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COMPENDIUM OF LESSONS LEARNED FROM ARCC CLIMATE CHANGE VULNERABILITY ASSESSMENTS

MARCH 2015

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ARCC



African and Latin American
Resilience to Climate Change Project

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AFRICAN AND LATIN AMERICAN RESILIENCE TO CLIMATE CHANGE (ARCC)

MARCH 2015

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ACRONYMS AND ABBREVIATIONS

ACCRA	Africa Climate Change Resilience Alliance
ARCC	African and Latin American Resilience to Climate Change Program
CBO	Community-Based Organization
CCVA	Climate Change Vulnerability Assessment
CDCS	Country Development Cooperation Strategy
CIESIN	Center for International Earth Science Information Network
CORDEX	Coordinated Regional Downscaling Experiment
CSAG	Climate Systems Analysis Group
CSE	<i>Centre de Suivi Ecologique</i>
DCCMS	Department of Climate Change and Meteorological Services
DR	Dominican Republic
DRRR	Disaster Response and Risk Reduction
FEWS NET	Famine Early Warning System Network
FGD	Focus Group Discussion
FtF	Feed the Future
GCM	General Circulation Model, Global Circulation Model
GIS	Geographic Information System
GODR	Government of the Dominican Republic
GOM	Government of Malawi
HH	Household
IA	Institutional Analysis
IP	Implementing Partner
IQC	Indefinite Quantity Contract
IPCC	Intergovernmental Panel on Climate Change
ISRA	<i>Institut Sénégalais de Recherches Agricoles</i>
JPC	Joint Program Cell
KII	Key Informant Interview
LAC	Local Adaptive Capacity

NAC	National Adaptive Capacity Framework
NAP	National Adaptation Plan
NGO	Nongovernmental Organization
PCA	Principle Component Analysis
PLACE	Prosperity, Livelihoods, and Conserving Ecosystems
PRA	Participatory Rural Appraisal
PREPARED	Planning for Resilience in East Africa through Policy, Adaptation, Research and Economic Development
RCP	Representative Concentration Pathway
SHRRP	Stakeholder Review and Recommendations Process
SOW	Scope of Work
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USG	United States Government
VA	Vulnerability Assessment
VCA	Value Chain Analysis
WALA	Wellness and Agriculture for Life Advancement
WAVA	West Africa Vulnerability Assessment
WRI	World Resources Institute
WMO	World Meteorological Organization

PROLOGUE

The African and Latin American Resilience to Climate Change (ARCC) program—a three-year program that began in September 2011—has helped USAID invest more effectively in activities that support economic growth, democratic governance, health, human rights, and the environment. ARCC worked with USAID to protect its existing development investments and design policies and programs that would be responsive to climate change. The climate change vulnerability assessment (CCVA), one of the tools used to inform this work, gauges the extent to which ecological and human systems are likely to be affected by climate change. The assessments provide information on sensitivity and exposure to changes in climate as well as the adaptive capacity of systems and populations to withstand these changes. They include studies of climate trends and projections for the future, estimates of the impact of climate change on natural and human systems, and analyses of past and current responses to similar impacts.

USAID missions are using the assessment results to inform climate change adaptation, food security, biodiversity, economic development, and health investments. In Uganda, Malawi, the Dominican Republic, Honduras, and Senegal, ARCC vulnerability assessment findings have been presented to key decision makers within government and civil society. ARCC has also delivered targeted technical assistance in institutional strengthening, policy development, transboundary river basin and coastal issues, groundwater, conflict, and adaptive farming practices related to climate change for USAID missions in Ethiopia, Ghana, Kenya, Mali, Rwanda, and the regional mission in West Africa.

Because of the highly contextualized and complex nature of climate change vulnerability research, ARCC specialists had the opportunity to explore new areas and discover new approaches as they implemented the project. As a result, ARCC was able to bring improved science, methods, tools, and shared learning on adaptation into the mainstream of USAID and partner programming. The ARCC program comprises four tasks:

- **Task One:** Developing Vulnerability Assessment Methodologies
- **Task Two:** Providing Outreach, Training, and Meeting Support
- **Task Three:** Developing and Managing Knowledge
- **Task Four:** Providing Technical Support to USAID Missions

This Compendium consolidates lessons learned by ARCC during its analysis of climate change impacts on populations and the natural systems upon which they depend, based largely on its experience with designing and implementing CCVAs in Africa and Latin America. By working with USAID missions to support programming relevant to climate change adaptation, ARCC has tested CCVA frameworks and methodologies in a variety of sectors, ranging from agriculture and food security to coastal resources, biodiversity, and key ecosystems. Thus, this Compendium also provides information that USAID missions can use to design assessments in the future.

EXECUTIVE SUMMARY

Before considering how to adapt to climate change, it is first necessary to understand the extent to which natural and human systems will be affected by various change scenarios. That is the purpose of a climate change vulnerability assessment (CCVA). These assessments treat climate change as a driving agent of change while acknowledging that other forces may also be at work, and they provide specific information on exposure and sensitivity as well as on the adaptive capacity of populations and the systems on which they rely.

For three years, starting in 2011, the USAID African and Latin American Resilience to Climate Change (ARCC) program gave specialists an opportunity to explore and discover how best to conduct CCVAs. In many countries, these were the first such assessments to have ever been conducted. ARCC's work brought improved science, methods, tools, and shared learning on adaptation to the programming of USAID and its partners. This Compendium draws on experience gained through preparing assessments in the Dominican Republic, Honduras, Malawi, Senegal, and Uganda. The lessons compiled in this report constitute a reference tool that can be used by assessment designers to define the scope of a CCVA and by key decision makers to introduce climate change adaptation into new or existing policies and programs.

The features of CCVAs make them complex undertakings. They both inform and are informed by stakeholders—community groups, policymakers, climate scientists, and other interested or involved parties. The assessments are highly multidisciplinary, as they must address a variety of sectors, including agriculture, energy, water, health, environment, public works, and trade and investment, among others. They also must operate on many scales simultaneously, considering the adaptive capacities of individuals, the community, and local and national institutions. In addition, climate change projections have a significant degree of uncertainty. These factors present challenges to the goal of any CCVA: to present results that are accurate, comprehensive, and useful, and that integrate all lines of inquiry.

Among the most important lessons from the ARCC experience was that a CCVA is both a product and a process. As a product, it compiles an evidence base for decision making; as a process, it both enables

WHAT IS CLIMATE CHANGE VULNERABILITY?

The CCVAs conducted by the ARCC program generally use the Intergovernmental Panel on Climate Change (IPCC) definition of vulnerability:

$$\text{Vulnerability} = f(\text{Exposure, Sensitivity, Adaptive Capacity})$$

This definition is widely accepted but a subject of debate. Sensitivity, as used here, is generally understood as the reciprocal of resilience, and often includes adaptive capacity, though ARCC has treated adaptive capacity as a separate concept. Exposure is considered problematic because it stands at the juncture of the threat and the entity confronting the threat. For example, a community is exposed to sea-level rise because they live on the coast, but a measure of the climate threat—sea-level rise—must then be isolated from some measure of the community, such as the number of people, poverty levels, or distance from the coast. In practice, the specific meaning of these terms is defined by the CCVA itself.

and demands meaningful dialogue with stakeholders. With this in mind, the Compendium offers lessons on conducting assessments, understanding their main analytic components, and using assessment findings to inform policy or programming.

ASSESSMENT UPTAKE

A CCVA does not end with the presentation of findings. It needs to have an afterlife, during which it is used to make decisions about policy or programming relevant to adaptation to the potential effects of climate change. ARCC found that the degree to which this “uptake” occurs is influenced by three factors: *credibility*, the perceived technical quality and adequacy of the findings; *salience*, the perceived relevance of the information provided; and *legitimacy*, the level of acceptance of the findings as an accurate reflection of reality.

Because decision makers and policymakers have no frame of reference for the scale of threat posed by climate change, they may resist or reject the premises of CCVA, questioning its technical quality (credibility), relevance (salience), and even its underlying assumptions (legitimacy). That is why it is essential to involve—and engage—stakeholders at every stage of the CCVA process. In addition, continual engagement with two particularly important types of stakeholders—“knowledge brokers” and “champions”—is also essential. Effective knowledge brokers can help link the design and findings of a CCVA to policy and programming by making information more accessible to decision makers and policymakers. Champions have a wider role; they help promote the usefulness and relevance of the CCVA to a range of audiences, including the public.

By engaging in dialogue with potential users of the results throughout the assessment process, an assessment team can overcome challenges to credibility, salience, and legitimacy, strengthening its ability to interpret scientific findings and translate them into actionable responses. ARCC found that uptake typically passes four stakeholder engagement landmarks. Engaging with stakeholders during the design process builds salience and legitimacy. Validating data and analysis with stakeholders during data collection increases credibility. Verifying findings through reporting and public discussion establishes legitimacy. Developing and validating recommendations with stakeholders enhances all three characteristics.

ASSESSMENT DESIGN

The conduct of a CCVA should follow standard research design practices. As for any well-designed research effort, the goal of the assessment should be stated clearly, in terms that succinctly define the scope. Secondary research questions help guide the fact-finding approach and methodology, but the overall goal sets the scope of the analysis. The development of research questions is typically an iterative process involving ongoing stakeholder engagement. At this early stage, it is critical to identify the stakeholders and begin engaging with them, starting with a limited circle of those most closely involved in the effort, such as representatives from donors (especially USAID, in ARCC’s case), the government, research or academic organizations, and representatives from those economic sectors central to the CCVA.

Another key design lesson from ARCC is the importance of applying an analytic framework. The assessments conducted by ARCC used the IPCC definition of vulnerability (exposure, sensitivity, adaptive capacity) as a framework, associating research questions with each of those terms. However, the components of that definition are open to interpretation. The way each one is defined influences the research design and can contribute to the legitimacy and credibility of results. Establishing a common set of definitions and terminology through the use of such a framework allows the assessment team and stakeholders to speak the same language, thus supporting more effective communication of key concepts throughout the process.

ASSESSMENT IMPLEMENTATION

Each assessment involves multiple lines of inquiry that engage a variety of disciplines, specialists, and research approaches. Hence, implementing a CCVA requires strong, consistent, and sustained leadership and a combination of technical, operational, and administrative skills that cut across multiple disciplines. Sufficient time is needed to assemble and develop such a team. ARCC found that continual joint planning and review of each study component helped to improve coordination and reduce the likelihood that the research would be carried out as a series of discrete, separate studies. This also promoted data collection efficiency and provided opportunities to triangulate preliminary results from the climate analysis with those from other study components to ensure the convergence of the evidence. This sometimes meant that adjustments had to be made as the CCVA progressed, as unanticipated data limitations arose or as stakeholders' understanding of the issues involved improved. This explains why two seemingly contradictory characteristics—focus and flexibility—were necessary for a CCVA team leader to be effective. Finally, ARCC discovered that research alone was not as compelling to stakeholders as was a coherent story, one that brought the patterns of data and information together in a way that all could readily understand.

TRANSLATING RESULTS INTO RECOMMENDATIONS

Communicating the findings of a CCVA involves appropriate timing and audience selection. ARCC found that uptake of its findings was most likely to occur when the timing coincided with important policy, programming, or investment cycles. However, ARCC also discovered that, because of the long time required to conduct some CCVAs, it was desirable to release preliminary findings or findings from specific subcomponents of an assessment to inform investment decisions. ARCC learned that communicating final CCVA findings beyond the primary donor can attract complementary investments from the government, other donors, and other actors.

In order to translate results into recommendations, ARCC found that it was important to maintain continuing dialogue with the stakeholders of a CCVA. Through the Stakeholder Review and Recommendations Process (SHRRP), a series of focused workshops, ARCC engaged key stakeholders, guiding them through an analysis of the assessment's results to develop a set of climate change adaptation options. The SHRRP workshops drew on the evidence base provided by the CCVA but also used climate change scenarios with localized content to engage stakeholders in a discussion on options for action. In addition to producing recommendations, the workshops also helped foster understanding and create the potential for action. While the ARCC assessments were commissioned specifically for use by USAID, as their implementation progressed, the relevance of findings to other audiences was recognized. As a result, ARCC and USAID began to engage with wider groups of stakeholders through meetings, symposia, and local press and radio programs.

Throughout the results and recommendations phase, ARCC found that care was needed when communicating the uncertainty that is inherent in climate projections. Some audiences were uncomfortable with the idea that climate projections decades into the future were unlikely to provide the narrow range of values for temperature and precipitation changes that they desired or expected. Involving these individuals in the CCVA at an earlier point helped alleviate some of this discomfort.

ARCC also gave its CCVA team members opportunities to offer ideas for implementing recommendations. When organized into meaningful categories, a collection of these otherwise separate recommendations gained valuable context for discussion. Categories might include strategy, policy, or program areas relevant to donors and other key stakeholders. Recommendations that built on adaptation practices that were already happening, or on interventions that USAID or others had identified as already underway, were more likely to have an immediate impact.

INSTITUTIONAL ANALYSIS

Adaptive capacity is ultimately enabled or compromised by institutions, which influence adaptation in critical ways. A thorough investigation of adaptive capacity must, therefore, engage institutions from the household level to community groups, and private sector entities to governmental and parastatal bodies, at every level. ARCC found that even a relatively superficial institutional analysis will improve the legitimacy of the CCVA with stakeholders and make the assessment product more relevant to users. By integrating the institutional assessment process into the CCVA, rather than carrying it out as a discrete analytic component, ARCC gained considerable efficiency.

ARCC also learned very early in the process to focus on a specific set of sectors or communities—those that were the focus of the CCVA as defined by the research goal—rather than exclusively on climate-related institutions. More specifically, ARCC learned to ask the questions that helped open the range of inquiry. For example, regarding a CCVA focused on agriculture-based livelihoods, ARCC would pose the question: “Which entities manage efforts or govern issues that affect agriculture (or natural resource management, or food security)?” rather than “Which entities know something about or have a specific mandate for “climate”?” ARCC learned that including local and national consultants and organizations in the CCVA team itself can help the team identify key actors, understand the local context, and access local institutions and their representatives. Finally, ARCC learned to appreciate the role of the knowledge brokers, who work alongside a local champion to identify and engage key institutional actors.

Climate Analysis

The keystone of CCVAs—and what makes them unique—is the climate analysis. It provides a solid scientific understanding of exposure, one of the three essential aspects of vulnerability. It is important, therefore, to conduct this analysis early in the development of the CCVA. Through conducting climate analyses, ARCC learned that considerable time and effort could be saved by reaching early agreement on the time horizon of climate projections, typically 15 and 30 years. Gathering and “cleaning” the historical data to be used as a basis for making such projections can be very time-consuming. The results of the projections from climate modeling then had to be “downscaled”—adjusted to a scale more relevant to the scope of the CCVA. ARCC found it important to put these projections in context, comparing them with current levels of inter-annual variations, as well as to the slower, decadal oscillations in climate.

Conclusions

- A properly executed CCVA provides:
- Guidelines for ensuring that development goals continue to be met in the context of a changing climate;
- Plausible climate change scenarios and identification of those areas, resources, populations, or enterprises most likely to be negatively affected by significant climate shifts;
- A strong evidence base to help guide prioritization of adaptation investments and the effective application of those investments;
- Targeted adaptation policies that protect specific investments; and
- A broad set of properties that help protect populations and the resources upon which they depend against the likely impacts of climate change.

Conducting a CCVA is a challenging task, but it is an important step toward defining the challenges that need to be faced now and in the future. CCVAs help to elucidate factors that need to be considered: the nature and degree of climate change impacts, what and who will be sensitive to those impacts, and the existing capacity to adapt. The results from CCVAs can help decision makers evaluate options that may help prevent or mitigate the negative impacts of climate change and increase resilience by improving the capacity of people and systems to adapt to change.

1.0 INTRODUCTION

Climate change represents one of the most significant challenges to the general wellbeing of humankind in the foreseeable future. While humans are among the most adaptable of species, the challenges presented by climate change, and the capacity to adapt to that change, differ greatly across geographic areas, populations, and socioeconomic classes. Climate Change Vulnerability Assessments (CCVAs) are designed to elucidate these factors—the nature and degree of climate change impacts, the sensitivities to those impacts, and existing adaptive capacities. The results from CCVAs can help decision makers evaluate options that may help prevent or mitigate the negative impacts of climate change and increase resilience by improving capacity to adapt to change. Understanding vulnerability to climate change and how to address it is part of USAID's mission to "end extreme poverty and promote resilient, democratic societies while advancing our security and prosperity."¹

The **CCVA process is, in a sense, a "journey."** The journey begins with a decision maker's desire to examine the anticipated impacts of climate change on a potentially vulnerable population or natural system. The CCVA gathers information on past and current climate conditions, and predicts future trends; it evaluates current social, economic, and natural conditions and their capacity to adapt; it identifies the range of stakeholders—both to learn from them and to improve their ability to act to address climate change; and, finally, it guides future policy and investment programming. This Compendium shares lessons from one particular set of CCVA journeys in hopes of providing useful insights to those about to embark on a CCVA journey of their own.

TEXT BOX 1.1: COMPENDIUM TARGET AUDIENCE

Donor staff and others who want to:

Commission a CCVA or use the results of a CCVA to better understand climate change impacts.

Define the scope of a new CCVA.

Integrate ("mainstream") climate change into programs.

Plan the way forward when embarking on a CCVA.

1.1 WHAT TO EXPECT FROM THIS COMPENDIUM

This Compendium is meant to serve as a reference tool to help readers find the most suitable path toward a chosen CCVA destination. The Compendium is intended for those interested in introducing **climate change adaptation into new or existing policies and programs**. This group includes USAID and other donor staff who are commissioning a new CCVA or who will be using the results from an existing CCVA to better understand how climate change might affect particular populations and

¹ <http://www.usaid.gov/sites/default/files/documents/1869/USAIDFY2015DevelopmentBudgetFactSheet.pdf>

sectors, and to use this understanding to develop or improve programming. Thus, by presenting lessons learned from the ARCC experience, we hope that readers will draw insights from this compendium that will help them define the scope of new CCVAs, or help them integrate ("mainstream") climate change vulnerability into existing programs to enhance adaptation and improve resilience. The Compendium is

also designed to help CCVA implementers plan the way forward as they embark on new CCVAs.

"Climate change," "vulnerability assessment," and "adaptation" are all multi-faceted and, to a degree, open-ended concepts. A CCVA may address all or any of the following: multiple socioeconomic systems and populations and their vulnerabilities; the uncertainties associated with climate change and its impacts, which may vary substantially throughout a geographic area of interest; and the adaptive capacity of natural systems, individuals, communities, institutions, and infrastructures, ranging from the local to the regional and national, and even the supra-national.

TEXT BOX 1.2: EXAMPLES OF ARCC CCVA TOPICS

Dominican Republic	Watershed and Coastal Resources
Honduras	Biodiversity and Key Ecosystems
Malawi	Agriculture, Water, Fisheries
Senegal	Agriculture and Livelihoods
Uganda	Agriculture and Livelihoods

This Compendium does not offer a specific, detailed guide for *how* to carry out a CCVA. Rather, by sharing ARCC experiences in designing, implementing, interpreting, and disseminating the results of CCVAs, it provides examples of lessons learned that have worked in specific contexts, for consideration by those who may find themselves in similar—though not likely identical—circumstances. Drawing on ARCC's experience, this Compendium will:

- Provide key considerations that ARCC learned to address as part of the CCVA planning process;
- Highlight details in the design and implementation of key components of a CCVA;
- Aid in identifying the partners (stakeholders) who will both inform and benefit from engagement in the CCVA process;
- Illustrate strategies and approaches, tested by ARCC, that worked in specific contexts; and
- Provide suggestions on how to efficiently and productively carry out a CCVA.

Case studies describing specific experiences and lessons-learned while conducting selected CCVAs appear as annexes to this Compendium.

TEXT BOX 1.3: CHARACTERISTICS OF A TYPICAL ARCC CCVA

- Is designed to inform USAID programming
- Sub-national, country-wide, or regional in scale
- Multi-sectoral and multi-disciplinary but focused mainly on agriculture, environment, and rural livelihoods
- Includes significant climate analyses components
- Considers secondary and tertiary impacts on people, communities, and economic systems
- Is conducted by "virtual" teams with no permanent field presence

I. 2 WHAT IS A CCVA? HOW DOES IT DIFFER FROM OTHER TYPES OF VULNERABILITY ASSESSMENTS?

The term "vulnerability assessment" (VA) has been in use for at least 50 years in a number of fields, including systems analysis, ecology, famine and food security, business, security, and disaster management. In the context of this Compendium, vulnerability assessments seek to gauge the degree to which lives and livelihoods—as well as the natural, economic, institutional systems on which they depend—are susceptible to and prepared (or ill-prepared) to cope with adverse change. Climate change vulnerability assessments specifically consider **climate as the driving agent of change**. There may, of course, be many confounding factors, such as population pressure, environmental degradation, or economic factors, that also drive change, and it may be difficult, if not impossible, to separate these factors from the effects of climate change. Yet CCVAs focus, as much as possible, on the underlying climate factors that most directly contribute to vulnerability.

To successfully adapt to climate change, it is no longer advisable to plan interventions based on historical climate conditions. Planning must incorporate future climate projections. One is forced to make decisions in the present—based on projections that are, to a degree, uncertain—whose impact may only be experienced decades later. Additionally, adaptations that may be appropriate in the short term (the next 5 to 10 years) may become maladaptive as the climate continues to change over subsequent decades.

On the operational side, CCVAs often address many different sectors, so they tend to be highly multi-disciplinary. They are also often multi-scalar, considering adaptive capacities at the individual, community, and institutional levels. These factors present challenges to meeting an important goal of the CCVA—to ensure that the results are truly integrated and more than the sum of their constituent parts. Our experience has provided lessons about how to do this effectively, and these lessons are described in this Compendium.

There is little that distinguishes the individual research practices employed within a VA from those of a CCVA. The latter, however, must consider future climate projections—and the uncertainties implicit therein—in each component study. Some of these practices, and the differences that distinguish CCVAs from other types of VAs, are discussed in greater depth in Section 3.3.3.

Because CCVAs investigate long-term issues that have a significant degree of uncertainty and are highly multi-disciplinary, it is necessary to engage a wide range of stakeholders in the CCVA process. In communicating potential climate impacts, it may be necessary to inform and educate them and other affected individuals about the reasons why climate change represents a new set of threats, or why it presents threats on a scale beyond their previous experience. Some may not appreciate that there will never be a time for "returning back to normal," some may be skeptical about the idea that the climate is changing, and some may be overtly hostile, actively resisting the idea that there is a need to adapt at all. This range of reactions taught ARCC a valuable lesson on the importance of engaging stakeholders throughout the CCVA process.

In the future, climate change will permeate all development sectors at all levels, from the individual, to the nation, to the world as a whole. Even a CCVA focused on agriculture must look across sectors when considering response options, sectors that may focus on energy, water, health, environment, public works, and trade and investment. All sectors must have a coherent and consistent strategy for managing resources, with both harmonized policies and harmonized messages. Responses must also be targeted to all levels, from communities, to districts, to the national level and beyond. These responses must be organized in ways that promote cohesion across levels, with all the governance challenges inherent therein. Only in this way will response options meet the considerable challenges imposed by climate change.

I. 3 WHAT DOES A CCVA PROVIDE?

The CCVA journey is **both a process and product**. The CCVA establishes an understanding of current conditions and an expectation of future conditions. It informs and is informed by stakeholders, be they community groups, policy makers, climate scientists, or the myriad other interested and involved parties.

As a **process**, the conduct of a CCVA both enables and requires a meaningful dialogue with stakeholders. When stakeholders are involved early in the CCVA journey, the process becomes more insightful and the resulting product more widely useful. From the start, a CCVA design that effectively engages stakeholders also helps ensure relevance, understanding, ownership, and eventual use (or "uptake") of the final CCVA product.

As a **product**, the CCVA is the compilation of a deliberate evidence base for decision making. Thus, a significant component of the CCVA process, as learned by ARCC, entails identifying and gathering information appropriate to areas of concern—e.g., livelihood surveys, crop phenologies, ecosystem studies—and producing new information when necessary, especially information related to projections of future climate conditions. Importantly, this process entails understanding the limitations and uncertainties of climate information. The CCVA product aligns and triangulates the gathered information and seeks to provide program planners and policy makers with insights to guide how best to address climate change vulnerability.

Climate change vulnerability assessments vary widely in scope and scale based on their budget, their spatial and temporal scales, and their focus (e. g., natural systems, agriculture, fisheries, water, or energy, or some combination of these and other areas of concern). If narrowly focused in scope and scale, a preliminary CCVA may be conducted in a few months on a modest budget from a desktop. A very comprehensive CCVA, however, may require a multi-million-dollar investment and span several years. The geographic area of interest might be restricted to a single community or be regional in extent. A CCVA may look only a decade into the future, or into the next century. And it may focus on only a single area of impact (on subsistence agriculture, for example) or have a broader focus (such as food and or some combination of these and other areas of concern).

If narrowly focused in scope and scale, a preliminary CCVA may be conducted in a few months on a modest budget from a desktop. A very comprehensive CCVA, however, may require a multi-million-dollar investment and span several years. The geographic area of interest might be restricted to a single community or be regional in extent. A CCVA may look only a decade into the future, or into the next century. And it may focus on only a single area of impact (on subsistence agriculture, for example) or have a broader focus (such as food and livelihood security).

Because the CCVAs conducted under ARCC were commissioned by USAID for the primary purpose of informing its programming—particularly that targeted to ending poverty and promoting resilience—the lessons described in this Compendium are necessarily USAID-centric. They were designed within the context of USAID's development mission, with an eye toward working in partnership with other development actors.

But the lessons may be applicable to other donor, demand-driven CCVAs (see Text Box 1.4) as well. Although household- and community-level information was often used to inform the assessments, USAID Mission programming typically takes place at sub-national, national, and regional levels; as a result, ARCC CCVAs generally covered large geographic areas. The CCVAs typically were multidisciplinary, but focused primarily on agriculture, the environment, and rural livelihoods. They also included analyses of secondary and tertiary impacts of climate change on people, communities, and economic systems. ARCC CCVAs benefited from highly interdisciplinary teams, with both national and international expertise, and included climate scientists to carry out detailed climate analyses—often the

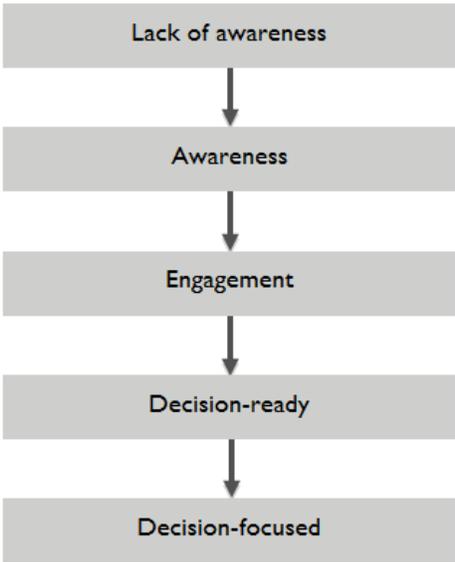
first of their kind for the countries in question. These teams tended to be "virtual" in nature, coming together periodically for the purpose of conducting various phases of the CCVA, but with no relationship with each other outside the CCVA activity; typically the only permanent field presence was a local partner.²

Whether a particular CCVA has characteristics similar to an ARCC CCVA or has a much different scope and scale, it is those very scope and scale "variables" that imply the questions to be addressed during the CCVA's early planning process. This step is not, however, the first in the VA journey.

TEXT BOX 1.4: THE DEMAND-SIDE VERSUS SUPPLY-SIDE CCVA

A "demand-side" or "top down" CCVA is one commissioned to inform a specific, articulated need, such as a specific policy, program, or investment decision. A "supply-side" or "bottom up" CCVA is one undertaken without an explicit, articulated need. Supply-side CCVAs might be undertaken to reveal findings or insights that have not yet been considered or anticipated by decision makers.

Both supply- and demand-side CCVAs can influence the decision process at various points along the decision "state" chain:



Purely supply-side VAs are more likely to influence the process at the first or second step, whereas demand-side CCVAs are more likely to influence it at latter steps. But either type of CCVA could influence the process at any point along the decision sequence.

While the focus of this Compendium is on donor-driven, "demand-side" CCVAs, ARCC also learned that it was common for a CCVA to uncover findings that had not been anticipated by decision makers, but that were very important for them to know about. Thus, while understanding where decision makers fall along the decision sequence can help demand-driven CCVA implementers target their results to effect change (movement) along the sequence, it is important to remain aware of the larger context, and to allow space in which to identify previously unanticipated findings. This essentially blurs the distinction between demand- and supply-driven CCVAs, and sets up the possibility that what might have begun as a demand-driven CCVA could instead bring new, unexpected ("supply side") priorities to the attention of decision makers.

² The length of time to complete each CCVA varied considerably depending on the number of sub-components and the methodologies applied. The case studies presented in Annexes D through H include the time frame for each study and give a sense of that range. The cost of each CCVA varied as well, based on the same factors, as well as on the availability of qualified local staff or the need to draw on international expertise. The costs ranged from about USD 300,000 to nearly USD 1,000,000 (with a mean and median of about USD 680,000 and USD 690,000, respectively).

I. 4 THE CCVA JOURNEY BEGINS AT ITS END

There is no one-size-fits-all plan or process for performing a CCVA; however, the first step in the journey is clear: to seek answers from stakeholders to the question, "What is our destination?" In CCVA terms, this could be interpreted as "What information concerning vulnerability and change adaptation should this assessment provide to inform policy and programming?" Examples include:

- Guidelines for ensuring that development goals continue to be met in the context of a changing climate;
- A set of plausible climate change scenarios and identification of those areas, resources, populations or enterprises most likely to be negatively affected by significant climate shifts;
- A strong evidence base to help guide prioritization of adaptation investments and the effective application of those investments;
- Targeted adaptation policies that protect specific investments, for example, in infrastructure or agriculture; and/or
- A broadly-defined set of properties that help protect populations and the resources upon which they depend against the likely impacts of climate change.

All of these goals share a common theme: How outcomes produced by existing or anticipated policies, programs, or projects can benefit by incorporating climate change adaptation. Only by clearly defining the goal of the CCVA can a clear path toward that goal be established. At the same time, the CCVA is itself a learning process. During the journey, it may be necessary to strengthen the dialogue with stakeholders, veer from a pre-determined path, and even revisit the goal itself (perhaps, for example, to reflect new stakeholder input or an unfortunate paucity of vital data).

I. 5 HOW THIS COMPENDIUM IS ORGANIZED

Chapter 2 covers the key factors that contribute to the eventual "uptake" of CCVA results. Chapters 3 through 5 then describe ARCC lessons learned along the way of the CCVA journey—during the *process* of conducting a CCVA. This journey begins by identifying the goal of a CCVA (Chapter 3). That chapter also discusses strategies and approaches that ARCC used to determine CCVA research questions, analytic frameworks, methods, and tools. Chapter 4 discusses implementation of the CCVA and integration of results. Chapter 5 discusses means for communicating CCVA findings and mechanisms for moving from results to recommendations for adaptation actions.

While a CCVA is likely to be interdisciplinary, three analytic aspects are common across all CCVAs: the institutional analysis, the climate change analysis, and other topic-specific analyses. Chapter 6 provides ARCC lessons for applying institutional analyses. Chapter 7 describes the aspect that distinguishes CCVAs from all other VAs: the climate analysis. Chapter 8 discusses certain analytic methods in the areas of agriculture, livelihoods and food security, and how they were adapted for a climate vulnerability assessment context. Overall conclusions from the Compendium are summarized in Chapter 9. The annexes provide case studies, additional details relevant to ARCC CCVAs, and supplementary material, including Annex I, which contains a comprehensive list of lessons learned.

2.0 ENHANCING "UPTAKE"

While many may argue that a CCVA ends with the presentation of assessment results, an important lesson of ARCC is that certain characteristics can improve the use or "uptake" of those results. We define uptake as the use or application of the findings from a CCVA to inform policy or programming. Understanding decision makers' needs from the outset, and how CCVA results are likely to be used in decision making, informs not only the design of the CCVA but also how it is carried out, and the utility of the study results. In this chapter, we discuss properties that can increase and enhance the eventual uptake of CCVA findings.

2.1 FACTORS THAT INCREASE AND ENHANCE UPTAKE

ARCC has identified five properties that can increase and enhance uptake of CCVA results. They consist of three enabling factors, **credibility**, **salience**, and **legitimacy**, together with the presence and active engagement of **knowledge brokers** and **champions**. All of these factors can enhance uptake both within the donor agency—improving the usefulness of the CCVA product to donor planning and programming—as well as with other important actors.

2.1.1 Credibility, Salience, and Legitimacy

Three enabling factors—credibility, salience, and legitimacy—are established in the science-policy literature³ as critical for the translation of science, in general, into policy and planning. The definition of these factors in the context of CCVAs are as follows.

- **Credibility** refers to the perceived technical quality and adequacy of the presented evidence and findings. Decision makers are likely to find results they perceive as having high technical quality to be much more compelling. For example, credibility is established when qualified scientists conduct a climate analysis using trusted data sources and the latest procedures to identify trends and describe the uncertainty of projections.
- **Salience** is the perceived relevance of the technical information provided. Salience is not established solely by the relevance of the CCVA product itself; the timing of its availability relative to policy, planning, or investment needs is also crucial.
- **Legitimacy** is the value whereby CCVA results are recognized and accepted as an accurate reflection of reality. Legitimacy is established by engaging a wide range of stakeholder perspectives to corroborate the design and validate the findings of the CCVA and by allowing them to participate in the CCVA implementation when appropriate. For example, validating climate trend analyses with real world experiences of climate change—e.g., by exploring the evolution of the practices of affected farmers and herders in response to those apparent trends—can enhance the legitimacy of the scientific analyses, as can incorporating quality data from host government sources.

³ See Cash, D.W., Clark, W.C., Alcock, F., Dickson, N.M., Eckley, N., Guston, D., Jager, J., Mitchell, R. (2003) Knowledge systems for sustainable development. *Proceeding of the National Academy of Science USA* 100(14):8086–8091.

TABLE 2.1: WAYS TO ACHIEVE CREDIBILITY, SALIENCE, AND LEGITIMACY

CHARACTERISTIC	ACTIVITIES
<p>Credibility</p>	<ul style="list-style-type: none"> • Use the best available, highest quality data, information, recognized methods, and analysis procedures • Clearly communicate data gaps, limitations of the methods, and uncertainties in the results • Discuss confounding (non-climate related) factors
<p>Salience</p>	<ul style="list-style-type: none"> • Gather and validate input from decision makers about their information needs and intended uses of the CCVA findings • Structure CCVA findings to directly address critical, expressed needs • Demonstrate an understanding of political, social, economic, cultural, and institutional contexts in which the CCVA is embedded • Release information from the CCVA in a timely manner aligned with policy, planning, and procurement schedules
<p>Legitimacy</p>	<ul style="list-style-type: none"> • Involve key stakeholders in the design of the CCVA • Ensure that stakeholders represent the full range of appropriate technical sectors and levels of society • Maintain dialogue and open involvement, providing voice to many actors throughout the CCVA process

Table 2.1 suggests some ways in which the characteristics of credibility, salience, and legitimacy can be achieved. This list is neither exhaustive nor prescriptive.

2.1.2 Engaging Stakeholders; Understanding the Role of Knowledge Brokers and Champions

The second key factor in strengthening uptake is stakeholder engagement. We demonstrated that uptake typically passes four stakeholder engagement landmarks. Salience and legitimacy are improved by

stakeholder engagement during the design phase (Chapter 3); credibility is enhanced during the data collection phase, as data and their analyses are validated through stakeholder engagement (Chapter 4); legitimacy is established through the verification of findings through reporting and public discussion (Chapter 5); and all three characteristics are strengthened when recommendations for adaptation options are developed and validated through an Stakeholder Review and Recommendations Process (Chapter 5).

Throughout the CCVA process, ARCC identified the participation of certain stakeholders—called "knowledge brokers" and "champions"—as key to enhancing uptake. By making information more accessible, an effective knowledge broker links the design and findings of the CCVA to policy and programming, as well as to the public at large. The role of knowledge brokers is also recognized in science-policy literature as important for facilitating development of a shared understanding that allows joint knowledge development, rather than knowledge generated by researchers alone (Hammill et al., 2013). Knowledge brokers can help build trust and cooperation during the stakeholder engagement process (PROVIA, 2013).

Knowledge brokers are typically a part of the CCVA implementation team or closely engaged with it. As is often the case with any type of vulnerability assessment, a member of the ARCC CCVA team (usually the team leader) often acts as the knowledge broker. As will be described in Chapters 3 through 5, recognition that a member of the CCVA team will likely be acting as a knowledge broker—at least during the assessment period—allows the team to plan and prepare activities proactively that will best contribute to the uptake of CCVA results.⁴ In addition to assuring greater impact, incorporating these activities into the process from the beginning helps manage expectations as well as time.

Champions play a role similar to that of knowledge brokers, although they are not members of the CCVA implementation team. Ideally, champions are credible individuals who understand the value of the CCVA for informing specific policies and programs; they serve as, or are associated with, the primary stakeholder. Champions provide a direct link to decision makers or are decision makers themselves. To ensure utility of results, a key lesson for ARCC was to identify champions during the early stages of the CCVA, even during the initial design and field research phases.

For the ARCC CCVAs, USAID mission staff often acted as champions—they explained to their colleagues the relevance of CCVA results for mission programming and promoted the use of CCVA results to inform mission procurements. Oftentimes, USAID mission staff also promoted the use of CCVA findings outside USAID, most notably to host government entities. The most useful and used CCVAs were those for which USAID played the greatest and most visible role as champion, especially those where USAID championed the results among host government entities and actively sought to engage host-country partners to join them as champions.

Knowledge brokers and champions outside the CCVA team and USAID can also improve uptake. These individuals are typically found in the pool of secondary users and stakeholders, especially among host government entities, with a particular mandate for addressing climate change adaptation issues or closely related issues such as disaster risk management and mitigation. The engagement of these additional and often critical change agents—or champions—is catalyzed by first identifying and then engaging them in the process as early as possible; in the design and implementation of the CCVA as well as in generation of adaptation options from its findings.

⁴ Because CCVA team members cannot be long-term knowledge brokers, it is important, during conduct of an assessment, to identify other individuals who can carry on this role once the assessment has been completed.

By engaging in dialogue throughout the CCVA process with potential users of the results, the CCVA team is in a better position to interpret scientific findings and translate them into actionable responses. As will be described in Chapters 3 and 4, information from these users can help inform the design and implementation of the CCVA in a way that legitimizes the CCVA process and improves the relevance and credibility of the CCVA product.

Although the five properties may be useful to any type of VA, they are even more critical in a CCVA. Climate change represents a complex phenomenon that can trace its roots to both anthropogenic and natural causes. By presenting a new and evolving "normal," climate change has begun to alter the scale of threats to a level that many individuals had never before had to cope with. For this reason, they may resist or reject the premises of CCVA, and question its technical quality (credibility), relevance (salience), and even its underlying assumptions (legitimacy). CCVA knowledge brokers need to represent a wider range of sectors, and effective champions need to be able to navigate between these sectors in true transdisciplinary fashion.

CONCLUSIONS AND KEY LESSONS FOR ENHANCING UPTAKE

In this chapter, "uptake" is defined as the use or application of the findings from a CCVA to inform policy or programming. Understanding, from the outset, how CCVA results are likely to be used in decision making will guide how the CCVA will be carried out. It will also strengthen the utility of the study results.

ARCC identified three enabling factors that can increase uptake—credibility, salience, and legitimacy—in the following ways:

- A **credible** study uses the best available, highest quality data and information, and recognized analysis procedures.
- A **salient** study is based on a solid understanding and recognition of the political, social, economic, cultural, and institutional contexts in which the CCVA is embedded.
- A study is **legitimized** by providing a voice to many actors, beyond those considered as primary stakeholders.

Stakeholders play a key role in ensuring all three factors are attained.

- Salience and legitimacy are strengthened through stakeholder engagement during the design phase by ensuring that the study is relevant to their needs and circumstances;
- Credibility is built during the data collection phase, as data and their analyses are validated through stakeholder engagement;
- Legitimacy is established through the verification of findings through reporting and public discussion; and
- All three characteristics are strengthened when recommendations for adaptation options are developed and validated through a participatory process.

ARCC also identified the participation of certain stakeholders—called "**knowledge brokers**" and "**champions**"—as key to improving uptake.

- Knowledge brokers make information more accessible by interpreting the design and findings of the CCVA and understanding how they relate to policy and programming.
- Champions are credible individuals who can provide a direct link to decision makers— or are decision makers themselves— and are in a position to use the information to catalyze change.

SECTION I: THE CCVA PROCESS

3.0 RESEARCH DESIGN

All ARCC CCVAs begin with a scoping mission. During the mission, the CCVA teams meet with USAID and other key stakeholders to understand expectations and gain a sense of the needs that the CCVA will address.

The design of a CCVA defines the nature, focus, and parameters of the vulnerability assessment. Like any VA, it is important that adequate time and effort be invested in defining a clear, cohesive design from the beginning. The CCVA design has three main elements:

- The goal (or main research question) of the CCVA;
- The guiding (or secondary) research questions and analytic framework; and
- The research approach, techniques, and tools.

In addition, a literature review and stakeholder engagement informs and validates the design.

3.1 DEFINING THE GOAL OF THE CCVA

By nature, vulnerability assessments, climate or otherwise, are complex undertakings. Care must be taken to ensure that the assessment remains headed in the right direction throughout the CCVA process, and that donor staff, relevant stakeholders, and members of the CCVA team all agree on the ultimate goal. In essence, a CCVA begins at its end, with the definition of its goal.⁵

As would be the case for any well-designed research effort, the CCVA goal (or "main research question") should be described in a clear and concise manner.⁶ As suggested by the examples⁷ in Table 3.1, the goal should not take the form of a lengthy discourse on the purpose of the CCVA. Rather, it should succinctly define the scope—the "what," "why," "where," and "for whom"—of the CCVA, while avoiding anything prescriptive (i.e., the "how"). The **scope parameters** of the goal serve two functions: they broadly define the set of stakeholders who may ultimately participate in the CCVA (Section 3.1.1), and they help define the guiding research questions (Section 3.2).

⁵ As noted in Text Box 1.4, ARCC CCVAs all started out as donor- and demand-driven. This is reflected in the description of the design process presented here. However, during the conduct of the CCVAs, findings are often revealed that are unexpected and that offer new insights. In addition, some eventual users of the CCVA results were identified only after the CCVA was completed. From these users' perspectives, the CCVA was purely supply-driven. Thus, while ARCC CCVAs were designed as demand-driven, in reality, this distinction was blurred.

⁶ Research design texts often refer to SMART research goals: Those that are specific, measurable, achievable, realistic, and time bound.

⁷ ARCC CCVAs were commissioned by USAID for USAID purposes; the CCVAs' end-goals were to improve understanding. The CCVA provided this in the form of a **deliberate evidence base**. These enhanced understandings were embedded in new USAID goals and purposes related to the agency's programming; these new goals were reflected in the scope and scale of each CCVA's design. In this way, uptake by USAID was all but assured. In time, other stakeholders recognized the value of the CCVAs; it was at that point that USAID and the ARCC teams consolidated lessons on uptake.

TEXT BOX 3.1: EXAMPLES OF ARCC CCVA GOALS

Uganda: To show how current climate patterns shape—and how future climate patterns may influence—key crop value chains and the livelihoods of households in the six Feed the Future (FtF) districts of Uganda that depend on them.

Malawi: To understand current and projected climate change impacts in central and southern Malawi on agriculture, fisheries, water, natural resources, and livelihoods; and to explore the extent to which national and district government communities, as well as households, are equipped to adapt to them.

Dominican Republic: To improve understanding of climate change impacts on watersheds and coastal resources—as well as the people who depend on them—in the four climate-sensitive areas of interest.

Senegal: To identify current and future climate stresses in eastern Senegal, describe the potential impacts of those stresses on livestock and crop-based livelihoods, and assess local capacity to respond.

ARCC also found that setting the goal (the main research question) and the associated secondary (guiding) research questions (Section 3.3) should be an iterative process involving donor staff, other key stakeholders, and the CCVA team members. In ARCC's experience, the more clearly the goal is stated, the easier it is to communicate with stakeholders and to derive a properly targeted set of secondary research questions.

3.1.1 Stakeholder Engagement and Institutional Analysis

In the most general sense, the goal of any CCVA is to understand and, if possible, to recommend how to prepare for the impacts of climate change on populations and the systems (natural, economic, institutional) on which they depend. Thus, ARCC learned that it is necessary to identify those individuals and communities most likely to be affected and those individuals and institutions most likely to take action, and to understand the role each plays. Therefore, it is essential to include stakeholders from various

TEXT BOX 3.2: LESSON: CONSIDER ALL STAKEHOLDERS

Stakeholders typically consulted by CCVA teams include ministries of land, environment, agriculture, and energy; meteorological services; other donors; local and international NGOs and CBOs; and research organizations. But other important stakeholders are often overlooked. These include:

- Ministry of Finance or equivalent
- Ministry/Department of Public Works
- Ministry/Department of Labor
- Emergency/Disaster Response and Risk Reduction entities
- Trade and farmer associations

institutions. An Institutional Analysis (IA, Chapter 6) is an important component of this process.

The primary stakeholder for the ARCC CCVAs was USAID. The ARCC CCVAs were developed to **inform the design** of the agency's policies and programs so that they would better address climate change adaptation where and when appropriate. Each CCVA design was developed in collaboration with USAID staff and refined as the ARCC team and USAID counterparts moved through the design process.

The particular mix of communities, natural resources, and economic activities that an ARCC CCVA intended to address resulted in unique sets of additional stakeholders. ARCC's experience suggests that, in order to eventually **implement** effective climate change adaptation policies and programs, additional national and local-level decision makers must be engaged throughout the CCVA process. This second tier of stakeholders became critical to the success of CCVA uptake because they became champions in defining, promoting, and implementing climate change-responsive policies and programs. Although good practice for any VA, the more complex the phenomenon studied, the more critical the choice of stakeholder institutions and the wider and deeper the set of partners required for effective uptake.

Understanding institutional enablers and barriers to action aids in the effective determination of realistic climate adaptation strategies. Identifying the institutions⁸ most likely to take action, and what those actions are likely to entail, also increases the relevance and applicability of CCVA results. ARCC found that the second tier of stakeholders (individuals, communities, and institutions) is in the best position to use knowledge from the CCVA results to champion desired change. If they are well informed about the findings from the CCVA, these stakeholders can provide ongoing leadership, planning, and monitoring during the implementation of climate change adaptation policy and programs. For this reason, it is important that these stakeholders embrace the relevance and utility of the CCVA by legitimizing both its goal and the research design established to reach that goal. Thus, it is also vitally important that the information, findings, and recommendations emerging from the CCVA be presented in a form that the broadest range of individuals can understand.

TEXT BOX 3.3: ARCC'S STAKEHOLDER ENGAGEMENT PROCESS

ARCC's stakeholder engagement process begins during the design phase with a small, carefully selected group. This group might include representatives from USAID, other donors, the government, research or academic organizations, and representatives from those economic sectors central to the CCVA. By initially limiting the group, focus is maintained on the issues of primary interest to USAID. As the CCVA progresses, additional stakeholders are identified and engaged. During the final stages of the CCVA process, stakeholders are given the opportunity to review and discuss the CCVA's findings and use those findings to help define recommendations for potential adaptation. Engaging stakeholders, soliciting their input, and, when appropriate, incorporating their suggestions, creates a sense of ownership in the final CCVA product and helps establish the credibility, salience, and legitimacy of the CCVA process.

⁸ IAs are discussed in detail in Chapter 6.

3.2 GUIDING RESEARCH QUESTIONS AND ANALYTIC FRAMEWORK

As with any type of VA, the main research question of a CCVA helps to guide the overall research, while the secondary research questions help guide the fact-finding approach and methodology—i.e., they guide the work of the CCVA study components.

We have learned that a significant portion of the initial work associated with a CCVA involves identifying appropriate stakeholders and working with them to formulate both the main and the guiding research questions. It is an effort well spent, as the **research questions act as the roadmap**, directing the investigation. The guiding research questions must

- Build on a clear definition of the dimensions of vulnerability (exposure, sensitivity, adaptive capacity);
- Bring together all parts of the assessment, defining the relationships between climate impacts and the people whose vulnerabilities are being studied; and
- Be realistic, which may be tested through the literature review, discussions, and the process of designing the research methods to be used.

3.2.1 The Role of an Analytic Framework

As for any type of VA, each guiding research question may require distinct techniques to collect, compile, or produce answers. Thus, the manner in which the questions are framed should align with an accepted, pre-defined analytic framework. This section describes the role of an analytic framework and use of guiding research questions in the design of a CCVA.

For most ARCC CCVAs, research questions (both main and guiding) were articulated within an analytic framework consistent with the Intergovernmental Panel on Climate Change (IPCC) definition of vulnerability as a function of exposure, sensitivity, and adaptive capacity:

$$\text{Vulnerability} = f(\text{Exposure, Sensitivity, Adaptive Capacity})$$

This definition is widely, though not universally accepted.⁹ Obviously, CCVA designs vary based on their respective goals, but the research questions that guided ARCC's investigations tended to parallel those posited by the IPCC framework (Table 3.1).

⁹ One part of the debate on the IPCC definition comes from a desire to align it with the disaster management/disaster, risk-reduction community, which more commonly applies the formula "Risk = $f(\text{Threat/Hazard} + \text{Vulnerability})$." Using this definition, the "threat" is climate change and "vulnerability" is generally synonymous with the "sensitivity" portion of the IPCC definition. Sensitivity is generally understood as the reciprocal of resilience, often fully including capacity. The term "exposure" is seen to be problematic because it is an conception that stands at the juncture of the threat and the entity confronting the threat (i.e., a community is exposed to sea-level rise because they live on the coast; but a measure of the climate threat—sea-level rise—must then be isolated from some measure of the "community," such as the number of people, poverty levels, or distance from the coast).

TABLE 3.1: EXAMPLES OF GUIDING RESEARCH QUESTIONS

Uganda	Malawi*	Dominican Republic
<ul style="list-style-type: none"> • How will climate change affect selected crop value chains? • What impacts will climate change and variability have on a representative range of Ugandan rural livelihoods? • How will farmers adapt in response to climate change impacts on the study crops? 	<ul style="list-style-type: none"> • What are the current and projected geophysical impacts (first-degree or exposure) of climate change? • What are the biophysical impacts (second-degree or sensitivity of natural systems)? • What are the socioeconomic impacts (third-degree or sensitivity of people/communities)? • What are the actual and potential adaptations to climate change (adaptive capacity)? <p><i>* Initially, the team used a different framework that measured "degrees" of climate change impact. Because this alternate conceptual framework is compatible with the IPCC definition, it was easily adjusted prior to presenting results.</i></p>	<ul style="list-style-type: none"> • What changes in climate are likely to take place? • What will be the likely impact of these changes on communities and urban centers that depend on marine resources? • How do/can communities and institutions adapt (respond)?

ARCC found that the IPCC vulnerability framework stands up to multiple assessment goals and helps communicate how each dimension of vulnerability is studied. It provides a common set of definitions and terminology that allows the assessment team and external stakeholders to "speak the same language," thus supporting more effective communication of key concepts.

Having a common language is especially important because the dimensions of vulnerability (exposure, sensitivity, and adaptive capacity) are in fact open to interpretation. For ARCC, the choices of definition were directed by donor interests, availability of data, or choice of analytic method.¹⁰ Beyond exposure, ARCC found that it is often difficult to determine whether an indicator is more representative of the concept of sensitivity or of adaptive capacity. In fact, many scholars regard these concepts as two sides of the same coin. Exposure is typically a more straightforward concept (in comparison to sensitivity and adaptive capacity) with a clear link to an event or process that an entity confronts, in this case the impacts of climate change.¹¹ Table 3.2 shows examples of vulnerability indicators for three ARCC CCVAs. The legitimacy and credibility of ARCC CCVAs benefited from thoughtful consideration of these choices.

¹⁰ Annex G describes how, for the Senegal CCVA, the team defined the dimensions of vulnerability in ways that would allow them the extended use of models for analyses.

¹¹ Two other ARCC documents that discuss these issues are: "Design and Use of Composite Indices in Assessments of Climate Change" (Dec. 2013) and "Spatial Climate Change Vulnerability Assessments: A Review of Data, Methods, and Issues" (Dec. 2013).

TABLE 3.2: EXAMPLES OF VULNERABILITY DIMENSION INDICATORS

Vulnerability Dimension	Uganda CCVA	Dominican Republic CCVA	Senegal CCVA
Exposure	Precipitation; temperature	Precipitation; temperature; wind; sea-level rise	Cropping systems: rainfall and temperature; livestock systems: quality and quantity of rangeland vegetation; surface water availability, and availability of field crop residue; markets: rates of road deterioration; frequency of commodity price shocks
Sensitivity	Phenology; crop diversification; value chains; household crop sales; off-farm income; household assets	Livelihoods; poverty; coastal infrastructure; mangroves and coral reefs; fish stocks; tourism	Off-farm and on-farm income; livestock and crops farmed; large/small ruminants; vulnerability of crops; market engagement
Adaptive Capacity	New technology; on-farm investment; diversification of revenue; access to loans	Institutional analysis	Assets in five forms of capital: human, natural, physical, social, and financial

3.2.2 Designing and Articulating Research Questions

A key challenge for ARCC was **defining individual, guiding research questions that together coherently combine to address the overall goal**, of the CCVA. The main research question holds together all parts of the assessment and defines the relationship between the primary climate impacts (e.g., on crops or ecosystems) and the secondary climate impacts on those who rely on them (e.g., people or communities). At the same time, the research questions (both the main question and secondary questions) must be realistic. Whether or not they are realistic can be tested through stakeholder discussions (Section 3.1.1), through the literature review (Section 3.2.3), and as part of the process of designing the methods to be used (Section 3.3).

3.2.3 Literature Review

ARCC experience suggests that, while developing the research questions, it is advisable to conduct a preliminary investigation of secondary information, a literature review, to gain a basic understanding the context—potential stakeholders, as well as political, social, and economic obstacles and opportunities—and the resources that may or may not be readily available to conduct the CCVA. This suggestion may seem at odds with the principle that defining the goal and guiding research questions is a prelude to all the other activities. It is not difficult to see, however, that a review of existing literature may help refine the research questions, an important step in ensuring that such questions are relevant and answerable. For example, are the data available adequate to answer the questions? If not, can such data be collected

within a reasonable time frame at reasonable cost? Can the questions be answered with the expertise available? Are appropriate analysis methods and tools available to address and answer the questions?

Literature reviews associated with ARCC CCVAs often included one or more of the following components:

- Identifying or confirming the most appropriate analytic framework upon which the assessment would be constructed;
- Reviewing all climate-related studies conducted in the country or region of interest;
- Reviewing other related studies in the topic areas most relevant to the CCVA;
- Identifying likely sources as well as gaps in data and information pertinent to each of the guiding research questions;
- Revealing the existence or roles of potential (possibly overlooked) stakeholders; and
- Investigating or confirming methods and techniques to be applied to answering one or more of the research questions.

A typical ARCC literature review consisted of web- and library-based desk studies. These might have been supplemented by a few key interviews¹² (i.e., with donors and institutions that had or were conducting other CCVAs or closely related studies in the country of interest). The interviews were used to capture more recent or unpublished sources than those from publically available sources. These reviews sometimes uncovered other studies (e.g., household surveys or focus group discussions) that could complement ARCC studies. The reviews also typically uncovered secondary sources of data that could be used for the CCVA analyses in lieu of investing resources in primary data collection.

Finally, for ARCC, a review of the existing literature often helped determine the research methods and tools to be used in the assessment, as discussed in the next section.

TEXT BOX 3.4: LESSON: DEVELOP AN EFFECTIVE LITERATURE REVIEW

To make the literature review highly useful, it must be seen as an integrated part of the CCVA. It is best conducted by an active member of the CCVA team. (If conducted by a student or another individual too far removed from the thinking that evolved on a specific CCVA, it will be much harder to ensure its value to the ensuing exercise.) It is also important to agree on the main questions, scope, and structure that frame the literature review, to make sure that it is appropriate and useful to the CCVA design process.

3.3 RESEARCH APPROACH, TECHNIQUES, AND TOOLS

Once the research goal is articulated, the guiding research questions defined and confirmed, and the literature review completed, the next step was to define the research methodologies. For a typical ARCC CCVA, as with any type of VA, the research methodologies consisted of three main steps:

- Identification of data and information requirements (often framed as sub-questions, see below);

¹² The majority of the key informant interviews were typically conducted during an earlier scoping phase.

- Identification of approaches and appropriate collection methods or techniques for producing the required data; and
- Design of appropriate data compilation and collection tools for each technique.

The following sections discuss each of these in turn.

3.3.1 Identification of Data and Information Requirements

The research questions determine the data and information requirements. One way to associate research questions with data and information requirements (and thereby with methods and tools) is shown in Table 3.3 (below). In this example, the ARCC CCVA team found it helpful to use a simple table that represented a form of reductionism common in the sciences, in which a series of dependent "sub-questions" help guide the identification of data needs for each research question.

3.3.2 Identification of Research Approaches, Techniques, and Tools

Because the issues a CCVA addresses are complex, often so are the relevant data. CCVA methodologies will, in many cases, require a "mixed-methods" approach that combines quantitative and qualitative techniques. In the example (Table 3.3), this is shown in the right-hand column. In this example, regression analysis on quantitative datasets allowed the team to establish the vulnerability status for households and determine which households were likely to be at the highest risk under future climate scenarios. Focus groups, which yielded qualitative data, were used to investigate the drivers of adaptive change in those households and communities, and provided insights into actions that may encourage or deter future adaptation. The fieldwork for both methods was conducted concurrently, requiring thorough integration and careful sequencing during design and implementation. (See Chapter 4 on Implementation and Integration.) In the example in Table 3.3, the ARCC team identified several suitable research techniques, e.g., climate analysis, livelihoods analysis, and phenological screening. For each technique, specific tools or instruments were then identified—e.g., climate downscaling and modeling, key informant interview or focus group discussion (FGD) topical outlines, household survey questionnaires, screening templates—to facilitate the collection and analysis of data to answer the particular research question.¹³

¹³ An example of the Participatory Rural Appraisal (PRA) process used to understand community vulnerability and resilience to climate change is available at <http://community.eldis.org/.5bb3d1c0>.

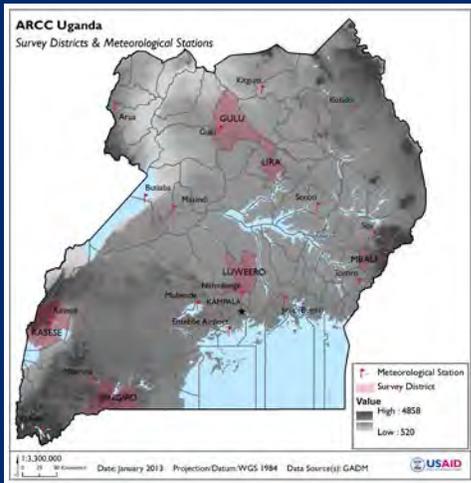


TABLE 3.3: POSTCARD FROM UGANDA: RESEARCH DESIGN

*VA Goal:
Show how current climate patterns shape—and how future climate patterns may influence—key crop value chains and livelihoods of households in six FtF districts of Uganda that depend on them.*

Guiding Research Questions

Sub-Questions

Method, Technique, Tools

How will climate change impact selected crop value chains?

For each crop value chain, what are the current, primary constraints (climate and non-climate), and on which segments are they found?

Value chain analyses

For each crop value chain, what is the probability and potential severity of major climate- and non-climate-related risks?

Climate analysis, value chain analyses

For each crop, how have climate variability and shocks affected quality and production?

Focus group discussions (FGDs), household (HH) survey, value chain analyses, phenological review

For each crop, how have climate variability and climate shocks affected "upstream" segments of the value chain (e.g., input supply and the value of market information)?

FGDs, value chain analyses

For each crop, how have climate variability and climate shocks affected "downstream" segments of the value chain (e.g., post-harvest processing and storage and farm-level aggregation)?

FGDs, value chain analyses

What are the potential risks to the future sustainability of value chains? What segments are most threatened?

Integrated analysis of the above

<p>What impacts will climate change and variability have on a representative range of Ugandan rural livelihoods?</p>	<p>In what ways do current livelihood profiles adjust decision-making as climate affects individual crops and value chains?</p>	<p>HH survey, community-level FGDs, key informant interviews</p>
	<p>What non-agricultural strategies are applied to different livelihood systems as crops are affected by climate change?</p>	<p>HH survey, FGDs, transport and water studies</p>
	<p>How are current livelihood vulnerabilities distributed across different households (exposure, sensitivity, adaptive capacity)?</p>	<p>HH survey</p>
	<p>How are household vulnerabilities within representative livelihood systems patterned according to gender and age differences?</p>	<p>HH survey, community-level FGDs, value chain analyses, transport and water studies</p>
	<p>How will current patterns of household vulnerability be expected to change under climate change scenarios?</p>	<p>Climate analysis, HH survey, FGDs differentiated by gender</p>
<p>How will farmers adapt in response to climate change impacts on the study crops?</p>	<p>How have farmers adapted to climate changes during the past 10 years? What livelihood assets have they drawn upon, or what adjustments to past patterns of climate variability have different livelihoods experienced or devised that can be applied to adapt to future events?</p>	<p>HH survey, community-level FGDs, secondary literature review, key informant interviews</p>
	<p>How are current livelihood systems affected by public policies and investments? What is the public role in supporting households as they are affected by climate (emergency vs. structural support)?</p>	<p>FGDs, HH survey, institutional analysis</p>
	<p>Which strategies have been short term, and which continued for a longer period?</p>	<p>FGDs, HH survey</p>
	<p>What effects have the responses (short and long term) had on agricultural vulnerability?</p>	<p>FGDs, key informant interviews, HH survey</p>
	<p>What effects have the responses (short and long term) had on non-agricultural vulnerability?</p>	<p>FGDs, research, HH survey</p>
	<p>What are the most common types of strategies across all the study zones?</p>	<p>Integrated analysis of FGDs and HH survey</p>

Table 3.4 presents examples of the mixed-method experiences from Uganda, Malawi, the Dominican Republic, and Senegal. As the ARCC CCVAs evolved, there was considerable adoption of methodologies and tools successfully employed in earlier ARCC CCVAs; new tools were tested as well.

TABLE 3.4: EXAMPLES OF MIXED-METHODS

UGANDA	MALAWI	DOMINICAN REPUBLIC	SENEGAL
<p>QUANTITATIVE</p> <ul style="list-style-type: none"> • Climate analysis, historical, downscaling, and projections • HH survey • Principle Component Analysis 	<p>QUANTITATIVE</p> <ul style="list-style-type: none"> • Climate analysis, historical, downscaling, and projections • Cost-change analyses aligned to value chains of six crops • Phenological analysis 	<p>QUANTITATIVE</p> <ul style="list-style-type: none"> • Climate analysis, historical, downscaling, and projections 	<p>QUANTITATIVE</p> <ul style="list-style-type: none"> • Climate analysis, historical, downscaling, and projections • HH survey
<p>QUALITATIVE</p> <ul style="list-style-type: none"> • Key informant interviews • FGDs 	<p>QUALITATIVE</p> <ul style="list-style-type: none"> • Participatory Rural Appraisal (PRA) with 12 systematic, qualitative tools 	<p>QUALITATIVE</p> <ul style="list-style-type: none"> • Rural analysis with focus groups • Livelihoods analysis 	<p>QUALITATIVE</p> <ul style="list-style-type: none"> • Key informant interviews at decentralized level • FGDs

3.3.3 How the Research Approach, Techniques, and Tools of a CCVA Differ from Other Types of VAs

Section 1.2 briefly touched on some differences between a CCVA and other types of VAs. The differences are largely attributable to the fact that CCVAs specifically address climate as the driving agent of change, with the challenges of communicating uncertainty and with program planning in the face of uncertainty. An important lesson from ARCC is that the conduct of the CCVA itself should simply follow standard practices for research design and implementation—that is, there is little difference in *how* one would design and implement a CCVA from how one would design and implement any type of VA. However, within specific components, there will be climate change-specific aspects, such as the following.

- A land cover, land use, or biodiversity study might need to look at how the geographic range of animals and plants (including crops) may shift due to climate change.
- A phenological or value chain study might similarly need to consider pests or diseases occurring in a geographic range expanded well beyond their current or historical range due to climate change.

- Higher average temperatures and a wider range of precipitation regimes due to climate change may need to be considered for assessing crop viability, even within a crop's historical range.
- Increased temperatures are likely to result in higher rates of evaporation; this will in turn have an impact on surface water availability and levels of soil moisture that might not have occurred in the absence of climate change.
- Sea level rise may present threats to coastal areas that would not have occurred in the absence of climate change.

These and many other effects need to be considered during the analyses of individual CCVA components. None of them affect the way in which the CCVA is designed or implemented, only the specific factors investigated during the conduct of the research.

There is one obvious but important area in which a CCVA provides a unique opportunity: the climate analysis component. In addition to being an input to the topic or sector studies, results from a historical climate trends analysis could, for example, be used to "triangulate" weather changes or weather-related events reported through focus group discussions or household surveys, correlating respondents' memories of these changes and events with actual data. Similarly, climate projection scenarios can be used to facilitate dialogue about adaptation recommendations, as discussed in Chapter 5.

Once the research design has been completed and the research approach, methods, and tools selected, it is time to take the next steps: implementation and integration.

CONCLUSIONS AND KEY LESSONS FOR RESEARCH DESIGN

An important lesson from ARCC is that the conduct of the CCVA itself should simply follow standard practices for research design and implementation—that is, there is little difference in how one would design and implement a CCVA from how one would design and implement any type of VA. Thus, before starting a CCVA, ARCC learned to:

- **Define the goal** by asking the question, "What is our destination?" As would be the case for any well-designed research effort, a key ARCC lesson was that the CCVA goal should be stated in a clear and concise manner that succinctly defines the scope—the "what," "why," "where," and "for whom"—of the CCVA.
- **Define individual "guiding (or secondary) research questions"** that help guide the fact-finding approach and methodology.
- **Involve stakeholders** in the development of the goal and research questions in an iterative process that, ultimately, enhances uptake.

Another key lesson from ARCC was the importance of applying an **analytic framework** that clearly defines each dimension of vulnerability. ARCC primarily used the IPCC definition of vulnerability as a function of exposure, sensitivity and adaptive capacity. The advantages of applying a clear and consistent framework are:

- **The legitimacy and credibility of results are enhanced** by adhering to a clear definition of the dimensions of vulnerability codified in the research design.
- **Key concepts are communicated more effectively** using a common set of definitions and terminology that such a framework provides which enables the assessment team and external stakeholders to "speak the same language."
- **Tool selection, data collection and cross-analysis are facilitated by the framework.** Associating the guiding research questions with each of the vulnerability framework dimensions helps organize data and information requirements and the selection of assessment methods and tools, and facilitates cross-analysis among research components.

The CCVA **climate analysis component** provides a unique opportunity during the cross-analysis step not provided by other types of VAs. Results from a historical climate trends analysis could, for example, be used to "triangulate" weather changes or weather-related events reported through focus group discussions or household surveys, correlating respondents' memories of these changes and events with actual data.

4.0 IMPLEMENTATION AND INTEGRATION

Good research practices are the foundation of CCVAs, as they are with all scientifically rigorous research efforts. As with other types of studies, CCVAs begin with a goal and set of guiding research questions (see Chapter 3). The research questions can be broken down into a hierarchy of questions and sub-questions, eventually resulting in a series of narrowly defined investigations targeting specific topics with appropriate data collection techniques (such as those portrayed in Tables 3.4 and 3.5).

The techniques ideally represent manageable pieces that can be assigned to individuals (typically consultants) or groups (i.e., research partners or subcontractors) who have the appropriate expertise to address each topic and then assist in integrating the results of their investigations into a coherent whole. Figures 4.1A through 4.1C, on the following pages, show how this was done for three ARCC CCVAs. Each investigation was typically undertaken as topic- or sector-specific study that required subject matter specialists. Within each study, research might include anything from a literature review of selected crop phenologies to a sophisticated climate downscaling and modeling initiative to a series of community-level rural appraisals.

Research methods and tools may intersect among the investigations, for example, when a household survey collects information concerning both existing adaptive practices in the agriculture sector (for use by an Agriculture Specialist) and market access (for use by a Value Chain Specialist). While it may be possible to answer specific research questions and sub-questions one by one, coordinating the process requires that CCVA team members—especially study or topic leaders—all take part in the design and planning, as well as the integration and implementation of the results.

This chapter briefly covers operational implementation and integration challenges; these are especially important because the lessons learned from ARCC's efforts to overcome these challenges are applicable to other CCVAs.

TEXT BOX 4.1: EXAMPLES OF ARCC CCVA RESEARCH TOPICS

Malawi	Agriculture, surface water, fisheries, and natural resources
Dominican Republic	Coastal and natural resources management, fisheries, tourism, and disaster response
Uganda	Agriculture, water resources, and livelihoods

FIGURES 4.1 A, B, C. EXAMPLES OF RESEARCH TOPICS AND INTEGRATION METHODOLOGY

FIGURE 4.1A. UGANDA

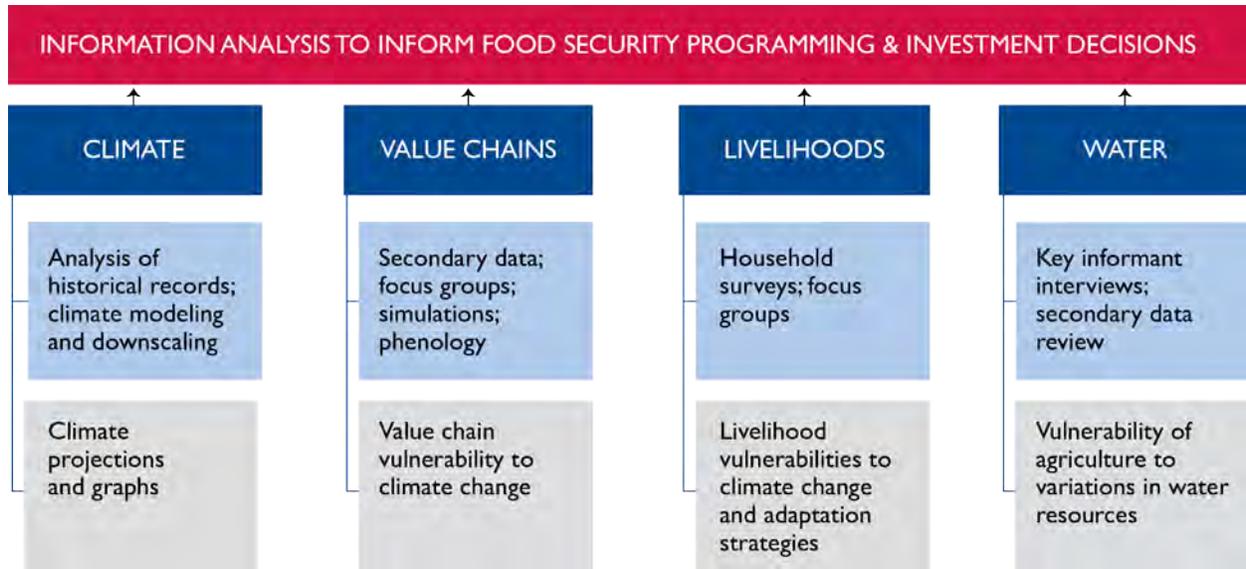


FIGURE 4.1B. MALAWI

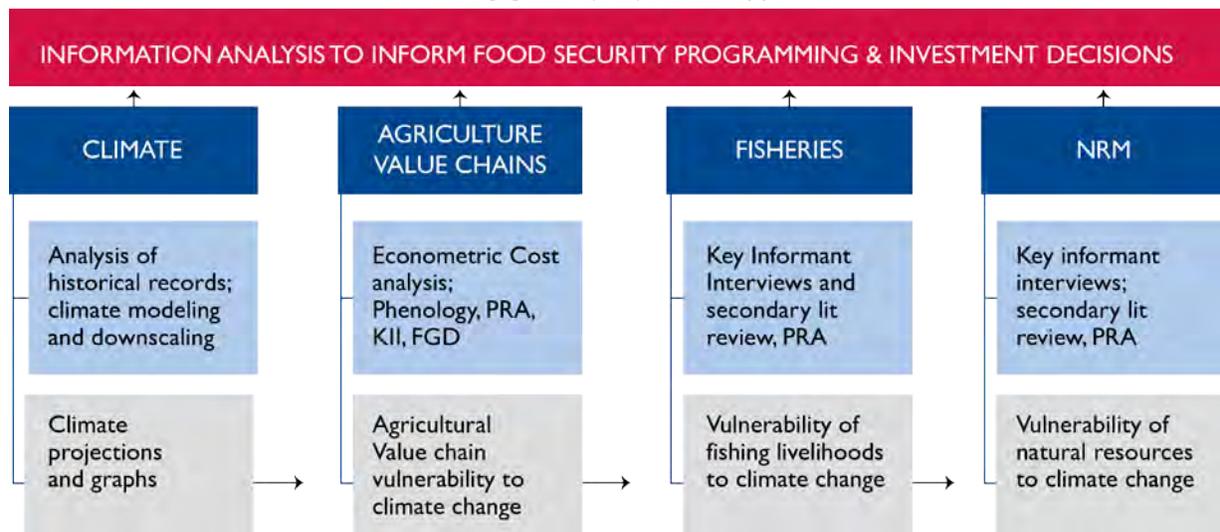
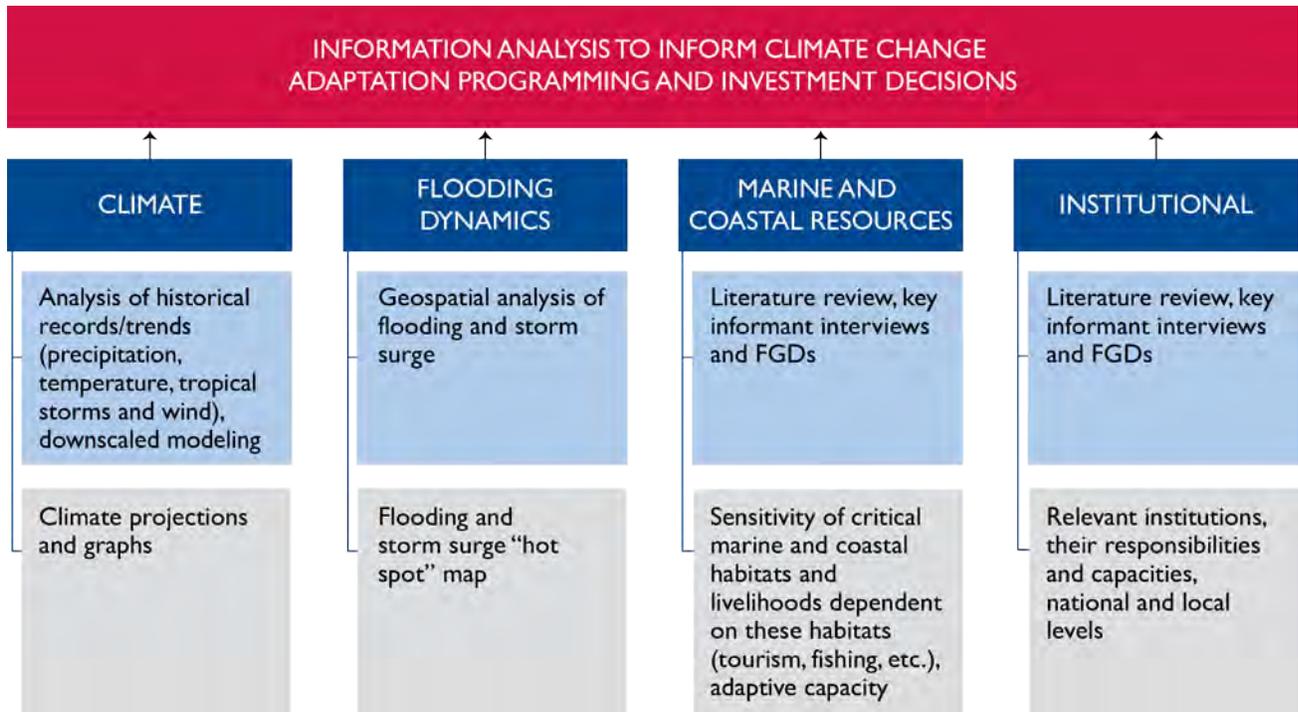


FIGURE 4.IC. DOMINICAN REPUBLIC



4.1 MECHANICS OF IMPLEMENTATION

Meaningful evidence-based CCVAs, like any type of VA, demand considerable time and resources. It is worth reviewing the basic steps that ARCC took when carrying out a CCVA for USAID:

- Conduct a scoping mission;
- Compose the CCVA team;
- Design the research effort;
- Coordinate and sequence the research effort to produce integrated results; and
- Assemble a coherent, evidence-based picture of the findings.

Steps 1 and 3 were discussed in Chapter 3. Steps 2, 4, and 5 are described below. An additional activity, that of managing and curating the data and information, occurs throughout the process and is described in a separate section at the end of this chapter.

TEXT BOX 4.2: EXAMPLES OF ARCC TEAM COMPOSITIONS

In addition to a team leader and administrative support:

- The **Uganda** team consisted of climate, value chain, phenological screening, groundwater, agriculture practices, and food security livelihoods specialists and specialty organizations;
- The **Malawi** team consisted of climate, PRA, agriculture and value chain, economy, phenology, water resources, fish, and natural resources specialists and specialty organizations;
- The **Senegal** team consisted of climate, anthropology, phenology, marketing/economy, livestock, and agriculture specialists;
- The **Dominican Republic** team consisted of climate, natural resource, coastal/marine, and disaster risk reduction specialists.

4.1.1 Compose the CCVA Team

Because CCVAs require an understanding of the inter-relationships between changing climate variables as well as their potential impact at multiple levels (natural systems, people, communities, and institutions), they are in almost all cases inherently complex undertakings. This complexity requires an overall CCVA Technical Team Leader who has the ability to guide a complex conceptual process to produce concrete outcomes and team members who are committed to, and understand the need for rigorous administrative oversight and operations management. Because of the nature of climate change, it is foreseeable that these teams will be larger and manifest more distinct technical differences than for other types of VAs. This makes the leadership even more critical.

ARCC teams typically comprised five to 10 specialists or specialty organizations (either as subcontractors or as research partners). The overall Technical Team Leader assured that all members of the CCVA team understood the analytic framework and assessment goal, and that they worked together in adherence to the agreed-upon framework (i.e., "spoke the same language," see Section 3.2). Subject-matter specialists managed the day-to-day process of data and information collection, compilation, and analysis associated with each topic or sector study. The Technical Team Leader managed and coordinated the process overall, and provided technical guidance and leadership. Effective and consistent team leadership was critically important in all the ARCC CCVAs (see Lesson in Text Box 4.3).

As the ARCC experience has shown, CCVA teams require a combination of technical and operational skills that takes time to assemble; so sufficient time and effort must be allocated for this.

CCVAs touch upon multiple sectors in multiple locations, take stock of the historical past, assess the present, and explore the future. Their multi-dimensionality requires flexibility and a willingness to meet the inevitable challenges that will arise. Fortunately, having strong, consistent leadership can help mitigate the steep learning curve, as can having a clearly articulated analytic framework and consistent set of research questions.

4.1.2 Coordinate and Sequence the Research Effort to Produce Integrated Results

Beyond general leadership and quality control, the main goal of coordination and sequencing of the topic or sector studies of a CCVA is to compile evidence that leads to the most rigorous possible findings. ARCC CCVA reports describe research efforts that take place in stages: scoping, design, literature review, fieldwork, and analysis.

Carefully coordinating the work on the various CCVA studies and analyzing and integrating the results as they become available, are challenging but central tasks. Sequencing of tasks is also important. In particular, as described in detail in Chapter 7, it is important that the climate analysis be carried out early in the study, as it will inform most, if not all, of the other topic or sector studies. But even with the most thorough planning, inevitably, events conspire to reduce the ability to execute the work in an ideal manner. Our experience demonstrates that assessments that include primary data collection may require a different sequential order than those that rely on compiling secondary data¹⁴ or literature. Jointly planning for each study and regularly discussing the separate analyses allow team members to make minor adjustments regarding the coordination of activities.

¹⁴ Annex F provides a case study of an ARCC CCVA that relied entirely on secondary data.

TEXT BOX 4.3: LESSON: INVEST APPROPRIATELY IN LEADERSHIP

Strong, consistent, and sustained assessment leadership helps keep the CCVA team aligned with the goal of the assessment. ARCC identified the following characteristics as being particularly important for coordinating an evidence-based CCVA.

Visionary: The ability to envision the potential goal of the vulnerability assessment as it evolves, several steps ahead of where it currently is;

Strategic: Expertise in negotiating and articulating the CCVA goal to multiple stakeholders and in developing practical steps and tactics that will allow the technical experts to iteratively design and implement the research methodology;

Responsive/Flexible: Have a good sense of where the assessment activities currently stand and be able to identify and make course corrections that respond to changing circumstances; be able to capitalize on the skills of team members to provide an insightful, synergistic synthesis;

Focused: Ability to keep the effort aligned to the research goal and focused on the research questions, while at the same time building the capacity of the team to answer the questions and meet the goal; and

Coordinated: Ability to guide the team to effectively explore relationships between analytic components and to build connections and engagement with partners and stakeholders.

As noted previously, a CCVA is much greater than the sum of its parts. A well-coordinated CCVA will enable more meaningful integration and synergy across many sectors. ARCC learned that coordination is crucial to avoid implementing the research as a series of discrete, standalone activities. Ideally, the data required, their sources, and the manner in which they are to be collected are all known before the CCVA team begins its fieldwork. Realistically, however, we learned that even as the CCVA progresses, improved understanding of both the climate-related impacts and non-climate impacts—as well as the limitations of the datasets themselves—may impose the need for additional adjustments.

Our experience highlights the need for a persistent commitment to **collaborative research**, whereby CCVA team members jointly design data collection instruments and share preliminary findings with one another, bringing evidence to bear to enhance the results of each topic or sector study. The ARCC experience demonstrates that the findings and results of one study quite often provide pertinent information for another study. This is not to say that the effort associated with one study or another was redundant—quite the contrary. In fact, ARCC found that a good practice during a CCVA is to ask the same or similar questions through more than one source or technique. This form of triangulation facilitated the desired **convergence of evidence**—varied but insightful perspectives on the same issues. Because it was rarely possible to collect additional data when data gaps were discovered, existing ARCC datasets were often "mined" by viewing the same data from a different perspective, or with a different research question in mind. In the case of ARCC, such data mining was successfully used to answer new questions that arose during the final analysis and integration or that were unanticipated prior to the analysis. (See, for example, Text Box 4.5.)

There are many ways to ensure that "cross-analysis" among topic or sector studies lead to effective integration. ARCC's experience found two particularly fruitful methods, one via regular peer-to-peer interactions (including "virtual" interactions using information technology tools; see Text Box 4.6) and larger CCVA team "integration exercises." Periodically cross-analyzing intermediate or preliminary results ensured that the various topic or sector studies remained aligned to the overall CCVA goal, provided information to support one another, and maintained a focus on delivering findings on the integrated set of research questions.

The two specific ways to conduct such cross-analysis are:

- Facilitated, participatory workshops in which the entire CCVA team discussed research findings and cross-referenced results with the climate analysis and other analyses, as appropriate, to answer main and secondary research questions; and
- Establishing cross-study sub-groups within the CCVA team that consolidated findings at the "nodes" of the research question hierarchy, reporting the integrated results of analysis that answered lower-level sub-questions, and passing those results up the hierarchy for further integration in answering higher-level questions.

TEXT BOX 4.4: POSTCARD FROM UGANDA: DATA MINING

Crop modeling was attempted for the Uganda CCVA, but the results were inconclusive. The crop model used generic seed varieties and could not be customized to local soil and climate conditions. As a result, the range of crop suitability thresholds that the model produced was too large to be of use in the CCVA.

Instead, a combination of value chain studies and phenological analyses were "mined" to provide the missing crop sensitivity information. Learning from this experience, a crop modeling exercise that also had been planned for Malawi was removed from that country's CCVA and replaced with a similar combination of value chain studies and a phenological analysis. This combination proved useful for the Malawi CCVA.

TEXT BOX 4.5: EXAMPLES OF DEVELOPING LOCAL CAPACITY

Developing the capacity of people and organizations is accepted as good development practice. As standalone research studies, however, ARCC CCVAs did not typically include a mandate nor provide a ready context for capacity building. In addition, the time frame requirements for evidence-based CCVAs tailored to inform USAID programming limited the opportunities for extensive capacity building.

ARCC learned that engaging local counterparts in research activities, however, can have numerous benefits. Such engagement helps researchers understand the local context, and the participation of local partners also helps to identify, and may facilitate, access to otherwise unavailable data sources. Engagement can serve as a ready means to validate or "ground-truth" the findings produced by an expatriate team. Perhaps most importantly, it can enhance the credibility, salience, and legitimacy of the research while promoting uptake of the results.

Nonetheless, ARCC experience also demonstrates that developing local capacity through participation in CCVA research is challenging. The availability of in-country expertise in key areas, especially areas such as climate modeling, is often limited. Additionally, as with any development project, potential partners often do not have the administrative capacity to manage subcontracts and/or the same expectations for scientific rigor that a CCVA process demands.

In spite of the lack of mandate for capacity building, per se, ARCC was able to find meaningful ways to engage local partners. ARCC found that, with sufficient forethought, local capacity building can be organized within the context of a CCVA in a way that greatly enhances the CCVA product without causing a significant increase in time or cost. ARCC assessments would have been less strong without this local participation. As a result of this added value, there were several cases in which an ARCC CCVA led to a demand for more formalized capacity building, which USAID subsequently supported, particularly in the area of climate information and analysis.

Capacity Building in Malawi

- **Staff from the Department of Climate Change and Meteorological Services** served as key members of PRA teams. This arrangement strengthened capacity within the meteorological office. Met staff were also sent to the climate modeling center in Cape Town, South Africa, to participate in data cleaning and selection of the parameters used in the climate analysis.
- **More than 25 local enumerators** underwent a three-day training to learn how to carry out PRA data collection efforts. They also participated in post-collection meetings to organize results. The field team leaders from these groups presented findings during the final workshop held in Lilongwe.

The first means—facilitated, participatory workshops—required at least a full day. Prior to the workshop, each topic or sector study leader, or subject matter specialist, compiled and synthesized his or her data and findings. During a morning workshop session, each shared their relevant data and

TEXT BOX 4.6: OPERATIONAL CHARACTERISTICS OF AN ARCC CCVA

Certain operational characteristics of ARCC CCVAs added to the management challenge. Team members, for example, were drawn from widely dispersed geographic locations, and cultural and academic backgrounds; in addition, the time frame for completion of the work was often limited.

As a result, after completing their field (mainly data collection) assignments, CCVA team members tended to go their separate ways. This made the integration phase particularly challenging. Information technology facilitated communications, but ARCC experience demonstrated the critical value of bringing everyone together for face-to-face cross-analysis and integration whenever possible.

findings with the rest of the team members. The climate scientist, for example, might present a summary of the climate component's key questions, methods, and assumptions followed by charts that illustrated historical trends and projections. Similarly, the livelihoods, crop value chain, and watershed specialists, might present their synthesized data and findings. The presentations were followed by discussions to clarify and cross-correlate the various team members' findings.

During an afternoon session, a facilitator worked with the team to extract and articulate data and findings across the topic or sector studies that answered the main or other research questions. When the research questions were organized by the key dimensions of vulnerability—exposure, sensitivity and adaptive capacity—this exercise also facilitated the production of knowledge in these three categories. For example, in the case of the cross-analysis workshop for ARCC's Dominican Republic CCVA, as a final exercise, the team used this information to collectively define possible adaptation pathways and recommendations. The exercise may also serve to reveal the overall "story" (see next section) of the CCVA.

TEXT BOX 4.7. EXAMPLE OF THE USE OF A DATA TRIANGULATION MATRIX

The ARCC Malawi PRA team used a matrix with sources across the columns and main themes down the rows. The PRA field teams sat together each evening to record findings from that day's research in the matrix cells. A simple look across one row (i.e., one studied theme) gave a quick indication of whether the evidence was converging, diverging, or missing. It also provided an opportunity to identify gaps in understanding that the PRA team leader could follow-up on the next day. This process increased confidence in PRA results.

The second method "paints" the overall picture by introducing its elements gradually. In other words, this method addresses the overall research goal by analyzing the hierarchy of questions and sub-questions (such as those shown in Table 3.3, Section 3.3) answering the most fundamental, basic questions first and gradually aggregating the answers to respond to more complex, compound questions. This approach is especially effective when sifting through large quantities of data and information derived from mixed methods, as it provides a systematic means to select and analyze the data. But it also requires foresight. A research question hierarchy, for example, must be designed at the outset, because both question gaps and data gaps can prove fatal to the integrity of the hierarchy and therefore to the analysis.

Effective analysis and integration often mean that subject matter specialists, whose previous experience and natural tendencies are toward separate "silos" of

analysis, must be coaxed into stepping out of their comfort zones. In this respect, the topic or sector study leaders must guide transdisciplinary research, and the overall CCVA Technical Team Leader must pay special attention to the sequencing of the climate change analysis. ARCC experience also shows that the Technical Team Leader must often remind the other team members about the main research question (what the team was ultimately trying to accomplish) to help the team from getting "lost in the weeds." Closing the gap between the separate topic or sector studies may require an iterative period of mutual education in order to arrive at a common understanding.

4.1.3 Assemble a Coherent, Evidence-Based Picture

Having conducted the topic or sector analysis and shared initial findings, it is time to finally pull together all the pieces of the puzzle into a compelling, coherent storyline. While the CCVA report (or "product") provides an evidence base and perhaps an action-oriented set of recommendations, it will be much more compelling if couched in a coherent story.

The story is the gestalt of the CCVA findings—the organization or pattern, the unified whole, that is more than the sum of its component parts. The story often emerges as the team discusses and reviews the findings, especially, and importantly, with others outside of the CCVA process. The story can (and should) be prompted by returning to the research structure identified during the design stage. In a sense, that structure gives the outline of what the research had intended to reveal and, as such, is a logical first step to outlining the story. But oftentimes research results in additional, unexpected and sometimes surprising, findings; or the analysis of the research reveals new ways of looking at or organizing the information.

TEXT BOX 4.8. POSTCARD FROM MALAWI: A STORYLINE

In Malawi, part of the CCVA "story" was that climate change is already happening, and many farmers are already adapting. But some are only coping, and these tended to be the poorest, least resilient, and most vulnerable.

Finding the story in the details of the research can be challenging. It can rarely be forced, but it can often be nudged. Beginning with the research design, a method used successfully in ARCC was to take each question and review the individual topic or sector reports one by one to see what evidence—from *any* study topic or sector—might relate to that question. Although finding the story to tell is not as simple as answering the questions in a rote manner, systematically going through each individual topic or sector report¹⁵ with a single question freshly in mind produced some surprising results and brought to the surface some otherwise undisclosed, insightful elements. It also helped identify additional questions that could be posed to glean a new—even if unplanned—perspective on a topic. Usually, once the CCVA teams started to weave together the answers, one or a few story lines began to emerge. See Text Box 4.8 for an example.

One can also coax out the story by talking about the CCVA findings with others. In fact, ARCC's experience has been that story lines often were sharpened and solidified when CCVA teams began presenting results to stakeholders and gauged their responses to the evidence to see how specific findings resonated with them.

¹⁵ The consultants and subcontractors for the Malawi CCVA, a typical CCVA for ARCC, generated well over 1,000 pages of reports.

Finally, packaging the story in a compelling way is crucial. CCVAs in ARCC have always led to at least one official presentation (typically using Microsoft PowerPoint) and at least one formal written report. The report is usually considered to be the main "product" of the CCVA, but typically additional presentations and numerous shorter summary documents were also produced. Without such shorter, more focused products, the most compelling messages of a CCVA can be lost on busy decision makers in reports that are too long, not succinct, or otherwise ineffective. Additional communications tips to improve uptake of the results are discussed in Chapter 5.

4.2 MANAGING AND CURATING THE DATA AND INFORMATION

As is true with any complex research undertaking, throughout the process of carrying out a CCVA—from scoping to design to implementation to compilation and presentation of results—large volumes of data and information are collected and analyzed. Here, "data" includes primary data collected by the CCVA teams as well as data compiled from secondary sources, e.g., from national hydrological meteorological services. Care must be taken to properly "curate" the data, that is, to ensure that it is accessible and documented, that its provenance is well described, and that it is documented as being useful with a reasonable level of confidence. Similarly, the information products generated during the CCVA must be managed. Here, "information" includes data collection instruments (e.g., survey questionnaires, FGD guides); consultant, subcontractor, and partner reports associated with the study components; and various draft and final CCVA reports, and other CCVA products. All must be labeled with version control on documents that are developed by teams of authors.

TEXT BOX 4.9: LESSON: CONSIDER TRADEOFFS BETWEEN PRIMARY AND SECONDARY DATA

As with any VA, for the non-climate analysis portions* of the study, acquisition of primary data may be undertaken to fill in gaps in available data from secondary sources, but primary data collection efforts often require a significant investment of time and resources. This investment must be balanced against the likely contributions of such data collection to the assessment. Secondary data sets may provide opportunities to avoid the costs associated with primary data collection, but secondary data (almost always collected for a purpose other than climate change adaptation) may not capture the parameters or level of detail required.

Both primary data collection and secondary data compilation efforts should be carefully monitored so that they remain relevant to the CCVA goals. ARCC has found that cataloging existing relevant study results (i.e., constructing a metadata catalog) and understanding key aspects of the methodologies used are well worth the invested time and may allow the CCVA team to produce knowledge more effectively.

** The climate analysis portion of the study requires meteorological data that must already exist. Chapter 7 provides detail on climate analysis.*

Almost without exception, data—whether from surveys, interviews, secondary sources, or compiled by technical consultants—will require some "cleaning."¹⁶ ARCC experience confirms that the data cleaning effort can be a lengthy one and should be performed as soon as is practical to reveal any shortcomings

¹⁶ Data cleaning does not imply manipulating the data to achieve a predetermined outcome; rather, cleaning reflects the reality that data collected or compiled will very rarely be free of error.

early enough to be addressed prior to the analysis and integration of results. Other lessons learned through ARCC data and information management follow.

- The sheer bulk of the data and information produced during a CCVA, and the numerous forms it can take (e.g., survey data, both raw and processed; geographic information system [GIS] layers, interview transcripts, consultant reports) must be organized so that it can be easily located, reviewed, and analyzed.
- The quality of data and information should be displayed along with the results: Are they accurate? Are they complete (enough to address the issue at hand)? If the team lacks confidence in the data, drawn conclusions may be weakened or potentially even misleading.
- Ideally, data and the tools (survey instruments, focus group discussion guides, and so forth) used to collect data should be archived by study component. For this purpose, ARCC used a combination of Microsoft SharePoint and DropBox.
- The credibility of the CCVA results depends on the quality of the underlying data. Since particular points of interest may be approached through multiple questions answered by different tools, "triangulation" is used to compare and contrast answers, increasing confidence in the results.

CONCLUSIONS AND KEY LESSONS FOR IMPLEMENTATION AND INTEGRATION

A typical ARCC CCVA consisted of several steps:

1. **Planning** a scoping mission;
2. Composing the team;
3. Designing the research effort;
4. Coordinating and sequencing the research effort to produce integrated results; and
5. Assembling a coherent, evidence-based picture of the findings.

ARCC quickly learned the importance of organizing a strong assessment team:

- **Investing in strong, consistent, and sustained leadership;** a leader who can provide focus to these complex studies while also being flexible, and
- **Composing an interdisciplinary team with the right combination of skills;** technical and operational.

ARCC also learned of other factors that contribute to successful implementation:

- **Effective sequencing and coordination of tasks,** especially the sequencing of the climate analysis vis-a-vis the topic or sector studies, promotes data collection efficiency and enhanced opportunities for triangulating preliminary results during the course of the assessment.
- **Continuous joint planning and review of each study component** helped to enhance coordination and reduce the likelihood of the research being carried out as a series of discrete, separate studies.
- **Making adjustments throughout the process** as a result of the stakeholders' improved understanding of both climate- and non-climate-related impacts, or due to unanticipated data limitations will ultimately, improve credibility and legitimacy.
- **Identifying the compelling "story" behind the data and information**—the organization or pattern, the unified whole—ensures that the CCVA is more than sum of its component parts.

5.0 FROM RESULTS TO RECOMMENDATIONS

Chapter 2 focused on key properties for enhancing uptake: establishing credibility, salience, and legitimacy; and engaging stakeholders, especially knowledge brokers and champions. Chapters 3 and 4 described ways in which ARCC integrated these properties into CCVA design and implementation. While applying these properties can enhance uptake, using CCVA findings to inform decision making also involves timely and targeted communications and outreach, and use of effective means for moving from results to recommendations. This chapter discusses some insights from ARCC that can help to enhance the transition from results to recommendations for action.

5.1 TIMELY, TARGETED COMMUNICATIONS AND OUTREACH

The more engaged stakeholders are during the entire CCVA process, the more they will recognize the value and relevance of the CCVA to their work. Thus, timely, targeted communications and outreach greatly increase the odds of the eventual uptake of results.

Because CCVA results are highly multidimensional, and climate projections necessarily uncertain, ARCC found that the most effective way to communicate findings was to make presentations that provided opportunities for clarification and discussion. For very senior individuals with limited time to attend formal presentations, ARCC found the most effective way to "get the word out" quickly and efficiently was to conduct a series of one-on-one or small group meetings, coupled with the distribution of very brief (few-page) handouts summarizing key findings. Such meetings allowed senior individuals to focus directly on aspects of immediate interest to them. This focus improved the relevance of the information for direct action, and the seniors' appreciation of its

TEXT BOX 5.1: LESSON: PRIORITIZE COMMUNICATIONS

Communicate CCVA results and adaptation options in a timely manner consistent with policy, programming, and investment cycles.

- To increase relevance, maintain a dialogue throughout the CCVA process between those who collect and analyze the information and those who will potentially use the information.
- Use climate change scenarios with localized content to encourage dialogue and relevance during the stakeholder review and recommendation process (See Section 5.2)
- Summarize lengthy technical documents in shorter versions that are easy to read. Retain the services of a person skilled in taking scientific information and packaging it with tables, informative graphics, or maps that really "speak" to the intended audience(s).
- Prepare standalone documents which tailor results to very specific audiences (i.e., farmers in a given region). If necessary, translate findings to common, local languages in a simplified manner so that more people are exposed to the scientific findings.

relevance in turn enhanced the credibility of the information when it was then further disseminated to their associates and subordinates.

As with any type of assessment, dissemination of appropriately packaged findings encouraged uptake when the timing coincided with important policy, programming, or investment cycles. However, ARCC also found that, due to the long time frames for conducting some CCVAs, it was necessary—and in fact became desirable—to release preliminary findings or findings from specific sub-components of a CCVA as internal documents to key users ahead of the public release of the final CCVA product. Often, such "partial products" proved to be adequate for informing investments. For example, results from a fisheries study carried out early in the process of a much larger CCVA study informed the procurement of a small fisheries project. However, many uses of CCVA results may require the complete, final CCVA product, such as information for developing a USAID Mission's Country Development Cooperation Strategy (CDCS).

TEXT BOX 5.2: POSTCARD FROM THE DOMINICAN REPUBLIC: COMMUNICATIONS AND OUTREACH

In the Dominican Republic, the ARCC CCVA team engaged local NGOs to help organize focus group discussions because of their familiarity with the local communities and power structures in the four study areas. In the process, NGO staff gained a heightened awareness of the range and scope of climate change issues facing their communities now and in the future. This heightened awareness prompted individuals from one NGO, in particular, to "want to make the most of [the study] in terms of information and outreach." To do this, they planned to take the CCVA results presentation "on the road"—spreading the word throughout the country—not just in the geographic areas that were the focus of the study. Because civil society groups are especially active in climate change adaptation in the Dominican Republic, ARCC considered this an unexpected but welcome addition to its communication efforts. Stakeholder engagement, outreach, and communications are now seen as among the particular successes of the Dominican Republic CCVA, due the significant reach of the CCVA results beyond government stakeholders into civil society stakeholders.

The communication of CCVA results beyond the primary donor can have important leveraging effects. It can attract other donors to invest in areas outside the primary donor's current development portfolio; it may prompt host governments to develop or invest more heavily in their own adaptation policies and strategies; and it may prompt others (nongovernmental organizations [NGOs], community-based organizations [CBOs], even the private sector) to support adaptation activities complementary to donor investments. Communication can be especially effective when it takes place throughout the entire CCVA process. Engaging in continuous communications (rather than waiting for the final results) helps stakeholders from diverse backgrounds navigate through the often complex data, information, and analyses associated with CCVAs and understand the CCVA's usefulness to them in advance of the release of the final product. It also better prepares them to make use of the final results when they do become available. Text Box 5.2 shows an example of successful communication and outreach methods used in the Dominican Republic.

The high uncertainty associated with climate projections presents its own set of challenges. Even in the absence of outright skepticism or resistance, some stakeholders can be uncomfortable with the idea that climate projections decades into the future are unlikely to provide the narrow range of values for

temperature or precipitation changes that they may desire or expect. ARCC has found that early engagement of climate experts in the CCVA can facilitate a shared learning process during which stakeholders become more comfortable with planning in the face of uncertainty. This, in turn, can lead to a better understanding of the important distinction between planning specific adaptation strategies versus planning for a more general enhancement of adaptation capacity.

5.2 STAKEHOLDER REVIEW AND RECOMMENDATIONS PROCESS

While many may argue that a CCVA ends with the presentation of assessment results, the most meaningful uptake is likely to take place long after the CCVA results have been published. Uptake may be promoted through proposing adaptation recommendations derived from the CCVA findings. One specific mechanism for moving from results to recommendations that ARCC used quite effectively was a participatory process that came to be known as the Stakeholder Review and Recommendations Process (SHRRP). For ARCC, this mechanism typically involved a workshop or series of workshops, during which key stakeholders analyzed the results from a CCVA to develop a set of climate change adaptation options. By moving from results to recommendations, ARCC found these workshops to be invaluable in bridging the gap between CCVA findings and adaptation actions. Drawing on the new evidence base provided by the CCVA, the SHRRP workshops also helped foster understanding and produce knowledge linked to potential action.

Within the SHRRP workshop setting, the precise activities carried out were less important than the processes of digesting the concepts, engagement, and the exchange of ideas. Text Box 5.4 (next page) describes two examples of workshops conducted in the Dominican Republic and Malawi.¹⁷ Although details differed, the outcome was the same: the SHRRP workshops established a direct and "usable" link between CCVA findings and climate change adaptation response actions. By using localized scenarios as nuclei for discussion, both workshops resulted in a detailed and concrete set of adaptation recommendations, not just a set of generic development options.

Applying the properties discussed in Chapter 2 throughout the CCVA process established a solid foundation for successful and productive SHRRP workshops. For ARCC, the dialogue created during the SHRRP workshops contributed to further establishing credibility, salience, and legitimacy, as well as to participant learning. Annex E provides additional detail of a specific example of a SHRRP workshop (in Malawi), and how the use of future climate scenarios enhanced uptake of CCVA findings.

TEXT BOX 5.3: COMMUNICATING UNCERTAINTY

Some effective ways to communicate the uncertainty inherent in climate projections include the following:

- Group sets of model results (e.g., driest, average, wettest rainy seasons).
- Use colored arrows or qualitative statements that communicate likelihoods (e.g., above normal, normal, below normal) rather than numbers.
- Do not use the word "uncertainty"! Instead use the word "variability," "range," "confidence" or "risk," as appropriate.

¹⁷ Additional detail about the SHRRP process in Malawi can be found in Annex E.

TEXT BOX 5.4: EXAMPLES OF SHRRP

In the **Dominican Republic**, ARCC facilitated a national-level workshop through the use of location-specific scenarios derived from the CCVA findings. Each scenario described the anticipated climate changes, sensitivities, and adaptive capacities for climate change-sensitive "hot spots" that were the areas of study of the CCVA. These provided a concrete means for focusing discussion, and the familiarity derived from the localized nature of the scenarios reinforced the relevance of the discussion for participants. Informed by the CCVA findings and aided by the use of the scenarios, workshop participants defined climate change adaptation strategies.

The workshop included participants from government agencies, NGOs, and the private sector—a broad range of participation that legitimized the process by allowing for multiple voices in the identification of adaptation options. The workshop also helped to improve understanding of constraints and opportunities for addressing each adaptation option, and led to increased awareness among participants about climate change and its implications.

After the national event, the CCVA team traveled to each "hot spot" area to present to local stakeholders the overall CCVA findings, the adaptation strategies that were developed at the national workshop, and the location-specific scenario that was developed for that particular "hot spot." During these local workshops the participants shared examples of local adaptation activities and generated recommendations that built on successes that were locally appropriate but still in line with the national strategies.

In **Malawi**, a SHRRP Workshop was co-hosted by USAID and the Government of Malawi (GOM). The workshop brought together donors, numerous GOM agencies, and NGOs. Participant sub-groups were chosen for four distinct, plausible, climate futures. Role-playing exercises required participants to step into the futures and "remember" what they did "back in 2013" to prepare themselves for success "today" (in 2030).

In a plenary session, the groups reassembled to identify those adaptation options applicable to all four climate futures. These were identified as being "robust" to a wide range of possible climate futures. The role-playing helped participants understand, at a very personal level, the relevance climate uncertainty held in their own decision making. At the end of the workshop, several participants made commitments to follow-on activities to ensure that some of the recommendations were acted upon within their own organizations. Participation in the workshop was enhanced by a significant communications and outreach effort carried out during almost two months prior to the workshop. Legitimacy was enhanced when a key GOM official took on the shared role of champion, with USAID. And credibility was enhanced when several community-level stakeholders described their personal experiences working in rural communities during the early phases of the CCVA.

5.3 BEYOND SHRRP

Beyond the workshop setting, a key lesson from the ARCC experience holds that meaningful participation among a broad range of stakeholders is critical to stimulate action. The meeting format (whether individual, group meetings), while time consuming, was also found to be a useful strategy for identifying recommendations for adaptation actions. The group meetings were often participatory in

nature, with hands-on exercises and scenarios (similar to those used in the SHRRP workshops) to help facilitate understanding. ARCC convened such meetings at regional, national and district levels. As supplements to the meetings, ARCC carried out a range of communications efforts. For professional audiences, these included preparation and distribution of short, non-technical written assessment summaries as well one-page briefs on specific topics; postings on national and regional websites;¹⁸ and handouts of materials on flash drives. For farmers and farmer associations, ARCC translated summaries and briefs into local languages and, with USAID staff, underwent interviews with local press and local radio programs.

ARCC relied on its own CCVA team members who, drawing from the CCVA information and findings, offered ideas for implementation recommendations. (In fact, these ideas were often the starting point for the SHRRP workshops.) Recommendations that built on adaptation practices that the CCVA team had identified as already happening, or on intervention efforts that USAID or the institutional analyses had identified as being already underway, were particularly important to identify. By taking a tiered approach, building on actual practices or existing opportunities, the CCVA teams were able to propose recommendations with the potential for a more immediate impact. Finally, when organized into meaningful categories (as opposed to individual, discrete recommendations), team-member-derived recommendations can provide valuable context for discussion. Such categories might include strategy, policy, or program areas relevant to donors and other key stakeholders.

In all cases, team members' recommendations were vetted with local stakeholders by a dialogue that verified and validated the proposed adaptation pathways.

¹⁸ Such as <http://www.eldis.org/> and relevant ministry websites.

CONCLUSIONS AND KEY LESSONS FOR RESULTS AND RECOMMENDATIONS

ARCC CCVAs were commissioned for use by USAID, to provide information for USAID planning and programming. As implementation of the CCVAs progressed, the relevance of the CCVA findings to other audiences was recognized, and ARCC and USAID began to reflect on means for enhancing the transition from results to recommendations for action for the following reasons:

- **Engaging in continuous dialogue** throughout the CCVA process enhanced uptake by laying groundwork for the eventual communication of results.
- **Using climate change scenarios** with localized context proved particularly fruitful during stakeholder review and the development of adaptation options.

ARCC, in partnership with USAID Missions, developed a participatory process that came to be known as the **SHRRP (Stakeholder Review and Recommendations Process)**. SHRRP typically involved:

- **A workshop or series of workshops** during which key stakeholders analyzed the results from a CCVA to develop a set of climate change adaptation options.
- **Fostering understanding and producing knowledge linked to potential action** drawing on the new evidence base provided by the CCVA.
- **Drawing from the CCVA information and findings**, CCVA team members offered ideas for implementation recommendations.
- **Organizing a collection of otherwise separate recommendations into meaningful categories** (e.g. strategy, policy or program areas relevant to donors and other key stakeholders) gained valuable context for discussion.
- **Building on opportunities such as adaptation practices already happening**, or on intervention efforts that USAID or others had identified as being already underway, helped identify strategies and recommendations with the potential for a more immediate impact and success.

Throughout the results and recommendations phase, ARCC found that care needed to be taken when **communicating the uncertainty** inherent in climate projections. ARCC found that some audiences were uncomfortable with the idea that climate projections decades into the future are unlikely to provide the narrow range of values for temperature and precipitation changes that they desired or expected so we learned to:

- **Involve individuals as early as possible** during the CCVA to help alleviate some of the discomfort.
- **Use words such as "variability," "range," "confidence," or "risk,"** when appropriate, to relay an equivalent meaning in a way that audiences found acceptable.

SECTION 2: KEY ANALYTIC COMPONENTS

6.0 INSTITUTIONAL ANALYSIS

As one of the three dimensions of vulnerability (together with exposure and sensitivity), adaptive capacity is defined as "the ability of a system to adjust to climate change and to moderate potential damage, to take advantage of opportunities, or to cope with the consequences" (IPCC, 2007). An adaptation strategy that works today (e.g., coping)¹⁹ does not necessarily translate into a capacity to adapt to similar or evolving challenges tomorrow. An exploration of adaptive capacity in the context of climate change must go beyond an examination of what is happening today to identify the potential for strengthened or new strategies for the future. Adaptive capacity transcends a single individual; it is inevitably influenced—enabled or compromised—by the policies, procedures, or perceptions of institutions.

Institutions influence adaptation in critical ways. First, they structure the degree to which impacts and vulnerability are individual or collective. Institutions also "mediate between individual and collective responses to climate impacts and thereby shape outcomes of adaptation" (Agrawal, 2008). Institutions deliver external resources, services, and information to communities that may facilitate adaptation, and institutions may govern access to those resources. Adaptive capacity is improved or impeded by the policies and actions of institutions from the local, national, and even international levels, in both the public and private spheres. Additional considerations related to climate change adaptation from a governance perspective are provided in Text Box 6.3, on page 49.

Thus, a thorough investigation of adaptive capacity must engage institutions at many levels. These may include individual households; community groups; private sector entities; and local, regional, and national governments, and parastatal entities. Each type of institution has a role in building and enabling adaptive capacity and hence in reducing vulnerability; therefore, an Institutional Analysis (IA) is an important component of the CCVA process. Without an institutional analysis, it is not possible to identify effective and realistic climate adaptation strategies. This chapter describes ARCC lessons learned from applying IAs in unique ways specific to the conduct of a CCVA.

6.1 ARCC'S INSTITUTIONAL ASSESSMENTS

There are many options for performing an IA; most are specific to the scale of analysis. ARCC tailor-designed IAs to suit the particular needs of each CCVA, and so that the IA might be applied in ways that used resources efficiently and effectively. In most cases, the ARCC IAs were integrated into the CCVA process through the component studies, rather than being conducted as discrete analytic components. For example, key informant interviews held with national institutions during the scoping phase were not repeated during the field research phase. During the field research phase, specific institutional issues identified during the scoping phase—such as the application of new climate change policies—were explored in focus groups discussions or interviews with local officials and community members as an integral part of the various component studies. The nature of the IA varied in each ARCC assessment; several are summarized in Text Box 6.1.

¹⁹ We use the term **coping strategies**, as those which are unplanned, short-lived, and less sustainable reactions, and **adaptive strategies**, as those which are more pro-active, sustainable actions.

TEXT BOX 6.1: SUMMARIES OF IAS CONDUCTED AS PART OF ARCC CCVAS

Uganda: As ARCC's first assessment, much learning took place during conduct of the Uganda CCVA. The most immediate lesson was simple recognition of the importance of an IA. The ARCC team completed an analysis of national institutions during the scoping phase. During the field research phase, the team supplemented the information gathered at the national level with semi-structured interviews conducted with relevant district officials. The team triangulated this information with service delivery questions integrated into village-level focus group discussions. The team also visited the National Agricultural Research Centers. Findings were supplemented through stakeholder consultations. The results provided an understanding of the key institutional players, their roles, inter-institutional relationships, plans, strengths, and weaknesses sufficient to inform development of specific adaptation options and recommendations for action.

Malawi: Because the Malawi CCVA was initiated in tandem with the Uganda CCVA, it was similar to the Uganda CCVA in that it did not incorporate a formal IA. Once again, the team derived institutional information from the component studies. In the case of Malawi, an adaptive capacity framework was applied post facto (see the Section 6.2). While this approach proved successful for the purposes of assessing institutional capacity sufficient to prepare for an options analysis exercise, the result was necessarily limited in terms of a more comprehensive institutional capacity assessment to adapt to climate change that a more formalized approach would have provided.

Dominican Republic: Drawing from the lessons in Uganda and Malawi, beginning with the DR CCVA, the ARCC teams began to incorporate IAs in a more deliberate fashion. An important lesson of the DR CCVA was the value of identifying *specific* key climate change actors within the government early in the study. Rather than an "institutional assessment" (which evaluates the extent to which a country's institutions, policies, and programs support critical aspects of adaptation), the DR CCVA identified key institutional actors for adaptation, their roles and responsibilities, and how they relate to one another (often called an "institutional mapping"). ARCC found that such a mapping can provide useful inputs to help structure additional analyses. But it has limitations. An institutional mapping usually does not delve into the unique characteristics of each institution needed to identify its capacity gaps and strengths or potential opportunities for donor support. Text Box 6.2 describes how, in the case of the DR, the more limited analysis provided by an institutional mapping made it difficult to identify specific climate responsive institutional development recommendations that might have been good candidates for donor support.

Senegal: Benefiting from the lessons of previous CCVAs, the IA conducted for the Senegal CCVA was more extensive and combined three formal IA approaches to assess the capacity of public, civic, and market institutions to build local capacity in Eastern Senegal. The CCVA team interviewed staff from national institutions during the scoping phase and then interviewed local officials during the field research phase. The information gathered was triangulated with village-level focus group discussions using structured interview guides. Three questions were explored through key informant interviews and a secondary literature review:

- Can the institution manage information and knowledge to assess and prioritize climate risks?
- Is the institution forward thinking in order to be flexible and innovative?
- Is it truly participatory in order to be responsive to the community within which it exists or functions?

In addition to this information, ARCC commissioned a local research organization to conduct a review of agriculture extension and research opportunities; what institutions had done and what had been effective.

6.2 INSTITUTIONAL ASSESSMENT FRAMEWORKS

The most fundamental lesson from ARCC is that any CCVA team should ascertain who the key actors are, their roles and responsibilities, and their capacities to carry out their mandates as they relate to climate change adaptation. This understanding is a prerequisite for ensuring that recommendations for policy, programming, and investment are practical—even more important because some of these recommendations are likely to be ones that address *institutional* adaptive capacity.

ARCC adapted aspects of existing institutional frameworks to guide the design of some of its CCVA-related institutional analyses. However, in practice, the application of these frameworks represent comprehensive, investment-intensive studies on their own, while ARCC CCVAs were designed to study numerous topics of which the IA was only one component. Thus, it was not practical to adapt any of the frameworks in their entirety. Two frameworks used to varying degrees by ARCC were the

- **Multi-level:** Adaptive Capacity Spheres of Influence, based on the Gupta Wheel, with eight dimensions; and
- **National level:** World Resources Institute's (WRI's) National Adaptive Capacity (NAC) framework, with five key functions.

The next two sections describe how these frameworks were adapted for use in ARCC CCVAs.

TEXT BOX 6.2: EXAMPLE OF A MISSED OPPORTUNITY RESULTING FROM A LIMITED INSTITUTIONAL MAPPING COMBINED WITH LATE TIMING

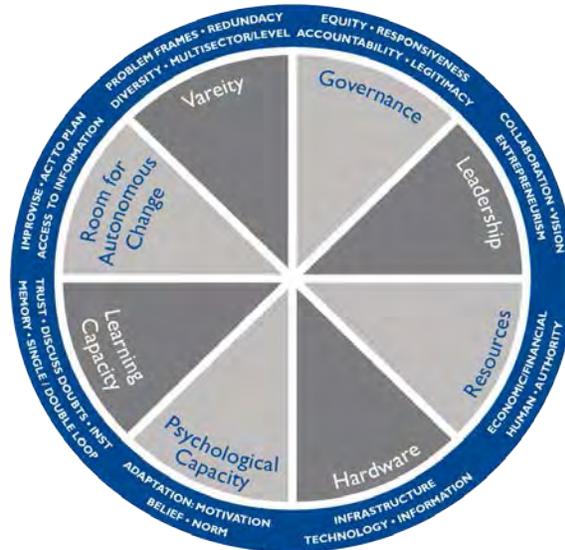
Hurricanes are common in the DR, and they can be devastating. In response, the country has developed an elaborate network of disaster response and risk reduction (DRR) organizational entities. This network includes central government units responsible for national-level policy, planning, and operational coordination; territorial-level entities responsible for intermediate-level planning, coordination, and management; and provincial-level entities responsible for local coordination, management, and response. These various entities often have overlapping or duplicate responsibilities; some are well-funded, resource-rich, and have ample capacity; others have less funding, access to fewer resources, and limited capacity. Nevertheless, all of these entities have been playing an increasingly visible role in their efforts to address the challenges presented by climate change.

Unfortunately, with their initial focus on technical entities at the national level—such as the Ministry of the Environment, the National Authority on Water, and the National Authority on Meteorology and Weather—the DR CCVA Team members did not become fully aware of the elaborate DRR structure until they conducted their field research. Had the DR CCVA team undertaken a more systematic institutional analysis during the scoping phase of the study, and thereby been alerted to the existence of this network earlier, they would have been in a better position to explore, during the field research phase, how well each component of the structure meshed and worked with the others, and to identify capacity shortfalls and whether there were any gaps or inconsistency in coverage. When the team visited the study zones they did conduct a quick assessment of how the network was functioning at the provincial and municipal levels and used this information as an indication of network performance, gaps and needs. However, had they been armed with the information prior to starting their field research, the team would have been in a better position to articulate specific opportunities to support institutional strengthening to fill capacity and performance gaps as well as to flag any policy mismatches that might exist among the various components of the network.

6.2.1 Adaptive Capacity Spheres of Influence

Figure 6.1 shows a multi-level institutional assessment framework adapted for ARCC's Malawi CCVA called the "Adaptive Capacity Spheres of Influence." This framework can be appropriate for gauging institutional capacity from the local to the national level. The Adaptive Capacity Spheres of Influence was derived from the six dimensions known as the "Gupta Wheel" (Gupta et al., 2010): leadership, variety, learning capacity, resources, fair governance, and room for autonomous change. ARCC added two additional dimensions that other practitioners (e.g., Grothmann, et al., 2013) have identified as key. The first addition is called "hardware," which is defined as having the infrastructure, technology, or information requisite for adaptation. The second is called "psychological capacity," and is defined as an individuals' realization that they (i) *can* adapt, (ii) *want* to adapt, and (iii) *should* adapt; these are named adaptation belief, adaptation motivation, and adaptation norm, respectively.

FIGURE 6.1. ADAPTIVE CAPACITY SPHERES OF INFLUENCE



Implementation: The Gupta Wheel framework for institutional assessment is designed to be applied first in a desk study, and then during interviews with key institutional actors, where a series of questions are answered in each of the dimensions. An example of a CCVA-related question for the Resources Sphere/Authority dimension might be, "How do you rate the level of authority given to your organization to deliver climate-related early warning services?" The question would initially be answered during the desk study by drawing from documents that describe the mandate and/or policies of the institution and then validated or expanded upon through interviews with multiple staff from the target institution. Such a systematic approach can yield an institutional assessment that is both quantifiable and comparable.

Limitations: While the approach was used successfully in Malawi, this was largely because the information needs were limited and highly specific. In addition, for the Malawi CCVA, the team replicated a sufficient portion of the process by "mining" the key informant and PRA data sets. This proved adequate for the purposes of the Malawi CCVA, but only because the interview and PRA data sources contained rich and detailed information, including the raw transcripts. The Malawi CCVA team recognized that to formally apply the Adaptive Capacity Spheres of Influence Framework would require a significant additional investment of time and resources in order to systematically compile evidence in all eight dimensions. In addition, analysts must be reasonably comfortable with qualitative proxies and/or ranges of values for hard-to-measure concepts.

TABLE 6.1: NAC FRAMEWORK OF FUNCTIONAL QUESTIONS

- Function 1: Assessment
- Function 2: Prioritization
- Function 3: Coordination
- Function 4: Information Management
- Function 5: Climate Risk Management

6.2.2 National Adaptive Capacity Framework (NAC)

WRI²⁰ and partners (Dixit, et al., 2010) developed the NAC framework to identify a set of five fundamental functions that all countries (governments) will need to perform to effectively adapt to climate change: assessment, prioritization, coordination, information management, and climate risk management. The framework was designed to help assess how well each of the functions is being performed. It identifies both strengths and weaknesses in the country's "adaptation system," reveals opportunities and impediments to adaptation, prioritizes target issues for advocacy, and identifies priority areas for capacity building among government stakeholders.

The NAC framework is based on the assumption that, while each country will need to implement adaptation strategies based on its specific context, there are a few "adaptation functions" that all countries must be able to perform. The framework also assesses whether governments take into consideration the costs and benefits of adaptation, as well as of the failure to adapt. It can be particularly useful to support in-country planning and capacity building.

Implementation: During its application of the NAC framework in Senegal, ARCC's CCVA team found that the framework enables users to systematically assess institutional strengths and weaknesses that may help or hinder climate change adaptation. The framework presupposes that effective institutions are at the heart of a country's ability to respond to growing climate risks. Table 6.1 summarizes the five key institutional functions that may be used to analyze targeted institutions. Each NAC function can be associated with a set of questions designed to gauge how well the country or specific institution is performing that function.²¹

ARCC found that the NAC Framework can be simplified somewhat and still provide meaningful results. In addition to using it in Senegal, ARCC conducted a national level institutional assessment in Rwanda (across many institutions) in the sectors of agriculture, health, and water. Placing careful queries within the categories of assessment, prioritization, coordination, information and knowledge management, and climate risk management, the ARCC team was able to score (from 1, highest to 5, lowest) the institutional capacity of the country based on a thorough review of available literature supplemented by key informant interviews conducted over a one week period.

Limitations: ARCC's Senegal and Rwanda teams found that NAC assesses only the functions necessary for adaptation; it does not assess whether or not the assets that would be needed to adapt actually exist. Furthermore, it is only applicable at the national level and does not provide guidance at the local level. Finally, although ARCC did demonstrate that the process can be simplified, the processes and instruments used in the NAC framework can also be extensive, requiring significant resources to implement effectively.

²⁰ WRI was a partner to Tetra Tech ARD under the ARCC contract.

²¹ The document "Ready or Not: Assessing Institutional Aspects of National Capacity for Climate Change Adaptation" (WRI) provides context and answer worksheets that can facilitate the process. It can be accessed at http://pdf.wri.org/ready_or_not.pdf.

TEXT BOX 6.3: CLIMATE CHANGE ADAPTATION AND GOVERNANCE

Considerations for Decision Making:

Uncertainty. The inherent lack of precision regarding the direction, rate, and magnitude of climate change creates a fundamental uncertainty in anticipating impacts at national and local scales. Decision makers must be prepared for a range of possible futures, and avoid locking into pathways that become dead ends if assumptions are wrong.

Non-linear change. Gradual and linear change in biophysical systems may occur long before a threshold is reached; systems may suddenly transition into a new state where their original characteristics are lost. If non-linear change becomes the norm, anomalies and surprises must be prepared for and embraced, in order "*not to clarify, map and plan for every single surprise, but to train to be surprised.*" (Lagadec, 2008).

Now and for the future. Change will happen over a long time, and the ultimate success of measures taken cannot be predicted. Adaptation actors must contend with the challenge of dealing with the present while having the long-term result of their actions in mind. There must be a link between decisions taken today and the availability of relevant options for tomorrow.

Incomplete information. There are climate models that cannot be scaled down to a localized level and decisions that carry implications for phenomena that have not yet occurred and must be anticipated. Adaptation decisions need to allow for many gradual and incremental steps based on what *is* known, rather than a few big steps that cannot be retraced.

Local and global, interconnected systems. Climate change uniquely links the global and the local. Changes in the global atmosphere produce local effects shaped by characteristics of the local environment. Communities are linked to global systems through markets, trade, and migration; national governments set policies that may enable or constrain conditions for effective local-level responses. No community is isolated from global events. Adaptation requires both individual decisions and collective action.

Multiple sectors. Changes in agro-ecosystems, hydrology, human health, and countries' terms of trade will reverberate across sectors. Impacts must be addressed through a wide lens that registers what happens throughout society. Climate change impacts must be addressed through multi-sectoral strategies.

Monitoring and learning. Acting on incomplete information in an incremental way—starting with the present and seeking future outcomes—requires close observation and monitoring of change when and where it occurs. Registering change is not sufficient; systems need to be set up for learning so that new knowledge is used for adaptation to new circumstances. Outcomes and results of adaptation and investments should be scrutinized, and the various signs of change continuously monitored.

Recommendations for the Development Practitioner:

- Seek institutional diversity: multilayered and polycentric, formal and informal
- Meaningfully engage stakeholders at all levels
- Decentralize decision-making and resources to where impacts are most directly experienced
- Support local authorities to integrate projects into regular plans and budgets for ownership and accountability
- Foster shared learning to improve understanding and collective action across sectors and at all levels

(Summarized from Schaar, J., and Caffrey, P., 2014)

TIPS ON INSTITUTIONAL ANALYSIS

Several general lessons concerning the importance and process of implementing an IA emerged from the ARCC experience.

Why is it important to conduct an IA?

- **IAs provide a direct measure of the level of engagement and preparedness of the institutions** likely to be involved in adaptation strategies. This understanding is a prerequisite for ensuring that recommendations for policy, programming, and investment are practical.

The conduct of an IA can also be a **mechanism to "touch base" with appropriate institutions** early in a CCVA process. In doing so, they may identify additional institutional stakeholders that should be represented. Even a relatively superficial IA will improve the legitimacy of the CCVA with stakeholders and make the CCVA product more relevant to users.

Lessons about the process:

- **Integrate the IA process into the CCVA**, rather than carrying out the IA as a discrete analytic component. This was accomplished by integrating IA questions into existing interview guides or surveys and triangulating information related to institutional performance, roles, challenges, opportunities and inter-institutional relationships between the various levels—national, regional and local.
- **Focus on a specific set of sectors or communities**, those that were the focus of the **CCVA** as defined by the research goal, rather than exclusively on climate "related" institutions. (See Text Box 3.1 in Section 3.1.1 for examples.) More specifically, ARCC learned to ask the question "for a CCVA focused on agriculture-based livelihoods which entities manage efforts or govern issues that affect agriculture (or natural resource management, or food security)?" as opposed to "Which entities know something about or have a specific mandate for "climate"?"
- **Include local/national consultants and organizations in the CCVA team** to aid in the identification of key actors. They understand the local context, and can access local institutions and their representatives.
- The CCVA Team, as the initial **knowledge broker**, works alongside a local "champion" to identify and engage the right institutional actors.

7.0 CLIMATE ANALYSIS

ARCC CCVAs are distinguished by their evidence-based approach, with climate analyses of the past, present, and future being the central differentiation between a CCVA and other types of VAs. CCVAs link changes in climate to changes in vulnerability and research the dimensions of vulnerability (exposure, sensitivity, and adaptive capacity). ARCC CCVAs were often the first of their kind to be carried out in the countries in which these studies were completed.

In modeling the climate, knowing the past and present climate conditions validates assumptions made and techniques used when making predictions of future climate trends. The climate analysis component of a CCVA provides the policy or program decision maker with:

- A solid understanding of one of the three essential aspects of the CCVA: exposure,²²
- Scientific credibility and an evidence base that becomes a sound foundation for future planning; and
- Baseline results and knowledge that can then be updated as new data (e.g., new emissions scenarios), understanding, and techniques become available.

For ARCC, the proven effective steps in a climate analysis were (1) clearly defining the scope of the analysis as a sub-component of the CCVA research design, (2) obtaining the necessary data, (3) deciding on an appropriate analysis methodology and performing the analysis, and (4) and interpreting and communicating what insights the results can and cannot provide (i.e., their limitations).

7.1 DEFINING THE SCOPE OF THE ANALYSIS

Broadly speaking, climate change research points to a warming world and a future in which changes in the patterns of precipitation will be significant. The goal of the CCVA is to estimate the impact of temperature and precipitation changes on particular populations and/or natural systems. Defining the scope of requirements for the climate analysis should begin early, be revised as additional needs become clear, and involve the entire team. At the same time, just as with the other components of the CCVA, the general approach and focus of the climate analysis should be clearly communicated to key decision makers and other stakeholders to obtain their endorsement on the objectives of the analysis.

Ideally, the climate change analysis would be completed very early in the assessment effort, identifying those geographic regions, natural systems, people, or livelihoods of interest most subject to changes in climate. Caution must be taken, however, not to shrink the focus prematurely. Two important considerations relevant to ARCC CCVAs that needed to be taken into account before focusing on the assessment were the following.

²² That is, an understanding of how temperature, precipitation, and other climate characteristics have behaved in the past, the present, and are projected to occur in the future.

- The focus of an assessment may be on particular livelihoods or economic activities. Those activities may not occur in geographic areas in which climate change is likely to be the primary driver of vulnerability.²³ In other words, rather than trying to answer questions of "where," CCVAs focused on livelihood and economic activity often attempted to answer questions of "who?" and "how?"
- Decision makers may prefer to focus on certain populations, regions, or programmatic areas. For example, they may select densely populated, highly productive agriculture areas rather than sparsely populated, already marginal areas where the economic impact of climate change or the number of affected people will be low. In this case, rather than "where," the question to be addressed was often "how and to what extent" is the changing climate going to affect populations or sectors?

By providing the climate information early, even if not first, other CCVA components can make use of it in their analyses. Some of the following were already discussed in Section 3.3 and include, for example:

- The results of analysis on historical climate trends is useful in the design of field research tools such as focus group discussions that investigate how people have responded or adapted to droughts and floods.
- Climate change projections are valuable in focusing a value chain analysis on the particular links of the value chain which are most sensitive to projected changes in temperature or precipitation.
- Similarly, climate change projections are useful for a phenological study which might need to consider pests or diseases occurring in an expanded geographic range well beyond their current or historical range due to climate change.

TEXT BOX 7.1: A CCVA VERSUS A "VA WITH CLIMATE INFORMATION"

Because this Compendium is one of ARCC experiences, the CCVAs discussed here are ones which attempt to estimate changes in vulnerability linked to changes in climate projected for one or more decades into the future. However, for another (non-ARCC) VA, depending on its objectives and the decisions it aims to inform, the inclusion of climate **projections** may not always be appropriate. A VA which included current and historical climate trend information might be quite adequate for many needs. For example, if the intent of the VA is to inform resource allocation and program planning over the next three to five years, a better understanding of current climatic conditions and recent (historical) climate trends, and their role in the overall vulnerability, might be more relevant. For the purposes of this Compendium, we call this type of assessment a "VA with climate information" rather than a CCVA.

ARCC found that the climate analysis and the information it provides for the other components of a CCVA inevitably have limitations, too. These limitations depend largely on the availability of quality data,

²³ In the case of ARCC's Senegal CCVA, for example, the vulnerability analysis focused on three livelihood types—livestock-dominated, agriculture-dominated, and mixed—in a study area in Eastern Senegal. The study looked at different portfolios of activities within each livelihood type, and assessed the respective vulnerability of these livelihood types to current climate variability and to potential future climate changes. The analysis was based on the fact that each activity within a livelihood type (e.g., specific crop, herd composition, off-farm income source) differed in its sensitivity to climate; thus each livelihood type differed in its sensitivity to climate conditions, as experienced by individuals and by communities. Hence, differences in vulnerability were not dominated by differences in exposure, which is what a pure climate analysis of the area would have pointed to.

limits in the methodology and, significantly, uncertainties in future policy making and implementation.²⁴ As with all of the CCVA components, by involving other CCVA team members, decision makers, and certain key stakeholders, and posing questions to the results of the analysis, all will have a better understanding of what insights the climate analysis can and cannot provide. In addition, the climate scientists will have a better understanding of how the climate results must be presented to be of use in the various CCVA component studies. ARCC accomplished then by involving climate scientists in other components of the CCVA, such as the PRAs (in Malawi) and the agriculture modeling (in Senegal).

Two areas where decisions should be made early, and with the involvement of these other individuals include **spatial resolution** of the exposure information and **time horizon**. Understanding each of these will guide the suitable choice of climate analysis to be undertaken, which in turn will define the analysis methods and data requirements. For example, in Uganda the CCVA team collaborated with USAID to understand the locations of the priority Feed the Future districts, and selected for study the ones that were situated near meteorological stations from which historical weather data could be obtained. The team studied temperature and precipitation data because these were the two climate factors that most influence agriculture outcomes.

7.1.1 Spatial resolution

Ideally, the spatial resolutions of the exposure information would be defined by the scales of analysis of the CCVA—e.g., community, sub-national, national, regional. However, it may not be possible to conduct climate analyses at the "finer" spatial resolutions due to limited density of meteorological stations across the geographical area of interest. In general, climate processes, especially climate change, are best understood at larger scales (global and regional). Downscaling (see Text Box 7.3) is required to carry out climate analyses at sub-national levels; this in turn requires access to a reliable historical record of appropriate meteorological data (see Section 7.2).

7.1.2 Time horizon

ARCC experience has demonstrated that considerable time and effort can be saved by reaching early agreement on the time horizon²⁵ of climate projections to be included in the assessment. If the assessment is intended to inform programs strictly in the near term (up to 10 years), then climate projections may not be necessary and a "VA with climate information" (see Text Box 7.1) might be adequate. If, however, the planning horizons are 15 to 30 years, or the near-term programs are intended to prepare populations or sectors for longer-term adaptation, as was the case with ARCC CCVAs, then climate projections are highly desirable. In that case, it will be important to communicate the uncertainty inherent in projections with long time horizons:

- Climate projections decades into the future are unlikely to provide the narrow range of values for temperature or precipitation changes that some decision makers may desire or expect;

²⁴ Scientists' understanding of the individual physical processes that drive the climate are well established. However, to construct models for predicting climate conditions decades into the future, this understanding must be combined with a still evolving knowledge of present day climate conditions. These models, in general, function on a global scale, not a local one. And, because the principle driver of climate change is anthropogenic in origin, it is subject to changes in policy and practice. Thus, there are significant uncertainties involved when predicting where climate change will lead.

²⁵ "Time horizon" is the time period for analysis of current and future exposure that is relevant to decision makers.

- Due to natural climate variability,²⁶ climate projections may not be reliable in terms of specific climate characteristics, such as the onset of rains, frequency of dry spells, or duration of rainy seasons;
- The accuracy of the projections (particularly at sub-regional scales) is dependent upon the quality and quantity of historical climate data available; and
- Climate projections differ significantly depending upon future emission scenarios and the adoption and implementation of policies impacting those emissions.

In summary, conducting the climate analysis early strengthens the team members' and external stakeholders' understanding of the climate change, and the relationships between climate change and other components of the CCVA. ARCC experience has shown that this dialogue is often an iterative, two-way process. The relationships between climate change and the other study topics or sectors are interdependent in complex ways, and the various component analyses (including the climate analysis) may need to be adjusted as new information informs the investigation of both short-term and long-term vulnerability.

7.2 OBTAINING THE NECESSARY DATA

The analysis of future climate change begins with a knowledge of historical and present day climate conditions based on historical and current meteorological data, and "extrapolates" (via models) these conditions into the future. Since global climate varies naturally on a decadal period, at least 30 years of historical data are needed to establish a historical trend and provide a basis on which to compare predictions with observations. Longer historical records of meteorological data generally lead to greater scientific credibility of the results.

In the countries where it worked, ARCC found two main types of data to be available that could be used in historical climate analyses:

- **Station Data:** Station data are rainfall amounts and temperature values (and perhaps other parameters) recorded in meteorological stations. The spatial sampling, quality and coverage of the records vary, and it is not unusual to find gaps in the records or other "confounds" (e.g., where the location of a station has changed). In general, these data can be acquired from national meteorological services, subject to local policies on their use or redistribution.²⁷
- **Gridded Data:** Gridded data are data products derived from station data, often complemented by additional sources such as satellite or model-derived data. Gridded data products provide rainfall and temperature estimates in the form of gridded "cells"; each cell may represent a span of several tens to hundreds of miles. The main advantages of gridded data are their ease of access (they are often freely available and easily accessible) and continuous spatial coverage.²⁸ However, their

²⁶ Climate variability is the variation of the climate within the analysis period (e.g., from 1975 to 2005), whereas "climate change" refers to a change in the mean state of the climate of an extended period (commonly 20 to 30 years) in the future relative to a similarly long reference period in the past. Text Box 7.2 provides additional information on climate variability.

²⁷ It should also be noted that, although observations are generally made daily, often the only easily accessible data records are monthly aggregates. Station data are sometimes called "point data" because the data are associated with the physical locations of the stations.

²⁸ Gridded data sets provide continuous spatial coverage (i.e., an absence of data gaps) because the data have been smoothed (e.g., interpolated) from point or other data. However, as a result of the smoothing process, a particular grid cell value may not capture the temporal or spatial variability of the data from which it was derived.

typically low spatial resolution,²⁹ time periods covered, and quantity of observed information can all vary considerably. Before use, gridded data should be validated against station data to gauge possible biases (e.g., in average values, amplitude of variability).^{30,31}

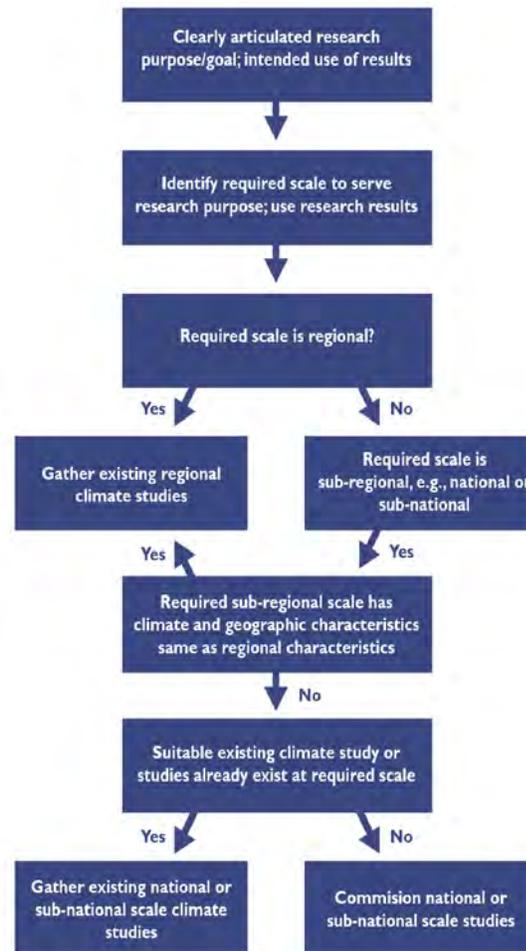
Two factors will establish the scale of the climate analysis. Ideally, the scale of analysis would be defined by the scope of the CCVA analysis. This includes the geographic scope (see Figure 7.1) and also the topic or subject scope, as the latter defines what climate data will be required (e.g., annual rainfall and temperature, average seasonal cycle, interannual and decadal variations, or statistics of daily values that may include extreme events, dry spells, and/or the onset and cessation of the rainy season). In reality, what it is possible to analyze will also be determined by the availability of adequate data.

7.2.1 Geographic scope

The answer to the question “**Is the scope regional³²** (e.g., “sub-Saharan Africa”), **national, or sub-national?**” will have a significant impact on what may be the most time-consuming effort associated with the climate change analysis: the collection and preparation of relevant data.

It is possible that one or more climate change studies already exist for the region of interest.³³ The results of these

FIGURE 7.1: DECISIONAL FLOW CHART FOR CHOOSING LEVEL OF CLIMATE ANALYSIS



²⁹ The spatial resolution is the dimension of the grid cell. Gridded climate data sets generally have large spatial resolutions that require downscaling (see Text Box 7.3) for use in local studies.

³⁰ A validation may have already been conducted. Thus, a first step would be to conduct a literature review to reveal existing validation reports.

³¹ Ideally, gridded data should be documented with an evaluation of error due to interpolation methods used, but this information is not always provided, and the methodologies for including such information are not well established. ARCC found that, when this information did exist, it was often provided as a qualitative estimate of the degree of confidence in the results for a given area, rather than a quantitative measure of error.

³² In the CCVA, “regional” means larger than a nation. Examples of regional-scale climate analyses include ones that cover sub-Saharan Africa, Asia, and the Caribbean.

³³ See for example, IPCC (<http://www.ipcc-data.org/>), the World Meteorological Organization (WMO) Global Framework for Climate Services (<http://www.gfcs-climate.org/>), and the World Climate Research Program and its Coordinated Regional Downscaling Experiment (CORDEX) (<http://wcrp-cordex.ipsl.jussieu.fr/>).

studies may be combined in a form of "meta-analysis." However, ARCC found that considerable care must be exercised when utilizing them, and that consultation with experts in the field can provide some confidence as to the quality of these studies, the data sets used, and any conclusions derived from them.

National and regional meteorological services are often the only entities with the mandate to record and archive weather data. ARCC often relied on meteorological services for historical data. When neither existing studies nor data sets were available, data were collected from regional or national entities within the trans-national region of interest. Gridded data sets on scales relevant for regional climate analyses are becoming more commonly available from these sources.

If the required scope is national or sub-national, the regional-level climate analyses *may* still be appropriate if the characteristics of the areas of interest are consistent with the characteristics of the region represented in the regional study. For example, ARCC contracted with the Climate Systems Analysis Group (CSAG) at the University of Cape Town to conduct an assessment of the status and possible evolution of climate projections for the West Africa Region, which was used to improve understanding of possible future climate changes in Mali. Alternatively, if the information from the climate analysis is going to be used for national-scale planning (e.g., to determine whether or not, as a nation, a country needs to reduce its reliance on rain-fed maize), then regional climate projections *may* still be adequate.

However, in most cases regional scale climate change projections in national and sub-national scales cannot be used to understand climate changes at the local level, especially in a country where the biophysical characteristics vary a great deal. (See Postcard from Malawi in Table 7.1 at the end of this chapter.)

If a national or sub-national level analysis is required, then the first step is to determine if such analyses already exist. Otherwise a climate change study specific to the purpose of the CCVA may be commissioned.

ARCC experience has shown that collecting and preparing data sets at the national and sub-national level may present a number of challenges. The data

- May not be freely available, they may either be considered proprietary or only available for sale under a restrictive license (which may preclude transfer of the data to a third party for analysis);
- May be geographically sparse, with meteorological station data available from only a very few sites within the areas of interest;
- May be of limited duration, available only for recent periods, or only intermittently in the more distant past;
- May be of mixed or of poor quality, not conforming to accepted standards (e.g., conflating "no data" with "no rain"); and/or
- May not be available in digital form—this is especially true for older data.

Regardless, the goal is to acquire datasets—rainfall and temperature in particular—which can be considered representative of the areas of interest and which extend back in time at least several decades. Once these data are made available, they must be carefully reviewed ("cleaned") to ensure that they are of acceptable quality. ARCC experience has shown that it is not unusual for the data "cleaning" period to be significantly longer than the data analysis period.

ARCC also found cases in which a great deal of relevant information upon which an analysis could build was already available. For instance, ARCC found much relevant information in Senegal and Mali, both

Sahelian countries where a considerable amount of weather and climate research has been conducted since the droughts of the 1970s and 1980s. This information was used to guide ARCC's climate analysis design and interpretation (in these cases, providing understanding of decadal variations in the Sahel). However, suitable, ready-to-use analyzed results for detailed climate studies were rarely available primarily because the area, resolution, and analysis parameters of existing studies did not coincide with the needs of the ARCC CCVA.³⁴

7.3 DECIDING ON AN APPROPRIATE ANALYSIS METHODOLOGY AND PERFORMING THE ANALYSIS

The "end-point" of the actual climate analysis depends upon the temporal scope of the CCVA. If the purpose is long-term planning, or if there is a desire to inform short-term programming in ways that account for long-term climate change, then the use of climate change models and more sophisticated methodologies that include climate projections will be required. For those focused on the near term or "contemporary" periods—the "VA with climate information"—an understanding of historical and present day climate trends may suffice. ARCC CCVAs were typically designed to assess both current and future vulnerabilities, and included both historical climate trends analysis and future climate projections. Historical climate analyses provided insights into current and recent vulnerabilities. The historical analysis was also used as a base from which to extrapolate future climate changes. ARCC CCVAs looked at climate projections decades into the future in order to understand the long-term impacts of climate change.

7.3.1 Climate variability

In addition to informing an understanding current vulnerability, and informing the prediction of future climate change, a historical climate analysis has one other critical role: To help understand the extent of **climate variability**. Climate varies naturally on a range of scales. Often, the variations on interannual and even decadal time-scales are much larger and have more profound consequences than long-term changes in climate. This natural climate variability can easily mask any climate change trend over time, be it projected or observed (see Text Box 7.2). Analysis requires long historical records, so that the trends identified are statistically robust and can be distinguished from variation over shorter periods.³⁵ Figure 7.2 provides an illustration. In most cases, these natural variations dominate short-term trends that might have their origin in climate change. Thus, ARCC found that it is important to make clear—both to the CCVA team members and to stakeholders—the degree to which natural and historic variations contribute to uncertainty in such an analysis.

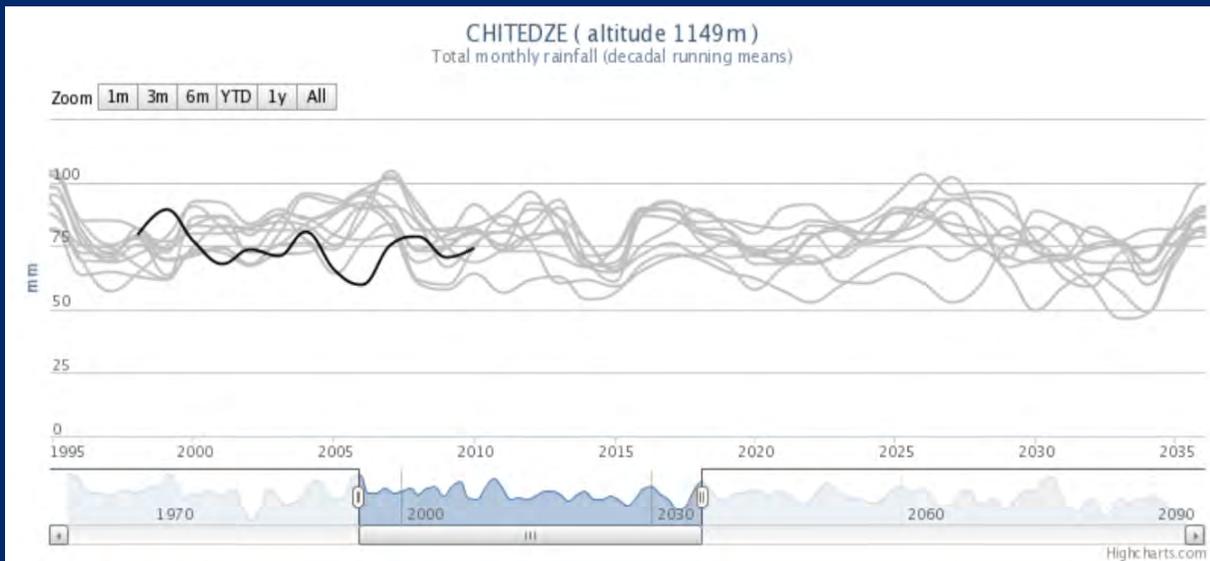
³⁴ Climate literature tends to focus on climate systems (such as monsoon or the intertropical convergence zone as a whole) irrespective of country boundaries. Conversely, a given country can span zones with different climatic characteristics, including different seasonality (e.g., two rainy seasons in the South of Uganda versus one in the North) and be influenced by different climatic systems.

³⁵ If the historical baseline is established on short periods that do not encompass a sufficient number of climate cycles, (e.g., 10 or 15 years around periods when the rainfall is respectively higher or lower than average), it could falsely imply that average rainfall is much higher or lower than is the case.

TEXT BOX 7.2: NATURAL CLIMATE VARIABILITY

The figure below illustrates the issue of climate variability and the challenge of detecting the climate change "signal" for the meteorological station of Chitedze, in Malawi. Grey lines show the rainfall for this station (expressed in millimeters per month) that is predicted from 1995 to 2035, i.e., over the historical period and into the future. The black line shows the rainfall that has been effectively observed at the station during the historical period. As can be seen in the figure, the station recorded higher levels of rainfall in the late 1990s and lower around and after 2005. Models exhibit similar swings but are not synchronous with observations or among the simulations. The projections into the future carry similar variability with a slightly larger spread among the models. More important, hardly any trend can be easily detected in rainfall, since the trend signal is much smaller than the natural decadal swings in rainfall.

ILLUSTRATION OF THE LONGER-TERM CLIMATE CHANGE SIGNAL VERSUS CLIMATE VARIABILITY AND MODEL SPREAD



Source: University of Cape Town, Climate System Analysis Group, 2013

7.3.2 Modeling and Projections

The ARCC CCVAs that sought to address the long-term impact of climate change required a more sophisticated (and demanding) level of analysis than just the historical trends analysis. It required looking at future climate projections. The projections analysis begins by assembling and examining historical and current climate data sets. These data sets, along with the results of general circulation models (GCMs),³⁶ are then used to project the anticipated climate conditions in the areas of interest decades into the future.

The IPCC defines "projections" as the result of a model-derived estimate of future climate based on specific forcings or "a potential future evolution of a quantity or set of quantities,"³⁷ based on assumptions of developmental pathways³⁸ for future socioeconomic and technological growth. Different GCMs incorporate somewhat different assumptions and approximations to provide these projections. The result is that no two projections agree in their entirety. By examining an ensemble of several model projections, confidence in the results increases. An ARCC CCVA typically looked at outputs from 10 GCMs.

The spatial granularity of present day GCMs (hundreds of kilometers) is significantly greater than that appropriate to the ARCC CCVAs (i.e., sub-national, national, or transboundary water basin). Thus, the results of the GCMs required downscaling (see Text Box 7.3), to produce projections on a scale more relevant to the scope of the CCVA.

TEXT BOX 7.3: WHAT IS DOWNSCALING?

Due to the very coarse resolution of the GCMs, it is necessary to apply a procedure—a "downscaling"—to extract finer scaled information relevant to a study area. Downscaling takes information at large scales and makes predictions at local scales.

There are two main types of downscaling: Dynamical and Statistical.

Dynamical downscaling requires running high-resolution climate models on a regional sub-domain, using observational data or lower-resolution climate model output as a boundary condition. These models use physical principles to reproduce local climates, by adding local forcing factors, such as topography and proximity to oceans and lakes.

Statistical downscaling develops statistical relationships between local climate variables (e.g., temperature and precipitation) and large-scale predictors (e.g., pressure fields), and applies the relationships to the output of GCM runs to simulate local climate characteristics in the future.

Source: Paraphrased from <https://gisclimatechange.ucar.edu/question/63>

³⁶ GCMs represent the Earth's climate through mathematical equations describing atmospheric, oceanic, and biotic processes as well as interactions and feedbacks. They are the primary tools that provide reasonably accurate global, hemispheric, and continental scale climate information that are used to understand present climate and future climate scenarios under increased greenhouse gas concentrations. For more information on GCMs, see USAID: A Review of Downscaling Methods for Climate Change Projections (October 2013).

³⁷ IPCC Data Distribution Centre, Glossary 2013

³⁸ The IPCC now calls these Representative Concentration Pathways (RCP). See <http://www.ipcc.ch/activities/activities.shtml#tabs-4> for more information.

7.3.3 Downscaling

There are a number of techniques used in downscaling.³⁹ Due to time and budget constraints, ARCC applied statistical downscaling methods. **Statistical downscaling** involves the establishment of empirical relationships between historical large-scale atmospheric variables and local climate variables. Once a relationship has been determined and validated, future atmospheric variables are projected using GCMs, which predict future local climate variables.

**TABLE 7.1:
POSTCARD FROM MALAWI**



Malawi as a whole is often classified as "sub-tropical." However, the climate of areas within Malawi are greatly influenced by topography and the presence of Lake Malawi, a huge water body (29,600 km²) that spans nearly two-thirds of the country's length, while highland peaks can reach as high as more than 2500 meters above the lake's level. Thus, within Malawi, climate is closely connected to its accentuated topography. In fact, Malawi climates can be classified into three main groups:

1. Semi-arid (Shire Valley and some parts along the Lakeshore Plain)
2. Semi-arid to sub-humid (medium altitude plateaus)
3. Sub-humid (high altitude plateaus and hilly areas)

As a result of these topographic variations, specific changes in climate are also expected to vary in important ways throughout the country, as shown in Table 7.2 below.

These differences can have important implications for each location. For example, in Bvumbwe, ARCC's analysis of recent historical climate trends showed that onset of the rainy season is later than the historic norm and is ending sooner; thus, the total length of the rainy season is becoming shorter. The annual total volume of rain, however, is increasing. More rain in a shorter period leads to an increase in the risk of flooding and also has implications not only for crop choices, but also for how the crops are grown and handled. For instance, sorghum is more sensitive to changes in temperature than to changes in precipitation, but the opposite is true for sorghum pests and diseases, which are more prevalent under conditions of increased precipitation.

In Ngabu, on the other hand, the rainy season is simply shifting—starting earlier but also ending earlier—with no change in the length of the season. However, here again, total rain accumulations are increasing, but so too are the number of dry spells per year. At the same time, the length of these dry spells is decreasing. In other words, the rain will be more "erratic" in this area. Erratic rainfall constrains crop choices, with maize being particularly affected.

Similar analyses can be made for other areas, other crops, and other factors (e.g., ground water recharge, surface water fisheries, livestock). The main message here is that if the results of the CCVA are intended for sub-national planning, then using the overall climate zone classification of "sub-tropical"—and treating the entire country as if the expected climate changes were going to be the same everywhere—will lead planners to miss many opportunities for effective adaptation interventions, and could, in fact, lead to the selection of adaptation options that are not viable for large and important portions of the country. This is the reason why a sub-national scale climate analysis is required if the results are to be used for sub-national planning.

³⁹ For additional detail, see USAID, op cit., October 2013.

TABLE 7.2: OBSERVED (RECENT HISTORICAL) CLIMATE CHANGE

Location	Characteristics	Rain onset	Rain cessation	Length of rainy season	Total rain volume	Annual number of dry spells	Length of dry spells
Bvumbwe	Elevation 3805 feet; centrally located in mountains/hills	Later	Earlier	Shorter	Increase	Decrease	Increase
KIA (Kamuzu International Airport)	Elevation 4035 feet; centrally located	No change	Earlier	A bit shorter	No change	Decrease	Increase
Mangochi	Elevation 1540 feet; situated between two water bodies	A bit earlier	Later	A bit longer	Small decrease	Small decrease	Small increase
Ngabu	Elevation 295 feet; inland; dry	A bit earlier	A bit earlier	No change in length (season shifts)	Possible increase	Increase	Small decrease
Nkhota kota	Elevation 1548 feet; situated on the shore of a very large water body	Later	Earlier	Shorter	Decrease	No change	No change

7.4 INTERPRETING AND USING THE RESULTS

For ARCC, with its focus largely on agriculture and rural livelihoods, the most important climate considerations for crops were temperature, moisture, and humidity. The crop lifecycle is dependent on daily characteristics for these climate variables leading up to, throughout, and after the cropping season (post-harvest storage) and on the occurrence of severe events. ARCC experience suggests that understanding the minimum, maximum, daily, and monthly variability in these climate characteristics over a period of no less than 30 years of data is valuable to understanding how climate change is likely to impact crop productivity and crop value post-harvest.

Regardless of the details of the climate analysis, at minimum it should yield an estimate of the inter-annual and decadal-scale climate variability (based on historic data) and the range of uncertainties associated with climate projections. ARCC found that it was extremely important to "contextualize" the projections—to compare them to current levels of inter-annual variations, as well as to the slower, decadal, "swings" in climate (see Text Box 7.2)

Precisely how the climate analysis results are employed depends on the requirements of the specific CCVA. ARCC used a variety of methods. In Senegal and Mali, for example, quantitative indices were developed and normalized to allow comparison to current and historical information. In Uganda, the climate analysis compared areas spatially according to exposure metrics. In Malawi, climate information was provided in a tabular format designed specifically for use in value chain analyses of six crops. In all cases, an understanding of how those data were produced, as well as their limitations, was critical to interpreting the results.

TIPS FOR CLIMATE ANALYSIS

For ARCC, the proven effective steps in a climate analysis were to:

- Clearly define the scope of the analysis as a sub-component of the CCVA research design,
- Obtain the necessary data,
- Decide on an appropriate analysis methodology and performing the analysis, and
- Interpret and communicate what insights the results can and cannot provide.

In defining the scope of the analysis, two areas where decisions needed be made early, and with the involvement of stakeholders, included **spatial resolution** of the exposure information and **time horizon**. Understanding each of these guided the choice of climate analysis to be undertaken. ARCC learned that considerable time and effort can be saved by agreeing early on the time horizon of climate projections for a climate analysis. The Compendium makes the distinction between a CCVA and a "VA with climate information" depending on the purpose and planning horizon:

- **A CCVA** is a VA which attempts to estimate changes in vulnerability linked to changes in climate projected for one or more decades into the future. If the planning horizons are 15 to 30 years, or the near-term programs are intended to prepare populations or sectors for longer-term adaptation, as was the case with ARCC CCVAs, then climate projections are highly desirable.
- **"VAs with climate information"** typically inform programs in the short-term for which analysis of current and historical climate trend information may be adequate.

Features of an ARCC Climate Analysis:

The analysis of future climate change begins with a knowledge of historical and present day climate conditions based on historical and current meteorological data; it then "extrapolates" (via models) these conditions into the future.

Historical and present day climate conditions provide insights into current and recent vulnerabilities and form an important part of the climate analysis:

- Global climate varies naturally on a decadal period, so **at least 30 years of historical data are needed** to establish a historical trend and provide a basis on which to compare predictions with observations.

- Uncertainty in such an analysis. Climate varies naturally on a range of scales. Often, the natural climate variations are much larger and have more profound consequences than long-term changes in climate. This natural climate variability can easily mask any climate change trend over time.
- **Data are usually available through national and regional meteorological services.**
- Oftentimes as **much time is needed for data cleaning** as for data analysis. It is time well spent, as both a long time record and a high quality data set enhance the scientific credibility of the results.

To help provide an **understanding of the extent of climate variability**, ARCC found that it was important to make clear the degree to which natural and historic variations contribute to. With ARCC's focus largely on agriculture and rural livelihoods, the most **important climate considerations for crops were temperature, moisture, and humidity**. Understanding the minimum, maximum, daily, and monthly variability in these climate characteristics over a period of no less than 30 years of data is valuable to understanding how climate change is likely to impact crop productivity and crop value post-harvest.

The historical analyses were also used as a base from which to extrapolate future climate changes by **modeling future climate**, which for ARCC entailed the following:

- The results of the GCMs require **downscaling** to produce projections on a scale more relevant to the scope of the CCVA. Existing climate models—general circulation models or GCMs—have a spatial granularity (hundreds of kilometers) that is significantly greater than that appropriate to a typical CCVA (i.e., sub-national, national, or transboundary water basin).
- An ARCC CCVA typically looked at **outputs from 10 GCMs**. No two projections agree in their entirety because different GCMs incorporate somewhat different assumptions and approximations to provide these projections. By examining an ensemble of several model projections, confidence in the results increases.
- The climate analysis should yield an estimate of the **inter-annual and decadal-scale climate variability and the range of uncertainties** associated with climate projections.
- It was extremely important to "**contextualize**" the projections—to compare them to current levels of inter-annual variations, as well as to the slower, decadal, "swings" in climate.

8.0 METHODS FOR THE ANALYSIS OF AGRICULTURE, LIVELIHOODS, AND FOOD SECURITY

8.1 INTRODUCTION

The African and Latin American Resilience to Climate Change (ARCC) Climate Change Vulnerability Assessments (CCVAs) emphasized analysis based on primary data. To collect these data ARCC modified standard methods in innovative ways. Often these modifications consisted of introducing climate-related data collection into methods that previously did not include climate as an element; less frequently, the modifications involved incorporating data from future climate projections into methods that commonly use historical climate data as an input. The modifications always consisted of aligning studied parameters with one or more of the dimensions of vulnerability: exposure, sensitivity, and adaptive capacity. ARCC also developed new uses for the results, integrating them into research frameworks focused on the evaluation of climate change vulnerability.

In addition to analyzing climate and institutions, ARCC CCVAs typically also addressed agricultural livelihoods and the related topic of food security. Six methods are presented in this chapter. Four methods focus on agriculture: agronomic analysis by phenological phase, crop modeling using climate projections, value chain analysis, and the collection of agricultural histories through focus groups. Two methods focus on the complementary topics of livelihoods assessment and food security: household surveys and participatory rural appraisals.

This chapter assumes some prior knowledge of the methods discussed; it is not intended to provide a basic introduction to the methods themselves. The purpose, rather, is to highlight the ways in which ARCC modified standard analytic methods for use in CCVAs, and how the project integrated the findings produced using these methods into CCVAs. The presentation of each method begins with a discussion of the questions the method is intended to address and follows with the critical decisions that need to be made when using that method in the context of climate change adaptation. Discussions concerning obtaining the necessary data, conducting the analysis, and interpreting and using the results follow. A summary of “tips” concludes the presentation of each method.

8.2 AGRICULTURE, LIVELIHOODS AND FOOD SECURITY METHODS

8.2.1 Method I: Phenological phase analysis

When and How to Use This Method

An agronomic analysis by phenological phase can be used to describe the relationship between climate and crops. The analysis provides information on how climate change may affect agricultural productivity, and in turn, food security, value chains, and the agriculture sector more generally.

Information used in a phenological study is primarily derived through literature reviews, although it may be necessary to use generic data as a proxy for country-specific data. Thus, the method described here is appropriate when a rough overview suffices, resources for research are limited, or when the crops being considered are cultivated under such a broad spectrum of conditions that more detailed analysis is impractical. Agronomic analysis may also be used as a foundation for additional research conducted in greater depth or with increased rigor.

What vulnerability questions does this method address?

- Are the crops studied being cultivated near their climatic thresholds?
- Which specific changes in climate are most likely to affect crop productivity?
- Are there particular times in their lifecycle where they are most vulnerable?
- Of the crops being studied, which appear to be most sensitive to expected changes in climate?

What are the critical decisions to make in using this method?

The use of this method requires careful selection of the specific crops in addition to a decision on whether the study will be conducted at the crop or variety level. Researchers must also decide whether the study will identify minimum/maximum or optimal crop requirements. As the level of information available on specific crops cannot be known prior to the study, decisions also need to be made regarding how absences in information will be managed. Interviews with active researchers would also influence these decisions, as active researchers have more current and detailed information than can be typically found in the literature.

Chapter 7 of the “Compendium of Lessons Learned from ARCC Climate Change Vulnerability Assessments” provides guidance regarding the critical decisions necessary to decide the source and type of the climate information used in analysis. When conducting analysis by agricultural profiles, the level of rigor of the analysis will determine to some extent the climate information and analysis necessary. However, even a basic agronomic analysis will reveal crop parameters that require targeted analysis of climate information. For example, information on the ability of a crop to sustain itself over a 10-day dry spell may be easier to obtain than data on the changes in the frequency of dry spells themselves. While the importance of such intra-seasonal climate values is undeniable, an early decision will need to be made about whether the resources are available to obtain these values at the spatial resolution and time horizon of the analysis.

Implementing the Method

Obtaining the Necessary Data

If not based on expert interviews with researchers working on the crops under study, the information on crops used to complete the agronomic review should draw exclusively from the most recent professional literature available, such as peer-reviewed scholarly journals, and should be based to the greatest extent possible on studies conducted within the study zone. During the conduct of its various assessments, ARCC used a variety of databases and search tools. These included the Agricola Database produced by the U.S. National Agricultural Library; Library and Information Science Abstracts (LISA), ProQuest Research Library; GeoRef; Meteorological & Geo-Astrophysical Abstracts; ABI/INFORM Global; and ProQuest Deep Indexing: Environmental Sciences, Earth Sciences. Technical reports used included those produced by Biodiversity International; Food and Agriculture Organization of the United Nations (FAO); Annual Reports and Technical Reports of CGIAR Centers; and National Programs for Agriculture in journals such as *Agricultural and Forest Meteorology*, *Climate Change Journal*, and *Sustainable Agriculture Research*. ARCC also used information from the FAO EcoCrop database, though EcoCrop provides information on general genotypes and not specific varieties cultivated in any one place.

Information concerning the agro-ecological context in which the crops are grown will also be needed. Principal biophysical data include soil types and their characteristics, dominant slope, and elevation. Principal information regarding cultivation practices includes farming calendars. Planting dates, in particular, will be necessary as they are used to “line-up” crop phenological stages with climate conditions. Much of this information can be found in the available literature, or through agricultural research institutions, or the Ministry of Agriculture of the country under study.

Additional guidance on acquiring climate data and producing the necessary climate information can be found in Chapter 7.

Conducting the Analysis

For these analyses, ARCC organized information by crop profiles. The typical contents of a crop profile would contain the following items:

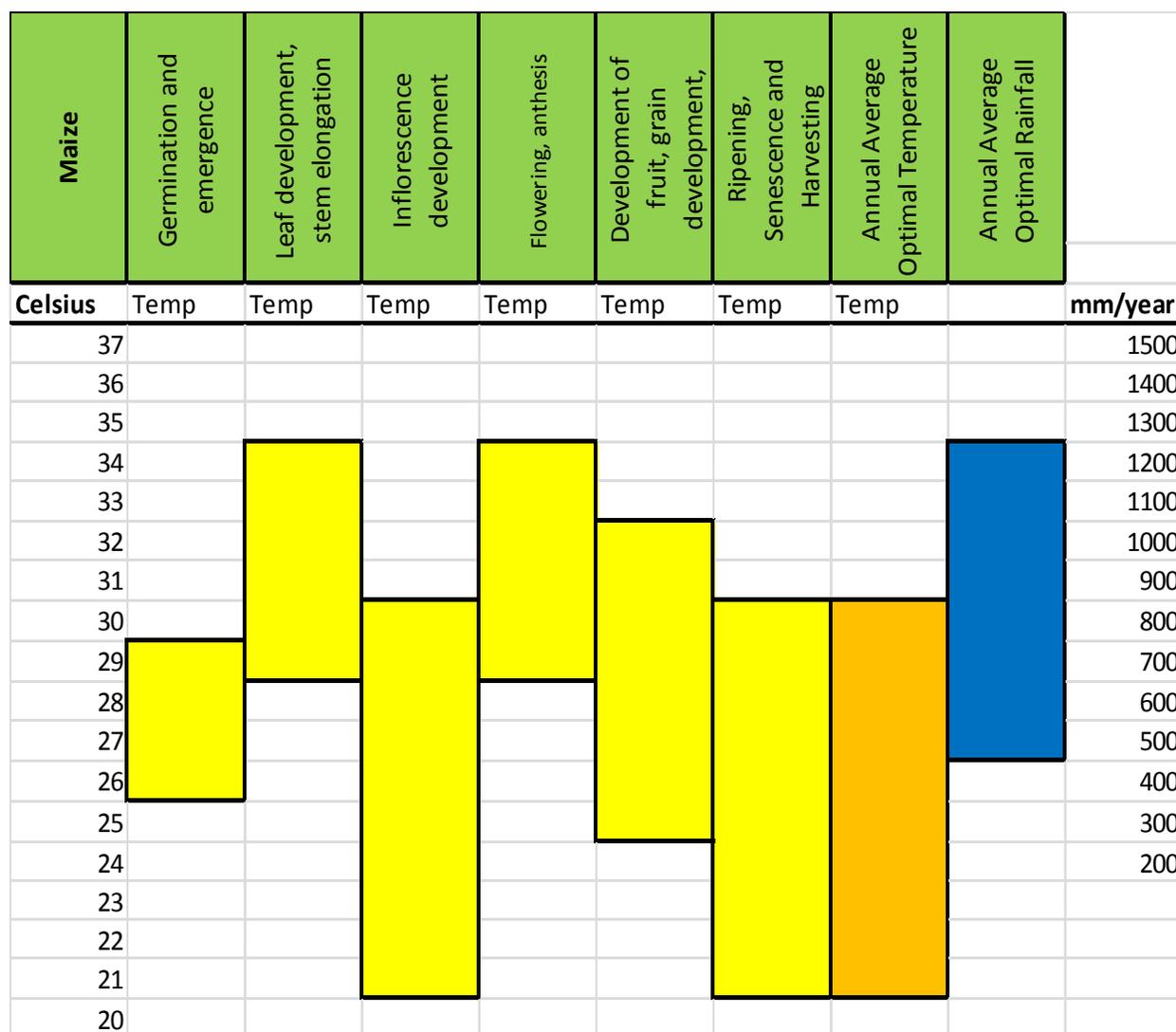
- A brief overview of the crop, including a description of its geographic distribution and importance
- A presentation of its life cycle
- Graphics illustrating known annual rainfall requirements for the crop and temperature requirements at different stages of physiological development
- Details of growth thresholds related to soil conditions, water availability, and temperature
- Additional background on the crop’s performance under different conditions, and variation in these parameters among different varieties

Constructing the profiles themselves consisted largely of organizing and presenting information in a manner amenable to cross-analysis with other study components. Graphs (e.g., Figure 1 below) were found to be a useful tool in presenting crop requirements.

Analysis consisted of screening the identified crop characteristics against the climatic and agro-ecological context of the geographic area under study. Simply put, where local conditions do not meet the crop

requirements, productivity is assumed to be affected.⁴⁰ A large number of climatic characteristics affect yields. These characteristics include the timing and duration of the rainy season, the concentration of rainfall and number of heavy rains, the frequency and duration of dry spells, and nighttime and daytime maximal and minimal temperatures. These events occur in combination and affect crops differently during different phases of the lifecycle. Conducting a reliable and thorough analysis, even a rough one, requires an experienced agronomist, preferably one with experience in the study zone.

FIGURE 8.1: MAIZE ANNUAL RAINFALL REQUIREMENTS AND TEMPERATURE REQUIREMENTS AT DIFFERENT STAGES OF DEVELOPMENT



⁴⁰ For an in-depth discussion of one application of this approach, see Simpson, B. (2014). "Agricultural Adaptation to Climate Change in the Sahel: An Approach to Conducting Phenological Screening". ARCC Project. USAID.

Interpreting and Using the Results

Even the most rigorous application of this approach faces limits in precision and certainty. The requirements of different varieties of the same crop may span a wide range of temperature and moisture levels; in most cases, research has identified requirements for a limited number of varieties. Further, annual rainfall averages provide an inaccurate proxy for the amount of rainfall actually made available to plants; rainfall is unused if it falls outside of the growing season or before a dry spell requiring replanting, or if it is lost in runoff. The spatial and temporal variability of climate and cultivation practices also pose limits to accuracy when determining whether requirements are met. Finally, it should be noted that various agronomic factors other than climate influence whether biophysical potentials are reached, and that supra-agronomic factors — such as access to inputs, market demand, and agricultural policy — also play a role in determining yields and overall levels of production.

Recognizing these caveats, the results of an agronomic analysis by phenological stage can be assembled in an accessible format, into up-to-date, critical information useful in understanding potential climate-related threats to the principal crops important to agricultural systems in the zones being studied. Collaboration with local agronomists can greatly strengthen the results, their interpretation, and their application. The profiles may also serve as a useful tool for identifying potential threats to crop production for further research.

ARCC used agronomic analysis as one component of assessing short-term threats climate change poses to agricultural productivity. The findings produced informed both exposure and sensitivity elements of vulnerability assessments.

TEXT BOX 8.1: TIPS FOR AGRONOMIC ANALYSIS

- Recognize the complexity of agricultural systems and the inherent limitations of this approach.
 - Conducting a phenological study is appropriate when a rough overview suffices, when resources for research are limited, when the crops being considered are cultivated under such a broad spectrum of conditions that more detailed analysis is impractical, or when the results of the study are to be used as a foundation for additional research conducted in greater depth or increased rigor.
- Screen identified crop characteristics against the climatic and agro-ecological context of the geographic area under study.
 - Where local conditions do not meet the crop requirements, productivity is assumed to be affected.
- Consider conducting interviews with local researchers on the crops in question for more current and site-specific information. Long-term collaboration could greatly strengthen analysis.
- Consider possible secondary uses of the findings of this method, including targeted research on potential threats, and use of the profiles to inform the fieldwork associated with other CCVA studies components.
- Organize information from the analysis of crop profiles in a manner amenable to cross-analysis with results from other study components.

8.2.2 Method 2: Crop Modeling Using Climate Projections

When and How to Use This Method

Like agronomic analysis, crop modeling can be a valuable tool to understand how changes in climate may affect crop yields. Crop modeling based on climate projections provides results for distant time horizons of 15 to 35 years; thus, the results may be used to inform decision-making regarding long-term policy and research directions. As the results of crop modeling are sensitive to changes in climatic and environmental parameters used, this method is most effectively applied where accurate, detailed information can be obtained, and where growing conditions are generally homogeneous across the study area.

What vulnerability questions does this method address?

- How do current climate projections suggest crop yields will change in the long term?
- Which crops are most sensitive to projected changes in climate in the long term?
- What are the geographic “hot spots” where crops are at greatest risk in the long term?

What are the critical decisions to make in using this method?

Of the two types of crop modeling — process-based and statistical — the latter requires less field data, employs a more transparent process, and is better adapted for use at larger spatial scales.⁴¹ ARCC, however, found process-based approaches to be more widely used. Consequently, there is more technical expertise available when looking for someone to conduct studies using this approach. Regardless of the approach used, however, deciding the locations to be used in modeling is critical. Because process-based crop modeling produces results at the plot level, and the method itself is resource- and information-intensive, the location modeled must be selected with particular care. The objectives of the research, experience of the modeler, and data access all should be taken into consideration when selecting which of the many available models to use.⁴²

No matter which type of crop modeling is used, the climate data must also be selected in a way that takes into consideration the range of results from different climate projections. Modeling for a large number of climate scenarios decreases uncertainty in the results but requires substantially greater effort, especially if multiple crops are being modeled at multiple locations. Another critical decision to be made concerns whether agricultural practices such as the use of fertilizer should also be modeled.

Crop modeling requires detailed information on the duration of each stage of the lifecycle — and the moisture and temperature requirements at each of these stages — for each crop variety being evaluated. It also requires information on parameters of the location being modeled, including climate, soils, and agricultural practices. Ground verification of models requires historical climate and yield information. The availability of such information should inform the decision to use this method.

⁴¹ Process or mechanistic crops models use algorithms and extensive data inputs to generate approximations of plant physiological responses to environmental factors. Statistical models, in contrast, use extensive empirical data sets of crop yields under different environmental conditions as the basis for predicting crop response to target environments based on key environmental parameters. For a discussion of the use of these two types of models in the context of climate change assessments, see: Simpson, B. (2014). *Agricultural Adaptation to Climate Change in the Sahel: an Approach to Conducting Phenological Screening*. ARCC project. USAID.

⁴² Characteristics in common crop models can be found in Annex VI of: ARCC. (2014). *Agricultural Adaptation to Climate Change in the Sahel a Review of Fifteen Crops Cultivated in the Sahel*. ARCC project. USAID.

Implementing the Method

Obtaining the Necessary Data

As with any modeling exercise, the quality of the results from crop modeling depends on the quality of the data used. The information necessary to set parameters may come from a variety of sources: an agronomic analysis; agricultural research literature; reports on other crop modeling experiences; researchers in the field; government publications; and, for information regarding current practice, fieldwork. In addition, a number of options exist to fill information gaps with generic data or default parameters, although the use of such may reduce the quality of the results. Crop modeling software typically includes default parameters; for example, the FAO EcoCrop database includes generic data on crops.

Obtaining the climate data for modeling presents a distinct set of challenges. Global Climate Models have produced a large number of projections of future climates, which, in some cases, are very different from each other. Modeling should be conducted in a way to reflect these differences. ARCC addressed this issue by using data from the extremes of the range of climate projections. This “best case/worst case” modeling demonstrates the range of likely future crop yields.

In some cases an additional step is necessary to randomly generate rainfall data in a form that can be used by the crop model with the climate projections. Again, the appropriate software must be selected and a strategy developed to select among the multiple sets of results generated by this simulator.

Conducting the Analysis

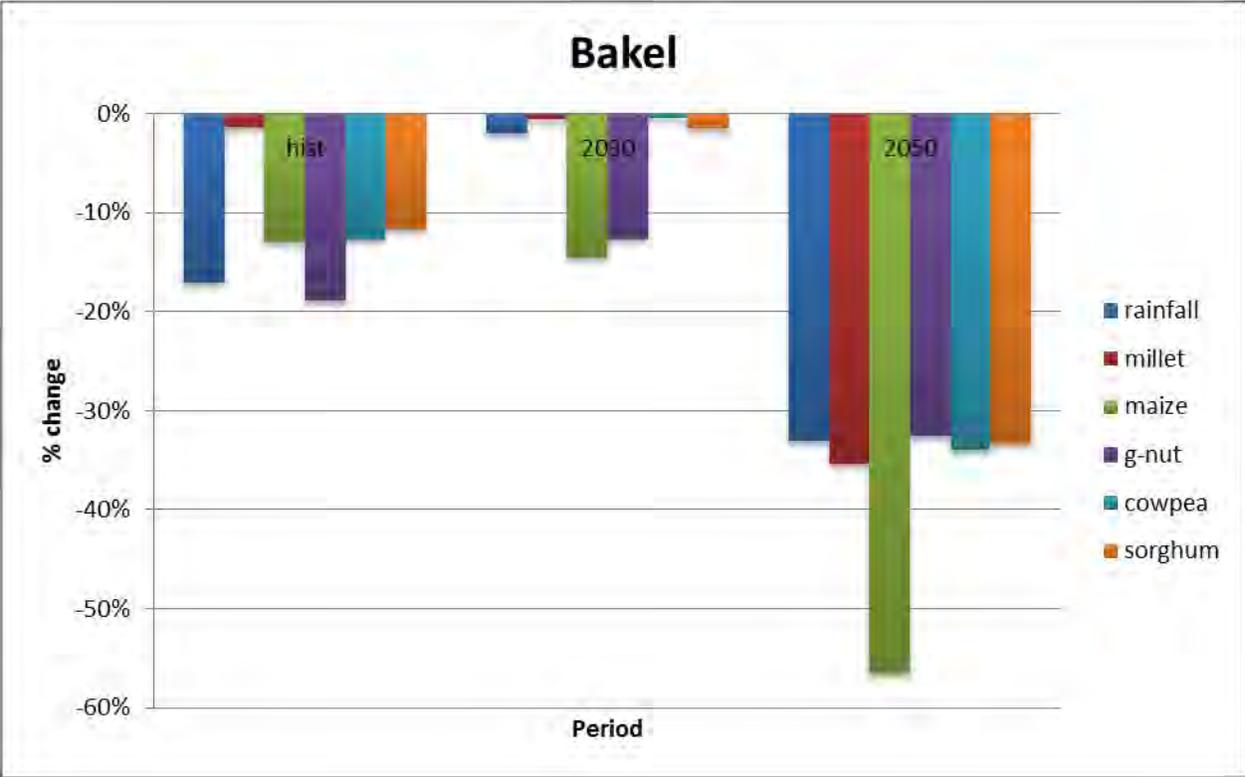
Using crop modeling software under any circumstance requires training and experience; modeling based on climate projections adds a new layer of complexity to the process. Steps in modeling include collecting and organizing the necessary information, using that information to set parameters in the software, piloting the selected parameters against known historical yields, making any necessary adjustments to parameters, running the software for the various crops and conditions being tested, and interpreting and presenting the results.

Interpreting and Using the Results

Crop modeling takes into consideration and quantifies the impact of a large number of crop and contextual factors. It is a significantly more rigorous approach than agricultural analysis by phenophase. Yet, while crop modeling provides quantified results, it still contains a large range of uncertainty. The degree of uncertainty in climate projections, the degree to which climate data accurately reflects rainfall patterns, and the precision of the information used in establishing the parameters of the crop model all affect the accuracy of the results. The potential changes in farmer practice — such as types of varieties planted and other unforeseen changes in context — further reduce the likelihood that the projected yields will accurately represent yields 15 to 35 years in the future.

As a result, interpretation should focus on the direction of change — and relative change among different crops, locations, and other parameters — rather than the specific amount of change expected. For example, the ARCC Senegal assessment placed modeling results in the context of historical changes in climate, comparing changes between dry historical periods, more favorable current periods, and projected future periods. ARCC used crop modeling as one component of assessments of long-term threats to agricultural productivity posed by climate change. The results informed both exposure and sensitivity elements of vulnerability assessments.

FIGURE 8.2: CROP MODELING RESULTS FOR BAKEL, SENEGAL



Summary: Results for one meteorological station in Senegal, based on the climate model projection closest to the multi-model average. Results show percent change relative to those from an “average” year in a 20-year reference period, 1990–2010, when annual rainfall averages were higher than the 1970–1980 historical period.

TEXT BOX 8.2: TIPS FOR CROP MODELING

- Select the type of modeling and modeling software based on expert evaluation of the field data available, objectives of the assessment, and technical expertise available.
- Use crop modeling when accurate detailed information can be obtained and where growing conditions are generally homogeneous across the study area.
- Select the location to be modeled with particular care, because process-based crop modeling produces results at the plot level, and the method itself is resource- and information-intensive.
 - By limiting the scope of the exercise, careful selection of the location and crops to be modeled help address the resource-intensive nature of crop modeling.
 - Crop modeling requires detailed information on the duration of each stage of the lifecycle — in addition to the moisture and temperature requirements of each stage — for each crop variety being evaluated. It also requires information on parameters of the location being modeled, including climate, soils, and agricultural practices.
 - Prior to committing to this method, consult with experts to determine if sufficient field-level information will be available to model accurately, as well as to explore the geographic area over which results can be extrapolated reliably.
- Select climate data in a way that takes into consideration the range of results from different climate projections.
- Collaborate with researchers familiar with the agricultural systems being studied, as this effort will provide an additional check on the findings and conclusions produced through this method.
- Focus the interpretation of results on the direction of change and the relative change among different crops, locations, and other parameters, rather than on the specific amount of change expected.

8.2.3 Method 3: Value Chain Analysis

When and How to Use This Method

A value chain analysis can be valuable in determining how climate change may affect crops beyond changes in potential yields. A simple value chain appears below:



The information generated concerning inputs, cultivation and production, storage and handling, processing, distribution (including transportation), sales, and consumption can be used to estimate the economic costs of climate change and identify potential points for effective intervention. ARCC applied value chain analysis to both subsistence and cash crops.

What vulnerability questions does this method address?

Numerous vulnerability questions can be answered using a value chain analysis. Questions might include:

- How will climate change affect each of the stages in a crop's value chain?
- How might different groups of people (urban/rural, traders/producers, men/women, domestic/international consumers) be affected by climate change?
- How might climate change affect non-production steps in the value chain such as post-harvest storage and primary processing, or transportation to markets?
- Which crops are most vulnerable to climate change?

What are the critical decisions to make before using this method?

The critical decisions to be made prior to initiating a value chain analysis include which crops to include in the analysis, whether to try to obtain climate projections or to base the analysis on current climate and/or historical trends, how to evaluate potential impacts of climate on the production potential of crops (such as through an agronomic analysis or crop modeling), what fieldwork will be conducted, and how quantitative or qualitative the analysis should be. In many countries, ARCC found a dearth of information on secondary and tertiary processing, transportation, distribution, and wholesale and retail trade. In such cases, it was difficult to analyze the steps further down the value chain. Thus, the decision of whether or not to conduct a value chain analysis will depend on the availability of data as well as on the time and resources available to carry out the study. It may be appropriate to analyze only a portion of the value chain (for example, to analyze only inputs, production, storage, and handling) if the study focuses on the local effects of climate change on subsistence farmers rather than on the entire chain.

Implementing the Method

Obtaining the Necessary Data

Several categories of information are required to conduct a value chain analysis. In addition to information on the production, addition of value, and marketing of the agricultural products to be studied, a climate analysis will be required. A current and historical climate trends analysis and/or projected climate analysis will provide climate change information against which value chain vulnerabilities can be evaluated. (For details about conducting a climate analysis, see Chapter 7.)

The crop selected, the level of development of the value chain itself, and the availability of information will determine the depth of detail for which information for the various stages of the value chain is collected. For analysis of the production phase of the crops it studied, ARCC used either an agronomic analysis (phenology study) or crop modeling to generate information on how climate change may affect crop yields. Obtaining the necessary data for these methods is discussed above.

In the contexts in which ARCC conducted its evaluations, the literature contained few detailed and accurate descriptions of the relationships among climate and the other community-level stages of value chains, such as practices for drying, storing, and processing crops. While the ARCC project used focus group and Participatory Rural Appraisal (PRA) methods to collect this data, key informant interviews with people working or living in the study zone may suffice.

Existing studies are more likely to address the down-stream stages of the value chain such as transportation and marketing. Such studies may even note weather-sensitive links in the chain such as the impact of high temperatures or humidity on transportation or storage. On the other hand, although the relationship between climate variability and extremes and transportation seems obvious, ARCC

found no studies on the potential impact of climate change on transportation – nor was the basic information to quantify such relationships, such as the impact of seasonal rainfall on roadways, available.

Conducting the Analysis

Many manuals describe how to conduct a value chain analysis.⁴³ When carrying out a value chain analysis with a climate lens, the analyst focuses on how specific climate factors affect the individual stages of value chains. Nevertheless, this dynamic between climate and the various stages should be described and understood in the context of the other factors that influence value chains, such as markets, economics, agriculture, trade policies, and so forth. These other factors become fixed or “controlled” in the analysis. For ARCC’s CCVA in Uganda, for example, the team assessed how increasing temperatures and increased precipitation during the traditional dry season would affect different events along the value chain (see table in the following pages).

Interpreting and Using the Results

Once the climate effects at various points along the production chain are understood, it should be possible to estimate the likely change in the marketing of the product. Combined with information about standard yields, the total area cropped, and post-harvest storage and transport, the analyst might then estimate such factors as the change in expenditures due to one or a combination of the following items:

- Seed variety choice or use of hybrid seeds
- Use of inputs such as fertilizer, including first and subsequent applications
- Changes in the planting and harvest periods
- Increased labor such as for weeding, stripping, or ridging
- Increased post-harvest processing costs (e.g., for drying, shelling)
- Other climate-induced post-harvest and storage costs
- Transport delays due to climate change impacts (such as increased flooding or storm surges) or impacts on cold chain transport
- Increased loss due to spoilage during transport
- Reduction in selling price due to lower-quality crops caused by climate change
- Potential for consumers to switch to other products when quantity or quality falls below a certain threshold

Many other aspects can be studied. The ones chosen should be informed by the crop, the number of crop products, the number of links in the value chain that are being studied, and the availability of data and information. Each aspect is studied through a climate change lens. The goal will be to determine where and how policies and programs can address those points along the value change that are most vulnerable to climate change impacts. The “most critical” could be identified as those most likely to occur (or already occurring), those with the largest overall economic impact, those that pose the greatest risk to food security, or some other measure that is relevant to the purpose of the analysis.

⁴³ In 2011, the World Agroforestry Center reviewed 32 guidelines and manuals for value chain analysis for agricultural and forest products. (For more information, please visit: <http://www.worldagroforestry.org/downloads/publications/PDFs/OP11160.PDF>)

TABLE 8.1: COMPARISON OF THE EXTENT OF CLIMATE-RELATED VULNERABILITY BY CROP IN UGANDA

Vulnerability	Coffee*	Matooke	Maize	Beans	Rice	Sorghum	Sweet Potatoes	Cassava
Rising temperature threatens suitability for production.	+++	++	++	+	+	+	+	0
Falling soil fertility reduces yields and makes crop more vulnerable to climatic stresses.	+++	+++	+++	++	++	++	+	+
Poor moisture retention capacity of soils increases vulnerability to precipitation variability.	+++	+++	++	++	++	+	+	+
Pests and diseases increase with rising temperatures.	+++	+++	+	++	++	+	+	0
International prices become increasingly volatile as a result of climate change impacts on supply.	++	0	++	0	0	0	0	0
High temperatures and unseasonable rain promote rapid spoilage and threaten quality.	+++	+++	++	+	0	0	+	+
Rising international concern over carbon footprint may threaten demand for exports.	+++	++	0	0	0	0	0	0
There can be shortages of disease-free planting materials, exacerbated by unreliable precipitation.	+++	+++	0	0	0	0	+++	+++
The crop is perishable. Extreme precipitation and flooding make transport more costly and difficult.	++	++	+	+	+	+	++	++
Increasing variability of precipitation and extreme events threatens suitability for production.	++	++	+++	+++	+++	+	+	+

Key: Relative impact of climate change on various aspects of vulnerability by crop:

- +++ *Highly Vulnerable*
- ++ *Moderately Vulnerable*
- + *Limited Vulnerability*
- 0 *Not Affected*

**Note: Threat of rising temperatures is much more acute for Arabica coffee than for Robusta*

TEXT BOX 8.3: TIPS FOR VALUE CHAIN ANALYSIS

- To conduct a value chain analysis under a climate change lens, a climate analysis is required in addition to information on the production, value, and marketing of the agricultural products to be studied.
- Lessons for conducting a value chain analysis with a climate change lens include the following:
 - Required data may not be available at the subnational, or even the national, level. For example, phenological data may only be available for generic eco-agricultural zones rather than a specific country or an area within a country. In such cases, it may be necessary to use phenological data associated with an eco-agriculture zone that is close or similar to the one being analyzed, rather than specific to it.
 - Most climate change effects will not occur in isolation. It will be necessary to look at combinations of climate effects on the value chain. Splitting these combinations into categories (such as low, moderate, and extreme climate change) can simplify the analysis and the presentation of results.
- As much as possible, the dynamic between climate and various stages in the value chain should be described and understood in the context of other factors that influence value chains, such as markets, economics, agriculture or trade policies, and so on.

8.2.4 Method 4: Agricultural Case Histories

When and How to Use This Method

Many methods of assessing climate change vulnerability at the community level have been developed for a variety of purposes. ARCC designed this process of collecting agricultural case histories as a rapid targeted tool, often to provide context for household surveys conducted in the same communities. The project used agricultural case histories to provide insight into the practices farmers use to adapt to changes in their context, including changes in climate. The understanding of these agricultural adjustments can, in turn, provide insight into the options available to farmers to respond to climate change. Agricultural histories can also provide information regarding the other factors to which farmers adapt their agricultural systems. Such factors may include a growing population, shifts in natural resource availability, or a rise in market demand. They may also include the increased availability of new technologies.

What vulnerability questions does this method address?

- How have farmers used different crops and types of land to adapt to climate?
- What particular practices have farmers used to increase production and manage risk?
- What are the differences in strategies that men and women employ?
- What has influenced the adoption of new practices?
- How do other factors such as market demand, natural resource availability, credit, and population affect climate adaptation strategies?

What are the critical decisions to make in using this method?

The collection of agricultural case histories through focus group discussions requires decisions common to any type of focus group-based research. These include decisions regarding the participant selection strategy, translation, logistics, facilitation, recording responses, and analysis. In the case of agricultural case histories, the enormous complexity of agricultural systems requires great attention to the boundaries of research, the topics to be discussed, and the level of detail sought. The types of adaptive practices to focus on should be determined in addition to whether discussions will focus on externally introduced innovations or more “autonomous” adjustments. Concentrating exclusively on practices with origins from outside of the community, such as field management techniques introduced by extension agents, is one way to delimit the study; however, doing so will also prevent a full understanding of the reasons for adopting these practices. Decisions will also need to be made regarding the precision and depth of information on varieties, types of land, and agricultural practices. Design of the discussion guide and moderator training will need to clarify the detail to which local perceptions of climate change are collected. Another critical decision to be made involves the level of detail to be collected on non-climate stressors. Discussion guides will need to produce a natural flow through these sets of information to clarify the complex relationships between climate change, other changes in the context, and adaptive practices. Given the practical time limits, discussion guides must strategically target the critical topics.

Implementing the Method

Obtaining the Necessary Data

In addition to the issues common to all focus group discussion fieldwork, clarifying terms presents distinct challenges when developing focus group research on a new topic. This method introduces a number of abstract terms that will need to be translated into practical definitions shared by all field researchers. Different people understand the word “climate” and how it differs from “weather” differently. Its manifestations present a similar challenge. At what point does a dry spell become a drought? When is a heavy downpour a flood? In one community, different people could answer differently that a lack of rain, high temperatures, or strong winds damaged crop yields.

Similarly, gaining a basic understanding of the origin of adaptive practices may result in confusion if discussion moderators do not have a common understanding of the information to be collected. The definition of “traditional” as a source of innovation, for example, may be interpreted in multiple ways, especially in cases in which external agents have introduced modified versions of practices developed initially by local farmers.

It is strongly recommended that researchers not introduce climate change as the focus of their research. The mention of climate change may easily direct the discussion in a more limited — and potentially politicized — direction, when a broad history of the evolution of agricultural practice is the true objective.

Conducting the Analysis

Analyses will differ depending on the intended use of the findings from the activity, and the extent to which the data collected is to be analyzed quantitatively or used for its qualitative, descriptive value. ARCC most often collected agricultural histories in conjunction with statistically designed surveys conducted in the same communities. The information collected in focus groups provided depth to the survey results, and deeper descriptions of trends. The quantitative survey provided statistically valid counts of practices employed in study communities.

ARCC agricultural case history focus groups discussions followed the following general outline:

1. General background on the community through interviews with community leaders (example topics: demographics, infrastructure, markets, governance, history with projects/extension agents, important historical events)
2. Principal categories of questions discussed separately with male and female focus groups:
 - a. Most important changes in the community over the past 20 years (examples: roads, new markets, migration, schools, illness, changes in government, conflict)
 - b. Most important changes in agriculture over the past 20 years (examples: natural resource degradation; new markets; new crops, lands, and methods; more or less labor)
 - c. Greater detail on specific changes
 - i. Changes in crops, including proportions of different crops/varieties planted, and associated field types
 - ii. Changes in the farming process, from seed and input selection, through processing and sale
 - d. For each practice identified:
 - i. Challenge addressed or opportunity met by each change (including climate conditions).
 - ii. Barriers and requirements to adopt/adjust. Why some people were unable to adopt the practice or make the change, and others not.
 - iii. Origins of the practice/adjustment.
 - e. Perceptions of changes in climate over the past 20 years

TEXT BOX 8.4: CORE FINDINGS FROM ARCC AGRICULTURAL CASE HISTORIES:

- The practices used to adapt to changes in climate
- The climatic challenges met by these practices
- The barriers and trade-offs associated with their adoption
- The non-climate factors associated with their adoption

ARCC tailored the above outline depending on the needs of the study. The largest modification involved adapting this format to accommodate a different system of production, such as raising livestock, or harvesting forest resources and products.

TEXT BOX 8.5: EXAMPLE FINDINGS FROM ARCC AGRICULTURAL CASE HISTORIES:

Uganda: Percentages of practices introduced by government, private sector, and other villages

Mali: Gender differences in factors limiting adoption

Senegal: Climatic considerations in investing in different types of livestock

In agricultural systems in which many crops are cultivated, systematic application of the guide proved to be onerous for both facilitators and participants. (In particular, Parts i and ii of Step C not only took time to administer but generated a very long list of practices to discuss in Step D.) To address this issue and reduce the duration of discussions, ARCC reduced the number of topics addressed in studies in which the results were to be quantified. In cases in which qualitative results were sought, ARCC used the discussion guide to generate a more open-ended, less rigorous, discussion.

Interpreting and Using the Results

Agricultural histories can provide a rich description of strategies farmers have used to adjust to changing climatic conditions. While they cannot demonstrate how farmers will

adapt to conditions in the distant future, or to unforeseen changes in climate, they can indicate the types of strategies farmers have employed in the past, and the considerations they have taken into account when engaging in them. The histories can also provide information on sources of externally introduced practices, and the conditions or characteristics that facilitate their adoption. Agricultural histories may also provide information on non-climate stressors that have influenced changes in agricultural systems, such as natural resource degradation, rising population, input subsidies, or changes in market prices or access. ARCC used agricultural histories as a means to assess the range of options available to communities to adapt to climate change and understand the process of climate adaptation. As such, the results informed both the adaptive capacity and options analysis elements of vulnerability assessments.

8.2.5 Method 5: Household Survey Organized by Sustainable Livelihood Asset Categories

When and How to Use This Method

A household survey allows researchers to characterize the populations within large geographic areas in a way that produces quantified results. These results can be analyzed on a household-by-household basis or aggregated to compare one group of households to another. Because such surveys produce statistically valid results from a sampled population, the results normally can be extrapolated to a larger population.

ARCC survey methods were based on those of livelihood vulnerability assessments conducted to evaluate food security. They were designed to collect information regarding the five categories of assets that contribute to sustainable livelihoods: natural, physical, financial, social, and human. The survey teams modified this approach to adapt it to the needs of the ARCC climate change adaptation assessments. The most significant modification was to analyze the results using the definition all ARCC assessments employed – that climate change vulnerability is a function of exposure, sensitivity, and adaptive capacity. Specifically, the surveys were designed to measure household assets as an indicator of sensitivity and capacity to adapt to climate change.

ARCC assessments focused on the slow-onset impacts of climate change on production systems of rural agricultural households. Household surveys following this design are generally not appropriate for exploring vulnerability to fast-onset climate threats such as floods and other extreme events. What they do provide is a rich portrait of the households in the geographic area studied; emerging threats to agricultural production; and information on relative levels of vulnerability. This information can be used to inform the selection of geographic and livelihood areas for intervention. Such surveys may also be used to identify the resources available to households to adapt to or recover from the impacts of climate change.

What vulnerability questions does this method address?

- What is the distribution of natural, social, financial, physical, and human resources across households studied?
- What is the importance of different livelihood strategies, particularly agricultural strategies, in the different households of the study area?
- What household characteristics are especially associated with climate change vulnerability?
- What are the greatest strengths to build on and weaknesses to address among households studied when designing adaptation strategies?

What are the critical decisions to make in using this method?

Before drafting the survey instrument and selecting the sample, the research team must clearly define climate change vulnerability and how the terms “exposure,” “sensitivity,” and “adaptive capacity” will each be defined and measured. The definition of these terms will vary based on the objectives and resources of the study. For example, ARCC household surveys were designed to measure sensitivity and adaptive capacity. Exposure was determined using information external to the survey – observational data from meteorological stations, and climate change projections. The exposure information was combined with survey results during analysis. This approach required decisions to be made on how to relate the exposure information to the survey results conceptually, geographically, and quantitatively. (An alternative approach, used in other studies, is to collect data on exposure through the survey itself.)

ARCC assessments defined adaptive capacity in terms of specific household assets. Decisions associated with measuring adaptive capacity centered on defining the specific indicators and questions to be used to measure assets in the five categories – natural, social, financial, physical, and human. For example, control over land was identified as a natural asset, and questions were constructed to measure that indicator.

Sensitivity is more difficult to define. Because climate change affects productivity, ARCC’s Uganda assessment team used crop and livestock sales as the indicator of sensitivity, equating lower sales with greater sensitivity. For ARCC’s Senegal Assessment, sensitivity was defined in terms of the anticipated impact of climate change on a household’s ability to produce crops and livestock. For example, households that principally farm crops that were expected to grow less well under projected climate conditions were scored as more sensitive to climate change; households that farm crops or raise animals that were expected to fare better under projected climate conditions scored as less sensitive.

Implementing the survey method may also require decisions concerning complementary research. ARCC surveys selected households as the unit of analysis and conducted interviews with heads of households. This approach provided one perspective. Specific questions did explore resources available to women in households; however, if gender questions are to be explored in depth, a second questionnaire administered specifically to women would be necessary. Similarly, depending on the objectives of the study, additional interviews at the community or administrative levels may provide needed institutional context or address questions that household heads would be unable to answer.

Implementing the Method

Obtaining the Necessary Data

The resource and logistical decisions involved in the application of the household survey method for climate change adaptation are no different from those in the application of household surveys conducted for other purposes. As with any household survey, the basic principles of survey design, the available resources, and research framework determine decisions regarding sample size, household selection, duration of interviews, and similar issues.

Both the Uganda and the Senegal assessments targeted vulnerable rural populations. The Uganda assessment selected districts in which to conduct the survey based on their relevance to USAID programming and that of other donors and the government of Uganda. The team also confirmed that each of the districts selected (six in all) was close to one or more meteorological stations with credible time-series data so that survey results could be related to changes in historical climate trends. The final sample consisted of 800 households divided among the districts roughly by population.

For the Senegal assessment, USAID identified the study area in collaboration with its implementing partners. The ARCC survey team divided the area into an arid northern sub-zone and a more humid

southern sub-zone, and conducted surveys in villages in each sub-zone in proportion to the total population. The study used meteorological data from the stations closest to the study zones. The final sample consisted of 450 households divided among 15 villages in the two sub-zones.

The final Senegal questionnaire collected information on the following topics: (1) household demographics and migration; (2) land farmed and crops harvested and sold; (3) herd size and change in size over the past decade; (4) animal sales, deaths, theft, and loss over the past year; (5) livestock products produced and sold; (6) livestock management practices; (7) household physical assets and lodging construction materials; (8) household participation in associations and organizations and assistance received; (9) employment and other sources of income; (10) savings; (11) food security and diversity; and (12) access to water and health of household members.

Conducting the Analysis

The objective of the ARCC surveys was to determine the sensitivity and adaptive capacity of the households under study. Subsequent analysis combined household survey data with results from other, complementary research that described the household exposure to climate. The complementary research included both past and present meteorological conditions, as well as projections of future climate change impacts. Combining the survey findings with the complementary research findings resulted in a description of the relative vulnerability of households of different types, as well as the household characteristics associated with vulnerability.

The ARCC Uganda and Senegal assessments provide two examples of this approach. In the analysis of the Uganda survey results, the ARCC team used the statistical procedure called “principal component analysis” (PCA). This procedure allowed the team to identify the most significant characteristics associated with adaptive capacity and sensitivity. Using PCA, the team identified household characteristics most closely associated with lower and higher levels of climate vulnerability, presented in terms of two household types: those that are more and less vulnerable. To further characterize sensitivity, the ARCC team computed the proportion of total household income represented by each crop grown, for each household type. The results of this analysis were combined with those of the analysis of the expected climate impacts on specific crops, resulting in identified levels of climate threat to the crops of greatest importance to the most vulnerable households. This analysis was carried out for both household types (more vulnerable and less vulnerable), for each of the eight crops, and for each of the six districts under consideration. The result was a matrix indicating the levels of sensitivity in each category (district, crop, household type). The following table presents a portion of this matrix.

TABLE 8.2: EXCERPTS FROM THE UGANDA CROP AND LIVELIHOOD TYPE SENSITIVITY MATRIX

DISTRICTS	Gulu		Lira		Luweero		Mbale		Isingiro		Kasese		Total	
	Most	Least	Most	Least	Most	Least	Most	Least	Most	Least	Most	Least	Most	Least
Vulnerability Level														
Matooke														
% Producer HHs	0	0	0	0	28	41	15	22	95	97	56	11	21	32
% of Total Production	0	0	0	0	57	35	49	55	80	78	72	49	72	62
Coffee														
% Producer HHs	0	5.3	0	0	27	29	37	52	3	8	48	78	20	40
% of Total Production	0	22	0	0	22	32	16	14	3	6	44	38	31	32
Maize														
% Producer HHs	16	63	57	56	68	95	98	100	59	72	47	53	56	71
% of Total Production	29	17	28	20	29	31	38	33	8	6	38	33	30	26

To characterize adaptive capacity, additional analysis described the livelihood assets associated with each of the two household types. The following table presents a portion of the findings from this analysis.

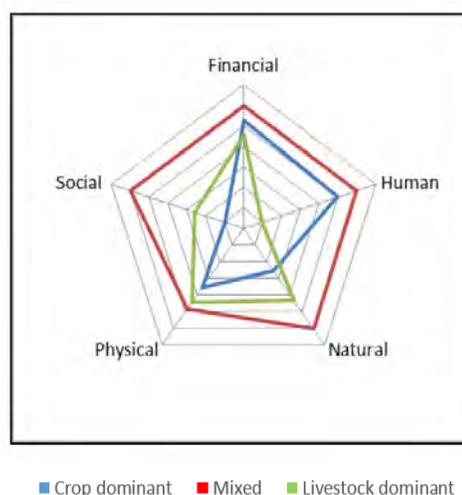
TABLE 8.3: EXAMPLE OF FINDINGS FROM THE UGANDA LIVELIHOOD ASSET ANALYSIS

District	Vulnerability Level	Financial Capital			Social Capital		Food Security	
		Crop (%) ^a	Animal (%) ^a	Off-farm (%) ^a	Participation Index	Social Capital Index	FCS (Food Consumption Score) ^b	Months Insecure ^c
Gulu	Most	352 (80)	99 (32)	573 (76)	2.1	1.4	55	3.0
	Least	1,153 (95)	1,205 (79)	4,403 (90)	2.4	1.5	55	1.7
Lira	Most	347 (60)	131 (45)	1,072 (50)	1.9	2.0	47	3.2
	Least	1,072 (83)	474 (56)	5,733 (67)	2.3	2.0	60	2.3

In Senegal, to measure household sensitivity, the ARCC team developed portfolios of each of the six household types studied: crop-dominant, mixed, and livestock-dominant, for the northern and southern sub-zones. Portfolios showed the proportion of each crop and livestock animal type cultivated or raised by category of household. The team then calculated the expected impact of climate change on each of the portfolios using modeled impacts of climate on the different crops and livestock types. The analysis thus quantified the expected impact on each household type’s agricultural portfolio that could be expected due to climate change. To characterize adaptive capacity and the relative areas of strength and weakness of different household types, the research team described the livelihood assets, organized by the five livelihood asset types, for each of the six household types studied. (The following figure presents a graphic of the results for three of the livelihood types.)

In both the Uganda and Senegal assessments, ARCC enriched household survey results with other sources of research data. As noted above, information concerning the projected impacts of climate on the productivity of crops and livestock was introduced to describe the “exposure” element of the definition of household vulnerability. In both cases, information obtained from focus group discussions strengthened the interpretation of findings by providing an overall context as well as a fuller understanding of agricultural systems and their recent evolution. Focus group discussions (described in the following section), as well as key informant interviews built on the foundation of the household surveys to develop recommended adaptation options for potential donor and government support.

FIGURE 8.3: ADAPTIVE CAPACITY OF THREE LIVELIHOOD TYPES IN SENEGAL



TEXT BOX 8.6: TIPS FOR CONDUCTING CLIMATE CHANGE VULNERABILITY SURVEYS

- To design the survey, first decide what questions you intend to address, the conceptual framework, and how you will conduct the analysis. If possible, conduct an analysis of mock results to make sure the survey answers the questions you have asked prior to finalizing the survey instrument. This step is especially important, because the concepts used in climate change vulnerability assessments are new and evolving.
- Build a rigorous definition of climate change vulnerability. How are exposure, sensitivity, and adaptive capacity defined? What survey questions indicate sensitivity and adaptive capacity? If exposure isn't measured in the survey, how will it be related to the survey results?
- Clearly communicate the expected results of the survey – what will and will not be measured. If a gender or institutional perspective is necessary, consider revising your unit of analysis.
- Employ the breadth of your results in the analysis. Do not focus exclusively on climate threats to agriculture, but conduct an analysis that clearly portrays the larger development context.

Interpreting and Using the Results

Surveys organized by sustainable livelihood asset categories (i.e., natural, social, financial, physical, and human) and conducted at the household level can be used to measure the full range of household assets and portray climate change vulnerability in the larger context of livelihood stressors that households face. When an analysis of the climate vulnerability of agricultural systems complements detailed surveys, their results may reveal unexpected levels of vulnerability, whether it be food insecurity, or in health, education, employment, or other key indicators of socioeconomic development. As such, they both highlight a climate change perspective and may also provide a foundation for identifying initiatives to address the broader set of related issues that underlie a population's inability to develop or retain the resources and measures to achieve resilience in the face of climate change. By describing the larger development context in which climate change will exert its impact, household surveys employing a livelihood approach can serve as a foundation for identifying entry points for intervention, and for defining options to support local climate change adaptation.

8.2.6 Method 6: Participatory Rural Appraisal

How and When to Use This Method

While surveys provide detailed measures of household assets, the strength of PRAs lies in their ability to describe the dynamics and drivers of vulnerability. PRAs can provide a rich description of the social relationships within a community. Used as part of a climate change adaptation assessment, the conduct of a PRA can help researchers to identify the climate stressors that community members consider important and to learn why they are important. PRAs can also reveal relationships between climate threats and other stressors, such as natural resource degradation, demographic shifts, or changes in input or sale prices. PRAs are contextual. They can reveal how people have responded to a range of stressors, and specifically how they have adapted to changes in climate. Researchers can use PRAs to explore how institutions, culture, and power relationships may reduce, mediate, or aggravate the impact of climate and non-climate stressors. In addition, PRAs can reveal adaptive behaviors – some of which may have long-term value, and some which may have unforeseen and unfortunate consequences. This

greater clarity on the drivers and dynamics of climate change adaptation helps researchers understand which responses are truly adaptive and which are short-term coping strategies, are inequitable, or are economically or environmentally unsustainable.

Like any PRA, a climate change adaptation-focused PRA can be used to help capture the perceptions of people often marginalized in the design of development efforts. A PRA's qualitative tools include focus group discussions, key informant interviews, and other interview techniques. In a climate change adaptation context, qualitative tools help researchers gain a better understanding of the causality (not just the correlation) of responses, as well as the attitudes and behaviors associated with them. Although collected using a qualitative approach, most PRA tools can also produce quantitative information. For example, focus group discussions and key informant interviews can be codified and statistics gathered on the frequency of words and concepts. Like household survey results, they also allow comparisons between and among households or groups of households.

PRAs are appropriate when sufficient time and resources are available for extended field visits that include spending days in a limited number of communities, and when there is less need for quantifiable, statistically valid results. Depending on the questions being asked and the tools used, it may be that a one-week PRA will provide the details required to answer the questions needed for a climate change adaptation study. PRAs can be especially valuable when follow-on implementation activities will take place in the communities studied. In such cases, PRA participants can understand their participation in the PRA as being relevant and important to the activities eventually implemented.

In many cases, a mixed-method approach that combines the two approaches (such as a household survey supplemented by just one or two PRA tools, such as focus group discussions or key informant interviews) may be optimal given limited resources to gather a full set of complementary relevant information. Such might be the case, for example, when a household survey is used to reveal areas of particularly high vulnerability and is followed by focus group discussions to explore the causative factors in those particular areas more deeply – or when focus group discussions are used to understand better the issues at hand prior to developing the survey instrument.

Which vulnerability questions does this method address?

Increasingly, local perspectives are valued in climate change assessments, and a PRA is particularly appropriate when there is a desire to learn from those perspectives. Questions that can be addressed include:

- What are local perceptions of climate and non-climate stressors on livelihoods? Which stressors are perceived to be more urgent or important, and why?
- How have the members of communities responded to climate change? What are the consequences of their responses? Are their responses economically or environmentally sustainable?
- How does climate affect some production systems and livelihoods? What are the differences between how systems and livelihoods are affected?
- Why are certain changes in climate tolerated while others are not? What enables communities to tolerate them?
- How willing are people to adopt certain strategies over others, and why? What are the various constraints to adoption?
- How do relationships within communities inhibit or enhance successful climate change adaptation?

When answering these questions, the PRA method allows researchers to “drill down” deeper than other methods — beyond age, gender, and education level — to understand differences among wealth groups, differences related to land ownership, or according to detailed livelihood profiles and family structures.

What are the critical decisions to make in using this method?

As when designing a survey for a CCVA, to implement a PRA researchers must first develop their definition of vulnerability. In ARCC, this work meant defining exposure, sensitivity, and adaptive capacity. These decisions guide the definition of the precise research questions to be addressed – and, from those questions, the selection and design of PRA tools.

Another critical decision, precisely as for surveys, is that of sampling. Using standard sampling methods — both for sampling locations and for selecting individual participants — increases the credibility of the results. Many sampling-related questions are the same as for any type of PRA: Is it necessary to distinguish results between various livelihood patterns, ethnic groups, or by gender? Is it important to compare results between administrative units, or between program beneficiaries and non-beneficiaries? For climate change adaptation PRAs, communities with a greater exposure to climate change should be prioritized. For climate change adaptation PRAs with an agriculture focus, for example, it would likely be important to select communities based on expected differences in livelihood strategies, located in representative agro-ecological zones. This approach will help researchers trying to identify a range of different contexts in which communities respond to climate differently, the range of responses, and potential robust adaptive practices.

Finally, what complementary climate information will be needed? How will it be used? Decisions made here may also affect the sampling. PRA communities for climate change adaptation assessments are best selected when they can be associated with meteorological stations with credible time-series data. Then, just as with survey results, PRA results can be related to changes in historical climate trends. However, when considering the extrapolation of these results to communities beyond those sampled, it is also important to ask how and why communities far from established meteorological stations might be different. Could it be that they are more isolated? Might they be even more vulnerable to climate effects?

ARCC used the PRA method as part of one CCVA: the Malawi Climate Change Vulnerability Assessment. The goal of the Malawi PRA was to understand the impact of climate change on rural communities in Malawi and the adaptation strategies they have or could employ to build resilience.

Communities were selected as being representative of livelihood zones characterized by the predominant means through which households access food and income. The PRA was undertaken through the dual lenses of socioeconomic differentiation and historical evolution. Its four objectives were to:

- profile each community, with a particular focus on aspects that would illuminate the impact of climate change and people’s ability to adapt or respond;
- understand the impact of climate change on livelihood portfolios and general well-being;
- understand the impact of climate change on agricultural production systems; and
- identify adaptation strategies that build resilience in the face of climate change.

The research framework identified 23 specific questions and sub-questions⁴⁴ associated with these objectives to be answered through the PRA. The ARCC team applied a “kit” of 12 tools,⁴⁵ each addressing a different research objective including food and livelihood security, as well as other topics related to climate change adaptation.

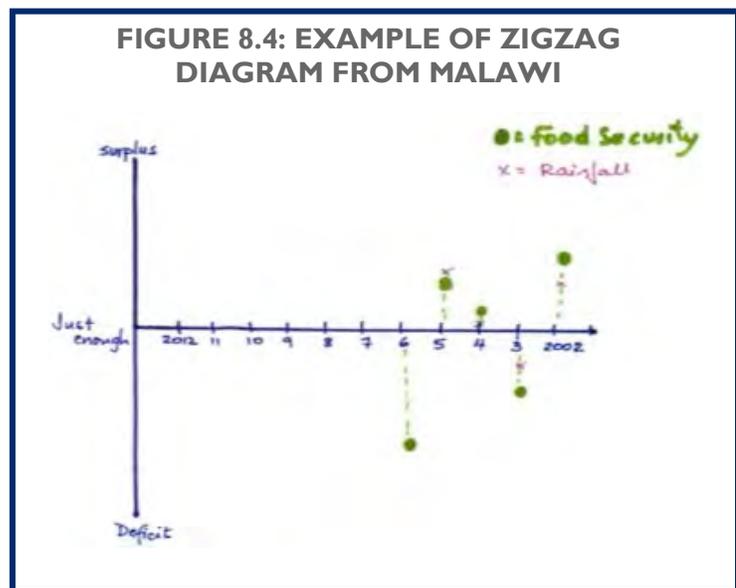
ARCC’s PRA in Malawi was one component of a large vulnerability assessment, which was guided by research questions focusing on food and livelihood security in the geographic areas of the country that were already targeted for USAID’s Feed the Future and Wellness and Agriculture for Life Advancement programs. Within these areas, sampling of PRA communities was designed to capture the diversity of livelihoods known to exist in the program area (using the Famine Early Warning Systems Network [FEWS NET] livelihood maps), and their proximity to nearby meteorological stations. Another climate change adaptation-related PRA might, for example, select communities based on distance to markets or to urban centers, or exposure to flooding.

Implementing the Method

Obtaining the Necessary Data

PRA’s produce the best results when teams live in (or as close as possible to) the communities of interest for the period of time required to complete the tools. It is likely that some of the tools will need to be administered following a specific sequence and build on one another. The following paragraphs describe three such tools used in the ARCC Malawi CCVA.

Zigzag Diagram: The standard zigzag diagram was modified to explore perceptions of the relationship between rainfall and food security. To discuss this relationship, participant groups were asked to graph changes in annual levels of rainfall and food security across the past decade. (See figure at right).



Livelihood Portfolio Evolution: The livelihood portfolio tool explores household livelihood strategies, with a focus on food security. The tool is designed to answer these questions: How does the combination of livelihood strategies differ among households of different wealth groups? How do portfolios of livelihood strategies differ between female-versus male-headed households? Have portfolios diversified or otherwise changed through time? Which combination of strategies do people perceive as the most efficient, or profitable,

⁴⁴ For example, one question/sub-question set associated with the adaptive capacity dimension of vulnerability was: What strategies have individuals, households, and communities already started to employ to attenuate the impacts of climate change? Why was this mix chosen? How have their chosen strategies evolved? How effective have they been?

⁴⁵ The 12 tools were hazard maps, vulnerability maps, zigzag diagrams, transects, field profiles, wealth rankings, livelihood evolution, household profiles, seasonal calendars, climate impacts, topic-specific key informant interviews, and village histories.

and under what circumstances? For the purposes of the Malawi assessment, the tool was modified to focus on evolution over time so that it could be aligned with observed climate trends.

Climate Impacts Matrix: The Climate Impacts Matrix is a tool that focuses on climate change issues. It synthesizes results explored through the other tools. The variables analyzed through the matrix represent the hypotheses the PRA team develops as a result of the PRA process, and identify the areas in which they feel that information is still needed. It captures “village life through a climate lens.”

Conducting the Analysis

The analysis of PRA data for a CCVA is essentially the same as for PRAs conducted for any other purpose, with the exception of the focus on the information relevant to climate change impacts and adaptation as well as the need to correlate the information gathered with local historical climate trends.⁴⁶ One of the challenges for the Malawi PRA was organizing and analyzing the wealth of data and information gathered. A “triangulation matrix” can help a PRA team aggregate and organize the gathered information in terms of the dimensions of vulnerability. The following tables show: 1) a simplified conceptual structure for such a triangulation matrix; and 2) the contents of one small segment of one portion of this matrix – in this case, for climate strategies and their success, as adopted in the village of Chiluzi.

TABLE 8.4: ARCC MALAWI TRIANGULATION MATRIX – A SIMPLIFIED, CONCEPTUAL STRUCTURE

Completed for each community	PRA Tool 1	PRA Tool 2	PRA Tool 3...
EXPOSURE: Records how exposure to climate-related hazards, threats, and changes in the natural resource base is perceived today and how it has changed; discusses frequency, intensity, coverage, and differentiated impact on vulnerable groups.			
VULNERABILITY: Describes how vulnerability (socioeconomic well-being, wealth, education, health, services, markets) is perceived today and how it has evolved over the past <i>n</i> years.			
ADAPTATION OPTIONS: Describes what strategies/options already have been employed as a response to evolving climate change exposure. Explores questions such as, Which are most successful, and why? Which would be feasible and/or ideal under what conditions?			

⁴⁶ In the case of the Malawi assessment, the PRA was conducted prior to the climate analysis. As a result, the distance from the studied villages and the closest meteorology stations ranged from 5 to 65 km. Yet, while it is important that some villages selected for the PRA are physically close to meteorological stations with long, reliable data records, villages further away might also be considered, and their climate exposure at least hypothesized. Including climate scientists in design, collection, and analysis of the PRAs in a guided way can be valuable in this regard.

TABLE 8.5: DETAIL FROM THE SUB-QUESTION, “WHICH [ADAPTION OPTIONS] ARE MOST SUCCESSFUL, AND WHY?” (MALAWI)

Community / Zone	Strategies adopted	Effectiveness (Success) of Strategies
Chiluzi – Rift Valley	<ul style="list-style-type: none"> • Use fertilizer and manure to increase crop production. • Adopt narrow ridge spacing and planting (<i>Sasakawa</i>). • Intercrop maize with drought-resistant crops, e.g., cassava and sweet potato. • Shift to hybrid maize and groundnuts. • Employ box ridges. 	<ul style="list-style-type: none"> • Using manure to supplement fertilizer especially helps members of the “Better-off” wealth group who have livestock, as compared to those who rely on compost manure. • Sasakawa has increased maize production effectively; more can be harvested from a small land area. • To some extent, intercropping has improved food security, as families can now rely on another crop, like cassava, when maize has failed. • Growing hybrid maize and groundnuts has proven to increase production effectively. • Box ridges have the double impact of helping to conserve water during dry spells and reducing soil erosion.

Interpreting and Using the Results

ARCC’s Malawi PRA teams validated their preliminary conclusions, drawn directly from the triangulation matrix, with communities prior to leaving the community. Once all of the data from all of the communities were collected, the ARCC Malawi PRA teams joined together for a multi-day joint “interpretation session.” Coming together as a group allowed rapid discernment of the principal commonalities and differences among the communities as well as a fully informed discussion of why and where agreement did and did not exist. Such face-to-face discussion allows for immediate and useful explanations to emerge – explanations that rarely would be possible otherwise.

At the end of the Malawi CCVA, a large number of stakeholders were gathered together to discuss options for adaptation. The PRA results were invaluable in providing credibility to the larger assessment team, and in enhancing the legitimacy of the team’s findings. This work allowed the stakeholders to focus on adaptation strategies rather than on any perceived shortcomings regarding the accuracy of the team’s understanding of the situation in the study communities.

TEXT BOX 8.7: TIPS FOR CONDUCTING PRAs IN CLIMATE CHANGE VULNERABILITY ASSESSMENTS

- Use the PRA method when seeking depth of insight; for detailed understanding of a local context and the many inter-relationships inherent in that context; and when it is necessary to understand not only what the climate stressors are, but also which ones are important to community members, why they are important, and the relationships between climate stressors and other stressors.
- Sampling, including geographic location and the recruitment of specific respondents (individuals, households, members in a households) is as important for PRAs as it is for surveys. Carefully choosing and knowing the characteristics of the PRA sample will assure more credible results.
- Choosing communities located close to meteorological stations will enhance the ability to correlate PRA results with historical climate trends data.
- For PRAs associated with climate change adaptation assessments, a “triangulation matrix” can help researchers organize and understand results in terms of the three vulnerability characteristics of exposure, sensitivity, and adaptive capacity.

8.3 CONCLUSIONS: AGRICULTURE, LIVELIHOODS, AND FOOD SECURITY ANALYSES

As we have seen, many standard analytic methods — ones originally developed to study agriculture, food security, and livelihoods — may be modified for use in a CCVA. For agricultural analyses these methods include agronomic analysis by phenological phase, crop modeling using climate projections, value chain analysis, and collecting agricultural histories through focus groups. For food security and livelihoods analyses these methods include household surveys and participatory rural appraisals. Modifications to these methods for use in a CCVA involve aligning studied parameters with one or more of the dimensions of vulnerability: exposure, sensitivity, and adaptive capacity. Any one of these methods or other suitable methods may be used alone to focus on one particular aspect of an issue. Alternatively, as was the case for ARCC, various methods can be used in combination to investigate an issue from complementary perspectives. The results from these analyses are then integrated into research frameworks that evaluate climate change vulnerability. As with all aspects of the CCVA, choosing which method or methods to use depends on the goal of the research, the context of the questions to be investigated, and the time and resources available to carry out the work.

9.0 CONCLUSIONS

Governments and donor agencies increasingly rely on CCVAs to improve their understanding of the nature and degree of potential climate change impacts, the sensitivities of systems and human populations to those impacts, and the capacities of people and institutions to adapt. A CCVA treats climate change as the driving agent of change and provides information on sensitivity, exposure, and the adaptive capacity of populations, as well as the systems upon which they rely.

But as we have seen, "climate change," "vulnerability assessment," and "adaptation," are all multi-faceted and, to a degree, open-ended concepts. The ARCC assessments were distinguished by their evidence-based approach to the analysis of the past, present, and projected future climate, and by their use of integrating frameworks for designing and organizing the dimensions of vulnerability (exposure, sensitivity, and adaptive capacity).

By presenting lessons learned from the ARCC experience, we hope that readers will draw insights from this Compendium that will help them define the scope of new CCVAs or integrate ("mainstream") climate change vulnerability into existing programs. We found that understanding and addressing climate change within an already complex and challenging development context is as much an art as a science. While credibility, salience, and legitimacy are hallmarks of a well-conceived and well-executed assessment, the ability to ensure that the information is used effectively to address the uncertain and multi-faceted nature of climate change requires the ability to make sense of complex relationships between climate change and natural and human systems. For this reason, every CCVA is unique—tailor-designed to meet the needs of a given group of decision makers and development practitioners within a particular setting. Yet, while the overall task is complex, care must be taken to create a design with a clear purpose that produces evidence-based findings that decision makers can "own," understand, and act on.

The results of a CCVA can be used to inform a future investment strategy or portfolio—or an existing portfolio—by promoting proven adaptation strategies. They can serve as a source of innovative interventions that will enhance the resilience of populations or systems in the future. The results can also be used as a baseline to gauge the effectiveness of these interventions. Typically, ARCC assessments have informed future USAID climate change adaptation investment strategies in the areas of food security and natural-resource dependent livelihoods, such as agriculture, pastoralism, and fisheries.

The CCVA product must be easily understood and more than the sum of its component parts. Our assessment teams sought to discover and communicate the compelling "story" behind the data and information: the organization or pattern, the unified whole. The truly salient results—the prominent, conspicuous results that really stand out and may have the greatest impact—are those that are derived from a deep understanding of the social, economic, cultural, and institutional contexts in which the CCVA is embedded. These contextual factors should—and do—influence the design and implementation of the CCVA, the way and extent to which CCVA results can be effectively communicated or disseminated, and the manner in which CCVA results are interpreted, understood, and applied. Again, by recognizing and designing the means for gaining this deeper contextual understanding, CCVA teams can further enhance the usefulness and uptake of the results. In practical terms, this was done by integrating local expertise into assessment teams, working closely with the potential users of the assessment to agree on the purpose and focus of its findings, and seeking input from stakeholders—those potentially affected by climate change—at critical points in the process.

Moving from results to recommendations for action, ARCC found that the most meaningful uptake may take place long after the results have been published, and that CCVAs may have many uses beyond those for which they were designed. Assessment implementers must be aware of the range of potential uses of the results of their work. CCVAs aim to present the most objective, scientifically valid information possible in order to ensure that future investment is well-targeted to real problems, greatly increasing the odds of successful interventions. However, although assessment teams strive to ground their work in evidence and scientific research, uncertainty and subjectivity inevitably enter into the process in multiple ways. Throughout the assessment process, the team needs to be aware of the limitations of an assessment and how its results may be used for specific ends in the future.

The use of a CCVA as a tool to increase awareness of climate change—for encouraging people to imagine the potential impacts of climate change on their lives and livelihoods—may be more important than the assessment itself. It can provide powerful leverage for change if it is deemed credible, salient, and legitimate by the decision makers that influence change. Teams that actively seek to identify and engage local champions during the conduct of the CCVA will also help ensure its continued relevance after its completion. ARCC assessment teams engaged USAID as their initial local champion, and through a process of participatory stakeholder review of findings and generation of recommendations, gained additional champions to advocate and act to address climate change.

This Compendium provides a snap-shot of, and insights from, a period in which approaches and methods for assessing climate change vulnerability are still being pioneered. It was designed to make a contribution to this growing body of knowledge. In the meantime, climate continues to change, as does our understanding of it. The CCVA cannot be a static thing. The accuracy of climate projections, particularly at sub-regional scales, is dependent upon the quality and quantity of historical climate data available; these data sources are continuously being updated and improved. National and international policies, as well as the world economy, have a direct impact on the emission scenarios on which climate projections are based. Populations move, systems adapt, globalization expands. An assessment completed last year may, by itself, have limited use in as few as three years. That same assessment, however, may be an excellent base from which to derive a new study; as such, it may find use not only today but also far into the future.

ANNEX A. REGIONAL CLIMATE SCIENCE INSTITUTIONS

TABLE A.1: REGIONAL CLIMATE SCIENCE INSTITUTIONS

KEY REGIONAL INSTITUTION	FOCUS	LOCATION OF INSTITUTION	WEBSITE
CIMA	Climate	Argentina	http://www.cima.fcen.uba.ar/
CPTEC/ INPE	Climate	Brazil	http://www.cptec.inpe.br/
CIIFEN	Climate, El Nino	Ecuador	http://www.ciifen-int.org
CSGM	Climate, extremes events, climate change	Jamaica	http://myspot.mona.uwi.edu/physics/csgm/home
OLE	Extreme events	Venezuela	http://cmc.org.ve/mediawiki/index.php?title=Portada
CRRH	Climate, water	Regional	http://www.aguayclima.com/
CAZALAC	Water	Chile	http://www.cazalac.org/eng/index.php
CEAZA	Drylands and dry areas	Chile	http://www.ceaza.cl
CATHALAC	Water and humid areas	Panama	http://www.cathalac.org
CRRH	Water	Costa Rica	http://www.recursohidricos.org
CIAT	CGIAR – Agriculture	Colombia	http://ciat.cgiar.org/latin-america-and-the-caribbean
CIMMYT	CGIAR – Maize, wheat	Mexico	http://www.cimmyt.org/en/
CIP	CGIAR (potato)	Peru	http://www.cipotato.org
FIOCRUZ	Health	Brazil	https://portal.fiocruz.br/
ACMAD	Climate	Niger	http://www.acmad.net/new/
ICPAC	Climate	Kenya	http://www.icpac.net/
CSAG	Climate	South Africa	http://www.csag.uct.ac.za/

KEY REGIONAL INSTITUTION	FOCUS	LOCATION OF INSTITUTION	WEBSITE
AGRHYMET	Agroclimatology	Niger	http://www.agrhymet.ne/eng/
ICRISAT (WCA)	Crops in semi-arid areas	Mail	http://www.icrisat.org/icrisat-wca-leaders-note.htm
ICRISAT (ESA)	Crops in semi-arid areas	Kenya	http://www.icrisat.org/icrisat-esa-leadersnote.htm
IITA	Tropical agriculture	Global	http://www.iita.org/home
CIAT	CGIAR, Tropical agriculture	Global	http://ciat.cgiar.org/
ICRAF	CGIAR, Agroforestry	Kenya	http://www.worldagroforestry.org/
IRI	Climate	USA	http://iri.columbia.edu/
NCAR/UCAR	Climate	USA	http://ncar.ucar.edu/
NCEP/African Desk	Climate	USA	http://www.cpc.ncep.noaa.gov/products/african_desk/cpc_intl/menus/intro.shtml
KNMI	Climate	Netherlands	http://www.knmi.nl/index_en.html
UKMO	Climate	UK	http://www.metoffice.gov.uk/
IRD	Climate/sectors	France	http://en.ird.fr/
CIRAD	Tropical Ag	France	http://www.cirad.fr/
LSHTM	Health	UK	https://www.lshtm.ac.uk/
Institut Pasteur	Health	France	http://www.pasteur.fr/ip/easysite/pasteur/en

ANNEX B. HISTORICAL CLIMATE DATASETS

This annex provides a list of sources for data for historical climate analyses. The datasets are arranged according to their "realism," from those derived from ground-based instrumentation to those that merge satellite information to the re-analyses that are model-based.

TABLE B.1: HISTORICAL CLIMATE DATA SETS

DATASET & VARIABLES	INSTITUTION	DATA CHARACTERISTICS	BENEFITS	POTENTIAL DRAWBACKS
Station data; <i>Rainfall, T</i>	National Meteorological Service	<ul style="list-style-type: none"> • Station, localized • Daily, monthly • Variable time span, usually go back at least to 1950 	<ul style="list-style-type: none"> • in situ or "true" values 	<ul style="list-style-type: none"> • Spatial coverage and representativity • Accessibility • Quality and completeness (often fewer temperature records)
GHCN v2 and v2 beta <i>Rainfall and T</i>	NOAA NCDC GHCN	<ul style="list-style-type: none"> • Global collection of station records • Monthly • Variable time span 	<ul style="list-style-type: none"> • As above 	<ul style="list-style-type: none"> • Very few stations in the areas of interest • Lots of gaps and short records • Basically not usable
CRU <i>Rainfall, T and other surface variables</i>	UEA	<ul style="list-style-type: none"> • Gridded global • 0.5x0.5 resolution • Monthly • Interpolated from <i>in situ</i> stations; several versions, most recent spans 1901–2012 	<ul style="list-style-type: none"> • Global • Spatial coverage • Freely available (upon registration) 	<ul style="list-style-type: none"> • Coarse resolution (space and time) • Data obtained by interpolation of station data; issue of representativity in data-sparse areas • Data prior to 1950 less reliable

DATASET & VARIABLES	INSTITUTION	DATA CHARACTERISTICS	BENEFITS	POTENTIAL DRAWBACKS
FCLIM <i>Rainfall</i> <i>T anomalies only</i>	USAID/FEWSNET/USGS	<ul style="list-style-type: none"> Gridded 0.1x0.1, monthly Parts of Africa 1950–2009 Interpolated from available <i>in situ</i> records and satellite observations 	<ul style="list-style-type: none"> Spatial coverage for selected countries High resolution Freely available (upon demand) 	<ul style="list-style-type: none"> Although dataset covers all of Africa, only a few countries have reliable data that include <i>in situ</i> observations Influence of inclusion of satellite data (starts in early 1980s) on data homogeneity Underestimation of amplitude or interannual rainfall variability Temperatures only available as anomalies relative to long-term mean
CHIRPS <i>Rainfall</i>	FEWSNET/UC SB-CHG	<ul style="list-style-type: none"> Gridded, global 0.05x0.05, 5-day, monthly 1981–present Merges satellite and <i>in situ</i> records 	<ul style="list-style-type: none"> Spatial coverage for selected countries High resolution 	<ul style="list-style-type: none"> New product – validity and issues not yet assessed Accessibility unknown Not long enough for some analyses As for all gridded data, local validity limited
ENACT <i>Rainfall</i>	Met Services, ACMAD	<ul style="list-style-type: none"> Gridded 0.1x0.1 Monthly, pentad, possibly daily in the future Dataset merges <i>in situ</i> and satellite observations 	<ul style="list-style-type: none"> Spatial coverage of the country Elaborated in collaboration with national Met Service and so includes best available station records 	<ul style="list-style-type: none"> A few countries in Africa; elaboration in progress Starts in 1980s, when satellite started Accessibility to be confirmed Validity and issues not tested

DATASET & VARIABLES	INSTITUTION	DATA CHARACTERISTICS	BENEFITS	POTENTIAL DRAWBACKS
ARC2 <i>Rainfall</i>	NOAA/NCEP/ CPC/FEWS	<ul style="list-style-type: none"> • Gridded, global • 0.1x0.1; daily, ten-daily • Satellite rainfall estimates 	<ul style="list-style-type: none"> • Spatial coverage and resolution • Daily resolution 	<ul style="list-style-type: none"> • Estimates based on temperature of brilliance of the clouds, but algorithms based on extra-tropical areas; there are issues with the values • Better for high-cloud convective rainfall • Better for estimating rain/no rain rather than rainfall amounts and so should not be used for amount estimation
ERA <i>Rainfall, surface temperature, atmospheric variables at different heights</i>	ECMFW Reanalysis; Several versions ERA15, EAR40, ERA-Interim	<ul style="list-style-type: none"> • Gridded, global • For Era Interim • Res. 0.7x0.7 • Monthly, daily • Starts in 1979 	<ul style="list-style-type: none"> • Global • Spatial coverage • Consistency between different variables (dataset is constructed using a GCM constrained by observations) • Not a simple geometric interpolation; might better capture some local contrasts 	<ul style="list-style-type: none"> • Not publicly available, but access can be gained • Dataset strongly depends on model and carries its biases; rainfall and surface temperature among the least-reliable variables; data prior to 1950 usually less reliable (fewer observations to constrain the model)

DATASET & VARIABLES	INSTITUTION	DATA CHARACTERISTICS	BENEFITS	POTENTIAL DRAWBACKS
"NCEP reanalysis 1" – <i>As above</i>	NOAA/NCEP– NCAR	<ul style="list-style-type: none"> • Gridded, global • Res. 2.5x2.5, daily, monthly • 1948–current 	<ul style="list-style-type: none"> • As above plus: • Publicly available • Largely used and validated (description of biases) 	<ul style="list-style-type: none"> • Dataset strongly depends on model and carries its biases; rainfall and surface temperature among the least-reliable variables; data prior to 1950 usually less reliable (fewer observations to constrain the model)
"NCEP reanalysis 2" – <i>As above</i>	NOAA/NCEP– DOE	<ul style="list-style-type: none"> • Gridded global • Res. 1.875x1.875, daily, monthly • 1979–current 	<ul style="list-style-type: none"> • As above plus: • Higher resolution • Considered as an improvement on Reanalysis 1. 	<ul style="list-style-type: none"> • Dataset strongly depends on model and carries its biases • Rainfall and surface temperature among the least-reliable variables

ANNEX C. CASE STUDIES

SUMMARY

This annex provides a summary of the five case study annexes to follow. By describing in detail the learning process as experienced during four of the ARCC CCVAs and one mapping exercise, each case study highlights key lessons from ARCC.

TABLE C.1: CASE STUDIES SUMMARY

CASE STUDY; KEY LEARNING EXPERIENCES
<p>Uganda CCVA: As ARCC's first CCVA, the Uganda CCVA presents lessons for how a CCVA research framework is developed and made operational. Since more than a year has passed since results from the Uganda CCVA have been disseminated, the case study also describes factors that led to successful uptake of the results.</p>
<p>Malawi CCVA: The Malawi CCVA included a fisheries study that was unique among ARCC CCVAs and yielded some interesting surprises. In addition, the Malawi CCVA design immediately followed that of the Uganda CCVA, so the Malawi team was able to draw lessons from Uganda. Specifically, this case study explores how the team applied future climate scenarios as a means for participatory options analysis</p>
<p>Dominican Republic CCVA: The DR CCVA case study offers useful insights into the importance of having a well-articulated research question and describes how a research question might evolve. In addition, while other ARCC CCVAs collected primary data, the DR CCVA team relied entirely on secondary data. The case study discusses some challenges inherent in reliance on secondary data, and how these challenges were met.</p>
<p>Senegal CCVA: As the most recent and most extensive CCVA conducted under ARCC, the Senegal CCVA broke new ground in the sophistication of analyses performed—applying multiple, sophisticated, quantitative modeling programs to the task. The case study focuses on lessons learned in dealing with the compounded uncertainty associated with applying multiple models.</p>
<p>Mali Vulnerability Mapping Exercise: The Mali Vulnerability Hot Spot Mapping case study describes another type of ARCC activity: a desk study-based mapping exercise for identifying climate vulnerability "hot spots." While hot spot mapping cannot replace the CCVA, it can be a first step for identifying areas in which to focus a CCVA field data collection effort, it can address questions or validate decisions about where (but not which) programming might make the most sense, and it can help stakeholders visualize variations in potential vulnerability to climate change in a country.</p>

ANNEX D. UGANDA CCVA CASE STUDY

TABLE D.1: UGANDA VULNERABILITY ASSESSMENT SNAPSHOT

Study Locations	Gulu, Lira, Luweero, Mbale, Isingiro, and Kasese Districts
Study Purpose	"To improve understanding of the impact of climate change on rural livelihoods in Uganda to inform food security and agricultural programming and investment decisions by focusing on select crop value chains"
Intended Audience(s)	USAID/Africa Bureau, USAID/Uganda, implementing partners, Government of Uganda, and other members of the donor community
Vulnerability Model	Vulnerability as a function of exposure, sensitivity, and adaptive capacity
Subjects, analytic components	Climate; water [1]; livelihoods; three agricultural studies (value chain analysis, phenology, and climate change impact simulations [2]) for each of eight crops (coffee, rice, maize, matooke, beans, sorghum, sweet potatoes, and cassava)
Methods Used	Analysis of historical climate records, climate modeling and downscaling, analysis of secondary crop data, focus groups, simulations, phenological review, household surveys, key informant interviews, and literature review
Recommendation Categories	Overarching strategies; development of a national context for adaptive agriculture; research and outreach at national, district, and community levels; livelihood strengthening and diversification; and concrete, prioritized actions
Duration of study	18 months—February 2012 to August 2013
Unique Contributions of the Study	Learning how to operationalize a research framework according to the model of vulnerability as a function of exposure, sensitivity, and adaptive capacity Considered a foundational document with information that had not previously existed in Uganda; lays a groundwork for further studies; and provides needed background information to aid in program design
Notes	[1] The water desk review, based on excellent secondary data, showed that groundwater is not likely to be affected by climate change, so a more in-depth analysis was not conducted. [2] The crop model software was found not to be appropriate for Ugandan conditions. The results were inconclusive and were not used.

INTRODUCTION AND BACKGROUND

The Uganda Climate Change Vulnerability Assessment was designed to inform USAID's first Climate Change Adaptation-funded work and to help USAID/Uganda apply the funds in a targeted, strategic

manner that would address climate change needs based on solid evidence. Specifically, the study's purpose was "To improve understanding of the impact of climate change on rural livelihoods in Uganda to inform food security and agricultural programming and investment decisions by focusing on select crop value chains"(Caffrey et al., 2013, p. 12). The Uganda CCVA was the first CCVA conducted under the ARCC program. Hence, it was the first time ARCC applied the model of vulnerability as a function of exposure, sensitivity, and adaptive capacity (as defined by the IPCC). It was also the first time that an ARCC CCVA research framework was developed and made operational. At the time of this writing, more than one year had elapsed since the initial dissemination of the study's results and important lessons learned in the area of uptake have emerged. This case study focuses on lessons in operationalizing the research framework as well as observations of activities and approaches that contributed to successful uptake of the CCVA's results.

STUDY DESIGN AND RESEARCH FRAMEWORK

The highly ambitious goals of the study necessitated a broad scope and several component studies, including analyses of climate, water, and livelihoods. It also necessitated three sets of studies for the key crops—value chain analyses, phenological studies, and simulations of climate change impacts on crop suitability for six locations across the country. Initially, each component study was assigned to a team of experts who worked through a shared planning process with reference to vulnerability as a function of exposure, sensitivity, and adaptive capacity. The step-by-step progression shown in Figure D.1 and the conceptual framework shown in Figure D.2 were developed to guide the assessment process.

FIGURE D.1: STEP-BY-STEP PROCESS FOR COMPLETING ARCC UGANDA CCVA

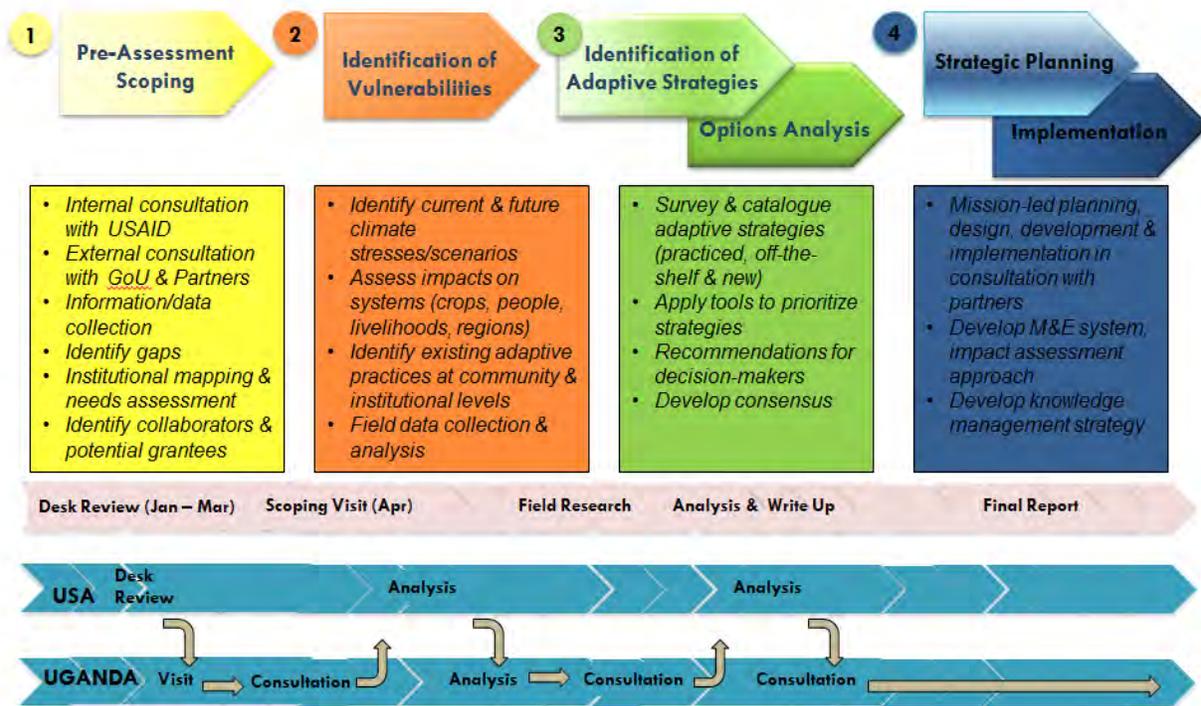
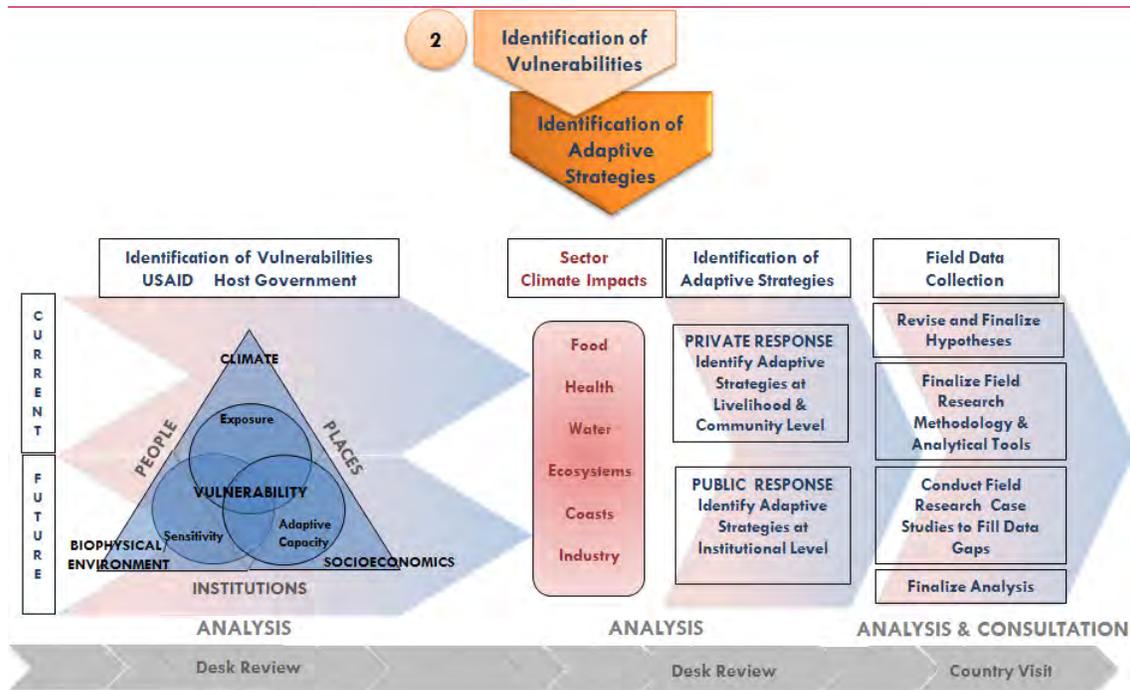


FIGURE D.2: EARLY ARCC CONCEPTUAL FRAMEWORK FOR VULNERABILITIES AND ADAPTATION STRATEGIES



While planning for the CCVA field work, the component teams naturally focused on their areas of specialization and on methodological and practical issues specific to their individual areas of study. It quickly became clear that the original step-by-step process and conceptual framework provided limited practical guidance for the component teams. While the process diagram and conceptual framework were useful for overall guidance, they fell short either in providing clarity on the study purpose or specific research questions or in providing guidance for answering the overall research question in an efficient, coordinated way once the actual field work had begun.

The ARCC team developed a new, more comprehensive research framework for this purpose. First, the team worked with USAID/Uganda and USAID/Washington to derive an overall research question. Based on the study purpose, the ARCC team, in close collaboration with USAID, developed the following overarching research question:

"How will projected changes in climate affect important agricultural value chains in Uganda and the livelihoods of villagers who rely upon these value chains?"

Next, by breaking this research question into a hierarchy of sub-questions,⁴⁷ the assessment team was able to streamline the analysis by linking the sub-questions to analytic components and methodologies required to address each component. The individual component teams were then able to identify areas of overlap and opportunities for complementary data collection, improving the data collection efficiency. The new research framework allowed inter-relationships between the components to be clarified and key elements of vulnerability to be mapped concretely to each component. In other words, the research framework "operationalized" the CCVA implementation.

⁴⁷ The sub-questions are included in Table 3.3, Chapter 3 of this Compendium.

The new research framework had several other benefits. It enabled USAID to more clearly connect the research question with the findings and to see the relevance of the assessment to the agency's planning and programming. The ARCC team's use of the framework encouraged a more coordinated approach to carrying out the work and an appreciation of the importance of sequencing the various components. It also allowed the ARCC team to identify more easily which components were critical for answering the overall research question—and which were not. For instance, after conducting the desk review and in consideration of the preliminary climate analysis results, the water assessment component was scaled back because the climate analysis component projected insignificant changes in average annual rainfall. It was judged that if ground and surface water use continued at current rates, its availability would not be significantly affected by climate change. Discontinuing work on the water study allowed for the redirection of resources to areas considered more critical to answering the overall research question.

Once the field work was completed, the new research framework was also effective as a tool for facilitating discussion among the component teams during the cross-analysis phase and for integrating component results into more than the sum of the parts. Two cross-analysis meetings held during the fall of 2012 proved critical in bringing together the findings from the separate component studies into an integrated whole. During these meetings, the component team leaders used the framework to systematically map their diverse findings back to the research sub-questions and to the three vulnerability dimensions: exposure, sensitivity, and adaptive capacity. Specifically, the component team leaders used the collected data to improve their understanding of vulnerability relative to the crops, communities, and households that were the focus of the study. They did so, integrating the evidence base which the studies produced, by answering these key questions:

- How will climate change affect selected crop value chains?
- What impacts will climate change and climate variability have on a representative range of Ugandan rural livelihoods?
- How will farmers adapt in response to climate change impacts on the study crops?

UPTAKE

One year after ARCC began disseminating findings from the Uganda CCVA has produced concrete examples of how the study results have informed policy and programs both within USAID and with other donors and the Government of Uganda. Study results have been used to design new USAID adaptation activities, modify USAID's Feed the Future plans to be more climate responsive, and to develop products for other USAID portfolios in health, biodiversity, and agriculture infrastructure. The World Bank and the German Federal Enterprise for International Cooperation (GIZ) have used the assessment report as a background document for program design. The Ugandan National Planning Authority used it as a key document in mainstreaming climate change in its next National Development Plan, while the Ministry of Agriculture used the study to inform an action plan for its Climate Change Task Force. Other implementing partners are using it to integrate climate adaptation into their programs and form the basis (and baseline data) for research programs.

Several factors have contributed to this very successful uptake. The study results were widely disseminated using a combination of communications methods that included presentations to both central government and district-level audiences, the organization of participatory options analysis workshops, and other smaller presentations. Many recipients cited the strong empirical nature of the research—in particular the climate and livelihoods component studies—as conferring significant credibility to the results. Ugandan stakeholders noted the originality of the research, which included the first high quality climate change analysis for Uganda, as being "foundational" for understanding how climate change may affect future food security. ARCC's participatory approach to presentation and

validation of results at national and district levels raised the profile of climate change and successfully engaged an array of stakeholders across governmental levels, significantly increasing the perceived legitimacy of the results. The development of six district-level scenarios increased the relevance of the study results to those audiences. Ongoing stakeholder engagement throughout the study, especially the close collaboration with USAID in establishing the overall research question, contributed to the salience of the study for USAID purposes. Engagement with other stakeholders contributed to the study's utility (salience) for their purposes.

CONCLUSIONS

A critical part of the success of the Uganda CCVA was its initial focus and framing. Early on, ARCC learned to appreciate the substantial benefit of the "up front" investment needed to enable implementation to proceed in an efficient sequence and to support meaningful cross-disciplinary integration of data and findings in a final analysis.

ARCC also quickly learned that meaningful stakeholder engagement hinges on creating opportunities for structured conversation between the CCVA team and the intended users of the CCVA results. Acting as a champion, USAID/Uganda played a significant role in this regard. This conversation should start early during the design phase, it should be iterative, and it should promote learning on both sides rather than serving as a one-way flow of requests or needs from users—or of ideas or specifications from an implementation team. This lesson proved to be especially important in the case of vulnerability to climate change, which was, at the time, still an unfamiliar issue among the primary target users.

Finally, the Uganda CCVA showed that attention to sequencing of study components and having multiple opportunities for collaborative planning and for cross-analysis of findings are all necessary to have a truly integrated assessment rather than just a collection of component studies.

ANNEX E. MALAWI CCVA CASE STUDY

TABLE E.1: MALAWI VULNERABILITY ASSESSMENT SNAPSHOT

Study Locations	Eight districts located in areas where USAID's Feed the Future (FtF) and Wellness and Agriculture for Life Advancement (WALA) programs operate, representing nine known FEWS NET livelihoods zones.
Study Purpose	To understand the current and projected impacts that climate change has and will have on central and southern Malawi, and explore to what extent national and district government entities, rural communities, and households are equipped to adapt to those impacts.
Intended Audience(s)	USAID/Malawi; Government of Malawi (GOM), Ministries and regional agencies; farmer associations and NGOs; other donors
Vulnerability Model	Degree of impact framework: Current and projected geophysical (first-degree), biophysical (second-degree), and socioeconomic (third-degree) impacts and adaptations
Subjects, Analytic Components	Climate; agriculture (maize, sorghum, groundnuts, pigeon peas, cowpeas, and soybeans). Sub-studies in fisheries, surface water resources, and natural resources
Methods Used	Literature review; participatory rural appraisals; key informant interviews; historical climate analysis, climate downscaling, future climate projections; crop phenology, value chain analyses, and economic studies of six crops..
Adaptation Recommendation Categories	Four overarching strategy areas: (i) provision of timely, accurate, and relevant information on first order impacts (weather and climate); (ii) focus on water and natural resources that provides a consistent framework for adaptation implementation across sectors; (iii) high-level, cross-sectoral adaptation planning, harmonization, and coordination; and (iv) a coherent approach to diversifying economically in what will remain (at least in the near term) a largely agrarian economy.
Duration of Study	Sixteen months (May 2012 - September 2013)
Unique Contributions of the Study¹	<ul style="list-style-type: none"> • Application of an alternative framework to the standard vulnerability model, resulting in a distinct approach to presenting the complexity of climate change vulnerability. • First comprehensive climate downscaling of historical climate analysis and climate projections for the entire country of Malawi (not only for the

	<p>study area).</p> <ul style="list-style-type: none"> • First ever Malawi-specific analysis of value chains for pigeon peas and cowpeas. • Participatory scenario planning for analysis of adaptation options
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INTRODUCTION AND BACKGROUND

The Malawi Climate Change Vulnerability Assessment was prompted by the need for a food security and agriculture sector-based vulnerability assessment that informed USAID’s Feed the Future initiative and programming for future climate change initiatives. The assessment was designed to be relevant to USAID and to other donors operating in Malawi, and included a fisheries study that was unique among the ARCC CCVAs. Although the fisheries study was a small component of the overall CCVA, as described in this case study, it was the first component to result in direct uptake by USAID, demonstrating how even a small study can have an immediate effect.

Because the Malawi CCVA design immediately followed that of the Uganda CCVA, the Malawi CCVA team was able to draw on and apply lessons from the Uganda CCVA. One such lesson was the use of future climate scenarios during the options analysis phase, an approach that also enhanced uptake of CCVA findings as described in this case study.

FISHERIES STUDY

Fishing accounts for a significant portion of Malawians’ animal protein diet and fish are the preferred source of protein for most Malawians. As such, maintaining a healthy fisheries industry is an important aspect of ensuring the nation’s food security. An estimated 1.6 million Malawians, or nearly 10 per cent of the total population, derive at least some income from fishing, fish processing, marketing and trading, boat and gear-manufacture, and associated industries (Brummet and Nobel, 1995; Andrew et al, 2003). Unfortunately fish catch estimates show a steady decline over the last several decades (World Fish Center, 2007).

The fisheries study component of the Malawi CCVA resulted in several surprises. For the study, the Malawi team’s fisheries expert drew heavily on qualitative information. The expert conducted key informant interviews with district-level fisheries sector officials, and took part in a much larger Participatory Rural Appraisal (PRA) activity that covered nine villages in eight districts.⁴⁸ As part of the PRA exercise, the fisheries expert and other PRA team members collected community member observations about fisheries; their perceptions concerning fish recruitment⁴⁹ and stocks; and how climate variability, deforestation, soil erosion, water turbidity, contamination, and economic development were all affecting the fisheries sector. The fisheries expert correlated these perceptions with the information provided by the fisheries sector officials.

Although the information gathered was anecdotal, it provided a basis for design of a more detailed study. The information gathered pointed to potentially significant impacts on fisheries biology, reproduction, productivity and habitats that may be associated with climate-induced changes⁵⁰ in

⁴⁸ Village sampling was conducted using livelihood zones in a way that captured the diversity of up to 77 percent of Malawi’s total (2003) population.

⁴⁹ Fish recruitment refers to the number of new fish that enter a population or type of settlement in a given period.

⁵⁰ The fisheries study was completed prior to the climate analysis, so the climate-induced changes were not ones derived from the climate study. However, once the climate study was completed, the CCVA team did review the

temperatures, precipitation and runoff linked to flooding and drought, as well as changes in wind patterns. (See Table E.2.)

TABLE E.2: REPORTEDLY OBSERVED CLIMATE IMPACTS ON FISH STOCKS

Fisheries Element	How would climate impact the element?	Recent impacts reportedly observed on fish stocks ⁵¹
Ecosystem/ breeding habitats	<p>Rising temperatures may cause some species of fish to migrate to deeper colder waters. There, they adapt (crowding out local species and creating an unbalanced ecosystem) or die.</p> <p>Winds can change upwelling patterns in the lake and may indirectly foster migration of fish to other areas, further from the shoreline</p>	Fish stocks (and inevitably, catches) decline
Fertilization and nest protection	Heavy siltation due to intense rainfall and high rates of runoff and soil erosion creates a murky environment in which fish cannot fertilize their eggs or protect their nests.	Fish stocks (and inevitably, catches) decline
Migration patterns	<p>Intense rainfall and high rates of runoff cause soil erosion and increase siltation, which hinders fish migration to larger lakes; erratic rainfall resulting in lower agricultural yields often triggers small-scale stream diversion for irrigation, also interrupting fish migration patterns.</p>	Reduced fish recruitment

In order to gain a detailed understanding of fisheries dynamics, during the PRA design, the PRA team had purposefully included one particular community in the sample that had been identified as a fishing village. To the surprise of all concerned, that village, Liguluche, could no longer be considered a predominantly fishing village. Although fishing was still practiced in Liguluche, due to the unavailability of larger fish, it been reduced to harvesting only small "usipa" fish—small fish found further from shore in deeper water—and fishing no longer played a dominant role in the village's economy.

Shortly after release of the Malawi CCVA report, USAID/Malawi issued a draft program description for a planned new activity: Fisheries Integration of Society and Habitats (FISH). The FISH activity is designed to "increase social, ecological, and economic resilience to climate change and improve biodiversity conservation through sustainable fisheries co-management."⁵² Findings from the Malawi CCVA were used in the development of the draft program activity, a direct and immediate uptake of CCVA results.

community members' observations about climate changes that had occurred, and were able to confirm these observations based on the then completed historical climate analysis.

⁵¹ While fish stocks are directly affected by changes in climate variables, the volume of fish catches is much more difficult to attribute to climate because of a multitude of confounding human factors. Fisheries resources in Malawi are already threatened by overfishing and a failure to observe laws and regulations designed to support sustainable use of fisheries. Additional threats are related to changes in land use, particularly conversion of forests to cropland, expansion of small-scale irrigation through stream diversion, and agricultural development in close proximity to rivers and water bodies. These aspects were not studied as part of the Malawi CCVA, which was focused on climate-induced impacts.

⁵² <http://www.usaid.gov/sites/default/files/documents/1868/MissionsForecast.pdf> (July 2014)

FUTURE CLIMATE SCENARIOS FOR OPTIONS ANALYSIS

The Malawi team benefited from the Uganda experience in the design of its adaptation options analysis phase. The Uganda team had successfully piloted location-specific climate scenarios as a means to enhance the relevance of the options analysis exercise to participants. The Malawi team took this one step further by employing a role playing approach that used localized future climate scenarios in an attempt to enhance not only relevance, but also to increase the concreteness of the resulting recommendations.

Four scenarios were used to help workshop participants imagine and grapple with multiple climate futures.⁵³ Each climate future was one that the CCVA's climate projections had identified as a plausible scenario. The role playing approach required that participants imagine themselves in one of these four climate futures, and describe "what they did in 2013" to prepare for this future "that they were now in, in 2020." The four climate future scenarios were:

- **Scenario A** – An erratic, uncertain climate future, where rains are unpredictable, with the possibility of both droughts and floods.
- **Scenario B** – A hotter dryer climate, with an increased frequency of droughts.
- **Scenario C** – A much wetter climate, also with higher temperatures but with heavier rains and an increased frequency of floods.
- **Scenario D** – More favorable climate conditions, in the short term.

Participants imagined the effects on natural resources, crops and livelihoods in Malawi, and imagined a future in which the challenges associated with these effects were successfully met. These became the basis for identifying adaptation options. The participants categorized their ideas into one of five categories: (i) Policy; (ii) institutions; (iii) technical; (iv) behavioral and (v) knowledge, data, information, or research. The group identified those options that they judged to be "robust" in that they could be applied to several climate scenarios—the "robust" options were held to be relevant regardless of what the future climate brings. Within each category, ideas were assessed according to whether they were flexible (allowing flexibility in the future to respond to uncertain risks), equitable (benefiting particularly vulnerable groups and communities), urgent (requiring implementation within the next two to five years), and synergistic (complimentary with GOM and donor objectives).

The result was a set of recommendations that fell into four overarching strategies around which to develop and implement the recommendations:

- Timely, accurate, and relevant information on weather and climate;
- A focus on water and natural resources that provides a consistent framework for implementation across sectors;
- High-level, cross-sectoral planning, harmonization, and coordination; and
- A coherent approach to diversifying what will remain (at least in the near term) a largely agrarian economy.

Both long- and short-term, and both local- and national-level recommendations were derived from these strategy areas. The longer term, climate-specific interventions seek to position Malawi to better deal

⁵³ All four of these future climate scenarios shared a common set of socioeconomic and environmental factors: increased population, poverty rates that were stable or increasing, and significant environmental degradation.

with an uncertain future. The shorter-term, "no regrets" options will allow Malawi to react to climate change and climate variability happening now, and represented actions with no significant downside impact.

CONCLUSIONS

The fisheries study was a small component of the overall CCVA, with findings based entirely on a literature review supplemented with key informant and community member interviews. Yet it yielded important, and sometimes surprising, results. The information gathered was current and grounded in the day-to-day realities of those individuals most directly affected by the impacts of climate change on this important source of livelihood. Due to the importance of fisheries on food security in the country, results from this study led to direct uptake by USAID, demonstrating how even a small study can have an immediate effect.

The future climate scenario and role playing approach for analyzing adaptation options also proved quite useful. First and foremost, the scenarios were particularly effective as a communication tool for making climate change "real" to participants (see Text Box E.1). The use of compelling narratives were particularly useful for moving the analysis process forward given the complex nature and uncertainties associated with climate change. It proved to be an effective tool to inform long-term strategic planning in the face of uncertainty; and it fostered strategic thinking in both change management and risk management. For the participants, the role-playing nature of the exercise helped make the future climate scenarios more real and immediate, which in turn allowed them more easily identify realistic, flexible, equitable, urgent, and synergistic recommendations that a majority of the participants supported. Most importantly from a programmatic perspective, it resulted in a set of robust response options that merited prioritization, and the identification of no and low regrets options that would attenuate risks for multiple climate scenarios.

TEXT BOX E.1: PARTICIPANTS' COMMENTS ON THE USE OF FUTURE CLIMATE SCENARIOS FOR ANALYZING ADAPTATION OPTIONS

- "My understanding of the seriousness of climate change has grown."
- "Climate change is happening. We cannot be complacent."
- "An eye-opener! Climate change is multi-faceted, and it will affect us all."

ANNEX F. DOMINICAN REPUBLIC CCVA CASE STUDY

**TABLE F.1: DOMINICAN REPUBLIC VULNERABILITY ASSESSMENT
SNAPSHOT**

Study Locations	Punta Cana/Bávaro; Yaque del Norte [Montecristi/Santiago]; Bajo Yuna (Samaná Bay and Peninsula); and Santo Domingo identified as vulnerability "hot spots"
Study Purpose	To improve understanding of climate change impacts on watersheds and coastal resources—as well as on the people who depend on them—in four climate-sensitive hot spots
Intended Audience(s)	USAID and the Government of the Dominican Republic
Vulnerability Model	Vulnerability as a function of exposure, sensitivity, and adaptive capacity
Subjects and Analytic Components	Climate, flooding and storm surge, tourism, fisheries, and coastal and watershed resources
Methods Used	Literature reviews analysis of secondary data; spatial (GIS) analysis; climate downscaling, historical analysis, future projections; KIIs and FGDs.
Adaptation Recommendation Categories	Organized according to "Adaptive Pathways." Pathway 1 - Disaster Risk Reduction and Early Warning Systems; Pathway 2 - Development Planning: Infrastructure and Land Use; Pathway 3 - Management and Conservation of Coastal Habitats and Watersheds
Duration of Study	Six months, December 2012 to May 2013
Unique Contributions of the Study	<ul style="list-style-type: none"> • The first comprehensive climate downscaling of historical (50 years) climate analysis and climate projections for the DR; analyses of geospatial flood risk, wind, tropical storms, and marine and coastal systems • An evidence base clarifying the strong relationship between climate change and marine and coastal ecosystem health. • A clearer understanding of likely future climate, with the dry season becoming wetter in one of the hot spots and the wet season become dryer in another.

INTRODUCTION AND BACKGROUND

The Dominican Republic Climate Change Vulnerability Assessment (DR CCVA) was conducted in response to requests from the USAID/Latin America and Caribbean Bureau and USAID/Dominican Republic. Initially, the requests were prompted by a desire to inform the Dominican Republic CDCS, as USAID well recognized the importance of climate change to this island nation's future development. Due to the short time frame required to provide the information and limited budget, the DR CCVA was carried out using only secondary (third-party) data; no primary data collection was undertaken.⁵⁴ This limitation presented challenges not encountered during other ARCC CCVAs, which allowed for the collection of primary data. In addition, before initiating field work, further refinement of the study's objective (or "research question") was required in order to clearly define its scope and depth of the study, as well as to focus understanding. This case study describes the lessons learned from these two crucial aspects of the study: reliance on secondary data and the importance of having a clearly articulated research question.

A CLEARLY ARTICULATED RESEARCH QUESTION

"It's all about getting everyone on the same page and keeping them there." This phrase summed up the leadership challenge associated with the DR CCVA. Like all climate change vulnerability assessments, the DR CCVA was bound to be highly complex—involving myriad areas of expertise—and interwoven, with each component of the study linked to the others. In such cases, it is easy to get lost in the weeds or to go off on a tangent. Avoiding these risks requires more than just a purpose statement; it requires a clearly stated, explicit, and agreed upon **research question**. The research question needed to be much more precisely framed than simply "to inform the CDCS." The DR CCVA team worked closely with USAID to understand precisely who would use the findings of the study and how they would use them. Then, starting with the study's purpose statement, USAID and the DR CCVA team worked together to develop a clearly defined research question.

The team adapted the IPCC definition of vulnerability as a function of the three dimensions of exposure, sensitivity and adaptive capacity. Using this definition provided a common, accepted set of definitions that aided communications among the team members and with stakeholders. Working with USAID and other key stakeholders, the team then further identified the What? Why? Where? For Whom? of the three vulnerability dimensions. The evolution of the DR CCVA research question (see Table F.1, next page) that emerged from these discussions offers some more broadly general insights into how a complete research question can address these basic issues of, What? Why? Where? For Whom? The first two columns of Table F.2 show an illustrative example of how the research question might have evolved during DR CCVA team's discussions with USAID and other stakeholders; these discussions would have added to and elaborated on the What? Why? Where? For Whom? The research question might not have evolved in precisely this way; the point is simply to show how it *might* have evolved to incorporate these key aspects.⁵⁵

⁵⁴ Focus group discussions and key informant interviews (KIs) were used to validate the secondary (third-party) data. In addition, KIs were used to assess institutional issues; this activity constituted original research and may even be considered as primary data collection if the meaning of the term "data" is expanded to include such information.

⁵⁵ The actual evolution of the research question [third column in Text Box F.1, next page] was documented in just three places: the original Scope of Work (SOW), a presentation made during the design phase of the study, and the final DR CCVA report.

TABLE F.2: EVOLUTION OF A RESEARCH QUESTION

ILLUSTRATIVE EVOLUTION OF A RESEARCH QUESTION	EXPLANATION OF THE EVOLUTION	ACTUAL EVOLUTION OF THE DR CCVA RESEARCH QUESTION
"Collect information to inform future development programming"	Why? How? Initial scope specified why (to inform programming), but left the "how" (by collecting information) too generic	In the SOW "Provide an objective, evidence-based product that can be effectively used by both the GODR and USAID to make policy and programming decisions"
"Collect information to inform future development programming in tourism, fisheries, water and energy "	What? This addition defined the programming in what sectors	
"Collect information to inform future development programming in tourism, fisheries, water and energy located in "climate hot spots" "	Where? This addition defined where the study was to be carried out	Preliminary Research Questions (Design Phase) <ul style="list-style-type: none"> • How has/will climate change impact water and marine resources? • How will these impacts affect society and natural systems? • How can/do people and institutions respond/adapt to these impacts?
" Improve understanding of climate change impacts on tourism, fisheries, water and energy located in "climate hot spots"	How? This addition elaborated how collecting information served to further the "why" — by improving understanding	
"Improve understanding of climate change impacts on watershed and coastal resources "	Where? This change improved the definition of "where" by defining exactly what constituted a "hot spot"	Final Research Question/Goal "To improve understanding of climate change impacts on watersheds and coastal resources—as well as on the people who depend on them—in four climate-sensitive hot spots."
"Improve understanding of climate change impacts on watershed and coastal resources— as well as on the people who depend on them —in four climate-sensitive hot spots"	For Whom? This addition specified precisely whom would ultimately benefit	

The ARCC lesson was twofold: getting the research question "right" is an evolutionary process that takes time and careful consideration and, because the research question will guide the design and execution of the study, it is very important to get it "right." In turn, what is "right" will depend on the needs the study addresses and the resources available to carry it out.

The very act of developing the research question in a collaborative fashion also served to further refine the DR CCVA team's understanding of the needs of the audience for the study, both within USAID and within the Government of the Dominican Republic (GODR). Through the many discussions, the ARCC team was able to glean a much better understanding of precisely who would be using the results of the study as well as the level and depth of information that they required.

Armed with a fully articulated and agreed upon research question, and with it a clearer understanding of the audience, the ARCC team was then in a good position to develop a solid design for the study. Data would need to be compiled from secondary sources that would help answer the research question and serve the needs of the primary audience.

RELIANCE ON SECONDARY DATA

Due to time and budget limitations, the ARCC team relied primarily on secondary data, i.e., there were insufficient resources to collect new, primary data. Initially, the team attempted to fill all of its data needs by compiling data from third party sources from institutions within the DR. For this, having face-to-face meetings was critical, even more important than if the team had been collecting primary data.⁵⁶ It was necessary to identify the appropriate sources, visit and establish relationships with them, and follow through on all the necessary data release protocols.

The data needs for the DR CCVA were wide-ranging in the subject matters they encompassed, including meteorology, land cover and land use, socioeconomics, infrastructure, and health. Many of the challenges encountered during compilation of these data were those commonly encountered when attempting to use data for an application other than that for which the data were originally collected (e.g., categorization, scale and time frame), while other challenges were those common in developing countries (e.g., data not being provided in an actual "data" format or data not being provided at all). But some were specific to a CCVA. For instance, while the meteorological data were found to be available and adequate, a significant amount of effort was required for data "cleaning" before the data could be used for climate analyses. In the case of the meteorological data, the data cleaning required an ARCC-provided climate scientist, because the local meteorologists did not have the expertise to clean data in a way appropriate for use in climate change modeling.

Data cleaning issues aside, ultimately only the meteorological data needs were fully met from sources within the DR. Data for other needs (e.g., flood modeling) had many gaps (both spatial and temporal), and additional data needed to be compiled from external sources to fill in the gaps. Fortunately, data are becoming more freely available on the Internet than ever before. In the case of the DR, a newly released data set⁵⁷ proved to be invaluable for creating the necessary flood risk maps so that time could be devoted to analysis rather than data preparation.

⁵⁶ Both face-to-face meetings and the focus group discussions had the side benefit of validating the assumptions of the study and "triangulating" preliminary results as they were developed.

⁵⁷ Flood model data for the DR combined data from several other sources, including the United Nations Environment Programme Global Resource Information Database (GRID), the Earth Resources Observation and Science (EROS) Data Center, and Dartmouth University's Flood Observatory. The dataset was an already integrated product that was easy to download and use, not requiring any data cleaning (or even any format conversions). Because it was created by Dartmouth, it was also well-documented.

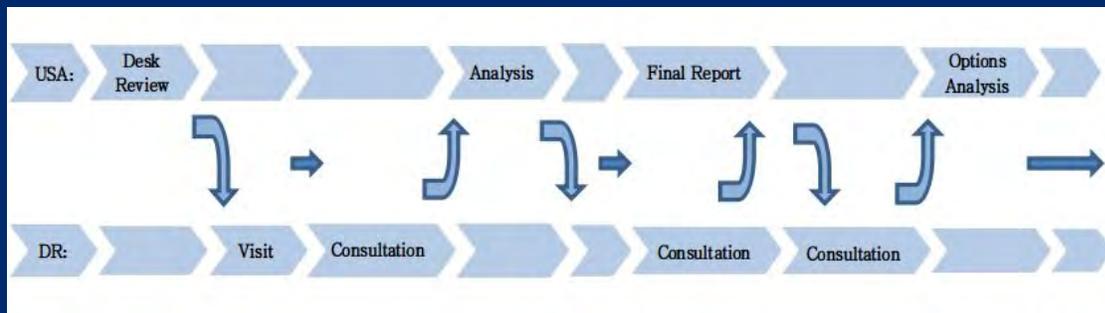
The data were indirectly "triangulated" through the use of focus group discussions and key informant interviews, i.e., the findings from the data (not the actual data) were validated through these means. For example, one of the findings from the analysis of future climate was a likelihood that rainfall decrease during what has traditionally been the peak rainy season, as well as the during the dry season, and a slight increase during the second rainy season.⁵⁸ This finding was confirmed by focus group comments such as the one in the text box at right. An important lesson from the DR CCVA was the importance of local knowledge to validate scientific findings, and how such validation can serve to enhance the legitimacy of the scientific findings. This is shown in Text Box F.I, which shows how consultations took place at the four hot spot sites during the field assessment phase, again to validate findings from the analysis, and again at the end of the study to validate and refine recommendations for adaptation options.

"Seasons are upside down. When it is supposed to rain, it is dry. When it is supposed to be dry, it rains."

— a focus group in La Pascuala

TEXT BOX F.I: THE POWER OF LOCAL KNOWLEDGE FOCUS GROUP DISCUSSIONS AND KEY INFORMANT INTERVIEWS

Local knowledge is critical in any situation, but even more so when researchers are relying on third-party data as the primary source of quantitative data. In the Dominican Republic, local stakeholder consultation at critical points provided significant contributions throughout the assessment process (see graphic below).



CONCLUSIONS

The Uganda CCVA was ARCC's first. From it, we learned about the importance of having a clearly articulated research question, in order to establish a research framework, guide operations, and carry out the research. With this knowledge, the DR team was able to more conscientiously and purposefully develop its research question. The enhanced salience that a collaborative approach to defining the research question confers, identified during the Uganda CCCVA, was confirmed during the DR CCVA. In addition, the added benefit of collaborative development for adding insight into and understanding of audience needs became apparent, and the evolution of a research question itself began to be understood in a more systematic way. The DR team also drew from the Uganda CCVA to enhance stakeholder

⁵⁸ Pages 30 and 35, USAID, Dominican Republic Climate Change Vulnerability Assessment Report, August 2013

engagement, building into the study design repeated opportunities for consultation and validation. This enhanced the legitimacy and credibility of the results.

By providing common definitions and a common language, the use of a standard definition for vulnerability as a function of exposure, sensitivity and adaptive capacity aided in the communication of the research question. Having a fully articulated and agreed upon research question, and clear understanding of audience needs, allowed the ARCC team to focus its data compilation activities. Many of the data compilation challenges encountered were those typical when relying on data collected for other purposes, or compiled from sources within developing countries. But other challenges were specific to a CCVA, especially those associated with the meteorological data, where significant effort was required by a climate specialist to "clean" the data in preparation for use in a climate analysis. The value of validating with local knowledge the scientific findings derived from the data was also confirmed during the DR CCVA, as was the increase in legitimacy that such validation confers.

The DR CCVA resulted in many unique contributions, several of which extended well beyond the initial purpose of the study. The DR CCVA resulted in

- Several important analytic products, including the first comprehensive climate downscaling of historical (50 years) climate analysis and climate projections for the DR; and a geospatial flood risk analysis, wind analysis, tropical storm analysis, and marine and coastal system analysis all of which have value beyond the climate change vulnerability analysis;
- An evidence base that clarifies the strong relationship between climate change and marine and coastal ecosystem health; the critical role of coral reefs and mangroves in mitigating storm surge damage; and, relative to the other studied elements, the very minimal role of winds in beach erosion; and
- A clearer understanding of likely future climate, with the first rainy season and dry season becoming dryer, and the second rainy season becoming wetter—as opposed to an absolute decrease in rainfall totals. The expectation of such a shift in rainfall patterns can be particularly important for policy-making and programming related to subsistence agriculture.

Overall, the DR CCVA provided a broad improvement in understanding of the relationships between how climate change affects important coastal and marine ecosystems and how those ecosystems, in turn, impact people and communities in the DR. As this understanding is evidence-based, the DR CCVA added an important new dimension to USAID's development planning and the GODR's policy programming. This new dimension should strengthen planning and policy in several sectors, including tourism, agriculture, environment, and water resources.

ANNEX G. SENEGAL CCVA CASE STUDY

TABLE G.1: SENEGAL VULNERABILITY ASSESSMENT SNAPSHOT

Study Locations	Four departments—Matam, Kanel, Goudiry, and Bakel—located in rural pastoral and rain-fed farming areas, that are considered part of the sylvo-pastoral and agro-sylvo-pastoral food crop livelihood zones as defined by FEWS NET
Study Purpose	To test a research hypothesis posited that households with livelihoods that include livestock are less vulnerable to climate change than are households whose livelihoods primarily depend on crop agriculture.
Intended Primary Audience(s)	USAID/Senegal and the Sahel Resilience Group [1]
Vulnerability Model	Vulnerability as a function of exposure, sensitivity, and adaptive capacity
Subjects, Analytic Components	Subjects: agro-pastoral livelihood types. Components: climate analyses (historical trends analysis, down-scaling, and projections); agricultural crops (millet, sorghum, cow peas, groundnuts and maize) and livestock (cattle poultry and small ruminants.)
Methods Used	Focus group discussions, household survey, and key informant interviews; climate analyses including down-scaled climate projections for two 20-year periods; crop and livestock resource modeling; spatial analysis; literature reviews; and consultation with local experts.
Adaptation Recommendation Categories	Strengthening crop diversification through improved sorghum varieties and high-yield forage; improved management of water and pasture resources; supporting integration of livestock into cropping systems; improved weather and market information.
Length of Study	25 months, May 2012 to June 2014
Unique Contributions of the Study¹	<ul style="list-style-type: none"> • Quantification of exposure, sensitivity and adaptive capacity (spider diagrams and composite indices) • By isolating factors that may contribute to pastoralist vulnerability, the study explored the assumption that pastoralists are more resilient than are crop-dependent farmers • Tested new survey technology (iPads and iForm Builder) during household survey.

[1] Much of the study zone falls in the Sahel, making the findings of the study potentially relevant to other areas of the Sahel.

INTRODUCTION AND BACKGROUND

The Senegal CCVA was designed to identify causes of vulnerability and food insecurity in households in Eastern Senegal, and identify those for which there is a potential for a viable intervention through USAID programming. The study area of Eastern Senegal was selected in consultation with USAID and the Government of Senegal due to high food insecurity in the region and because it had been identified as a future location of USAID investment. The findings from the assessment were also expected to overlap and inform initiatives of the Sahel Resilience Group (previously named the Joint Planning Cell [JPC] for the Sahel).

The study area is one of mixed livelihoods that depend on both crops and livestock, but where pastoral livestock-dependent households were expected to be more prevalent in the northern portion, and crop agriculture-dependent households were expected to be more prevalent in the south. The specific research question addressed was "What are the most effective strategies for improving resilience of households to climate change?" The choice of study area provided a unique opportunity to test the commonly-held belief that households with livelihoods primarily based on pastoralism are less vulnerable to climate change than those primarily dependent on sedentary crop-based agriculture.

The Senegal CCVA was the last and most extensive CCVA conducted under ARCC. As such, it applied many lessons learned under previous ARCC CCVAs, and also broke new ground in the sophistication of analyses performed—applying multiple, sophisticated, quantitative modeling programs to the task. This case study focuses on lessons learned in dealing with the inherent, compounded uncertainty associated with applying multiple models.

TABLE G.2: SENEGAL INDICATORS OF VULNERABILITY

Vulnerability Dimension	Indicators
<p>Exposure: the biophysical limits imposed by climate; specifically the constraints on cropping, livestock systems, and markets produced by rainfall and temperature patterns.</p>	<ul style="list-style-type: none"> • Cropping systems: less favorable rainfall and temperature for the production of millet, sorghum, cow peas, groundnuts, and maize • Livestock systems: decreased quantity and quality of range land vegetation, decreased surface water availability, and reduced availability of field crop residue • Markets: increased rates of road deterioration and rising frequency of commodity price shocks
<p>Sensitivity: the current relative dependence of households on climate-affected production and exchange systems</p>	<ul style="list-style-type: none"> • Proportion of off-farm to on-farm income • Proportion of livestock to crops farmed • Proportion of large to small ruminants • Proportion of vulnerable to less vulnerable crops • Level of market engagement

<p>Adaptive Capacity: the ability of a household to modify its circumstances or behavior so as to successfully adjust to existing and anticipated external climate trends and shocks through household access to or control of assets</p>	<ul style="list-style-type: none"> • Human: health, nutrition, labor, education • Natural: fields, pasture, water • Physical: property, farm machinery and tools • Social: farmers' associations, kinship networks, extension services, development programs • Financial: income (including remittances, seasonal migration, crop sales, paid employment), stored wealth and assets
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DEFINING EXPOSURE, SENSITIVITY, AND ADAPTIVE CAPACITY

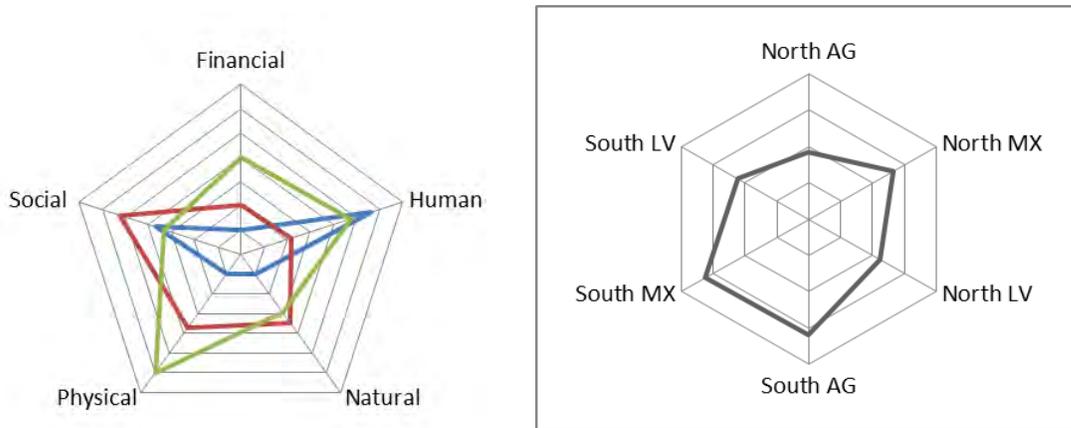
The Senegal CCVA team employed the IPCC definition of vulnerability as a function of exposure, sensitivity, and adaptive capacity. Table G.1 provides details of the vulnerability model applied for all three dimensions. As much as possible, the team defined the three dimensions of vulnerability quantitatively, so they could be integrated and together describe vulnerability. So, rather than defining exposure in terms of first-order impacts from climate (i.e., temperature and precipitation), as did the other ARCC CCVAs, the Senegal CCVA team defined exposure as the climate-dependent part of productivity. Specifically, the team defined exposure as the biophysical limits on cropping systems, livestock systems and markets.⁵⁹ This definition opened the way for analysis of modeled impacts of climate change on crops, livestock and market factors.

Through the previous ARCC CCVAs, the Senegal team had learned that sensitivity and adaptive capacity are often the inverse of one another, with higher sensitivity often representing lower adaptive capacity and vice versa. The team quantified sensitivity, so that it could be modeled in a way that would allow the measurement of the impact of the proportion of crops and livestock managed by a household, as well as their level of market engagement.

Using survey results, the team developed a composite index defined as the assets owned, controlled or accessed by households, which they displayed in spider diagrams (see Figure G.1) showing the types of capital (social, financial, human, natural, physical) most critical to each livelihood type (agriculture, livestock, mixed). The team subsequently also measured stressors on households' productive systems, such as chronic illness, food insecurity, and herd size, that described which regions and livelihood type experienced higher levels of household stress.

⁵⁹ he market analysis (not discussed in this case study) included a GIS analysis of market access where separate spatial layers were used to compare individuals' abilities to access and use markets (e.g., distance to markets, quality of road, topography and soil type). Major areas of the study area scored very low, representing significant barriers to household use of markets as an adaptive strategy.

**FIGURE G.1: ADAPTIVE CAPACITY INDICATORS
(CAPITAL, LEFT; ZONE AND LIVELIHOOD, RIGHT)**



Household Adaptive Capacity by Zone and Livelihood (South Only), Left.
Adaptive Capacity Stress Indicators by Zone and Livelihood, Right.
AG – Agriculture, MX – Mixed, LV – Livestock
—AG —MX —LV

This approach allowed the team to ascribe specific indicators to adaptive capacity and measure how a household experiences stress. The team also conducted literature reviews and key informant interviews to understand institutional adaptive capacity in the study area. This integrated approach to measuring adaptive capacity was new to ARCC.

The Senegal CCVA team used models to understand exposure, sensitivity and adaptive capacity, in the process piloting new tools to explain current and future vulnerability. The models included climate modeling, with downscaled climate projections; crop productivity modeling and simulations; and application of the Sahelian Transpiration Evaporation and Production (STEP) model to assess livestock carrying capacity. These models, together with numerous other quantitative and qualitative assessment methods, attempted to explain, "Who is vulnerable now?" and "Who will be more vulnerable" in the future?

The historical climate analysis identified two reference periods: a dryer period between 1971 and 1990, and a wetter period between 1991 and 2000. The team referenced these historical periods to climate projections for 2030 and 2050 time horizons. The results of the analysis described future projections in terms of how much climate is likely to change from the past conditions experienced during the historical reference periods. The reference periods gave the results of future climate change a historical context for decision making. Importantly, it also allowed the team to partially address the high degree of uncertainty inherent in distinguishing the effects on vulnerability of future climate *change* from that of natural decadal and inter-annual climate *variability*, i.e., by grouping periods of historically dry or wet conditions for analysis of future vulnerability.

Using the climate information, the team then simulated future crop productivity impacts based on projected rainfall and temperature. To determine who would become more vulnerable over time, the team took a "hazard-impact assessment" approach that integrated the modeled impacts on crop productivity and the availability of water and biomass resources. The team applied FAO's CropWat Model to simulate a range of impacts on productivity of millet, sorghum, cow peas, groundnuts and a maize hybrid. Because crop models contain a high level of uncertainty due to limited data and real-world

sensitivity of crops to intra-seasonal rainfall distribution, the team used only the results derived from the trends and projected climate conditions that were close to the multi-model average—a conservative estimate of future climate change.

Finally, the team applied the STEP model to assess livestock carrying capacity for the 2030 and 2050 time horizons. The team used the same set of data as that used for the crop modeling activity: meteorological conditions, soil characteristics, soil development stages and farming practices. The integrated approach to studying pasture, water, and agricultural yields which produce fodder for livestock underscored the significance of the assessment as being more than the sum of its parts. In order to be effective, each of the separate studies had to be integrated in a way that explored the causal factors that drive vulnerability—both climate and non-climate—and adaptive responses.

CONCLUSIONS

The Senegal assessment was launched in May 2012 and completed in June 2014, making it the longest running of any of the CCVAs conducted under ARCC. It was also one of the most complex assessments with multiple research methods that included a number of modeling exercises, included those described briefly in this case study. In addition to modeling exercises, the Senegal CCVA team conducted literature reviews, focus group discussions, a household survey, key informant interviews, and consultations with local experts.

Not unexpectedly, the team found that the uncertainties inherent in data-based modeling were compounded by those inherent in projections with long time horizons, and were further compounded when the results from one model (e.g., climate) are used as input to another model (e.g., crop and livestock). While this compounding of uncertainties will always constrain such analyses, the team was able to partially address it in a number of ways. First, the team intended from the beginning to take a highly quantitative, model-intensive approach to the CCVA. The component leaders ensured that the component teams understood how the different analyses were interconnected and they used common data sets for each model whenever feasible, reducing the possibility of introducing additional uncertainty simply by using different data sets. The team used the two historical climate reference periods to help distinguish the effects on vulnerability of future climate change from those of natural climate variability. They used multi-model averages for climate projections and combined model results with qualitative studies, such as literature reviews; the qualitative studies were critical for interpreting model results. The majority of the analyses were carried out by Senegalese organizations⁶⁰ and consultants, which ensured a level of "grounding" that would have been unlikely had the analyses been conducted by expatriate entities. The team held regular coordination calls throughout the CCVA to ensure that analyses across components would work together; and held a two day, in-person cross-analysis meeting to pull together the findings from all of the components.

Reflecting on the assessment's emphasis on quantitative methods, the team successfully piloted a number of innovative approaches for assessing vulnerability. Because the results were based upon real simulations of wetter (good for crops) years and dryer (bad for crops) years, the assessment confirmed the expectation that erratic rainfall and temperature have historically been, and will continue to be, major determinants of risk to people living in the study area. Using historical experiences, such as

⁶⁰ The Centre de Suivi Ecologique (CSE) carried out most of the pastoralist resource modeling and spatial analysis and ground truthed the results. The Institut Sénégalais de Recherches Agricoles (ISRA) carried out the majority of the field research including the household survey, focus group discussions, key informant interviews, crop modeling, and description of current climate and provision of climate data.

referencing historically dry and wet periods, made the findings more understandable and should increase confidence that policies and programs designed to help people adapt will not be maladaptive.

The team also exposed some important limitations to what can possibly be known or predicted about vulnerable populations. The high level of uncertainty that is inherent both in modeling exercises and in projecting long time horizons underscores the limitations of quantitative, model-based analyses. But perhaps more importantly, the team learned that, because individual farmers make decisions influenced by many non-climatic factors, it is impossible to effectively isolate climate factors from other sources of farmer decision making. The ways in which pastoralists and crop farmers make decisions is complex and not entirely possible to know. This, together with the fact that policy making and programming processes rarely focus on planning for future time frames such as 2030 and 2050, perhaps a more useful focus is on the immediate issues being faced in light of current climate change over the next five or ten years.

At the time of writing this case study, the Senegal CCVA was still being reviewed by USAID/Senegal and the options analysis phase had not yet been completed. However, in light of the findings described here, the soundest adaptation options may be those that reduce risk through diversification of livelihoods, such as investment in assets outside of farming altogether.

ANNEX H. MALI CLIMATE VULNERABILITY "HOT SPOT" MAPPING CASE STUDY

TABLE H.1: MALI "HOT SPOT" MAPPING SNAPSHOT

Study Location	Country-wide
Study Purpose	To inform USAID/Mali's climate adaptation and broader development programming
Intended Audience(s)	USAID/Mali
Vulnerability Model	Vulnerability as a function of exposure, sensitivity, and adaptive capacity
Subjects, analytic components	Pilot study of quantitative detection of potential vulnerability "hot spots," producing a composite index (vulnerability) from three sub-indices (exposure, sensitivity, and adaptive capacity)
Methods Used	Geographic information system (GIS), index development, Principle Component Analysis (PCA), climate projections (temperature/precipitation)
Adaptation Recommendation Categories	Not applicable
Duration of study	Three months ending January 2014
Unique Contribution of the Study	Successful proof of concept for computing "vulnerability index" maps. The resulting maps were to be found useful for identifying geographic areas with potentially high vulnerability and for examining the spatial patterns of potential vulnerability in specific geographic areas. The resulting hot spot maps can be used to identify areas in which to conduct detailed vulnerability assessments.

This case study describes another type of activity in the ARCC portfolio—a desk study based mapping exercise designed to identify potential climate vulnerability "hot spots."

TEXT BOX H.1: APPROPRIATE USE OF VULNERABILITY HOT SPOT MAPS

PURPOSE, AUDIENCE, AND PROCESS

The stated purpose of the Mali Vulnerability Hot Spot Mapping was "to be used by USAD/Mali to inform its climate adaptation and broader development programming" (de Sherbinin et al., 2014). On the surface, this purpose seems essentially identical to the high-level objectives of the ARCC CCVAs, i.e., to guide USAID investments and programming. The key difference was that this exercise used quantitative methods to identify areas (hot spots) within Mali with a high index of potential vulnerability. The results from this exercise provided USAID/Mali with an evidence base that further justified the choice of intervention areas that had already been made using other criteria. In other words, the maps became a resource for confirming the suitability of programming that was already underway rather than for identifying opportunities for new investment (personal communications, USAID/Mali, 14 April 2014⁶¹).

ARCC experience demonstrated that mapping efforts can never replace CCVAs. Hot spot maps may be used as a first step, to identify areas to focus on for a field-based CCVA. Or they may be used, as was the case in Mali, to provide an evidence base to help validate decisions made using other, complementary, criteria. They can also be excellent tools for visualizing the spatial distribution of potential vulnerabilities in a country. Appropriate use of hot spot maps requires an appreciation of the many limitations inherent in mapping exercises, in general, and the assumptions and compromises that must be made when generating maps.

This exercise was designed specifically for internal use by USAID/Mali—not for external consumption. The result was a more focused, effective product.

USAID/DC staff were involved from the exercise's initial design through its conclusion. While developing the map products, ARCC, USAID/DC, and USAID/Mali enjoyed a high level of technical exchange, including discussions of methods and decisions about potential data sources. This exchange assured that USAID understood and accepted the complexities and limitations of the maps (as described below and in Table H.1), which reduced potential for misinterpretation or misapplication of the maps.

USAID, including actors not involved in the design stages, widely used the Mali map products internally in a range of technical sectors. USAID/DC took great care to include language in presentations to ensure that all of the USAID-internal audiences would appreciate the limitations of the resulting maps.

METHODOLOGY

The ARCC team based its design on the model of vulnerability as a function of exposure, sensitivity, and adaptive capacity. The team identified candidate indicators with readily available data of acceptable quality as proxies for the three vulnerability dimensions. Just as with ARCC's CCVAs, the team used their best judgment to decide whether particular indicators better represented the concept of sensitivity

⁶¹ The maps did not initially inform decisions about new investments; however, as additional audiences within USAID learned of the maps, new investment decisions may have resulted.

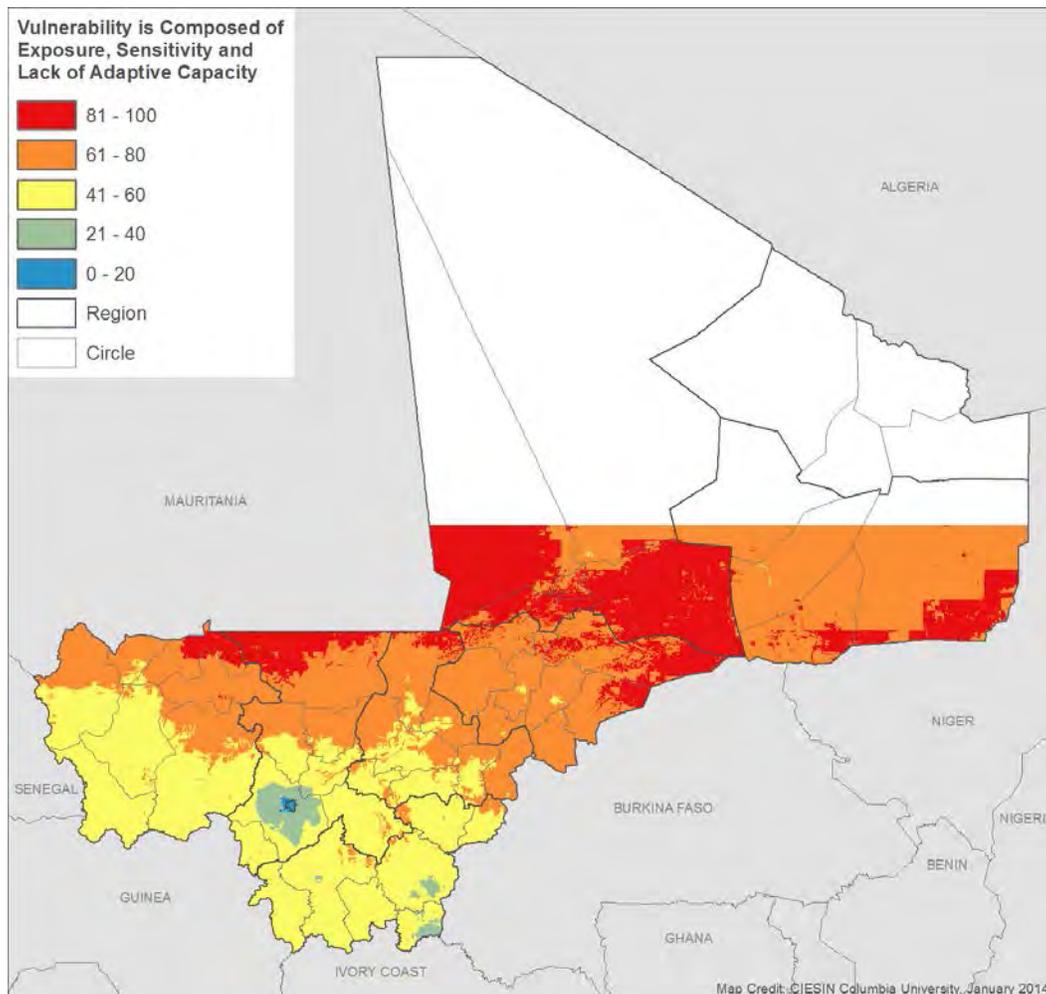
or of adaptive capacity. Table H.2 shows the 18 indicators used in the baseline (current)⁶² Mali hot spot mapping. Figure H.1 shows the resulting current vulnerability hot spot map.

TABLE H.2: INDICATORS USED IN MALI HOT SPOT MAPPING BY COMPONENT OF CURRENT VULNERABILITY

Component	Data Layer
Exposure	Average annual precipitation (1950–2009)
	Inter-annual coefficient of variation in precipitation (1950–2009)
	Percent of precipitation variance explained by decadal component (1950–2009)
	Coefficient of variation of the Normalized Difference Vegetation Index (NDVI) (1981–2006)
	Long-term trend in temperature in July-August-September (1950–2009)
	Flood frequency (1999–2007)
Sensitivity	Household wealth (2006)
	Child stunting (2006)
	Infant mortality rate (IMR) (2006)
	Poverty index by commune (2008)
	Conflict events/political violence (1997–2012)
	Soil organic carbon/soil quality (1950–2005)
	Malaria stability index
Adaptive Capacity	Education level of mother (2006)
	Market accessibility (travel time to major cities)
	Health infrastructure index (2012)
	Anthropogenic biomes (2000)
	Irrigated areas (area equipped for irrigation) (1990–2000)

⁶² Future vulnerability hot spots were also computed. These were based on projections of two indicators, precipitation and temperature trends, for future time periods centered on 2030 and 2050. Due to time and resource constraints, the Mali team was unable to develop future scenarios for the sensitivity and adaptive capacity indicators. (Page 7, USAID, Mali Climate Vulnerability Mapping, January 2014.)

FIGURE H.1: OVERALL CURRENT "HOT SPOT" VULNERABILITY INDEX



In its final report, the ARCC team pointed out that the selected indicators were based on assumptions about the mechanisms that produce vulnerability, and that the team was unable to test these assumptions against outcome measures. They also noted that the utility of the maps would have been significantly enhanced by a better understanding of the underlying functional form of the relationships among indicators, the degree to which the indicators may have been correlative, and threshold effects for certain indicators (de Sherbinin et al., 2014, p. 2). Both the ARCC team and USAID/Mali noted that, in some cases, data for some indicators were not available at a suitable resolution or were not of adequate quality. For these reasons, the team found alternative indicators or dropped the unsuitable indicators from the analysis. For example, the exposure data set did not include parameters likely to be particularly relevant to agriculture, such as temperature thresholds associated with crop development and unexpected interruptions in precipitation during the rainy season. As a result, projected changes in vulnerability may have been underestimated (de Sherbinin et al., 2014, p. 21). Similarly, the future climate scenarios used average annual precipitation and did not consider the impact of seasonal rainfall variability.

Because it was a desk study with no opportunity to collect primary data, the mapping exercise was data-driven rather than purpose-driven. For example, the inclusion of a health indicator was not tied to a strategic choice from USAID to understand the link between health and climate change (USAID's health unit became an audience for the product only at the completion of the exercise); rather, it was based on a general agreement that health-related data were available at the required resolution and were of adequate quality—and that they represented a key facet of Malian or African climate vulnerability. Table H.3 summarizes these and other considerations identified while carrying out the pilot mapping exercise in Mali as well as some ARCC lessons learned.

APPROPRIATE USE OF HOT SPOT MAPS

The maps resulting from the Mali exercise were found to be useful for identifying geographic areas with potentially high vulnerability and for examining the spatial patterns of potential vulnerability in specific geographic areas. USAID/Mali used the hot spot maps to validate choices already made for programming interventions using other complementary criteria (personal communication, USAID/Mali, 15 April 2014).

Such hot spot maps could also help identify areas in which to conduct detailed vulnerability assessments. For instance, as an early step in a CCVA, pre-identifying geographic areas of potentially high vulnerability can greatly streamline the associated field data collection process, ensuring that field work focuses not only in those areas likely to be the most vulnerable but also on issues that appear to have the largest influence on the measure of potential vulnerability. Indeed, the report clearly states that the "maps should be used in conjunction with ground validation" (de Sherbinin et al., 2014, p. 2).

An unintended but very real value of the maps was as a communication tool to help USAID staff gain an overall understanding of the relationships between climate change vulnerability and other factors within their development portfolios. This lesson was important for ARCC, as ARCC's prior CCVA experience highlighted the challenges of communicating to stakeholders about vulnerability to climate change and the complex nature and likely impact of climate change. The maps provided an effective tool for visualizing climate change vulnerability and the implications it might have on existing and planned development portfolios. Because they focus on areas with a high index of potential vulnerability, such maps might also be an effective way to influence cost-effective investment in field-based CCVAs, investment in programs to address climate change vulnerability, or in leveraging funds to address climate change adaptation.

Nevertheless, the results and the methodology as a whole must be applied with caution. Both the ARCC team and USAID have been careful to document and communicate these considerations. In spite of the use of the term "vulnerability index," the hot spot maps do not provide a measure of actual vulnerability, i.e., they do not represent absolute vulnerability index values, only relative values. In addition, they are only applicable within Mali, as they are based on data and assumptions relevant to Mali.

CONCLUSIONS

Exercises such as this can address questions or validate decisions about **where** programming might make the most sense, but it cannot answer questions about **which** programs are best suited for investment. This question requires fieldwork—a careful, intentional exploration of how institutions and populations currently cope and what help they may need to adapt tomorrow.

Systematic inclusion of map-based deliverables as one set of early products in a CCVA is useful in scoping the CCVA because it helps identify areas in which to focus field data collection; however, creating "hot spot" maps may not be a useful step in every country. Rather, this exercise may be most useful in large countries (or regions) with high levels of spatial diversity.

Hot spot maps can be excellent communication tools for increasing a CCVA's traction with users or for helping donors and other stakeholders visualize variations in potential vulnerability to climate change in a country and how those variations might affect development portfolios. Hot spots maps will never replace CCVAs. There will always be a crucial need for CCVA results that answer the **what** question: What type of programming is most likely to reduce climate vulnerability now and in the future?

TABLE H.3: VULNERABILITY HOT SPOT MAPPING CAUTIONS AND LESSONS

Mali Hot Spot Mapping Caution	ARCC Lesson
<p>The identification of potentially vulnerable areas is sensitive to a range of underlying methodological assumptions and depends on the robustness of the underlying data. Small changes in either the assumptions or the data values can result in large changes in the vulnerability index for a particular area.</p>	<p>The ARCC team conducted sensitivity tests for all indicators and clearly documented the test results. The ARCC team also provided a rationale section for each indicator layer and documented the methodological assumptions made in the development of each indicator.</p>
<p>Among the assumptions mentioned above are the mechanisms that produce vulnerability and how (if) the underlying data capture these mechanisms. As a pilot study, the ARCC team was not able to test or validate the underlying vulnerability mechanisms.</p>	<p>When possible, data should be used from sources for which they have been collected in a manner purposefully designed to capture an underlying vulnerability mechanism, i.e., where the data has already been tested against outcome measures.</p>
<p>Different approaches for combining indicators can result in different values in the vulnerability index for an area. The Mali pilot study used two approaches for combining the indicators into a vulnerability index: additive (weighted and unweighted) and a PCA. The former approach assumed prior relationships among indicators that may not exist.</p>	<p>The PCA method overcame some of the shortcomings of the additive approach by not assuming any prior relationships among the indicators (de Sherbinin et al., 2014, p. 23).</p>
<p>Using data with different spatial scales or time steps can result in data that is not directly comparable and potentially misleading results.</p>	<p>As much as possible, data should be spatially and temporally aligned. It will likely be necessary to aggregate data in some cases and to disaggregate it in others. The ARCC team carefully documented such procedures in this mapping exercise.</p>
<p>Point data must be converted to some sort of continuous surface in order to be integrated into the maps.</p>	<p>There are many methods for developing continuous layers from point data, and the benefits and drawbacks of each are well documented in the literature. The ARCC team involved experts who understood these trade-offs and who could clearly document and justify the decisions that were made.</p>

Mali Hot Spot Mapping Caution	ARCC Lesson
<p>Indicators are often normalized to the same range, and zero to 100 was used in the Mali mapping exercise. For instance, a travel time of 36 hours to the nearest population center had the same impact on sensitivity and adaptive capacity as an infant mortality rate of 136 deaths per 1,000 births (de Sherbinin et al., 2014, p. 22). By normalizing indicators, each (unweighted) indicator contributes equally to the vulnerability index; however, as the ARCC team noted, this approach may not be accurate—some indicators may have more influence than others on sensitivity or adaptive capacity.</p>	<p>To partially address this issue, the ARCC team applied statistical measures (such as trimming the distribution tails of certain data sets). Such measures were well-documented. Weighting the indicators might also be used to compensate for inherent differences, but only if the underlying mechanisms for the vulnerabilities are well understood.</p>

ANNEX I. CHECKLIST OF ARCC LESSONS LEARNED

SUMMARY OF ARCC LESSONS LEARNED FOR ENHANCING UPTAKE

Design and implement measures to enhance credibility, salience, and legitimacy of the results

For enhancing credibility:

- Use the best available, highest quality data, information, and recognized methods and analysis procedures
- Clearly communicate data gaps, limitations of the methods, and uncertainties in the results
- Discuss non-climate related confounding factors

For enhancing salience:

- Gather and validate input from decision makers about their information needs and intended uses of the CCVA findings
- Structure CCVA findings to directly address critical, expressed needs
- Demonstrate an understanding of political, social, economic, cultural, and institutional contexts in which the CCVA is embedded
- Release information from the CCVA in a timely manner aligned with policy, planning, and procurement schedules

For enhancing legitimacy:

- Involve key stakeholders in the design of the CCVA
- Ensure that stakeholders represent the full range of appropriate technical sectors and levels of society
- Maintain dialogue and open involvement, providing voice to many actors throughout the CCVA process

Fully engage stakeholders during all phases of the CCVA: Design, data collection and analyses, verification of findings, and development and validation of recommendations for adaptation options

- Identify knowledge brokers and champions early in the process and engage them fully
- Recognize that a member of the CCVA team will likely act as a knowledge broker

Understand the political and social context of the CCVA

Because climate change has begun to alter the scale of threats to a level that many individuals have had no previous experience, credibility for CCVAs may be more contested, salience may be more sensitive, and legitimacy more crucial than for other types of VAs.

SUMMARY OF ARCC LESSONS LEARNED FOR CCVA RESEARCH DESIGN

Invest adequate time to develop a clear, cohesive, and agreed-upon research design

- State the CCVA **goal** (or "main research question") in a clear and concise manner. It should succinctly define the scope—the "what," "why," "where," and "for whom"—of the CCVA, while avoiding anything prescriptive (i.e., the "how"). (A **SMART research goal** is one that is specific, measurable, achievable, realistic, and time bound.)
- Build the research goal on an **established analytic framework** that clearly defines each dimension of vulnerability (such as the IPCC definition of vulnerability as a function of exposure, sensitivity, and adaptive capacity).
 - Carefully consider the **specific definition of each dimension of vulnerability**. The way in which each dimension is defined will influence the research design and can enhance the legitimacy and credibility of the results.
 - Such a framework also provides a common language for communicating vulnerability concepts.
- Select **secondary (guiding) research questions** that together coherently combine to answer the overall goal (main research question).
- **Test realism** of both the main and secondary research questions through stakeholder discussions, literature review, and as part of the process of designing the research methods.
- **Associate research questions with the vulnerability framework dimensions**, and also with data and information requirements (and thereby with methods and tools).
- Follow standard practices for research design and implementation, but within specific topic or sector studies, **identify the climate change-specific aspects**.

Engage stakeholders from the beginning

- Develop the research goal and guiding research questions through an iterative process that involves donor staff, other key stakeholders, and the CCVA team members
- Ensure that the research goal is agreed to by key stakeholders before selecting research methodologies.
- Conduct an institutional analysis to identify those (individuals, communities) most likely to be affected and those (individuals, institutions) most likely to take action, and to understand the role each plays. Consider all stakeholders, including often overlooked stakeholders.

SUMMARY OF ARCC LESSONS LEARNED FOR IMPLEMENTATION AND INTEGRATION

Establish a Suitable Interdisciplinary Team with Appropriate Leadership

- Invest in strong, consistent, and sustained leadership. Leadership qualities include visionary, strategic, responsive/flexible, focused and coordinated.
- Allow sufficient time to compose an interdisciplinary team with the right combination of technical and operational skills. Ensure that the team includes members who will provide adequate administrative (not just technical) oversight.

Commit Persistently to Collaborative Research

- Pay particular attention to the coordination and sequencing of tasks, especially the sequencing of the climate analysis vis-a-vis the topic or sector studies.
- Practice continuous joint planning and review for each study and regularly discuss the separate topic or sector studies to enhance coordination and avoid implementing the research as a series of discrete, separate studies.
- Looks for areas of intersection of research methods and tools among the topic or sector studies, both to improve data collection efficiency and to enhance opportunities for triangulating results.
- Allow for adjustments to be made as the CCVA progresses and understanding improves about both the climate-related impacts and non-climate impacts, or as needed due to limitations of available data.
- Consider tradeoffs between collecting new, primary data and compiling existing, secondary data.
- Manage and curate the data and information throughout the CCVA process.

Assemble a Coherent, Evidence-Based Picture

- Referring back to the research design, review each research question and the individual topic or sector study results one by one to see what evidence—from *any* study topic or sector—might relate to each question.
- Formalize the process of "cross-analysis" among topic or sector studies to enable effective integration to take place.
- Share findings and results with stakeholders and gauge their responses to the evidence to see how specific findings resonated with them.
- Find the compelling "story" behind the data and information, the organization or pattern, the unified whole, that is more than the sum of its component parts.

SUMMARY OF ARCC LESSONS LEARNED FOR GOING FROM RESULTS TO RECOMMENDATIONS

Prioritize Communications

- Engaging in continuous dialogue throughout the CCVA process, to lay a groundwork for eventual communications of results.
- Communicate CCVA results and adaptation options in a timely manner consistent with policy, programming, and investment cycles.
- To enhance relevance, maintain a dialogue throughout the CCVA process between those who collect and analyze the information and those who will potentially use the information.
- Use climate change scenarios with localized content to enhance dialogue and relevance during the stakeholder review and recommendation process.
- Summarize lengthy technical documents in shorter versions that are easy to read. Retain the services of a person skilled in taking scientific information and packaging it with tables, informative graphics, or maps that really "speak" to the intended audience(s).
- Prepare standalone documents that tailor results to very specific audiences (i.e., farmers in a given region). If necessary, translate findings to common, local languages in a simplified manner so that more people are exposed to the scientific findings.
- Consider releasing preliminary findings or findings from specific sub-components of a CCVA as internal documents to key users ahead of the public release of the final CCVA product.

Take Care When Communicating the Uncertainty Inherent in Climate Projections

- Group sets of model results (e.g., driest, average, wettest rainy seasons).
- Use colored arrows or qualitative statements that communicate likelihoods (e.g., above normal, normal, below normal) rather than numbers.
- Do not use the word "uncertainty" at all if the audience is uncomfortable with the idea that climate projections decades into the future are unlikely to provide the narrow range of values for temperature or precipitation changes that they may desire or expect. Instead use the words "variability," "range," "confidence," or "risk," as appropriate.

Derive Adaptation Recommendations

- Consider taking a stakeholder-driven approach to the review and recommendations process. Foster meaningful participation among a broad enough range of stakeholders to stimulate action.
- Allow CCVA team members to draw from the CCVA information and findings and offer ideas for implementation recommendations. Build recommendations on adaptation practices that the CCVA team had identified as already happening, or on intervention efforts that the donor and/or the institutional analyses has identified as being already underway.
- Organize recommendations into meaningful categories, such as strategy, policy, or program areas relevant to donors and other key stakeholders.

SUMMARY OF ARCC LESSONS LEARNED FOR INSTITUTIONAL ANALYSIS

Broaden the Range of Target Institutions and Integrate the IA into the CCVA

- Focus on institutions that reflect a specific set of sectors or communities—those that are the focus of the CCVA as defined by the research goal—rather than exclusively on climate "related" institutions.
- Integrate the IA process into the CCVA, rather than carrying out the IA as a discrete analytic component. This may be accomplished by integrating IA questions into existing interview guides or surveys and triangulating information related to institutional performance, roles, challenges, opportunities and inter-institutional relationships between the various levels—national, regional and local.
- Include local/national consultants and organizations in the CCVA team itself, if possible. This will aid in identifying key actors, understanding the local context, accessing the local institutions and their representatives.

Use the Institutional Analysis to Further Multiple Purposes

- Allow the IA to act as a mechanism to "touch base" with appropriate institutions early in a CCVA process. In doing so, they may identify additional institutional stakeholders that should be represented. The legitimacy of the CCVA will be improved by involving stakeholders in a way that makes the CCVA product more relevant to users.
- The IA process may also reveal important sources of data and information, including those from the "grey" (unpublished) literature or little-known databases.

SUMMARY OF ARCC LESSONS LEARNED FOR CLIMATE ANALYSIS

Determine the scope of the analysis

- Understand whether the focus of interest for decision makers is to identify geographic areas where climate change is likely to be the primary driver of vulnerability, or if it is on a particular population, region, programmatic area or economic activity which may or may not occur in such areas. In other words, are decision-makers focused on identifying "Where?" or on "Who," "How," and/or "To what extent?"
- Establish early in the process whether it is necessary to estimate changes in vulnerability linked to changes in climate projected for one or more decades into the future.
 - If the planning horizons are 15 to 30 years, or the near-term programs are intended to prepare populations or sectors for longer-term adaptation, then climate projections are highly desirable.
 - If the goal of the VA is near-term planning, then a "VA with climate information," which considers current and historical climate trends, may be more appropriate.
- Work with key stakeholders to establish the time horizon of analysis. If it is determined that future climate projections are indeed required, make sure stakeholders understand the significant investment of time and expertise that will be needed, and that they are comfortable with the uncertainty inherent in climate projections.
- Work with stakeholders as well to define the spatial resolution of the exposure information, as this will define both the climate and non-climate data requirements.

Conducting the Climate Analysis

- Expect to compile at least 30 years of historical meteorological data. Ensure that adequate time is allotted for data cleaning.
- Expect to carry out a downscaling procedure for a sub-national, national, or watershed-level CCVA.
- Sequence the climate analysis in such a way that it can be used as input to other component studies. By working closely with those other component teams, climate scientists will be able to format the outputs of their climate analyses in ways that are more accessible and useful to the non-climate analyses.

Interpreting and Using the Results

- The climate analysis should yield an estimate of the inter-annual and decadal-scale climate variability (based on historic data) and the range of uncertainties associated with climate projections.
- It is important to "contextualize" the projections—to compare them to current levels of inter-annual variations, as well as to the slower, decadal, "swings" in climate
- Precisely how the results are employed will depend on the needs of the other CCVA components.

ANNEX J. SOURCES

- Agrawal, A. (2008). "The Role of Local Institutions in Adaptation to Climate Change." Social Dimensions of Climate Change, Social Development Department, The World Bank, Washington, D.C.
- Andrew, T.G., Weyl, OLF, and Andrew, M. (2003). "Aquaculture Master Plan Development in Malawi: Socio-economic Survey Report."
- Baptista, S. (2014) "Design and Use of Composite Indices in Assessments of Climate Change Vulnerability and Resilience." USAID.
<http://community.eldis.org/.5b36f357/.5b36f800/.5b9bfce3/.5c154922>
- Brummet, R.E., and Noble, R. (1995). "Aquaculture for African Smallholders." ICLARM Technical Report No. 46, Manila. Internal Centre for Living Aquatic Resources Management.
- Caffrey, P., et al. (2013). "Dominican Republic Climate Change Vulnerability Assessment Report." USAID. <http://community.eldis.org/.5b36f357/.5b36f800/.5b9bfce3/.5bba6155>
- Caffrey, P., et al. (2013). "Uganda Climate Change Vulnerability Assessment Report." USAID.
<http://community.eldis.org/.5b9bfce3/ARCC-Uganda%20VA-Report.pdf>
- Cash, D.W., Clark, W.C., Alcock, F., Dickson, N.M., Eckley, N., Guston, D.; Jager, J., and Mitchell, R. (2003). "Knowledge systems for sustainable development." Proceeding of the National Academy of Science USA. DOI: 100(14):8086–8091.
- de Sherbinin, A. (2014). "Climate change hot spots mapping: what have we learned?" *Climatic Change*. 123:23-37.
- de Sherbinin, A. et al. (2014). "Mali Climate Vulnerability Mapping." USAID.
<http://community.eldis.org/.5bf8c6aa>
- de Sherbinin, A. (2014). "Spatial Climate Change Vulnerability Assessments: A Review of Data, Methods and Issues." USAID. <http://community.eldis.org/.5b36f357/.5b36f800/.5b9bfce3/.5c1548cc>
- Dixit, A. McGray, H., Gonzales, J. and DesMond, M. (2010). "Ready or Not: Assessing Institutional Aspects of National Capacity for Climate Change Adaptation." WRI, Washington, D.C.
- Dixit, A. (2012). "From Assessment to Adaptation: Approaches for Adaptation Options Analysis". Approaches for Adaptation Options Analysis. The World Resources Institute. Retrieved from <http://community.eldis.org/.5bce1db6>
- Freudenberger, M., et al. (2014). "ARCC Institutional Analysis of Mali-Météo and AEDD: Program and Methodology for Assessment Team."
- GCC Mali Climate Change Vulnerability Assessment SOW. Available at http://www.wri.org/sites/default/files/pdf/ready_or_not.pdf GCC Mali Climate Change Vulnerability Assessment SOW, Draft 5/24/2012
- Grothmann, T. et al. (2013). "Assessing institutional capacities to adapt to climate change—integrating psychological dimensions in the Adaptive Capacity Wheel." *Nat. Hazards Earth Syst. Sci. Discuss.* 1:793-828.

- Gupta, J., et al. (2010). "The Adaptive Capacity Wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society." *Environ. Sci. Policy*. 13:459-471.
- Holling, C.S. (1986). "The resilience of terrestrial ecosystems: local surprise and global change." Pages 292-317 in W. C. Clark and R. E. Munn, editors. *Sustainable development of the biosphere*. Cambridge University Press, Cambridge, UK.
- Hammill, A.; Harvey, B.I., and Echeverria, D. (2013) *Understanding Needs, Meeting Demands: User-oriented analysis of online knowledge broker platforms for climate change and development*. Winnipeg: IISD.
- IPCC. (2007). Appendix II Glossary. Retrieved from <http://www.ipcc.ch/pdf/glossary/ar4-wg2.pdf>
- IPCC. (2013). IPCC Data Distribution Centre, Glossary 2013
- Lagadec, P. (2008). *A New Cosmology of Risks and Crises—Time for a Radical Shift in Paradigm and Practice*. Departement D'Economie, Ecole Polytechnique: Paris.
- Miller, D. (Forthcoming). *Senegal Climate Change Vulnerability Assessment and Options Analysis*. USAID. <http://community.eldis.org/.5c0acf50>
- Moser, S.C.; and Ekstrom, J.A. (2010). "A framework to diagnose barriers to climate change adaptation." *Proceedings of National Academy of Sciences*. 107(51):22026-22031.
- Oreskes, N. (2004). "Science and public policy: what's proof got to do with it?" *Environ Sci Policy*. 7:369-383.
- Preston, B.L., Yuen, E. J., and Westaway, R.M. (2011). "Putting vulnerability to climate change on the map: a review of approaches, benefits, and risks." *Sustain Sci*. 6:177-202.
- PROVIA. (2013). "PROVIA Guidance on Assessing Vulnerability, Impacts and Adaptation to Climate Change." Consultation document, United Nations Environment Programme, Nairobi, Kenya, Retrieved from <http://www.unep.org/provia>
- Schaar, J. and Caffrey, P. (2014). *Adaptation and Governance. African and Latin American Resilience to Climate Change Project*: U.S. Agency for International Development: Washington, DC.
- Strauss, A. and Corbin, J. (1998). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* (2nd edition). Sage, London.
- Trzaska, S., and Schnarr, E. (2014). *A Review of Downscaling Methods for Climate Change Projections*. USAID <http://community.eldis.org/.5b36f357/.5b36f800/.5b9bfce3/.5c1548b0>
- Wood, L. and Moriniere, L. (2013). *Malawi Climate Change Vulnerability Assessment*. USAID. <http://community.eldis.org/.5bb3c38e>
- World Fish Center (2007). *Food Security and Poverty Alleviation Through Improved Valuation and Governance of River Fisheries in Africa: Fisheries Co-Management in Malawi: An Analysis of the Underlying Policy Process*.

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