve water service delivery and strengthen water governance in selected areas of Honduras's dry corridor. The project will finance the local water harvesting reservoir systems, Sistemas Integrados de Agua Segura (SIAS), basic sanitation units,[57] and infrastructure modernization in the middle Nacaome Basin's José Cecilio del Valle Dam and the downstream water supply system. The latter includes installing gates on the spillway to increase storage, improve reservoir operation, and increase the usable capacity of an existing hydropower plant; building a centralized water treatment plant and dedicated pipeline to increase water quality and supply for four municipalities downstream; and dam safety interventions.

The project will also support a community-based integrated micro-watershed management approach in the areas serviced by the SIAS, by strengthening community-driven water governance, climate-smart agriculture and better-value chain practices.

Future changes in average temperature and precipitation patterns can impact some of the gains from irrigation and water supply and sanitation infrastructure. Extreme events—including tropical storms, flooding, and droughts—can also reduce benefits from infrastructure investments. Honduras has experienced 17 storms, 14 riverine floods, and 10 droughts since 1990.[58] The infrastructure for this project is in low-lying areas that are particularly vulnerable to flooding and high winds from storms.

### Hypothetical excerpts from PAD *Economic Analysis Section* that fulfill A rating criteria (risk stress testing)

Including climate and disaster risks in the project's economic analysis shows the project is robust. Without including climate impacts, the NPV in the optimistic scenario is $67 million, while the NPV in the pessimistic scenario is $50 million. When climate impacts are added at a low level of impact, the NPV increases to $72 million (table CSB3.2). This increase despite a reduction in crop yield and water supply is because the "without project" alternative is relatively vulnerable to climate impacts and operational expenditure (OPEX) costs

**TABLE CSB3.2** • Results under four extreme scenarios (climate impact and baseline pessimism)

| Adjusted NPVs and BCRs | | |
|---|---|---|
| Baseline scenario: | Optimistic | Pessimistic |
| **No/low climate impact:** | | |
| NPV ($, millions) | 72.4 | 55.0 |
| BCR | 1.86 | 1.61 |
| **High climate impact:** | | |
| NPV ($, millions) | 54.8 | 40.2 |
| BCR | 1.64 | 1.43 |

*Note:* The numbers in blue indicate that, in both low and high climate impact scenarios and optimistic and pessimistic project scenarios, the NPV and BCR remain above an acceptable threshold (NPV>0 and BCR>1).

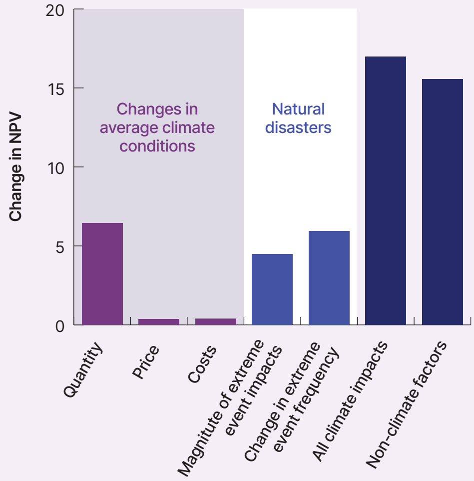
are higher. Under a high-impact climate scenario, the project's NPV decreases to $55 million.

In the worst-case scenario—pessimistic scenario (OPEX costs overruns, only one crop per year instead of two, and no crop diversification) with high level of climate impacts—the NPV is about $40 million and the BCR is 1.43. This indicates that the project is highly robust to climate impacts. The climate impacts would have to be more than four times higher than the worst case to make the NPV fall below 0.

The sensitivity analysis (figure CSB.3.6) shows that the NPV is more sensitive to climate than other impacts. Changes in quantities of water and crops due to average climate conditions, disasters, and change in disaster frequency all have similar levels of impact on NPV, and there is little sensitivity to the price impacts of average climate conditions. Hence, measures to address impacts from both average conditions and disasters will further strengthen the project. Additional exploration at the local level would be beneficial in identifying opportunities to address specific risks to the infrastructure from extreme events. Using more heat- and drought-resistant crops, flood-resilient practices and implementing measures to reduce water quality degradation will also be beneficial.

**Analysis of climate impacts:** This assessment of the impacts of climate change on the outcomes of the project uses the methodology outlined under Resilience Rating A described in Section 3.2. This involves:

**FIGURE CSB3.6** • Sensitivity analysis




1. Selecting and reporting optimistic and pessimistic baseline scenarios that do not account for climate change.

2. Assessing the impact of climate change on the project's reported costs and benefits in the optimistic and pessimistic scenarios. The impacts of climate change are measured by accounting for:

   - Projected changes in average conditions
   - Natural hazards most likely to impact the project location and assets
   - Projected changes in frequency and severity of the natural hazards.

For changes in average conditions, the impacts on the projects considered are: a decrease in potable water supply; a decrease in water available for irrigation; and the impacts on crop yields and crop prices from decreased water for irrigation and changes in temperature. OPEX costs are also expected to increase due to:

- Warmer temperatures, which will increase evapotranspiration rates and degrade water quality—for example, due to increased growth of algae, microbes, and invasive species
- Changes in precipitation patterns, with heavier rainfall leading to increased sedimentation, increased nutrient loads, and eutrophication.

The major natural hazards in Honduras include droughts, tropical storms, and flooding (World Bank 2012); these are all included in the analysis. Climate change scenario selection is based on RCP 2.6 and RCP 8.5 emission scenarios to reflect a range of low and high impacts. According to A-rating guidance, RCP 8.5 is considered excessively pessimistic (box A.4.1). However, the analysis uses this scenario to provide a more conservative estimate of climate impacts.

**Baseline scenario:** The baseline economic analysis without climate impacts considers two future scenarios—one with and one without project infrastructure investment interventions. The NPV is estimated using the summary net incremental cost and benefits flows. This forms the "optimistic scenario" for the no-climate-change baseline.

A second baseline without climate impacts, the "pessimistic scenario," is also considered, in which the "with-project" scenario has 10 percent cost overruns and the number of crops per year falls to one instead of the two assumed in the optimistic scenario. There is no crop diversification with cassava and chilies, as assumed in the optimistic scenario.

**Climate impacts from projected changes in average climate conditions:** The analysis incorporates impacts of average conditions on crop yields and prices using estimates from literature (Hannah et al. 2017, Havlík et al. 2015). Impacts on potable water supply and OPEX costs were more challenging to estimate. Estimates for neighboring Nicaragua find that water balance in 2050 may fall by 36–64 percent (World Bank 2013). More conservative figures are used in the analysis for the impact on water supply, which assumes a reduction of 7–10 percent reduction in the "with-project" scenario and 10–15 percent in the "without-project" scenario. The baseline economic analysis uses a shadow price for water. Based on internal estimates, it is assumed this will increase by about 1–2 percent in 2050.

**Climate impacts from natural hazards:** The analysis considers and differentiates the impacts of drought, floods, and storms on yields, water supply, hydroelectricity generation, and repair and reconstruction costs with and without the project. Estimated impacts on yields and water supply are based on internal estimates. The impact of drought on hydroelectricity is based on a global study, since there were no regional estimates available (van Vliet et al. 2016). Estimates of repair and reconstruction costs from floods are taken from a report prepared by Miyamoto—an earthquake and structural engineering firm—for the World Bank (Miyamoto International 2019). Estimates could be improved if local hydrological studies were conducted to identify the level of flooding at the site of the infrastructure. Local studies can also inform specific measures (such as engineering improvements) to decrease vulnerability to floods.

**Climate impacts based on changes in frequency of natural hazards:** Changes in the frequency of natural hazards are estimated using CCKP indicators of projected change in annual drought likelihood and projected change in rainfall of very wet days. Changes in frequency of natural hazards have a significant impact on NPV (figure CSB3.6).

**Summary:** Overall, the "without project" alternative has high OPEX costs and is more vulnerable to climate impacts. The project remains viable under the stress test's worst-case scenario.

## 3.6 • Links with other World Bank climate change commitments

IDA19 calls on the World Bank to "develop new resilience metrics designed to give increased incentives for more effective climate adaptation actions."[37] Applying a stress test to the residual climate and disaster risk of a project can help ensure projects are robust and include adaptive measures.

The level of analysis required for an A rating can build on analysis undertaken for other rating levels and link with other climate corporate commitments. For example, the selection of natural hazards included in the A-rating analysis can build on the risk screening undertaken at level C and/or the risk assessment undertaken at level B. As with the C and B ratings, the analysis and inclusion of risk management measures required for an A rating also has direct linkages with climate co-benefits—particularly for adaptation. Not only does it inform the project's climate vulnerability context and intent to address climate vulnerabilities, it also articulates the direct link between specific project activities and identified climate risks.

As with B and C ratings, the analysis required for an A rating can also inform a project's ESF, a World Bank requirement which applies to IPFs (including technical assistance projects) and IPF components of PforRs. The ESF requires borrowers to comply with 10 ESSs, some of which have direct linkages to climate risk screening.[38] For example, if the risk screening identifies an increased risk of flooding, which could then impact occupational health and workers' safety, these results should be shared with the environmental and social specialists.

BOX 3.2

# Template for reporting on disaster and climate risk section in the project document's economic analysis

To achieve an A rating, a project must show how climate and disaster risks do not make the project financially unviable. It is recommended that the project's economic analysis include a section on disaster and climate risks, built around the steps in this template.

## STEP 1:
## Provide the background of the analysis

1. Identify the baseline and key climate and disaster risks (see C and B ratings in Chapters 1 and 2)

2. Establish the optimistic and pessimistic project scenarios used for the baseline without climate change impacts.

3. Select the climate change scenarios, including choice of emission scenario or RCP, climate and impact models, and use of expert opinion.

4. Select the natural hazards included in the analysis—these could be based on ThinkHazard! categories.

5. Select the metric, such as NPV, and threshold (for example, NPV>0) that will be used to determine the project's success or failure. Other context/sector-specific metrics are also relevant—for example, establishing a reservoir's threshold water yield, the gigawatts of energy produced in a hydropower facility, or the poverty implications of an intervention.

## STEP 2:
## Present results as NPV or BCR in extreme scenarios (other relevant metrics for project success or failure are also acceptable)

Provide the results for four extreme scenarios, based on maximum and low climate impact and on optimistic and pessimistic project scenarios. Table B3.2.1 provides an example of results under different low/high and optimistic/pessimistic scenarios. The numbers in blue indicate that, under a low climate impact scenario, the NPV and BCR remain above an acceptable threshold (NPV>0 and BCR>1). The numbers in red indicate that, under a high climate impact scenario, the project falls below acceptable thresholds (NPV>0 and BCR>1).

**TABLE B3.2.1** • Results under four extreme scenarios

| Adjusted NPVs and BCRs | | |
|---|---|---|
| Baseline scenario: | Optimistic | Pessimistic |
| **No/low climate impact:** | | |
| NPV ($, 1,000s) | 295 | 99 |
| BCR | 1.6 | 1.2 |
| **High climate impact:** | | |
| NPV ($, 1,000s) | -32 | -208 |
| BCR | 0.95 | 0.71 |

**BOX 3.2**
*continued*

**STEP 3:**
**If failure is possible, describe the identified "switching scenarios"**

1. Provide NPV or BCR maps showing the uncertainty space in which the project fails. If failure is determined through another metric—such as a low number of lives saved—then provide the uncertainty map for this metric. Also include a sensitivity analysis highlighting the factors that have most influence on project success or failure. These should correspond to the project's main vulnerabilities, and are therefore to the best opportunities to make the project more robust (figures B3.2.1 and B3.2.2).

2. Describe the socioeconomic and climate context in one or more scenarios in which the project fails—for example, if NPV or BCR is equal to the limit set by the team.

Then, depending on the results of the plausibility/consequence analysis, there are three options:

**If failure scenario(s) are considered implausible**, report on why the identified switching scenarios appear implausible—for example, the project fails only with an extreme sea level rise scenario that exceeds most published estimates. Conclude with a "no identified vulnerability" estimate.

**If failure scenario(s) are considered manageable**, provide an explanation of the options available in case of failure to restore the project's economic viability or explain why the failure is not material for the beneficiaries, countries, or areas. Conclude with a "no identified vulnerability" estimate.

**If failure scenario(s) are plausible, unmanageable**, and threaten the economic viability of the project or make it unbeneficial, provide a qualitative (and quantitative if possible) estimate for the plausibility of the scenario and its consequences. Based on the sensitivity analysis figure, indicate the most likely origin of failure—for example, quantities produced in the average year v. increase in likelihood of extreme disaster. Conclude with a "significant vulnerability identified" estimate. The project will get an NR rating.

**Presenting results as "switching scenarios"**

The white lines in figure B3.2.1 delineate the switching scenario between tolerable risk and failure, denoted here as an NPV below zero or a BCR lower than 1. The horizontal axis depicts pessimism due to non-climate-related challenges that may affect the project—such as delays, government switchover, or procurement issues—while the vertical axis depicts pessimism due to climate and disaster risk.

The graphs (which are the standard outputs of the RiST tool) show how different scenarios for non-climate risks (such as implementation risks) can be combined with different levels of climate change impact to result in failure. For example, figure B3.2.1a suggests that the project is vulnerable to underperformance in the instance where project outcomes are pessimistic at 30 percent (with 100 percent representing the worst-case project scenario) if climate impacts are high, at around 90 percent (with 100 percent representing the highest projected impacts from climate and disaster risks). If the lines slant diagonally, it means that both project pessimism and climate impacts matter. If the lines are vertical, only non-climate factors are affecting the project; if they are horizontal, only climate impact and disaster risks are affecting the project.

### Presenting results through a sensitivity analysis

A sensitivity analysis can help developers understand the impacts of each parameter, where the greatest vulnerabilities may exist, and the role of the discount rate. In this example, figure B3.2.2a shows that the most important factors are the impacts and frequency of extreme events, suggesting where opportunities lie for making the project more robust. Figure B3.2.2b presents the project's sensitivity to the discount rate.

**FIGURE B3.2.1** • Sample NPV and BCR maps of "switching scenarios"

a) NPV map b) BCR map

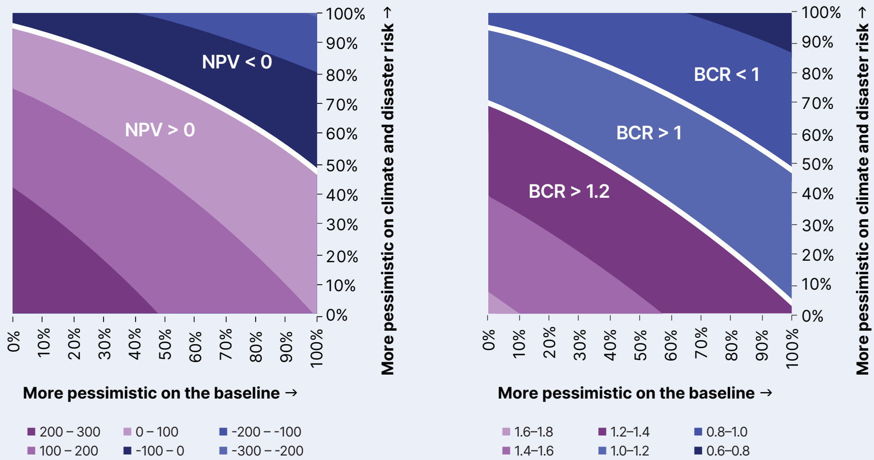
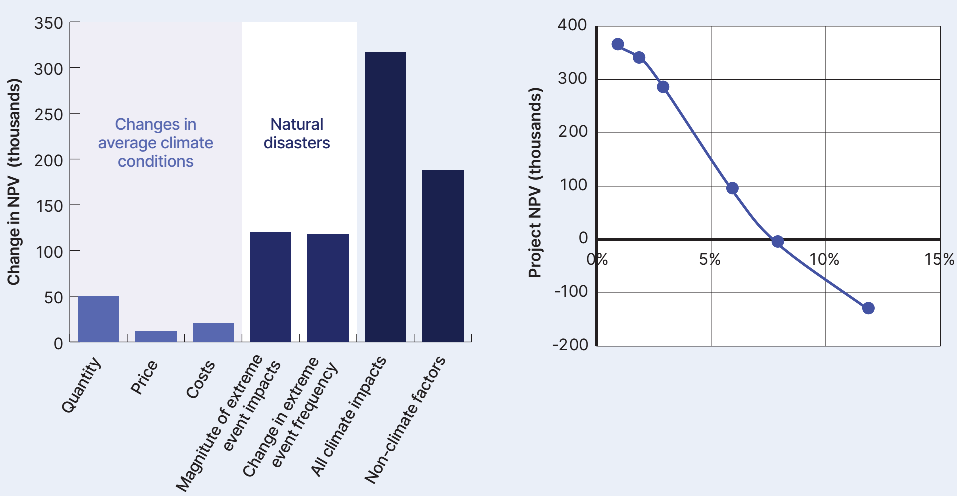



**FIGURE B3.2.2** • Sample sensitivity analysis

a) Sensitivity analysis b) Role of the discount rate (on the median scenario)



BOX 3.3

# The boundaries of an analysis

Note that the RiST model for climate and disaster risk stress testing is affected by the scope of the economic analysis. For example, narrow project boundaries can make an irrigation project seem beneficial, but when placed in the wider context of regional drought and additional interactions with ground water management, the project cost-benefit analysis may produce a different result. Setting appropriate boundaries is important for identifying possible risks of maladaptation.

# 4. Resilience *of* the project, B+ and A+ ratings: contingent planning

## 4.1 • Rating overview

The + rating is an extension of the B and A ratings, with the addition of a more systematic exploration of the risks to the project and contingent planning in case of unexpected situations that were not considered in the project design.[59] For example, while drainage infrastructure can be designed to manage an increase in heavy rainfall of up to 20 percent, based on scientific evidence and modeling results, it is also important to reflect on options available to the country or the beneficiaries if that assumption proves too low. This is particularly important for large-scale projects, whose failure can have major consequences to livelihoods and well-being.

## 4.2 • Key principles

Key principles for a + rating reflect the key principles for decision making under deep uncertainty, including:

» **Accept (rather than ignore) uncertainty.** Future climate projections hold tremendous uncertainty, given the challenge of modeling complex earth systems and being able to provide localized information. However, relying on historical weather and climate data may not be enough to design climate-sensitive investments that are highly vulnerable to changes in future risks. To provide a robust design for projects with long lifetimes, project developers should accept that projects will have to perform in a range of imperfectly known environmental conditions, and must therefore include uncertainty as a design factor.

» **Accounting for low-probability scenarios.** It is well documented that most people underestimate the plausibility of catastrophic scenarios or have excessive confidence in the ability of models and empirical analysis to inform decision making. Accepting that a project can fail in extreme cases, even if a model or data analysis suggests it is not possible, makes it easier to explore catastrophic scenarios, improve design and resilience, and be prepared in case of unexpected events.[60] Contingency planning means being prepared for the consequences if something bad happens, even in unlikely cases.

» **Ensure decision making is robust.** In contrast to traditional decision making—which may optimize results for one predicted future—robust decision making considers a variety of plausible futures. Given deep uncertainties, the process starts by investigating a range of vulnerabilities, rather than only considering the most probable ones. Robust analyses typically use specialized local knowledge through stakeholder involvement to build a cloud of possible vulnerabilities that is much broader than project planners could conceive alone. Explicitly integrating low-probability events can allow for a more comprehensive vulnerability analysis and stronger projects; but of course, this must be weighed against other costs and benefits (Hallegatte et al. 2012).

## 4.4 • Tools and guidance

Projects can also achieve a + rating if project preparation and design follows sector best practice guidance in terms of climate change resilience and DMDU.[61] For examples of methodologies that fulfill these requirements, see A+ and + methodologies in Appendix 1. A review of existing DMDU methodology is also available Hallegatte et al. (2012). These are some of best practice methodologies.

**Climate Risk Informed Decision Analysis (CRIDA).**[62] Also known as "decision scaling", CRIDA is a method of incorporating climate change information into decision making, by first identifying which sets of climate change would affect the project and then determining the likelihood of those sets. As such, it connects bottom-up vulnerability analysis with top-down climate model information and retains the strengths of both approaches. As a process committed to acceptance of deep uncertainties, CRIDA does not attempt to reduce uncertainties or make predictions, but rather to determine which decision options are robust to a variety of plausible futures.

**Robust Decision Making (RDM).**[63] RDM provides a decision framework developed specifically for decisions with long-term consequences and deep uncertainty. An RDM analysis begins with an existing or proposed project plan, and exhaustively explores its vulnerabilities and sensitivities, through stakeholder involvement and analytical methods. It then uses this information to identify potential vulnerability-reducing modifications to the plan. The proposed modifications are presented to decision makers, who evaluate their adoption.

RDM is designed to support stakeholder dialogues that help define project objectives, including the range of uncertainties considered and the scenarios that best describe any vulnerabilities. As a "context-first" process that inverts the traditional ordering of analytic decision making, RDM only considers probability distributions in its final steps. This facilitates both the use of imprecise or missing probabilistic information and engagement among stakeholders who may hold differing expectations about the future. The approach is also particularly appropriate when different stakeholders disagree on the monetary value of a project's costs and benefits—for example, disagreements over the value to attribute to a project's health or biodiversity implications—since it does not require the definition of a single metric to value the project (such as the NPV).

**Real option analysis** (Borison 2003). This is similar to a cost-benefit analysis but considers at least two decision points. As a result, it can attribute a value to an action today that makes it possible to do something else later, if needed. For example, a seawall foundation can be made deeper and stronger, so that the wall can be made bigger if sea level rise makes it necessary. This possibility of enlarging the seawall later if needed has a value, which depends on the likelihood of various scenarios and can be compared with the cost of building deeper foundations to guide decision making. It is applicable when probabilities can be attributed to the various scenarios under consideration, and when all costs and benefits of a project can be expressed in monetary form.

## 4.3 • Reporting in project documents

To earn a + rating, project documents are required to have an additional section that includes:

» A systematic exploration of the possible scenarios that considers interaction of risks and potential risk compounding. The analysis should go beyond a standard sensitivity analysis, which typically considers the impact of individual risks rather than the impacts when multiple threats materialize in parallel.

» A description of the consequences and implications of a failure scenario, exploring its impact on final users, beneficiaries, and project employees. For example, an energy sector project might consider the implications of repeated outages for households and firms, or implications for public finance if maintenance costs are unexpectedly increased due to climate change.

» Identification of the changes that may lead to failure scenarios, such as accelerated sea level rise, unexpectedly rapid increases in water scarcity, or pest outbreaks caused by changing climate conditions. The cause of failure is often a combination of causes—for example, rapid change in precipitation together with quick increase in per capita water demand—so considering each threat individually can be misleading.

» A description of the instruments/processes in place to ensure monitoring of changing economic and environmental conditions (for example, weather monitoring station and trend analysis of heavy precipitation events) and those in place to learn from the project performance, such as monitoring of hydropower generation and trend analysis.

» A discussion of how a project adapts over time as new information becomes available through regular monitoring. Examples include:

  - Additional capital expenditure (CAPEX) to upgrade or retrofit the project to maximize flexibility and minimize the cost of retrofitting—for example, increasing a dike's foundations so it can be enlarged if sea level rises.
  - Increasing operational and maintenance expenditures (OPEX) to manage unexpected change—for example, allocating more budget for maintenance to account for the accelerated aging of roads due to heavier and more frequent precipitation events.
  - Adaptive activities that adjust to new conditions—for example, replacing a crop with another that is more suited to decreased levels of rainfall or higher temperatures.
  - "Soft" solutions to manage increased variability—for example, using insurance or other financing instruments to mitigate impacts in the event of a disaster.
  - An exit strategy in case the project becomes nonviable—for example, strategic retreat in case of accelerated sea level rise.

See case study box 4 for an example of an A+ rated project.

CASE STUDY BOX 4

# A + rated project: contingent planning in project documents

| | |
|---|---|
| Country: | Mozambique |
| Project name: | Integrated Feeder Road Development Project |
| Project number: | P158231 |

This project aims to enhance road access in selected rural areas in support of livelihoods of local communities and to provide immediate response to an eligible crisis or emergency as needed. The project identifies the key risks to the project location—devastating floods and cyclones that cause fatalities, displaced people, and loss of cultivated areas (C-rating risk screening). In relevant districts, flood likelihood maps are used to identify priority areas for enhancing road access and road rehabilitation (B-rating risk assessment and consideration of adaptation measures). Furthermore, the economic analysis of the project NPV and internal rate of return (IRR) were calculated in 2,000 scenarios to capture the uncertainty that may affect the performance of each investment, and included climate projections in the analysis for current, low, medium, and high scenarios (A-rating quantification of risks). In considering the cost of failure and exploring impacts to final users, project developers determined that cleaning and repairing bridges, together with upgrading culverts, was the most robust intervention in almost every district. To monitor changing climate conditions on roads, a Geospatial Climate Resilience Tool was used to inform the annual implementation plan A+ rating criteria for contingency planning). See the following excerpts from the project paper and refer to the full project paper for more information and reference details.

**Excerpt from the project document *Country Context Section* that fulfills C rating criteria (risk screening)**

In addition, Mozambique is highly vulnerable to climate change risks and successive, increasingly frequent, extreme climate-related events have disrupted economic activity. It is among the top- twenty countries threatened by climate change and the second nation in Africa, after Madagascar, with the highest impact of weather-related shocks in the past 20 years in terms of fatalities and economic losses.

**Excerpts from the project document *Project Design and Project Description Sections* that fulfill B rating criteria (risk assessment)**

The proposed project will enhance rural access in selected districts in Nampula and Zambezia by adopting climate resilient interventions across the road network in an integrated manner. Components 1 and 2 [of the project] target integrated rehabilitation and maintenance of road networks (including primary, secondary, tertiary, vicinal, and unclassified roads). The project components are detailed in the following paragraphs and Annex 1 [of the project document].

Climate resilience is incorporated into the project design and planning using an innovative "decision making under deep uncertainty" (DMDU) methodology. Road

CASE STUDY:
A+ RATED PROJECT

infrastructure in Mozambique suffers from severe and recurring flood damage (as described in Section 1.B, Sectoral and Institutional Context of the project document). Traditional planning approaches do not account for the benefits of building climate resilience in the network and often lead to suboptimal investment decisions. Recent findings have demonstrated that hardening of road infrastructure may not be the optimal strategy to increase climate resilience. In light of these lessons, the project pilots an innovative methodology to incorporate the benefits of flood disaster resilience into project prioritization and economic evaluation. The DMDU methodology is described in Annex 4 [of the project document].

### Excerpt from the project document *Economic Analysis Section* that fulfills A rating criteria (risk stress testing)

Economic indicators were calculated for each investment option under more than 2,000 scenarios to capture the uncertainty that may affect the performance of each investment through eight different factors: (a) climate intensity; (b) flood duration; (c) traffic growth in the absence of interventions; (d) traffic growth due to agriculture development; (e) discount rate; (f) repair time; (g) construction cost; and (h) bridge repair cost. Five intervention options were assessed in each district and the best option was selected based on its robustness. The median NPV over 20 years for the selected interventions is US$70 million and the IRR is 20 percent.

### Excerpt from the project document *Detailed Project Description Section* that fulfills A+ rating criteria (contingent planning)

**Component 4: capacity building and project administration.** This component will finance knowledge development and institutional capacity-building activities through the provision of goods, training, and consulting and non-consulting services. The proposed activities build on the institutional-strengthening activities of the previous project, comprising, among others, the following areas:

**Climate resilience [one of five areas listed under component 4].** This would assist the [National Road Administration (Administraçao Nacional de Estradas)] ANE, the [Road Fund] RF, and the National Institute of Disaster Management, among others, in (a) development of a geospatial screening tool to identify transport assets that are most critical and vulnerable to climate change impacts. The tool would be managed in conjunction with the National Institute of Disaster Management and the Ministry of Transport and Communications; (b) extension of the climate resilience DMDU tool for economic analysis of road infrastructure projects to the entire country; and (c) enhancement of disaster risk management for road infrastructure. The climate resilience tool is expected to support development of a disaster risk management master plan in the road sector, which will establish strategies and prioritize actions to enhance climate resilience of road assets.

# II. Resilience *through* the project

Resilience through the project outcomes (or simply, **resilience *through* the project**), expressed in letter grades A+ to C, characterizes the extent to which projects explicitly contribute to the resilience of their beneficiaries, or the communities, asset networks, wider systems or even countries in which they are situated. Such projects are intentionally designed with the objective or subobjective of improving resilience. The distinction between this dimension and the resilience *of* the project dimension is important, because not all development projects seek to improve resilience more broadly beyond the individual investments being themselves resilient to impacts of climate change and natural hazards. As such, this dimension is meant to help prioritize and promote those investments that support transformation towards resilient development pathways as they relate to current and long-term climate impacts.

## 5. Resilience *through* the project, C rating: development or poverty-reducing projects

It is widely recognized that, in most circumstances, resilience to climate change is enhanced by good development, with higher and more stable incomes, lower poverty, better access to infrastructure and financial services, and stronger social protection and health care systems (Hallegatte et al. 2015). Therefore, all projects with development benefits are assigned a C rating.

All World Bank projects contribute to development or poverty reduction, and are therefore rated at least C. The substance of their contribution to development is detailed in several sections of project documents, such as the economic analysis, or rationale for World Bank engagement. To gain a C rating, non-World Bank projects would need to demonstrate significant socioeconomic benefits beyond the flow of revenues to the investor.

**TABLE 2.1 • Resilience *through* the project: overview of ratings**

### C — Development

- *The project aims to reduce poverty or contribute to development*

*Note: For each level, additional requirements are in italic.*

### B — Resilience building

- The project aims to reduce poverty or contribute to development
- *Risks and vulnerabilities posed by climate change and natural disasters are identified*
- *Intent to reduce identified risks or vulnerability is articulated*
- *Resilience-building measures for beneficiaries or the wider system are included*

### A — Transformational projects

- The project aims to reduce poverty or contribute to development
- Risks and vulnerabilities posed by climate change and natural disasters are identified
- Intent to reduce identified risks or vulnerability is articulated
- Resilience-building measures for beneficiaries or the wider system are included
- *The transformational dimension of the project is explained, with an identification of the barriers or obstacles to resilience that the project will tackle (for example, through a change in policies or regulations, capacity building, or the development of new technologies)*

### B+ / A+ — Climate resilience indicator(s)

Same as B or A, plus:

- *At least one indicator related to building absorptive, adaptive, and/or transformative resilience is included in the project results framework*

# 6. Resilience *through* the project, B rating: resilience and adaptation projects

## 6.1 • Rating overview

A B rating is assigned when a project has identified risks and vulnerabilities posed by climate change and natural disasters, and included appropriate resilience-building activities that are *intentionally* designed to contribute to resilience building for beneficiaries, particular sectors, the wider community, ecosystems, built systems, and/or the region where the project is taking place. As well as protecting the outcome of the project—say, by making a bridge more resilient—the activities should boost the resilience of the users, beneficiaries, or areas. For example, based on its location, a bridge can make a population more resilient by facilitating evacuation in case of floods. To receive a B rating, project documents should outline the vulnerability context of the location, sector, wider community and/or system, articulate the project's intent or contribution to reducing this vulnerability, and address vulnerabilities through specific project resilience-building activities. This is akin to the three steps of the MDBs' *Joint Methodology for Tracking Climate Change Adaptation Finance*.

## 6.2 • Key principles

To build resilience through an operation, project developers should both understand the wider context in which their project is taking place and intentionally consider what aspects of resilience the project can help strengthen. Resilience building, which can take place through several activities, involves strengthening two core resilience capacities:

» **Absorptive capacity:** The ability of people, assets, and systems to prepare for, mitigate, or prevent negative impacts of hazards to preserve and restore essential basic structures and functions.

- *For example: supporting reforestation and assisted regeneration efforts of forest landscapes to restore critical ecosystem services that can help mitigate climate impacts and support community livelihoods.*

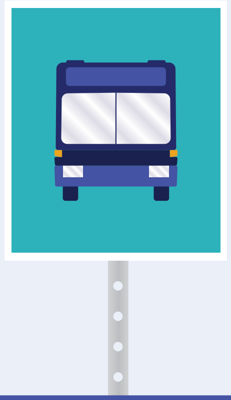
» **Adaptive capacity:** The ability of people, assets, and systems to adjust to, moderate, and recover from potential hazards, to continue to function without major qualitative changes.

- *For example: establishing an irrigation system for farmers who previously depended on variable rainfall to water their crops.*

Developers can use several resilience-building attributes to enhance these core resilience capacities, and these may be realized through a variety of activities (see Appendix 5 for a list of resilience attributes).[64] If an operation finances any activities that contribute to one or more resilience attributes, it can be said to be strengthening resilience. However, there is no universal approach. Project developers should identify how the project addresses relevant resilience capacities and attributes in the given geographic, socioeconomic, and sectoral contexts. Box 6.1 is one example for developing resilience through sector-specific criteria.

BOX 6.1

# Designing resilience *through* projects: the transport sector



To better reflect resilience *through* transport projects, the World Bank Transport GP has developed the following sector-specific resilience criteria.

| **1. Building resilience of project beneficiaries, businesses, and industries** | |
|---|---|
| **1.a. Transport system** | Project provides 24×7 transport services (with minimum interruptions) to users during extreme climatic events, minimizes loss of connectivity and service. |
| **1.b. Vulnerable populations** | Project enhances resilience of vulnerable communities situated in climate sensitive or FCV regions. |
| **2. Building resilience of network, infrastructure, and maintenance** | |
| **2.a. Transport network** | Network-level climate vulnerability assessments are undertaken to identify hotspots. Project either improves the resilience of these locations or provides alternatives. |
| **2.b. Infrastructure** | Climate-vulnerable locations are identified and climate-smart design and engineering solutions are applied. |
| **2.c. Maintenance** | Project is unlikely to fail due to lack of maintenance. |
| **3. Creating an enabling environment for systematic resilience** | |
| **3.a. Policy initiatives** | Project supports policy initiatives on climate resilience, resource efficiency, and strategies to "build back better" through climate-informed financing plans and incentives. |
| **3.b. Institutions** | Institutional structures, business procedures, capacity building, knowledge base, and awareness programs are improved to boost climate resilience. |
| **3.c. Asset management** | Network-level vulnerability assessment is carried out, suitable plans for retrofitting climate resilience through rehabilitation and maintenance programs are drawn up. |
| **3.d. Innovations and research** | Project supports climate-smart, innovative, resource-efficient, and nature-based solutions for design, construction, maintenance, and research and development. |

## 6.3 • Guidance

For more information on how resilience attributes can help build resilience through operations, see the *Integrating Resilience Attributes into Operations: Guidance Note for Project Task Teams*. Reporting requirements for a B rating follow the three steps of the MDBs' *Joint Methodology for Tracking Climate Change Adaptation Finance*.[65] For information on the requirements of each step of the methodology, refer to the *Reference Guide on Climate Adaptation Co-benefits*. World Bank projects that have climate adaptation co-benefits qualify for the B rating, and no further analysis is needed.

## 6.4 • Suggested timing in the World Bank project cycle

Project developers are encouraged to consider the vulnerability of a project, its beneficiaries, and the wider system as early as the concept stage. Actions and project components that increase resilience can be refined during the project design phase.

## 6.5 • Reporting in project documents

The reporting requirements for a B rating are the same as for the MDBs' *Joint Methodology for Tracking Climate Change Adaptation Finance*—that is, for World Bank adaptation co-benefits. The following steps outline the information that must be included in project documents.[66] Note that establishing a project's vulnerability context (step 1) is similar to the risk identification requirement for resilience *of* the project. For resilience *through* the project, the emphasis is on identifying climate risks to beneficiaries and the wider system rather than vulnerabilities to the project itself.

**Step 1: Establishing a robust vulnerability context.** The climate change vulnerability context sets out the current and anticipated impacts of climate change on a project's location, sector, and/or beneficiaries. The climate change vulnerability context should include location-, sector-, and beneficiary-specific information—for example, how climate change can impact key resources in the project location, asset network, and/or vulnerable populations. The vulnerability context should also use a robust evidence base to provide details of current and future impacts. For example, it could draw results from the *Climate and Disaster Risk Screening Analysis for Resilience of the Project*, levels C and above.) A strong vulnerability context can span several paragraphs or be as short as four to five lines. Regardless of the length, it should contain enough information on current and/or projected impacts of climate change, including the types of risk that are attributable to climate change. For World Bank projects, this is usually included in the "country context", "strategic context", or "key risks" sections of project documents, or as a separate annex.

**Step 2: Intent to address vulnerability.** To credit a project for adaptation co-benefits, the joint MDB methodology for tracking climate finance requires project documents to provide a strong and clear intent to address the project's climate change vulnerability context. Where applicable, the intent to address vulnerability should discuss the need to adapt or incorporate resilience measures. This can be as short as one or two sentences. For World Bank projects, this is usually included in the "strategic context", "project development objectives" (PDOs) and/or "higher-level objectives", or "project description" sections of project documents.

This step can be informed by the climate and disaster risk screening process, as it encourages project developers to think through the elements of their project that serve to build the adaptive capacity of beneficiaries and sector institutions.

**Step 3: Link to project activities.** The link to project activities should clearly state which aspect of the project or specific project activities contributes to climate resilience. For World Bank projects, linkage to project activities is established at the: component or subcomponent level for IPF projects; prior action (PA) level for development policy financing projects (DPF); and disbursement-linked indicator (DLI) level for PforR projects. Activities should also contribute to one or more adaptive and absorptive resilience-building capacities by strengthening one or more resilience attributes. This is usually included in the "project description" section of project documents.

See case study box 5 for an example of a B-rated project.

## 6.6 • Links with other World Bank climate change commitments

The B rating has direct synergies with climate adaptation co-benefits, as already highlighted in section 6.1.

CASE STUDY BOX 5

# A B-rated project: resilience and adaptation

| | |
|---|---|
| Country: | Iraq |
| Project name: | Baghdad Water Supply and Sewerage Improvement Project |
| Project number: | P162094 |

This project aims to improve the quality of drinking water supply and wastewater services in Baghdad. Project documents discuss the risks of flooding, extreme heat, and water scarcity in Iraq and how, combined with projected population trends and increasing urbanization, these may lead to increased pressure on urban water systems across the country and in Baghdad more specifically (establishing the project's vulnerability context). The project documents qualitatively estimate the risk to the project as moderate (fulfilling the criteria of a C rating for resilience *of* the project). The document also articulates the intent to address the project's vulnerability to climate threats and enhance climate resilience to project beneficiaries through activities such as improving wastewater collection systems to avoid contamination issues from flooding (fulfilling the criteria for a B rating for resilience *through* a project). See excerpts from the project below and refer to the full project document for more information and reference details.

**Excerpt from project document *Sectoral and Institutional Context Section* that fulfills B rating criteria (vulnerability context)**

**Climate change.** According to the ThinkHazard! profile for Iraq, the Baghdad area is at a high level of exposure to future river floods and at a medium level of exposure to water scarcity. In addition, the country is at risk of higher temperature and heat. Some recent examples of possible climate events that have affected the country have been: (a) changes in the severity and frequency of drought and flood events such as in 2013 and 2015; (b) increases in temperature with heat wave temperatures above 50°C that resulted in a government shutdown in 2015; (c) decreases in water availability due to lower than normal precipitation. Untreated wastewater in Baghdad has been leaking out of sewers and overflowing into the streets and into the Tigris (which is Baghdad's only local source of fresh drinking water), which represents a public health risk in case of climate change-induced flooding of the Tigris.

CASE STUDY:
B-RATED PROJECT

**Excerpt from project document *Sectoral and Institutional Context Section* that fulfills B rating criteria (articulated intent to build resilience)**

The [Baghdad Water Authority] BWA and [Baghdad Sewage Authority] BSA need to take a long-term approach to climate change, which requires supply-side measures as well as demand management. Adapting to these changes requires planning infrastructure to meet future demand in addition to protecting against potential scarcity or abundance of water. This requires investing in new raw water sources (such as groundwater) to diversify the resource base, expanding treatment facilities to accommodate larger flows, or using desalination, recycling or multi-purpose storage facilities. There is a need to take an integrated approach to planning that relies on flexible designs and the use of climate action plans to mitigate risk.

**Excerpt from project document *Sectoral and Institutional Context Section* that fulfills B rating criteria (actions to build resilience)**

The capacity of the [Mayorality of Baghdad] MoB to cope with climate change impacts still needs to be developed. Data availability is limited due to weak forecast and monitoring systems, which limits the capacity to make reliable forecasts on extreme weather events and therefore affects the quality of decision-making at the central, MoB and municipal levels. The project includes a component on integrated urban water management including resilience (climate change adaptation measures) and sustainability of water use. Project investments will also contribute to climate change adaptation and mitigation by efficient use and savings of water resources, improvements to the wastewater collection system to avoid the spread of uncollected wastewater during climate change-induced flooding, as well as by reducing [greenhouse gas] GHG emissions. The social risk associated with the project is moderate. The project will improve the much-needed water and sanitation services.

# 7. Resilience *through* the project, A rating: transformational projects

## 7.1 • Rating overview

The A rating is reserved for projects that not only boost the resilience of beneficiaries through their outputs but are also "transformational" in their outcomes. Here, "transformational" refers to projects that affect upstream policies, country-level strategic plans or frameworks, system-level change,[67] or technology and data enhancements that help remove obstacles to resilience building.

## 7.2 • Key principles

Key principles for an A rating include:

» **Change incentives and institutions.** Resilience projects are transformational if they make it significantly easier and cheaper to adapt to climate change and reduce climate and disaster risks in the future, beyond the beneficiaries of the current project. This happens when a project or program:

- Fixes market failures—for example, by removing incentives to build housing in flood plains
- Builds institutional capacity—for example, by creating a land-use plan that takes risks into account or improves building regulations—or
- Generates information or innovative spillovers—for example, by developing a hazard map that can be used for future investments.

Reforming land use management and urban planning, for example, can enable future investments that are less exposed to natural risks. In this context, it is particularly important to consider long-term policy horizons and their implications, not just short-term impacts. Given that resilience to accelerating climate change will require planning from local to landscape scales, it is important to consider system-level programming and enhanced cross-sector synergies. See box 7.1 for more detail on transformation through resilience-building action.

» **Create local ownership**. Transformational adaptation needs to combine the science that evaluates future risks and locally led design by co-producing knowledge (Brooks et al. 2019). Local ownership and high-level political buy-in are important for capacity building, empowerment, and lasting impacts. Transformational projects and outcomes usually require participatory approaches, in-depth stakeholder dialogues, and strong partnership with multiple agencies and organizations.

While there is a continuum in terms of the level of transformation achieved through adaptation projects, extreme cases are easy to identify. For example, an intervention that improves capacity in local authorities so they can create land use plans based on new zoning legislation that prevents people from investing in places with excessive natural disaster risk requires investments in data, land registries, and institutions. But, as well as reducing risks, ensuring that land use plans consider flood risks and provide free data on flood-prone areas also affects broader development patterns, without entailing a cost per new infrastructure/unit built. After those initial capacity investments, it also reduces losses by avoiding costs from disasters and does not require a continuous injection of resources. This will influence all future investments, including private investments. As such, this intervention enhances resilience by decreasing vulnerability and future losses from natural disasters. By mobilizing other sources of finance, affecting the behavior of other economic actors, and reducing long-term risks, it is highly transformational, even in the absence of further investments funded with concessional resources.

## 7.3 • Suggested timing in the World Bank project cycle

Project developers are encouraged to consider the vulnerability of a project, its beneficiaries, and the wider system as early as the concept stage.

## 7.4 • Reporting in project documents

To achieve an A rating, reports must explain the project's transformational effect (see box 7.1). This includes:

- » Identifying one or several barriers to the implementation of similar resilience or adaptation projects, or one or several drivers for the lack of resilience or inability to adapt. This could include:
    - An absence of data on future climate change risks or current hazard spatial distribution, making it impossible for people to make informed decisions on where to invest and live.
    - Institutional weakness and lack of cross-sectoral collaboration, preventing the enforcement of existing land use plans and regulations.
    - A lack of instruments to finance disaster risk reduction.
- » Identifying the project activity or output that will remove or significantly lessen upstream barriers to future resilience project implementation or drivers for the lack of resilience. This could include:
    - Creating a data platform to make climate change scenarios and cross-sectoral hazard data freely available
    - Institution and capacity building that improves government and local authority ability to improve system-level resilience planning and enforce land use planning
    - Creating specific funds to help municipalities finance disaster risk reduction projects
    - Consultations, participatory processes, and stakeholder engagements that build consensus on the need for action, or for specific actions.

For further examples of transformational activities, see box 7.1.

BOX 7.1

# Measuring transformational potential

An index of transformational action can help measure a project or program's transformational potential—that is, its impacts on barriers to implementation for future projects or programs. It can reflect four levels: very high, high, moderate, and none.

A **Only projects that score very high or high on this index can receive an A rating in resilience *through* the project.**

**Very high:** The project or program aligns government processes, economic incentives or price signals with resilience objectives, significantly improves access to finance for future resilience projects, or reduces the cost of technologies to enhance resilience.

*For example: Major change in land-use planning or building regulations; demonstration projects with new technologies for resilience; changes in bank regulations to facilitate the financing of resilience projects; or changes in policy to make social protection more reactive to climate shocks.*

**High:** The project or program influences strategic or system-level planning and provides important foundations for future investments, projects, or programs that increase resilience; builds technical and institutional capacity that will facilitate future action; or improves the incentive structure.

*For example: Creating a household registry to provide post disaster support to populations or decreasing barriers to cross-sector collaboration for disaster prevention or response; supporting NDC planning and implementation; creating capacity for risk assessment or climate change modeling; implementing a law to make land-value capture available as a way of financing low-carbon or resilience projects; changing the tax structure; and reforming insurance markets.*

**Moderate:** The project or program helps build momentum, without affecting the basic incentives or costs in the country.

*For example: A large flood management project.*

**None:** The project or program increases resilience but does not trigger any structural change or improvement in incentives or barriers to implementation of future projects.

*For example: A small drainage project.*

Projects can be cost-effective and desirable without being transformational.

*For example, building one seawall to protect one neighborhood may lead to net benefits thanks to avoided losses due to floods but is not a transformational project because it would not change risks in other places.*

Special attention should be devoted to the risk of "maladaptation", or risks that a project reduces short-term immediate climate change or disaster impacts but creates incentives that increase risk taking and long-term vulnerabilities.

*For example, flood protection that prevents frequent floods but is not accompanied by complementary actions may attract more people and investment in a flood zone; or irrigation infrastructure that leads farmers to use more water-intensive crops, increasing their vulnerability to long-term changes in climate. Such projects lead to maladaptation and should not be counted as building the resilience of beneficiaries.*

CASE STUDY BOX 6

# An A-rated project: transformational effects

CASE STUDY: A-RATED PROJECT

| | |
|---|---|
| **Country:** | Nepal |
| **Project name:** | Nepal Programmatic Fiscal and Public Financial Management Development Policy Credit |
| **Project number:** | P168869 |

This project aims to support the government of Nepal in its efforts to establish a framework to move towards fiscal federalism and improve its policy framework for public financial management. Project documents identify key constraints around limited provincial and local-level capacities, the country's vulnerabilities to climate change—including floods, landslides, windstorms—and geophysical hazards such as earthquakes, and their impacts on economic growth and vulnerable groups. The project seeks to address these constraints and build resilience to climate change though innovative policy measures, achieving potentially transformational outcomes. This includes increasing forest cover as one of the indicators under a motor vehicle tax revenue-sharing formula to mitigate carbon emissions and build resilience against landslides. Climate adaptation considerations are also integrated into budget coding and guidelines on integrating climate considerations into local planning. The project further supports coordination and management of disaster management, risk reduction, recuperation and response activities as well as monitoring and mitigation measures. Transformational outcomes are possible by helping to reduce the fiscal risks posed by Nepal's vulnerability to disasters and climatic shocks. See excerpts from the project document below and refer to the full project document for more information and reference details.

**Excerpt from project document *Country Context Section* that fulfills B rating criteria (establishing the climate vulnerability context, articulating intent to address vulnerability, and actions to build resilience)**

**Nepal is one of the most disaster and climate vulnerable countries in the world and this puts a big strain on the government's budget.** More than 80 percent of Nepal's population is at the risk of multiple natural hazards such as floods, landslides, windstorms, hailstorms, fires, earthquakes and glacial lake outburst floods (GLOFs). It is therefore important under the new federal structure to build local capacity to manage disasters and climate change taking into account local-level risk profiles, including investments in post-disaster reconstruction, early warning preparedness, and long-term climate resilience. Strong coordination across localities, in particular, to effectively manage national level disasters will be critical. The Disaster Risk Reduction and Management (DRRM) Act is expected to help manage the disaster response through better coordination among local, provincial and federal government, other public-sector entities, International/National Non-Governmental Organizations, Private Sector and Local Communities. The Act also requires the government to set up a separate fund, for disaster management. Cognizant of the topographical fragility of the country, the Constitution has made a provision for fiscal transfers to local governments (linked to special grants) to address local specific disaster response. Development Policy Credit 2 [of the project document] supports implementation of the DRRM Act at the local level.

**Excerpt from project document *Project Description Section* that fulfills A rating criteria (transformational change through removing budgetary barriers)**

**To ensure further progress on fiscal federalism, the National Natural Resources and Fiscal Commission (NNRFC) has adopted the framework for the calculation and devolution of the equalization and conditional grants and has made the framework public.** In line with the Constitution, these transfers are expected to contribute to a more balanced development across provinces and regions, and support and uplift underserved regions and groups. The equalization grant is based on the revenue and expenditure needs of the provincial and local governments, taking into account their population and the level of development. Conditional grants are transfers to provincial and local governments for project implementation aligned to national policies and standards. In addition, to mitigate carbon emissions, the motor vehicle tax is levied by each provincial government and shared between the provincial and related local governments in the ratio of 60:40, using forest cover as one of the indicators in the revenue sharing formula between local and provincial governments. The 40 percent share to local governments is allocated according to the following variables and weights: a) forest area (5 percent); b) road length (50 percent); and c) total population (45 percent). By including forest area, the sharing mechanism also accounts for environmental factors and is meant to mitigate the impacts of motor vehicle emissions. The larger the forest area, the more revenue will be allocated. This aims to incentivize local governments to keep more forest area to counter greenhouse effects which could also help counter climate related disasters and ensure environmental sustainability at the local level. The framework was first used for preparation of the FY19 budget. To ensure transparency, the NNRFC has made the framework (including the formulas under it) public.

**Climate change mitigation incentives captured in the revenue sharing formula are reinforced by a Climate Change Financing Framework that integrates climate change in planning and budgeting.** A Climate Change Financing Framework (CCFF) was prepared building on the Climate Change Policy 2011 as a policy framework to mobilize, manage and target finance in support of realizing the country's strategic climate goals and targets. The Inter-Ministerial Committee to oversee implementation of the framework was formed in February 2018 and the first meeting was conducted on January 7, 2019. The MoF has taken important steps to develop an expenditure reporting system capable of producing a consolidated report on climate expenditures. It has also revised the budget guidelines and budget calendar to integrate climate change. The CCFF reinforces the incentives provided by the revenue sharing formula to increase forest cover and is helping to improve integration of climate change costs in public expenditure allocations, resource management and investment decision making, to generate better climate policy outcomes.

# 8. Resilience *through* the project, B+ and A+ ratings: results monitoring

## 8.1 • Rating overview

To go from a B to a B+ or from an A to an A+ rating, a project must monitor or track the progress of resilience-building activities through at least one climate- or disaster-resilience indicator. Climate indicators that reflect resilience measures should be incorporated into the project's results framework and grounded in its theory of change.

Indicators allow project developers to define and measure an operation's progress, providing an evidence base on whether the desired result was achieved, be that an activity conducted, an output delivered, or some short, medium, or long-term change occurred. Climate indicators monitor and track the progress of climate results by measuring the outputs or outcomes of mitigation and/or adaptation interventions. Climate adaptation indicators should measure adaptation to specific and identified climate-driven vulnerabilities. Including such an indicator (and therefore achieving a + rating) reflects higher confidence that the project will achieve its intended objectives, and better transparency in post-project results.

## 8.2 • Key principles

Key principles for a + rating include:

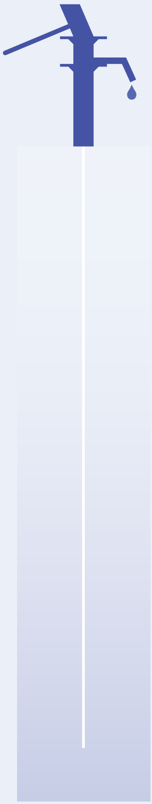
» **Project and context specificity.** There is no single, universal indicator or set of uniform indicators for measuring adaptation and resilience building, as there are many possible ways to improve adaptation to climate change and build resilience. Because of different local contexts and the variability of climate impacts in specific locations, sectors and communities, activities that increase adaptation in one place may not have the same effect elsewhere.[68] Climate adaptation or resilience indicators should be rooted in the knowledge of the identified climate impacts to the particular project/program area, and the context-specific knowledge of climate vulnerabilities,[69] which depend on factors such as location, beneficiaries, and sector (box 8.1).

» **Time horizons and a theory of change.** Increased adaptation and resilience to climate change often occurs over the long term and may not be realized until after a project ends. It can therefore be challenging to select an indicator that accurately measures climate results in a single project. When selecting indicators, it is therefore important to review the project's theory of change—or road map for achieving long-term goals—and consider how to address both the short and longer-term challenges of a changing climate, what the expected climate results are, and how to measure them.

**BOX 8.1**

# Sample approach for selecting a climate adaptation indicator in the water sector

Consider a water project in a drought-vulnerable area where the water table is dropping fast due to unregulated groundwater consumption. A decision flow chart may look like this:



**Will the operation support activities that build adaptation and/or resilience to current or expected climate change impacts?**

**If yes:**

**Which inputs/activities will contribute to adaptation/ resilience?**

*The operation will support activities that improve the monitoring of groundwater consumption in a drought-vulnerable area with low water table levels.*

**What adaptation/resilience outputs/outcomes will they lead to?**

*These could include improved monitoring of groundwater consumption which could help regulate the use of groundwater, reduce groundwater consumption because of increased efficiency in allocation of groundwater between multiple water users, all aimed at building resilience to drought conditions.*

**How can the progress in achieving those outputs/ outcomes be measured using indicators?**

*The indicators could track:*

- *Number of groundwater monitoring stations installed to monitor and regulate groundwater consumption (output)*
- *Groundwater monitoring report produced annually (output)*
- *Reduction in groundwater consumption per water user because of enhanced efficiency (outcome)*
- *Increase in water table levels (outcome)*

## 8.3 • Guidance

Internal World Bank users can find more information on using climate adaptation indicators in the *Climate Indicators Guidance Note*[70] or the World Bank climate indicators webpage.[71] For further information on monitoring and evaluation (M&E), visit the Resilience Monitoring and Evaluation (ReM&E) Portal.[72] See Appendix 6 for some examples of climate adaptation indicators by sector.

## 8.4 • Suggested timing in the World Bank project cycle

Project developers are encouraged to consider the vulnerability of a project, its beneficiaries, and the wider system as early as the concept stage. They should consider actions, project components, and a climate indicator during project design, and incorporate these into the project's theory of change.

## 8.5 • Reporting in project documents

To achieve a + rating, project reports must include:

- A qualitative outline of the vulnerability context of the location, sector, wider community and/or system, articulation of intent or contribution to reducing this vulnerability, and link to specific resilience building project activities (see the MDBs' *Joint Methodology for Tracking Climate Change Adaptation Finance*).

- A climate indicator related to building absorptive, adaptive, and/or transformative resilience in its results framework (table 8.1).

See case study box 7 for an example of a + rated project.

## 8.6 • Links with other World Bank climate change commitments

The B+ and A+ ratings have direct synergies with two World Bank climate change corporate commitments: adaptation co-benefits (as already highlighted) and incorporating a climate indicator in the project's results framework. Indicators are critical components of an operation's M&E system. For World Bank operations, indicators are part of the Results Framework (or in the case of development policy financing, the Results and Policy Matrix) and are tracked at regular intervals. Indicators are defined in the project or program preparation stage and, in essence, link development theory to practice as they are tracked throughout implementation and at completion.

**TABLE 8.1 •** Sample indicators for resilience attributes

| Resilience attributes | Illustrative indicators |
|---|---|
| **Preparedness** | » Number of climate early warning systems installed and operational<br>» Number of agro-meteorological centers established to improve drought and flood forecasts<br>» Area mapped using spatial technology to predict future flood/drought risks<br>» Number of beneficiaries with access to emergency shelter and evacuation routes<br>» Increased adoption of climate-smart agricultural and management practices promoted by the project<br>» Percentage of targeted farmers using climate information for agricultural production |
| **Robustness** | » Kilometers of unpaved roads in rural areas rebuilt for all seasons, or upgraded to climate-resilient standards<br>» Number of bus rapid transit stations with improved stormwater drainage |
| **Protection** | » Share of coastal area with erosion control measures implemented<br>» Number of buildings retrofitted with climate-resilient design/structural measures to protect from recurrent damage caused by frequent floods and hurricanes |
| **Recovery** | » Increased area under sustainable landscape management practices<br>» Area of degraded catchments and water courses restored<br>» Percentage of drought-affected population with access to safety net programs<br>» Increase in number of households with disaster risk insurance |
| **Rapidity** | » Decrease in number of days to reallocate project proceeds in the event of climate-related disasters<br>» Time taken to deliver financial, food, or medical support to households affected by climate-related emergency |
| **Diversity** | » Increase in household income from shifting to less climate-sensitive livelihoods<br>» Number of farmers provided with access to new irrigation services in an area previously dependent on rainfall |
| **Redundancy** | » Hydropower dam developed to serve as a backup for power sites<br>» Kilometers of road built to serve as network redundancy in case a bridge crossing collapses in the event of a disaster |
| **Flexibility** | » Number of new public bus rapid transit routes established to provide residents with quick access to basic infrastructure<br>» Number of ministries with contingency budgets for disaster response |
| **Inclusion** | » Number of local women trained on climate impacts |
| **Integration/ connectedness** | » Number of districts with established surveillance systems to monitor climate-exacerbated diseases |
| **Learning** | » Number of health workers trained to be better equipped for climate-exacerbated disease outbreaks |

CASE STUDY BOX 7

# A B+ rated project: climate adaptation indicators

CASE STUDY:
B+ RATED PROJECT

| | |
|---|---|
| Country: | Sierra Leone |
| Project name: | Integrated and Resilient Urban Mobility Project |
| Project number: | P164353 |

This project, previously discussed in case study box 2, is an example of how a + rating may be added to a project. The project uses a multi-hazard risk assessment to identify the climate and disaster risks, and incorporates identified hotspots into resilient road design, thus achieving a B rating for resilience *of* the project. The project also explicitly states the objective of boosting resilience to the wider transport network and includes project activities—such as rehabilitating key road sections, improving drainage capacity, and slope stability interventions in identified hotspot areas—to support this aim. It thus meets B-rating criteria for resilience *through* the project. By also including development objective indicators and intermediate results indicators for resilience-building interventions and incorporating climate-smart design, the project meets the + criteria for resilience *through* the project. The following highlights from the project appraisal document illustrate the additional criteria for meeting the + requirements for resilience *through* the project. See the full project document for more information and reference details.

**Excerpt from project document *Project Description Section* that fulfills B rating criteria (intent to build the resilience of project beneficiaries)**

The project development objectives (PDO) are to improve quality of public transport, address climate resilience, improve road safety in selected areas and enhance institutional capacity in the transport sector.

## CASE STUDY BOX 7

*continued*

CASE STUDY:
B+ RATED PROJECT

**Excerpt from project document *Project Description Section* that fulfills B rating criteria (activities to build resilience)**

This component will finance physical investments to improve access, climate resilience and road safety. The resettlement cost identified in the [Resettlement Action Plan] RAP under this component will be financed by IDA. The identification and prioritization of investments use the results of the state-of-the art region-wide spatial analysis that integrates sectoral (education, health, agriculture, tourism), climate change impacts (flooding and landslides), and socioeconomic data (poverty and excluded groups) to identify investments that will boost social and economic inclusion, climate resilience, and the city's competitiveness (see detailed framework in Annex 8 [of the project document]).

**Excerpt from project document *Results Framework and Monitoring Section* that fulfills + rating criteria (inclusion of at least one results indicator that reflects resilience building activities)**

**TABLE CSB7.1 •**
Project development objective indicators

| Indicator name | Baseline | End target |
|---|---|---|
| Address climate resilience | | |
| People benefitting from improved resilient roads (number) | 0.00 | 50,000 |

| Monitoring & evaluation plan: intermediate results indicators | |
|---|---|
| Indicator Name | Project roads with climate adaptation and resilience interventions |
| Definition/ description | This indicator measures the kilometers of roads that had climate adaptation and resilience design as part of the project |
| Frequency | Annual |
| Data source | Progress report |
| Methodology for data collection | This indicator will be measured from progress reports produced by the contractor and verified by the supervisor |
| Responsibility for data collection | Ministry of Transport and Aviation |

# Appendix 1. Resilience rating and existing methodologies

The tables in this appendix link existing research and methodologies on vulnerability and risk assessments with the RRS ratings. There are examples for resilience *of* the project ratings from seven sectors: transport (table A.1.1), water (table A.1.2), hydropower (table A.1.3), energy (table A.1.4), forestry (table A.1.5), agriculture (table A.1.6), and buildings (table A.1.7). For resilience *through* the project, there are examples from the health sector (table A.1.8).

Note that some of these methodologies contain different levels of analysis that correspond to different resilience ratings consistent with the RRS methodology. This list of resources will be updated as additional methodologies are mapped and/or become available.

**TABLE A.1.1 • Examples from the transport sector for resilience *of* the project ratings**

A+

Oh, J E, Espinet Alegre, X, Pant, R, Koks, E E, Russel, T, Shoenmakers, R, and Hall, J W. 2019. *Addressing Climate Change in Transport: Volume 2: Pathway to Resilient Transport* (English). Vietnam Transport Knowledge Series. Washington DC: World Bank Group. http://hdl.handle.net/10986/32412

| Summary: | Criteria: |
|---|---|
| The second of two volumes, this report lays out a pathway to a low-carbon and climate-resilient transport sector in Vietnam and provides a methodological framework to analyze critical and vulnerable points of the transport network. | 1. The methodology follows and expands on sectoral best practice and guidance.<br>2. Threats from natural hazards and climate change impacts are considered.<br>3. Considered risk reduction and adaptation options are listed and rationale for inclusion is reported.<br>4. Identified threats and a quantitative level of residual risk are reported.<br>5. Robust estimates of the NPVs (or BCRs) of different adaptation options for different transport link failures are created using the minimum and maximum NPV for each type of option for each type of failure scenario.<br>6. Aligns with the DMDU methods. |

A

World Bank Group. 2018. *Supporting Road Network Vulnerability Assessments in Pacific Island Countries*. Transport Knowledge Note. Washington DC: World Bank. http://hdl.handle.net/10986/29691

**Summary:**

Road network vulnerability assessments are shown through a pilot undertaken in Samoa. Components include:

» Identifying the threats posed by geophysical and climate-related events

» Assessing the risk of transport network failures

» Assessing potential damage to network components—for example, bridge and road links) and potential impacts to communities and economies

» Identifying potential measures to enhance the resilience of transport networks

» Undertaking a cost-benefit analysis of potential measures to inform the prioritization of investments

**Criteria:**

1. The methodology follows and expands on sectoral best practice and guidance.
2. Threats from natural hazards and climate change impacts are considered.
3. Considered risk reduction and adaptation options are listed and rationale for inclusion is reported.
4. Identified threats and a quantitative level of residual risk are reported.
5. A cost-benefit analysis is undertaken to inform an assessment plan: economic indicators—beneficiaries, costs, internal rate of return and NPV—are used to assess the comparative performance of a variety of alternative options for investment. Depending on the risk-aversion of decision makers, several criteria can be used to choose the best alternative.
6. A catastrophic risk assessment through probability analysis is recommended.

A

US Federal and Highway Administration. 2018. *FHWA Vulnerability Assessment and Adaptation Framework*. https://www.adaptationclearinghouse.org/resources/fhwa-vulnerability-assessment-and-adaptation-framework.html

**Summary:**

Most recently updated in 2018, this framework is a manual to help transport agencies assess the vulnerability of transport infrastructure and systems to extreme weather and climate effects.

In 2014, the Federal and Highway Administration (FHWA) published *Hydraulic Engineering Circular No. 25–Volume 2. Highways in the Coastal Environment: Assessing Extreme Events*,[a] which provides technical guidance on how to incorporate extreme events and climate change into coastal highway designs, with a focus on sea level rise, storm surge, and wave action.

In June 2016, FHWA released a similar update to *Hydraulic Engineering Circular No. 17–2nd Edition. Highways in the River Environment: Floodplains, Extreme Events, Risk, and Resilience*,[b] which provides technical methods on how to incorporate floodplain management, risk, extreme events, resilience, and adaptation for highways in the riverine environment. The guidance in the manual draws on the best actionable engineering, scientific methods and data.

**Criteria:**

1. The methodology follows and expands on sectoral best practice and guidance.
2. Threats from natural hazards and climate change impacts are considered.
3. Considered risk reduction and adaptation options are listed and rationale for inclusion is reported.
4. Identified threats and a quantitative level of residual risk are reported.
5. Engineering-informed assessments test the asset against future climate scenarios and evaluate how it would perform under projected climate scenarios.
6. The efficacy of adaptation options is also evaluated under future scenarios and through an economic impact, cost-benefit and life-cycle cost analyses.

**B** Paige-Green, P, Verhaeghe, B, and Head, M. 2016. *Climate Adaptation: Risk Management and Resilience Optimisation for Vulnerable Road Access in Africa. Climate Adaptation Options Report*. https://www.gov.uk/research-for-development-outputs/climate-adaptation-risk-management-and-resilience-optimisation-for-vulnerable-road-access-in-africa

**Summary:**

This study addresses appropriate and economic methodologies for vulnerability and risk assessments; prioritizing adaptation interventions; and optimizing asset resilience in the context of rural access low-volume roads. It also provides evidence of cost, economic and social benefit links to rural communities arising from more resilient rural access to support wider policy adoption across Africa

**Criteria:**

1. The methodology follows risk assessment tools or sectoral guidance.
2. Threats from natural hazards and climate change impacts are considered.
3. Considered risk reduction and adaptation options are listed and rationale for inclusion is reported.
4. Climate change scenarios are constructed, impacts on the transport sector are assessed, and a semi-quantitative, indicator-based assessment method for quantification and prioritization of risks exists.

**B** Le Roux, A, Makhanya, S, Arnold, K, Roux, M. Council for Scientific and Industrial Research, Paige-Green Consulting Ltd, and St Helens Consulting Ltd. 2019. *Climate Adaptation: Risk Management and Resilience Optimisation for Vulnerable Road Access in Africa. Climate Risk and Vulnerability Assessment Guidelines*. https://www.research4cap.org/ral/CSIR-PGC-StHelens-ClimateAdaptation-RiskVulnerabilityGuideline-AfCAP-GEN2014C-190926-compressed.pdf

**Summary:**

This report provides guidance and methods for conducting a climate vulnerability assessment at national, regional, and project levels. It also provides a framework for identifying and prioritizing potential adaption measures, conducting stakeholder consultations, and developing a monitoring and evaluation plan. The report focuses on risk to rural access roads.

**Criteria:**

1. The methodology incorporates sector-specific climate indices and sectoral guidance for hazard mapping, including local data collection.
2. The vulnerability assessment draws on multiple climate scenarios to account for different climate futures using a timeframe that is relevant to the project assets.
3. Risk management measures are identified, considered, and prioritized, based on districts that are most at risk and climate-sensitive engineering designs.

a. https://www.fhwa.dot.gov/engineering/hydraulics/pubs/nhi14006/nhi14006.pdf
b. https://www.fhwa.dot.gov/engineering/hydraulics/pubs/hif16018.pdf

## TABLE A.1.2 • Examples from the water sector for resilience *of* the project ratings

**A+** Bonzanigo, L, Rozenberg, J, Felter, G C, Lempert, R J, and Reed, P M. 2018. *Building the Resilience of WSS Utilities to Climate Change and Other Threats: A Road Map*. Washington DC: World Bank Group. http://hdl.handle.net/10986/31090

**Summary:**

While not explicitly labelled as a vulnerability assessment, the authors suggest that, to incorporate resilience in their choices, utilities must consider all possible uncertainties—including climate change—from the start.

**Criteria:**

1. The methodology follows and expands on sectoral best practice and guidance, including The Decision Tree Framework and DMDU.

A+ Engle, N L, Medina, D, Felter, G, and Nelson, S. 2020. *Resilient Water Infrastructure Design Brief* (English). Washington DC: World Bank Group. http://hdl.handle.net/10986/34448

**Summary:**

This design brief guides users on how resilience can be built into project engineering designs. With a focus on the three natural hazards most likely to affect water and sanitation infrastructure—droughts, floods, and high winds from storms—it provides a six-step process to help users address weather and climate-related challenges that are most likely to affect an infrastructure component during its operational lifetime.

This brief distills concepts of traditional risk assessment, DMDU literature, and the results of those efforts into a practical approach to designing resilient water infrastructure. Applying the outlined methodology will guide analysts to evaluate the vulnerability of system components, understand the consequences of the failure of those components on the utility's performance, and select suitable mitigation options to improve the resilience of the components.

**Criteria:**

1. The methodology follows and expands on sectoral best practice and guidance including the Decision Tree Framework and DMDU.

A+ Ray, P A and Brown, C M. 2015. *Confronting Climate Uncertainty in Water Resources Planning and Project Design: The Decision Tree Framework* (English). Washington DC: World Bank Group. http://hdl.handle.net/10986/22544

**Summary:**

This book outlines a risk assessment process for World Bank water resource projects that can serve as a decision support framework. General steps include project screening according to climate sensitivity, an initial analysis (risk statement), an exhaustive stress test to identify climate sensitivity of the system and vulnerabilities, and a resulting climate risk management plan.

**Criteria:**

Follows best-practice guidance as mentioned in the RRS.

B USAID. 2015. *Incorporating Climate Change Adaptation in Infrastructure Planning and Design*. https://www.climatelinks.org/resources/incorporating-climate-change-adaptation-infrastructure-planning-and-design-overarching

**Summary:**

This is an interesting approach in that it places vulnerability and risk assessments both as part of planning and design methodologies, where vulnerability assessments involve exposure and sensitivity analysis, while risk assessment includes a consequence and likelihood analysis. This evaluation informs the development of adaptation strategies. This report presents an overview of potential impacts on typical infrastructure activities, adaptation responses, and strategies for a climate altered future—including resilience for sanitation,[a] flood management,[b] and potable water.[c]

**Criteria:**

1. Threats from natural hazards and climate change impacts are considered.
2. Considered risk reduction and adaptation options are listed and rationale for inclusion is reported.
3. A semi-quantitative, indicator-based assessment method for quantification and prioritization of risks exists.

| B | US Environmental Protection Agency. 2014. *Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans and Online Companion Tool for Vulnerability Assessment Reports*. https://www.epa.gov/cre/risk-based-adaptation |
|---|---|
| **Summary:**<br><br>This workbook provides guidance for conducting risk-based climate change vulnerability assessments and developing adaptation action plans with a coastal and watershed focus. The workbook recommends vulnerability assessments as a step before risk analysis. It uses the international standard for risk management and adapts it for the climate change community. | **Criteria:**<br><br>1. Threats from natural hazards and climate change impacts are considered.<br>2. Considered risk reduction and adaptation options are listed and rationale for inclusion is reported.<br>3. Identified threats and a qualitative level of risk are reported.<br>4. Iterative risk management and monitoring of risks due to climate change are carried out. |

a. https://www.climatelinks.org/resources/methodology-incorporating-climate-change-adaptation-infrastructure-planning-and-design-2
b. https://www.climatelinks.org/resources/methodology-incorporating-climate-change-adaptation-infrastructure-planning-and-design-0
c. https://www.climatelinks.org/resources/potable-water-incorporating-climate-change-adaptation-infrastructure-planning-and-design

### TABLE A.1.3 • Examples from the hydropower sector for resilience *of* the project ratings

| B to A+ | International Hydropower Association. 2019. *Hydropower Sector Climate Resilience Guide*. https://www.hydropower.org/publications/hydropower-sector-climate-resilience-guide |
|---|---|
| **Summary:**<br><br>This guide provides a practical and useful approach for identifying, assessing and managing climate risks to enhance the climate change resilience of new and existing hydropower projects. | **Criteria:**<br><br>1. Adopts the DMDU approach, including climate stress tests to assess project performance under different possible future climate scenarios to support resilient design decision making.<br>2. Threats from natural hazards and climate change impacts are considered.<br>3. Considered risk reduction and adaptation options are listed and rationale for inclusion is reported.<br>4. Resilience options are evaluated through climate stress tests to evaluate each option’s ability to reduce potential risks while satisfying the specified performance metrics for future climate scenarios.<br>5. M&E includes evaluation and reassessment of climate risks. |

**TABLE A.1.4** • Examples from the energy sector for resilience *of* the project ratings

| A+ | World Bank. 2020. *The Good Practice Note for Energy Sector Adaptation*. Washington DC: World Bank. https://worldbankgroup.sharepoint.com/sites/energy/Documents/Energy%20Resilience%20Good%20Practice%20Note/Energy%20Resilience%20Good%20Practice%20Note_Feb2020.pdf (World Bank internal document) |
|---|---|
| **Summary:**<br>This note helps World Bank project developers incorporate climate adaptation and resilience into power sector projects for client countries. | **Criteria:**<br>1. Draws on the Decision Tree Framework, with adaptations to allow generalization to a broad range of asset types and project circumstances.<br>2. Threats from natural hazards and climate change impacts are considered.<br>3. Considered risk reduction and adaptation options are listed and rationale for inclusion is reported.<br>4. Identified threats and a quantitative level of residual risk are reported.<br>5. Risk assessment includes stress tests, use of climate projections and scenarios to capture the full range of uncertainty in future conditions.<br>6. The efficacy of adaptation options is assessed using cost-benefit analysis, multi-criteria analysis, and scenario analysis. |

| A | Asian Development Bank. 2013. *Guidelines for Climate Proofing Investment in the Energy Sector*. https://www.adb.org/sites/default/files/institutional-document/33896/files/guidelines-climate-proofing-investment-energy-sector.pdf |
|---|---|
| **Summary:**<br>These guidelines provide a step-by-step method for assessing climate risk and incorporating adaptation measures into energy projects. | **Criteria:**<br>1. Threats from natural hazards and climate change impacts are considered.<br>2. Considered risk reduction and adaptation options are listed and rationale for inclusion is reported.<br>3. Risk assessment tool or sectoral guidance is used.<br>4. Once adaptation options are identified, economic (cost-benefit) analysis is used to quantify climate change impacts along two scenarios: with or without adaptation options. Sensitivity analysis and probabilistic (or risk) analysis can be applied to explicitly account for risk and uncertainty within the framework of the cost-benefit analysis. |

| B | Energy Sector Management Assistant Program (ESMAP). 2010. Hands-on Energy Adaptation Toolkit (HEAT). https://www.esmap.org/node/312 |
|---|---|
| **Summary:**<br>This toolkit is designed to lead an assessment of climate vulnerabilities and adaptation options in the energy sector. It uses a stakeholder-based, qualitative, and semi-quantitative risk assessment approach to identify adaptation measures and their costs and benefits. | **Criteria:**<br>1. Threats from natural hazards and climate change impacts are considered.<br>2. Considered risk reduction and adaptation options are listed and rationale for inclusion is reported.<br>3. Identified threats and a qualitative level of risk are reported. |

**TABLE A.1.5 • Examples from the agriculture sector for resilience *of* the project ratings**

**A**

Ahouissoussi, N, Neumann, J E, Srivastova, J P, Okan, C, Boehkert, B, and Strzepek, K M. 2014. *Reducing the Vulnerability of Azerbaijan's Agricultural Systems to Climate Change: Impact Assessment and Adaptation Options*. Washington DC: World Bank. http://hdl.handle.net/10986/18239

| Summary: | Criteria: |
|---|---|
| This national-level study is a primarily quantitative vulnerability assessment of the effects of climate change on crop yields, irrigated agriculture, and livestock. To develop a menu of adaptation options, the authors consulted with farmers and local government officials. The analysis focused on assessing the impacts of climate change on key crops in three agricultural regions of Azerbaijan. | 1. The methodology follows and expands upon sectoral guidance.<br>2. Threats from natural hazards and climate change impacts are considered.<br>3. Considered risk reduction and adaptation options are listed and rationale for inclusion is reported.<br>4. Impact assessments test crops against future climate scenarios (low, high and medium impact) and evaluate how they would perform under projected climate scenarios.<br>5. The efficacy of adaptation options is also evaluated through quantitative benefit-cost and social analyses. |

**B**

World Bank. 2016. *Agricultural Sector Risk Assessment: Methodological Guidance for Practitioners*. Agriculture global practice discussion paper, no. 10. Washington, DC: World Bank. http://hdl.handle.net/10986/23778

| Summary: | Criteria: |
|---|---|
| Looking at risk from an integrated perspective, this conceptual framework views agricultural sector risk assessment as a tool to help decision makers understand risk exposure and to provide the basis for developing appropriate risk management solutions.<br><br>The agricultural sector risk assessment serves as a methodological guidance for identifying and justifying strategies that strengthen the resilience of agricultural systems aimed at adapting agriculture to climate change conditions. | 1. Threats from natural hazards and climate change impacts are considered.<br>2. Risk assessment tool or sectoral guidance is used.<br>3. Considered risk reduction and adaptation options are listed and rationale for inclusion or non-inclusion is reported. |

**B**

USAID. *ARCC Vulnerability Assessments in Africa*. https://www.climatelinks.org/content/arcc/va/africa

| Summary: | Criteria: |
|---|---|
| This compendium of USAID vulnerability assessments conducted in Africa explores agricultural adaptation to climate change through impact studies on pests and diseases affecting livestock and studies of selected crops. The compendium includes national-level vulnerability analysis as well, with examples primarily from West Africa. | 4. The methodology follows and expands on sectoral best practice and guidance.<br>5. Threats from natural hazards and climate change impacts are considered.<br>6. Considered risk reduction and adaptation options are listed and rationale for inclusion is reported.<br>7. Identified threats and qualitative and quantitative level of risk are reported. |

**TABLE A.1.6** • Example from the forestry sector for resilience *of* the project ratings

| C to A | World Bank. 2020. *Overview of a Four-Step Approach to Building Climate Resilience in Plantation Forestry Projects*. (forthcoming). |
|---|---|
| **Summary:**<br>The World Bank has been developing an approach to incorporate resilience to climate change-related hazards into World Bank forestry projects. The approach provides a pathway to building resilience to address climate risk throughout the project cycle. | **Criteria:**<br>1. Threats from natural hazards and climate change impacts are considered.<br>2. An assessment method for quantifying and prioritizing risks exists.<br>3. Considered risk reduction and mitigation options are listed and rationale for inclusion is reported. |

**TABLE A.1.7** • Example from the buildings sector for resilience *of* the project ratings

| C to A | International Finance Corporation. 2020. *Building Resilience Index*. https://www.resilienceindex.org/ |
|---|---|
| **Summary:**<br>This is a web-based hazard mapping and resilience assessment framework that evaluates location-specific, climate-related risks for real estate projects or portfolios, and the resilience measures that have been implemented. The index is designed for stakeholders in the real estate sector, including financial institutions, lenders, construction developers, insurers, buyers, and governments. The resilience of a building is indicated by the index through a standardized letter grade system. Buildings are rated according to their ability to maintain construction integrity and operational continuity. | **Criteria:**<br>1. Threats from natural hazards and climate change impacts are considered.<br>2. Risk assessment tool or sectoral guidance is used.<br>3. Considered risk reduction and mitigation options are listed and rationale for inclusion is reported.<br>4. A quantitative level of residual risk is reported through estimated expected loss. |

**TABLE A.1.8** • Examples from the health sector for resilience *through* the project ratings

| | |
|---|---|
| **A+** | World Health Organization. 2013. *Protecting Health from Climate Change: Vulnerability and Adaptation Assessment*. https://www.who.int/globalchange/publications/vulnerability-adaptation/en/ |
| **Summary:**<br>This guide provides step-by-step guidance on conducting a national or subnational assessment of current and future vulnerability to the health risks of climate change, and of policies and programs that could increase resilience, taking into account the multiple determinants of climate-sensitive health outcomes. It is primarily focused on qualitative approaches, including stakeholder consultations, epidemiological studies, risk distributions through spatial mapping, and analysis of future health risks and relationships between weather variables and climate-sensitive health outcomes through qualitative and quantitative means. | **Criteria:**<br>1. The methodology is sectoral best practice and guidance.<br>2. Threats from natural hazards and climate change impacts are considered.<br>3. Possible additional burden of adverse health outcomes due to climate change are estimated through qualitative or quantitative methods for projecting future health risks.<br>4. Estimates of the costs of current and projected impacts without additional policies and programs (the costs of inaction) and of the costs of policies and programs to address these risks (the costs of action) are recommended to help with health policy and resourcing decision making.<br>5. Iterative risk management and monitoring of health risks due to climate change are undertaken.<br>This evolving set of resources will support effective and evidence-based action to protect health from climate change, making it is easier and cheaper to adapt to climate change and reduce climate and disaster risks in the future. |

| | |
|---|---|
| **A** | World Bank. 2017. *Methodological Guidance, Climate Change and Health Diagnostic: A Country-Based Approach for Assessing Risks and Investing in Climate-Smart Health Systems*. http://documents1.worldbank.org/curated/en/552631515568426482/pdf/122328-WP-PUBLIC-WorldBankClimateChangeandHealthDiagnosticMethodologyJan.pdf |
| **Summary:**<br>This guidance provides steps for conducting a health and climate assessment that describes risks, capacities and opportunities. The approach expands on existing guidance from WHO on established approaches for carrying out climate change and health assessments. A significant portion of the diagnostic assesses health systems and health risks due to climate change, including cascading disruptions or failures that compound existing vulnerabilities. The end result is a report that summarizes and prioritizes interventions for enhancing the resilience of a country's health system. | **Criteria:**<br>1. The methodology is based on sectoral best practice and provides a strategy for prioritizing interventions for enhancing the resilience of a country's health system.<br>2. Improving the resilience of the wider health sector is transformational in scope. |

B

Climate and Health Program at the Centers for Disease Control and Prevention (CDC). 2019. *Assessing Health Vulnerability to Climate Change: A Guide for Health Departments*. https://www.cdc.gov/climateandhealth/pubs/assessinghealthvulnerabilitytoclimatechange.pdf

**Summary:**

The CDC has developed this Building Resilience Against Climate Effects (BRACE) framework to assess the people and places in a health department's jurisdiction that are susceptible to health impacts associated with climate change. The framework uses two quantitative approaches to assess vulnerability: overlay analysis of risk factors and spatial regression. The end result is a mapping product that can be used to identify communities and places that are vulnerable to disease or injury linked to climate-related exposure. Separate guidance has been issued for identifying the most suitable health interventions for the health impacts that are of greatest concern.

**Criteria:**

1. Threats from natural hazards and climate change impacts to the population are considered.
2. Screening tool or sectoral guidance is used to identify vulnerability context of location and populations.
3. Suitable health interventions are identified.

# Appendix 2. Climate and disaster indices: sectoral examples

**TABLE A.2.1** • Climate and disaster indices: agriculture

| Hazards | Sample indices | Relevance for agriculture projects |
|---|---|---|
| **Extreme temperature** | » Change in annual/monthly mean temperature<br>» Change in daily maximum temperature<br>» Change in growing season length<br>» Change in number of frost days (minimum temperature <0°C) | » Upper heat thresholds may reduce or stall crop productivity<br>» Changes in temperature can affect growing season length and suitability of crop type<br>» Extreme heat can contribute to aridity and drought conditions; extreme cold or frost can lead to crop failure |
| **Extreme precipitation and flooding** | » Change in annual/monthly precipitation<br>» Change in maximum cumulative rainfall<br>» Change in number of consecutive wet/dry days<br>» Number of very wet days[a]<br>» Days of rainfall above 20 and 50mm<br>» Maximum daily rainfall | » Change in precipitation can affect suitability of crop types and farming practices and lead to new pest outbreaks<br>» Temporal gaps between rainfall episodes, intensity of rainfall and availability of water during critical times of the season can impact crop yields or irrigation needs<br>» Flooding can damage crop storage and processing facilities and rural road infrastructure |
| **Droughts** | » Change in maximum number of consecutive dry days<br>» Annual mean drought index (Standardized Precipitation-Evapotranspiration or SPEI)<br>» Annual severe drought likelihood<br>» Change in annual rainfall range | » Dry days directly impact soil moisture and can increase stress on water resources<br>» Dry conditions may lead to crop failure and exacerbate risks of flash floods if followed by heavy precipitation |
| **Strong winds/storms** | » Wind speed<br>» Coastal flooding extent<br>» Change in storm surge height | » High winds can increase evapotranspiration, decrease soil moisture, and exacerbate drought conditions<br>» Strong winds or storms can damage or injure crop or livestock and increase soil erosion |
| **Sea level rise** | » Sea level rise extent<br>» Historical sea level anomaly | » Sea level rise can reduce land availability for crops, pasture, and/or fisheries<br>» Sea level rise can increase soil erosion |
| **Natural hazards** | » Average annual hazard occurrence | » Wildfires, earthquakes, volcanoes, tsunamis, land subsidence and other hazards can damage crops, cropland, livestock, pasture and infrastructure such as rural roads and storage facilities |

**TABLE A.2.2** • Climate and disaster indices: energy

| Hazards | Sample indices | Relevance for energy projects |
|---|---|---|
| **Extreme temperature** | » Change in annual/monthly mean temperature<br>» Change in number of days with dangerous heat<br>» Change in cooling/heating degree days<br>» Change in number of frost days (minimum temperature <0°C)<br>» Cold Spell Duration Index | » Increased cooling/heating demand<br>» Reduced power generation efficiency<br>» Evaporation of reservoirs and watersheds for hydropower supply<br>» Reductions in substation capacity and transformer lifespan |
| **Extreme precipitation and flooding** | » Change in annual/monthly precipitation<br>» Change in maximum cumulative rainfall<br>» Days of consecutive wet days<br>» Number of very wet days<br>» Days of rainfall above 20 and 50mm<br>» Maximum daily rainfall | » Shifts in peak flow and generation of hydropower<br>» Risks to physical infrastructure from flooding and interruption of generation, transmission and distribution networks, and grid-based access |
| **Droughts** | » Change in maximum number of consecutive dry days<br>» Annual mean drought index (SPEI)<br>» Annual severe drought likelihood<br>» Change in annual rainfall range | » Evaporation of reservoirs and watersheds for hydropower supply<br>» Reduced supply of cooling water<br>» Shifts in peak flow and peak generation for hydropower |
| **Strong winds/storms** | » Wind speed<br>» Change in number of days without noticeable wind<br>» Coastal flooding extent<br>» Change in storm surge height | » Physical damage to power infrastructure, including mini-grid and off-grid infrastructure<br>» Disruption of energy lines/decrease in efficiency<br>» Increase in power outages |
| **Sea level rise** | » Sea level rise extent<br>» Historical sea level anomaly | » Inundation of power infrastructure and reduced infrastructure lifespan; saltwater corrosion of electrical components |
| **Natural hazards** | » Average annual hazard occurrence | » Physical damage to power infrastructure<br>» Reduction of transmission capacity and efficiency |

*Notes to tables A.2.1 and A.2.2:*

*Table A.2.1:* See the CCKP Agriculture Sector Portlet for further information on indices by subsector https://climatedata.worldbank.org/CRMePortal/web/agriculture

a. This indicator captures how much of the precipitation sum in an area comes primarily from extreme rainfall events as opposed to more evenly distributed events. The unit is expressed as a percentage of the heaviest 5 percent of precipitation events compared to total precipitation. The larger the number, the more the location is dominated by a few heavy rainfall events. Conversely, the smaller the number, the more evenly distributed the precipitation, and the largest rainfall events are not that exceptional overall.

*Table A.2.2:* See the CCKP Energy Sector Portlet for further information on indices by subsector. https://climatedata.worldbank.org/CRMePortal/web/energy

**TABLE A.2.3** • Climate and disaster indices: forestry

| Hazards | Sample indices | Relevance for forestry projects |
|---|---|---|
| **Extreme temperature** | » Change in daily maximum temperature<br>» Increase in mean annual temperature<br>» Number of very hot days<br>» Average temperature of the warmest month of the year<br>» Change in number of frost days (minimum temperature <0°C) | » Extreme heat can cause greater aridity and risk of forest fires<br>» Extreme hot and cold temperatures can affect tree growth, mortality, and health, increasing risk or susceptibility to pest pathogens |
| **Extreme precipitation and flooding** | » Change in 20-year return period for maximum 1-day precipitation<br>» Change in maximum cumulative rainfall<br>» Days of consecutive wet days<br>» Change in annual/monthly precipitation | » Extreme precipitation and flooding can lead to downed trees<br>» Flooding/excess moisture can weaken trees, and make them more susceptible to pest outbreaks |
| **Droughts/ water scarcity** | » Annual mean drought index (SPEI)<br>» Annual probability of experiencing extreme long-term drought (using 36-month window, where SPEI is computed over the full period)<br>» Annual severe drought likelihood<br>» Change in maximum number of consecutive dry days | » Severe and prolonged drought can dampen growth and increase tree mortality<br>» Dry days directly impact soil moisture and can change the availability of catchment water resources<br>» Drought/water scarcity may increase risk of forest fire |
| **Strong winds/storms** | » Annual mean windspeed at 10 m (m/s)<br>» Annual exceedance probability of experiencing gale-force winds as a result of a tropical cyclone or subtropical cyclone | » Strong winds can cause blow over and affect tree growth<br>» Breakage may leave trees more vulnerable to fungi and other pest invaders |
| **Forest fires** | » Annual mean Fire Weather Index (FWI)<br>» Maximum daily value of the FWI<br>» Daily probability of days per year that the FWI exceeds the 95th percentile<br>» Relative change in the annual monthly mean of the FWI (%) | » Weather conditions such as higher temperatures, low rainfall, increased aridity and winds can contribute to higher risk of forest fires |
| **Shift in silviculture/ growing zone** | » Areas experiencing a >= 2°C increase in mean annual temperature<br>» Areas experiencing a >= 50 mm increase in mean annual precipitation<br>» Change in growing season length | » Changes in precipitation and temperature patterns can affect suitability of tree type, and make trees more susceptible to pest outbreaks<br>» Long-term changes in availability of catchment water resources |
| **Pests and pathogens** | » Absolute change in mean minimum winter temperatures, relative to reference climate period (°C)<br>» Absolute change in mean maximum winter temperatures, relative to reference climate period (°C)<br>» Areas experiencing a >= 1 standard deviation increase in mean annual precipitation | » Lack of winter frost and wetter conditions can improve breeding grounds of pests and pathogens<br>» More extreme hot/cold temperatures can increase stress on trees, making them more susceptible to disease |

**TABLE A.2.4 • Climate and disaster indices: health, nutrition, and population**

| Hazards | Sample indices | Relevance for health, nutrition, and population projects |
|---|---|---|
| **Extreme temperature** | » Change in annual/monthly mean temperature<br>» Change in record high temperatures<br>» Change in number of dangerous heat days and of tropical nights<br>» Probability of heat/cold wave<br>» Warm/Cold Spell Duration Index | » Increase in heat-related illnesses—such as respiratory and cardiovascular disease—and death, especially in urban heat islands<br>» Air pollution and increasing allergens: asthma, cardiovascular disease, respiratory allergies<br>» Changes in vector ecology—for example, warm temperatures and humid climates may shift patterns of disease-carrying mosquitoes and ticks |
| **Extreme precipitation and flooding** | » Change in annual/monthly precipitation<br>» Change in maximum cumulative rainfall<br>» Days of consecutive wet days<br>» Number of very wet days<br>» Maximum daily rainfall | » Impacts on water quality, affecting diseases such as cholera, typhoid, diarrhea, or hepatitis E, and potentially causing harmful algal blooms<br>» Degraded living conditions and potential exacerbation of existing health vulnerabilities<br>» Changes in vector-borne diseases, such as malaria or dengue<br>» Impacts on access to health facilities |
| **Droughts** | » Change in maximum number of consecutive dry days<br>» Annual mean drought index (SPEI)<br>» Annual severe drought likelihood<br>» Change in annual rainfall range | » Impacts on water, food supply, and malnutrition<br>» Degradation of water and sanitation services<br>» Forced migration, civil conflict<br>» Mental health impacts for farmers related to loss of jobs or income |
| **Strong winds/storms** | » Wind speed<br>» Coastal flooding extent<br>» Change in storm surge height | » Injuries, fatalities, and loss of homes and livelihoods<br>» Degraded living conditions and potential exacerbation of existing health vulnerabilities<br>» Washout of service delivery infrastructure (roads) or damage to hospital infrastructure or energy supply<br>» Changes in vector ecology |
| **Sea level rise** | » Sea level rise extent<br>» Historical sea level anomaly | » Forced migration<br>» Saltwater intrusion into freshwater aquifers which impacts food and water supply |
| **Natural hazards** | » Average annual hazard occurrence | » Injuries, fatalities, loss of homes and livelihoods<br>» Degraded living conditions and potential exacerbation of existing health vulnerabilities<br>» Forced migrations<br>» Mental health impacts |

*Notes:* See the CCKP Health Sector Portlet for more information on indices by subsector https://climatedata.worldbank.org/CRMePortal/web/health/systems-and-service. Project developers may also find useful climate information on the Interactive Climate Indicator Dashboard—Health (WBG) Tool; World Bank Group. 2017. Geographic Hotspots for World Bank Action on Climate Change and Health; and California Department of Public Health. Climate Change and Health Impacts. https://www.cdph.ca.gov/Programs/OHE/Pages/CCHEP.aspx.

**TABLE A.2.5** • Climate and disaster indices: transport

| Hazards | Sample indices | Relevance for transport projects |
|---|---|---|
| **Extreme temperature** | » Change in annual/monthly mean temperature<br>» Change in number of days with dangerous heat<br>» Change in number of very hot days<br>» Warm Spell Duration Index<br>» Frost days (minimum temperature <0°C) | » Extreme temperatures can affect road surfaces (asphalt binder) or cause track or rail buckling<br>» Extreme temperatures can affect the health and safety of construction workers and impede construction<br>» Urban heat island effects, exacerbated by construction dust/ built infrastructure, may impede beneficiary usage<br>» Extreme temperatures can impact engines/electronics and reduce aircraft lift, requiring longer takeoff runs<br>» Extreme cold weather impacts, can impede construction and operation |
| **Extreme precipitation and flooding** | » Change in annual/monthly precipitation<br>» Change in maximum cumulative rainfall<br>» Days of consecutive wet days<br>» Number of very wet days<br>» Days of rainfall above 20mm and 50mm<br>» Maximum daily rainfall | » Extreme precipitation and flooding can cause road or bridge damage and soil erosion<br>» Flooding can overwhelm tunnels and drainage systems with water and storm debris<br>» Flooding can halt public transport and render pedestrian walkways/ cycling paths inaccessible, make line markings invisible, cause road safety risks, cause flooding of open parking lots/bus stands, and so on |
| **Droughts** | » Change in maximum number of consecutive dry days<br>» Annual mean drought index (SPEI)<br>» Annual severe drought likelihood<br>» Change in annual rainfall range | » Drought can cause low water levels that decrease cargo limits, restrict ship navigability and berthing, and potentially require additional dredging<br>» Drought can cause water levels to periodically decrease and limit inland shipping |
| **Strong winds/storms** | » Wind speed<br>» Coastal flooding extent<br>» Change in storm surge height | » High winds and debris can damage transit structures<br>» Strong winds/storms can pose risk to road use safety<br>» Storms cause risks for waterway and maritime transport assets and operations |
| **Sea level rise** | » Sea level rise extent<br>» Historical sea level anomaly | » Sea level rise can cause the inundation of transport infrastructure/saltwater corrosion<br>» Sea level rise can exacerbate soil erosion around transport infrastructure |
| **Natural hazards** | » Average annual hazard occurrence | » Natural hazards can cause physical damage to transport infrastructure<br>» Earthquakes may lead to bridge collapse |

**TABLE A.2.6** • Climate and disaster indices: water

| Hazards | Sample indices | Relevance for water projects |
|---|---|---|
| **Extreme temperature** | » Change in annual/monthly mean temperature<br>» Change in monthly maximum and minimum temperature<br>» Change in evapotranspiration<br>» Average annual basin temperature | » High temperatures can exacerbate water shortages and increase water demand—for example, for irrigation or cooling in energy generation<br>» Warming temperatures can affect evapotranspiration and shifts in the amount and timing of flow and runoff<br>» Rising temperatures can increase algal blooms and pathogens, decrease dissolved oxygen and harm aquatic life in waterways |
| **Extreme precipitation and flooding** | » Change in annual/monthly precipitation<br>» Change in maximum cumulative rainfall<br>» Days of consecutive wet days<br>» Days of rainfall above 20 and 50mm<br>» Change in five-day maximum rainfall over a 25-year period | » Heavy precipitation can cause erosion and sedimentation in waterways, reducing reservoir capacity<br>» Greater precipitation can increase runoff and introduce new contaminants into the water supply, increasing the pollutant load<br>» Heavy rainfall events can cause sewers to overflow, releasing untreated sewage into lakes, rivers and coastal waters |
| **Droughts** | » Change in maximum number of consecutive dry days<br>» Changes in mean annual runoff<br>» Changes in annual base flow and storage<br>» Annual mean drought index (SPEI)<br>» Annual severe drought likelihood<br>» Change in annual rainfall range<br>» Change in mean annual irrigation deficit | » Droughts can reduce recharge to surface and ground water supplies<br>» Lower water levels can lead to higher concentrations of contaminants<br>» Lower water levels can result in lack of supply to meet water pumping and irrigation needs<br>» Droughts can lead to degradation of water and sanitation services |
| **Strong winds/storms** | » Wind speed<br>» Coastal flooding extent<br>» Change in storm surge height | » Strong winds/storms can lead to the overtopping of dams and reservoirs<br>» Strong winds/storms can disrupt electricity supply, impacting pumping and water treatment systems |
| **Sea level rise** | » Sea level rise extent<br>» Historical sea level anomaly | » Sea level rise can damage the structural integrity of embankments, levees, and dikes, and can cause saltwater intrusion into freshwater aquifers |
| **Natural hazards** | » Average annual hazard occurrence | » Natural hazards can cause physical damage to the structural integrity of water supply infrastructure, dams, levees, and dikes |

*Note:* See the CCKP Water Sector Portlet for further information on indices by subsector https://climatedata.worldbank.org/CRMePortal/web/water

# Appendix 3. General and sector resources for assessment of climate risk and resilience options

## A.3.1 • General climate and disaster information resources

**Climate Change Knowledge Portal:** The World Bank's 'one stop shop' for global data on historic and future climate trends, vulnerabilities, and sectoral impacts for all countries. Country profiles and subnational data also available. https://climateknowledgeportal.worldbank.org; https://climateknowledgeportal.worldbank.org/country-profiles.

**ThinkHazard!:** Developed by the World Bank Global Facility for Disaster Reduction and Recovery (GFDRR), this platform provides hazard-level ratings for all countries and sub-national units.[73] Rated hazards—including extreme heat, water scarcity, flooding, earthquakes, landslides, tsunamis, cyclones, and wildfires—can help identify a project location's baseline exposure to risks. https://thinkhazard.org.

**National meteorological agencies:** Often provide more localized climate information. To access via the World Meteorological Organization's member resource page, search by country. https://public.wmo.int/en/about-us/members/national-services.

### A.3.1.1 • Floods

**Frequency of extreme precipitation increases extensively with event rareness under global warming** (*Scientific Reports* 9, 16063. Myhre, G, Alterskjær, K, Stjern, C W, Hodnebrog, Ø, Marelle, L, Samset, B H, Sillmann, J, Schaller, N, Fischer, E, Schulz, M, and Stohl, A 2019): Using current data on damages and frequency of intense precipitation events, finds that the most intense precipitation events observed today are likely to almost double in occurrence for each degree of further global warming. https://doi.org/10.1038/s41598-019-52277-4.

**FM Global Flood and Earthquake Risk Map:** Highlights areas of high and moderate risk. https://www.fmglobal.com/research-and-resources/nathaz-toolkit/flood-map.

### A.3.1.2 • Hurricanes

**Global increase in major tropical cyclone exceedance probability over the past four decades** (*Proceedings of the National Academy of Sciences of the United States of America*, 117 (22) 11975–11980. Kossin, J P, Knapp, K R, Olander, T L, Velden, C S 2020): Discusses the frequency of tropical cyclones in ocean basins based on a 39-year period from 1979–2017. Between the early and latter halves of the time period, the probability of major cyclones increased by about 8 percent per decade. https://www.pnas.org/content/117/22/11975.

### A.3.1.3. Earthquakes

**OpenQuake Map Viewer (Global Earthquake Model):** Depicts the geographic distribution of peak ground acceleration with a 10 percent probability of being exceeded in 50 years, computed for reference rock conditions (shear wave velocity, VS30, of 760–800 m/s). https://maps.openquake.org/map/global-seismic-hazard-map/#3/28.46/90.35.

## A.3.2. Sector-specific resources

### A.3.2.1. All infrastructure

***Overview of Engineering Options for Increasing Infrastructure Resilience*** (Miyamoto International 2019. Washington, DC: World Bank): Provides a list of resilience options in infrastructure regularly implemented in leading countries. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/474111560527161937/final-report.

- ***Overview of Engineering Options for Increasing Infrastructure Resilience: Technical Annex:*** Technical annex to Miyamoto (2019); provides further detail. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/620731560526509220/technical-annex.

***Lifelines: The Resilient Infrastructure Opportunity*** (Hallegatte, S, Rentschler, J, and Rozenberg, J 2019. Washington DC: World Bank): Lays out a framework for understanding infrastructure resilience—the ability of infrastructure systems to function and meet users' needs during and after a natural shock—and makes an economic case for building more resilient infrastructure. Concludes by identifying five obstacles to resilient infrastructure and offering concrete recommendations and specific actions to improve the quality and resilience of these essential services. http://hdl.handle.net/10986/31805.

### A.3.2.2. Agriculture

**Online Guide to Climate-Smart Agriculture:** Comprehensive guide on CSA basics, planning, financing, investing, including a resources library and case studies developed by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) for the World Bank in collaboration with a range of other partners and institutions. https://csa.guide/.

- **CSA country profiles:** Overview of the agricultural challenges in countries around the world, and how CSA can help them adapt to and mitigate climate change. Developed by the International Center for Tropical Agriculture (CIAT) and CCAFS, in partnership with the World Bank, Costa Rica's Centro Agronómico Tropical de Investigación y Enseñanza, and USAID's Bureau for Food Security. https://p4s.ccafs.cgiar.org/tools/csa-country-profiles-and-climate-risk-profiles.

- **Climate Smart Agriculture Investment Plans (CSIAPs): Bringing CSA to Life**. Developed by the World Bank in cooperation with a wide range of partners—including the Adaptation for African Agriculture Initiative, the CIAT and the International Institute for Applied Systems Analysis—built off the CSA profiles. Identifies concrete actions governments can take to boost CSA, through investment opportunities and policy design and implementation. Countries can also use the CSAIPs to inform their NDC updates and national agriculture investment plans. https://www.worldbank.org/en/topic/agriculture/publication/climate-smart-agriculture-investment-plans-bringing-climate-smart-agriculture-to-life.

**Ag Observatory:** Aims to support the World Bank and partners to access and deploy high resolution and near real-time geospatial agrometeorological data for productive and resilient food systems and landscapes. https://worldbankgroup.sharepoint.com/sites/Agriculture/Pages/SitePages/Ag-Observatory-Providing-Agricultural-Intelligence-for-the-World-Bank-and-Partners-03252020-115126.aspx?tab=sitepages&page=managecontentadmin (World Bank Group internal link).

***Future of Food: Shaping a Climate-Smart Global Food System*** (World Bank 2015): Guidance on improving the productivity and resilience of the current food system, and ways to make agriculture part of the solution to climate change. http://hdl.handle.net/10986/22927.

***Guidelines for Climate Proofing Investment in Agriculture, Rural Development, and Food Security*** (Asian Development Bank 2012): A step-by-step methodological approach to help project teams assess and incorporate climate change adaptation measures into investment projects. https://www.adb.org/sites/default/files/institutional-document/33720/files/guidelines-climate-proofing-investment.pdf.

#### A.3.2.3. Energy

***The Good Practice Note for Energy Sector Adaptation*** (World Bank 2020): Helps World Bank project developers incorporate climate adaptation and resilience into power sector projects for client countries. https://worldbankgroup.sharepoint.com/sites/energy/Documents/Energy%20Resilience%20Good%20Practice%20Note/Energy%20Resilience%20Good%20Practice%20Note_Feb2020.pdf (World Bank internal link).

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***Hydropower Sector Climate Resilience Guide*** (International Hydropower Association 2019): A methodology for identifying, assessing and managing climate risks to enhance the resilience of hydropower projects. https://www.hydropower.org/publications/hydropower-sector-climate-resilience-guide.

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***Guidelines for Climate Proofing Investment in the Energy Sector*** (Asian Development Bank 2013): A step-by-step method for assessing climate risk and incorporating adaptation measures into energy projects. https://www.adb.org/documents/guidelines-climate-proofing-investment-energy-sector.

**Hands-On Energy Adaptation Toolkit (HEAT)** (World Bank Energy Sector Management Assistance Program 2010): A stakeholder-based, semiquantitative, risk assessment tool for project developers who want to undergo more in-depth risk assessments. Prioritizes risks to a country's energy sector and identify adaptation options. https://esmap.org/node/312.

### A.3.2.4. Forestry

***Forest Adaptation Resources: climate change tools and approaches for land managers***, 2nd edition (US Department of Agriculture 2016): Provides a collection of resources designed to help forest managers incorporate climate change considerations into management and devise adaptation tactics. https://www.nrs.fs.fed.us/pubs/52760.

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**Building Resilience Against Climate Effects (BRACE) Framework** (Centers for Disease Control and Prevention): Allows health officials to develop strategies and programs to help communities prepare for the health effects of climate change. Part of this effort involves incorporating complex atmospheric data and both short and long-range climate projections into public health planning and response activities. https://toolkit.climate.gov/tool/building-resilience-against-climate-effects-brace-framework.

» **Assessing Health Vulnerability to Climate Change: A Guide for Health Departments.** Part of the BRACE Framework. https://toolkit.climate.gov/tool/assessing-health-vulnerability-climate-change-guide-health-departments.

***Methodological Guidance: Climate Change and Health Diagnostic. A Country-Based Approach for Assessing Risks and Investing in Climate-Smart Health Systems*** (World Bank Group 2018): Provides steps to identify events and conditions where climate stresses and shocks undermine the effectiveness of health systems (at local or national scales), increasing morbidity and mortality. Uses these insights to prioritize interventions toward establishing climate-smart health systems that both increase resilience and reduce climate forcing emissions. http://documents1.worldbank.org/curated/en/552631515568426482/pdf/122328-WP-PUBLIC-WorldBankClimateChangeandHealthDiagnosticMethodologyJan.pdf.

***Climate and Health Intervention Assessment Evidence on Public Health Interventions to Prevent the Negative Health Effects of Climate Change*** (Centers for Disease Control and Prevention (CDC) and the Building Resilience Against Climate Effects (BRACE) Midwest/Southeast Collaborative 2017): Outlines the findings of the BRACE Midwest/Southeast Collaborative on the evidence of effectiveness of various interventions for reducing the negative health impacts of climate change. https://www.cdc.gov/climateandhealth/docs/ClimateAndHealthInterventionAssessment_508.pdf.

***Tracking Progress on Health and Climate Change*** (Lancet Countdown 2019): Tracks the relationship between health and climate change across five key domains and 41 indicators. https://www.lancetcountdown.org/.

***Geographic Hotspots for World Bank Action on Climate Change and Health*** (World Bank Group 2017): A guide to countries that would most benefit from immediate efforts to ensure that health considerations are at the forefront of climate change adaptation responses and mitigation measures. Draws on vulnerability indices related to health outcomes, data outlining the disease burden linked to pollution, and proxies that measure country health systems' performance or readiness to cope with increased burden of disease. http://documents1.worldbank.org/curated/en/209401495434344235/pdf/113571-Working-Paper-PUBLIC-Final-WBG-Climate-and-Health-Hotspots.pdf.

***Climate Smart Healthcare: Low Carbon and Resilience Strategies for the Health Sector*** (World Bank Group 2017): A menu of tools for building low-carbon health care and addressing climate-related health impacts. http://documents1.worldbank.org/curated/en/322251495434571418/pdf/113572-WP-PUBLIC-FINAL-WBG-Climate-smart-Healthcare-002.pdf.

**Health and Climate Country Profiles** (WHO and UNFCCC 2015 and 2019): Developed in collaboration with national health services. Snapshots of the climate hazards and expected health impacts of climate change facing countries that highlight opportunities for health co-benefits from climate mitigation actions, track current policy responses and summarize key priorities for action. https://www.who.int/globalchange/resources/countries/en/.

***Reducing Climate-Sensitive Disease Risks*** (World Bank 2014): Builds on scientific and operational knowledge of early action tools to help practitioners reduce the risks of key climate-sensitive infectious diseases by strengthening risk management systems for disease outbreaks. Includes an assessment of known interventions such as the establishment of surveillance systems, the development of region and nation-specific disease outlooks, the creation of climate-sensitive disease risk maps, and the construction and implementation of early warning advisory systems. http://hdl.handle.net/10986/18634.

### A.3.2.6. Telecommunications

***No Broken Link: The Vulnerability of Telecommunication Infrastructure to Natural Hazards*** (Sandhu, H S, and Raja, S 2019): Discusses the impact of climate events on various types of digital infrastructure, highlighting key considerations for governments and digital infrastructure owners to make their infrastructure more resilient, while maintaining affordability of services. http://hdl.handle.net/10986/31912.

### A.3.2.7. Transport

***From a Rocky Road to Smooth Sailing: Building Transport Resilience to Natural Disasters*** (Rozenberg, J, Espinet, X, Fox, C, Hallegatte, S, Koks, E, Rentschler, J, and Tariverdi, M 2019): Summarizes the main findings on the risks to transport networks and users from natural disasters and climate change, and the main recommendations for building more resilient transport networks. http://hdl.handle.net/10986/31913.

**Highway Development and Management Model (HDM-4) Dissemination Tools** (World Bank): Help predict road network performance as a function of climate, among other input factors. https://collaboration.worldbank.org/content/sites/collaboration-for-development/en/groups/world-bank-road-software-tools.html.

***Vulnerability Assessment and Adaptation Framework*** (FHWA): For use in analyzing the impacts of climate change and extreme weather on transport infrastructure, assessing adaptation options, and informing decision making. https://www.adaptationclearinghouse.org/resources/fhwa-vulnerability-assessment-and-adaptation-framework.html.

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***Green Roads for Water: Road Infrastructure in Support of Water Management and Climate Resilience*** (World Bank Transport Sector Guideline 2019): Includes principles, techniques, and case studies on road-water harvesting and roads for watershed management. https://roadsforwater.org/guideline/roads-for-water-harvesting-in-semiarid-areas/.

***Global Roadmap of Action Toward Sustainable Mobility (GRA)*** (Sustainable Mobility for all (SuM4All) 2019): Produced in cooperation with the World Bank Group and German Cooperation. A guide for decision makers on mobility that is efficient, accessible, safe, and green. https://www.sum4all.org/gra.

**Country Mobility Diagnostic** (SuM4All): Combines standardized performance assessments on mobility with policy solutions and investment plans to achieve sustainable mobility. https://www.sum4all.org/key-products/country-mobility-diagnostic-cmd.

***Addressing Climate Change in Transport (Vol. 2):*** Pathway to Resilient Transport (World Bank Group 2019): Lays out a pathway to a low-carbon and climate-resilient transport sector in Vietnam and provides a methodological framework to analyze critical and vulnerable points of the transport network. http://hdl.handle.net/10986/32412.

***Climate and Disaster Resilient Transport in Small Island Developing States: A Call for Action*** (World Bank Group 2017): Provides a framework for integrating climate change and disaster risks considerations in transport asset management systems along the asset lifecycle. http://documents1.worldbank.org/curated/en/879491510323939763/pdf/120998-PUBLIC-11-15-2017-WB-RTSIDS-Report.pdf.

***Enhancing the Climate Resilience of Africa's Infrastructure: The Roads and Bridges Sector*** (World Bank Group 2016): Develops a methodology to compare the cost of inaction against proactive adaptation measures in the transport sector, looking at three main dimensions: assessing the cost of road assets over their entire life cycle, considering a variety of climate change scenarios, and quantifying the broader impact of climate-related traffic disruptions. https://www.worldbank.org/en/topic/transport/publication/enhancing-the-climate-resilience-of-africas-infrastructure-the-roads-and-bridges-sector.

***Incorporating Climate Change Adaptation in Infrastructure Planning and Design*** (USAID 2015): First in a series created to address how to incorporate climate change adaptation in planning and designing infrastructure projects. https://www.climatelinks.org/resources/incorporating-climate-change-adaptation-infrastructure-planning-and-design-overarching. It also provides additional guidance on:

- **Roads:** https://www.climatelinks.org/resources/methodology-incorporating-climate-change-adaptation-infrastructure-planning-and-design-1.

***Moving Toward Climate-Resilient Transport: The World Bank's Experience from Building Adaptation into Programs*** (Ebinger, J O and Vandycke, N L 2015): Takes stock of the World Bank's efforts and experience in building resilient transport systems. http://hdl.handle.net/10986/23685.

***Climate Proofing ADB Investment in the Transport Sector: Initial Experience*** (ADB 2014): Presents transport case studies based on a selection of climate risk and vulnerability assessments conducted by ADB. Captures lessons learned and identifies opportunities to further mainstream climate risk management in transport sector investment projects. https://www.adb.org/sites/default/files/publication/152434/climate-proofing-adb-investment-transport.pdf.

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***Confronting Climate Change Uncertainty in Water Resources Planning and Project Design: The Decision Tree Framework*** (World Bank Group 2015): Outlines a pragmatic bottom-up process for assessing project risks that can support decision making and project planning under uncertainty, including climate risk management responses. http://hdl.handle.net/10986/22544.

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***Resilient Water Infrastructure Design Brief*** (World Bank 2020): General guidance on resilient design principles of specific assets within a broader water utility system to allow project developers to verify that World Bank-financed infrastructure uses sound resilience design principles and contributes to the overall objective of utility resilience. Complements *Building the Resilience of WSS Utilities to Climate Change and Other Threats: A Road Map* (World Bank 2018). http://hdl.handle.net/10986/34448.

***Guidelines for Climate Proofing Investment in the Water Sector: Water Supply and Sanitation*** (Asian Development Bank 2016): A step-by-step methodological approach to assist project teams in managing climate change risk in the context of water supply and sanitation investment projects. https://www.adb.org/documents/guidelines-climate-proofing-investment-water-sector.

***Incorporating Climate Change Adaptation in Infrastructure Planning and Design*** (USAID 2015): This report presents an overview of potential impacts on typical infrastructure activities, adaptation responses, with guidance and checklists to follow for assessing infrastructure assets that are exposed to changing climatic conditions and selecting planning and management decisions. https://www.climatelinks.org/resources/incorporating-climate-change-adaptation-infrastructure-planning-and-design-overarching.
It also provides strategies for a climate altered future, including resilience for:

» **Sanitation:** https://www.climatelinks.org/resources/methodology-incorporating-climate-change-adaptation-infrastructure-planning-and-design-2.

» **Flood management:** https://www.climatelinks.org/resources/methodology-incorporating-climate-change-adaptation-infrastructure-planning-and-design-0.

» **Potable water:** https://www.climatelinks.org/resources/potable-water-incorporating-climate-change-adaptation-infrastructure-planning-and-design.

# Appendix 4. Managing uncertainty and climate scenarios

For exceptional disasters and long-term climate change in particular, the uncertainty is often very large, and it is difficult to determine what is impossible or implausible. However, the challenge of selecting an appropriate range of values for the economic analysis of a project is not only related to climate change. Similar issues exist in other parameters, such as future economic growth, exchange rates and interest rates, which are also highly uncertain.

## A.4.1 • Estimating low- and high-impact scenarios

For socioeconomic trends, as for climate change scenarios, the choice of the optimistic and pessimistic scenarios should follow these important principles:

» **It is better to overestimate than underestimate the uncertainty.** The first objective is to identify vulnerabilities, which is better done by considering a wide range of possible scenarios. It is best to calculate the switching value and determine the switching scenario, for which the project NPV is null (unless another definition of failure is used). The switching scenario will not be affected by the range of values selected for no/low-impact and high-impact scenarios, so these can be safely selected as relatively extreme scenarios.

» **It is important to consider a wide range of possible futures when a project failure can have catastrophic impacts.** When a project can fail catastrophically, it is preferable to identify low-probability risks than to miss important vulnerabilities. Not implementing a project (or increasing its cost to reduce vulnerability) is unlikely to lead to catastrophic outcomes, while implementing a vulnerable project can be catastrophic. For small projects and when a failure is manageable with limited impacts, then it is more acceptable to fail, and a narrower range of value can be selected.

» **The no/low- and high-impact scenarios should be plausible, but remember that most people tend to be too conservative regarding what is possible in the future.** It is well documented that most people underestimate the plausibility of massive structural changes and exploring low-probability scenarios is a good way of identifying a project's vulnerabilities.

» **Most importantly, a project that fails in the high-impact scenarios may still be a very good project, provided it has a good return in more optimistic cases and**

**that failure is not catastrophic.** By accepting that a project can fail in pessimistic cases, we make it easier to explore pessimistic scenarios and improve design and resilience.

## A.4.2 • Choice of climate scenarios

When choosing climate scenarios, project developers have to consider which greenhouse gas emission scenarios and climate models to use (box A.4.1). A project's time horizon will also influence their choices. For example:

» **For projects with a time horizon ending before 2030**, developers can consider current climate conditions and risks as constant and need not consider emission scenarios. When assessing current risk levels, however, it is important to take into account the fact that natural hazards are not stationary, as they have already been affected by climate change. In the absence of good climate (and hazard) observed data, it is recommended to use climate models.

» **For projects with a time horizon ending before 2040**, the impact of greenhouse gas emissions is minimal and it is possible to use only one emission scenario, such as RCP 4.5. Since emission scenarios also differ along other dimensions—such as non-$CO_2$ greenhouse gas or aerosol emissions—there may be special cases where it is useful to consider different emissions before 2040, but those will be exceptions. However, even for a project ending before 2040, there will be significant differences in risks across climate models, and more than one climate model should be used.

» **For projects continuing beyond 2040**, it is important to consider different emission scenarios and different climate models. It is recommended to use the RCP 6.0 as a pessimistic emissions scenario, and the RCP 2.6 as an optimistic scenario in terms of emissions and human impact on the climate.[74]

There are now many climate models, and their main results are regularly reviewed in academic journals and by the IPCC. Although these models are all based on similar knowledge of climate system mechanisms and similar approaches to modeling, they may still lead to different results. While all models agree on projecting an increase in global temperatures, they may disagree radically on local changes, especially in terms of changes in precipitation or extreme events. For this reason, it is essential to use more than one climate model when defining no/low- and high-impact scenarios. In practice, exploring the outcome of at least five climate models from leading climate research centers is recommended before selecting scenarios.

BOX A.4.1

# What are climate scenarios and RCPs?

The term "scenarios" is used to refer to descriptions of possible futures, either qualitative or quantitative. Scenarios differ from forecasts or predictions, because they are based on a set of assumptions regarding external factor, such as policy choices or technological evolutions. For example, a scenario can describe the evolution of the world in the absence of climate policies, without being a forecast (since there are climate policies). Scenarios can be more or less likely. Worst-case scenarios are designed to be unlikely, but must be possible and internally consistent.

Climate scenarios are simulations using global climate models that show the evolution of the main climate variables (temperature, precipitations, humidity, cloud cover, wind, and so on) over time, in response to an emission or concentration scenario. When used with an emission scenario, global climate models include a (carbon cycle) module to translate emissions into concentrations of gases in the atmosphere.

RCPs, or representative concentration pathways, are concentration scenarios developed as the input concentration assumptions for the Coupled Model Intercomparison Project (CMIP), which coordinates the production of climate scenarios reviewed by the IPCC. They also include other factors that are external to climate models, such as land use and land cover. The initial RCPs describe four different 21st century pathways of greenhouse gas emissions and atmospheric concentrations, air pollutant emissions and land use. They represent different intensities in the additional radiative forcing (in watts per square meter) caused by human activities, and can be linked to socioeconomic scenarios (shared socioeconomic pathways), which represent different possible evolution of the world in terms of demography, technology, economy, behaviors, and so on.

The RCPs include one stringent mitigation scenario (RCP 2.6, broadly consistent with a 2°C target), two intermediate scenarios (RCP 4.5 and RCP 6.0), and one scenario with very high greenhouse gas emissions (RCP 8.5). RCP 8.5 is today considered unrealistic in view of recent technological and policy evolutions. RCP 2.6 is representative of a scenario that aims to keep global warming less than 2°C above pre-industrial temperatures (IPCC 2014). RCP 1.9 has been recently added to represent a scenario consistent with the 1.5°C target.

Using RCPs as input, climate models simulate future changes in characteristics of Earth systems such as temperature, precipitation, and storms. Due to differences in climate sensitivity across models, each RCP leads to a range of increases in global mean temperatures. Other differences across models lead to further differences in terms of precipitation, storm tracks and intensity, and so on. It means that one RCP is consistent with many different climate scenarios, and therefore different impacts. Climate scenarios are generated by CMIP. Current available scenarios correspond to CMIP5, which generated scenarios for IPCC's Fifth Assessment Report. A new generation, CMIP6, is currently being produced (with first results already available), in preparation of the Sixth Assessment Report.

For a stress test, it is important to consider a range of possible climate scenarios, including various magnitudes of global warming (usually measured by change in average temperature, which can be done using climate scenarios with different forcing, such as RCP 2.6 and RCP 6.0 or 8.5) and a range of possible climate change patterns to capture the differences in local climate patterns, which can be done by using multiple climate models. Note that even though RCP 8.5 is considered unrealistic in terms of carbon emissions, the scenario can still be used to generate a high climate change impact scenario for stress testing purposes.

# Appendix 5. Resilience attributes

**TABLE A.5.1 •** Resilience attributes that support resilience-building pathways and the core resilience capacities

| Resilience attributes | Definitions | Examples |
|---|---|---|
| **Robustness** | Ability of the community and/or system to maintain its characteristics and performance in the face of, or to withstand, climate change and/or disasters | » Strong institutions that help avoid the system's collapse amid the impact of climate shocks and stressors<br>» Design and implementation of new policies and/or regulations that increase preparedness |
| **Learning** | Ability of the community and/or system to generate feedback with which to gain or create knowledge and strengthen resilience-relevant skills and capacities | » Availability of capacity-building programs on adaptation options<br>» Mechanisms to document traditional adaptation knowledge and lessons learned<br>» Access to relevant information and knowledge about local climate change impact |
| **Redundancy** | Availability of additional or spare resources and/or institutions that can be accessed in case of shocks or stressors, and that are interchangeable among them (overlapping functions, services and/or capacities) | » Availability of multiple livelihoods or sources of income—such as remittances, cash crops, and paid labor—which create a financial surplus or additionality that can be used to respond to climatic events<br>» Access to multiple sources of support/expertise (such as credit sources) that can substitute one another to help fill gaps in times of need |
| **Rapidity** | Speed at which assets can be accessed or mobilized by community stakeholders and/or system to achieve goals in an efficient manner | » Availability of early warning systems that alert the community about imminent threats<br>» Swift access to the information needed to take decisions<br>» Savings, credit and insurance mechanisms to ensure rapid access to the financial resources required to respond to shocks—for example, shelter and food needs |
| **Connectedness** | Breadth of resources and structures that a system can access, at multiple levels, to respond or adapt to shocks or stressors | » Access to networks formed by members at local, regional or national levels—for example, regional institutions or a national volunteer groups<br>» Access to extended (regional or international) markets, or organizations to pull resources and support climate responses |

| Resilience attributes | Definitions | Examples |
|---|---|---|
| **Diversity** | Ability of the community and/or system to undertake different courses of actions with the resources at their disposal, to mitigate risks | » Availability of multiple and/or diverse livelihood options, land use, and infrastructure choices<br>» Access to different sources of scientific research and/or information, and to traditional and/or indigenous knowledge to inform responses to shocks<br>» Access to diverse and/or varied sources of knowledge that foster innovative responses to climate change challenges |
| **Flexibility** | Ability of the community and/or system to respond to uncertainty associated with climate change and disaster risk | » Availability of flexible institutions that support alternative pathways of action to climatic impacts<br>» Ability to inform decisions with new information that becomes available, adopt new tools or agricultural inputs that can improve productivity and make crops more resistant to climatic impacts |
| **Inclusion** | Extent to which the community and/or system provides equal access to rights, resources, and opportunities to its members | » Availability of programs to improve the skills and competencies of vulnerable community members, including trust, self-worth and other psychosocial factors<br>» Participative community-level decision-making processes; transparency and representation of all groups (women, elders, youth, persons with disabilities) within local decisions and processes<br>» Traditional knowledge and technologies used in local adaptation strategies |
| **Self-organization** | Ability to independently rearrange functions and processes in the face of shocks or stressors, to diagnose problems, assess priorities, and/or mobilize resources to initiate solutions | » Ability of locally led adaptation efforts<br>» Local organizations that coordinate access to disaster prevention and response resources<br>» Community-based social networks that help create awareness and disseminate information about local climate change impacts |

*Source:* World Bank. 2020. *Africa: Enhancing Climate Resilience through Resilience Attributes—Good Practices and Guidance Note.* http://documents1.worldbank.org/curated/en/321901597031973150/Africa-Enhancing-Climate-Resilience-through-Resilience-Attributes-Good-Practices-and-Guidance-Note.docx.

# Appendix 6. Examples of climate adaptation indicators

Climate adaptation indicators can be embedded in a project's M&E framework to monitor and track climate change interventions. See sector examples of adaptation indicators below.

### 1. Agriculture and food

- Increase in crop yield due to climate-resilient agricultural practices
- Sustainable growth rate guidelines revised to improve predictability of grain procurement in drought-prone areas

### 2. Digital development

- Number of digital systems developed to support mobilization and emergency response to climate and disaster risks
- Spatial information tools developed to monitor civil works projects in areas vulnerable to flood and storms

### 3. Education

- Number of schools/educational facilities equipped to serve as shelters during a climate and/or disaster emergency
- Percentage of schools built that incorporate climate-resilient design measures in the construction of school facilities

### 4. Energy and extractives

- Rapid emergency repair teams and mutual aid agreements among utilities in place to quickly fix transmission and distribution infrastructure damaged by natural disasters
- Number of residential, commercial, or industrial buildings retrofitted to include climate-resilient envelopes

### 5. Environment

- Reduction in damages to climate-vulnerable coastline due to coastal protection interventions
- Number of municipalities with coastal management plans that integrate specific disaster risk reduction and climate change adaptation measures

### 6. Finance

- Share of funds fully disbursed in the form of climate adaptation loans
- Establishment of a contingency fund that can be used for early financing of recovery response to a climate-related disaster

## 7. Governance

- Number of households impacted by climate-induced disasters receiving e-government services
- Percentage of public sector infrastructure project proposals screened for climate vulnerability and/or risk with an online tool

## 8. Health

- Satellite data used to predict outbreaks of cholera before seasonal monsoon and disease management planned accordingly (Yes/No)
- Reduction in mortality rate from the use of an extreme heat early warning system on a national level

## 9. Jobs

- Percentage of small businesses impacted by climate-induced disasters registered with financial institutions to enroll in small businesses loan program
- Percentage of factories that have implemented safety measures against extreme climate events to protect the workers

## 10. Macroeconomics and trade

- Increase in the percentage of gross fixed capital formation contributing to GDP as a result of post disaster economic recovery
- Share of ministries and agencies undertaking climate risk screening and climate budget tagging to prioritize climate investments

## 11. Poverty and equity

- Number of villages and/or local groups provided with cash transfer programs targeting populations that are vulnerable to climate change risks
- Adoption of community infrastructure design that incorporates climate-resilient measures

## 12. Transport

- Number of new national transport projects implemented by the relevant authority that apply harmonized climate resilience standards
- Climate-resilient and sustainable mobility roadmap prepared, and associated monitoring tool developed

## 13. Urban resilience and land

- Number of people supported by early warning and response systems
- Immediate response mechanism established and ready to provide access to financial resources in case of an eligible climate-related crisis or emergency

## 14. Water

- Area under enhanced flood protection
- Number of water source protection corridors established and managed in areas affected by drought

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# Endnotes

1. Adapted from the Intergovernmental Panel on Climate Change (IPCC) definition of resilience: "The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions" (Denton et al 2014).
2. Climate change adaptation means adjusting to actual or expected climate impacts to moderate harm or exploiting beneficial opportunities. Definition adapted from IPCC (2018).
3. The World Bank Group tracks climate-related finance through "climate co-benefits"—that is, the share of its lending commitments that contribute to climate change mitigation and/or adaptation. Climate co-benefits are based on the joint multilateral development banks' methodologies for tracking climate change adaptation and mitigation finance (African Development Bank et al. 2020).
4. For example, a small-scale irrigation in one village and a massive hydropower dam will not need or be able to afford the same level of analysis of future climate change risks. The RRS provides examples of sector methodologies that, when followed, would lead to a certain rating.
5. The World Bank Group's five corporate commitments related to climate change are: climate and disaster risk screening, greenhouse gas accounting, calculating the shadow price of carbon, climate co-benefits, and climate indicators.
6. For information on corporate reporting for climate and sustainability matters, see CDP et al. (2020).
7. Acceptable rates of return or risk will vary across countries, sectors, projects, and investors.
8. It is important to note that a high rating aims to assure decision makers and investors that the project will deliver as expected despite disaster and climate risks. However, it does not guarantee that the proposed design is the best possible design, in the context of climate change.
9. Determining risk levels can be based on information sources such as: ThinkHazard! for hazard ratings for all countries and subnational units (https://thinkhazard.org/); Climate Change Knowledge Portal (CCKP) for climate information, country profiles, and subnational data (https://climateknowledgeportal.worldbank.org/); and national meteorological agencies for more localized climate information (https://public.wmo.int/en/about-us/members/national-services).
10. A risk assessment goes beyond a screening in that it evaluates a project's sensitivity to climate and natural hazards based on specific assets as well as impacts to beneficiaries and project activities—for example, using hazard mapping.
11. This analysis can use the tool developed for the RRS (described in Chapter 3) or an equivalent approach that meets similar standards.
12. A review of existing DMDU methodology is available in Hallegatte et al. (2012).
13. There is no C+ rating, because a simple screening does not offer the information needed to plan for unexpected outcomes or threats.
14. For more information on the World Bank's project cycle, see https://www.worldbank.org/en/projects-operations/products-and-services/brief/projectcycle.
15. For example, ThinkHazard!'s ratings for all countries and subnational units can provide a basis for understanding whether hazard risks in a project location may be high, medium, or low. https://thinkhazard.org/. CCKP provides information on historic and projected climate trends, vulnerabilities, and sectoral impacts for all countries, including country profiles and subnational data that can add depth to the understanding of key hazards. https://climateknowledgeportal.worldbank.org/country-profiles.
16. These documents will be released in the first few months of 2021.
17. https://climateknowledgeportal.worldbank.org/.
18. Acceptable rates of return or risk will vary across countries, sectors, projects, and investors.
19. It is important to note that a high rating aims to assure decision makers and investors that the project will deliver as expected despite disaster and climate risks. However, it does not guarantee that the proposed design is the best possible design, in the context of climate change.
20. https://climatescreeningtools.worldbank.org/. For more information on climate and disaster risk screening, including sector-specific guidance, visit the webpage: https://worldbankgroup.sharepoint.com/sites/Climate/Pages/Risk-Screening.aspx (World Bank Group internal link).
21. https://thinkhazard.org/en/.
22. https://climateknowledgeportal.worldbank.org/. The Climate and Disaster Risk Screening Tools also directly link to climate information from CCKP for the selected project country.
23. https://climateknowledgeportal.worldbank.org/country-profiles.
24. https://public.wmo.int/en/about-us/members/national-services.
25. https://www4.unfccc.int/sites/NDCStaging/Pages/All.aspx.
26. https://unfccc.int/topics/resilience/workstreams/national-adaptation-programmes-of-action/napas-received.
27. https://unfccc.int/non-annex-I-NCs.
28. Risk screening is required for IDA and IBRD operations under IDA17, 18 and 19 policy commitments, the World Bank Group Climate Change Action Plan, and the World Bank Group 2025 Targets and Actions. Screening has been a requirement for all IDA operations since July 1, 2014 and for all IBRD operations since July 1, 2017. Fulfillment of the World Bank climate and disaster risk screening requirement does not specify using a particular tool.
29. Mitigation co-benefits are determined based on a positive list of activities that are compatible with low-emission pathways that have been agreed by MDBs to be classified as climate mitigation finance. Adaptation co-benefits are assigned to activities that reduce the risks or vulnerabilities posed by climate change and increase resilience using a three-step approach.
30. For more detail on climate co-benefits, including sector-specific guidance, visit the co-benefits webpage: https://worldbankgroup.sharepoint.com/sites/Climate/Pages/Co-Benefits.aspx (World Bank Group internal link) or the webpage on World Bank Group corporate climate commitments: https://worldbankgroup.sharepoint.com/sites/Climate/Pages/CCKNOW.aspx (World Bank Group internal link).

31. All 10 ESSs either mention climate risk, suggest adaptive measures for extreme weather, or both: ESS1 (assessment and management of environmental and social risks and impacts); ESS3 (resource efficiency and pollution prevention and management), ESS4 (community health and safety), and ESS6 (biodiversity conservation and sustainable management of living natural resources) explicitly mention climate risk and have a direct connection to climate and disaster risk screening. ESS2 (labor and working conditions), ESS5 (land acquisition, restrictions on land use, and involuntary resettlement), ESS7 (indigenous peoples / sub-Saharan African historically underserved traditional local communities), ESS8 (cultural heritage), ESS9 (financial intermediaries), and ESS10 (stakeholder engagement and information disclosure) can also be affected by potential climate and disaster risks.
32. https://climatescreeningtools.worldbank.org/. Climate and Disaster Risk Screening Guidance Notes provide examples of risk management measures for agriculture, energy, health, transport, and water sectors. To access these, visit: https://worldbankgroup.sharepoint.com/sites/Climate/Pages/Risk-Screening.aspx (World Bank Group internal link).
33. World Bank (2015) *Climate and Disaster Resilient Transport in Small Island Developing States: A Call for Action*. http://hdl.handle.net/10986/28798.
34. See endnote 31.
35. https://thinkhazard.org/en/ and https://climateknowledgeportal.worldbank.org/.
36. To be released in the first months of 2021.
37. The International Development Association (IDA) is the part of the World Bank that helps the world's poorest countries. Overseen by 173 shareholder nations, IDA aims to reduce poverty by providing zero to low-interest loans (called "credits") and grants for programs that boost economic growth, reduce inequalities, and improve people's living conditions. IDA19 builds on the strong momentum of IDA18 to accelerate progress toward the World Bank Group Twin Goals and the Sustainable Development Goals. For more information, see https://ida.worldbank.org/replenishments/ida19.
38. See endnote 31.
39. To be released in the first months of 2021.
40. The 20-year lifetime of the project is based on the project's EFA.
41. The choice of hazards was based on high-risk climate hazard ratings for Uganda as identified on the ThinkHazard! platform, a literature review, including CGIAR's Agriculture Country Profiles (https://p4s.ccafs.cgiar.org/our-work/projects/csa-country-climate-risk-profiles) and consultations with sector experts.
42. "RCP 8.5 refers to the concentration of carbon that delivers global warming at an average of 8.5 watts per square meter across the planet. The RCP 8.5 pathway delivers a temperature increase of about 4.3˚C by 2100, relative to pre-industrial temperatures. RCP 8.5 is often contrasted with RCP 2.6, which would deliver a total warming of about 1.8˚C by 2100" (ClimateNexus. https://climatenexus.org/climate-change-news/rcp-8-5-business-as-usual-or-a-worst-case-scenario/).
43. Although guidance suggests that an RCP8.5 scenario may be excessively pessimistic, given uncertainties in climate projections and the sensitivity of agriculture to climate change, the analysis uses worst case scenarios for the purposes of testing robustness.
44. The pessimistic project scenario is one in which no total factor productivity spillovers occur to farmers not receiving inputs.
45. Crops in the analysis include: sorghum, maize, cassava, Irish potato, sweet potato, millet, simsim (sesame), ground nut, beans, banana, coffee, cotton, and rice.
46. http://regiocrop.climateanalytics.org/.
47. For cassava, possible yield impacts in 2030 range from a 2 percent increase to 13 percent decline; Irish potato yields could decline by 6–34 percent; and groundnut yields by 1–9 percent. Data is based on RCP2.6 (low) and RCP8.5 (high) scenarios for 2030 in sub-Saharan Africa (Hallegatte et al. 2015) and Uganda (RegioCrop). Where RegioCrop country-specific crop data was available, the analysis used those numbers and compared with data from Hallegatte et al. (2015) to ensure the largest possible range of projected impacts was included to reflect uncertainty.
48. Under changing future average climate conditions, fuel prices and the cost of transport may increase.
49. "With project" impacts of drought on yields are assumed to be 15 percent lower than "without project" impacts for weak and moderate intensity events; 10 percent lower for strong intensity events; and the same for the most extreme events. Event intensity is defined as weak (1 in 5-year occurrence events); moderate (1 in 10-year); strong (1 in 100-year); and extreme (1 in 1,000-year).
50. The costs associated with irrigation in the most extreme (1 in 1000-year) events are estimated by doubling average labor costs. Costs in less extreme/lower intensity events are interpolated from there. Labor costs for each crop, provided in the project EFA, are assumed as 80 percent of total variable costs for each crop.
51. "With project" impacts of pest outbreaks on yields are assumed to be 20 percent lower than "without project" impacts for weak and moderate intensity events; 10 percent lower for strong intensity events; and the same for the most extreme events.
52. The costs associated with the most extreme events reflect a 75 percent increase in average input intensity. Costs in less extreme/lower intensity events are interpolated from there. Estimates for the input intensity of each crop are provided in the project EFA.
53. "With project" impacts of storms and/or flooding on yields are assumed to be 10 percent lower than "without project" impacts for weak, moderate, and strong intensity events; for the most extreme events, they are assumed to be the same.
54. The most extreme case reflects a tripling of labor costs as a proxy or estimate for costs associated with flood management and rebuilding farm infrastructure and replanting. Costs in less extreme cases are interpolated from there. Labor costs for each crop, provided in the project EFA, are assumed as 80 percent of total variable costs for each crop.
55. Severe drought is based on the Standardized Precipitation Index (SPEI) which captures the cumulative balance between water gain and loss across an interannual timescale. Severe drought is likely once the SPEI drops below -2. CCKP uses the 12-month integrated SPEI to compute the annual likelihood of severe drought. There is a clear trend towards an increasing likelihood of drought conditions, particularly in the subtropics, but the overall trend is positive in most places due to increasing temperatures and little precipitation variability. (CCKP)

56. For a strong intensity 1-in-50-year event, the high estimate changes to a 1-in-30-year event. Estimates for the change in frequency of less severe events is interpolated from there.

57. The units will comprise a basic latrine, a septic tank, and a handwashing sink. The project will prioritize families living upstream of the local water reservoirs.

58. EM-DAT database. Accessed November 4, 2020.

59. There is no C+ rating, because a simple screening does not offer the information needed to plan for unexpected outcomes or threats.

60. For example, because the 2011 tsunami in Japan was higher than what had been considered as the worst-case scenario (that is, it was considered impossible), the consequences of such an event had not been considered in infrastructure design. This led to high vulnerabilities that could have been reduced by relatively cheap design changes.

61. For more information on DMDU, see https://www.deepuncertainty.org/.

62. https://agwaguide.org/about/CRIDA/.

63. https://www.rand.org/topics/robust-decision-making.html.

64. For a more in-depth discussion, see World Bank (2017), other work by the World Bank's Resilience M&E project, (https://worldbankgroup.sharepoint.com/sites/wbsites/resilience/Pages/index.aspx, World Bank internal resource).

65. Adaptation co-benefits are assigned to project activities when the project document: (i) sets out the climate change vulnerability context of the project; (ii) makes an explicit statement of an intent to address the identified climate vulnerabilities as part of the project; and (iii) articulates a clear and direct link between specific project activities and the project's objective to reduce vulnerability to climate change. This means the project document must reflect these three key steps to receive adaptation co-benefits.

66. See *Reference Guide on Climate Adaptation Co-benefits* for more details and guiding questions on each step. https://worldbankgroup.sharepoint.com/sites/Climate/Documents/Climate%20Co-Benefits/1%20Reference%20Guide%20on%20Adaptation%20Co-Benefits.pdf (World Bank Group internal resource).

67. System-level, transboundary, and/or long-distance impacts of climate change may include the effects on human, economic, social or environmental dimensions beyond a project's physical assets. System level-planning reflects interconnectedness and accounts for the potential of complex relationships between sources and drivers of risk and appropriate climate resilience responses.

68. For example, "land area with improved drainage capacity" may be a valid climate indicator for a project benefitting a community that is vulnerable to increased storm surges, but it would not be valid in a location that is prone to droughts and desertification.

69. These vulnerabilities can be identified through climate and disaster risk screening. See https://climatescreeningtools.worldbank.org/ and https://worldbankgroup.sharepoint.com/sites/Climate/Pages/Risk-Screening.aspx (World Bank internal link).

70. https://worldbankgroup.sharepoint.com/sites/Climate/Knowledge%20Base/Climate%20Indicators%20GN%20Final.pdf (World Bank internal link).

71. https://worldbankgroup.sharepoint.com/sites/Climate/Pages/Indicators.aspx (World Bank internal link).

72. https://worldbankgroup.sharepoint.com/sites/wbsites/resilience/Pages/index.aspx (World Bank internal link).

73. Based on data from OasisHub and the Open Data Resilience Index. https://oasishub.co/; https://index.opendri.org/.

74. RCP 8.5 has been used in most of the literature as the "pessimistic" scenario. However, existing climate policies and changes in the price of carbon-free technologies (renewable energy in particular) makes this scenario unrealistically pessimistic today. It is therefore recommended to use RCP 6.0 instead. When impact assessments are available only for RCP8.5 and not for RCP 6.0, then it is recommended to use RCP 8.5, taking into account when assessing the plausibility of the scenarios that RCP 8.5 can be considered excessively pessimistic at this point.

Resilience is the capacity to prepare for disruptions, recover from shocks, and grow from a disruptive experience. The World Bank Group has developed a ***Resilience Rating System*** that provides guidance and specific criteria to assess resilience along two complementary dimensions.

- **Resilience *of* the project** rates the confidence that expected investment outcomes will be achieved, based on whether a project has considered climate and disaster risks in its design, incorporated adaptation measures, and demonstrated economic viability despite climate risks.

- **Resilience *through* the project** rates a project's contribution to adaptive development pathways, based on whether investments are targeted at increasing climate resilience in the broader community or sector.

The objectives of the ***Resilience Rating System*** are to:

- Better inform decision makers, investors, and other stakeholders on the resilience of projects and investments.

- Create incentives for more widespread and effective climate adaptation through enhanced transparency and simpler disclosure.

- Identify best practices to allow proven lessons on resilience to be scaled up across sectors and countries.

- Guide project developers on the best ways to manage risk and improve the quality of projects, while allowing flexibility for different sectoral and country contexts.

The resilience rating methodology, from C through to A+ in each dimension, can serve as a guide for institutions, public and private sector participants, and project developers, that are looking to improve disaster and climate resilience.