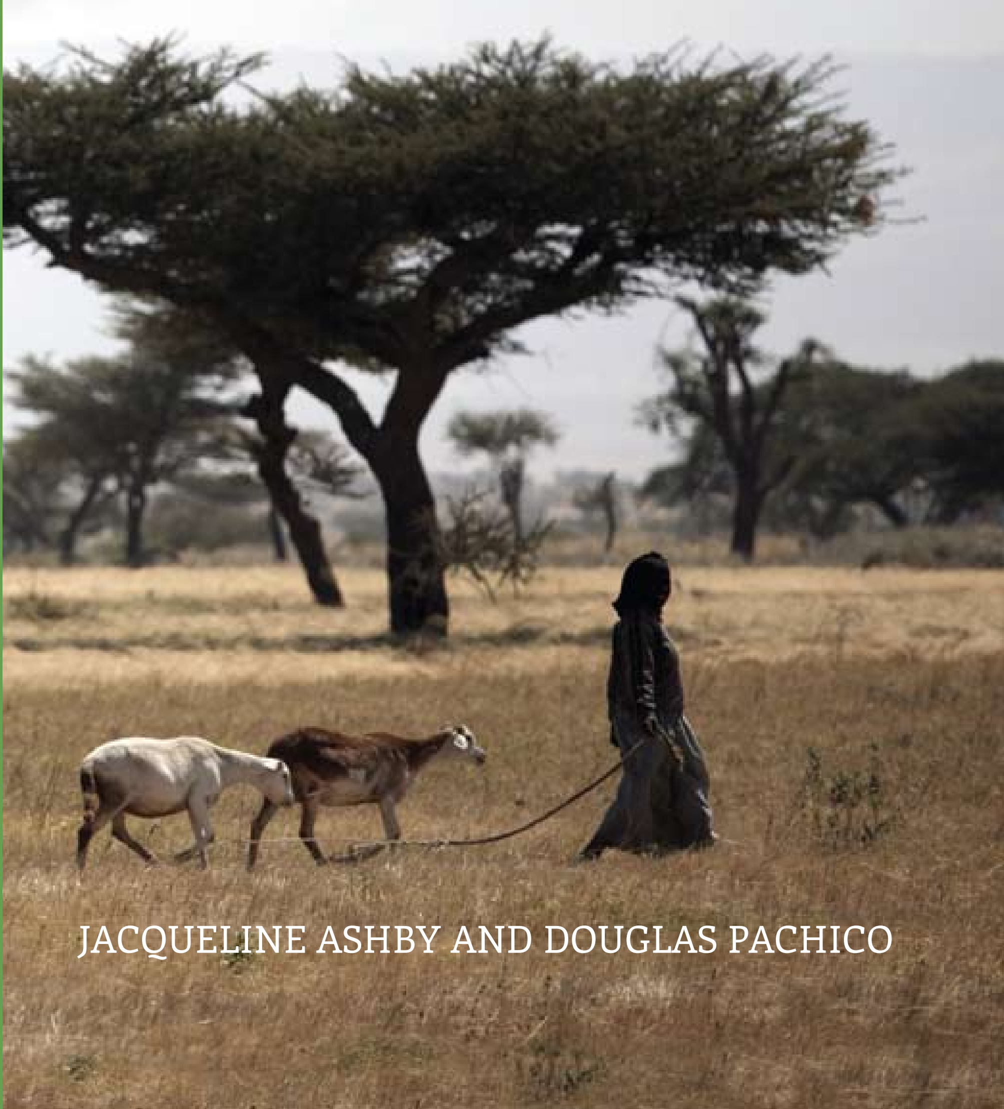
A GUIDE FOR DEVELOPMENT PRACTITIONERS

CRS CATHOLIC RELIEF SERVICES

CLIMATE CHANGE
FROM CONCEPTS TO ACTION



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Cover Arid fields in the Rift Valley of Ethiopia. In the tropics and subtopics, droughts have become longer, more intense and affected wider areas. Photo: Andrew McConnell

Catholic Relief Services
is the official international relief and development agency of the United States Catholic community. Through development projects in fields such as education, peace and justice, agriculture, microfinance, health, HIV and AIDS, CRS works to uphold human dignity and promote better standards of living. CRS works in 99 countries around the world and, since 1943, has provided emergency relief in the wake of natural and human-made disasters.

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Climate Change: From Concepts To Action

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CONTENTS

Note: Sources and resources appear in full at the end of each section.

“Action to mitigate global climate change must be built upon a foundation of social and economic justice that does not put the poor at greater risk”

PHOTO: DAVID SNYDER

RUNNING DRY

Mwongeli Ndiku, a neighbor to CRS beneficiary Joyce Wambua in the Kathonzweni District of southern Kenya, shows how she collects water from a distant borehole each day, walking an hour each way carrying the load of as much as 45 pounds. Because they did not terrace their farm, as Wambua did with CRS support through the ARC project, Ndiku and her family lost their entire harvest to the drought then gripping much of Kenya. Including a climate change perspective and adaptive and mitigation measures in programs will help make them more proactive.

PREFACE

"In facing climate change, what we already know requires a response; it cannot be easily dismissed. Significant levels of scientific consensus—even in a situation with less than full certainty, where the consequences of not acting are serious—justify, indeed can obligate, our taking action intended to avert potential dangers. In other words, if enough evidence indicates that the present course of action could jeopardize humankind's well being, prudence dictates taking mitigating or preventative action …

We especially want to focus on the needs of the poor, the weak, and the vulnerable in a debate often dominated by more powerful interests. Inaction and inadequate or misguided responses to climate change will likely place even greater burdens on already desperately poor peoples. Action to mitigate global climate change must be built upon a foundation of social and economic justice that does not put the poor at greater risk or place disproportionate and unfair burdens on developing nations …

Passing along the problem of global climate change to future generations as a result of our delay, indecision, or self-interest would be easy. But we simply cannot leave this problem for the children of tomorrow. As stewards of their heritage, we have an obligation to respect their dignity and to pass on their natural inheritance, so that their lives are protected and, if possible, made better than our own …

The common good requires solidarity with the poor who are often without the resources to face many problems, including the potential impacts of climate change. Our obligations to the one human family stretch across space and time. They tie us to the poor in our midst and across the globe, as well as to future generations."

Excerpts from United States Conference of Catholic Bishops. 2001. *Global Climate Change: A Plea for Dialogue, Prudence, and the Common Good*. Washington, DC, USA. http://old.usccb.org/sdwp/international/globalclimate.shtml

INTRODUCTION
PURPOSE AND CONTENT

Why a climate change guide?

This climate change guide has been developed to enable CRS and its partners to more effectively address the needs of the rural poor—who are threatened by the impact of climate change and whose livelihoods will be damaged in tropical and developing countries—and to enable them to take advantage of the new opportunities that the impact of climate change sometimes presents.

Due to the threat of climate change, CRS can only remain loyal to its "Do No Harm" ethos if a climate change perspective is included in its programs. Otherwise it risks promoting development paths that may soon lose viability and even leave the poor worse off.

The poor already face pressures on their livelihoods—ranging from natural disasters to resource degradation—so some may see climate change as a distant and theoretical threat that can be ignored in the face of more pressing issues. Such a view is shortsighted and misleading, as the first part of this guide will show.

The accumulated evidence of global warming is mounting fast. The threat is real and immediate. There is evidence that climate change is already having significant negative impacts. The frequency of climate-associated natural disasters such as floods has been growing. Increasing drought is a clear trend in several parts of the world, and warmer temperatures are affecting crops. Climate change issues cannot responsibly be left for some distant future.

How should the work of CRS and its partners be transformed?

Climate change considerations can be incorporated into the existing CRS Integral Human Development (IHD) framework. Part 3 of the guide will show that major elements of current development strategies, many of the types of interventions being introduced, and many of the fieldwork methods being used, are relevant—even essential—to assisting the poor in adapting to climate change. Taking climate change seriously may mean only incremental and subtle—but carefully considered—changes to CRS's programs.

The aim of this guide is to consider how to modify and use existing CRS strategies, frameworks, tools and programmatic responses to insure that the poor are better equipped to adapt to climate change. Such a perspective can enrich CRS's work by contributing to the sustainability of the innovations it introduces and helping forge new relationships with stakeholders, partners and donors.

Who are the users of this guide?

The main users of the guide are expected to be CRS leadership, staff, and partners at the country level. Development practitioners and policy makers in general should also find it useful.

What is the content of the guide?

The guide has three main parts:
- Evidence, causes, and trends
- Strategies
- Action for adaptation

The **first part** reviews some fundamental concepts that provide a foundation for working with a climate change perspective. It reviews the evidence for climate change; discusses potential causes; and describes current understanding of climate change trends.

The **second part** introduces three broad strategies for dealing with climate change: adaptation to its impacts; mitigation to slow the process of climate change; and climate-smart agriculture that combines adaptation, mitigation, and productivity.

Because adaptation directly addresses the vulnerabilities of the rural poor and is central to climate-smart agriculture, the **third part** focuses on concrete action to facilitate adaptation to climate change by the rural poor. The guide aims to foster skills that enable readers to advance work with communities threatened by climate change so that they can be more resilient in adapting to its risks. The action steps aim to provide a structured and practical approach to developing better projects that include a climate change perspective. Some elements of these action steps consist of analysis that can be undertaken by CRS staff and partners while others involve proactive participation by communities. These approaches share common principles with other community-based development work, with the difference that they prioritize responses to climate change. Practical options for both analytical and participatory approaches are offered.

Many development activities that CRS is now taking part in can contribute to mitigating, and adapting to, the consequences of climate change, so it is important to see how this ongoing work can be leveraged to provide even greater benefits to the rural poor.

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CLIMATE CHANGE: EVIDENCE, CAUSES AND TRENDS

PHOTO: SARA A. FAJARDO/CRS

CROPS ON TOP

Maria Santos Peña of Cantón Sant a Anita, El Salvador, tends to the outdoor vegetable garden she planted with the help of CRS and Caritas El Salvador. In a flood prone area, the elevated gardens are protected from water run-off and also allow the women to control the amount of irrigation each plant gets. The women say the gardens have been a huge financial boon. Not only do they no longer need to buy vegetables but they can sell the extra at a small profit.

Successful responses to climate change in development projects require the ability to make informed use of expert information as well as local knowledge about climate change trends. Thus, it is important to have a background in the basics of climate change science and a feel for the kinds of evidence that experts use to analyze the current situation and to create future scenarios.

The aim is not for staff to become instant experts but to be familiar enough with the science to understand how to apply some central concepts and principles where CRS works and to do what is needed to assist communities to prepare for this change. The literature on climate change is vast and growing rapidly. It touches on a broad variety of fields, from astronomy to oceanography, from economics to political science. Although there is a growing body of evidence and a clear scientific consensus about some of the main features of climate change and its impacts, there are some gaps in scientific knowledge as well as uncertainties about the future, which the guide points out. Despite a broad scientific consensus, some aspects of climate change remain controversial.

This section lays the foundation for making sound judgments to design development projects in situations that climate change is influencing, could significantly influence, or could even determine the success of. Knowledge of basic climate change concepts is needed in order to consider its risks and what can be done about them in the poor rural communities with whom CRS works. The guide provides a brief summary of evidence of climate change, the role of agriculture in climate change and some major climate change trends.

1.1 EVIDENCE OF CLIMATE CHANGE

What history says about climate change

The Earth's climate has not been stable in either historical or geological time scales. The historical record shows abundant examples of climate change. For example, during the Roman Warm Period (250 BC–400 AD), climate was favorable to agriculture in northwest Europe and the Mediterranean, with vineyards in what is now Britain and olive production in parts of Turkey, where winters are now too severe for those crops.

Later, in the Medieval Warm Period (950–1250 AD), Norse settlers found favorable settlement conditions for farming in Greenland, while extended droughts undermined Pueblo agriculture in what is now the southwestern USA. This warm period was followed by the Little Ice Age (1250–1850), when the Thames

River in London regularly froze, glaciers engulfed Swiss villages, and Norse settlers abandoned Greenland. Cool, rainy summers in northwest Europe led to repeated famine, especially the great famine of 1315 to 1317. Thus, history shows that climate changes can significantly affect agriculture and food security.

PREHISTORIC PROOF CONFIRMS CLIMATE CHANGE

Cave art and other archeological remains suggest that parts of what are now the uninhabitable areas of the Sahara Desert were populated and had moist savannas teeming with wildlife during the Green Sahara Period (6000–2000 BC). Settlement of the Americas is generally attributed to the crossing of a land bridge between Siberia and Alaska that existed when sea levels were much lower than today due to a colder climate. Farmers in early Bronze Age Britain (≈ 2000 BC) cultivated areas that have since been abandoned for agriculture for being too cold.

1

Longer geological time spans show major changes in the Earth's climate. Ice ages have been a recurring feature in geological time. Some 2.5 million years ago the glaciation of the Quaternary Period began, with ice sheets of up to 3,000 meters thick covering much of what is now North America and northern Eurasia. This glaciation reached a peak about 22,000 years ago. The Earth is now in an interglacial period that began some 10,000 to 15,000 years ago. (See Brian Fagan's book, *The Little Ice Age*, for numerous examples of effects of climate change on human society).

Is climate changing today?*

There is strong evidence that climate change, in the form of global warming, is occurring today. Over the last century, temperatures have risen nearly everywhere over land as well as on the ocean surface and in ocean air. These trends have accelerated since the 1970s. Average global land temperatures have risen 0.74° C over the last century. The Earth is close to being warmer than it has been for more than 1,000 years and temperatures are not far from the upper bound of the temperature range of the last 400,000 years.

Most glaciers have been in retreat since the 1960s, while Arctic sea ice coverage is also falling, reaching a record low in the summer of 2012. Ice sheets in

*The Intergovernmental Panel on Climate Change's *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* forms the basis of the material in this section.

Antarctica and Greenland have also been declining.* Sea level is rising both because of melting ice and because warmer water expands. Total water vapor in the atmosphere has increased due to warmer air (IPCC 2007a).

Changes in the behavior of plants and animals are also consistent with a warming climate. According to the Audubon Society, more than 60 percent of migrating bird species in North America have extended their winter range northward by an average of 35 miles in the last 40 years, indicating generally warmer conditions. Season creep—earlier springs and later autumns—has also led to the earlier flowering of many wild plants as spring warming comes earlier in high latitudes. Coral reefs are dying off as oceans become warmer (Wilkinson 2008).

Migrating bird species in North America have extended their winter range northward by an average of 35 miles in the last 40 years

Rainfall trends over the last century present a complex picture. Precipitation has generally increased in northern latitudes, but there has been a downward trend in rainfall since the 1970s in southern Africa and parts of southern Asia. There is a significant downward trend in rainfall in the Sahel—the zone between the Sahara Desert in the north and the Sudanian Savanna in the south—since 1920. Moreover, in the tropics and subtopics, droughts have become longer, more intense and affected wider areas due to the combined effects of decreased rainfall and a higher demand for water by crops when temperatures are higher (IPCC 2007a).

1.2 CAUSES OF CLIMATE CHANGE

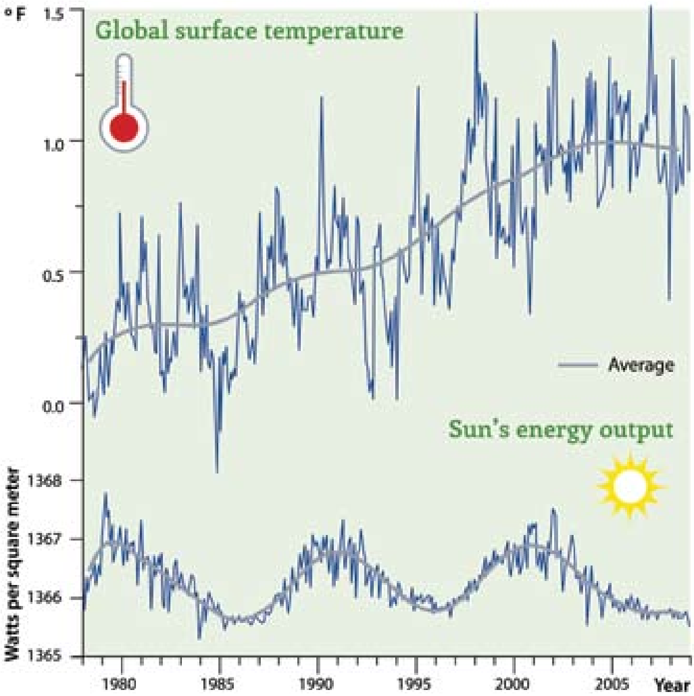
What causes climate change?

The causes of climate change are complicated and occur over different time scales. For example, eccentricities in the Earth's orbit around the sun and shifts in its tilt toward the sun affect the amount of heat it receives. Known as Milankovich Cycles, and confirmed by studies of ice cores and sediments, these movements have had impacts on climate over tens of thousands of years. In the 1970s, forecasts based on these cycles predicted that the Earth was on the verge of entering a cooling period, so these cycles are not responsible for ongoing global warming (National Aeronautics and Space Administration).

* A report by Paul R. Holland and Ron Kwok in *Nature Geoscience* 5 (2012) said that while Arctic ice shrank in September 2012 to its smallest area in 33 years of satellite records, Antarctic sea-ice cover was increasing slowly due to increased winds. The report did not say by how much.

The amount of heat that the sun emits also affects the Earth's climate. There are regular cycles in the amount of heat radiated by the sun that reaches Earth. Such sunspot variations are correlated with changes in global temperature and have continued in their 11-year up-and-down cycles while the Earth's temperature has risen steadily instead of following the sunspot cycles (**Figure 1**). While scientific understanding of changes in the sun's emission of energy is imperfect, the current scientific consensus is that an increase in heat radiated by the sun is a much less important factor to global warming than changes in the Earth's atmosphere (IPCC 2007a).

Figure 1. Energy from the sun has not increased



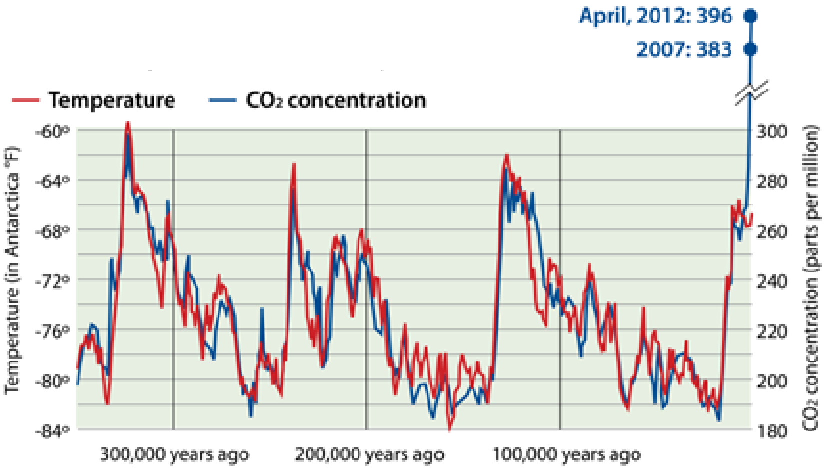
Source: Global Climate Change Indicators. 2011. National Oceanic and Atmospheric Administration, National Climatic Data Center: Washington, DC, USA. http://www.ncdc.noaa.gov/indicators/

The composition of the atmosphere is strongly related to the Earth's climate. Over the last 400,000 years the concentration of carbon dioxide (CO_2) in the atmosphere and temperature (**Figure 2**) have been closely correlated. Four peaks in temperature over this period have coincided with four peaks of CO_2 in the atmosphere. Similarly, when there is less CO_2 in the atmosphere, temperatures have been cooler. Thus, CO_2 is said to have a "greenhouse" effect on the Earth's temperature. Since most climate scientists believe that recent rapid changes in the atmosphere are responsible for recently observed global warming, the guide will now consider the effects of greenhouse gases (GHG) on climate.

Greenhouse gases and climate change

Climate scientists see the accumulation of CO_2 and other greenhouse gases in the atmosphere as the fundamental cause of current global warming. Greenhouse gases capture and hold solar heat that warms the air. The more greenhouse gases there are in the atmosphere, the more heat is trapped and the higher the Earth's temperature becomes.

Figure 2. CO_2 Concentrations and temperature have tracked closely over the last 300,000 years



As ice core records from Vostok, Antarctica show, the temperature near the South Pole has varied by more than 20° F during the past 350,000 years in a regular pattern that constitutes the ice age/interglacial cycles. Changes in CO2 concentrations (blue) track closely with changes in temperature (red) during these cycles, but CO2 levels are now higher than at any time during the past 650,000 years. Source: Southwest Climate Change Network. 2009. Tucson, Arizona, USA. http://www.southwestclimatechange.org/figures/icecore_records. Source: Image modified and courtesy of the Marian Koshland Science Museum of the National Academy of Sciences. http://www.koshland-science-museum.org/

In 2010, the concentration of CO_2 in the atmosphere was 389 parts per million (ppm), higher than any indicated in ice cores which contain samples of the Earth's atmosphere over the last 650,000 years. During that period, CO_2 levels varied from a low of 180 ppm to a high of 270 ppm. For the last 20 million years,

CO_2 concentrations have been less than 300 ppm but are now climbing rapidly, from 313 ppm in 1960 to 389 ppm in 2010. Furthermore, the rate of accumulation of CO_2 in the atmosphere is accelerating (IPCC 2007a).

Although volcanic activity was the original source of much of the CO_2 in the atmosphere, today the major cause of the increase in CO_2 emissions is human activity (anthropogenic). Currently, volcanoes contribute less than 1 percent of CO_2 emissions. The major effect of volcanoes today is to cool the Earth by releasing massive quantities of ash and gaseous particles (aerosols) that reflect the sun's heat back into space, causing global temperatures to fall: for example, in 1815, Mount Tambora in Indonesia erupted causing "the year without a summer" and, in 1991, the eruption of Mount Pinatubo in the Philippines led to a global temperature fall of about 0.4°C (Self et al 1995).

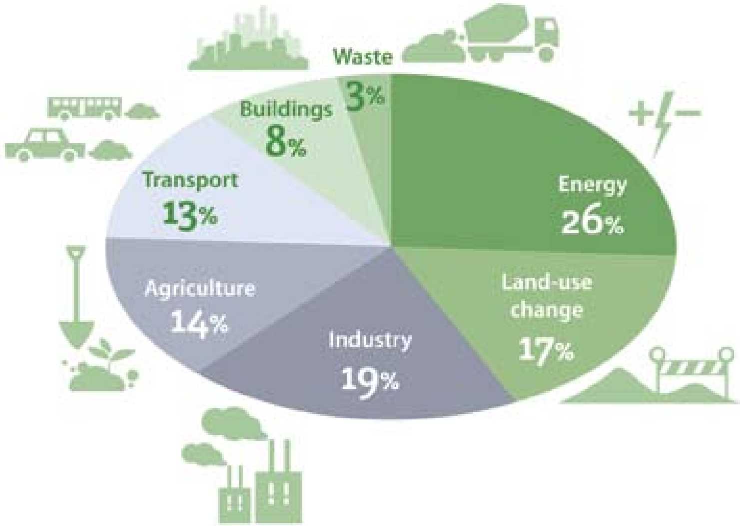
The major effect of volcanoes today is to cool the Earth by releasing massive quantities of ash and gaseous particles (aerosols) that reflect the sun's heat back into space.

Global emissions of CO_2 reached 34 billion tons in 2011 and this amount continues to rise. Since 2000, an estimated total of 420 billion tonnes of CO_2 was cumulatively emitted due to human activities (including deforestation). Scientific literature suggests that limiting the average global temperature rise to 2°C above pre-industrial levels – the target internationally adopted in UN climate negotiations – is possible if cumulative emissions in the 2000–2050 period do not exceed 1,000 to 1,500 billion tonnes of CO_2. If the current global increase in CO_2 emissions continues, cumulative emissions will surpass this total within the next two decades (Jos et al 2012). Anthropogenic greenhouse gas emissions also include methane (CH_4) and nitrous oxide (N_2O) and others such as hydrofluorocarbons that are released by various industrial processes. These are recognized as less important than CO_2 to the greenhouse effect because they are generated in much lower quantities (IPCC 2007a).

The role of agriculture in causing climate change

The major sources of anthropogenic greenhouse gases are shown in **Figure 3**. Energy (26%) and industry (19%) are the most important. Land-use change (17%), consisting mainly of the harvesting of forestry products and the clearance of natural vegetation for agriculture, is also an important source. Direct agriculture activities (14%) are about as important as transport (13%). Developing countries account for 74 percent of agriculturally related greenhouse gases. (IPCC 2007b).

Figure 3. Greenhouse gas emissions by sector



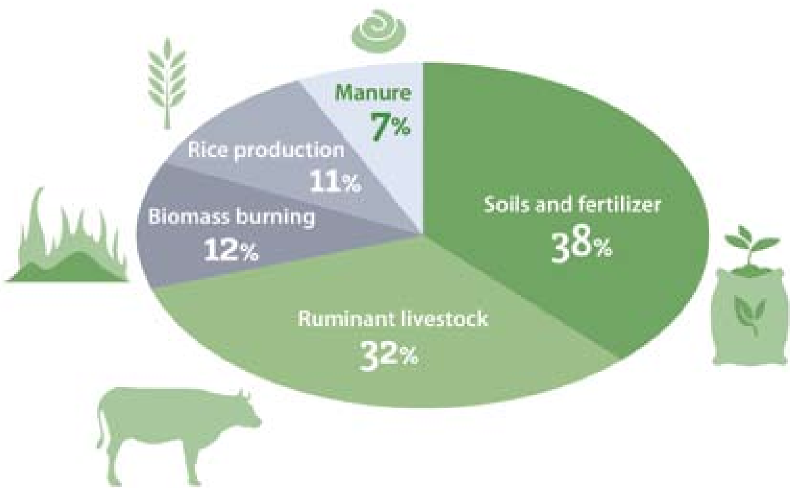
Source: The World Bank 2010, Figure 7

There are several ways that agriculture directly contributes to greenhouse gases (**Figure 4**). The most important is the release of nitrous oxide (N_2O) by microbial transformation of nitrogen in the soil, emitting N_2O as a by-product. While this is a natural part of the nitrogen cycle, additional N_2O is released beyond natural levels when fertilizer or compost is added to the soil. Nitrous oxide is a potent greenhouse gas and accounts for 38 percent of greenhouse gas emissions directly related to agriculture. From 1990 to 2005, N_2O emissions increased 17 percent, and with continued rising fertilizer use it is expected to rise another 35 to 60 percent by 2030 (Smith et al 2007).

The second most important source of greenhouse gas coming directly from agriculture is methane (CH_4). Methane is produced by the digestive process in ruminant livestock (enteric fermentation). It contributes 32 percent of agriculture's direct emission of greenhouse gases and has also grown 17 percent in the 1990-2005 period. Livestock also generate N_2O which is released from manure, causing 7 percent of agriculture's emission of greenhouse gases. Combining methane and nitrous oxide, livestock produce a total of 39 percent of agricultural greenhouse gases. As the demand for meat grows, and therefore the number of livestock increases, it is anticipated that methane and nitrous oxide emissions from livestock will rise 60 percent by 2030 (IPCC 2007b).

The burning of crop residue emits CO_2 into the atmosphere, and produces 12 percent of agriculture's direct emissions of greenhouse gases. Most of the world's biomass burning occurs in Sub-Saharan Africa and Latin America, which together account for 74 percent of the total. There is also movement of carbon between agricultural soils and the atmosphere, but the current net of this exchange is generally considered to have only a minimal effect on the global carbon cycle. Rice production in flooded conditions produces methane when organic matter is decomposed in anaerobic conditions, accounting for 11 percent of agriculture's direct greenhouse gas emissions. Most of rice's CH_4 emissions come from South and East Asia, which together contribute 82 percent of global emissions from this source. These emissions can be expected to grow in proportion to the expansion of the area under irrigated rice that is expected to be in the range of 4 to 16 percent by 2030 (Smith et al 2007).

Figure 4. Sources of agricultural greenhouse gas emissions



Source: Smith et al 2007, p. 503.

These "direct" emissions of greenhouse gases from agriculture do not include CO_2 emissions from the conversion of natural vegetation, mostly forests, to agriculture. When trees are burned to clear land, CO_2 is released into the atmosphere. Land-use changes, such as clearing forests for pastures or agriculture, account for 17 percent of global greenhouse gas emissions. As much as

80 percent of these CO_2 emissions are estimated to come from conversion of land to agriculture, making this "indirect" source of agricultural greenhouse gases about as important as the direct effects discussed above. South America and Asia are each responsible for about 40 percent of land conversion, with Africa accounting for most of the rest (Smith et al 2007).

In addition, agriculture makes several other indirect contributions to greenhouse gas emissions. For example, CO_2 is emitted in the manufacture of fertilizer, pesticides, and machinery, while fuel is burned in transport of farm products, farm inputs and in the use of farm machinery, also emitting CO_2.

Taking into account direct activities of agriculture and the clearing of natural vegetation for agricultural land use, all world agriculture in total accounts for about one-third of world greenhouse gas emissions.

1.3 CLIMATE CHANGE TRENDS

Scientists have developed global climate models to project likely future paths of climate change. These models accurately replicate observed recent climate change, but their projections of future climate lead to a wide range of results due, in large part, to the complexity of the factors affecting climate. Scenarios of future climate are also heavily dependent on greenhouse gas emissions that in turn depend on human decisions, making climate projections uncertain.

Warming drives other climate changes

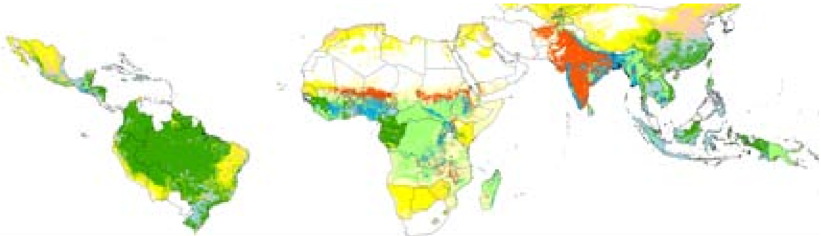
Despite their limitations, global climate models consistently project a future of global warming (IPCC 2007a). The consensus of scientists is that global warming is not reversible in the next decades. Due to the lifespan of CO_2 in the atmosphere and heat stored in the oceans, temperatures will only slowly decrease even after CO_2 emissions stabilize or begin to fall.

Higher temperatures drive other changes such as increasing the rate of evaporation and moisture-holding capacity of a warmer atmosphere, leading to higher total global precipitation. Rainfall variability and intensity is expected to increase but, due to complex changes in atmospheric and oceanic circulation systems, changes in rainfall will not be the same everywhere in all seasons. While some regions will be wetter, others, especially the tropics, will experience more prolonged and frequent droughts that are more severe at higher temperatures.

Since hurricanes and tropical cyclones are formed in warm-ocean conditions, it is expected that global warming will increase the severity and frequency of these catastrophic storms. Climate change will also have major effects on the hydrological cycle. When rainfall events are intense, a greater share of the rainfall may just run off because a lower share of it can infiltrate the soil.

Coastal zones may be particularly at risk due to climate change. The Intergovernmental Panel on Climate Change projected in 2007 that sea levels would rise by between 18 and 59 cm during the 21st century, as higher temperatures melt ice and warm water occupies more space. The risk of flooding in coastal zones will be greater in those cases when run-off from more intense precipitation carries a heavier sediment load that accumulates in river deltas, flood plains and estuaries. This in turn will alter tidal ranges and could lead to saltwater intrusion into freshwater resources and more severe damage from storm surges. Some coastal areas will be inundated as unusually high surge tides become more frequent (IPCC 2007a).

Figure 5. Large areas of tropical agriculture are highly exposed to climate change



HIGH EXPOSURE		LOW EXPOSURE	
High sensitivity	Low Sensitivity	High sensitivity	Low Sensitivity
Low capacity	Low capacity	Low capacity	Low capacity
High capacity	High capacity	High capacity	High capacity

Source: Ericksen, P., P. Thornton, A. Notenbaert, L. Cramer, P. Jones, M. Herrero. 2011. *Mapping Hotspots of Climate Change and Food Insecurity in the Global Tropics*. CCAFS Report No. 5. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS): Copenhagen, Denmark. http://cgspace.cgiar.org/handle/10568/3826

This is a domain indicating "vulnerability" of food insecure people to climate change, based on a three factors: The first is **exposure**, calculated here based upon coefficient of variability of rainfall. The median of 21 percent for cropped areas in the tropics was taken as the cutoff point for High or Low. The second is **sensitivity**, calculated based on the percent of area cropped, with the difference between High and Low sensitivity taken as 16 percent of area cropped, which is the mode for the tropics. The third factor is **coping capacity**, calculated based on the percent of population with chronic food insecurity, using the proxy of stunting. A cutoff of 40 percent stunting* was the threshold between High and Low capacity.
*Stunting (UNICEF): Moderate and severe = below minus two standard deviations from median height for age of reference population.

Climate impacts on livelihoods of the poor

Climate change will have major impacts on human welfare, especially affecting livelihood outcomes of the poor—and particularly the rural poor as agriculture is one of the livelihoods most sensitive to climate change—who are the focus of the CRS 'justice lens' through which its programming is viewed. In terms of the Integral Human Development framework of CRS, climate change may be considered through an assessment of the shocks, cycles and trends that affect the assets and livelihoods of the poor, as well as the adaptive capacities to mitigate the impacts of climate change.

INTEGRAL HUMAN DEVELOPMENT (IHD)

This concept affirms that human development cannot be reduced or separated into component parts. Rather, personal wellbeing can only be achieved in the context of just and peaceful relationships and a thriving environment. It is the sustained growth that everyone has the right to enjoy. IHD promotes the good of every person and the whole person; it is cultural, economic, political, social and spiritual.

Source: Technical Resources: Program-related materials on CRS relief and development work.
http://www.crsprogramquality.org/ihd/

2

Resources: Evidence, causes and trends

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2

STRATEGIES TO CONFRONT CLIMATE CHANGE

PHOTO: CRS STAFF

TREES OF LIFE

A farmer from Madagascar (right) visits a fellow farmer in Zambia to learn about the Conservation Agriculture with Trees program. The tree is *Faidherbia albida*, the "fertilizer tree" that produces its leaf canopy during the dry season and loses it in the rainy season so that crops receive full sun and rich natural leaf fertilizer.

Since shocks and trends related to climate change impact the assets, livelihood strategies and livelihood outcomes of the poor, small-scale farmers* and poor rural communities must increase their capacity to mitigate and adapt. CRS staff and partners must understand strategic approaches that can guide small farmers to deal with climate change. Three broad strategic approaches include:

Adaptation adjusting farming practices to climate change
Mitigation reducing greenhouse gases to prevent climate change
Climate-smart agriculture combining adaptation, mitigation and productivity

2.1 ADAPTATION TO CLIMATE CHANGE

Adaptation to climate change consists of "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC 2007). Effective adaptation should increase resilience or the capacity to recover from negative effects of climate change. Adaptation aims to confront climate change that is occurring, while mitigation aims to reduce the concentration of greenhouse gases in order to minimize the effects of climate change.

Adaptation aims to confront climate change that is occurring, while mitigation aims to reduce the concentration of greenhouse gases in order to minimize the effects of climate change

Adaptation is a strategy that is explicitly designed to overcome vulnerabilities caused, or worsened, by climate change. It involves acting to tolerate the effects of global warming.

There are several types of adaptation: it may prevent, moderate, withstand, or take advantage of, the effects of climate change. For example, levees can **prevent** flooding; conservation agriculture can **moderate** soil erosion; resistant varieties may **withstand** high temperatures; new crops may **take advantage of** new growing conditions. Adaptation can be in response to climate change that has already occurred, or in anticipation of expected climate change.

* Small-scale farmers, small holder farmers and small farmers are defined as those who typically cultivate up to 20 hectares of land. For this guide, 'small farmers' is widely used.

ADAPTING TO CLIMATE CHANGE: CRS EXPERIENCES IN INDIA AND ETHIOPIA

INDIA In Chhattisgarh state, increased frequency of flooding has been brought on by deforestation and possibly exacerbated by climate change. The flooding increased silt levels in traditional rainwater catchment systems thereby limiting irrigation and lowering crop yields. CRS worked with local organizations to adapt to these shocks by rejuvenating ponds to increase rainwater capture. Crop yields have increased, dry-season cropping has become possible, and household incomes have risen.

ETHIOPIA Higher temperatures and ever more variable rainfall is reducing both crop yields and livestock productivity. CRS worked with local communities to build terraces that retain soil moisture and reduce soil erosion. Trees and grass were planted on the terraces to improve soils while providing firewood and livestock feed.

3

Although there is a broad array of potential adaptation measures that can partly reduce negative impacts of climate change, it will not always be possible to completely resolve these. There are a number of limits to adaptation: biophysical, technical, economic, institutional and social. Adaptation is necessary, but it is not a cure-all.

Adaptation and resilience

Livelihoods of the rural poor often have a poor adaptive capacity*, a product of low resilience, that is, a limited ability to recover from external shocks. Poor adaptive capacity or low resilience can be related to climate change or it may have other fundamental causes that are worsened when the poor are unable to adapt to the effects of climate change. Having a low adaptive capacity is part of what it means to be poor—for example, poor people seldom have reserve stocks of grain when there are production shortfalls and they often then consume their seed stocks, making it much harder to adapt to poor harvests.

The rural poor are often ill prepared to adapt effectively to prevailing weather risks let alone future climate change. Many development interventions can reduce this adaptation deficit by improving livelihood resilience. Indirect measures such as land tenancy and improved market access can enhance overall livelihood resilience and thus indirectly contribute to adaptation to climate change. Dealing with non-climatic issues (e.g. improved local research capacity) can be more effective in dealing with climate change than interventions that are narrowly planned around climate change impacts (e.g. higher night-time temperatures affecting crop development).

Options to adapt to climate change are presented in Section 3.3.

Adaptation and regrets

Adaptation options are usefully classified as 'low regret' and 'high regret'. A **low-regret** adaptation refers to interventions that include few risks and are worth making even if climate change were non-existent, for example, increased crop diversification, improved crop/livestock integration or soil-conservation measures. Uncertainty about future climate change enhances the attractiveness of these options. Low-regret options address problems of current climate variability while reducing the adaptation deficit for future climate change.

PHOTO: JENNIFER HARDY

A-MAZ-ING MAIZE

Nicolau da Silva Soares, 47, and his wife Martina da Costa Soares, 37, display the results of CRS Timor-Leste's pilot project to improve nutrition and food security. They are pictured here with their children, Dominico Silva Lay and Mani Silva Lay. In the village of Ossu Rua outside Baucau, Timor-Leste, CRS and partners Foods Resource Bank and Seeds of Life are helping farmers try new varieties of maize seeds and food and seed storage solutions. Previously, farmers lost up to 50% of their harvest to mold, rats and weevils. The traditional maize seeds also yielded small, sparse cobs that only thrived in a specific type of soil. Farmers now report maize that is larger and healthier.

Low-regret adaptations are "win-win" strategies. They generate important benefits in the face of future climate change, and they produce benefits immediately in terms of dealing with current weather variability. Much of what CRS is already doing to improve the livelihoods and disaster-preparedness of the poor also improves their capacity to adapt to current weather variability and so is, simultaneously, a low-regret adaptation to climate change. Thus, a good way to initiate action in anticipation of climate change can be to re-enforce ongoing activities that increase livelihood resilience to existing weather variability. Then, planning can include any modifications needed to these activities to better take into account future climate risks.

In contrast, **high-regret** adaptations increase costs, risks and complexities such that these investments would not be worth making if climate change did not occur. Large-scale physical infrastructure—for example, sea walls to protect a coastline against rising sea levels—is a significant investment that would have few, if any, benefits if global warming were not to impact the area of intervention. If climate change projections were to prove overestimated, then there would be a high regret for having made such large investments, where money may have been better spent on other initiatives.

2.2 MITIGATION OF CLIMATE CHANGE

Actions to decrease or prevent forces driving climate change—principally by reducing the quantity of greenhouse gases in the atmosphere—constitute climate change mitigation. According to The World Bank, "While adaptation manages the unavoidable, mitigation seeks to avoid the unmanageable" (The World Bank 2012a).

Mitigation strategies have to be tailored to specific ecosystems, production systems and the socio-economic context

Since some 74 percent of global emissions from agriculture originate in low- or medium-income countries (Wollenberg et al 2012), there are major opportunities for mitigation initiatives in developing countries. The world's 1.8 billion small farmers manage 22 million hectares, so could play a significant role in climate change mitigation. The effectiveness of alternative measures to mitigate climate change varies from region to region and depends on local circumstances. Mitigation strategies have to be tailored to specific ecosystems, production systems and the socio-economic context.

While the forces driving future climate change may be weakened by mitigation, climate change is not completely reversible. The carbon already in the atmosphere will not dissipate for as long as another century, and other greenhouse gases may persist even longer. Even if greenhouse emissions were to completely cease, a certain amount of future global warming is already inevitable. Consequently, some adaptation is necessary.

There are three ways in which farmers can contribute to mitigating climate change through agricultural practices:

- Reduce emissions of greenhouse gases from agricultural activities
- Help remove greenhouse gases from the atmosphere
- Avoid emissions by substituting biofuels for fossil fuels

Reduction of greenhouse gas emissions by small farmers

Agriculture, including land-use change, accounts for nearly one-third of greenhouse gas emissions. Potentially the most critical role of smallholders in reducing these would be reducing or halting the clearance of new land for agriculture. This includes the converting of forest, wetland or grassland into crop or pasture land. For example, many small farmers at the forest margins clear trees to grow the food they need for their subsistence. Enabling these smallholders to get greater productivity out of the farmland they already cultivate could relax pressures on land clearance, thereby making a significant contribution to lessening CO_2.

Furthermore, enabling small farmers to earn higher incomes from existing forest resources—for example, through community forest management—can make deforestation less attractive. Yet small farmers are not always the major culprits in deforestation. In Latin America, most land clearance is undertaken for commercial farming even though it is often done through transient sharecroppers. The commercial sector is becoming increasingly prominent in land clearance in many parts of the tropics.

Enabling small farmers to earn higher incomes from existing forest resources—for example, through community forest management—can make deforestation less attractive

Burning of crop residue or vegetation growing during a fallow period are common practices in some small farm systems, for example, in shifting cultivating systems on the forest margins. Reducing the burning of crop residue or weeds in small farm systems could make a contribution to climate change mitigation.

Small farmers apply only a small proportion of global fertilizer and own only a modest share of the world's cattle thus their reduction of greenhouse emissions can contribute only a modest share of what is needed to mitigate climate change.

Carbon sequestration potential for small farmers

Carbon sequestration—the capturing of carbon from the air and storing it in the soil or in the above-ground biomass—is the most promising avenue for small farmers to contribute to mitigating climate change. It is estimated that 89 percent of the total technical potential for climate change mitigation related to agriculture comes from carbon sequestration in the soil, compared to 9 percent technically possible from limiting methane emissions from livestock and rice, and 2 percent from lowering nitrous oxide emissions from fertilizer (Smith et al 2007). Despite the clear potential of carbon sequestration, there are finite limits to the quantity of carbon that can be stored in the soil. Saturation could be reached within 50 to 100 years of proactive carbon sequestration efforts.

Agronomic practices that increase yields and productivity may produce higher levels of carbon residue that can lead to greater carbon storage in soils. These include:

- Increasing soil fertility
- Including perennial crops in rotation
- Reducing tillage
- Increasing organic matter in the soil—for example, from incorporation of crop residue
- Planting cover crops such as legumes between rows of a grain crop
- Converting arable land to pasture
- Grazing pastures optimally. These sometimes enjoy greater carbon build-up than that in over-grazed or degraded pastures.
- Restoring degraded lands

Agroforestry raises the amount of carbon in above-ground biomass as well as in the soil. For example, coffee systems in poly-culture with shade trees can sequester significant amounts of carbon in the above-ground biomass (**See Box 4**).

ABOVE-GROUND CARBON SEQUESTRATION IN POLY-CULTURE COFFEE SYSTEMS

Carbon can be stored either in the soil or in above-ground vegetation. By keeping this stored carbon out of the atmosphere, atmospheric greenhouse gases are reduced and climate change is mitigated. Farm practices can greatly affect the amount of carbon that is sequestered. For example, a study showed that where coffee is grown with shade trees and other plants like plantains, 71 tons of carbon is stored per hectare. In coffee monoculture under shade, this falls to 37 tons per hectare, while coffee monoculture without shade sequesters only 17 tons of carbon per hectare. This illustrates the high potential of storing carbon in above-ground biomass in agroforestry systems.

Source: Van Rikxoort 2011

4

Biofuels and mitigation

Crops and crop residue can be used as feedstock to produce biofuels such as ethanol or diesel. Although biofuels release CO_2 when they are burned, this is CO_2 that has only recently been obtained from the atmosphere through photosynthesis and its emission does not add to atmospheric CO_2 in the same way that burning fossil fuel does. The net change in CO_2 from substituting biofuels for fossil fuels depends, however, on the energy input that goes into producing and processing biofuel feedstock.

The use of biofuels as part of a climate change mitigation strategy has become controversial. Diverting land and other agricultural resources to the production of biofuels could adversely affect food supplies, raise food prices, and increase world hunger, and could have large-scale negative environmental impacts. Nevertheless, some countries—such as Brazil , a world leader in biofuel development—have been making major investments to develop biofuels as an energy source. While some schemes for on-farm bioenergy use have been promising on a small scale, to date commercial biofuel production has been concentrated among large-scale commercial farmers.

Incentives for small farmers to invest in mitigation

Although many mitigation practices have advantages for farmers, the direct returns do not often justify their investment. In many cases, farmers need additional incentives. Fortunately, the benefits of climate change mitigation extend beyond farmers to the global community so that from a global perspective it can make sense to compensate farmers for adopting practices that mitigate climate change.

Mechanisms that provide incentives to farmers to undertake mitigating practices include carbon-offset markets, whereby entities that are emitting greenhouse gases (e.g. coal-fired electric utilities) pay others to sequester carbon to offset their emissions. Carbon trading occurs within the framework of the Clean Development Mechanism (CDM) which provides payments to farmers for tree planting, biofuels using animal waste (biogas), and irrigation in rice. However, the CDM has reached relatively few small farmers. Transaction costs are typically high; returns to small farmers are generally low; and there is usually a long waiting period between when farmers have to invest and when payments begin (Wollenberg et al 2012).

Other mechanisms to provide incentives for mitigation activities include payment for environmental services and the Reducing Emissions from Deforestation and Forest Degradation (REDD) program that provides grant funding to projects, or a carbon insetting approach (**See Box 5**). Such options for climate change mitigation by small farmers can often lead to greater longer-term resilience and adaptation capacity while also being profitable in the short run. These attractive opportunities that combine mitigation, adaptation and improved profitability and productivity constitute what has become known as "climate-smart" agriculture.

CARBON INSETTING IN CENTRAL AMERICA

CRS is working with partners in a pilot project that embeds carbon sequestration within the supply chain rather than through an external market mechanism like the CDM. The buyers of a product pay a premium for crops that sequester carbon. These are most often the harvests from perennials or tree crops. Carbon insetting involves processors and marketing companies in co-investment with farmers to reduce the carbon footprint of the supply chain, enhance farmer income, and provide an assured supply of the raw product to the supply chain. Cocoa and coffee are ideal crops for this initiative because they sequester carbon, protect the environment and produce profitable yields year after year.

5

2.3 CLIMATE-SMART AGRICULTURE

Climate-smart agriculture is a strategy that seeks to simultaneously increase crop productivity, enable agriculture to better adapt to climate change, and contribute to mitigation of climate change. The Food and Agricultural Organization (FAO) defines climate-smart agriculture as "agriculture that sustainably increases productivity, resilience (adaptation), and reduces/removes greenhouse gases (mitigation)".

Climate-smart agriculture: Agriculture that sustainably increases productivity, resilience (adaptation), and reduces/removes greenhouse gases (mitigation)

Climate-smart agriculture achieves a triple win. In the **first**, higher yields and improved productivity translate into better food security and income for farmers. In the **second**, agriculture becomes more resilient to weather variability and unfavorable climate change. And in the **third**, agriculture can help reduce climate change by sequestering greater amounts of carbon in the soil and woody biomass. For example, by increasing the soil's organic matter through conservation tillage, crop yields improve, soil erosion decreases, and additional carbon is absorbed in the soil. Improved fertilizer-application practices such as timing, amount and placement, can raise yields while reducing costs and increasing soil carbon. With higher and less variable crop yields, farmers have greater and more stable income that improves their resilience and their capacity to invest in adaptation.

The key to climate-smart agriculture is to find adaptations that enhance productivity and resilience while reducing greenhouse gas emissions. Objectives of poverty alleviation, adaptation and mitigation can be pursued together.

Pursuing a strategy of improved adaptive capacity is an effective entry point to achieving climate-smart agriculture. Farmers and rural communities will have direct incentives to adapt to climate change with the understanding that, if they fail to adapt, their livelihoods may be seriously affected. In contrast, farmers have fewer direct incentives to invest in mitigation. While there are some promising pilot projects using carbon-offset incentives or payments for environmental services, the reach of these approaches remains severely restricted because the regulations to get certified for payments for planting, keeping a tree alive, and proof required to show that a planted tree is there year after year, are burdensome and out of the reach of most small rural villagers. There is some successful use of geographic information tools, but there is still a lot of overhead required for monitoring, recording and being accountable to the those paying for the carbon offsetting.

For most farmers, the driver for adopting climate-smart agricultural practices will be short-term productivity and adaptability rather than the incentives of mitigation. How the rural poor can better adapt to climate change is the main focus of this guide.

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Online review of adaptation with a helpful glossary.

3

TAKING ACTION TO ADAPT TO CLIMATE CHANGE

PHOTO: BEN DEPP

ROCK SOLID
Community members build soil conservation walls in the mountains above their homes in Chardonnieres, Haiti, with support from CRS, which is working in this community on a multi-year program of soil conservation, health training, and the introduction of improved agricultural techniques.

Improving the capacity of the poor to adapt to climate change is central to any CRS strategy, because the poor are especially vulnerable, have limited capacity to adapt, and few incentives to invest in climate change mitigation unless such investment also enhances adaptation or current productivity.

The biggest challenge for adaptation is the vulnerability of livelihoods to any risk. A useful way to approach this challenge is to understand the three components that drive vulnerability:

According to the IPCC, vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed; its sensitivity; and adaptive capacity (IPCC 2007).

Livelihood vulnerability = Exposure + Sensitivity – Adaptive capacity

Vulnerability is therefore calculated as:

Vulnerability = 1/3(Exposure + Sensitivity + (1-Adaptive Capacity))

(Heltberg et al 2010)

Impact of climate variability and climate change on vulnerability

Changes in mean climate, variability, extreme events and sea-level rise	Effects on livelihoods	Impact on vulnerability
• Increased temperature and changes in precipitation reduces agricultural and natural resources. • Changes in precipitation run-off and variability leads to greater water stress. • Increased incidence or intensity of climate-related extremes such as water stress. • Temperature, water and vegetation changes resulting in increasing prevalence of disease.	• Direct impacts of climatic shocks and stresses such as livelihood assets, health, food and water security. • Increased pressure on coping strategies and social protection measures. • Reduced ability recover due to increased frequency of climatic shocks or increased intensity of climatic stresses	Increased vulnerability due to: • Lower capacity to prepare • Lower capacity to cope • Lower capacity to recover from climatic and non-climatic shocks and stresses

Source: DFID 2004.

Thus, vulnerability of livelihoods to climate change depends on:

- The nature of the climate change to which a livelihood is exposed
- The impacts of climate change on livelihoods (sensitivity)
- The adaptive capacity of the livelihood system

CLIMATE CHANGE SENSITIVITY, ADAPTABILITY, AND VULNERABILITY

Sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. Climate-related stimuli encompass all the elements of climate change, including mean climate characteristics, climate variability, and the frequency and magnitude of extremes. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g. damages caused by an increase in the frequency of coastal flooding due to sea-level rise).

Adaptive capacity is the ability of a system to adjust to climate change, including climate variability and extremes, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Source: IPCC 2007

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CRS can reduce the vulnerability of the poor to climate change by increasing their adaptive capacity. To be effective, it is essential to understand both exposure to climate change and the sensitivity of livelihoods to this exposure.

A key principle for dealing with climate change on any scale is being aware that there will always be competing interests—that often require negotiation—between social groups who stand to lose or gain from a proposed adaptation or mitigation intervention. This is why climate change interventions always have a greater probability of success if the intended stakeholders understand **why** changed practices are needed; **how** they can be involved in planning, implementing and monitoring activities; and **who** shares the responsibility for success and further action.

The first challenge for CRS is to establish what can be done about the effects of climate change in a given target region or project area. To view CRS' project design and implementation through a climate change lens, staff need to:

1. Assess exposure to climate change
2. Examine climate change impacts on livelihoods
3. Brainstorm alternative adaptation strategies
4. Work with communities to implement adaptation to climate risks

3.1 ASSESSING EXPOSURE TO CLIMATE CHANGE RISKS

Understanding the likely future climate patterns and weather risks in a country or region is the essential first step to developing an adaptation strategy with the poor communities there. Three approaches to assess exposure can be useful:

- Local knowledge of current weather risks
- Weather trend data
- Climate model forecasts

Each of these approaches has strengths and weaknesses, discussed below. In all cases CRS is more likely to achieve success by working with partners with relevant expertise, either climate scientists or local communities.

Using weather trends to forecast climate change

Data on temperature and rainfall are often available from weather stations for periods up to a century or longer. This data can show changes that occur over time and constitute trends—for example, rising temperatures or increased rainfall variability—and can be used to project potential future climate change and trends that are particularly relevant to locations where there are weather stations or in places that have similar climates.

There are important limitations to the use of weather trend data to forecast future climate. Apparent trends can change; what has happened in the recent past may not always continue in the future. Trends are generally more reliably identified from longer series of observations, and consistent observations from multiple sites, but these are not always available.

Although there are disadvantages, using weather trends to project future changes remains a useful approach. Projections of climate change based on trend analysis are fairly widely available and several websites that contain such analysis in an understandable way are cited in the references at the end of this section.

Using models to forecast climate change

Developing mathematical models of future climate change has clear advantages in systematically using scientific methods that are based on causal relations, not merely empirical observations like trends analysis. A modeling approach can involve a series of interrelated or nested models. For example, a global climate model can generate a broad future climate scenario. From a global climate scenario, a more location-specific regional climate model can be developed. The results can in turn drive even more detailed models, for example, of crop growth, soil erosion, or the risk of flooding. Such a cascade of linked models—from global climate to maize yield in a particular village—can be tailored to address a specific time frame and exploit scientific knowledge to gain valuable insights.

MODELING CLIMATE CHANGE IN CENTRAL AMERICAN MAIZE AND BEAN SYSTEMS

Vulnerability of maize and bean production to climate change in Central America was assessed in a CRS partnership with the International Center for Tropical Agriculture (CIAT) and the International Maize and Wheat Improvement Center (CIMMYT). A future climate scenario was derived from global climate models that forecast higher temperatures and increased drought for most of the region. Crop models were then used to examine likely productivity under the future climate conditions. The study found that maize yields would drop throughout the region except in the highlands of Guatemala where warmer conditions would favor maize. Generally, maize yields would decline by about 20 percent while the fall in bean yields is expected to be up to 25 percent of total production volume by 2059, with 15 and 8 percent yield reductions in Honduras and El Salvador within 16 years. The reduced maize and bean yields are expected to result in losses worth at least $122 million a year in Central America.

Source: Schmidt 2012

7

A modeling approach has several advantages over a more simple trends analysis. It can provide a richer set of forecasts that cover a wider range of variables not just to weather, but to highly significant outcomes like crop yields or land use. Modeling can be better tailored to specific situations, issues or locations thus making it possible to envisage the local consequences of a future global climate scenario. Models can also incorporate uncertainties and provide probabilities of a range of outcomes through multiple simulations.

Despite a rigorous base in theory and empirical data, climate models deal with such complex phenomena that they provide only important insights, rather than certainty. Climate models are also extremely demanding in terms of expertise, data and time. Undertaking a modeling effort is usually only justified when dealing with highly strategic issues over a fairly wide geographical reach. Even then, it is generally only feasible when working with partners who have relevant experience.

Many results of climate modeling are widely available at the country or regional level in fairly simple non-technical formats (**See resources at the end of this section**). This information can help construct future scenarios about important variables such as temperature, rainfall, or frequency of extreme climate events. The results are often an adequate basis for considering the types of situations to which the rural poor—with whom CRS and its partners work—will have to adapt.

Using local knowledge of current weather risks

Local knowledge of current weather risks is integral to all livelihoods of the poor who depend on natural resources, whether, for example, this involves use of land, forests, water, plants and animals, or coastal resources. The rural poor are already acutely aware of existing weather risks that affect their livelihoods. For example, small farmers know that fields on steep slopes are subject to slides under heavy rainfall; that valleys are subject to flooding; and that their crops are susceptible to drought or high temperatures. Key informant interviews, rapid rural appraisals, participatory exercises, and expert opinions can all contribute to identifying these risks.

And it is these risks that are most likely to be intensified by climate change, so the existing awareness of rural people about changes in local weather patterns may first alert CRS and its partners to the risks. Mapping risks can also motivate rural communities to take steps to adapt before there is any intervention from outsiders. Learning about recent adaptations in local practice can provide useful insights into how risk is perceived by the community. Often the first step in adapting to future climate change is to enhance adaptation and resilience in the face of the risks of the current climate. Not only are people likely to see the virtue of adaptation, but they may also already have coping strategies that can form the basis of adaptation. Principles and the process for working with local communities to tap their insights about weather risks and trends are presented in Sections 3.2.2 and 3.4.

Recent weather data on temperature, rainfall and severe storms can also be useful for quantifying and confirming the nature and frequency of known risks. Thus, local knowledge of existing weather risks may be combined with trends analysis of changing weather patterns and climate modeling to get a many-sided perspective of the likely paths of climate change and the impact it is likely to have on the livelihoods of the rural poor.

Summary: Assessing exposure to climate change risks

Simple analysis of climate trends data coupled with probing local knowledge is often sufficient for understanding climate change risk at the project level. In many cases, this can be complemented with online sources that present, in a non-technical format, expected risks based on modeling and statistical analysis of trends. Major strategic issues that affect a wide area (e.g. the future of maize in East Africa), will require an in-depth study that combines climate, crop and economic models. Such analysis needs to be conducted with specialized research partners.

Resources: Assessing exposure to climate change risks

Adaptation Learning Mechanism
http://www.adaptationlearning.net/
Brief qualitative climate scenarios for many countries.

Baca, M., P. Laderach, J. Hagger, O. Ovalle, S. Ocon and L. Gomez. 2012. *Vulnerabilidad u estrategia de adaptacion al cambio climatico en los medios de vida de las familias de Nicaragua, El Salvador, Guatemala Y Mexico*. Centro Internacional de Agricultura Tropical: Cali, Colombia. http://dapa.ciat.cgiar.org/identification-of-the-vulnerability-of-coffee-farmers-livelihoods-and-development-of-adaptation-strategies-to-climate-change-in-mesoamerican/ *A framework for assessing vulnerability, although the specific methods used are sometimes too demanding to be practical at the project level. In Spanish.*

CIAT. 2011. Climate Analogues.
http://gismap.ciat.cgiar.org/analogues/
Web-based tool that finds places in the world with climate today that corresponds to a future climate scenario.

Climate Information Portal.
Stockholm Environmental Institute & the University of Cape Town. http://cip.csag.uct.ac.za/webclient/map *Historic and projected climate data for Africa in an easy-to-use format.*

DFID. 2004. The impact of climate change on the vulnerability of the poor. http://www.mycleansky.com/data/3vulnerability.pdf
www.dfid.gov.uk/

The Hadley Centre for Climate Prediction & Research. 2003. *Generating High Resolution Climate Change Scenarios Using PRECIS. National Communications Support Unit Handbook*. With UNDP Global Environment Facility. New York, New York, USA. http://www.metoffice.gov.uk/precis/intro
Discussion of modeling approaches; somewhat complicated for daily use.

Heltberg, Rasmus, and Misha Bonch-Osmolovskiy. 2010. *Mapping Vulnerability to Climate Change*. The World Bank: Washington, DC, USA.

IPCC. 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds)]. Cambridge University Press: Cambridge, UK and New York, New York, USA. http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=0

National Adaptation Programmes of Action http://unfccc.int/cooperation_support/least_developed_countries_portal/submitted_napas/items/4585.php *Some 39 countries have plans posted on the UN Framework Convention on Climate Change. These typically include an overview of projected climate change in non-technical language.*

Schmidt, Axel, Anton Etzinger, Kai Sonder, Gustavo Sain. 2012. *Tortillas on the Roaster: Central American Maize Bean Systems and the Changing Climate.* CIAT, CIMMYT and CRS. http://dapa.ciat.cgiar.org/tortillas-on-the-roaster-new-study-to-support-maizebean-farmers-in-central-america-to-adapt-to-climate-change/ *Case study on assessing exposure to climate change risk.*

United Nations Development Program (UNDP). Climate Change Country Profiles. http://www.geog.ox.ac.uk/research/climate/projects/undp-cp/ *Discussions of climate trends for 61 countries.*

The World Bank. Climate Risk and Adaptation Profiles. http://sdwebx.worldbank.org/climateportalb/home.cfm?page=country_profile *User-friendly climate projections for 49 countries.*

PHOTO: SILVERLIGHT

INCOME SAUCE
Women make hot sauce from ingredients largely cultivated in their fields in Toquian Chico Community, Guatemala. The diocesan Caritas office in San Marcos and CRS brought technical assistance to these women to create this micro-business, enabling them to diversify their income sources. The product is sold in a restaurant in San Marcos bringing money and empowerment to them.

3.2 ASSESSING LIVELIHOOD VULNERABILITY TO CLIMATE CHANGE

It is crucial to understand—in a given target or project area—how livelihoods are exposed to climate change, how sensitive livelihoods are to the likely climate change impacts, and what the current adaptive capacity is. The CRS Integral Human Development (IHD) framework (**See Box 2, page 15**) can be used to assess the vulnerability of livelihoods of the rural poor to climate change.

Climate change impacts in the IHD framework

In the CRS IHD framework, exposures to climate change should be considered in shocks, cycles and trends and how these events may degrade assets and undermine livelihoods. For example, climate change can increase the frequency of intensity of natural disasters such as extreme storms or floods that destroy **physical capital** such as buildings, roads or irrigation infrastructure; degrade **natural assets**, for example, through increased soil erosion, more frequent forest fires, or the drying up of water sources; and cause losses of **financial assets**, for example, crop failure due to higher temperatures. Thus the IHD framework includes the relationship between expected exposure to climate change, the sensitivity to climate change that determines how seriously exposure will affect assets of the poor, and the livelihoods that depend on these assets.

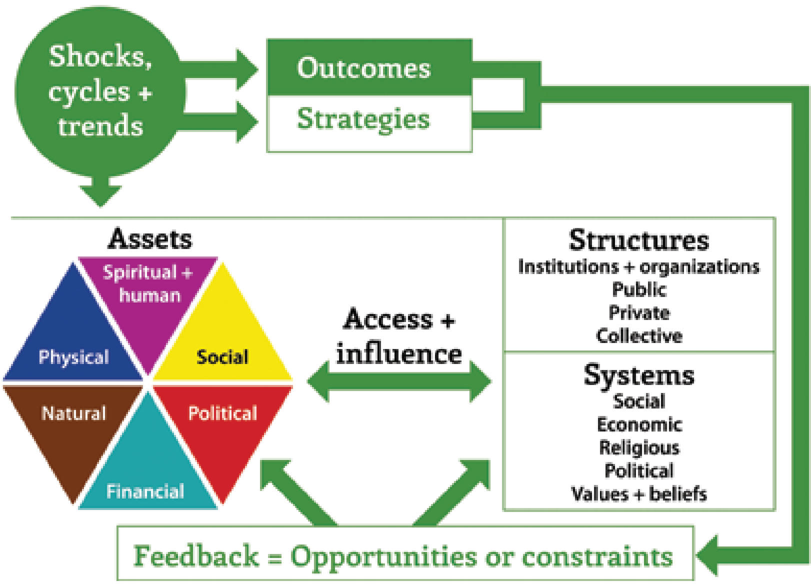
Climate change vulnerabilities have to be assessed in the context of other vulnerabilities identified in the IHD framework. Changes in population, natural resources, and markets can be even more important than climate changes, and all drivers of vulnerability and their interactions need to be considered along with climate change. For example, an increasing population can lead to settlement on flood plains that are more vulnerable as climate change raises flood risk.

Climate change vulnerabilities have to be assessed in the context of other vulnerabilities identified in the IHD framework

Climate change impact is not always negative. For example, increased rainfall in a particular place could lead to a longer growing season, less drought stress, and increased surface water available for irrigation. But it could also lead to more soil erosion, more intense attacks of fungal plant pathogens, and floods. Climate risk assessment has to be comprehensive, considering all the possible consequences—both positive and negative—of climate change.

Overall, the impact of climate change can be analyzed in two ways: an analytical or modeling approach (3.2.1) and from the perspective of people who are affected by it (3.2.2). The latter approach starts at the local or community level and works in a participatory fashion to understand current vulnerabilities and risks and how they are affected by weather, and it examines the strategies and capacities that farmers use or could use to adapt to current weather variability or future climate change.

Figure 6: The CRS Integral Human Development conceptual framework



Often the feasibility of climate change adaptation will depend in part on the capacity to overcome other vulnerabilities and risks affecting a community or region. For example, increases in heavy rains caused by climate change could worsen soil erosion, but the absence of secure land tenure could constrain investment in soil conservation practices. Thus, the direct problem caused by climate change (increased soil erosion) cannot be addressed until the other problem (insecure tenancy rights) is resolved.

In some cases, enhancing overall livelihood resilience will be the most effective adaptation to climate change. For example, greater participation in markets through the growing of more cash crops could increase household income, thereby permitting the accumulation of savings that could be used to invest in adaptation, for example, installing physical barriers in fields against increased soil erosion risk. Similarly, greater engagement in off-farm income-generating activities could make households less vulnerable to weather risks to agriculture. Thus, sometimes adaptation can be improved more by indirect action than specific intervention against climate change.

In some cases, enhancing overall livelihood resilience will be the most effective adaptation to climate change

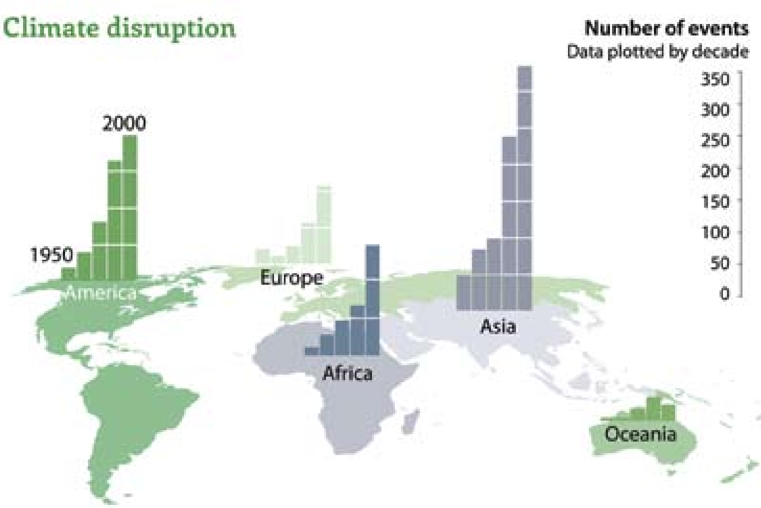
Livelihood strategies of the poor will often have to change to increase their adaptive capacity to plan for trends and shocks caused by climate change. Often these modifications are knowledge intensive and require clear strategies to improve human capital. CRS can play an important role in enabling the poor to do this by investing in assets and promoting structural and systemic change, for example by focusing on strengthening national agricultural extension systems for small-scale farmers. Depending on the circumstances, CRS may work with local communities in a variety of ways as suggested by the IHD framework to reduce risks and vulnerability to:

- Empower people to better advocate for their interests in the face of climate change
- Increase resilience through diversification of assets and livelihoods strategy
- Cope with disasters
- Recover assets post-disaster with increased resilience to future disaster events

Climate change impacts on natural disasters

Climate change can intensify the risks of hydro-meteorological disasters. The frequency of floods has been rising globally (**See Figure 7**) and increased precipitation coupled with greater frequency of exceptionally heavy rainfall will lead to more frequent and more severe floods. Floods may impact rivers that border fertile land where population density and agricultural production is often higher. Flood damage can be particularly problematic in river deltas where run-off from rainfall meets rising sea levels also caused by climate change.

Figure 7. Increasing frequency of floods, 1950-2000



Source: Reid et al. 2005. *Millennium Ecosystem Assessment Synthesis Report. Pre-publication Final Draft Approved by MA Board on March 23, 2005. A Report of the Millennium Ecosystem Assessment.* Millennium Ecosystem Assessment.

Climate change impacts on agriculture

Temperature increase, the clearest result of climate change, has direct and multiple effects on crop performance. Daytime high temperatures can affect plant maturation, reduce grain fill, retard physical development of crops and sterilize pollen, thereby preventing grain formation. Nighttime high temperatures increase plant respiration and reduce productivity. Overall, warmer temperatures increase the rate of evapotranspiration so that plants require more water to thrive. Higher temperatures also affect seasonality, with longer summers and shorter cool seasons. Changes in seasonality can hinder the work of pollinating insects essential to crop yield and lengthen the reproductive period of insect pests, thereby building up pest populations and increasing damage.

Daytime high temperatures can affect plant maturation, reduce grain fill, retard physical development of crops and sterilize pollen, thereby preventing grain formation

Figure 8. The migration of coffee

Photo: Michael Sheridan

The effects of rainfall patterns are complex and location-specific. In some places, rainfall will increase, favoring agriculture where water has been a limiting factor, but it can also bring problems. Wetter conditions can exacerbate fungal disease problems, cause waterlogging of crops, and increase nutrient leaching from the soil. In places where rainfall decreases with climate change, increased drought can lower crop productivity and deplete irrigation resources.

Global warming is expected to increase the frequency and severity of extreme precipitation events, regardless of whether total rainfall rises or falls. More intense rainfall events can cause flooding, increase soil erosion, damage irrigation or water control structures, and lead to storm surges that cause saltwater damage or contamination of fresh water sources in coastal areas.

Climate change impacts on human health

Climate change can harm human health. Among the most direct effects is increased cardiovascular mortality during heat waves. Climate change can also have a direct affect on vector-transmitted diseases, such as malaria and dengue fever from mosquitoes, or encephalitis and Lyme disease from ticks.

At higher temperatures, the development time of pathogens is accelerated, increasing the transmission potential to humans. Climate change can also affect the abundance of vectors and therefore the risks of disease spread. Each disease vector flourishes in particular climate regimes, and climate change can impact these conditions in ways that may lessen or increase vector populations. Climate change will affect the prevalence of allergens either negatively or positively depending on the situation. Earlier onset and increases in the seasonal production of allergenic pollen have occurred in mid- and high latitudes in the Northern Hemisphere (Parry et al 2007).

Climate change can also have a direct affect on vector-transmitted diseases, such as malaria and dengue fever from mosquitoes, or encephalitis and Lyme disease from ticks

Water scarcity can lead to poorer water quality and higher rates of water-borne disease while high rainfall and flooding can contaminate drinking water supplies leading to diarrheal disease. More indirectly, climate change can affect agriculture and therefore food security and nutrition levels. Malnutrition then results in higher vulnerability to disease.

Assessing climate change risks to health can be complex. At its most basic, the process can begin with the examination of the current distribution and burden of climate-sensitive disease. A scenario of future climate change can be used to project what the impacts on climate-sensitive disease might be. Projections of the likely influence of other drivers of health—population, income, or changes in food supply—should also be made to permit an estimate of the net impact on health attributable to climate change. Based on this information, potential adaptations to reduce the expected future disease burden of climate change could be identified. In some cases, the effect of climate change may be less than the impact of other factors on disease, for example, population or land-use change.

3.2.1 Analytical methods for assessing climate change impacts

There are a variety of analytical approaches to assessing the impact of climate change. Geographic information systems (GIS), crop models and economic models can all contribute to a deeper understanding of livelihood vulnerabilities. Based on an assessment of likely future climate change (**See Section 3.1**), the impact on livelihoods can be appraised based on the projected impact on crop yield, soil erosion or farm income.

GEOGRAPHIC INFORMATION SYSTEMS Agro-climatic data and GIS can be used to envisage which areas are likely to be suitable or unsuitable for particular crops in the future. The CRS-CIAT studies of coffee in Central America are good examples of such an approach. With relatively straightforward climate parameters from climate scenarios as well as basic parameters determining crop performance, crop suitability maps can be developed. Such an analysis can be effective in communicating with policy makers or local communities the future impacts of climate change. This data is especially useful for comparing the prospects of different crops across regions. This approach has the advantage of relatively modest data requirements, and a number of tools are widely available to facilitate such analysis and can be found in the resource lists of this guide. Nonetheless, CRS can most effectively take advantage of such approaches by partnering with specialists in this technical area.

CROP MODELS A process-based crop model is a more demanding and sophisticated approach that can yield rich results that take the uncertainty out of planning interventions for adaptation and mitigation. Such models can calculate the growth and yield responses of different crops to a combination of factors, including precipitation, temperature, crop management practices and soil quality. While standard crop models are widely available, using these effectively requires significant expertise and detailed weather, soil and crop-management data. Development-oriented agencies such as CRS needs to partner with or consult agricultural scientists, either in-house or external, to take advantage of these approaches.

ECONOMIC MODELS can be linked with crop-process models to provide additional insights into socio-economic outcomes such as land use, crop prices, and household income. Economic models can complement crop-process models, for example, by considering the affordability of a changed fertilizer practice or the seasonal availability of labor if a crop's planting time is changed. Moreover, economic models can incorporate resource use and financial decision-making considerations into scenarios based on climate change, as well as calculate socio-economic outcomes as diverse as crop profitability, labor use, farm income or even food consumption and nutrition. However, these models require substantial socio-economic data in addition to climate and crop information. Like the crop-process models, they are typically suitable for use by experienced specialists rather than general development practitioners.

Economic models require substantial socio-economic data in addition to climate and crop information

ANALYTICAL APPROACHES IN PERSPECTIVE

While there is an extensive array of modeling techniques available to analyze climate risks, they must be used judiciously. The crop-process and economic models discussed above generally require high levels of expertise; often need expensive data collection; and usually involve a considerable investment in time. In general, CRS will seek partners to undertake such analyses, rather than develop and run the models itself.

It is neither feasible nor necessary to do extensive modeling of climate change impact at the level of each individual development project. Instead, modeling approaches may generally be more appropriate at strategic and regional levels. There are common issues that are important across a region, for example, the influence of increasing temperature on coffee production across the countries of Central America, or the effects of reduced rainfall on maize in East Africa. A thorough analytical assessment of such regionally significant issues can provide sufficient guidance to individual countries or projects within the region without the need for an exhaustive analysis at the project level.

3.2.2 Community-level methods to assess climate change impacts

Community-level assessment of climate risks is the first step of four to develop a community-level assessment and action plan. The purpose of the community-level climate assessment is to strengthen local understanding of climate change and capacity for effective response. Local understanding and ownership of solutions are indispensable for the success of responses to climate change.

Community-level risk assessments tap into local knowledge about climate change, information that is seldom recorded systematically, but that can provide important insights. Local knowledge provides a snapshot of how people perceive risks and how acceptable different interventions are to them.

Community-level assessment has the following objectives:

- **To assess** how communities see climate change. What events and trends do people who depend on the local landscape and its natural resources and processes perceive? How have trends changed over the past years?
- **To understand** how local people interpret the risks and impacts on their livelihoods, food security, health and safety, and wellbeing

- **To identify** how local people have responded to perceived changes
- **To share** scientific climate change information and facilitate its integration with local knowledge and learning about climate change
- **To make** a local self-assessment of the risks of climate change
- **To support** the community to develop an action plan for climate change response

Preparing for the community-level climate risk assessment or vulnerability and capacity assessment

Facilitating a community climate risk assessment requires familiarity with scientific information—including the use of modeling and other methods reviewed in Section 3.2.1—about the area's climate change trends and processes (if available). It is also important to understand the culture and history of the communities where the self-assessment will be carried out by talking to local informants who know the community and its history well. There are several guides referred to at the end of this section that can be consulted for more complete information.

Local knowledge about, and interpretations of, climate change related risk should be obtained. There are many techniques for eliciting and sharing local knowledge, including the use of oral history, developing timelines and seasonal calendars, participatory photography, video, storytelling, and the building of papier-mâché landscape models. Sources for finding these tools are provided at the end of this section. Understanding local knowledge and facilitating its sharing among different groups in a community not only helps program staff to work more effectively in the local context and provide a baseline in terms of changes and trends perceived by local people, it also helps the members of the community build a shared picture of climate change that may be new to them, as different social groups and individuals do not automatically share knowledge. Knowledge-sharing among different groups and stakeholders helps to prepare the ground for collective action and negotiation for the local climate change action plan.

There are many techniques for eliciting and sharing local knowledge, including the use of oral history, developing timelines and seasonal calendars, participatory photography, video, storytelling, and the building of papier-mâché landscape models

Preparation for community climate assessments includes sharing scientific climate change related information with local people. This should be as locally relevant as possible and tailored to suit different groups in the community. This part of the assessment should not be done until the facilitators have a good grasp of local knowledge elicited as described above. The external information needs to be carefully targeted to enable local people to reach their own conclusions about climate change. The goal should be to build local capacity to locate, interpret and analyze the most locally relevant climate change information, not to overwhelm people with a mass of facts.

Understanding local knowledge provides a basis for deciding how to frame and communicate scientific information about climate change with communities. Care should be taken to present information to people in ways they will best understand, considering literacy levels and typical ways of sharing information, such as the need to separate groups by gender, through storytelling, drawings or graphics, etc.

Selecting participants for the community-level risk assessment

Always take into account social inequality within a community

An important principle when preparing and conducting community-level risk assessment is that risk is not distributed equally. The poor are often the most at risk but even among the poor there will be different degrees of risk—for example, for the young, the aged, women, or for those living in high-risk areas such as on fragile slopes or on flood plains.

This means that terms like "community" or "household" or "family" do not describe single, unified entities. Communities contain different groups with different and often conflicting interests that have to be teased out and understood in order to assess risk. Various analyses and systems to rank the vulnerability of community members should be employed in a community assessment to discern social differences that may have an important effect on perceptions of climate change risks and impacts.

Conduct a stakeholder analysis

It is important, as part of the preparation for a community-level risk assessment, to carry out a stakeholder analysis, preferably a participatory stakeholder analysis with key informants who represent different social positions and groups in the community. This can be done rapidly by convening different groups in a single meeting or by moving around the community to conduct interviews, which is more time consuming. Whatever method is used, it is essential to make sure the analysis is not flawed by only inviting to a meeting or interviewing those people who, for example, have time to spare or who are easily accessible by road or whose husbands give them permission.

The risk assessment is only as inclusive as the stakeholder analysis on which it is based, and that analysis is only reliable if biases like the ones above are eliminated. A stakeholder analysis and a wealth ranking of the community then provide a social "map" that describes groups with different interests in the way local assets such as land, forest and water are managed as well as in the way external services such as credit, agricultural extension, marketing, infrastructure, health and education are provided.

Participants in self-assessment of risk at the community level should be carefully selected from these different groups and be provided with the opportunity to identify, understand, prioritize and assess risks without being intimidated, overwhelmed or silenced by others who may not agree with them. To ensure this, the assessment may be done with focus groups that represent the different kinds of stakeholders—for example, women, nomadic graziers, people dependent on non-timber forest products in collectively managed forests, agricultural laborers, commercial farmers, landlords, tenants and so on.

Once the risk assessment data is disaggregated for different focus groups, the results can be compared. Then, if everyone is in agreement, the group assessments can be pooled. If they don't agree, this is a signal that different strategies are needed for managing climate change response with different groups of beneficiaries or actors.

Carrying out the self-assessment of risk

This should be carried out with different groups of people in the community or project area organized according to the important types of social differentiation identified previously as described above. Groups should be composed of roughly similar people because mixing different perspectives and interests together in a single group may result in conflicting ideas. The first component of the assessment is to facilitate a participatory identification and prioritization of threats related to climate change using six questions for evaluating threats (**See Box 8**). The second component uses this information to make a risk evaluation matrix (**See Box 9**).

PARTICIPATORY ASSESSMENT OF SENSITIVITY TO CLIMATE CHANGE IMPACTS: PRIORITIZING IMPACTS

Make a list of all the important climate change impacts or future threats the group of participants can identify, for example, early season drought, flooding of low-lying fields and houses, malaria. Then evaluate each impact using the six assessment questions below. These questions should be answered using scientific information as well as local knowledge. Each question involves assessing risk along a continuum according to the best of this combined knowledge and information.

Six assessment questions

1. **Will this climate change impact occur frequently or infrequently?**
2. **Is the number of households in the community likely to be affected large or small?**
3. **From when it first appears, does this impact develop very quickly (no time to prepare) or quite slowly (enough time to prepare)?**
4. **Does this impact and its after effects last a long time (define this locally) or a short time?**
5. **Is the damage it causes very costly or not very costly?**
6. **Is it very likely to happen or not very likely to happen?**

8

A common technique for performing this assessment is to ask the group to choose a symbol for each climate change threat, for example, a pot of sand for drought and a pot of water for flooding. After analyzing the six assessment questions, individuals can award stones, coins or seeds to weight the importance of each climate change or threatened change. Thus the group can rank each impact in order of importance (for example, the symbol that gets the most stones) and then focus the risk assessment (**See Box 9**) on the top two or three climate change impacts identified, to assess what exposure to climate change implies for them.

For example, if the group has prioritized flooding as the most important likely impact, the risk assessment matrix provides a tool for analyzing the implications in terms of criteria it decides are important—in the example below, how long the effects will last and how many people will be affected. If the conclusion is that many people will be affected for a long time, the analysis has detected a high degree of sensitivity or susceptibility to flooding. But if only a few people will be affected for a short time, the level of sensitivity to flooding is relatively lower.

RISK-ASSESSMENT MATRIX

Start with the climate change impact that the group has identified as most important, for example flooding. Then select two of the six assessment questions listed in **Box 8** they consider most important for evaluating the impact—for example, for flooding this might be the two questions shown below. The two questions should be used to make a matrix as illustrated below. The group can set two levels for each question (or criterion): for example "high" and "low". This gives a matrix with four boxes. Then the group discusses the significance of each box for the climate change impact being assessed. In the example below, the group would assess flooding with respect to how many families will be affected and how long the effects will last. The group can experiment with using different combinations of the questions to assess flooding. The point is to tease out what aspects of flooding are most threatening. The facilitator should then assist the group to make a summary and use the risks identified to make a community action plan for flood risks.

EXAMPLE: The risk-assessment matrix for flooding

Question	**Will the effect of flooding last a long time or a short time?**	
Is the number of families likely to be affected by flooding large or small?	Long time	Short time
Many families affected	Many affected for a long time	Many affected for a short time
Few families affected	Few affected for a long time	Few affected for a short time

9

One of the most important benefits of using the risk assessment matrix frequently with different groups of stakeholders and then having the groups share their conclusions is that it is an important first step in building their capacity to adapt to climate change. Once a group or a community learns that making this analysis should be a frequent activity, and that they don't need to depend on an outside agency or facilitator to do this exercise, they have taken an important first step on the path toward more self-reliant capacity to adapt to climate change impacts.

Resources: Assessing livelihood vulnerability to climate change

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FAO. 2012. Participatory Rural/Relaxed Appraisal Tool Box (PRA). http://www.fao.org/docrep/003/x5996e/x5996e06.htm *Comprehensive tool box including tips for facilitators and examples of specific ways to engage the community, plus reference materials.*

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UNDP [Seemin Qayum, Stephen Gold and Yannick Glemarec]. 2012. Prepare stakeholder analysis matrix. In *Multi-Stakeholder Decision-Making: A Guidebook for Establishing a Multi-Stakeholder Decision-Making Process to Support Green, Low-Emission and Climate-Resilient Development Strategies*. New York, New York, USA. http://www.undp.org/content/undp/en/home/librarypage/environment-energy/low_emission_climateresilientdevelopment/MultiStakeholder/

UNFCCC. 2010. *Fact sheet: The need for adaptation*. Bonn, Germany. http://unfccc.int/press/fact_sheets/items/4985.php *Seven-page description of climate change adaptation in sustainable development, funding mechanisms and current UNFCCC climate change adaptation efforts.*

3.3 ADAPTATIONS TO CLIMATE CHANGE

Knowing what kind of climate change to expect and how it can affect livelihoods is essential to identifying successful adaptations. Thus identifying potential adaptations should be preceded by reviewing the expected climate change in the target region (**See Section 3.1**) and assessing the vulnerabilities of the livelihoods of the poor to climate change (**See Section 3.2**).

Adaptations need to be tailored to particular circumstances. The nature of climate change, how it affects livelihoods and what assets people have to adapt are all highly variable and location-specific. A wide variety of alternative adaptations should be considered and these need to be discussed with local communities so that they can decide which will work best in their circumstances.

Adaptations need to be tailored to particular circumstances

Farmers and communities are important decision makers in adaptation and consistently face weather variability for which they may have developed a variety of adaptations (e.g. short-season varieties, multiple cropping, supplementary irrigation). These are *autonomous* adaptations, that is, they are natural or spontaneous responses to weather variability and are implemented only when there are clear direct benefits. Strategies that farmers are already using to deal with existing weather variability can provide important clues for what may be feasible in adapting to climate change.

In contrast, *planned* adaptations are those undertaken by public or civil society institutions to provide options or incentives for farmers and other private actors to enable them to better adapt to climate change. For example, the breeding of a heat-tolerant plant variety or the implementation of a new set of policies to regulate water rights, are planned adaptations designed to induce certain individual behaviors (e.g. choice of variety to plant, irrigation decisions). Conscious public sector decisions and investment in planned adaptations can encourage and support individuals to autonomously take action that adapts to climate change.

Farmers are well acquainted with confronting changing or highly variable conditions besides weather, for example, resource availability, technology, and market conditions. Farmers and rural communities have often adapted autonomously to such risks and uncertainties. However, in many tropical, developing counties it is quite likely that the rate and magnitude of climate change is exceeding and will exceed that of normal change in agriculture. In order to ensure that the poor and vulnerable are able to adapt to climate change, planned adaptations are almost certainly needed. The public sector and civil society have an important role in facilitating this adaptation. This can include a variety of measures such as capacity building, institutional innovation, technology development and investment. To be effective in this role, staff must be able to proactively understand the threats of climate change in particular circumstances and work with local communities to identify and implement appropriate adaptations.

3.3.1 Crop adaptations

Agriculture is the sector that is most vulnerable to climate change because of its heavy dependence on rainfall and temperature. Precipitation, temperature, soil moisture and erosion, pests and diseases will all be affected and, in turn, these will influence crop productivity, often adversely in the tropics.

Whether or not climate change offers new challenges or new opportunities to crop production, small farmers will still require significant adaptations. Some potential crop adaptations are noted here, while other agriculturally related adaptations in water, soil or pest management follow separately.

- Diversify crop systems to build in more resilience
- Introduce agro-forestry systems*
- Switch to crops that demand less water
- Adjust planting dates to fit new rainfall patterns
- Adopt new crop rotations
- Sow varieties suitable for new temperature, water, and pest regimes
- Grow short-season varieties to escape drought/heavy rains
- Improve grain storage to enhance food security/resilience
- Adjust fertilizer applications to new soil moisture regime
- Establish or enhance early warning systems for crop disease, pest infestation and drought

3.3.2 Water-management adaptations

In rain-fed farming systems, conserving excess water is an important adaptation as is the expansion of irrigation. Irrigation systems may have to be adapted due to decreased water availability, while the use of marginal water sources such as

* These are production systems that combine crops or livestock with trees or shrubs. For example, alley cropping alternates several rows of trees with a row of maize. If the trees are leguminous they add nitrogen to the soil when their leaves drop and fertilize the maize, which needs a lot of nitrogen. Another system is coffee grown under tall shade trees that produce lumber, feed for livestock, and fruit or nuts for a double source of income and products. The trees provide multiple environmental benefits and crop benefits, shade on hot days, habitat for predator insects that consume crop pests, and can serve as windbreaks.

brackish water or waste water will sometimes be a useful adaptation practice. Improved water management will often be an attractive investment even in the absence of climate change since it can increase crop yields and cropping intensity; reduce yield variability; and provide opportunities to diversify into higher-value crops. There are a number of water-management adaptations to climate that can be considered for use on farms or at the community level.

- Capture rain water run-off using terraces and trenches
- Divert rainwater into farm ponds and small reservoirs for future use
- Use affordable drip-irrigation systems
- Improve the soil's water-holding capacity through minimum tillage or by retaining crop residue to raise soil organic matter (such an increase in soil carbon also contributes to mitigation)
- Alter timing and amount of irrigation to improve water-use efficiency
- Install soil drainage where increased rainfall causes waterlogging
- Use ridging to help reduce effects of excess moisture
- Improve water infiltration through barriers on sloping lands
- Plant water-efficient crops and varieties
- Use salt-tolerant crops to take advantage of saline water resources
- Sustainably use ground water resources
- Conserve natural riverine ecosystems, especially wetlands

3.3.3 Soil-management adaptations

Soil management is an important part of adaptation to climate change in agriculture, affecting plant productivity not only through nutrient availability but also through its effect on water availability. For example, global warming is expected to reduce soil carbon, which in turn lowers both soil moisture-holding capacity as well as fertility. Where rainfall increases, there are risks of waterlogging. Greater rainfall intensity due to climate change increases losses to soil erosion. Consequently, there are a number of adaptations that can be important.

- Use live barriers (hedges, trees) or other physical barriers (stones, cement) to reduce soil erosion where rainfall intensity increases
- Use minimum tillage to reduce losses to erosion
- Use crop rotation and cover crops to protect soil and maintain moisture
- Incorporate crop residue into soil for increased organic matter and improved soil health
- Apply mulch or organic fertilizer to improve the soil's water-holding capacity
- Use contour cropping to conserve soil moisture and organic matter

- Terrace to conserve soil nutrients and moisture
- Change land use, for example, from crops to livestock or to agro-forestry
- Adjust fertilization practices to new crops and climate
- Improve soil resilience through green manure legumes and nitrogen-fixing trees
- Plow deeply to break up hard pans and improve water filtration
- Level land to increase water filtration

3.3.4 Crop pest- and disease-management adaptations

Pest and disease problems can both change and intensify with climate change. For example, where rainfall increases, pressures of fungal disease can rise. Similarly, drier conditions can lead to the invasion of new insect pests that may face fewer natural enemies. With warmer conditions, some insects will be able to pass through more life cycles in a season, thereby elevating their populations and the damage they cause. There is a high degree of uncertainty about which specific future disease and pest problems may become more acute. While crop modeling and experience may provide reasonably reliable projections of the effects of a climate change scenario on crops, insect and disease, behavior is less well understood and extremely complex. Insects, for example, are subject to natural enemies and disease. These, like migration and population growth, are not always well understood and difficult to model. Despite the relatively high degree of uncertainty about pest and disease pressures under climate change, they are likely to result in significant shifts in the pest and disease complex, for which a variety of adaptations may be useful.

With warmer conditions, some insects will be able to pass through more life cycles in a season, thereby elevating their populations and the damage they cause

- Develop pest surveillance systems for early detection of invasive pests
- Use integrated pest management to control newly emerging pest problems
- Sow pest-resistant crop varieties
- Employ multiple cropping/rotation to help reduce pest problems
- Tailor pesticide applications to new insect and disease pressures

3.3.5 Livestock system adaptations

Livestock systems can be strongly affected by climate change, and direct effects on livestock include diminished animal growth at higher temperatures, reduced water availability due to drought, and lower production of livestock feed. Climate-induced land-use change can increase pastures at the expense of cropland. In general, more intensive livestock systems are likely to have less difficulty in adapting, while traditional low-input livestock systems may have less capacity to adapt. There are a number of adaptations that are possible with livestock systems.

- Integrate crop/livestock systems to enhance resilience through diverse production and income streams and the synergies that come from manure for soil fertility and crop residue for animal feed
- Employ silvopastoral systems—which combine grazing and forestry—for shade, feed and carbon sequestration
- Promote small-animal rearing where water and fodder are scarce
- Use crop residue as animal feed rather than burning it
- Use new sources of livestock feed: fodder banks, drought-resistant trees and shrubs, seasonal grasses
- Alter grazing practices (animal density, timing, duration)
- Develop water points
- Change to more appropriate breeds or species
- Convert from extensive grazing to more intensive systems

3.3.6 Infrastructure adaptations

Large-scale infrastructure adaptations tend not to be the most attractive climate change interventions. Any uncertainty about the future impact of climate change or about the effectiveness of infrastructure as a response pushes such adaptations into the high-regret category. The massive investment and longer project time horizons involved in such interventions further increases the risk of relying on this type of adaptation. In general, CRS is unlikely to take a leading role in large-scale infrastructure adaptations to climate change. Nonetheless, there could be situations where national policy makers are considering such measures, so it is useful to note a few illustrative infrastructure adaptations. Flooding, for example, is likely to become a more severe problem as total global precipitation increases through greater rainfall intensity and more frequent extreme events. Flood risks are intensified by the increased sediment load that could clog watercourses due to elevated rates of soil erosion. Flood risks typically cannot be managed solely at the farm or community level, requiring action at a watershed scale and higher level government coordination. Some activities that might be promoted at higher levels include:

CRS is unlikely to take a leading role in large-scale infrastructure adaptations to climate change

- Large-scale irrigation systems
- Levees for flood control
- Flood bypass zones
- Improvement of roads to facilitate market integration to increase income and resilience
- National or regional strategies for grain storage to provide resilience in the face of crop failure

3.3.7 Institutional adaptations

Important adaptations to climate change can be made at an institutional level. Strengthening institutions and capacities can supplement adaptation that is done directly with crops, water, soil, livestock, pests or infrastructure. Without institutional adaptation, other adaptations are often not feasible. For example, without viable agricultural research institutions to breed new crop varieties with heat tolerance, drought resistance, or resistance to new pests and diseases, farmers will not be able use improved crops in their adaptation strategies. Some examples include:

- Strengthen seed systems to deliver new water-efficient varieties
- Enhance capacity to diffuse information on adaptation through strengthened extension systems
- Promote supportive policy and access to markets to diversify and increase income thereby improving livelihood resilience
- Implement water pricing and enhanced water allocation systems
- Build capacity and organizational structure for irrigation system management
- Introduce crop insurance schemes to reduce household vulnerability when crops fail
- Establish weather forecasting and advisory systems
- Promote off-farm income opportunities to reduce livelihood dependence on agriculture and therefore the weather
- Strengthen micro-credit to enhance financial resilience
- Encourage land tenure/titling to provide incentives for soil and water conservation

3.3.8 Human health adaptations

Although the focus of this guide is on natural resources, adaptations to climate change's impact on human health will be important in some communities, especially where climate change appears likely to aggravate an already heavy disease burden. Many adaptations to these burdens will involve actions that fall outside the health sector, for example, water supplies and sanitation.

A few examples of adaptations are:

- Vector control, for example, eliminating mosquito breeding sites
- Vector surveillance
- Improved public health infrastructure
- Preventative measures (e.g. treated bed nets, etc.)
- Communications and awareness about disease
- Development and diffusion of disease control measures (e.g. vaccines or medicines)

3.3.9 On-farm energy efficiency

Enhanced efficiency of on-farm energy use can be important both for adaptation in the face of rising energy costs and to mitigate climate change through reduced reliance on fossil fuels. Some interventions include:

- Bio-digesters to capture and burn methane for fuel
- Efficient cooking stoves to economize on firewood
- Energy efficiency in crop production
- Solar energy
- Alternatives to boiling for water purification
- Energy-efficient post-harvest technologies, for example, water-efficient wet milling for coffee processing, drying patios for grain.

Resources: Adaptations to climate change

IPCC. 2012. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*. [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds)]. Cambridge University Press: Cambridge, UK, and New York, New York, USA. *Detailed survey of issues related to disasters, adaptation and climate change.*

Oxfam. 2009. *Introduction to Climate Change Adaptation: A Learning Companion. Oxfam Disaster Risk Reduction and Climate Change Adaptation Resources*. Oxford, UK. http://policy-practice.oxfam.org.uk/publications/introduction-to-climate-change-adaptation-a-learning-companion-202465 *Introductory overview.*

UNDP. 2010. *Designing Climate Change Adaptation Initiatives: A UNDP Toolkit for Practitioners*. UNDP Bureau for Development Policy: New York, New York, USA. http://www.adaptationlearning.net/sites/default/files/Toolkit_for_Designing_Climate_Change_Adaptation_Initiatives___November_2010.pdf *Useful with excellent list of additional sources.*

United Nations Framework Convention on Climate Change. 2010. *Handbook on Vulnerability and Adaptation Assessment. Consultative Group of Experts on National Communications from Parties Not Included in Annex I to the Convention (CGE)*. http://unfccc.int/resource/cd_roms/na1/v_and_a/index.htm *Wide-ranging inventory of adaptation responses.*

The World Bank. 2012. *Mainstreaming Adaptation to Climate Change in Agriculture and Natural Resource Management Projects.* http://climatechange.worldbank.org/climatechange/content/mainstreaming-adaptation-climate-change-agriculture-and-natural-resources-management-project *Review of adaptation with a helpful glossary.*

3.4 MOBILIZING COMMUNITY ACTION AND PLANNING TO ADAPT TO CLIMATE CHANGE

Although there are a wide variety of potential adaptations to climate change, successful adaptation can only result from action by farmers and their communities in response to their particular situations. But this is not a completely autonomous process. Effective adaptation can be facilitated by proactive support from development agencies. This section sketches some of the approaches that can help CRS catalyze successful community-level adaptation. First, some principles for planning and action will be reviewed, followed by a presentation on the process to move from planning to action.

3.4.1 Principles for community-level climate change planning and action

This section provides an overview of the process of carrying out a community-based response to, and preparedness for, climate change. Responding to climate change is not just a question of coping with biophysical risks; it will always involve some kind of social process to strengthen stakeholders' capacity to respond.

However, there is no blueprint for conducting community-level planning and action. This process will almost always have to be adapted to local circumstances. It is important, therefore, to understand the principles on which the community-level process is based (**Box 10**). If in doubt about how to adapt the process, it is useful to refer to these principles and to make sure the process follows them as faithfully as possible.

SEVEN PRINCIPLES FOR PLANNING + IMPLEMENTING A COMMUNITY-LEVEL CLIMATE CHANGE RESPONSE

- Initiate responses to climate change at the local level with community participation
- Understand local knowledge and adaptive strategies
- Balance long-term and short-term costs and benefits in a response strategy
- Pay attention to social difference and then be inclusive
- Consider which social groups need empowerment in order to respond effectively to climate change
- Design scaling-up strategies early in the local process
- Build capacity to respond to future climate change as well as to implement a specific solution

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1. Initiate responses to climate change at the local level with community participation. Assessment—including risk assessment with groups and communities, planning, implementation and monitoring—should be decided at the local level with community participation. It is important to build on existing local groups and organizations and strengthen them and to avoid creating new, parallel structures. Participation makes it more likely that local people will buy into a climate change response and take responsibility for implementation including contributing to its costs.

2. Understand local knowledge and adaptive strategies. Communities, groups and households within them may have been adapting to progressive climate change for a long time. Even if the current rate or severity of climate change means that traditional ways of adapting are less effective, it is still important not to ignore or override local experience and knowledge. Response to climate change at the community level will be reinforced by building on local knowledge about the risks and local strategies for responding to these.

3. Balance long-term and short-term costs and benefits in a response strategy. Effective responses to climate change at the community-level can require some critical long-term investments, such as forest conservation, that do not have an obvious short-term pay-off to local people, and especially to the very poor and vulnerable. A community-based climate change planning and action process should always seek to balance these kinds of long-term investments with others that have a more immediate pay-off for local people. This can mean introducing a mix of solutions to balance mitigation with production, for example. Balance is needed to make sure there is adoption of innovation and that there are ways to meet some of the costs to make adaptive changes sustainable, whenever possible. Balance helps to reduce vulnerability without creating dependency or weakening the development of local capacities for self-help.

Balance helps to reduce vulnerability without creating dependency

4. Pay attention to social differences and then be inclusive. Climate change is not egalitarian, and risk is not the same for everyone. Age, ethnicity, gender, religion or disabilities may put some people more at risk than others within a community. That is why climate change responses should not be planned or implemented as if "the community" were a unit in which everyone was at the same starting point and everyone would benefit equally.

In general, the most vulnerable people lack a safety net of savings or assets they can fall back on in hard times and have little access to employment, insurance or credit. They often suffer from poor health or nutrition. Planning and action at the community level must always distinguish the risks facing different social groups such as women (**See Box 11**), children, the aged and the infirm and ensure proposed strategies include them or are specially tailored to meet their needs.

SOCIAL DIFFERENCE AND CLIMATE CHANGE: POTENTIAL EFFECTS ON WOMEN

Climate change risk	**Potential effect**	**Potential effect on women**
Increased ocean temperature	Increased deterioration of coral due to thermal stress	Loss of coral reefs can damage tourism and small-scale fisheries industries, sectors in which women comprise a large part of the workforce.
Direct increased land temperature	Increased drought and water shortage	Women and girls in developing countries are often the primary collectors, users and managers of water. Decreases in water availability will increase their workload.
	Decreased crop production	Rural women are responsible for half of the world's food production and produce between 60 to 80 percent of the food in most developing countries. In Africa, the percentage of women producers disadvantaged by climate-related crop changes could range from 48 percent in Burkina Faso to 73 percent in the DRC.

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Source: Adapted from IUCN and UNDP. 2009. *Training Manual on Gender and Climate Change*. In partnership with the Gender and Water Alliance, Energia International Network on Gender and Sustainable Energy, UNESCO, FAO, and WEDO as part of the Global Gender and Climate Alliance. In UNDP [Katharine Vincent, Lucy Wanjiru, Adeline Aubry, Andre Mershon, Charles Nyandiga, Tracy Cull, and Khamarunga Banda]. 2010. *Gender, Climate Change and Community-based Adaptation. A Guidebook for Designing and Implementing Gender-Sensitive Community-Based Adaptation Programmes and Projects*. New York, New York, USA.

5. Consider which social groups need empowerment in order to respond effectively to climate change. Capacity for effective response to climate change is often as much a question of empowerment of the most vulnerable as it is of providing them with material benefits. This is because preparedness for, and response to, climate change at the local level involves extensive negotiation between different interest groups, some of whom will always be more powerful than the most vulnerable. Sometimes there will be conflict between people with different perceptions about, and interests in, how climate risk should be managed. For the most vulnerable members of a community and for women, the process often needs to include awareness building and empowerment so they can really participate. In addition, it is a good idea to train community leaders in strategies for policy advocacy.

Sometimes there will be conflict between people with different perceptions about, and interests in, how climate risk should be managed

6. Design scaling-up strategies early in the local process. Whatever the climate change risks are for local communities, the sources of risk are almost always going to be the result of a combination of factors internal and external to the local community. This means some elements of effective response will be beyond the scope of local decision making. Because effective responses to climate change cannot be carried out exclusively at the local level, it is essential to design scaling-up strategies early in the local process. Scaling up here means working in parallel at other institutional levels. This involves linking community-level planning and action to extra-local decision-making processes. Scaling up can involve building networks, associations or federations of local organizations and must take advantage of opportunities to work with other support organizations on communication, planning and advocacy.

7. Build capacity to respond to future climate change as well as to implement a specific response. Building capacity to respond to climate change is a basic objective of community-level planning and action. Climate change is inherently unpredictable and even when the risks are quite well understood, communities need to be able to learn how to adapt rather than to just implement mechanically changes recommended by outsiders. This is why it is important to make sure that the planning and action process builds adaptive skills even when pressed to mitigate against a disaster or prepare for an emergency.

3.4.2 Process for community-level planning and action for climate change response

In this section, a four-step process for planning and implementing a climate change response at the community level is outlined. Even though termed "community-level", this process always requires working on at least two organizational levels: the community level and an external institutional level. This is emphasized in point 6 above. It is essential to engage stakeholders from outside the community early on in a local process—usually the local government administration closest to the community as well as public sector and civil society organizations with related mandates that may already be actors in the community. Stakeholders may also include external groups or other communities with an interest in forests, grazing areas, water sources, roads, telecommunications, or any type of intervention that affects their interests.

Although the following explanation of the four-step process is framed at the community level, it is essential to keep in mind that a similar four-step process should be undertaken with the extra-community stakeholders so they are informed and buy into the assessment, planning and implementation of community-level activities.

The objectives of the four-step process are to improve community capacity to:

- Plan local responses to, and preparedness for, climate change
- Understand and assess the risks associated with climate change
- Combine local knowledge with scientific knowledge to understand risks and to develop sustainable responses
- Respond to progressive climate change
- Recover after a climate change-induced shock or disaster
- Mitigate the effects of climate change on its most vulnerable members

Step 1: Participatory assessment

The most important objective of a participatory assessment is to raise the awareness of the local population of its need to plan responses to climate change by making an analysis of the current situation and the risks it presents.

The assessment involves combining the community-level self-assessment of climate change impacts described in Section 3.2 with a self-assessment of vulnerabilities and capabilities.

Community-level self-assessment of vulnerabilities and capabilities

The self-assessment of vulnerability and capability is a complement to the assessment of climate change impacts. In the example of the risk assessment matrix applied to flooding in Section 2, different groups in the community assessed how many families would be affected by flooding and for how long. The next step is to assess how vulnerable those families are and what capabilities they have to respond to flooding.

When vulnerability is discussed it can be very important to share the results of the stakeholder analysis with the participating groups. This social map should be familiar and indeed self-evident to the inhabitants of the community but privileged groups are still liable to discount or dismiss other less-privileged groups, so the complete stakeholder analysis serves as a useful reminder about making the self-assessment inclusive.

There are many ways to self-assess vulnerability but one framework that is comprehensive and simple, the CRS Integral Human Development framework, uses six assets as dimensions, as illustrated in **Box 12**. The six assets refer to types of resources or capital that the community has that can be aspects of vulnerability but also represent resources for adaptation to climate change.

These are:

- **Natural assets** including soil, water, forests on which the local population depends
- **Human assets** including the labor force, community knowledge and the state of its health and education
- **Social assets** including social cooperation
- **Physical assets** including infrastructure such as roads, transportation, sources of energy, communications and housing
- **Financial assets** including savings, income and credit
- **Political assets** include the community's relationships with local, regional or national government as well as civil society organizations that can influence policy on their behalf

The community-level self-assessment of vulnerability and capability should be prepared for, and conducted with, the same preparation and selection of participants as the risk assessment discussed earlier, and with reference to the same climate change impacts prioritized for the risk assessment.

COMMUNITY-LEVEL SELF-ASSESSMENT OF VULNERABILITY AND CAPABILITY USING THE SIX ASSETS FROM THE CRS IHD FRAMEWORK

Group: Families living close to the river		
Assets	**Vulnerability**	**Capacity**
Natural assets	The river is liable to flood.	Local wood and stone is available for containment and strengthening of house construction.
Human assets	Elderly people cannot evacuate quickly.	Local knowledge and skills for construction. Youth can assist the elderly.
Social assets	There is conflict between owners of river margins wanting to reforest and squatters building along the river's edge.	Existing youth clubs in river communities can be harnessed for assistance in time of flood.
Physical assets	Road and telephone communications are poor.	All homes have radios that could be used for early warning.
Financial assets	There are no local funds for mitigation.	The community is willing to co-pay in kind.
Political assets	Local leaders are inexperienced in dealing with external legislators.	An urban community downstream is willing to tax to subsidize clean-water interventions.

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Step 2: Drawing up a community-level climate change action plan
The objective of Step 2 is for the community to discuss and agree on a realistic plan of action. If the community is divided in its assessment of risks and there is conflict about how to act, this can require persistent work by facilitators to reconcile them and overcome the conflict. There is an extensive range of tools and techniques that can be used for this participatory planning, and links to these can be found in the resources section of this guide. This step involves the

community in taking collective decisions about the most locally appropriate solutions for responding to climate change. Commitment to action to be taken on-farm and in the community by individuals and their families, as well as by groups, depends on their levels of empowerment built during the assessment. The action plan is based on combining:

- Results of the self-assessment of risk which produces one (at most three) prioritized climate change impacts
- The evaluation of risks for each priority climate change impact using the risk-assessment matrix
- The vulnerability and capability assessment for each priority climate change impact
- Information about possible solutions and interventions that draws on local knowledge and external knowledge of the many options discussed in Sections 2.1 to 2.4

Key elements needed in a community-level action plan are illustrated in **Box 13**.

ELEMENTS OF A COMMUNITY-LEVEL ACTION PLAN

- Local organization coordinates activities and monitors progress of the plan
- Local training on how to keep up the assessment of climate change risk and how to use climate change information and Information and Communication Technology (ICT)
- Selected technical solutions proposed for adaptation
- If proposed technical solutions need further testing, a plan for local mechanisms to validate them should be put into place
- Plan for technical assistance and credit plans so proven solutions can be adopted
- Emergency action plans for disaster response
- Plans for mitigation, if desired
- Leadership training to strengthen collective action and local leaders
- Plan for early warning systems
- Land-use plan for farms and watersheds
- Advocacy plan to gain support of important policies and external stakeholders
- Financial plan
- Procedure and responsibilities assigned for monitoring and evaluation of the plan

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Step 3: Implementation of action plans

The objective of Step 3 is to mobilize the community to put its plan into action and to obtain the resources needed from the community and from external sources. Often a community action plan has to confront a considerable level of uncertainty about what solutions will work locally. Also, since the climate may be changing progressively, there may be growing, unanticipated variability in season-to-season rainfall and temperature conditions. So one of the crucial success factors for a community action plan is whether it builds local capacity to adapt and ultimately the resilience needed to recover after a climate change-induced shock.

Four elements of an action plan are important for building adaptive capacity and resilience:

- Training to keep on assessing risk locally and learning from climate change information,
- Testing and experimenting locally with potential solutions
- Monitoring and evaluating the progress of the action plan
- Blending local and external knowledge to find adaptive solutions (**See Box 14**)

EXAMPLES OF ADAPTATIONS COMBINING LOCAL AND SCIENTIFIC KNOWLEDGE

BAIRAS: In southern Bangladesh, floating gardens, or *bairas*, have been devised to withstand increasingly frequent flooding and water-logging. Using water hyacinth (*baira*), a local invasive weed that floats in water, floating mats have been developed on which soil, manure and rotting baira can be spread and a number of crops cultivated. These mats simply ride out water-logging and flooding. They are easy to build using local resources and knowledge, are recyclable and sustainable, and are ideally suited to the particular problem faced. Local knowledge is central to the success of *bairas*.

Source: Irfanullah 2005

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The elements in Steps 1, 2 and 3 are like the gasoline that keeps the motor of a community-level action plan running. A community action plan that downplays or neglects these three elements may be successful in implementing a set of solutions for climate change today but will fail to create local capacity to adapt to future uncertainty.

Step 4: Monitoring, evaluating and learning
The objective of this step is to keep track of the implementation of the plan and understand its results. This step involves:

- Tracking and following up on the actions in the plan
- Monitoring the climate change impacts and risks identified in the assessment to see if they have changed

A participatory monitoring and evaluation (M&E) process is highly desirable because this reinforces local adaptive capacity. It will help everyone responsible for implementing the local climate change action plan activities to obtain and use information needed to adjust the plan. And it will ensure a higher degree of self-conscious learning about what works. Resources for implementing M&E are in the resources section at the end of the guide.

A successful community-level action plan for responding to climate change should not end when external agencies take their leave. The participatory M&E system is one way to help local people see that they are ultimately responsible for keeping the plan in motion, especially if they learn how to draw on external resources, information, expertise and political capital to make sure they succeed.

Resources: Mobilizing community action and planning to adapt to climate change

Dummet, Cassie. 2009. *Community Based Disaster Preparedness: A How-To Guide*. Catholic Relief Services: Baltimore, Maryland, USA. http://www.crsprogramquality.org/publications/2009/11/20/community-based-disaster-preparedness-a-how-to-guide.html *Several approaches to community fieldwork.*

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Gell, Fiona. 2010. *Gender, Disaster Risk Reduction, and Climate Change Adaptation: A Learning Companion*. Oxfam: Oxford, UK. http://policy-practice.oxfam.org.uk/publications/gender-disaster-risk-reduction-and-climate-change-adaptation-a-learning-compani-218230 *Especially useful approaches to gender issues.*

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ACRONYMS

CBA	Community-based adaptation
CCAFS	[CGIAR Research Program on] Climate Change, Agriculture and Food Security
CDM	Clean Development Mechanism
CGIAR	Consultative Group on International Agricultural Research
CH4	Methane
CIAT	Centro Internacional de Agricultura Tropical International Center for Tropical Agriculture
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo International Maize and Wheat Improvement Center
CO_2	Carbon dioxide
CRS	Catholic Relief Services
FAO	Food and Agricultural Organization [of the United Nations]
GGCA	Global Gender and Climate Alliance
GHG	Greenhouse gas
GIS	Geographic information systems
ICIMOD	International Centre for Integrated Mountain Development
ICRI	International Coral Reef Initiative
ICT	Information and Communication Technology
IHD	Integral Human Development [framework]
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
M&E	Monitoring and evaluation
N_2O	Nitrous oxide
ppm	Parts per million
PRA	Participatory rural appraisal
REDD	Reducing Emissions from Deforestation and Forest Degradation
RRA	Rapid rural appraisal
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WEDO	Women's Environment and Development Organization

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