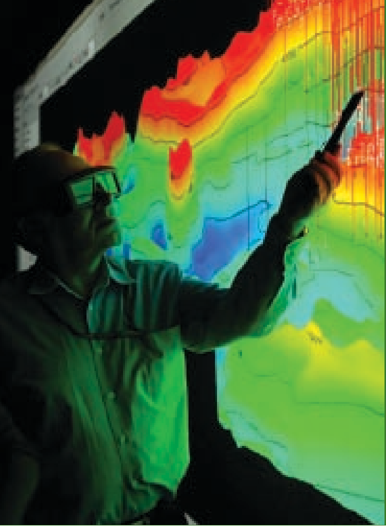

Mapping the Menace of Global Climate Change

The impacts of global climate change on agriculture will vary over time and across locations, depending on different agroecologies, farming systems, production conditions and even particular plant species. Likewise, strategies and measures for coping with those impacts will need to be adjusted to the variable circumstances of rural people in diverse landscapes.

There is plenty of scope for developing broadly applicable solutions to the problems rural people will face. Among them are stress-tolerant crop varieties; better practices for managing soil, water and other natural resources; new approaches to agricultural diversification; and innovative institutional arrangements and policies that foster positive change. But to make those measures as effective as possible, they must be targeted in advance and with a reasonable degree of precision to the places where they will be most needed and are most likely to work.

In recent years, CGIAR scientists have progressed significantly in determining what specific consequences rural people, especially the poor, can expect to face at specific locations as a result of climate change during the coming decades.

Such predictions are made possible by the information revolution that is reshaping the modern world. Among the innovations it has placed in the hands of scientists concerned with agriculture and other land uses is a set of tools referred to as geographic information systems, or GIS. These are computer-based programs that bring together and analyze information from diverse sources and present the results in map form. When linked with computer models simulating changes over time and space in crops, landscapes, weather and other complex systems, GIS offers a powerful means of predicting and visualizing likely futures for plants, people and places. The maps produced by GIS provide an early warning as to which of these are at greatest risk and where.

Pinpointing the Risks to Maize Production

Several years ago, researchers from two CGIAR-supported Centers — the International Center for Tropical Agriculture (CIAT) and International Livestock Research Institute (ILRI) — mapped the expected impact of climate change on maize production in all of Africa and Latin America, where the crop is a vital staple.

They did so through the use of crop and climate simulation models, in combination with a computer tool they developed to generate daily weather data for specific sites. Called MarkSim, the product served as a link between different scales of analysis — global for climate change and local for crop modeling — as well as a bridge between time frames (i.e., the baseline of 1990 and scenarios for 2025 and 2055).

The results indicate an overall 10 percent decline in maize productivity by 2055, equivalent to crops losses worth an estimated US$2 billion per year. More importantly, the predicted effects of climate change vary from one place to another, falling into one of three categories. First, in highland areas, which are not very extensive on a continental scale, higher temperatures will actually benefit maize. Second, much more extensive areas will experience minor reductions in yield. And third, under the worst-case scenario, many areas can expect to see devastating maize crop losses, which justify major efforts to change current agricultural systems and thus avert dire food shortages.

Expected Changes in Wheat Production Areas

Using a different approach, researchers at the International Maize and Wheat Improvement Center (CIMMYT) have examined the potential impact of climate change on wheat production.

For the purposes of crop technology development, CIMMYT classifies world production in terms of "mega-environments." These are broad, often noncontiguous or even transcontinental areas showing similar crop production conditions.

Focusing on South Asia's Indo-Gangetic Plain, which produces about 90 million tons of wheat grain each year (or nearly 15 percent of total production worldwide), CIMMYT researchers examined how climate change might affect the current classification of two wheat mega-environments. While both are irrigated, one is favorable for wheat production, while the other is not because of heat stress early and late in the wheat growing season.

Under climatic conditions expected to prevail in 2050, researchers project that the favorable wheat mega-environment will shrink by just over half, mainly because of increased heat stress. This will most likely lead to a major reduction in wheat harvests, threatening the food security of about 200 million people.

Charting the Demise of Crop Wild Relatives

In another study, scientists from Bioversity International, CIAT and the International Rice Research Institute (IRRI) used a simulation model to quantify the impact of climate change on the geographical distribution of wild species related to four major food crops: cowpea, peanut, potato and rice.

They estimate that 16 to 22 percent of the wild relatives of the first three crops will become extinct by 2055 and that the distribution of most of them will be reduced by more than half. The exact rate of extinction and habitat loss will depend on the pace at which wild species manage to migrate as rising temperatures contribute to making current habitats unsuitable. The impacts on peanut wild relatives will be especially severe, because they disperse as slowly as one meter per year. About half of the 51 peanut-related species studied will become extinct, and their distribution will decline by more than 90 percent.

Crop wild relatives are worth worrying about, because they contain genes for traits such as drought tolerance and pest resistance, which could prove useful for adapting crops to harsher conditions. To keep these options open, two steps are necessary. First, it is urgent that samples of endangered wild species be collected and preserved in genebanks. Though many samples are already in storage, they represent only a fraction of the total genetic variation still available. Second, the habitats of crop wild relatives must be protected so as to conserve not just the plants themselves, but the evolutionary process through which genetic diversity continues to be created in the wild.

Hotspots of Vulnerability in Africa

In addition to foreseeing the fate of plants on which people depend, CGIAR scientists are mapping the vulnerability of whole agricultural systems to the double menace of climate change and poverty.

A recent study carried out by ILRI in sub-Saharan Africa used several climate models to examine four different scenarios for the region toward 2050. The most vulnerable areas were found to be the West African Sahel; the rangelands, Great Lakes and coastal areas of Eastern Africa; and the drier zones of Southern Africa. Researchers next characterized the vulnerability of those and other areas in terms of various biophysical and social factors (such as soil degradation, market access, and HIV prevalence) and then integrated the results with those for climate change.

The combined results indicate which agricultural systems, by country, constitute "hotspots of vulnerability." Published in 2006, these results have already been used in several influential studies, including the UK government's *Stern Review on the Economics of Climate Change.*

In addition, the ILRI research has highlighted important points for future vulnerability assessments. It is clear, for example, that since macro-level studies mask enormous variability at the local level, the analysis must ultimately be done on a national basis, preferably with rural communities playing a central role. Only then can this research provide a detailed and reliable guide for local action in the development of adaptation strategies.