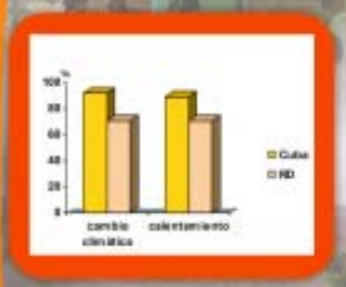
Development and Adaptation
Climate Change
Experiences and Challenges

# CLIMATE CHANGE-INDUCED DROUGHT ADAPTATION STRATEGY FOR THE CARIBBEAN REGION AND BEYOND




CRMI
INSMET
IPF
UNDP Cuba

This publication is a summary of the results achieved through the implementation of the following projects:

- **UNDP/CIDA Development and Adaptation to Climate Change** (in Cuba and the Dominican Republic) and
- **UNDP/GEF Capacity Building for Stage II Adaptation to Climate Change in Central America, Mexico and Cuba**

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The full report with the project results is available at: www.undp.org.cu

*The views expressed in this publication are those of the authors and do not necessarily represent those of UNDP or the United Nations system.*

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# Foreword

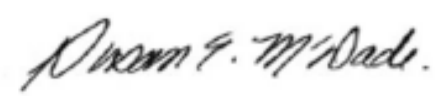
The relevance of climate change issues is coming to the forefront of the development debate, with the Fourth Intergovernmental Panel on Climate Change (IPCC) Assessment Report released in 2007 containing new scientific data which confirms the serious impacts on climate conditions worldwide due to human activities. These impacts are most critical for the developing world, particularly Small Island Developing States (SIDS) and Least-Developed Countries (LDC), where climate change means drought, famine and the loss of people's livelihoods, homes, land, or even their lives. The Assessment Report states that vulnerability to climate change can be exacerbated by the presence of other stresses like "poverty and unequal access to resources, food insecurity, trends in economic globalization, conflict, and incidence of disease such as HIV/AIDS."

In the face of this complex issue, among the various actions undertaken by the United Nations system, UNDP decided to devote its Human Development Report 2007 to climate change. Administrator Kemal Dervis stated that UNDP can support governments' response to this complex challenge by helping them weave climate-change adaptation integrally into their national development strategies. Global warming cannot be looked at as an environmental issue anymore: it is undoubtedly a threat to human development as a whole. All development strategies must therefore account for climate-related risk. A significant concern is that climate change could impede achievement of the Millennium Development Goals, and the targets set for 2015.

In this context, the United Nations Development Programme in Cuba is pleased to present this publication, which summarizes the main findings of the studies conducted in Cuba and the Dominican Republic in view of the severe drought processes initiated in 2003 and which constitutes an important contribution for decision-makers in Caribbean countries.

I would like to thank the Canadian International Development Agency (CIDA) and the Global Environment Facility (GEF) for support provided during the implementation of the projects **Development and Adaptation to Climate Change** (in Cuba and the Dominican Republic) and **Capacity Building for Stage II Adaptation to Climate Change in Central America, Cuba and Mexico**, respectively. I would also like to acknowledge the cooperation established with the UK Hadley Center for the development of Caribbean regional climate models. UNDP is grateful for the ongoing collaboration of the Cuban and Dominican Republic scientific communities and public institutions which have participated in this research effort.

The most significant achievement of this work is that it represents a successful experience in south-south collaboration among scientists, government officials and experts in Cuba and the Dominican Republic, as well as in other Caribbean and Central American countries. These efforts facilitated knowledge transfer and the validation of the Adaptation Policy Framework – a UNDP developed methodology – into practice. The singular value of this initiative and its results can also be found in its replicability, and in the usefulness of its recommendations for other developing countries. UNDP is glad to have supported and documented such a worthy undertaking.



Susan McDade
UNDP Resident Representative
Cuba

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# Introduction

Scientific consensus predicts near-term irregular precipitation patterns associated with human-induced global climate change. In some regions of the world, climate models forecast extended periods of drought followed by periods of more frequent and intense precipitation. Lack of water for agriculture threatens livelihoods while droughts degrades soil quality. Short periods of intense rainfall then cause erosion and desertification, leading threats to sustainable development worldwide. These patterns are currently being observed in the Caribbean region, causing adverse socioeconomic and environmental effects. An analysis of regional meteorological data shows that drought has become far more frequent in recent years than in the past, in both Cuba and the Dominican Republic (DR). In fact, the most recent drought in eastern Cuba, which lasted from May 2003 to April 2005, was the most severe on record to date. This drought caused devastating crop failures and widespread hardship throughout the region.

Two studies were conducted from 2003 to 2006 in the framework of the project **Development and Adaptation to Climate Change**, implemented by United Nations Development Programme (UNDP). This project was funded by the Canadian International Development Agency (CIDA) as well as Cuban and Dominican institutions. These studies examined Cuba and the Dominican Republic to identify the nature of drought events, assess their adverse effects and document how residents of drought-affected regions are adapting to their changing environment. In the case of Cuba, the studies were complemented by and have been continuously developed as part of the UNDP project **Capacity Building for Stage II Adaptation to Climate Change in Central America, Cuba and Mexico**. This project was financed by the Global Environment Facility (GEF) and executed by the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC). The two studies are entitled **Agricultural and Meteorological Drought: A Scientific Study** and **Framework Project for Present and Future Drought Adaptation Policies in the Dominican Republic and the Republic of Cuba.** In addition to identifying and documenting the existing situation, the studies offer improved tools to apply drought warning protocols. Moreover, through robust use of scenario planning methodology, they offer a host of policy recommendations. The methodologies used in the study are applicable to other regions experiencing similar circumstances.

*Landscape ravaged by drought in eastern Cuba.*

# Section I

## Study Summary I

## Agricultural and Meteorological Drought: A Scientific Study

### Overview

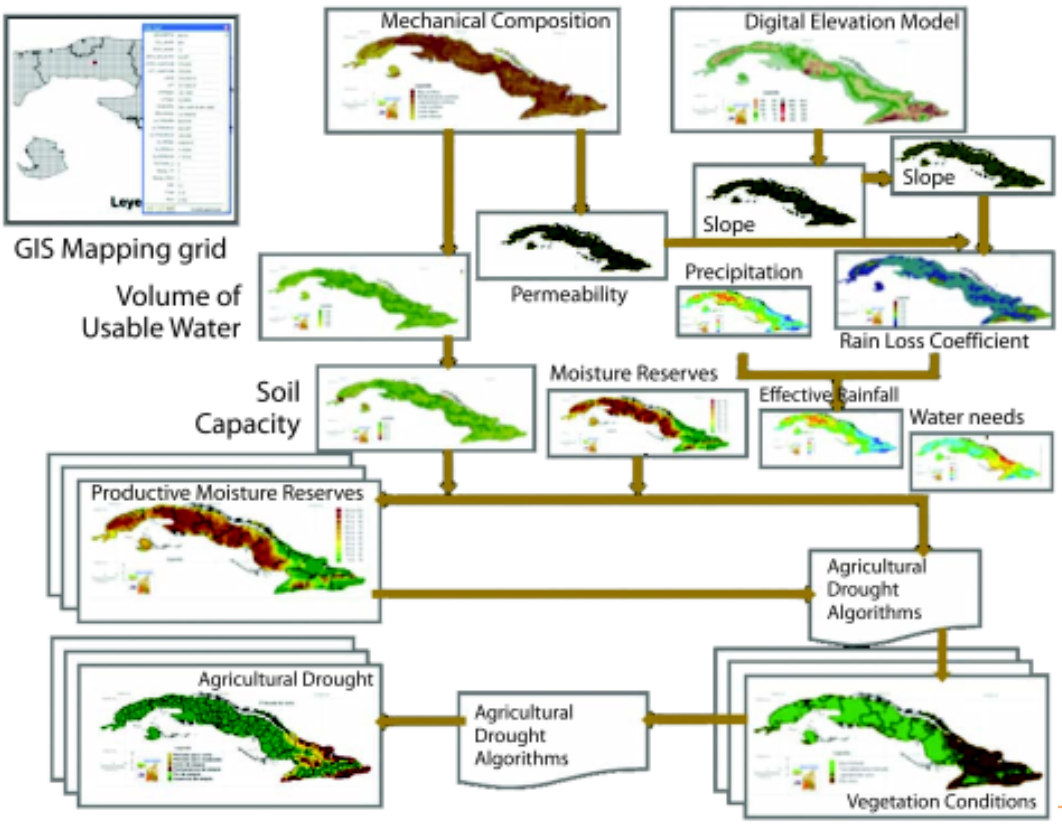
Various institutions such as Cuba's Meteorological Institute (INSMET) and the Dominican Republic's National Meteorological Office have been monitoring and recording meteorological data in these countries for many years. Until now, these data have not been compiled in an easily accessible and readily comprehensible fashion. This study created meteorological and agricultural drought maps of both Cuba and the Dominican Republic from which strategic planners can make essential decisions regarding drought preparedness and climate change adaptation. The analyses conducted in Cuba are also an important scientific contribution to the description of the atmospheric process leading to a significant shortage in precipitation.

### Study Design

Led by INSMET climate experts, researchers from both countries compiled meteorological and agricultural data from a range of sources such as national meteorological institutes and regional/global atmosphere databases. These data included precipitation, soil characteristics, topography, vegetation conditions and other variables related to drought processes, such as atmosphere circulation indicators and their effects in a given region.

A good knowledge of climate variations background is always required to understand the effect of climate on both the environment and society and to identify what scientific contribution could be developed as a response. Thus, the study was first oriented to determine the normal climatic patterns and their variability over the regions under study, describing the behavior of precipitation and drought variations from 1961 to the present. Afterward, and using atmospheric indicators, a description of the circulation process was then developed as a way to explain the possible relationships between rainfall and the atmospheric process. This last phase can potentially help to develop and improve a climate warning system that would be very useful for planning strategies.

**Fig. 1: Methodology used to generate agricultural drought maps**



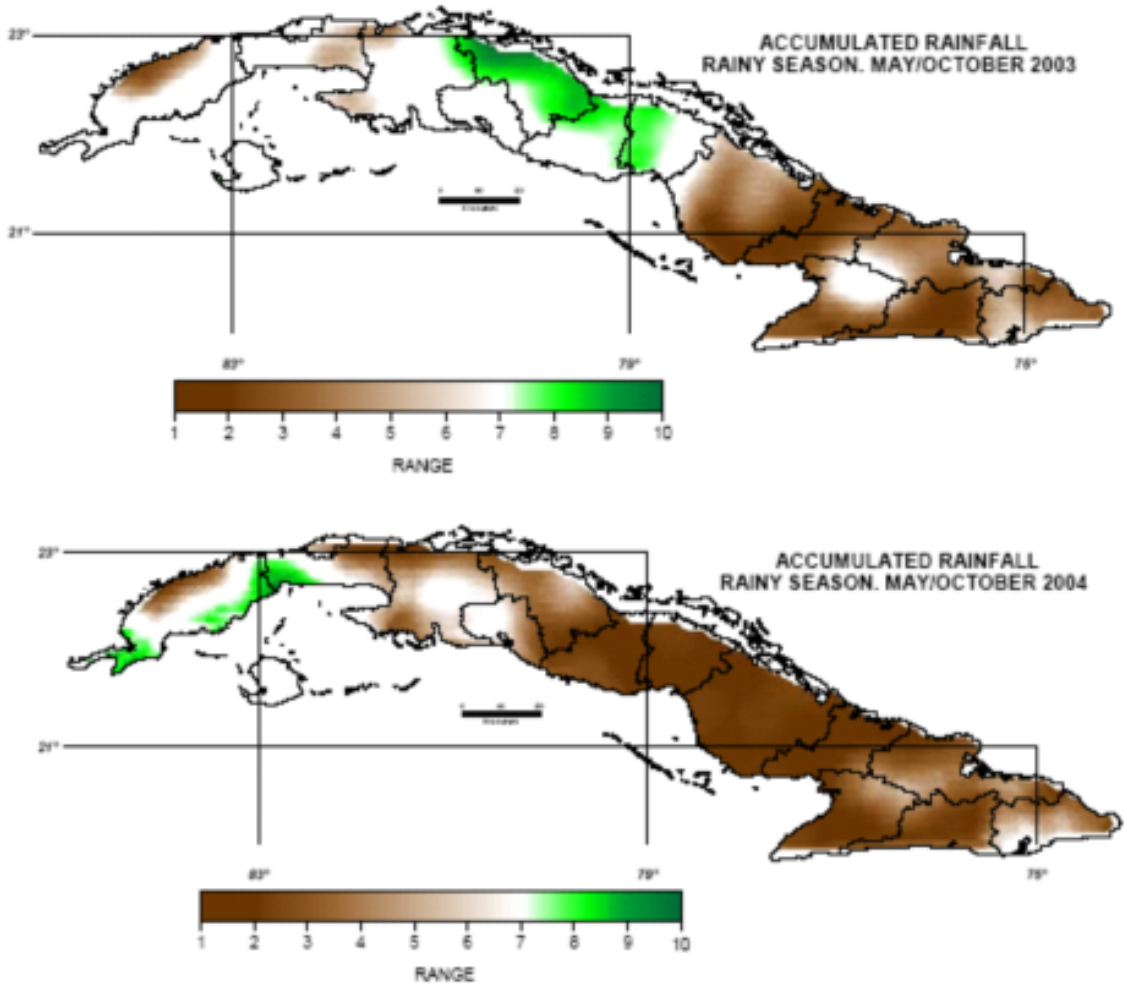
Using geographical information system (GIS) technology, researchers produced spatial grid information of 4 km$^2$ of resolution for the different data types. Each grid point then was mapped to a specific geographic location as well as a series of relevant characteristics related to drought. Using a combination of GIS software and other tools, researchers created comprehensive drought susceptibility maps of both Cuba and the DR. Figure 1 summarizes this process for Cuba in more detail.

## Main Results

A conceptual and methodological framework for meteorological and agricultural drought analysis was developed and well documented. This framework constitutes a contribution to other initiatives or projects which study and characterize drought processes, irrespective of the geographic region or country.

In the case of Cuba, two main drought periods were identified. The first was at the beginning of the 1960s, and constituted the most extended dry period since 1931, with about 5 consecutive drought years. The second, which was described as one of the most intense drought processes in the eastern part of Cuba, occured from 2003 to 2005. Figure 2 illustrates the intensification of the drought process by comparing the accumulated rainfall in the rainy seasons of 2003 and 2004.

**Fig. 2: Accumulated rainfall, rainy seasons 2003 and 2004**



From a meteorological point of view, the study showed that changes in atmospheric circulation processes associated with the increase of downward vertical movements have been the cause of the recent rainfall reduction by inhibiting the normal development of convective processes. This is crucial to understanding the causes of drought in the region and represents a step toward the development of more efficient drought prediction schemes and the strengthening the Cuban Drought Monitoring and Early Warning System (Figure 3).

The series of maps produced (Figure 4) allows researchers to convey critical drought information in a concise fashion. This contributes to the creation of drought warning systems and helps planners make informed decisions. From these maps, planners can easily estimate drought susceptibility at any location in Cuba or the DR on a monthly or ten-day basis. Maps of this nature are an essential input to a comprehensive drought warning strategy.

**Fig. 3: Cuban drought monitoring and early warning system**

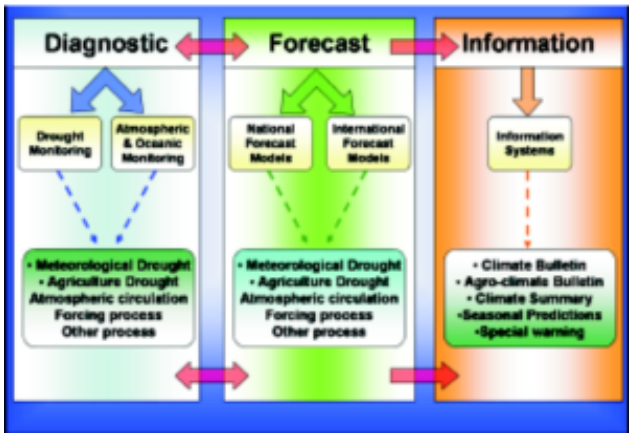
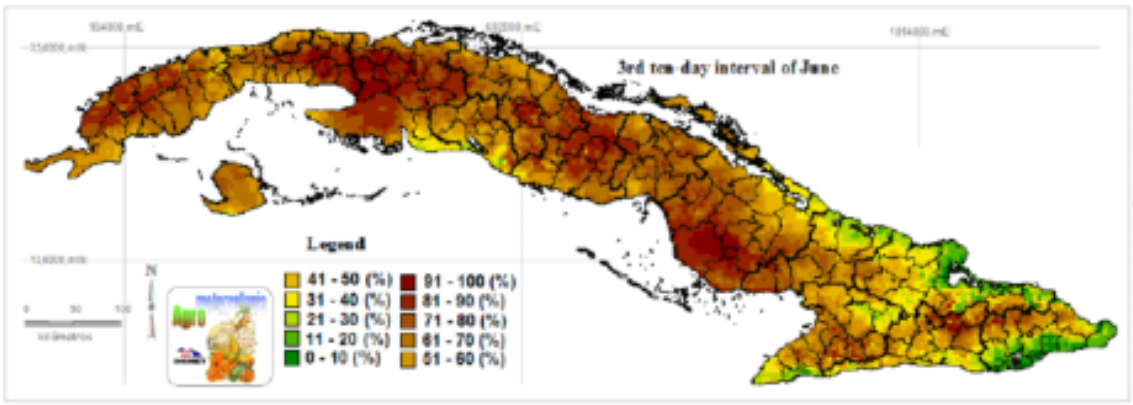
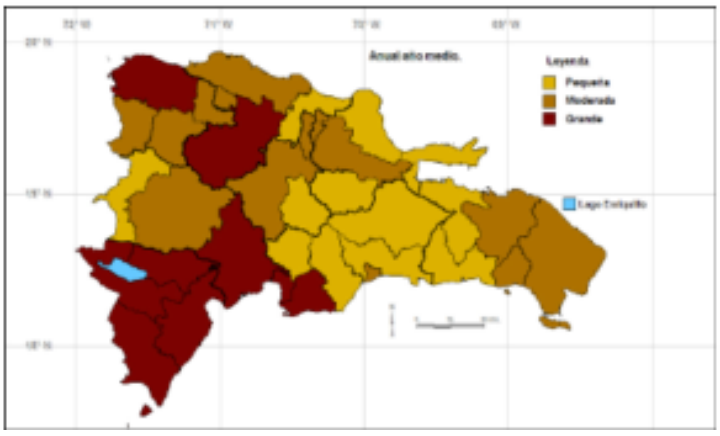



**Fig. 4: Sample Cuban and Dominican Republic agricultural drought maps**



# Section II

## Study Summary II

## Framework Project for Present and Future Drought Adaptation Policies in the Dominican Republic and the Republic of Cuba

### Overview

Using a combination of field research and quantitative and qualitative analysis conducted in both Cuba and the Dominican Republic, researchers identified and ranked an extensive list of adaptation policy recommendations. After conducting field research, experts performed a vulnerability analysis and generated future socioeconomic scenarios for each country. This allowed them to formulate policy recommendations for the two Caribbean nations, as well as to rank the various recommendation categories by expected impact. Researchers ranked efforts related to improved soil conditions particularly high in both the Dominican Republic and Cuba. Researchers in Cuba also suggested that improved water supply and utilization were critical, and finally experts in both countries emphasized measures aimed at the population's general welfare.

### Study Design

The study examined three municipalities in Las Tunas province in eastern Cuba and seven provinces in western Dominican Republic (Figures 5 and 6), with a similar area in both cases. In each case, researchers polled both agricultural producers and governmental and non-governmental specialists charged with identifying and addressing drought-related challenges. A combination of qualitative and quantitative methods was used to poll 716 respondents in the Dominican Republic and 940 respondents in Cuba. The majority of those polled were men. Researchers applied random assignment methodology and existing data to assure a geographically and socio-economically representative sample of the population. Data collected formed the basis for establishing the existing situation in these regions, documenting current adaptation strategies and ultimately offering policy recommendations for future interventions. The project used self-reported surveys to collect information on demographics, agricultural practices as well as behavioral and technological adaptations to drought. A basic questionnaire was designed by the research team. It was then adapted to each country and group targeted, with some variation in the questions included. Experts used comprehensive data analysis techniques, including the use of GIS, to identify and pinpoint vulnerability to drought by both region and sector. Finally, experts used scenario planning methodology in conjunction with the data collected to create a probable future and offer policy recommendations that would most appropriately address this future.

**Fig. 5: Study Area in the Republic of Cuba**


**Fig. 6: Study Area in the Dominican Republic**

## Current Situation

Identifying the existing situation in drought-affected regions is critical to formulate policy recommendations that can help local populations adapt to adverse conditions. It is important to understand local land ownership policies, average farm size, existing agricultural irrigation systems and local soil characteristics when assessing a region's vulnerability to drought and generating local and national adaptation strategies.

The following observations were made in Cuba and the Dominican Republic:

· All crops exhibited significant decreases in yield as a result of drought. In Cuba, chick pea and black bean crops were ruined. Cassavas, sweet potatoes, bananas and vegetables were significantly affected, while sugarcane proved to be more resilient. These effects are summarized in figure 7.

· Small farms outnumber larger land holdings. Small farms tend to be less economically resilient to adverse conditions since they have a lower borrowing capacity and fewer resources with which to adjust behavior and procure alternative water sources.

· In the Dominican Republic, a majority of land owners do not have property deeds, which also hinders their access to credit.

· Significant portions of both nations depend upon rain water for irrigation and have no alternative sources of water. Only 7% of respondents in the Dominican Republic irrigate while 36% of Cubans utilize at least partial irrigation systems.

· Both study areas experienced livestock deaths due to lack of drinking water for animals and insufficient pastures for grazing.

Each of these characteristics underscores these regions' vulnerability to drought as well as the need for effective adaptation policies. Moreover, one can conclude that other regions with similar socioeconomic, environmental and policy variables might suffer from a similar array of effects.

## Existing Adaptations

A combination of government-implemented adaptation measures and individual strategies were observed in the regions studied, particularly in Cuba, many of which could prove useful in other regions suffering from similar circumstances.

The most significant and effective measures included:

· Building pools or artificial ponds to store water for the duration of the drought.

· Planting more drought resistant crops.

· Constructing and maintaining wells, which sometimes included purchasing an electricity source – however, level of grid electricity access is high in these regions (97% in Cuba and 90% in Dominican Republic).

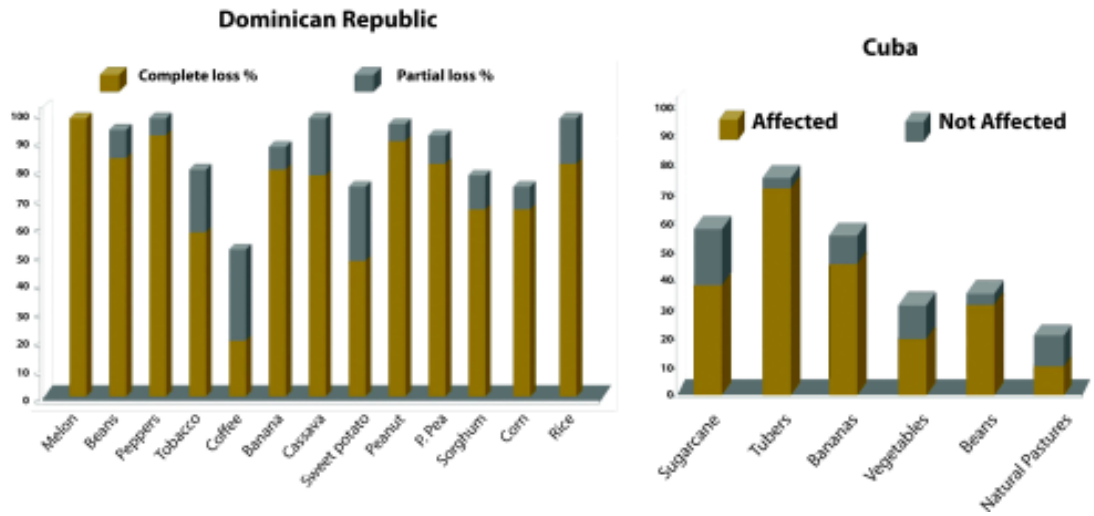
· Finding alternative water-saving measures to feed livestock.

· In times of extreme drought, the Cuban government offers water distribution trucks and trains to those in need. This explains a number of the differences observed between Cuba and the Dominican Republic; Cubans were better able to adapt for this reason.

· While no Cubans reported moving during times of drought in search of jobs, 46% of those surveyed in the Dominican Republic reported migrating in search of employment.

· Some among those surveyed reported not using toilets due to drought, and instead constructing temporary outdoor latrines, a practice that poses sanitation and health issues.

**Fig. 7: Effect of drought on crops**



## Vulnerability Assessment

Researchers in Cuba performed a comprehensive drought vulnerability assessment through a rigorous quantitative and qualitative analysis of the field data collected. They first identified key variables that determine vulnerability to drought. Experts then assigned weighted scores to these variables depending on the importance they played according to region, specific location and sector, and applied the weighted variables to determinate vulnerability. Researchers in the Dominican Republic performed a similar analysis but used supplementary data from Cuba to extrapolate country- specific conditions.

Using GIS, researchers were able to geographically plot data points, thereby creating maps that show the overall vulnerability to drought by region and sector.

Experts calculated vulnerability based on the following equation:

*Vulnerability = Impact – Adaptation*

As such, to minimize vulnerability to drought, one could either decrease impact or improve adaptation.

## Recommendations

Researchers ranked a host of adaptation measures according to anticipated impact into different implementation stages and priority levels. Specifically, each adaptation measure was ranked on the basis of three criteria:

- Vulnerability of variable being addressed.
- Effectiveness of adaptation measure.
- Existing conditions of variable.

Figures 8 and 9 summarize the level of priority for each adaptation category. An exhaustive list of all potential adaptation measures for both countries, totaling nearly 200 for Cuba and 150 for the Dominican Republic, can be found in the original study. Since adaptation recommendations are site, region and country-specific, communicating broader categories of adaptation strategies is a more effective way to present these findings.

As indicated in the figure 9, researchers in Cuba ranked both improved water supply and improved soil condition highest among near-term policy recommendations.

Water resource adaptations included steps such as:

- Improve water utilization efficiency.
- Increase use of ground water through improved and new wells.
- Establish irrigation control systems.
- Increase use of wind power to increase ground water utilization.

Soil condition adaptations included:

- Apply comprehensive soil management techniques.
- Implement crop rotation for sugarcane to improve yield.
- Match soil types with appropriate crops.

Although the Dominican Republic also ranked soil resources among its top priorities, it was suggested that adaptations related to population are of critical importance. Population-related adaptations included:

- Substitute charcoal and firewood use for clean-burning liquefied petroleum gas (LPG) and biogas.
- Support improved living conditions such as sanitation and quality of homes.

Importantly, experts place 67% of adaptations in Cuba in the first implementation phase, underscoring their serious situation and the immediate need for relief. Recommendations in the Dominican Republic were more balanced between different implementation phases. However, most of the latter measures were merely a continuation of those initiated in phase I.

**Fig. 8: Prioritized adaptation categories in the Dominican Republic**

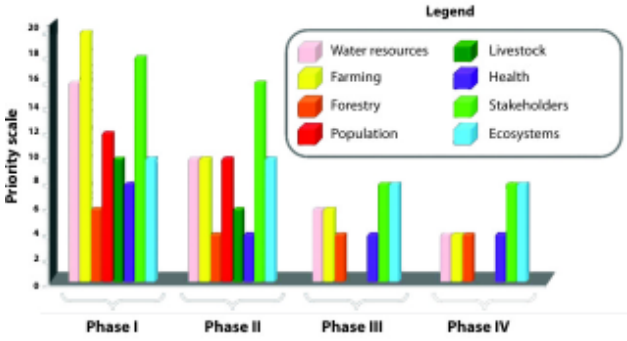
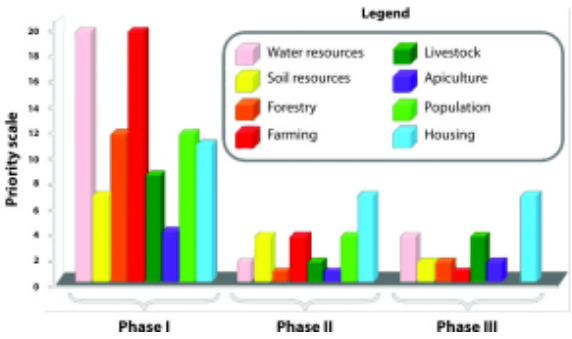
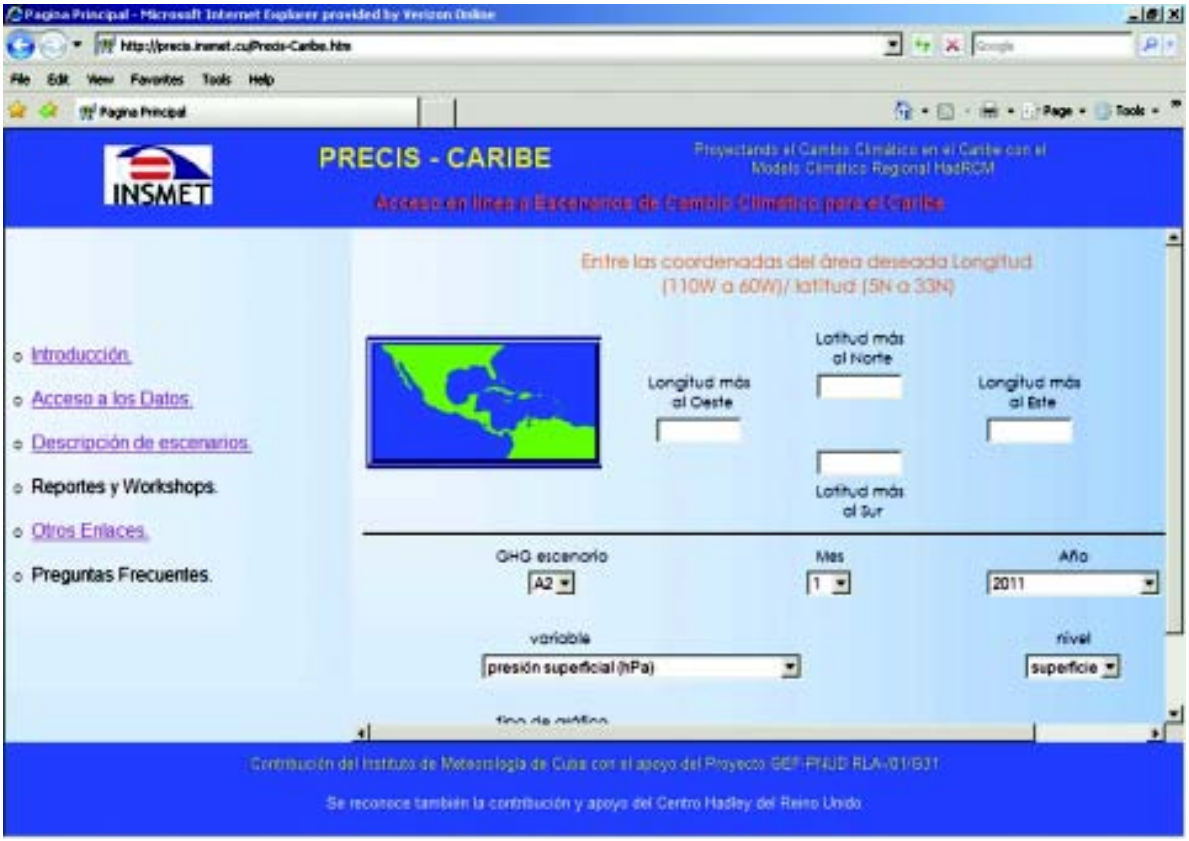



**Fig. 9: Prioritized adaptation categories in Las Tunas, Cuba**



# Section III
## PRECIS-CARIBE system




The PRECIS - CARIBE site is located at http://precis.insmet.cu/Precis-Caribe.htm

Beyond these studies, collaborative work was undertaken with other Caribbean institutions and the UK Hadley Center for Climate Prediction, to improve and develop regional climate modelling capacities. As a result of these efforts, in Cuba INSMET developed PRECIS-CARIBE, an Internet on-line access to the regional future climate projections generated with the PRECIS Regional Climate Model, developed by the UK Met Office Hadley Center.

For drought or other climate-related process, high resolution climate data is crucial for the assessment of the impact of climate change and the development of adaptation strategies. However, the costs of technical and human resources required for such an exercise are so high that developing countries are unable to undertake this initiative alone. In response to this need, and with support from the UNDP/GEF "Capacity Building for Stage II Adaptation to Climate Change in Central America, Mexico and Cuba" and the UK Met Office, the Regional Modeling System PRECIS was assimilated and used in Cuba to produce detailed future climate change projections for the Caribbean Basin. More than just a one-country effort, the assimilation and implementation of the PRECIS modeling system constitutes a joint Caribbean initiative, under which INSMET in Cuba as well as the University of West Indies in Barbados and Jamaica are running different experiments in a coordinated manner. As part of these efforts, an Internet-based PRECIS climate data acquisition system has been established at INSMET, facilitating access to climate change projections and their use in impact and adaptation assessment within the region.

# Conclusions

The methodologies described here offer a framework within which to address drought and climate change adaptation strategies. Readily accessible and easily interpretable meteorological and agricultural data are central to formulating climate change adaptation strategies, highlighting the relevance of the study **"Agricultural and Meteorological Drought: A Scientific Study"**. However, additional information and analysis are needed to identify the most appropriate and effective adaptation strategies in a given region. The combination of field research and qualitative and quantitative analysis employed in the study **"Framework Project for Present and Future Drought Adaptation Policies in the Dominican Republic and the Republic of Cuba"** ensures a thorough exploration of policy options while prioritizing them to guarantee maximum impact. Vulnerability assessments allow researchers to identify priority sectors and regions, whereas scenario planning offers a picture of the future based on variables identified today. The methodologies associated with climate change adaptation outlined here allow decision makers to plan appropriately for drought and other meteorological and agricultural changes.

## Main Outputs and Tools

- An extensive study of the main features which characterize vulnerability to drought in selected regions of the two countries.
- Elaboration of indicators which permit the evaluation of vulnerability to drought as a climatic element.
- A detailed report assessing meteorological and agricultural drought in Cuba and the Dominican Republic.
- Two manuals on methods and procedures for research on meteorological and agricultural drought, tested during the training of Dominican specialists.
- A strengthened system for monitoring, early warning and forecast of meteorological and agricultural drought in Cuba, through the improvement of analysis techniques used and the introduction of new information technologies.
- A data base and results available for drought-associated studies and assessments, which also facilitate the development of systems with interactive access. This improves access to climate data for use in decision-making.
- A training manual on climate change and drought, which was used in training activities during the project.
- A survey methodology which includes prior training of interviewers, who then in turn become trainers. This increased the capacities of the research team and involved more participants in the initial research process.
- Identification of drought response measures, ranked according to priority, which can be applied to address the adverse consequences of drought in the regions under study, and which can also be replicated in other regions through the identification and development of intervention projects.
- Development of the PRECIS – CARIBE web page, which allows access to the regional climate future projections generated with the PRECIS Regional Climate Model, developed by the UK Hadley Center.

## Participating Institutions

Institute of Meteorology (INSMET), Cuba
www.insmet.inf.cu

Institute of Physical Planning (IPF), Cuba

Secretary of State for the Environment and Natural Resources, Dominican Republic
www.medioambiente.gov.do

Secretary of State for Agriculture (SEA), Dominican Republic
www.agricultura.gov.do

National Meteorology Office (ONAMET), Dominican Republic
www.onamet.gov.do

## Acknowledgements

Support from CIDA, Canada, through the UNDP/CIDA project **Development and Adaptation to Climate Change** (in Cuba and Dominican Republic).
www.acdi-cida.gc.ca

Support from GEF, through the UNDP/GEF project **Capacity Building for Stage II Adaptation to Climate Change in Central America, Mexico and Cuba**.
www.thegef.org

The role of the UK Met Office Hadley Center in providing training, advice, data and model infrastructure for the development of the PRECIS-CARIBE system.
www.metoffice.gov.uk

Support from the CRMI for this publication.
www.undp.org.cu/crmi

The Caribbean Risk Management Initiative (CRMI) was launched in 2004 by the UNDP's Bureau for Crisis Prevention and Recovery (BCPR), as a knowledge network designed to build capacity across the Caribbean region for the management of climate-related risk. With the acceleration of global climate change and given the vulnerability of Caribbean countries, the increasing risk experienced by the Caribbean to a range of natural, environmental and technological hazards remains one of the region's most critical unresolved development problems.

One harsh aspect of Caribbean reality is that, increasingly, women, men and children must brace themselves to face the destructive force of droughts, hurricanes and floods year after year, while governments and communities struggle to acquire the capacity to adequately mitigate and manage these risks.

As part of the UNDP strategy for knowledge management, the CRMI offers support in meeting this challenge. The CRMI provides a platform for coordinating and sharing knowledge and experiences on risk management throughout the Caribbean, across language groups and cultures. The premise is that the way forward involves finding and sharing the lessons learned in the region.

**UNDP** Is a global development network advocating for change and connecting countries to knowledge, experience, and resources to help people build better lives. We are on the ground in 166 countries, working with people to develop their own solutions to global and national development challenges. As populations develop local capacity, they draw on the people of UNDP and our wide range of partners.

World leaders have pledged to achieve the Millennium Development Goals (MDGs), including the overarching goal of cutting poverty in half by 2015. UNDP´s network links and coordinates global and national efforts to reach these Goals. Our focus is helping countries build and share solutions to the challenges posed by:

- Democratic Governance
- Poverty Reduction
- Crisis Prevention and Recovery
- Energy and Environment
- HIV/AIDS

UNDP helps developing countries attract and use aid effectively. In all our activities, we encourage the protection of human rights and the empowerment of women.

## UNDP´s Approach to Climate Change

Climate change poses significant threats to the achievement of the MDGs, especially those related to the elimination of poverty and hunger and the promotion of environmental sustainability. For this reason, UNDP is committed to supporting developing countries in responding to climate change cross-cutting issues as part of their overall sustainable development efforts.

UNDP integrates climate change initiatives into its energy and environment practice area and works with developing countries to create integrated solutions to social, economic and environmental challenges, with a primary focus on improving the lives of those living in extreme poverty.

In its climate change programme, UNDP is acting on both aspects: mitigating climate change and adapting to climate change. Among the priorities of the latter, UNDP is working on integrating climate change considerations into cross sector decision making in the areas of agriculture, water, land use, energy and health; on undertaking vulnerability and adaptation assessments to help identify appropriate response measures; and on assisting to identify and manage climate risks, particularly in relation to natural disaster management.

UNDP´s country level assistance on climate change and risk management is supported by policy and technical advisors posted in the Bureau for Development Policy (BDP), particularly in the Energy and Environment Group and UNDP/GEF as well as the Bureau for Crisis Prevention and Recovery (BCPR). UNDP funds climate change and risk management activities through its regular resources, thematic trust funds and through resource mobilization with various donors. As an implementing agency of GEF and the Multilateral Fund of the Montreal Protocol, UNDP develops an extensive project portfolio at the country and regional levels.

More information about UNDP activities on climate change and risk management is available at: www.undp.org/climatechange and www.undp.org/bcpr .