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TECHNICAL REPORT

CLIMATE VULNERABILITY ASSESSMENT

AN ANNEX TO THE USAID CLIMATE-RESILIENT
DEVELOPMENT FRAMEWORK



MARCH 2016

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March 2016

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ACRONYMS

ARCC	African and Latin American Resilience to Climate Change
CCKP	Climate Change Knowledge Portal
CCRD	Climate Change Resilient Development
CCSP	Climate Change Science Program (US)
CDCS	Country Development Cooperation Strategies
CRED	Centre for Research on the Epidemiology of Disasters
DFID	Department for International Development (UK)
EM-DAT	Emergency Events Database
FEWS NET	Famine Early Warning Systems Network
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Reduction and Recovery
GHCN	Global Historical Climatology Network
GIS	Geographic Information System
GIZ	German Corporation for International Cooperation
GPR	Ground penetrating radar
HDI	Human Development Index
IPCC	Intergovernmental Panel on Climate Change
MWLECC	Ministry of Water, Land, Environment and Climate Change
NAP	national adaptation plan
NAPA	National Adaptation Programme of Action
NASA	National Aeronautics and Space Administration (US)
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Administration (US)
PPCR	Pilot Program for Climate Resilience
PRA	Participatory Rural Appraisal
RMI	Republic of the Marshall Islands
SERVIR	Regional Visualization and Monitoring System
SREX	IPCC Report Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptations
UNDP	United Nations Development Programme

UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
USAID	United States Agency for International Development
USGS	United States Geological Survey
VA	Vulnerability Assessment
VI-CRED	Climate and Regional Economics of Development Vulnerability Index
WMO	World Meteorological Organization

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I. INTRODUCTION

Climate variability and change can have significant impacts on regional, national, and local development efforts. In order to reduce these impacts and promote climate-resilient development, decision makers and development practitioners need to understand the climate vulnerabilities of the people, sectors, and places that they care about. As stated in USAID’s Climate Change and Development Strategy (USAID, 2012):

“Climate adaptation requires that we utilize science, technology, innovation, and the best available information to understand and respond to unavoidable impacts.”

Climate vulnerability can be determined by three interacting factors: **exposure** to climate stressors, **sensitivity** to those stressors, and **adaptive capacity** to manage stressors (see box at right). A climate vulnerability analysis can identify the what, where, when, and why of vulnerability, considering the social, economic, and environmental systems upon which people depend. In this way, climate vulnerability assessments (VAs) offer valuable information to help reduce risk.

VA is a broad term that covers a range of methodologies drawing from a variety of fields. VAs range from narrative descriptions of the ways in which climate may affect community livelihoods, to technical analyses of infrastructure assets under scenarios of climate variability and change. The approach described in this document can help ensure your VA is fit-for-purpose and aligned with the United States Agency for International Development (USAID) “development-first” framework to addressing climate vulnerability (see pp. 5 – 6).

Broadly speaking, VAs help to address the following questions:

- **Who or what** is vulnerable to climate stressors?
- **Where** is someone or something vulnerable within a country or region?
- **When** is someone or something vulnerable?
- **Why and how** is someone or something vulnerable?
- **How important** are climate stressors relative to non-climate stressors?

KEY DEFINITIONS

Adaptive capacity

The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC, 2014b).

Climate stressors

Climate factors that can affect the functioning of a system or limit the potential success of development interventions (USAID, 2014a). They can include both climate variability (such as an annual monsoon or dry season) and climate change (such as rising average temperatures).

Climate vulnerability

The degree to which something or someone can be harmed by or cope with a climate stressor (USAID, 2014a).

Exposure

The extent to which something is subject to a climate stressor; whether it is in harm’s way (USAID, 2014a).

Non-climate stressors

Development challenges such as environmental degradation, corruption, population growth, and pollution that can harm the functioning of a system, thus hindering the achievement of development goals (USAID, 2014a).

Resilience

The ability of people, households, communities, countries and systems to mitigate, adapt to and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth (USAID, 2013f).

Sensitivity

The extent to which something will be positively or negatively affected if it is exposed to a climate stressor (USAID, 2014a).

Vulnerability assessment

An analysis of the extent to which human and ecological systems are likely to be affected by climate variability and change (USAID, 2014a).

A VA can be used to inform strategic decisions by identifying which sectors or regions are most vulnerable.¹ For example, a VA might allow a government or donor agency to decide whether to prioritize the tourism or agriculture sector for climate change adaptation efforts, or whether to focus such efforts in coastal or inland areas. At the project level, a VA might help a planner or manager understand how and why a sector, place, or population is vulnerable in order to design effective interventions to reduce those vulnerabilities. For example, if crops are failing in a specific area, a VA can reveal whether the problem is due to exposure to droughts, sensitivity of crops to heat or salinity, lack of adaptive capacity of farmers to anticipate or respond to these stressors, or some combination of these factors.

VA outputs can be presented in a variety of formats, such as a map, matrix, index, report, or other type of communication (see Appendix E), but **should always be guided by the intended purpose and use of the information so the results are as informative and actionable as possible**. In addition, VAs **should, from the outset, meaningfully involve stakeholders in the assessment process** so they have a stake in the findings and are more likely to use the results.

ENTRY POINTS AND REQUIREMENTS

For many development agencies, including USAID, information about climate vulnerability is required as input to multi-year country or regional strategies (e.g., USAID's Country Development Cooperation Strategies (CDCS)) as well as input to the design of both climate change adaptation and broader development projects. Executive Order #13677 (2014) on Climate-Resilient International Development requires U.S. Government agencies to factor climate resilience considerations systematically into their international development activities. Screening tools to support this process are under development, and are intended to flag climate issues that may merit adjustments in project designs or additional analysis. This document may provide useful ideas for people wishing to conduct VAs to inform their work.

For certain countries, a desk review may uncover many good sources of existing information, such as national assessments and official documents from the government or assessments conducted by other donors, non-governmental organizations, universities, and research institutes. Often, however, existing assessments will not provide adequate or properly targeted information to inform strategic planning or project design. In such a case, this document should help you to structure a new or complementary assessment.

The purpose of this document is to provide an introduction to VAs and specific ideas for structuring an actionable, credible, and useful assessment. *The primary audience for this document is those who are designing and managing VAs, not those carrying them out.* It is written for a general audience that includes both USAID staff and broader audiences.

This document is one of several annexes to USAID's *Climate-Resilient Development Framework* (see next section). It is organized into four sections followed by additional resources. With a special focus on early decision making, Section 2 introduces readers to a range of possible questions that help frame VAs at the country, sector, project, or local levels. Once this context has been established, Section 3 discusses some of the basic concepts that underpin most VAs. Section 4 provides a concise exploration of the

¹ Although this document focuses primarily on a process for identifying potential negative outcomes associated with climate impacts, the approaches are also useful for identifying positive opportunities, such as the potential for exploiting an extended growing season in cold regions, or potentially greater water availability or river transport options in areas projected to become wetter. However, since the net effects of climate change are generally expected to be harmful to most sectors, we have focused this document on understanding the negative impacts.

methodologies, techniques, tools, resources, and likely outputs for designing and carrying out VAs. And Section 5 briefly discusses how the VA process is a primary input into the decision making for adaptation planning and actions. The document concludes with references and five appendices to further assist practitioners in implementing successful adaptation measures.

USAID CLIMATE-RESILIENT DEVELOPMENT FRAMEWORK

Different institutions have employed a range of approaches to VA. Many approaches begin with climate data as the starting point for evaluating risks and opportunities. Data and information are an essential input to climate-resilient development, but starting with climate data (such as model outputs) can overemphasize uncertainty, cost a great deal to generate the data, and create a mismatch between the timescales of data and the development decisions being made. The approach described here integrates climate data once the purpose and methods of the assessment have been determined.

Focusing initially on what's needed to inform development decisions can help to orient a VA. Fundamentally, the assessment should enable the integration of climate change considerations into existing development activities or processes in an integrated fashion. USAID has prepared a broad framework to help decision makers and development practitioners understand and address climate variability and change within development programs. The *Climate-Resilient Development Framework: A Guide to Understanding and Addressing Climate Change* (USAID, 2014b), begins with understanding development priorities, current stressors, and vulnerabilities; and then considers climate impacts over relevant timescales to understand current and future risks and identify priorities for action (see Figure 1). VA plays an important role in the Framework and its implementation, as shown by the Assess stage. The development-first approach described in the Framework helps in designing a VA that focuses on the sectors, issues, and timescales of greatest relevance and importance to development objectives, and so climate data is used in ways that are useful and cost-effective. The box below contains some additional information about the Framework.



Figure 1. USAID's Climate-Resilient Development Framework.

THE CLIMATE-RESILIENT DEVELOPMENT FRAMEWORK

The Framework is organized into a five-stage process for planning and implementing climate-resilient development initiatives (see Figure 1): Scope, Assess, Design, Implement, and Evaluate.

The Scope stage establishes the context for assessing vulnerability and ultimately for adaptation actions. This includes identifying development goals, along with the inputs and enabling conditions required to achieve those goals; and identifying development challenges resulting from climate and/or non-climate stressors. It is also important to determine what decisions are being made, the timeframe of the decisions, and how the decisions can be influenced through the initiative.

The Assess stage draws on the information developed during the Scope stage. This stage involves a more detailed assessment of the vulnerability of key inputs and/or the system identified in the Scope stage to climate and non-climate stressors, as well as the capacities of stakeholders and implementing partners to deal with potential impacts or take advantage of opportunities.

Assessment lays the groundwork for the Design stage of the Framework, which focuses on the identification of adaptation actions. Vulnerability assessment can help identify specific types of actions and provide a baseline for evaluating the effectiveness of those actions over time. The identified actions are implemented in the Implement stage, and monitored and adjusted in the Evaluate stage.

Before you begin a VA, figure out what you need to know and what level of detail is necessary. *Why are you considering a VA? Who will use the results and how?* For instance, the process of identifying climate stressors may in some cases generate enough information to directly guide the development of relatively obvious “no-regrets” options² to reduce the negative impacts of climate stressors or to take advantage of opportunities. For example, if a drinking water aquifer has experienced salt-water intrusion because of recent sea level rise, it is likely that future sea level rise will worsen the situation and that immediate action would be warranted. This community may not require a detailed VA to begin exploring options for protecting the aquifer or obtaining alternate freshwater sources.

² Adaptation measures that are beneficial in any case and regardless of specific changes are referred to as “no regrets” options. These options are compatible with historic and current climate trends, and are further justified when future projections are considered (USAID, 2014a).

2. FRAMING A VULNERABILITY ASSESSMENT



Climate change can impact the supply, quantity, and quality of drinking water. Adaptation can help ensure consistent water supplies. Source: USAID, 2010.

Before designing a VA, answering some basic questions about what you are trying to accomplish more broadly in terms of development will help you to frame what is needed. The scope of a VA will vary according to the nature of the development challenge, including the geographic or jurisdictional area of concern (e.g., regional, national, municipal), expected project and decision lifetime (e.g., 5 years, 20 years, 50 years), and sector(s) of interest (e.g., cross-sectoral, a single sector, one aspect of a sector). In other words, for the information generated by an assessment to be relevant to key decisions, it should be largely tailored to their spatial, temporal, and sectoral scales.

Start by clearly articulating **what decisions the assessment will inform**. In the case of international development programs, VAs are often relevant at the following three levels:

- To inform strategic decisions, such as the sectoral or geographic scope of a country portfolio or an initiative, for example, what are the most at-risk economic sectors or regions in a country?
- To inform the design of a portfolio or initiative within a sector like water resources, health, or transport; for example, what are the climate-related vulnerabilities facing food security?
- To inform specific investments within a program or initiative, such as which assets should be upgraded or which adaptation strategies are viable within a specific community or site.

This initial step in framing a VA will guide the level of effort required for an assessment. For example, identifying priority sectors that are vulnerable to climate risks in a country may be accomplished through a desktop analysis of existing information combined with stakeholder consultations. However, informing design standards for costly capital investments may require a much more detailed and technically sophisticated VA. This step also provides a reference for determining the relevant geography, timeframe, and sectors for the VA.

Which sectors are relevant? The sectoral coverage of an assessment should match the sector or sectors you seek to influence, including related sectors that interact with your sector. For example, if you are designing a food security program, you may wish to include some combination of agriculture, water, health, and/or transportation information, depending on the context. The data and methods associated with an agriculture, water, health, or infrastructure assessment vary widely, so the more sectors you include, the larger the assessment becomes in terms of team members, stakeholders, and analytical requirements. Conversely, an assessment that is focused on the development of a national climate change adaptation strategy will require coverage of the range of sectors that are most important to the country.

What is your geographic scope? The geographic coverage of an assessment should be consistent with the geographic scope of your programs or decisions. It may be important to understand spatial differences in vulnerability within your region, country, province, or municipality, and these issues should be made explicit. An assessment can be conducted at the regional scale looking at trans-boundary resources of concern; the national scale; or the subnational scale looking at a priority sub-region, municipality, or set of project sites. Align the geographic scope of your assessment with the scope of activities you want to inform. A national-level assessment will not be useful if you need specific local information. Are you interested in the most significant vulnerabilities of a country; or the vulnerability of coastal agriculture relative to inland agriculture; or the vulnerability of infrastructure within a city? All of this being said, you may need to consider the role of climate vulnerabilities outside your primary area of concern. For example, climate-related migration from the inland agricultural areas of a country may lead to impacts on coastal fisheries. And a community-level assessment may benefit from consideration of potential vulnerabilities at the landscape level, such as projected impacts to ecosystem services on which the community depends.

What is your timescale? The timescale covered by an assessment should be consistent with the timescale of the decisions a program or initiative will support. For example, a program to support agricultural extension for farmers who are making decisions over weeks, seasons, or years will want to address seasonal and year-to-year stresses and vulnerabilities, while perhaps considering longer-term thresholds or risks for agricultural planning or research. In contrast, a program focused on urban planning must consider the impacts of climate change over many decades and may require an assessment of impacts on urban infrastructure over the next century. Think about how frequently people are making decisions and how long those decisions last to determine the appropriate period of time to be covered by the assessment.

Keep in mind that there are tradeoffs; a broad geographic scale and/or a large number of sectors should provide useful comparative information about priorities, but will not provide the detailed information you would get from a more targeted assessment within a smaller geographic area and/or single sector. You may want to consider a nested approach to VA that begins with an initial analysis with broader coverage and then moves to a more targeted analysis of areas with high vulnerability and/or opportunity for impact. A common solution in the USAID context is to do an initial desk review along with consultations to identify priority issues (internally), followed by a more targeted sector assessment that informs a project design (with contractor support), and finally, more localized or focused assessments as part of project implementation (through project partners). Overall, to ensure the assessment is used, reflect on what you need so the assessment is designed to match. After you have determined the geographic, temporal, and sectoral scope, consider the practical questions related to budget and timing in TABLE 1 below to help you further define the objectives and scope of a VA.

TABLE I. PRACTICAL QUESTIONS TO CONSIDER IN DEFINING VULNERABILITY ASSESSMENT OBJECTIVES.

Question	Considerations
What budget is available?	<p>Funding may constrain the scope of a VA. Identifying your potential budget at the beginning of the process can help keep expectations realistic and shape your approach. Generally, funding for a VA should represent a small portion of the overall funding available for a program.</p> <p>You will need to tailor the scope of the VA and the methods used to the available funding. A basic desktop VA integrating existing information could be accomplished by one person over a period of days to weeks, while an in-depth assessment may require a multi-member team working for months. Funding may be needed to hire researchers, analysts, and writers; to pay for travel and other logistical support; to acquire data and equipment; to conduct workshops; and to prepare and disseminate reports.</p>
What technical expertise is needed?	<p>VAs often require multi-disciplinary teams of experts. You might include people who understand climate modeling and can use climate predictions appropriately. If you are interested in water security, for example, you might need a water resource engineer, a water policy expert with country or local knowledge, and a climate specialist who is familiar with the area's trends and projections. If irrigation or flood control are major issues, you may want specialists to weigh in. Drawing on local technical expertise is always recommended. Experts may be available in universities, research institutes, governments, NGOs, and consultancies. You may need to modify the scope of the assessment if relevant expertise is unavailable or out of budget.</p>
When are the findings needed?	<p>Consider the decision processes that depend on the assessment findings, and align the timing of your assessment to provide timely input.</p>
What type of output is needed by decision makers?	<p>VA outputs can be presented in different formats depending on the intended audiences and how they might use the results. For example, if engineers use the results to review the design of drainage infrastructure, they will need detailed technical data. If communications experts want to share the results with the general public, the information will need to be presented in a simple, concise, and relatable message. Other stakeholders may need different outputs, such as:</p> <ul style="list-style-type: none"> • A report with high-level conclusions and narrative descriptions, • A table comparing different sectors or locations, • A map demonstrating where stressors and vulnerabilities overlap spatially, or • An index quantifying vulnerability to allow quick comparison.

Question	Considerations
What is the role of stakeholders in the assessment process?	Stakeholder involvement throughout the assessment process is critical to capitalize on local knowledge, promote transparency, and increase legitimacy and accountability (see USAID, 2013a). Consult stakeholders before you get started, include their questions and concerns in the assessment, and involve them in the data gathering and analysis to the extent possible.
What data are needed, and what data are available?	A wealth of existing data and information is available in national assessments and reports, and many climate-related studies have been carried out by previous development projects. This information should be the starting point for any new assessment, and a number of knowledge platforms exist to promote data and information sharing. However, data are not always available or at the right geographic or temporal scale to be useful to specific VA questions, so your assessment team will need to factor in the time and costs associated with gathering the right data to answer the question. You may also need to modify the assessment if relevant data are unavailable or out of budget.

So what do VAs look like? There are different levels of effort for a VA depending on the answers to the above questions. Think carefully about the needs of your audience and the decisions you are trying to influence in light of the available resources. A high-level desktop review of existing information and/or a stakeholder-driven process may be sufficient to identify climate sensitivities in a multi-year country strategy. A more focused sectoral strategy being developed by a government partner, however, may require a more comprehensive assessment that involves new data collection and/or analysis, including the use of climate modeling techniques. Examples of two types of assessment are given in TABLE 2 below.

TABLE 2. TWO EXAMPLES OF VULNERABILITY ASSESSMENTS.

	Basic vulnerability assessment	Detailed vulnerability assessment
Geographic Scope	City of Majuro, Republic of the Marshall Islands (RMI)	Uganda
Timescale and Objective	To inform more effective management of freshwater resources in Majuro in the short- and medium term	To inform food security programming and investment decisions by the Government of Uganda, USAID/Uganda, and the donor community through 2030
Methods	<p>Five steps:</p> <ol style="list-style-type: none"> 1. Workshop and stakeholder dialogue to guide the assessment 2. Desk review of recent, current, and projected climate trends and analysis of quality and quantity of water resources. 3. Field investigation of water infrastructure 4. Interviews with government, water managers, NGOs, and other stakeholders 5. Preparation and dissemination of findings and recommendations 	<p>Six steps:</p> <ol style="list-style-type: none"> 1. Review of all relevant literature 2. Scoping visit to guide the assessment 3. Field assessments 4. Data compilation and analysis of historical climate data and climate projections 5. Presentation of results 6. Participatory analysis and definition of climate adaptation options

TABLE 2. TWO EXAMPLES OF VULNERABILITY ASSESSMENTS.

	Basic vulnerability assessment	Detailed vulnerability assessment
Activities	<ul style="list-style-type: none"> Stakeholder training and problem assessment and prioritization for water, fisheries, agriculture, education, and health Water demand and supply analysis for El Niño-driven droughts Analysis of freshwater depletion during El Niño-driven droughts due to excessive pumping rates Field survey of public sector rainwater harvesting potential 	<ul style="list-style-type: none"> Trend analysis of historical data Analysis of downscaled projections Livelihoods survey and focus group discussions Quantitative crop modeling, phenological screening, and value chain assessments Qualitative water resources assessment Institutional capacity assessment Analyses of climate change and biodiversity, health, and infrastructure Series of stakeholder workshops and planning sessions for six main economic sectors
Outcomes	<ul style="list-style-type: none"> Identified adaptation measures in four categories (infrastructure, policy, good practices, and capacity building) Synthesis report and recommendations provided to Ministry of Resource Development RMI, with donor support, implemented selected recommendations related to rainwater harvesting 	<ul style="list-style-type: none"> Identified a number of adaptive pathways, including technical, investment, and diversification solutions Improved awareness and understanding of climate change impacts and adaptation constraints and opportunities Informed \$13 million in new USAID programs and a joint GIZ/USAID program
a. USAID, 2009. b. USAID, 2013b.		

You can also consider the following examples of questions that a VA can answer depending on its scale of analysis. As suggested previously, there are at least three scales at which you may be doing an assessment: country-level, sector-level, and project- or community-level.

2.1. COUNTRY LEVEL

This type of VA seeks to understand which sectors, geographies, groups of people, or programs are vulnerable to climate variability and change at the national level. This is typically a comparative analysis, meaning that it identifies higher-and lower-risk areas and populations. This can help to inform the development of a country strategy, focus programmatic decisions, or prioritize investments. Some of the questions that you might ask are listed below:

- Which development objectives or economic sectors are more vulnerable to climate variability and change? Why?
- Which regions or cities are more vulnerable to climate variability and change?
- Which socioeconomic groups are more vulnerable to climate variability and change?
- Which government or donor programs are more vulnerable to climate variability and change?

USAID/EASTERN CARIBBEAN REGIONAL VULNERABILITY ASSESSMENT

This assessment (<http://goo.gl/eyzSSe>) provided a comparative summary of climate change vulnerability of the ten countries that are covered by the USAID/Barbados and Eastern Caribbean Mission (Antigua and Barbuda, Barbados, Dominica, Grenada, Guyana, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, and Trinidad and Tobago). The goal was to inform USAID's Regional Development Cooperation Strategy for the period 2014 to 2018. The assessment had a particular emphasis on issues related to the vulnerability of the countries' marine and terrestrial ecosystems to climate change.



The assessment began with a review of existing documents to summarize the vulnerabilities of each country to climate change, as well as the predicted effects of changes in climate and sea level on the country's physical infrastructure. Data were obtained from documents, key informant interviews, and focus group discussions to establish the existing legal and institutional framework for adaptation in each country. Data collected from 274 key informants during interviews and discussions, as well as observations made during 36 site visits in the 10 countries, provided the basis

for identifying priority issues and needed actions for the countries to strengthen their legal and institutional capabilities to respond to climate change. Those actions were compared with USAID's interests, capabilities, and available resources.

This low-lying area of Georgetown, the capital of Guyana, contains the majority of the shipping ports, as well as dense commercial and residential coastal development.

Photo credit: Vanessa Benn, USAID, 2013c.

2.2. SECTOR LEVEL

A sector-level VA seeks to understand how (and how much) a specific sector is vulnerable to climate variability and change, or looks at it in the context of a specific sector activity, either new or existing. This is typically more of an in-depth analysis to inform the design of a program or activity.

Some of the questions that you might ask within a given sector are listed below, including questions that are broadly applicable to any sector as well as more specific questions for different sectors. Note that these are illustrative questions only. Carefully selecting questions will help to guide you towards the more appropriate methods for your VA.

General

- What are the climate stresses and impacts facing the sector in the near term? Long term?
- Have climate stresses changed in recent decades, and how are they likely to change in the future?
- How important are climate stresses relative to non-climate stresses?
- Which factors contribute to the sector's vulnerability to climate variability and change?
- Which components of the sector (e.g. crops, sub-populations, infrastructure assets) are most/least vulnerable to climate variability and change?
- How are different stakeholders in the sector (e.g. farmers, water users, men, women, business owners) more or less vulnerable to climate variability and change?
- What efforts are being made to manage climate stresses in the sector? What are the successes and failures, and can successes be replicated or scaled?
- To what extent are those working in the sector using relevant climate information, including forecasts or early warnings?
- Are the relevant government ministries/departments prepared to manage climate impacts in the sector? Do laws, policies, or regulations enable or constrain adaptation?

Agriculture

- Which crops or agricultural value chains are most/least vulnerable to impacts of climate variability and change?
- What crop development or livestock productivity thresholds are of greatest concern in the near term and long term?
- How relevant is climate information to farming or grazing decision-making (e.g., forecasts and early warnings)? What is the quality of this information and to what extent is it reaching relevant agriculture decision-makers?
- Which agricultural value chains (e.g. maize, wheat, coffee) are more vulnerable to climate change?

Water

- How is climate change expected to affect future water supply and demand scenarios?
- To what extent do current or future water supply efforts have adequate measures for source and catchment protection?
- How is projected climate change likely to impact water supply and storage?
- How is projected climate change likely to impact wastewater treatment and sanitation systems?
- How is climate change likely to impact the potential for conflict over water?

Health

- How are climate variability and change expected to impact the incidence, seasonal transmission, and geographic range of vector-borne diseases? Water-borne diseases?
- Have climate-sensitive disease burdens changed in recent decades, and how are they likely to change in the future?
- What are the linkages between climate variables and the nutritional value and productivity of key crops?
- How might climate change impact the siting and operations of hospitals and clinics?

Infrastructure

- Which dams/roads/energy systems/cities/ports are most/least vulnerable to impacts of climate variability and change?
- Are there thresholds for dam/road/energy system/flood control/port performance that could be surpassed by climate stresses?
- To what extent are designers/planners using climate projections in their designs and planning? To what extent are they being factored into operations and maintenance?

Biodiversity and Ecosystems

- Which ecosystems are most vulnerable to impacts of climate variability and change (e.g., coral reef systems) or important to moderating those impacts (e.g., wetlands, mangroves) for people?
- How important are climate stressors for the ecosystem relative to non-climate stressors?
- What human populations and biodiversity are most vulnerable to the indirect impacts of climate variability and change on ecosystems?

USAID/PHILIPPINES WATER SECTOR VULNERABILITY ASSESSMENT

This assessment (<http://goo.gl/0nlSYT>) focused on the water sector in Iloilo, a USAID priority region in the Philippines. The objectives of the assessment were to: (1) identify current and future water security and climate risks to Iloilo's economic growth; (2) engage local partners in the assessment, laying the foundation to build capacity and ownership; and (3) identify and analyze a set of options for addressing these risks.



As part of this assessment, the technical team approached water security using a climate-resilient development perspective. While many of the issues faced by Iloilo involve basic development challenges, climate variability is already having major impacts on water security, and climate change will very likely have important implications for the long-term sustainability of development projects designed to ensure greater water security. The study considers these issues together.

Field work was conducted over two weeks by a technical team consisting of four technical experts including a water resources engineer, a water governance lawyer, and two climate change adaptation and policy specialists. The technical team analyzed available literature on the region before the assignment; gathered climate, socioeconomic, and other relevant data from knowledgeable sources both within and outside the Philippines; consulted with stakeholders at the national, regional, provincial, municipal, barangay, and household levels; and conducted site visits to water infrastructure projects, reforestation projects, private and government housing developments, and commercial developments. The VA report summarized the water security issues in Iloilo and presented a number of preliminary adaptation options identified by the research team in consultation with stakeholders that merit consideration for near-term implementation. A multi-criteria tool for evaluating and comparing the options was also developed.

Co-location of washing station and shallow well.

Photo credit: Jason Vogel, Stratus Consulting, USAID, 2013d.

2.3. PROJECT OR COMMUNITY LEVEL

This type of VA seeks to understand whether and how a specific community- or project-level activity is vulnerable to climate variability and change. This can help to target or adjust activities, and may be best carried out as a part of project activities. Some of the questions that you might ask for a given assessment are listed below (among many other possible questions), and will determine the appropriate assessment methods:

Agriculture

- Are the most frequently planted crops vulnerable to variable or shifting precipitation patterns?
- Are people pasturing their livestock in floodplain areas that are vulnerable to flooding?

Water

- Is a water source covered/protected, or is it an open bore hole that is vulnerable to flooding?
- Can dams and reservoirs withstand higher water levels during floods?
- Is water for irrigation critically dependent on annual or seasonal rainfall patterns that will change?

Health

- Are communities or sub-sectors of the population malnourished, making them more sensitive to climate-related stressors such as drought?
- Will people be affected by an increase in the number of days of extreme heat?

Infrastructure

- Can energy systems withstand higher temperatures and more intense storms?
- Are precipitation projections likely to surpass drainage capacity?
- Do building design codes sufficiently account for climate variability and change? Are they enforced?

Biodiversity and Ecosystems

- Are watersheds vegetated and able to handle runoff from increasingly heavy rains?
- Will projected sea level rise inundate coastal wetlands?
- Are higher temperatures already affecting flora and fauna richness and diversity due to migration and competition from invasive species?
- Are there certain climate-related thresholds beyond which the ecosystem cannot recover?

In a community-level assessment, it is considered good practice to consider how communities define their own vulnerabilities and how they have traditionally managed climate variability such as floods and droughts. Translating climate variability and change into local terms and timeframes is essential with local-level assessments. This will be important information for defining priorities and identifying adaptation options.

For all such assessments, it is also important to understand how people access information and which sources of information are more credible or trusted. Thinking through the questions and issues discussed in this section will help you to frame a more successful assessment and ensure that the results are used to improve project outcomes and promote climate-resilient development.

3. A CONCEPTUAL FRAMEWORK FOR VULNERABILITY ASSESSMENT

No matter which decisions you are trying to influence and what scale you are planning to assess, many VAs follow a similar conceptual framework. One of the first steps is to identify climate and non-climate stressors that may affect the location, population, or sector you are assessing.

3.1. CLIMATE STRESSORS

Climate stressors include changes in meteorological conditions such as temperature, precipitation, and wind. Changes in sea level, landslides, flooding, or drought can also be considered climate stressors because these changes can result indirectly from other climate stressors. Climate stressors include climate variability (e.g., some years are marked by higher temperatures or shorter wet periods than other years) as well as climate change (e.g. average temperatures and precipitation are anticipated to generally change over time). Thus, climate stressors can include differences in rainfall that are experienced from year to year, as well as changes in longer-term trends of seasonal or annual rainfall.

In characterizing climate stressors, take into account both observations of past variability and change, as well as model projections of future conditions. (More information on how to do this is under the **Methods** section below.) Climate variability such as season-to-season and year-to-year differences in rainfall patterns and temperature can affect sectoral performance, e.g., crop production or water resources management. Climatic extremes (and projected changes in extremes) are also important to consider because they generally pose more of a threat to development than changes in average climate conditions (IPCC, 2012). In addition, impacts are often greatest when extreme events, such as cyclones, interact with the gradual effects of sea level rise and other slow-onset processes.

Questions that should be considered to identify appropriate climate information for using in a VA include the following:

- **Which climate variables matter for your assessment?** Different climate variables matter to different systems. For instance, roads are sensitive to rainfall and temperature, crops are sensitive to temperature and rainfall during the growing season as well as salinity, and public safety is sensitive to temperature (e.g. the intensity and duration of heat waves). If you are designing an assessment that goes beyond synthesizing previously generated information about impacts and vulnerabilities, start by identifying the climate variables that matter to your assessment.
- **Which climate stressors were important in the past?** Create a list of these stressors and document in appropriate detail the nature of the past stressors and the resulting impacts. This information can be obtained from desk reviews of prior analyses, and/or through consultations with stakeholders and sectoral experts.
- **Are different stressors expected to be important in the future?** Assessing future exposure requires information about future climate stressors, combined with knowledge about the

location and characteristics of inputs.³ Relevant information can be obtained from climate model projections, desk reviews, and consultations.

- **How should the assessment use historical climate information?** For assessments concerned with the next 5–10 years, analysis of historical trends of climate stressors may provide more useful information than projections of future climate change. However, when using records of past climate, remember to consider that future climate stressors could be different than those experienced historically. For example, the severity, frequency, location, and timing of extreme events could shift.
- **How should the assessment use future climate information?** If the assessment is concerned with the next 10–20 years or beyond, historical climate information can help establish vulnerability to current climate stressors. However, to capture the difference between past and future climate, climate model projections and other sources of information about future climate stressors will be required (e.g., sea level rise and storm surge scenarios). Consideration of climate change projections is particularly important for making decisions about the more distant future, because the influence of climate change and increased variability may grow.

3.2. NON-CLIMATE STRESSORS

Non-climate stressors are development challenges that can increase vulnerability because they harm the functioning of a system and the achievement of development goals. Examples of non-climate stressors include:

- **Economic:** Rising prices, economic shocks
- **Social:** Increasing crime, population displacement, population growth, urbanization
- **Physical:** Aging pipelines, poorly maintained sewers, substandard buildings
- **Political:** Poor governance, corruption, legal or regulatory barriers
- **Environmental:** Unsustainable consumption of natural resources, deforestation, pollution

Non-climate stressors should be considered in a VA because they directly affect development initiatives and in some cases overshadow the impact of climate stressors. It is important to consider how non-climate stressors could change in the future. For example, many national governments develop scenarios for long-term economic growth and population change. These scenarios can be useful for understanding likely changes in exposure to climate stressors, as well as other components of vulnerability (sensitivity and adaptive capacity).

Non-climate and climate stressors can interact in a variety of ways, with the former exacerbating or reducing the impact of the latter, and vice versa. Considering both types of stressors and their interactions in an assessment ensures you have a broader understanding of the drivers of vulnerability.

In some cases, non-climate stressors contribute directly to increased exposure to climate stressors. For example, urbanization may drive population growth in coastal areas that are exposed to sea level rise. Or the garbage that clogs sewers in urban environments may contribute to flooding during heavy rainfall events.

³ Inputs are defined in the *Climate-Resilient Development Framework* as the critical requirements needed to meet development goals. They might include water, labor, fertilizer, roads, or energy. By breaking down a development goal or a system into its constituent inputs (and enabling conditions), you can more precisely understand what is actually vulnerable to climate impacts and how.

Non-climate stressors can also increase the sensitivity of a system to future climate stressors. For example, pollution and human interference often damage coral reefs and the fisheries that depend on them. Coral reefs already stressed by these factors will have a more difficult time coping with higher temperatures and lower pH (due to increased levels of dissolved CO₂ in the ocean), since their tolerance for additional stress is lower.

3.3. EXPOSURE, SENSITIVITY, AND ADAPTIVE CAPACITY

Once you have identified climate and non-climate stressors, you can begin to assess the *vulnerability* of a place, population, or sector to those stressors. Climate vulnerability has been traditionally understood in terms of a relationship between exposure, sensitivity and adaptive capacity.⁴ Here we talk about each of those concepts; the following section describes specific methods by which to assess them in a VA.

Exposure is the extent to which something is subject to a climate stressor; in other words, whether it is directly exposed to the stressor. To assess exposure, the first step is to identify stressors that may affect the geography, sector or population of concern. The next step is gathering data and characterizing exposure in terms of whether the geography, sector or population is located in the same place, and at the same time, as particular stressors.

- **What locations might the climate stressors affect?** Understanding the spatial distribution of climate stressors can help determine what inputs are likely to be exposed. Considering how the spatial distribution of stressors may evolve over time is also a critical element.
- **How does exposure to climate stressors change over time?** Understanding how climate stressors may affect inputs at different times of the year, or over time, is also important. For instance, flooding is a risk during the rainy season, while drought is a risk during the dry season. And crops get planted, harvested, stored, and transported at different times of the year.

Sensitivity is the extent to which something will be positively or negatively affected if it is exposed to a climate stressor. The effect may be direct (e.g., a change in crop yield in response to temperature change) or indirect (e.g., damages caused by severe coastal flooding and sea level rise) (IPCC, 2001). The more sensitive a place, population, or sector is to one or more climate stressors, the more vulnerable it tends to be. For example, older adults tend to be more sensitive to extreme heat compared with the general population, and certain varieties of crops are more sensitive to drought and salinity than others. Some questions to ask include:

- **How has the place, population, or sector been affected by climate stressors in the past?** Past events can serve as a useful indicator of future sensitivity. By knowing how something was impacted in the past, you can better understand how it may respond to future climate stressors. Caution is advised, however, given that past conditions are not always a good predictor of future conditions.

⁴ Recent reports by the Inter-governmental Panel on Climate Change (IPCC) modify this definition, separating exposure to a given hazard (or stressor) from vulnerability to that hazard, which is a combined function of sensitivity and adaptive capacity (IPCC 2013, 2014a). However, since each of these components remains important to an overall understanding of vulnerability and risk (even if the relationship among them changes), they are discussed separately.

- **Is information available about the sensitivity of similar places, populations, or sectors elsewhere?** It can be difficult to understand how something will react to changes in climate, particularly if there is no historical precedent. Therefore, it can be useful to consider the sensitivity of analogues - places that currently experience the conditions expected in your location in the future. For example, information about the sensitivity of an energy system to higher temperatures could be approximated by assessing similar systems located in regions that are currently warmer than your location. Such analogues should be considered with caution since the underlying conditions in two locations are never exactly the same.
- **Is the place, population, or sector unaccustomed to new stressors?** Climate change may introduce new stressors. If these stressors have not been encountered in the past, it may be more difficult to respond to them. For example, if climate change creates conditions favorable to disease vectors, such as malaria-carrying mosquitoes, in regions where they were not present previously, the effect can be devastating relative to areas where immunity has built up over time. Conditions that become suitable to new pest outbreaks that damage crops or trees are another example.
- **Are there thresholds or tipping points beyond which the system could become highly affected by stressors?** Thresholds can limit the ability of something to withstand impacts. Once thresholds are surpassed, systems may fail catastrophically. For example, a storm surge that overtops a sea wall can have devastating consequences for the communities the wall was designed to protect. Or groundwater that becomes contaminated by salt water intrusion is very hard to treat.
- **Which elements of a system have the greatest sensitivity?** Highly sensitive places, populations, or sectors can be identified through many of the considerations listed above, such as: past damage from climate stressors, pressure from both climate and non-climate stressors, introduction of new stressors, and possibility of exceeding tipping points.

The potential for harm from climate change can be minimized by reducing exposure and sensitivity, and by ensuring that something is more capable of anticipating or recovering from climate-related impacts. *Adaptive capacity* describes the ability to take actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities from current climate extremes such as droughts and floods, as well as longer-term climate change. The adaptive capacities of individuals, households, and organizations⁵ vary according to their access to information, ownership of or access to resources, the skills of the people within these systems, and the ability to assess climate issues and make decisions. The dimensions of adaptive capacity are explored further in Table 3 below.

The information gained by analyzing adaptive capacity as part of a VA can be useful when identifying adaptation options. In addition, the analysis can help identify gaps in capacity among different systems; these gaps can then be addressed to reduce vulnerabilities. In most cases, adaptive capacity is best assessed in qualitative terms. Typically, an analysis will reveal that a system has high, medium, or low adaptive capacity in relation to a particular climate stressor(s). Ranking adaptive capacities can be difficult, but your results will contribute to the identification and assessment of potential adaptation actions by revealing strengths and weaknesses.

⁵ Ecological systems also exhibit varying degrees of capacity to recover from extreme events, referred to as ecological resilience, and to adapt to longer-term climate change. Ecological systems are viewed in this section as natural capital whose services may help to enhance the adaptive capacity of people.

TABLE 3. ADAPTIVE CAPACITY.

Dimension	Illustrative Questions
Human capital – <i>Knowledge and skills</i>	<p>What is the education level of the population?</p> <p>What traditional knowledge or practices relevant to addressing climate variability are available in communities?</p> <p>Do people know about available adaptation options?</p> <p>Do people have skills relevant to those options, such as construction methods, agricultural practices, or ecosystem management approaches?</p> <p>Do people have access to relevant information, such as forecasts or early warnings? Is the information presented in languages and formats that are understood?</p>
Social capital – <i>Informal and formal support structures</i>	<p>Are there strong social networks and relationships? (The more communities and households exhibit connectedness, social participation, equality, and inclusivity, the more likely they will be able to respond to both climate and non-climate stressors)</p> <p>Do government institutions effectively serve local communities?</p> <p>What other institutions are relevant for adaptation? What are their capacities?</p> <p>Do land-use plans exist for a given area? Are they enforced?</p> <p>Do social factors like age, gender, marital status, and others affect the options available to people to adapt to climate stressors?</p>
Natural capital – <i>Ecological assets</i>	<p>Do formal protected areas exist, and are they managed adequately to maintain the supply of ecosystem services and/or biodiversity that support livelihoods (e.g., fishing, tourism)?</p> <p>Are ecosystem services valued and safeguarded?</p> <p>Do people depend on natural resources for their livelihoods?</p>
Physical capital – <i>Built environment</i>	<p>Is there a good system of roads and other physical infrastructure?</p> <p>Are flood control and drainage systems functioning and well-maintained?</p> <p>What is the capacity and condition of irrigation systems?</p>
Financial capital – <i>Financial resources or tools for managing risk</i>	<p>Do people have access to insurance that can act as a safety net at household and national scales when extreme climate events occur?</p> <p>Do people have access to savings to respond to extreme events in the absence of or in addition to insurance?</p> <p>Are government budgets (national and/or local) available to invest in reconstruction after extreme events, and/or in longer-term adaptation options?</p>

By assessing exposure, sensitivity and adaptive capacity, you can develop an understanding of the overall vulnerability of a system (or a particular place, population or sector, or of individual inputs) to climate variability and change.

4. DESIGNING A VULNERABILITY ASSESSMENT

Now that you have framed your assessment and identified the questions you want to answer, this section discusses methods for a VA. This section will be relevant to those whose role is to scope and manage a VA. It covers assessment methods, information sources, and outputs.

4.1. METHODS

Common methods for conducting a VA are described below. Typically, some combination of these methods are used together or in sequence. In most cases, you would start with a desktop review to understand what information exists already and where there are gaps. Then you might consult with stakeholders and experts, possibly through a combination of meetings and workshops. You might utilize community-based assessment approaches and integrate the results with other data sources. Additional analyses or modeling may be required depending on your specific goals, the availability of information and resources, etc. Practical considerations (e.g. available budget, expertise, and data) will be important for choosing methods. You may ask your assessment team to suggest the most appropriate methods for the VA based on their knowledge of best practices.

4.1.1. DESK REVIEWS

Desk reviews are studies that draw on existing information. They do not require field work or additional analysis, and can help you to answer many of the questions in your assessment if others have already explored those questions. A desk review can help you to understand how climate impacts have affected a country, sector, or particular community in the past, or how they may be affected in the future. A variety of information sources can be included in the review, such as:

- Other VAs that have been done for a given area or sector, including national reports submitted to the UN Framework Commission on Climate Change (UNFCCC)
- Other climate-related analyses done for a country or region, including project documents for climate adaptation projects like the Pilot Program for Climate Resilience (PPCR)
- Sources of climate data, including downscaled projections from climate models that were generated for other assessments
- Hazard and/or risk maps
- Storm damage assessment reports, which document whether and how extreme events previously affected a system
- Disaster risk reports, which provide information on risks of weather hazards in a given region
- Sector-specific historical records from past events, which can provide useful information about vulnerability; for example, a record of crop yields in drought years or transportation system repair costs following a tropical cyclone

It is important to note in desk reviews that past impacts or vulnerabilities may differ from those in the future: future climate stressors may differ, and non-climate stressors (such as population growth or demand for resources) may differ and affect the ability of a system to respond in the future.

Pros +/- Cons -	+ : Low cost, flexible level of effort, good for initial stocktaking - : Not participatory, may be thin in a country with scant information
Sources	See Appendices, including: Documents submitted to the UNFCCC – National Communications, NAPAs, Nairobi Work Program National climate change policies and plans Knowledge platforms like the World Bank Climate Change Knowledge Portal or WeAdapt Climate projections and impact assessments Adaptation project databases
Notes	Where there is a lot of activity and information, or strong government effort, a desk review can be sufficient to select adaptation priorities for programs. In a crowded donor space, however, it may be difficult to identify strategic opportunities based only on available information. Desk reviews can be a good input to further consultations, workshops, or analyses.
Example	In Peru, USAID commissioned a quick response desk study of vulnerability and adaptation . This study was intended to inform the in-country assessment process for future USAID/Peru-funded adaptation activities addressing climate change challenges. The approach consisted of the following steps: 1) Assess particular Peruvian sectors, locations, and populations most vulnerable to climate change using existing documents and databases; 2) Identify activities of bilateral and multilateral donors, international non-governmental Organizations (NGOs), and the Government of Peru with which USAID might collaborate or complement with its own activities; and 3) Identify gaps and opportunities.

4.1.2. CONSULTATION WITH STAKEHOLDERS AND EXPERTS

Stakeholders have first-hand knowledge about the extent to which climate stressors affect development. However, this information may be subject to bias, especially if it is not readily accessible to participants in consultations and/or the expertise is not available to independently assess the information. Broad, representative consultation is important to ensure a wide range of perspectives. You will want to select stakeholders across government, civil society, academia, and the donor community. The focal institution for climate change within a government will be important, as well as sectoral ministries or departments that are ultimately responsible for integrating adaptation into their plans, budgets, and projects. Experts can also provide substantive information and analysis for a VA. For example, managers of particular inputs, such as transportation systems, can provide information about exposure based on historical events and the infrastructure, ecosystems, or social support systems that they oversee. Engineers may be able to provide information or analysis related to sensitivity, including design and construction standards relevant to climate impacts, and adaptive capacity information, such as backup systems, substitutes, or redundancy built into the system. Agro-meteorological specialists can provide information or analysis on agricultural system vulnerabilities to climate impacts.

Pros +/- Cons -	+ : Participatory, draws on local knowledge, helps coordinate activities with other donors and engage counterparts, can learn about future plans in addition to current activities, can provide access to additional data - : Can be costly in a large country, need to ensure that a variety of perspectives is represented so selected views do not bias results
Sources	Key donors, responsible ministries, NGOs, universities, research institutions, local planning and other departments, private sector, sector/livelihood organizations, vulnerable populations, etc.
Notes	GIZ, SIDA, SDC, UNDP, DFID, the World Bank and other MDBs have dedicated adaptation programs, and many governments have climate policies and programs in place that should be built upon. Consultations can greatly assist with the coordination of climate-resilient development programs.
Example	For the Eastern Caribbean VA mentioned earlier, 274 people (stakeholders and experts) were interviewed through a combination of individual interviews, group meetings, and focus group discussions. They were asked a set of questions about data and information, adaptation options, adaptive capacity, decision-making, and recommendations for prioritization by USAID. This reassured USAID that they had a representative view of the issues.

4.1.3. STAKEHOLDER WORKSHOPS

Along with individual consultations with stakeholders and experts, stakeholder workshops can be an excellent way to understand vulnerabilities (and begin to consider adaptation options). By getting different perspectives in the same room, you may also uncover new dimensions of vulnerability, identify cross-sectoral linkages, and fill gaps in knowledge. (It is also possible to have too many perspectives represented in these workshops.) The level of discussion and the types of questions to be asked and answered should be tailored to the range of skills and experience of participating stakeholders in order to ensure useful results. A central government authority that regularly interfaces with donors and participates in UNFCCC meetings will use different language when discussing climate issues than most local communities.

Pros +/ Cons -	+ : Participatory, transparent, results owned by stakeholders, opportunity for capacity building and awareness raising - : Requires outreach, coordination and planning, and supplementary analysis
Sources (Participants)	Key donors, responsible ministries, NGOs, research institutions (including climate scientists), local planning or other departments, private sector, sector/livelihood organizations, vulnerable populations, etc.
Notes	Generally, workshops can be planned for one or two days to cover: <ul style="list-style-type: none"> • Plenary discussion of socioeconomic context and development priorities to frame the discussion • Breakout discussion/brainstorming about sectoral issues, for example, inputs and enabling conditions necessary to support selected development priorities • Discussion/identification of climate and non-climate stressors that affect those conditions and inputs • Discussion/identification of possible adaptation options to build resilience (in context of ongoing efforts to avoid duplication), and initial priority-setting
Example	The Government of Jamaica’s Ministry of Water, Land, Environment and Climate Change (MWLECC) convened a workshop, “ Climate Change: Toward the Development of a Policy Framework for Jamaica ” in Kingston, Jamaica on July 26 and 27, 2012. (USAID supported organization of the workshop.) The objective was to develop inputs for a policy framework that will enable Jamaica to achieve its Vision 2030 national development goals in the context of climate change. The event was attended by more than 150 individuals, including representatives from ministries, agencies, and other entities within the Government of Jamaica; NGOs and civil society; academia; the private sector; and international development partners. Participants engaged in a series of exercises aimed at eliciting inputs to the policy framework, and gave recommendations on next steps for advancing Jamaica’s climate change adaptation planning.

4.1.4. COMMUNITY-BASED METHODS

Particularly in a site-based VA, community-based approaches can provide an important source of information that complements outputs from desk review, expert consultation, modeling, and other approaches. These methods are most appropriate for use by project implementers to inform field-based activities. Communities often have unique and specific information about past experiences and potential vulnerabilities, though it is important to combine this knowledge with information from other sources. For example, the women responsible for collecting and transporting water in an African village may be in the best position to identify whether and how a regional drought affected the mountains that supply their water (i.e., exposure and sensitivity) and the village’s ability to derive water from alternative sources (i.e., adaptive capacity).

A number of specific methods can be employed, many of them related to Participatory Rural Appraisal (PRA) approaches – for instance, household surveys; community mapping of assets and vulnerabilities;

seasonal calendars to understand how vulnerability is expressed at different times of the year; and vulnerability matrices that link climate stressors with assets and livelihoods.

Pros +/ Cons -	+ : Can generate specific information to inform local activities, may yield new information, participatory/important for buy-in - : Should be combined with other methods to validate local perceptions
Example	In Nepal and Peru, USAID supported the development of Local Adaptation Plans of Action (LAPAs) in conjunction with field- and science-based approaches to glacial lake risk reduction. The LAPA processes were based on extensive community consultations, capacity building on climate change and related issues, and the participatory development of adaptation options that can be mainstreamed into government plans, policies, and funding mechanisms. The LAPA process was originally designed in Nepal, where it was intended to reflect the needs and aspirations of Nepal's diverse communities, as well as the wide range of impacts experienced from climate variability; and lead to greater local ownership of the results from VA and adaptation planning.

4.1.5. ADDITIONAL ANALYSES

Additional or specialized analysis may be needed depending on your scope, the decisions you are trying to influence, and your sector or area of interest. For instance, a climate impact assessment might look at the specific type and severity of impacts expected for the agricultural sector depending on projected climate change. Hydrological, crop, disaster, or economic modeling may help to understand likely changes in a particular area or sector based on potential future climate conditions. These analyses may require higher-resolution data about weather and climate. If downscaled climate data is required but not readily available (based on your desk review and consultations), you may consider generating such data as part of the VA. See the next section for more information.

Types	Impact modeling/assessment; hazard, vulnerability or risk mapping; economic analysis of impacts and/or adaptation options; institutional assessment; etc.
Pros +/ Cons -	+ : Targeted, action-oriented, publishable, may raise awareness - : Can be costly, time-consuming, data requirements may be prohibitive
Notes	Targeted analyses can answer questions critical to inform program design (e.g., Which areas are most at risk? Which approaches will be most cost-effective?), and can raise awareness of climate risks with better evidence. Additional modeling activities can also engage local researchers and build local capacity and champions.
Example	In Uganda, the VA described above included value chain analysis for eight key crops of interest to assess their sensitivity to projected changes in climate; and phenological analysis to assess how projected changes in climate may affect the requirements for the growth cycle of each crop as well as associated diseases and pests. Additional crop modeling was planned, though not fully successful. The study found that coffee and banana crops were the most vulnerable to climate change, followed by maize, beans and rice. Sorghum, cassava and sweet potato were less vulnerable.

4.2. INFORMATION SOURCES

In some cases, information and data for the assessment will be readily available, but in others there will be data gaps or limitations that must be acknowledged when designing the assessment and reporting results. When existing data are insufficient to inform the assessment, modeling or other analyses may be required – particularly if the assessment results will directly inform the selection of local- or regional-scale adaptation actions. If the objective of the assessment is to inform broad policy choices or general investment priorities, existing data sources are more likely to be sufficient, but they will still need to be evaluated for quality and reliability.

The Appendices provide examples of existing sources of information on climate-related hazards, historical climate data, and climate change projections, as well as freely available sources of climate data

or data visualizations for many parts of the world. In many cases, local information sources, such as a country's hydro-meteorological services, may be required for climate information relevant to your specific study area. Information on non-climate stressors is often available in government strategy documents and action plans for addressing poverty, environmental degradation, and other factors that affect development.

Climate models can produce simulations of possible future climatic conditions using computer-based tools that account for a wide range of factors affecting weather and climate, including changes in concentrations of greenhouse gases.⁶ The results from global climate models are available at spatial resolutions of approximately 50 to 400 km, depending on the model; for some local VAs, this resolution will be too coarse. In those cases, experts use a process called downscaling to assess potential exposure to climate stressors at finer scales. Additional information on downscaling is available in USAID, 2014b.

Due to uncertainties and assumptions inherent in climate models as well as in the emissions scenarios used to generate model projections (e.g., assumptions about economic growth, population growth, energy use, etc.), a single climate model run or a single scenario should not serve as the sole basis for an assessment. Collections or ensembles of model runs, using multiple emissions scenarios, provide a sample set of projections that are representative of a range of possible futures. These projections provide decision makers with an idea of the different possibilities and their relative likelihoods.

When additional information is needed and time and resources allow, a climate model can be used in conjunction with other models to obtain further insight into changes in climate stressors. For example, an expert might integrate projected climate variables into hydrologic models to better understand potential changes in river flooding and drought. A variety of models can help you explore potential changes in storm surge, waves, and coastal erosion.

6. For information on climate modeling and recent projections, see the website of the Intergovernmental Panel on Climate Change (IPCC) (www.ipcc.ch).

4.3. OUTPUTS

Communicating the results of the VA to interested stakeholders and decision makers is necessary to facilitate action and garner support. Early communication of the purpose and intermediate results of the assessment can help to increase buy-in for the final assessment results. In addition to determining ways to display the results of the VA, you will need to consider effective venues to disseminate the results, as well as methods for communicating the uncertainty of the VA. In **Section 2**, we briefly discussed the different kinds of outputs that may come out of a VA process depending on your objectives. **TABLE 4** outlines some of the types of outputs, along with advantages and disadvantages of each. This is not a comprehensive list.

Note that these outputs are not necessarily independent. For example, mapped results from an agriculture model could be shown together with a vulnerability index that accounts for adaptive capacity of the agricultural system in order to understand potential impacts and the ability of the community to address them. Any description of vulnerability should include a discussion of methods and uncertainties.

TABLE 4. TYPES OF VULNERABILITY ASSESSMENT OUTPUTS.

Type	Main uses	Advantages	Disadvantages
Report	Summarize findings from various methods	Familiar format, can reach a wide audience	Can be long, technical, hard to follow and thus not used effectively if sufficient outreach is not conducted
Vulnerability index ^a	Prioritize locations or systems based on the general magnitude of vulnerability	Easily understandable (e.g., using color coding or scores) Helpful for comparing relative vulnerabilities	May not include key relationships between variables that affect vulnerability Does not directly imply the nature of adaptations that would be helpful The relationships between the indicators and vulnerability is not always clear
Qualitative ranking (e.g., high, medium, low)	Prioritize vulnerabilities	Easily understandable Useful for prioritizing action	Does not communicate complex or less obvious aspects of vulnerability well May be open to interpretation and therefore contain uncertainties Does not directly imply the nature of adaptations that would be helpful
Maps	Visually convey the spatial character of vulnerability and/or exposure, sensitivity, and adaptive capacity	Helpful for understanding spatial relationships Useful for facilitating group discussion Useful for generating stakeholder support through co-development of a map	GIS-based maps require technical knowledge, monetary resources, and large amounts of data Hand-drawn or qualitative maps may not be reliable enough to inform decisions Spatial complexity may not communicate significant underlying uncertainties Does not imply the nature of adaptations that would be helpful
Profiles	Compare different elements of vulnerability for a single input or compare the vulnerability of different inputs	Helpful for demonstrating relative differences among the components of vulnerability Useful for summarizing complex information into a simple statement or visual graphic	Specific formats of graphics may not communicate well with all stakeholders May not depict all the contextual information that is important for decision-making Can be unclear and too complex
a. Note that a vulnerability index can be used to create qualitative rankings or maps.			

4.3.1. VULNERABILITY INDEX

A vulnerability index typically involves an equation that estimates vulnerability based on a quantitative analysis of indicators that account for exposure (e.g., location in a flood plain), sensitivity (e.g., condition of an asset), and adaptive capacity (e.g., access to resources). A vulnerability index can be useful for assessing current conditions and how they change over time, or for comparing the vulnerability of different sectors or jurisdictions (see Figure 2). It can help to convey complex, multi-variate outputs in a simpler form. However, it is only as good as the data that is used, and data is often not available for all important vulnerability factors or at the desired scale of analysis. You can create a new index or use existing vulnerability indices to assess vulnerability.⁷

	Vulnerable Sectors' Share of GDP Index	Share of Coastal Population Index	People per Cubic Meter of Freshwater Index	Unweighted Vulnerability Index	VI-CRED
Africa	1.00	0.20	0.03	0.41	1.61
China	0.69	0.07	0.07	0.28	1.09
Russia/Eastern Europe	0.41	0.00	0.04	0.15	0.58
Europe	0.16	0.44	0.07	0.22	0.87
Latin American/Caribbean	0.35	0.44	0.00	0.26	1.03
Middle East	0.35	0.23	1.00	0.53	2.06
Other High Income	0.05	1.00	0.05	0.37	1.43
South Asia	0.96	0.30	0.01	0.42	1.65
United States	0.00	0.44	0.07	0.17	0.66
World	0.20	0.28	0.02	0.17	0.65

Figure 2. Climate and Regional Economics of Development Vulnerability Index (VI-CRED), developed by the Stockholm Environment Institute (SEI).⁸

The indicators that are used in vulnerability indexes must be selected with care. There is no clear consensus about using indicators because of issues associated with the selection and development of indicators, the assumptions used in aggregating and weighting indicators, the difficulty in obtaining data that are consistent and high-quality across a study region, and the interpretation of the vulnerability indices. Above all, it is important that the indicators and the process for analysis (e.g., the weighting and relationship between indicators) be both transparent and in line with the objectives and scope of the assessment.

Vulnerability indices are used to compare similar units in order to prioritize among them. For example, they can help to compare localities based on which ones have the greatest economic exposure to climate stress (measured by e.g., employment or value of agriculture, fisheries, tourism, etc.), the greatest physical exposure (measured by e.g., low-lying territory, coastline, etc.), and the lowest adaptive capacity

⁷ See for example, <https://www.weadapt.org/knowledge-base/vulnerability/sample-of-existing-vulnerability-indices>.

⁸ Developed by SEI in 2012, VI-CRED is an index composed of measures of climate-sensitive economic sectors as a percentage of gross domestic product (GDP), share of population living at less than 5 meters above sea level, and freshwater resources per capita. For more information, see: <http://www.sei-international.org/publications?pid=1838>.

(measured by poverty, education, etc.). They are also used to compare physical assets by integrating data relating to exposure and sensitivity of urban infrastructure, dams, reservoirs, roads, etc. The process for designing indices should include diverse stakeholders, including local experts and stakeholders whose jurisdictions are being represented by the data. Using a consultative process for designing indices can help to build consensus and promote collaborative, coordinated, and collective action toward reducing vulnerability based on the findings.

4.3.2. QUALITATIVE RANKING

Many VAs identify the most vulnerable systems or inputs through ranking or prioritization (see Figure 3). These rankings or prioritizations can be based on quantitative information, qualitative information, expert judgment, or a combination of these. They are typically categorical (e.g., high/medium/low or on a scale of 1–5).

NO. NOMBRE	TIPO DE INFRAESTRUCTURA	UBICACIÓN				COMPONENTES BILANDOS			
		Temperatura y sequías		Precipitación e inundaciones		Temperatura y sequías		Precipitación e inundaciones	
		Presente	Futuro	Presente	Futuro	Presente	Futuro	Presente	Futuro
1	REHABILITACION DE AGUA POTABLE Y ALCANTARILLAS	1	2	2	3	1	2	1	3
2	REHABILITACION DE AGUA POTABLE Y ALCANTARILLAS	1	2	2	3	1	2	1	3
3	REHABILITACION DE AGUA POTABLE Y ALCANTARILLAS	1	1	2	3	1	2	1	3
4	REHABILITACION DE AGUA POTABLE Y ALCANTARILLAS	1	1	1	3	1	2	2	3
5	REHABILITACION DE AGUA POTABLE Y ALCANTARILLAS	2	3	3	4	1	2	3	4
6	REHABILITACION DE AGUA POTABLE Y ALCANTARILLAS	3	2	2	3	1	2	1	3
7	INSTALACION DEL SISTEMA DE ABASTECIMIENTO DE #	2	3	2	3	2	3	1	2
8	INSTALACION DEL SISTEMA DE RIEGO	3	4	4	4	3	4	3	4
9	MEJORAMIENTO DEL CANAL LATERAL	2	3	3	4	3	4	2	3
10	INSTALACION DEL SISTEMA DE AGUA POTABLE	2	3	2	3	2	3	3	4
11	CONSTRUCCION DE VEREDAS	1	1	1	2	2	3	2	3
12	CONSTRUCCION DE PISTAS Y VEREDAS	1	2	1	2	2	3	2	3
13	MEJORAMIENTO DE CALLES	1	2	2	3	2	3	2	4
14	CONSTRUCCION INTEGRAL DE PISTAS Y VEREDAS	1	2	3	4	2	3	3	4
15	CREACION DE PISTAS Y VEREDAS	1	2	3	4	2	3	3	4
16	PISTAS Y VEREDAS PISTAS Y VEREDAS	1	1	1	3	1	3	2	3
17	CONSTRUCCION DE VEREDAS	1	2	1	3	2	3	1	3
18	PISTAS Y VEREDAS PISTAS Y VEREDAS	1	2	1	3	1	2	2	3
19	PISTAS Y VEREDAS PISTAS Y VEREDAS	1	2	1	3	1	2	2	3
20	MEJORAMIENTO DE LA TRANSITABILIDAD PEATONAL	1	2	1	2	1	2	1	2
21	CONSTRUCCION DE PISTAS	1	2	1	3	2	3	1	3
22	CONSTRUCCION DE VEREDAS	1	2	1	3	2	3	1	3
23	CADENAS PRODUCTIVAS CADENAS PRODUCTIVAS	2	3	3	4	2	3	2	3
24	MEJORAMIENTO Y AMPLIACION DE LA GESTION INTEGRAL	2	3	2	3	2	3	3	4
25	CONSTRUCCION DE PLATAFORMA DEPORTIVA	1	2	2	3	1	2	2	3
26	CONSTRUCCION DE PARQUE	1	2	2	3	1	2	2	3
27	CREACION DE PLATAFORMA DEPORTIVA	1	2	2	3	1	2	2	3
28	CONSTRUCCION DEL PARQUE	1	2	2	3	1	2	2	3
29	CONSTRUCCION DEL PARQUE	1	2	2	3	1	2	2	3
30	CREACION DE MINI COLISEO DEPORTIVO	2	3	2	3	1	2	2	3
31	MEJORAMIENTO Y REHABILITACION DEL COMPLEJO D	1	2	2	3	1	2	2	3

?	Insufficient information or understanding Greater familiarity with the project or climate information is needed and/or better information is required. This rating should be reassigned once there is sufficient understanding.
1	Low exposure / sensitivity or high adaptive capacity The climate hazard is not applicable OR it is relevant, but the project, asset, or service is not vulnerable.
2	Potential exposure or sensitivity / uncertain adaptive capacity The climate hazard could undermine the effectiveness of the infrastructure project, asset, or service but more information is required to understand vulnerability.
3	Moderate exposure / sensitivity and adaptive capacity The infrastructure project, service, or operation is exposed and sensitive to impacts from the climate hazard.
4	High exposure / sensitivity or low adaptive capacity The infrastructure project, service, or operation is highly exposed and sensitive to the climate hazard, with a limited ability to respond.

Figure 3. Color-coded vulnerability ranking system used for the Climate Resilient Infrastructure Services activity in Piura, Peru under USAID’s Climate Change Resilient Development Project. Source: USAID.

When a ranking system is used, a description or definition of each category is typically provided, along with data uncertainties. Ranking systems help to clearly communicate information on the relative level of vulnerability.

4.3.3. VULNERABILITY MAPS

Vulnerability maps are useful tools for assessing and communicating the spatial nature of vulnerability including changes in spatial aspects over time (see Figure 4). Maps can rely on a variety of inputs, ranging from qualitative stakeholder knowledge to quantitative Geographic Information System (GIS) analytics. They can be used as a tool throughout a VA, including during stakeholder consultations, during the technical assessment itself, or as a communication tool to explain the assessment results. GIS can be

used to display and overlay indicators (e.g., poverty levels), components of vulnerability (e.g., exposure of roads defined by overlays of sea level rise and roadways), or quantitative vulnerability indices (e.g., the sum of indices of exposure, sensitivity, and adaptive capacity). Hand-drawn maps, developed in group settings, can be useful for gathering input for participatory VAs.

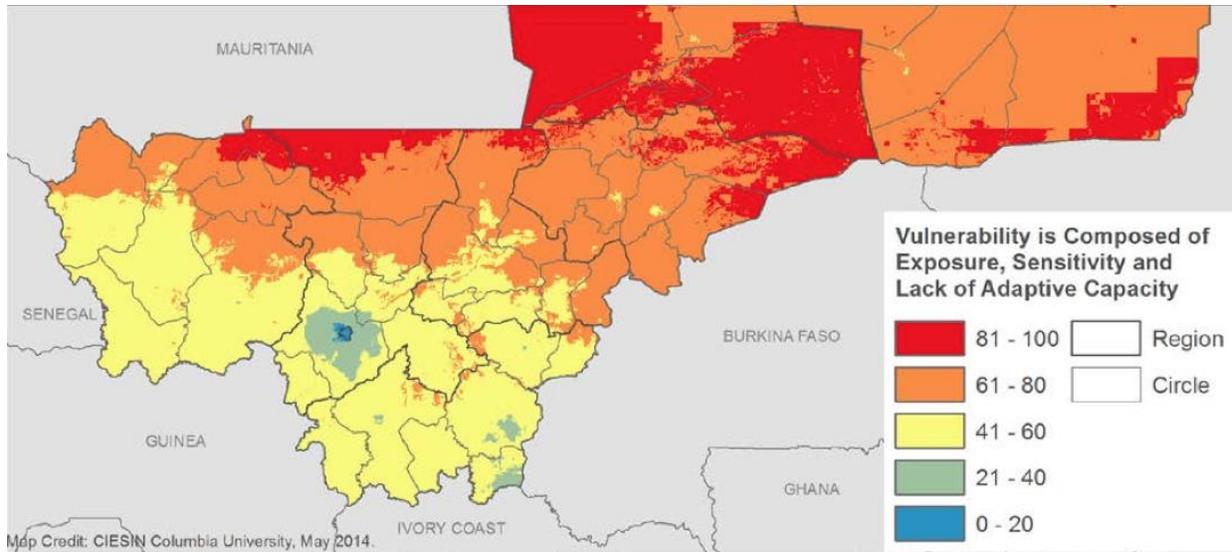


Figure 4. Vulnerability Map of Mali produced by USAID’s African and Latin American Resilience to Climate Change (ARCC) project Source: USAID, 2014c.

4.3.4. VULNERABILITY PROFILE

A vulnerability profile is a way to summarize the vulnerability of particular inputs to development (such as water, labor, transportation networks, institutions, financial resources). A profile can be a written summary, a graphic, or a combination of text and graphics (see Figure 5). Graphic vulnerability profiles are often presented as pentagrams or radar charts. In a radar chart, the spokes of the plot typically represent different inputs. An indicator with a high score (higher vulnerability) is plotted further away from the center.

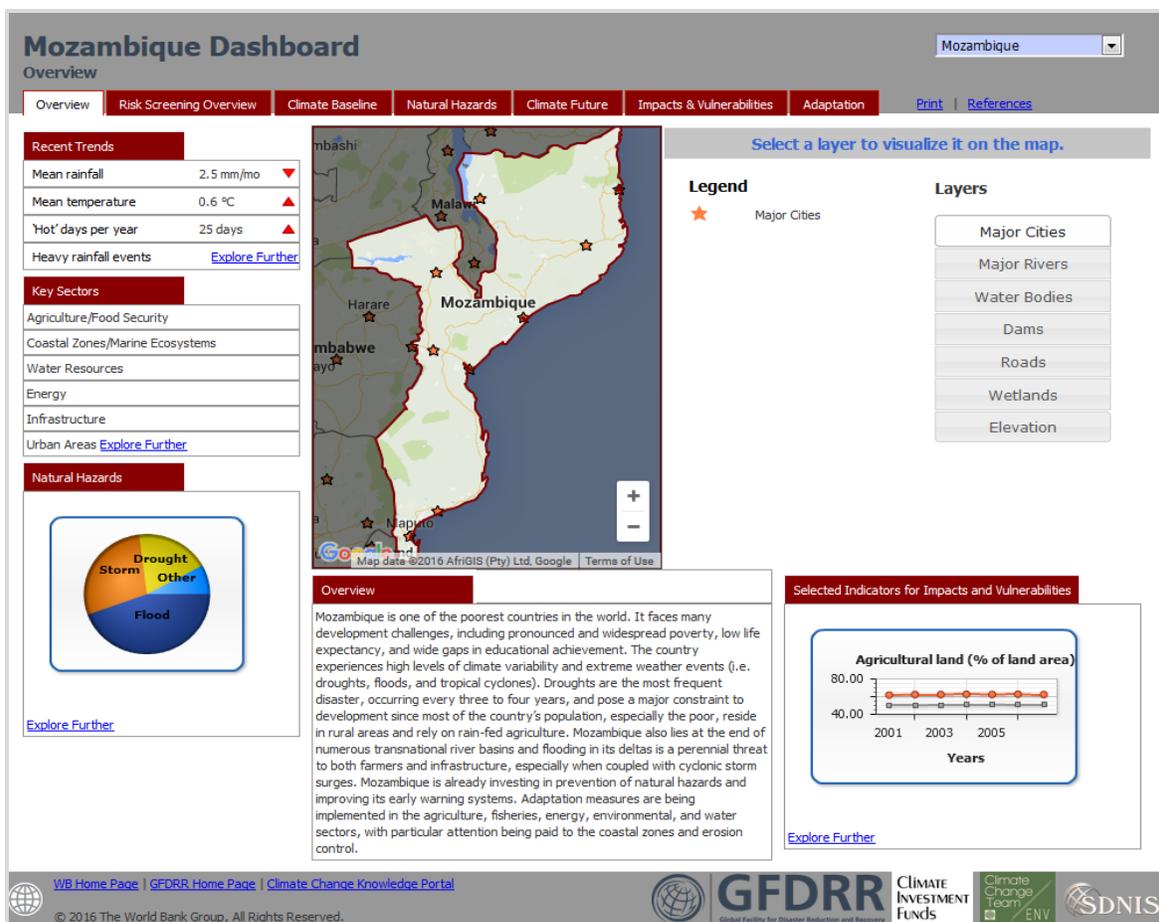


Figure 5. Climate Vulnerability Profile of Mozambique. Source: World Bank's Global Facility for Disaster Reduction and Recovery.

4.3.5. UNCERTAINTY

Regardless of how you are communicating the results of a VA, you should discuss the uncertainties. This will help decision makers understand key limitations in the analysis, as well as identify areas where confidence is high, leading to better-informed decisions. Uncertainty exists at each step in the VA process. Observations contain uncertainties associated with factors such as instrument errors, measurement gaps, recording errors, and errors in interpretation. Models may contain uncertainties inherent in the data, uncertainties related to hypotheses about relationships among variables, and uncertainties in terms of underlying assumptions and scenarios. The treatment of uncertainty in any particular analysis depends primarily on the source and type of information (qualitative or quantitative) available, the ways the information was used in the assessment, and the intended use of assessment results.⁹

⁹ The U.S. Climate Change Science Program (CCSP) has prepared guidance on "best practices" for addressing uncertainty in climate change studies (CCSP, 2009).

5. CONCLUSIONS: USING THE RESULTS OF A VULNERABILITY ASSESSMENT

A VA is best seen as a means to an end, not an end in itself. It is primarily an input into decision-making, and should contribute towards the broader iterative cycle of planning, designing, managing, implementing, and evaluating climate-resilient development actions. As described at the outset of this annex, a VA is designed to explore who or what is vulnerable; where, when, why and how they are vulnerable; and how important climate stressors are relative to non-climate stressors. The results can help determine which sectors, locations, or groups should be the focus of adaptation activities; which vulnerabilities should be reduced and how; and how any such efforts should be combined with other types of interventions that manage other stressors. They can also inform the identification and analysis of adaptation options.

You may be able to use information from a VA to determine whether and how to modify existing development activities. For example, you may learn that a road project being designed for a river valley might need to be relocated to avoid being flooded. This is an example of reducing exposure to a climate stressor. Similarly, the assessment can help you understand how severely a particular stressor might affect a system. For example, an assessment may show that certain types of drainage systems may have protected buildings from flooding in the past. This type of information will be helpful for determining whether similar actions may reduce impacts under future conditions as well.

You may also use the information to determine strengths and weaknesses for reducing vulnerability. The analysis of adaptive capacity can provide an excellent starting point. For example, the analysis may indicate that a city's financial resources are limited, but that it has high levels of social capital. This would point toward the potential near-term effectiveness of adaptations like typhoon preparedness systems that rely on informal training and communication and benefit from social capital, while seeking additional funding for adaptations that require new expenditures (e.g., storm surge protection barriers).

Assessment results can also help to manage adaptation options to increase their effectiveness. For instance, assessment results can be helpful in defining baseline exposure, sensitivity, and adaptive capacity before any adaptation action; and developing plans to monitor important indicators of exposure, sensitivity, and adaptive capacity during implementation. This can also be useful for third parties who may continue to monitor those indicators after the end of a given project or program. Repeating VAs over time can help to track changes in vulnerability due to climate change, as well as changes in socio-economic conditions and non-climate stressors. You can also use vulnerability monitoring to adjust the prioritization of vulnerabilities and the resources devoted to addressing them, and to improve management of adaptation actions.

There are many useful resources for further information on designing and managing a VA; some are listed in the **Appendices** which follow this section. In addition, USAID's [Climatelinks](#) is a public resource for adaptation practitioners to share examples and experiences. It includes many examples of [sample VAs](#) and additional resources.

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RESOURCE APPENDICES

APPENDIX A: PREVIOUS CLIMATE CHANGE STUDIES

Type of information	Description	Source	Web address
Regional Assessments			
Climate Change 2013, Working Group II: Impacts, Adaptation and Vulnerability	Regional assessments for Africa, Asia, Australasia, Europe, Central and South America, North America, Polar Regions, Small Islands, and the Ocean	Intergovernmental Panel on Climate Change (IPCC)	http://www.ipcc.ch/report/ar5/wg2/
National Assessments			
National Communications	These country-specific reports provide information and research on a country's sectoral sensitivities	Countries submitting reports to the United Nations Framework Convention on Climate Change (UNFCCC)	http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php
National Adaptation Programmes of Action (NAPAs)	These country-specific reports often include information on sectoral or location-specific sensitivity. Information may be out-of-date	Countries submitting reports to the UNFCCC	http://unfccc.int/cooperation_support/least_developed_countries_portal/submitted_napas/items/4585.php
National Adaptation Plans (NAPs)	These country-specific adaptation plans may include information on sectoral or location-specific sensitivity or adaptive capacity. They are intended to have a longer-term focus than NAPAs.	Countries submitting reports to the UNFCCC	http://unfccc.int/adaptation/workstreams/national_adaptation_plans/items/6057.php
Pilot Program for Climate Resiliency reports	Source of country plans and projects	World Bank Group	https://www.climateinvestmentfunds.org/cifnet/
Global Environment Facility (GEF) project reports	Source for material on climate resilience	World Bank Group	http://www.thegef.org/gef/gef_Documents_Publications
Government reports	National climate change policies, strategies, and action plans	Sector and planning agencies and departments, including hydrometeorological services	
National stocktaking			

Type of information	Description	Source	Web address
Current and Planned Adaptation Action by country and region	Takes stock of priority interests and adaptation needs; efforts by governments to support adaptation through policy and planning; the scope of international support for adaptation efforts in different countries and sectors; and potential gaps in adaptation efforts at the country and regional levels. 12 regional and 114 individual country profiles were completed.	Adaptation Partnership (IISD, supported by State Department and other donors)	https://sites.google.com/a/ccrdp-roject.com/adaptation-partnership2/activities

APPENDIX B: CLIMATE-RELATED HAZARDS

Type of information	Description	Source	Web address
Country Programs for Disaster Risk Management and Climate Adaptation	Country profiles include information on key socioeconomic sectors, such as agriculture and water resources, that can be used to understand sensitivity.	Global Facility for Disaster Reduction and Recovery (GFDRR)	http://www.gfdr.org/gfdr/CountryPrograms
Global Assessment Report on Disaster Risk Reduction	This UN report explores trends in disaster risk for each region and for countries with different levels of socioeconomic development. It also provides self-assessments of governments' progress toward disaster risk management.	United Nations International Strategy for Disaster Reduction Secretariat (UNISDR)	http://www.preventionweb.net/english/hyogo/gar/2015/en/home/GAR_2015/GAR_2015_1.html
Famine Early Warning Systems Network (FEWS NET) Data Portal	This data portal provides access to geo-spatial data, satellite image products, and derived data products for use in food security monitoring.	FEWS NET partners include USGS, USAID, Chemonics International Inc., NASA, and NOAA	http://earlywarning.usgs.gov/fews/
Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)	This 2012 IPCC report provides information on the implications of climate extremes for society and sustainable development.	IPCC	http://www.ipcc-wg2.gov/SREX/images/uploads/SREX-SPMbrochure_FINAL.pdf
Emergency Events Database	EM-DAT contains core data on the occurrence and effects of disasters worldwide from 1900 to present. It is updated daily from numerous sources and is considered the most important publicly available source of global disasters data. Output is available as tables, graphs, and maps.	Centre for Research on the Epidemiology of Disasters (CRED), Department of Public Health, Université Catholique of Louvain (Brussels, Belgium)	http://www.emdat.be/

APPENDIX C: CLIMATE DATA AND DATA VISUALIZATIONS

Climate data/ visualization	Description	Source	Web address
Climate Change Knowledge Portal (CCKP)	Visualization tool for numerous climate variables from a range of sources. A central hub of information, data and reports about climate change around the world.	World Bank Group	http://sdwebx.worldbank.org/climateportal/index.cfm
SERVIR	Remotely sensed information about climate variability and change.	SERVIR Global partners including USAID, NASA, regional hubs and research collaborators	http://www.servirglobal.net
Surging Seas	Interactive tools to visualize sea level rise scenarios.	Climate Central	http://sealevel.climatecentral.org
Climate Wizard	Simple map-based tool to view maps of temperature and precipitation changes.	The Nature Conservancy; University of Washington; University of Southern Mississippi	http://www.climatewizard.org/index.html
International Research Institute for Climate and Society Data Portal	Access to wide range of data, information and tools for managing climate risks.	International Research Institute for Climate and Society, Columbia University	http://iri.columbia.edu
World Meteorological Organization (WMO) Global Framework for Climate Service	Climate observation and projections in a climate services framework.	World Meteorological Organization	http://www.gfcs-climate.org/
Climate Services Partnership	Platform for knowledge sharing.	Climate Services Partnership	http://www.climate-services.org/
Climate Information Portal	Web interface for observational data, climate projections and guidance documents.	University of Cape Town	http://cip.csag.uct.ac.za/webclient2/app/
Global Historical Climatology Network (GHCN)	Quality-controlled, station-level datasets for temperature and rainfall from thousands of weather stations worldwide. Also includes global climatologies.	NOAA	http://www.ncdc.noaa.gov/ghcnm/
Climatic Research Unit of the University of East Anglia	Quality-controlled, temperature and rainfall data from thousands of weather stations worldwide. Also includes global climatologies.	University of East Anglia	http://www.cru.uea.ac.uk/cru/data/availability/
NASA Goddard Institute for Space Studies	Quality-controlled, temperature data from thousands of weather stations worldwide. Also includes global climatologies. Includes a web-based visualization tool.	NASA	http://data.giss.nasa.gov/gistemp/

Climate data/ visualization	Description	Source	Web address
Global Change Master Directory	Wide range of data sources, including remotely sensed information relevant to numerous sectors.	NASA	http://gcmd.gsfc.nasa.gov/
Aqueduct Water Risk Atlas	Online maps show where water-related risks are most severe today and how climate change and/or development could affect water resources over the next 30 years.	World Resources Institute	http://www.wri.org/applications/maps/aqueduct-atlas/
Program for Climate Model Diagnosis and Intercomparison	Comprehensive archive of output from the world's leading models; large array of simulations produced using a wide range of emission scenarios.	Lawrence Livermore National Laboratory	http://www-pcmdi.llnl.gov/
Maurer et al. (2009)	Statistically downscaled results from a wide range of global models run for three emission scenarios.	Santa Clara University	http://www.engr.scu.edu/~emaurer/global_data/

APPENDIX D: SOURCES FOR INDICATOR DATA

Data/tool	Description	Source	Web address
Millennium Development Goals	Eight goals for meeting the needs of the world's poorest people. Country- and sector-specific indicators are provided.	UNDP	http://unstats.un.org/unsd/mdg/Default.aspx
International Human Development Indicators Profiles	Country-specific social vulnerability based on the Human Development Index (HDI) of the United Nations Development Program. The HDI combines indicators of life expectancy, educational attainment and income.	UNDP	http://hdr.undp.org/en/data/profiles/
Climate Change Knowledge Portal	A web-based tool that provides country-specific indicators of sensitivity, including information on water access, sanitation, land use, wealth, age, and agriculture.	World Bank Group	http://sdwebx.worldbank.org/climateportal/index.cfm
Open Data	A data catalog that provides access to a number of indicators that can be used to assess sensitivity.	World Bank Group	http://data.worldbank.org/
Demographic and Health Survey	A 30 + year record for most developing countries of demographic and health survey information.	USAID	http://www.measuredhs.com/
Least Developed Countries Factsheets	Country-specific development statistics for least developed countries that can be used to assess sensitivity.	United Nations Development Policy and Analysis Division	http://www.un.org/en/development/desa/policy/cdp/ldc/profile/
Government statistics databases	National and local government websites provide information on development indicators.	Various local governments	
Adaptation Learning Mechanism	Web-based information platform that includes case studies of adaptation.	UNDP	http://www.adaptationlearning.net/explore
WeAdapt	Web-based information platform that includes case studies of adaptation.	WeAdapt Knowledge Partners	http://weadapt.org/

APPENDIX E: ILLUSTRATIVE EXAMPLES OF VULNERABILITY ASSESSMENTS

Name of Study	Description	Source	Web address
Dominican Republic Climate Change Vulnerability Assessment (2013)	Assessment of climate change impacts on watersheds and coastal resources, and the people dependent on them, in four climate-sensitive targeted hotspots in Dominican Republic.	USAID	http://www.usaid.gov/documents/1862/dominican-republic-climate-change-vulnerability-assessment-report
Climate Resilient Urban Development: Vulnerability Profiles of 20 Indian Cities (2013)	VA of 20 cities in India. The document provides an overview of the research methodology, findings, and recommendations to lay out an information base for future action.	Integrated Research and Action for Development	http://accrn.org/resources/documents-and-tools/2013/08/01/climate-resilient-urban-development-vulnerability-profiles-
Assessing City Resilience: Lessons from Using the UNISDR Local Government Self-Assessment Tool (LGSAT) in Thailand and Vietnam (2103)	The LGSAT is designed to help cities reflect on and assess their own capacity for disaster risk reduction. This document reviews the outcomes and findings from applying the tool in four cities across Thailand and Vietnam.	Institute for Social and Environmental Transition (ISET)	http://pdf.usaid.gov/pdf_docs/pnaec709.pdf
Uganda Climate Change Vulnerability Assessment Report (2013)	Assessment of climate change impacts on key crop value chains and the livelihoods of households that depend on them.	USAID	http://community.eldis.org/.5b9bfce3/ARCC-Uganda%20VA-Report.pdf
Adaptation to Climate Change Vulnerability Assessment and Economic Aspects - Plurinational State of Bolivia (2010)	A pilot of the World Bank's Economics of Adaptation to Climate Change study. Assessment of Bolivia's vulnerability to climate change, with a particular focus on the agricultural and water sectors.	World Bank	http://documents.worldbank.org/curated/en/2010/01/16441371/adaptation-climate-change-vulnerability-assessment-economic-aspects--brplurinational-state-bolivia
Climate Change in the Federated States of Micronesia: Food and Water Security, Climate Risk Management, and Adaptive Strategies (2010)	Assessment of climate risks to Micronesia in response to nation-wide inundation by extreme tides in December 2007, September 2008, and December 2008.	University of Hawai'i Sea Grant College Program	http://www.sprep.org/att/irc/ecopies/countries/fsm/74.pdf
Confronting a Changing Climate in Michoacán, Mexico (2010)	Assessment of climate change impacts and vulnerability in the state of Michoacán, Mexico, with a focus on the water and agriculture, two key sectors of the economy.	World Bank	http://documents.worldbank.org/curated/en/2010/11/17457641/confronting-changing-climate-michoacan
Vulnerability Through the Eyes of the Vulnerable: Climate Change Induced Uncertainties and Nepal's Development Predicaments (2009)	Synthesis of climate change impacts in the Nepal Himalaya and assessment of Himalayan residents' vulnerability to such changes.	Nepal Climate Vulnerability Study Team	http://i-s-e-t.org/resources/major-program-reports/vulnerability-through-the-eyes-of-vulnerable.html

Name of Study	Description	Source	Web address
An Assessment of Climate Change Vulnerability, Risk, and Adaptation in Albania's Energy Sector (2009)	VA of Albania's energy sector. One of the largest sources of vulnerability is Albania's reliance on hydropower, which accounts for 90 percent of the country's electricity production.	World Bank	http://documents.worldbank.org/curated/en/2009/12/11935944/climate-vulnerability-assessments-assessment-climate-change-vulnerability-risk-adaptation-albanias-power-sector

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