AN INTRODUCTION TO THE ARCC CLIMATE CHANGE IN MALI SERIES

INTRODUCTION

The five independently conceived reports gathered under the ARCC Mali Studies Series[1] address diverse yet related topics. For this series, ARCC mapped the relative climate vulnerability across Mali and produced an overview of the potential impacts of climate change on Mali's water resources. The series also includes a study of the promotion and adoption of field level adaptation practices and a report presenting the results of an exercise in which specific adaptive practices were modeled in the Mopti region. The final study introduced below consists of an evaluation of two national institutions critical to the support of climate change adaptation in Mali.

Together, these documents serve as a resource for the Malian government and its partners who are working to reduce climate change vulnerability in the rain-fed agricultural zones of Mali. In addition to presenting findings on five important topics, these documents help frame further research. They pilot new approaches, highlight methodological challenges to be addressed, and identify questions for further research.

FINDINGS

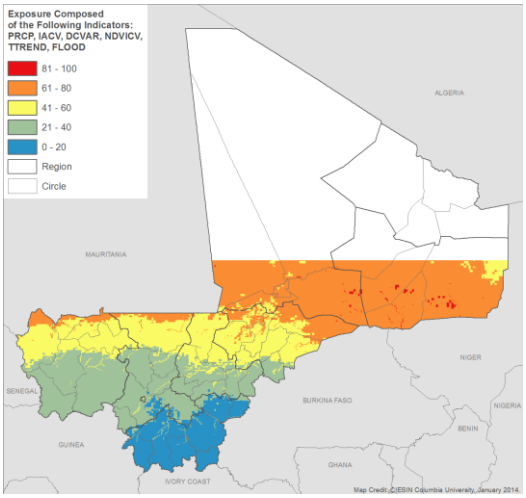
Mapping Climate Vulnerability

Vulnerability to climate change varies across a country due to a number of different factors. In order to represent this variation, ARCC drew on available high-quality data to develop a series of maps. Eighteen indicators were organized into three groups to characterize the components of climate change vulnerability — exposure, sensitivity, and adaptive capacity — and then mapped (de Sherbinin, 2014). The indicators used to create the exposure map consist primarily of historical climate data, while those used to generate the sensitivity map comprise the most recent data on poor health, poor soils, poverty, and conflict. Indicators of assets, such as mother's education, health infrastructure, and irrigation, were combined to produce the adaptive capacity map. The three maps were then combined to form a single map representing variations one measure of vulnerability to climate change across Mali.

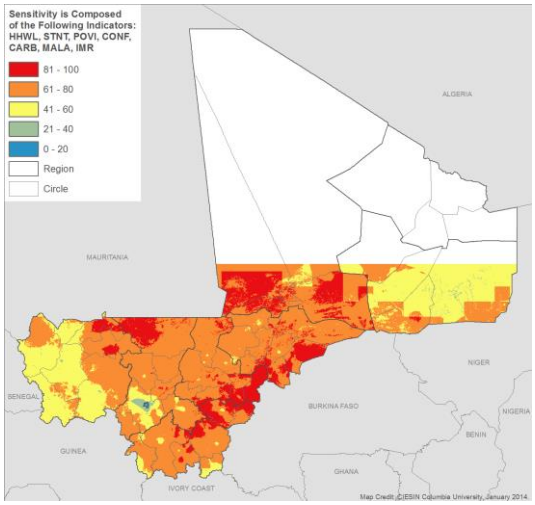
[1] "Mali Climate Vulnerability Mapping," de Sherbinin, A., et al., USAID, 2014; "Water Resources in Mali," Murray-Rust, H. USAID, 2013; "Climate Change in Mali: Organizational Survey and Focus Groups on Adaptive Practices," LaLumia, C., et al., USAID, 2014; "Mali Agricultural Adaptive Practices Impact Modeling Assessment," Folle, S., & Mulla, D.J. , USAID, 2014; and "Climate Change in Mali: Institutional Analysis of L'Agence de L'Environnement et du Développement Durable (AEDD) and L'Agence Nationale de la Météorologie (Mali-Météo)," Freudenberger, M., et al., USAID, 2014.

VULNERABILITY COMPONENT AND OVERALL MAPS FOR MALI

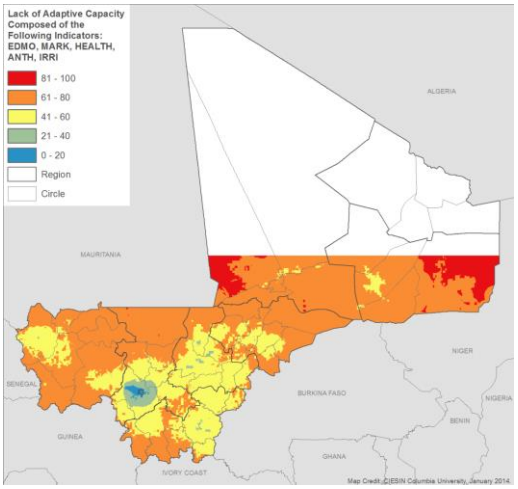
Exposure



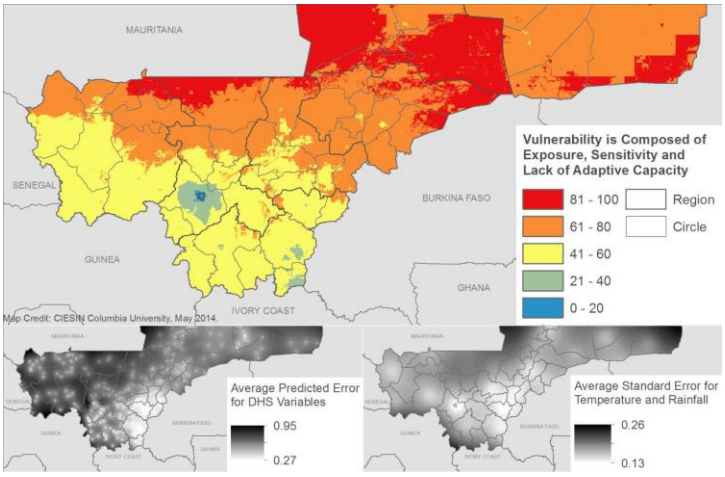
Sensitivity



Lack of Adaptive Capacity



Overal Vulnerability, With Inserts Indicating Levels of Error



The results for current vulnerability, (Figure 1, bottom right), suggest that large swaths of lightly populated northern Mali are most vulnerable to impacts from climate change. Bamako and the region around Sikasso are areas of relatively low vulnerability, while much of southern Mali, the most densely settled agricultural region of the country, has medium vulnerability. The areas of Mali that are in the medium-high or high vulnerability category are less densely populated, but their populations are still sizeable.

ARCC additionally produced a series of maps in which the exposure layer included projected future climate conditions. The results from this expanded analysis suggest that the overall patterns of exposure and vulnerability will change significantly by 2050, when large areas of northern Mali shift from medium-high to high vulnerability.

This innovative mapping effort was limited by the quality and spatial resolution of the data available, as well as our understanding of how these various indicators combine into a singular representation of vulnerability. As a result, the maps only roughly describe the relative vulnerability across Mali. However,

this does not decrease their utility as a tool to help decision makers visualize, understand, and discuss the importance and impact of the various sets of data that constitute the components of climate change vulnerability.

Responding to Climate Change

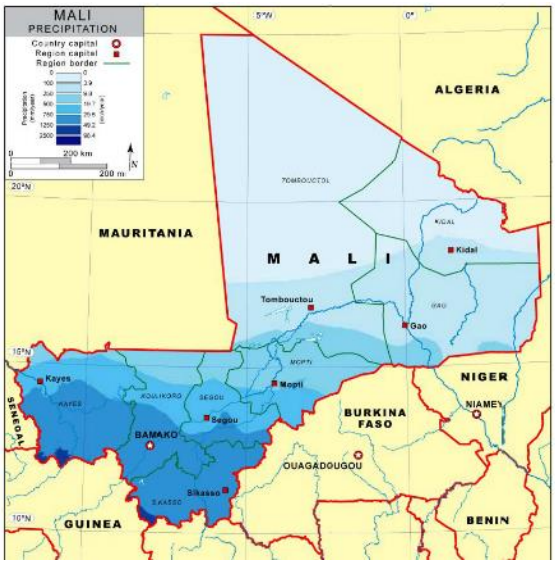
The threat climate change poses to people's access to water also varies spatially across Mali. People living away from the country's water rich river valleys are more vulnerable to shifting rainfall patterns. To increase national food production and increase national food security, Mali has focused its agricultural investments on improving rural water supplies by exploiting groundwater and expanding large-scale irrigation system development near the inland delta. While this approach has been successful on the whole, it has not had a significant impact on the access to water of rural populations living far from the country's main rivers (Murray-Rust 2013).

While water management has been decentralized to the Commune level in Mali, support services at that level mirror central government structures; thus, efforts at the village level almost always focus on an exclusive use, such as domestic water supply, agriculture, or livestock. In rural areas, where access to water is limited, an Integrated Water Resources Management (IWRM) approach is needed.

Effective IWRM, as exemplified by the Multiple-Use Services approach, operates at three levels: household strategies to improve resilience through behavior change in agriculture and water-related hygiene; village strategies for participatory development of IWRM strategies; and support to service providers at the Commune level. As climate change is expected to negatively affect the availability of water for all uses, strategies that balance the multiple needs for water will be critical to ensure that the limited amount of water available is used as effectively as possible.

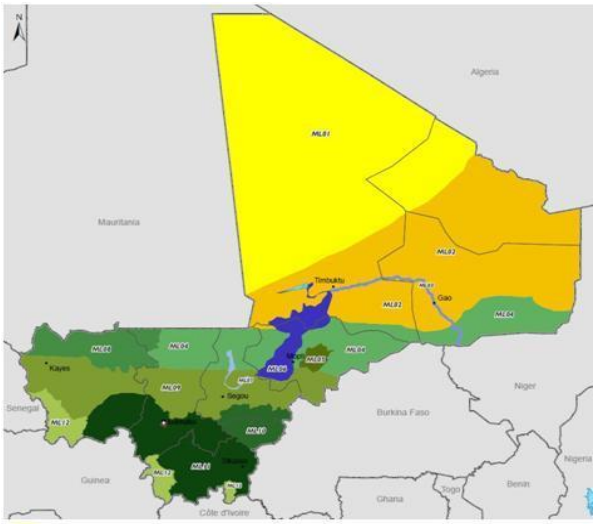
At present, Commune cadres often have little or no access to the tools and information necessary to develop effective IWRM plans in the context of a changing climate. They need guidance on how to develop IWRM plans, information about projected changes in rainfall and temperature, and an effective

RAINFALL MAP OF MALI



Source: World Trade Press, 2013

LIVELIHOOD ZONES IN MALI



Source: USAID/FEWSNET, 2010

planning approach to use limited financial and human resources to address coming challenges.

Promoting Adaptive Agricultural Practices

Because communities that are distant from the major rivers are highly dependent on increasingly erratic rainfall, improved management of rainwater for agricultural use will be essential to strengthening the resilience and increasing the food security of rural populations. The ability of farmers to adapt to both changes in rainfall and increasing temperatures by adjusting practices to improve water retention and alleviate poor soil fertility will be especially important.

FARMER IN DJININA VILLAGE, KOULIKORO

Photo by Sue Upton

While nongovernmental organizations (NGOs) in Mali promote a wide variety of agricultural practices intended to help farmers adapt to the effects of climate change, farmers adopt these practices — or do not — based on their own needs and experience (LaLumia et al., 2014). To understand which practices are adopted and why, the ARCC project conducted two related assessments: a survey of NGOs, to learn which practices they promoted; and focus groups with farmers in Mali, to learn which practices they adopted.

The first survey found that NGOs appear to focus their activities in the southern regions of Mali, probably because of the sparse population, logistic challenges, and insecurity in the north. The most important factors determining which practices these NGOs promote are the local biophysical context

BARRIERS TO ADOPTION: SOIL HUMIDITY RETENTION PRACTICES

Practice	Factors Most Often Limiting Adoption	Advantages of Adoption (in Addition to Retention of Soil Humidity)	Disadvantages of Adoption
Compost	manure, equipment, labor, transportation, knowledge	soil fertility, increased productivity	not long lasting, burns crops if inadequate rains
Contour Planting	knowledge	soil fertility	none reported
Cross-Ridges	draft animals and equipment	soil fertility, limits runoff	none reported
Dikes and Bunds	labor, transportation, equipment	soil fertility, limits soil erosion	none reported
Plowing with Animal Traction	draft animal labor and equipment, transportation, cost of draft animals	soil fertility, permits deep cultivation, enables cultivation of more land	cost of maintaining animals
Live Fencing	knowledge, appropriate seed/cuttings	soil fertility, sale of jatropha seed, protection against fire and animals	none reported
Manure	manure, equipment, transportation	soil fertility, increased productivity	not long lasting
Mulching	knowledge, labor	limits burning of plants	none reported
Rock Lines	transportation, rocks, labor, knowledge	limits soil erosion, soil fertility	risk of injury
Zaï	labor, lack of land	soil fertility	none reported

and the needs of the populations they target. NGOs generally take a conservative approach to climate change adaptation that builds on current agricultural practices, addresses immediate concerns (e.g., productivity), puts anthropogenic climate change in the context of historical shifts in climate, and integrates climate change adaptation into other local concerns. Virtually all of the practices that NGOs promote in the Mali predate the recent increased escalation of climate change funding.

However, more than 70 percent of the NGOs surveyed indicate they promote at least one practice addressing expected climate change impacts by improving soil fertility, managing soil moisture, providing supplemental water, or employing agroforestry techniques. Practices to strengthen soil fertility, with direct application of manure and composting, were most common. The NGOs also disseminate cereal, legume, and vegetable varieties.

The focus groups revealed that farmers make a broad range of adjustments to adapt to changes around them, which include the degradation of natural resources, new market demands, population pressure, and changing climate conditions. Farmers alter the proportions of the crops they cultivate, experiment with new varieties and new crops, increase the amount of land farmed, and open cultivation of new types of land, including water-accessible plots for gardening market vegetables. Farmers also adopt new crop management practices.

When deciding what to plant, farmers consider a number of crop characteristics, including taste. In addition to assessing climate suitability, they match crops with the soils available. In the study villages, when farmers decided to abandon crops, they have most often shifted to crops that take fewer days to mature, in response to decreases in the duration of rainfall.

The rate at which a particular field practice is adopted is strongly correlated with the resource intensity of that practice. For example, fewer farmers report adopting practices that require high levels of labor, cash, and technical knowledge. They also consider trade-offs among diverse constraints when making these decisions. When adopting new practices, farmers adopt those that address multiple objectives, such as improving both soil fertility and moisture retention. Composting and manure addition are two commonly adopted practices that are known, have low-inputs, and fit a range of contexts.

The study also found a mismatch between the practices promoted by NGOs and those adopted by farmers. Although the focus groups were conducted in villages where the NGOs worked, many of the practices most commonly promoted by the NGOs were among those with the lowest levels of adoption. On the other hand, when farmers have the support of national agencies, they do use a few specific costly and knowledge-intensive practices — chemical fertilizer, herbicides, and pesticides — that are not promoted by NGOs.

PERMEABLE ROCK DAM, BURKINA FASO

Photo by B.M. Simpson

Together these two surveys offer a glimpse into the strategies farmers have used to adjust their agricultural systems to new climate regimes, the types of characteristics they consider in their decisions, and the relative importance of different benefits and constraints. While by no means comprehensive or definitive, these surveys provide further evidence of the wide range of strategies practiced, the complex process of farmer decision-making around adaptation, and the challenges facing the NGO,

donor, and state agency efforts to reinforce farmer resilience.

Evaluating of the Utility of Specific Practices

Among the practices farmers have employed to adapt to changes in climate, those that manage moisture may become the most important as temperatures rise and the rainfall regime in Mali changes. As the climate changes, it will be critical to understand the limits of these practices, as well as to learn when to select them and how to adapt them to new conditions. Researchers commonly use process modeling to evaluate the effectiveness of agricultural practices. For ARCC, Folle and Mulla (2014) used the Agricultural Policy/Environmental Extender (APEX) model, developed for use in managing farms and small watersheds, combined with data derived from climate projections, to explore the effect of four traditional water harvesting practices on crop yields for a variety of soil conditions in the Sahelian agro-ecoregion of Mali.

The hypothetical site modeled consisted of the four soil types most commonly found in the region. The types used ranged from poorly developed soils with low organic content and low water holding capacity to those with higher organic content and better water holding capacity. The crops used for the modeling were maize, millet, sorghum, and upland rice. The four practices evaluated were soil or stone bunds, vegetated filter strips, contour ridges, and planting pits (*zai*). The performance of each practice was evaluated for each crop and soil type based on the impacts on crop yield, surface runoff, soil organic carbon content, and soil loss, and compared with the performance without use of a water harvesting practice. The model evaluated results for current climate parameters, as well as for climatic parameters projected for 2030 and 2050.

The modeled performance of the rainwater harvesting practices was affected by climate, soil type, slope steepness, and crop. The four practices generally improved crop yield and soil fertility under each of the future climate change scenarios although, under some circumstances, water harvesting could negatively affect crop yields due to increased water logging. The extent of the benefits depends on specific combinations of crop, soil, slope, and water harvesting practice. Benefits are greatest for maize and sorghum on more fertile lithosols and luvisols, especially for scenarios that involve decreased precipitation. In general, contour ridges and *zai* are more effective at improving crop yield, reducing runoff and erosion, and preserving soil organic carbon than bunds and vegetative strips.

The modeling was hampered by two challenges. First, the fine-tuning of the parameters selected for the APEX model was limited by the available information concerning soil and climate characteristics and historical crop yields in the area modeled. Second, projected changes in precipitation and temperature vary widely and only a few scenarios could be tested.

Despite these challenges, the study successfully demonstrated an approach to evaluate the future performance of field-level practices under future climate scenarios.

PLANTING PITS (TASSA) BEFORE PLANTING AND RAINY SEASON, NIGER.

Photo by H. P. Liniger

Institutional Support for Climate Change Monitoring and Adaptation

Mali's ability to reduce vulnerability and support local efforts to adapt to climate change is tied closely to two institutions: *L'Agence de L'Environnement et du Développement Durable* (AEDD) and *L'Agence Nationale de la Météorologie* (Mali-Météo). The mandate of AEDD, created in

2010, is to coordinate national environment policy and help translate the national strategy for climate change into specific actions. The agency informs and educates policy makers, the administration, and the public on the environment and climate change. The mandate of Mali-Météo, created in 2012 out of the former Central Department of Meteorology of the Ministry of Equipment and Transport, is to provide reliable and timely weather, water, and climate information and analysis to public and private users. The ability of these two agencies to fulfill their mandates depends on their capacity to make assessments, set priorities, coordinate national and local actors, manage information, and contribute to climate risk reduction. The institutions must also be sustainable, which requires a reliable and sufficient funding stream.

AEDD currently attends most closely to the implementation of the national climate change policy. Although it is responsible for coordinating and monitoring numerous government policies on the environment and climate change, mainline ministries and agencies are responsible for translating those policies into specific action. This division of labor, and AEDD's lack of control over funding for climate change projects, has made it difficult for the agency to establish its authority within the government.

With the recent added responsibility to act as secretariat for the Mali Climate Fund, it now has an avenue to create a clear identity and claim legitimacy within the government, as well as with the public.

To take advantage of this opportunity, the study recommends that the government and its partners provide support to the AEDD Climate Fund communications and outreach plan and to the development of a charter to set out how information on climate change issues is to be collected, preserved, and used by the government and the public. Currently, priorities are set mainly through the ministries of agriculture, water, and livestock, but climate information needs to be part of the decision-making process in other ministries as well. AEDD can aid in this integration and overall coordination by contributing to the updating of data bases and maps. Further, the agency's Information Center, an important tool for information management, needs to be expanded into all regions of Mali, which will also improve in climate risk management. Finally, long-term business planning is necessary to help prepare the agency for sustainability and long-term financial autonomy.

Mali-Météo is a financially autonomous agency, and as such it is required to raise its own financial resources from the public and private sectors. It, therefore, operates on a fee-for-service basis. While it has identified some markets for its services and clients who are willing to pay, it lacks the capacity to provide the kinds of sophisticated products that those clients most need. It is also hindered by an inadequate network of observation stations; those that do exist are in need of maintenance and improvement, and the entire network needs to be expanded. Its current revenues do not provide sufficient funds to cover its recurrent costs, let alone make the sizable capital improvements it needs to sustain and improve its data gathering and service provision.

MALI-MÉTÉO HEADQUARTERS IN BAMAKO

Photo by Mark Freudenberger

Mali-Météo has the potential to fulfill its responsibility for collecting, analyzing, and delivering climate

information and to make an important contribution to coordinating Malian and international research on climate change. The study finds that achieving these objectives will require careful assessment and priority setting. To make the best use of its limited resources and fulfill the increasingly important role it plays in climate change adaptation, Mali-Météo will need to clarify its role in providing weather and climate analysis and develop a rigorous long-term business plan based on analysis of the market for its services. The study also finds that continued government support will be necessary. Significant investments are needed in Mali-Météo's infrastructure, not only to improve the network of observation stations, but also to improve its analytical capabilities with updated hardware, software, and skills training. Additional resources are also urgently needed to preserve the agency's highly vulnerable archives of weather data.

IMPLICATIONS FOR CLIMATE CHANGE PROGRAMMING IN MALI

A number of lessons can be drawn from the five studies discussed above. In the process of exploring key questions facing the farmers of rain-fed systems, they clarified the limits of available information on climate, plant processes, and farmer adoption. This understanding of the limits of current knowledge, in addition to the study findings, highlights several considerations that should be taken into account when supporting farmer agricultural adaptation to climate change.

The ARCC Mali mapping study represents one approach to the vital process of evaluating the relative vulnerability of different populations and understanding the numerous factors that make them vulnerable. In themselves, the maps represent a powerful tool to broaden understanding of the potential impacts of a changing climate. The study reinforces our understanding of the cross-cutting nature of climate change through the use of three-layer maps that portray the components of vulnerability. The tables of indicators used to produce these layered maps indicate the types of questions that need to be answered when evaluating vulnerability at the smaller geographic scale to facilitate action plans and implementation. The maps showing the potential impact of different climate scenarios communicate the uncertainty of our current level of knowledge. Together, they underscore the importance of staying informed about expected climate trends, as well understanding the limits of our knowledge about those trends.

The study of Mali's water resources also describes areas of different relative vulnerability to climate change and highlights our understanding regarding how climate stressors exist alongside other stressors, some of which may be more significant in the near term. At least in the foreseeable future, for the people dependent on Mali's rivers, challenges associated with general management of those resources will overshadow climate change as a factor influencing the quality and quantity of water available. It is in the areas distant from the country's great rivers that climate change will critically amplify water stress. In these more vulnerable areas, government personnel and their partners from NGOs and donor projects will need to work in an informed and coordinated manner to implement integrated water resource management.

The cross-sectoral nature of climate also influences the approach to be taken in facilitating rural producer adaptation to new climate regimes. The ARCC study of the promotion and adoption of agricultural practices in Mali describes the spectrum of factors producers take into consideration when modifying their agricultural systems. These include solutions that meet both technical criteria, and a range of other economic, cultural and institutional factors. Farmers adopt practices to reduce risk and increase production. They produce for their own food security as well as in response to market opportunities. As the impacts of climate change are felt, it will be increasingly important that state, donor, and NGO actors coordinate their efforts to inform rural producers of changes in the larger context, as well as to promote specific adaptive strategies and practices.

The extreme geographic specificity of the performance of different adaptive practices demonstrated in the ARCC modeling exercise should not discourage efforts to understand the challenges farmers face

when making decisions regarding the distribution of crops and varieties among fields of different types, the abandonment or adoption of crops, or the opening up of new fields. As climate trends reveal themselves, it will be increasingly important to monitor evolving needs at the field level. Greater efforts are needed to identify approaches to support farmer adoption of new practices and provide robust solutions that are useful in a range of climate conditions, including expected future ones. Yet it will also be necessary to recognize that farmers themselves will be making the decisions. As in the past, much of the innovation will come from farmers themselves, so facilitating communication of farmer-driven innovations will be important.

The process of supporting integrated, informed, and robust solutions at the local level will require that the roles and capacities of two national level institutions be significantly strengthened. *L'Agence Nationale de la Météorologie* (Mali-Météo) must be able to provide reliable and timely weather, water, and climate information and analysis to public and private users. *L'Agence de L'Environnement et du Développement Durable* (AEDD) needs to be able to make assessments, set priorities, coordinate national and local actors, manage information, and contribute to climate risk reduction.

Taken together, these studies serve to illustrate a number of high level lessons which are, in turn, reinforced by the larger body of ARCC work. Strengthening climate change adaptation in the agricultural zones of the West African Sahel will require a broad perspective, one that takes into account the complex interrelationships of development issues that impact— and serve as the context for — farmers as they make decisions regarding climate change adaptation. Significant advances will be necessary in the collection, analysis, and distribution of relevant information, especially (but not exclusively) climate information. And while support to vulnerable rural populations will require an understanding of the role of climate in the larger development context, as well as how the a spectrum of stressors impact vulnerability at the local level, the enormous temporal and spatial specificity of climate and agriculture in West Africa described above suggests that, in the end, the most effective way to support local level adaptation will be to provide the best information and widest range of effective and relevant options for decision making to the individuals who are at the front lines of adaptation.