MALAWI CLIMATE CHANGE VULNERABILITY ASSESSMENT

EXECUTIVE SUMMARY

The Malawi Vulnerability Assessment (Malawi VA) was an initiative of the United States Agency for International Development's (USAID) African and Latin American Resilience to Climate Change (ARCC) program.[1] Its goal was to understand current and projected climate change impacts in central and southern Malawi, and to explore to what extent national and district government entities, rural communities, and households are equipped to adapt to those impacts. The research was based on the premise that a climate change vulnerability assessment of rural livelihoods will be useful to guide USAID's food security programming and climate change investment decisions. The findings presented in this report are derived from a three-phase analysis effort. Through this effort, the Malawi VA team attempted to unravel a climate change storyline across many themes: agriculture, fisheries, water and natural resources, livelihoods, and (to the extent possible) institutions and policies.

The Malawi VA recognizes two climate change response options: mitigation and adaptation. **Adaptation** was the focus of this study. The analytical framework used to compile the Malawi VA results was based on the common model of **vulnerability** as a function of **exposure, sensitivity**, and **adaptive capacity**. The Malawi VA focused its analysis primarily on exposure, sensitivity, and adaptive strategies (rather than adaptive capacity).

Because of the depth of analysis carried out during the Malawi VA, a further refinement of "**degrees of impact**" provides a framework for a deeper analysis than would otherwise be possible. Using this further refinement, **exposure** aligns to the direct (or "first degree") manifestations of the climate system: temperature, precipitation, winds, and hazards such as flooding and drought. Sensitivity is expressed as second- and third-degree impacts, where the second-degree impacts are the spontaneous adaptation of the biophysical world to the climate changes, and the third-degree impacts are the socioeconomic impacts. (The Malawi VA also looked at adaptive strategies, strategies that populations and agricultural market systems use to address the second- and third-degree impacts.) Thus, the "degrees of impact" framework aligns to the standard model while enabling a systematic exploration of increasing complexity. However, in moving from first-degree to higher degrees of impacts, attribution of change to climate alone becomes increasingly difficult.

[1] ARCC is a three-year, USAID-funded program to provide technical, analytical, and project assistance, as well as capacity building, to promote adaptation to climate change in a way that improves the ability of vulnerable populations to respond to climate challenges and safeguards economic growth. The program focuses on promoting the Economic Growth Objective within the USAID Foreign Assistance Framework by promoting adaptation to climate change and integration of adaptation into other economic investments to safeguard and promote sustainable, climate-resilient growth.

The Malawi VA distinguishes **climate variability** (variations in the mean state of climate on all temporal and spatial scales beyond that of individual weather events, such as droughts and floods) from **climate change** (shifts in the mean state of the climate or in its variability persisting for extended periods of time [decades or longer]).

Key to building the foundation for the entire Malawi VA was understanding the current and projected manifestations of climate change in the study area of central and southern Malawi. For this, the Malawi VA team is carrying out a climate modeling and downscaling exercise. Understanding communities' vulnerability to climate change was accomplished through in-depth participatory rural assessment exercises carried out in nine representative villages in eight districts, supplemented by almost 50 key informant interviews (KIIs). In addition, the Malawi VA team conducted detailed agricultural studies of six crops identified as being significant for food security and of interest to USAID: maize, sorghum, groundnuts, pigeon peas, cowpeas, and soybeans. These agricultural studies included phenological studies, value chain analyses, and economic analyses. The Malawi VA also carried out studies in the areas of fisheries, water resources, and natural resources management. Throughout these analyses, the Malawi VA team recognized the confounding factors of population pressures and poverty, environmental degradation, and the constraints imposed by incomplete or limited institutional capacities and regulatory oversight.

Results from the Malawi VA **climate analysis** underscored the variability of Malawi's climate, which is strongly influenced by at least three powerful external drivers: the El Niño Southern Oscillation (ENSO), an Indo-Pacific phenomenon that modulates circulation; the Indian Ocean Dipole (IOD), an equatorial pattern that affects rainfall; and the Subtropical Indian Ocean Dipole (SIOD), which may be linked to higher than normal rainfall in southern Africa. The uncertainties introduced by these strong external atmospheric drivers, along with uncertainties in future greenhouse gas emissions, contribute to considerable uncertainty in climate projections for the region and greatly restrict the ability to isolate climate change from normal climate variability.

Even so, several climate change trends are already observed and are expected to intensify during the coming decades. The Malawi VA climate modeling results show that a gradual increase in average annual temperature is already occurring and will continue; rural farmers interviewed during the participatory rural assessment exercise confirmed these historical trends. The climate models also showed that the largest increases in temperature were projected to take place during the early summer months—just when planting begins and crops germinate. Farmers reported that rain was more erratic, while the historical climate analysis revealed that rainfall patterns are already shifting, with later rainy season onset in most areas of the country and earlier cessation in all areas. The climate models showed that this trend is expected to continue into the future, with average monthly rainfall expected to decrease during the months of December and January, and increase during the months of February, March, and April. Overall, the rain day frequency is expected to decrease slightly while dry periods (between rain days) are expected to increase. However, reductions in total annual rainfall is not necessarily predicted for all areas—in many areas, heavier rains may make up for the shortfall in rain day frequency.

Heavier rains, less predictable rains, hot spells, and extended dry periods all contribute to making farmers' decisions regarding planting and harvesting more difficult. In response to the changes they have already observed, farmers have been altering the dates for planting their crops and making use of selected seed for shorter cycle crops. Some are clearing land and planting crops closer to streams and lakes. Farmers are increasing their use of conservation agriculture techniques to

conserve soil moisture, as well as investing in dry season irrigated vegetable gardens. Many are adopting intercropping and diversifying their crops.

Looking toward an uncertain climate future, the Malawi VA focused on six crops of particular relevance to USAID/Malawi programming: maize, soybeans, sorghum, pigeon peas, cowpeas, and groundnuts. **Maize**, mostly rain fed, is considered the most important food staple in Malawi. Yet since 1990, regularly occurring droughts have significantly compromised maize production throughout the country, resulting in food shortages that now take place every two to three years. The projected impacts on maize due to climate change—and the anticipated periods of extreme heat and droughts—include a high to very high potential for decreased productivity and decreased yield.

Sorghum was an important staple in Malawi prior to the introduction of maize, and is still regularly grown as a source of food and for brewing beer. Recently, sorghum production has been increasingly affected by poor and unpredictable rainfall. However, in the future, sorghum may begin to replace maize due to its drought tolerance, albeit with a moderate potential for reduced productivity due to the increased temperatures predicted by the climate change modeling. Irregular rains also fuel fungal growth in sorghum—a challenge for post-harvest handling.

Malawi is one of the most important **groundnut** producing countries in southern Africa; groundnuts represent a quarter of household-level agricultural income in the country. In addition to a food source, groundnut hulls are valuable as fodder for animals and fuel. Additionally, growing groundnuts helps fix atmospheric nitrogen in soils, enhancing soil fertility. Late onset of rains has already led to the adoption of early maturing varieties, rather than drought resistant varieties. Early maturing varieties cope better with low rainfall, but then the very labor-intensive groundnut harvest period overlaps with that of other crops. Expected future temperature increases and variable precipitation are highly likely to decrease groundnut productivity, while the continued occurrence of late, heavy rains will negatively impact early maturing varieties by promoting aflatoxin, which will in turn limit export market opportunities.

Pigeon peas rank as the third most important legume crop after groundnuts and beans; farm households consume about two-thirds of the pigeon peas produced in Malawi. Pigeon peas can withstand low moisture conditions and do well in areas with low rainfall. As a drought- and temperature-tolerant legume able to tolerate low soil fertility, production will likely increase with climate change, especially in southern Malawi. Pigeon peas' seed yield is expected to decrease slightly due to seeds' sensitivity to drought. The earlier maturing (preferred) varieties tend more toward decreased yields and post-harvest, pest-related losses (primarily from weevils and aphids); new varieties are being developed to counter these disadvantages.

Cowpeas are important in poor rural regions throughout the semi-arid and sub-humid areas of east and southern Africa, and Malawi is no exception. Cowpeas are widely known as the "crop of the poor" because the plant's green pods and leaves are the earliest food available before cereals mature. As such, cowpeas serve as "insurance" against food shortages during the "hungry season." Cowpeas adapt well to climate stresses during reproductive stages, but are not drought resistant. Drought, heat, poor soil fertility, and inappropriate agronomic practices all contribute to low productivity. Projected changes due to climate change are a slight to moderate decrease in productivity due to extended periods of drought.

Soybeans can grow at a range of altitudes and temperatures, and they require little water. Production of soybeans in Malawi has been irregular, mostly driven by external factors (donor pressure and export markets), due to the plant's nitrogen fixing properties and multiple uses: feed for livestock and fish, bio-fuel and industrial oil, and for human consumption. Yet medium-maturing varieties are already being negatively affected by late rains that augment fungal infections. The future for soybean production in Malawi is uncertain, as pressures by donors and export markets to increase production will be countered by high sensitivity to planting conditions (difficult with late onset, or erratic, or heavy rains, especially for medium-maturing varieties), together with drought intolerance in early stages.

Clearly, a robust agriculture sector requires reliable **water** sources. Historically, Malawi has enjoyed an abundance of surface water. In fact, surface water comprises more than 90 percent of total water availability in Malawi, and precipitation is its principal source. This abundance has allowed the country to develop large-scale irrigation systems and an important hydropower industry, both of which contribute significantly to the nation's economy. Hydropower provides the country with almost all of its energy usage. This hydropower comes from just five power plants on the Shire River, fed by Lake Malawi; fluctuations in the level of Lake Malawi directly affect river flow rates.

Already the impacts of climate change on water availability in Malawi are evident. Erratic rains, extended dry periods, and increased evaporation have combined with population growth and increased water demand to turn Malawi's historical water abundance rapidly into water scarcity. In fact, due to low lake levels beginning in 1997, electrical power production is often rationed at the end of dry seasons, typically in October and November. Although climate change may increase wet season surface water yields slightly, this will be more than offset by dry season decreases. Overall, climate change will contribute to a reduction in the total water balance by as much as one-half by 2035.

In the face of climate change, competition for this water will certainly grow worse. It is expected that smallholder farmers currently reliant on rain-fed agriculture will divert water toward supplemental small-scale irrigation, further reducing the water available for large-scale irrigation systems, hydropower, and municipal use. Other non-climate factors will exacerbate the situation, including mining, urbanization, and poor land use practices. Although the country is moving toward a system of integrated water resource management, these nascent efforts are largely based on a first-come, first-served basis and are being applied in a context that lacks the solid institutional capacity needed to deal with the country's growing and significant water scarcity challenges. In addition, these approaches do not yet capture or regulate small-scale users nor consider the likely shortages due to the impacts of climate change.

In addition to Lake Malawi and the Shire River, among the most threatened of Malawi's water sources is the small but economically important **Lake Chilwa**. Lake Chilwa is the source of about one-quarter of the fish production in the country. With a maximum depth of just five meters, the lake is surrounded by wetlands. In the past, seasonal lake-level fluctuations have left the lake partially or completely dry—Lake Chilwa completely dried in 1968 and 1995. Such dryings are expected to increase with climate change; the shallow depth and very low total volume of the lake make for conditions of a very fragile hydrologic system, one especially vulnerable to variability in precipitation and increased evaporation.

Not only in Lake Chilwa, but throughout Malawi, it appears that **fisheries** have and will be increasingly impacted by climate change. In the mid-1990s, significant declines in 12 species of fish were recorded in Malawi. Although the specific nature of the impact of climate change on fisheries is not well studied or understood (owing to shortages of monitoring equipment and support for such research), it appears that impacts on fisheries biology, reproduction, productivity, and habitats may be associated with changes in temperatures, precipitation, and increased runoff into lakes and streams. Winds can change upwelling patterns in the lake and indirectly induce migration of fish to other areas, often further from the shoreline. Intense rains can lead to soil erosion, high rates of runoff, and siltation, creating an environment in which fish cannot fertilize their eggs or protect their nests. Heavy siltation may also hinder fishes' ability to migrate.

Many factors other than climate change also contribute to the decline of fisheries in Malawi: overfishing and a failure to observe laws and regulations designed to support sustainable use of fisheries, changes in land use (particularly conversion of forests to cropland with resulting erosion), expansion of small-scale irrigation through stream diversion, and eutrophication due to agricultural runoff. While fish stocks are directly affected by changes in climate variables, the decrease in the volume of fish catches is much more difficult to attribute to climate because of these confounding human factors.

In other areas of **natural resources**, the impacts of climate change are increasingly being felt and exacerbating the effects of environmental degradation, population pressures, widespread poverty, and unsustainable land use practices. The combination of deforestation with increased rainfall runoff and accelerated erosion are contributing to land degradation on a large scale in Malawi. In addition to non-sustainable agricultural practices, climate change may contribute to reduced soil moisture (e.g., increased evaporation rates). Increased droughts make forests more vulnerable to wildfires. Ungulates (both domestic and wild) are especially vulnerable to climate-related changes in habitat and food supply.

All of the climate manifestations, biophysical impacts and disruptions to crops, water, fisheries, and other natural resources have had a role in influencing the **livelihoods** of rural communities in central and southern Malawi. Once primarily dependent on agriculture, these communities are finding that their agricultural lands, often degraded through poor husbandry and lack of access to fertilizer, are being further degraded due to soil leaching by heavy rains and floods. Floods can bring sandy soils that do not retain moisture. Erratic rainfall constrains crop choices, with maize particularly affected. Increased population puts pressure on arable lands, a shrinking commodity. As a result, many farmers are moving to new areas that may be less suitable, such as previously shared-resource areas like wetlands (*dambos*) and forests, to compensate for decreasing yields and competition for land.

Although nationally agriculture remains the most important sector of Malawi's economy, today, individual farmers are questioning agriculture's future viability as a reliable source of household income. Nearly all households studied during the Malawi VA are searching for alternative ways to increase revenues to compensate for lower yields—and most start their search in the natural reserves closest to home. All across central and southern Malawi, the most significant reported income-generating activity (IGA) is increasingly derived from forest products; in their efforts to cope with the impacts of climate change, most rural households are investing more time and effort in harvesting, producing, and marketing charcoal and firewood. Other alternatives are timber harvesting and hunting, both limited and dwindling options.

Farmers are already changing the timing and patterns of cropping and replacing crop types. Some farmers are starting to replace agricultural plots that are no longer productive with small-scale aquaculture. These small fish farming enterprises contribute to food security as well as income generation. Some are attempting to cope with declining soil fertility by increasing their use of manure and compost. Additionally, some are taking steps to protect and regenerate trees in cultivated fields in order to help replenish soil organic matter through leaf drop and leaf litter. There is also an increasing reliance on casual labor and remittances as strategies to improve livelihoods. Other alternatives are brick making; collecting mushrooms, fruits, and wild honey; and collecting reeds for weaving into mats.

While farmers and rural community members in Malawi have proven to be quite innovative in responding to climate change, more attention is needed to monitor their chosen coping responses and to encourage a genuine transformation from coping to adaptation—especially for the poorest households whose options are severely limited. The truly successful and sustainable adaptation strategies over the longer term are those that contribute to adaptive capacity and resilience to climate variability, and which are not linked to the unsustainable use of natural resources. Further, not all adaptation strategies will be appropriate for everyone, or will be appropriate under all future climate scenarios. It will therefore be critically important to provide Malawians not simply with recommendations but with a range of options. This, in turn, relies on raising awareness of the likely climate change trends and their impacts in Malawi, and on providing the knowledge, skills, training, and resources needed to enable and empower people to select and exercise a diversity of options, as required; in other words, to build **adaptive capacity**.

By focusing on increasing the resilience of the country and its communities, individuals, and natural assets to climate change and climate variability, USAID's adaptation efforts will help protect existing investments, maintain development gains, and contribute to economic security. USAID supports three broad categories (pillars) of adaptation activities:

- **Improving access to science and analysis for adaptation decision making.** Strengthening knowledge about what to expect and what can be done to adapt to climate change.

- **Establishing effective governance systems for adaptation.** Supporting engagement, coordination, participation, and planning processes, including building the capacity of key institutions, necessary for effective, longer-term adaptation.

- **Identifying, promoting, and piloting actions that increase climate resilience.** Implementing adaptation strategies that deliver development gains in a changing climate.

The results of the Malawi VA informed an **options analysis** of potential responses. The options analysis explored approaches to strengthen adaptive capacity and risk management across communities and institutions at all appropriate scales. The options analysis also distinguished longer-term, climate-specific interventions that seek to enable Malawi to deal better with a volatile, uncertain, complex and ambiguous future from shorter-term, "no regrets" options that react to climate variability and change already underway. By focusing on increasing the resilience of the country and its communities, individuals, and natural assets, USAID's climate change adaptation efforts will help protect existing investments, maintain development gains, and contribute to economic security.