THE INTERNATIONAL RESEARCH INSTITUTE FOR CLIMATE AND SOCIETY

IRI

2004-2006
REPORT

COLUMBIA UNIVERSITY

Contents

The IRI was founded on the belief that scientific breakthroughs in our understanding and prediction of climate can help developing countries overcome persistent and often devastating climate-related challenges.

COVER IMAGE: L. MASCARIÑAS: BANAUE, PHILIPPINES
IMAGES (THIS PAGE): ANA LAURA TADDEI (INSET)

THE INTERNATIONAL RESEARCH INSTITUTE FOR CLIMATE AND SOCIETY

2004-2006 REPORT

Letter from the Chairman, IRI Board of Overseers

IRI is the product of a dream–a vision conjured up a decade or more ago by a few creative individuals with energy and eloquence sufficient to convince policymakers that it was worth bringing to reality. The message was that with better observational data, notably for the tropical Pacific Ocean, and better models, it should be possible to develop, at least for some regions, skillful predictions of climate variability on seasonal or even interannual time scales. The challenge was to find an institutional framework and support that would allow climate scientists to work with experts on agriculture and health and water resources and risk management to ensure that climate predictions could be applied usefully to address real world problems in these disciplinary areas. And there was a clear recognition from the outset that the predictive skills that were available were most reliable for regions of the world where societies have been most vulnerable to unanticipated climate variability: tropical and subtropical regions of Africa, Asia and South and Central America.

The concept was endorsed and announced publicly by President George H.W. Bush at the Earth Summit in Rio de Janeiro in 1992. IRI was formally constituted four years later, supported generously from the outset with resources from the National Oceanic and Atmospheric Administration (NOAA), the Central Weather Bureau of Taiwan, and Columbia University. In the ten years that have elapsed since its inception, IRI has achieved a remarkable record of success living up to its mandate.

Today, IRI has programs in Africa (working most recently with the African Union Commission) and, with a diverse set of partners, is applying its skills in Latin America, India and Southeast Asia to address the multiple challenges to development posed by unanticipated variability in climate. It has important (formal) collaborative agreements with a number of national and international organizations including the British Department for International Development, the UN Economic Commission for Africa, the European Centre for Medium Range Weather Forecasting, the World Bank, the World Heath Organization, and the World Meteorological Organization. IRI is recognized now as an important member of the international development community, helping developing nations cope with the formidable challenges posed by unanticipated climate change and variability.

As is evident from experience with Hurricane Katrina in 2005 and the Indian Ocean tsunami in 2004, gaps in comprehension, communication and capability are all-too-often decisive considerations limiting the productive application of climate and environmental science to real world environmental problems. We are reminded all too often that scientific understanding does not in itself ensure a decrease in the vulnerability or hardship to which people are exposed as a result of unanticipated environmental change. We need institutions with strong scientific foundations committed to understanding the common, but complex, problems that limit societal advancement, and also committed to work with partners and decision makers to find opportunities to bridge gaps and address problems. IRI is such an institution.

On behalf of my colleagues on the Board, I would like to take this occasion to express our appreciation to the dedicated staff of IRI for the success they have enjoyed over the past ten years; to the founding Director-General, Antonio Divino Moura for his vision in establishing the institution; and to the current Director-General, Stephen Zebiak for his continuing dedication and leadership. I would like to extend a special thanks to The International Science and Technical Advisory Committee (ISTAC) which has worked with the Institute from its inception to help guide its development. Thanks also to NOAA and its Climate Program Office for their early vision in motivating research to enable policymakers to make use of best available climate science to minimize damage to human societies due to unanticipated climate variability. Last, but not least, my thanks to the distinguished Members of the Board for their dedicated service and for the indispensable role they have played in guiding IRI's transition to the status it now enjoys as a valued member of the international development and research communities.

MICHAEL B. MCELROY

Statement from the Director-General

Our tenth anniversary has given us a great deal to reflect on: a now sizeable body of experience, a changing institutional landscape, and an evolving view of the many opportunities and challenges that lie ahead. I'd like to offer a few thoughts on each of these.

The IRI is about connecting what science can offer with operational practices in key climate-sensitive sectors, toward the benefit of societies. A prerequisite for this endeavor is the continual development of knowledge, expressed in products, tools and methodologies that enable climate-related risks and opportunities to be more effectively managed. Much of our multi-disciplinary research agenda over the past decade has been devoted to this foundational work. But equally important from the beginning have been the practical engagements–place and problem-based projects undertaken with operational decision makers, policy makers, and other institutional partners–where the knowledge across all the relevant disciplines can be brought to bear to solve real problems. The most significant lesson learned from this experience is that the approach we began with ten years ago was fundamentally flawed. We learned that the products and approaches derived from the climate research and operational communities are not seen as useful or even useable on the ground. The two most important reasons for this are: the information not being cast in the terms that decisions and policies are actually made; and the institutional and policy setting creating disincentives or barriers to the uptake of new practices in decision making. As a result of this experience, we now see clearly the advantage of a different approach—one that begins with immersion in the problem and the setting, undertaken together with local stakeholders and partners. If it proceeds well, it ends with a change of practice, incorporating new climate-related information tailored to the decision or policy context at hand. In between lies an intensive engagement that allows trust to be built and the mutual discovery of possibilities for genuinely improved outcomes. Today the IRI has a much greater appreciation for both the scope and the importance of this work at the interface between science and society that is needed to make a difference.

There are important developments on the international scene concerning climate and society: first, a growing concern about the issues surrounding climate change, including the expressed need to develop the capacity for societies to adapt to climate changes; second, increasing awareness of the importance of climate-related risk management to advancing development needs and programs. Together, these are leading to much needed linkages between programs in these arenas to the benefit of all. In particular, the lessons being learned in managing climate-related risks and opportunities in the present, year by year, are able to inform longer-term adaptation and development initiatives. The broader combined agenda also provides further impetus to the climate risk management efforts. Such synergy is long overdue, and very welcome.

As we review our progress and lessons learned to date, IRI remains thoroughly committed to the vision we began with ten years ago and we are increasingly confident that the future holds great promise for societies to better cope with climate, to their decided benefit. But there is much to be done. We know the agenda must include continued advancement of the underpinning science, more demonstrations of improved outcomes in practice, increased awareness, demand and uptake of climate risk management and continued attention to education and the building of capacity globally. In this mix must come new mechanisms to capture, distill and disseminate the relevant knowledge, information, tools and good practices that will support widespread uptake throughout societies. It is a challenging agenda, but one that we are eager to support.

The achievements of IRI to date rest squarely on the talent and dedication of our outstanding staff. With this resource as an anchor, I look forward to the institution's continued success in the years to come.

Stephen E. Zebiak

STEPHEN E. ZEBIAK

10 Years

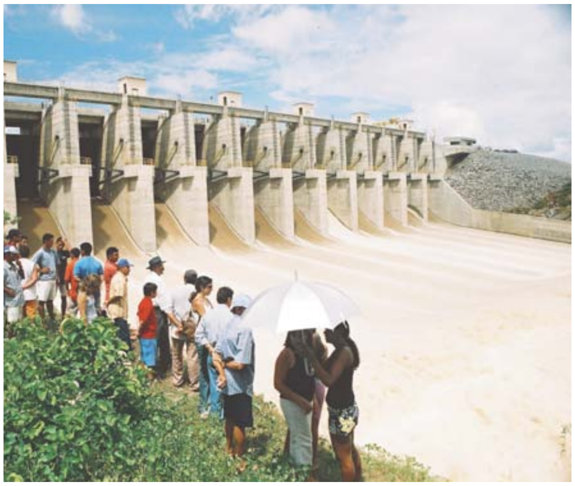
The International Research Institute for Climate and Society

IRI remains thoroughly committed to the vision we began with ten years ago, and we are increasingly confident the future holds great promise for societies to better cope with climate, to their decided benefit. But there is much to be done.

Climate has an impact on health, water, agriculture and other vital sectors, providing the opportunity to help societies confront a whole range of hardships–from malaria epidemics to water scarcity and food shortages. Population growth, changing livelihoods and urbanization continue to raise demands on resources and ecosystems. Under heightened stresses, even minor climate fluctuations are significant.

The Institute has expanded over its ten years to engage the multi-disciplinary questions at the heart of the interplay between climate and sustainable economic development. While maintaining a strong core capacity in climate science, the IRI includes experts in fields as varied as economics, epidemiology, agronomy and hydrology. These experts in turn connect with a wide array of others at institutions around the world to bring knowledge to inform problems of focus.

The IRI has benefited greatly from the foresight, vision, and support of many. The collaborative agreement between the National Oceanic and Atmospheric Administration Climate Program Office and Columbia University provides a strong financial basis for the institution that enables critical exploratory work in climate risk management for development, in a setting rich with expertise, intellect and experience. It also leverages significant additional direct and in-kind investments that are needed to advance the work. Collaborations with numerous national and international institutions with expertise in areas including climate, development, health, agriculture, food security, water resources and policy enable collective advancements in best practices, and important forums for communicating these. Interest and advocacy of NGOs, bilaterals and multilaterals further enables the role of IRI as a catalyst for the creation and provision of science that addresses the climate



R. Taddei

Timeline of Collaboration

1986

El Niño Pacific Ocean warming successfully predicted by Columbia University's Cane-Zebiak model

1989

Concept of the IRI emerges from the 18-country Tropical Ocean Global Atmospheric (TOGA) Project

1992

Proposal for the IRI developed by an international group of scientists and government representatives

1993

Pilot phase of IRI initiated with NOAA support to Columbia's Lamont-Doherty Earth Observatory (LDEO) and Scripps Institution of Oceanography (SIO)

1995

The International Forum on Forecasting El Niño: Launching an International Research Institute for Climate Prediction (Washington, DC)

Columbia provides seed funding for an IRI Data Library

IRI initiated with NOAA award of $19 million to Columbia University with activities at LDEO/Columbia University and SIO/University of California, San Diego

1996

Founding Director-General Antonio Divino Moura appointed at LDEO/Columbia.

IRI launches institutional website, http://iri.columbia.edu

IRI partners with Instituto Meteorológico Nacional to conduct its first regional training course in San Jose, Costa Rica

1997

First Regional Climate Outlook Forum (RCOF) convenes (Zimbabwe), initiating fora for climate forecasting and applications communities worldwide

IRI begins issuing seasonal forecasts; first global net assessment forecast produced, beginning regular quarterly production

Onset of major (1997-1998) El Niño

1998

IRI addresses participants at the Summit of the Americas (Santiago, Chile) on the epic 1997-1998 El Niño and climate prediction

IRI introduces new products: Forecast skill; Global extreme rainfall; Climate Information Digest, Climlab statistical software

Timeline of Collaboration

Non-governmental organizations begin to support IRI demonstration projects

IRI initiates UCAR International Post-Doctoral Scientist Program

1999

IRI initiates scientific agreements with 15 partners in ten countries

IRI and climate science community collaborate to advance climate models

USAID, World Bank and Inter-American Development Bank support IRI programs in Sub-Saharan Africa and Latin America

2000

NOAA establishes cooperative agreement with Columbia University for $42 million to support IRI for 2000-2005

IRI headquarters inaugurated, Monell Building, Columbia University (Lamont Campus); IRI staff consolidated

140 researchers, practitioners and policy makers from 30 countries come to IRI's International Forum on Climate Prediction, Agriculture and Development

Taiwan's Central Weather Bureau contributes $4.5 million over three years to advance projects

First operational use of objective multi-model combination schemes enabling the monthly production of global net assessment forecasts

IRI Map Room is launched on the website

2001

IRI Board Chair and several new international members appointed; Secretariat for international affairs and development established

IRI computing infrastructure upgrade completed

Forecast products run monthly instead of seasonally

IRI conducts its first in a series of workshops on Dynamical Downscaling of Seasonal to Interannual Climate Predictions

IRI joins ongoing efforts to convene the Annual International Regional Spectral Model Workshop

2002

START and The David and Lucille Packard Foundation support IRI Advanced Training Institute on Climatic Variability and Food Security; 19 agriculture and food security professionals from Asia, Africa and Latin America participate

risk management needs of the developing world.

The efforts and resources we invest in understanding climate and in managing its impacts today can have a profound effect on development, wellbeing and sustainability. Climate risk management combines sustainable strategies to cope with climate's interactions and impacts on development or resource management problems. It covers a broad range of potential actions, including: diversification, resource allocation rules, insurance, infrastructure design and development, and training that address the vulnerability associated with both short-term climate variability and long-term climate change. It combines proactive programs to avoid adverse outcomes of climate and it attempts to remove barriers to achieving positive goals in the face of opportunities in climate-sensitive areas such as agriculture, water resources, food security, health and livelihoods.

Our experience has led us to an increasingly integrated approach to engage climate-sensitive problems. Our work aims to:

- Deliver advancements in climate science tailored to the needs of decision-makers.
- Develop, explore and evaluate climate risk management strategies.
- Strengthen development efforts through the incorporation of climate risk management approaches.
- Create new education and training products and share information in support of managing climate-related risks.

The future of the IRI is tied to programs to improve socioeconomic conditions in regions where climate fluctuations, combined with other stresses, have the potential to arrest development. As we learn from our partners we become better able to assist in catalyzing the processes that help to solve develop-

ment problems of the regions. Science provides us this important opportunity to engage problems in these regions proactively– problems that have frequently been considered the unavoidable consequences of life in tropical and subtropical regions of the world.

Increasingly, core agendas of national, international and global efforts are focusing on the socioeconomics of resource management and the environment through initiatives relating to climate change adaptation. These interactions are expanding the opportunities open to the IRI. Recognizing that climate risk management is associated with numerous problems across multiple time scales, the IRI is increasingly drawn into these discussions, where we learn from the experience and knowledge of others and where we provide needed expertise, analysis and training. As a consequence, climate risk management is entering into a growing number of development and climate change adaptation strategies in the world, enabling decisions and policies that consider the near-term challenges and opportunities in addition to longer-term approaches.

H. Meinke

Timeline of Collaboration

IRI initiates production of monthly ENSO probability forecasts and related information

2003

IRI endowment started with Taiwan contributions

IRI begins issuing tropical cyclone forecasts for several ocean basins

Climate Predictability Tool (CPT) is launched on the website

IRI hosts Dialogue on Climate: Science, Policies and Applications, co-hosted by Global Environment Action (GEA) (Tokyo, Japan)

2004

IRI plays a major role in developing and delivering Columbia University's M.A. Program in Climate and Society

Computer Simulation Laboratory/NCAR grants computing awards to IRI

IRI is designated a PAHO-WHO Collaborating Centre for Early Warning Systems for Malaria and other Climate-Sensitive Diseases

IRI signs MOU with World Meteorological Organization

2005

IRI's name is changed to The International Research Institute for Climate and Society

UK's Department for International Development (DfID) begins support of IRI work

IRI signs MOU with India Institute of Technology Management (Delhi, India)

NOAA establishes $48 million cooperative agreement with Columbia University to support IRI for 2005-2010

NOAA National Weather Service Climate Services Division's 3rd Climate Prediction Applications Science Workshop is held at the IRI

2006

IRI designated key international collaborator for Ministry of Agriculture (India)-funded project

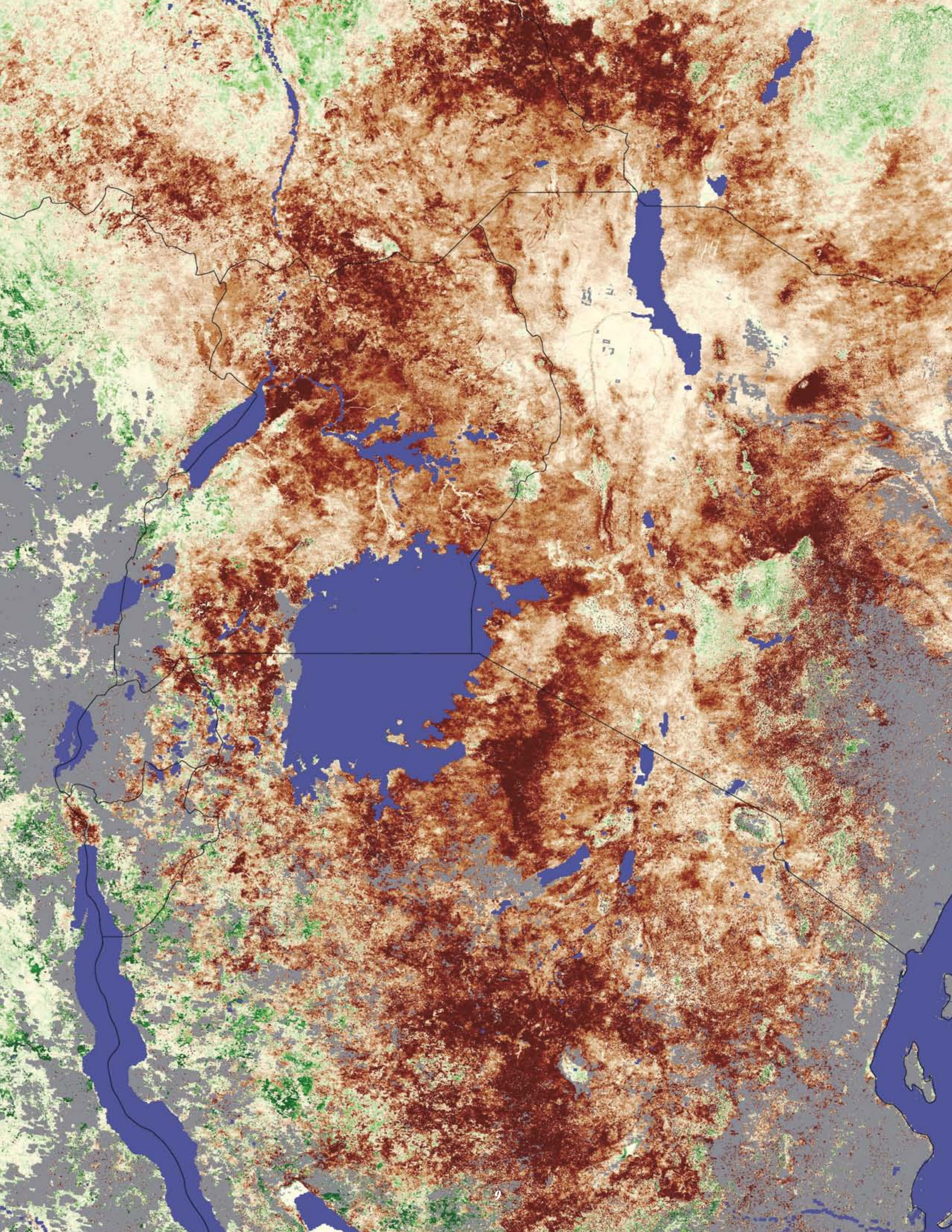
IRI hosts international policy forums:

• Climate and Development in Africa: Gaps and Opportunities A Panel Discussion (New York and Palisades, NY)

• Joint International Conference on Living with Climate Variability and Change: Understanding the Uncertainties & Managing the Risks (Espoo, Finland), co-hosted by WMO and the Finnish Meteorological Institute

SELECTED REPORTS

Year	Report
1997	El Niño Impact on Water Resources in Central and South America and New Methodologies of Practical Use to Seasonal and Interannual Hydrologic Forecasts
1999	Climate Prediction and Disease/Health in Africa: Results from a Regional Training Course, Niamey, Niger
	Applications of Climate Forecasting to Agriculture: A Report from a Regional Training Course, Toowomba, Australia
2000	Current Approaches to Seasonal to Interannual Climate Predictions
	Summary Report of the Workshop: Linking Climate Prediction Model Output with Crop Model Requirements
	Proceedings of the Workshop on Forecast Quality
	Coping with the Climate: A Way Forward –Summary and Proposals for Action: A Multi-Stakeholder Review of Regional Climate Outlook Forums Concluded at an International Workshop
	Workshop on Interannual Climate Variability and Pelagic Fisheries
2001	Greater Horn of Africa Technical Reports: Use of Climate Information in the Greater Horn: Assessing the Needs of Institutional Users
	The Drought and Humanitarian Crisis in Central and Southwest Asia: A Climate Perspective
	Climate and Fisheries: Interacting Paradigms, Scales, and Policy Approaches: The IRI-IPRC Pacific Climate-Fisheries Workshop
2002	Greater Horn of Africa Technical Reports, Climate Forecast Information: The Status, Needs And Expectations Among Smallholder Agro-Pastoralists In Machakos District, Kenya
	Preparing for El Niño: Advancing Regional Plans and Interregional Communication Workshop Proceedings
	Greater Horn of Africa Technical Reports, Assessing the Value of Climate Forecast Information for Pastoralists: Evidence from Southern Ethiopia and Northern Kenya
	Joint International Workshop on Applicable Methods for Use of Seasonal Climate Forecasts in Water Management
	Advanced Training Institute on Climate Variability and Food Security
	Dialogue on Climate: Science, Policies and Applications
2003	Properties of Tropical Cyclones in Atmospheric General Circulation Models
2004	The Role of Climate Perceptions, Expectations, and Forecasts in Farmer Decision Making
	Climate Variability and the Millennium Development Goal Hunger Target
	Sustainable Development in Africa: Is the Climate Right?
2005	Report on the Workshop on Climate Risk Management in Southeast Asia
	Retrospective Forecasts with the ECHAM4.5 AGCM
2006	A Gap Analysis for the Implementation of the Global Climate Observing System Programme in Africa
	Workshop on Tropical Cyclones and Climate



Climate for Development

..the IRI is increasingly focused on collaborating with development institutions to produce and use tools and strategies that help societies overcome their vulnerability to climate.

The livelihoods of millions of people in the world's least developed countries, especially in Africa, are critically dependent on a climate that is highly variable. The developing economies of Latin America and Asia are bound to climate-sensitive sectors such as agriculture and energy – the quality of life in their rapidly growing cities is tied to climate-related environmental factors. Climate touches on issues as diverse as epidemic control, water supply, transportation and the availability of credit for farmers. By understanding these problems and the role of climate, IRI and its partners are seeking solutions that can achieve sustainable advances in development.

Throughout its regional programs the IRI is increasingly focused on collaborating with development institutions to produce and use tools and strategies that help societies overcome their vulnerability to climate. The process requires a thorough understanding of the local conditions and a deep commitment to finding solutions. The IRI's scientific capacity allows us to collaborate and learn in these areas, but the programs are led and the solutions delivered by the local institutions that in many cases have been on the front lines of development work for decades. This section highlights a few examples of this work.

Leo Mascariñas

S. Harrison

Africa

In 2005, the IRI report "Sustainable Development in Africa - is the climate right?," highlighted the importance of managing climate-related risks for the achievement of the Millennium Development Goals (MDGs) in Africa. The report was timed to coincide with the discussion on African development and climate change at the G8 Summit in Gleneagles, Scotland, where the G8 Heads of State and Environment and Development Ministers recognized that urgent action was needed to help Africa adapt to the impacts of climate change, and undertook to strengthen cooperation on helping Africa obtain full benefit from the Global Climate Observation System (GCOS). The United Kingdom's Department for International Development commissioned the IRI to undertake a 'Gap Analysis' in order to identify where effort would need to be made if investment in the observing systems in Africa were to have significant development payoffs.

The analysis identified the problem as being one of 'market atrophy': negligible effective demand coupled with inadequate supply of climate services for development decisions. It concluded that substantive gaps in policy, practice, climate services and climate observations would need to be filled if climate information were to assist in the achievement of the MDGs. These findings were endorsed in April 2006, at a stakeholder workshop for GCOS-Africa in Addis Ababa, which was hosted by the UN-Economic Commission (UNECA) for Africa and co-organized by the IRI (with the IRI's Director-General giving the keynote climate science presentation). The workshop participants agreed on the need for a major 'Climate for Development in Africa' program which would be led by the development community and focus on support for the achievement of the health and hunger MDGs through better management of climate variability.

The IRI continues to work closely with the Joint secretariat of the African Union (AU), UNECA and the African Development Bank and other regional and international partners to make this program a reality. The institute has been officially thanked by the AU for its important role.

Asia

The Asia and Pacific region is home to over 4 billion people, including two-thirds of the world's poor and undernourished people. The region's highly variable climate strongly affects livelihoods. Hydro-climatic hazards particularly affect poor people, causing loss of hard-won assets and reduced ability to participate in the development process. Increasing population, as well as the changing structure of rural and urban water consumption, is placing huge demands on traditional water sources. Decision makers face growing pressure to provide clear and reliable guidance to manage competition over water.

S. Someshwar

States play a dominant role in socioeconomic development in Asia. Many governments have strong development plans, and allocate significant resources to them. In some countries, such as India and Indonesia, recent decentralization efforts have led to increasing authority and responsibility of local government for key dimensions of development. In a number of countries, including India, Indonesia, Philippines, Sri Lanka and Vietnam, IRI partners with national and local government agencies, building capacity to proactively manage climate risks and helping countries reach their development goals, engaging also university-based research institutes in the region.

Work in Indonesia provides a good example of our approach. We are working with the ministry of agriculture at the district level in West Java to help develop decision models integrating climate information to manage risks for rice farmers. In Nusa Tenggara Timur, one of Indonesia's poorest provinces, we work with the food security and planning agencies to help develop strategies for anticipatory action at provincial and regency levels to address food insecurity problems linked to the ENSO cycle. In Central Kalimantan, IRI is working with the provincial department of environment, CARE Indonesia and Wetlands International to develop an early response system for peat land fires. These efforts are also supported by USAID and the European Union, often with additional supplements from the government of Indonesia. New efforts under way include management of competing water claims in the Citarum catchment (three cascade dams that supply water for hydroelectricity, irrigation, and Jakarta's municipal needs) and helping forecast rice production at national and provincial levels.

S. Someshwar

R. Taddei

Latin America

Although most development indexes published by the United Nations (UN) and other international agencies place the Latin America and Caribbean region above the mean values of the developing world, an outstanding characteristic of the region is its enormous disparity. Compound indexes such as the UN Human Development Index (UN-HDI), which takes into account the life expectancy at birth, adult literacy rate and GDP per capita, often mask huge inequalities that exist in the society, within a given region as well as within the individual countries of a region. Since a considerable amount of people in the region are living below the income threshold determined by the HDI, IRI is interested in examining the dynamic interaction between climate and socio-economic characteristics in an attempt to improve current conditions. In addition, although the region is endowed with an abundant supply of natural resources, environment degradation is steadily increasing and consequently posing financial, environmental, and health-associated risks to the local population.

Despite the socioeconomic and environmental challenges to Latin America and the Caribbean, an outstanding feature of the region is the established capacities to produce climate information and predictions, as well as to incorporate climate knowledge and products into practical decisions and policies. Consequently, our general strategy in this region over the next five years will be oriented to collaborate with the existing organizations that possess such capacities and contribute to further develop them by introducing new approaches, products and decision aid tools. We believe that helping societies manage their climate related risk, and identify sustainable production practices, are crucial steps to reverse the environmental degradation trend.

F. Fiondella

Climate Risk and Climate Change

Scenarios of the climate expected 50 to 100 years from now have raised environmental awareness and motivated actions towards reducing greenhouse gas emissions. The risks associated with climate change demand that these efforts continue. However, the long time horizons have led many decision makers to regard climate change as a problem of the distant future. But is it?

In many regions of the world, climate variability results in socio-economic shocks, chronic constraints on development and missed opportunities to take advantage of exceptionally good conditions. A likely outcome of climate change is reported to be more frequent and damaging extreme events and an intensified state of socio-economic vulnerability. The impacts are expected to be disproportionately high in areas that are experiencing rapid and unplanned urbanization, land degradation, resource scarcity, epidemic stresses and other climate-sensitive development challenges. As such, many of the problems associated with climate change are already characterized by problems of the present.

I. Howard Geekcorps

Societies can benefit from climate information on a variety of time scales, including: current observations, historical conditions and impacts, and various short-term to seasonal forecasts. Longer time scales are especially important when considering investments and strategies that are expected to last well into the future–and must therefore take into account projected demands and conditions. This includes areas such as reservoir design, urban planning, transportation infrastructure, and development prioritization. Projected likely trends over the next 10 to 30 years can be guided by studying observed trends and variability, careful consideration of projected trends and variability, and assessment of the implications of the expected range of climate variations, in the context of the problem and region. But is climate information enough?

Climate-sensitive problems are, by their nature, complex, interconnected, and time sensitive. The use of additional scientific inputs requires consideration of the available resources, capacity, policies, practices, culture, behavior and the pathways through which decisions occur. Gaps in

The Earth Institute

institutional coordination, information, education, communication, and knowledge management often limit the capacity to bring the best available solutions to bear on a problem, but these gaps can be bridged by:

- Increasing knowledge and understanding of how decisions are made, and where climate information can help
- Developing climate information that is useful to and meets the demands of the people responsible for making the decisions, while disentangling issues of shorter term variability from those of longer-term trends
- Creating opportunities to link institutions, to learn, educate, build capacity, and share knowledge toward 'best practice' guidelines for improved climate risk management.

Learning to better manage year-to-year climate variability increases resilience and adaptive capacity to many aspects of climate change. Societies that assess current climate risks and create proactive risk management strategies will be better equipped to confront the coming development and environmental problems, since the challenges of the future will frequently be an extension and intensification of the challenges of the present. Current efforts to understand and confront the behavior and the impacts of climate can have a profound effect on socio-economic sustainability and the ability of many societies to face the impacts of climate change.

IRI Projects & Partners

Collaboration is vital to every stage of IRI's work around the world. Our partners help us identify and fill the gaps in knowledge and capacity that have stalled progress in their home countries' ability to manage climate risks.

H. Meinke

We collaborate with stakeholders to understand how climate information might be useful. Together, we design the products and decision support tools that are needed. We work with other institutions to identify the gaps that have prevented progress and we bring together the knowledge, methods and networks necessary to create solutions. We take that learning and share it with others, so that they may better visualize how climate information may improve their decisions.

Before we implement a project, we establish its potential value by simulating the outcomes of past events with the new intervention strategies. We make design adjustments and reassess our ideas, until the stakeholders, partners and our own scientists are convinced that the climate risk management program can be operationalized toward improved decisions. As the project develops, we monitor its outcomes and make the changes necessary. We define the principal decision points and re-articulate the solution in order to work in different and larger settings. Our research focuses on the sectors that are important for development, the regions in which we work, and the aspects of the problem in which we are engaged.

Africa

Collaborative activities focus on demand for timely and relevant climate information that is vital to Africa's highly climate sensitive sectors, including: Food Security, Health and Water. Research, knowledge and practical capacity building are essential in demonstrating the improvements required if the MDGs are to be achieved on this continent.

L. Ptito-Anderson, Roll Back Malaria

Project Title	Objective	Partners
West Africa Climate and Health	Develop and predict new abilities for improved stratification of climate-sensitive disease outcomes (malaria, meningitis) through the creation of tools involving remote sensing, geographical information systems and climate information.	Centre de Recherche Médicale et Sanitaire (CERMES), Niger Ministries of Health/WHO African Centre of Meteorological Application for Development (ACMAD) Regional Training Centre for Agrometeorology and Operational Hydrology and their Applications (AGRHYMET), Niger
Malaria control decision support: Malaria Outlook Forum for Southern Africa	Develop malaria early warning systems for epidemic-prone areas using vulnerability assessment, seasonal climate forecasts, climate/environmental monitoring and health surveillance.	Ministries of Health, Southern Africa Southern Africa Malaria Control (SAMC)/WHO Drought Monitoring Center (DMC) Harare
Forecast improvement: Regional Climate Outlook Forum, Africa; Training for Climate Forecasters	Improve climate variability management at the national level in Africa by enhancing the capacity of climate forecasters to implement approaches and evaluate the expected skill when applied in real time.	ACMAD Intergovernmental Authority on Development (IGAD) Climate Prediction and Application Center (ICPAC), Kenya DMC Harare International Center for Research in Agroforestry (ICRAF), Kenya National meteorological services
Global Climate Observing Systems (GCOS) in Africa: Climate for Development (ClimDev)	Strengthen the resilience of the hunger and health MDGs across the four sub-regions in Sub-Saharan Africa through improvements in policy, practice, climate services and climate observations. The purpose of the first phase is to provide credible, quantitative assessment of the incremental development benefit of climate risk management and associated climate information services, within ongoing initiatives relating to the hunger and health MDG targets. Major areas of activity expected in: –Health (including malaria) –Food Security (alleviation of chronic and acute hunger) –Water (related to health and food security)	Joint Secretariat of the African Union UN-Economic Commission for Africa (UNECA) African Development Bank Joint Secretariat Global Climate Observing System Secretariat (GCOS)

AFRICA (continued)

Project Title	Objective	Partners
Gap Analysis for the Implementation of GCOS Program in Africa *(Completed)*	Determine, document and analyze the variance between the proposed implementation plans of the GCOS project and identifiable needs of the policy and decision-makers within climate-sensitive development sectors in Africa that will contribute to the achievement of the Millennium Development Goals.	U.K. Department for International Development (DfID) UNECA GCOS
Improving Malaria Early Warning in Eritrea *(Completed)*	Improve the malaria early warning system involving remote sensing, geographical information systems and climate forecast products, and improve preparedness to malaria epidemics and adapt available control methods.	EPIVEC/Centers for Disease Control and Prevention Eritrean National Malaria Control Program
Malaria Stratification in Eritrea *(Completed)*	Create a malaria stratification map for the Ministry of Health in Eritrea that can be used as a baseline for indicating areas prone to epidemics.	Environmental Health Project/USAID Ministry of Health, Eritrea
Mitigating the Effects of Hydro-climatic Extremes in Southern Africa *(Completed)*	Improve multi-sector, short- and long-term climate risk management and emergency response to climate variability throughout the southern African region.	DMC Harare WMO Southern Africa Development Community (SADC) Regional Remote Sensing Unit South Africa Weather Service United States Geological Survey (USGS)
Regional Climate Prediction and Risk Reduction in the Greater Horn of Africa Computing Infrastructure and Technical Support to the GHA Program *(Completed)*	Improve monitoring, prediction and applications for early warning of climatic hazard events in support of disaster reduction and other regional sustainable development objectives.	ICPAC WMO Inter-African Bureau of Animal Resources (IBAR) USAID Famine Early Warning System USGS University of Nairobi, Kenya National Aeronautics and Space Administration World Food Program
Assessing the use of tailored seasonal climate forecast in decision-making by farmers and intermediaries and the impact on desired outcomes: A Southern Province, Zambia Pilot Study *(Completed)*	Evaluate the livelihood benefits of seasonal rainfall forecasts to farmers at pilot sites; identify and secure collaboration with implementation partners and institutions that may facilitate effective use of climate information.	Zambia Meteorological Department SADC Regional Remote Sensing Unit University of the Witwatersrand Golden Valley Agricultural Research Trust SADC Drought Monitoring Center


H. Bhojwani

Latin America & Caribbean

Activities in the Latin America and Caribbean Program focus on identifying key climate risk issues and problems engaging also the existing capacities for producing and disseminating climate knowledge in the region. Scaling up of successful demonstrations is achieved by replicating and tailoring activities to new countries and sub-regions.

Project Title	Objective	Partners
Impacts of Water Resource Management Choices in Ceará, Brazil: Roles of Streamflow Forecasts, Rainfall Forecasts and Participatory Decision Making (IRI / FUNCEME Collaborative Activities for Nordeste of Brazil)	Provide decision support to policy makers for reducing vulnerability to drought. The project seeks to help the Government of Ceará to more effectively anticipate rainfall and water supply at different spatial and temporal scales and then take related actions that improve outcomes for multiple groups.	Fundação Cearense de Meteorologia e Recursos Hídricos (FUNCEME), Ceará, Brazil Secretariat for water resources, Ceará, Brazil Companhia de Gestao dos Recursos Hídricos, (COGERH) Ceará, Brazil Universidade Federal do Ceará (UFC), Brazil University of Miami University of Arizona University of Michigan School of International and Public Affairs, Columbia University (CU) Earth and Environmental Engineering, CU
Climate Risk Assessment and Risk Management in the Agricultural and Forestry Sectors of Uruguay	Characterize climate variability at different temporal scales (from interseasonal to longer-term climate change), assess its impacts on food and forest production, and explore responses that result in improved planning and decision-making.	Instituto Nacional de Investigación Agropecuaria (INIA), Uruguay
Development of an Information and Monitoring System to Evaluate Risks in Agricultural Production in Paraguay and Uruguay	Establish an information and monitoring system based on historic records, satellite images and simulation models integrated in a GIS for the evaluation of risks in agricultural production, associated with climate variability and technology levels in Paraguay and Uruguay. IRI's participation involves assisting national staff members in training activities (GIS, database construction and management, simulation models), and in the incorporation of climate information (including seasonal climate forecasts) in the information systems.	INIA Instituto Nacional de Tecnología Agropecuaria (INTA), Argentina Universidad Católica Nuestra Señora de la Asunción (UCA) del Paraguay, Paraguay Inter-American Development Bank
Using Climate Knowledge in the Design of Conventional and Non-Conventional Agricultural Insurance Systems in Latin America and the Caribbean	Analyze the impact of climatic risks on agricultural producers in Southeastern South America, and explore ways in which climate knowledge can be effectively incorporated into agricultural insurance systems.	

Latin America & Caribbean *(continued)*

Project Title	Objective	Partners
Development of Effective Communication Strategies for Dissemination of Climate Information (IRI / FUNCEME Collaborative Activities for Nordeste of Brazil)	Elaborate a detailed analysis of the communication processes through which FUNCEME participates in the local social life of Northeast Brazil. Part of this research focuses on the forms through which the local population interprets the information produced by meteorologists and by other producers of climate forecasts in the region (including the local "rain prophets", for instance). The goal is to create a set of communicative strategies taking into consideration negative transformations of meanings in the communication process, and to prevent common misinterpretations and misuses of climate information.	FUNCEME Comitas Institute for Anthropological Study (CIFAS)
Improving Water Management and Energy Pricing in Hydroelectric Power Generation in Colombia Using Seasonal Climate Forecasts	Improve the reliability and efficiency of hydroelectric power generation using seasonal climate forecasts. In particular, the goals are: to identify climate variables that are key to the electricity market and to the electricity production and costs based on predictability (e.g. projections of future inflows), and to identify ways for improving "operational strategy" (shorter timescale) as well as its "planning strategy" (longer time scale, e.g. 2 years).	Centro Nacional de Despacho (CND) Empresas Publicas de Medellín (EEPM), Colombia
National Integrated Dengue and Malaria Surveillance and Control System for Colombia	Improve the control of malaria and dengue in Colombia by: (a) providing the evidence of the role of climate in disease dynamics, (b) assessing the value of such evidence to improving disease prevention and control, and (c) providing tools and training in order to develop the capacity of disease control staff to use the information created in improving malaria control decision-making.	Instituto Nacional de Salud, Colombia Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM), Colombia Universidad Nacional, Colombia World Bank Pan American Health Organization (PAHO)
Regional Climate Outlook Forums (RCOFs)	Contribute to the Regional Climate Outlook Forums of southeast South America, western South America, northeast Brazil and Central America by: (a) providing climate information (model runs, data library, IRI's forecasts), (b) organizing short courses for researchers on the use of CPT, IRI's data library, (c) presenting educational material to stakeholders on probabilistic climate forecasts and their applications in decision making.	Centro Internacional de Investigaciones para el Fenomeno El Niño (CIIFEN), Ecuador Centro de Previsão de Tempo e Estudos Climáticos (CPTEC), Brazil WMO, and several regional and national organizations working in agriculture, water resources, health and disasters
Climate Variability and Change in the Mixed Crop/Livestock Production Systems of the Argentinean, Brazilian and Uruguayan Pampas: Climate Scenarios, Impacts and Adaptive Measures (AIACC, Project LA27) *(Completed)*	Establish, use and maintain an agricultural systems network in the Pampas to assess the impact of climate change / variability and explore adaptive responses for the mixed grain/livestock production systems.	INIA INTA Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), Brazil Agricultural Production Systems Research Unit (APSRU), Australia

E. Ebrahimian

Asia & Pacific

Projects in the Asia and Pacific Regional Program are designed to promote problem-driven climate risk management research. To maximize opportunities for learning and scaling up, we work side-by-side with local and national-level stakeholders, enabling better understanding of problems and development of practical, proactive strategies for managing climate risks.

Project Title	Objective	Partners
Managing Climate Variability to Improve Livelihoods in Indonesia and India	Demonstrate improvements in livelihoods subject to high climate variability in India and Indonesia through development of a livelihood framework, decision support tools and increased capacity building.	Indian Institute of Tropical Meteorology Institute for Development Studies, India Udayana University, Indonesia Department of Earth and Environmental Engineering, CU
Climate Risk Management in Indonesia, Philippines and Vietnam	Help develop sustainable end-to-end institutional systems in Indonesia, Philippines and Vietnam that demonstrate improvements in the performance of climate-sensitive sectors at the community level with the capacity to achieve similar success nationally in other locations.	Asian Disaster Preparedness Centre (ADPC) Bureau of Meteorology and Geophysics, Indonesia Philippine Astronomical, Geophysical, Atmospheric Service Administration (PAGASA) Bogor Agriculture University, Indonesia Ministry of Agriculture, Indonesia CARE Indonesia National Water Resources Board, Philippines Manila Metropolitan Water Works and Sewerage System, Philippines National Irrigation Administration, Philippines National Power Corporation, Philippines Bupati Office, Indramayu, Indonesia Office of the Mayor, Iloilo Municipio, Philippines Hydro-Meteorological Service, Vietnam University of the Philippines at Los Baños
Integrated Rural Resource Management in India	Develop and demonstrate institutional systems for climate risk management for rural and agricultural livelihoods, built upon improved climate information.	Indian Institute of Technology (IIT), India Ministry of Agriculture, India Indian Meteorology Department, India National Centre for Medium Range Weather Forecasting, India Indian Council for Agricultural Research Space Applications Centre, India European Centre for Medium-Range Weather Forecasting (ECMWF) Hadley Centre, UK Meteorological Office
Adapting to Climate Change by Managing Climate Variability in Southeast Asia	Analyze past climate trends and assess the benefits of using climate variability information and forecasts in designing climate change adaptation measures and policies.	ADPC

Project Title	Objective	Partners
Early Response Systems for Fire Management in Indonesia	Contribute to development of early action systems for improved fire management in the peatlands of Central Kalimantan, Indonesia, including the identification of how climate information could be best integrated into decision-making.	CARE Indonesia Department of Environment, Province of Central Kalimantan, Indonesia University of Palangkaraya, Indonesia Bogor Agriculture University, Indonesia
Impacts of Climate Variability on Vector-borne Disease Transmission in Sri Lanka and the Development of an Early Warning System	Develop models to forecast malaria risk and a prototype early warning system for the Uva Province in Sri Lanka.	Lamont-Doherty Earth Observatory, CU International Water Management Institute, Sri Lanka Mahaweli Authority, Sri Lanka University of Sri Jayawardenapura, Sri Lanka Ministry of Health, Sri Lanka
Enhancing the Resilience of Farming Systems in South and South East Asia *(Completed)*	Demonstrate and deliver benefits from climate forecast information for agricultural decision makers, and plot a course for large-scale, sustained operational support of seasonal climate prediction within India, Pakistan and Indonesia.	Queensland Department of Primary Industries, Australia Pakistan Agricultural Research Council, Pakistan Indian Institute of Science, India Tamil Nadu Agricultural University, India Indian Institute of Tropical Meteorology, India Bureau of Meteorology and Geophysics, Indonesia Bogor Agricultural University Global Change System for Analysis, Research and Training
Climate Change Impact and Adaptation in the Plantation Sector in Sri Lanka *(Completed)*	Identify adaptation options and assess their feasibility of implementation; build capacity of natural and social scientists to undertake assessment studies.	Sri Lanka Department of Meteorology Sri Lanka Association for Advancement of Science Tea Research Institute, Sri Lanka Coconut Research Institute, Sri Lanka University of Peradeniya, Sri Lanka

Prediction

Working in partnership with leading international climate prediction centers, and through our regional programs, we develop advanced climate models and predictions. These are combined, calibrated and tailored using statistical methods. The combined exploratory and operational research is informed by collaborations and stakeholder demands, often yielding innovations in methods and products.

H. Bhojwani

Project Title	Objective	Partners
Forecast Operations: Routine Forecasts	(i) Provide reliable monthly forecast and verification products for global seasonal climate, ENSO and tropical cyclone activity using state of the art methodologies in seasonal to interannual climate prediction. (ii) Maintain and adapt computer software including dynamical model codes and internet sites that support the forecast operation and its products. (iii) Produce special or focused forecast products in response to user demand.	Max Planck Institute, Germany National Aeronautics and Space Administration/Goddard Space Flight Center, U.S. Center for Ocean-Land Atmosphere Studies (COLA), U.S. Queensland Dept. of Natural Resources, Australia Geophysical Fluid Dynamics Laboratory, U.S. Centro de Previsão de Tempo e Estudos Climáticos (CPTEC), Brazil Climate Prediction Center and Environmental Modeling Center/National Centers for Environmental Prediction (NCEP)/National Oceanic and Atmospheric Administration (NOAA), U.S.
Forecast Operations: Implementation of New or Improved Systems, Tools, Software and Products	Implement new or improved systems, tools, software and products into monthly climate or SST forecasts.	
Improving SST Prediction	Provide the most accurate and reliable predictions possible of global SSTs and of ENSO probabilities.	European Centre for Medium-Range Weather Forecasts NCEP
Statistical Methods	Develop statistical methods for prediction, extraction of predictive information from GCM ensembles, calibration against observed data, and downscaling. Work in this project consists of developing methodological advances, and then working with individuals in the Forecast Operations and IT groups to facilitate transition to operations and software tools.	University of California, Irvine, U.S. South African Weather Service Commonwealth Scientific and Industrial Research Organisation (CSIRO), Land and Water, Australia Fundação Cearense de Meteorologia e Recursos Hídricos (FUNCEME), Ceará, Brazil
Dynamical Regional Model Development and Downscaling	Improve understanding of the physical mechanisms of regional predictability, underpin statistical downscaling methods, and construct downscaled climate information for regional projects.	FUNCEME Beijing Normal University Central Weather Bureau, Taiwan IGAD Climate Prediction and Applications Centre (ICPAC), Kenya South African Weather Service CPTEC, Brazil

Project Title	Objective	Partners
Predictability Research	Improve understanding of the physical mechanisms of regional climate variability on subseasonal-to-interdecadal time scales, through modeling and diagnostic studies, and to direct these advances toward improving predictions of relevant quantities for specific regional projects and forecast operations.	Massachusetts Institute of Technology Max Planck Institute University of California Los Angeles University of California Irvine Lamont-Doherty Earth Observatory COLA Philippine Astronomical, Geophysical, and Atmospheric Service Administration (PAGASA), Philippines
Climate Diagnostics Research	Improve understanding of the climate system on seasonal to decadal timescales utilizing observations and modeling studies and to develop capacity for rapid-response analyses of recent climate events in support of IRI regional projects.	
Variability, Trends and Change	Provide mechanisms and tools for society to cope with climate variability on all temporal scales by placing IRI seasonal climate information and predictions in the context of lower frequency variability, trends and change.	Atmospheric and Environmental Research, Inc. NOAA Climate Prediction Center
Large Ensemble Impact on Predictive Skill in Tier-2 Integrations Using Prescribed Sea Surface Temperature	(i) Assess the impact of ensemble size on seasonal forecast skill, and (ii) assess parameterization of the forecast probability distribution function as a function of ensemble size.	National Center for Atmospheric Research (NCAR), U.S. Max-Planck Institute for Meteorology
Impact of Increased Model Resolution on Predictive Skill in Tier-2 Integrations Using Prescribed Sea Surface Temperature	(i) Asses the impact of increased model resolution on seasonal forecast skill, and (ii) evaluate the potential benefit to the IRI real-time forecast system from increasing resolution.	NCAR Max-Planck Institute for Meteorology
Retrospective Forecasts Made Using Retrospectively Forecast SST	Estimate real-time forecast skill from two of the operational IRI forecast models using hindcasted SST.	NCAR Max-Planck Institute for Meteorology
SST Prediction and Predictability Systems	Improve SST prediction in the tropics on the 1 to 6 month timescale and to better understand the limits of predictability of tropical SST from the viewpoint of both model deficiencies and intrinsic limits in the observed system.	NOAA/Ocean Data Assimilation for Seasonal-to-Interannual Prediction Applied Research Centers Lamont-Doherty Earth Observatory Texas A&M University COLA Tel Aviv University
Real-Time Dynamically-Based Climate Diagnostics of Observations and Forecasts	Improve understanding and attribution of real-time observed and forecasted climate anomalies via use of dynamical techniques.	
Investigating Some Practical Implications of Uncertainty in Observed in SSTs	Improve understanding of the implications of uncertainties, such as those due to bias, sampling and random errors.	NOAA's Office of Climate Observations/Cooperative Institute for Climate Applications and Research (CICAR)
Forecasting Tropical Cyclone Activity Using Atmospheric General Circulation Models	Develop and improve operational tropical cyclone forecasts products, increasing coastal societies' preparedness for tropical cyclone impacts.	South African Weather Service Max Planck Institute for Meteorology

Project Title	Objective	Partners
Development of Global Model Systems for Prediction and Predictability Studies	Improve predictive skill and understanding of predictability limits by improving some aspect of global models, including numerics, physics, or boundary conditions.	
Performance-Based Probabilistic Multi-Model Climate Change Scenarios *(Completed)*	Develop probabilistic multi-model scenarios that will reflect the most reasonable estimates of changes in regional climate and its variability according to the available modeling and observational evidence.	National Science Foundation
The Predictability of Onset and Character of Warm Season Rains in South America Using a Nested Modeling System *(Completed)*	Examine higher order rainfall statistics from a gridpoint regional climate model nested in GCM historical ensemble integrations.	NOAA/Climate Diagnostics Center University of Lund, Sweden
Data Assimilation for Coupled Predictability and Prediction *(Completed)*	Improve understanding of how data assimilation impacts coupled model forecasts.	NOAA Applied Research Center/ODASI - Geophysical Fluid Dynamics Laboratory COLA NASA's Seasonal to Interannual Prediction Project

Climate & Environmental Monitoring Research

By providing data, analyses, and expertise in data and the diagnoses of climate anomalies, we ensure that up-to-date and comprehensive real-time climate-related information is available to support climate risk management activities. This includes the ongoing development of data and analysis tools as well as climate and vulnerability indices for use in conjunction with seasonal forecasts.

J. Hansen

Project Title	Objective	Partners
Malaria Early Warning System (MEWS) Project Domain - Activities in support of IRI-PAHO/WHO Collaborating Center on Early Warning Systems for Malaria and other Climate-Sensitive Diseases	(i) Provide the evidence of the role of climate in disease dynamics and assess the value of such evidence to improving epidemic prevention and control; and (ii) provide tools and training in order to develop the capacity of disease control staff to use the information created in improving 'real world' decisions.	PAHO/WHO
IRI Data Library	Faciliate data exchange by providing a WWW data library that provides multi-disciplinary access to data needed to study short-term climate change and its impact.	Thematic Real-time Environmental Data Distributed Services OpenDAP Distributed Ocean Data Sets

Project Title	Objective	Partners
Environmental Information Systems Database Development	Provide frequently updated, near 'real-time', information on those various environmental processes that are considered useful to the IRI's regional programs.	Center for International Earth Science Information Network (CIESIN) USGS NASA WCRP/GEWEX Food and Agriculture Organization (FAO) of the U.N.
Map Rooms - Capability Enhancements	Enhance society's ability to understand climate variability and its synergistic relationships with other environmental factors for applications in various sectors and decision systems.	
IRI Climate Information Digest	Create awareness of ongoing climate events around the world and the impacts they have on society, to provide some basic education about the change of seasons and climatology, and to provide context for seasonal forecasts.	NOAA/Office of Global Programs
Data Library Mirror Site Pilot Project *(Completed)*	Provide local Data Library access and functionality.	Central Weather Bureau, Taiwan

Impacts Research

Our research is designed to help understand the impact of climate fluctuations on various societal outcomes-of-interest, such as malaria incidence in Botswana, crop yields in Gujarat and tax receipts in Indonesia. By considering the question of why climate matters to these outcomes, we aim to better contribute to the drafting of evidence-based policy and practices.

J. Hansen

Project Title	Objective	Partners
Improving Locusts Outbreak Forecast in Africa and Asia using Climate Forecast Products (Pilot Project)	Understand the relationship between meteorological/climatic factors and the outbreak of Desert Locust by analyzing the historical data available (1930 to present) on Desert Locust outbreak and climatic factors; and, to improve and tailor forecasting products.	FAO
Malaria Early Warning System: Building on Botswana Work and Scaling Up to Other Epidemic-Prone Countries in Africa	Provide the evidence of the role of climate in disease dynamics in African countries and to assess the value of such evidence to improving epidemic prevention and control; and, provide tools and training in order to develop the capacity of disease control staff to use the information created in improving malaria control decision-making in Africa.	

Project Title	Objective	Partners
Predictability of Crop Yields in West Africa Using Seasonal Climate Forecasts	Assess the predictability of crop yields in West Africa, particularly in Mali, Burkina Faso and Côte D'Ivoire, using seasonal climate forecasts and soil information.	Tropical Agriculture Program, Earth Institute, CU
Determinants of Meningitis in Ethiopia	Develop forecasting models to predict meningitis epidemics within sub-Saharan Africa by incorporating epidemiological, weather and environmental information at the local level; improve epidemic meningitis control through a better understanding of the etiology of the disease in its epidemic form and the local environmental determinants.	Liverpool School of Tropical Medicine, U.K. Ethiopian Ministry of Health
Documentation and Characterization of Drought Disasters and Hazards	Review over 800 historical drought disasters and 76 famines in EM-DAT, with reassignment of dates and loss data as necessary according to a strict methodology, use the resulting data as a basis for studying characteristics of drought hazard events that are associated with drought disasters.	Center for Research of the Epidemiology of Disasters, Université Catholique de Louvain, Belgium
Routine Residual Spray Programs in Angola, Uganda and Zambia - Seasonality of Malaria Transmission *(Completed)*	Provide initial information, through the IRI Data Library, on the seasonality of malaria transmission, and contribute to USAID/RTI development activities to support residual spraying in epidemic prone areas in Tanzania, Angola and Uganda.	RTI International
Identification of Global Natural Disaster Risk Hotspots *(Completed)*	Deliver a global first-order natural disaster risk assessment for all major natural hazards.	Center for Hazards and Risk Research, CU Center for International Earth Science Information Network (CIESIN), CU World Bank United Nations Development Program United Nations Environment Program Working Group 3 on Risks, Vulnerability and Impacts of the International Strategy for Disaster Reduction United Nations Office for the Coordination of Humanitarian Affairs Atmospheric and Environmental Research, Inc. National Center for Atmospheric Research Middlesex University World Food Program Norwegian Geotechnical Institute United States Geological Survey
Disaster Risk Indexes Comparison (DRIC): Global Natural Disaster Risk Hotspots, The Disaster Risk Index (DRI) and Indicators for Disaster Risk Management for the Americas (RIA) *(Completed)*	Help stakeholders, government and the international community to understand how three disaster risk reports and their results can be interpreted in relation to one another, and to produce a forward looking evaluation of the current state of the art, usefulness and complementarity of the three programs for modeling the disaster risk management and to recommend the steps that could be taken to improve their use in disaster risk management.	CIESIN

Project Title	Objective	Partners
Rift Valley Fever Database for the Greater Horn of Africa *(Completed)*	Create a suitable database for the modeling and prediction of Rift Valley Fever outbreaks in the Greater Horn of Africa.	African Union-Interafrican Bureau of Animal Resources
Dust and Dry Season Analysis for the Sahel (Completed)	Create health-relevant gridded climate and environmental data sets for use in regional and local analysis of climate/land use/health interactions.	University Abdou Moumouni of Niamey, Niger
Disaster and Risk Field Assessments: Natural Hazards Disaster Review of the December 2004 Tsunami-Affected Areas of India *(Completed)*	Contribute to the sustainable risk mitigation approach in India, in particular: (1) to construct a geographical information systematic historical record of the diverse set of hazards that triggered the disasters in the India affected areas during the last century, and (2) recommend the application of wise land use policies which combine knowledge and lessons from the past disaster history of the affected areas.	CIESIN Center for Research on Environmental Decisions, CU
El Niño Drought Impacts in 2002/2003: A Comparative Study of National Media Coverage *(Completed)*	Use social scientific methods of media analysis to understand the social effects of and responses to climate anomalies in particular countries by reviewing publicly available national media coverage.	University Corporation for Atmospheric Research Earth Institute, Columbia University

Decision Systems Research

Decision systems research involves the study and enhancement of decision strategies in order to better incorporate climate risk and related environmental information. The research also includes methodologies for developing the specific climate and environmental information to inform decisions over a range of sector and problem contexts.

A. Giannini

Project Title	Objective	Partners
Climate Information-Based Water Allocation with Decision Analyses on Multi-Sectoral Applications Research and Tool Development **– Multi-Objective Reservoir Analysis Using Probabilistic Streamflow Forecast (MORAPS)**	Integrate rainfall forecasts and climate information to inform and optimize decision systems for improved water resource allocation. –Develop a generic decision tool for water allocation using seasonal streamflow forecasts.	Columbia University-Department of Earth and Environmental Engineering University of Nairobi Meteorology Department Fundação Cearense de Meteorologia e Recursos Hídricos, Ceará, Brazil National Water Resources Board, Philippines Metropolitan Waterworks and Sewerage System, Philippines
Decision Making Under Uncertainty - Extreme Climate Events in NY	Develop interventions that can facilitate improved mental models of the climate distribution by correcting for cognitive and affective (emotional) biases.	Center for Research on Environmental Decisions (CRED), CU

Project Title	Objective	Partners
Climate-Based Crop Forecasting Methodology Development and Intercomparison	Contribute to the welfare of rural communities dependent on crop production by advancing the use of dynamic climate forecasts for prediction of crop production at multiple scales, and quantitative analyses of crop and farm management responses to forecasts.	Queensland Department of Primary Industries and Fisheries, Australia University of Florida Department of Agricultural and Biological Engineering French Agricultural Research Centre for International Development (CIRAD) International Crops Research Institute for the Semi-Arid Tropics, Kenya
Developing and Evaluating Methodologies to Create Information about Land-Surface Characteristics that are Influenced by Hydroclimatic Variablity	Improve our ability to develop decision support information where detailed knowledge of land surface characteristics are needed.	National Aeronautics and Space Administration Mahaweli Authority, Sri Lanka
Exploring the Properties of Market Mechanisms (including Insurance) for Managing Climate Risk	Improved management of climate risk through market/insurance mechanisms; in particular, to explore the theoretical properties of different market mechanisms intended to trigger positive outcomes in the presence of information about climate risk, including seasonal forecasts; and, to provide guidance on the effectiveness of different approaches.	CRED, CU Commodity Risk Management Group-World Bank
Climate-Related Decision Support Research, Development and Implementation for the Millennium Villages	Evaluate climate variations and trends that are important to achieving and evaluating the Millennium Development Goals (MDG) at Millennium Villages in eastern Africa.	Earth Institute MDG Support Center, Kenya International Center for Research in Agroforestry

Institutions & Policy Systems Research

Institutions and Policy Systems research focuses on the development of methodologies for mapping existing institutions and policies, and analyzing the role of policy responses in development outcomes. This research enables the identification of key decision points into which climate information can be integrated.

E. Ebrahimian

Project Title	Objective	Partners
Mapping Institutions and Policy Responses	Develop and pilot methodologies to map institutions and policy processes to manage climate-related problems, initially in the context of diverse demonstration sites in Southeast Asia, including: 1) managing competing water uses for the Angat Reservoir, Philippines; 2) Food security in Nusa Tenggara Timur, Indonesia; 3) Integrated water resources management in Bali, Indonesia.	Institute for Strategic Planning and Policy Studies, University of the Philippines Los Baños Center for Agricultural and Rural Development Studies, Bogor Agriculture University, Indonesia Udayana University, Indonesia

Project Title	Objective	Partners
Methodologies to Analyze Policy Responses and Development Outcomes	Analyze policy responses to climate-related problems on two fronts: (1) using Bayesian modeling to investigate development outcomes of drought and policy responses, and (2) analyzing rice production data in Indonesia and the Philippines to identify the role of climate variability, and assess the potential for integrating climate information into rice import decision making.	Philippine Dept. of Agriculture, Bureau of Agricultural Statistics Ministry of Agriculture, Indonesia Institute for Development Studies Jaipur; Udayana University
Methodologies to Analyze the Institutional Utility of Climate Information	Investigate current and past uses of climate information, via a literature review and focused country/regional case studies, and to assess the benefits and costs of climate information use by institutions.	
Social Meanings of Climate Information	Investigate meanings attributed to climate information, derived from the social embeddedness of the institutions that generate them, via: 1) Climate Outlook Forums and 2) indigenous forecasting methods.	

EDUCATION

Through the development of curricula, training modules, training courses, workshops, academic program graduates, and visiting scientist opportunities, our aim is to continually expand a knowledge base of climate risk management approaches. Our learning products and tools are increasingly developed in modular formats that allow for tailored packaging of relevant information around targeted problems or sectors.

J. Hansen

Project Title	Objective	Partners
Regional Climate Outlook Forum Support, Nordeste, Brazil	Improve climate variability management in the region by enhancing the capacity (i) of climate forecasters to implement approaches and evaluate their expected skill when applied in real-time and (ii) among RCOF partners to achieve measureable improvements in selected aspects of climate variability management.	Instituto Nacional de Meteorologia Centro de Previsão de Tempo e Estudos Climáticos U.K. Met Office
Dynamical Downscaling Training	Foster a network of expertise for cutting-edge issues and methods in downscaling.	National Oceanic and Atmospheric Adminstration/Office of Global Programs (OGP) Scripps Experimental Climate Prediction Center

Education (continued)

Project Title	Objective	Partners
Climate Predictability Tool Training	Foster a network of expertise for improved understanding of climate predictability.	World Meteorological Organization Commission for Climatology Expert Team
Tutorials/Workbooks **–Dynamical Downscaling** **–Climate Predictability** **–Climate and Agriculture** **–Climate and Malaria**	Create stand-alone training materials and best practices that can be utilized in regions for: –creating regional climate products; –understanding of climate predictability as well as to inform best practices for the development of climate forecasts; –broader uptake and understanding of climate and environmental influences and control opportunities.	Columbia Center for New Media Teaching and Learning
Master's Program in Climate and Society	Enable numerous IRI staff in teaching, mentoring, and/or course curricula development; to educate diverse population of master's students in climate-informed approaches to problem solving; to stimulate faculty recognition of the importance of climate informed development training at Columbia University.	The Earth Institute at Columbia University Department of Earth and Environmental Sciences, CU
Visitors Program	Build a global network of resource managers, innovative senior scientists, and policy leaders dedicated to collaboration in the search for development solutions.	The Earth Institute at Columbia University Additional partners pending
Regional Climate Outlook Forum Support, Africa *(Completed)*	Improve climate variability management at the national level in Africa by enhancing the capacity (i) of climate forecasters to implement approaches and evaluate their expected skill when applied in real-time and (ii) among RCOF partners to achieve measureable improvements in selected aspects of climate variability management.	IGAD Climate Prediction and Application Center (ICPAC), Nairobi (formerly DMC, Nairobi) Drought Monitoring Center, Harare ACMAD World Meteorological Organization NOAA/Climate Program Office (formerly OGP)
Climate and Society Reference Tool *(Completed)*	Advance research and activities related to the applications of climate information by facilitating multi-disciplinary thinking and cooperation among stakeholders.	NOAA/OGP
Advanced Training Institute on Climatic Variability and Food Security *(Completed)*	Equip young agriculture and food security professionals in developing countries to apply advances in climate prediction at a seasonal lead time to their home institutions' ongoing efforts to address climate-sensitive aspects of agricultural production.	Global Change System for Analysis, Research and Training The David and Lucile Packard Foundation
Climate and Malaria Training (in French) *(Completed)*	Enable incorporation of relevant climate and environment information toward early warning systems for malaria epidemics and to enable effective control programs in the languages appropriate to the control program regions.	Ministère de la Santé, Institut d'Hygiène Sociale, Antananarivo, Madagascar/RTI International

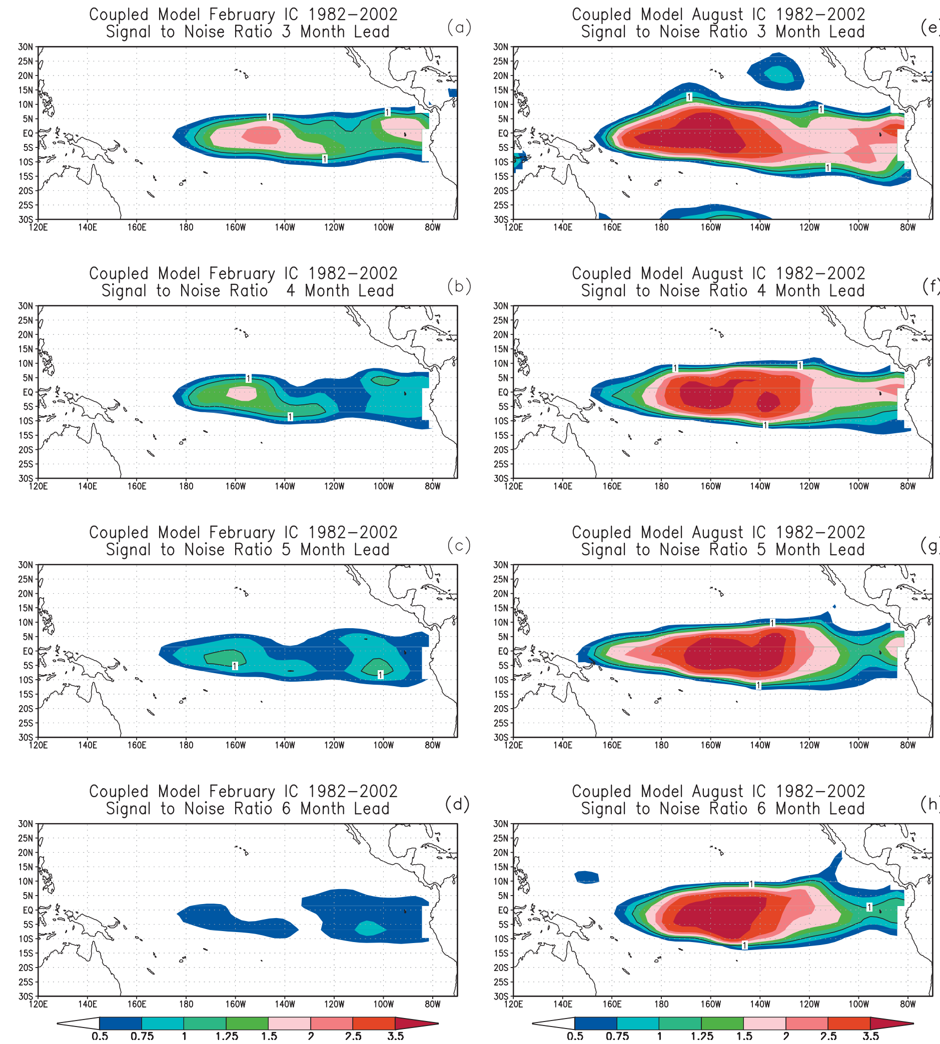
Selected Accomplishments

Coupled Model Systematic Error Diagnostics ■ IRI Global Climate Forecasts ■ Regional Climate Change Projections ■ Estimating Seasonal Precipitation Tercile Probabilities from Ensembles ■ Generalized Probabilistic Climate Forecasts ■ Late 20th century Sahel drying in the IPCC 4AR simulations ■ Cluster Analysis of Typhoon Tracks ■ Deconstructing the Indian Monsoon: Analysis of Daily Precipitation using a Hidden Markov Model ■ ENSO Prediction ■ Potential Predictability of Local Daily Rainfall Statistics ■ Intercomparison of Statistical Weather Downscaling Methods ■ Climate Dynamical Modeling for Regions ■ Analysis-based Precipitation Monitoring ■ The 1997-98 Summer Rainfall Season in Southern Africa ■ Enabling Better Searches in the IRI Data Library ■ Environmental Monitoring ■ Standardizing Drought-related Losses in EM-DAT ■ Fine Scale Natural Hazard Risk and Vulnerability Identification Informed by Climate in Sri Lanka ■ Subseasonal Characteristics of Rainfall in Central West Africa using a Hidden Markov Model ■ Potentially Predictable Components of West African Summer Rainfall ■ Development and Training on Malaria Early Warning Systems ■ Supporting Climate Risk Management in Smallholder Farming in Kenya ■ Space-Time Modeling: Determinants of Meningitis Epidemics in Ethiopia ■ Index Insurance and Climate Risk Management in Malawi ■ Reversal of the ENSO Rainfall Signal in the Philippines ■ Regional Climate Modeling and Downscaling for Indonesia and the Philippines ■ Managing Competing Water Uses in the Philippines: Angat Reservoir ■ Managing Food Security Using Climate Information: Nusa Tenggara Timur, Indonesia ■ Climate Risk and Elephant Management in Sri Lanka ■ Climate and Coconut Production in Sri Lanka ■ Climate Change/Variability in the Mixed Crop/Livestock Production Systems of the Argentinian, Brazilian and Uruguayan Pampas: Climate Scenarios, Impacts and Adaptive Measures ■ Longitudinal Study of the Process of Communicating Climate Forecasts in Ceará, Brazil

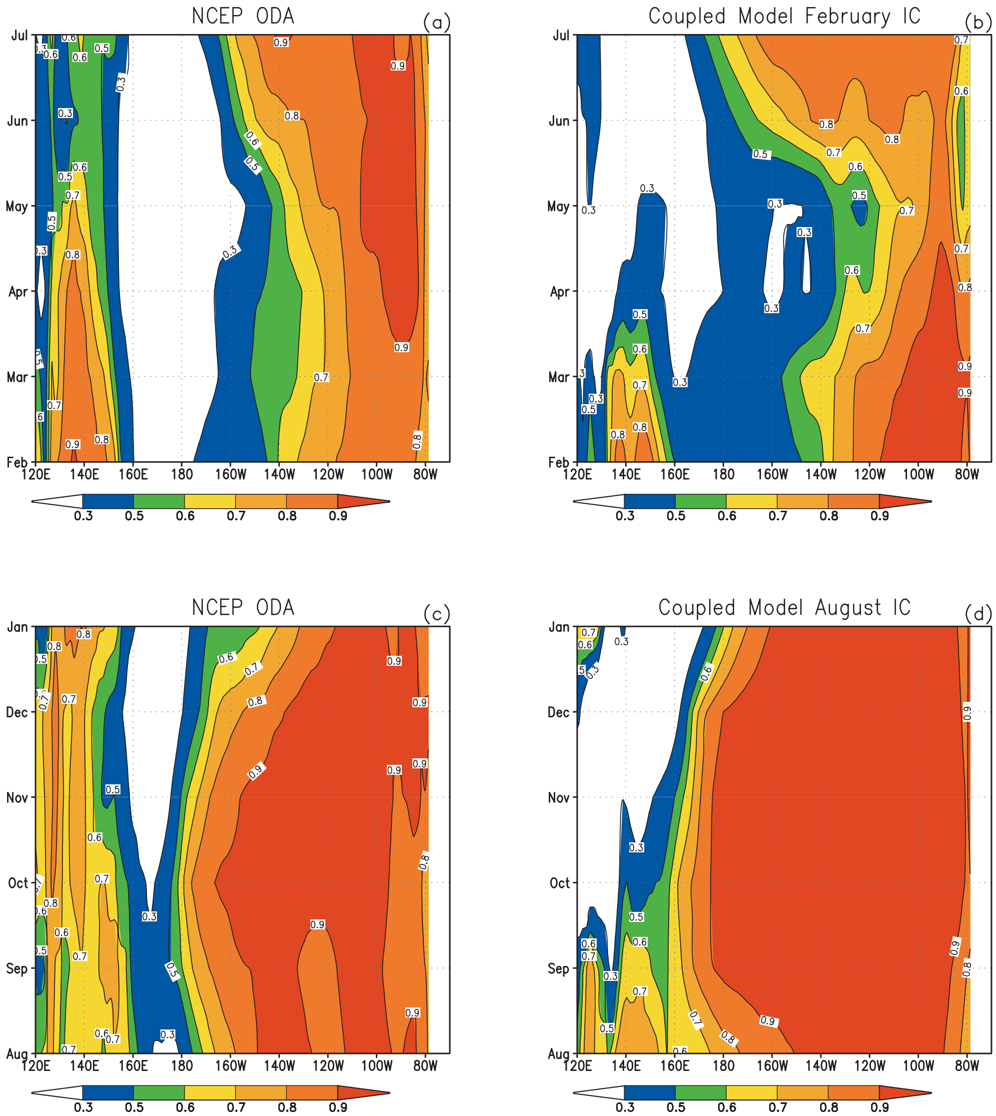
Coupled Model Systematic Error Diagnostics

The evaluation and development of global dynamical seasonal forecast tools, and the dynamical diagnostics of seasonal climate anomalies are the primary foci of IRI work in dynamical prediction systems. Currently, this work is focused on the development of coupled atmosphere-ocean models with the goal of improving seasonal forecast skill of anomalous sea surface temperature (SST), precipitation, and near-surface air temperature in the tropics. These models are being used in prediction and predictability studies at IRI. The atmospheric component models in use range in complexity from statistical models to full atmospheric general circulation models (AGCMs). The oceanic component models range in complexity

Signal-to-noise ratio for coupled model SST forecasts for the tropical Pacific at different lead times. Warmer colors indicate <None>33larger signal-to-noise ratios; cooler colors indicate smaller signal to noise ratios. (a)-(d) February 1 initial condition forecasts at leads of (a) 3, (b) 4, (c) 5, and (d) 6 months. Note the decreasing signal-to-noise ratio with increasing lead time which is associated with a breakdown in predictability (spring barrier) over this period. (e)-(h) August 1 initial condition forecasts at leads of (e) 3, (f) 4, (g) 5, and (h) 6 months. Note that the signal-to-noise ratio remains high even with increasing lead time.



from simple slab thermodynamic ocean models to full oceanic general circulation models (OGCMs). Results from one of these coupled models have recently been used to investigate the cause of the spring SST predictability barrier in coupled forecast models. The figure above shows the signal-to-noise ratio for SST from the coupled model for forecasts begun before the spring barrier (February 1 initial condition) and after the spring barrier (August 1 initial condition). Forecasts passing through the spring barrier are seen to have a much smaller signal-to-noise ratio compared to those forecasts that do not pass through the spring barrier. The cause for this smaller signal-to-noise ratio during the spring barrier period is hypothesized to be due to the decoupling of the oceanic surface mixed layer water from the underlying subsurface water. The figure below shows the local correlation between SST and upper ocean heat content (HC) along the equator as a function of time for observations (NCEP ODA) and coupled model forecasts starting from February 1 and August 1 initial conditions. The coupled model is seen to do a reasonable job of simulating the observed coupling between SST and HC in the central and eastern



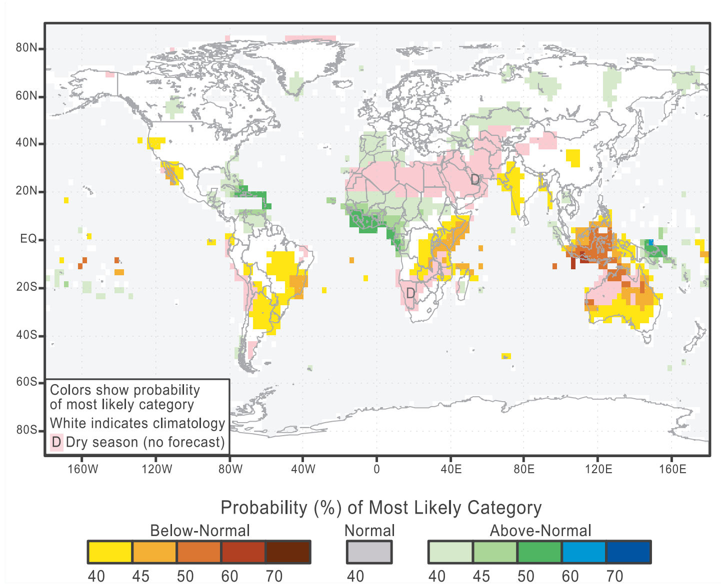
Correlation coefficient between SST anomalies and upper-ocean heat content anomalies averaged between 2°S and 2°N as a function of month, with time increasing upward along the vertical axis for observations (left panels) and model results (right panels). Warmer colors indicate stronger correlations; cooler colors indicate weaker correlations; a perfect model would show the same pattern as the observations. (a) NCEP Ocean Data Assimilation product. (b) Coupled model forecast starting from February 1 initial condition. Note that the correlations in the central and eastern Pacific weaken starting in mid-March with significant departures from April onward. (c) NCEP Ocean Data Assimilation product. (d) Coupled model forecast starting from August 1 initial condition. Note that the model correlations for the central and eastern Pacific remain consistently high.

Pacific for the August 1 forecasts but is seen to have too weak a coupling starting around April for forecasts that start from February 1. The decoupling of the mixed layer temperature anomalies from the subsurface temperature anomalies means that the mixed layer is more susceptible to stochastic processes such as anomalous heat fluxes. This model result is consistent with several recently published observational studies.

IRI Global Climate Forecasts

Each month, IRI issues probabilistic net assessment forecasts of seasonal precipitation and temperature for approximately 2° latitude-longitude boxes for all land areas across the globe. The forecasts are issued for four overlapping 3-month periods over the coming six months. For example, in January, forecasts are issued for February to April (FMA), March to May (MAM), April to June (AMJ), and May to July (MJJ). Probabilities are given over three broad categories of occurrence: above normal, near normal, and below normal. Probabilities are also given for the likelihood of a seasonal extreme, compared to a historic record of 30 years, defined as less than the 15th

IRI Multi-Model Probability Forecast for Precipitation for Aug.-Sept.-Oct., issued July 2006



percentile, or greater than the 85th percentile, of historic occurrence. Multi-model ensemble predictions from a set of atmospheric general circulation models, themselves governed by current sea surface temperature predictions, provide the primary input to these forecasts (see also Global Sea Surface Temperature Forecasts). The forecast probabilities are then analyzed and adjusted subjectively by climate experts, yielding the IRI net assessment forecasts.

The use of multi-model ensembling algorithms has resulted in more objective and efficient forecast processes in recent years. IRI currently employs two methods of multi-model combination. The first is a Bayesian approach. The weights of the individual models are determined by maximizing a measure of skill for their combination over the historical hindcast period, where the climatological equal-odds forecast is the default forecast in the absence of model skill. The second approach uses canonical variate analysis (CVA), which is a type of discriminant analysis. It is mathematically similar to canonical correlation analysis, but predicts forecast categories probabilistically rather than as discrete values. The CVA-derived forecast probabilities for the individual models are then averaged together. Finally, the probabilities produced by the Bayesian approach and by the CVA are averaged to obtain the final forecast probabilities.

An examination of the correspondence between forecast probabilities and subsequent observed relative frequencies among IRI's net assessment forecasts, the objective multi-model forecasts, and single AGCM results has been undertaken. Comparable performance is observed for the net assessment and the multi-model ensemble methods, indicating that the objective forecast system is approaching the skill of that system, but that human intervention in the form of subjective final forecast adjustment continues to result in an improved product. The objective system brings great promise for further improvement through inclusion of significantly more inputs than could be considered using the more labor-intensive, subjective approach.

The science of climate forecasts begins with sea surface temperatures (SSTs), where the ocean meets the atmosphere. SSTs are the strongest influences on climate and the keys to climate prediction. Among SSTs, the most important are those of the tropical oceans. And among those oceans, says veteran IRI research scientist Lisa Goddard, "The tropical Pacific is the 800-pound gorilla. It's so big, it has global connections." This gorilla shapes the seasonal weather for Africa, Asia, and South America, and even exerts the biggest influence on rainfall in the United States.

Goddard is adept at explaining the ingredients of climate science: "You typically have very cold water along the equator coming off of South America, and very warm water where all of the strongest, deepest convection in the world happens–in the western Pacific over the Indonesian area. That means you've got a temperature difference between the east and west sides of the Pacific. Winds want to move towards the warmest water, she says, so they move from east to west. As they do, so the earth rotates, leading to a divergence of winds off the equator, and a divergence of water. "So you're pushing water off the equator, and that brings up cold water from the subsurface. The east-to-west winds maintain an east-to-west temperature difference," she says.

"But let's say a pulse of warm water comes across, and now cold water from the deep is not making it to the surface. That weakens the east-to-west temperature difference, which weakens the east-to-west winds, and that's going to pull up even less cold water, so it's going to get warmer. You can get this positive feedback cycle, and you can get an El Niño condition of warm water in the east Pacific."

These conditions, in turn, eventually alter the structure of the western Pacific, which leads to changes that ultimately replace the warm waters of El Niño with the colder waters of La Niña, the next phase. These two phases proceed on predictable time-scales. "If you're measuring how the ocean's structure is changing in response to the wind," says Goddard, concluding the lesson, "you can put that ocean structure into an ocean model."

"We're not trying to say exactly what will happen," says Goddard, "but to make the probabilities of what may happen correct. So if we say that below normal conditions are 60 percent likely, then 60 percent of the time we say that conditions should be below normal. That would be a reliable forecast."

While Goddard spends her days immersed in SSTs and computer models, her research colleague, Simon Mason, works to make IRI's climate data more understandable and useful to meteorological services and other users. Mason is the principal designer of IRI's unique Climate Predictability Tool (CPT). Anyone with an internet connection and Windows software can access the CPT and quickly produce a forecast based on the latest data–for no charge. Like much of the work at IRI, the CPT is a direct response to a problem. Since 1997, IRI has been participating in Climate Outlook Forums (COFs) held in Africa. The forums' purpose is to reduce the climate-related risks by strengthening the continent's meteorological services. In earlier years, the meteorologists spent most of the two-week forum producing a seasonal forecast for their countries. "It was very expensive and very slow," says Mason, and some of the forecasts were scientifically suspect. "CPT was designed to do those problems," says Mason, who spends a lot of time in Africa training meteorological services personnel to use the tool. "It was designed to be very easy to use, and easy to set up your analysis. Now most people can make forecasts in a matter of an hour or two rather than in two weeks."

Because the CPT is so easy to use, many countries are producing climate forecasts every month rather than once or twice a year. Further, the forecasts made by neighboring countries now tend to agree, which allows for consistent regional and even subcontinental forecasts.

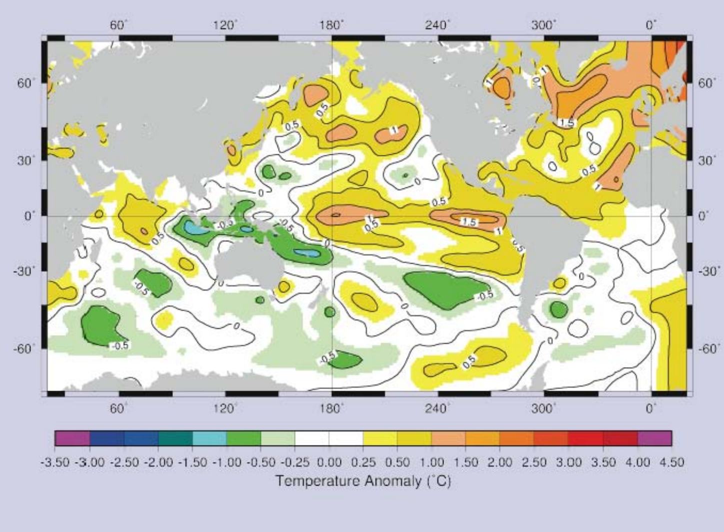
Mason next hopes to persuade meteorologists to produce tailored forecasts in language that any user can follow. "I want them to start getting to the point where they're understanding what the agricultural community needs to know, for example, and how to provide climate information in a way that meets those specific needs." For instance, it does no good to tell farmers, "The probability is 40 percent that the upcoming season's rainfall will be in the upper tercile."

"That's way too abstract, virtually incomprehensible," says Mason. Instead, he has been urging meteorological services to ask farmers how much rain they need for a particular crop, and then to tell them what their chances are of getting that amount in the upcoming season. It comes down to communication with users, whether they be farmers, water managers, or health officials.

That's what has been happening recently in Swaziland, according to Mandla Dlamini, who does climate data management in Swaziland's meteorological services. Dlamini was trained by Mason and uses the CPT every month. "IRI has helped us to identify the areas that we need to address for our users," he says. "Swaziland now uses climate information for planning agricultural activities, water management, and energy. The information is also applicable in malaria management and for cholera."

Farmers and others have started to trust the forecasts. This success, however, is a mixed blessing, because increasing demands for climate information have stretched a thin staff even thinner. "For example, the whole country has only one agro-meteorologist," says Mandla, "which means that he has to produce all these advisories for agricultural purposes in both winter and in summer. It is quite a task for one person. I would love to see some capacity-building for the country and for the meteorological services."

Mason agrees. "Because some countries are so poor, they don't have resources dedicated to forecasting, and the meteorologists have not been able to get the training required to communicate with nonmeteorologists. They also often have too many tasks. Having said that," he adds, "one reason I like working in Africa is that there is a lot of enthusiasm, a lot of will to make progress. I find it very fulfilling, going into the field, working with people who have to face these climate problems firsthand, assisting them with the development of their services, and trying to make a difference."

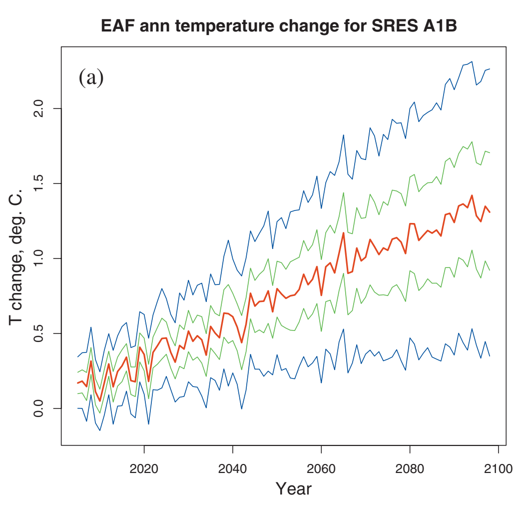


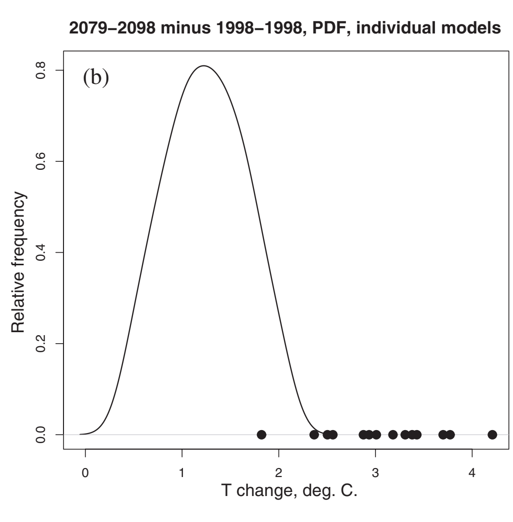
Regional Climate Change Projections

Even more challenging than predicting how the globally averaged temperature is likely to change is attempting to project temperature changes in particular regions of the globe. In a general way, the increased difficulty results from a reduction in constraints: As a whole, the Earth's climate must eventually come into balance with energy received from the sun. At the regional level this strong constraint does not operate, however, since the various regions can exchange energy with the oceans, or indirectly, with one another, through oceanic or atmospheric motions.

One approach for dealing with regional climate-model uncertainty is to combine models, perhaps giving extra weight to those that have best simulated the observed climate variations of the twentieth century. Such an optimal combination of models can then be used to produce climate projections, or forecasts, for the century to come. The figure shows a regional temperature projection that has been generated in just this way, for eastern Africa, under the assumption that greenhouse gas concentrations by 2100 will have risen to somewhat less than twice the level of the 1990s (scenario "SRES A1B"). Notable here is that the scheme for combining climate models produces a somewhat lower estimate of the expected temperature change than would a simple average of the underlying models. This reflects the relationship between climate models and observations during the twentieth century, the calibration period for this multi-model climate projection.

Projections such as these are only a starting point for the near-term climate forecasts presently under development at the IRI. Such forecasts are intended to serve decision makers, who are typically constrained, by practical considerations, to considering time horizons of at most a few decades. The projections will provide estimates of expected changes in mean regional climates, while additional studies will provide information on expected variability about the projected means.





(a) Projected time series of annual-mean east African temperatures for 2005-2098, relative to 1979-1998. The projection is given in probabilistic form, the red central trace representing the mean, the green and blue lines the 25%-75% and 5%-95% uncertainty bands, respectively. (b) Mean temperature change for the years 2079-2098. Here, the projection is shown as a probability distribution (solid line), temperature changes as given by the individual climate models as circles.

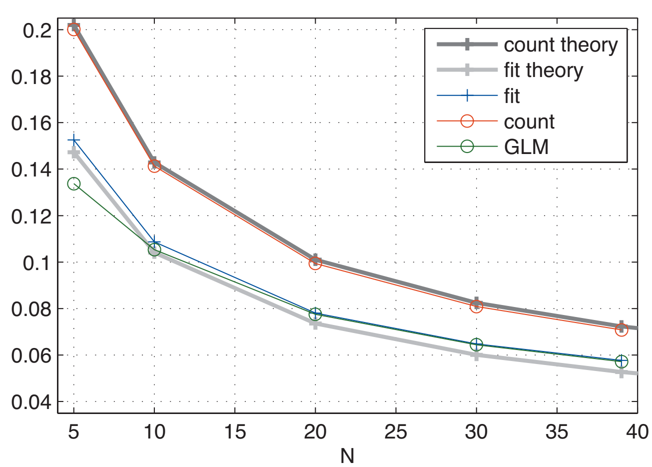
Estimating Seasonal Precipitation Tercile Probabilities from Ensembles

Seasonal climate forecasts are necessarily probabilistic, and so may be characterized by a probability density function (pdf). The IRI issues seasonal forecasts of precipitation and temperature in the form of tercile-based categorical probabilities–that is, the probability of the below-normal, normal and above-normal categories. These three probabilities provide a coarse-grained description of the forecast pdf. Forecasts that differ from equal-odds probabilities, to the extent that they are reliable, are indications of predictability in the climate system. Accurate estimation of the tercile probabilities is important for making accurate climate forecasts.

Tercile probabilities are estimated from a finite number of model ensembles. A simple estimate of the tercile probabilities is the fraction of ensemble members that fall into each category. Alternatively, the entire forecast pdf, including tercile probabilities, can be estimated by fitting a pdf with adjustable parameters (mean, spread, shape, etc.) to the ensemble data. Here a normal distribution is used. The counting method has the advantage of making no assumptions about the form of the forecast pdf. Both approaches are affected by sampling error due to finite ensemble size.

We compared theoretical descriptions of the accuracy of the counting and Gaussian tercile probability estimators with empirical ones obtained by sub-sampling from a large ensemble of GCM simulations. The figure below shows that the spatially averaged error of the precipitation tercile probabilities is well described by theory and that the error of the estimator based on fitting a a normal distribution is smaller, on average, than that based on the counting estimator. Strikingly, the error level of the normal fit estimate with ensemble size 24 is comparable to that of a counting estimate with ensemble size 40. A third approach, known as a generalized linear model (GLM), has accuracy similar to as the normal fit.

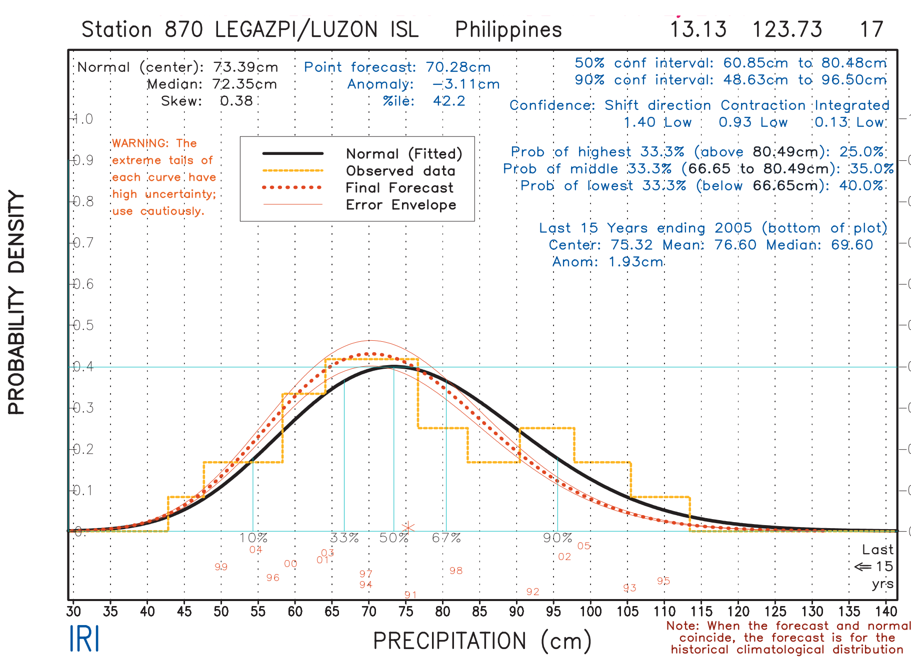
Spatially averaged rms error of the below-normal probability as a function of ensemble size N. The gray curves are the theoretical error levels for the counting and Gaussian fit methods. The colored curves are the error levels obtained by sub-sampling from a large ensemble of GCM precipitation simulations.



Generalized Probabilistic Climate Forecasts

Because the uncertainty in climate predictions for upcoming seasons is too large to forecast as a narrow range, forecasts are expressed in terms of probabilities of wide outcome ranges. Since the beginning of IRI's climate forecast production in 1997, probabilities have been issued for each of three broad, and equally likely, categories with respect to the observed historical distribution: below-, near-, and above-normal. This forecast format conveys shifts in the odds of the direction of coming climate in a general way, such as a shift toward the below-normal category at the expense of above normal. A fundamental problem with this format is that the ranges of climate outcomes that matter most to users generally do not correspond to the ranges described by these three broad categories. Farmers in northern Argentina, for example, may be most interested in the probability of receiving rainfall in the top 15% of the climatological distribution, and also the bottom 40%, either of these boding unfavorably for crop yield. Most users are not equipped to use the probabilities of the three general categories to construct their own overall distribution and then extract the probabilities of the categories that they need most.

The IRI has developed a product for precipitation forecasts in which the forecast distribution is displayed graphically and compared with the climatological distribution (see figure below). An accompanying probability look-up utility is available in which a user can enter any precipitation amount interval and receive its forecast probability, compared with the probability of the same interval climatologically, based on the long-term record of observations for the given season.



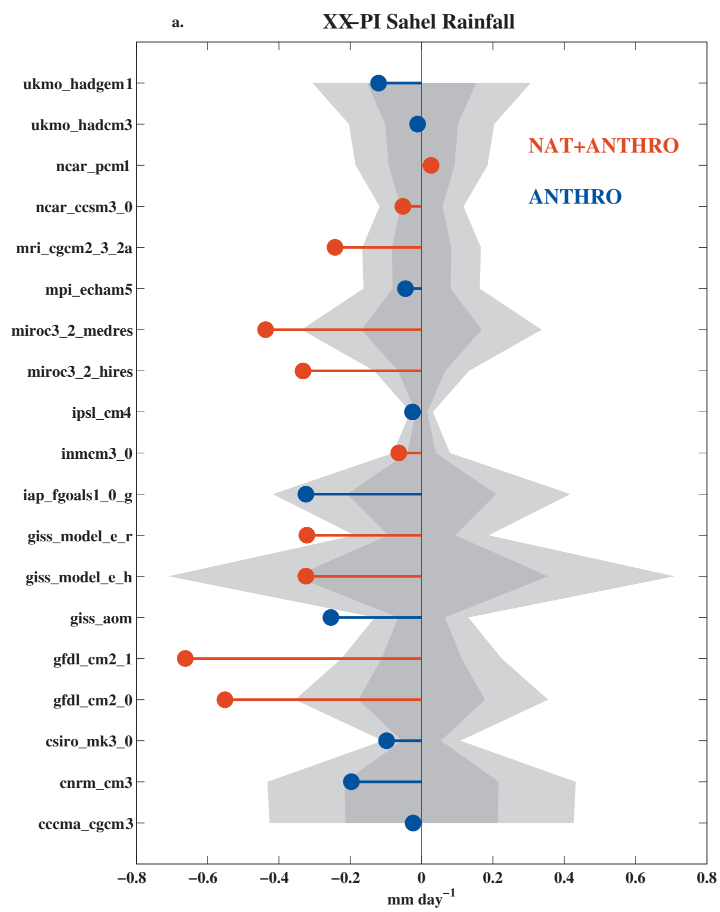
3-Month Total Precipitation Multi-model Probability Forecast for JAS 2006 - 0.5 Month Lead Outlook - Made Mid-June 2006

LATE 20TH CENTURY SAHEL DRYING IN THE IPCC 4AR SIMULATIONS

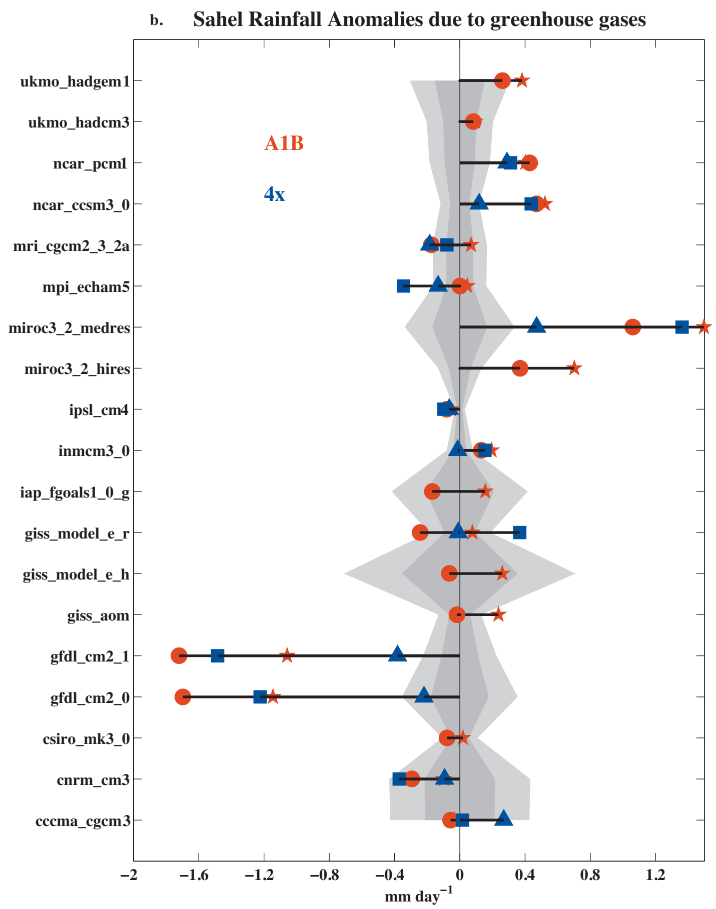
The archive of coupled ocean-atmosphere simulations contributed by 16 climate modeling groups worldwide in preparation for the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 4AR, due to be released in 2007; http://www-pcmdi.llnl.gov/ipcc/about ipcc.php) provides an invaluable tool to assess advances and limitations of state-of-the-art climate models, to explore mechanisms of variability, and to detect change.

A collaborative analysis of rainfall trends in the 20th and 21st century simulations from the IPCC archive, focusing on the semi-arid Sahel region of Africa–a region plagued by recurrent drought since the early 1970s, was undertaken. The study resolved that the combined effect of anthropogenic greenhouse gas and aerosol emissions is a sea surface temperature pattern that is consistent with late 20th century dry conditions in the Sahel; 16 of 19 models simulated significantly drier conditions when compared to the average of pre-industrial, simulations, i.e. those without any variability in the forcings, anthropogenic or natural (see Figure a). However, the consensus breaks down when the change in Sahel rainfall is analyzed in idealized simulations with greenhouse gas forcing only (see Figure b., right side). Then, for past

Difference in mean June-July-August Sahel rainfall between the end of the 20th century in the "20th century" (XX) simulations and a 25-year mean in the Pre-Industrial simulation (PI). The red dots represent models in which XX simulations were forced with varying natural and anthropogenic forcings, while the blue dots represent models forced by anthropogenic forcings only. Grey shading represents the 1 (light) and 2 (dark) standard deviations in 25-year mean Sahel rainfall in the PI simulation.



levels of atmospheric concentrations as well as future, there is consistency in each model's behavior, but the multi-model consensus falls apart. This breakdown points to the necessity to investigate mechanisms of variability and change for tropical precipitation, especially tropical continental precipitation and its relation to the warming of the oceans.



Blue symbols represent differences in mean June-July-August Sahel rainfall between the 4x simulations (in which CO2 is increased at a rate of 1% per year to 4 times the pre-industrial concentration) and the pre-industrial simulations; triangles and squares denote the difference at approximately the time of CO2 doubling and quadrupling respectively. The red symbols represent differences between the A1B scenario simulations at a CO2 concentration of ~700 ppm (years 75-100) and the PI simulations (in circles), or the end of the 20th century in the XX simulations (in stars).

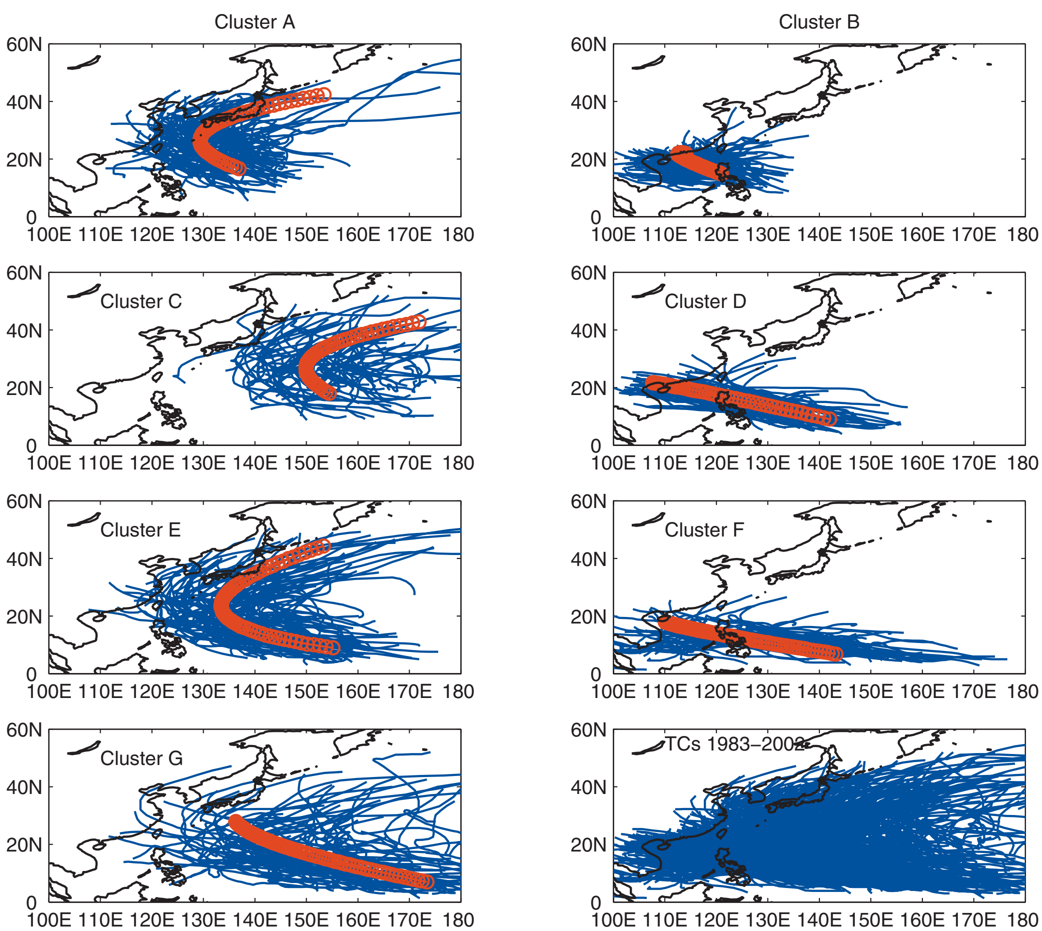
Cluster Analysis of Typhoon Tracks

The impacts of tropical cyclones (hurricanes and typhoons) in our society are very large, both in terms of human lives and economical value, causing more insured losses than any other natural disaster. A better understanding of the climate factors that influence tropical cyclone landfall in specific areas could help save many lives, especially in developing countries.

A new probabilistic clustering technique, based on a regression mixture model, is used to describe tropical cyclone tracks in the western North Pacific (WNP). Each component of the mixture model consists of a quadratic regression curve of cyclone position against time. The Joint Typhoon Warning Center best track data for the period 1950-2002 is best described by seven distinct clusters (shown below).

Both genesis location and trajectory play important roles in defining the clusters. Several distinct types of straight-moving, as well as 'recurving' trajectories are identified, thus enriching this main distinction found in previous studies. Intensity and seasonality of cyclones, though not used by the clustering algorithm, are both highly

Tropical cyclone tracks (blue) over the Western North Pacific, during the period 1983 – 2002 in each of the 7 clusters (named A to G) and for all tropical cyclones; the mean regression curve of each cluster is shown in red open circles.



stratified from cluster to cluster. Three straight-moving trajectory types have very small within-cluster spread, while the recurving types are more diffuse.

The seven clusters have different characteristics, such as genesis location, trajectory, intensity and seasonality. Tropical cyclone landfalls over East and Southeast Asia are found to be strongly cluster dependent, both in terms of frequency and region of impact.

The large-scale patterns of atmospheric circulation and sea surface temperature associated with each of the clusters were investigated, as well as associations with the phase of the El Niño Southern Oscillation (ENSO). Composite wind-field maps over the WNP provide a physically consistent picture of each tropical cyclone type, and of its seasonality. Anomalous vorticity and outgoing long wave radiation indicate changes in the monsoon trough associated with different types of tropical cyclone genesis and trajectory. The steering winds at 500 hPa are more zonal in the straight-moving clusters, with larger meridional components in the recurving ones. Higher values of vertical wind shear in the mid-latitudes also accompany the straight-moving tracks, compared to the recurving ones.

The influence of ENSO on tropical cyclone activity over the WNP is clearly discerned in specific clusters. Two of the seven clusters (E and G) are typical of El Niño events; their genesis locations are shifted southeastward and they are more intense. The largest cluster (A) is recurving, located northwestward, and occurs more often during La Niña events. Two types of recurving and one of straight-moving tracks (A, B and E) occur preferentially when the Madden-Julian oscillation is active over the WNP region.

The next step will be to analyze the predictability of each cluster on seasonal scales to explore the possibility of forecasting landfall probabilities in different parts of Southern Asia.

Deconstructing the Indian Monsoon: Analysis of Daily Precipitation using a Hidden Markov Model

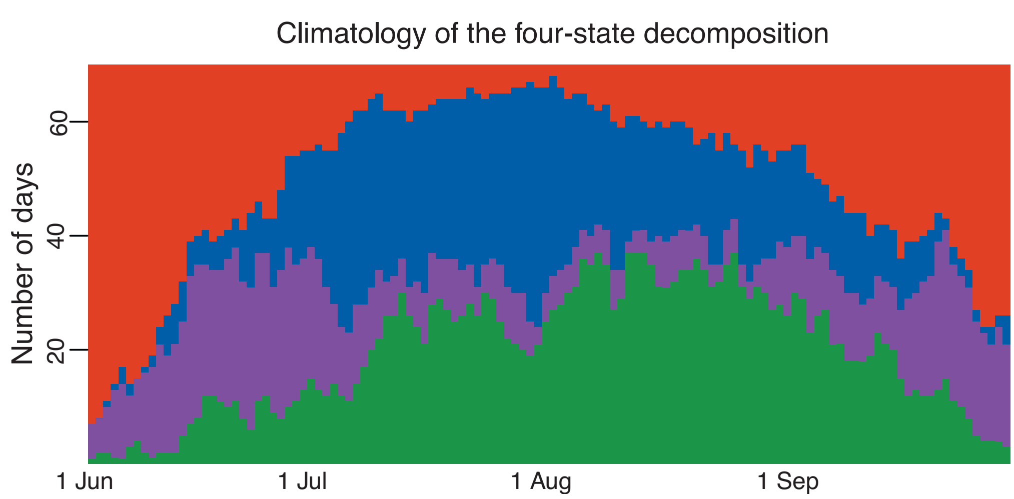
It has been said that India's economy amounts to "a gamble on the monsoon." While economic diversification may make this less so today than in the past, more than half of India's agriculture remains solely dependent on rainfall for its irrigation–and most of this rainfall occurs during the season of the southwest monsoon–June, July, August and September (JJAS). Thus, the monsoon remains an important factor in the national economy, as well as in the lives of the many millions of people directly involved in agricultural production.

The hidden Markov model (HMM) works by examining patterns of daily rainfall, and classifying them in terms of both space and time. This deconstruction is expressed in terms of a small number of hidden states, so described because they are not directly observable but must be inferred from the rainfall that is observed.

The day-to-day progression of these states occurs behind the scenes, only indirectly determining the observed sequence of rainfall patterns and amounts. Analysis of the statistical properties of the states and the associated rainfall patterns not only enables a better understanding of the monsoon itself, but opens a window on potential future changes in monsoon behavior.

The figure below illustrates a four-state decomposition of daily JJAS monsoon rainfall at a network of 13 weather stations located in the western and central regions of India, for the period 1901-1970. The JJAS season runs from left to right along the x-axis, while height of the colored bars on the y-axis corresponds to the number of days, over the full 70-year period, during which each of the four states occurred. Red represents a dry state (little rainfall at any station), and can be seen to predominate at the beginning and end of the season. Blue and green are both wet states, sharing

Climatology of the four-state decomposition of daily JJAS monsoon rainfall



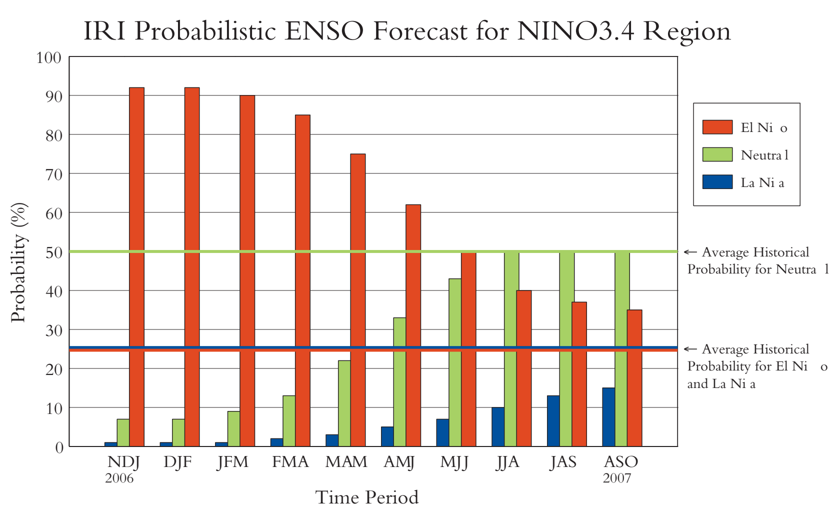
dominance during the peak rainy season of July-August. While both of these states are characterized by plentiful rainfall, rainfall patterns differ between them. Purple represents a transitional state, occurring principally at the beginning of the peak rainy season and again near the end.

Dry-state days occurring during the peak season are found to correspond to monsoon breaks, as identified in previous studies, while the jagged appearance of the plot tells us something about the character of day-to-day fluctuations among states, in the climatological, or average-over-years, sense. Finally, the HMM decomposition is also a useful tool for downscaling–inferring rainfall patterns at finer spatial scales than climate models are able to reproduce directly.

ENSO Prediction

Probabilistic El Niño/La Niña Forecasts, issued each month (see figure below), are based on a large set of both dynamical and statistical models that have achieved recognition through publications describing their development and performance. The forecast probability distribution is determined by first averaging together NINO3.4 predictions to form the mean of the distribution. The spread about that mean value is then estimated from the historical error distribution of the prediction models. If needed, the IRI forecasters modify the objective probabilities based on subjective assessment of the most recently observed evolution of the tropical Pacific air-sea system.

A qualitative analysis of this procedure since its inception in 2002 indicates that the objective forecast performs well when an event is imminent. However, subjective intervention by skilled forecasters is still needed when conditions are neutral, or when more uncertainty appears in the system.



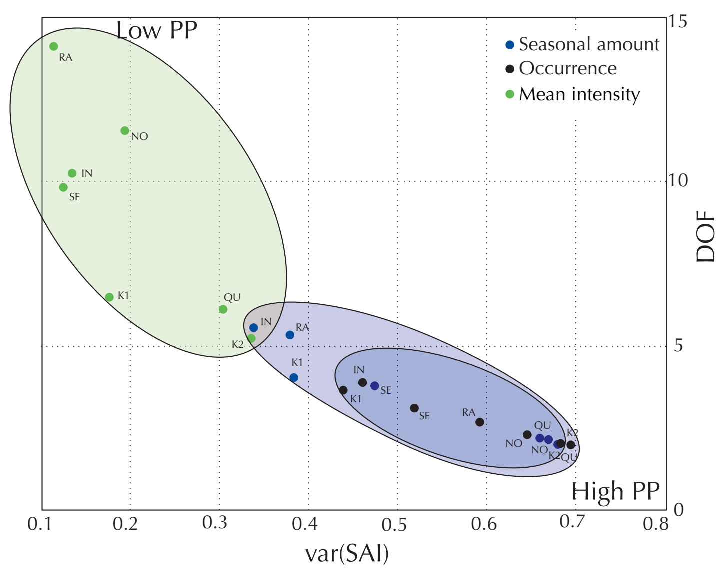
IRI Probabilistic ENSO Forecast for NINO3.4 Region

Potential Predictability of Local Daily Rainfall Statistics

It is important to assess which aspects of local daily weather are potentially predictable at the seasonal scale. For example, dry spells during critical growth phases may adversely affect crop yield. Perhaps the simplest breakdown of seasonal rainfall amounts is into the frequency of occurrence of rainfall and the mean intensity of rainfall on wet days. We have assessed the potential predictability of these statistics of daily rainfall–seasonal amount, occurrence frequency, and mean intensity–using station rainfall observation networks in 7 tropical regions of IRI interest.

The diagram in the figure below situates the 3 rainfall quantities for each of the 7 regions in terms of their potential predictability, expressed in terms of the number of spatial degrees of freedom (DOF) and the component of interannual variability that is shared between the stations on each network [var(SAI)]. High values of potential predictability (PP) correspond to high var(SAI) and low DOF (bottom right). A high PP means that observed variability is spatially-coherent while a low PP means a lot of spatial independence between even nearby stations, suggesting lack of any uniform signal, and thus a weak potential predictability, associated with a global-scale forcing such as sea surface temperatures.

The results paint a picture that is highly consistent across the 7 regions: the frequency of occurrence is much more potentially predictable than the mean intensity of rainfall, with seasonal amount somewhat less predictable than occurrence. Thus, although the interannual variability of seasonal rainfall amount has components related to both frequency of occurrence and mean intensity at local-scale, the frequency of occurrence is where the GCM's skill is likely to be highest. This is likely to be of particular significance in agriculture where the occurrence distribution controls the likelihood of dry spells.



Spatial degree of freedom (DOF) on ordinate and interannual variance of the standardized anomaly index [var(SAI)] on abscissa of the seasonal amount (in purple), frequency of occurrence (= number of wet days > 1 mm) (in black) and mean intensity of rainfall (= seasonal amount / frequency of occurrence) (in green) for 7 tropical regional-scale networks (SE; Senegal in Jul–Sep; QU; Northern Queensland in Dec–Mar; K1: Kenya in Mar-Mat; K2: Kenya in Oct–Dec; RA: Rajasthan, India in Jun–Sep; IN: NW India in Jun–Sep; NO; Brazilian Nordeste in Feb–Apr).

Casey Brown, one of IRI's newest research scientists, hadn't thought much about water until he was stationed at a U.S. Air Force base in Honduras. The base's waste-water treatment plant was old and defective. One day Brown's commander asked him to check for consequences by walking downriver. He found people using the contaminated water for cooking, washing, and other daily needs, and assumed that his report would lead to repairs at the treatment plant. Instead, higher-ups avoided that expense through a loophole in the regulations.

"That got me interested in water policy," says Brown. "It brought me face to face with how a lot of people in world access their water, and how the quality of their water has real health implications. With water, if you're downstream, you're very dependent on those upstream. It's a bit of a metaphor for everything."

He joined IRI after earning a Ph.D. at Harvard in environmental engineering with a focus on water management. He is particularly interested in the crises triggered by droughts and unsteady water supplies. "You can't get rid of the variability," he says, "but if you know it's coming, you can factor in a three-month lead time and think about what you'll do."

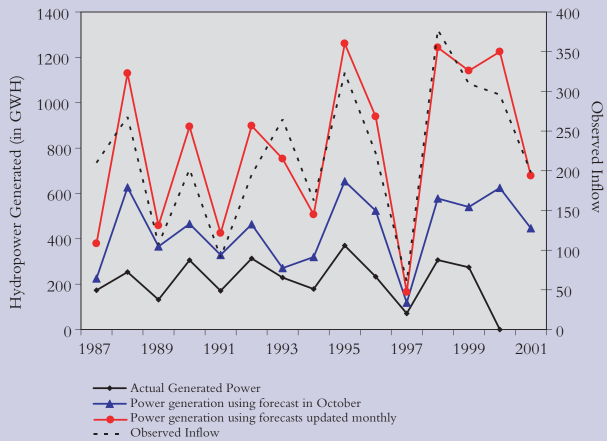
MWSS Manila

This sounds simple and sensible, but in his first project for IRI, collaborating with Shiv Someshwar on managing the Angat Reservoir in the Philippines, Brown quickly realized the need to factor in other variables as well: people, politics and policies.

Manila's 10 million people get 97 percent of their water from the Angat Reservoir. Farmers depend on the reservoir to irrigate 30,000 hectares of crops. The Luzon power grid depends on flows from Angat to generate hydroelectricity. In wet years the reservoir can meet all these demands, but some years are dry. That's when the arguments begin over who gets water and who doesn't. The scale usually tips towards Manila, as city water managers struggle to meet the city's growing demands for water. Farmers face uncertainty about when – and if – they will receive water every season. Hydropower generation may also be decreased, and in extreme cases, authorities have been forced to import additional coal as a result.

So the question, says Brown, is how to use the water more efficiently, maximize hydropower and help farmers survive. His multi-part answer: combine a seasonal climate forecast with flexible water policies, drought-resistant crops, and perhaps a reservoir insurance program. Again, sensible ideas, but change entails risk. Angat's managers, for instance, have never used forecasts which are probabilistic by nature, and this makes them nervous. "You have to build up trust in the new ideas. "In some years they actually spill water," continues Brown. "The reservoir fills up and overflows, and water that could generate power or irrigate is wasted."

Brown and IRI's Sankar Arumugam, now at North Carolina State University, recently created a simulation model for distributing Angat's water using seasonal streamflow forecasts. "We say, 'Here's how the model recommends that you allocate water this year, but don't do it and let's see what actually happens.'" If the model proves its worth, everyone will understand the benefits.



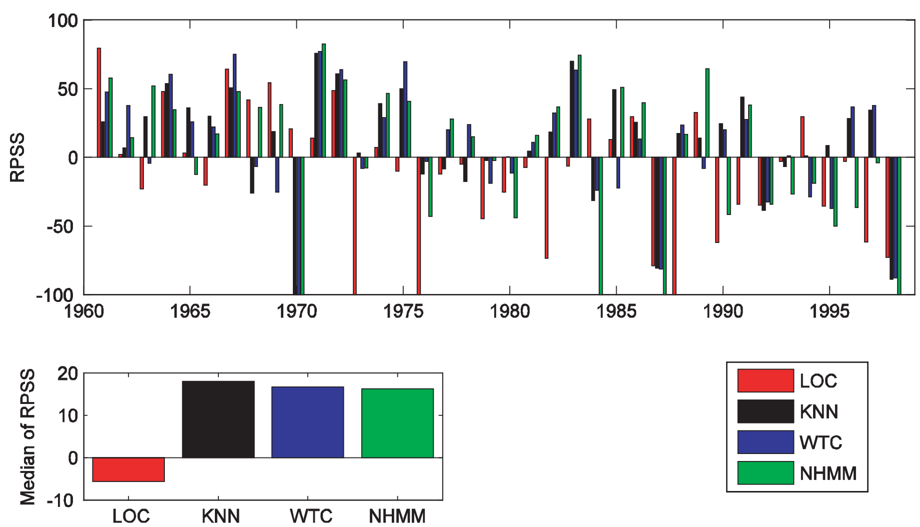
"Everyone knows that water in Manila is a problem," says Brown, "so as it becomes known that there's something to improve it, people want to look into it." For example, the Philippine meteorological service, which collaborated with IRI on the simulation model, is keen to provide better forecasts for Angat. The model was developed in collaboration with the Philippine meteorological service. The IRI team, which also includes Brad Lyon and Esther Ebrahimian, are working closely with the Philippine met service to build their capacity to develop forecasts that meet the needs of decision makers.

But a forecast alone isn't enough. "It doesn't give you any new water," says Brown. It must be combined with policies and programs that deal with the consequences of giving water to some and taking it from others. If the forecast predicts a higher risk of drought, for instance, farmers can be warned to plant crops that don't require irrigation. IRI and its partners in the Philippines are also exploring the possibility of an insurance program, in which insured farmers would be paid if their water allocation fell below a prescribed amount.

Other stakeholders would benefit, too—the reservoir managers, the authorities, and the citizens of Manila. "The selling point to them," says Brown, "is that you do not have crises every five years. The big thing we're learning is how to implement a new idea in these highly risk-averse institutions. You can't just say, 'Here's a forecast, go run with that.' You have to work with the top management people, but also sit with the technical people and roll up your sleeves and see what their needs are, and then integrate yourself and your product into how they're already doing their business. That's a big lesson that's going to be useful anywhere."

Intercomparison of Statistical Weather Downscaling Methods

Local daily weather sequences are required for driving the crop-simulation models that form a key tool in developing climate risk management solutions in agriculture. Statistical downscaling methods translate seasonal forecasts made with GCMs into ensembles of stochastic daily sequences of local weather, and several competing schemes are being developed for this task at IRI. To develop "best practice" it is important to intercompare these schemes.



Hindcast RPSS for the simulation of the seasonal frequency of occurrence (= number of wet days > 1 mm) with four methods of downscaling (LOC: local scaling; KNN: K-nearest neighbor analog; WTC: Weather Types Classification; NHMM: nonhomogeneous hidden Markov model) averaged over 4 stations in western Senegal (Dakar, Kounghel, Diourbell, Kaolack). WTC, NHMM and KNN use the meridional and zonal winds at 925, 700 and 200 hPa simulated over 0-30W and 5-25N from a 24-member ensemble of ECHAM 4.5 forced by prescribed SST on 1961-1998.

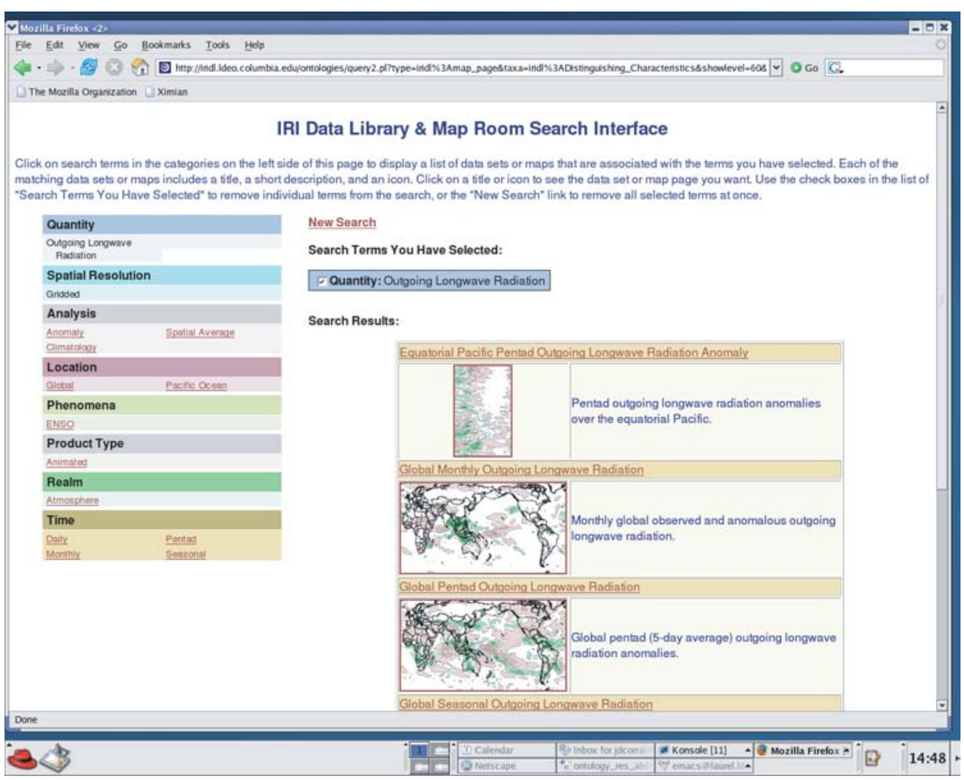
The figure above illustrates an intercomparison of 4 such methods, in terms of hindcast Rank Probability Skill Score (RPSS) skill averaged over 4 stations over western Senegal. Local scaling (LOC) is a simple baseline technique that calibrates raw GCM precipitation at the closest GCM grid point to the station-location of interest, such that their climatological frequency of occurrence and mean intensity match. The K-nearest neighbor (KNN) and weather type classification (WTC) schemes are more sophisticated and are based on resampling historical daily rainfall observations, according to the similarity between observed (i.e. reanalyzed) and GCM-simulated atmospheric circulation fields. Lastly, the nonhomogeneous hidden Markov model (NHMM) stochastically simulates daily sequences from a reduced set of hidden states, derived from rainfall records, whose transitions are modified according to GCM-simulated wind fields. The results show that in this case, the mean skill of LOC is worse than using long-term climatology while the three more sophisticated methods perform rather equally well on average mean, although with differences in performance between the methods seen in particular years.

Enabling Better Searches in the IRI Data Library

Researchers have traditionally struggled with organizing and cataloging earth-science datasets in such a manner as to be able to find them easily and share them with others. Frequently datasets are tagged with metadata (i.e. data about the dataset). There are many fixed metadata schemas for the search and retrieval of datasets. But they have trouble representing the richness of datasets coming from an ever-evolving science.

For the IRI Data Library, we prefer a more relational and flexible type of metadata. The RDF/XML descriptive framework in the form of OWL (Web Ontology Language) ontologies presents that possibility. According to the OWL Use Cases and Requirements document, "An ontology formally defines a common set of terms that are used to describe and represent a domain. Ontologies can be used by automated tools to power advanced services such as more accurate Web search, intelligent software agents, and knowledge management."

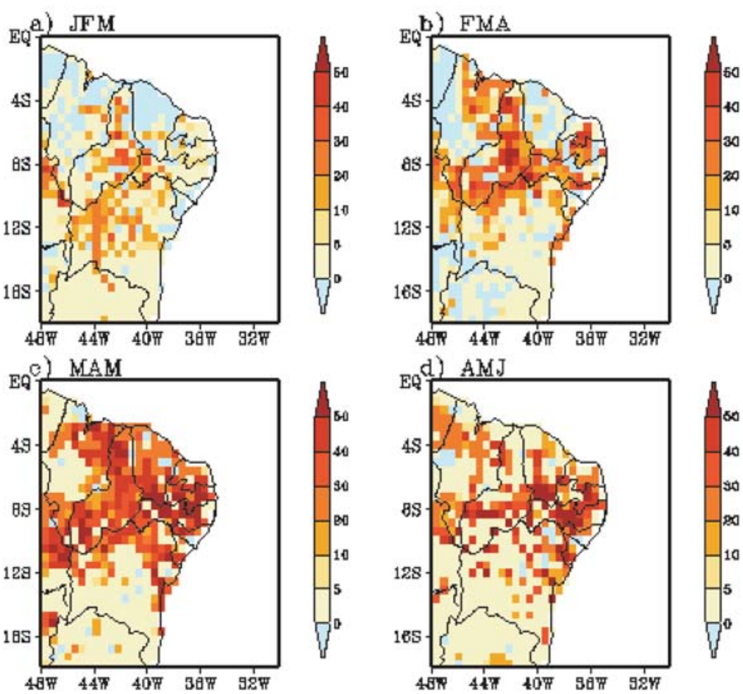
We have developed an ontology framework that is structured to encompass the IRI data repositories. Because ontologies can be expressed in RDF/XML we can import ontologies created by other organizations. To extend the descriptiveness of our framework, we import ontologies from the National Science Foundation's Marine Metadata Interoperability Project (MMI) and from NASA's Semantic Web for Earth and Environmental Terminology Project (SWEET). We combine our dataset ontology with a faceted search ontology to present the user with a simple, intuitive way to search for datasets using a common Web browser.



CLIMATE DYNAMICAL MODELING FOR REGIONS

In addition to the global scale net assessment forecasts, the IRI undertakes regional climate modeling to create forecasts at regional scales. This is commonly called "downscaling." Downscaling enables seasonal climate predictions on spatial scales that are more relevant to most risk management decision makers. The downscaling forecast system uses regional climate models that are nested within the IRI global seasonal climate forecasts.

IRI develops dynamical downscaling forecast systems in partnership with the institutions in the region, and then works with those institutions toward their continued advancement. Downscaling forecasts then become issued operationally by those institutions. Operational downscaling forecasts have been issued in northeast Brazil since 2001 by FUNCEME; in Taiwan since 2003 by the Central Weather Bureau, and in the Greater Horn of Africa since 2005 by ICPAC. Downscaling forecasts will start being issued for South Africa in November 2006 by the South African Weather Service, and for Southeast China in November 2007 by Zhejiang Climate Center. The dynamical downscaling prediction system in northeast Brazil was the first such kind of operational system in the world. The ECHAM4.5 atmospheric global circulation model (AGCM) and the NCEP regional spectral model (RSM) form the core of

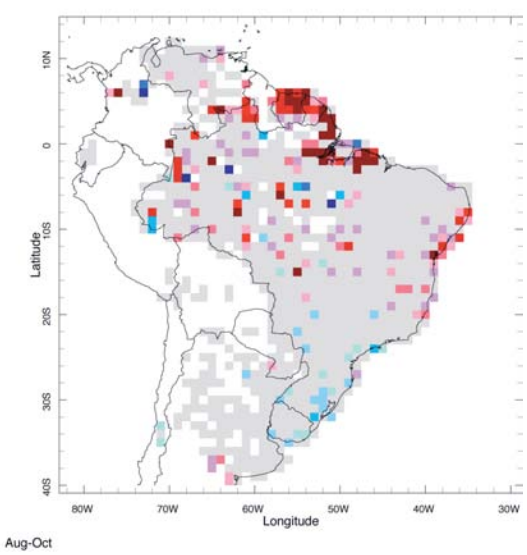


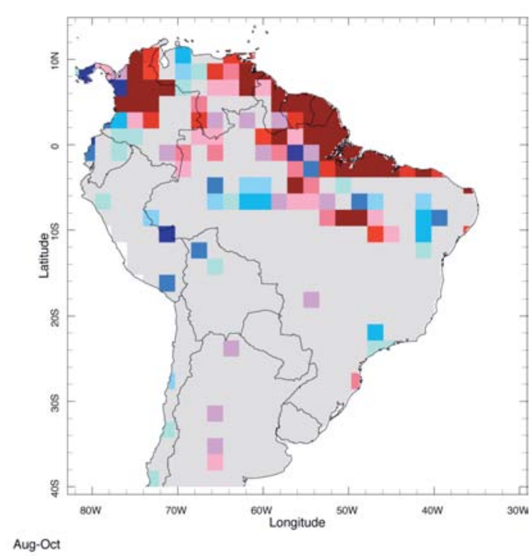
Average RPSS (%) over 2002-04 1-Month Lead Rainfall Forecasts this prediction system. It is a two-tiered prediction system; sea surface temperature (SST) forecasts are produced first, which then serve as the lower boundary condition forcing for the ECHAM4.5 AGCM–NCEP RSM nested system. Historical "hindcasts" for 1971–2000 with the nested model, using observed SSTs, provided estimates of model potential predictability and characteristics of the model climatology. During 2002-04, the overall rainfall forecast skill, measured by the ranked probability skill score (RPSS), is positive over a majority of northeast Brazil (see figure below). Higher skill is found for March – May (MAM) season and AMJ season with forecast lead time up to 3 months. The skill of the downscaled forecasts is generally higher than that of the driving global model forecasts.

Analysis-based Precipitation Monitoring

The implementation of climate risk management into many decision systems requires some knowledge of up-to-date precipitation information on the sub-seasonal, submonthly, and in some cases, daily temporal scales. In many decision scenarios the requirements are not only the latest estimates of rainfall but also for some estimates of how the current estimates compare to the historical record. The availability of consistent daily weather observations is limited in many parts of the world. The new generation of satellite-based precipitation estimates provide credible high-spatial resolution estimates of daily rainfall but these products have very short data records. In the future, satellite-based rainfall estimates are likely to become the source of historical

Regions with significantly different histograms of daily rainfall for El Niño versus La Niña for August through October, based on the Kolmogorov-Smirnov statistic, are indicated on the maps at left. Red shades indicate El Niño drier versus blue shades for El Niño wetter. Analysis based on: a) Liebmann and Allured (2005) 1º x 1º gridded station data, and b) NCEP/NCAR reanalysis, Kalnay et al. (1996) at a ~1.875º x 1.875º resolution, all for the 1961 to 1990 period.





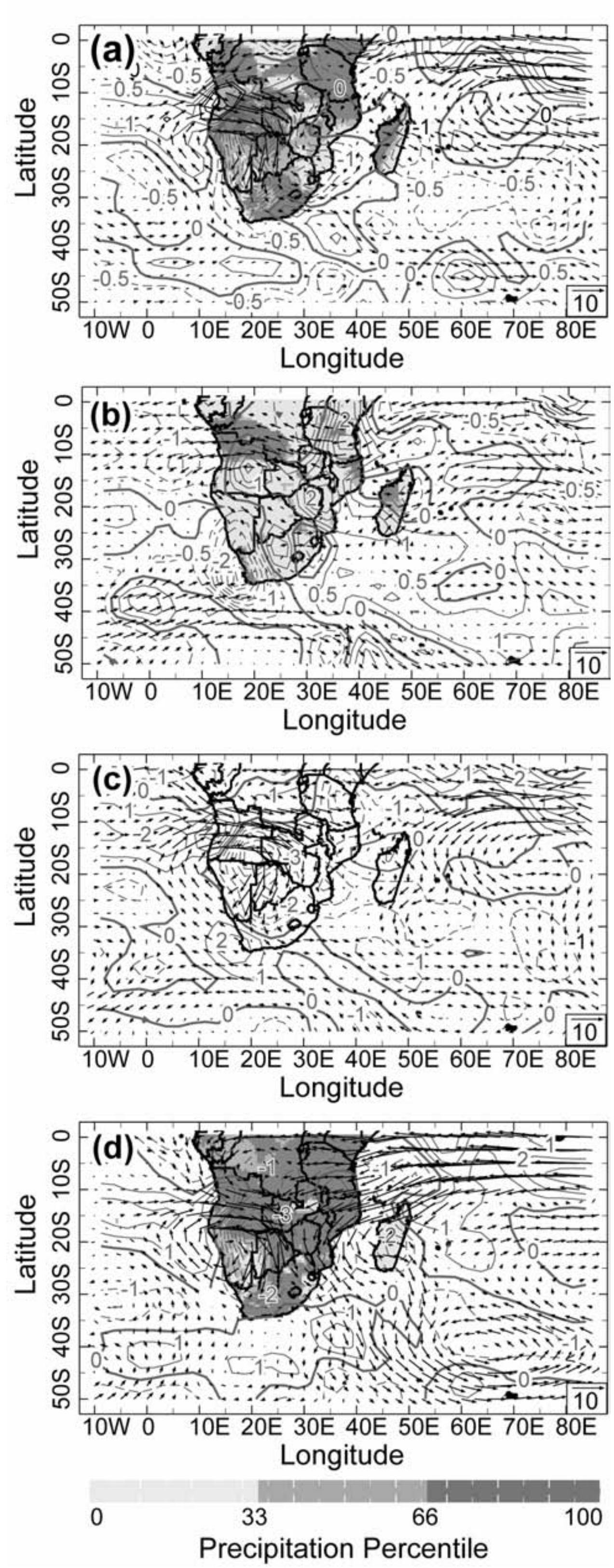
data as well as real-time precipitation estimates for climate monitoring. However, the need for consistent, long-record daily rainfall records exists now.

The IRI has initiated a joint research project with NOAA's Climate Prediction Center to investigate the usefulness of gridded station observations and model-based reanalyses as tools for monitoring daily rainfall and thus as a means for estimating the observed statistics of weather within climate. As a first step in the analysis, the ENSO-related shifts in the observed histograms of daily precipitation in gridded station analysis are compared to the shifts in the NCEP/NCAR reanalysis for South America. Statistically significant shifts in the daily histograms are identified using a Kolmogorov-Smirnov test. Preliminary comparisons suggest that while the reanalysis does not ideally replicate the gridded station results the reanalysis may be useful as a tool for indicating candidate regions for further analysis with gridded station data. Appropriate corrections to the reanalysis rainfall estimates will be developed and tested.

The 1997-98 Summer Rainfall Season in Southern Africa

Following the onset of the strong El Niño of 1997–98, historical rainfall teleconnection patterns and dynamical model predictions both suggested an enhanced likelihood of drought for southern Africa, but widespread dry conditions failed to materialize. A diagnostic study of NCEP-NCAR reanalysis data was undertaken to explore how the large-scale and regional-scale atmospheric circulations during the 1997–98 El Niño differed from previous events. The study focused on comparisons with the strong 1982–83 El Niño, utilizing composites of eight other El Niño events occurring between 1950 and 2000, targeting the January–March season.

Observational results indicate significant differences from the 1982–83 and composite El Niño in 1997–98. An anomalously strong Angola low, exceptionally high sea surface temperatures (SSTs) in the western Indian and eastern tropical South Atlantic oceans and an enhanced northerly moisture flux from the continental interior and the western tropical Indian Ocean all appear to have contributed to more seasonal rainfall in 1997–98 than in past El Niño events.



Anomalous moisture transport (arrows) and its convergence (lines) along with precipitation in tercile classes (shading) for a) Jan-Mar 1998, b) Jan-Mar 1983, c) the difference between 1998 and 1983 (precipitation not shown), and d) January 1998.

Pietro Ceccato and Tufa Dinku believe sometimes the best way to see what's happening on the ground is to watch from space. Both are researching ways to apply satellite technology to climate-related problems in Africa.

Ceccato came to IRI in 2004 via Italy, Belgium, the UK, and Africa. He trained as an agronomist and soil scientist and later worked in the Central African Republic. His research at IRI involves combining climate data with remote sensing and Geographical Information Systems (GIS) to create products that can alert officials of impending problems for agriculture and human health. At the moment, 21 countries in Africa and Asia are benefiting from his work on remote early-warning systems.

Using satellite technology, Ceccato can estimate rainfall and monitor vegetation. For instance, a surge in plant growth in the grasslands signals moisture–and moisture means mosquitoes. "In the grasslands of Eritrea," says Ceccato, "we have found a good correlation between the development of vegetation and the development of malaria."

He is part of a team that helped establish this link for Eritrea's health services by looking at the malaria outbreak of 2003, which was preceded by a rise in vegetation. He has since trained scientists in Eritrea to monitor vegetation through remote sensing, and expects to expand this training to other countries in the Sahel.

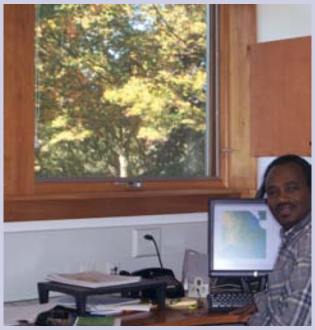
Vegetation can also give officials advance warning about potential agricultural problems, such as locust plagues. This pest lives in deserts from the west coast of Africa to India. Whenever rain makes the desert bloom, the locusts lay their eggs in the moist soil beneath the vegetation. After hatching, the young locusts congregate in the vegetation and quickly mature. They then swarm toward the agricultural fields. If nothing stops them, they can travel for thousands of miles, devastating crops as they go.

Before satellite imagery, governments fought the pest by sending control teams randomly into the desert to look for congregations of locust hatchlings. This was highly inefficient and expensive. "Using satellite images, you can send teams directly into the areas where you see vegetation–definitely an improvement in terms of time and money," says Ceccato, but only if countries can act on the information before the swarms fly.

In late 2003, for instance, after rain fell in Mauritania's desert, the early warning system for locusts worked very well. Teams used vegetation maps created by remote sensing to find and destroy many locusts. But the area involved was immense, the teams soon ran out of pesticides, and the government lacked money to buy more. The swarms moved to Morocco and then invaded Algeria, reproducing all the while. As the situation worsened, repeated warnings and appeals for money launched by UN Food and Agriculture Organization were ignored. In June 2004, the swarms invaded Niger, Mali and Senegal and the locusts captured public attention through dramatic images on television. By then the crisis was full-blown and funders offered help. The swarms weren't brought under control until the end of 2004.

Still, Ceccato is pleased about the remote sensing tools now available and is working to make them easy to use. "In IRI's Map Room, we provide satellite images and tools to analyze data as simply as possible. You don't have to be an expert in remote sensing and you don't have to buy expensive software. Everything is done through the Internet, free of charge. You can extract data about rainfall or vegetation and use it to map areas at risk for malaria or locusts."

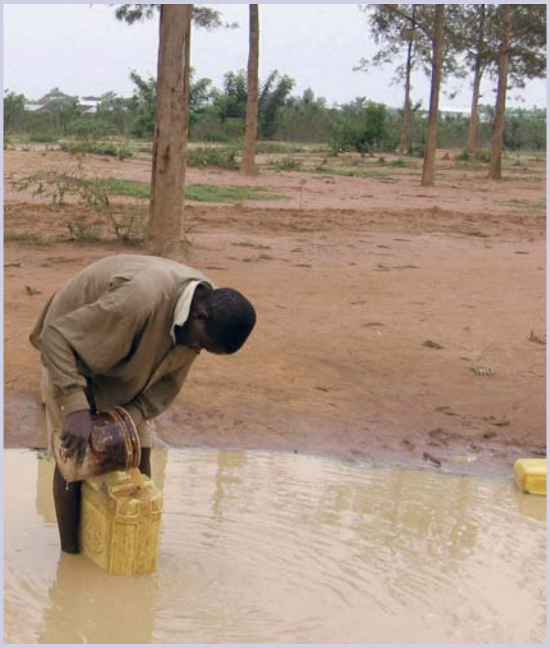
Currently, he's working on a new product to help health officials predict and prepare for outbreaks of meningitis. The disease flares up during dry, dusty conditions. "So by monitoring the dust, we might have a tool to forecast meningitis," says Ceccato.



Tufa Dinku is eager to put satellite technology to another use throughout Africa, starting with his native Ethiopia. "My passion," he says, "is to go back in time and develop a database using satellites and rain-gauge observations."

Ethiopia, like most countries, depends on a network of stations for information about rainfall, past and present. But this network is seriously flawed, says Dinku. There aren't enough stations, and many of the ones in use are old and deteriorating. The stations tend to be located in cities, not in rural areas, where most of the weather-related problems occur. Finally, the data collected from these stations aren't well-organzied and are difficult to access. "The meteorological services who own the data are reluctant to give it away, because it is their core resource," says Dinku, who once worked for Ethiopia's meteorological services.

Dinku's work for IRI is to combine the data from Africa's weather stations with satellite data, to fill any gaps. Rain-gauge data can be accurate, but sparse to nonexistent in remote areas, whereas satellite data provides less accuracy but more extensive coverage. Dinku hopes to organize and standardize Africa's satellite climate information. Improving the scientific tools, of course, is just the beginning. People in the relevant institutions must be persuaded to use them. Meteorological services are under-funded and understaffed, and they focus their efforts on producing daily weather forecasts. But since most Africans are farmers, says Dinku, the daily forecast isn't nearly as important as a seasonal forecast. In Ethiopia, for example, up to 80 percent of the population lives in rural areas. "So if the rural population doesn't grow food," notes Dinku, "the whole country is in crisis." Which brings him back to the ability of satellite technology and rain gauges to provide up-to-the-moment monitoring. "For example, if you know that a region is having a shortage of rainfall," he says, "then instead of waiting until the last minute to do something, governments and agencies can plan ahead."



The Earth Institute

Having lived through several droughts and famines in Ethiopia's dry southern region, Dinku knows the consequences of waiting until the last minute and beyond. He says simply, "The people were suffering." He hopes that his work, and the work of IRI, can help prevent the past from repeating itself.

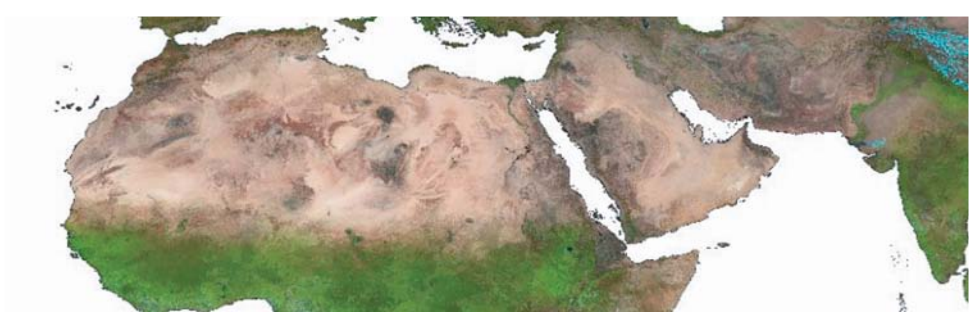
Environmental Monitoring

Monitoring the influence of interannual and seasonal climate variability on the physical and biological environment provides useful indicators of changes threatening socioeconomic systems and livelihoods. Food security and health are prime examples where drought, or flooding, can have profound implications for vulnerable populations in the developing world. Information on these changes is useful both for researchers and the operational agencies aiming to understand and mitigate the adverse impacts of events such as these.

The information available from the fleet of Earth Observing Satellites circulating the globe today is unprecedented. Meteorological and environmental satellites observe processes at the Earth's surface in real-time and provide frequently-updated estimates of rainfall, surface temperature, and vegetation condition for large remote areas that would otherwise remain unsampled. The IRI works with a number of partners in identifying and providing the most reliable satellite-derived products in a format most useful for impacts researchers and decision makers.

The Desert Locust (Schistocerca gregaria) distribution extends from West Africa to India. During invasion periods, adults form swarms that fly or are carried by wind over great distances. Swarms can devastate crops and create starvation conditions in some of the poorest regions of the world. The UN Food and Agriculture Organization (FAO) Desert Locust Information Service (DLIS) collaborates with the National Locust Units to collect and analyze field data (e.g., vegetation, rainfall, locust and control information) to assess the current situation and forecast the scale, timing and location of locust breeding and migration. The warnings, assessments and forecasts produced by DLIS are used to plan survey and control operations, and by the international donor community to target assistance, especially during emergencies.

In collaboration with DLIS, IRI is developing products to estimate rainfall and ecological conditions in the Desert Locust's recession area. The maps and analysis products illustrate recent conditions which provide ideal breeding conditions for the locusts. Additional information may be included in the future and we welcome the opportunity to work with others on the further development of these products.



Standardizing Drought-related Losses in EM-DAT

Currently, the only publicly available global disaster event database is the Emergency Disasters Data Base (EM-DAT), which is maintained by the Center for Research on the Epidemicity of Disasters (CRED), Brussels, Belgium. EM-DAT sources include United Nations (UN) agencies, nongovernmental organizations (NGOs), insurance companies, research institutes, and press agencies. Criteria for inclusion in EM-DAT as a "reported disaster" includes exhibiting one or more of the following characteristics: at least 10 people killed, 100 people affected, declaration of a state of emergency and/or appeal for international assistance. EM-DAT contains approximately 9,000 natural disaster entries from 1900 to the present. Reporting is more consistent in recent decades, but data problems include missing data; a lack of standardized definitions and assessment methods; differences among loss variables in terms of how losses associated with different types of hazards are reflected; the confounding roles of exposure and vulnerability in creating losses; and problems with respect to the attribution of losses to particular types of hazard events. A full inventory of losses in any given disaster may include not only mortality, but also economic losses across the range of social, productive, infrastructure, and environmental sectors. This dataset has been used to assess the impact of climatic disasters on mortality and economic outcomes.

IRI and CRED are collaborating on a project focused on improving the documentation of drought disasters in the EM-DAT database. Drought is both an exceptionally important hazard in terms of its association with large scale losses, as well as an exceptionally difficult hazard to characterize. While EM-DAT uses a strict definition for the inclusion of all types of disaster events, which is primarily based on losses, it lacks a firm definition for tracking and recording the dates and locations of drought disasters. The current project seeks to standardize the way drought-related losses are recorded in EM-DAT. At the conclusion of the project, researchers, operational agencies and the public will have access to a rigorously verified, temporal- and geo-referenced dataset on global historical drought losses. Improved data on drought losses will advance the understanding of the impact of drought on society and socio-economic development by improving the precision of how loss data are recorded in future entries and facilitating the use of data by all users and applications.

Fine Scale Natural Hazard Risk and Vulnerability Identification Informed by Climate in Sri Lanka

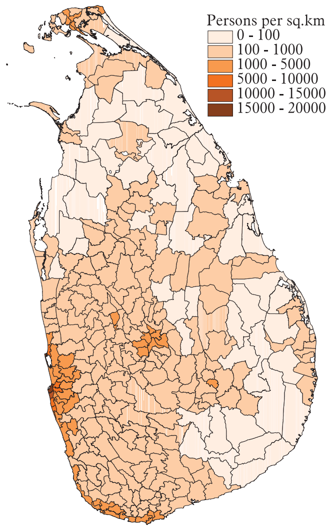
Although many natural disasters have hydro-meteorological antecedents, little advantage has been taken of the availability of weather and climate data, advanced diagnostics and seasonal predictions for disaster risk management. In a case study conducted as part of a World Bank funded global study, IRI scientists developed methodologies for injection of climate data into hazard risk assessment and laid the ground work for the future use of seasonal-to-interannual climate predictions for dynamic hazard predictions. This work had to be conducted at spatial scales fine enough to be useful for action at local administrative division levels. The results from this study coupled with the high-resolution seasonal climate prediction techniques developed in a related study and point the way to using historical, current and predictive climate information to inform disaster management policy and early warning systems.

***Facing page:** Estimates of food insecurity and a number of hydro-meteorological hazards in Sri Lanka (panels 1-10) have been analyzed to provide an assessment of the spatial distribution of multiple hazards (panel 11). Each hazard was weighted by severity measured by relief expenditure which tends to give prominence to drought. Other measures such as weighting by fatalities gives prominence to cyclones and landslides resulting in subtle but important differences. Seasonal multihazard maps (not shown) were also constructed and found to be useful.*

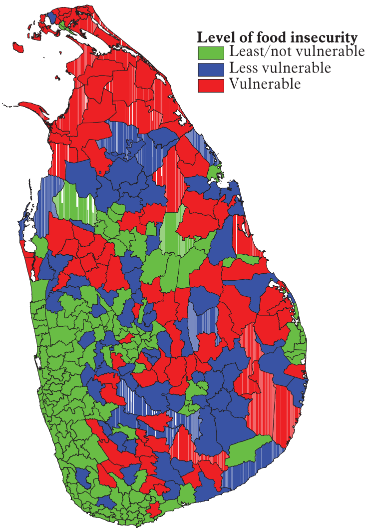
***The 2004** Indian Ocean Tsunami's impact (panel 12) dwarfed all other disasters in the history of Sri Lanka except the malaria epidemic in 1932-35. The number who died, those who were injured, and the property damage were each 100 times larger than the next largest disaster. There is such wide latitude in how one may weight for tsunami's in a multi-hazard map that it remains best kept as a separate indicator.*

Similar maps have been published by the World Bank Disaster Management Unit and are to be included in the second edition of Sri Lanka government's National Atlas.

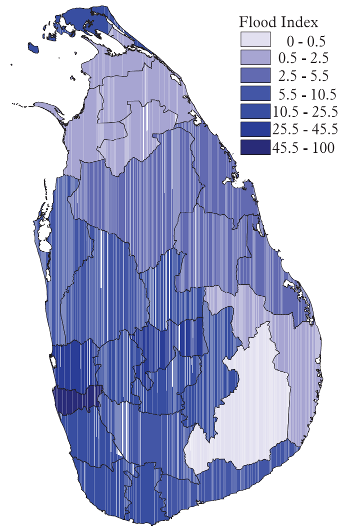
1. Population Density



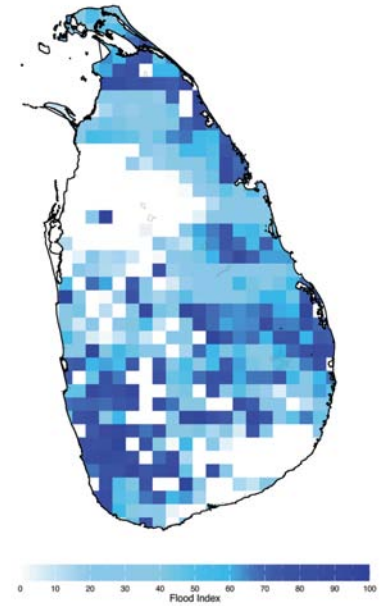
2. Food Security (WFP)



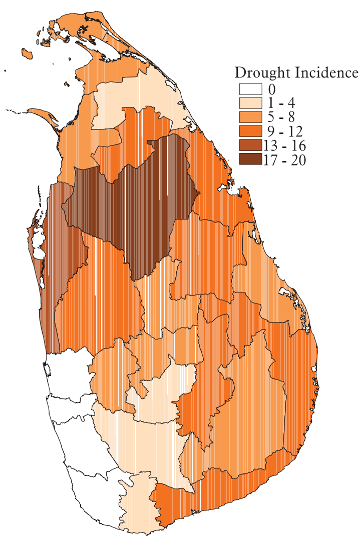
3. Flood Incidence



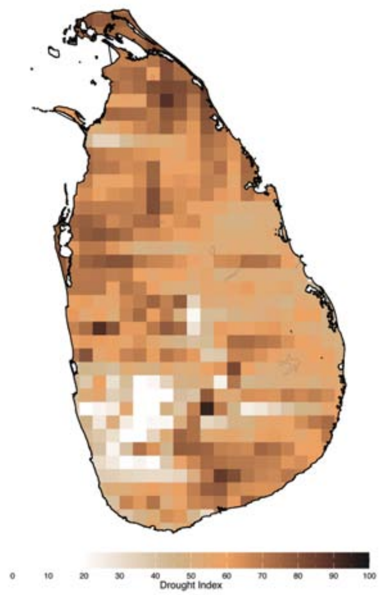
4. Flood Hazard Estimate



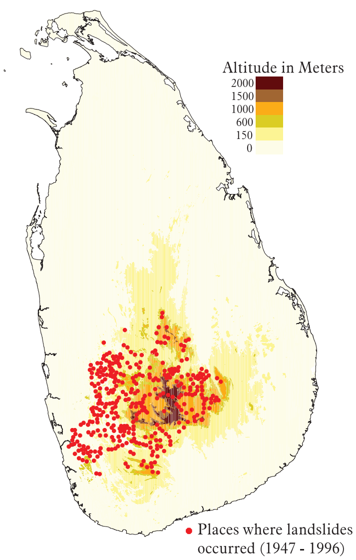
5. Drought Incidence



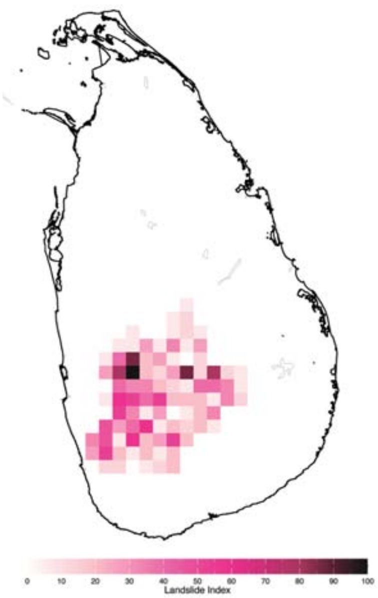
6. Drought Hazard Estimate



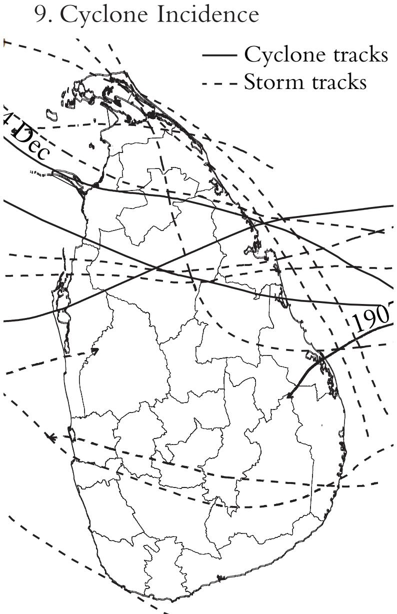
7. Landslide Incidence



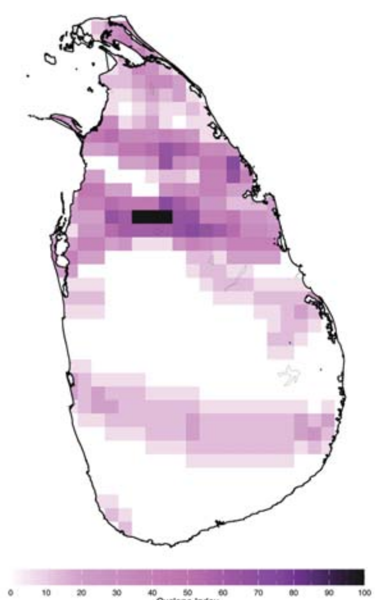
8. Landslide Hazard Estimate



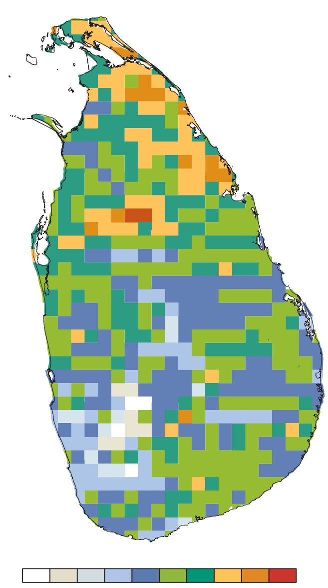
9. Cyclone Incidence



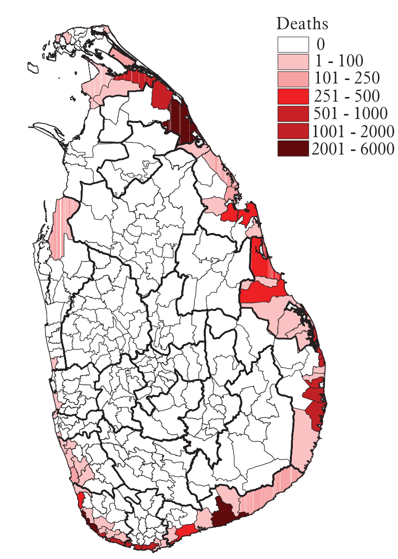
10. Cyclone Hazard Estimate



11. Multi-Hazard Estimate



12. 2004 Tsunami Deaths Incidence



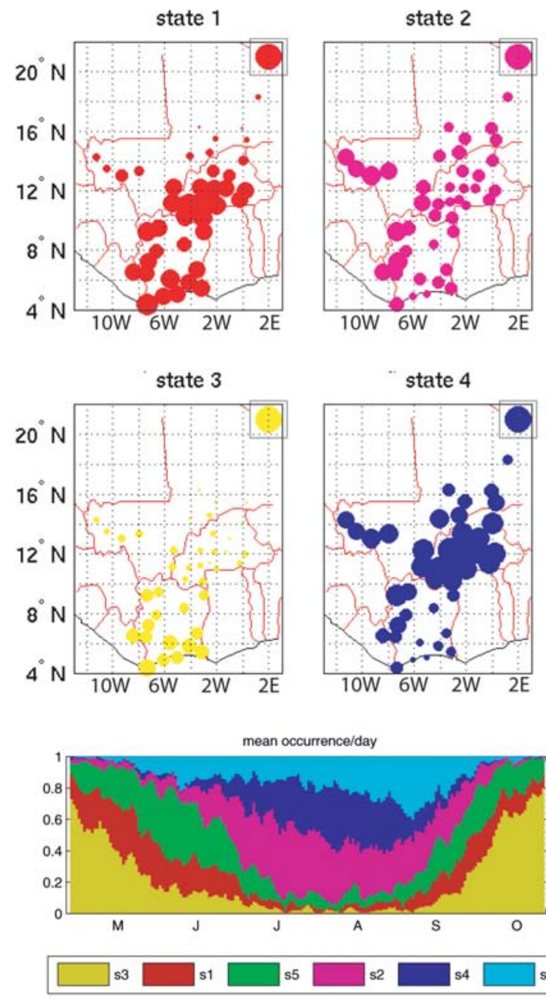
Subseasonal Characteristics of Rainfall in Central West Africa using a Hidden Markov Model

One of the major challenges in translating general circulation model (GCM) outputs, such as seasonal forecasts, to meet societal needs is that the potential users of climate information are often concerned with the characteristics of high-frequency weather at a particular location. Unfortunately such statistics of local weather are poorly represented in GCMs due to limits in predictability horizon and resolution. The Hidden Markov Model (HMM) appears to be a powerful diagnostic and downscaling tool linking large scale seasonal climate structures to intraseasonal characteristics of local climate and has been applied in different regions of interest to IRI.

The basic assumption underlying this technique is that multi-station daily rainfall observations can be well described in terms of a few underlying (hidden) weather states, with a Markovian dependence in time. It can thus be used: first, to diagnose the weather patterns associated with rainfall variability at the station level and simulate associated weather/circulation patterns sequence; second, to downscale GCM outputs to the daily rainfall at station level.

For example the analysis of daily rainfall in a network of 42 stations in Central West Africa allows us to identify 6 well-separated rainfall structures including a predominantly dry state (yellow), a state with enhanced probability of rainfall over the Sahel (blue), a moderately wet state (red) and a moderately dry state (magenta). Note the clear seasonal evolution in the probability of occurrence of one of these states (bottom panel). The method also discriminates between dry and wet spells within the July to September peak rainfall season in the Sahel (magenta vs. blue state) and between the dry states during the pre and peak season (yellow vs. magenta states).

In addition to the changing distribution of probable occurrence of states over a year (lower panel), variability in prevalence of states also varies with time over multiple years or decades and is related to changes in the distribution of sea surface temperatures (SST) and atmospheric circulation around the globe. Current research on the use of HMM as a downscaling technique to infer sub-seasonal characteristics of the rainy season – such as the number of rainy days or the distribution of dry-spell lengths – from large scale SST or atmospheric fields shows promising results for this region.



Estimated occurrence of HMM states in a 6-state decomposition of daily rainfall in Central West Africa (Cote d'Ivoire, Burkina Faso and Mali, 42 stations, 1951-98)
a) rainfall occurrence probability associated with states 1 (red - moderately wet), 2 (magenta - moderately dry), 3 (yellow - predominantly dry) and 4 (blue - wet Sahel).
b) mean seasonal cycle of estimated occurrence for all 6 states.

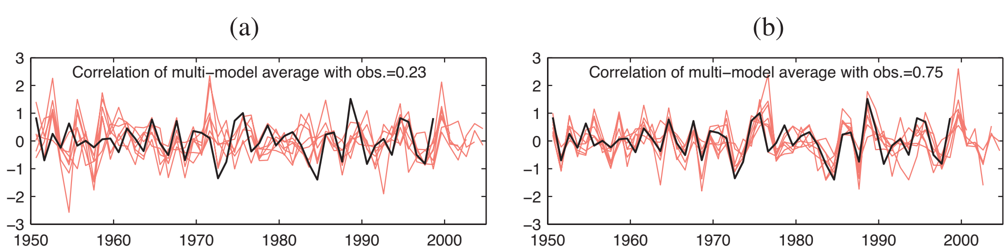
Potentially Predictable Components of West African Summer Rainfall

IRI seasonal forecasts are based on a two-step procedure where first the sea surface temperature (SST) for the coming months is predicted, and then the temperature and precipitation responses to that SST are computed using atmospheric general circulation models (GCMs). Forecast skill is determined by the relative strength of the SST-related atmospheric responses and the fidelity of the GCM. Statistical analysis points to SST as being an important modulator of Sahelian rainfall. However, while many GCMs forced by observed SST reproduce aspects of Sahelian rainfall on the decadal time scale, most have difficulty reproducing variability on the year-to-year time scale, thereby limiting the skill of seasonal forecasts.

To better understand the SST-forced climate response of the GCMs, we used signal-to-noise analysis to identify the predictable components of the GCM output. GCM integrations contain the potentially predictable climate signal due to SST forcing as well as unpredictable weather noise. Predictable components maximize the climate signal relative to the weather noise. Over West Africa, the first two of these predictable components are associated with precipitation in the Guinea Coast and Sahel regions and correlate well with observations on both interannual and decadal time scales. This is remarkable since the raw model output shows very little correlation with observed Sahel rainfall on the interannual time scale.

The analysis suggests that the model output is contaminated by spurious responses to SST forcing and that removal of these responses gives a more accurate estimate of the atmospheric response due to SST forcing. The figure below shows the time series of a July-September Sahel rainfall index computed from observations and from 7 GCM simulations. The correlation of the raw multi-model average with observations is slight (0.23). Removal of empirically identified spurious responses increases the correlation multi-model average with observations to 0.75.

Time-series of the interannual components of the observed Sahel index (heavy black line) and 7 GCM simulated indices (gray lines) computed from the (a) raw model output and (b) filtered output.



Development and Training on Malaria Early Warning Systems

The IRI is working with National Malaria Control Program (NMCP) in several countries in Africa to develop Malaria Early Warning Systems (MEWS) based on the MEWS framework proposed by UN World Health Organization.

By studying the pattern of historical malaria incidence, an epidemic vulnerability map is produced. By investigating the relationship between environmental variables (rainfall vegetation) and year-to-year variability of malaria, epidemic risk monitoring opportunities are identified. The use of satellite data to monitor rainfall and vegetation is then developed through the use of the IRI Data Library to provide the satellite data and analysis to the NMCP. Once created, MEWS is implemented in collaboration with the NMCP in countries. Training on the use of MEWS, IRI Data Library, satellite images and integration within GIS are conducted.

In July 2005, training was conducted in Eritrea at the NMCP for the personnel coordinators at district levels. Both development and training on MEWS was funded by the Research Triangle Institute in conjunction with their USAID contract.

In March-April 2006, following a request from the Ministry of Health of Madagascar, training was conducted at IRI for the Madagascar malaria control staff. The visit was funded by the Global Fund for AIDS, TB and Malaria.

A MEWS training curricula has since been developed both in English and in French. The curricula will be utilized in training under development for East and Southern Africa and for Francophone West Africa.

Training in Eritrea for the NMCP staff (July 2005)

Supporting Climate Risk Management in Smallholder Farming in Kenya

Past research in Eastern Province, Kenya, revealed a high degree of awareness of seasonal climate forecasts and interest in applying the information in farming decisions, as well as several obstacles that we expect can be overcome. Farmer workshops in Machakos and Makindu, July 2004, provided an opportunity to test interventions that address constraints related to relevance and comprehension. We downscaled GCM forecasts of rainfall amount and frequency, and tested an approach to communicating the information to farmers that included: relating farmers' memory of past variability to probability of exceedance; discussing interpretation of the resulting climatological distribution and hypothetical shifts; and deriving a shifted distribution for past La Niña years. Farmers in breakout groups identified a rich set of promising livelihood responses to hypothetical probabilistic forecasts. Ongoing analysis of questionnaires, administered before and after a forecast presentation workshop, is yielding insights into how farmers are currently responding to forecast information, and the immediate added value of tailored information coupled with training.

Economic analysis suggests that adjusting a few maize-management practices in response to GCM-based rainfall forecasts has the potential to increased Machakos farmers' average net incomes between about 4% and 16%. Farm-level bioeconomic modeling gives a richer picture of how livelihood decisions and constraints interact with the predictable components of rainfall variability, and yields insights about interventions such as reducing credit constraints. The research reveals that:

- Farmers see rainfall as their greatest challenge.
- Skillful regional forecasts can be downscaled and translated into crop yields.
- Farmers can understand forecasts in probabilistic terms.
- Farmers perceive a range of opportunities to take advantage of advance climate information.
- Using forecasts to adjust crop management show potential livelihood benefits.

The effort has led to guidelines for presenting downscaled probabilistic climate information to farmers, and a request from the Ministry of Agriculture to equip agricultural extension officers to be effective at communicating climate information and supporting climate risk management.

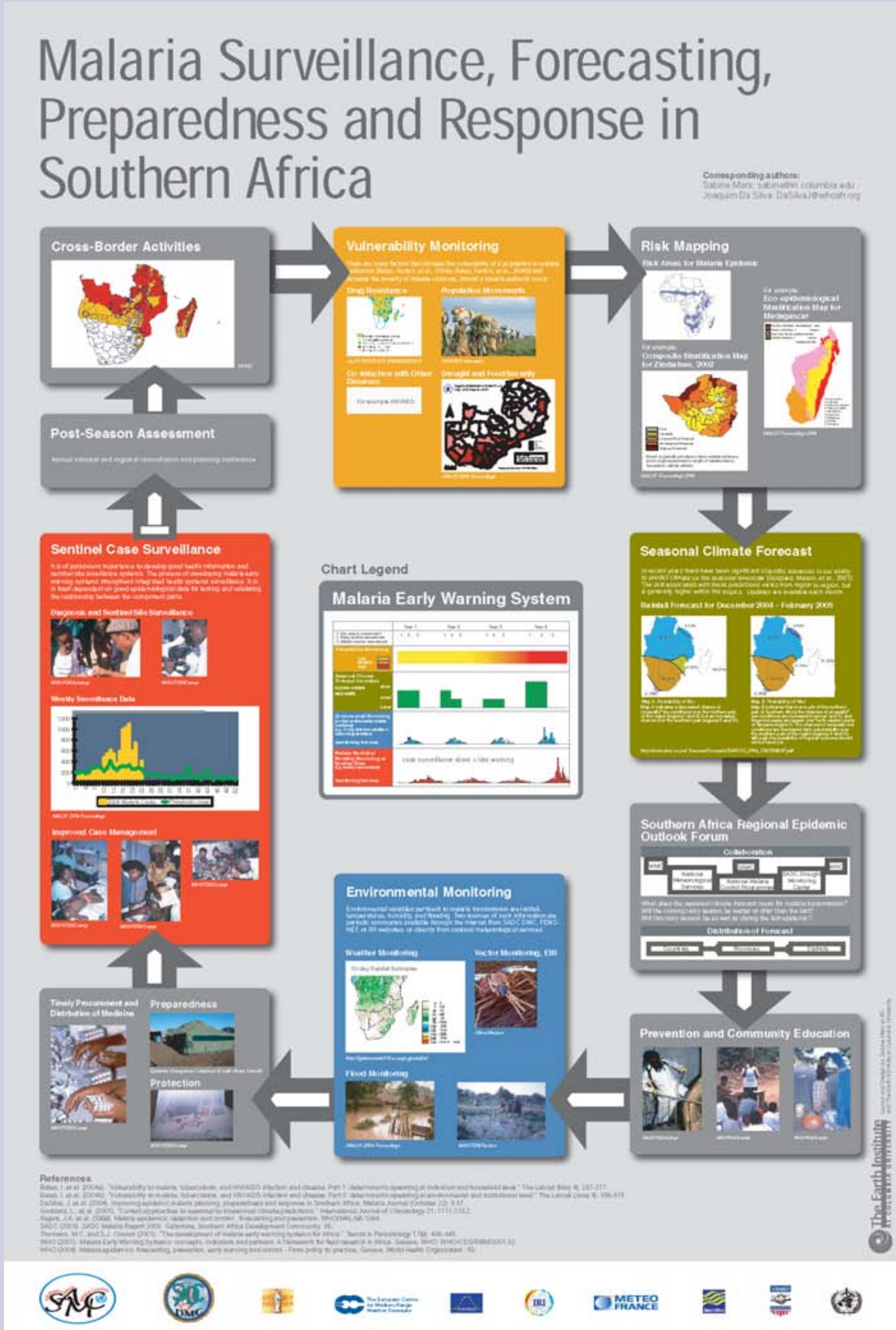
Madeleine Thomson began her scientific career "mucking about in African swamps." As a medical entomologist working in the tropics she soon confronted the question: how are disease bearing insects affected by climate and other environmental variables, and what are the health consequences? Which brought her to the question that still occupies much of her time as a Senior Research Scientist at the IRI: how can climate information help health services better target their resources?

She started to study the links between insects, disease, and climate in 1988 in the humid forests of Sierra Leone. That year, *Simuliun damnosum s.str.,* a fly that normally lives in the West African savannah started appearing in the region. The fly transmits the parasitic worm which causes the disease "river blindness," which had a devastating effect on rural communities living near the major savannah river systems. Why were these savannah flies so far from their normal habitat? Thomson believed that that year's unusually strong winds might have carried the flies into the humid forests. If this was correct, she wondered, could the winds and their impacts have been anticipated?

"My approach has always been pragmatic" says Thomson. "Can we explain the phenomena we observe and can we use knowledge to make a difference? The idea of being problem-driven is absolutely critical to IRI now. It's a collective effort. We talk with climate scientists and disease control people, and together come up with something useful that can work in the field." That's how the team approached one of the continent's most deadly scourges, malaria. The parasite kills between one and three million people every year, 90 percent of them in Africa. "Everyone knows that certain mosquitoes transmit malaria and that the disease thrives in hot and wet conditions, but we needed to know the precise relationships between malaria outbreaks and variables such as rainfall, temperature, and surface water. What triggers an epidemic? Can we use this knowledge to provide early warning?"

Thomson is quick to point out that technical knowledge isn't enough. Just because you know something is good doesn't mean that policymakers will pick it up," says Thomson. "You have to ask, 'whose mind am I trying to change?' Get that sorted out and you're more likely to produce something that will have an impact." Working through the World Health Organization and the Roll Back Malaria Partnership the IRI team was able to join efforts to combat epidemics in southern Africa. "By working closely with technical groups and with ministries of health and the national meteorological services, we can help build strong partnerships that not only issue early warnings but also provide an early response."

Thomson's task was to let this partnership's needs drive the research. "If you do things the other way around," she says, "you're very likely to miss key elements that the experts in that area consider extremely important. And if you miss those, the quality of your work will suffer. When you produce something together, learning together, something they specify, it's more likely to meet their needs and they're more likely to use it." In southern Africa, the partners had three goals: to reduce malaria by at least half; to report outbreaks of malaria within two weeks of inception; and, to control the outbreaks within another two weeks. The IRI began looking for evidence of a link between these goals and climate variability. "If you know that 60 percent of malaria cases in Botswana result directly from variability in rainfall," says Thomson, "and if you know about the likely changes in the amount of rainfall, to what extent can that improve the outcomes? You create the evidence in such a way that policymakers can see the relevance to what they want to achieve." In Botswana, IRI scientists established that the amount of rainfall from December through February correlated to the annual incidence of malaria, which peaks in March and April. That is, climate observations could offer a prediction for malaria outbreaks. However, this only gives a one to two month lead time.

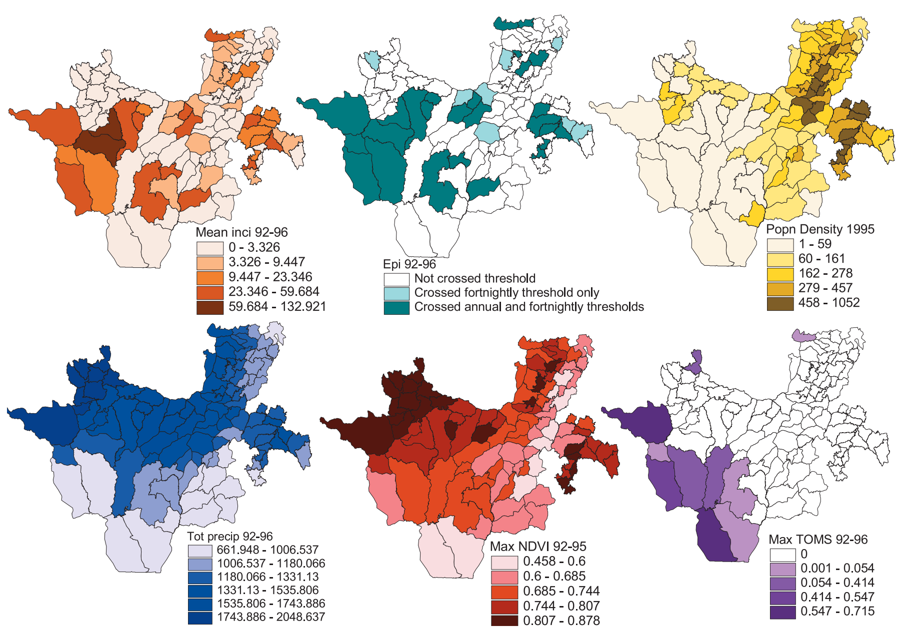


Working with the regional climate institutions and European climate models the IRI has demonstrated that seasonal climate forecasts can give a heads-up 5 months in advance of an unusually high or low malaria season. This knowledge is now being put to practical use. "So while we were delighted to have some of the more technical aspects published in Nature," says Thomson, "the fact that the countries are actually using the approach we advocate is what motivates our work." The forecast, for the end of 2005 and early 2006, predicted a heightened risk for heavy rains in southern Africa. Newspaper reports from Botswana and Namibia state that the forecast gave the health services an early warning, which allowed them to prepare for an outbreak by increasing their stocks of medicine and equipment, by distributing containers of supplies in likely epidemic areas, and by spraying insecticide. "We're assisting them to achieve their own objectives. IRI's mandate is to help societies' manage problems related to variations in climate," says Thomson. "I think other countries will be looking to set up their own IRIs," she adds, "but at the moment IRI is definitely in the forefront."

Space-Time Modeling: Determinants of Meningitis Epidemics in Ethiopia

Meningitis is a seriously debilitating and often fatal respiratory disease that is prevalent in semi-arid regions of the developing world. In some locations, particularly where airborne dust or pollutants abound, the disease can quickly reach epidemic proportions causing socio-economic hardship among the affected communities. Further developments in the use of forecasting models to predict meningitis epidemics within sub-Saharan Africa are being undertaken with the incorporation of epidemiological, weather and environmental information at the local level. That is, the study considers the variations in these parameters within a region, and the degree to which forecasts can be tuned to better inform decision making and planning at the local level. The pilot study is based in the Southern Region of Ethiopia and is a collaboration among the Ministry of Health, Ethiopia; the School of Tropical Medicine of the Department of Medical Microbiology, University of Liverpool, UK; and the IRI.

Data from meteorological stations include rainfall, humidity, temperature and visibility. Data from satellite sources include TOMS aerosols (dust), SPOT Vegetation/AVHRR NDVI and derived products (land cover and soil types) and other locally available data on the environment. Other data include topography, population, village distribution, roads, health facilities and administrative boundaries. Epidemiological data include incidence and epidemic history of meningitis, vaccine use, prevalent strains among cases and contacts, asymptomatic carriage of pathogenic strains and other seasonal infections. Information is collected for the last decade and



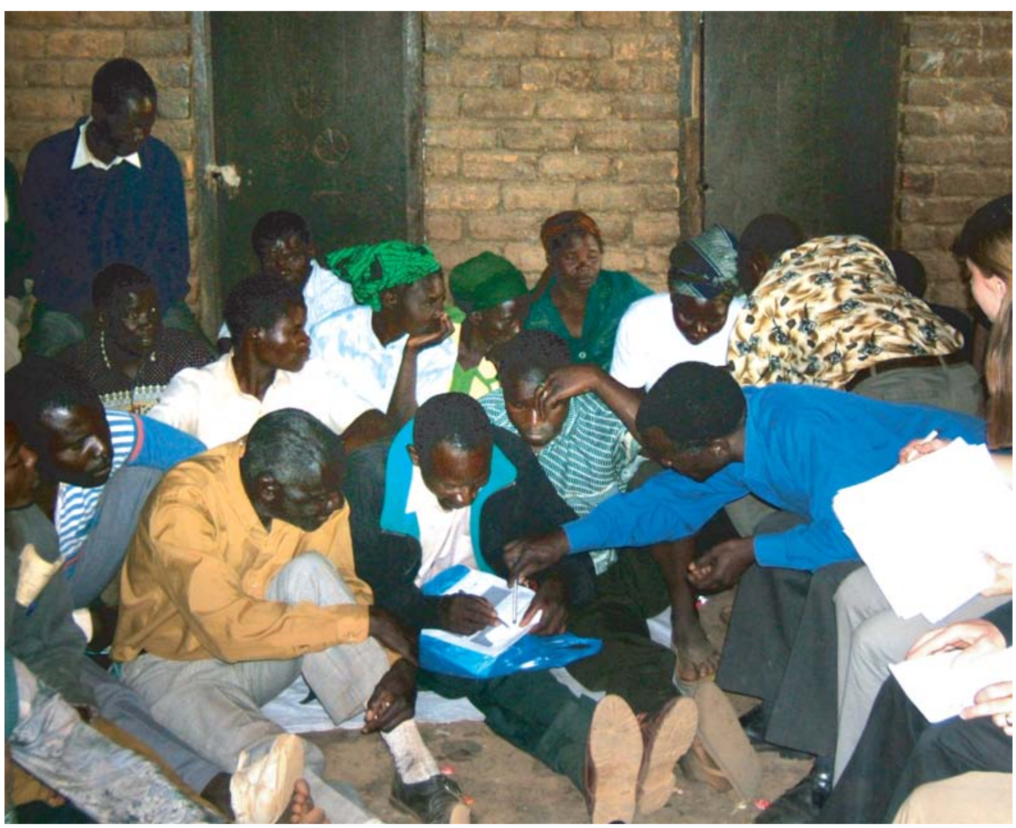
Tracking meningitis epidemics in the southern region of Ethiopia known as Sidama.

prospectively for 2003/4. Models to forecast the spatial and temporal distribution of epidemics are based on multiple regression methods that have previously been used to forecast meningitis epidemics in Sub-Saharan Africa at a larger geographical scale.

In this analysis, both environmental and epidemiological variables are assessed for their ability to predict the spatial and temporal distribution of epidemics. Variables found to be significantly related to epidemics are combined to develop comprehensive forecasting models at Zone and Woreda levels of government for Southern Ethiopia.

Index Insurance And Climate Risk Management In Malawi

IRI is working with partners to provide financial instruments to help smallholder farmers in Malawi to cope with climate risk. Because climate risk has made it infeasible for microfinance institutions to provide stand alone loan products to farmers, farmers have not been able to obtain the high quality seeds and fertilizer that they would like to use. If these inputs were available, the farmers could enjoy substantially increased yields.



D. Osgood

IRI has designed the contracts for a drought insurance system that provides the backbone for a package of loans, groundnut, and maize inputs for smallholder farmers. The insurance targets the financing risk, allowing farmers access to loans, which, in turn provide access to inputs, and the cash necessary to pay for the insurance premium.

This package is possible because of a new innovation in insurance. Traditional insurance contracts insure against crop failure, but these lead to perverse incentives to farmers to allow the crops to fail. There is also an incentive for less productive farmers to buy insurance and for more productive farmers not to buy insurance. These problems would lead to more payouts, which would in turn lead to higher premiums, which has ultimately made this type of insurance too expensive to be workable.

To address these problems, the new insurance contracts are written against an index. In Malawi, this index is based on rainfall. Farmers have correct incentives to make productive choices, because allowing crops to fail does not increase the insurance payout. Index insurance is also cheaper to implement because the insurance company does not need to send auditors to the field to verify damage. However, the farmer is no longer insured against the damage of crop failure, but only against drought. If crops fail for a reason other than drought, then the farmer receives no compensation. Because index insurance does not protect against all risks, it is usually designed to target a key risk that has undermined other mechanisms.

The pilot project in Malawi is insuring groundnut farmers against drought during critical growth periods. So far it appears to be successful. A total of 892 farmers, in

D. Osgood

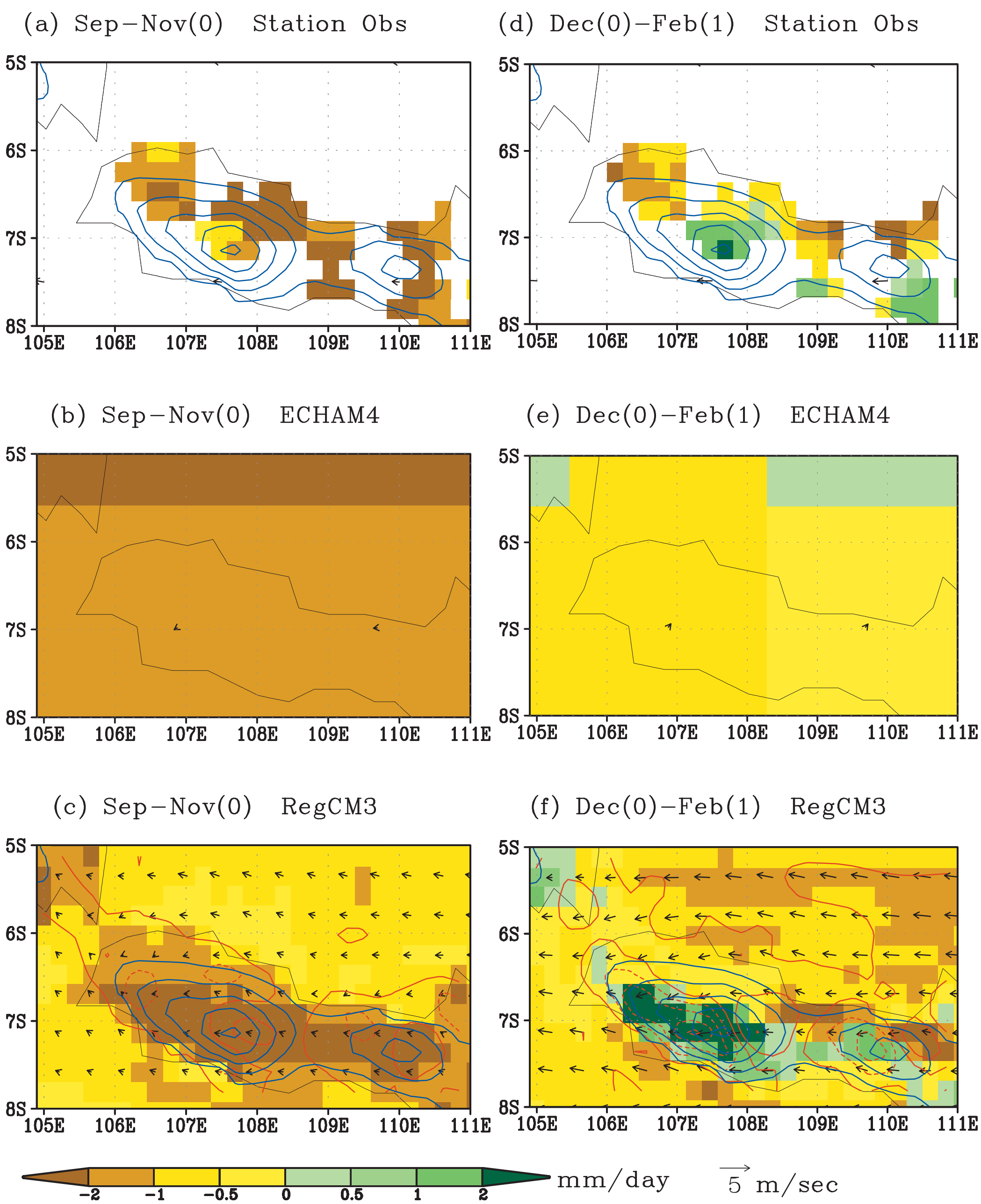
farmers' clubs of 10–20 members, bought insurance in 2005 in the pilot project and the number is expected to climb to several thousand for 2006. Partners in the project include Malawi farmers, financing associations (NASFAM, OIBM, MRFC, Malawi Insurance Association), the World Bank CRMG, the Malawi Met Service, and CUCRED. In interviews, farmers have reported that the way that they adapt to climate change and variability is by enrolling in the insurance program. Scale-up in Malawi is primarily limited by the logistical challenges of education and signing of contracts for large numbers of new farmers, as demand is overwhelming. The program is financially self-sustaining, with farmers paying their own input costs, insurance premiums, interest, and even taxes. We are developing similar programs in Kenya and Tanzania, and additional projects are being scoped.

IRI is developing the insurance program to allow farmers to make much more effective use of climate information. Farmers in the program are aware of the relationships between ENSO and seasonal precipitation but have expressed frustration because they cannot take actions to benefit from this knowledge. They have articulated an interest to shift their crop mix to take advantage of seasonal forecasts, increasing the fraction of their land with drought tolerant crops in response to dry forecasts years and shifting towards higher risk but higher productivity crops in response to wet forecasts. Because the farmers have complained that the appropriate seeds are not available or affordable, IRI is working to build the forecast into the insurance package, so that the insurance package reflects the best mix of seeds and financial tools for the seasonal rainfall probabilities expected.

D. Osgood

Regional Climate Modeling and Downscaling for Indonesia and the Philippines

Multi-member 30-year ensemble dynamic regional climate modeling has been conducted over Southeast Asia using a regional climate model RegCM3 forced by the ECHAM4 T42 simulation. The higher resolution (60km or 25km grid) regional climate model outputs provide climate information at sufficient geographical detail to inform climate risk demonstration projects in Indramayu of Java, Indonesia, and Iloilo and Angat of the Philippines.



El Niño-Climatology composite of seasonal precipitation (mm/day; shaded), low-level winds (m/s, vector) and divergence (red contour interval is 1e-5 in c&f). Top panels: observation, middle: ECHAM4, bottom: RegCM3. Terrain heights are shown by blue contours (interval 200m). El Niño years: 72/73, 82/83, 86/87, 91/92, 94/95, 97/98; Java Indonesia.

The regional climate model outputs have been analyzed by using IRI's Climate Predictability Tool (CPT) and other statistical methods to assess the predictability of SE Asian climate. The regional model is able to simulate the seasonal and interannual variation of the regional climate, particularly the impacts of the El Niño Southern Oscillation (ENSO). Cross-validation against the observed rainfall shows that the regional climate predictability is seasonally dependent. The rainfall prediction skill appears to be lower during rainy season, whereas it appears to be higher in transitioning seasons. Local rainfall predictability is greatly improved by using the high-resolution RegCM3 regional model over using the coarse resolution ECHAM4 global model.

The figure on the previous page shows a composite anomaly of warm ENSO years of precipitation, low-level winds and divergence (red contours in c and f) for the period September to November (SON, left panels) and also for the following period of December to February (DJF, right panels) over western Java, Indonesia. Station observations of precipitation show a spatially coherent dry anomaly in the SON season (a). In contrast, spatial coherence is low in the DJF season, with a northeast dry and southwest wet dipolar precipitation anomaly structure in the warn ENSO years (d). The coarse-resolution ECHAM4 (b) and (e) cannot resolve these fine scale features. By contrast, the 25 km grid regional model (c) and (f) compares well with the composite anomalies (a) and (d). The seasonal variation of spatial coherence was well simulated, as was the northeast-southwest dipolar precipitation anomaly structure in DJF.

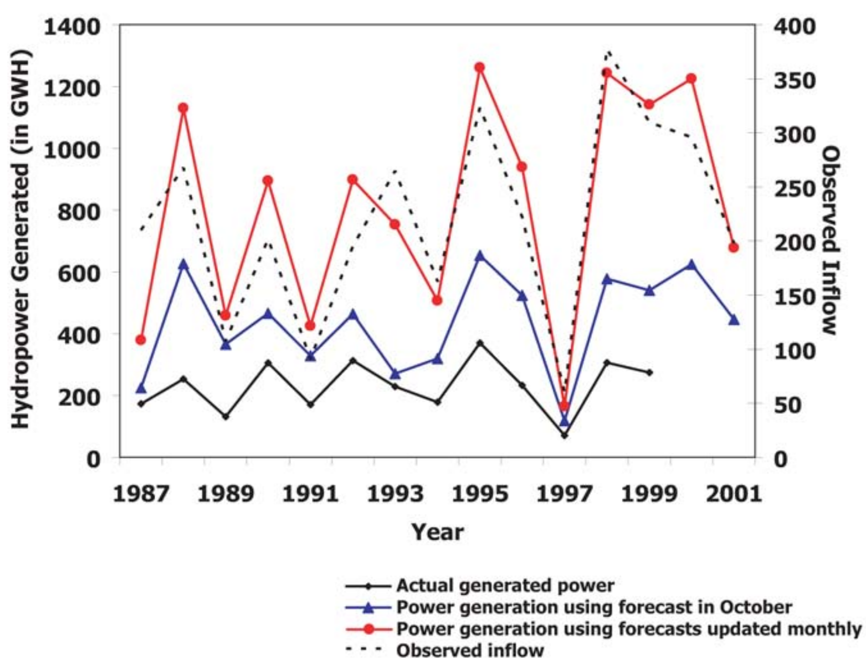
It is found that the dipolar structure in DJF is caused by the ENSO impact on local sea breezes. The sea breezes from opposite directions converge over the narrow island in the afternoon and trigger heavy convective rain. In warm ENSO years, the large scale trade wind anomaly is easterly, which enhances the sea breeze from the northeast but hinders that from the southwest, so the sea breeze convergence line and heavy rain is shifted toward the southwest. In SON, the large-scale atmospheric conditions appear to remain quite stable. But in the peak rainy season (DJF), the atmosphere appears to become sensitive to the ENSO-trade-sea breeze interactions.

Managing Competing Water Uses in the Philippines: Angat Reservoir

Angat is a critical multi-purpose reservoir in the Philippines, providing 97% of water supply for metro Manila, home to 11 million people. At the same time, it irrigates about 30,000 hectares of rice in Bulacan Province over two seasons, supplies 248MW of hydropower for the island of Luzon, and helps control floods. This region experiences high interannual variability in rainfall, often associated with the ENSO phenomenon. Increasing demands for water in this region presents challenges for decision makers, who must allocate water across urban and rural uses.

IRI has been working with the National Water Resources Board and other key government stakeholders involved in water allocation to develop and test risk management strategies that make use of advanced climate information. Angat is one of several demonstration sites in a five-year project funded by the Office of Foreign Disaster Assistance of USAID, undertaken collaboratively with the Asian Disaster Preparedness Center (ADPC). Following IRI's approach to problem-driven research, the project integrates climate science and risk management research across local, national and regional scales.

Initial project research identified key climate problems in the context of urban, rural and power generation needs. Institutions and policy-systems scientists at IRI have been working with socio-economic researchers at the University of the Philippines Los Baños to conduct a detailed analysis of the institutions and policies guiding Angat water allocation decisions. This research identifies a number of critical constraints on



Comparing water allocation strategies with and without seasonal inflow forecasts for the Angat reservoir. The graph shows the estimated improvements in hydroelectric power production each year when water allocations are based on seasonal forecasts. This research is being conducted in collaboration with water managers at the Angat dam facility.

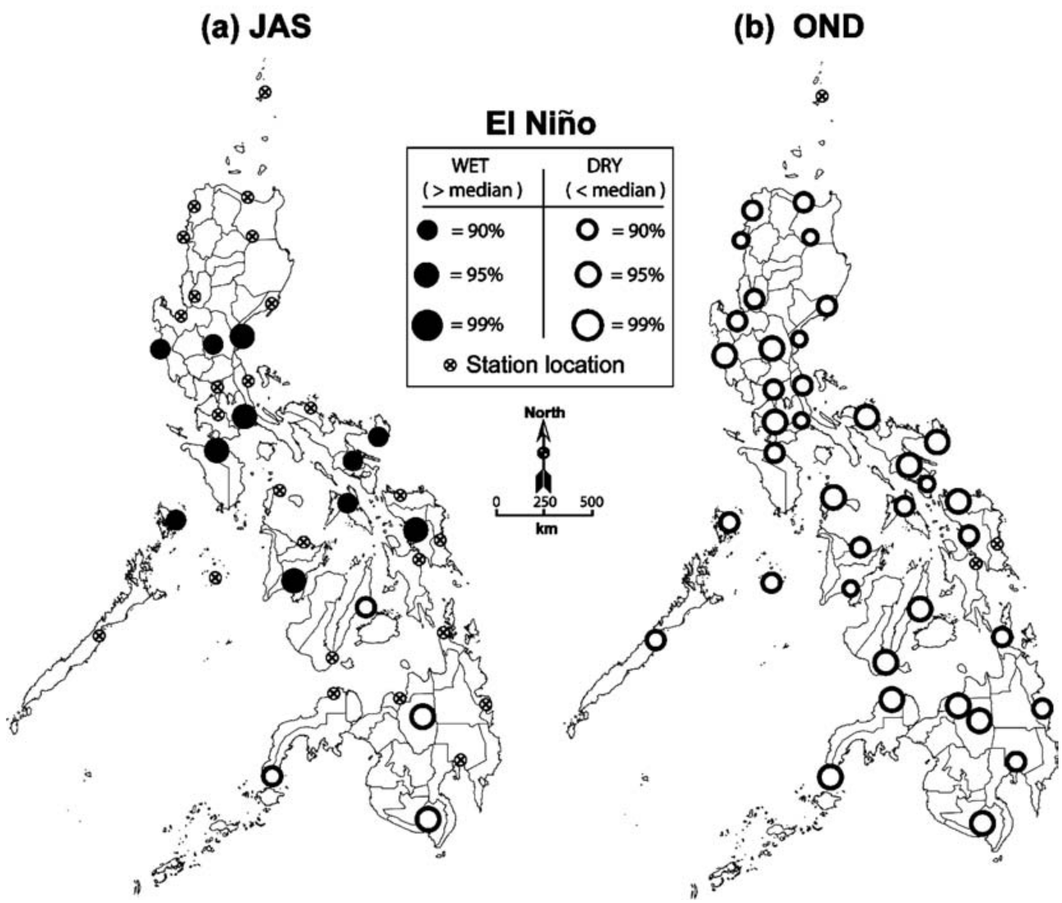
decision making, and suggests needs for climate information during certain seasons in low-flow as well as high-flow years. Simultaneously, IRI climate scientists have been collaborating with PAGASA, the Philippine meteorological service, to build an improved understanding of the impact of ENSO, and to build their capacity in statistical and dynamical downscaling.

Based on an understanding of key climate problems and institutional and policy constraints on decision making, improved climate diagnostic and forecasting capacities are being used to develop decision tools for experimental uptake by Angat stakeholders. A reservoir model using monthly updating of streamflow forecasts has been developed, which may enable improved management of power production and water releases to farmers during the high flow period of October-December. Presently, researchers are designing a decision model for low-flow periods, especially to help manage risks faced by rice farmers when water deliveries are uncertain.

E. Ebrahimian

Reversal of the ENSO Rainfall Signal in the Philippines

Seasonal rainfall in the Philippines is known to be modulated by the El Niño Southern Oscillation (ENSO) phenomenon, with ENSO warm (cold) events frequently contributing to drought (excessive rainfall) in many areas. Using rainfall data from 40 observing stations across the Philippines, we find that the seasonal rainfall response to ENSO reverses sign between boreal summer (July–September, JAS) and fall (October-December, OND). Above-median, boreal summer rainfall is observed at several stations in the north-central Philippines during El Niño (Figure (a)) before anomalously dry conditions become manifest the subsequent fall (Figure (b)). Conversely, during La Niña, below-median summer rainfall occurs at several stations before the onset of anomalously wet conditions in fall. The results are shown to not simply be a consequence of ENSO transitions during boreal spring, but from a change in behavior of the large scale monsoon system during the life cycle of ENSO events.



Boreal summer rainfall is observed at several stations in the north-central Philippines during El Niño (Figure (a)) before anomalously dry conditions become manifest the subsequent fall (Figure (b)).

Managing Food Security Using Climate Information: Nusa Tenggara Timur, Indonesia

The province of Nusa Tenggara Timur (NTT) lies in the eastern part of the Indonesian archipelago. It is among the poorest in Indonesia, with over 35% of its 4.2 million inhabitants living below the national poverty line. NTT routinely suffers from food security problems. Its climate, drier than most other parts of Indonesia, is highly variable, and interannual variability appears closely linked with the ENSO phenomenon. In years with poor crop yields, rates of acute malnutrition can be close to 20-25%. Food aid is regularly needed in NTT. In normal years, 20,000-25,000 tons of food aid are supplied per year. In El Niño years, 50,000-55,000 tons may be required.

S. Someshwar

IRI is collaborating closely with governmental and nongovernmental agencies managing food security in NTT to use climate information to support earlier action to prevent major food security crises. NTT is a demonstration site in a five-year project funded by the Office of Foreign Disaster Assistance of USAID, undertaken collaboratively with the Asian Disaster Preparedness Center (ADPC). The project integrates climate science and risk management research across local, national and regional scales.

IRI has developed a strong collaboration with CARE Indonesia, a humanitarian organization playing a significant role in responding to food security crises in the region. During the 1997-98 El Niño, CARE spent $8.5 million over two years, serving 17,000 families in NTT. In addition, IRI has built a research partnership with the Center for Agricultural and Rural Development Studies (CARDS), based in Bogor Agriculture University, Indonesia. IRI, CARDS and CARE have carried out a detailed landscaping of the policies and institutions guiding decision making on food security. At present, most key food security decisions are made based on monitoring of malnutrition rates, and food aid does not arrive until months later. Forecasting the onset of the monsoon (which normally arrives in late October/early November in NTT) may offer possibilities for earlier action before malnutrition sets in.

IRI is also collaborating with the Bureau of Meteorology and Geophysics (BMG) and climate researchers at Bogor Agriculture University to build climate science and forecasting capacity, and to develop experimental forecasts for testing by food security decision makers in NTT. Research is now underway to identify actions that decision makers might take earlier based on climate information, such as the timing of monsoon onset.

In October 2005, the International Research Institute changed the last part of its name from "for Climate Prediction" to "for Climate and Society." Dr. Shiv Someshwar is a great example of that expanded emphasis. A social scientist, he is director of Institutions and Policy Systems Research at IRI, and also directs the institute's Asia program.

"Before we dash in and say, 'This is the kind of climate information we can produce, and surely it's going to help you,'" says Someshwar, "we first need to understand the social reality and how it is being tempered by climate. A key part of our work is to understand the current management system." By this, he means the programs, the policies, the people in charge, the stakeholders, the flow of decisions and resources across high-level agencies and on down to local groups.

Most countries, for instance, already have climate-related programs, but they are reactive rather than anticipatory. "Second," adds Someshwar, "we have found that most institutions are risk averse and have policy constraints about how decisions are made. So we need to look at the range of decisions they can actually make and how we can help them make those decisions better–what resources they will need–which will include looking at policies and how to change them. The ability to generate climate information in itself is not sufficient."

Someshwar joined IRI from the development world, where supply-side approaches are all too common. "Huge amounts of resources are thrown in by well-meaning donors and scientists, to show how a certain type of farming method or hybrid seed or tool will work at village X. And then at the end you come up with a beautiful multimedia presentation and you present it to the government and to the donors and you say, 'Now it's up to you to replicate it elsewhere.' Most people take one look and say, 'We can never replicate this across the 100,000 villages in my state.'

"If you truly want to have a sustainable operation," he continues, "right from the beginning you need to understand current reality, current constraints, and then how best to change those constraints by working with the agencies, the organizations, and the people in a position to affect change. The only way to do that is to understand how they function in their world, rather than to assume that one kind of information or one kind of technology is going to revolutionize their way of working."

Engaging with the system brings several other benefits. First, the decision makers feel like partners, so they become champions of change instead of obstacles to it. Second, unlike many development agencies, IRI does not suddenly descend and suddenly depart, but rather settles in for the long haul, providing the tools, training, and support to make institutional changes that are self-sustaining. It takes patience.

As an example, Someshwar points to Indramayu in West Java, Indonesia, where IRI is working with national, district, and local groups, along with Dr. Rizaldi Boer, head of the climatology lab at Bogor Agricultural University in Java. Indramayu is in one of Java's most important rice-growing regions, but is highly vulnerable to climate fluctuations linked to El Niño. Droughts hurt its subsistence rice farmers and force the government to import rice. The consequences ripple throughout Indonesia. "Economic activities really slow down," says Boer, "and that has a big multiplier effect on the economy as a whole."

Boer cites several barriers to the use of climate information in Indonesia. First, districts often lack meteorologists with the skills necessary to create a forecast. Second, meteorologists who do have the skills may be unable to communicate the forecast in understandable terms. This creates a third barrier: the confounding nature of the information makes it worthless to local officials and farmers. Lastly, the meteorologists are often too busy to produce a forecast in time for farmers to benefit. If the forecast implies that farmers should change their cropping plans for the coming season, for instance, local governments and farmers need at least two months to acquire seeds and arrange a market for the new crop.

S. Someshwar

Boer and IRI are trying to overcome these barriers in Indramayu through understanding how institutions actually make decisions, and developing climate information to meet those needs. This project work builds upon Boer's work over the past several years to develop "climate field schools," where farmers learn how to use climate information.

"We educate the farmers so they can make use of the recommendations," says Boer. "We started with three farmers' groups, each one consisting of 30 farmers. The local government expanded this, so that within three years the field school has been implemented for 100 farmers' groups and about 3,000 farmers." The central government, impressed, wants to start field schools in another 50 districts. The Philippines are interested as well.

Boer calls this systemic, top-to-bottom approach "the most significant contribution of IRI—the process of institutionalizing the use of climate information to make the programs become sustainable."

That's why Someshwar came to IRI four years ago. "IRI is the only place on the planet that connects climate information with actual use of that information in real-world settings, to actually help developing countries not just understand climate fluctuations but also manage them."

Climate Risk and Elephant Management in Sri Lanka

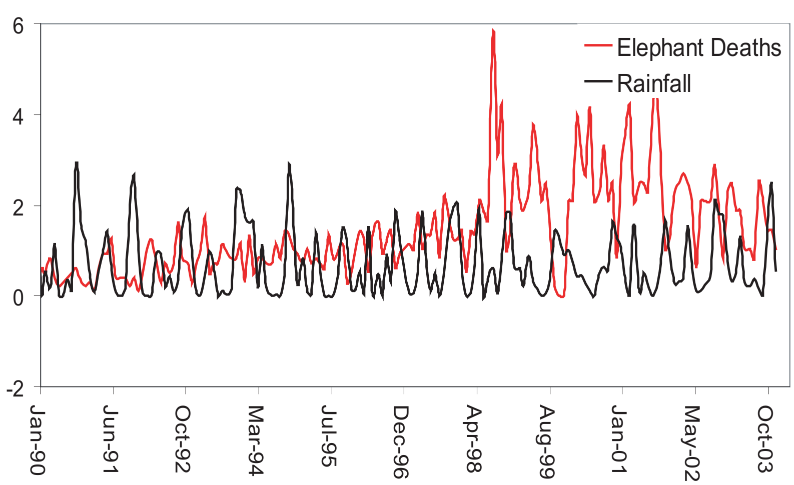
L. Zubair

Global populations of the endangered Asian elephant (Elephas maximus) face an uncertain future due, in part, to their populations having been relegated to small and relatively isolated pockets throughout their historic range in southern and southeastern Asia. In Sri Lanka, their numbers have dwindled to some 3,000-4,000 individuals. Resource competition over two of the most important climatically influenced variables in the habitat—vegetation and water—is driving much of the conflict currently engulfing humans and elephants.

The sustainable coexistence of humans and elephants depends on:

- The maintenance of elephant population in numbers that ensure their genetic viability and resilience to occasional shocks
- The preservation of the habitat of elephants including climate-risk informed management of dual-use or nonconservation areas.
- The development of human societies in the peripheral areas so as to support their coexistence with the elephant populations and the minimization of human-elephant conflict.
- Planning and management strategies that take into consideration near- and long-term trends in demographics, environment, climate and land use.

Climate affects water availability, vegetation, agricultural practices and irrigation. Stresses to any or all of these factors can result from rainfall excesses or drought, which in turn lead to competition and conflict between humans and elephants, and



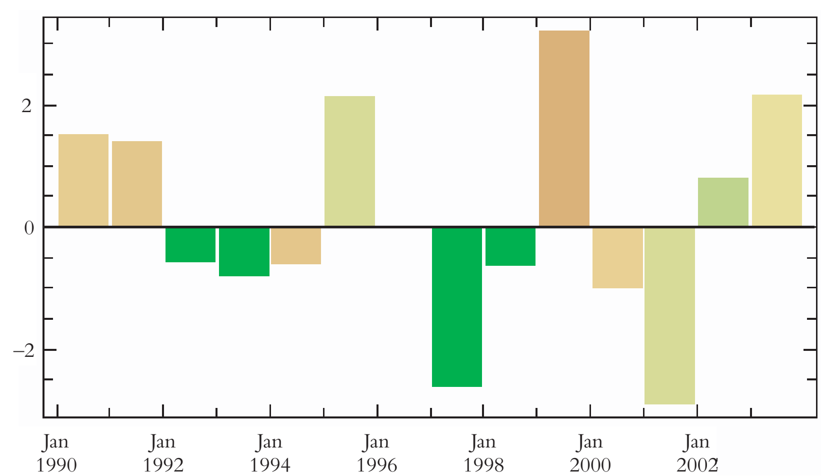
Monthly data on aggregate national elephant deaths and rainfall for the Eastern region of Sri Lanka from 1990-2003.

the need for regulation and protection in rural areas.

In a collaborative study with Wildlife Trust and other institutions, we have developed a database of fine-scale indices needed to analyze and inform wildlife management. These include climatic parameters such as rainfall and temperature, hydrological parameters such as stream flow, vegetation indices, and drought indices.

We found that (a) the seasonality of elephant deaths peaked at the end of the dry season in April and August and declined in the wet seasons (b) both the long-term trends and interannual trends showed that there were greater elephant deaths during years which had dry periods and (c) that while climate was a significant factor in elephant deaths, other factors remain important too.

Year-to-year departures of elephant deaths from normal (as derived from a long-term trend) as a bar chart. Each bar is colored by the January to July rainfall, with drier years shown in shades of brown and wetter years shown in shades of green (color intensity corresponds with increased intensity of dryness or wetness). This figure shows that during years that were dry (tan or brown bars) elephant deaths increased in most, but not all, instances.



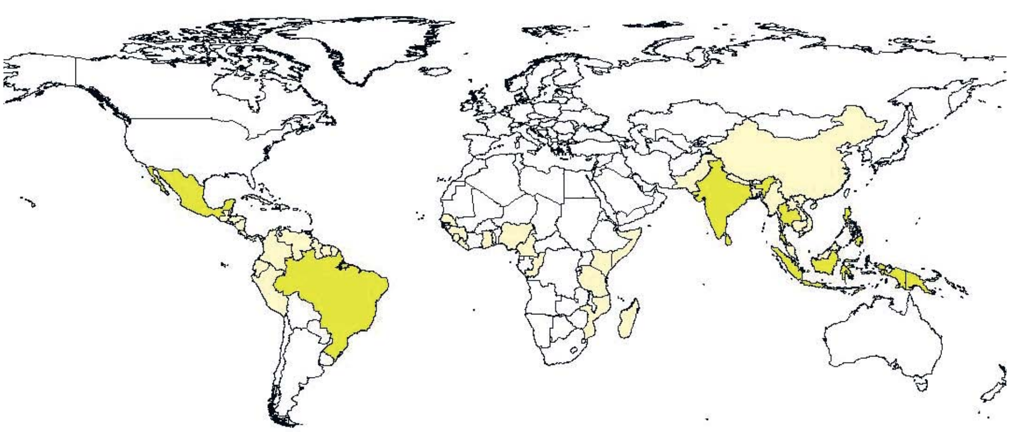
Climate and Coconut Production in Sri Lanka

Coconut cultivation sustains the livelihood of large numbers of people living in the tropics and is the most important crop for food security after rice in Sri Lanka. Coconut is vulnerable in particular to drought and there is concern as to how

coconut plantations can cope with climatic variability and adapt to climate change. These issues were addressed by a team of scientists including meteorologists, agricultural economists, crop scientists and statisticians drawn from Sri Lanka's Department of Meteorology and Coconut Research Institute in collaboration with IRI scientists from 2002 to 2005. The project was funded from the Adaptation and Impact Assessment to Climate Change (AIACC) program administered by global change SysTem for Analysis, Research and Training (START).

Coconut is a perennial crop which has a prolonged reproductive phase of 44 months. Weather and climate affect all stages of the long development cycle extending to 44 months and thus there is likely to be extended predictability based on climate variability. Annual production could be forecast 3 months ahead of the start of each year based on observed climate. Use of seasonal climate forecasts can extend this lead time.

Forecasting of Annual National Coconut Production (ANCP) is important for national agricultural planning and negotiating forward contracts with overseas importers. Climate and the long term trends (attributed to "technology") are major factors that determine ANCP.

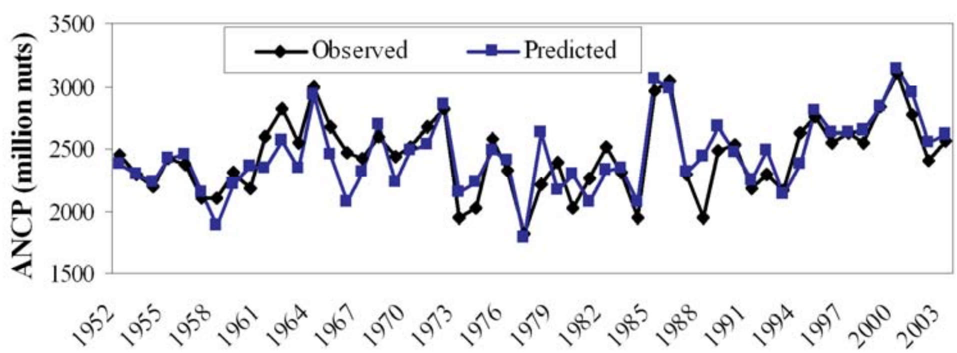


World-wide distribution of coconut. Coconut is distributed in the tropical regions with large plantations in Indonesia, Philippines, India and Sri Lanka. Areas that contribute greater than 2% of the global production are shaded in darker yellow and those which have significant production below this threshold are shaded in lighter yellow.

IRI researchers collaborated in climate analyses and crop-climate interactions, results synthesis, and research outputs. The climate effect was estimated by regressing production data that had been de-trended to remove the "technology effects" with quarterly rainfall in the year prior to harvest. The technology effect was estimated from the historical log-linear trends.

The work improved research capacities for the scientists involved, and also resulted in improved operational capacity. Four research assistants obtained experience in climate analysis. Two of these obtained M.S degrees in related fields. Two scientists from the Coconut Research Institute were hosted at the IRI, resulting in the development of a regression model that integrates both climate and technology effects in coconut production and that predicts ANCP with high accuracy. This model is now in operation at the Coconut Research Institute (http://www.cri.lk/yield.html) and is provided to other government agencies. These results are also reported in several collaborative publications in regional and international journals.

Predicted and observed annual coconut production based on a model that accounts for technological change and seasonal climate.



When La Niña is strong, drought can parch southeast South America. Crops shrivel, cattle die, farmers despair. That was the pattern in Uruguay until 1999, when climate science helped to create a new blueprint for the future.

In October of that year, the IRI predicted a heightened risk of reduced rainfall for the coming months, and began collaborating with Uruguay's National Agricultural Research Institute (INIA) to use satellite technology to monitor vegetation, thus tracing the drought's progress into the year 2000. The climate information completely altered Uruguay's usual response to drought.

"The information was absolutely fundamental in making decisions and passing the crisis," says Juan Notaro, the country's Minister of Agriculture at the time. (He is now an executive director at the Inter-American Development Bank in Washington, D. C.) Because the vegetation maps made clear which areas were being hit hardest, Notaro could concentrate resources from various government ministries—equipment, money, and other aid—on the places that needed the most help. The information allowed him to stay ahead of the crisis. It also served to defuse panic, resentment, and demands from various factions.

"There was pressure from farmers, from farmers' unions, from local governments, from the Congress, from the press," says Notaro. But the climate reports made all decisions transparent, and trustworthy - because the decisions were based on precise information, not the influence of the powerful or well-connected. Ultimately, Uruguay's farmers lost few cattle and the public was satisfied with the government's response to the crisis.

Two people who provided information to Notaro were Augustín Giménez from INIA and Walter Baethgen, now director of IRI's program for Latin America and the Caribbean. Giménez runs the Unit of Agroclimatology and Information Systems (GRAS) within INIA. The GRAS website, which provides climate information to the agricultural sector, gets 2,000 hits every day, an indication of how important such data has become in Uruguay.

Giménez says that farmers use the website for daily, weekly, and seasonal planning. Farmers who grow wheat or sunflowers can get early warning about the possibility of disease hitting their crops, and take preventive measures. "Something like 40 or 50 percent of our prosperity is from agricultural production and commodities," says Giménez, "so climate information is very important for us."

He worked closely with IRI's Baethgen to develop these systems. Baethgen, an agronomist by training, calls his work in Latin America and the Caribbean "climate risk management." On the science side, this means learning from the past, monitoring the present, and predicting the future. On the people side, it means finding the best partners and collaborating with them to reach the widest practical results. "We try to identify the right stakeholder communities that can affect a big number of farmers," he says, "and that's typically government agencies working in policies, in planning, in insurance, rural development organizations, rural credit organizations."

First, of course, he must establish credibility with those stakeholders by giving them useful products. That's daunting in Latin America because the agricultural sector is so diverse, ranging from large commercial cattle operations in the grasslands of Uruguay to small potato farmers in the Andes. "So you have to tailor the products into something relevant for the different actors," says Baethgen.

R. Taddei

Baethgen believes that climate tools should not only help farmers mitigate losses in bad years, but maximize profits in good ones. "Take a medium-sized commercial corn grower," he says, "In 30 years they may have three or four years that are really bad, and on the other extreme they have five or six years where their income is very big. Sometimes the income from those six years corresponds to 60 percent of the total income in 30 years. So it's important to help them take maximum advantage from the very good years, because that can really affect their financial situation."

For instance, if the forecast for the next three months indicates a high probability for plentiful rainfall, farmers should be encouraged to take advantage by planting high-income crops such as corn, soybeans, and sunflowers, and by using first-rate seeds and extra fertilizer. On the other hand, if poor rainfall is predicted, farmers could devote more acreage to drought-resistant crops such as sorghum, which might cut their income but also their losses. Such flexibility gives farmers more financial resilience, and this, in turn builds resilience into the national economy.

That benefit can be deepened, Baethgen believes, by making it easier for farmers to get credit and insurance. Banks and insurers tend to shy away from farmers because of the uncertainties involved in agricultural production. Baethgen and others at IRI are developing tools to replace these uncertainties with climate information that helps insurers quantify risks. For instance, IRI can use historical climate records to estimate the minimum amount of rainfall required to produce a decent yield of corn in, say, southern Brazil, and then couple this with seasonal forecasts and simulation models to create a picture of the future.

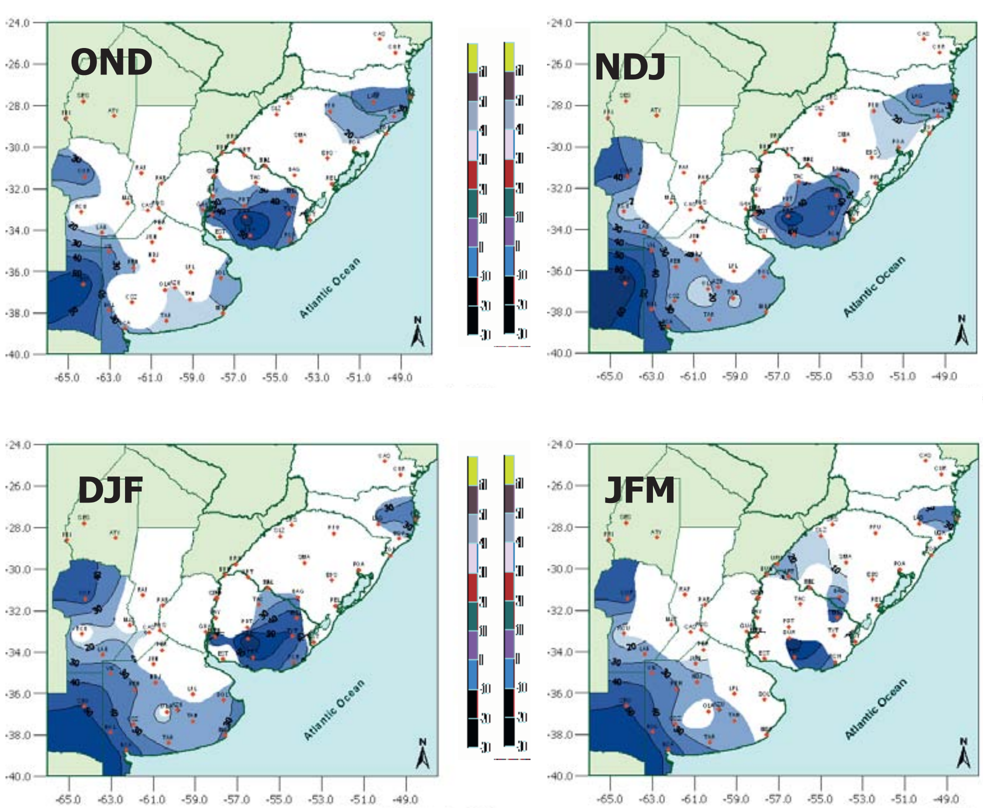
"You can characterize the whole range of risks that a farmer will confront under different climate conditions," says Baethgen. "So then the insurance company can say, 'Of all these risks, I can cover this part, and I will charge you this much, and you will have a 90 percent chance of recovering your costs.' And then the credit company will say, 'OK, with that level of risk, if you buy this insurance, I will give you a loan.' So you generate this very nice cycle," continues Baethgen. "The farmers have access to insurance, therefore they have access to credit. Because they have access to credit, they can improve the technology and invest in better agricultural inputs such as seeds and fertilizers."

So far IRI has helped Uruguay launch a model to support insurance programs along these lines, and Baethgen also hopes to develop similar programs in Brazil, Chile, Argentina, Paraguay, and Bolivia.

Climate Change/Variability in the Mixed Crop/Livestock Production Systems of the Argentinean, Brazilian and Uruguayan Pampas: Climate Scenarios, Impacts and Adaptive Measures

The Pampas (central Argentina, southern Brazil and Uruguay) constitute a major food producing region of the world. The objective of the proposed research was to establish, use and maintain an agricultural systems network in the Pampas to assess the impact of climate change/variability and explore adaptive responses for the mixed grain/livestock production systems. This study was undertaken in collaboration with INIA, INTA, and EMBRAPA.

The observed climate data revealed increases in the rainfall (especially in the summer and spring, see figure below), decreases in summer maximum temperatures, and increases in the minimum temperatures throughout the year. During our study period (1930 – 2000) the frost regime became milder: frosts started later, ended earlier and their temperatures became higher. The increased rainfall in spring and summer observed in the late twentieth century has resulted in more favorable condi-



Significant changes in rainfall observed in two periods (1930-1960 vs 1970-2000) for spring and summer trimesters. Results are expressed as percent changes with respect to the 1930-1960 values.

tions for the growth of pastures and summercrops. However, those same conditions and the shorter and milder frost seasons have also resulted in increased disease and pest pressures on plants and animals.

Possible climate change scenarios were created using two methods: (a) projecting the trends observed in climate in the last 70 years using a weather generator (LARS), and (b) using a GCM (Hadley center - HADC). The climate scenarios projected with the two methods used in this study were considerably different. In both cases rainfall increased (especially in spring and summer) but LARS projected changes that were much larger than HADC. Both methods projected increases in minimum temperatures, but opposite results in maximum temperatures (LARS decreased and HADC increased). These results confirm the huge level of uncertainty of climate change scenarios (especially for precipitation) and the caution with which such scenarios should be used for projecting changes in crop and pasture yields.

Finally, we tested the ability of incorporating South Atlantic Ocean (SAO) surface temperatures to improve applications of ENSO-based seasonal rainfall forecasts in agriculture. Warm SAO anomalies in August and September were consistently associated with mean or high maize yield levels, even under La Niña or neutral years. Complementing ENSO phases with SAO information led to improved ENSO-based climate forecasts.

Longitudinal Study of the Process of Communicating Climate Forecasts in Ceará, Brazil

What limits effective communication of climate information and forecasts? An innovative analysis of the communication processes by which the Ceará Foundation for Meteorology and Water Resources (FUNCEME) participates in the local social life of Northeast Brazil is beginning to yield some clues. The study focuses on the forms through which the local population interprets climate information communicated by meteorologists, rain prophets, and climate forecast producers in the region. It considers how the meteorological agency takes into consideration social and political pressures that are not strictly connected to science outcomes, but instead to the practical hurdles of outreach and scientific communication.

R. Taddei

Effective provision climate information appears to be much more than a simple communicational task. This requires an investigative approach that considers also the management of the social image of the meteorological agencies as social agents as stakeholders in public and private decision-making processes. This approach is linked to recent developments in communicational studies that point to the fact that the context in which communication processes take place is a crucial factor in how messages are interpreted and used. In some circumstances–especially those in which collective anxieties are present, as is common in climate related events–contextual factors (be they political or religious, for instance) may transform the climate information in ways that are not predicted by the issuer of the information. For such reasons, strict economic or productive analyses of the use of climate information have not been enough for the production of successful communication strategies in this area.

The study will yield communicative strategies that take into consideration negative transformations of meanings in the process of communication flows, so as to prevent common misinterpretations and misuses of climate information.

R. Taddei

N. Davi

Financial Information

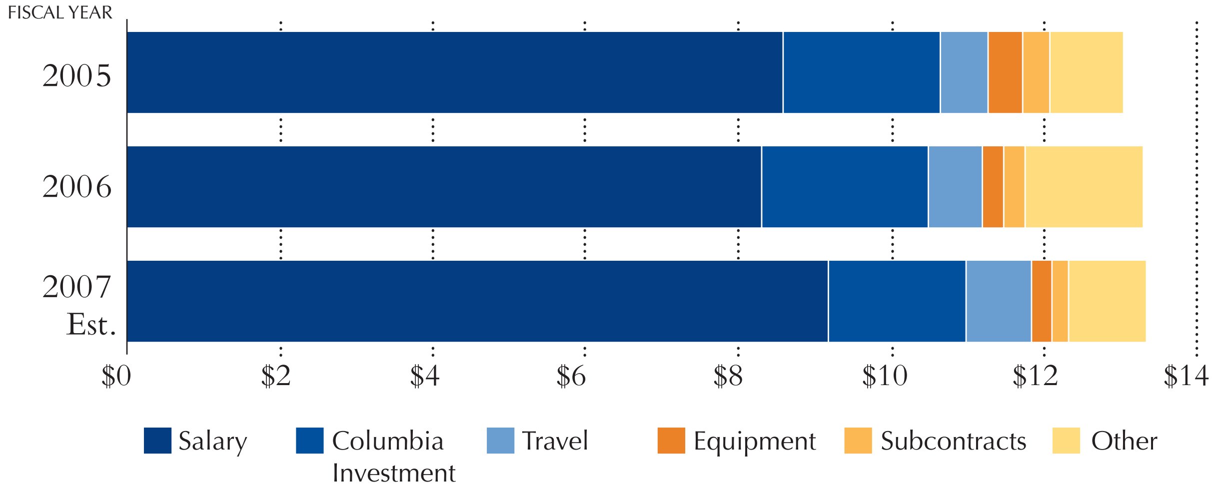
New funding sources over the period July 2004–June 2007 are about $12 million, with an additional $500,000 (to date) pending for 2007.

Growth in spending over the ten-year period since the initiation of the IRI in mid-1996 shows a rapid increase from 2000–2002, with more modest growth prior and following that period. In very early years, annual incoming resources outpaced the spending, resulting in a modest reserve that has subsequently been spent down in more recent institutional growth.

Funding sources by fiscal year

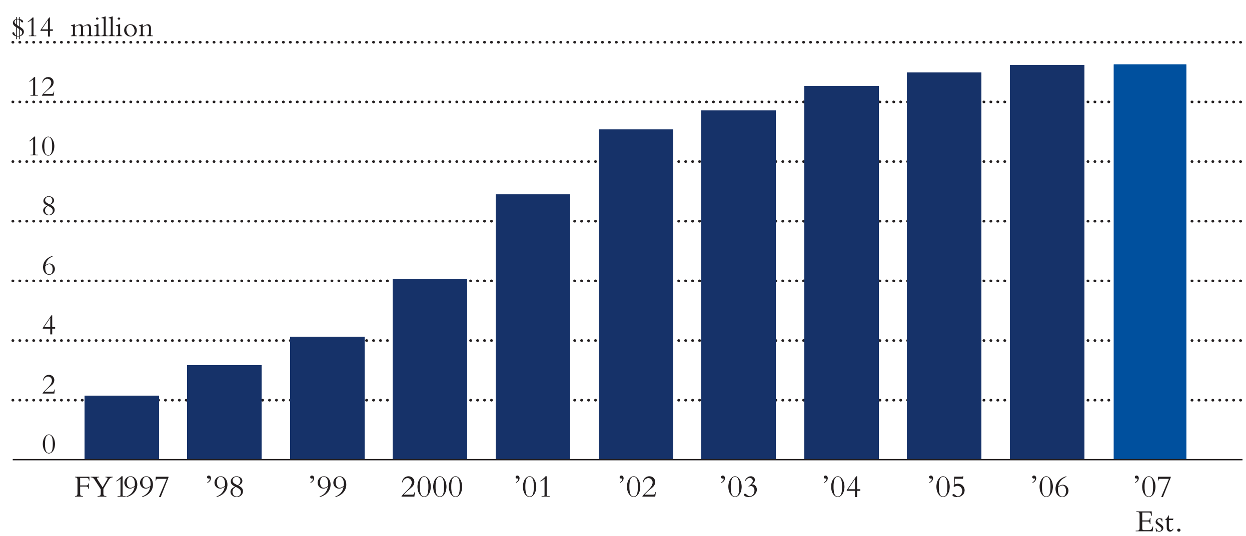
	FY05	FY06	FY07
CORE RESEARCH AND FUNDING IMPLEMENTATION FUNDING			
NOAA Office of Global Programs	$ 9,036,355	$ 9,036,356	$ 9,036,356
Columbia University Cost Share	2,485,420	2,329,788	2,398,746
Endowment Interest	92,402	94,808	97,261
PROJECT FUNDING			
DFID, UK Department for International Development - Gap Analysis		155,400	
RTI International, Improving Malaria Early Warning System		134,385	
Asian Disaster Preparedness Center, Climate Forecast Applications for Disaster Mitigation in South East Asia		104,458	141,020
NOAA Applied Research Centers, ocean data assimilation, regional modeling, SST prediction	107,502		
Camp Dresser and McKee, Malaria Early Warning Systems in Eritrea	59,000		
NOAA PACS, Study of Seasonal Rainfall Predictability for Tropical South America		58,664	
NOAA CICAR, South Atlantic Ocean - Atmosphere Interaction	49,967	53,831	56,619
FUNCEME, integrated water resources management, Ceara, Brazil	48,200		
DOE Tropical Atlantic, Northern Brazil, West Africa	44,597	43,033	43,557
NOAA CICAR, Investigating practical implications of uncertainty in observed SST's		30,000	30,000
National Science Foundation, SGER: Performance-based Probabilistic Multi-Model Climate Change Scenarios	25,000		
National Science Foundation, NSF (Direct), ADVANCE, IGERT-Workshop on Tropical Cyclones and Climate		34,484	
National Weather Service, Climate Prediction Assessment Workshop	15,000		
INIA, Instituto Nacional de Investigation Agropecuaria		13,445	13,555
RTI International, Integrated Vector Management Task Order	12,607		
Queensland Dept. of Primary Industries, farming system resilience to climatic risk, South and Southeast Asia	6,475		
World Bank, Refining Weather Insurance Contracts for Farmers in Malawi			55,055
US Geological Survey, Enhancing Malaria Early Warning with Earth Observation and Modeling Results			111,755
NOAA CICAR, Tropical Cyclones and Climate (pending)			95,173
NOAA CICAR, Investigation of the statistics of precipitation within seasonal climate in observations, analyses and the NCEP CFS (pending)			108,789
North Carolina State University, Climate Information based Water and Energy Management in the Greater Horn of Africa (pending)			46,203
USAID, Managing Climate Risks Across Timescale for Sustainable Urban Development (pending)			305,867
TOTAL	**$ 11,982,525**	**$ 12,088,652**	**$ 12,539,956**

Expenditures by fiscal year and expense category, in millions



Over the past two years (2005 and 2006), expenditures have been relatively constant by major category with total spending of about $13 million, and current projections for 2007 show a continuation of that trend. Each year, Columbia invests about $2 million in salaries and programs that directly and indirectly advance the mission of the IRI. Of the remaining $11 million in expenditures, support of staff constitutes about 78% (about $9 million) of the balance. The remaining $2 million constitutes spending in travel (6%), equipment (3%), subcontracts (3%), and other allowable expenses (10%).

Total expenses, by fiscal year



Governance

THE BOARD OF OVERSEERS CONSISTS OF DISTINGUISHED INDIVIDUALS WHO HAVE HELD LEADERSHIP ROLES IN GOVERNMENT, ACADEMIA, AND NATIONAL OR INTERNATIONAL SCIENTIFIC AND DEVELOPMENT ORGANIZATIONS. THE BOARD ADVISES ON MATTERS OF INSTITUTIONAL DEVELOPMENT, AND PROMOTES IRI AND ITS PROGRAMS INTERNATIONALLY.

Prof. Michael McElroy (Board Chair)

Prof. Michael McElroy is the Gilbert Butler Professor of Environmental Studies, Founding Chair of the Department of Earth and Planetary Sciences, and from 2000-2004 was Director of the Center for the Environment at Harvard University. His research is directed at studies of the wide-ranging effects of human activities on the composition of the atmosphere, and how changes in the composition affect climate. McElroy has served on numerous committees of the National Academy of Sciences, the U.S. Congress and various agencies of the U.S. Government including the Office of the Vice-President. He is a Member of the China International Council for Sustainable Development. He received his BA and Ph.D. in applied mathematics from Queen's University in Belfast, Northern Ireland.

Hon. Kazuo Aichi

Hon. Kazuo Aichi is currently a member of the House of Representatives in the government of Japan. In this capacity, he is the Director of the Special Committee for Research on the Constitution of Japan, and also a member of the Committee on Foreign Affairs. Within the Liberal Democratic Party, he is president of the Central Institute of Politics. Prior to his current position, he was Director General of the Global Environmental Action, a non-governmental institution in Japan committed to helping develop solutions to global environmental problems. He has held several positions in the Japanese government, including member of the House of Representatives for 24 years, State Secretary of Foreign Affairs, Minister of the Environment, and Minister for the State of Defense. Aichi received a Law Degree from Tokyo University.

Mr. Chiang-Lin Hsin

Mr. Chiang-Lin Hsin is Director General of Taiwan's Central Weather Bureau. Prior to this, he was a Counselor at the Ministry of Transportation and Communications from July 1995 to February 2004. Hsin served under five Ministers, where his ability to work with legislators was of particular value. His skills in public affairs contributed significantly to the development of Ministerial policies and approval of annual Ministerial budgets. Hsin received his Bachelor's Degree in Atmospheric Science from the Chinese Culture University in 1967. He joined the Central Weather Bureau after serving his one year of military service in 1968, and worked as a weather forecaster, weather station chief, section chief, and senior meteorologist with the CWB from 1968 to 1995.

Dr. Nay Htun

Dr. Nay Htun is University Professor and Senior Advisor to the President of the Council, University for Peace where his teaching and research focus on environmental and human security. He is also the Senior Advisor to the UN Secretary General, Personal Envoy for DPRK and is the Chairman of the UNEP Regional Advisory Committee for Asia and the Pacific. He served with the United Nations for 25 years, where he was Assistant Secretary General at both UNEP and UNDP. He serves on a number of non-profit organizations, including the Chulabhorn Research Institute and the Stockholm Environment Institute-Asia. He obtained a Ph.D. in Chemical Engineering in 1966 from Imperial College, London University.

Dr. Chester Koblinsky

Dr. Chester Koblinsky is the Director of the Climate Program Office, Office of Oceanic and Atmospheric Research, National Oceanic and Atmospheric Administration (NOAA). As Director, he manages the climate research and observation programs of NOAA. While at Scripps Institution of Oceanography and later at NASA's Goddard Space Flight Center, Koblinsky developed satellite-based ocean remote sensing systems, publishing numerous papers on the subject. He also developed new satellite missions, including Aquarius, which was aimed at mapping sea surface salt concentration. He has served as adviser to such programs as the World Ocean Circulation Experiment, CLIVAR and the U.S. Climate Change Science Program. Koblinsky holds a Ph.D. in Oceanography from Oregon State University.

Dr. Julia Marton-Lefèvre

Dr. Julia Marton-Lefèvre became Rector of the University for Peace, a UN Treaty Organization with its main campus in San José Costa Rica, in May 2005. Prior to this position, she was Executive Director of LEAD International, based in London. She is also Vice Chair of the World Resources Institute and a member of a number of boards and commissions, including: the Board of Directors of the International Institute for Environment and Development (IIED); LEAD International and the Library of Alexandria. She serves on environmental advisory boards of the Dow Chemical Company and The Coca-Cola Company. She studied history, ecology and environmental planning in the U.S. and in France.

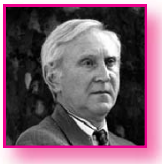
Dr. R.K. Pachauri

Dr. R.K. Pachauri is Director-General of the Tata Energy Research Institute (TERI) and chairman of the Intergovernmental Panel on Climate Change. TERI provides professional support in energy, environment, forestry, biotechnology and natural resources conservation. He serves on numerous boards and committees both on the national and international level, among them the World Resources Institute Council, International Solar Energy Society, World Energy Council, and the International Association for Energy Economics. He has served in various committees in the Government of India, where his expertise in climate change and the environment has proved to be a valuable resource. Pachauri obtained an MS in Industrial Engineering, a Ph.D. in Industrial Engineering and a Ph.D. in Economics from the North Carolina State University.

Prof. Jeffrey Sachs

Prof. Jeffrey Sachs is the Director of the Earth Institute and Professor of Sustainable Development at Columbia University and a Research Associate of the National Bureau of Economic Research. Prior to this, he served as Director of the Center for International Development (CID), Harvard Institute for International Development (HIID), and the Galen L. Stone Professor of International Trade at Harvard University. In January 2002, Sachs was appointed by Secretary General Kofi Annan as his Special Advisor on the Millennium Development Goals. Sachs is the recipient of many awards and honors. He has published more than two hundred scholarly articles, and has authored or edited many books. Sachs received his B.A., summa cum laude, from Harvard College in 1976, and his M.A. and Ph.D. from Harvard University in 1978 and 1980 respectively.

B. Vergara



Sir Crispin Tickell

Sir Crispin Tickell is chancellor of the University of Kent at Canterbury, chairman of the Climate Institute in Washington, DC and director of the Green College Centre for Environmental Policy and Understanding. He is the former United Kingdom Permanent Representative to the United Nations, British Ambassador to Mexico and Permanent Secretary of the Overseas Development Administration. He serves as Convener of the British Government Panel on Sustainable Development and is a member of the China Council for International Cooperation on Environment and Development. He is the author of Climatic Change and World Affairs, which two decades ago pointed to the possibility that climate change could affect international stability.

Dr. Ching-Yen Tsay

Dr. Ching-Yen Tsay was until 2004 a Minister of State for the Executive Yuan of the Taiwanese Government. He is a professor at the National Central University and the National Chiao Tung University. He is a former Director-General of the Central Weather Bureau and was responsible for establishing the collaboration of the IRI and that institution. Tsay has held numerous positions in government and education, among them Vice Chairman of the National Science Council, Director-General of the Civil Aeronautics Administration, and Director of the Department of Atmospheric Sciences, National Taiwan University. Tsay has a BS in Meteorology from National Taiwan University and a Ph.D. in Meteorology from the University of Utah.

Rt. Hon. Simon Upton

Rt. Hon. Simon Upton is Chairman of the Organisation for Economic Cooperation and Development (OECD) Round Table on Sustainable Development in Paris, France. Prior to this he served 19 years as a Member of the New Zealand House of Representatives, including 9 years as a Minister. His portfolios included Environment, Research Science and Technology and Health. He is a member of the Van Lennep Eminent Persons Group on Subsidies sponsored by the International Institute for Sustainable Development, and a member of the Advisory Board to the Holcim Foundation for Sustainable Construction. He holds degrees in English literature, music and law from the University of Auckland, New Zealand and a MLitt in political philosophy from Oxford University, where he was a Rhodes Scholar.

Dr. Stephen E. Zebiak

Dr. Stephen E. Zebiak is IRI Director-General and *ex-officio* member of the Board of Overseers.

Personnel

At a Glance - October 2006

Office of the Director-General

Stephen E. Zebiak	*Director-General; Senior Research Scientist*
Haresh Bhojwani	*International Development Officer*
Ann Binder	*Manager, Staff and Operations*
Molly Hellmuth	*Director, Climate and Society Publication Secretariat; Associate Research Scientist*
Carolyn Z. Mutter	*Assistant Director for Science Management*
Maria Salgado	*Executive Assistant to the Director-General*

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Walter Baethgen	*Director, Latin America and Caribbean Regional Program; Research Scientist*
Stephen Connor	*Program Leader, Environmental Monitoring Research; Director, PAHO/WHO Collaborating Centre on early warning systems for malaria and other climate sensitive diseases; Research Scientist*
Simon Mason	*Program Leader, Climate; Research Scientist*
Chester Ropelewski	*Program Leader, Climate Monitoring Research*
Shiv Someshwar	*Director, Asia and Pacific Regional Program; Director, Institutions and Policy Systems Research; Research Scientist*
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M. Neil Ward	*Director, Decision Systems Research*

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M. Benno Blumenthal	*Manager, Data Library*
David DeWitt	*Research Scientist*
Lisa Goddard	*Research Scientist*
James Hansen	*Research Scientist*
Upmanu Lall	*Senior Research Scientist*
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Andrew Robertson	*Research Scientist*
Liqiang Sun	*Research Scientist*
Michael Tippett	*Research Scientist*

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Gilles Bellon	*Postdoctoral Research Scientist (France)*
Casey Brown	*Associate Research Scientist*
Suzana Camargo	*Associate Research Scientist*
Miguel Carriquiry	*Postdoctoral Research Scientist (Uruguay)*
Pietro Ceccato	*Associate Research Scientist*
John del Corral	*Senior Staff Associate*
Tufa Dinku	*Postdoctoral Research Scientist (Ethiopia)*
Esther Ebrahimian	*Senior Staff Associate*
Alessandra Giannini	*Associate Research Scientist*
Arthur Greene	*Postdoctoral Research Scientist (US)*
Emily Grover-Kopec	*Senior Staff Associate*
Pauline Dibi Kangah	*Postdoctoral Research Scientist (Côte d'Ivoire)*
Dong Eun (Donna) Lee	*Staff Associate*
Huilan Li	*Senior Staff Associate*
Shuhua Li	*Staff Associate*
Bradfield Lyon	*Associate Research Scientist*
Ashok Mishra	*Postdoctoral Research Scientist (India)*
Silvia Mosquera-Machado	*Postdoctoral Research Scientist (Colombia)*
Ousmane Ndiaye	*Graduate Research Assistant*
Judith Omumbo	*Postdoctoral Research Scientist (Kenya)*
Daniel Osgood	*Associate Research Scientist*
Jian-Hua (Joshua) Qian	*Associate Research Scientist*
Sylwia Trzaska	*Associate Research Scientist*
Tsegay Wolde-Georgis	*Senior Staff Associate*
Lareef Zubair	*Associate Research Scientist*

Affiliates

Mohammed Boulahya	*Senior Advisor, Africa*
Mark Cane	*Vetlesen Professor, Columbia University, Earth and Environmental Sciences, Applied Physics and Applied Math*
Rafael Flor	*Research Coordinator, Tropical Agriculture Program, Columbia University*
Roberto Lenton	*Senior Advisor, International Development*
Cheryl Palm	*Senior Research Scientist, Tropical Agriculture Program, Columbia University*
Alexander Pfaff	*Associate Professor of Economics and International Affairs, Columbia University*
Pedro Sanchez	*Director, Tropical Agriculture Program, Columbia University*
Adam Sobel	*Assistant Professor, Columbia University, Applied Physics and Applied Math, Earth and Environmental Sciences*
Jim Williams	*Consultant, European partnerships and mobilization*

Adjuncts

Mathew Barlow	*Staff Scientist, Atmospheric and Environmental Research, Inc.*
Kenneth Broad	*Assistant Professor, University of Miami*
Ping Chang	*Professor, Texas A&M University*
Eli Galanti	*Porter Fellow of the Porter School of Environmental Studies, Department of Geophysics and Planetary Sciences, Tel Aviv University*
Matayo Indeje	*Associate Research Scientist, Climate Downscaling and Application, IRI/MDG Technical Support Centre, UN Millennium Project*
Richard Kleeman	*Professor, New York University*
Ben Orlove	*Professor, University of California Davis*
Jennifer Phillips	*Assistant Professor, Bard College*
Balaji Rajagopalan	*Assistant Professor, University of Colorado*
Anji Seth	*Assistant Research Professor, University of Connecticut*
Renzo Taddei	*Visiting Professor, Yale University*

Visiting Research Scientists

Francisco de Assis de Souza Filho	*Research Scientist; Vice-President, Brazil Water Resources Association (ABRH) (Brazil)*
Young il Moon	*Professor (Korea)*
Vincent Moron	*Associate Research Scientist (France)*

S. Someshwar

Institutional Support

Office of the Director General

Francesco Fiondella	*Communications Officer*
Maria Risë Fullon	*Project Coordinator*
Nancy Kurul	*Administrative Assistant*
Lori Scally	*Project Finance Manager*
Sandra Vitelli	*Administrative Assistant*

Computer Systems

Baaba Baiden	*Web Manager*
Sara Barone	*Analyst/Programmer*
Brian Falk	*Intermediate Systems Analyst/Programmer*
Xiaofeng Gong	*Senior Analyst/Programmer*
Lulin Song	*Analyst/Programmer*
Jeff Turmelle	*Senior Analyst/Programmer*

Part-Time Research Assistants

Colby Blitz
Jessica Bolson
Liliana Botcheva-Andonova
Simbarashe Chidzambwa
Richele Corrado
Peter Falcier
Nicole Kuhnke
Anthony Kwon
Patrick McNamara
Dinali Nelum Fernando
Kareff Rafisura
Joseph Selinger
Asher Siebert
Abraham Sorber
John Ten Hoeve
Allison Wing
Hyemin Yang

Staff Biographies

Office of the Director-General

Stephen E. Zebiak

Director-General; Senior Research Scientist

Dr. Zebiak's research experience is in ocean-atmosphere interaction, climate variability and climate prediction. He completed his Ph.D. at the Massachusetts Institute of Technology in 1984, and subsequently held positions ranging from Postdoctoral Research Scientist through Senior Research Scientist at the Lamont-Doherty Earth Observatory, before joining IRI as Director of Modeling and Prediction Research in 1998. He was an author of the first dynamical model used to predict El Niño successfully, first published in 1986. Dr. Zebiak has served on numerous national and international Working Groups and Advisory Committees, including: Chair, International CLIVAR Working Group on Seasonal to Interannual Prediction; Canadian Climate Research Network Advisory Panel; U.S. National Research Council Advisory Panel for the TOGA Program, Committee on Improving the Effectiveness of U.S. Climate Modeling, and Committee on Strategic Guidance for NSF's Support of the Atmospheric Sciences. Dr. Zebiak has also served as associate editor of the Journal of Climate. He was named Fellow of the American Meteorological Society in 2006.

Haresh Bhojwani

International Development Officer

Before joining the IRI, Bhojwani managed a group of sustainable development and conservation NGOs in Latin America. Originally from the Canary Islands, he received a law degree from Marquette University and has practiced as a human rights, immigration and criminal defense lawyer and advocate in Europe, Central America and the USA. He is also a photographer.

Ann Binder

Manager, Staff and Operations

Binder prepares budgets and sub-contracts in support of IRI and its projects. She compiles income streams and affiliated program budgets into a coherent single financial plan to serve the IRI, its funding agencies, and collaborative business resources. Binder coordinates human resources for the IRI and assembles information, documents, and hiring plans in coordination with the Lamont-Doherty Earth Observatory and Columbia University. She also works with governmental organizations that facilitate visitor and post-doctoral programs. Binder has a B.A. in Education.

Molly Hellmuth

Program Leader, Climate and Society Publication Secretariat; Associate Research Scientist

Since joining the IRI in August 2005, Dr. Hellmuth has built partnerships with multilateral and bilateral development agencies, research centers and NGOs, to create a truly international publication. The inaugural publication issue is financially supported by the UK's Department for International Development, and includes support and contributions from international partners UNECA, AU, UNDP, GCOS and WHO. As an associate research scientist, she continues to research adaptive water-resource management strategies and policies in the face of changing socio-economic and climatic conditions.

Carolyn Z. Mutter

Assistant Director for Science Management

Dr. Mutter contributes program and staff development, financial and strategic planning, oversight of communications and outreach activities and coordination of educational initiatives, regularly engaging colleagues at Columbia University, where she also serves as co-chair of the University's Commission on the Status of Women. Prior to 1997, she was an LDEO Associate Research Scientist, contributing to or leading marine investigations of earth structure and dynamics. She also served on the LDEO work-life committee, whose efforts led to the establishment of a child-care center on campus. Additional prior roles include Adjunct Professor (Barnard) and member of the U.S. Science Advisory Committee.

Maria Salgado

Executive Assistant to the Director-General

Salgado's education and experience serve her well in the IRI's international environment. Educated in the Philippines and Japan (B.A. in Psychology, M.S. in Social Psychology/Organizational Behavior), she has worked in Japanese, French and American banks in various financial capacities, and at the United Nations Children's Fund (UNICEF) in market research, product development and inventory management.


E. Ebrahimian / R. Fullon

Program Leaders

Walter Baethgen

Director, Latin America and Caribbean Regional Program; Research Scientist

Before joining the IRI, Dr. Baethgen was a Senior Scientist in the Research and Development Division of IFDC (International Soil Fertility and Agricultural Development Center) where he worked mainly in Information and Decision Support Systems for the Agricultural Sector (1987-2003). During 1989-90, he acted as a consultant for the Food and Agriculture Organization (FAO) of the United Nations in Colonia, Uruguay. In 1990, he was stationed with IFDC in Montevideo, Uruguay, to establish and coordinate regional research programs in Latin America in collaboration with national and international organizations. Dr. Baethgen has acted as a consultant for the Inter-American Development Bank (IDB), the United Nations (FAO, UNDP, UNIDO), the International Atomic Energy Agency (IAEA), the World Bank and the Inter-American Institute for Agricultural Science (IICA).

Stephen Connor

Program Leader, Environmental Monitoring Research; Director, PAHO/WHO Collaborating Centre on early warning systems for malaria and other climate sensitive diseases; Research Scientist

Dr. Connor has a background in Development/Natural Resource Economics and has specialized in the geography of infectious disease in Africa. He has worked extensively in sub-Saharan Africa for the UK Medical Research Council, the UK Department for International Development's Malaria Knowledge Programmes, and is an advisor to WHO's Roll Back Malaria Technical Resource Network on Epidemic Prevention and Control. Dr. Connor investigates the interaction of climate, environment, economy and social vulnerability in determining the patterns and persistence of infectious disease in the developing world. Since 2005, Dr. Connor has also directed the activities of the PAHO/WHO Collaborating Centre on early warning systems for malaria and other climate sensitive diseases.

Simon Mason

Program Leader, Climate; Research Scientist

Dr. Mason engages in research related to the IRI's forecast effort. He has been responsible for assisting in the production of the Net Assessments, including the development of objective multi-model combination schemes. His current work focuses on forecast verification, and prediction research and application, primarily within the context of the Africa Regional Program. He is also responsible for the development of the Climate Predictability Tool (CPT). Dr Mason arrived at the IRI in late 1997, initially being based at Scripps Institution of Oceanography.

Chester Ropelewski

Program Leader, Climate Monitoring Research

Before joining the IRI, Ropelewski served as a research meteorologist with the Climate Prediction Center, U.S. National Weather Service of NOAA. As Chief of the Center's Analysis Branch from 1990-97, he directed research and operational climate monitoring for over a dozen senior level climate research scientists. His primary research interests include studies of the El Niño Southern Oscillation and its influence on rainfall and temperature, the analysis and display of climate information, the influence of the land surface on atmospheric processes and the detection of global climate change. At the IRI, Ropelewski leads the IRI effort to develop methods and data sets to improve monitoring of the climate system.

Shiv Someshwar

Director, Asia and Pacific Regional Program; Director, Institutions and Policy Systems Research; Research Scientist

Dr. Someshwar is leading a number of research initiatives in South and South East Asia on reducing livelihood vulnerability and increasing systems' resilience to climate variability and climate change. He specializes in the institutional and policy dimensions of livelihoods and sustainable development. He is an anchor faculty for the Masters program in Climate and Society at Columbia University. Dr. Someshwar received his Ph.D. from the University of California. Prior to IRI, he was at the Rockefeller Foundation.

Madeleine Thomson

Chair, Africa Regional Program Committee; Director, Impacts Research; Senior Research Scientist

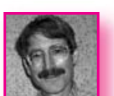
Dr. Thomson has over 20 years experience in operational research for infectious-disease control (mainly in Africa): onchocerciasis, malaria, kala azar, meningococcal meningitis. She has focused on the potential value of climate and environmental driven models, which can be used to create risk maps and early warning systems for epidemics. She is a frequent contributor to the WHO Roll Back Malaria Technical Support Network for Prevention and Control of Malaria Epidemics, a member of the WMO-CCl Expert Team 3.8 on Health-related Climate Indices and their Use in Early Warning Systems and is Lead Author, Millennium Ecosystem Assessment in the Condition Working Group Chapter 16 on infectious disease.

M. Neil Ward

Director, Decision Systems Research

Dr. Ward joined the IRI in April of 2000 from the University of Oklahoma, where he was principal investigator for a range of climate research topics. Dr. Ward also has extensive experience in operational forecast products and systems from his work in Europe. At the IRI, Dr. Ward focuses on the link between forecast products and user applications. In this role, he works in the field with collaborators to better understand requirements, and also with the forecast research and production team at the IRI, to ensure that the feedback users provide becomes incorporated, whenever possible, into improved forecast developments.

Senior Research and Operations Staff



Anthony Barnston

Head, Forecast Operations

Prior to arriving at the IRI at the end of June 2000, Barnston was an operational seasonal climate forecaster and developmental researcher in empirical prediction methodology at the Climate Prediction Center of NOAA for 17 years. He was Editor of the Experimental Long Lead Forecast Bulletin from 1992-97. With his forecast staff, Barnston ensures the production of a range of IRI forecast products issued on a monthly basis for the globe, including forecasts of sea surface temperatures, outlooks for seasonal precipitation and temperature anomalies, and extreme event forecasts. His goal is the continual improvement of the IRI's forecast operation, including the generation of new versions of the forecasts tailored to specific user groups.

M. Benno Blumenthal

Manager, Data Library

Dr. Blumenthal facilitates data exchange and multidisciplinary access to data worldwide through the creation and development of a large and growing library and website for the study of short-term climate variability. Dr. Blumenthal has been at the IRI since August 1997, following ten years of climate research and the development of the prototype IRI Data Library at Lamont-Doherty Earth Observatory.

David DeWitt

Research Scientist

Dr. DeWitt specializes in the construction and use of coupled atmosphere-ocean general circulation models (GCMs) with emphasis on seasonal to interannual predictability research. Dr. DeWitt provides leadership and mentoring on dynamic prediction systems research. Prior to arriving at the IRI in July 1999, Dr. DeWitt spent five years engaged in similar research at the Center for Ocean-Land-Atmosphere Studies.

Maxx Dilley

Research Scientist (11/01 - 7/05)

Dr. Dilley is a geographer with experience in designing and implementing programs in disaster and risk management. Prior to coming to the IRI in November 2001, he worked for two years at the World Bank Disaster Management Facility and for seven years at the U.S. Agency for International Development's Office of U.S. Foreign Disaster Assistance. Dr. Dilley shared responsibility for the Africa Region and Impacts Research programs. He was responsible for developing the program in disaster and risk management and he also played a role in IRI partnership development. In July 2005, Dr. Dilley moved to Geneva, Switzerland to join the UNDP's Bureau for Crisis Prevention and Recovery as a Policy Advisor.

Lisa Goddard

Research Scientist

Dr. Goddard has been working for the IRI since 1995. She pursues several lines of research aimed at improving the quality and content of seasonal climate predictions. Dr. Goddard also participates in several national and international advisory panels, working to advance research, development and implementation of climate forecasts. In addition, Dr. Goddard contributes to the real-time production of the IRI's ENSO outlook and seasonal climate forecasts. She has a Ph.D. in Atmospheric and Oceanic Sciences from Princeton University, where she did her thesis research on the physics and energetics of El Niño.

Senior Research Staff, continued

James Hansen

Research Scientist

Dr. Hansen, an agricultural systems scientist, focuses on climate risk management and seasonal forecast applications for food and livelihood security in smallholder farming systems of the tropics. His work addresses climate-based crop forecasting, design and communication of climate information, supporting and evaluating agricultural management responses, and institutional support and evaluation of benefit. His work at the University of Florida, prior to arriving at the IRI in 1999, contributed to the establishment of a statewide climate-information extension program.

Upmanu Lall

Senior Research Scientist

Dr. Lall's principal areas of expertise are statistical and numerical modeling of hydrologic climatic systems and water-resource systems planning and management. He is a Professor of Earth and Environmental Engineering at Columbia University and a Senior Research Scientist in hydrologic applications at the IRI. Prior to joining the IRI, Dr. Lall was a Professor at the University of Utah and Utah State University.

Leo Ostwald

Manager, IRI Computing

Ostwald has held systems-engineering administration positions for various organizations, including Bank of America, Naval Atlantic Meteorology and Oceanography Center and Computer Sciences Corporation. He holds M.S. degrees in Physical Oceanography and Engineering Acoustics from the Naval Postgraduate School. Ostwald administers and ensures maximum ongoing system performance and availability for the IRI's full-time operational activities. He has lead responsibility for IRI systems, including high performance computing platforms, mass storage facilities, UNIX/LINUX workstations, PC's, remote site communications and scientific visualization.

Andrew Robertson

Research Scientist

Dr. Robertson came to the IRI in November 2001 from the Department of Atmospheric Sciences at UCLA, where he was principal investigator on NOAA and DOE research grants concerned with climate variability on interannual-to-interdecadal time scales. Dr. Robertson provides leadership on prediction research, seeking to advance understanding of short-term regional climate predictability and to develop useful seasonal-to-interannual predictions of applications-relevant quantities with small spatial and temporal scales.

Liqiang Sun

Research Scientist

Dr. Sun performs research on forecast methodology and the application of nested regional models to higher resolution forecasts. Prior to joining the IRI in October 1997, Dr. Sun received his Ph.D. from North Carolina State University.

Michael Tippett

Research Scientist

Dr. Tippett works in the areas of predictability, statistical methods and data assimilation. Prior to joining the IRI in June 1999, Dr. Tippett obtained his Ph.D. in Mathematics from New York University and worked at the Max Planck Institute for Plasma Physics in Germany, and the Center for Weather Prediction and Climate Studies (CPTEC) in Brazil.

Research Staff

Lee Addams

Earth Institute Postdoctoral Fellow (9/04 - 9/06)

Dr. Addams received his Ph.D. in Geological and Environmental Sciences in September 2004 from Stanford University, School of Earth Sciences. He performs research on the application of climate forecasts to management of combined groundwater/surface water systems, especially focusing on agricultural regions. He also works on assessments of global, basin-scale water supplies in response to climate variability.

Sankar Arumugam

Associate Research Scientist (12/01 - 8/05)

Dr. Arumugam received his Ph.D. in water resources engineering from Tufts University and his M.S. in water resources and environmental engineering from Indian Institute of Technology Madras. He is involved in developing hydrologic forecasting models, linking seasonal hydroclimatic forecasts with river-basin planning models and designing decision analysis framework to promote integrated water management practices that can reduce vulnerability of the society from climate-related disasters. Dr. Arumugam left the IRI in August 2005 to become an Assistant Professor in the Department of Civil, Construction, and Environmental Engineering at North Carolina State University.

Michael Bell

Senior Staff Associate

Before joining the IRI in 2001, Bell received his M.S. in meteorology at the University of Oklahoma, studying West African rainfall variability. Bell works in support of the climate-monitoring activities of the IRI, including the continued development of the Climate Information System, production of the monthly Climate Information Digest, and support of the IRI Data Library.

Gilles Bellon

Postdoctoral Research Scientist (France)

Dr. Bellon's research involves tropical climate and monsoons. He is particularly interested in the dynamics of the Intertropical Convergence Zones. He joined the IRI after completing a Ph.D. at University Pierre and Marie Curie (Paris) and a short post-doc at the Indian Institute of Science (Bangalore).

Yasemin Biro

Senior Staff Associate (9/04 - 5/05)

Dr. Biro obtained her Ph.D. and M.S. from University of California Berkeley, and she also holds degrees from Tulane University, Cornell University, and The London School of Economics and Political Science. Before joining the IRI, she worked as Program Manager in the Global Environment Facility Secretariat/The World Bank (Climate Change focal area). Dr. Biro resigned from the IRI in May 2005 to pursue other interests.

Casey Brown

Associate Research Scientist

Dr. Brown specializes in climate risk management for the water sector and sustainable management of water resources. His current work includes developing a climate-resilient water-supply system with seasonal climate forecasts for Manila, Philippines; drought-risk management for the Colombian energy system; and adaptation to climate change in water resources. His research focuses on increasing the resilience of water systems to climate variability and change through the use of advanced climate science, including climate prediction, in combination with innovative water resources management techniques and economic mechanisms, including index insurance. Dr. Brown teaches the course, Managing Climate Risks and Adapting to Climate Change in Columbia's Climate and Society Masters Program. He obtained his Ph.D. in environmental engineering science as a National Science Foundation Fellow at Harvard University. His thesis topic was sustainable management of groundwater in southern India and included fieldwork in India and Nepal.

Suzana Camargo

Associate Research Scientist

Dr. Camargo is exploring the potential use of AGCMs and regional climate models in forecasting hurricane/typhoon frequency, with emphasis on the western North Pacific Basin. She is also interested in the influence of El Niño Southern Oscillation on tropical cyclone activity. In collaboration with the IRI Forecast Division, she is responsible for issuing experimental seasonal tropical cyclone activity forecasts in different regions of the world. Before joining the IRI in June 1999, Dr. Camargo conducted research at the Max-Planck Institute for Plasma Physics, Germany and São Paulo State University, Brazil. She received her Ph.D. in Physics from the Technical University of Munich, Germany in 1992.

Miguel Carriquiry

Postdoctoral Research Scientist (Uruguay)

Dr. Carriquiry's research involves designing conventional and non-conventional agricultural-insurance products to manage climatic risks. He received his Ph.D. in Agricultural Economics from Iowa State University in 2004, where he focused on agricultural-risk management and industrial organizations.

Pietro Ceccato

Associate Research Scientist

Dr. Ceccato develops and implements new RS/GIS applications for the monitoring of malaria and meningitis in Africa. Prior to joining the IRI in August 2004, he was a consultant for the United Nations Food and Agriculture Organization in Rome, Italy. He received his Ph.D. in Remote Sensing in November 2001 from the University of Greenwich, Chatham Maritime, United Kingdom.

Saurabh Dani

Staff Associate (6/03 - 3/05)

Dani joined the IRI in June 2003. He received a Masters in Public Policy and Administration from the School of International and Public Affairs, Columbia University in 2003 and an earlier Masters in Environmental Engineering from the University of Missouri/Rolla in 1998. Dani's focus was on projects in the Asia region. His research interests include using the livelihoods framework towards reducing adverse impacts of climate variability on vulnerable communities. Dani left the IRI in March 2005 for an in-region position with the Asian Disaster Preparedness Center, Thailand.

Research Staff, continued

John del Corral

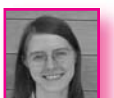
Senior Staff Associate

Del Corral is supporting the work of the IRI Data Library by developing and maintaining the Taiwan mirror site and developing a geospatially referenced gazetteer database that is linked to the Data Library. He also contributes to the planning and development of the IRI web site. Del Corral has held positions at the National Center for Atmospheric Research, the Atmospheric Sciences Research Center, Scripps Institution of Oceanography, and the Institute for Computational Earth System Science. He was part of the IRI Forecast division from 1997-1999 and rejoined the IRI in July 2002.

Tufa Dinku

Postdoctoral Research Scientist (Ethiopia)

Dr. Dinku earned his M.S. and Ph.D. from the University of Connecticut in civil engineering with concentration in the area of hydrological remote sensing. Before coming to the U.S. for his post-graduate education, Dr. Dinku worked at the National Meteorological Services Agency (Ethiopia) for over ten years. The major part of his current research is evaluation of different satellite rainfall products.



Esther Ebrahimian

Senior Staff Associate

Ebrahimian joined the IRI in April 2004. Previously, she worked on climate change, livelihoods and adaptation issues at the Global Environment Facility's Small Grants Program, based at the UNDP. She holds a master's degree in Environmental Policy Studies from the School of International and Public Affairs at Columbia University, and a master's degree in Development Studies from the University of Cambridge. At the IRI, she coordinates research in the Asia-Pacific Program and contributes to institutions and policy systems research.

Polly Ericksen

Postdoctoral Research Scientist (8/03 - 4/05)

Dr. Ericksen has a MS in Economics and a Ph.D. in Soil Science. Prior to joining the IRI, she worked in the area of international development and natural resource management. At the IRI, she focused on the institutional and policy environment to which climate information would be applied in IRI projects. In April 2005, Dr. Ericksen took a position with the Global Environmental Change and Food System Programme/Centre for Ecology and Hydrology in Oxfordshire, UK.

Alessandra Giannini

Associate Research Scientist

Dr. Giannini conducts fundamental research on the mechanisms underlying interannual to interdecadal variability of climate in tropical regions. She is interested in understanding the basic dynamics of monsoons and in providing her climate expertise to region- and sector-specific projects ongoing at the IRI. Her joining the IRI, upon completion of a post-doctoral fellowship at NCAR, is a return to LDEO/Columbia, where she completed her Ph.D. in 2001.

Arthur Greene

Postdoctoral Research Scientist (US)

Dr. Greene received his Ph.D. from Lamont-Doherty Earth Observatory of Columbia University, where he studied the response of mountain glaciers to changes in climate under the supervision of advisor, Wallace S. Broecker. He then spent a year as a visiting researcher at the Laboratoire des Sciences du Climat et de L'Environnement in Gif-sur-Yvette, France, where he worked with Nathalie de Noblet on the land-surface model ORCHIDEE. Subsequent to this, and before arriving at the IRI, Dr. Greene served as science consultant in the development of a web site for the Comer Science and Education Foundation.

Emily Grover-Kopec

Senior Staff Associate

Grover-Kopec has a B.S. degree in Atmospheric, Oceanic, and Space Sciences from The University of Michigan and a M.S. degree in Meteorology from Penn State University. Her involvement with the Data Library includes the development of tools and interfaces that facilitate the use of climate data within the agriculture and health communities. Her other research interests include the improvement of monitoring and assessment of climate-related impacts, particularly those associated with hydro-meteorological drought.

Amor Ines

Postdoctoral Research Scientist (Philippines) (1/04 - 1/05)

Dr. Ines completed his M. Eng. in Irrigation Engineering and Management in 1998, and Dr. Eng. in Integrated Water Resources Management in 2002, from the School of Civil Engineering of the Asian Institute of Technology (AIT), Bangkok, Thailand. Prior to coming to IRI, he worked as a Doctoral Researcher with the International Water Management Institute at Colombo, Sri Lanka and a Senior Research Associate of the Space Technology Applications and Research Program, School of Advanced Technologies at AIT. At the IRI, he was primarily involved in the development of a climate-based crop forecasting methodology. In 2005, Dr. Ines accepted an Associate Research Scientist position in the Department of Biological and Agricultural Engineering, Texas A&M University.

Pauline Dibi Kangah

Postdoctoral Research Scientist (Cote d'Ivoire)

Dr. Kangah received her Ph.D. in Geography from the University of Oklahoma, Norman, in September 2004, with a thesis entitled "Rainfall and Agriculture in Central West Africa since 1930." She joined the IRI in December 2004 and her responsibilities include updating and analyzing historical climate and crop data for the West African region. Specifically, she has undertaken a project on the predictability of crop yields in Burkina Faso, Côte d'Ivoire, and Mali.

Labao Lan

Senior Staff Associate (6/99 - 5/05)

Dr. Lan was responsible for the porting and adaptation of codes for their efficient operation in a parallel computing configuration, and helped in the design and implementation of more versatile and comprehensive infrastructures. Dr. Lan received his Ph.D. in Geology from the University of Minnesota in 1992. Dr. Lan left in May 2005 to pursue other opportunities.

Dong Eun (Donna) Lee

Staff Associate

Dr. Dong Eun (Donna) Lee joined IRI in June 2005. Her research interest has been modeling North Pacific variability on various timescales. She finished her Ph.D. in Atmospheric and Oceanic Science from University of Wisconsin-Madison in 2005. Her work in IRI includes studies on coupled prediction of seasonal to interannual climate variability.

Huilan Li

Senior Staff Associate

Prior to joining the IRI in November 2001, Li received a M.S. in Climatology from the Institute of Atmospheric Physics, Chinese Academy of Sciences in 1999 and a M.S. in Atmospheric Science from the University of Wyoming in 2001. Li's research focus is on dynamical and statistical downscaling and the impacts of land-surface interactions. Li also works on enhancements in model infrastructure and supports documentation and training materials of relevance.

Shuhua Li

Staff Associate

Dr. Li received his Ph.D. in Meteorology from Monash University, Australia in 2000. Prior to joining the IRI in July 2004, Dr. Li was an assistant research scientist at Goddard Earth Sciences and Technology Center, the University of Maryland, investigating the importance of gravity waves in global climate and data assimilation. At the IRI, he is involved in forecasting and prediction research relating to global and regional climate prediction.

Bradfield Lyon

Associate Research Scientist

Dr. Lyon is engaged in observational studies of seasonal to interannual climate variability, particularly drought, and is involved in real-time global monitoring efforts. His work includes the development of diagnostic tools for climate monitoring, analysis, and for climate applications. Dr. Lyon received his Ph.D. in Meteorology from Massachusetts Institute of Technology and joined the IRI in 1999.

Sabine Marx

Postdoctoral Research Scientist (Germany) (5/03 - 1/05)

Dr. Marx received her Ph.D. from Carnegie Mellon University in Medical History (2002) and Masters degree from the University of Cologne, Germany, in Sociology, Psychology and Pedagogy (1994). Her work focused on understanding perceptions of climate variability and cognitive determinants of forecast use by farmers. She supported the development of the Health and Climate in West Africa Programme, and performed research on public and scientific perceptions of the relationship between climate and health in contemporary and historical perspectives. In January 2005, Dr. Marx transferred to Columbia University's Center for Research on Environmental Decisions (CRED), as its Associate Director.

Ashok Mishra

Postdoctoral Research Scientist (India)

Dr. Mishra comes from the Indian Institute of Technology, West Bengal, where he earned his Ph.D. in Agricultural Engineering, with a focus on hydrological modeling. As a post-doctoral associate in Decision Systems, he works on the combined use of seasonal climate prediction and crop simulation for long-lead yield forecasting and decision-analysis applications.

Silvia Mosquera-Machado

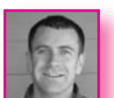
Postdoctoral Research Scientist (Colombia)

Dr. Mosquera-Machado attended Moscow State University in Russia and was awarded a bachelor's degree in Physics and a M.S. degree in Physics and Mathematics-"Geophysicist" with specialization in Seismology in 1991. She received a Postgraduate certificate in Geological Risk Management from Geneva University and West Indies Mona Campus in Jamaica in 1998. In 2002, she was awarded a Ph.D. in Earth Sciences from the University of Geneva, Switzerland. Her field of interest is multi-hazard and risk analysis and management through integration of Geographical Information Systems and geophysical modeling considering the physical, social and human aspects of disasters. Prior to joining the IRI, she was a program manager at the World Institute for Disaster Risk Management in Alexandria, Virginia.

Research Staff, continued

Ousmane Ndiaye
Graduate Research Assistant
Ndiaye earned an engineering degree in Meteorology from The Hydrometeorological Institute of Training and Research (IHFR) of Oran (Algeria) in 1996 and a M.S. degree in Atmospheric Physics from the University of Paris XII Val-de-Marnes in 1998. Ndiaye is a meteorology professional at the Senegalese National Service (DMN) and was an associated researcher to the "Laboratoire de Physique de l'Atmosphère et de l'Océan Siméon Fongang" (LPASF) of the University of Dakar, Senegal. He was a visiting researcher under the CLIVAR project, investigating the interannual rainfall variability over Sahel with the Regional Spectral Method (RSM) and the ECHAM (GCM).

Judith Omumbo
Postdoctoral Research Scientist (Kenya)
Dr. Omumbo worked as an epidemiologist with the Public Health Group of the Kenya Medical Research Institute (KEMRI) Wellcome Trust collaborative programme in Nairobi, Kenya from 1996-2001. While with the Public Health Group she gained experience in running field-based epidemiological investigations of malaria and specifically in conducting surveys of community-based disease indicators. Her current work is on developing risk maps of climate sensitive diseases for Africa. She is a graduate of Oxford University (Ph.D., 2004), Hebrew University, Jerusalem (Master in Public Health 1993) and the University of Nairobi (Bachelor of Dental Surgery 1987).



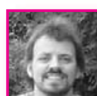
Daniel Osgood
Associate Research Scientist
Dr. Osgood received his Ph.D. in Agricultural and Resource Economics from the University of California, Berkeley, in December 1999. Prior to joining the IRI, he was an Assistant Professor and Assistant Specialist of Agricultural and Resource Economics at the University of Arizona.

Cristina Perez
Postdoctoral Research Scientist (USA) (12/02 – 12/04)
Dr. Perez received her Ph.D. in Applied Mathematics from the University of Colorado at Boulder and earned her B.S. in Mathematics at the University of North Carolina in Chapel Hill. Her research interests include tropical meteorology, specifically precipitation dynamics and the El Niño-Southern Oscillation, and climate predictability. Dr. Perez successfully completed her postdoctoral scientist position.

Jian-Hua (Joshua) Qian
Associate Research Scientist
Dr. Qian works on the development, testing and validation of regional scale forecast systems, and downscaling methodologies to address nesting strategies, physical parameterizations, initialization, forecast validation and analysis, and the dynamics of regional scale climate variability. Dr. Qian received his Ph.D. in Atmospheric Science from North Carolina State University.

Sarika Rathi
Staff Associate (6/05 - 5/06)
Rathi arrived in June 2005 while completing her Ph.D in Economics at the Indira Gandhi Institute of Development Research in Mumbai, India, focusing on approaches to solid waste management in Mumbai. At the IRI, she was involved in identifying and evaluating data sets at relevant scales that capture livelihood impacts of climate variability and of policies in select countries and sectors. She also conducted statistical and other analyses for regional research. Rathi successfully completed the tasks assigned during her term position.

Sara Rauscher
Staff Associate (10/03 - 9/05)
Dr. Rauscher joined the IRI in October 2003. She received her Ph.D. in Geography from the University of Wisconsin in 2004. Her research interests include dynamical and statistical climate downscaling and interactions between land-surface processes and climate. Upon completion of her term appointment in September 2005, Dr. Rauscher accepted a position as Visiting Scientist at the Abdus Salam International Centre for Theoretical Physics, Italy.



Anton Seimon
Earth Institute Postdoctoral Fellow (9/03 - 9/05)
Dr. Seimon received his Ph.D. from the University of Colorado at Boulder's Department of Geography. With research interests in the atmospheric sciences, mountain geography and political ecology, he has studied climate, society and environmental change in the Andes mountains and adjacent Amazon rainforest in southern Peru since 1996. Dr. Seimon successfully completed his Postdoctoral fellowship.

R. Fullon

Anji Seth

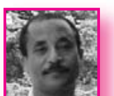
Associate Research Scientist (6/99 - 7/05)

Dr. Seth researches the role of regional processes in climate and climate variability using observations and nested regional climate models. Prior to joining the IRI in 1999, she conducted research as a post-doctoral fellow and NOAA grant principal investigator at the National Center for Atmospheric Research. As a lead developer of the IRI's climate monitoring and information systems, Dr. Seth developed research methods to improve understanding of the evolution of societal impacts related to climate anomalies. In July 2005, Dr. Seth accepted a position with the University of Connecticut, and simultaneously holds an Adjunct Associate Research Scientist appointment with the IRI.

Sylwia Trzaska

Associate Research Scientist

Dr. Trzaska received her Ph.D. from the Universite de Bourgogne, Dijon, France in September 2002. Her work focused on diagnostic and modeling studies of the relationships between sea-surface temperatures and rainfall in Western and Southern Africa and the respective roles of ENSO and Atlantic variability. Her research at the IRI involves studies of air-sea interactions and climate variability and predictability in the Atlantic region on interannual to subseasonal timescales with special focus on West Africa and socio-economic impacts.



Tsegay Wolde-Georgis

Senior Staff Associate

Dr. Wolde-Georgis joined the IRI in 2003 as a Senior Staff Associate and coordinator of the Africa Program. He received his Ph.D. in International Studies from the University of Denver in 1993. He also studied at Addis Ababa, Carleton and the Johns Hopkins Universities. He was a post-doc at the National Center for Atmospheric Research in Boulder between 1995-1997. Before joining the IRI, Dr. Wolde-Georgis worked in various capacities at the Embassy of Ethiopia in Washington DC, Asmara University and the University of Natal in Durban, South Africa.

Lareef Zubair

Associate Research Scientist

Dr. Zubair contributes to projects in agriculture, water resources, disaster management, environmental management, public health and renewable energy. He undertakes research on the impact of climate on the land surface, hydrology and the atmospheric boundary layer and on the climate of the equatorial Indian Ocean. His work has included climate impact assessment, adaptation measures to climate variability and change and capacity building. He received his M.Sc. and Ph.D. from Yale University in 1990 and 1993.

Affiliates and Adjuncts

Affiliates

Mohammed Sadeck Boulahya

Senior Advisor, Africa

During the last three decades, Dr. Boulahya has had outstanding success in research and capacity building on applying weather and climate to natural-resource management and agriculture in Algeria, the whole of Africa and beyond. He has a Research Certificate of Specialization in Agro-meteorology, State Engineer in Meteorology, WNO Class 1 and a Diploma in Advanced Applied Mathematics. He was the Co-Founder and First Director General of ACMAD.

Mark Cane

Vetlesen Professor, Columbia University, Earth and Environmental Sciences; Applied Physics and Applied Math

Dr. Cane is a Professor of Earth and Climate Sciences in the Department of Earth and Environmental Sciences and in the Department of Applied Physics and Applied Mathematics at Columbia University. He also serves as a member of the IRI's International Science and Technical Advisory Committee (ISTAC). With colleague Stephen Zebiak, Dr. Cane, who received his Ph.D. 1975 in Meteorology from M.I.T., devised the first numerical model able to simulate El Niño and the Southern Oscillation.

Rafael Flor

Research Coordinator, Tropical Agriculture Program, Columbia University

Flor serves as research associate of the United Nations Millennium Project Hunger Task Force, an advisory body of the United Nations. Previously, Flor served as Research and Policy Analyst of the UN Millennium Project and worked in several development projects funded by USAID, CIDA, Zamorano University and WRI in Central America, including the post-Mitch reconstruction project in Honduras. Currently, he is conducting interdisciplinary research on economic, political, environmental and sociological issues that relate to agricultural productivity, agricultural markets, nutrition and their policy implications.

Affiliates and Adjuncts, continued

Roberto Lenton

Senior Advisor, International Development

Dr. Lenton, a citizen of Argentina, received a Civil Engineering degree from the University of Buenos Aires and M.S. and Ph.D. degrees in Water Resources Systems from the Massachusetts Institute of Technology. Prior to joining the IRI, Dr. Lenton was Director of the Sustainable Energy and Environment Division (SEED) at the United Nations Development Programme in New York, a position he held from 1995 to 2000, Director General of the International Water Management Institute from 1987 to 1994 and Program Officer with the Ford Foundation in New Delhi and New York from 1977-1986.

Cheryl Palm

Senior Research Scientist, Tropical Agriculture Program, Columbia University

Prior to joining the Earth Institute, Dr. Palm was Senior Scientific Officer at the Tropical Soil Biology and Fertility Program in Nairobi, Kenya from 1991 to 2001, and is currently an Honorary Senior Research Fellow with the TSBF Institute of CIAT, the Centro Internacional de Agricultura Tropical. Dr. Palm received a B.S. and a M.S. in Zoology from the University of California, Davis and a Ph.D. in Soil Science from North Carolina State University.

Alexander Pfaff

Associate Professor of Economics and International Affairs, Columbia University

Dr. Pfaff is an Assistant Professor of Economics and International Affairs at Columbia University. He completed his Ph.D. at Massachusetts Institute of Technology in 1995. His focus is the interplay between the environment and economic growth and development, particularly in the area of land use.

Pedro Sanchez

Director, Tropical Agriculture Program, Columbia University

Prior to joining the Earth Institute, Dr. Pedro Sanchez served as Director General of the World Agroforestry Centre (ICRAF) in Nairobi, Kenya (1991-2001), with research in 20 countries of Africa, Latin America and Southeast Asia. He is also Professor Emeritus of Soil Science and Forestry at North Carolina State University, where he led a project that helped Peru become self-sufficient in rice in only five years, and helped Brazilian scientists to turn over 70 million acres of infertile savanna soils in the Cerrado region into the breadbasket of South America. Dr. Sanchez received his B.S. in Agronomy and M.S. and Ph.D. in Soil Science from Cornell University. He was the recipient of the 2002 World Food Prize and a 2003 MacArthur Fellowship.

Adam Sobel

Assistant Professor, Columbia University, Applied Physics and Applied Math, Earth and Environmental Sciences

Dr. Sobel has been collaborating with the modeling and prediction research team on atmospheric and climate dynamics since he was appointed Assistant Professor, Department of Applied Physics and Applied Mathematics and Department of Earth and Environmental Sciences at Columbia University in early 2000.

Adjuncts

Mathew Barlow

Staff Scientist, Atmospheric and Environmental Research, Inc.

Dr. Barlow examines Pacific Ocean variability and the spatial evolution of ENSO. His research focuses on decadal Pacific Sea Surface Temperature (SST) variability. He also develops real-time drought monitoring tools for evaluating malaria vulnerability in Africa. Dr. Barlow earned a Ph.D. in Meteorology from the University of Maryland in 1999. He was at the IRI from July 1999 through August 2002, first as a Postdoc and then as an Associate Research Scientist.

Kenneth Broad

Assistant Professor, University of Miami

Dr. Broad identifies the social implications of the use of climate information by decision-makers in different sectors (e.g., fisheries, water resources, agriculture, health) in South America, Indonesia, and the United States. He coordinates multinational, multidisciplinary teams of social, physical and natural scientists working on numerous projects. Dr. Broad has worked with the IRI since 1996, and is now at the Rosenstiel School of Marine and Atmospheric Science, University of Miami. He completed his Ph.D. in Anthropology at Columbia University in 1999.

Ping Chang

Professor, Texas A&M University

Dr. Chang received his Ph.D. in Atmospheric and Oceanic Sciences from Princeton University in 1988. He taught at Texas A&M University from 1990-1998 and was the Head of Physical Oceanography there from 1995-2000. He is currently an Adjunct Professor at the Institute of Oceanology and Director of The Joint Center of Ocean Circulation and Climate/Environment Studies at the Chinese Academy of Sciences.

Eli Galanti

Porter Fellow of the Porter School of Environmental Studies, Department of Geophysics and Planetary Sciences, Tel-Aviv University

Prior to arriving at the IRI in October 2003, Dr. Galanti worked on his Ph.D. thesis, entitled "ENSO dynamics and predictability – A study using a hybrid-coupled model and the adjoint method" at the Weizmann Institute, under the guidance of Prof. Eli Tzipermann. His research interests include coupled ocean-atmosphere dynamics, mainly with relation to seasonal climate prediction, as well as physical ocean dynamics and thermodynamics. At the IRI, Dr. Galanti's focus was on understanding the interannual dynamics of the global tropical ocean-atmosphere system, and on setting up an improved dynamical system for the prediction of the global tropical SST.

Matayo Indeje

Associate Research Scientist, Climate Downscaling and Application, IRI/MDG Technical Support Centre, UN Millennium Project

Dr. Indeje performs research on regional climate modeling. He provides expertise in development of tools for downscaling global climate forecasts to regional scales suitable for user applications and also support in training programs at IRI. Prior to joining the IRI in October 2000, Dr. Indeje received his Ph.D. from North Carolina State University and previously worked at the Drought Monitoring Centre, Nairobi in operational climate forecast products.

Richard Kleeman

Professor, New York University

Dr. Kleeman received his Ph.D. in Mathematical Physics from Adelaide University in 1986. He was a visiting senior research scientist at the IRI from 1997-98. Dr. Kleeman is currently an Associate Professor of Mathematical Sciences at New York University.

Ben Orlove

Professor, University of CA, Davis

Dr. Orlove is a Professor of Environmental Studies at University of California at Davis. He completed his Ph.D. at Berkeley in 1975 and is the author of seven books and over forty articles on social aspects of environmental and economic change, focusing primarily in Latin America.

Jennifer Phillips

Assistant Professor, Bard College

Dr. Phillips came to the IRI in January 2000 after spending six years at NASA's Goddard Institute for Space Studies. Her Ph.D. from Cornell (1994) focused on plant/water relations and international agriculture. She is a former Fulbright scholar and NATO research fellow. At the IRI, Dr. Phillips worked on climate applications in agriculture, and improving decision-making with seasonal climate forecasts.

Balaji Rajagopalan

Assistant Professor, University of Colorado

Dr. Rajagopolan engages in research related to the prediction of climate variability and the use of predicted information in hydrologic applications. He is currently at the University of Colorado at Boulder.

Renzo Taddei

Visiting Professor, Yale University

Dr. Taddei conducts research on sociological, anthropological, and communication aspects of the use of climate information in rural areas of Latin America. He received his Ph.D. in Applied Anthropology from Columbia University in spring 2005. Dr. Taddei, a Visiting Professor at Yale University starting September 2006, is also an Adjunct Associate Research Scientist with the IRI.

E. Grover-Kopec

Visiting Research Scientists

Francisco de Assis de Souza Filho
Research Scientist (Brazil)
Dr. Assis de Souza Filho specializes in water resources. His research focuses on Water Resources Allocation and Planning (WRAP). He worked on different dimensions of WRAP: water policy and regulation (economic incentives and enforcement), reservoir operation and hydroclimatic forecasting. He is Vice-President of the Brazil Water Resources Association (ABRH) and former President of Fundação Cearense de Meteorologia e Recursos Hídricos (FUNCEME), Ceara, Brazil.

Young il Moon
Professor (Korea)
Professor Young il Moon is visiting from the Department of Civil Engineering at Seoul University in Korea. He specializes in hydrology, in particular on floods and dam safety. He has worked on nonlinear forecasting of hydroclimatic series and its applications to water/hazard management.

Vincent Moron
Associate Research Scientist (France) (8/04 - 8/06)
Dr. Moron obtained his Ph.D. in physical geography at the University of Dijon (France) in 1993 under the guidance of Dr. Bernard Fontaine. His research focuses on the predictability and skill of tropical rainfall (Africa and South America), relationships between ENSO and North Atlantic atmospheric circulation and relationships between sea surges in the southern France and atmospheric variability.

C. Ropelewski

Institutional Support

Office of the Director General

Francesco Fiondella
Communications Officer
Before joining the IRI in October 2006, Fiondella worked at The Wall Street Journal as an information-graphics editor and staff reporter, specializing in science and health. He has also written for Discover, Scientific American and Reuters Health. He has Masters degrees from Columbia University in both environmental science and journalism. As Communications Officer, Fiondella develops content about the IRI's programs and activities for the public via the web and other featured publications.

Maria Risë Fullon
Project Coordinator
Fullon is responsible for the organization, maintenance, and analysis of current and pending project data and budgets for IRI's project management database. She brings over 10 years of database development and knowledge management experience from the public accounting and real estate industries. She earned a B.A. in Broadcast Communications at the University of the Philippines.

Nancy Kurul
Administrative Assistant
Kurul joined the IRI in June of 2004, following almost 25 years in higher educational administration She received her M.A. in Sociology (specialization in Organizational Productivity) and her B.A. in History (with Secondary High School Teaching Certification in History, Political Science, Sociology and Psychology) from the University of Iowa. At the IRI, Kurul provides administrative support, including coordinating travel arrangements and facilitating reimbursements for foreign and domestic travel, conference organization and routine office functions.

Tricia Preble
Outreach Communications Coordinator (10/00 -12/04)
Preble received a B.S. in Biology from the State University of New York College at Geneseo in 1995, and M.S. degrees in Biology and Business Management from the State University of New York at Stony Brook in 1998. Preble provides technical writing and graphical services for IRI products and publications, and is responsible for coordinating outreach and information management efforts. Although Preble resigned from full time employment in December 2004, she continues to work intermittently on IRI outreach products.

Institutional Support, continued

Lori Scally

Project Finance Manager

Scally is responsible for the financial analysis, budgeting and reconciliation of IRI accounts. She prepares financial data for routine and specialized reports. She brings 15 years of financial services and management experience from the mutual-fund industry and earned a B.S. in Biology from Oneonta State College.

Sandra Vitelli

Administrative Assistant

Vitelli assists in organizing professional conferences and meetings, for Training, Applications and Monitoring. She facilitates the coordination of events by arranging calendars, travel and accommodation preparations for visiting scientists, including reimbursement vouchers related to expenses and dissemination of reports. She also provides daily office support.

Computer Systems

Baaba Baiden

Intermediate Analyst/Programmer

Baiden joined the IRI in 2004 and serves as the webmaster for IRI's website, providing programming support and assisting in an ongoing redesign and redevelopment effort. Prior to joining the IRI, she worked on web design and information architecture projects in the financial services and non-profit industries. She holds a B.A in Math-Computer Science and an M.S. in Information.

Sara Barone

Analyst/Programmer

Barone is responsible for developing and operating a database for geophysical data, and assisting scientists in the retrieval of data. She also develops graphics tools for display and analysis of geophysical data and provides guidance for data-storage systems and software tools. Barone has degrees in Computer Science, Mechanical Engineering from UNICAMP, Brazil and Energy and Environmental Science from New York University.

Jia Fang

Intermediate Analyst/Programmer (2/00 - 4/05)

Dr. Fang provided specialized programming support to the design, maintenance and ongoing development of the IRI website. Prior to joining the IRI, she obtained her Ph.D. in Geophysics from the Lamont-Doherty Earth Observatory at Columbia University. She played a leading role in the software development of the IRI Climate Impacts Database associated with the Climate Information Digest. In 2005, Dr. Fang and her family relocated to southern New Jersey.

Brian Falk

Intermediate Systems Analyst/Programmer

Falk joined the IRI in October of 2004, shortly after graduating from the University of Pennsylvania. As a member of the systems staff he helps ensure the healthy operation of IRI's computing infrastructure. This includes the implementation of network services such as mail and remote access, as well as the setup and monitoring of several high performance computing clusters.

Xiaofeng Gong

Senior Analyst/Programmer

Dr. Gong performs global and regional climate simulations and plays a central role in the execution of model predictions for use in the IRI forecast system. Prior to arriving at the IRI in January 1999, he obtained his Ph.D. in Meteorology at the University of Oklahoma in 1998.

Brendon Hoch

Intermediate Analyst/Programmer (7/07 - 8/04)

Hoch joined the IRI in July 1997, after receiving a M.S. in Atmospheric Sciences from Ohio State University. Hoch supported and maintained all desktop computing platforms. He provided expertise in programming, system administration and development and utilization of IRI software products in support of training programs. In 2004, Mr. Hoch assumed a position as Technical Manager in the Chemical, Earth, Atmospheric and Physical Sciences Department, Plymouth State University, New Hampshire.

Virginia Jaworski

Intermediate Analyst/Programmer (8/04 - 2/06)

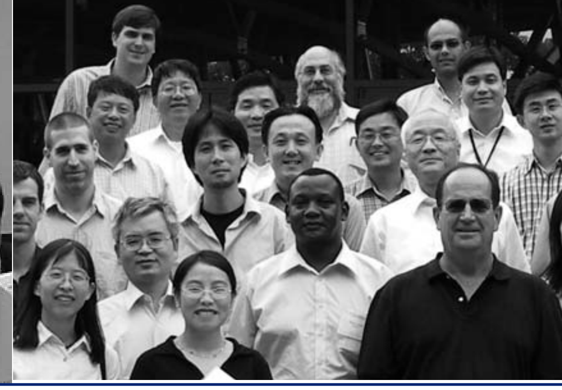
Jaworski received her B.S. degree from the State University of New York, Binghamton in Engineering. She has over twenty-five years of experience in various areas of information technology, including IBM mainframes and AIX and Linux systems engineering and administration. Jaworski joined the IRI in 2004 as a Systems Analyst on the IT team, supporting the Windows and Linux workstations and servers. She resigned from the IRI in 2006.

Jeff Turmelle

Senior Analyst/Programmer

Turmelle joined the IRI in September of 2001 after four years as a system manager on the R/V Maurice Ewing. He has a B.S. degree in Computer Science from University of Lowell, Massachusetts. Turmelle is part of the systems administration team and is responsible for maintaining the computing infrastructure of the IRI.





R. Vergara, T. Preble, J. Rhoads

IRI Hosted Meetings 2004-2006

Event	Partners
Third Climate Prediction Applications Science Workshop 15-17 Mar 2005 Palisades, NY	NOAA National Weather Service Climate Services Division
The 6th International Regional Spectral Model Workshop 11-15 Jul 2005 Palisades, NY	Experimental Climate Prediction Center, Climate Research Division, Scripps Institution of Oceanography NOAA Office of Global Programs
Climate and Development in Africa: Gaps and Opportunities A Panel Discussion 30 Jan-2 Feb 2006 New York and Palisades, NY	U.K. Department for International Development
Tropical Cyclones and Climate Workshop 25-27 Mar 2006 Palisades, NY	Earth Institute ADVANCE Program IGERT Joint Program in Applied Mathematics and Environmental Science National Science Foundation
Joint International Conference on Living with Climate Variability & Change: Understanding the Uncertainties & Managing the Risks 17-21 Jul 2006 Espoo, Finland	Finnish Meteorological Institute World Meteorological Organization

Representing the IRI Around the World

Africa

WHO/P. Virot

1-11 Jul 2004 "Improving Climate Forecast Communications for Farm Management in Uganda" project: final site visit, field work and workshop, Entebbe, Uganda *B. Orlove, J. Phillips*

4-17 Jul 2004 West Africa Health Program meetings, Niamey, Niger; Ouagadougou, Burkina Faso *O. Ndiaye, M. Thomson, S. Zebiak*

14-27 Jul 2004 Machakos agricultural pilot project meetings/workshops and ICRISAT farmer workshop on decision-making and the potential role of seasonal climate forecasts, Nairobi, Kenya *M. Dilley, J. Hansen*

19 Jul-5 Aug 2004 Roll Back Malaria Partnership Meeting and Southern Africa Joint Consultation and Planning Meeting, Gaborone, Botswana *S. Connor, S. Marx*

18-20 Aug 2004 Rift Valley Fever Workshop, Nairobi, Kenya *M. Dilley, M. Indeje*

23-27 Aug 2004 Greater Horn of Africa Climate Outlook Forum (COF)-14 and Food Security Outlook Forum, Nairobi, Kenya *M. Dilley, P. Ericksen, M. Indeje, T. Wolde-Georgis*

27 Aug-1 Sep 2004 USAID Southern Province (Zambia) pilot project management meetings, Harare, Zimbabwe *M. Dilley, J. Hansen*

1-2 Sep 2004 Southern Africa Regional COF (SARCOF) meetings, Harare, Zimbabwe *M. Dilley, S. Mason*

26-29 Sep 2004 Malaria Outlook Forum (MALOF), Harare, Zimbabwe *S. Connor, S. Marx, S. Mason*

25-30 Oct 2004 International Meeting on Meningitis, Niamey, Niger *M. Thomson*

5-14 Nov 2004 Southern Africa Development Community (SADC)/FAO Remote Sensing Project, Harare, Zimbabwe *J. Hansen*

8-10 Nov 2004 USAID/Greater Horn of Africa meetings, Dubai, UAE *M. Dilley*

29 Nov-15 Dec 2004 Greater Horn of Africa Food Security Outlook Forum follow up: interviews on monitoring, planning and response in Kenya, Nairobi and Lokichogio, Kenya *P. Ericksen*

5-10 Dec 2004 SARCOF and MALOF project updates, Harare, Zimbabwe *S. Mason*

12-21 Dec 2004 Consultation meetings: Climate & Health Venue (ACMAD/CERMES), Niamey, Niger *P. Ceccato*

16-28 Jan 2005 GHA Food Security Outlook Forum follow-up interviews on monitoring, planning and response, Ethiopia *P. Ericksen, T. Wolde-Georgis*

24 Jan-5 Feb 2005 2005-2009 Country Roll Back Malaria Strategic Plan Workshop, Asmara, Eritrea *P. Ceccato*

1-8 Mar 2005 Africa regional program development and partner meetings and GHA Climate Outlook Forum, Nairobi, Mombasa and Sauri, Kenya *M. Dilley, M. Indeje, S. Zebiak*

15-19 May 2005 ICTP: The First International Workshop on Climate Variability over Africa, Alexandria, Egypt *A. Giannini*

30 May-2 Jun 2005 8th PRESAO Conference, Niamey, Niger *P. Dibi Kangah, S. Trzaska*

28 Aug-11 Sep 2005 SARCOF, RCOF and related activities, Nairobi, Kenya and Livingstone, Zambia *J. Hansen, B. Lyon, S. Mason*

10-22 Sep 2005 Assessments of Impacts and Adaptations to Climate Change (AIACC) meeting, Naivasha and Nairobi, Kenya *M. Hellmuth*

19-24 Nov 2005 Predictability of Crop Yield project follow-up and field research, Ouagadougou, Burkina Faso *P. Dibi Kangah*

23-28 Nov 2005 ACMAD Climate and Health Workshop, Niamey, Niger *P. Ceccato, M. Thomson*

26-29 Nov 2005 *Colloque Meningocoque*– Challenges in the Meningitis Belt (CERMES and Fondations Merieux), Niamey, Niger *M. Thomson*

28 Nov-2 Dec 2005 African Monsoon Multi-disciplinary Analysis (AMMA) First International Conference, Dakar, Senegal *L. Addams, A. Giannini, P. Dibi Kangah, J. Hansen, O. Ndiaye, M. Thomson, S. Trzaska*

29 Nov-1 Dec 2005 Southern Africa MALOF2 2005-06, Harare, Zimbabwe *E. Grover-Kopec, S. Mason*

3-4 Dec 2005 AMMA Climate Impact Workshop "Closing the gap: Developing the use of seasonal forecast products and climate observations by operational users in West Africa", Dakar, Senegal *P. Dibi Kangah, A. Giannini, J. Hansen, O. Ndiaye, S. Trzaska, M. Thomson*

5-9 Dec 2005 AMMA/CIRAD Agriculture and Food Security Work-shop, Thies, Senegal *J. Hansen, O. Ndiaye*

Africa, continued

17-18 Jan 2006 Capitalization of the assets of the agrometeorologic assistance to the rural community in Mali (Mali National Weather Service workshop), Bamako, Mali *P. Dibi Kangah*

21 Jan-6 Feb 2006 ICRISAT visit to conduct modeling analysis on climate forecast applications on agricultural decision/management for improving crop return, Nairobi, Kenya *A. Mishra*

5-10 Feb 2006 East Africa collaborative meetings, Nairobi, Kenya and Kampala, Uganda *J. Hansen*

6-7 Feb 2006 Making the Best of Climate project inception (Association for Strengthening Agricultural Research in Eastern and Central Africa), Nairobi, Kenya *J. Hansen, M. Indeje*

8-9 Feb 2006 UNDP/GEF Coping with Drought and Climate Change workshop and advisory committee, Nairobi, Kenya *J. Hansen*

25 Feb-4 Mar 2006 COF 2006 and ICPAC implementation of downscaling forecast system post-processing package, Nairobi, Kenya *M. Indeje, L. Sun*

24 Mar-13 Apr 2006 Rift Valley Fever collaborative meetings, Nairobi, Kenya *J. Omumbo*

24-28 Mar 2006 Climate Adaptation Challenges: Building Capacity for African-Based Research Workshop, Nairobi, Kenya *M. Hellmuth*

3-4 Apr 2006 8th Session of the The Sahara and Sahel Observatory) Executive Board, Nouakchott, Mauritania *N. Ward*

18-21 Apr 2006 Climate Information for Development Needs: An Action Plan for Africa, Addis Ababa, Ethiopia *H. Bhojwani, T. Dinku, M. Hellmuth, M. Thomson, T. Wolde-Georgis, S. Zebiak*

9-10 May 2006 International Conference on the Application of Meteorological Extremes, Pretoria, South Africa *S. Mason*

11-20 May 2006 Participation at PRESAO test prediction; CPT training, meetings at ACMAD and AGHRYMET/Meeting at Omus, Niamey, Niger and Dakar, Senegal *S. Trzaska*

15-17 May 2006 Annual Meeting of the International Task Force on Commodity Risk Management, Pretoria, South Africa *D. Osgood*

10-13 Jul 2006 CLIVAR Variability of the African Climate System (VACS) Workshop-Southern and Easter African Climate Predictability Workshop, Dar es Salaam, Tanzania *A. Giannini, S. Mason*

25 Aug-11 Sep 2006 World Bank project activity: index insurance design, Lilongwe, Malawi *D. Osgood*

28 Aug-7 Sep 2006 CILSS (Permanent Interstate Committee for Drought Control in the Sahel) meetings, Ouagadougou, Burkina Faso *M. Hellmuth*

28 Aug-1 Sep 2006 Pre-SARCOF-10 training, Harare, Zimbabwe *S. Mason*

31 Aug-1 Sep 2006 COF for the Short Rains of 2006, Nairobi, Kenya *M. Indeje*

1-8 Sep 2006 Project partner meeting : GCOS-Climate and Development in Africa, Addis Ababa, Ethiopia *M. Thomson*

6–7 Sep 2006 Third MALOF, Gaborone, Botswana *S. Mason*

Europe

26 Aug-3 Sep 2004 Meningitis work with the Liverpool School of Tropical Medicine (LSTM) and meeting with European Centre for Medium Range Weather Forecasting (ECMWF), Liverpool and Birmingham, UK *M. Thomson*

13-17 Sep 2004 EU ENSEMBLES project start-up meeting, Hamburg, Germany *S. Connor, S. Mason*

20-24 Sep 2004 Ateliers African Monsoon Multiscale Analyses (AMMA), Dijon, France *S. Trzaska*

25 Sep-11 Oct 2004 Project and collaboration meetings: Laboratoire d'Océanographie Dynamique et de Climatologie, Laboratoire d'etude des transferts en Hydrologie et Environnement, and Centre de Recherches de Climatologie, Paris, Grenoble and Burgundy, France *S. Trzaska*

27-28 Sep 2004 Disaster Risk Hotspots project meetings and activities at the Norwegian Geotechnical Institute, Oslo Norway *M. Dilley*

27-29 Sep 2004 DQC Water Conference, Amsterdam, Netherlands *S. Arumugam*

29 Sep-1 Oct 2004 Center for Research on the Epidemiology of Disasters (CRED) collaborative meetings to launch a review of historical drought disasters in support of the development of disaster early warning systems, Brussels, Belgium *M. Dilley, E. Grover-Kopec*

12–15 Oct 2004 International CLIVAR WGSIP panel meeting, Exeter, UK *D. DeWitt*

18–21 Oct 2004 Joint WGSIP/WGNE/WGCM Workshop on Ensemble Methods, Exeter, UK *A. Robertson*

25–28 Oct 2004 Hotspots/ Loss-risks meetings, Geneva, Switzerland *M. Dilley*

28-30 Oct 2004 Invited speaker: Local Culture, Economic Development, and Disputes over the Legitimate Representation of the Environment: The Social Life of Climate Information in the Brazilian Northeast (original title in Portuguese: Cultura local, desenvolvimento econômico, e as disputas pela representação legítima sobre o meio ambiente: a vida social da informação climática no Nordeste brasileiro). II International Conference on Sociocultural Research and Development, Paredes de Coura, Portugal *R. Taddei*

11-12 Nov 2004 Invited speaker: Mainstream climatic responses: Agriculture, rural development and forestry. OECD: Global Forum on Sustainable Development: Development and Climate Change, Paris, France *W. Baethgen*

16-20 Nov 2004 WMO: Commission for Basic System Expert Team on Infrastructure for Long Range Forecasting, Geneva, Switzerland *S. Mason*

8-14 Jan 2005 Final Sub-global Working Group meeting of the Millennium Ecosystem Assessment, Scheveningen, The Netherlands *P. Ericksen*

10-11 Feb 2005 RT4/ RT5 ENSEMBLES Meeting, Paris, France *S. Mason*

10-15 Mar 2005 Food security meetings and WFP Emergency Needs Assessment Workshop, Rome, Italy *M. Dilley*

22-28 Mar 2005 Meeting with the Abdus Salam International Centre for Theoretical Physics (ICTP) Director and the Earth Systems Physics group, Trieste, Italy *L. Zubair*

22 Apr 2005 FAO meeting, Rome, Italy *P. Ceccato, C. Ropelewski*

24-29 Apr 2005 European Geosciences Union General Assembly, Vienna, Austria *P. Ceccato, E. Galanti*

26-27 Apr 2005 Royal Society Workshop, Food Crops in a Changing Climate, London, UK *J. Hansen*

26-27 Apr 2005 Royal Society Workshop: Food Crops in a Changing Climate, London, UK *J. Hansen*

29 Apr 2005 European Commission Joint Research Center meeting, Ispra, Italy *P. Ceccato*

9-10 May 2005 Advanced Institute on Climate Variability and Food Security: Final Synthesis Workshop, Geneva, Switzerland *J. Hansen*

11-13 May 2005 WMO International Workshop on Climate Prediction and Agriculture: Advances and Challenges, Geneva, Switzerland *J. Hansen, N. Ward*

18-20 May 2005 Meeting of scientific organizing committee members for the WMO decision-making conference, Geneva, Switzerland and Helsinki, Finland *M. Dilley*

21-24 May 2005 NATO ASI workshop, Gallipoli, Italy *S. Mason*

23 May-1 Jun 2005 Hotspots launch-CRED/TAG meeting, ISDR Inter-Agency Task Force meeting, CARE International Global Disaster Risk Management meeting, Brussels, Belgium, Geneva, Switzerland, and Amsterdam, Netherlands *M. Dilley*

6-8 Jun 2005 Global Organization for Earth System Science Portal Meeting, Chilton, Didcot, UK *B. Blumenthal*

10-18 Jun 2005 ENSEMBLES RT1/2A Meeting, Toulouse, France *S. Mason*

11 Jun-6 Jul 2005 Project meetings: Ethiopian Meningitis, ENSEMBLES, AMMA, University of Liverpool and LSTM, Liverpool, UK *M. Thomson*

15-17 Jun 2005 ECMWF Forecast Products Users Meeting, Reading, UK *S. Mason*

16 Jun-5 Jul 2005 Collaborative meetings with the LSTM and London School of Hygiene and Tropical Medicine, Liverpool and London, UK *S. Connor*

22-25 Aug 2005 ICTP: Coordinated Observation and Prediction of the Earth System Task Force for Seasonal Prediction -THORPEX Workshop on Seasonal Prediction, Trieste, Italy *D. DeWitt*

4-11 Sep 2005 ENSEMBLES General Assembly Meeting, Athens, Greece *S. Mason*

12-14 Sep 2005 Joint ENSEMBLES, WHO and Wengen-2005 International and Interdisciplinary Workshop, Wengen, Switzerland *S. Connor, S. Mason, M. Thomson*

12-15 Sep 2005 Royal Meteorological Society 2005 Conference: Seasonal Climate Forecasting for Societal Benefit in the Developing World: Progress and Prospects, Exeter, UK *S. Zebiak*

14 Sep 2005 XVI International Congress for Tropical Medicine and Malaria-Climate, landuse change and infectious disease in the Sahel, Marseilles, France *M. Thomson*

24 Sep-2 Oct 2005 CIRAD research collaboration meetings, Montpellier, France *A. Mishra*

11-12 Nov 2005 FAO Multilateral Evaluation of the 2003-2005 Desert Locust Campaign, Rome, Italy *P. Ceccato*

7-12 Mar 2006 European Space Agency: Earth Observation in Epidemiology (Epidemio) conference; FAO visit to discuss collaborations between Geonetwork and Data Library and Locust Group and IAI, Frascati, Italy *P. Ceccato*

15-23 Mar 2006 Wellcome Trust: Malaria Network Meeting, Oxford, UK *J. Omumbo*

27-29 Mar 2006 EWCIII Third International Conference on Early Warning Systems, Bonn, Germany *S. Mosquera-Machado*

30-31 Mar 2006 Royal Society workshop: Climate Change in Africa: Linking Science and Policy for Adaptation, London, UK *S. Connor, M. Hellmuth*

31 Mar 2006 Tyndall Centre for Climate Change Research visit and presentation, Norwich, UK *S. Connor*

2-7 Apr 2006 WMO meeting presentation on Health, Climate and Weather, Geneva, Switzerland *M. Thomson*

3-14 Apr 2006 WMO Meeting of Joint Expert Teams on Long-Range Forecasting; ECMWF collaborations on Botswana forecasts, Reading, UK *S. Mason*

Europe, continued

8-10 May 2006 The Stern Review meeting: The Economics of Adaptation to Climate Change, London, UK *M. Hellmuth*

15-18 May 2006 WMO Task Force on Social and Economic Applications of Public Weather Services, health sector representative for the session: Requirements for and Use of Weather, Climate and Water Information by Sectors, Geneva, Switzerland *S. Connor*

23-24 May 2006 Symposium on Multi-Hazard Early Warning Systems for Integrated Disaster Risk Management, Risk Identification and Linkages to Early Warning, Panelist: Adding Risk Information to Early Warnings for Decision Support, Geneva, Switzerland *S. Zebiak*

8-9 Jun 2006 Ensembles RTI/2A Meetings, Reading, UK *S. Mason*

19-25 Jun 2006 ECMWF Meeting, Reading, UK *S. Mason*

20 Jun-2 Jul 2006 Project partner meetings: UK DfID, World Food Programs, LSTM, London and Liverpool, UK *S. Connor, M. Thomson*

9 Jul 2006 Climate & Society Series resource meeting: GreenInk, London, UK *M. Hellmuth*

17-21 Jul 2006 Joint International Conference on Living with Climate Variability & Change: Understanding the Uncertainties & Managing the Risks, Espoo, Finland *W. Baethgen, H. Bhojwani, C. Brown, E. Ebrahimian, M. Hellmuth, R. Lenton, S. Someshwar, M. Thomson, S. Zebiak*

24-28 Jul 2006 Summer Academy on Social Vulnerability - Global Water Hotspots: Water-related social vulnerabilities and resilience-building, Munich, Germany *C. Brown*

17-18 Aug 2006 Pre-COF meetings, and Climate and Development in Africa project meeting, Geneva, Switzerland *S. Connor, S. Mason, M. Thomson, N. Ward*

Australia, Asia and the Pacific Islands

E. Ebrahimian

12-16 Jul 2004 Fifth Regional Spectral Model Workshop, Seoul, Korea *H. Li, L. Sun*

12-16 Jul 2004 Workshop on Seasonal Climate Monitoring for Indochina, Vientiane, Laos *S. Mason*

19-28 Jul 2004 South and Southeast Asia project meetings, Delhi, Jaipur and Jhunjhunu, India, and Bangkok, Thailand *E. Ebrahimian, S. Someshwar*

20-21 Jul 2004 Workshop on Techniques for Climate Analysis and Forecasting, Hong Kong, China *S. Mason*

28 Jul-6 Aug 2004 South and Southeast Asia project meetings, Manila/Iloilo, Philippines; and Hanoi/Hue/Quang Tri, Vietnam *S. Dani, E. Ebrahimian, B. Lyon, S. Someshwar*

18 Aug 2004 Dialogue on Climate-Sustainable Development and Society, Bangkok, Thailand *S. Someshwar*

24-30 Sep 2004 Millennium Ecosystem Assessment Meeting, Kuala Lumpur, Malaysia *P. Ericksen*

26 Sep-1 Oct 2004 Fourth International Crop Science Congress, Brisbane, Australia *J. Hansen, A. Ines*

28 Sep-3 Oct 2004 Central Weather Bureau Workshop, Taipei, Taiwan *M. Bell, U. Lall, C. Ropelewski, N. Ward*

29 Sep-7 Oct 2004 CLIPS Training Workshop, Doha, Qatar *S. Mason*

1-7 Oct 2004 Collaborative meetings with Queensland Department of Primary Industries, Agricultural Production Systems Research Unit, Toowoomba, Queensland, Australia *J. Hansen*

2-6 Nov 2004 WMO Third International Monsoon Workshop, Hangzhou, China *J. Qian, C. Ropelewski*

7-12 Nov 2004 International Symposium on Tropical Weather and Climate, Guangzhou, China *J. Qian*

8-16 Nov 2004 Climate and Malaria project work; Department of Wildlife and AIACC project partner meetings, Colombo, Sri Lanka *L. Zubair*

11-24 Nov 2004 India Integrated Rural Resources (IRRM) Project Planning Meetings, Delhi, Bangalore and Pune, India *E. Ebrahimian, A. Robertson, S. Someshwar*

17-19 Nov 2004 "Convener on Climate" for the International Conference on Sustainable Water Resources Management in the Changing Environment of the Monsoon Region, United Nations University, Colombo, Sri Lanka *L. Zubair*

29 Nov-3 Dec 2004 Project/partnership meetings: India Meteorological Department, Delhi, India; GEA and JICA, Tokyo, Japan *S. Someshwar, N. Ward, S. Zebiak*

17-21 Jan 2005 World Conference on Disaster Risks, Kobe, Japan *M. Dilley*

2-4 Feb 2005 WMO Expert Team on Verification, Tokyo, Japan *S. Mason*

7-12 Mar 2005 Managing Climate Variability to Improve Livelihoods in South and Southeast Asia project meetings, Bangkok, Thailand *E. Ebrahimian, S. Someshwar*

9-31 Mar 2005 Gujarat project site visit and partner meetings, Ahmedabad, India *S. Dani*

12-17 Mar 2005 India IRRM project meetings, New Delhi, India *E. Ebrahimian, A. Robertson, S. Someshwar*

4-13 Apr 2005 First Session of the Forum on Regional Climate Monitoring-Assessment-Prediction for Regional Association II, Beijing Climate Center, Beijing, China *J. Qian*

20 May-3 Jun 2005 Asia regional program project meetings, Manila, Philippines and Jakarta, Indonesia *C. Brown, E. Ebrahimian, S. Someshwar*

10-17 Jul 2005 Project meetings with Angat reservoir stakeholders and to present recent research results on the application of climate forecasts for operational management of Angat System, Manila, Philippines *C. Brown, S. Arumugam*

13-15 Jul 2005 Climate Predictability Tool (CPT) Training, Manila, Philippines *B. Lyon, S. Mason*

18-21 Jul 2005 Workshop on Climate Risk Management in Southeast Asia, Asian Institute of Technology, Pathumthani, Thailand *C. Brown, E. Ebrahimian, A. Giannini, B. Lyon, J. Qian, K. Rafisura, S. Someshwar, N. Ward*

19-22 Jul 2005 Pacific pilot project scoping: discussions with: Secretariat of the Pacific Community and South Pacific Applied Geoscience Commission, Suva, Fiji; and with FAO, Ministry of Agriculture, Samoa Observatory, South Pacific Regional Environment Programme, University of the Pacific and WMO; including a presentation on Verification of Seasonal Climate Forecasts, Apia, Samoa *S. Mason*

22-27 Jul 2005 Climate and weather forecast and hydrological application discussions with scientists of the Tropical Marine Science Institute and the Singapore Meteorological Service, National University of Singapore, Singapore *J. Qian*

25-27 Jul 2005 Climate information and food security discussions, Nusa Tenggara Timur, Indonesia *A. Giannini, S. Someshwar*

25-27 Jul 2005 Institutional landscaping research, Manila, Philippines *E. Ebrahimian, K. Rafisura*

25-27 Jul 2005 Visit to ASEAN Specialized Meteorological Center and the National University of Singapore, Singapore *B. Lyon, J. Qian, N. Ward*

25-28 Jul 2005 Visit, Cebu, Philippines *C. Brown*

28-30 Jul 2005 Visits with the Office of the Governor of Bali, BAPPEDA (the Planning Agency) and Udayana University to discuss on-going water resources management project and site visits to districts affected by climate variability, Indonesia *E. Ebrahimian, S. Someshwar*

31 Jul-3 Aug 2006 Site visit to Palangka Raya, Central Kalimantan to develop new efforts with CARE Indonesia on fire management, Indonesia *E. Ebrahimian, S. Someshwar*

4-12 Aug 2005 Meetings at Indian Institute of Technology (IIT-Delhi) with Ministry of Agriculture, Indian Met Department and others to discuss IRRM project, India *E. Ebrahimian, A. Robertson, S. Someshwar*

7-17 Aug 2005 Meetings with Institute of Development Studies, Jaipur, Rajasthan to initiate data collection for Bayesian analysis of the impact of droughts on livelihoods, India *S. Rathi, S. Someshwar*

7-9 Aug 2005 Meetings with Indian Institute of Tropical Meteorology to discuss climate data analysis for Rajasthan and Gujarat project work, Pune, India *A. Robertson*

10-11 Aug 2005 Discussions with Asian Disaster Preparedness Center (ADPC) and Sustainable Urbanism International regarding potential collaborations on water resources management, hydropower, and urban climate risk management, Bangladesh *S. Someshwar*

21 Aug - 4 Sep 2005 Sri Lanka Climate and Malaria project activities, Sri Lanka *L. Zubair*

26 Aug-11 Sep 2005 Climate downscaling meetings at Beijing Normal University, National Climate Center, Zhejiang Climate Center, and China Meteorological Administration, Beijing, China *L. Sun*

7-23 Oct 2005 WMO Workshop of Global Producing Centers of Long-Range Forecasts, Jeju Island, South Korea *S. Mason*

1-2, 8 Nov 2005 CC1 Technical Meeting: Climate as a Resource and CC1 formal session, Beijing, China *N. Ward*

3-11 Nov 2005 ADPC project meetings, Bangkok, Thailand; training on institutional mapping, Kupang, Indonesia; CARE Indonesia meetings on fire management project, Kalimantan, Indonesia; meetings at World Bank at JICA offices, Jakarta; Indonesia; urban climate risk discussions with stakeholders, Yogyakarta, Indonesia *S. Someshwar*

5-12 Nov 2005 "Applying climate information to enhance the resilience of farming systems exposed to climatic risk in South and Southeast Asia" project team meeting, synthesis workshop and stakeholder meeting, Pune and Hyderabad, India *J. Hansen*

7 Nov 2005 JMA and JICA training lectures, Tokyo, Japan *N. Ward*

16-23 Nov 2005 Asia-Pacific Economic Cooperation Climate Center Opening Ceremony and Symposium, Busan, Korea *A. Robertson*

8-11 Dec 2005 Scientific Conference on Asia-Pacific Environment and Health, Bangkok, Thailand *S. Connor*

1-9 Jan 2006 Institutions and Policy Systems Research program activities and Livelihoods project research (SE Asia) activities, Kupang and Denpasar, Indonesia *E. Ebrahimian, S. Someshwar*

2-4 Feb 2006 Managing risks of changing climate for alleviating poverty. Delhi Summit on Sustainable Development, New Delhi, India *S. Someshwar*

Australia, Asia and the Pacific Islands, continued

7-11 Feb 2006 Meetings with HMS and other stakeholders on climate risk and water management, Hanoi, Ho Chi Minh City, and Can Tho Province, Vietnam *E. Ebrahimian, B. Lyon, S. Someshwar*

12–15 Feb 2006 Scoping of integrated river basin management for the Mekong River and urban climate risk management, Phnom Penh, Cambodia *E. Ebrahimian, S. Someshwar*

12-23 Feb 2006 Climate science workplanning and coordination at PAGASA; institutional landscaping of Angat Reservoir stakeholders and visit to University of the Philippines, Manila and Los Baños, Philippines *E. Ebrahimian, B. Lyon*

13-16 Feb 2006 CLIVAR Working Group on Seasonal to Interannual Prediction, Wellington, New Zealand *D. DeWitt*

28 Mar-1 Apr 2006 Managing Climate Variability National Program - Terms of reference for an international review panel, Adelaide, Australia *J. Hansen*

2-7 Apr 2006 Symposium on Asian Winter Monsoon - Winter MONEX: A Quarter Century and Beyond (WMONEX 25+), Kuala Lumpur, Malaysia *J. Qian, S. Zebiak*

6-8 Apr 2006 2nd Session of the Forum on Regional Climate Monitoring, Assessment and Prediction for Asia, Beijing, China *C. Ropelewski*

8-14 Apr 2006 BMG and PAGASA collaborations on climate downscaling, Kuala Lumpur, Malaysia; Jakarta, Indonesia; Manila, Philippines *J. Qian*

25 Apr-6 May 2006 Meetings in region: India IIRM project partners, ICRISAT, CRIDA; Delhi, and Hyderabad, India *W. Baethgen, E. Ebrahimian, S. Someshwar, A. Robertson*

7-9 Jun 2006 NOAA-BRKP sponsored workshop, "Use of Ocean Observations to Enhance Sustainable Development - Training and Capacity Building Workshop for the Eastern Indian Ocean," Bali, Indonesia *A. Giannini, S. Someshwar, S. Zebiak*

11-13 Jun 2006 Project meetings with BMG Research and Development Divisions, Jakarta, Indonesia *A. Giannini*

10-14 Jul 2006 7th International Regional Spectral Model Workshop, Ramat Gan, Israel *M. Indeje, L. Sun*

21-26 Jul 2006 CARE International project meetings for fire management, Jakarta and Palankaraya, Indonesia *P. Ceccato, S. Someshwar*

22-25 Jul 2006 ADPC project partner meetings, Bangkok, Thailand *E. Ebrahimian, S. Someshwar*

25-29 Jul 2006 Angat Reservoir project partner and institutional mapping meetings, Manila Philippines *E. Ebrahimian, S. Someshwar*

30 Jul-7 Aug 2006 Workshop on the Science of Seasonal Climate Prediction, Canberra, Australia *S. Mason*

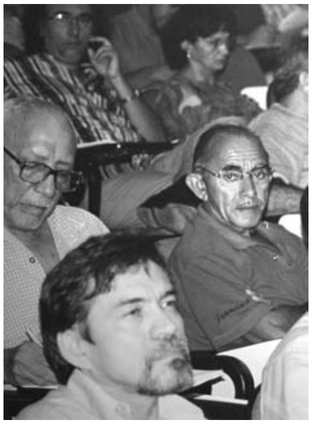
12-18 Aug 2006 26th Conference of the International Association of Agricultural Economists, Gold Coast, Australia *J. Hansen*

19-26 Aug 2006 Project meetings: MWSS, NWRB, NPC and NIA water managers and scientists for forecast use in water allocation for Angat reservoir and west Java water managers/ scientists for Citarum reservoir system, Manila Philippines and Jakarta, Indonesia *C. Brown, E. Ebrahimian, S. Someshwar*

27-30 Aug 2006 Project meetings: Food security decision making and rice importation, Kupang, Indonesia *E. Ebrahimian, S. Someshwar*

8 Sep 2006 Managing Climate Risks, The Agriculture Risk Working Group of the XI Five Year Plan, Indian Planning Commission, New Delhi, India *S. Someshwar*

Central America, South America & the Caribbean



R. Taddei

9 Jul 2004 Invited speaker: The Social Life of the Water Laws – Notes and Reflections on the Case of Ceará (original title in Portuguese: A Vida Social das Leis sobre Recursos Hídricos – Notas e reflexões sobre o caso do Ceará). Seminar in Commemoration of the 70th Anniversary of the First Brazilian Water Law (Seminário Comemorativo dos 70 Anos do Código das Águas), organized by the Brazilian Association for Water Resources (ABRH). Fortaleza, Brazil *R. Taddei*

16-20 Aug 2004 Improving climatic risk management for dryland cropping in two regions of South America, Fortaleza, Brazil *W. Baethgen*

21-30 Aug 2004 "Building capacity to use climate information and forecasts to enhance decision-making in agriculture in Argentina" project consultation meetings, Buenos Aires, Argentina *S. Marx*

24-27 Aug 2004 Assessing Impacts and Adaptation to Climate Change (AIACC): 2nd Latin America and Caribbean Regional Workshop, Buenos Aires, Argentina *W. Baethgen*

29 Aug-3 Sep 2004 XIII Brazilian Congress of Meteorology, lecture presented, "State of Art of Climate Forecasting in Brazil, Fortaleza, Brazil" *L. Sun*

7-16 Sep 2004 River reservoir management modeling, Fortaleza, Brazil *S. Arumugam*

11-17 Sep 2004 El Niño early warning for sustainable development meeting, Galapagos, Ecuador *W. Baethgen, A. Barnston*

13-16 Sep 2004 10th GEWEX Hydrometeorology Panel Meeting, Montevideo, Uruguay *A. Seth*

17-18 Sep 2004 Workshop on American Monsoons System held in the context of the Coordinated Enhanced Observing Period Inter-monsoon Model Study (CIMS) Project, Montevideo, Uruguay *A. Seth*

27 Sep-31 Oct 2004 IRI's Latin Americas program planning meetings, Montevideo, Uruguay *W. Baethgen, Y. Biro*

11-15 Oct 2004 Economic Commission for Latin America and the Caribbean (ECLAC) meeting, Santiago, Chile *P. Ericksen*

27 Oct 2004 Groundwater Modeling and Management in the Yaqui Valley (stakeholder research and management applications), forum convener and presenter, San Carlos, Mexico *L. Addams*

27-29 Oct 2004 21st RCOF for Southeast South America, Asuncion, Paraguay *W. Baethgen*

15-17 Nov 2004 Losses and Risks subregional meeting, Manizales, Colombia *M. Dilley*

15-17 Nov 2004 4th RCOF for Western South America, Guayaquil, Ecuador *W. Baethgen*

16-19 Nov 2004 WHO Ministerial Summit on Health Research, Mexico City, Mexico *S. Connor*

4-12 Dec 2004 10th Session of the UNFCCC Conference of Parties (COP 10), Buenos Aires, Argentina *W. Baethgen, Y. Biro*

9-24 Jan 2005 Lectures on downscaling and collaboration on analysis of IPCC scenarios, Instituto Geofisico del Perú, Lima, Peru *A. Seth*

15-23 Jan 2005 VII International COF, Fortaleza, Brazil *L. Sun*

14-18 Feb 2005 WMO Training Workshop on Climate Early Warning Systems, Brasilia, Brazil *S. Connor, C. Ropelewski*

21-22 Feb 2005 Expert Team Meeting on Climate Watches and Warnings, Brasilia, Brazil *C. Ropelewski*

23-26 Feb 2005 "Meningococcal Meningitis - From Basic Science to Ecology" symposium sponsored by the LSTM and the Mother and Child Institute, Recife, Pernambuco, Brazil *M. Thomson*

11-14 Apr 2005 Meetings with agencies and ministries at Ceará state and Brazilia, Brazil *W. Baethgen, S. Zebiak*

16-20 May 2005 Alexander von Humboldt International Conference on The El Niño phenomenon and its global impact, sponsored by CIIFEN (Centro International para la Investigación del Fenómeno de El Niño) and European Geosciences Union, Guayaquil, Ecuador *W. Baethgen, B. Lyon*

26-27 May 2005 Conference on Vulnerability and Hydrometeorological Risk Management (organized by CIESAS, UNAM and Colegio de México), Mexico City, Mexico *R. Taddei*

1 Jun 2005 Climate sciences and society in the Brazilian Northeast: socio-anthropological contributions to understanding the communicative processes related to climate issues (original title in Spanish: Ciencias climáticas y sociedad el en Nordeste de Brasil: aportes socio-antropológicos para entender los procesos comunicativos relacionados con el clima). Universidad Nacional Autónoma de México– Centro de Ciencias de la Atmósfera, Mexico City, Mexico *R. Taddei*

15-19 Jun 2005 2nd planning grant workshop meeting for GECAFS Caribbean proposal, Georgetown, Guyana *N. Ward*

13-16 Jul 2005 WMO/ CLIPS-sponsored meeting, "Regional Technical Meeting on CLIPS and Agrometeorological Applications for the Mercosur Countries"; conducted training session, "The IRI Climate Prediction Tool - Hands-on Exercise", Campinas, Brazil *A. Barnston*

8-19 Aug 2005 CLIPS Focal Point Training Workshop for Regional Association III, Lima, Peru *S. Mason*

11 Aug 2005 Seminar speaker - Evaluation of the Implementation of the National Water Resources Policies, in Brazil and in the State of Ceará, promoted by the Ceará State Metropolitan Basin Water Committee, Fortaleza, Brazil *R. Taddei*

11-14 Oct 2005 CLIVAR/ OOPC/GOOS/Argo/CPPS Workshop on the South Pacific, Concepcion, Chile *D. DeWitt*

17-28 Oct 2005 IAI Training Institute on Climate Variability and Climate Change in the Americas, Asuncion, Paraguay *W. Baethgen*

31 Oct 2005 Mexican Geophysical Union Annual Meeting; discussion on prospective collaborations with the University of Mexico, the Mexican Weather Service, the Mexican Water Authority and other participants in Mexico's emerging National Climate Research Program, Puerto Vallarta, Mexico *C. Ropelewski*

7-11 Nov 2005 IAI Training Institute on Climate and Health in the Americas, Kingston, Jamaica *S. Connor*

7-10 Nov 2005 Institute for Advanced Studies of the University of Sao Paulo: Regional Conference on Global Change: South America, Sao Paulo, Brazil *W. Baethgen*

Central America, South America & the Caribbean, continued

16-18 Nov 2005 Working group "Society and Nature in South America: Anthropological Theories, Cultural Practices and Environmental Conflicts," IV RAM - Anthropological Meeting of the MERCOSUR, Montevideo, Uruguay *R. Taddei*

27 Nov-2 Dec 2005 Linking the Sciences of Environmental Change to Society and Policy - lessons from 10 years of research networks in the Americas (an IAI-SCOPE Rapid Assessment Process Project), Ubatuba, Brazil *W. Baethgen*

16-18 Jan 2006 1st International Conference on Climate Studies in Northeast Brazil, Fortaleza, Brazil *L. Sun*

19-20 Jan 2006 VIII Semi-Arid Northeast Brazil COF, Fortaleza, Brazil *L. Sun*

23-27 Jan 2006 Visit to Universidad Nacional Autonoma de Mexico to initiate collaboration on dynamical downscaling model for agricultural decision-making, Mexico City, Mexico *L. Goddard*

8-11 Feb 2006 Facilitator for Climate Risk Management in Agriculture Sector Workshop-Caribbean Community Secretariat's Mainstreaming Adaptation to Climate Change, Georgetown, Guyana *N. Ward*

16-22 Mar 2006 World Water Council, Government of Mexico: Fourth World Water Forum, Mexico City, Mexico *L. Addams, H. Bhojwani, C. Brown, M. Hellmuth, S. Trzaska, W. Baethgen*

5-6 Apr 2006 UNDP/ UNICEF/La Red conference, "Managing risks associated to ENSO, climate variability and climate change," Guayaquil, Ecuador *W. Baethgen*

22-23 Apr 2006 Ninth Annual Meeting of the WCRP/ CLIVAR/VAMOS Panel (VPM9), Foz do Iguaçu, Brazil *L. Goddard*

24-28 Apr 2006 8th International Conference on Southern Hemisphere Meteorology & Oceanography, Foz do Iguaçu, Brazil *M. Bell, S. Camargo, C. Ropelewski*

8-11 May 2006 Monsoon Regional Climate Applications: Binational Workshop, Guaymas, Sonora, Mexico *E. Grover-Kopec*

22 May-1 Jun 2006 Instituto Nacional de Meteorologia (INMET) climate prediction lecture, guest lecturer, Brazilia, Brazil *A. Barnston*

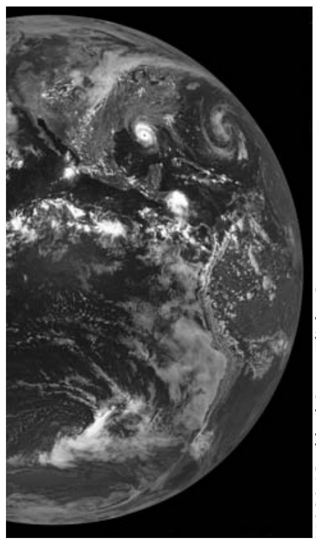
23-27 May 2006 Brazil Ministry of the Interior and Ministry of Science and Technology, with The World Bank: Water Resource Management and Sustainable Development, speaker; first meeting of FUNCEME's international science and technical advisory committee, Fortaleza, Brazil *W. Baethgen*

28-30 Jun 2006 Project coordination meetings: Climate Risk Management in Agriculture of MERCOSUR and Climate Risk Management in the Elqui River Basin, Santiago, Chile *W. Baethgen*

15-17 Aug 2006 IAI workshop and Latin America & the Caribbean training program meetings, Sao Paolo, Brazil *W. Baethgen*

7-15 Sep 2006 CGIAR Scientific Council Annual Meeting, Cali, Colombia *W. Baethgen*

North America



NASA/Goddard Space Flight Center

7-9 Jul 2004 Ninth Annual Community Climate System Model Workshop, Santa Fe, NM *D. DeWitt, A. Seth*

11-16 Jul 2004 6th Annual CALMet Conference, Boulder, CO *B. Hoch*

14-16 Jul 2004 Earth System Modeling Framework Meeting Denver, CO *David DeWitt*

10-11 Aug 2004 AMS Annual Meeting Program Chair planning meeting, Livermore, CA *B. Lyon*

19-20 Aug 2004 First meeting of the Committee on Strategic Guidance for NSF's Support of Research in the Atmospheric Sciences, Washington, DC *S. Zebiak*

10 Sep 2004 NOAA Office of Global Programs meetings, Silver Spring, MD *C. Ropelewski*

26-27 Sep 2004 RightRisk group meeting, Denver, CO *D. Osgood*

7-9 Oct 2004 USGS project collaboration meeting and USGS-FEWSNet Science Workshop, Sioux Falls, SD *P. Ceccato, M. Dilley*

13-15 Oct 2004 National Research Council Panel on providing strategic advice to NSF/ATM, Boulder, CO *S. Zebiak*

18-22 Oct 2004 29th Climate Diagnostic and Prediction Workshop, Madison, WI *S. Camargo, B. Lyon, C. Ropelewski*

20-22 Oct 2004 NOAA's Applied Research Center (ARC) council meeting, Madison, WI s*D. DeWitt*

21 Oct 2004 Seasonal Climate Prediction: An Under-exploited Weapon in Our Arsenal Against Hunger and Poverty. Thomas G. Bullen, CFG Memorial Lecture Series in Science and Technology, Iona College, New Rochelle, NY *J. Hansen*

31 Oct-4 Nov 2004 American Society of Agronomy Annual Meeting, Seattle, WA *J. Hansen, A. Ines, N. Ward*

3 Nov 2004 Invited speaker: “Climate Variability and Agriculture: Predicting and Managing the Impacts.” Impact of Climate Variability on Agricultural and Natural Resource Management Symposium, ASA-SSSA-CSSA 96th Annual Meeting, Seattle, WA *J. Hansen*

7-11 Nov 2004 American Society of Tropical Medicine and Hygiene 53rd Annual Meeting, Miami, FL *S. Marx, M. Thomson*

22-23 Nov 2004 Climate Observing System Council Meeting, Silver Spring, MD *L. Goddard*

29 Nov 2004 Institute for the Study of Earth, Oceans, and Space, invited seminar speaker, University of New Hampshire. Durham, NH *B. Lyon*

1-2 Dec 2004 NCEP Climate Guidance Product Users Workshop, Washington, DC *A. Barnston*

1-3 Dec 2004 Center for the Study of Earth from Space site review, Seattle, Washington *C. Ropelewski*

7-10 Dec 2004 USAID disaster risk hotspots project meeting, ProVention Consortium meeting and CRED workshop, Washington, DC *M. Dilley*

13-17 Dec 2004 2004 AGU Fall Meeting, San Francisco, CA *L. Addams, S. Arumugam, B. Blumenthal, S. Camargo, A. Giannini, S. Rauscher, A. Seth, L. Sun, M. Thomson, L. Zubair*

3-6 Jan 2005 ESIP Federation 2005 Winter Meeting, Washington, DC *B. Blumenthal*

7-9 Jan 2005 Allied Social Science Associations Annual Meeting, Philadelphia, PA *D. Osgood*

9-13 Jan 2005 85th AMS Annual Meeting, San Diego, CA *J. del Corral, H. Li, B. Lyon, S. Mason, C. Ropelewski, M. Tippett*

10-11 Jan 2005 Environmental Change and Food Systems (GECAFS) Decision Support Systems Inaugural Workshop, Gainesville, FL *W. Baethgen*

12 Jan 2005 AMS Committee on Climate Variability and Change annual meeting, San Diego, CA *B. Lyon*

23-24 Jan 2005 EHP Eritrea Malaria Project presentation to USAID, Washington, DC *P. Ceccato, M. Thomson*

25-28 Jan 2005 Scientific Steering Committee Meeting, Miami, FL *L. Goddard*

28 Jan 2005 NOAA/OGP Meeting: "Developing a better performance measure for the seasonal climate forecasts issued by NOAA's Climate Prediction Center (CPC)", Washington, DC *A. Barnston*

31 Jan-1 Feb 2005 Asia regional program project discussions with Climate and Society Interactions Group at NOAA/OGP, World Bank, and World Resources Institute, Washington, DC *E. Ebrahimian, S. Someshwar*

31 Jan-2 Feb 2005 Presentation of IRI work on methods for using climate model output with crop simulation, and planning and evaluation meeting, University of Florida, Gainesville, FL *J. Hansen*

31 Jan-2 Feb 2005 U.S. CLIVAR Atlantic Science Conference, Miami, FL *L. Goddard, O. Ndiaye, A. Robertson*

3-7 Feb 2005 Review panel meeting for the Climate Prediction Application Workshop, Washington, DC *C. Ropelewski*

16-17 Feb 2005 Invited speaker on "Prediction of malaria epidemics in Botswana" at University of Florida, Gainesville, FL *S. Mason*

17-18 Feb 2005 Third Meeting of Committee on Strategic Guidance for NSF's Support of the Atmospheric Sciences, Washington, DC *S. Zebiak*

24 Feb 2005 Cooperative Institute for Climate Applications and Research (CICAR) meeting to discuss topics in climate research of interest to the cooperating institutes (GFDL/ LDEO), Princeton, NJ *A. Giannini*

1-3 Mar 2005 NCAR Atmosphere Model Working Group Meeting, Boulder, CO *D. DeWitt*

1-4 Mar 2005 Workshop on Analyses of Climate Model Simulations for the IPCC AR4 (CLIVAR/ CMEP) and presentation on "Performance-based probabilistic multi-model climate change scenarios," Honolulu, HI *A. Greene*

4-6 Mar 2005 Eastern Economic Association Annual Meeting, New York, NY *D. Osgood*

15-17 Mar 2005 Climate Prediction Applications Science Workshop: Research and Applications on Use and Impacts, IRI, Lamont Campus of Columbia University, Palisades, NY *S. Arumugam, C. Brown, S. Connor, J. Hansen, E. Grover-Kopec, B. Lyon, C. Ropelewski, L. Sun, N. Ward, L. Zubair*

21-24 Mar 2005 Moderate Resolution Imaging Spectroradiometer (MODIS) Science Team Meeting, Baltimore, MD *P. Ceccato*

29 Mar-3 Apr 2005 National Academy of Science Review Panel, Washington, DC *C. Ropelewski*

30 Mar-1 Apr 2005 Ecological Modeling for NASA Applied Sciences Workshop, Monterey, CA *S. Connor*

5-9 Apr 2005 Annual Meeting of the Association of American Geographers, Denver, CO *S. Rauscher*

13 Apr 2005 Panel presentation for Climate Research Committee Meeting, Washington, DC *N. Ward*

2-6 May 2005 USDA/Food for Peace Annual Food Aid Conference presentation on Food Security Outlooks, Kansas City, MO *M. Dilley*

4-6 May 2005 CRED Annual Investigators Meeting, Columbia University, New York, NY *B. Lyon*

9-10 May 2005 Integrated Earth Observing System (IEOS) Workshop, Washington, DC *C. Ropelewski*

North America, continued

11-13 May 2005 Hidden Markov Models and Coupled Ocean Atmosphere Modes project collaboration, Los Angeles, CA *A. Robertson*

16-18 May 2005 Workshop on Observational and Modeling Requirements for Predicting Drought on Seasonal to Decadal Time Scales, Washington, DC *C. Ropelewski*

16-19 May 2005 University of Maryland "Predicting Drought on Seasonal to Decadal Time Scales" workshop, Adelphi, MD *C. Ropelewski, A. Seth*

17-20 May 2005 GECAFS Workshop, SAC4 and Exec8 meetings, Washington, DC *Y. Biro*

23-27 May 2005 AGU Conference, New Orleans, LA *S. Arumugam, D. DeWitt, A. Robertson, M. Tippett*

7 Jun 2005 Government University Industry Research Roundtable Meeting, Washington, DC *S. Zebiak*

7-9 Jun 2005 2nd Northeast Tropical Workshop, Rensselaerville, NY *S. Camargo*

7-13 Jun 2005 Earth System Science Interdisciplinary Center, University of Maryland and NOAA, Washington, DC *C. Ropelewski*

15-16 Jun 2005 Congressional Briefing on potential benefits of advanced forecasting/ Meeting with NOAA Office of Global Programs, Washington, DC *S. Zebiak*

15-17 Jun 2005 First Pan-WCRP Workshop on the monsoon climate systems: Toward better prediction of the monsoons, participant and presenter on behalf of the CLIVAR panel on VACS, UC Irvine, CA *A. Giannini*

20-23 Jun 2005 AMS Applied Climatology Conference, Savannah, GA *E. Grover-Kopec*

21-23 Jun 2005 10th Annual CCSM Workshop, Breckenridge, CO *A. Greene*

28 Jun 2005 Launching of the Nelson Mandela Institution for Knowledge Building and the Advancement of Science & Technology in sub-Saharan Africa, Washington, DC *S. Zebiak*

30 Jun 2005 COLA seminar entitled "Potential predictability, ensemble forecasts and tercile probabilities", speaker, Calverton, MD *M. Tippett*

6-8 Jul 2005 4th Meeting of the Committee on Strategic Guidance for NSF's Support of the Atmospheric Sciences, Irvine, CA *S. Zebiak*

11-15 Jul 2005 6th International Regional Spectral Model Workshop, Palisades, NY *S. Camargo, H. Li, J. Qian, L. Sun*

23-28 Jul 2005 "Climate Risk Management: Case Studies in Public Health, Natural Disaster and Renewable Energy" presentation, 2005 Association of Environmental Engineering and Science Professors Research and Education Conference, Potsdam, NY *L. Zubair*

15-19 Aug 2005 US CLIVAR Summit; Co-chair of the 'Predictability, Predictions and Applications Interface' panel; a panel presentation at the plenary session of organizational meeting convened to define the terms and goals of newly-established US CLIVAR panels, Keystone, CO *L. Goddard*

17-20 Aug 2005 5th EM-DAT Technical Advisory Group Meeting (Center for Research of the Epidemiology of Disasters, OFDA/USAID), Washington, DC *E. Grover-Kopec*

6-7 Sep 2005 50th Anniversary Symposium of GFDL "Modeling and Understanding Climate Variations and Change, and Advancing Climate Predictability for the Benefit of Society" and Atmospheric and Oceanic Sciences program reunion, Princeton, NJ *L. Goddard, S. Zebiak*

12-15 Sep 2005 US Dept. of Energy INCITE Review Panel, USDE High Performance Supercomputing proposal review panelist, San Diego, CA *D. DeWitt*

30 Sep - 3 Oct 2005 NOAA OGP Review Panel (Climate Test Bed), Silver Spring, MD *C. Ropelewski*

4-5 Oct 2005 USAID, World Bank and RTI meetings, Washington, DC *H. Bhojwani, M. Thomson, T. Wolde-Georgis*

20-22 Oct 2005 NOAA Office of Climate Observations (OCO) Climate Observations Systems Counsel meeting, Silver Spring, MD *L. Goddard*

24-28 Oct 2005 NOAA's 30th Annual Climate Diagnostics and Prediction Workshop, State College, PA *A. Barnston, S. Camargo, L. Goddard, A. Greene, J. Qian, C. Ropelewski, S. Zebiak*

25-26 Oct 2005 UNEP-Finance Initiative (FI) Global Roundtable, New York, NY *D. Osgood*

31 Oct 2005 GFDL collaboration meetings, Princeton, NJ *A. Giannini*

2-3 Nov 2005 Site review of the COAPS, Tallahassee, FL *C. Ropelewski*

7-10 Nov 2005 NOAA OGP NCTP Panel to review 2005 grants; Meeting with NASA/GSFC collaborators and presentation, Silver Spring, MD *L. Zubair*

9 Nov 2005 Columbia SIAM (Society for Industrial and Applied Mathematics) Chapter Lecture, Columbia University, New York, NY *S. Camargo*

11 Nov 2005 Earth Institute conference "Understanding Katrina": Session 1 (Examining the Science: Physical Phenomenon, Predictability and Uncertainties of Hurricanes) panelist, New York, NY *S. Camargo*

14-16 Nov 2005 US Climate Change Science Program, Arlington, VA *A. Greene, A. Mishra, D. Osgood, N. Ward*

15 Nov 2005 Global Roundtable on Climate Change, Fall 2005 Conference, Technology and Economics: Moving Toward Solutions, Columbia University, New York, NY *S. Camargo*

26-30 Nov 2005 Project collaboration (UCLA) meetings, Los Angeles, CA *A. Robertson*

28 Nov-12 Dec 2005 COP-11, Montreal, Canada *H. Bhojwani, S. Connor, M. Helmuth, N. Ward, S. Zebiak*

1 Dec 2005 Climate knowledge for adaptation and sustainable development, COP-11 side event, Montreal, Canada *N. Ward*

4-10 Dec 2005 2005 AGU Fall Meeting, San Francisco, CA *B. Blumenthal, C. Brown, B. Lyon, S. Mosquera-Machado*

9-13 Dec 2005 CPC Meetings, Camp Springs, MD *C. Ropelewski*

13-14 Dec 2005 American Society of Tropical Medicine-RTI Symposium "Rolling Back Malaria in Eritrea - Success from a Comprehensive Program", Washington, DC *M. Thomson*

4-6 Jan, 2006 Global Risk Identification Program, Risk Sub-Programme Planning Workshop, Lamont Campus, Columbia University, Palisades, NY *S. Camargo, E. Grover-Kopec, S. Mosquera-Machado*

6 Jan 2006 U.S. CLIVAR Panel Co-chairs and NOAA Program Leaders Meeting, Silver Springs, MD *L. Goddard*

9-12 Jan 2006 2nd Climate Prediction and its Application to Society Workshop, Honolulu, HI *A. Robertson*

20 Jan 2006 Speaker for the Workshop on Climate Risk: Climate variability and change: Risks to farmers in Hudson Valley, NY, Acra, NY *B. Lyon*

26 Jan 2006 USAID meeting, Washington, DC *H. Bhojwani, J. Omumbo, S. Someshwar*

27 Jan-2 Feb 2006 AMS Annual Meeting, Atlanta, GA *C. Brown, B. Lyon, C. Ropelewski, M. Tippett, L. Zubair*

30 Jan-2 Feb 2006 Climate and Development in Africa: Gaps and Opportunities, A Panel Discussion, Columbia University, New York, NY and IRI, Palisades, NY *P. Ceccato, S. Connor, T. Dinku, E. Ebrahimian, J. Hansen, M. Hellmuth, P. Dibi Kangah, R. Lenton, J. Omumbo, D. Osgood, C. Ropelewski, M. Thomson, T. Wolde-Georgis, S. Zebiak*

31 Jan 2006 US CLIVAR Town Hall Meeting at AMS, Atlanta, GA *L. Goddard*

15 Feb 2006 Invited panelist on Policies of Climate Adaptation in Africa at the UK Embassy-sponsored symposium, Africa: Looking Back and Ahead - Addressing the 2005 Promise for a Better World, Howard University, Washington, DC *M. Thomson*

15 Feb 2006 Invited speaker: "Weather and Climate Science: How have they evolved?", Mysteries of Science seminar series, 92nd St. Y, New York, NY *C. Ropelewski*

16-17 Feb 2006 The American Association for the Advancement of Science Annual Meeting, St. Louis, MO *L. Goddard*

20-23 Feb 2006 Organizing committee, Knowledge Systems for Sustainable Development (KSSD) Project Meeting: "Linking Knowledge with Action in the Pursuit of Sustainable Water Resources Management", Phoenix, Arizona *L. Addams*

20-24 Feb 2006 2006 AGU Ocean Science Meeting, Honolulu, HI *D. Lee*

21-26 Feb 2006 Planning Meeting for the Latin America Regional Climate Center, Washington, DC *C. Ropelewski*

9-10 Mar 2006 Harvard China Project meeting, Cambridge, MA *C. Brown*

17-21 Mar 2006 The National Academies: Community Disaster Resilience - A Disasters Roundtable Workshop, Washington, DC *S. Mosquera-Machado*

21-24 Mar 2006 2006 NOAA Climate Prediction Applications Science Workshop: Research and Applications on Use and Impacts, Tucson, AZ *M. Bell, E. Grover-Kopec, C. Ropelewski, R. Taddei, L. Zubair*

25-27 Mar 2006 Tropical Cyclones and Climate Workshop, IRI, Palisades, NY *S. Camargo, , E. Grover-Kopec, J. Hansen, P. Dibi Kangah, U. Lall, A. Mishra, S. Mosquera-Machado, D. Osgood, C. Ropelewski, L. Sun, R. Taddei, M. Thomson, S. Trzaska, N. Ward, L. Zubair*

27-28 Mar 2006 CPC Climate Predictability Tool Training, Washington, DC *S. Mason*

6-9 Apr 2006 Annual Meeting of the Association for Asian Studies Meeting, San Francisco, CA *E. Ebrahimian, S. Someshwar*

6 Apr 2006 Columbia University "Public Health Impacts of Climate Change" course, guest lecturer, New York, NY *S. Camargo*

6 Apr 2006 Invited speaker: El Niño: Catastrophe or Opportunity. Cornell University - Dept. of Earth and Atmospheric Sciences, Ithaca, NY *L. Goddard*

11-12 Apr 2006 36th Biological Systems Simulation Conference, Fort Collins, CO *J. Hansen*

12 Apr 2006 Guest Lecture, Course: "Weather, Climate and Environment," Department of Geography, University of Connecticut, Storrs, CT *S. Camargo*

23-24 Apr 2006 DOE Climate Change Prediction Program Meeting, Cambridge, MA *A. Greene, A. Robertson*

23-25 Apr 2006 Ocean US IOOS DMAC Expert Team on Data Transport and Access meeting, Boulder, CO *B. Blumenthal*

24-28 Apr 2006 AMS Conference on Hurricanes and Tropical Meteorology, Monterey, CA *A. Giannini, S. Camargo*

26-27 Apr 2006 THORPEX Applications Meeting, Washington, DC *N. Ward*

4 May 2006 NOAA climate briefing to congressional staffers, Washington, DC *M. Thomson*

4-5 May 2006 U.S. Component of African Monsoon Multidisciplinary Analyses (AMMA), Silver Spring, MD *A. Giannini, S. Trzaska*

9 May 2006 COLA seminar speaker: Towards Prediction of the Full Probability Distribution of Seasonal Climate, Calverton, MD *L. Goddard*

9-12 May 2006 NOAA OCO Annual Systems Review Meeting (Climate Observing Systems Council member), Silver Spring, MD *L. Goddard*

9-11 May 2006 NASA Review Workshop, Baltimore, MD *P. Ceccato*

9-16 May 2006 Development of a river basin management model for World Bank Institute, Washington, DC *C. Brown*

15-24 May 2006 University of Georgia DSSAT v.4 Training Program, Griffin, GA *M. Carriquiry, A. Mishra*

North America, continued

23-26 May 2006 AGU Joint Assembly, Baltimore, MD *D. DeWitt, V. Moron, J. Qian, A. Robertson*

30 May 2006 CPC meeting, Camp Spring, MD *M. Bell, C. Ropelewski*

1-2 Jun 2006 Atlantic Decadal Predictability Workshop / Research agenda planning, Princeton, NJ *L. Goddard*

4-5 Jun 2006 Plumtree User Group East Coast Meeting, Framingham, MA *B. Baiden, J. Turmelle*

7-10 Jun 2006 Joint NOAA and South East Asia Center for Ocean Research and Monitoring workshop: Use of ocean observations to enhance sustainable development - Training and capacity building workshop for the Eastern Indian Ocean, Bali, Indonesia *A. Giannini, S. Someshwar, S. Zebiak*

9 Jun 2006 COLA seminar speaker: Climate downscaling: The value added using regional dynamical models, Calverton, MD *L. Sun*

19-21 Jun 2006 Fifth Global Organization for Earth System Science Portal Workshop, Livermore, CA *B. Blumenthal*

19-22 Jun 2006 Collaborative Technologies Conference, Boston, MA *B. Baiden*

20-22 Jun 2006 11th Annual Community Climate System Model Workshop, Breckenridge, CO *A. Greene*

7-10 Jul 2006 CPC Meeting, Silver Spring, MD *C. Ropelewski*

12-14 Jul 2006 Presentation of IRI applied activities on the use of remote sensing for human health to NASA Division on Earth and Life Studies project: "Observations and Research Results to Practical Affiliations: A review of NASA's approach", Washington, DC *P. Ceccato*

16-22 Jul 2006 NCAR Summer Colloquium on Climate and Health, lecturer: Introduction and Use of Remote Sensing to Predict Disease Outbreaks, with lab, Boulder, CO *P. Ceccato*

17-21 Jul 2006 NCAR ScicomP12 Conference, Boulder, CO *D. DeWitt*

20-22 Jul 2006 Transforming the Professoriate:Preparing Women for Careers in Science and Engineering, Blacksburg, VA *P. Dibi Kangah, S. Mosquera-Machado*

23-26 Jul 2006 2006 American Agricultural Economics Association Annual Meeting, Long Beach, CA *M. Carriquiry, D. Osgood*

24 Jul 2006 Guest Lecture, School of International and Public Affairs at Columbia University, Master of Public Policy and Administration in "Environmental Science and Policy", Palisades, NY *S. Camargo*

25-31 Jul 2006 Climate Change, Sustainable Development and Human Health, Snowmass, CO *S. Connor, M. Thomson*

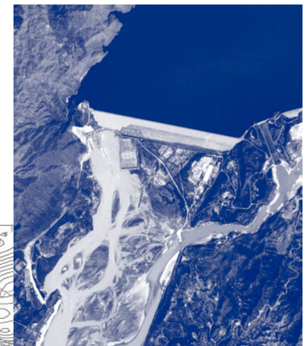
26-28 Jul 2006 U.S. CLIVAR Summit, Breckenridge, CO *L. Goddard, S. Mason*

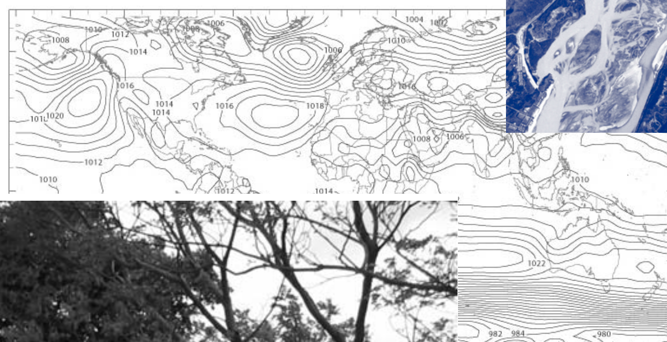
31 Jul-4 Aug 2006 International Geoscience and Remote Sensing Symposium - 27th Canadian Symposium on Remote Sensing, Denver, CO *P. Ceccato, T. Dinku*

13-16 Sep 2006 The National Academies: Strategic Advice on the U.S.Climate Change Science Program, La Jolla, CA *L. Goddard, C. Ropelewski*

18-20 Sep 2006 World Bank management training, Washington, DC *C. Brown*

21 Sep 2006 GISS-NASA meeting, Washington, DC *P. Ceccato*





A. Giannini (l); Image Science & Analysis Laboratory, NASA Johnson Space Center (ISS005-E-12804, http://eol.jsc.nasa.gov) (r)

Selected Publications

Peer-Reviewed Articles and Books

Alevs, J.M.B., J.N.B. Campos, F.D.A. D.S. Filho, D.F. Moncunnil, E.M.D. Silva, W.L. Barbosa, A.G. Ferreira, **L. Sun** and A.D. Moura, 2005. An evaluation of climate simulations from a regional spectral model nested in a global model (ECHAM4.5) over the north sector of northeast Brazil region (1971-2000). *Brazilian Society of Meteorology*, **20**, 191-206.

Barnston, A.G., A. Kumar, **L. Goddard** and M.P. Hoerling, 2005. Improving seasonal prediction practices through attribution of climate variability. *Bull. Amer. Meteor. Soc.*, **86**, 59-72.

Berri, G.J., Antico, P.L., and **Goddard, L.** 2005. Evaluation of the Climate Outlook Forum seasonal precipitation forecasts of Southeast South America during 1998-2002. *Int. J. Climatol.,* **25**, 365-377.

Biasutti, M. and **A. Giannini**, 2006. Robust Sahel drying in response to late 20th century forcings. *Geophys. Res. Lett.*, **33**, doi:10. 1029/2006GL026067

Brown, C. and **U. Lall**, 2006. Climate and Development: The role of variability and a framework for resilience. *Natural Resources Forum*, **30**, 4.

Brown, C. and P. Rogers, 2006. Effect of forecast-based pricing on irrigated agriculture: A simulation. *ASCE J. of Water Resources Planning and Management*, **136**, 6.

Brown, C., P. Rogers and **U. Lall**, 2006. Demand management of groundwater with monsoon forecasting. *Agricultural Systems*, **90**, 293-311.

Camargo, S.J., **A.G. Barnston** and **S.E. Zebiak**, 2005. A Statistical Assessment of Tropical Cyclone Activity in Atmospheric General Circulation Models. *Tellus A*, **57A**, 589-604.

Camargo, S.J. and **A.H. Sobel**, 2005. Western North Pacific Tropical Cyclone Intensity and ENSO. *J. Climate*, **18**, 2996–3006.

Ceccato, P., **S.J. Connor,** I. Jeanne and **M.C. Thomson**, 2005. Application of Geographical Information System and Remote Sensing Technologies for Assessing and Monitoring Malaria Risk. *Parassitologia*, **47**, 81-96.

Connor, S.J., 2005. Climate and environmental monitoring applications in epidemic early warning. In *Remote Sensing and the Control of Infectious Diseases: Proceedings of an Inter-American Workshop*. Ed. Confalonieri, U.E.C & Marinho, D.P. , ENSP/FIOCRUZ, Rio de Janeiro. 104 pp.

Connor, S.J. and **M.C. Thomson**, 2005. Epidemic malaria: preparing for the unexpected. *SciDevNet Dossier on Malaria. Policy Brief*, November 2005. 17 November 2005, http://www.scidev.net/dossiers/index .cfm?fuseaction=dossierItem&Dossier=23.

DaSilva J., B. Garanganga, V. Teveredzi, **S.M. Marx**, **S.J. Mason** and **S.J. Connor**, 2004. Improving Epidemic Malaria Planning, Preparedness and Response in Southern Africa. *Malaria Journal*, **3(37)**.

DeWitt, D.G., 2004. Diagnosis of the Tropical Atlantic near equatorial SST bias in a directly coupled atmosphere-ocean general circulation model. *Geophys. Res. Lett.*, **32**, L01703,doi:10.1029/ 2004GLO21707.

DeWitt, D.G., 2005. Retrospective forecasts of interannual sea surface temperature anomalies from 1982 to present using a directly coupled atmosphere-ocean general circulation model. *Mon. Wea. Rev.*, **133**, 2972-2995.

DeWitt, D.G. and E. K. Schneider, 2006. Diagnosing the Annual Cycle Modes in the Tropical Atlantic Ocean Using a Directly Coupled Atmosphere–Ocean *GCM*, **19**, 5319-5342.

Dinku, T. and E.N. Anagnostou, 2005. TRMM Calibration of SSM/I Algorithm for Overland Rainfall Estimation. *J. of Applied Meteorology and Climatology*, **45(6)**, 875–886.

Eichler, T., D. Rind and **S.E. Zebiak**, 2006. Impact of Global Warming on ENSO Variability Using the Coupled GISS GCM/ZC Model. *Intl. J. Climatology*, **26**, 1283-1314.

Giannini, A., R. Saravanan and P. Chang, 2005. Dynamics of the African monsoon in the NSIPP1 atmospheric model. *Climate Dynamics,* doi: 10.1007/s00382-005-0056-x Issue: Online First.

Graham, N.E. and **S.J. Mason**, 2005. A method for ensemble expansion and improved definition of forecast distributions from climate simulations. *Quarterly Journal of the Royal Meteorological Society*, **131**, 939-963.

Greene, A.M., **L. Goddard,** and **U. Lall.** 2006. Probabilistic multimodel regional temperature change projections. *J. Climate,* **19**: 4326-4343.

Grimm A M., A.K. Sahai and **C.F. Ropelewski**, 2006. Interdecadal Variations in AGCM Simulation Skills. *J. Climate*. **19**, 3406–3418.

J. Hansen

Grover-Kopec, E.K., **M.B. Blumenthal**, **P. Ceccato**, **T. Dinku**, **J.A. Omumbo** and **S.J. Connor**, 2006. Web-based climate information resources for malaria control in Africa. *Malaria Journal*, **5(38)**.

Grover-Kopec, E., M. Kawano, R.W. Klaver, **B. Blumenthal**, **P. Ceccato** and **S.J. Connor**, 2005. An online operational rainfall-monitoring resource for epidemic malaria early warning systems in Africa. *Malaria Journal*, **4**, 60.

Goddard, L. and M. Dilley. 2005. El Nino: Catastrophe or opportunity. *J. Climate,* **18**: 651-665.

Hansen, J.W., 2004. Can smallholder farmers benefit from seasonal climate forecasts? In *New Directions for a Diverse Planet: Proceedings for the 4th International Crop Science Congress, Brisbane, Australia, 26 September - 1 October 2004*. Eds. T. Fischer, N. Turner, J. Angus, L. McIntyre, M. Robertson, A. Borrell and D. Lloyd. The Regional Institute Ltd., Gosford, Australia (published online at http://www.cropscience.org.au/icsc2004/). (Refereed proceeding)

Hansen, J.W., 2005. Integrating seasonal climate prediction and agricultural models for insights into agricultural practice. *Philosophical Transactions of the Royal Society B*, **360**, 2037-2047.

Hansen, J.W. and **A.V.M. Ines**, 2005. Stochastic disaggregation of monthly rainfall data for crop simulation studies. *Agricultural and Forest Meteorology*, **131**, 233-246.

Hansen, J.W., A. Potgieter and **M.K. Tippett**, 2004. Using a general circulation model to forecast regional wheat yields in Northeast Australia. *Agricultural and Forest Meteorology*, **127**, 77-92.

Herceg, D., **A. Sobel**, **L. Sun** and **S.E. Zebiak**, 2006. The Big Brother Experiment and seasonal predictability in the NCEP Regional Spectral Model. *Climate Dynamics*, **27**, 69-82.

Honda, M., Y. Kushnir, H. Nakamura, S. Yamane and **S.E. Zebiak**, 2005. Formation, Mechanisms and Predictability of the Aleutian-Icelandic Low Seesaw in Ensemble AGCM Simulations. *J. Climate*, **18**, 1423-1434.

Huang, H., **A.W. Robertson** and Y. Kushnir, 2005. Atlantic SST gradient and the influence of ENSO. *Geophys. Res. Lett.*, **32**, L20706, doi:10.1029/2005GL023944.

Indeje, M., **M.N. Ward**, L.J. Ogallo, G. Davies, **M. Dilley** and A. Anyamba, 2006. Predictability of the Normalized Difference Vegetation Index in Kenya and Potential Applications as an Indicator of Rift Valley Fever Outbreaks in the Greater Horn of Africa. *J. Climate*. **19(9)**, 1673-1687.

Ines, A.V.M. and **J.W. Hansen**, 2006. Bias correction of daily GCM rainfall for crop simulation studies. *Agricultural and Forest Meteorology*, **138**, 44-53.

Ines, A.V.M. and K. Honda, 2005. On quantifying agricultural and water management practices from low spatial resolution RS data using genetic algorithms: A numerical study for mixed-pixel environment. *Advances in Water Resources*, **28(8)**, 856-870.

Ishikawa, T., **A. Barnston**, K. Kastens, P. Louchouarn and **C. Ropelewski**, 2005. Testing the Efficacy of Climate Forecast Maps as a Means of Communicating with Policy Makers. *Cartography and Geographic Information Science*, **32(1)**, 3-16.

Kravtsov, S., **A.W. Robertson** and M. Ghil, 2005. Bimodal Behavior in the Zonal Mean Flow of a Baroclinic Beta-Channel Model. *J. Atmos. Sci.*, **62**, 1746-1769.

Kumar, K.K., R.K. Kumar, R.G. Ashrit, N.R. Deshpande and **J.W. Hansen**, 2004. Climate Impacts on Indian Agriculture. *International Journal of Climatology*, **24**,1375-1393.

Lall, U., F.L. Hellweger, A.F. Blumberg, P. Schlosser, D.T. Ho, T. Caplow and H.H. Li, 2004. Transport in the Hudson estuary: A modeling study of estuarine circulation and tidal trapping. *Estuaries*, **27**, 527-538.

Landman, W. A., S. Botes, **L. Goddard**, and M. Shongwe. 2005. Assessing the predictability of extreme rainfall seasons over southern Africa. *Geophys. Res. Lett.*, **32**: L23819, doi:10.1029/2005GL023787

Landman, W.A., **A. Seth** and **S.J. Camargo**, 2005. The Effect of Regional Climate Model Domain Choice on the Simulation of Tropical Cyclone-like Vortices in the Southwestern Indian Ocean. *J. Climate,* **18**, 1263-1274.

Landman, W.A. and **L. Goddard**, 2005. Predicting southern African summer rainfall using a combination of MOS and perfect prognosis. *Geophys. Res. Lett.*, **32**, L15809, doi:10.1029/2005GL022910.

Levinson, D.H., ed, 2005. State of the Climate in 2004, *Bull. Amer. Meteor. Soc.*, **86(6)**, S1-S86. IRI authors: **M.A. Bell** (North Africa, West Africa, East Africa and the Greater Horn), **S.J. Camargo** (Western North Pacific typhoon season), and **E.K. Grover-Kopec** (Central America, Southwest Asia).

Peer-Reviewed Articles and Books, continued

Lyon, B., 2004. The strength of El Niño and the spatial extent of tropical drought. *Geophys. Res. Lett.*, **31**, L21204, doi:10 .1029/ 2004GL020901.

Lyon, B., 2006. Robustness of the influence of El Niño on the spatial extent of tropical drought. *Advances in Geosciences*, **6**, 207–209.

Lyon, B., and **A.G. Barnston**, 2005. The Evolution of the Weak "El Niño" of 2004-2005. *CLIVAR Variations*, Spring 2005, **3(2)**.

Lyon, B. and **A.G. Barnston**, 2005. ENSO and the Spatial Extent of Interannual Precipitation Extremes in Tropical Land Areas. *J.Climate*, **18**, 5095–5109.551–567.

Lyon, B., N. Christie-Blick and Y. Gluzberg, 2005. Water Shortages, Development, and Drought in Rockland County, NY. *Journal of the American Water Resources Association*, **41(6)**, 1457-1469.

Mann, M.E., **M. Cane**, **S.E. Zebiak** and A. Clement, 2005. Volcanic and Solar Forcing of the Tropical Pacific over the Past 1000 Years. *J. Climate*, **18**, 447–456.

Mosquera-Machado, S. and S. Ahmad, 2006. Flood hazard assessment of Atrato River in Colombia. *Water Resources Management*, 12 October 2006, doi: 10.1007/ s11269-006-9032-4.

Noor A.M., **J.A. Omumbo**, A.A. Amin, D. Zurovac D. and R.W. Snow, 2006. Wealth, mother's education and physical access as determinants of retail sector net use in rural Kenya. *Malaria Journal*, **5**, Article #5.

Omumbo J.A., S.I. Hay, R.W. Snow, A.J. Tatem and D.J. Rogers, 2005. Modeling malaria risk in East Africa at high-spatial resolution. *Tropical Medicine & International Health*, **10**, 557-566.

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Rauscher, S.A., A. Seth, **J.-H. Qian** and **S.J. Camargo**, 2006. Domain choice in an experimental nested modeling prediction system for South America. *Theor. Appl. Climatol.,* **86**, 229-246, DOI 10.1007/s00704-006-0206-z.

Robertson, A.W., S. Kirshner and P. Smyth, 2004. Downscaling of daily rainfall occurrence over Northeast Brazil using a Hidden Markov Model. *J. Climate*, **17**, 4407-4424.

Robertson, A.W., **U. Lall**, **S.E. Zebiak** and **L. Goddard**, 2004. Improved Combination of Multiple Atmospheric GCM Ensembles for Seasonal Prediction. *Monthly Weather Review*, **132**, 2732-2744.

Roel, A., **W.E. Baethgen** and F. Lago, 2005. El Niño effects on rice yields and prices in Uruguay. *ACA,* 41.

Savory, E.C., L.E. Cuevas, M.A. Yassin, C.A. Hart, A.M. Molesworth and **M.C. Thomson**, 2006. Evaluation of the meningitis epidemics risk model in Africa. *Epidemiology & Infection*, Feb 14, 1- 13.

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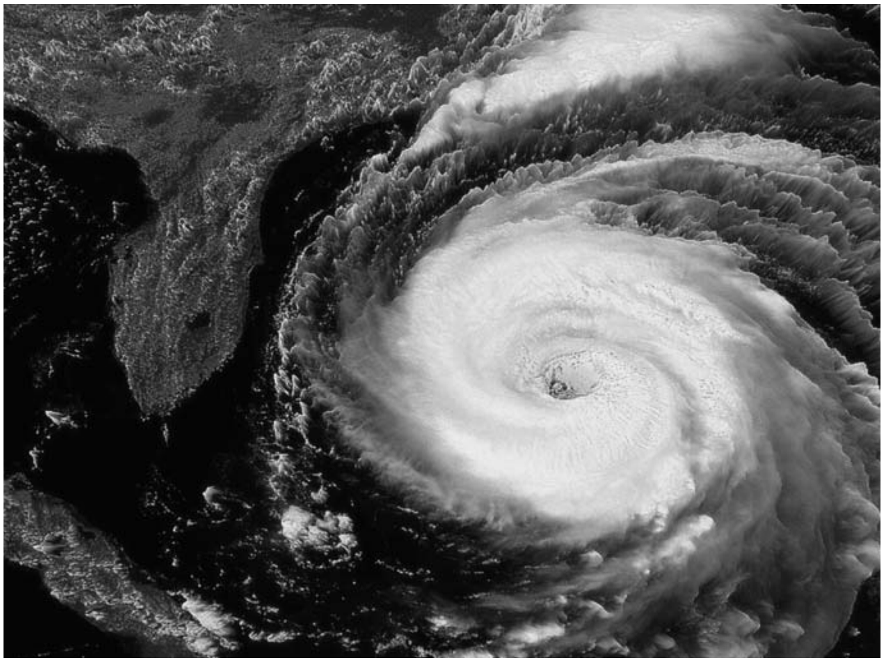

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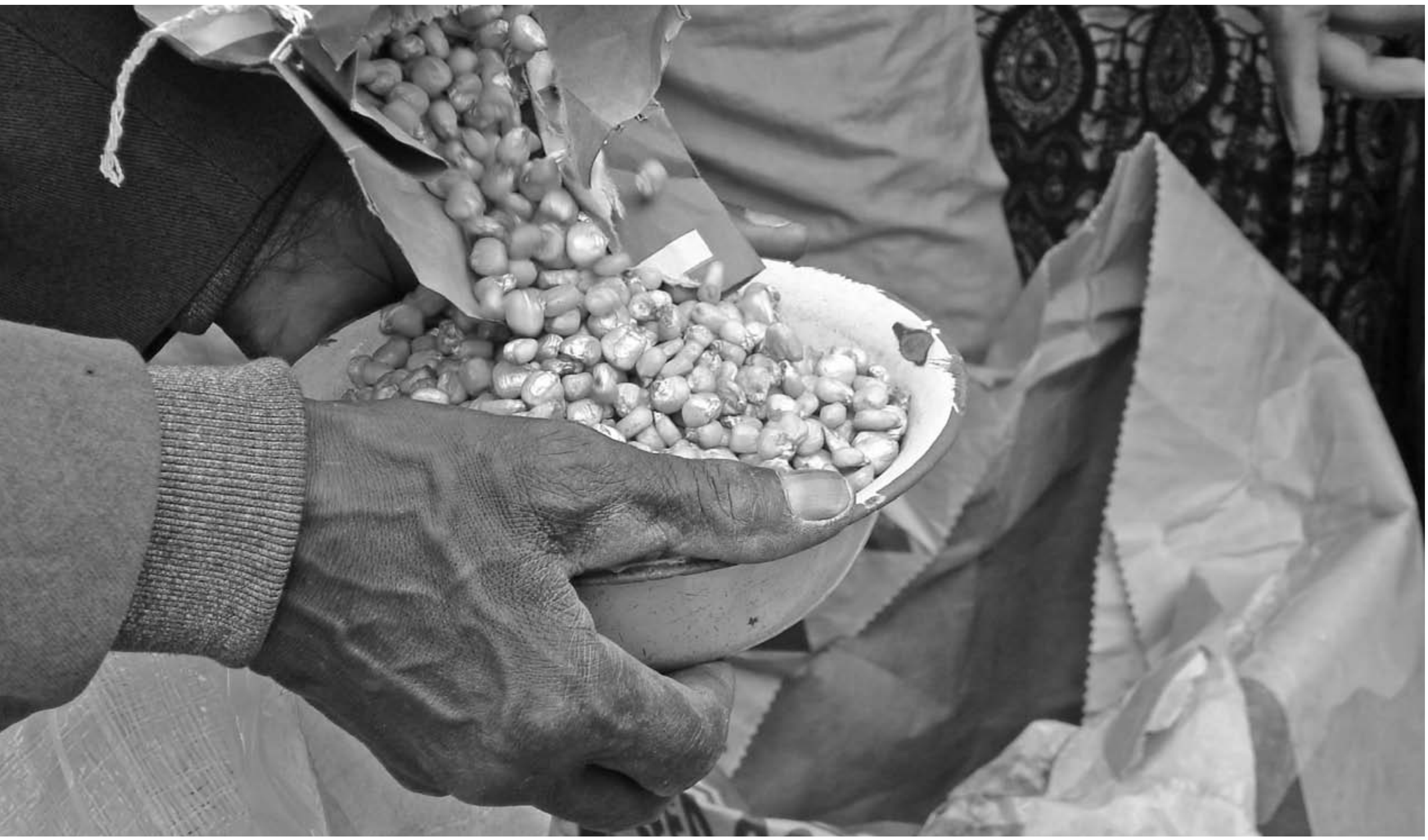
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Acronyms

ADPC	Asian Disaster Preparedness Center, Thailand
AGCM	Atmospheric General Circulation Model
AIACC	Adaptation and Impact Assessment to Climate Change
AU	African Union
BMG	Badan Meteorologi & Geofisika (Bureau of Meteorology and Geophysics), Indonesia
CARD	Center for Agricultural and Rural Development, Iowa State University, US
CARE	Cooperative for Assistance and Relief Everywhere, Switzerland
CLIVAR	Climate Variability and Predictability, UK
COF	Climate Outlook Forum
CPT	Climate Predictability Tool
CRED	Centre for Research on the Epidemiology of Disasters, Belgium
CRMG	Commodity Risk Management Group (World Bank)
CUCRED	Columbia University Center for Research on Environmental Decisions, US
CVA	Canonical Variate Analysis
DfID	Department for International Development, UK
DLIS	UN FAO Desert Locust Information Service
ECHAM	European Centre Hamburg Model
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária, Brazil
EM-DAT	Emergency Disasters Data Base
ENSO	El Niño Southern Oscillation
FAO	UN Food and Agriculture Organization
FUNCEME	Fundação Cearense de Meteorologia e Recursos Hídricos, Ceará, Brazil
GCM	General Circulation Model
GDP	Gross Domestic Product
GEA	Global Environment Action
GIS	Geographical Information Systems
GISS	Goddard Institute for Space Studies, Columbia University, US
GLM	Generalized Linear Model
GRAS	Unit of Agroclimatology and Information Systems, INIA
HADC	Hadley Center GCM
HMM	Hidden Markov Model
ICPAC	IGAD Climate Prediction and Applications Centre, Kenya
IFRC	International Federation of Red Cross and Red Crescent Societies
IGAD	Inter-Governmental Authority on Development, Djibouti
INIA	Instituto Nacional de Investigación Agropecuaria, Uruguay
INTA	El Instituto Nacional de Tecnología Agropecuaria, Argentina
IPCC	Intergovernmental Panel on Climate Change
IRI	The International Research Institute for Climate and Society
ISTAC	International Science and Technical Advisory Committee
KNN	K-Nearest Neighbor
LDEO	Lamont-Doherty Earth Observatory, Columbia University, US
MDG	Millennium Development Goals (UNDP)
MEWS	Malaria Early Warning Systems
MMI	NSF's Marine Metadata Interoperability Project
MOS	Model Output Statistics
MOU	Memorandum Of Understanding
MRFC	Malawi Rural Finance Company Limited
NASA	National Aeronautics and Space Administration, US

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NASFAM	National Smallholder Farmers' Association of Malawi
NCAR	National Center for Atmospheric Research, US
NCEP	NOAA NWS National Centers for Environmental Prediction, US
NHMM	Nonhomogeneous Hidden Markov Model
NMCP	National Malaria Control Program
NOAA	National Oceanic and Atmospheric Administration, US
NSF	National Science Foundation, US
NTT	Nusa Tenggara Timur
NWS	National Weather Service, US
ODA	Ocean Data Assimilation
OGCM	Oceanic General Circulation Model
OIBM	Opportunity International Bank of Malawi
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Service Administration
PAHO	Pan American Health Organization
RCOF	Regional Climate Outlook Forum
RPSS	Ranked Probability Skill Score
RSM	Regional Spectral Model
SAO	South Atlantic Ocean
SIO	Scripps Institution of Oceanography, US
SST	Sea-Surface Temperature
START	Global Change System for Analysis, Research and Training, US
SWEET	NASA's Semantic Web for Earth and Environmental Terminology Project
TOGA	Tropical Oceans and Global Atmosphere Program
UN	United Nations
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UN-HDI	United Nations Human Development Index
USAID	United States Agency for International Development, US
WHO	World Health Organization of the UN, Switzerland
WMO	World Meteorological Organization of the UN, Switzerland
WNP	Western North Pacific

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