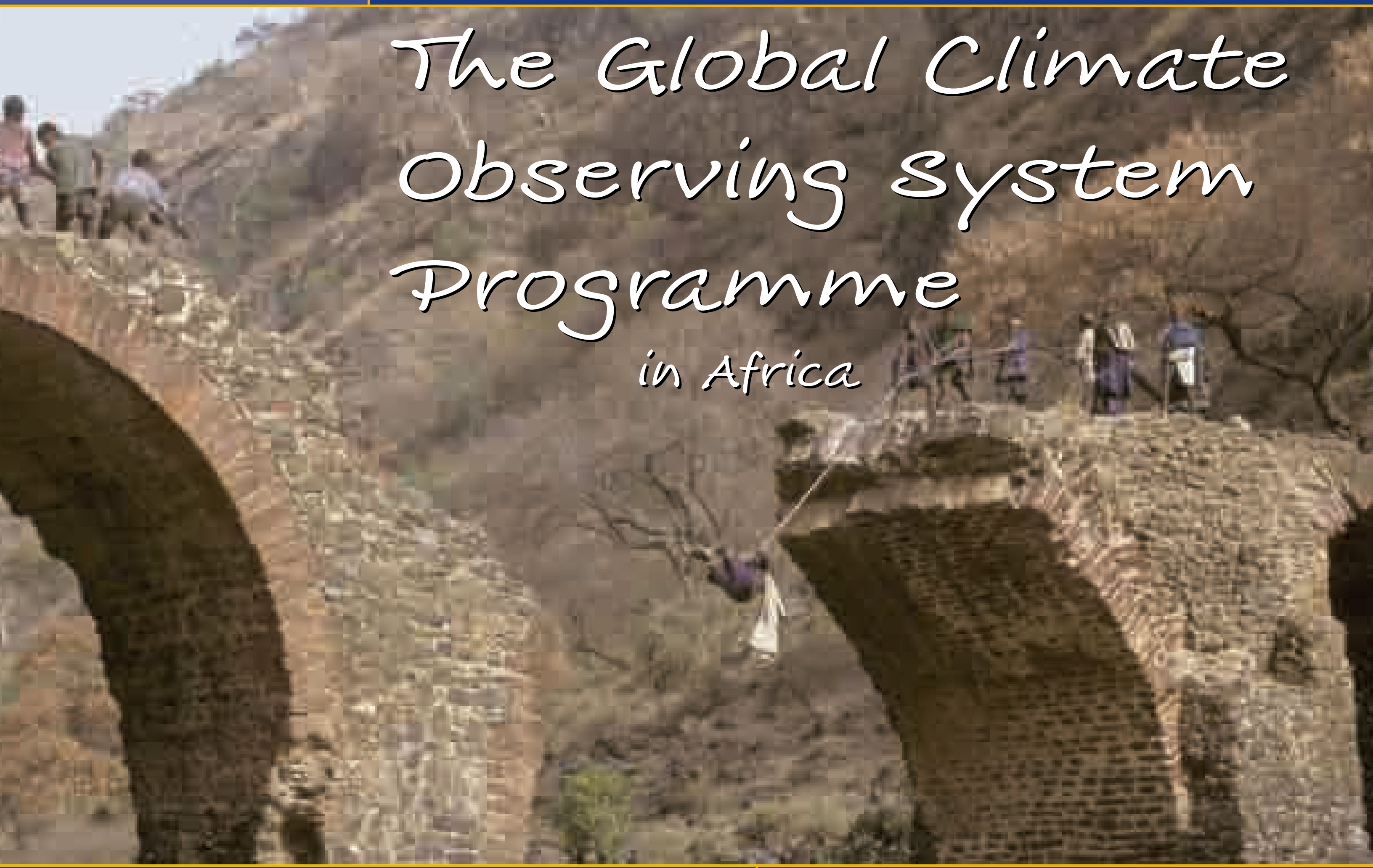
A GAP ANALYSIS
FOR THE IMPLEMENTATION OF

The Global Climate Observing System Programme in Africa



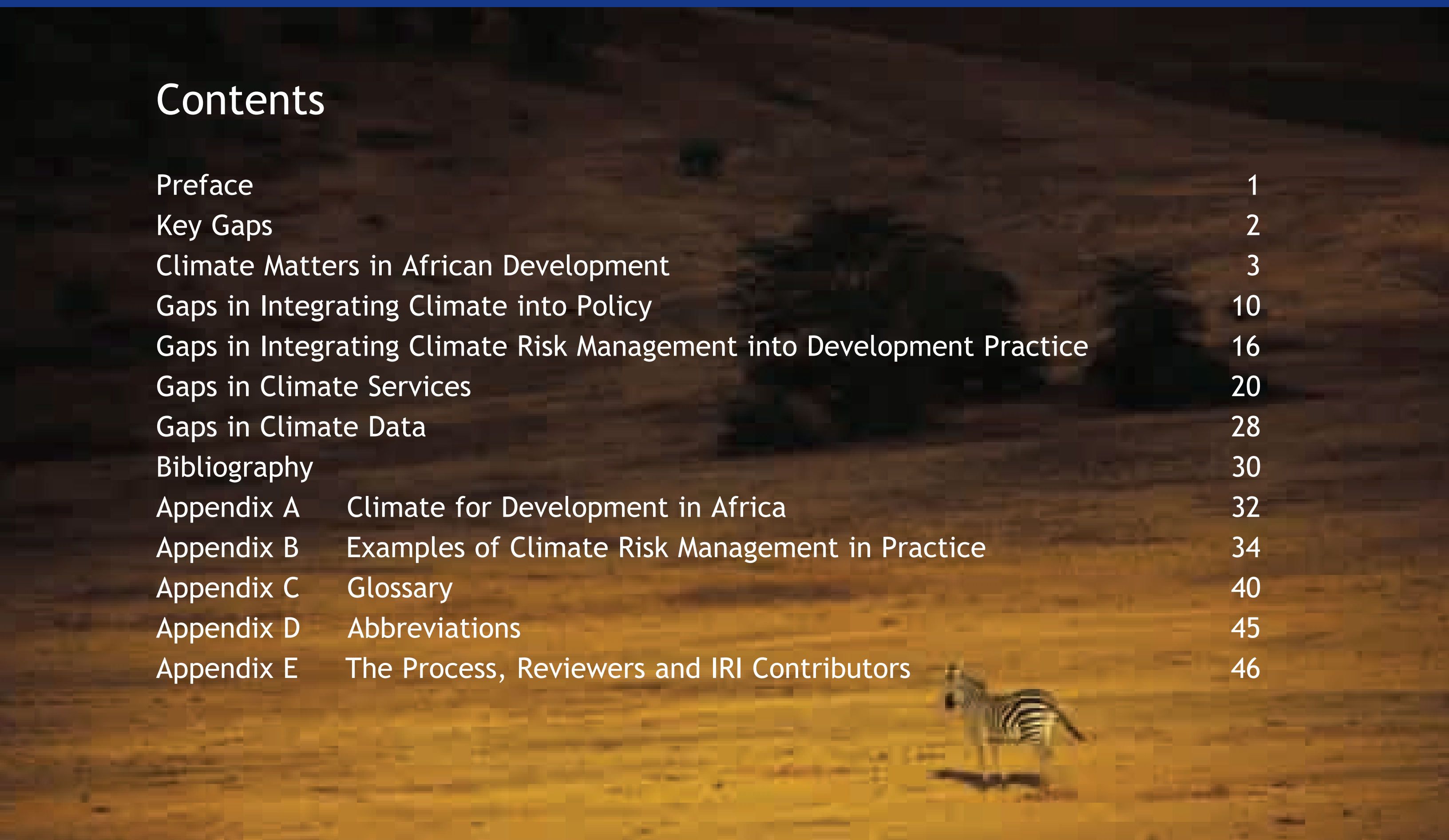
The International Research Institute for Climate and Society (IRI)

Global Climate Observing System (GCOS)

United Kingdom's Department for International Development (DfID)

UN Economic Commission for Africa (ECA)

COLUMBIA UNIVERSITY



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COVER IMAGE:
The Second Portuguese Bridge, Ethiopia

Bridges to Prosperity (B2P) is a volunteer-based charity that seeks to empower poor African, Asian, and South American rural communities through footbridge building, thereby advancing personal responsibility, community public works, economic prosperity, and access to schools, clinics, jobs, and markets. It was founded in 2001 by Ken Frantz with the repair of the Second Portuguese Bridge as its first project. For more on its footbridge building mission and outreach, visit B2P at www.bridgestoprosperity.org.

A Gap Analysis for the Implementation of the Global Climate Observing System Programme in Africa

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The International Research Institute for Climate and Society (IRI)

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For further information please contact:

Email: africa@iri.columbia.edu

Africa Program Coordinator
The International Research Institute for Climate and Society (IRI)
The Earth Institute at Columbia University, Lamont Campus
61 Route 9W, Monell Building
Palisades, NY 10964-8000 USA
Phone: 845-680-4468
http://iri.columbia.edu

To download this document, visit:
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PREFACE

This report is the main output from a Gap Analysis, financed by the United Kingdom's Department for International Development (DfID) as a major contribution to a Global Climate Observing System (GCOS) workshop to address climate and development issues in sub-Saharan Africa. The requirement is to assess key gaps in the use of climate information from the perspective of the decision-making community at household, community, district, national and regional levels, for a range of sectors, with particular emphasis on health, agriculture and water.

The report was prepared by a group of people with broad, deep and diverse experience with climate sensitive development problems, and with climate and development communities in Africa. It was strengthened by review by a larger community of development experts (Appendix E). An earlier draft of this report, along with GCOS Regional Action Plans (RAP) for Western and Central Africa and for Eastern and Southern Africa, formed the foundation for discussions at the April 2006 joint GCOS / UN Economic Commission for Africa (ECA) workshop, *Climate for Development in Africa* (Appendix A). The objective of the workshop was to initiate development of an implementation plan that makes development interests central to activities that address deficiencies in Africa's provision of climate information and services.

This report incorporates feedback from workshop discussion groups, as participants raised a number of important issues, cited a number of examples of development activities that already incorporate climate information, and proposed a number of actions to remedy the gaps, which are beyond the scope of this report. In response to the demand for more information on existing practices, the IRI, in consultation with ECA and the GCOS Secretariat (and with support from DfID), will prepare case studies of climate information services for development in Africa.

Workshop participants, representing a cross-section of African development institutions, political bodies and sectors; development partners; and the climate community, strongly endorsed the key findings of the Gap Analysis — that while important exceptions exist, poor incorporation of climate considerations in development:

- Are widespread from top to bottom (policy level to field operations);
- Are prevalent in all sectors — agriculture, food security, water, health, planning;
- Are similar across all regions (with a few fine exceptions that show the potential);
- Affects government, private sector and civil society partners similarly; and
- Has persisted for a long time.

In essence, the problem is one of “market” atrophy: negligible demand coupled with inadequate supply of climate services for development decisions. The workshop participants were in agreement on the value of better management of climate risk since:

- Climate variability lies behind much prevailing poverty and food insecurity;
- Climate variability must be managed vastly better to deliver the Millennium Development Goals (MDGs) in Africa; and
- Climate variability will continue (and may even increase) as a major obstacle to development under climate change.

A major, continent-wide effort to integrate climate risk management into climate-sensitive development processes (at all levels) is an urgent and top priority requirement for Africa today.

KEY GAPS

Gaps in integrating climate into policy...

... in perspective and communication between development and climate community

... in evidence of impact of climate variability (cv) and climate change (cc) on MDG-related outcomes

... in evidence of utility of climate information to reduce impact of negative (and enhance positive) impact of cv and cc

... in understanding of policy constraints

... in capacity to create evidence of role of climate in development for policy makers

Gaps in integrating climate into practice at scale...

... in guidelines for best practice

... in communication

... in institutional coordination

... in capacity - education

... in methods, tools

... in knowledge management

... in monitoring and evaluation

Gaps in climate services...

... in pro-poor services

... in hydrology and climate services

... in realizing the new role of climate services

... in integrating station and satellite data

... in capacity to tailor and communicate information to fit user needs

Gaps in climate data...

... in observations for local use

... in data coordination with user communities

... in observations for national planning - early warning

... in observation for regional planning - early warning

... in observations for global change

CLIMATE MATTERS IN AFRICAN DEVELOPMENT

Developing the economies and livelihoods of Africa remains the greatest development challenge for our increasingly globalized world (CFA, 2005). Through the time-bound (2000-2015) MDGs, the energies of all major development partners are focused on achieving measurable targets. While most of the world's less-developed regions are making significant progress towards these goals, sub-Saharan Africa is not (UN, 2005), principally because it has not been able to generate sustained economic growth of the type that now characterizes much of Asia. Indeed for much of Africa, the situation is actually getting worse.

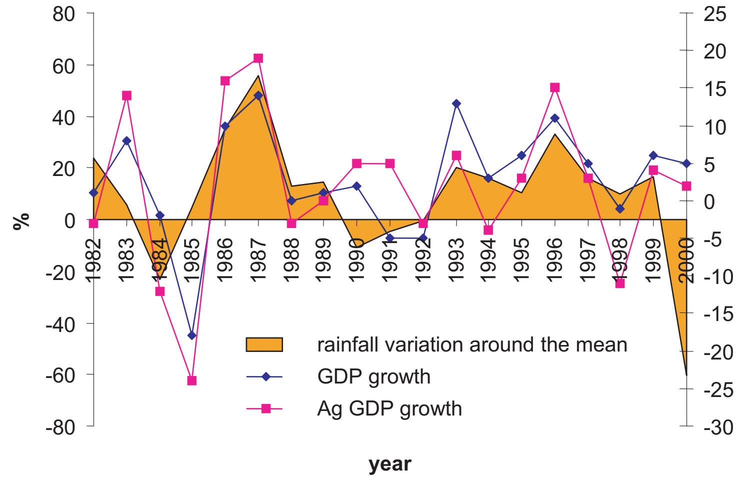
Sub-Saharan African economies are especially susceptible to climate due to their predominately agrarian structure. On average, 25% of GDP derives from agriculture, 70% of the work force is in the rural sector and, where there are no mineral resources, most of the exports originate in this sector. Population and land tenure pressures have led to reduced productivity, increasing the vulnerability of the predominantly rainfed agricultural systems to rainfall variations. Despite a trend toward urbanization, the majority of poverty remains in the rural areas, where households have limited assets to withstand climatic, disease or income shocks. The impact that climate variability can have on such agrarian economies is well reflected in the case of Ethiopia, where economic growth and food imports closely track variations in rainfall (Figure 1). The coping responses of insecure rural populations exacerbate the impacts of climatic shocks, such as drought and flooding, on the health and diversity of the ecosystems on which they depend.

In a year currently characterized by drought across much of the continent, nearly half the countries in sub-Saharan Africa require food relief. Food crises associated with climatic extremes erode assets and livelihoods, and divert scarce resources away from long-term development (Benson and Clay, 1998). Seasonal and chronic hunger still predominates across much of Africa, usually in the period before the harvest. Sub-Saharan Africa is the only region of the world where childhood malnutrition is actually increasing. Thus, an expanding proportion of households are vulnerable to food insecurity and, as a result, an increasing proportion of aid supporting agriculture is being allocated to food relief.

Political instability, periodic famines, the ravages of the AIDS pandemic and high rates of poverty mask the real progress that is being made in democratization, liberalization and good governance of African economies, and strengthening of civil society, as well as recent continental initiatives (AU/NEPAD, 2004; ECA/AU, 2005), such as NEPAD, designed to promote African ownership and direction of the development process (NEPAD, 2005).

Climate variability and change contribute to this development challenge. While economic development is the best means by which to build resilience, climate-informed policy and practice supported by climate information services and data may help to reduce the burden and contribute to the achievement of the MDGs (Table 2, pages 8-9) and sustainable development.

Figure 1. Relationship of overall GDP, Agricultural GDP and rainfall in Ethiopia (Grey and Sadoff, 2005).



*Because of the diversity of applications, **climate information** is intentionally a broad term that includes summary statistics of climatic variables (rainfall, temperature, wind, etc), historic time-series records, near-real-time monitoring, predictive information from daily weather to seasonal to interannual time scales, and climate change scenarios. It covers a range of spatial scales; and can include derived variables related to impacts, such as crop water satisfaction indices, epidemic disease hazard or streamflow.*

In addition to its impact on nutrition, climate impacts health through the spatial and temporal distribution of climate-sensitive infectious and parasitic diseases (WHO, 2004) — the primary cause of morbidity and mortality in the region (Murray et al, 2001), where many millions die annually from the combined effects of malnutrition and preventable disease (WHO, 2001). Poor health is both a driver and an outcome of poverty (Malaney et al, 2004).

The role of climate shocks in driving individuals below the poverty line is well established (Dercon, 2004). Several recent studies have pointed, in particular, to the importance of losses of livestock in explaining households' decline into poverty (Kristjanson, 2004). Epidemic livestock diseases, such as Rift Valley Fever, not only impact livestock production but also have a dramatic impact on the livestock trade in the Horn of Africa and the livelihoods of pastoralist communities (Yuill, 1991).

Without advanced warning, societal safety nets are costly, and cumbersome to mobilize and target effectively. Using climate information in support of integrated early warning systems would help improve health, food security and livelihood outcomes, to the extent that they are coupled with effective early response.

Water is a key driver of economic growth and poverty reduction, an essential input to almost all production — agriculture, industry, energy, transport — and a basic requirement for healthy people and ecosystems. It can also be a force for devastation through drought, *Figures 2-5. Distribution of childhood malnutrition (2), disasters (3) and epidemic disease outbreaks (4-5). Africa's semi-arid regions, which are characterized by highly variable rainfall, tend to coincide with these negative anti-development outcomes.*

Figure 2

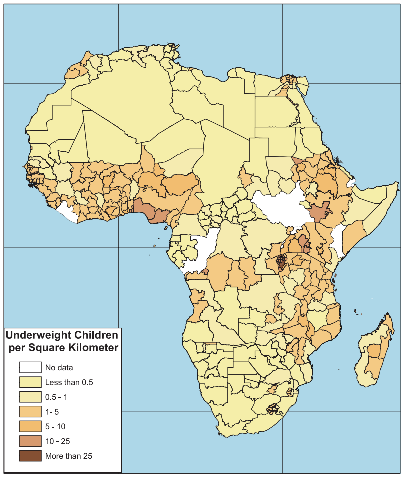


Figure 3

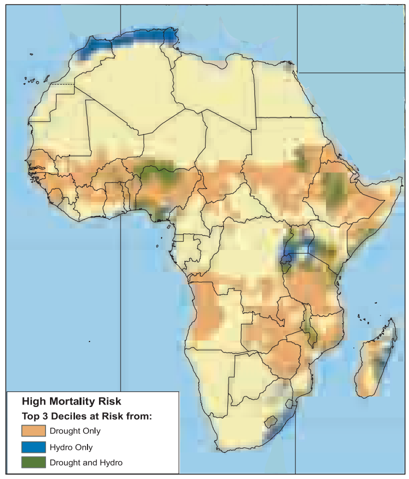


Figure 4

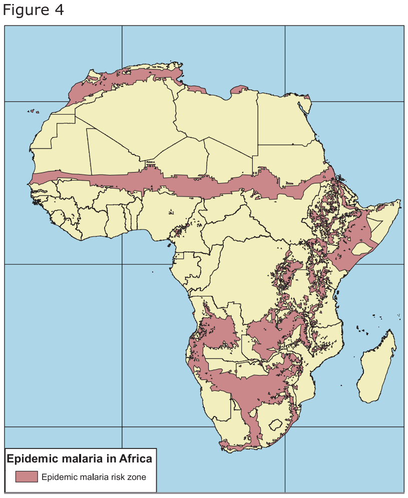
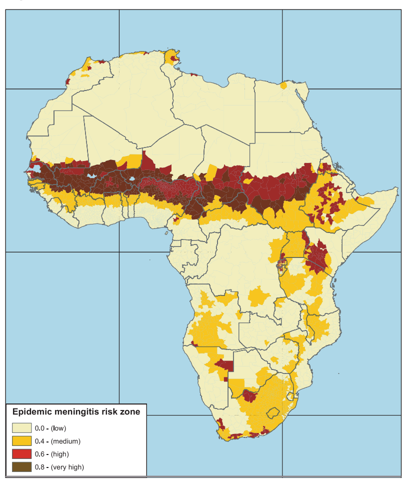


Figure 5



The semi-arid regions of Africa (Figures 2-5) are home to more than 140 million people. These populations experience high interannual and decadal climate variability and as a consequence are subject to multiple hazards including hunger, drought, malaria and meningitis epidemics and high disaster risk.

landslides and epidemics, and the object of regional conflict. Climate is a fundamental driver of the water cycle, helping to determine both availability and demand in the short- and long-term. Understanding current climate variability and future change is essential to infrastructure planning and the development of integrated water resource management systems.

Most development goals are predicated on sustainable management of the natural resource base (MDG 7). Climate shocks stress fragile natural resources (soils, water, biodiversity) that are often overexploited. The coping responses of insecure rural populations, whose livelihoods depend on primary production and hence the natural resource base, exacerbate the direct impacts of climatic shocks on ecosystems.

Direct impacts of climate variability and change on urban populations, including slum dwellers, include flooding from sea level rise; food, water, and public health insecurity; destroyed infrastructure; and loss of hydro-power. Secondary impacts can include economic losses due to industrial closures and reduced demand for goods and services, the decline in government tax receipts, and consequently, cuts in public sector funding for priorities such as infrastructure and public health. Finally, extensive rural-urban economic linkages mean that impacts in urban centers are also felt in rural areas and vice versa — with cyclical trek to the cities in drought years.

The African Union's *Africa Regional Strategy for Disaster Risk Reduction* (2004a) concluded, *"Hydro-meteorological hazards (drought, flood, windstorms, particularly tropical cyclones, landslides and wildfire), occur most pervasively and account for most of the people affected by disasters."*

Although less visible than extreme events, the indirect impact of climatic uncertainty is an equally serious impediment to development (Hansen et al., 2004). The inability to anticipate when climatic extremes will occur is a disincentive to investment, adoption of innovation and the success of other development interventions. Climatic uncertainty necessitates short planning horizons and risk

Table 1. The costs of flood and drought in Kenya as a result of the La Niña drought of 1998-2000 and the El Niño floods of 1997-98 are economy-wide and society-wide (The World Bank, 2004).

Kenya: The Impact of Flood and Drought		
1997-8 El Niño Flood Impacts	(millions)	%
Transport infrastructure	$777	88%
Water supply infrastructure	$45	5%
Health sector impacts	$56	6%
Total Flood Impacts	$878	
Flood Impacts as % of GDP 1997-8		11%
1998-2000 La Niña Drought Impacts	(millions)	%
Hydropower losses	$640	26%
Industrial production losses	$1,400	58%
Agricultural production losses	$240	10%
Livestock losses	$137	6%
Total Drought Impacts	$2,417	
Drought Impacts as % of GDP 1998-2000		16%

Climatic extremes, such as drought and flooding, take a direct toll on lives, health, livelihoods, assets and infrastructure (Table 1), while their unpredictability is an impediment to development even in years when climate conditions are favorable. In some areas, climatic uncertainty can, in part, be reduced through skillful seasonal climate forecasts, supporting investment options in favorable years.

management strategies that buffer against climatic extremes, often at the expense of inefficient resource use, reduced average productivity and profitability, and accelerated resource degradation.

Europe, the US, South Africa, Japan and Australia have mitigated many of the impacts of their variable climates through massive investment in infrastructure. While the need for Africa to invest intensively in physical infrastructure for transport, energy and water supply is widely recognized, it is not possible to achieve the level of resilience found in wealthy countries in the near term. Efforts to close the gap between what will be available and what is needed drives current efforts in climate science to provide new tools for reducing the impact of variability.

Climate variability has received less attention than other development issues, in part because it has been considered part of the environmental baseline that is not amenable to management. Yet there is growing recognition that better management of climate risk is both a crucial step toward achieving the MDGs and an opportunity to build some of the resilience needed to adapt to the uncertainties of a changing future climate.

"All countries need further access to information and to develop the scientific capacity that will allow their governments to integrate climate, environmental, health, economic and social factors into development planning and resilience strategies. We note that Africa's data deficiencies are greatest and warrant immediate attention" (G8 Gleneagles Plan of Action, 2005; see Figures 2-5). These deficiencies exist despite the phenomenal increase in availability of climate and environmental data from satellite remote sensing; and improvements in our understanding of, and ability to monitor and model the global climate system, which now provide a useful degree of predictability at a seasonal lead-time in some regions of Africa. The weaknesses of the ground-based (and upper air) observing systems contribute to these deficiencies (described in detail in Washington, et al., 2004). It is clear, however, that even if an invigorated climate observation network is developed and supported, the contribution of this investment to enhancing the achievement of the climate-sensitive MDGs (IRI, 2005) will be marginal if major gaps between the supply of data and their effective use for development are not addressed.

The remainder of this report considers some of these key gaps, and the innovative work and opportunities being undertaken and identified in Africa (from the farmer in her field to the policy maker at his desk) to bridge these gaps, for more effective integration of climate considerations in both the advancement of the MDGs in the short term and sustainable development on longer time frames.

Table 2. Relationship of the MDGs to the impact of climate variability, the role of interventions and the use of climate in planning.

Goal	Impacts of Climate Variability	Role of Climate Interventions	Outcomes: Climate Sensitive Development Planning
Goal 1: *Eradicate extreme poverty and hunger*	• Drought and flooding triggers acute hunger from loss of agricultural production. • Extreme climatic events cause loss of infrastructure and productive assets. • Climatic uncertainty is a disincentive to investment, intensification, technology adoption, fertilizer use, and high value agricultural enterprises. • Repeated disasters stagnate economic growth. • The poor are trapped in a downward, vicious cycle of increasing poverty and asset loss, because they never recover from climate shocks.	**Short-term risk reduction** • Climate-based food insecurity early warning increases lead-time, aids targeting of relief efforts. • Advance information can be used to manage grain stocks to stabilize prices and availability, and adjust supply of credit and production inputs to farmers. **Risk reduction in longer term planning** • Climate information (monitoring and prediction) empowers poor farmers to better manage risk, and to exploit opportunity in favorable years. • Climate information enables planners to better manage risk for improved agricultural productivity and economic growth, and climate proofing of infrastructure at design, construction and maintenance. Climate impact assessment helps understand relationships, decision points, and investment opportunities. • Climate information provides opportunity to spread risk through social insurance schemes that provide a safety net for the poor during climatic shocks. • Prediction of hydro-climatic extremes helps societies prepare and mitigate disasters, reducing losses in infrastructure and productive activities.	**Short-term risk reduction** • Local capacity built to respond rapidly to disaster, crisis and pre-crisis conditions. • Fewer public resources spent on disaster rehabilitation and relief and on reconstruction. More public resources available for positive development progress. **Risk reduction in longer term planning** • Small-holder agricultural practice is resilient to climate variability. • Stronger economic growth due to resilient irrigation, land use, cropping and trade policies. Generates macroeconomic and investment strategies that minimize recessive impacts. Development to be adaptive to changing climate conditions.
Goal 4: *Reduce child mortality*	• Poor sanitation from both water shortages and flooding contribute to morbidity and mortality from diarrhoeal diseases. • Malaria (whose endemicity and epidemicity are impacted by climate) during pregnancy is associated with lower birth weight, increased infant mortality.	• Climate monitoring and forecasts help identify high-risk areas prone to water contamination based on water shortages or flooding. • Climate forecasts can prompt malaria early warning, increasing lead-time for mobilization and distribution of resources to remote areas.	• Plan for water storage and delivery implementation, investment, design and maintenance. • Develop national and regional capacities to plan for, anticipate and react to epidemics. • Understand long term implications of climate change on disease distribution and socioeconomic vulnerability.

Goal	Impacts of Climate Variability	Role of Climate Interventions	Outcomes: Climate Sensitive Development Planning
Goal 5: *Improve maternal health*	• Climate variability impacts on food production and nutrition; affects pregnant women and the development of embryo and fetus. • Pregnant women are more likely to contract and die of malaria.	• Climate-based food insecurity early warning increases lead-time for organizing interventions. • Climate prediction provides advance information for activating relevant aid and raising awareness on the ground (e.g., maternal education programs).	• Develop resilience in food production, storage, and markets by taking into account comprehensive climate sensitive socioeconomic data. • Prioritize, design, and resource long term health, training and capacity building programs with awareness of climate sensitivity. • Develop understanding of dynamic health distribution, socioeconomic impacts, capacity and resource needs in the face of changing climate conditions. Develop understanding of climate impacts on health distribution.
Goal 6: *Combat HIV/ AIDS, malaria and other diseases*	• Climate variability influences endemicity and epidemicity of malaria and other infectious diseases transmitted by insects. • Climate variability impacts on food production and nutrition; affects susceptibility to HIV/AIDS, malaria, and other diseases. • People infected with HIV are more likely to develop AIDS and die of it if they contract malaria.	• Climate monitoring supports targeting high-risk areas. • Climate-based early warning increases lead-time of epidemic detection, prevention, and control of climate sensitive diseases, e.g., malaria early warning can facilitate activation of funds for preventive measures (ITNs and insecticides) and medicines and their distribution to remote areas.	• Combined understanding of climate history, climate impacts and affected socioeconomic factors to be used in prioritizing, designing, implementing and maintaining health care investments. • Develop and maintain communication and response networks that use the best applied climate information. • Develop understanding of dynamic health distribution, socioeconomic impacts, capacity and resource needs in the face of changing climate conditions. Develop understanding of climate impacts on health distribution.
Goal 7: *Ensure environmental sustainability*	• Climate variability constraints both quality and quantity of water supply. • Resource management regimes fail because they ignore the impact of climate variability, e.g. for water or pastures. • Resource degradation is blamed on people who are actually responding to climatic variations. • Floods overwhelm water and sanitation infrastructure, management and operations. • During heavy rains, slum dwellers are highly vulnerable to flooding impacts on lives, dwellings, and water quality.	• Water reservoirs can be managed more effectively for multiple purposes under both scarcity and surplus, using reliable climate forecasts. • Managing rangelands based on understanding of climate-human-livestock interactions enhances sustained productivity.	• Sustainable development initiatives to be informed by climate regime and resource allocation demands. • Long term sustainability and/or impact mitigation through adaptation to climate change policies, designs and applications. • Biodiversity conservation to take into account climate variability and change. • Climate information to enable design of sustainable resource management regimes that account for variability and climate-human interactions. • Improved designs of water infrastructure systems, using climate information, mitigate adverse environmental consequences of extreme climatic events.

GAPS IN INTEGRATING CLIMATE INTO POLICY

In order for climate information to serve the development agenda (since greenhouse gas emissions from Africa are negligible, there is little need at the moment for the African development agenda to serve the climate!) it is imperative that the development community lead the way.

The gap that exists between development stakeholders and the climate research community is understandable. It is the natural gap that occurs between disciplines, between theory and practice and between the more- and less-developed world. Filling such a gap requires vision, will (on behalf of both communities) and substantial investment of time and resources.

The recent OECD report on climate change and development, *Bridge Over Troubled Waters* (Agrawala, 2006), points out that *"the climate change and development communities are not monolithic blocks that can be linked by a simple handshake. Rather, mainstreaming (climate change into development) may require a meshing at multiple levels between the diverse range of actors and institutions connected with the two fields."*

Key Gaps

A significant gap in perspective exists between policy makers focused directly on growth and development (MDGs) in Africa and those focused on climate change issues.

Africa and Global Climate Change Politics

Given the pressing problems confronting African countries, the tendency is for governments and policy makers to focus on shorter-term policy interventions and problem solutions. It can probably be said that nowhere on the continent outside South Africa and northern Africa is climate systematically integrated into longer-term planning and investment decision-making.

Building Bridges

- *Develop a dialogue between development and climate community*
- *Link climate change adaptation to building resilience for MDGs*
- *Develop Integrated Climate Risk Management on all operational time-scales*

Until recently, many in the climate change community viewed adaptation to climate change as a "sell out" to the mitigation resistance policies of the US and other parties. It is only in the last few years that mitigation and adaptation have been seen as essential components of a global climate strategy. For example, several development agencies have begun to assess ways to "mainstream" climate into their development practices to ensure their sustainability. Achieving this in practice has proved to be a difficult challenge. The United Nations Framework Convention on Climate Change (UNFCCC)-driven National Adaptation Programs of Action (NAPAs) are one process designed to help identify and prioritize the adaptation needs of 49 of the world's least developed countries.

Africa has lost out in this process. The need for climate information to serve current development needs have been buried in the discussion about policies to deal with uncertain, scenario-based future impacts of climate change. The NAPAs housed in the Ministries of Environment have had difficulties engaging decision-makers from the other sectors, involving the Met Office or contemplating managing climate variability today as a strategy for managing climate change tomorrow.

Climate and National Planning

With the current attention placed on Africa and climate, the question remains — why do so few African nations consider climate issues and information routinely in economic planning? The effectiveness of planning depends on sound analysis of policy options, which depends on access to quality information. In order to initiate the routine integration of climate information into development activities, a critical first step is effective and compelling presentation of the data, analyses, and policy options to those who set priorities and allocate resources. In the absence of accurate and adequate data on climate and development outcomes, convincing models of climatic outcomes, and compelling analyses, development policy-makers are forced to concentrate on whatever available information is amenable to decision-making.

Decentralization of services and the need for indicators of progress towards the MDGs has provided new impetus for improved statistical services at the district and national level that can integrate the various data sources collected in a manner suitable for both local decisions and national policy.

Institutional Coordination

At present, there is the lack of effective institutional arrangements to facilitate the generation, analysis and systematic integration of relevant climate information with other pertinent information in a form that planning and operational agencies can use, which begs the question where such institutional capacity should reside. Should it be built within the institutions that serve development within specific sectors? In the regional climate centers or national meteorological offices? The universities? Or in national or regional boundary institutions, such as Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle (AGHRYMET) which serves to link agriculture, hydrology and meteorology in order to deliver specific services to the Comité Permanent Inter-Etats de Lutte Contre la Sécheresse dans le Sahel (CILSS) countries?

Key Gaps

There are gaps in evidence required for policy-makers:

- *with regard to the impact of climate variability and change on climate-sensitive MDG outcomes*
- *with regard to the utility of climate information in improving these outcomes.*

Key Gaps

There is a gap in our understanding of institutional, policy and technical constraints to the effective use of climate information.

Building Bridges

Commission relevant operational research on the impacts of climate, the utility of climate information in practical settings and the institutional, policy and technical constraints to effective uptake

To understand potential gaps, it is important to be aware that within different sectors there may be a very wide range of institutions working at different administrative scales that are generally poorly coordinated.

Key Gaps

There is a gap in capacity to create the necessary evidence for policy-makers and no clear institutional home where this capacity should be developed.

For example, Ministries of Agriculture generally comprise a number of relatively independent units all working on their own specific problems. Reform of agricultural institutions, decentralization of service delivery, and increased participation of civil society (e.g. farmer associations) and the private sector have led to a complex organizational environment. The resulting fragmentation does not lend itself easily to coherence in policy or to coordinated institutional approaches to assisting farmer risk management practices or responding to droughts, and makes it difficult, for example, to share capacity to analyze climate data or develop crosscutting approaches to support risk management. Engaging "boundary institutes" such as national research centers, universities and NGOs in the development of demand-led climate information may help to provide a more cohesive approach to delivering appropriate information services in this complex environment.

Building Bridges

Farmers associations have become a new, and in some areas, powerful co-ordinating force demanding improved climate services while representing the interests of their members and bringing order into a highly fragmented sector.

Conversely, many donor-supported climate-sensitive health programs (e.g., the African Programme for Onchocerciasis Control and the Roll Back Malaria initiatives, respectively) have a strong centralized structure involving a wide range of international and national players. At the district and community level however, it is the local health providers that must integrate the many demands of the different programs.

Timely climate-informed decisions are critically important for food security response, but analyses tend to be duplicated by multiple institutions. Evidence suggests that the importance of international organizations in determining policies and programs, and the constraints that these international and regional organizations work within, together impose constraints on national-level decision-making. Such considerations need to be carefully assessed so that climate and other information can be integrated effectively and used by all organizations together for planning a coherent early response.

The water sector is probably the most advanced in terms of incorporating climate into strategic planning, at least in the more water-scarce countries. This is because of the importance of this often scarce resource to wealth creation and quality of life, but also because of (a) the major dependence of water resources on climate variability, (b) the high cost and long timescale for building dams (for example) and (c) the extent of political support and awareness from Integrated Water Resource Management initiatives. Planning in water however can be more complicated by the need to consider transboundary watershed management, and the concomitant weaknesses of information services and decision-making at the regional scale. Coherent regional policies, an evolved approach to demand management, and unified information services on both climate and water demand trends are essential requirements for long-term regional water management.

Building Bridges

- *Manage better the knowledge we have and create new knowledge*
- *Support analytical capacity in African operational and research environments to integrate MDG indicators and climate variables in decision frameworks*

These institutional complexities mean that there is often a delay, confusion, and consequent lack of credibility in messages disseminated to communities with regard to changes in climate risk.

Awareness and Evidence

In principle, climate-informed policy, planning, investment and interventions result in more resilient, less vulnerable economies and societies, thus fostering sustainable development. In practice, achievement of this goal is also critically dependent on improved decision-making of numerous development stakeholders, including government planners, donors, line managers, extension workers, NGOs and farmers (Table 3). Thus, demand for climate information must come from their individual and collective awareness that managing climate variability can improve the return on development investments. However, this demand must be met by efficient supply of credible, timely and appropriate information in a form that supports the particular management problem, as well as improved capacity for utilizing such information effectively.

Use of climate information is one small, but under-exploited component of the suite of interventions targeting the MDGs. In theory, allocation of scarce resources among competing interventions is based on evidence of benefits relative to costs. Recent advances in, e.g., data management software, satellite remote sensing, climate modeling and climate risk management mean that some applications of climate information do not benefit from the body of evidence that more traditional development interventions have accumulated. On the other hand, climate information services potentially add value to other development interventions across a range of sectors.

Table 3. Opportunities for climate related development interventions. (= level of priority)*

Users	Examples	Strategic			Operational	
		Policy	Infrastructure	Research	Routine	Hazard
Planning Ministries	Planning, finance, policy analysts	****	****	***	****	
Line Ministries	Agriculture, water, energy, health, environment, education	***	***	***	***	***
Statistical Services for Development	National Statistics Office	***		***		
Emergency Preparedness & Response	IFRC, FEWSNET, WFP	**	**	**		****
Scientific & Engineering Community	Universities, research centres	****		****		
Local Communities	Households, communities	**	**	**	****	****
Civil Society	Farmers associations, women's groups	**	**	**	****	****
Technical Cooperation Agencies	CGIAR, IRD, GTZ	***		***	***	
Regional Transboundary Organizations	River basin authorities	****	****	***	****	****
Development Financial Agencies	Development banks, bilateral donors	****				
Energy	Hydroelectric authorities	**	****		***	
Private Sector	Agribusiness, tourism, construction, mining	**	**	*	***	****

In some sectors, such as health, research that quantifies the economic impacts of climate variability and change can improve strategic planning, provide justification to policy-makers for integrating climate into economic planning, and can be a first step in developing demand for climate information and services.

Policy gaps will not all be plugged by better evidence of either the impacts of climate on development or the value of climate information, although this would be a valuable starting point. Major policy initiatives, such as the World Bank Rural Development Strategy, the national Poverty Reduction Strategy Papers (PRSPs) and specific sectoral policies, may hinder the demand and effective utilization of climate information for development as they are orchestrated around assumptions of climatology rather than year-to-year variability and long-term change.

Lack of a strategic lead from the center will be reflected in similarly weak sectoral planning and policies. There is need to assist this process both centrally and sectorally, through raising the awareness of, e.g., development advisers, and augmenting their ability to respond efficiently by means of appropriate training and support. This will facilitate integration of NAPAs into PRSPs, as well as short-term policy and planning convergence based on integrated climate risk management for coping with climate variability today and for much of climate change tomorrow.

There are several ways through which national policy frameworks could be created to help overcome the routine competition between ministries. For instance governments can formulate policies that create incentives for any type of intersectoral collaboration that benefits the national good over and above strict sectoral division. It is essential that such policies emanate from the highest policy-making level, such as the Prime Minister's office and have the active support of the Ministry of Finance (along with appropriate allocations of funds for the intersectoral actions proposed). Experience shows that policies with budget appropriations attached have a greater chance to overcome the routine competition between sectors.

GAPS IN INTEGRATING CLIMATE RISK MANAGEMENT INTO DEVELOPMENT PRACTICE

While there are barriers to the effective uptake of climate information in development practice in Africa today, the story is not all doom and gloom. The creation of policy-relevant evidence of the utility of using climate information in practical settings in Africa is increasing; and examples of current activities are presented in Appendix B. Examples of innovations in communication, and effective engagement of the Met Offices with national development partners highlights opportunities for effective investment in climate information for development. However, current level of activity is woefully inadequate in view of the scale of the development challenge.

Key Gaps

There is no clear guidance on best practice for climate risk management.

Capacity Building for Development Stakeholders

Development and resource management professionals frequently lack understanding of what can be done with climate information. The result is lack of demand for climate services, failure to integrate climate information into development practice, and inadequate resource mobilization.

Building Bridges

Developing countries have limited resources, so it is particularly important to invest in reducing climate related risk through practices that work. This could be supported by the production of effective risk management guidelines.

A concerted capacity-building program is required to enable decision-makers at all levels to incorporate climate risk management into the development process. This should include:

- Awareness campaigns on climate-related issues in development, such that the public may act as informed consumers and demand climate services that meet their needs;
- Identification of climate services required to improve climate risk management for the range of stakeholders, specifically targeting poor and vulnerable communities;
- Use of communication networks, media, extension services, farm schools, internet and research-for-development journals to communicate credible climate information tools and practices;
- Training of technical sectoral specialists, and cross-cutting specialists such as economists and statisticians involved in assessment of development outcomes, in the use of climate and information for decision-making; and
- Curriculum development, at all levels of education, to service the broad uses of climate information.

Supporting "Best Practice"

One identified gap is the need to ensure professional standards in climate risk management. Guidelines could address issues such as:

- Developing demand-led climate science, methods, tools and products;
- Communicating climate risk to rural communities;
- Assessing quality of climate information products relative to user requirements;
- Monitoring and evaluating progress towards improved climate risk management;
- Assessing the value of climate information for particular development outcomes.

There is extensive experience in climate risk management to draw on globally (e.g., Australia, the Regional Integrated Sciences and Assessments (RISAs) in the US). One clear message from the GCOS *Climate for Development* workshop was a need to identify, learn from and replicate successful activities. While participants called for efforts to identify elements of "best practice" and proposed several examples within Africa, they also recognized that practices must be adapted to the peculiarities of climate-sensitive problems and their institutional and policy context within each country (Birner et al, 2005).

Although some successful approaches and lessons have been published, much of the resulting knowledge exists within institutions in forms that cannot be shared readily in the absence of a concerted effort. A "knowledge systems" approach provides methodology for organizing and sharing approaches and experiences among institutions for rapid and effective uptake.

Experience indicates that effective knowledge-action systems: (a) define and frame the problem to be addressed via collaboration between knowledge users and knowledge producers; (b) tend to be end-to-end systems that link user needs to basic scientific findings and observations; (c) are often anchored in "boundary organizations" that act as intermediaries between nodes in the system — most notably between scientists and decision-makers; (d) feature flexible processes and institutions to be responsive to what is learned; (e) use funding strategies tailored to the dual public/private character of such systems; and (f) require people who can work across disciplines, issue areas, and the knowledge action interface (Cash and Buizer, 2004).

Key Gaps

Communication pathways should enable feedback between users and information providers, as well as serve multi-purpose needs.

Building Bridges

Information must be communicated appropriately for it to be considered at all by potential users. It is essential that users (e.g., farmers) must be provided with timely credible messages that permit them to integrate climate into risk management decisions that they make routinely.

Key Gaps

Gaps in institutional coordination, capacity and education, methods tools, knowledge management and monitoring and evaluation need to be addressed.

A continental-scale knowledge systems initiative should develop and sustain capacity through programs that evolve best practices and share experiences and methods as widely as possible. Accounts of successful integration of climate into risk management strategies need to be conveyed with reliable information on the current state of the climate, and future prospects. Reference web sites will be required together with comprehensive sets of e-learning course modules, and research, development and policy toolboxes for building an Africa-wide knowledge base sufficient for all requirements. Sharing of experience-based knowledge must continue to be underpinned by relevant research at universities, national and international research centers, and national and regional climate centers.

Building Bridges

- *A comprehensive program of activity focused on multiple climate-related risk (water, health, agriculture etc) to provide practical demonstration of climate risk management in mainstream development initiatives—targeting climate-sensitive MDGs*
- *Scaling up of best practice to meet MDG challenge.*

Reaching Community-Level Stakeholders

Rural communities that depend on farming and other primary production activities are the ultimate stewards of much of the natural resource base and the segment of society that is most affected by climate. Integrating climate information into the risk management strategies of communities with climate-sensitive livelihoods depends on effective use of communication infrastructure and networks to support dialogue with users, to facilitate awareness and education campaigns, and to receive feedback so that users can help shape the services they receive.

The communication environment is improving rapidly in most urban areas in Africa. Five years ago, only a handful of countries had local internet access or mobile telephones. Now services are available in virtually every major city, but many countries focus only on high-income, population-dense corridors, and fail to reach rural populations and critical catchment areas where climate information is crucial.

Community radio systems offer immense potential to support climate information services and a range of other information needs across multiple sectors. Radio can broadcast during the hours most appropriate for sub-user groups (e.g., women's listening groups) and provides opportunity for local ownership and voice. Community access to complementary national, regional and global information and knowledge — fostered through the most appropriate Information and Communication Technology (ICT) and satellite communication platforms — is of considerable extra benefit. Traditional radio, TV and print media, which often disseminate information in local languages, can also be effective.

It is important to recognize that ICT alone is rarely the best solution, but should complement existing institutional communication networks. Where government extension services or their alternatives (e.g., agricultural development NGOs, agribusiness) are functioning, the resulting human interaction can build trust; communicate quantitative, location-specific information; foster mutual learning and provide feedback to information and service providers in a manner that is difficult with ICT alone.

Key Gaps

The most significant communication gap is with rural communities.

Communication systems (institutional and ICT-based) that enable access and use of climate, weather and water services are an essential investment in development, even though initial demand may be low. Availability of useful information increases the demand for information. Expanding equitable communication channels is a long-term development commitment, requiring years of investment, but one that can address multiple development objectives.

Building Bridges

Communications at the local level can be used to serve multiple objectives and so the climate community must partner with development agencies.

A "business-as-usual" approach, with a scattering of well-intended workshops, will not be sufficient. Delivering the MDGs and adapting to climate change require truly exceptional measures. A capacity building program of this importance requires a strong lead from a major development organization with sustained technical support from UN organizations including World Meteorological Organization (WMO), whose support for the process would be indicated by rebalancing their aptly named World Climate Program towards Least developed country (LDC) development needs. Careful planning of this program with a range of development partners is essential.

GAPS IN CLIMATE SERVICES

Key Gaps

The key gap identified is that in too many countries, the Met Office is insufficiently engaged with the national development agenda and that services for rural poor populations are negligible.

In principle, it is the responsibility of the National Met Offices to make the appropriate observations, process data to produce the information required by decision-makers, and make sure that the decision-makers have sufficient advice or knowledge to make use of the information as easily as possible.

Data Policy

In practice, constraints associated with mandates, priorities and capacities of Met Offices mean that potential users often either create their own climate information or get by without it. (Note the thousands of farmers across Africa who run their own volunteer weather stations, which may or may not be affiliated with the national system.)

Key Gaps

There is a gap between what is currently provided (24-hour weather forecasting) and what is needed for achieving the MDGs (climate and hydrology services).

Reasons for the difficulties in obtaining climate information from the Met Offices vary. Often it is "against policy to disseminate data freely," for reasons that include a strong push by donors for privatization and institutional cost recovery, inadequate resourcing due to low prioritization in national budgets, and a non-service culture where data restrictions are perceived as a means of securing economic value. While the factors that have led to restrictive data policies may be understandable, the consequences for development have been disastrous.

A resource can be considered a public good if it is non-rival — meaning that use does not diminish its availability to others — and non-excludable — meaning that one group does not prevent others from accessing it. Climate data clearly meet the first criterion of a public good; increasing access increases value, and at little additional cost. Regarding the second criterion, data access policy determines whether climate data are, in fact, a public good available to advance a country's collective development objectives, or a private good that provides income to the Met Office and utility to those commercial enterprises that have the resources to pay and capacity to use them.

Balance of Information Services

Weather forecasting (24-hour to a few days) is the mainstay of the National Met Offices in sub-Saharan Africa, and is important to a range of stakeholders such as air and marine transport, commercial agriculture and the general public in areas prone to cyclones. Information such as historic variability, real-time monitoring and seasonal forecasting, has more value than weather forecasting for management of infectious diseases and food crises, and more generally for economic and social development in rural Africa, where the majority eke out livelihoods from smallholder agriculture or pastoralism in an environment where the climate determines their basic survival. It is these services that need to be dramatically strengthened if the Met Offices are to serve this population effectively.

Although countries are encouraged to maintain their observation networks to high standards, technological developments (especially satellites and numerical modeling) are changing the field. A gap has developed in terms of costs and perceived benefits from station observations. In return for supplying their observational data for use in global (Numerical Weather Prediction) models, Met Offices in Africa receive model outputs from which they can produce much better weather forecasts than they could by themselves. All parties benefit from this global partnership, though not equally since (as noted above) short-term weather forecasts are of relatively little benefit to the poor in these countries, who appear to have limited options for responding to short-term weather forecasts.

Aligning National Met Offices as Service Providers

Met Offices have so much potential to offer decision-makers and the development agenda, besides their current contribution to public security through weather forecasting. For instance they could:

- Provide an enhanced range of useful climate risk management services;
- Assist with delivery of the MDGs and adaptation to climate change;
- Contribute useful services for integrated water resource management;
- Assist with hazard early warning and disaster risk reduction; and
- Contribute productively to real-time environment monitoring.

Thus, a major challenge for the broad stakeholder community is to assist the national Met Offices to engage their considerable talents in assisting with delivery of national development targets and achieving the MDGs. Without this fundamental reorientation, the gulf between service (potential) user and service provider will remain.

Building Bridges

- *Focus on national development objectives which serve the poor*
- *Strengthen climate and water services, early warning, environmental monitoring and analysis of future trends — next 10 - 20 years.*

Many Met Offices in Africa have daily access to vast amounts of high-quality information from the global network. This includes top quality forecasts, satellite observations every 20 minutes, and a multitude of ancillary information that is steadily increasing in abundance. However, there is much to be done before this technical capacity translates into services that meet the needs of development; it is often coupled with poor organizational structure, weak management skills, limited vision and lack of abilities to communicate effectively with rural and other user communities. Aligning climate services to the needs of development requires strong leadership and a partnership approach among national and regional institutions and the international climate community.

Key Gaps

Few National Met offices in the LDCs have realized that their prime function has moved away from "creating information" towards providing services, and especially to meet development needs.

Met Offices, when working effectively, are multi-sectoral information service providers, and as such, they have no obvious home within government line Ministries. Their mandates and influence are often constrained by their position within, for example, ministries of transport or environment or the military. In some countries, weather services are part of the hydro-meteorological services, giving them a strongly applied perspective. Consideration should be given to try strengthening this kind of model in African countries, i.e. emphasizing new needs in (a) hydrology, (b) early warning, (c) environmental monitoring and (d) future trends.

Key Gaps

Lack of knowledge and understanding of "user needs" and how development decisions are made, so there is little capacity to tailor information appropriately.

One way forward would be to create a Development Unit in the Met Office, whose main responsibilities are to gear the resources of the services towards contributing to the national development agenda, and to coordinate the Met Office's contribution to national development. The Development Unit could:

- Represent the Met Office on national, regional issues regarding climate and development;
- Identify research areas relevant to the country's development agenda in general, and to particular sectors and communities;
- Evaluate the Met Office's own resources so that it has clear understanding of what the institution can and cannot deliver;
- Assess the value of its organization to the national economy; and
- Take steps to foster demand for climate information by actively identifying, engaging and raising the awareness of potential users; and to supply climate information services that respond to this new demand.

Regional and Sub-Regional Integration

Considering the generic nature of weather and climate services, and the global or regional scale of much climate modeling work, there is considerable scope for regional integration and developing complementarity in services, especially where small countries exist in close proximity to larger ones. Early attempts at regionalization provided little more than poor-quality duplication of the national Met Offices.

Key Gaps

Met Offices will have to change focus to become full players in the challenge to reduce poverty, build sustainable development and help their own societies manage the impacts of climate variability and change. In addition, they have to adapt to the changes that have occurred over the years in the technologies that underpin climate products.

Much might be achieved cost-effectively by adopting a version of the European Satellite Application Facility model, where stronger services take on regional roles, as Kenya has with the Institute for Meteorological Training and Research (IMTR) and Inter-Governmental Authority on Development (IGAD) Climate Prediction and Application Center (ICPAC). AGRHYMET has worked towards providing multi-technical capacity and is growing from a CILSS to an Economic Community Of West African States (ECOWAS) organization.

However, to be effective such regional centers need (a) a wider range of development partners, (b) stronger direction towards regional development through the Regional Economic Communities (RECs) and financing partners, and most importantly, (c) greater appreciation of a demand-led process.

Building the Capacity of Climate Services

There is an urgent need to develop climate services that are commensurate with the particular needs of development stakeholders, and scale of action required to meet the development challenge. Capacity building to meet this demand should include:

- Awareness raising, within the national Met Offices and broader climate community, of the MDGs, national development priorities, roles of PRSPs and NAPAs, and rural community information needs;
- Management training in the participatory process of developing a strategic plan and evolving the service to meet the needs of development partner priorities as an effective 21st century "environmental information service provider";
- Training in communication, working with development partners and the media, to bring climate information to where it is needed;

- Technical training to decentralize services, to enable widespread best practice, and to collect and process the data needed to deliver the information services required by local development stakeholders; and
- Training in resource mobilization and management of interdisciplinary projects for development in order to obtain more resources and extend their reach.

Key Gaps

Decision-making timescales of 2-10 (MDG) or up to 30 years are strategic for policy and infrastructure planning. There is a lack of available climate information or climate research at these scales.

Progress is currently being made in a number of cases by means of short-term training for effective decentralization of service delivery, data management and information service delivery. Short-term professional training should be upscaled, and strongly oriented toward a clearly defined development strategy that recognizes the importance of climatic information to development services.

Trained staff in rural locations is a key element of the development strategy, along with enlightened leadership and a committed central team. There is also urgent need for training observers and data analysts who handle the volunteer networks. They are, at one and the same time, both providers and users of climatic information.

Climate Information for Development

In the past few decades, several things have changed the landscape of climate information products, including the realizations that: (a) the base state of the climate system is changing; (b) climate variability is, to some extent, predictable, and (c) remote sensing systems can provide valuable climate information. Accompanying these developments has been an increasing awareness of the value of this new information. Thus, climate services may now include all aspects of climate, from observations and forecasts to application of this information.

Complete Archives of Daily Observations

Complete, quality-controlled archives of historic daily observations are central to many development applications. They provide the basis for understanding trends, deriving climate statistics of interest, and placing current observations into historical context. Agricultural planning and engineering (e.g., solar energy, bridge, dam, coastal protection) design rely on climatologies derived from historic observations. Climatic time series are particularly important for water resource management. Levees, dams, and reservoirs are often engineered on the basis of inadequately short records of flood levels, with dramatic examples of inadequate flood or drought protection.

Historic data are the basis for downscaling and calibrating forecast products, and calibration of satellite data. Food aid and insurance applications use historic observations with statistical or simulation models to quantify agricultural production risk. Historic observations are essential for evidence creation when used in detailed analysis of climate and specific societal outcomes, and are key to the creation of products based on an understanding of such relationships such as weather insurance.

Near-Real-Time Observations for Operational Management and EWS

Near-real-time climate observations serve as a useful proxy for climate-sensitive variables, such as soil moisture and habitat for disease vectors, which can be more difficult to measure. Crop and forage production, disease vector populations, and risk of flooding and landslides are all sensitive to the recent history of rainfall. Operational systems for forecasting these impacts for management or early warning derive at least some of their predictability from near-real-time observations.

Since information may be required before network data can be collated and disseminated, satellite data are now widely used for large-scale weather monitoring in "near real time." Most of the semi-operational rainfall estimates use gauge data to calibrate the satellite estimates. Because only a portion of the synoptic observations is available for these adjustments for most of Africa, the quality is much less than it would have been if they were adjusted using all locally available gauges.

While satellite data provide good approximations of rainfall in many areas, interference from humidity, temperature and dust degrade their quality. Rigorous quality check, and blending satellite data with the available rain gauge data would help to overcome these problems. Putting both the gauge data and the gauge-adjusted estimates on a rectangular grid simplifies use with other data of interest to multiple users, including agriculture, food security, water resources and disease control planners, within a GIS. This approach could be implemented as part of the Climate Data Management projects envisioned in the Regional Action Plans (RAPs) of GCOS.

One important technical gap often found is a lack of broader understanding as to how best to use the satellite data services to which Met Offices have privileged access as part of the global weather community. This may be rectified to some extent by the impending European Commission programme, African Monitoring of Environment for Sustainable Development (AMESD), but still has much under-exploited potential.

Building Bridges

- *Data for development from local to global scale with primary objective of delivery of development impact*
- *Communication systems designed for rural communities*

Prediction for Operational Management and EWS

Where proven to have skill, forecast products at different time scales (weather, medium range, seasonal) may contribute to operational management (e.g., timing of water release from a dam) as well as hazard management (e.g., malaria early warning) and longer-term planning (e.g., agricultural planning for temperature sensitive crops) when integrated into an appropriate decision-making framework. Given the relatively long history of use, the direct use of daily weather forecasts is generally well established. The value of seasonal forecasts derives largely from the ability to forecast impacts such as disease risk, reservoir inflow or crop or forage production, often using models that incorporate historical and near-real-time observations and climate forecasts.

Climate Change Scenarios for Infrastructure, Policy and Investment

Managing climate variability today is an essential but not a sufficient step toward adapting to climate change tomorrow. GCM-based climate change scenarios are generally consistent in predicting temperature rise across Africa, but show considerable uncertainty about both the magnitude and direction of changes in precipitation. Appropriate use of a range of such scenarios combined with analysis of trends in historic data can contribute to the understanding of future trends and uncertainties that are crucial for the long planning horizons involved in infrastructure planning and many policy and investment choices. It is important that countries take a strategic view on likely climate change impacts and start to adapt accordingly. Much greater priority is required for development of NAPAs and their integration in PRSPs (for example). For infrastructure, the particular challenge posed by climate change is to incorporate likely future trends into designs so that they build resilience for future conditions as well as for present ones.

Spatial Information

For many development applications, a particularly useful way to integrate climate information with other information relevant to decisions is to use a GIS to explore relations and create maps. Maps (e.g., agroecological zone, disease risk) based on statistical or rulebased decision models and informed by climatology (and often a wide range of other non-climatic information) help indicate what policies are appropriate, what investments should be made, and where research and intervention should be targeted.

Similar maps and models can be used operationally as indicators of the current status of the season, or as indicators of changes in risk, when they incorporate near real-time weather and possibly climate forecast data. For example, crop models driven by near real-time daily weather and historic climate information are incorporated into food security models, and malaria early warning models are driven by seasonal changes in weather-related risk.

GAPS IN CLIMATE DATA

Key Gaps

The principal gap in observational data is at the farm level and the main problem with current climate services (where they exist) is that they are largely inaccessible and irrelevant to the million of rural poor whose livelihoods are climate-dependent.

Building Bridges

Filling this gap requires greater concentration on community level participation in observational networks, and improving communications to be able to deliver climate services.

Key Gaps

The current monitoring system is insufficient for supporting growth and sustainable development. It is oriented more towards meteorology than climate, and more towards global interests and the presumed needs of government sectoral managers than the needs of local communities.

In recognizing the importance of systematic observation to further the needs of the United Nations Framework Convention on Climate Change, the Conference of the Parties (COP) noted that adequate high-quality data for a variety of climate-related purposes is not available in many countries due to insufficient geographic coverage, the low quantity and quality of the data produced by current global and regional observing systems, and the failure to rescue available historical data. These problems are especially acute in Africa, where lack of funds for modern equipment and infrastructure, inadequate training of staff, the high costs of continuing operations, and problems associated with political instability and conflict are often major constraints. To begin to remedy this situation, the COP invited GCOS to organize a Regional Workshop Programme to identify priority climate-observing needs in ten developing regions. For each region in the programme, Regional Action Plans were developed to address these priority needs. Each Action Plan is a strategy document containing brief descriptions of projects identified as priorities by the region as a whole.

In the case of sub-Saharan Africa, two workshops were held and, subsequently, two Regional Action Plans were developed, one for the countries of Eastern and Southern Africa and one for those of Western and Central Africa. These Action Plans contain considerable detail and will not be discussed further here. They may, however, be reviewed on the GCOS website at http://www.wmo.ch/web/gcos/gcoshome.html. The projects are also briefly summarized in the GCOS-ECA report of the Addis Ababa workshop. Both plans contain projects that address needs for climate-related observations, needs to improve information availability, and needs to build climate application partnerships for decision-making. Common themes in the Action Plans are improving and sustaining operational observing networks, such as the GCOS Surface and Upper Air Networks; recovering historical data; improving national and regional coordination; education, training, and capacity building; and national planning and reporting. Improving the quantity and quality of climate data is a necessary, if not of itself sufficient, step to improving climate services and climate risk management. Some additional issues to highlight are the following:

Criteria for Local Observational Systems

We found little evidence that climate data were used well locally except in particular instances, so it is not surprising that there appears to be little local concern in the decline of observations and data. This situation needs to be changed by vastly improving services to communities, policy and resource managers whilst maintaining and improving global services. Local observations for local development should comprise community-owned systems for producing user-friendly information of relevant parameters (in the first instance rainfall) for immediate local use with minimum training.

Wherever possible, local observations should be supported by user-friendly technology and energy-efficient systems, local manufacture of equipment to sustain the networks, with provision for local maintenance and production of spare parts to ensure continuity in operation. The Mali experience incorporated local rainfall observations in television and radio reports generating pride and greater inclusion.

Observational Systems for National to Global Development and Compliance

Observations for national to global purposes require networks owned and supported in partnership, with standardized databases and appropriate arrangements to ensure sustained collection of both environmental data and socio-economic indicators. Specified data analysis and compatible archiving systems will be necessary for climate, water and other environmental variables. Integrated regional centers (possibly virtual) will be required to organize and share knowledge required for multi-disciplinary products and services for development stakeholders in cost-effective and sustainable ways. In order to maximize the development benefits of new investments in nationally and globally relevant observing systems, it is recommended that such investments prioritize, in order:

1. Data rescue, management and dissemination;
2. Renovation of recently quiet stations such that the archived data from those stations may be used in conjunction with new data; and
3. New stations that combine future benefits (once the station has been running for many years) with immediate benefits such as calibrating satellite data or cross referencing with other data source (e.g. streamflow).

Key Gaps

Strengthening the observation network is only one side of the coin. If the collected data is not properly quality-controlled and presented in a format that encourages stakeholders to use the data, the outcome of such initiatives will be much less than the potential.

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APPENDIX A

CLIMATE FOR DEVELOPMENT IN AFRICA

Summary of the Joint Global Climate Observing System/ UN Economic Commission for Africa Meeting Addis Ababa, Ethiopia, 18-21 April 2006

Development Context to the Meeting: Development in many parts of Africa is constrained by the variability and extremes of climate, as recognized in the NEPAD framework by the Assembly of the Heads of State and Governments of the African Union. The livelihoods of many millions of people, especially in the least developing countries, are critically dependent on a climate that is not only highly variable and unreliable in the short-term but may also be changing as part of long-term global climate change. Achievement of the Millennium Development Goals (MDGs) in Africa will only be possible if the climate is managed more effectively. Adequate climate data is key to making the case for, and informing the integration of, climate risks into national development planning and implementation. However, Africa's climate observing systems are weak and deteriorating, and climate information is rarely used effectively in planning. The G8 in 2005 recognized that urgent action was required to help Africa adapt to climate change.

The Global Climate Observing System (GCOS): GCOS is an internationally sponsored and coordinated global framework for obtaining the climate data needed for climate monitoring, research, policy formulation, and national economic development. Governments assign the lead role in GCOS implementation in most countries to their National Meteorological and Hydrological Services (NMHSs).

The Process So Far: A GCOS UNDP/GEF-supported project was established to help facilitate improvements in climate observing networks in developing countries necessary for detection, monitoring, and modeling of climate change and for supporting sustainable development. In Africa, where climate change effects are expected to be among the more severe, experts from the climate and policy communities, working with GCOS, have produced Regional Action Plans (RAPs) containing projects addressing priority needs for climate observations. The Action Plans for Eastern and Southern Africa and for Western and Central Africa have broad support within their respective regions. A RAP for North Africa will be finalized by mid-2006. DfID supported a user-centered "Gap Analysis" facilitated by IRI to analyze gaps in the use of climate information from the perspective of the decision-making community in sub-Saharan Africa at household, community, district, national, and regional levels for a range of essential development sectors including health, agriculture and water. The meeting at the UN Economic Commission for Africa in Addis Ababa was arranged to seek a common framework for action in the light of the RAPs, the Gap Analysis, and expressions of support for the process from the 2005 G8 Gleneagles Plan of Action.

Objective of the Meeting: The objective of the meeting was to initiate development of an implementation plan that makes development interests central to activities that address deficiencies in Africa's provision of climate information and services.

Outcome of the Programme: The programme outcome will be to strengthen the resilience of poverty reduction efforts in Africa to climate variability and change through user-driven delivery, use, and long-term availability of climate information.

Meeting Participation: The meeting was hosted with the active participation of ECA and IRI and was attended by some 100 persons. These included a cross section of African development institutions and political bodies (including the African Union Commission, the African Development Bank, the Southern African Development Community, and the Indian Ocean Commission); development partners (from the United Kingdom, Ireland, the Netherlands, Sweden, Denmark, Finland, and Canada, and the UN Development Programme, UN Environment Programme, and European Commission), and the user community (with representation from health, water, agriculture, food security, disaster management, and other sectors), the climate community (including the GCOS Secretariat, the World Meteorological Organization, the WMO Regional Association for Africa, the African Center for Meteorological Applications for Development, IGAD Climate Predictions and Applications Center, and several NMHSs), and the IRI.

Meeting Execution: The Ethiopian Minister for Water opened the meeting, and dignitaries from the African Union, African Development Bank, WMO, UNEP, ECA, and GCOS contributed opening statements. The first day examined climate change in the context of development issues. The Gap Analysis was presented on day two and was followed by breakout groups that examined the gaps and proposed actions to fill these and additional gaps. The results of were reported back to plenary on the third day. Donor interests and the RAPS were also explored on the third day. Agreement on a framework (roadmap) for action towards implementation was reached on the fourth and last day of the meeting.

Meeting Output: A Framework for Action: Participants developed a programme designed to help deliver and sustain those MDGs that are climate sensitive. Participation in the programme would be open to people in all countries of sub-Saharan Africa (at least). The programme would involve a process of integrated climate risk management involving four inter-related thrusts:

- Awareness raising directed to the African political leadership;
- Implementation of climate risk management throughout pertinent sectors;
- Development of improved climate support services; and
- Improvement of observation networks and data management that are fundamental to climate risk management.

In order to generate widespread political, donor and practitioner support for the programme the immediate priority area of activity identified was:

1. The creation of effective climate information demand coupled with the creation of effective climate information supply; and
2. The demonstration of the economic value of climate information services to development outcomes.

APPENDIX B
EXAMPLES OF CLIMATE RISK MANAGEMENT IN PRACTICE

Climate knowledge is a crosscutting development issue that needs to be integrated into different sectors where planning and investment is managed. At present, examples of this process happening in Africa appear to be relatively rare. In the following section, we highlight a limited number of examples of what is currently being achieved as an indication of the type of innovation and activity that is happening across the continent. These examples are meant to be illustrative and not comprehensive. They reflect the specific reference to health, agriculture and water in the Gap Analysis terms of reference. Participants at the GCOS *Climate for Development in Africa* workshop cited a number of other relevant examples of ongoing climate-related development activity within Africa. The IRI, in consultation with ECA and the GCOS Secretariat and with support from DfID, plans to prepare a more in-depth report on some of these ongoing activities, as an advocacy tool.

Farm-Level Adaptive Risk Management

Operational agricultural, food security and climate institutions are increasingly focused on reaching rural communities with relevant climate information and support for climate risk management. Alleviating the known barriers to effective climate risk management within rural communities will require a comprehensive strategy that includes effective dissemination of relevant climate information, appropriate technical guidance and intervention in financial services and production inputs. This requires expanded efforts to provide rural communities with equitable and timely access to relevant climate information services.

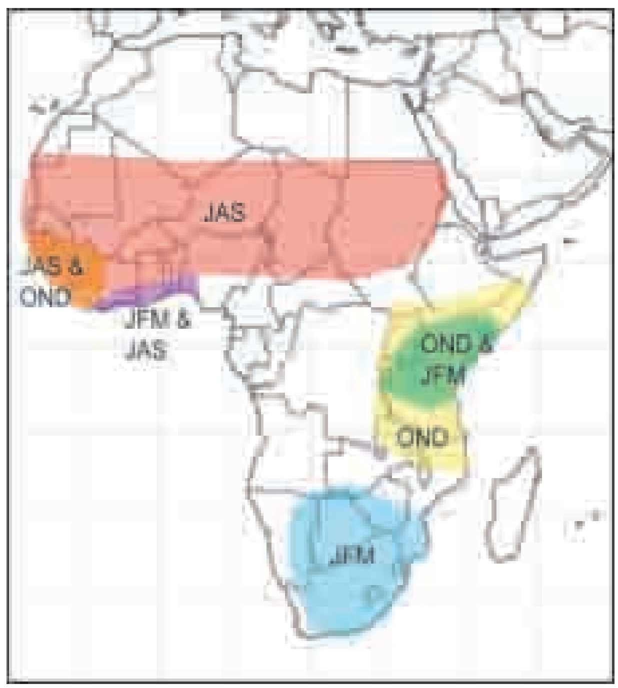

Figure 1.1 Regions and seasons with greatest potential predictability in Africa. JAS = Jul-Sep, OND = Oct-Dec, JFM = Jan-Mar.

Mali appears to be a successful example of "at scale" activities designed to improve climate risk management in agricultural communities across the country (with the exception of the arid north).

Initiated in 1982 by the CILSS structure in response to the Sahelian drought, the National Meteorological Services, through an interdisciplinary working group, started providing agro-meteorological support to rural farming communities. According to the 2006 final project report, implementation of the project resulted in:

- An improved understanding of the meteorological needs of the farming community;
- Decision-making tools for farmers;

- Identification of small-holder farmer traditional references;
- Training of rural women and farmers on agro-meteorological observations and interpretation; and
- Dissemination and communication of weather and seasonal climate forecasts.

Similar attempts at this type of programme were conducted in Senegal, Mauritania, Cape Verde, Chad and Burkina Faso but have not proved as successful. Understanding the ingredients of success for such a programme is essential if it is to be replicated elsewhere. What is encouraging about the Malian programme, an evidence of its success is that it resulted in significant budgetary allocation from the national government to the Meteorological Services.

Management of Agricultural Trade and Food Stocks

With the structural adjustment programs of the 1990s, food staple markets were liberalized and governments withdrew from managing grain stocks and setting floor prices. This resulted in significant increases in price variability facing African farmers and consumers, due in part to the rainfall variability, and in part to weak integration in grain markets resulting from underdeveloped road and transport infrastructure, very high marketing costs limiting spatial arbitrage, and lack of investment in storage infrastructure. Such market structures can result in local gluts and scarcities and wide swings in prices, which limits the potential for trade, significantly reduces farmer incomes, and increases the risks for market agents who might invest in storage and arbitrage businesses.

There are a number of initiatives on the continent moving toward resolving this impasse in staple grain markets. These include the warehouse receipt systems being tested in West Africa, Zambia, and Kenya, formation of the Uganda Grain Traders Association focused on export of maize, and development of market information systems in Mali, Kenya, and Uganda. These organizational innovations rely on information on prices and market opportunities. With further development of the storage and warehouse receipt system within an inter-regional market, the possibility exists for the development of a futures market. The system of communicating price information throughout the country by cell phone has the potential to expand to include weather information and forecasts, which could substantially reduce the risks involved in managing grain stocks, either as a part of domestic trade or linked to either export or import. Although experience with using climate information to intervene in markets is still limited, economy-wide modeling in Mozambique suggests considerable potential aggregate benefits of market applications of climate forecasts (Arndt et al., 2003).

Management of Food Crises

Because rain-fed agriculture is the main source of food and livelihood in Sub-Saharan Africa, extreme weather events are among a multiple of key stressors that cause food insecurity and hunger. Agricultural failure results not only in direct loss of production but also in loss of rural employment and income, leading to the destruction of rural communities and livelihoods.

Effective response to evolving food crises depends on timely delivery of adequate and appropriate assistance to those who need it most. Timeliness of response has become a particular concern since the priority has shifted from saving lives to saving livelihoods. The strategies that households employ to cope with acute food shortages often come at the cost of future livelihood potential. Timely, well-targeted, temporary assistance to replace lost food income and maintain households at at-least minimally food secure levels both reduces immediate hardship and alleviates the need for households to liquidate productive assets. If emergency assistance is delayed, the livelihood impacts of divestment of productive assets, over-exploitation of natural resources or migration can persist long after the food crisis is over, eroding the capacity of households and communities to deal with future crises.

Climate-informed improvements in monitoring, trigger mechanisms, and financing, have the potential to shift the needs assessment and subsequent phases forward by about four months. Because of satellite remote sensing it is now possible to identify widespread crop failures several weeks before the end of the growing season and estimate expected production by mid-growing season. Advances in crop forecasting techniques using seasonal forecasts have the potential to increase the lead-time and accuracy of food security assessments based on monitoring alone; integrating seasonal forecasts into food security assessments has been explored at regional Climate Outlook Forums led by the regional climate centers (ACMAD, ICPAC, DMC) with support of international climate institutions (IRI, ECMWF, UKMet, Meteo France, Hadley Centre, etc.).

It must be noted, however, that the established process for mobilizing resources is to launch an appeal to donors following the verification of a food crisis within a needs assessment report. This results in a delay of several months before any intervention can be undertaken and severely constrains the potential value of an early warning system.

Weather Index Insurance

Weather index insurance, in which an insurance payoff is triggered by a climate index, may be a means to overcome delays in early response to climate-related crisis. This approach is being tested at national level in Ethiopia and Malawi to provide governments with aid before people starve or divest productive assets. In Malawi, insurance is being applied to make loans to farmers possible and to allow them to take advantage of seeds with higher productivity but higher dependence on rainfall. Similar actions are being explored in Morocco, Kenya, Tanzania, Uganda, and South Africa. Other policies are also being developed whereby an agency pre-commits to action based on a forecast value, early warning system, or measured climate parameter (trigger) to mitigate a developing crisis. In Ethiopia, an insurance system is being tested in cooperation with the WFP to provide immediate funding for food aid in response to large droughts, using a trigger based on rainfall.

Development of these index strategies is hindered by gaps in available climate information, gaps that could likely be eliminated through appropriate efforts. Index tools must be better engineered so that they leverage climate information to produce synergies. Otherwise, they can be undermined by seasonal forecasts, long-term trends, or climate change. A farm level index insurance project in Morocco has been halted because uncertainty in long-term precipitation trends threatened to make the system insolvent.

Water Infrastructure for a Changing Climate

Climate extremes can have major impact on infrastructure. Limiting the impact of climate seasonality, variability and extremes can be achieved through major infrastructure investments, and has always been seen as an essential component of economic development in wealthy countries. In order to achieve greater cost-effectiveness in water programme design and reduce the impact of climatic extremes, appropriate design and planning methodologies, backed by adequate climate and hydrological data, must be available to optimize this investment.

The particular challenge posed by climate change is to incorporate likely future trends into designs so that they build resilience for future conditions as well as for present ones. For example, it is likely that small changes in rainfall will result in much greater changes in the amount of water that flows into rivers, streams and lakes. Similarly, both climate and hydrological information are required to help plan irrigation, urban water supply and to manage droughts and floods effectively, in a changing climate. Lack of understanding of the relation between climate change and the flow of water in rivers as well as to groundwater resources is a major constraint to water managers, which could be overcome through cooperative research between climate and water scientists.

Accurate stream flow simulations are especially vital for the management and allocation of scarce water resources and require detailed hydrological and climate monitoring. Allocation of water rights is already a contentious issue and will become even more so as demand for water grows and as countries move towards more participatory system of water management in which all major interest groups are represented in the decision-making process. Added complexity derives from the wide temporal fluctuations in river flows caused by highly variable rainfall regimes, and the need to take into account a broader understanding of integrated water management that incorporates land use management.

Malaria Epidemic Early Warning

The African Heads of State declared their support for the Roll Back Malaria initiative in Africa in April 2000 with the Abuja Targets. In these targets, national malaria control services are expected to detect 60% of malaria epidemics (which generally occur in years of well-above average rainfall) within two weeks of onset, and respond to 60% of epidemics within two weeks of their detection. With the support of the WHO Regional Office for Africa, teams are engaged in the development of recommendations, guidelines and technical support to improve prevention and control of epidemics within the various sub-regions.

The results of this activity can be seen in the southern African region, which has a long history of malaria epidemics, and now has an advanced integrated approach to epidemic malaria control based on key determinants in the region:

- Vulnerability assessment;
- Seasonal climate forecasts;
- Climate and environmental monitoring; and
- Health surveillance.

Experience and evidence for use of an integrated warning system approach within a national malaria control programme has been demonstrated in Botswana over the past few years and is seen as an example of best practice in the region. As a result, for the second year running, SADC countries have prepared for the malaria season with a regional meeting (The MALOF) at which vulnerability is assessed in the context of the pre-rainy season climate forecasts that have been tailored to the needs of the malaria community (see Figure 1.2).

The African Development bank is currently planning to invest substantially in epidemic malaria control in East and West Africa, where implementing organizations are seeking to learn from the southern African experience. The perceived benefit of climate information to the health services is further demonstrated by donor support for meteorological stations and early warning activities at health facilities in Eritrea and Niger. In the latter, ARGOS satellite technology is used to routinely pass on epidemic surveillance data, and climate data from these facilities to the central level and a number of epidemic alerts have been initiated (and responded to) through this system.

Figure 1.2 Poster produced for regional Malaria Outlook Forum (MALOF) for SADC countries

Evaluating Development Impacts in the Face of Varying Climate

The process of measuring progress towards the MDGs has created a set of databases and indicators that are an essential element in driving forward the development agenda. The impacts of interventions are ascribed to progress in specific outcomes in comparison to a baseline year. Since many of the MDG indicators are climate-sensitive, to avoid confounding the measurement of progress with (e.g., inter-annual variability in climate), it is imperative to distinguish between the impact of interventions, and the impact of varying climate. Such analysis is dependent on the availability of relevant climate information at the appropriate spatial and temporal scale. In the absence of such methodologies, measurement of achievements may be over-optimistic (in climatically favorable years) or overly pessimistic (in years when climatic factors are largely responsible for the outcome of interest). Appropriate climate information must be available to eliminate this confounding factor and establish the true impact of interventions on climate-sensitive targets such as malaria morbidity and crop production.

Communication Systems for Rural Communities

RANET Uganda is a project specifically designed for rural communities to use available user-friendly, new information technologies to timely access and use needed weather and climate information as well as any other needed development information. The Uganda Department of Meteorology implements this project in partnership with organizations that are directly working with farmers, and have shown interest in assisting them with access and use.

The new information technologies used in RANET include satellite channels, digital receivers, adapters, computer, software, Internet, websites, development facilitators, development information, FM radio transmitters, and wind-up radios.

On the national level, the Uganda Department of Meteorology implements RANET Uganda in rural communities of Uganda, through collaborative partnerships with World Vision Uganda, ActionAid Uganda, Africa 2000 Network and Uganda National Farmers Federation. To date, under those partnership arrangements, 10 sites have been established with World Vision, 10 sites with Action Aid, 4 sites with Africa 2000 Networks and 4 with Uganda National Farmers Federation (Figure 1.3).

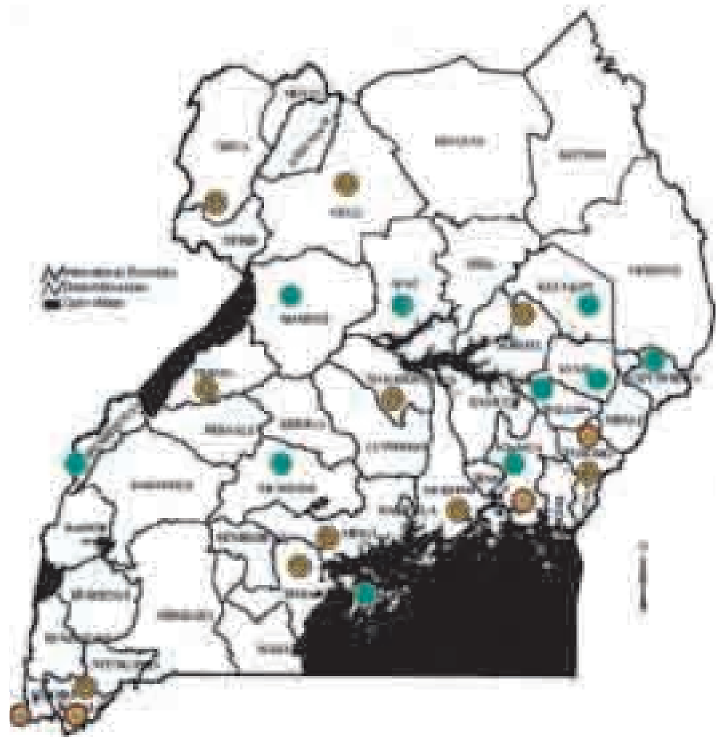

Figure 1.3 Map indicating locations of rural farmers who benefit from RANET sites supported by partners

APPENDIX C

GLOSSARY

Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

African Union (AU). Founded in July 2002, the AU is the successor organization to the Organization of African Unity (OAU). Modeled after the European Union (but currently with powers closer to the Commonwealth of Nations), it aims to help promote democracy, human rights and development across Africa, especially by increasing foreign investment.

Capacity building. Specifically, capacity building encompasses the country's human, scientific, technological, organizational, institutional and resource capabilities. Capacity building is much more than training and includes the following:

- Human resource development, the process of equipping individuals with the understanding, skills and access to information, knowledge and training that enables them to perform effectively;
- Organizational development, the elaboration of management structures, processes and procedures, not only within organizations but also the management of relationships between the different organizations and sectors (public, private and community); and
- Institutional and legal framework development, making legal and regulatory changes to enable organizations, institutions and agencies at all levels and in all sectors to enhance their capacities.

Climate is the statistics of weather integrated over time (typically at least three months) and often over space. Although the most basic aspect of climate is the long term average of weather for a particular time of year, it includes other statistics related to variability.

Climate change refers to long-term changes in the weather statistics (e.g., means or variability) that define climate. Although the climate fluctuates at a continuum of time scales, climate change generally refers to long-term trends due, e.g., to increases in greenhouse gas concentrations, rather than natural oscillations.

Climate information. Because of the diversity of applications, climate information is intentionally a broad term that includes summary statistics, historic time-series records, near-real-time monitoring, predictive information from daily weather to seasonal to interannual time scales, and climate change scenarios. It covers a range of spatial scales; and can include derived variables related to impacts, such as crop water satisfaction indices, epidemic disease hazard or streamflow.

Climate observations - ground based data. These are observations about the state of the atmosphere at the earth's surface or aloft measured at climatological stations at least once daily. The measured elements include temperature, total precipitation, wind velocity, soil temperature, soil moisture, etc. Ground-based observers use a multitude of small sensors to collect and measure data. In addition, the sensor may not be an instrument but it might consist of human observation (e.g., for visibility estimates). Therefore, the metadata (source, sensors, and parameters, etc.) associated with ground-based data are quite complicated and need to be well managed if they are to be shared between organizations.

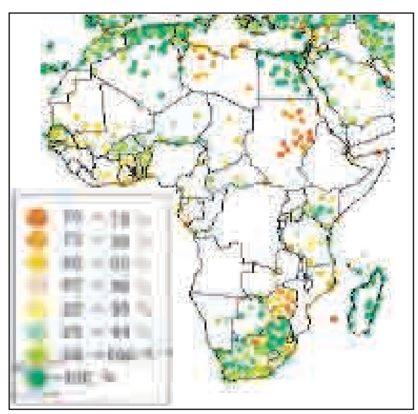

Fig. 2.1 GTS Reporting

The data made available to the global climate community in near real-time comes from the Global Telecommunication System (GTS). Large areas of Africa do not report at all (or consistently) data to the global network (Figure 2.1). Local stations may provide individuals or local organizations with valuable climate data (particularly rain gauges on farms) but in many areas these volunteer stations have also declined in number.

Climate observations - satellite data. Satellite data are fundamentally different from ground-based data. The most obvious difference is that satellite data are obtained remotely by sensors on board satellites in space. The main advantage of satellite observations is that we can obtain data from remote and inaccessible regions. The disadvantage is that satellites do not measure or record the required climate elements directly; instead, the required information are obtained from satellite measurements indirectly, and usually using the ground observations for calibration. Satellite data have been particularly valuable for creation of near real time rainfall products and indices that reflect environmental factors such as vegetation greenness. Other climatic variables such as air temperature, soil moisture and humidity are still at experimental stages.

Climate prediction. Year-to-year climate variations are influenced by interactions between the atmosphere and the more slowly varying ocean and land surfaces, such as those associated with the El Niño-Southern Oscillation (ENSO) in the tropical Pacific. Improvements in our understanding of these interactions, advances in modeling the global climate system and substantial investment in monitoring the tropical oceans now provide a degree of predictability at a seasonal lead time in several regions of the world, including parts of Africa. The predictability of the October-December "short rains," starting in early September is particularly high over a region centered over Lake Victoria, and extends from southern Ethiopia through Tanzania. In West Africa, rainfall shows good predictability in the humid coastal region, and moderate predictability in the Sudan and Sahel regions. Existing climate models provide credible but weaker predictability of rainfall in the February-April "long rains" in part of eastern Africa, and in January through March over a substantial portion of southern Africa. Periodic regional climate outlook forums in eastern, southern and West Africa have fostered awareness and dialogue, but have not yet incorporated advances in methods for downscaling forecasts and modeling hydrological, agricultural and health impacts.

Climate Risk Management (CRM) seeks to promote the achievement of sustainable development goals by helping to manage vulnerability associated with both short-term climate variability and longer-term climate change. It involves proactive, precautionary programs to realize positive outcomes for communities and societies in climate-sensitive areas such as agriculture, water resources, food security, health and livelihoods.

Climate scenario is a potential future realization, e.g., associated with climate change, that does not have an associated probability.

Climate shock is a damaging climatic extreme, such as a drought, flood or heat wave.

Climate variability refers to variations in the atmosphere at time scales ranging from months to decades, falling between the extremes of daily weather and the long-term trends associated with climate change.

Coping capacity is the manner in which people and organizations use existing resources to achieve various beneficial ends during unusual, abnormal and adverse conditions of a disaster phenomenon or process.

Disaster. A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources.

Early warning systems (EWS). These systems include a chain of concerns, namely: understanding and mapping the hazard, monitoring and forecasting impending events, processing and disseminating understandable warnings to political authorities and the population and undertaking appropriate and timely actions in response to the warnings.

Forecast. A forecast is a future projection that is expressed either deterministically or with an associated probability distribution.

G8. The G8 stands for the "Group of Eight" nations. It is up to the country that has the Presidency to set the agenda and organize the annual G8 Summit. The G8 Environment and Development ministers meeting in 2005 recognized that urgent action to help Africa adapt to climate change is necessary to ensure that its impacts do not undermine the achievement of the Millennium Development Goals, and they committed to helping Africa understand and manage climate risks. The G8 Plan of Action, agreed by Heads of State at Gleneagles in July 2005 (under the Presidency of the UK), contains commitments to improve climate risk management with a specific focus on improving the availability and use of climate information in planning processes and scientific capability in Africa.

To followup on the G8 Plan of Action, the UK is providing support to the GCOS Secretariat to develop a programme of work to (a) improve African capacity to use climate information in planning, including developing decision support systems and tools relevant to local planning needs, (b) improve African climate data management systems and (c) address key deficiencies in African terrestrial atmospheric and oceanic climate observation networks.

Geographic information systems (GIS). Analysis that combine relational databases with spatial interpretation and outputs often in form of maps. A more elaborate definition is that of computer programs for capturing, storing, checking, integrating, analyzing and displaying data about the earth that is spatially referenced.

Global Climate Observing Systems (GCOS). The Global Climate Observing System was established in 1992 to ensure that the observations and information needed to address climate-related issues are obtained and made available to all potential users. It is co-sponsored by the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the United Nations Environment Programme (UNEP) and the International Council for Science (ICSU). GCOS is intended to be a long-term, user-driven operational system capable of providing the comprehensive observations required for monitoring the climate system, for detecting and attributing climate change, for assessing the impacts of climate variability and change and for supporting research toward improved understanding, modeling and prediction of the climate system. It addresses the total climate system including physical, chemical and biological properties, and atmospheric, oceanic, hydrologic, cryospheric and terrestrial processes.

Gross Domestic Product (GDP). Total market value of the goods and services produced by a nation's economy during a specific period of time.

Integrated Water Resource Management (IWRM). IWRM aims are to improve the management, conservation, and sustainable use of water resources, promoting social and economic growth. Specific actions involve the promotion of water governance, assistance in the development of policies, laws and regulations for integrated water resource management, capacity building in regional, national and local institutions, and promotion of the exchange of information through for example the IWRN (Inter-American Water Resources Network).

Least Developed Countries (LDCs). An informal group of countries defined using a number of parameters including per capita GDP. Under current proposals, Least Developed Countries and Small Island Developing States would gain special consideration for adaptation and convention funding, technology transfer, capacity building and the CDM.

Livelihood. The means by which an individual or household obtains assets for survival and self-development. Livelihood assets are the tools (skills, objects, rights, knowledge, social capital) applied to enacting the livelihood. increase its capacity for learning and adaptation, including the capacity to recover from a disaster.

Met Offices. This is the name used in this report in order to distinguish the institution from the services that it provides. Services provided by the Met Offices usually comprise short-range weather forecasting (as seen on TV) as well as climate statistics (possibly related to agriculture for example) and, in some cases, hydrological information services as well. There is no common collective term for "weather" and "climate" as meteorology has become too closely associated with short-term weather rather than climate.

Millennium Development Goals (MDGs) are eight goals that all 191 United Nations member states have agreed to try to achieve by the year 2015. The United Nations Millennium Declaration, signed in September 2000, commits the states to the following goals:

- Eradicate extreme poverty and hunger;
- Achieve universal primary education;
- Promote gender equality and empower women;
- Reduce child mortality;
- Improve maternal health;
- Combat HIV/AIDS, malaria and other diseases;
- Ensure environmental sustainability; and
- Develop a global partnership for development.

National Action Plans. Plans submitted to the Conference of the Parties (COP) by all Parties outlining the steps that they have adopted to limit their anthropogenic GHG emissions. Countries must submit these plans as a condition of participating in the UN Framework Convention on Climate Change and, subsequently, must communicate their progress to the COP regularly. The National Action Plans form part of the National Communications which include the national inventory of greenhouse gas (GHG) sources and sinks.

National Adaptation Programs of Action (NAPAs) were established in the 7th Conference of the Parties (UNFCCC, 2004). NAPAs are intended to assist LDCs in meeting their needs and concerns with respect to adaptation to climate change, by setting priority activities to be undertaken (UNFCCC, 2004).

New Partnership for Africa's Development (NEPAD) is an economic development programme of the African Union. The NEPAD was adopted at the 37th session of the Assembly of Heads of State and Government in July 2001 in Lusaka, Zambia. It is meant to develop values and monitor their implementation within the framework of the African Union.

Poverty Reduction Strategy Papers (PRSP) describe the country's macroeconomic, structural and social policies and programs over a three year or longer horizon to promote broad-based growth and reduce poverty, as well as associated external financing needs and major sources of financing. Prepared by the member countries through a participatory process involving domestic stakeholders as well as external development partners, including the World Bank and International Monetary Fund they are updated every three years with annual progress reports.

Resilience. This is the capacity of a system, community or society to resist or to change in order that it may obtain an acceptable level in functioning and structure. This is determined by the degree to which the social system is capable of organizing itself, and the ability to increase its capacity for learning and adaptation, including the capacity to recover from a disaster.

Regional Economic Communities (RECS). The principal African RECs are:

- The Arab Maghreb Union (AMU) - 5 members
- The Common Market for Eastern and Southern Africa (COMESA) - 20 members
- The Economic Union of Central African States (ECCAS) - 11 members
- The Economic Union of West African States (ECOWAS) - 16 members
- The Southern African Development Community (SADC) - 14 members
- The West African Economic and Monetary Union / Union Économique et Monétaire Ouest Africaine (UEMOA) - 8 members
- The Central African Economic and Monetary Community (CEMAC) - 6 members
- Intergovernmental Authority for Development (IGAD) - 7 members
- Community of Sahel-Saharan States (CEN-SAD) - 17 members

The NEPAD Plan of Action looks to the RECs to become the leaders in regional economic integration.

Risk can either refer to the variability and resulting uncertainty of outcomes, or to the resulting likelihood of experiencing a particular adverse outcome such as food insecurity. The latter definition is often expressed as the product of hazard and vulnerability.

Stakeholder. A person who has something to gain or lose through the outcomes of a planning process or project. In many circles these are called interest groups and they can have a powerful bearing on the outcomes of political processes.

Sustainable development. Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of “needs”, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs. (Brundtland Commission, 1987).

Transboundary. We can define transboundary regionalism as a spatially integrated form of political co-operation and problem-solving that transcends the limits of nationally-based administrative practice and attempts to create (or re-create, as the case might be) a sense of cohesiveness, interdependence and common interests across national boundaries.

Vulnerability refers to characteristics of human communities or social systems that cause them to be susceptible to adverse outcomes when exposed to a hazard event.

Weather refers to the state of the atmosphere at a particular point in time and space. It can be characterized by variables such as precipitation, temperature, humidity, sunshine, cloudiness and wind on a given day or shorter period.

Weather index insurance, in which an insurance payoff is triggered by a climate index, is currently being explored as a viable method for reducing the impact of climate-related risk on investments in agriculture. Since adverse effects are reduced with this type of insurance farmers and other agricultural stakeholders may be more willing to invest in farm level inputs.

APPENDIX D

ABBREVIATIONS

AGRHYMET	Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle
AU	African Union
CBO	Community Based Organization
CGIAR	Consultative Group on International Agricultural Research
CILSS	Comité Permanent Inter-Etats de Lutte Contre la Sécheresse dans le Sahel
CLICOM	ClImat COMputing Project
CLIMSOFT	CLIMatic SOFTware
DfID	Department for International Development (UK)
ECOWAS	Economic Community Of West African States
ENDA	Environment Development Interaction in the Third World
FAO	Food and Agriculture Organization of the UN
FEWSNET	USAID Famine Early Warning System Network
GEF	Global Environment Facility
GIS	Geographic Information System
GUAN	Global Upper Atmosphere Network
GCOS	Global Climate Observing System
GTZ	Deutsche Gesellschaft für technische Zusammenarbeit GmbH
ICPAC	IGAD Climate Prediction and Application Center
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communication Technology
IDS	Institute for Development Studies
IFRC	The International Federation of Red Cross and Red Crescent
IGAD	Inter-Governmental Authority on Development
IMTR	Institute for Meteorological Training and Research
IRD	Institut de recherche pour le développement
IRI	International Research Institute for Climate Prediction
IWRM	Integrated Water Resource Management
LDC	Least developed country
MDG	Millennium Development Goal
NAPAs	National Adaptation Programs of Action
NASA	National Aeronautics and Space Administration
NEPAD	New Partnership for Africa's Development
NGO	Non-government organization
NWP	Numerical Weather Prediction
PRSP	Poverty Reduction Strategy Paper
RAPs	Regional Action Plans
RASCOM	Regional African Satellite Communications Organization
RISAs	Regional Integrated Sciences and Assessments program of NOAA
RSA	Republic of South Africa
REC	Regional Economic Communities
RFE	Rainfall estimates
RURANET	Rural Radio Network
SADC	Southern African Development Community
TV	Television
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WFP	World Food Programme
WHO	World Health Organization

APPENDIX E

THE PROCESS

The report has been prepared following written contributions, a panel discussion, Climate and Development in Africa: Gaps and Opportunities, Columbia University, New York, 30 January 2006, a "Gap Analysis" Brainstorming Workshop, IRI, Palisades, New York, 30 January-2 February 2006, involving:

Mohammed S. Boulahya
Regional Advisor, Africa Climate, Environment and Partnership for Development, Algiers, Algeria

Stephen Connor
Director, PAHO/WHO Collaborating Centre on Climate Sensitive Diseases
International Research Institute for Climate and Society, New York, USA

Menghestab Haile
Deputy Chief, Vulnerability Analysis and Mapping, World Food Programme, Rome, Italy

Roberto Lenton (panel discussion only)
Co-chair, Millennium Project Task Force on Water and Sanitation, New York, USA

John Lynam
Managing Director
The Kilimo Trust, Nairobi, Kenya

Mike Muller
Visiting Fellow, School of Public and Development Management, Wits University, Johannesburg, South Africa

Roger Stern
Chief Biometrician, Statistical Services Centre, University of Reading, Reading, UK

Jim Williams
Specialist in Natural Resource Management and Resource Mobilization, Kent, UK

under the editorial oversight of
Jim Hansen (IRI)
Molly Hellmuth (IRI)
Madeleine Thomson (IRI)
Jim Williams

with valuable insights and inputs from IRI staff.

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External Reviewers

Abdirahman Ali, International Livestock Research Institute, Addis Ababa, Ethiopia
Bruce Angle, Meteorological Service of Canada
Emma Archer, University of the Witwatersrand, Wits University, South Africa
Tarekegn A. Abeku, London School of Hygiene and Tropical Medicine, University of London, London, UK
Peter Cooper, ICRISAT, Nairobi, Kenya
Fatima Denton, Roskilde, Denmark
Sam Fujisaka, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia
Gedeon Galu, FEWSNET, Nairobi, Kenya.
Bruno Gerard, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Belgium
Nuhu Hatibu, Soil and Water Management Research Network (SWMnet) of ASARECA, Nairobi, Kenya
Bubu Pateh Jallow, Department of State (Ministry) for Fisheries and Water Resources, Banjul, the Gambia
Bryony Jones, VSF-Belgium, PO Box 13986, Nairobi, Kenya
Amir Kassam, The University of Reading, Reading, UK
Willem Landman, South Africa Weather Service, South Africa
Rahel T. Leslie, Millennium Development Concepts (MDC), Maryland, USA
Isabella Masinde, Centre for Livelihood Opportunities Unlimited and Technologies, Nairobi, Kenya
Nancy McCarthy, International Food Policy Research Institute, Washington, DC
Sarah Macfarlane, Global Health Sciences, University of California, San Francisco, USA
Elijah Mukhala, SADC Secretariat, FANR Directorate, Gaborone, Botswana
Shiva Murugasampillay, Gloabal Malaria Programme, WHO Geneva, Switzerland
Durton H. Nanja, Ministry of Communications and Transport, Meteorological Department, Livingstone, Zambia
Abdulsalami Nasidi, Federal Ministry of Health, Nigeria
Robinson K. Ngugi, University of Nairobi, Nairobi, Kenya
Eric Odada, University of Nairobi, Nairobi, Kenya
Balgis Osman Elasha, Higher Council for Environment & Natural Resources, Khartoum, Sudan
Steve Palmer, UK Met Office, UK
Derk Rijks, Agrometeorological Applications Associates, France
Bob Scholes, Natural Resources and the Environment (NRE), CSIR, Pretoria, South Africa
Seydou B. Traore, AGRHYMET Regional Center, Niamey, Niger
Evariste Sinarinzi, Institut Geographique di Burundi, Gitega, Burundi
Ibrahima Socé Fall, WHO AFRO, Harare, Zimbabwe
Kelly Sponberg, NOAA, USA
Steve Twomlow, ICRISAT, Bulawayo, Zimbabwe

IRI Contributors

Lee Addams
Haresh Bhojwani
Pietro Ceccato
Tufa Dinku
Esther Ebrahimian
Risë Fullon
Alessandra Giannini
Pauline Kangah
Sabine Marx
Simon Mason
Silvia Mosquera-Machado
Carolyn Mutter
Ousmane Ndiaye
Judy Omumbo
Daniel Osgood
Chet Ropelewski
Sylwia Trzaska
Jeff Turmelle
Neil Ward
Tsegay Wolde-Georgis
Stephen Zebiak

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THE INTERNATIONAL RESEARCH INSTITUTE FOR CLIMATE AND SOCIETY
The Earth Institute at Columbia University, Lamont Campus
61 Route 9W, Monell Building
Palisades, NY 10964-8000 USA

Phone: 845-680-4468
Fax: 845-680-4866
http://iri.columbia.edu