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## AFRICA REGION

# Making Development Climate Resilient: A World Bank Strategy for Sub-Saharan Africa

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## Abbreviations and Acronyms

AAA	Analytical and Advisory Activity
AAP	Africa Action Plan
ACMAD	African Centre of Meteorological Application for Development
ACPC	Africa Climate Policy Center
ACRM	Adaptation and Climate Risk Management
ADAPT	Assessment and Design for Adaptation to Climate Change: A Prototype Tool
ADP-SP	Agricultural Development Program Support Project (Malawi)
AERC	African Economic Research Consortium
AF	Arab Funds
AfDB	African Development Bank
ALRMP	Arid Lands Resource Management Project
APL	Adjustable Program Loan
AQM	Air Quality Management
AsDB	Asian Development Bank
AUC	African Union Commission
BNPP	Bank Netherlands Partnership Program
BNWPP	Bank-Netherlands Water Partnership
BRT	Bus Rapid Transit
CAADP	Comprehensive Africa Agriculture Development Plan
CAI-SSA	Clean Air Initiative-Sub-Saharan Africa
CAS	Country Assistance Strategy
CAU	Commission of the African Union
CC	Climate Change
CCISP	Climate Change Implementation Support Program
CCISP	Climate Change Implementation Support Program
CDC	Centers for Disease Control and Prevention
CDM	Clean Development Mechanism
CEIF	Clean Energy Investment Framework
CER	Certified Emission Reduction
CFL	Compact Florescent Light
CIF	Climate Investment Fund
CLIM-DEV	Climate Information for Development in Africa
CO <sub>2</sub>	Carbon Dioxide
CO <sub>2</sub> e	CO <sub>2</sub> Equivalent
COMESA	Common Market for Eastern and Southern Africa
CPF	Carbon Partnership Facility
CPS	Country Partnership Strategy
CRM	Climate Risk Management
CSIF	Country Strategy Investment Framework
CTF	Clean Technology Fund
DALA	Damage and Loss Assessment

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DFID	Department for International Development (UK)
DRMP	Disaster Reduction Management Plan
DRR	Disaster Reduction and Recovery
EAPP	Eastern Africa Power Pool
EB	Executive Board-CDM
EBRD	European Bank for Reconstruction and Development
ECLAC	Economic Commission for Latin America and the Caribbean
ECOWAS	Economic Community of West Africa States
ENSO	El Nino Southern Oscillation
ENV	Environment Department (World Bank)
ER	Emission Reduction
ESKOM	South African Electricity Public Utility
EU	European Union
FCPF	Forest Carbon Partnership Facility
FIF	Forest Investment Fund
FLEG	Forest Law Enforcement and Governance
GCCA	Global Climate Change Alliance (EC)
GCM	Global Climate Model
GDP	Gross Development Product
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Reduction and Recovery
GGFR	Global Gas Flaring Reduction Partnership
GHG	Greenhouse Gas
GTAP	Global Trade Analysis Project
GW	Gigawatt
GWh	Gigawatt Hour
GW-MATE	Ground Water MATE
ha	Hectare
HD	Human Development Department (World Bank)
HFA	Hyogo Framework of Action
IBRD	International Bank for Reconstruction and Development
ICPAC	IGAD Climate Prediction and Applications Centre
IDA	International Development Association
IDB	Inter-American Development Bank
IEA	International Energy Agency
IETA	International Emissions Trading Association
IFC	International Finance Corporation
IGAD	Intergovernmental Authority on Development
IIASA	International Institute for Applied Systems Analysis
IPCC	Inter-Governmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction (UN)
JI	Joint Implementation
JICA	Japanese International Cooperation Agency
KACCAL	Kenya Adaptation to Climate Change in Arid Lands
kg	Kilogram

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kWh	Kilowatt Hour
LDC	Least Developed Country
LEAP	Livelihoods, Early Assessment and Protection
LED	Light Emitting Diode
LGP	Length of Growing Period
LIMLETTE	Belgian Town (associated with a collaborative process between the World Bank and the European Commission)
LPG	Liquefied Petroleum Gas
MDB	Multilateral Development Bank
MDG	Millennium Development Goal
MIGA	Multilateral Investment Guarantee Agency
MW	Megawatt
NAPA	National Adaptation Programme of Action
NARS	National Agricultural Research System
NASA	National Aeronautics and Space Administration
NASFAM	National Smallholder Farmers' Association of Malawi
NEPAD	New Economic Program for Africa's Development
NMT	Non-Motorized Transport
NO <sub>x</sub>	Oxides of Nitrogen
NRM	Natural Resources Management
OMVS	Senegal Basin Organization
OPC	Office of the President and Cabinet (Malawi)
OSS	Observatoire du Sahara et du Sahel
PPCR	Pilot Program for Climate Resilience
PPP	Public Private Partnership
PREM	Poverty Reduction and Economic Management Department (World Bank)
PRSP	Poverty Reduction Strategy Paper
PSNP	Productive Safety Net Programme (Ethiopia)
PV	Photovoltaic
RCCC	Regional Climate Change Coordination
REC	Regional Economic Community
REDD	Reducing Emissions from Deforestation and Forest Degradation
RIL	Reduced Impact Logging
SADC	Southern Africa Development Community
SAG	Specific Advisory Group
SALM	Sustainable Agricultural Land Management
SAPP	Southern Africa Power Pool
SCF	Strategic Climate Fund(s)
SDD	Sustainable Development Department
SFDCC	Strategic Framework on Development and Climate Change
SIP	Strategic Investment Program (GEF)
SLM	Sustainable Land Management
SREP	Scaling-up Renewable Energy Program for Low-Income Countries
SRFF	Standby Recovery Financing Facility
SSA	Sub-Saharan Africa

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SWA	Sector-Wide Approach
SWM	Sustainable Watershed Management
t	Metric ton
TAEC	TerrAfrica Executive Committee
tCO <sub>2</sub> e	Tonnes of CO <sub>2</sub> Equivalent
TFESSD	Trust Fund for Environmentally and Socially Sustainable Development
TICAD	Tokyo International Conference on African Development
TWRM	Transboundary Water Resources Management
UEA-CRU	University of East Anglia-Climate Research Unit
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Program
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environmental Program
UNFCCC	United Nations Framework Convention on Climate Change
UNITAR	United Nations Institute for Training and Research
WAPP	West Africa Power Pool
WBG	World Bank Group
WBI	World Bank Institute
WFP	World Food Program
WHO	World Health Organization
WMO	World Meteorological Organization
WRDP	Water Resources Development Project (Niger River)

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The issue of most concern to African countries is adaptation to the impacts of climate variability and change. They are also willing to contribute to the mitigation agenda, and need technology and financial support to develop and make accessible abundant renewable energy, as well as coal resources. African countries also stressed the need for support and a greater emphasis on capacity building of both national and regional institutions, with a priority for climate and meteorological information, as well as disaster preparedness and strategic planning.

Moreover, while countries welcome a strong role for the World Bank Group and AfDB in the climate change agenda, they want the two development institutions to remain focused on poverty reduction in Africa and work closely and with other institutions on resource mobilization and implementation. African countries also want the programs and activities stemming from the strategies of both institutions to build on what countries have already identified as priorities in their National Adaptations Plans of Action (NAPAs), Communication Strategies to the United Nations Framework Convention on Climate Change (UNFCCC), Poverty Reduction Strategies, and also to give more attention to community-level issues.

Finally, African countries expressed frustration and confusion about the availability and accessibility of financing for climate change in relation to both existing and new instruments, and therefore, countries have high expectations for support from the World Bank Group and AfDB to access financing, particularly grant resources for climate-change-related activities.

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## Executive Summary

### Introduction

1. **This Strategy for Making Development Climate-Resilient in Sub-Saharan Africa** is the World Bank’s operational response to climate variability and change on the continent.<sup>1</sup> Grounded in a climate risk review of the Africa Region’s Sustainable Development portfolio, it adds the climate change dimension to the Region’s development strategy and business plan — the Africa Action Plan (AAP, 2009-2012) — and will be an integral part of the AAP in the future. The AAP and the climate change strategy are a sound and realistic framework for climate-resilient development in Sub-Saharan Africa.

2. **The proposed strategy is based on the premise** that increased climate variability threatens the development gains of African countries, and that these effects need to be anticipated so that development efforts can be made more resilient to climate change.

3. **Climate has always featured prominently in African development**, and people across the continent have been living with and adapting to a high degree of climate variability and its associated risks for many centuries. Yet the accelerated changes in the climate and increasing incidence of climatic disasters (floods, droughts, cyclones) during the last century — and the scientific consensus that Africa is the continent most vulnerable and least able to cope with these changes — have brought these risks into sharper focus, and made the need to address them more urgent.

4. **The major challenge is to identify actions that will support** and/or accelerate ongoing development efforts while making them more resilient to climatic risks. Therefore, the need to link adaptation to development, and to manage development,

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1. The Strategy has benefited from extensive internal and external consultations (both formal and informal) with Sub-Saharan African country governments, members of civil society, the private sector, and development partners, African institutions, and a special partnership with African Development Bank (AfDB). Its principles and recommended actions follow the World Bank Group’s overall strategy for addressing climate change in developing countries, the *Strategic Framework for Development and Climate Change* (World Bank, 2008f). The SFDCC articulates a set of principles for integrating climate change and development challenges, while maintaining economic growth, poverty reduction, and achieving the Millennium Development Goals as priorities.

The SFDCC assumes that adapting to climate variability and change is critical to sustaining and furthering development gains; that access to energy and increased energy use are fundamental; and that addressing climate change must not divert resources from core development needs. The SFDCC identifies six areas where scaled-up action in client countries will need to be mainstreamed into both country operations — including policy dialogue, lending, and analytical work — and regional and global operations. These action areas are: (i) making adaptation and mitigation a core part of all development efforts; (ii) narrowing the resource gap with innovative instruments for low-cost and grant-based financing; (iii) promoting innovative market mechanisms; (iv) leveraging private financing; (v) speeding the spread of climate-friendly technologies; and (vi) stepping up policy research and capacity building.



climate change adaptation, and disaster risk reduction as one integrated agenda — are the core principles of this strategy.

## Looming Threat of Climate Change

5. **More than one-half the countries in Sub-Saharan Africa** have made important economic reforms in recent years — improving macroeconomic management, liberalizing markets and trade, and widening the space for private sector activity. Where these reforms have been sustained — and underpinned by civil peace — they have not only raised growth and incomes and reduced poverty, but also enabled countries to increase domestic and foreign investment and expand social and human development programs. Yet despite these gains, Sub-Saharan Africa is home to many of the world's poorest countries. Average income per capita in real terms is lower than at the end of the 1960s, and life expectancy is lower now than 30 years ago. Incomes, assets, and access to essential services are unequally distributed. One African in four has access to electricity services and one African in five lives in a country severely disrupted by conflict.

6. **Across these emerging opportunities and development challenges looms the shadow of a changing climate**, which, added to the shocks stemming from the current global economic slowdown, will make it increasingly difficult for African governments to balance urgent short-term needs and longer-term development priorities.

### Africa's heightened vulnerability to climate change

7. **Climate change is a key development issue in Sub-Saharan Africa** because of the region's special vulnerabilities. These include the continent's natural fragility (two-thirds of the surface area is desert or dryland), significant and fragile terrestrial and coastal ecosystems, and high exposure to natural disasters (especially droughts and floods), which are forecast to increase and intensify as climate change progresses. Moreover, the region's livelihoods and economic activities are very much dependent on natural resources and rainfed agriculture, which are highly sensitive to climate variability. While biomass provides 80 percent of the primary domestic energy supply in Africa, rainfed agriculture contributes some 30 percent of GDP and employs about 70 percent of the population, and is the main safety net of the rural poor. Added to this is the spread of malaria — already the biggest killer in Africa — to higher elevations because of rising temperatures, compounding the effects of climate change with an increasing disease burden.

8. **Africa has a very low level of economically developed infrastructure.** There are few water control systems and little water storage capacity, despite relatively abundant resources. The transport, energy, information, and communication systems are also poorly developed, which may hinder adaptation efforts. Further, Africa's rapidly urbanizing population is vulnerable due to poorly defined property rights, weak land-use planning, and informal settlements, frequently on land subject to erosion or flooding. Finally, armed conflict, terms-of-trade shocks and aid dependence add to the weight of these factors, all of which combine to lower productivity and erode assets (land

productivity, livestock, water resources) and capabilities (health, nutrition, and education) — and threaten to keep Africans in a “low human development trap” (UNDP, 2007).

9. **Although subject to many uncertainties**, the impacts of climate change on development in Africa are expected to be diverse and significant, based on climate projections reported in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007). While temperature in Africa is likely to increase by 1.5 to 4 °C on average during this century — greater than the global average — predictions of rainfall changes in Africa are generally less consistent than those for temperature, with increases in equatorial Africa, decreases in the Sahel and southern Africa, and more variability in eastern Africa. These changes will be accompanied by an increase in extreme events (floods and droughts) and sea level rise of some 20 to 50 centimeters by 2050, particularly in West Africa (Accra, Ghana; Benin, Togo; Abidjan, Côte d’Ivoire; and the Niger delta).

10. **If nothing is done, the potential impacts of such changes are two-fold:**

- **African economies and communities are likely to be severely impacted** because of projected increases in extreme weather events, reduced crop yields and livestock productivity, drinking water shortages, reduced potential for hydroelectricity, spread of diseases such as malaria, potential migration and social strife, increased cost of infrastructure maintenance and development, and increased pressure on service delivery and fiscal resources.
- **The productivity of the natural resource base is likely to decline** as a result of watershed erosion, loss of soil productivity, loss of woodlands and forests, desertification, coastal erosion, and loss of aquatic and terrestrial biodiversity with consequent effects on agriculture, forestry, and water resource-based economic activities, fisheries, urban and coastal infrastructure, and tourism.

11. **Therefore, through economic diversification and growth**, and with continuing dependency on the sustainable use of land and water resources, adapting to climate change will need to be a critical element of Africa’s development agenda.

### **Social and gender dimensions of vulnerability to climate change**

12. **The people most affected by climate change** and who will find it hardest to adapt are those living in poverty, in low-income countries with weak or unstable states. Under these conditions, the physical effects of climate change will considerably increase the negative impacts on livelihoods, and in a vicious circle, increase the risks of mass migration, violent conflict, and further state fragility. Sub-Saharan Africa is particularly vulnerable, not only because of its low income and high incidence of poverty, but also because of the fragility of most of its state structures and the prevalence of violent conflict over the past decades.

13. **The degradation of ecosystems**, including forests and coastal ecosystems that support livelihoods, desertification, and droughts, and the increased frequency and severity of extreme weather events, will increase the fragility of many rural livelihoods

and thus intensify human vulnerability. Africa is likely to be affected by greater food insecurity and diminished access to safe water.

14. **Although broad sections of society may face similar levels of exposure** to climate variability, the degree of vulnerability to adverse impacts will be shaped mainly by livelihood opportunities, gender, age, disability, social class, and ethnicity. The poor tend to be most dependent on climate-sensitive sectors or activities such as agriculture, fishing, and forestry, while at the same time they face fewer possibilities to diversify into less climate-sensitive activities. Indigenous peoples, although not as numerous in Sub-Saharan Africa as in other regions, are especially vulnerable to climate change effects on ecosystems because they depend so heavily on forests and other natural habitats.

15. **From a social development perspective**, history teaches us that focusing on increasing resilience and the adaptation capacity of communities is fundamental and requires an understanding of the impact of climate variability on poverty and vulnerability, and who is affected. Rural women may be particularly affected because they tend to play a greater role in natural resource management and ensuring nutrition. They often grow, process, manage, and market food and other natural resources, and are responsible for managing vegetable gardens and collecting fuel and water. In addition, actions to mitigate climate change must benefit the poor and avoid exacerbating inequalities, thus the importance of building the adaptive capacity and resilience of communities, vulnerable groups, and the institutions that support them. Finally, building adaptation and resiliency must be based on the capacities of affected communities themselves.

## Objectives and Core Principles of the Strategy

16. **The World Bank Group’s strategy** — *Making Development Climate-Resilient: A World Bank Strategy for Sub-Saharan Africa* — aims to articulate a vision, key messages, priorities, and operational implications of the Bank Group’s climate-related work in Sub-Saharan Africa. It is grounded in an assessment of the diverse climatic profile and vulnerabilities of the region, including identified knowledge gaps, expected impacts, work already under way by countries and partners, and key actions to be taken over time.

17. **The strategy is underpinned by four principles:**

- **Disaster risk reduction and climate change adaptation need be managed as a single integrated agenda.** Adapting to climate requires preparing for long-term changes in average climatic conditions. From a development perspective, however, most impacts of climate change, especially in the short to medium term, will materialize through variability and extremes. Because climate disasters are already occurring on a regular basis, risk management provides a more relevant entry point for most development planning and investment decisions than would a long-term scenario for changing average conditions. It would also yield positive economic and social returns in the short run.

- **Adaptation and risk reduction are fundamentally about sound development.** Climate change adds urgency and the need for renewed focus on prioritization, as well as ensuring that adaptation is fully integrated into growth and poverty reduction strategies.
- **Mitigation should go hand-in-hand with adaptation,** but should not be a constraint on Africa's access to energy and economic growth. Given that African countries contribute little to global greenhouse gas (GHG) emissions and that two-thirds of the continent's CO<sub>2</sub> emissions originate with land-use changes, the continent should be able to continue on a growth path through a mix of clean coal, renewable, and energy-efficient technologies, along with sustainable land and water management.
- **Scaling-up financing is necessary to meet Africa's development needs in a climate-constrained environment.** There is clearly a need for additional financing to build capacity, mainstream climate change considerations into development planning, and climate-proof existing and future investments. The UNFCCC process is expected to produce an agreement on new, additional and predictable funding streams to finance the additional costs of climate resilience and low-carbon growth in developing countries. *For the purposes of the Bank's ongoing development work* in most African countries, the International Development Association (IDA), with its mission of poverty reduction, will continue to be the main platform for funding development through sector operations and will increasingly play a vital role in helping to mainstream climate considerations into core development. In addition, these funding streams will be augmented by new climate investment funding, carbon finance, and other emerging specialized instruments. There will also be greater scope to leverage financing from the private sector using many of these instruments.

18. **World Bank support to Sub-Saharan African countries** will be mainstreamed into country and regional programs along four pillars:

19. **Pillar 1 — Make adaptation and climate risk management a core component of development.** While adapting to climate variability and change will push up the cost of development, for most African countries adaptation is fundamentally about sound, resilient development. Key focus areas include disaster risk reduction; sustainable land, water, and forest management; coastal and urban development; watershed management, increased agricultural productivity; health; and social issues.

20. **Pillar 2 — Take advantage of mitigation opportunities.** Most of the region's mitigation opportunities are linked to more sustainable land and forest management, clean energy use and development (such as geothermal or hydropower), and the creation of sustainable urban transport systems. Some opportunities exist to access carbon finance by reducing emissions from deforestation and forest degradation,<sup>2</sup> and through renewable energy and energy efficiency. If included in future compliance markets, agriculture soil

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2. A pilot REDD (Reduce Emissions from Deforestation and Forest Degradation) program through the voluntary market is in place until 2012.

carbon could significantly enhance these opportunities. This will help African countries to commit to the mitigation agenda while furthering development.

21. **Pillar 3 — Focus on knowledge and capacity development.** While there is unequivocal evidence that the climate is changing, there is a great deal of uncertainty about the pace and extent of change and the impacts on different sub-regions and sectors. This uncertainty makes policy decisions more complex, and magnifies the need for Africa to build its knowledge and analytical base, as well as strengthen the capacity of country and regional institutions for weather forecasting, water resources monitoring, land-use information, disaster preparedness, risk management, and planning and coordination.

22. **Pillar 4 — Scale-up financing opportunities.** The actions proposed under this strategy will be funded primarily through IDA’s core development finance. In addition to IDA’s programmatic financing, incremental financing to build the knowledge base, strengthen institutions, and climate-proof investments<sup>3</sup> will come from both existing and new institutions. Whilst carbon finance (CF) and Global Environment Facility (GEF) have operating for a number of years, more instruments include: the Adaptation Fund of the United Nations Framework Convention on Climate Change (UNFCCC); the World Bank Group’s Climate Investment Funds (Strategic Climate Funds; Clean Technology Fund); and two new Carbon Fund instruments — the Forest Carbon Partnership Facility and the Carbon Partnership Facility. A number of these will help to leverage underlying finance from both public and private sources.

## **Climate Change Affects Resource Sectors That Are Already at Risk**

23. **Climate variability and change will impact land and water resources,** which are already at risk from unsustainable management and lack of adequate development. This will most directly affect agriculture and energy development, which are fundamental to Africa’s growth and poverty reduction programs.

### **Land resources**

24. **A majority of the African population is heavily dependent on land resources.** In light of population growth, local development pressure, and climate change, maintaining a healthy natural resource base is a major challenge in rural areas. Food productivity is constrained by insufficient nutrient input, lack of erosion control, and pressure from overgrazing. Increases in agricultural output have come largely through the expansion of cropland into increasingly marginal areas. Forests and woodlands are being cleared despite not being suitable for permanent agriculture.

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3. During the timeframe of the strategy (2010-2012) and beyond, reliance on increasing IDA resources is key, while a number of alternative financing instruments are being discussed, including extending a two percent levy on Clean Development Mechanism (CDM) proceeds to Joint Implementation projects or carbon emission transactions.

25. **Lack of effective land management** has resulted in widespread land degradation across the continent, eroding the foundation of rural livelihoods and increasing the threat of food insecurity. Some estimates suggest that about 67 percent of the total area of Sub-Saharan Africa, about 16 million square kilometers, is affected by some form of land degradation, of which about one-fourth is rated severe to very severe.

26. **Land degradation processes may be exacerbated by climate change.** More intense rainfall promotes soil erosion. Increasing temperatures increase evapotranspiration rates that reduce soil moisture, and in conjunction with shifting rainfall patterns, will affect vegetation patterns and the growing period for crops. Prolonged dry spells and erratic climatic conditions may lead to short-term coping strategies such as deforestation to increase livelihoods. They may help to mitigate the immediate impact of a climatic event, but will prove to be maladaptive in the long term by having adverse consequences for watersheds, biodiversity, and provision of important ecosystem services.

27. **Declining land productivity and ecosystem services** makes rural livelihoods more vulnerable to climatic variations and affect their capacity to recover from climatic shocks such as prolonged dry spells. Forest degradation and other changes in land cover may also increase exposure to floods as water infiltration capacity is reduced and surface run-off is increased.

28. **Land-use changes and land degradation also contribute** to greenhouse gas emissions and affect local climatic conditions. Emissions from land use, land-use change, and deforestation are the single largest source of emissions in Sub-Saharan Africa. Where land-use changes reduce above-ground organic carbon, soil carbon also usually declines. This decline in organic matter has adverse effects on several physical, chemical, and biological soil properties, which impact land productivity, biodiversity, and ecological functions. Land cover changes can also lead to changes in local climatic conditions due to different surface reflectivity and water transpiration.

### **Water resources**

29. **Water is a vital development component of nearly every sector in Africa,** including urban services and industry, land management, energy, agriculture, environmental services, and fisheries. Lack of a reliable water supply of adequate quality undermines public health, restricts industrial growth, limits energy production from hydropower (and possibly thermal sources as well), constrains agricultural productivity and food production, and threatens and may eliminate important environmental services, including fisheries.

30. **Climate change will manifest itself primarily through changes** in average temperature and precipitation, which are important drivers of the water cycle and hence the seasonal occurrence and volume of water in groundwater aquifers, soils, lakes, rivers and wetlands. This adds a new dimension to the already high variability of precipitation and the water cycle, and presents a huge challenge to water resource development planners and managers who are used to basing their forecasts and designs solely on

historical information. In addition to the challenge of finding enough water at the right time for all economic sectors and the environment, most countries also have to struggle with the destructive and sometimes cumulative impacts of water-related natural calamities brought about by climate change.<sup>4</sup>

31. **Water storage is vital to guard against the effects of high climate volatility** and ensure that water is available where and when it is needed. In most of Sub-Saharan Africa, precipitation occurs in just one season lasting four to six months, and the seasonal and inter-annual variation in the timing and volume of precipitation is high. Africa (excluding South Africa) has the world's lowest surface water storage capacity, at about 43 cubic meters per person per year, compared to a water storage capacity in North America of 6,150 cubic meters per person per year.

32. **Though Africa is endowed with a generous supply of water resources**, most of its river basins cross country borders, highlighting the importance of effective institutions that help to ensure shared benefits from cooperation. Africa has estimated annual renewable surface water resources of about 4,590 billion cubic meters per year, three-quarters of which are concentrated in eight large transboundary river basins: Congo, Niger, Ogadugne (Gabon), Zambezi, Nile, Sanga, Chari-Lagone, and Volta. There are a total of 63 transboundary river basins which account for 90 percent of Africa's surface water resources and cover 64 percent of its surface area. In addition to rivers, there are more than 160 lakes larger than 27 square kilometers, primarily in the equatorial region and the East Africa highlands.

33. **The very large investments required** to develop multi-purpose and single-purpose water resource infrastructure will necessarily require a more thorough analysis of the returns to investment that explicitly account for hydrologic risk. The need to give greater consideration to these risks has important implications for the way the cost-effectiveness of early investments in water resource infrastructure are assessed. Without taking such risks into consideration, current low-yielding agricultural practices, combined with the high investments for irrigation water, partly justify the severe inadequacy in irrigation investment in most of Africa.

34. **Future development efforts will have to include unlocking hydropower**, water supply, irrigation, flood and drought management, navigation, environmental, and other economically and socially important water uses. The close connection between the urgent need to increase access to modern energy, and rewards from GHG mitigation through clean energy, gives Africa the opportunity to adopt a multi-purpose water resource development approach involving complementary water security infrastructure to manage hydrological variability. Such variability includes storage, containment, ecological balances, water conservation, flood management, drought mitigation, hydropower development, and water for industry, domestic use, navigation, and irrigation.

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4. For example, floods in Mozambique caused average growth to drop from 7.5 percent per year between 1994 and 2003 to 1.5 percent in 2000. Kenya suffered an 11 and 16 percent drop in GDP due to the El Niño floods and the La Niña drought between 1997 and 2000

35. **This multi-purpose and integrated approach** — which follows directly from the unitary character of water resources — has the clear potential not only to help countries build economic resilience to climate change, but more importantly, to diversify their economies through sustainable intensification of agriculture based on irrigation, and develop and/or deepen new economic activities made possible by a larger and more stable supply of electricity. Multi-purpose water resource development has the potential to offer significant benefits to the countries of Africa, provided that appropriate water governance institutions are established to manage the complex dynamics of multi-country development.

### **Agriculture**

36. **The recent food crisis has highlighted the important fact** that climate change may become a threat multiplier, and thus the need for policy makers to move the agricultural agenda forward quickly and decisively. Compared to other World Bank regions, agriculture in Sub-Saharan Africa has the lowest productivity, and climate change (through warming, changes in rainfall, increased flooding, extreme heat events, pests, and loss of irrigation water) could have severe consequences for agricultural production. Crop failures and livestock deaths are already imposing significant economic losses and are undermining food security. These impacts are likely to become more severe as global warming continues.

37. **Neglect of the agriculture sector has contributed** to unfavorable socioeconomic and ecological conditions for the rural poor, leaving them particularly vulnerable to climate variability and change. The agricultural productivity of smallholder farmers is affected by severe degradation of the natural resource base and low water availability, which are being exacerbated by climate change. Agriculture is mainly rainfed, with only 7 percent of the cultivated area under irrigation. Of particular concern for the region are soil erosion and nutrient depletion. About 75 percent of Africa's farmland is affected by severe mining of soil nutrients, and without carbon fertilization, agricultural output would be reduced by an estimated average of 28 percent in Africa.

38. **Under-investment in the sector is one important cause of poor agricultural performance.** The vast majority of Africa's 200 million rural poor has very little access to new technologies, advisory services, input and output markets, credit, water and sanitation, and roads. Public spending on agriculture is particularly low, amounting to only 4 percent of agricultural GDP in agriculture-based economies, compared with 10 percent in successful transforming countries in 1980 (at the beginning of their transition period). Per capita growth of the agricultural population — which is a crude measure for agricultural income — is only 0.9 percent, less than one-half that of any other region.

39. **The agriculture sector has features that make it a unique instrument** for sustainable development, including providing mitigation benefits on a potentially massive scale. With 82 percent of Africa's population living in rural areas, the agriculture sector is fundamental for economic growth, poverty reduction, and environmental sustainability in the region, as highlighted by the World Development Report (2008g). Since agriculture will continue to be a major part of many African economies for a long time, the right



kinds of investments, including expanded irrigation, could lead to productivity gains that improve the lives of a large percentage of the rural population. In addition, for the vast majority of the land—which is rainfed—mixed crop-livestock and conservation farming focused on sustainable land, soil moisture, and biomass management technologies, could help boost productivity and sequester significant amounts of carbon in soils, thus contributing to mitigating greenhouse gases and potentially providing additional financial resources to small farmers.

### **Energy resources**

40. **The lack of access to electricity, or its unreliable supply,** is a major impediment to growth and competitiveness of African economies, particularly exports. Only 24 percent of Africa’s population has access to even basic electricity supply. Underlying the low level of access are exceptionally low levels of installed generation capacity, of which 60 percent is in South Africa alone. Twenty-eight countries are or have been affected by the energy crisis in the past two years, and the mismatch between demand and available supply is growing. With more than 550 million Africans without access to electricity, energy demand is expected to soar in the future, as is energy production—which could exacerbate the effects of climate change.

41. **Climate change presents additional challenges to the energy sector,** which has already been hit hard by high oil prices. More erratic rainfall has severely affected the power generation of hydropower dams in both eastern Africa (Ethiopia, Tanzania and Uganda) and western (Ghana, Cameroon) Africa, forcing these countries to spend their limited resources to add emergency generation capacity, most of which relies on coal- or fuel-based systems, thus aggravating greenhouse gas emissions.

42. **Africa has large, unexplored potential for hydro, solar, and wind power** and other new renewable resources. Of its huge hydroelectric power potential, only 7 percent is currently utilized, compared, for example, to more than 30 percent in Latin America. While wind and solar power potential are being assessed across the continent, a geothermal potential of 7,000 megawatts has been estimated mainly in the Rift Valley in eastern Africa. The African Ministerial Conference on Hydropower and Sustainable Development agreed in 2007 on an ambitious plan of action for developing the huge untapped hydropower potential on the continent. Nonetheless Africa’s development imperative means that all available sources of energy will be needed, including thermal power installations and, in some cases coal.

43. **Africa has an unprecedented opportunity to benefit from GHG mitigation.** By choosing a cleaner development pathway through low-carbon alternatives to meet its future energy needs, African countries can receive support from carbon finance schemes and the Clean Development Mechanism (CDM) of the Kyoto Protocol. For the 44 African countries and 22 technologies that have been approved by the CDM Executive Board, there is an estimated technical potential of more than 3,200 low-carbon energy projects.

44. **If fully implemented, this pool of potential projects could provide** more than 170 gigawatts of additional power generation capacity, more than twice the continent’s current installed capacity, and avoid GHG emissions totaling about 740 million tonnes of carbon dioxide equivalent per year. A conservative estimate of the total capital cost for these potential low-carbon energy projects is about \$150 billion. To unlock this potential would require both CDM reforms and important regulatory reforms, such as allowing the sale of renewable energy to national electricity grids, most of which are managed in monopolistic arrangements, as well as the collection and transport of renewable energy and the dissemination of clean energy technologies, among others.

## Priority Areas of World Bank Support

45. **In addition to incorporating climate change in the policy dialogue**, the World Bank will focus its actions along the four pillars of the strategy. Most of the proposed actions are not new but build on — and add a climate risk management perspective to — the development work already ongoing in various sectors through the implementation of the Africa Action Plan.

### Policy dialogue

46. **The main focus of the Bank’s approach is mainstreaming climate change** policy and action in the Poverty Reduction Strategies (PRS), Country Assistance/Partnership Strategies (CAS/CPS), and key sector strategies (e.g., agriculture, forestry, water, energy, health, and infrastructure), to ensure that country programs and budgets reflect climate risks. This will be done systematically and timed with country updates of Poverty Reduction Strategies and development plans, as well as the Bank’s own country strategies and sector programs.<sup>5</sup>

### Adaptation and mitigation opportunities

47. **Mainstreaming climate change analytical work and investments** into IDA/IBRD-financed sector operations will focus on a number of areas where the Bank is already implementing significant programs. The Strategy provides entry points and opportunities to incorporate actions aimed at strengthening resiliency to climate risk and enhancing the mitigation benefits of development programs, through provision of information, piloting, and innovating, as well as providing expertise and resources to add value to ongoing operations. The following is an indicative — but not exhaustive — list of such actions.

48. **Sustainable agriculture and watershed management.** Overall, the focus will be on investing in research and advisory services to develop and disseminate adaptation options, and scaling-up investments that build resiliency. At a country level, particularly in West Africa and the Sahel, Horn of Africa/East Africa, and Southern Africa, priority will be given to promoting and scaling-up investments in land and watershed

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5. Policy dialogue is already underway in several countries, including Ethiopia, Kenya, Mozambique, Zambia, Malawi, Cameroon, Ghana, Burkina Faso, Niger, Nigeria, and Senegal.

management, test piloting new crop varieties, expanding conservation farming, piloting and expanding irrigation technology options, developing and enhancing early warning and risk sharing mechanisms, and supporting community-driven programs. In addition, the strategy will support analytical work and pilot investments that enhance carbon sequestration in agricultural soils, and help collect technical and economic information to help build the capacity of African countries.

49. **Water resources management and disaster risk reduction.** Building on the region’s overall focus on river basin management (in the Nile, Niger, Zambezi, Congo, and Senegal river basins, as well as Lake Chad and Lake Victoria), scaling-up infrastructure includes multi-purpose storage and improving water-use efficiency. The strategy will call for support across the region to build the capacity to manage hydrologic risk through institutional strengthening, information and knowledge development (including historical and projected climate information, hydro-meteorological data acquisition and management tools, and support to basin organizations and water utilities for climate risk assessment and strategic planning). Moreover, building on work already underway on disaster risk management, especially in priority areas (including West Africa, Horn of Africa/East Africa, and eastern Southern Africa), the strategy calls for particular focus on droughts and floods and will require a combination of analytical work and investments in hazard risk and vulnerability assessments, policy and institutional capacity building, and updating and using infrastructure norms and standards in new operations.

50. **Urban development.** While the main entry point will be developing and utilizing land-use planning and flood and drainage risk mapping in planning urban services, priority areas include rapidly growing urban and peri-urban areas in West, East, and Southern Africa. Future Bank operations in these areas could have an added focus on assessing long-term water supply and reliability, strengthening urban services management through development and use of flood drainage risk mapping, and investing in shifting municipal services infrastructure away from risk zones, and redesign of infrastructure to mitigate flood and drainage problems.

51. **Coastal zones and fisheries.** The main focus is on supporting countries in West, East, and southern eastern Africa to manage coastal areas for sea level rise and sustainable fisheries. Specific initiatives include vulnerability assessments of coastal urban areas and infrastructure investments to sea level rise, flooding, and coastal erosion. Moreover, the strategy will support strengthening capacity for fisheries management, monitoring and evaluation of climate change effects on specific fisheries, and fishing communities.

52. **Forestry and biodiversity conservation.** The strategy supports work already underway in sustainable forest management and conservation of critical/fragile terrestrial and aquatic ecosystems in several countries of the Congo Basin and Southern Africa. In addition, a program to support generating carbon revenues from Reduced Emissions from Deforestation and forest Degradation (REDD) in seven countries is also being implemented.

53. **Health.** The main focus will be on raising awareness, information sharing among health and climate agencies, and promoting investment in vector control and surveillance programs — in areas where disease vectors could increase — with a special focus on malaria in West Africa and the Horn of Africa. In addition, access to water supply and sanitation, and improving health and nutrition programs across the regions will have significant adaptation benefits.

54. **Social and gender issues.** Across Sub-Saharan Africa, the strategy calls for ensuring that responses to climate change are gender-sensitive and support community-based programs that factor in local adaptation to climate change. It would also ensure that the poor and those living in low-income areas, weak and fragile states, and in flood and drought-prone areas, are not left behind. Some analytical work — focused on costing adaptation options through local institutions, and vulnerability assessment with particular attention to migration, youth issues, and indigenous peoples — is already underway in some parts of West and East Africa. New analytical work will be undertaken to identify operational approaches for mainstreaming gender in climate-change-related programs, with a particular focus on natural resource and watershed management and community-driven programs.

55. **Energy access.** The overall focus is on supporting the Africa Action Plan program of investments in energy development and access, using a mix of clean coal technology, renewable energy (especially hydropower), and energy efficiency. Because of pervasive and widespread use, solid biomass (wood fuel, charcoal, and crop residue) will continue to be an important source of energy in Africa over the next 30 years, while biofuels will see some moderate increase. While promoting low carbon growth in middle income countries (e.g., South Africa and Botswana), elsewhere, the focus is on expanding generation capacity and regional trade (through the East, West, and Southern Africa Power Pools), investing in geothermal (in East Africa), promoting gas flaring reduction (in West Africa), and supporting off-grid renewable energy in several other countries.

56. **Transport.** In addition to a region-wide recommendation for the strategy to review and revise transport standards to account for a shift in the frequency and magnitude of extreme events such as floods, investments in urban transport projects in several major African cities (e.g., Lagos, Accra) already include measures to reduce GHG emissions, and also support public transport, improved safety, and reduced exposure to air pollutants.

### **Special focus on knowledge and capacity development**

57. **There are significant deficits in knowledge and capacity** to address the problems of climate change. Capacity development is a long-term challenge that is embedded in essentially all development initiatives by the Bank and other development partners. Climate change adds a layer of complexity to existing capacity development challenges, and requires integration and coordination among sectors. The strategy identifies three groups of activities not necessarily mutually exclusive. The first is aimed at building the knowledge base and capacity within the Bank; the second targets building

the capacity of Bank clients through technical assistance and analytical work; and the third aims to build capacity through sector-specific investment operations.

BUILDING THE KNOWLEDGE BASE AND CAPACITY WITHIN THE BANK

58. **The Bank is planning a number of regional initiatives** to help generate the knowledge necessary for operational design and client support.<sup>6</sup> Among these are two major new initiatives:

59. **Development of a climate information portal.** This initiative involves augmenting ongoing programs with data collection, case studies, and operational toolkits to help identify solutions that can be piloted through country and regional operations. A core element of the portal involves setting up a database (accessible to client countries and other stakeholders) that includes historical and projected climate information, hydrology, land use, and prediction models appropriate for Africa. Also included are several types of case studies, including: (i) adaptation in agriculture and watershed management; (ii) water resources management and the implications of climate change for hydropower development and management (e.g., operational implications of future hydrologic risk, and analysis of the efficiency of rehabilitation versus building new infrastructure); and (iii) impacts of sea level rise.

60. **Development of an analytical capacity on economic issues related to climate variability and change.** A number of pilot economic studies will be initiated — in Ethiopia, South Africa, Mozambique, Ghana, and Sudan — to test and develop methodologies and obtain estimates of the economic impacts of climate variability and change that are useful for policy work, and the costs and benefits of adaptation. These studies will also feed into other regional and global economic assessments managed by the Bank's global climate change and Global Facility for Disaster Reduction and Recovery (GFDRR) teams. Additional work will identify economically viable carbon finance opportunities (including carbon sequestration in agricultural soils) using existing CDM-related instruments or new initiatives. Finally, new work will be initiated on climate-proofing and carbon footprints in the Bank investment portfolio in Africa through two specific activities: (i) screening the Africa Region portfolio for development projects in key sectors in each country for climate risk to identify measures that can improve climate resiliency and adaptation to climate change; and (ii) developing methodologies to estimate the carbon footprint and shadow price of carbon in Bank operations. This information will be useful to estimate the additional costs of mainstreaming adaptation/carbon resource management (CRM) and/or mitigation opportunities into the Region's project portfolio and pipeline.

STRENGTHENING THE CAPACITY OF BANK CLIENTS TO MANAGE CLIMATE RISK

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6. While aimed at building internal institutional capacity, information and knowledge generated under this group of activities will also be made available to Bank clients and partners. Moreover, it is important to note that while initially capacity building within the Bank is necessary, over time, an assessment will be done regarding the comparative advantage of the Bank and various other international and regional institutions to maintain climate-related data and modeling capacity.

61. **The Bank is planning a number of regional and country-based initiatives** to provide technical assistance and help build a knowledge base in client countries. Some of these initiatives include:

62. **At a national level, a capacity building program for climate risk management** is needed at all levels — not just among a few technical specialists in a central government agency, but also within regular sector agencies, local government, the private sector, and non-governmental partners. In most cases, the key is not so much to identify the information, but to apply it in an appropriate way to reduce risk. The initial focus will be on economic and hydro-meteorological planning, and energy agencies in several countries, including Ghana, Mozambique, Ethiopia, Kenya, Madagascar, Malawi, Niger, and Zambia.<sup>7</sup>

63. **In areas identified as hot-spots from a disaster risk perspective,** the Bank will support the development of National Program Frameworks for Disaster Risk Management and Climate Risk Management. These programs — already underway in Ghana, Mozambique, and Ethiopia — will benefit from funding under the Hyogo Framework for Action,<sup>8</sup> and will focus on the these areas: policy, institutional capacity and consensus building; disaster risk assessment; vulnerability assessment, monitoring, and early warning; knowledge and capacity enhancement for DRM; reducing underlying risk factors and integration across sectors, and disaster preparedness and recovery.

64. **At a regional level, the Bank will collaborate** with the World Meteorological Organization (WMO) to strengthen regional climate and hydrologic institutions. WMO will work with national meteorological institutions and the Climate Predictions and Applications Center of the Intergovernmental Authority on Development in East Africa (ICPAC) to strengthen local and regional capacities to assemble climate information and assess the validity of regional climate modeling methods to inform the design of adaptation and climate risk reduction strategies. In consideration of practical applications, the project will emphasize the dialogue between information providers and users. Other regional organizations that could benefit from such an initiative include the climate observatory OSS (Observatoire du Sahara et du Sahel), ACMAD (African Centre of Meteorological Applications for Development), and the SADC drought monitoring center.

65. **Support for Climate for Development in Africa Program,** (ClimDev-Africa), which is a joint initiative of the African Union Commission (AUC), the United Nations Economic Commission for Africa (UNECA), and the African Development Bank. This will be done through sharing climate information from the Bank Climate Portal, analytical tools and studies, as well as collaboration on joint workshops and training, and coordination at the country level.

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7. In particular, an initiative already under way in Madagascar works with national champions and institutions by linking them with international centers of excellence, and will be replicated in several other countries.

8. International Strategy for Disaster Reduction (ISDR): Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters.

CAPACITY BUILDING IN INVESTMENT OPERATIONS WITH CRM COMPONENTS

66. **Capacity building involve support to project and country teams** in identifying country-level adaptation activities either as components or stand-alone investment operations in key sectors, in close collaboration with key development partners (DFID, EU, AfDB, JICA, UN agencies, etc.). While this initiative will be progressively rolled out through the project pipeline over time, some of the operations already under way or at an advanced planning stage include:

- **Adaptation to Climate Change in Arid Lands Project in Kenya** will mainstream climate risk management within the ongoing Arid Lands Management Project.
- **Zambezi Valley Market-led Smallholder Development Project in Mozambique** factors climate change in planning and implementation of new approaches to improve the livelihoods of small farmers.
- **Agriculture Development Program Support Project (ADP-SP) in Malawi** focuses on food security and sustainable agricultural growth. As part of the ADP-SP, the Bank is implementing a pioneering weather-index insurance scheme aimed at buffering small-scale farmers against productive losses associated with climate variability. This effort is complemented by a macro weather insurance scheme that helps to transfer risk of severe national droughts to international markets and provide the government with timely funding if a contractually specified catastrophic rain deficit occurs during the cropping season. The project also finances capacity building in commodity risk management.
- **Productive Safety Net Program (PSNP) in Ethiopia**, for the chronically food insecure, focuses on consumption smoothing, asset protection, and the creation of community assets through a public works program and direct support. A new drought risk management tool (Livelihoods, Early Assessment and Protection, LEAP) will help predict and mobilize funding ahead of a drought.
- **Niger River Water Resources Development Project (WRDP)** will include climate adaptation activities in key sectors — infrastructure, agriculture including irrigation, environment, and energy — that can be implemented by the riparian countries as part of their investment plans.

**Expanding access to financing**

67. **The proliferation of different funds and initiatives is creating confusion** and a potential for duplicate efforts. The Bank will help its client countries to obtain adequate information and access these funds. Over the longer term, the Bank will encourage the development of coherent and integrated funding mechanisms for Africa around IDA, consistent with the climate change arrangements that will eventually emerge after 2012.

68. **In addition, because funding levels in the short and medium term** are still inadequate, and most new funds are designed for piloting and learning (e.g., the Pilot Program for Climate Resilience), the Bank will continue to advocate for increases in international funding to support disaster and climate risk management in Africa in the

context of regular investment operations, thus ensuring that international money can be programmed for effective risk reduction in the short and long terms.

69. **The actions proposed under this Strategy** will be funded primarily through IDA’s core development finance. IDA will also be used as a platform to leverage financing from the private sector, and other multilateral and bilateral donors, UN agencies, and new multilateral climate financing. Considerable effort will be expanded to ensure that African countries have the opportunity to access additional financing from a variety of emerging financing sources, which can be broadly classified into two groups — development-based and market-based.

#### DEVELOPMENT-TARGETED FINANCING

70. **This category includes the World Bank’s new Climate Investment Funds (CIFs)**, including: (i) the Clean Technology Fund (CTF) targeted at high-emitting developing countries; and (ii) the Strategic Climate Funds (SCFs), which include the Pilot Program for Climate Resilience (PPCR), the Forest Investment Fund (FIF), and the Scaling-up Renewable Energy Program for Low-Income Countries (SREP). Three African countries have been selected to participate in the PPCR, (Niger, Zambia and Mozambique) and two are likely to participate in the CTF (South Africa and Nigeria). The operational modalities of the FIF and SREP are still being finalized. In addition, other funding sources are also being set up, including the GEF Trust Fund and its Special Priority on Climate Change; the Special Climate Change Fund and the Least Developed Countries Fund under the UNFCCC; the Adaptation Fund under the Kyoto Protocol, UNDP’s Adaptation Program for Africa, ClimDev, and other bilateral initiatives.

71. **On the disaster risk reduction side**, the Global Facility for Disaster Reduction and Recovery (GFDRR) is a new and rapidly expanding vehicle for funding disaster risk reduction and recovery efforts. The GFDRR includes a mechanism for accelerated recovery, the Standby Recovery Financing Facility (SRFF), which aims to mainstream disaster risk reduction and climate change in post-disaster operations.

72. **Given the significant overlap between disaster risk management and adaptation**, the strategy calls for close coordination among financing sources in such a way as to allow disaster risk reduction investments to be financed under adaptation funds, while ensuring that disaster risk reduction programs funded under the GFDRR pay appropriate attention to changes in climate risks. Close cooperation among the various agencies managing these funds will be needed to develop guiding principles, both in headquarters and at the country level. This approach will be piloted in Madagascar, Mozambique, and Malawi, and will be extended to Ethiopia, Kenya, Senegal, Niger, and Mali.

73. **Finally, financing targeted at scaling-up sustainable land management** will be provided through TerrAfrica, a multi-stakeholder platform focused on scaling-up and harmonizing sustainable land management (SLM) investments through coalition building, knowledge generation, and country-specific investments and activities. An important part of the funding under TerrAfrica is through the GEF Strategic Investment Program (SIP) on SLM. This approach is complemented by a range of World Bank



projects that blend IDA investments and GEF grant financing for activities focused on climate change, including large project components focused on SLM issues.

74. **Carbon finance.** Carbon finance increases the bankability of projects by adding an additional revenue stream that reduces the risks of commercial lending or grant financing, and thus provides a means to leverage new private and public investment into projects that reduce greenhouse gas emissions, thereby mitigating climate change while contributing to sustainable development. Therefore, in addition to small specialized Carbon Finance Funds (most of which have been in existence over the past 10 years), and while the challenges of the CDM and the negotiations around a long-term framework for the post-2012 period are worked out by the international community, the World Bank added two new instruments — the Forest Carbon Partnership Facility (FCPF) and the Carbon Partnership Facility (CPF) to help pilot positive incentive mechanisms:

75. **The Forest Carbon Partnership Facility has been designed** to set the stage for a large-scale system of incentives to reduce deforestation and forest degradation (REDD). It will assist developing countries in their REDD efforts by adding value to standing forests. The FCPF, approved by the World Bank Board of Executive Directors in 2007, is already operational and has received expressions of interest from 17 African countries.

76. **The Carbon Partnership Facility is designed** to develop emission reductions and support their purchase over long periods after 2012, using a programmatic approach. Its objective and business model are based on the need to prepare large-scale, potentially risky investments with long lead times, which require durable partnerships between buyers and sellers, and which use a programmatic rather than individual project approaches.

#### CARBON FINANCE AND THE CLEAN DEVELOPMENT MECHANISM

77. **The Strategy will help position African countries** to tap into the expanding carbon market in the context of the CDM and through new instruments. Current carbon finance mechanisms have not delivered the needed resources to Africa. At the end of 2008, out of 2,700 CDM projects already under validation worldwide, only 12 are in Sub-Saharan African countries (excluding South Africa).

78. **The Bank will scale-up efforts to systematically identify** viable CDM opportunities (and opportunities for the post-2012 funds) across Africa's energy sector, as well as in relation to biomass (e.g., bagasse, forest and forest industry residues, agriculture and agro-industrial residues). The Bank will support projects in rural electrification (Ethiopia), electricity transmission and distribution (Ethiopia, Kenya, Nigeria), energy efficiency (Kenya, Ghana, Senegal), hydropower (Nigeria), waste-to-energy (Nigeria, Swaziland), agroforestry (Ethiopia, Congo), and carbon finance (Uganda, Rwanda).

79. **Constrained financing is another major barrier to scaling-up** clean energy development in Africa. While carbon finance can bring an additional revenue stream to clean energy projects, it cannot provide the much needed up-front financing. The Bank

will adopt a sector-wide approach to scale-up financing in the energy sector, and will do more to integrate carbon finance into its mainstream business in the future.

#### INSURANCE

80. **Risk transfer can help to mitigate some of the most severe impacts** of natural hazards due to climate change. At the national level, the government may use risk insurance to supplement its own contingency funds by transferring some of the risk to international financial markets. At the local level, there are encouraging pilots on index-based weather index insurance, which can help local farmers cope with climate variability and enhance investment opportunities.

81. **International financing may help to jump start** (or, in case of clearly rising climate risks, even subsidize) insurance mechanisms. The Caribbean Catastrophe Risk Insurance Facility is an example of such multinational pooling of risks, with reinsurance for damages above the capacity of the common pool. In addition to exploring the possibility of setting up such a stand-alone facility for Africa, the Bank will continue to support the piloting and rolling out of country-based risk insurance schemes, either as part of social protection programs, as in Ethiopia; as part of rural development and agriculture support programs, as in Malawi; or in the form of index-based crop insurance products for small farmers, as are under development in Senegal.

### Important Role of Partnerships

82. **With the adoption of this Strategy**, the Bank is well positioned to work with African institutions and other partners to support the efforts of vulnerable countries to incorporate climate risk management measures into their economic growth and poverty reduction programs. The Bank Group will strengthen existing partnerships and forge new ones, using its global, multi-sector knowledge base; its financial resources and convening power; and its private sector arms, IFC and MIGA, all to address the cross-cutting nature of the problems and challenges associated with climate variability and change.

83. **Building on the feedback received during the joint World Bank-AfDB** climate change strategy consultations in May-June 2008, the following key partnership-building actions will help speed up implementation and the efficient use of resources:

- Build on the work already undertaken by countries, especially through the National Adaptation Plans of Action (NAPAs), and other emerging disaster and/or climate change strategies.
- Engage the economic and finance ministries, and help countries access both existing financial resources (e.g., GEF, CDM); and new resources (e.g., Climate Investment Fund [CIF];<sup>9</sup> Arab Funds [AFs]).

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9. The Climate Investment Funds are being established by the World Bank jointly with the regional development banks (African Development Bank, Asian Development Bank, European Bank for

- Support regional initiatives such as CLIM-DEV, and regional climate centers (ACMAD, SADC’s Drought Monitoring Center, etc.).
- Joint implementation and joint/parallel financing, with the African Development Bank, of portfolio screenings for climate risk; training programs for staff and clients; and programming missions to roll out the implementation of the Pilot Program for Climate Resilience (PPCR).
- Close coordination with the African Union Commission, NEPAD, and regional economic communities (e.g., ECOWAS, COMESA, and SADC).
- Close coordination and leveraging resources with UK/DFID, EC (notably through the LIMELETTE process), Japan/JICA (notably through the TICAD process), UN agencies (e.g., UNDP, UNEP, WFP, UNECA, and WMO), the Arab Funds, and other partners and stakeholders.
- Build on the TerrAfrica multi-stakeholder platform on scaling-up sustainable land management.

## Monitoring Results

84. **While a framework for tracking climate resiliency over time** will be developed as part of the implementation of the strategy, in consultation with client countries and development partners, the main focus over the next three fiscal years (2010 to 2012) is on the following short-term to medium-term results, which will be monitored through sector operations and an annual report on the implementation of the regional climate strategy:

- Implementation of enabling activities and actions at country level, including: (i) five countries with climate change mainstreamed into PRSPs and/or CASSs; and (ii) five countries with disaster preparedness programs.
- Preparation and dissemination of analytical work, including at least three flagship regional sector studies (water resources, land management, and transport), and six country case studies (vulnerability assessment, economics of climate change, cost of impact and adaptation options, hydrologic risk).
- Introduction of adaptation measures and technical assistance activities into the investment portfolio, starting with the water, agriculture, and energy sectors (six projects with explicit climate change adaptation component or sub-components and associated incremental cost).
- Utilization of carbon finance and pilot climate finance opportunities including: (i) CDM projects in at least five new countries; (ii) at least seven countries start implementing FCPF programs; (iii) at least three countries start implementing PPCR programs; and (iv) at least one county starts implementing a CTF program.

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Reconstruction and Development, and Inter-American Development Bank) to promote international cooperation on climate change and support progress toward a future climate change regime.

## Final – Ready for Print Shop

- Outreach activities (with clients and partners), including: (i) at least two regional workshops per fiscal year, (ii) preparation and dissemination of at least 10 country climate briefs and dissemination notes.
- Set-up of a regional coordination mechanism for mainstreaming climate change into sector operations, and for monitoring the implementation of the strategy.
- Regional training of staff and client countries (some 150 regional staff and 150 partners in client countries trained (in collaboration with the World Bank Institute).

## Incremental Resources to Support Implementation

85. **Implementation of the Strategy will through the country programs and will require strengthening multi-sector** coordination within the regions and with other units in the Bank, additional capacity for monitoring and reporting, as well hiring/training additional Bank staff. Moreover, scaling-up implementation will require mobilizing trust fund resources for technical assistance and project preparation support. In addition to an enhanced administrative Bank budget over FY10-12, significant resources will be mobilized from various trust funds and work will be initiated on setting up a new trust fund dedicated to supporting technical assistance to clients and implementation support for project preparation.



## **Part 1 — Challenges of Climate Change in SSA**



## 1. Introduction

### 1.1 Looming shadow of climate change across the SSA development agenda

86. **Many Sub-Saharan Africa countries have made important economic reforms** in recent years — improving macroeconomic management, liberalizing markets and trade, and widening the space for private sector activity. Where these reforms have been sustained — and underpinned by civil peace — they have raised growth and incomes and reduced poverty. Even as parts of the region are making headlines with wars and natural disasters, other parts are making headway with rising interest from domestic and foreign businesses and higher levels of investment.<sup>10</sup> Nevertheless, despite these gains in the second half of the 1990s, SSA entered the 21<sup>st</sup> century as home to many of the world's poorest countries. Average income per capita is lower than at the end of the 1960s. Incomes, assets, and access to essential services are unequally distributed. One African in five lives in countries severely disrupted by conflict. Across these hopeful signs and development challenges, the shadow of a changing climate now looms.

87. **Climate has always featured prominently in African development**, and the continent's populations have lived and adapted to a high degree of climate variability and its associated risks since time immemorial, moving from hunter-gatherer to pastoralists to more agriculture-based livelihood systems. Flood irrigation was widely practiced along many rivers and in the many wetlands that dot the continent, and is the precursor to modern irrigation systems. Yet, the accelerated changes in the climate during the last century — and the unanimous view that Africa is the most vulnerable and least able to cope with these changes — have brought into sharp focus both the threat and opportunities presented by climate change.

88. **Sub-Saharan Africa (SSA)** lies almost exclusively within tropical latitudes. Two-thirds of its land surface can be classified as fragile desert or dryland (UNEP, 2002). Away from the equator, average annual rainfall declines rapidly and is characterized by higher variability (Figure 3-1). This general picture is somewhat modulated by the influence of larger scale atmospheric circulation and topography. For example, the western equatorial regions are wetter than the eastern. The Ethiopian highlands experience a much cooler and wetter climate than the surrounding lowlands due to topographic effects.

89. **The main challenge is that most African economies and most of the poor** depend on climate sensitive sectors. Agriculture, which contributes some 30 percent of GDP and employs 70 percent of the population, is mainly rainfed — less than 5 percent of cultivated land is irrigated (Table 2-1) — and highly sensitive to droughts and floods.

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10. More recently, external factors affecting Africa's continued progress include: (i) higher oil prices leading to a terms-of-trade shock of about 2 to 4 percent of GDP between 2005 and 2008; (ii) higher food prices (80 percent increase in global price of food since 2005); and (iii) the global financial crisis affecting the flow of private capital.



Africa has the lowest water storage capacity in the world. Malaria, which is already the biggest killer in Africa, is spreading to higher elevations in part due to climate change. Africa's rapidly urbanizing population is vulnerable — poorly defined property rights, weak land-use planning, and informal settlements, frequently on land subject to erosion or flood plains, all contribute to vulnerability. Finally, armed conflicts, terms-of-trade shocks, and aid dependence add to the weight of these factors. Africa's vulnerability could lead to “low human development traps” (UNDP, 2007) from ex ante losses in productivity, and erosion of assets (land productivity, livestock, water resources) and capabilities (health, nutrition, and education).

## 1.2 Challenges and opportunities of a changing climate

90. **Africa accounts for only 4 percent of global greenhouse gas (CO<sub>2</sub>) emissions** that are driving climate change, which reflects the current low levels of income and energy consumption in SSA (Figure 2-2 ). Although climate change has been caused largely by the activities of industrialized countries, efforts to curb global greenhouse gas emissions may create pressure on African countries to curtail energy demands. If such demands slow economic growth, it would be particularly unfortunate because African countries are for the first time in 30 years experiencing sustained growth as fast as developing countries other than China and India (Figure 2-1). Moreover, with only 25 percent of the population with access to electricity, ensuring that energy access and consumption grow rapidly in Africa is a key development challenge.

91. **Alternatively, climate change presents an opportunity for Africa** to accelerate growth and reduce poverty. The opportunity cost of delaying much needed development programs in an increasingly climate-constrained world may be significantly higher in both socioeconomic and political terms. For example, one reason why such a small percentage of cultivated land is irrigated is that the cost of extending irrigation has exceeded the longer-term benefits. But the increased threat of climate change may, at the margin, tip the balance in favor of irrigation as a critical adaptation measure to improve food security and sustain agricultural growth. Similarly, with the prospect of the emergence and re-emergence of disease spreading conditions, malaria may rise in the priorities of policy makers, resulting in benefits for current and future victims. Finally, the benefits of building resiliency into ongoing development programs would far exceed the additional cost when compared to the cost of emergency relief, rehabilitation, and recovery associated with extreme events (Box 1-1).

92. **Even mitigating climate change could be a benefit for Africa.** With land and forest degradation accounting for more than 60 percent of CO<sub>2</sub> emissions in Africa, compared to about 30 percent in the developing world as a whole, Africa could help mitigate climate change by more sustainable management of natural resources, especially land. Most existing carbon trading mechanisms focus on reducing emissions from energy and industry and are currently not well adapted to Africa's needs, but the potential is there.

93. **Africa has the world’s highest level of untapped hydropower resources.** One reason these remain untapped is that a large percentage of African rivers cross national boundaries so that hydropower development requires multilateral coordination and cooperation. Inasmuch as mitigating climate change is a global public good, there is a better chance that the global community would be willing to facilitate the cooperation required for African countries to fully utilize their hydropower potential. However, it may also be necessary for the Clean Development Mechanism (CDM) to either adopt more flexible additionality requirements, or develop renewable energy funds that promote the development of hydropower and other renewables.

94. **Therefore, the objective of the present World Bank strategy** in the Africa region, *Making Development Climate Resilient for Sub-Saharan Africa*, (called the “CC-Strategy” throughout this report) is to provide a road map for the Bank to address climate variability and change in Sub-Saharan Africa, with the aim of helping its clients achieve climate-resilient growth. It is designed to be an integral part of the Region’s development strategy and business plan (the Africa Action Plan, AAP).

**Box 1-1. Economic and social impacts of weather-related disasters is severe**

Droughts and floods cause significant losses and negatively affect economic growth. The aggregate impact of drought on the economies of Africa can be large — 8 to 9 percent of GDP in Zimbabwe and Zambia in 1992, and 4 to 6 percent in Nigeria and Niger in 1984. Floods are among the most devastating natural hazards in Africa and flash floods are one of the greatest hazards arising from tropical cyclones and severe storms. Devastating floods have been reported in major cities across the region. The cost of the year 2000 floods in Mozambique was an estimated \$550 million, with a reduction in the GDP growth rate of 1.5 percent (during the period 1994 to 2003 the annual average growth rate was 7.5 percent). The 1997/98 flood in Kenya destroyed \$1.8 billion worth of infrastructure and property.

Source: World Bank (2005)

### 1.3 Key messages of the CC-Strategy

95. Four key messages underpin the CC-Strategy:

- **Reducing the risk of disaster and adapting to climate change need be managed as one integrated agenda.** While adapting to the climate requires preparing for long-term changes in average climatic conditions, from a development perspective, most impacts of climate change, especially in the short to medium term, will materialize through variability and extremes. These risks already occur, and therefore reducing disaster risk under the current climate is a “no-regrets” adaptation strategy. For most development planning and investment decisions, it provides a much more relevant entry point than a long-term scenario of changing average conditions, and yields positive economic and social returns even in the short term.
- **While adaptation is essentially a risk management strategy — with associated costs and benefits — for most African countries adaptation is fundamentally about sound, resilient development.** A changing climate adds urgency to the need to manage development in the face of increased climate variability, and to ensure that disaster risk reduction and adaptation are fully integrated into growth and poverty reduction strategies. Therefore, growth and poverty reduction should remain the main

focus of Africa's development agenda, despite the emergence of new challenges brought about by climate change.

- **While African countries contribute little to global GHG emissions, mitigation should not be a new constraint to Africa's access to energy and economic growth.** Moreover, there are important synergies and benefits among adaptation and mitigation in key development areas such as energy access, transport, and land management.
- **There is clearly a need for additional financing to build capacity and mainstream climate variability and change considerations into development planning.** For most African countries, adaptation to climate variability and change will be integrated into sector policy dialogue and sector investment operations, hence, IDA will remain the principal financing instrument taking full advantage of new carbon finance and specialized instruments.

96. **The CC-Strategy is grounded** in *Development and Climate Change: A Strategic Framework for the World Bank Group* (World Bank, 2008f) — an overall guide to scaling-up of WBG actions — which itself builds on progress with the Clean Energy Investment Framework (World Bank, 2006a). In addition, the CC-Strategy has benefited from extensive internal and external consultations (both formal and informal) with Sub-Saharan African governments, members of civil society, the private sector, and development partners, as well as African institutions, and a special partnership with the Africa Development Bank (AfDB).

#### 1.4 Four pillars of the strategy

97. **This CC-Strategy document is divided in two parts.** Part 1 focuses on the region's development context (both from a macro and key sector perspectives), a climate profile, a summary of the main impacts of climate change, and concludes with a summary of key initiatives and activities already being undertaken by the countries themselves, the Bank, and key partners.

98. **Part 2 presents the strategy in terms of these four pillars:**

- **Making adaptation and climate risk management a core component of development,** with a focus on energy disaster risk reduction; increased agricultural productivity; sustainable land, water, and forest management; coastal and urban development; health; and social issues.
- **Benefiting from mitigation opportunities** through access to carbon finance to reduce emissions from deforestation and forest degradation (REDD), promoting carbon sequestration based on sustainable agricultural land and forest management, and promoting renewable energy, energy efficiency, cost-effective clean coal, reduced gas flaring, and efficient transport.
- **Focusing on knowledge and capacity development** by improving weather forecasting, water resources monitoring, land use information, disaster preparedness, appropriate technology development, and strengthening capacity for risk management, planning, and coordination.

- **Scaling-up financing for climate risk management**, using IDA15 and additional resources from existing sources (e.g., CDM and GEF), and new instruments, including UNFCCC's Adaptation Fund, World Bank Group's Climate Investment Funds (Pilot Program for Climate Resilience, Clean Technology Fund), the Forest Investment Fund, and new World Bank carbon finance instruments (the Forest Carbon Partnership Facility and the Carbon Partnership Facility).

## 2. Development Context<sup>11</sup>

99. **The CC-Strategy foresees adaptation to a changing climate** and mitigation of greenhouse gases as an integral part of the development agenda in SSA. It is important to examine the development context and its relation to climate change, and to highlight both key vulnerabilities as well as opportunities to accelerate development in key sectors, including land management, water resources, urbanization, energy, agriculture, and disease control. Part 2 of this CC-Strategy outlines specific sector and country-level recommendations.

### 2.1 Macroeconomic context

100. **After stagnating for decades, economic performance in Africa** is markedly improving. In recent years, GDP growth in SSA has accelerated to about 6 percent per year, while inflation registered below a two-digit level, a recent low point. The much improved economic performance is confirmed by several recent assessments.<sup>12</sup> For the first time in 30 years, SSA is experiencing sustained growth as fast as developing countries other than China and India, and average incomes have been rising in tandem with those in other regions (Figure 2-1). The top performers in Africa are doing very well compared with fast-growing countries in other regions.

101. **During 2000 to 2006, about 26 SSA countries experienced GDP growth** exceeding 4 percent per year, while as many as 14 countries exceeded 5.5 percent. Countries with at least 4 percent GDP growth are now a sizable portion of Sub-Saharan Africa — about 70 percent of the region's total population and 80 percent of the region's GDP. As a group, these countries have been growing consistently at nearly 7 percent per year, whether considered in the more recent period or a longer period extending from the mid-1990s.

102. **The population of SSA is expected to exceed 1 billion people in 2030**, the region is one of the world's major net exporters of energy resources,<sup>13</sup> but biomass resources provide over 80 percent of total domestic primary energy supply, and electricity contributes less than 3 percent of total final energy consumption (Box 2-1). Some 45 to 50 percent of electricity is generated from hydropower, with an equal amount from oil- and gas-fired thermal power plants. However, demand for electricity is expected to grow by 5 to 7 percent per year between now and 2050 (IEA, 2006).

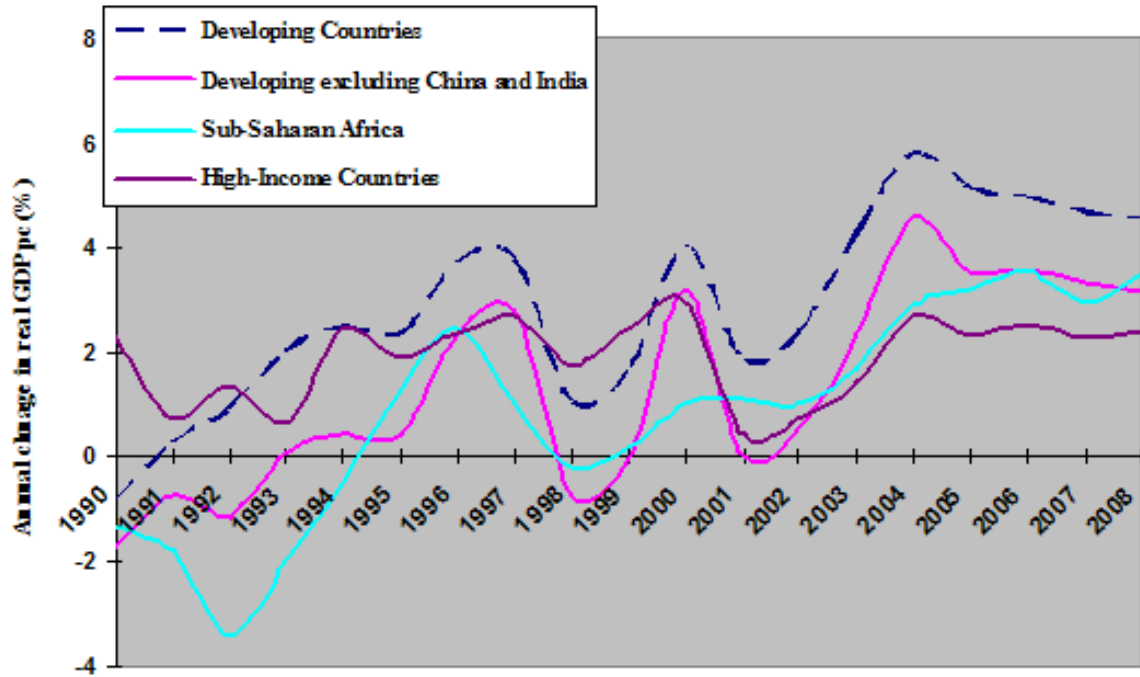
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11. Parts of this section draw on a paper presented at the AERC 20<sup>th</sup> Anniversary Conference Natural Resources Management and Climate Change (Bouzaher, A., S. Devarajan, and B. Ngo, 2008).

12. Arbache et al. (2007)

13. In fact, only seven countries are net energy exporters.

Figure 2-1. Comparative per capita income

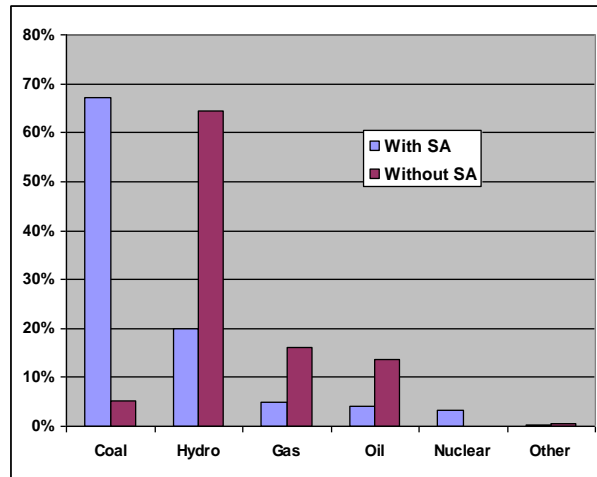


Source: Graph derived based on data from Arbache et al. (2007)

Box 2-1. Mix of primary energy supply in SSA. Biomass provides 80% of the total domestic primary energy supply in Africa



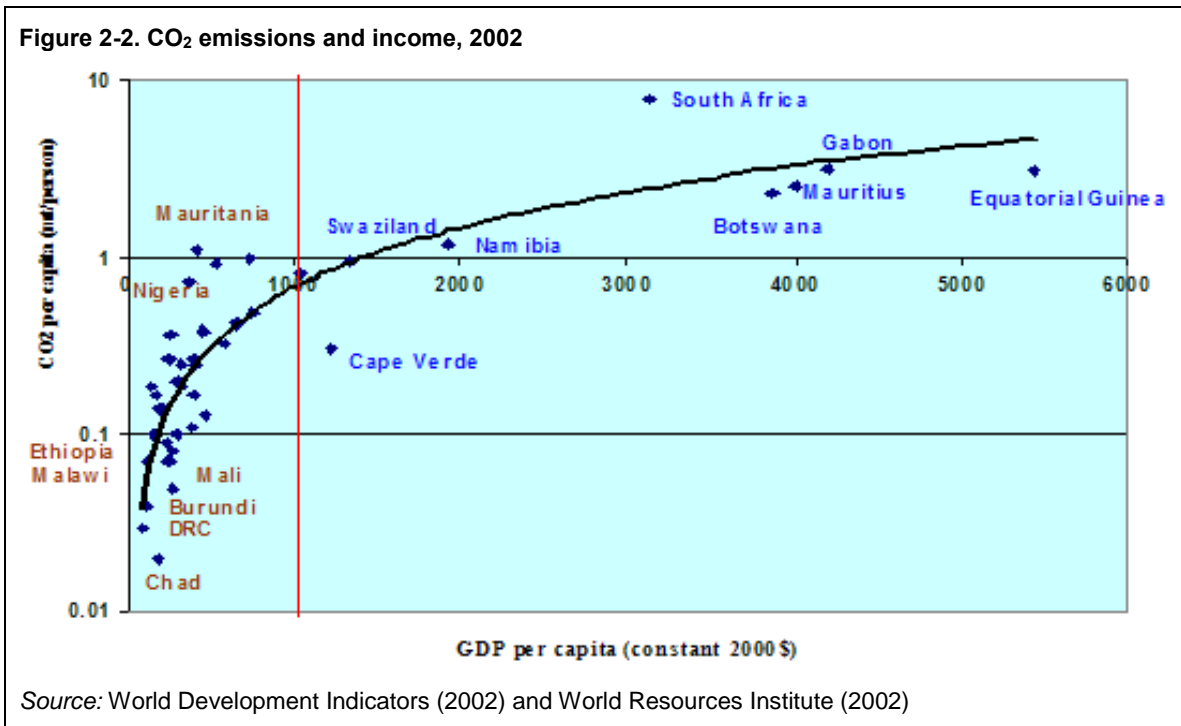
Power Generation and Mix in Selected SSA (2005)



Source: IEA (2007)

103. **Despite very low levels (both in absolute terms and on a per capita basis),** CO<sub>2</sub> emissions in SSA (excluding South Africa) reflect a heavy reliance on energy from biomass and low levels of efficiency.<sup>14</sup> Globally, however, CO<sub>2</sub> emissions are strongly linked via energy to development (World Bank, 2008d). In SSA the relationship between per capita income and per capita emissions is stronger for richer countries (more than \$1,000 income per capita); for lower income countries there is significant variation in emissions at a similar level of income, reflecting differences in deforestation and energy efficiency (Figure 2-2). As energy supply and demand increase over time, development in SSA will generally be expected to produce higher emissions.

104. **With an average 30 percent share of GDP and 70 to 80 percent of employment,** agriculture continues to be the dominant sector in the 19 countries with an average annual GDP growth rate of 4.5 percent or more (over the period 2000 to 2006, Figure 2-3). Moreover, because agriculture is mainly rainfed and characterized by low productivity (only 3.6 percent of arable land is irrigated [Table 2-1]), these economies are constantly exposed to the risks of high climate variability (e.g., precipitation) and extreme climatic events, especially droughts and floods, and it is not uncommon to see swings in annual GDP that exceed 30 percent.



## 2.2 Urban growth and development

105. **Growth of cities and urban areas is a major strategic development issue.** Africa is the fastest urbanizing continent, and is arguably the least prepared for the

14. CO<sub>2</sub> emissions in SSA — 10 percent from electricity/heat; 15 percent from manufacturing and industry, transport, fugitive emissions, and waste; 10 percent from agriculture; and about 65 percent from land use change and forestry.

transition.<sup>15</sup> This reflects what is currently underway in Asia and what took place in Latin America over the past five decades. By 2030, it is expected that one in two Africans will live in an urban area. However, urban growth in Africa is not only being driven by rural-urban movement, but is increasingly being fueled by growth from within the towns and cities themselves. Urban centers play a key role in fighting poverty and sustaining economic growth — over the past decade, industry and services (located mainly in urban areas) have contributed to 79 percent of total GDP growth in Sub-Saharan Africa (Kessides, 2006).

**Table 2-1. Agriculture continues to face many challenges**

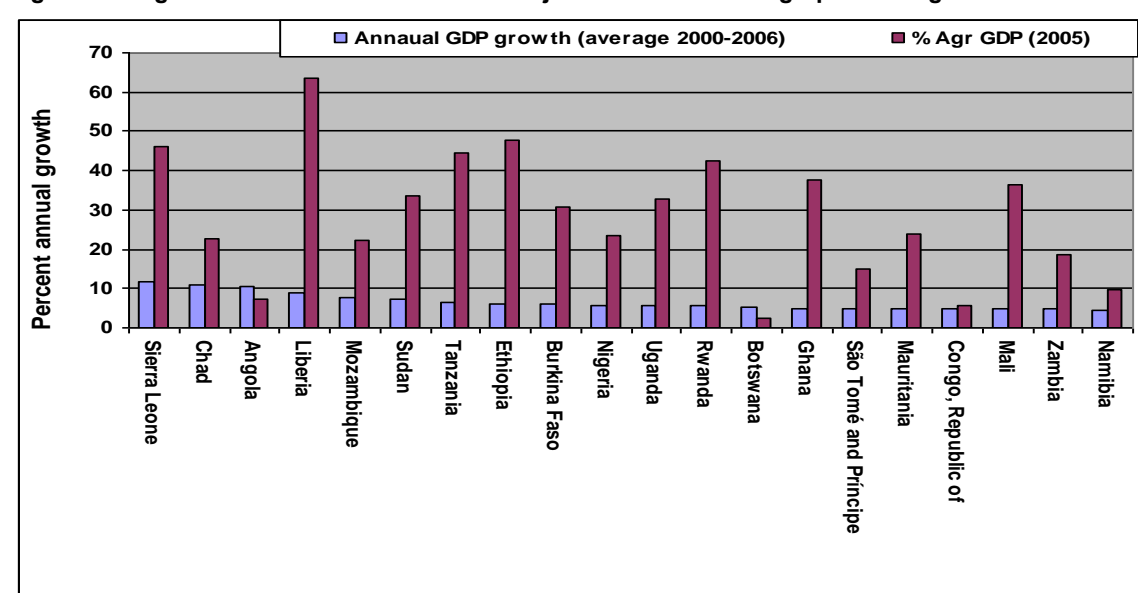
Region	Irrigated area (% of cropland)		Fertilizer consumption (kg/ha of arable land)		Cereal yield <sup>a</sup> (metric tonnes/ha)	
	1989-91	2001-03	1989-91	2001-03	1989-91	2001-03
SSA <sup>b</sup>	3.6	3.6	14.2	12.3	1.04	1.09
Latin America	11.1	11.4	60.02	89.5	2.20	3.16
South Asia	33	39	75.4	106.6	2.13	2.51

a. Cereals include wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, mixed grains

b. Sub-Saharan Africa includes South Africa

Source: World Bank IEG Database (2008)

**Figure 2-3. Agriculture continues to make a major contribution to high-performing economies**



Source: Based on data from Arbache et al. (2007) and World Development Indicators 2006

15. Some countries that have lower levels of urbanization are now experiencing rapid annual urbanization growth (e.g., 9.3 percent in Rwanda, 6.66 percent in Burundi, and 5.2 percent in Burkina Faso). (E. Ouayoro, State of AFTU2 FY07 Note).



106. **The problem is not just population growth.** Two aspects of the urban growth phenomena in SSA highlight the nature of this strategic problem — SSA has the highest urbanization rate and the highest worldwide rate of informal settlements, which will clearly affect the links between urban development and climate change in the Region.

- **Urban population growth rates in Africa of an annual 4.5 percent** have been and will continue to be the highest in the world. City-based populations are growing faster than their counterparts in Asia. These higher growth rates are expected to continue well into the next two decades. Consequently, how SSA cities develop will be one of the main influences on future greenhouse gas emissions.
- **In SSA urban and peri-urban areas, slum dwellers are 72 percent** of the total urban population (compared to 50 percent worldwide). The current rate of slum growth substantially exceeds the impact of any attempts at urban development. Over the next 25 years, there will be an additional 300 million urban residents in Africa, and the vast majority will have no alternative but to move to the slums. Much of this housing is vulnerable to the impacts of natural hazards. A large portion of housing stock in SSA is built through the informal sector, not meeting minimum safety standards.

107. **Cities and urban areas are particularly vulnerable to climate change.** Urban conglomerations are particularly vulnerable to disruptions from natural hazards (including those related to climate change), especially in SSA countries where the combination of structural poverty, decaying and sub-standard infrastructure, high population densities, and the concentration of economic assets and commercial and industrial activities magnify the problems of unplanned and uncontrolled growth (World Bank, 2003). Because many of the most important cities in SSA are located in or near the coast, the rise in sea level and associated problems are a fundamental challenge that urban settlements face from global warming.

108. **Floods are also among the most devastating natural hazards in Africa** and disproportionately effect cities. Rising sea levels combined with tropical cyclones and the accompanying intense rainfall cause severe and more rapid onset of flooding. Flash floods, which often stem from higher rainfall intensity, are becoming increasingly important hazards. Devastating floods have been reported in major cities across the region. The cost of the year 2000 floods in Mozambique was an estimated \$550 million, lowering the country's GDP by 1.5 percent (during the period of 1994 to 2003 the annual average growth rate was 7.5 percent) (World Bank, 2005).

109. **Urban areas face a double threat.** Africa's urban areas and cities face twin risks from climate variability and change. Domestic and industrial water supplies are vulnerable to drought and seasonal stream flow variations and availability of groundwater, while urban services (including housing, transport, health and safety, drainage, and wastewater) are vulnerable to floods and restricted drainage, compounded

in coastal areas by sea level rise (Box 2-2).<sup>16</sup> In the housing sector alone, current trends suggest that the rate of slum growth substantially exceeds the impact of any attempts at urban upgrading. The vast majority of new urban residents will have no alternative but to move to the slums. In such rapidly urbanizing areas, the combination of structural poverty, decaying and sub-standard infrastructure, high population densities, and the concentration of economic assets and commercial and industrial activities magnifies these problems (World Bank, 2003).

110. **Despite rapid urbanization, the majority of the African population** is strongly dependent on land resources. More than two-thirds of Africa's poorest households are rural. In most African countries agriculture is the major source of employment and contributes significantly to the aggregate GDP.

111. **In the face of population growth**, local development pressure, and global environmental change, maintaining a healthy natural resource base is a major challenge in many rural areas. Food productivity per capita has remained stagnant in many parts of Africa. Population growth has already overtaken agricultural GDP growth in much of Sub-Saharan Africa. Increases in agricultural output are largely from expansion of crop land into increasingly marginal areas. Forests and wood lands are being cleared even though they are not suited for permanent agriculture. In addition, land productivity is constrained, by among other factors, insufficient nutrient inputs, lack of erosion control, and pressure from overgrazing.

### 2.3 Land management

112. **The lack of effective land, forest, and watershed management** has led to widespread land degradation across the African continent. This erosion of the natural asset base, which is a primary foundation of rural livelihoods, undermines food security and constrains economic development. These problems have resulted in the loss of land productivity (World Resources Institute, 2005), declines in forest cover and biodiversity, and decreases in the quality and quantity of water resources. Estimates on the extent of land degradation vary depending on methodology. Some Africa-wide estimates have suggested that about 67 percent of the total area of Sub-Saharan Africa is affected by some form of land degradation, i.e., about 16 million square kilometers, of which about one-fourth is rated severe to very severe (FAO, 2000). Other estimates based on remote sensing data paint a less severe picture, suggesting that about 10 percent of agriculture and mix cropping area is affected by land degradation (Vlek et al., 2008). The extent of land degradation varies considerably across the region and is further influenced by data availability and the method of aggregation.

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16. Sea level rise, and the surge that accompanies large storms such as cyclones, can impede drainage and affect the extent and magnitude of flooding for considerable distances inland depending on the coastal topography.

**Box 2-2. Impact of sea level rise on the city of Mombasa**

Mombasa (700,000 inhabitants) is already affected by climate-related disasters, especially floods, droughts, and strong winds (El Nino in 1997, frequent floods, tsunami in 2006, drought in 2005/06). These disasters are projected to increase in frequency and intensity with long-term climate change. Sea level rise and frequent flooding damage existing infrastructure (transport, telecommunications), and thus negatively affect economic and commercial activities in the city. The IPCC has estimated that if the emission of greenhouse gases continues at the current rate, the sea level will rise by an additional 8 to 20 centimeters by 2030, and 21 to 71 centimeters by 2070 (IPCC, 2001). It is estimated that about 17 percent of Mombasa, or 4,600 hectares will be submerged with a sea level rise of only 0.3 meters. There will be also large areas rendered uninhabitable due to flooding or water logging or agriculturally unsuitable due to salt.



*Source:* Climate change and coastal cities: The Case of Mombasa, Kenya: African Centre for Technology Studies, Nairobi, 2007

113. **Land degradation processes may be exacerbated by climate change.** More intense rainfall promotes soil erosion. Increasing temperatures increase evapotranspiration rates, reducing soil moisture and in conjunction with shifting rainfall patterns will affect vegetation patterns and the length of the growing period for crops. Prolonged dry spells and erratic climatic conditions may result in short-term coping strategies such as deforestation. This may help to mitigate the immediate impact of a climatic event, but will prove to be mal-adaptive in the long-term by having adverse consequences for watersheds, biodiversity, and provision of important ecosystem services.

**Box 2-3. Land degradation and climate change are closely linked**

**Land degradation** can increase vulnerabilities to climate variability and affect GHG emissions through:

- Reduced land productivity
- Increased erosion and run-off
- Reduced land cover and soil carbon
- Water logging and soil compaction
- Changes to microclimates due to changes in land cover



**Climate change** will add to existing stress and accelerate land degradation processes through:

- Heavy precipitation that causes soil loss
- Changes in vegetative cover due to shifting climatic conditions
- Climatic extremes triggering short-term coping responses that erode the natural resource base



114. **Land degradation increases the vulnerability of rural livelihoods** to climate variability and change. Declining land productivity and ecosystem services make rural livelihoods more vulnerable to climatic variations and affects their capacity to recover from climatic shocks such as prolonged dry spells. Forest degradation and other changes in land cover may also increase exposure to floods because the capacity of water to infiltrate is reduced and surface run-off increases.

115. **Aside from affecting land productivity and ecosystem services**, land-use changes and land degradation also contribute to greenhouse gas emissions and affect local climatic conditions. Emissions from land use, land-use change, and deforestation are the single largest source of emissions in Sub-Saharan Africa (Figure 2-4).<sup>17</sup> Where land-use changes reduce above-ground organic carbon, soil carbon usually declines. This decline in organic matter is accompanied by adverse effects on several physical, chemical, and biological properties of the soil, which affect land productivity as well as biodiversity and ecological functions. Land cover changes can also lead to changes in local climatic conditions as a result of changes in surface reflectivity and water transpiration. Consequently, sustainable land management approaches are required that focus on improving food security and development prospects today, while maintaining a healthy natural resource base for the challenges of tomorrow.

## 2.4 Key role for agriculture

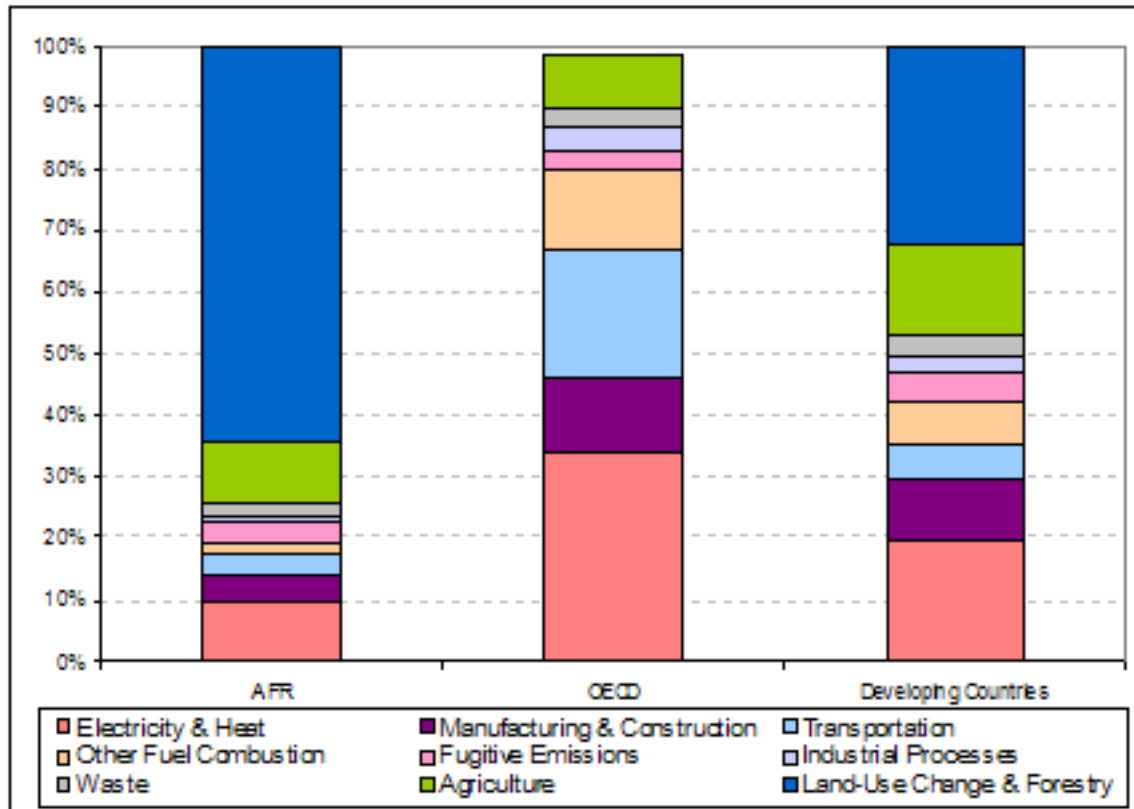
116. **Changing climate and agriculture.** The recent food crisis has highlighted the important notion that climate change may multiply threats; thus the urgency for policy makers to decisively move the agricultural agenda forward. In addition to warming, changes in rainfall, increased flooding, extreme heat events, pests, and loss of irrigation water, climate changes may affect yields. Despite the dire predictions, the continent is endowed with a significant undeveloped resource base; about one-third of potential cropland is currently used for cultivation and only a tiny fraction is irrigated (Figure 2-5).

117. **Most studies predict that impacts will vary by region**, but will be more pronounced in Africa. There is a strong consensus about the severe consequences for agricultural production in SSA, assuming a limited adaptive capacity of smallholder

17. Sources of greenhouse gas emissions and relative contribution to total emissions. In Africa the majority of greenhouse gases are released from land-use changes and deforestation (World Bank).

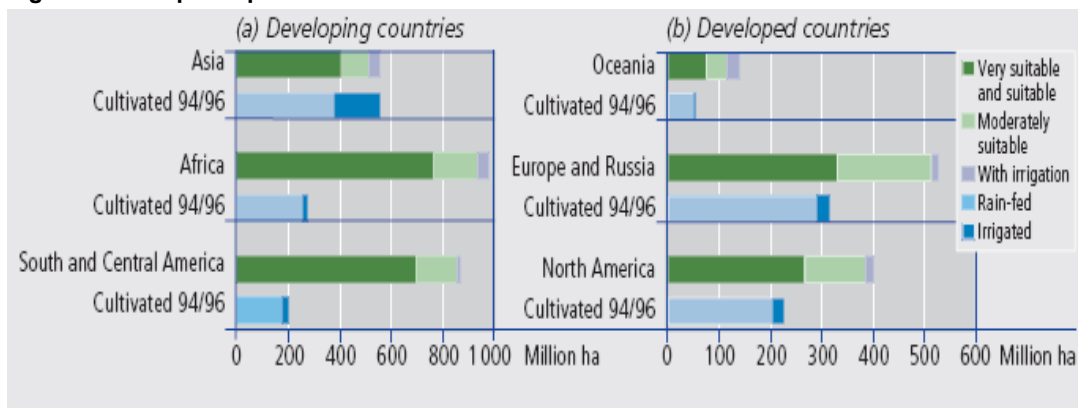
farmers. For example, Cline (2007) estimates that without carbon fertilization, agricultural output would be reduced by 21 percent in developing countries while industrial countries would experience a more modest decrease of 9 percent by 2080. Among the developing countries, the losses would be most severe in SSA, with an average reduction of agricultural output by 28 percent.

**Figure 2-4. Sources of greenhouse gas emissions. Land degradation is a contributor to greenhouse gas emissions**



Source: World Bank, based on 2002-2006 data from IEA and WRI

**Figure 2-5. Cropland potential and land used for cultivation**



Source: IIASA (2000)

118. **Key climate change factors will impact agriculture.** Climate change is expected to further exacerbate the already high vulnerability of agricultural producers in SSA. Scientific evidence about the seriousness of the climate threat to agriculture in Africa is unambiguous. Climate change will have far-reaching consequences for the agricultural sector that will disproportionately affect the poor in SSA. Five main factors will have a direct impact on agricultural productivity — changes in temperature and precipitation, climate variability, water availability (or surface run-off), and carbon dioxide fertilization. Crop failures and livestock deaths are already imposing significant economic losses and are undermining food security. These impacts are most likely becoming more severe as global warming continues.

119. **Current low level of agricultural development.** The agriculture sector is a unique instrument for sustainable development in Sub-Saharan Africa. The sector is key for economic growth, poverty reduction, and environmental sustainability in the region as highlighted by the *World Development Report 2008*. Agriculture contributes some 30 percent of GDP and employs 70 percent of the labor force, while 82 percent of the SSA population lives in rural areas. Despite its potential, the agriculture sector has been vastly underused for development (Figure 2-5). Public spending on agriculture is particularly low in SSA. According to the *World Development Report 2008*, in agriculture-based countries public spending for agriculture as share of their agricultural GDP is 4 percent compared to 10 percent in successful transforming countries in 1980 (at a time when they still had a high share of agriculture in GDP). Under-investment in the sector is one important cause of poor agricultural performance in Africa. In SSA, growth per capita of the agricultural population — which is a crude measure for agricultural income — has been only 0.9 percent, less than one-half that in any other region.

120. **Vulnerability of smallholders and the rural poor.** The neglect of the agriculture sector contributed to unfavorable socioeconomic and ecological conditions for the rural poor in Africa, leaving them particularly vulnerable to climate variability and change. The rural poor in SSA increased over the last decade to more than 200 million. They have very little access to services and infrastructure such as technologies, advisory services, input and output markets, credit, water and sanitation, and roads. The agricultural productivity of smallholder farmers is also affected by severe degradation of the natural resource base and low water availability, which are being exacerbated by climate change. Agriculture is mainly rainfed, with only 7 percent of cultivated area under irrigation. In addition to the need for soil moisture management in farming, of particular concern are soil erosion and nutrient depletion. About 75 percent of Africa's farmland is affected by severe mining of soil nutrients. The International Fertilizer Development Center reports that the average rate of soil nutrient extraction is 52 kilograms of nitrogen-phosphorus-potassium per hectare per year, five times the average application per hectare of nutrients through fertilizer.

121. **Modalities to expand irrigated agriculture.** We illustrate the potential to expand irrigated agriculture by using the Zambezi River basin as an example (Box 2-4). Current hydrologic risks are characterized by erratic and unreliable rainfall over much of the region, with a very low percentage of run-off occurring during the dry season. Agriculture, which is the source of livelihood for 80 percent of the Zambezi basin's rural

population, is very risky (World Bank, 2008a). The average maize yield (70 percent of cereal area) is 1.06 tonnes per hectare, a fraction of the potential irrigated yield of 7.5 tonnes per hectare. In addition, the average rice yield is about 1.1 tonnes per hectare, compared to potential irrigated yields of 4 to 5 tonnes per hectare. Because of climate variability and low productivity, the Zambezi basin countries tend to be chronically short of food, requiring large food imports and donor food assistance. FAO studies have projected that the value of net agricultural trade in Southern Africa between 1997 and 2030 will worsen for cereal crops (expected to constitute about one-half of agricultural production) (Bruinsma, 2003; Westlake and Riddell, 2005). To achieve a cereal requirement of 163 kilograms per person per year (equivalent to self-sufficiency), it is estimated that tripling the area under irrigation (from a base of about 200,000 hectares), at a rate of 32,000 hectares per year across the basin, would require about 7 percent of the water available in the Zambezi annually, and would benefit 30 percent of the rural population in the basin.

**122. Imperative to increase productivity and production.** The trend toward drier rainy seasons in Southern Africa has also been observed for parts of Eastern Africa, which directly impacts agricultural productivity. Findings from a recent simulation study (Funk et al., 2008) concluded that if current trends in declining rainfall and agricultural capacity continue unabated, by 2030 the number of undernourished people in eastern Africa will increase by more than 50 percent. At the same time, a mere 15 percent increase in yields per decade would approach achieving the MDG of halving the number of undernourished people by 2030. Thus, there is very large scope for increased production and food availability if water is available for timely irrigation and farmers have better water control and modern inputs. At the same time, because climate projections for Southern Africa indicate a drying trend over large parts of the region, with intensifying occurrence of floods and droughts, irrigation investments will also serve as a buffer against increased climate variability in the future. Irrigation development needs to be part of a package of technology and institutional reforms (Box 2-4).

## **2.5 Need to rapidly increase access to electricity**

**123. The Bank's ongoing strategy for the energy sector in SSA is designed to address key constraints (including long-term under-investment, weak utilities, failed privatization, on-and-off reforms, and capacity constraints), and significantly contribute to:** (i) increasing generation and transmission capacity, including regional trade; (ii) accelerating energy access through increasing electrification and promoting sustainable household fuels; (iii) strengthening power utilities and increasing supply-side efficiency; and (iv) improving demand-side efficiency.

**Box 2-4. Importance of irrigation to grow the agriculture sector and reduce poverty — the case of the Zambezi River basin**

Both land and water resources are ample at the basin level,\* although water is not always in the right place at the right time, and there are a number of important factors and problems that strongly influence the profitability of smallholder irrigated agriculture. A major scaling-up of irrigated agriculture in the Zambezi River basin is possible based on new models and approaches already emerging in the region.

**Potential benefits**

- A high-growth scenario triples the current estimated rate at which the riparian countries could expand irrigated area, and the irrigated area in the basin would rise to about 551,000 hectares and about 6 percent of the rural population in 2020 would have access to improved irrigated land and direct increases in income.
- Indirectly, an additional 6 to 12 percent of the rural population would benefit through employment (on- and off-farm), lower food prices, increased food availability, and the general rise in rural economic activity induced by the expansion of profitable irrigated agriculture. Hence, a total of about 12 to 18 percent of the basin's rural population in 2020 would directly or indirectly benefit.
- About 80 percent of the rural population is not directly or indirectly reached by this investment in irrigated agriculture. If irrigation expansion takes place as a part of comprehensive water-for-agriculture strategy to improve agriculture productivity, then a wider impact on rural poverty and food security could be achieved through the introduction of conservation farming and water harvesting to improve rainfed farming supported by strong extension services and improved inputs.

**Key lessons from existing models**

- Programs should address the issues that undermine smallholder profitability at each step of the value chain, and to do this the existing and potential private sector actors must be brought into the program by providing incentives such as favorable policy reforms and access to financing.
- Program financing mechanisms should be structured to impose high appraisal standards and commercial discipline on sub-project sponsors to ensure that the programs remain demand driven, and do not creep steadily toward traditional bureaucratic, government supply-driven approaches.
- Cost minimization and cost-effectiveness are paramount to ensure that sub-projects are financially and economically sound.
- Government desires are high and their capacities to administer and manage a scaled-up water-for-agriculture program are extremely limited. Hence, it will be essential for governments to outsource the essential technical and social services needed to implement accelerated programs.
- Government capacities to coordinate, manage, and supervise the programs must be strengthened. Decentralization remains crucial for the sector in order to locate the most important strategic expertise — such as irrigation and rainfed agriculture advisory services strongly linked to a revitalized research system — as close as possible to the rapidly expanding number of new smallholder farmer groups.
- Continuing training of farmers and farmer groups in skills ranging from leading and managing their own businesses and organizations, to cropping systems and water management, is critical for long-term success.
- A key part of the enabling environment — which will improve capacity to attract investment financing — involves improved planning and upgrades to monitoring networks and information systems.
- Continuing training of farmers and farmer groups in topics ranging from how to lead, manage, and operate their new organizations to water management and new crops and cropping practices, has been well demonstrated to be crucial for long-term success.
- Programs must be targeted to maximize the opportunity for early success and demonstration. This will depend in large part on upgrading monitoring networks and information systems and improved planning. The current deteriorated state of the hydrologic monitoring networks and the lack of planning has resulted in very limited and poorly documented investment portfolios, further limiting the ability to attract investment financing.

\* It is estimated that annual availability of water resources in the Zambezi is about 110 cubic kilometers, of which 3 percent is used for agriculture, human consumption, and industry; 13 percent is used for hydropower production; and 85 percent is discharged to the Indian Ocean. With expected lower run-off due to climate change, an integrated approach to managing the Zambezi will be needed to balance the various socioeconomic needs in the basin and the sustainability of the critically important delta ecosystem.

Source: World Bank (2008a)



124. **Unmet demand for electricity.** The lack of access to electricity, or its unreliable supply, is a major impediment to the growth and competitiveness of African economies, particularly exports. Not only is electricity important for growth, access to electricity also helps power other MDGs and meet the population's basic needs. Underlying the low level of access are the exceptionally low levels of installed generation capacity in Sub-Saharan Africa of which 60 percent is in South Africa alone. The mismatch between electricity demand and supply has grown. Twenty-eight countries are or have been affected by the energy crisis in the past two years, an unprecedented situation. With more than 550 million Africans without access to electricity, energy production and consumption are expected to soar in the future.

125. **Effects of climate variability and change on the electricity sector.** Climate change presents additional challenges to African electricity sectors, which have already been hit hard by high oil prices. More erratic rainfall has severely affected hydropower dams in both East (Tanzania and Uganda) and West (Ghana) Africa, forcing these countries to spend their limited resources to add emergency generation capacity, most of which relies on coal- or oil-based systems, thus aggravating greenhouse gases emissions.

126. **Developing new sources of electricity.** Africa has large, unexplored potential for hydropower, solar, wind power, and other renewable resources. Of its huge hydroelectric power potential, only 7 percent is currently utilized, compared, for example, to over 30 percent in Latin America (Figure 2-6). A recent UNEP-funded study identified 2,000 megawatts of wind power potential in Ghana. A geothermal potential of 7,000 megawatts has been estimated mainly in the Rift Valley in East Africa. Faced with the need to increase access to modern energy and the opportunity offered by Africa's vast potential in renewable energy, particularly hydropower, the African Ministerial Conference on Hydropower and Sustainable development agreed on a plan of action for developing the huge untapped hydropower potential on the continent. It called for: (i) development of a holistic Africa Energy Vision (2025) combining water and energy sectors under the auspices of the African Union; (ii) establishing a permanent secretariat in collaboration with the International Hydropower Association; (iii) developing, in association with UN-Energy Africa, a regular monitoring and reporting system on Africa's hydropower, and devising a strategy to assist member countries with technical expertise; and (iv) integrating energy and water sector ministries for holistic development of water resources. Building on the Ministerial Conferences on Hydropower, efforts are being made to directly engage the private sector — financiers, investors, manufacturers, engineers and environmentalists — with governments for hydropower development.

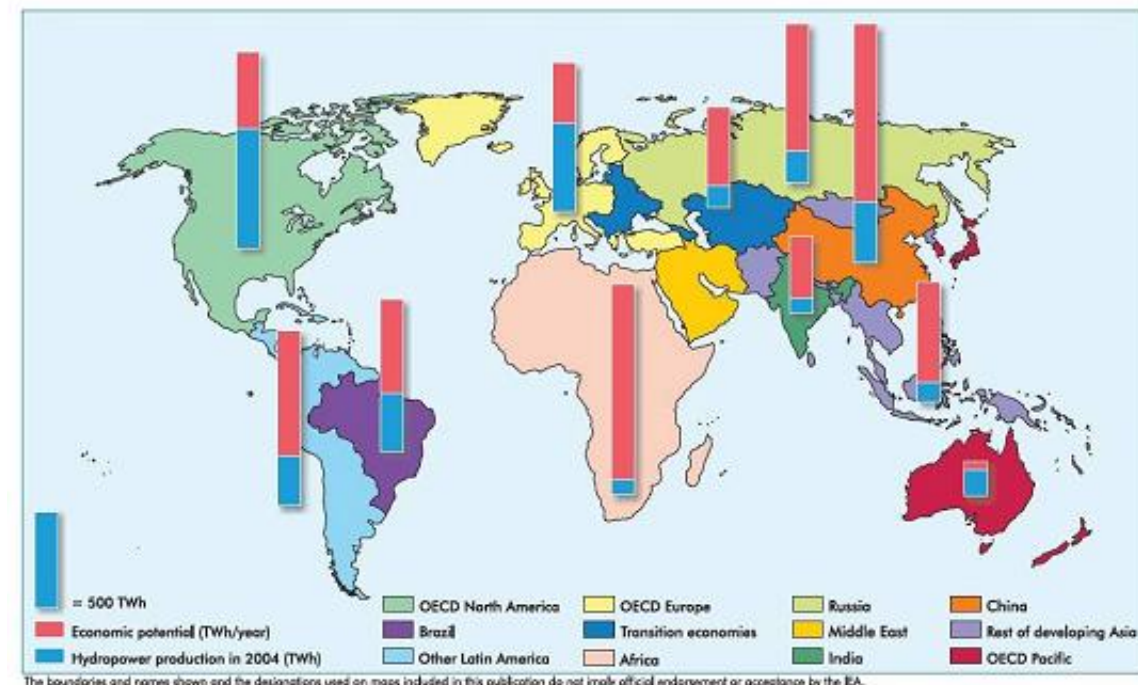
127. **Opportunities that arise from GHG mitigation.** Sub-Saharan Africa has an unprecedented opportunity. By choosing a cleaner development pathway (World Bank, 2008h) through low-carbon alternatives that can reduce greenhouse gas (GHG) emissions, this region can meet its future energy needs, and at the same time receive support from carbon finance schemes<sup>18</sup> and the Clean Development Mechanism (CDM)

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18. The carbon market is the most tangible result of efforts to mitigate climate change. By creating a market for emission reductions, in effect paying people and businesses to reduce GHG emissions, the carbon market provides a financial incentive to invest in clean energy projects, energy efficiency, fuel switching, waste management, and forestry.

of the Kyoto Protocol (Box 8-1). For 44 SSA countries using 22 technologies that have been approved by the CDM Executive Board, the report estimated a technical potential of more than 3,200 low-carbon energy projects. If fully implemented, this estimated pool of potential projects could provide more than 170 gigawatts of additional power-generation capacity, more than twice the continent’s current installed capacity. It is estimated that the achievable avoidance of future GHG emissions would total about 740 million tonnes of carbon dioxide equivalent per year.<sup>19</sup> A conservative estimate of the total capital cost for these potential low carbon energy projects is about \$150 billion, although detailed economic analyses of the potential investments remain to be done. To unlock this potential would require important reforms such as filling the regulatory gaps needed to allow the sale of renewable energy to national electricity grids — most of which are managed in monopolistic arrangements — as well as the collection and transport of renewable energy and dissemination of clean energy technologies, among others.

Figure 2-6. SSA and world hydropower potential



Source: International Energy Agency (2007)

## 2.6 Challenges of integrated water resource management

128. **Importance of water in the Sub-Saharan Africa development agenda.** Water is a vital component in the development of nearly every sector in Sub-Saharan Africa. Lack of a reliable supply of water of adequate quality undermines public health, restricts

19. While there is no basis to value the GHG emissions reductions, the current price of a tonne of “certified emission reduction” in the European Union carbon market currently ranges from 20 to 25 euros.

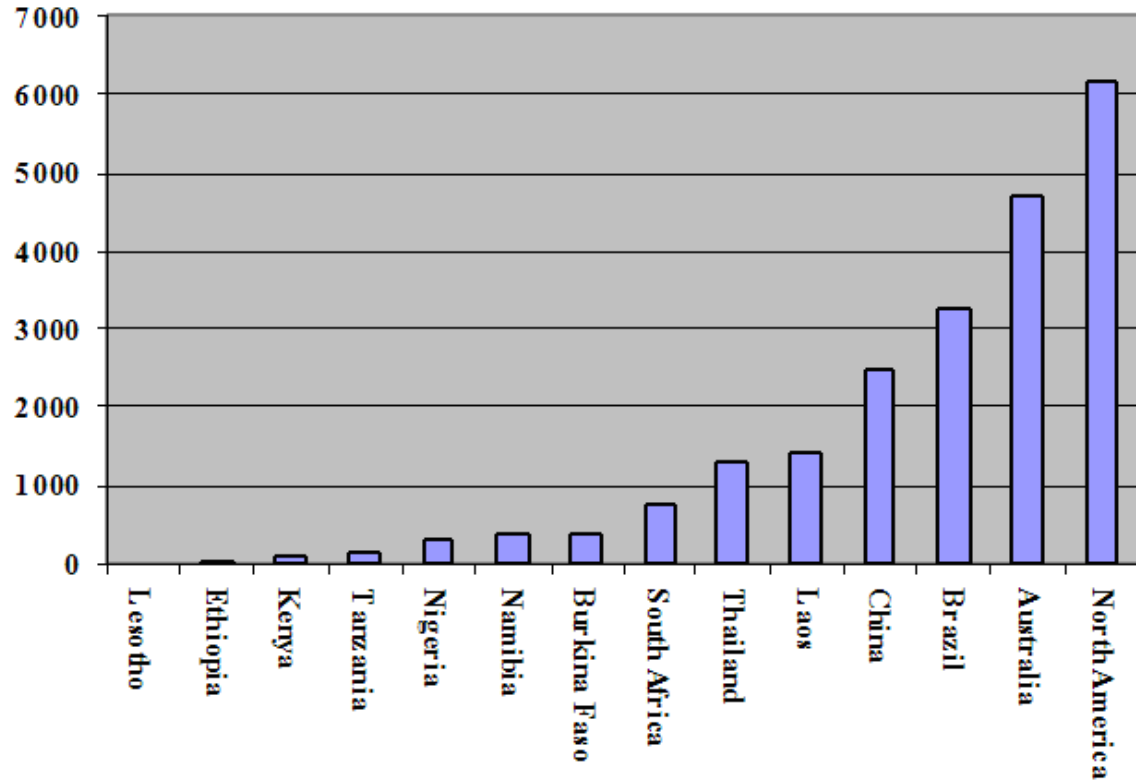
industrial growth, limits energy production from hydropower (and possibly thermal sources as well), constrains agricultural productivity and food production, and threatens and may eliminate important environmental services, including fisheries. Until now, the pursuit of water resources to meet these increasing needs and demands has been undertaken city-by-city, sector-by-sector, and project-by-project. Externalities, including increased costs and diminished water availability, are already apparent and will become an increasing burden with the growth of cities and the development of rivers for hydropower and other uses. But water is a unitary resource — i.e., water use in one part of the system (watershed or drainage basin) alters the resource base and affects water availability and water users in other parts of the basin or watershed — and it is not always where and when it is needed. In a great many cases in Sub-Saharan Africa, water is scarce and this scarcity is exacerbated by unfettered competition for this vital resource.

129. **Unitary and scarce water resources should be managed.** In the face of scarcity and rising demand, the development challenge is to effectively manage water resources to ensure that water use is balanced across the various demands and sectors and that the economic benefits from productive uses of water are maximized. Water allocation needs to be both equitable and efficient, and water resources need to be proactively protected and monitored — the fundamental functions of water management. The lack of a policy and institutional framework for such management, and more importantly, the lack of a knowledge base and human resources to carry out these functions, has been a constraint to timely and accelerated development to support sector development in SSA. For example, the vast potential for irrigation remains largely underutilized, which has significant implications for agriculture growth, food security and rural poverty. Similarly, only a small fraction of the available hydropower potential has been developed even though access to energy is extremely low. Access to other services, such as domestic water supply and sanitation, also remains low. Harnessing water in key economic sectors has to be balanced by the demand to preserve biodiversity and the environment, essential to sustaining marginal livelihoods in Africa.

130. **Importance of water storage to overcome high climate variability.** In most of Sub-Saharan Africa, precipitation occurs in just one season of 4 to 6 months, and the seasonal and inter-annual variation in the timing and volume of precipitation is high. As a consequence, seasonal and inter-annual variations in accessible surface and groundwater are also high. Hence, water storage is vital to ensure that water is available where and when it is needed. Water storage in a watershed or river basin occurs naturally in the groundwater aquifers and the soil, but these processes can be greatly disrupted by poor land management and land degradation, and in many cases can be readily over-exploited. However, with few exceptions, in Sub-Saharan Africa surface water in the streams and rivers of a watershed or basin is the largest volume of water that can potentially be stored for use by multiple sectors when it is needed, particularly in the dry season. Sub-Saharan Africa (excluding South Africa) has the world's lowest surface water storage capacity at around 43 cubic meters per person per year and has developed less than 7 percent of its hydropower potential. In contrast (Figure 2-7), North America has a water storage capacity of 6150 cubic meters per person per year and has developed 60 percent of its hydropower potential. Using the present water storage capacity of South Africa (750 cubic meters per person per year) as an indicator of where other African countries might

want to be, the World Bank estimates, for example, that Nigeria and Ethiopia alone have storage investment requirements of \$67 billion and \$46 billion, respectively.

Figure 2-7. Water storage in selected SSA countries and the world (cubic meters per capita)



Source: World Bank (2006d)

131. **Water resources in Sub-Saharan Africa are primarily transboundary.** Although Africa has no dearth of water resources, most of its river basins cross country borders. Africa is endowed with generous water resources, with estimated annual renewable surface water resources of about 4,590 billion cubic meters per year. Three-quarters of these resources are concentrated in eight large transboundary river basins — Congo, Niger, Ogadugne (Gabon), Zambezi, Nile, Sanga, Chari-Lagone, and Volta. The total number is 63 transboundary river basins, which together account for 90 percent of surface water resources and cover 64 percent of the SSA surface area. In addition to rivers, there are more than 160 lakes larger than 27 square kilometers, primarily in the equatorial region and the East African highlands. Developments in the context of the Nile River basin (in eastern and northern Africa), the Senegal River basin (in West Africa) and the beginning of a similar process in the Zambezi River basin (in Southern Africa) highlight the benefits of these regional agreements (Box 2-4). In addition to the direct benefits from improved agricultural and power production, there is potential from transboundary water projects for improved ecosystem sustainability, broader economic benefits from regional cooperation, and integration and political benefits through a shift from the competition for a scarce resource to cooperation and development.

**132. Governance is a core development issue for water resources management.**

With so much of Africa's natural resources shared among countries, effective institutions that help to ensure shared benefits are important. Only a few basin organizations (Nile Basin Initiative, Niger Basin, and Senegal Basin) are currently implementing transboundary water resource management (TWRM). These basins are preparing investment plans with similar plans in the pipeline for the Gambia and Volta basins. SADC is helping the Zambezi basin countries to finalize a Watercourse Agreement that will among other things establish such an institutional framework and prepare a Strategic Development Plan for the basin. Many other river basins still suffer from lack of financial resources, management tools, and above all, governance issues such as ongoing conflicts and the primacy of national agendas at the expense of cooperation.

**133. Effects of a changing climate on water resources.**

Climate change will manifest itself primarily through changes in average temperature and precipitation, and increases in the magnitude and frequency of related extreme events such as floods and droughts. Temperature and precipitation are important drivers of the water cycle and hence the seasonal occurrence and volume of water. This adds a new dimension to the already high variability of precipitation and the water cycle because it suggests that in the future the historical climate and hydrologic record may not be an appropriate predictor of conditions. This presents a huge challenge, not only to water resources development planners and managers, but also to the sector authorities responsible for deciding on the conditions and criteria for which their systems will be planned and designed. For example, if floods are more frequent, then what transport planners would have estimated from the historical record as a 100-year flood (say for the design of river crossings or cross drainage) may in the future be a 25- or 50-year flood. Similarly, water supply utilities would have to consider new drought or low flow design criteria, and power utilities may find that water available for hydropower generation is different than what they might have estimated based on historical records.

**134. Effects of a changing climate on the hydro economy.**

The challenge brought about by climate change on the hydro economy of most countries in Africa is not just a problem of finding enough water at the right time for all economic sectors and the environment. Most countries also must struggle to reduce the destructive and sometimes cumulative impacts of water-related natural calamities such as floods and droughts (e.g., floods in Mozambique caused average growth to drop from 7.5 percent a year during the period 1994 to 2003 to 1.5 percent in 2000. Kenya suffered an 11 percent and 16 percent drop in GDP due to the El Niño floods and the La Niña drought between 1997 and 2000. The very large investments required to develop multi-purpose and single-purpose water resource development infrastructure will necessarily require a more thorough analysis of the returns to investment that explicitly account for hydrologic risks. The need to give greater consideration to these risks has important implications for the way in which we assess the cost-effectiveness of early investments in water resources infrastructure. Without taking into consideration the impact of climate change in the form of increased hydrologic risk, current low-yielding agricultural practices combined with the high investment costs of irrigation partly justify the severe inadequacy in irrigation investments in most of Africa. However, preparing Ethiopia's water resources assistance strategy highlights the fact that the returns to irrigation and drainage are significantly

higher if the enormous costs of hydrologic viability — caused by severe droughts and floods — are considered. If the larger and more frequent damages and losses forecast to occur with changing climate regimes are considered, they could help to justify larger infrastructure projects to help manage the impact of extreme natural events.

**Box 2-5. Senegal River Basin**

The four riparian countries of the Senegal River basin — Guinea, Mali, Mauritania and Senegal — rank among the 25 poorest countries in the world. All riparian countries are facing energy shortages and growing water constraints, which hampers their economies. The basin's hydropower potential is estimated at 1,200 megawatts, of which less than 25 percent is currently exploited. Similarly, potential irrigable area is estimated at 320,000 hectares, of which less than 32 percent are currently developed. Although the Senegal River Basin Organization (OMVS) has existed since 1972, the structure has not been fully inclusive because upstream riparian Guinea has not been involved. This has limited the development opportunities and shared benefits that could arise from cooperative and integrated management of the entire basin.

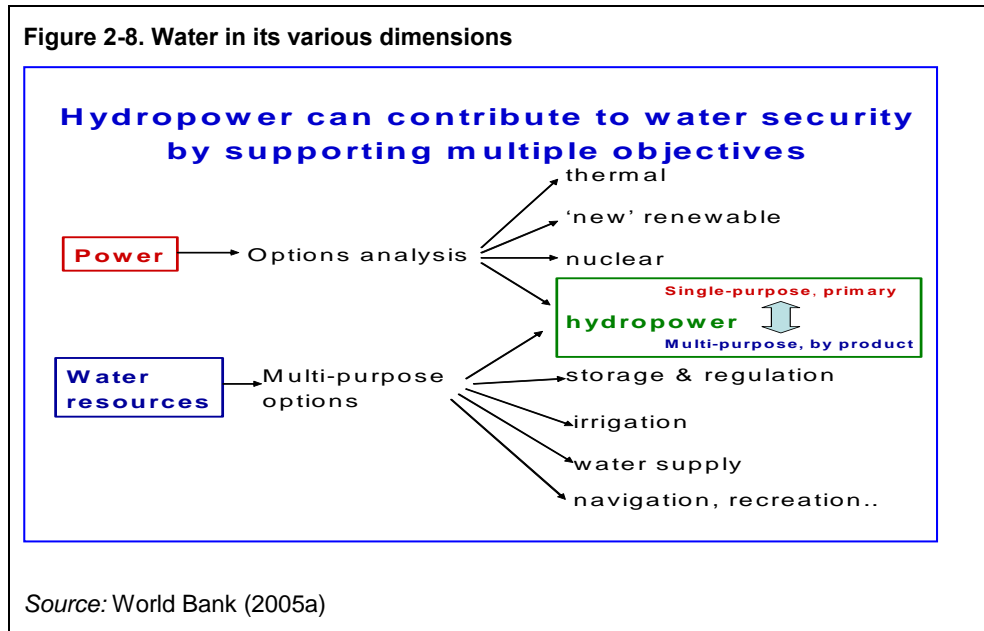
With support by development partners, the four riparian countries have worked to enhance regional integration of the Senegal River basin for multi-purpose water resources development that supports joint ownership of water infrastructure and fosters growth. The focus is placed on three activities to reach this objective: (i) regional institutional development for water resources; (ii) local level multi-purpose water resources development to promote income generation activities and create tangible basin-wide benefits at the ground level; and (iii) regional multi-purpose and multi-sector master planning.

Integrated river basin management, coupled with the development of multi-purpose water resources infrastructure, is expected to yield expanded opportunities for growth, reduced immigration and poverty, and improved health and livelihoods for the population while also preserving the environment. The multi-purpose approach will also broaden the scope of potential investments, generate a wider range of direct and indirect benefits (e.g., the development of a least-cost energy market in the context of the West Africa Power Pool), and enhance the participation of local communities in water management.

Source: IDA at Work: Water Resources

**135. Importance of multi-purpose and integrated water development.** Future development efforts will have to include unlocking the hydropower, water supply, irrigation, regulation for flood and drought management, navigation, environmental, and other economically and socially important water uses. The close connection between the urgent need to increase access to modern energy and rewards from GHG mitigation through clean energy presents Africa with an opportunity to take a bolder approach to water resources. A multi-purpose water resource development approach would involve complementary water security infrastructure to manage hydrological variability — storage, containment, ecological balances, water conservation, flood management, drought mitigation — hydropower development, and water for industry, domestic use, navigation, and irrigation. This multi-purpose and integrated approach (which follows directly from the unitary character of water resources) has the clear potential not only to help countries build economic resilience to climate change, but more importantly to diversify their economies. Such diversification would include sustainable intensification of agriculture based on irrigation and other technologies and practices, and development and/or deepening of new economic activities made possible by the availability of a larger and more stable supply of electricity (Figure 2-8). While multi-purpose water resource development has the potential to offer significant potential benefits to the countries of Africa, infrastructure alone is not a panacea without the development of appropriate water institutions and improved governance, as well as managing the complex dynamics

of multi-country development (Box 2-3). Badly managed water resources and water infrastructure will not support growth.



## 2.7 Public health — malaria<sup>20</sup>

136. **The menace of malaria.** Despite remarkable improvements in global health, Sub-Saharan Africa continues to face significant challenges in controlling communicable diseases and improving the health of its population. Malaria infects millions of people each year and impedes economic growth (Box 2-6). The World Health Organization (WHO, 2007) indicates that there are 500 million newly infected cases annually. The Centers for Control Disease (CDC) estimates that 700,000 to 2.7 million people die of malaria each year and 75 percent of those are African children. In recent years, there has been a resurgence of malaria in areas where the disease was once eliminated or under control. Following the 1997/98 El Niño event, malaria, Rift Valley fever, and cholera outbreaks were recorded in many countries in East Africa (UNEP, 2000).

137. **Increased risk in a changing climate.** Projections indicate that climate change will cause varying shifts in ecosystems that will affect insects, animals, and plants, which will be forced to shift, expand, and adapt to new environments. As temperature increases, some regions in Sub-Saharan Africa, once hyper-arid or semi-arid, will receive higher precipitation or become more humid. These areas may provide hospitable environments for new emerging vectors or the expansion of known infectious disease vectors. A warmer and higher precipitation environment may open up new areas for malaria; altered temperature and rainfall patterns could also increase the incidence of yellow fever and dengue fever.

20. Although the strategy deliberately focuses on malaria, the potential impacts of climate change also include nutrition, diarrheal disease, and other conditions linked to lack of safe water and sanitation, injuries from flooding, heat stress, and various other illnesses (Confalonieri et al., 2007)

138. **Climate may affect disease incidence.** Any extreme climate event or prolonged climate stress is likely to have an effect on the prevalence of infectious diseases, especially in the regions of SSA with a high prevalence HIV/AIDS, tuberculosis, and malaria. People with HIV/AIDS, with their pre-existing vulnerabilities, may become one of the most susceptible and vulnerable populations and are likely to suffer higher rates of morbidity and mortality. Furthermore, climate-related population displacement could create the conditions for increased transmission of HIV infection, tuberculosis, and malaria. Extreme climate events can impair health care infrastructure, health care services, delivery systems, human resources, and trigger mass migrations among affected populations, exposing them to insecurity and conflict. Climate change has the potential to bring further devastation to populations that are already dealing with infectious diseases.

139. **Projected trends.** Climate change is likely exacerbate the incidence and impact of infectious diseases. A lower disease burden would offer the best resilience, thus providing an opportunity for African countries to strengthen their health systems and scale-up investment to expand prevention and treatment programs for these diseases while focusing on human resources, monitoring and evaluation, and surveillance systems, particularly at the sub-regional and regional levels.

**Box 2-6. Public health and economic burden of malaria**

Projections and modeling of climate change effects on malaria indicate with high confidence that malaria will surge in Southern Africa and the East African highlands, and that the global population affected by malaria will increase by an extra 260 to 320 million people by the 2080s (IPCC FAR, 2007). Research also shows that malaria not only imposes significant burdens on population health, but also impedes economic growth. Using cross-country data from 1965 to 1990, Gallup and Sachs (2001) show that in countries where malaria has been eliminated, economic growth has usually been substantially higher than in neighboring countries. The same study shows that by controlling for initial poverty, economic policy, tropical location, and life expectancy, countries with intensive malaria grew 1.3 percent less per person per year, and a 10 percent reduction in malaria was associated with 0.3 percent higher growth. Micro-level studies also indicate that malaria is associated with reduced household socioeconomic status

Source: Somi et al. (2007)

## 2.8 Promoting price signals and environmental markets

140. **Regulatory frameworks and growth.** An important source of increasing growth and reducing poverty is improving the regulatory frameworks for natural resources, specifically in water, mining, rural land, fisheries, and forestry. Over-exploitation and mismanagement of these resources have many causes, but ill-defined rules about property rights and the absence of proper valuation of natural resources are generally at the core of the problems.

141. **Climate change and market regulation.** Climate change will add to the pressure to address these issues, be it for water pricing payments or ecosystems. Work done in Madagascar and Mozambique on the proper costing of different environmental resources shows that it would not only ensure sustainable exploitation of natural resources, but also generate additional fiscal resources to cover the public sector role in helping to ensure their sustainable management.



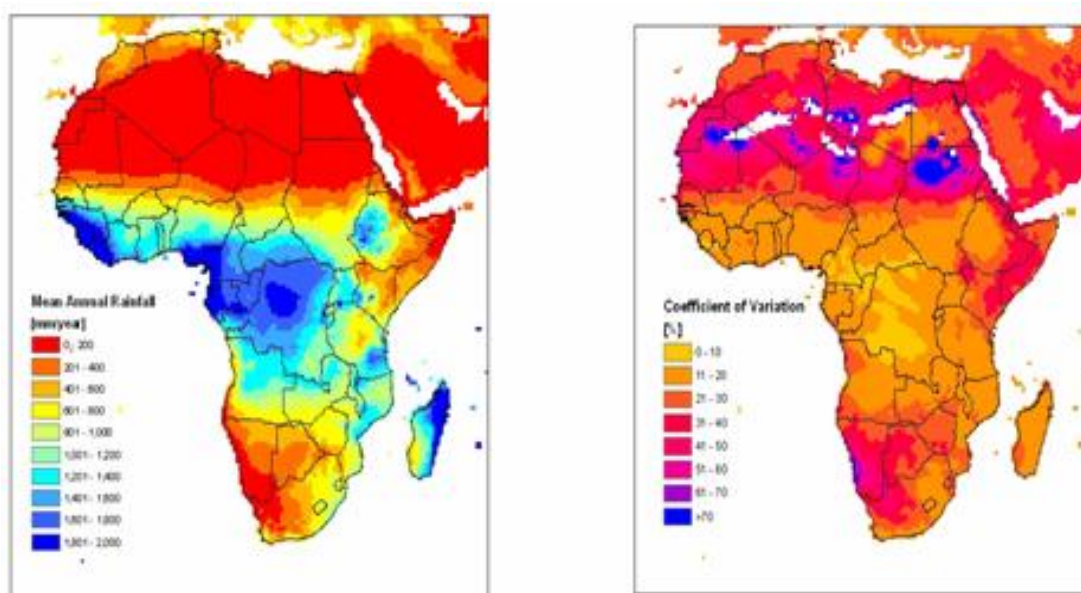
142. **Establishing better incentives.** Stronger regulatory frameworks and improved pricing of resources will help to establish the incentives for stronger public-private partnerships for climate change adaptation. The majority of adaptation practices, with the exception of large infrastructure investments, are managed directly by private actors. Given the very large costs of climate adaptation (as per existing estimates), contributions by the private sector play an important role. Private operators are generally better suited than their public counterparts to deal with the additional risk brought about by climate change (analysis and mitigation).

### 3. Climate Profile of Sub-Saharan Africa

#### 3.1 Characteristics of the climate in Sub-Saharan Africa

143. **Two-thirds of Africa’s land surface can be classified as dryland** (UNEP, 2002). Africa is the only continent that resides almost exclusively within tropical latitudes. Moving south or north from the equator, there is a steep decline in average annual rainfall, accompanied by an increase in variability (Figure 3-1). Large parts of the continent are already exposed to a high degree of climate variability on an annual and inter-annual basis. Climate also depends on circulation and topography; for example, the western equatorial regions are wetter than the eastern, and the Ethiopian highlands experience a cooler and wetter climate than the surrounding lowlands due to topographic effects. These conditions are development constraints as well as opportunities that need to be integrated into the dialogue about development policy and investment operations.

**Figure 3-1. Average annual precipitation (mm/year) (left) and coefficient of variation (%) (right) across Africa**



Note: While agriculture is often the mainstay of economies in Africa, the figures illustrate that for large parts of the continent, marginal climates for natural-resource-based activities, characterized by high degrees of rainfall variability, predominate (A. Lotsch, 2006).

Source: Derived from UEA-CRU 1951-2000 monthly time series.

144. **Rainfall variability is high in Sub-Saharan Africa.** The historical climate and hydrologic record in Sub-Saharan Africa is marked by great variations in inter-annual and intra-annual precipitation, with frequent droughts of varying length. The worst droughts were those of the 1910s, which affected East and West Africa alike. They were generally followed by higher rainfall amounts, but negative trends were observed again from 1950 onward, culminating in the droughts of the early 1970s and mid-1980s. In 1973 (but less

so in 1984), almost all African countries suffered, north and south alike. In contrast, the 1992 Southern African drought was relatively limited in space because the Sahel received relatively high rainfall.

145. **Regional variation in climate characteristics.** Based on general climate characteristics, Sub-Saharan Africa can be broadly divided into five main regions as described in Table 3-1 — West Africa (including the Guinea coast and the Sahel), Horn of Africa, East Africa, Central Africa, and Southern Africa (further differentiated into eastern and western sub-regions). The classification of the Sub-Saharan African climate suggested in this report is based on annual rainfall totals, characteristics of the rainy season, inter-annual climate variability, and the influence of teleconnections<sup>21</sup> such as El Nino.

146. **Climate characteristics.** The basic climate of the homogenous climate regions is set out in Table 3-2. The regions have been established for several decades as identifiable elements of the African climate. Many of the regions also map closely to agro-ecological zones, and some have emerged from ecological studies rather than climate studies (e.g., the Sahel and Guinea coast). In many cases, countries are split into more than one region or sub-region (e.g., Nigeria, South Africa, Mali).

147. **El Nino and climate variation.** The variations in the Indian Ocean sea-surface temperature caused by El Nino Southern Oscillation (ENSO) exert a strong influence on the inter-annual climate variability of parts of the continent. This applies in particular to Eastern Africa (Box 3-1) where the challenge of changing climatic conditions has been underscored in the frequent occurrence of climate-related disasters.

## 3.2 Global climate trends

148. **Unmistakable trends caused by the emission of greenhouse gases.** There can be no more doubt that the Earth's climate is changing (Figure 3-2) and the main causes are human induced. The Fourth IPCC Report (2007) offers a dauntingly clear warning — “change of the climate system is now unequivocal.” Eleven of the last 12 years (1995 to 2006) rank among the 11 warmest years in the instrumental record of global surface temperatures (since 1850).<sup>22</sup> Scientists also agree on looming prospects for more extreme

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21. Teleconnections refer to climate anomalies that are driven by climate variations in other geographic locations. For example, changes in atmospheric pressure and sea-surface temperatures in the Pacific, which are associated with El Nino events, influence the rainfall patterns over Eastern Africa.

22. The datasets on which the global warming trends were calculated have been developed in conjunction with Hadley Centre of the UK Met Office Stations and the Climate Research Unit (CRU) at East Anglia.

*“Why are the temperatures expressed as anomalies from 1961-90? Stations on land are at different elevations, and different countries estimate average monthly temperatures using different methods and formulae. To avoid biases that could result from these problems, monthly average temperatures are reduced to anomalies from the period with best coverage (1961-90). For stations to be used, an estimate of the base period average must be calculated. Because many stations do not have complete records for the 1961-90 period several methods have been developed to estimate 1961-90 averages from neighbouring records or using other sources of data. Over the oceans, where observations are*

weather patterns. This is underpinned by massive research and data analysis. The causes of these trends include burning fossil fuels (mainly in developed countries) which produces some 6 billion tonnes of CO<sub>2</sub> annually, to which are added another 1.6 billion tonnes from deforestation (mainly in developing countries). Agricultural activities are also responsible for significant amounts of other green house gases, mainly methane and nitrous oxide.

**Table 3-1. Regional and country climate variations in Sub-Saharan Africa**

Region	Sub-region	Countries	Key climatic features
West Africa		Mauritania, Senegal, Mali, Burkina Faso, Niger, Chad, western Sudan Guinea, Sierra Leone, Liberia, Côte d'Ivoire, Ghana, Togo, Benin, Nigeria	The region can further be subdivided into: (i) Sahel: Rainy season occurs from July to September. Region is characterized by large inter-decadal climate variability and prolonged drought periods; (ii) Sudan: Region below the Sahel, characterized by a wetter rainfall regime, and (iii) Guinea coast: Bi-modal rainfall regime, no prolonged drought periods, wettest region of West Africa.
Horn of Africa		Ethiopia, eastern Sudan, Eritrea, Somalia	Different timing of rainy season than in East Africa.
Central Africa		Cameroon, Central African Republic, Gabon, Equatorial Guinea, Congo, DRC, northern Angola	Central Africa: Largely defined by annual total rainfall. Wettest region on the continent. Bi-modal rainy seasons: October to December and March to May. No known ENSO teleconnections, instead inter-annual climate variability is influenced by Atlantic modes.
East Africa		Kenya, Uganda, Burundi, Ruanda, Tanzania	East Africa: Bi-modal rainy seasons October to December (short rains) and March to May (long rains). Inter-annual climate variability is strongly influenced by Pacific and Indian Ocean teleconnections
Southern Africa	Western Southern Africa Eastern & Central Southern Africa	Western South Africa, western Botswana, Namibia, southern Angola Eastern and central South Africa, Lesotho, Swaziland, Mozambique, Zimbabwe, Zambia, Malawi	Rainfall peaks between January to March. Inter-annual climate variability by ENSO and Indian Ocean teleconnections.

generally made from mobile platforms, it is impossible to assemble long series of actual temperatures for fixed points. However it is possible to interpolate historical data to create spatially complete reference climatologies (averages for 1961-90) so that individual observations can be compared with a local normal for the given day of the year” (Brohan et al., 2006). See also <http://www.cru.uea.ac.uk/cru/data/temperature/#datter>)

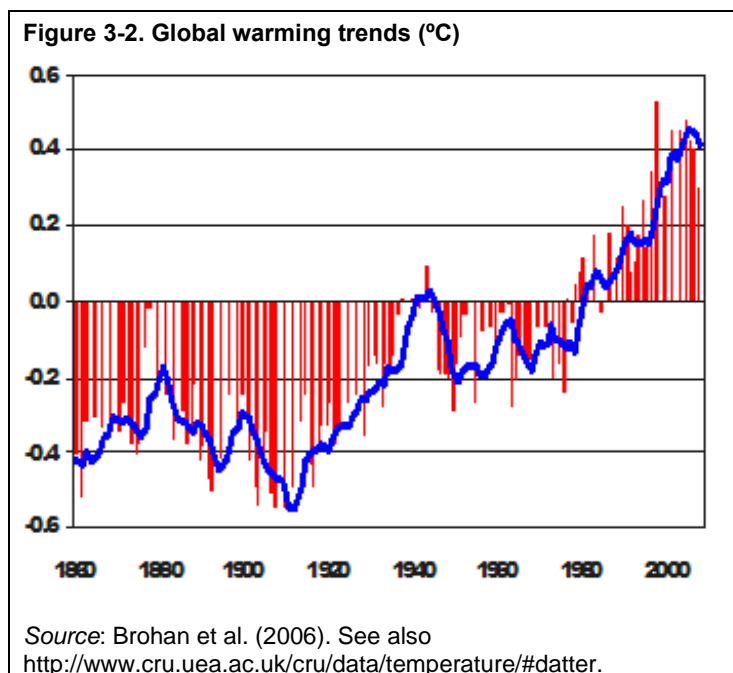
**Table 3-2. Regional climates of Sub-Saharan Africa**

Region/sub-region	Rainfall seasonality	Approximate seasonal rainfall (mm)	Approximate mean annual temperature (°C)
Sahel	July-September	100-400	27-30
Sudan	July-September	400-1200	24-27
Guinea coast	May-October	>1200	24
Horn of Africa	July-September	200-1200	16-30
Central Africa	Bi-modal transition seasons	>1300	20-24
East Africa	Bi-modal transition seasons March to May (long rains), October to December (short rains)	500-1200	18-21
Western Southern Africa	January to March	10-450	16-21
Eastern & Central Southern Africa	December to February	450->1500	18-22

**Box 3-1. Influence of ENSO in Kenya**

During the warm phase of El Nino (ENSO), Kenya experiences a substantial increase in precipitation. While the relative water gains from rainfall are substantial, in particular in the drylands where vegetative cover and productivity both increase, these gains are not always utilized due to lack of adaptive capacity. Floods wash away top soils and outbreaks of water- and vector-borne diseases, such as rift valley fever and malaria, affect both livestock and human health. By contrast, the cold phase of ENSO, La Nina, which often follows an El Nino episode, leads to prolonged below-normal rainfall or drought conditions. Hence, people in the drylands of Kenya have to cope with a broad spectrum of climate variations.

*Source:* World Bank staff (based on literature review)



149. **IPCC projections of global climate change.** Considerable uncertainty is associated with projections of the level or magnitude of changes in climate parameters such as temperature and precipitation, as well as the onset, extent, and severity of the impacts. Projections of climate parameters are derived from Global Climate Model (GCM) runs that are based on specific scenarios of the future. The scenarios include basic assumptions about economic growth and structure, population trends, and the extent of reliance on fossil fuels. The IPCC projections are summarized in Table 3-3 for several different scenarios. Depending on the rate of GHG emissions, IPCC projections indicate that temperature would increase in the range of 1.1 to 6.4 °C by 2100. A rise of the global average temperature beyond 2 °C is generally considered as having devastating effects on people, and food- and fiber-supporting ecosystems. The higher the degree of global warming the greater the likelihood of consequences for human livelihoods and development processes.

**Table 3-3. IPCC scenario forecasts of temperature change in 2080 (change in average global temperature)**

IPCC scenarios	Relative to pre-industrial temperature (°C)	Relative to 1980 to 1999 average temperature (°C)
Constant year 2000	+0.6 (0.3-0.9°)	+ 1.1
B1	+ 1.8 (1.1.- 2.9)	+ 2.3
A1T	+ 2.4 (1.4-3.8)	+ 2.9
B2	+ 2.4 (1.4-3.8)	+ 2.9
A1B	+ 2.8 (1.7-4.4)	+ 3.3
A2	+ 3.4 (2.0-5.4)	+ 3.9
A1F1	+4.0 (2.4 -4.6)	+ 4.5

Scenario A1: Rapid economic and population growth, (i) combined with reliance on fossil fuels (A1F1), and (ii) non fossil energy (A1T).

Scenario A2: Lower economic growth, less globalization, and continued high population growth.

Scenario A1B: Rapid economic and population growth with a balanced mix of technologies and supply sources, with technology improvements.

Scenarios B1 and B2: Some mitigation of emissions through increased resource efficiency and technology improvement.

Source: IPCC (2007)

150. **Potential adverse impacts of climate change.** There are many projected adverse consequences of climate change, including:

- Decreased water availability in many water-scarce regions, especially in arid and semi-arid lands in the sub-tropics;
- Reduction in agricultural productivity in the tropics and sub-tropics for almost any warming, and in mid-latitudes for warming more than a few degrees changes in

productivity and composition of ecological systems, with coral reefs and boreal forests most vulnerable with increased risk of extinction of some vulnerable species;

- Increased risk of floods, potentially displacing tens of millions of people due to sea level rise and heavy rainfall, especially in small island states and low-lying deltaic areas; and
- Increased incidence of heat stress mortality and the number of people exposed to vector-borne diseases, such as malaria and dengue, and water-borne diseases such as cholera, especially in the tropics and sub-tropics

### 3.3 Projected climate changes for Sub-Saharan Africa

151. **Climate projections in Africa are hindered by limited data.** While there is growing evidence that climate change is already underway, regional and local trends are often masked by the high annual and inter-annual variability in climatic conditions. The sparse meteorological data networks, spurious data records, and/or difficult data access in many parts of the continent represent an additional constraint to detecting climatic changes. The resolution and quality of available climate information vary considerably across the continent. Notwithstanding these issues, a large number of Global Climate Model (GCM) simulations for a range of scenarios are available and are being used to assess the potential changes that SSA may experience (Table 3-4).

**Table 3-4. Overview of climate changes projected for Africa**

Change	Region
<i>Average conditions</i>	
Temperature increase	Entire continent (median projected increase in annual average temperature: 3 to 4 °C (end of century to present))
Decrease in rainfall	West coast of Africa as far south as 15° N Southern Africa
Increase in rainfall	Northern parts of East Africa
Uncertain projections for rainfall	Sahel (already high variability) Guinean coast Southern Sahara
Sea level rise	Low lying islands and coastal zones Delta regions
<i>Extremes</i>	
Increase in intense precipitation events	Entire continent (this applies also in regions of mean drying because there is a proportionally larger decrease in the number of rain days)
<i>Cyclones</i>	Uncertain — changes in magnitude and frequency, and shifts in cyclone tracks possible

Source: Based on IPCC (2007)

152. **The region will have to plan on:** (i) increased temperatures that will stress agricultural and natural ecosystems; (ii) increased water shortages and regional differences in water availability; (iii) shorter growing periods for parts of Sub-Saharan Africa; and (iv) intensified precipitation events that may increase the magnitude and frequency of flooding.

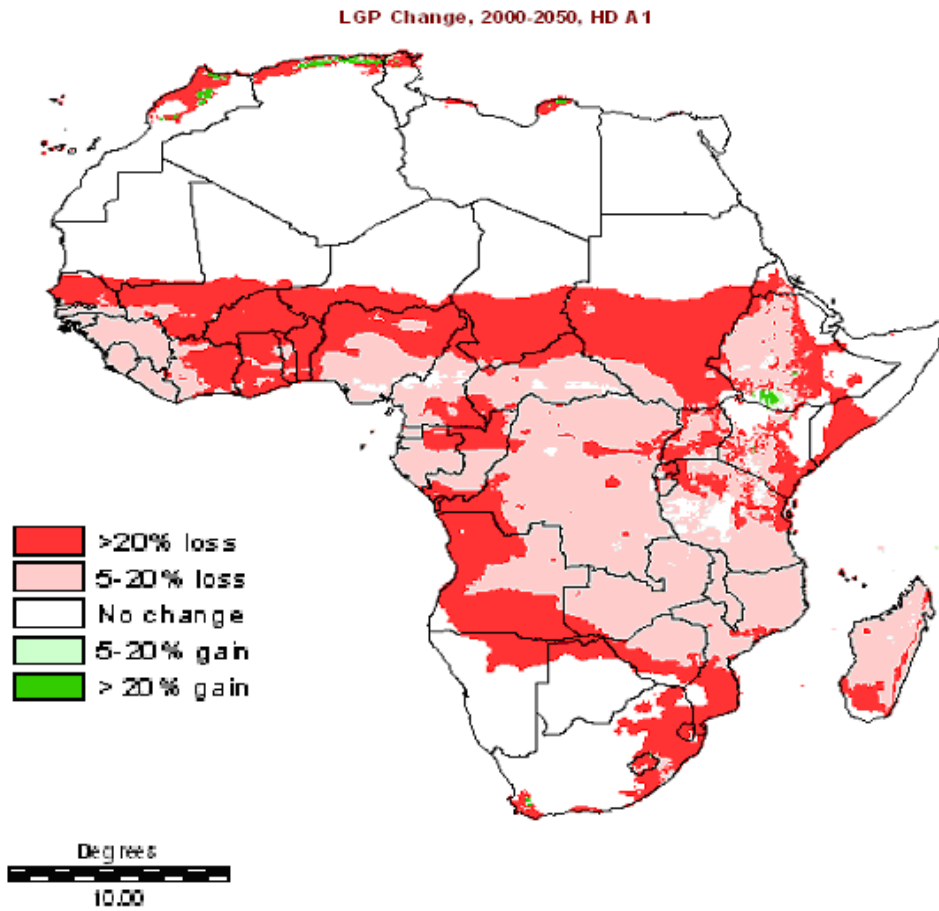
153. **Projected temperature changes.** On the whole, the African continent has warmed by about 0.5 °C over the last century. Based on climate simulations available to date, the median projected additional increase in average annual temperature is likely to reach 3 to 4 °C by the end of this century.

154. **Climate projections for precipitation.** The existing precipitation gradient, from the tropics to the sub-tropics, could be further exacerbated in the future. As global warming progresses, it is generally expected that dry areas are becoming drier and wet areas are becoming wetter. Areas that already receive substantial amounts of rainfall are expected to receive more rainfall in the future. Areas receiving only sparse rainfall today are likely to experience even less rain over time, which poses an additional challenge to livelihoods and economic activities that depend on natural resources. Increases in temperature will increase evaporation from the soil and water bodies and increase transpiration by plants, but the overall change in run-off (and hence stream flow) and groundwater recharge depends on the level of change in precipitation. Projected changes in annual average precipitation are indicative of overall wetting and drying of the annual climate. It is these variations in the timing and magnitude of monthly rainfall, when combined with changes in temperature and other conditions (development including infrastructure, land management, etc), that result in changes in run-off and groundwater recharge. Considerable research is ongoing to utilize the GCM simulation results to simulate changes in the hydrologic cycle and to model river basins to assess changes in stream flow that provide a basis to assess climate risk.

155. **Projected changes in the length of growing (LGP) period.** While the magnitude of change differs depending on the type of model and scenario used, the general picture of how growing periods may change across the region (Figure 3-3) suggests that the decline in the length of growing period is most pronounced in areas where climatic conditions are already a constraining factor to agriculture-based livelihoods. Declining LGPs are also observed in some areas with projected increases in rainfall due to enhanced evaporation under global warming. However, just as important may be changes in monthly and seasonal precipitation, especially the early or late onset or cessation of rainfall.



Figure 3-3. Relative change in length of growing period (LGP) by 2050 compared to present



Source: Thornton et al. (2006)

## 4. Climate Change Impacts

### 4.1 Prospective changes to climate and country exposure to climatic risks

156. **More climatic extremes.** As described in Chapter 3, temperatures are rising and rainfall is becoming more unpredictable, but generally dry areas will become drier and wet areas will become wetter. Africa experienced important shifts in climate over the past millennia, but likely changes in the next few decades may present some of the greatest challenges. Along with rising temperatures, there is also likely to be increased rainfall variability leading to more precipitation extremes and growing water stress. Growing seasons will be affected. More intense and unpredictable weather events are likely in countries such as Kenya, Ethiopia, Malawi, Mozambique, and Madagascar (Figure 4-1). The six warmest years on record in Africa have occurred within the last 20 years and the average temperature rose approximately 0.5 °C during the 20<sup>th</sup> century. In addition, the continent has seen a decrease in rainfall over large parts of the Sahel and Southern Africa, and an increase in parts of East and Central Africa. The number of weather-related disasters, droughts and floods, has doubled in Africa over the last 25 years, and Africa has higher mortality rates from droughts than any other region.

157. **Nature and level of climatic changes.** The initial problem for policy makers and sector development authorities is to determine the nature and level of potential climatic changes. In Figures 4-1 and 4-2 we have mapped IPCC projections (available for a global 0.5° × 0.5° grid that ranges in size from 250 to 600 kilometers) to each SSA country. We then assessed the level of risk using assumed risk threshold parameters that differentiate the degree of predicted change (e.g., change in precipitation greater than 10 percent is assigned a high risk).<sup>23</sup> In addition to monthly changes in wet- and dry-season precipitation, to determine flood and drought risk we also used predictions of changes in maximum short-duration rainfall (5 days), number of consecutive dry days, and change in run-off based on hydrologic modeling of IPCC projections of temperature and precipitation change.

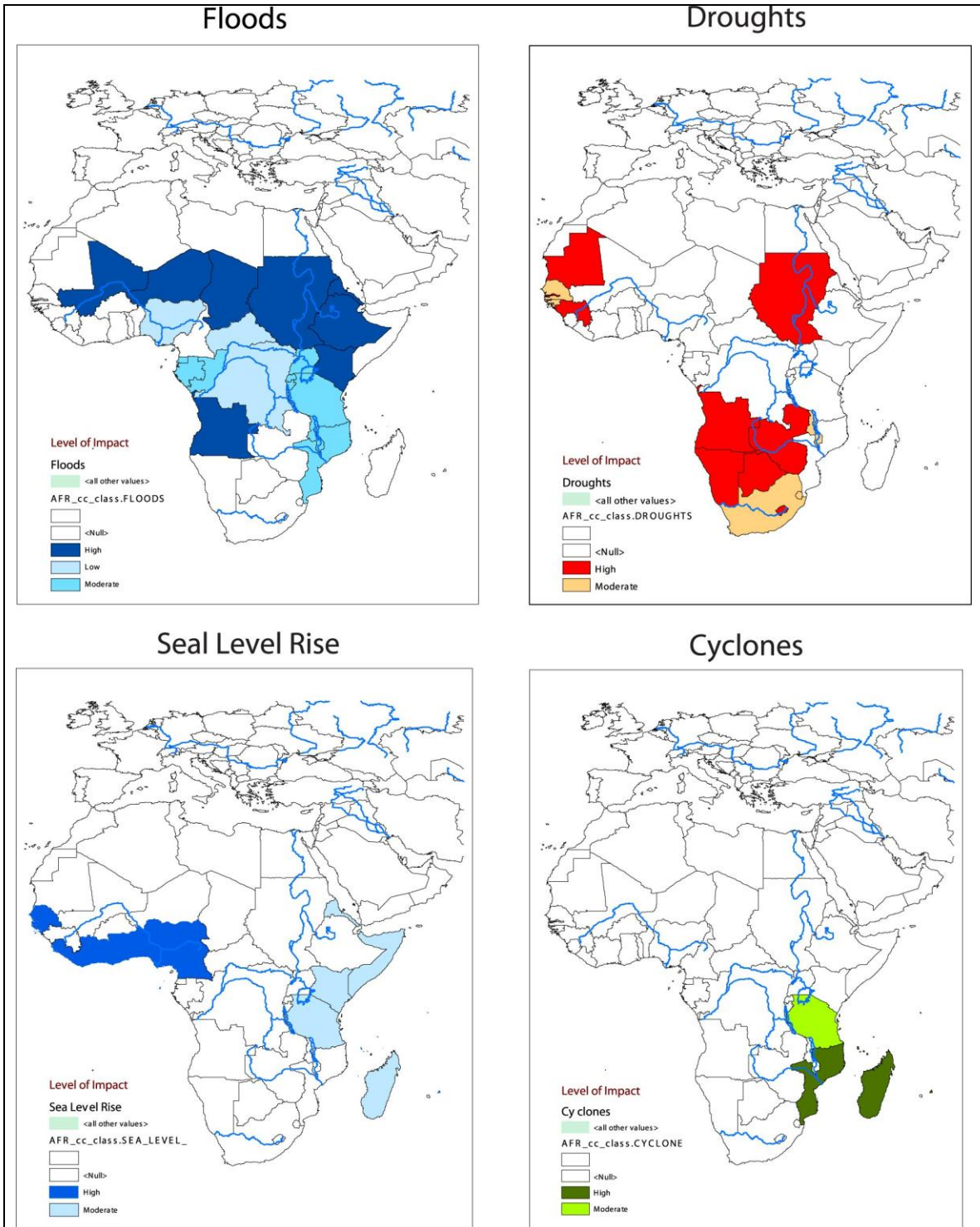
158. **Relative risks.** Table 4-1 and Figure 4-1 are meant to be indicative of relative risk or exposure and hence to help establish priorities. Countries with a high risk of exposure need to begin developing the capacity and knowledge base to determine specific manifestations for these projections, and formulate medium- and long-term plans to adapt and adjust. For example, hydrologic modeling of increased temperature and rainy season precipitation indicates that these changes are generally amplified as increased run-off. Increased rainy season precipitation accompanied by increased short-duration rainfall (increased intensity) would indicate increased flooding risks (increased magnitude and frequency). On the other hand, increased precipitation may mainly increase water basin

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23. These results are based on data from 11 GCMs for the A1B scenario (Table 3-3) for precipitation, and eight GCMs for temperature. Data available for the GCM global 0.5° × 0.5° grid were mapped within country boundaries. Because of systematic biases and other model differences, all the GCM model results do not agree in some regions. Overall, about two out of three of the 11 models agree on the sign of precipitation change.



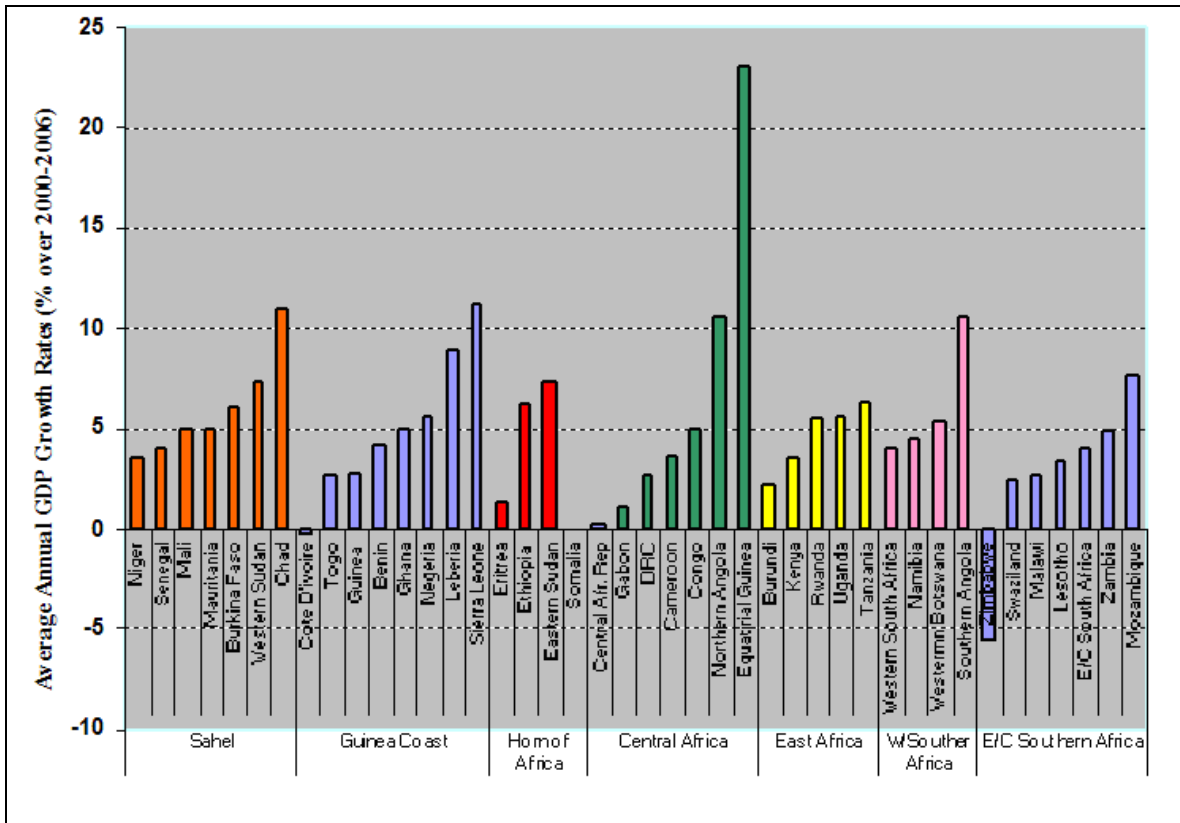
Figure 4-1. Country exposure to the risks of climate change



## 4.2 Effects of climate change on economic growth

159. **Improved economic performance.** After stagnating for several decades, economic performance in Africa has been improving. In recent years GDP growth has been accelerating to about 6 percent per year while inflation registered below a two-digit level, a recent low point (Arbache et al., 2007). The current growth performance has lasted more than a decade, and average incomes in Africa have been rising in tandem with those in other regions (Figure 4-2).

Figure 4-2. Economic performance by main climatic regions in SSA



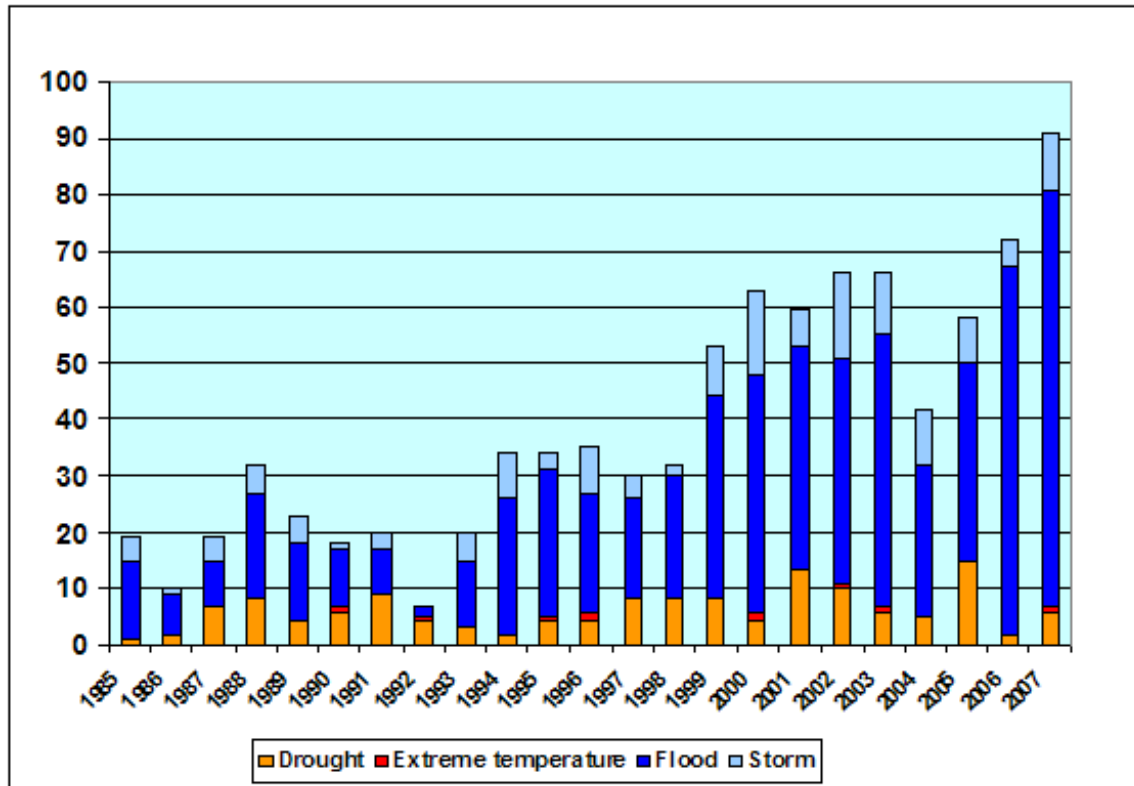
Source: Data from Arbache et al. (2007), Table 1

160. **Recent economic performance** exhibits a similar pattern across climatic zones. The distribution among countries between high and low performers is similar across the main climate zones in SSA (Figure 4-2). While average GDP growth between 2000 and 2006 was highest in Central Africa (6.6 percent), closely followed by western Southern Africa (6.1 percent), the Sahel (6 percent), and the Guinea coast (5.0 percent), it was lowest in the Horn of Africa (4.9 percent), East Africa (4.6 percent), and eastern Southern Africa (4.2 percent). Interestingly, in the Sahel region — where further drying conditions are projected along with large uncertainties and shortening of the main growing period — has seen solid economic performance of late predictions (IPCC, 2007; Washington, 2008).

161. **Sub-Saharan African economies have a degree of built-in climate resilience.** Some measure of resilience to climate variability is clearly already built into African economies, despite their many vulnerabilities. Present development strategies and models already include important adjustments and adaptations to weather, climate, and hydrologic risks. This includes investments in water storage, flood control and drainage infrastructure, crop varieties and practices, irrigation infrastructure, diversification of water supply sources, coastal defenses, health systems, etc.

162. **Climate change introduces new risks.** While an even greater degree of adaptation to climate variability needs to be built into SSA economies, climate change introduces a new set of risks and challenges. Past variations and patterns are an incomplete guide to what might be expected in the future. Extremes such as droughts, floods, and cyclones are predicted to increase in frequency and magnitude (Figure 4-3); sea levels are expected to rise, adversely affecting not only coastal zones but drainage far inland in many cases; and seasonal patterns of rainfall intensity and magnitude are predicted to change, increasing in some sub-regions and seasons and decreasing in others. Parts of Sub-Saharan Africa have already experienced an increase in temperature, and this important change is predicted to increase and affect larger areas.

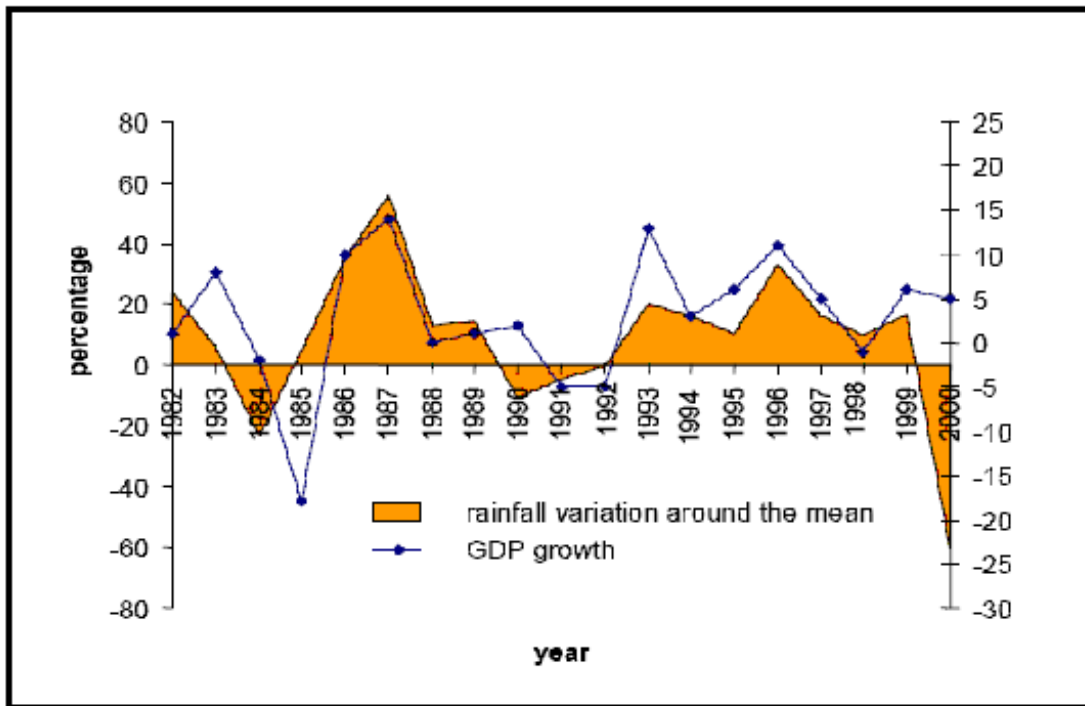
Figure 4-3. Number of reported hydro-meteorological disasters in SSA (1985-2007) and increasing trend



Source: EM-DAT

163. **Agriculture is most vulnerable sector.** While all of Africa’s major economic sectors are vulnerable to climatic change, agriculture is the most vulnerable. In most African countries, due to a lack of economic diversification and the importance of rainfed agriculture, there is a close association between GDP growth and rainfall. The persistent correlation between rainfall and GDP growth in Ethiopia (Figure 4-4) is striking; this is not the case in countries with higher incomes and highly diversified economies such as China or India, or African countries with low dependence on agriculture (e.g., Botswana, Namibia, Mauritius). Moreover, long-term projections forecast that Africa’s agricultural output could be reduced more than any other region of the world.<sup>24</sup>

Figure 4-4. Links between rainfall and GDP growth (Ethiopia)



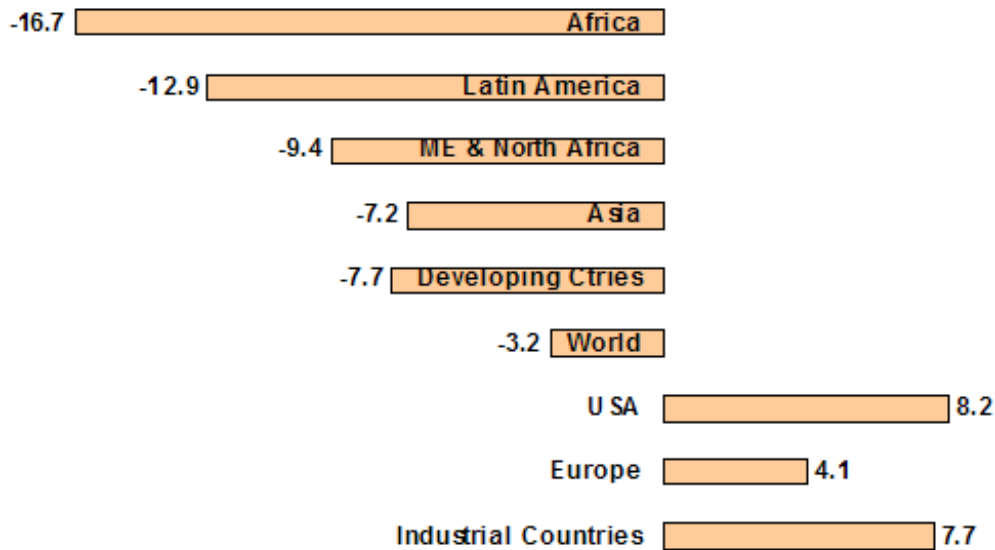
Source: World Bank (2006c)

164. **High cost of natural disasters.** Droughts and floods cause significant economic and social losses (Figure 4-5). Country-level studies over the past 30 years suggest that the impacts of hydrology and rainfall variability on economic development are significant, estimated at 8 to 9 percent of GDP in Zimbabwe and Zambia in 1992, and 4 to 6 percent in Nigeria and Niger in 1984. In Ethiopia, it was estimated that droughts and floods reduced economic growth by more than one-third. Annual damages in Kenya due to flooding and drought from 1998 to 2000 range from 10 to 16 percent of GDP (the 1997/98 flood alone destroyed \$1.8 billion worth of infrastructure and property). The

24. A recent global study by IIASA (2002.) concludes that climate change will have a significant negative impact on cereal production in Africa. This will be due to the increase in areas where the length of the growing period will fall below 120 days per year (thus more land area would become arid). Some 180 million Africans will potentially be threatened by famine.

Mozambique 2000 floods cost the country \$550 million (1.5 percent reduction GDP growth rate). In addition to direct and immediate impacts, floods and droughts can also have persistent effects through destruction of productive capital and/or, in the absence of safety nets, disposal of productive capital for survival (for example, the sale of livestock by poor households).

Figure 4-5. Change in agricultural output potential (2080 as % of 2000)



Source: Cline (2007)

165. **Energy scarcity is a drag on SSA economies.** Climate change also affects the availability and reliability of energy. Lower annual rainfall in some parts of the continent has sharply reduced the power generation capacity of hydroelectric dams. Meanwhile, because of a combination of factors (including low investment, inadequate management, and international prices), 28 countries in Africa have been affected by power crises in the past two years. This energy scarcity, compounded by high fuel prices, has raised the cost of transport, industrial, and commercial sector operations in most African countries.

### 4.3 Effects on progress toward the Millennium Development Goals

166. **Climate change is a development issue.** Climate change poses a threat to sustainable development and may unravel progress that has been made toward achieving the Millennium Development Goals (MDGs) by 2015 and beyond unless measures to mitigate risk are taken. This was the message of a report on poverty and climate change written by the World Bank and nine other multilateral and bilateral organizations (AfDB et al., 2003), highlighting the importance of recognizing climate change as a development issue. This message was echoed by reports from civil society organizations (e.g., IIED, 2007) and other stakeholder groups.



167. **Conceptual links between climate change and the MDGs.** These reports generally describe the conceptual links between climate change and the objectives of different MDGs, examining how climate change will challenge the processes required to achieve the MDGs. For the MDGs concerned with income levels and hunger, human health, and access to water and sanitation, there is insufficient momentum to meet the targets by 2015 across wide areas of Africa. The MDGs most susceptible to direct climate change impacts are MDG 7, particularly increased access to potable water, MDG 1, progress on food security, and MDG 6, prevalence and death rates associated with malaria. A search of the literature revealed that there is currently a lack of systematic, quantitative assessments of the impacts of climate variability and change on the sectors (social and economic) that are central to achieving and sustaining the MDGs across African countries.

168. **MDGs: goals, targets, and current status.** Table 4-2 lists the Millennium Development Goals, some associated targets, and their current status in Sub-Saharan Africa.

**Table 4-2. Progress on Millennium Development Goals and targets across Africa**

<b>MDG and measure of achievement</b>	<b>1990</b>	<b>2004</b>	<b>2015 target</b>
MDG 1: People living on \$1 (PPP) as % of population	44.6	44	22
MDG 2: Net primary enrollment rate (%)	53	64	100
MDG 3: Promote gender equality			
Percent of girls who completed primary education	51	61	100
Percent of illiterate women in the 15 to 24 age group	80	88	100
MDG 4: Under-5 mortality per 1,000 births	185	168	62
MDG 5: Deliveries attended by skilled health workers (%)	42	46	100
MDG 6: Combat malaria, tuberculosis, HIV/AIDS and other diseases			
Adult HIV/AIDS prevalence (percent of adult population)	2.7	5.8	Stop increase
Tuberculosis prevalence (cases per 100,000 excluding HIV infected)	337	492	Stop increase
MDG 7: Ensure environmental sustainability			
Access to improved water source (% of population)	49	56	75
Access to improved sanitation (% of population)	32	37	66
MDG 8: Develop a global partnership for development			
Share of ODA flows (% of donor GNI)	0.33	0.22	0.7

Source: World Bank: Millennium Development Goals

169. **Evidence of climate change effects.** Table 4-3 shows the different ways that current climate variability and climate change will continue to affect sectors that are central to achieving and sustaining the MDGs across Africa. It is important to note that no studies were encountered in the review of literature that assessed how climate change will affect MDGs across Africa. Some general assertions have been made by UNDP and UNFCCC about the likely impacts of climate and climate change on the MDGs, but these have not been followed up with empirical studies. Information about the likely impacts on achievement of the MDGs was obtained from the National Communications on Climate Change, which non-Annex 1 Parties are required to prepare and submit to UNFCCC.<sup>25</sup>

#### 4.4 Costs of adapting to climate change

170. **Estimating the cost of adaptation to future climate change is problematic.** First, climate change affects all sectors, making it difficult to separate adaptation from general development. Second, it is increasingly difficult to extrapolate future impacts of climate change from historical climate and hydrologic patterns — making any estimate of the costs of adaptation highly speculative. For example, if Ethiopia improves its flood management forecasting and information system, what proportion of this is an adaptation to past (and current) variability versus that for future climate changes? With these important caveats, there have been several attempts to provide approximate estimates of the financing required for adaptation. Most have focused on “climate-proofing,” that is, they looked principally at the cost of adapting current investments and infrastructure to protect them against climate change risks.

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25. The UNFCCC (the Convention) divides countries into three main groups according to differing commitments:

Annex I Parties include the industrialized countries that were members of the OECD in 1992, plus countries with economies in transition (EIT), including the Russian Federation, the Baltic States, and several Central and Eastern European States.

Annex II Parties include the OECD members of Annex I, but not the EIT Parties. They are required to provide financial resources to enable developing countries to undertake emissions reduction activities under the Convention, and help them adapt to adverse effects of climate change, as well as “take all practicable steps” to promote the development and transfer of environmentally friendly technologies to EIT Parties and developing countries.

Non-Annex I Parties are mostly developing countries. Certain groups of developing countries are recognized by the Convention as being especially vulnerable to the adverse impacts of climate change. The 49 Parties classified as least-developed countries (LDCs) by the United Nations are given special consideration under the Convention because of their limited capacity to respond to climate change and adapt to its adverse effects. Parties are urged to take full account of the special situation of LDCs when considering funding and technology-transfer activities (Out of 49 countries classified as LDCs, 33 are from Sub-Saharan Africa) ([http://unfccc.int/essential\\_background/convention/items/2627.php](http://unfccc.int/essential_background/convention/items/2627.php)).

**Table 4-3. Evidence of the ways that climate change will affect the achievement and sustainability of the MDGs across Africa**

Climate impacts	Sector	Information from climate projection research work
<b>MDG 1: Eradicate extreme poverty and hunger</b>		
Productivity declines in terms of crop yields, animal product off-take reduces household incomes and/or worsens food security	Crops	<ul style="list-style-type: none"> <li>Productivity of mixed rainfed and semi-arid systems, particularly in the Sahel, expected to decline.</li> <li>Agricultural GDP losses range from 2 to 4% with some model estimates.</li> <li>Food security, already a humanitarian crisis in southern Africa, is likely to be further aggravated.</li> <li>Wheat production likely to disappear from Africa by the 2080s.</li> <li>Southern Africa likely to experience notable reductions in maize production under possible increased ENSO conditions.</li> </ul>
	Livestock	<ul style="list-style-type: none"> <li>Changes in disease distribution, range, prevalence, incidence, and seasonality can all be expected. However, there is low certainty about the degree of change.</li> </ul>
	Fisheries	<ul style="list-style-type: none"> <li>Fisheries productivity may or may not decline due to change in water temperature, salinity, acidity, and other fluctuations; however, the emergence of new water bodies, improved low-flow availability, or more extensive flooded areas where rainfall will increase may create new opportunities.</li> <li>Rainfall changes might affect water levels in freshwater bodies which can therefore change fish habitat (including breeding habitat), salinity, and acidity. In the marine environment, currents might change and coastal erosion might be more pronounced, both potentially affecting fish habitat, breeding, and migrations.</li> </ul>
	Nutrition	<ul style="list-style-type: none"> <li>Nutrition (as measured by underweight) is likely to be affected by reduced food production and availability.</li> </ul>
<b>MDG 2: Ensure that all children remain in school and receive a high-quality education</b>		
Loss of livelihood assets (natural, health, financial, and physical capital) may reduce opportunities for full-time education in numerous ways	Food security	<ul style="list-style-type: none"> <li>Experience in several African countries (Ethiopia, Ghana, Niger) shows that children aged 5 and under are more likely to be stunted if they were born during a drought year.</li> <li>In Kenya, being born in a drought year increases the likelihood of children being malnourished by 50 percent.</li> </ul>
<b>MDG 3: Promote gender equality and empower women</b>		
Climate change affects women more than men, exacerbating gender inequalities	Agri-culture	<ul style="list-style-type: none"> <li>Rural women in developing countries are the primary producers of staple foods, a sector that is highly exposed to the risks that come with drought and uncertain rainfall.</li> </ul>
Women and girls have to cope with fewer resources and a greater workload	Water	<ul style="list-style-type: none"> <li>Climate change means that women and young girls have to walk further to collect water, especially in the dry season.</li> </ul>
<b>MDG 4: Reduce child mortality &amp; MDG 5: Improve maternal health</b>		
Children and pregnant women are particularly susceptible to vector-borne diseases	Health	<ul style="list-style-type: none"> <li>Some 800,000 children under age 5 in sub-Saharan Africa die as a result of malaria each year, making it the third largest killer of children worldwide. Rainfall, temperature, and humidity are three variables that most influence transmission of malaria — and climate change will affect all three.</li> <li>In eastern Africa, flooding in 2007 created new breeding sites for disease vectors such as mosquitoes, triggering epidemics of Rift Valley Fever and increasing levels of malaria.</li> </ul>

**Table 4-3. Evidence of the ways that climate change will affect the achievement and sustainability of the MDGs across Africa (continued)**

Climate impacts	Sector	Information from climate projection research work
<b>MDG 6: Combat malaria, tuberculosis, HIV/AIDS, and other diseases</b>		
Water stress and warmer conditions encourage disease	Environment	<ul style="list-style-type: none"> <li>The highlands of Eastern Africa and areas of Southern Africa are likely to become more suitable for malaria transmission.</li> </ul>
<b>MDG 7: Ensure environmental sustainability</b>		
Alterations and possible irreversible damage in the quality and productivity of ecosystems and natural resources	Water and sanitation	<ul style="list-style-type: none"> <li>Increase in number of people who could experience water stress by 2055 in northern and Southern Africa. In contrast, more people in Eastern and western Africa will be likely to experience a reduction rather than an increase in water stress</li> <li>Parts of Southern Africa are projected to experience significant losses of run-off, with some areas being particularly affected (e.g., parts of South Africa)</li> <li>Increasing difficulty in maintaining wetlands and aquatic ecosystems and environmental flows.</li> <li>There is no clear indication of how flow in key river basins (e.g., Nile, Zambezi, Niger, Senegal) will be affected by climate change because of the uncertainty about rainfall patterns in the basins and the influence of complex water management and water governance structures</li> </ul>
<b>MDG 8: Develop a global partnership for development</b>		
Funding for development and adaptation must be greatly increased to meet the needs of the poor	Diplomacy and policy	<ul style="list-style-type: none"> <li>Developed countries have fallen short of targets they have set for themselves to achieve wide-reaching development objectives.</li> <li>Climate change challenges will require significant additional resources.</li> </ul>

Source: IIED (2007), see also AfDB et al. (2003)

171. **World Bank/UNDP approach.** The first estimate is based on preliminary calculations by the World Bank of the additional cost of adapting or climate-proofing new investments financed each year by development aid, domestic resources, and foreign direct investments. Of the \$3 trillion per year of investments in the developing world, the majority of which are domestic investments, and assuming that the percentage of these investments that are sensitive to climate risk varies between 5 and 20 percent, total yearly adaptation costs are estimated to range from \$4 to 37 billion. A recent update by UNDP (2007) using 2005 as a base year put the mid-range of the costs of adaptation at about \$37 billion a year (Table 4-4).<sup>26</sup>

26. A new global study, *The Economics of Adaptation to Climate Change* (World Bank Environment Department), is a multi-year multi-country study designed to help developing country decision makers to better design climate change adaptation strategies through an improved understanding and assessment of the risks posed by climate change, the adaptation measures that can be taken to reduce risks and/or adverse impacts, and the costs and benefits of such measures. The study results from a partnership between the World Bank, which is leading the technical aspects of the study, and the governments of the United Kingdom, Netherlands, and Switzerland, which are funding the study. The study will be initially focus on seven case study countries — Ethiopia, Mozambique, Ghana, Bangladesh, Vietnam, Bolivia, and a small East Pacific island country (being identified at present).

172. **Oxfam’s NAPA-based estimate.** Extrapolating from the project cost of some 13 national adaptation action plans (NAPA), Oxfam puts the financing needed for immediate climate-proofing at between \$1.1 billion and \$2.2 billion for the least-developed countries, rising to \$7.7 to \$33 billion for all developing countries (Table 4-5). Using a different approach, Oxfam attempted to estimate the broad financing requirements for community-based adaptation. Drawing upon a range of project-based per capita estimates, it reached an indicative figure of around \$7.5 billion in adaptation financing requirements for people living on less than \$2 per day.

173. **UNFCCC sectoral adaptation estimates.** The third estimate comes from an analysis by the UNFCCC<sup>27</sup> to estimate additional investments needed for adaptation in 2030 in selected sectors (Table 4-6). Due to the difficulties of estimating the adaptation costs to climate change in sectors such as ecosystems, these estimates may be low because the adaptation needs of some sectors were not included. Estimates are based on climate modeling assumptions. For the world as a whole, it was estimated that additional investments needed for adaptation in 2030 could be as high as \$170 billion per year, a large share of which is accounted for by infrastructure (representing some 0.2 percent of an \$80 trillion global economy). The costs for developing countries are estimated at \$57 billion and could be as high as \$100 billion per year several decades from now.

**Table 4-4. UNDP 2005 estimates to “climate proof” development**

Type of investment	Developing countries (billion \$)	Estimated portion sensitive to climate change (%)	Estimated cost of climate adaptation (%)	Estimated cost (billion \$)	Mid-range of estimated cost (billion \$)
Domestic investment	2,724	2-10	5-20	3-54	30
Foreign direct investment	281	10	5-20	1-6	3
Net official development assistance	107	17-33	5-20	1-7	4

*Source:* UNDP (2007) using broad estimates from various sources and assumptions on climate sensitivity and cost from Stern (2006)

174. **Two studies also identified possible sources** of funding (UNFCCC 2007, 2008). In agriculture, forestry, and fisheries, a large share of additional investment will be in production<sup>28</sup> and processing and thus will likely be covered by private sector agents. But public resources will likely be needed for research and development, extension, and

27. UNFCCC (2007, 2008). Estimates of financial flows and investment needs for adaptation have not changed from the 2007 report, and remain in the tens of billions, possibly hundreds of billions dollars of per year. The update reflects efforts to assess adaptation needs through regional and national bottom-up assessments as compared to global top-down estimates

28. Most wild fisheries are already at maximum production capacity and processing plants throughout the world tend to operate at 50 percent capacity or less. Production will increase through aquaculture, but not through wild capture fisheries.

direct support to small-scale farmers. For water resources, 80 percent of the estimated need will be in developing countries and the majority of financing will come from the public sector, both domestic and foreign. The totality of the additional investment needs in human health will be in developing countries with most of the cost to be shouldered by the families of those affected. But external support is expected to play an important role. For coastal zones, about one-half of the adaptation needs will be in developing countries with the large coastal deltas in Asia and Africa and small island states as most affected. Additional sources of external development assistance will likely be needed. In infrastructure, the very wide range of the estimate reflects the significant uncertainty of the climate impacts.

**Table 4-5. NAPA-based estimates**

Grouping	Population (millions)	GDP (billion)	Land use (sq. km.)
NAPA 13, submitted	218	83	349
All LDCs	741	257	2,262
All developing countries	5,094	8,347	15,178
	Population basis	GDP basis	Land-use area basis
Scaling-up from NAPA budgets	\$1.1 billion	\$1.0 billion	\$2.2 billion
Scaling-up for all LDCs	\$7.7 billion	\$33.1 billion	\$14.4 billion

Source: Oxfam (2007)

**Table 4-6. UNFCCC estimates of adaptation investment needs in 2030**

Sector	Global (billion \$)	Share of developing countries (%)	Source of- funding
Agriculture, forestry, and fisheries	14	50	Private sector
Water supply	11	80	Public sector
Human health	5	100	Families
Coastal zones	11	40	Public sector
Infrastructure	8-130	25	Public sector

Source: UNFCCC 2007 and 2008

## 5. Primary Ongoing Initiatives and Programs

### 5.1 Introduction

175. **This section briefly reviews key programs** that are either underway or at an advanced stage of preparation, and which have direct relevance to the Bank strategy. The main focus is on initiatives with strong country and/or African institution ownership.

### 5.2 World Bank Group Africa Action Plan

176. **Platform for climate-resilient development.** The Africa Action Plan (AAP) is the World Bank Group's strategy, in partnership with others, to help each African country reach as many of the MDGs as possible (World Bank, 2006). The AAP provides a results-oriented framework to support critical policy and public actions by African countries, with a focus on building honest and capable states through governance reforms; raising the rate of growth; enabling the poor and women to participate in, and benefit from, growth; building partnerships at the country, regional, and global levels; greater country and sector selectivity in the design and targeting of interventions; better harmonization and alignment of development partner actions to support country-led strategies; and the establishment of sound monitoring and evaluation systems. Moreover, the Africa Region is focusing on the results agenda through IDA 15, which requires reporting at mid-term on progress with incorporating climate change into IDA 15 overall results.

177. **Strengthening the drivers of growth, and leaving no one behind.** The AAP underlines that the poor and marginalized must benefit from a shared growth agenda. It contains 25 initiatives and over 100 suggested actions, focusing on three broad areas:

- Build capable states and improving government.
- Strengthen the drivers of growth — a vibrant private sector, expanded exports, infrastructure investment, increased agricultural productivity, as well as investments in education, health, and access to economic opportunity for the poor.
- Increase the impact of partnerships among governments and development partners/agencies with a special focus on agriculture as a driver of growth (Box 5-1).

178. **AAP focus areas.** African country Poverty Reduction Strategy Papers and the growth agenda they support form the foundation for the AAP. The Plan makes specific commitments, such as increased financial support for free primary education in 15 countries and more funding for roads, power, and other infrastructure. It also proposes an expansion of the Bank's Malaria Booster Program by 150 percent in 17 countries, and expects to scale-up lending support for HIV/AIDS programs in 10 countries, as well as greater investment toward achieving the Millennium Development Goals. In addition, the Africa Action Plan supports the African Infrastructure Consortium in mobilizing resources for country and cross-border regional infrastructure projects.

**Box 5-1. Scaling-up support for African agriculture**

For many African countries, a push for agricultural exports will be the means by which they kick-start sustainable growth and open markets to African products. Many countries have the climatic conditions to compete in a world market, for example, the cut flower industry in Kenya and Ethiopia and horticultural products in Senegal. More important, 70 percent of Africans find employment and livelihood in agriculture.

The AAP sees agriculture as a driver of growth, and calls for the World Bank Group to help governments design, cost, and mobilize the resources needed to implement comprehensive programs of agricultural development, and to work with the New Partnership for Africa's Development (NEPAD) and development partners to scale-up coordinated support.

Source: World Bank

### **5.3 World Bank carbon finance program**

179. **Catalytic role of carbon finance.** Because carbon finance provides a means to leverage new private and public investment in projects that reduce greenhouse gas emissions over the past decade — thereby mitigating climate change while contributing to sustainable development — the World Bank has pioneered a number of carbon finance mechanisms, using funds contributed by governments and companies in OECD countries to purchase project-based greenhouse gas emission reductions in developing countries and countries with economies in transition. The emission reductions are purchased through one of the 10 carbon funds on behalf of the contributor, and within the framework of the Kyoto Protocol Clean Development Mechanism (CDM) or Joint Implementation (JI).

180. **Carbon finance can help reduce poverty.** The World Bank carbon finance initiatives are an integral part of the Bank's programs to reduce poverty through its environment and energy strategies. Carbon finance has served as a catalyst in bringing climate issues to bear in projects relating to rural electrification, renewable energy, energy efficiency, urban infrastructure, waste management, pollution abatement, forestry, and water resource management.

181. **Building the capacity to access carbon finance.** Because African countries lack supportive national CDM approval systems and have significantly higher transaction costs and risks, they are largely bypassed in favor of larger transactions in middle-income countries (So far, only about 3 percent of CMD projects are being implemented in SSA.) Therefore, a specific strategy for Africa is being implemented to ensure an equitable share of the benefits of carbon finance.

182. **New partnerships with African countries.** Under the Africa-Assist window of the global Carbon Fund-Assist program, new partnerships between selected African countries, regional and international organizations, donors, and civil society are being fostered to support critical “learning-by-doing” capacity building opportunities in about a dozen SSA countries. The World Bank and the Government of France, through its Agence Française de Développement/FFEM are supporting the development of a new Africa-focused carbon finance partnership. This initiative covers a six-month preparation phase, followed by a five-year active implementation phase, with a core focus on



facilitating CDM project development, and a special focus on North, West, and Central Africa.

183. **Climate Investment Funds (CIFs) are new instruments** established by the Bank jointly with the regional development banks (AfDB, AsDB, EBRD, and IDB) to promote international cooperation on climate change and support progress toward the future of the climate change regime. The CIFs seek to mobilize new and additional resources at significant scale. The CIFs have the objective of providing experience and lessons in responding to the challenges of climate change through learning-by-doing. These new funds build on the experience gained from the World Bank’s Clean Energy Investment Framework (CEIF), which identified the need for increased financial resources and instruments to fill the financing gap to scale-up clean energy investments and integrate climate resilience into development assistance.

184. **The CIFs include** the Clean Technology Fund (CTF) and the Strategic Climate Fund (SCF). The CTF is designed to promote scaled-up demonstration, deployment, and transfer of low-carbon technologies in the power sector, transportation, and energy efficiency in buildings, industry, and agriculture. The CTF is already operational, and (as of December 2008) its steering committee has approved the first three proposed programs (Turkey, Egypt, and Mexico). Programs for Nigeria and South Africa are under preparation. The SCF will provide financing to pilot new development approaches or to scale-up activities aimed at a specific climate change challenge through targeted programs. The first program to be included in the SCF — the Pilot Program on Climate Resilience (PPCR) — is already piloting national-level actions to enhance climate resilience in a few highly vulnerable countries, including three in Africa: Niger, Mozambique, and Zambia. The PPCR is also operational with a fund of \$500 million, and is expected to support four or five programs in Sub-Saharan Africa. Another program under the SCF, the Forest Investment Fund, is expected to be operational by the end of the second quarter of 2010. Other programs under consideration include support for energy efficient and renewable energy technologies to increase access to “green” energy in low income countries; and investments to reduce emissions from deforestation and forest degradation through sustainable forest management (World Bank, [www.worldbank.org/cif](http://www.worldbank.org/cif)).

#### 5.4 Country-driven National Adaptation Plan of Action (NAPA) process

185. **Helping LDCs with climate change.** Realizing the limited ability of the LDCs to adapt to the adverse impacts of the effects of climate change, in 2001 the UNFCCC established a process to help poor countries prepare NAPAs.<sup>29</sup> This process was aimed at identifying priority activities that respond to their urgent and immediate needs to adapt to climate change. “The NAPA takes into account existing coping strategies at the grassroots level, and builds upon that to identify priority activities, rather than focusing on scenario-based modeling to assess future vulnerability and long-term policy at state level. In the NAPA process, prominence is given to community-level input as an

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29. Out of 49 countries classified as LDCs, 35 are in Sub-Saharan Africa.

important source of information, recognizing that grassroots communities are the main stakeholders.”<sup>30</sup>

186. **With support from the Least Developing Countries Funds** through the GEF<sup>31</sup> and its main implementing agencies (UNEP, UNDP, and the World Bank)<sup>32</sup>, 28 African countries have so far prepared NAPAs (Table 5-1). The main focus areas were wide ranging, including capacity building and awareness raising, agriculture and natural resource management, livelihood enhancement, disaster management, and health. Besides an initial summary and overview in 1997 by UNITAR (United Nations Institute for Training and Research), no systematic assessment of the NAPAs has been undertaken.

**Table 5-1. Sub-Saharan African countries with complete NAPAs**

Country	Year prepared
Benin, Central African Republic, Ethiopia, Gambia, Guinea-Bissau, Liberia, Mozambique, Sierra Leone	2008
Burkina Faso, Burundi, Cape Verde, Guinea, Lesotho, Mali, Rwanda, Sao Tome and Principe, Sudan, Tanzania, Uganda, Zambia	2007
Comoros, Madagascar, Malawi, Niger, DRC, Senegal,	2006
Mauritania	2004

187. **Building on NAPAs.** Overall, however, by striking a balance between a quick response — to identify a number of projects and activities, generally at the local and community levels through an extensive participatory process — and a review of key vulnerabilities and risks, the NAPAs provide a good basis to build upon. As more refined climate projections and downscaling make more detailed assessments possible, efforts are expanded to embed adaptation requirements into development plans, programs, and budgets.

188. **Implementation faces challenges.** In addition, while most NAPAs identify activities that are incremental to what is already built into a number of existing development efforts that may address climate change adaptation, their early implementation would help build a body of experience and knowledge to prepare more comprehensive adaptation strategies. But it is important to note that implementation faces many challenges, including lack of coordination mechanisms with other national initiatives and programs, and availability of funds.

## 5.5 ClimDev for Africa initiative

189. **Joint initiative with strong support.** The ClimDev-Africa program is a joint initiative of the African Union Commission (AUC), the United National Economic

30. <http://unfccc.int/adaptation/napas/items/2679.php>

31. [http://www.gefweb.org/NAPA\\_guidelines\\_revised\\_](http://www.gefweb.org/NAPA_guidelines_revised_)

32. The World Bank supported preparation of only two of these (Sao Tome and Madagascar)

Commission for Africa (UNECA), and the African Development Bank. The program enjoys strong political support from African heads of government, as well as by Africa’s ministers of finance, planning, and environment.

190. **Building policy capacity.** ClimDev supports Africa’s response to climate variability and change by building regional, sub-regional, and national policy capacity. It will improve the quality and availability of information and analysis to decision makers. Its immediate beneficiaries will be the institutions that seek to manage the response to climate change in Africa. Through these bodies, the program seeks to increase the resilience of Africa’s population to climate change, enabling effective adaptation activities.

191. **Three main focus areas.** ClimDev will be implemented by the African Climate Policy Center (ACPC) based in UNECA (newly established), and financial management of the ClimDev Trust Fund will be provided by the AfDB. Political leadership of ClimDev will be provided by the AUC. The program’s first four-year provisional budget is estimated to be \$134 million, expected to be disbursed on a demand-driven basis through a blend of programmatic and Trust Fund modalities. The program includes three main focus areas:

- **Making climate information widely available**, organized into nine groups of products, and aimed at ensuring that policy makers across Africa, policy support organizations, and the population at large have access to comprehensive and understood climate information.
- **Providing analytical tools and technical support**, organized into 10 groups of products, and aimed at enhancing the scientific capacity of local and regional institutions to produce effective and quality policy-supporting analyses and best practices.
- **Increasing awareness and advocacy for enhanced decision making**, organized into seven groups of products, and aimed at strengthening the capacity of African policy makers to make use of best available information and policy and practice recommendations in response to climate change.

## 5.6 UNDP Adaptation Program for Africa

192. **Incorporating climate change risk into development.** Under a three-year \$92 million program “Supporting Integrated and Comprehensive Approaches to Climate Change Adaptation in Africa,” supported by the Government of Japan, UNDP will help 21 countries across the African continent to incorporate climate change risks and opportunities into national development processes to secure development gains under a changing climate. The program will help countries establish an enabling environment and develop the capacity required at local and national levels to enable them to design, finance, implement, monitor, and adjust long-term, integrated, and cost-effective adaptation policies and plans that are robust within a wide range of possible changes in climate conditions. The program aims to support achievement of country-level outcomes, including: (i) introduction of long-term planning mechanisms for dealing with climate

risk; (ii) development of institutional frameworks for managing climate risk at the local and national levels; (iii) implementation of climate-resilient policies in priority sectors; (iv) expansion of financing options; and (v) generation and sharing of climate risk-related knowledge.

## 5.7 Other initiatives and programs

193. **In addition to the above programs**, a number of bilateral programs are being developed and implemented, including:

- Japan’s “Cool Earth Partnership” program which has earmarked \$10 billion over the next several years to support: (i) mitigation policies, (ii) adaptation policies for developing countries vulnerable to climate change, and (iii) improving access to clean energy; and
- The European Commission’s Global Change Alliance (GCCA) aims to provide substantial resources for adaptation and disaster risk reduction for the most vulnerable countries (€50 million to the GCCA over the period 2008 to 2010).

## **Part 2 — World Bank Strategy**



## 6. Introduction

194. **No compromise for poverty reduction efforts.** The World Bank Group strategy in the Africa region, *Making Development Climate Resilient for Sub-Saharan Africa*, is grounded in the Strategic Framework for Climate Change and Development (SFCCD). This latter document is a guide to scaling-up WBG actions to help integrate climate change and development challenges without compromising growth and poverty reduction efforts — through country operations, including policy dialogue, lending, and analytical work in client countries, and through regional and global operations. The SFCCD itself builds on progress with the Clean Energy Investment Framework (CEIF) —that emerged from the 2005 Gleneagles process — and expands to various sectors and thematic areas, including energy, transport, industry, urban development, water, agriculture, forestry, biodiversity, economic management, and social and human development.

195. **The SFDC identified six areas where scaled-up action in client countries** will be necessary and mainstreamed into country operations through regional and global operations. These action areas are: (i) making adaptation and mitigation a core part of all development efforts; (ii) narrowing the resource gap with innovative instruments for low-cost and grant-based financing; (iii) promoting innovative market mechanisms; (iv) leveraging private financing; (v) speeding the spread of climate-friendly technologies; and (vi) stepping up policy research and capacity building.

196. **The Bank’s response to climate risk is an integral part** of the region’s development strategy. The Bank’s operational response to climate change in Sub-Saharan Africa is designed to be an integral part of the Region’s development strategy and business plan (the Africa Action Plan [AAP]).<sup>33</sup> The proposed strategy is based on the premise that increased climate variability threatens development gains in Sub-Saharan African countries. The major challenge is therefore to anticipate the effects of climate change and identify actions that support ongoing development efforts which will enhance growth and make it more resilient to the inevitable changes in climate and variability. Therefore, adaptation actions are inextricably linked to development actions, and form the core pillar of this strategy.

197. **The strategy is grounded in the current development agenda** and Bank portfolio. This strategy is informed by an assessment of the Region’s investment portfolio that was undertaken to identify opportunities that would enhance the resiliency of development in individual countries by introducing adaptations into sector development strategies and projects. These adaptations would reduce the exposure or sensitivity of project beneficiaries to weather, climate, and hydrologic variability in key sectors. The recommendations of the strategy are focused on countries and sectors where the risks from climate change are estimated to be relatively higher using climate projection information over the period 2030 to 2050 as a guide.

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33. World Bank (2005b)

## 6.1 Disaster risk management and adaptation form a continuum

198. **Current experience offers important lessons for future adaptation** to increased frequency and severity of natural disasters. From a development perspective, most impacts of climate change, especially in the short to medium term, will materialize through climate variability (e.g., the present high variability of seasonal and annual precipitation) and climate extremes (such as floods and droughts). Moreover, the main risks of variability and extremes in a changing climate are risks that already occur, although often aggravated and modified. Reducing disaster risk under the current climate is thus a “no-regrets” climate change adaptation strategy. For most development planning and investment decisions, it provides a much more relevant entry point than a long-term scenarios of changing average conditions, and yields positive economic and social returns even in the short turn.

199. **A comprehensive approach to climate issues in development is needed.** For many countries (e.g., Ethiopia, Kenya, Mozambique, Madagascar, Malawi), disaster impacts are a recurrent element of economic performance and development efforts, not only in terms of major disasters at the national scale, but also through many smaller events at the district and local level, with severe poverty implications. That pattern of recurrent disasters is being aggravated by climate change. Such patterns cannot be effectively managed in a mode of humanitarian aid, but call for integration of disaster risk reduction into development, as agreed in the Hyogo Framework for Action.<sup>34</sup> The World Bank is strongly committed to scaling-up its own efforts to integrate disaster risk reduction into its support to client countries.

200. **Disaster risk reduction and climate change adaptation** should largely be managed as one integrated agenda. The resulting “adaptation and climate risk management” (ACRM) approach, treating existing and future climate-related risks as one continuum, generates social and economic benefits in the short term, while also reducing vulnerability to long-term climate changes. Climate change adaptation can build on the experience of disaster risk reduction, and learn from past successes and difficulties. At the same time, the rising concerns about climate change and increasing financing bring opportunities to raise the profile of disaster risk reduction and engage a wider range of actors. On the other hand, there is a substantial risk of duplication of efforts between the adaptation and disaster risk reduction communities, with two sets of international and national institutions, two sets of inter-sectoral coordination mechanisms, and two sets of funding channels. Therefore, a key recommendation of this strategy is the integration of climate change adaptation and disaster risk reduction under a single “climate risk management” pillar. This strategy is already being implemented in several countries (see Box 9-8 for Madagascar, example).

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34. The World Conference on Disaster Reduction was held January 2005 in Kobe, Hyogo, Japan, and adopted a Framework for Action 2005-2015 entitled “Building the Resilience of Nations and Communities to Disasters” (referred to as the Hyogo Framework for Action). Also see Burton and Van Aalst (2004) and World Bank (2006d).



## 6.2 Four pillars of the strategy

201. **Part 1 of this paper outlined four pillars on which the strategy is based.** The next four chapters outline the strategy of each pillar, as briefly summarized below.

202. **Pillar 1 — Make adaptation and climate risk management (ACRM) a core component of development.** While adaptation is essentially a risk management strategy — with associated costs and benefits — for most African countries, adaptation is fundamentally about sound, resilient development. A changing climate adds urgency and the need to manage development in the face of increased climate variability, as well as to ensure that disaster risk reduction and adaptation are fully integrated into growth and poverty reduction strategies. Key areas on which to focus include energy; disaster risk reduction; sustainable land, water, and forest management; coastal and urban development; increased agricultural productivity; health; and social issues.

203. **Pillar 2 — Take advantage of mitigation opportunities.** While African countries contribute little to global GHG emissions, there are important synergies and benefits between adaptation and mitigation. SSA countries may be able to access to carbon finance against reducing emissions from deforestation and forest degradation (REDD), promoting renewable energy, energy efficiency, cost-effective clean coal, reduced gas flaring, and efficient transport. Given the huge infrastructure deficit in the region, and particularly in terms of energy and the heavy reliance on fuelwood, SSA countries can also take advantage of opportunities to mitigate emissions and develop clean energy alternatives by accessing new technologies and tapping into the expanding carbon markets. Most of SSA's mitigation opportunities are linked to more sustainable land and forest management, and energy use and development, as well as sustainable urban and transport systems. In particular, to fuel Africa's further development and provide electricity to its population, there is potential to develop cost-effective clean energy, while contributing to the mitigation agenda. Thus, the mitigation benefits of development form the second pillar of this strategy.

204. **Pillar 3 — Focus on knowledge and capacity development.** Improved weather forecasting, monitoring water resources, land-use information, disaster preparedness, appropriate technology development, and strengthening capacity for risk management, planning, and coordination are all part of this pillar. While there is unequivocal evidence that the climate is changing, there is a lot of uncertainty about the pace and extent of change and the impacts on different sub-regions and sectors, making policy decisions more complex and magnifying trade-offs and opportunity costs. Therefore, generating information, building the knowledge and analytical base, and strengthening institutional capacity of African countries and regional institutions to manage climate risk is a central theme and the third pillar of this strategy. This will require Africa to have more access to appropriate technologies, information, and adequate financing, as well as adequate capacity to plan and prepare for projected changes in climate (means, variability, and extremes) in order to avoid costly investments.

205. **Pillar 4 — Scale-up financing opportunities.** IDA15 and additional resources from existing sources (e.g., CDM and GEF), and new instruments, including UNFCCC

Adaptation Fund, World Bank Group’s Climate Investment Funds (Pilot Program for Climate Resilience, Clean Technology Fund), and the Forest Investment Fund. While incremental financing will be needed to build the knowledge base, strengthen institutions, and climate-proof investments, adaptation is consistent with the most urgent development needs, and climate change concerns reinforce the urgency to address the fundamental problems facing poor people. Therefore, IDA financing remains the main platform for integrating climate resilience in the development processes in African countries, with additional support from the emerging instruments noted above.

## 7. Pillar 1 — Adaptation and Climate Risk Management

### 7.1 Adaptation

206. **Development is essential to increase resilience** because it is the poor that tend to be most vulnerable to climatic changes. Adaptation starts today as a comprehensive approach for reducing vulnerabilities of livelihoods and development processes to climate variability and change. The frequent occurrence of weather and climate-related disasters in Sub-Saharan Africa underscores the importance of better management of current climate conditions. Global warming is superimposed on these existing challenges as it changes current climatic conditions over time and introduces additional risks. With strong institutions, education, health, infrastructure, and a diversified economy, African countries will strengthen resilience to climate risks, but will also need to undertake better analyses of risks at national and local levels in order to prepare for the future.

207. **Present development activities already encompass important adaptations.** Weather, climate, and the hydrologic cycle have pervasive effects on economic and social activity and hence on development. The traditional social and economic systems of Sub-Saharan Africa are adapted in important ways (to varying degrees) to long-term weather and climate characteristics. These traditional adaptations generally accommodate seasonal variations, limits, and extremes of local climate to minimize loss and ensure survival. Thus present development strategies and models already include important adjustments and adaptations to weather, climate, and hydrologic risks. Examples include water storage, flood control and drainage infrastructure, crop varieties and practices, irrigation infrastructure, diversified water sources, coastal defenses, etc.

208. **Climate change introduces a new set of risks.** More can and should be done, but climate change introduces a new set of risks and challenges. Past variations and patterns are a lesser guide to what might be expected in the future. Extremes such as droughts, floods, and cyclones are predicted to increase in frequency and magnitude; sea levels are expected to rise and affect coastal zones and drainage systems far inland in many cases; seasonal patterns of rainfall intensity and magnitude are predicted to change, increasing in some sub-regions and seasons and decreasing in others (Chapter 3).

### 7.2 Disaster risk management

209. **Sub-Saharan Africa is disaster prone.** Disasters are forecast to increase and intensify as climate change progresses, including floods and droughts in West, East, and eastern Southern Africa, cyclones along the Eastern Southern Africa coast, and biological hazards such as disease epidemics and pest infestations. The increasing risk of such disasters is compounded by urban growth in flood plains and coastal areas, environmental mismanagement, and limited regulatory and enforcement capacity. This will further undermine already vulnerable communities across the continent due in part to their location and exposure to hazards in various locations, and also due their high dependence on natural resources. Strategies to reduce the risk of disaster are a necessary first step to

reducing vulnerability, and such strategies should be focused on increasing awareness, improving disaster management planning, and developing preparedness, early warning and response, and recovery plans and programs. Disaster risk reduction needs to be integrated into each country's development planning, especially into PRSPs and sector strategies and plans.

210. **Households will be subjected to stress.** Climate change will lead to greater frequency and magnitude of extreme hazard events and disasters in Sub-Saharan Africa. The increase in temperature will increase stress on agricultural systems and ecosystems; more intensified precipitation and floods; increased drought and water shortages; more severe cyclones, and shorter growing seasons. The predictions suggest less rainfall in areas of sparse rainfall today, and more rainfall in areas of substantial rainfall, coupled with increased evaporation rates. At the community and household level, it is the interaction of multiple stresses, asset ownership, and livelihoods along with the role of social protection that finally determines vulnerability.

211. **Climate change will add surprises** and increase the likelihood of complex disasters. For example, several locations will experience both more erratic rainfall (drought) and generally higher flood risks, i.e., a succession of droughts and floods with more devastation than either hazard would have caused in isolation. Because most impacts of climate change will materialize through extremes, reducing disaster risk is a no-regrets climate change adaptation strategy. Regardless of future scenarios for climate change and the degree to which success is achieved in the longer-term climate change mitigation/adaptation agenda, investing more in disaster risk reduction is likely to generate net social benefits for communities and societies, if done right.

#### 7.2.1 SHIFT ATTENTION FROM EX-POST EMERGENCY RESPONSE TO EX-ANTE DISASTER RISK REDUCTION

212. **Plan ahead.** In conventional disaster management, changing hazards should be factored into development, contingency planning, disaster response, recovery, and reconstruction. However, effective disaster risk management in a changing climate requires more than business as usual. Changing hazard and risk patterns will have major implications for all aspects of disaster risk management, and there is a need to shift attention from ex-post disaster emergency response, as one-off events, to ex-ante mainstreaming of disaster risk management and integration of disaster risk reduction and climate change adaptation. Climate change is an additional argument for commitment to integrating disaster risk reduction into development policy and planning at all levels. To this end, disaster risk reduction and climate change adaptation should largely be managed as one integrated agenda, especially because weather-related disasters and epidemics are so dominant in Sub-Saharan Africa. While adaptation to climate change also covers long-term adjustments to gradual changes in average conditions, most impacts will indeed occur through variability and extremes in the short and medium term. Hence, both disaster risk reduction and climate change adaptation are largely about *climate risk management*. This approach will generate social and economic benefits in the short term, while also reducing vulnerability to long-term climate changes.

213. **Engage key regional partners.** Disaster risk reduction should be based on the Africa Regional Strategy for Disaster Risk Reduction (DRR) and the Hyogo Framework of Action (HFA). It is important to fully engage the key regional partners within this agenda, most of them similar to those mobilized through climate change partnerships (AU, AfDB, RECs, ECA).

214. **The approach to disaster risk reduction,** inspired by the business model of GFDRR, is to advance disaster risk reduction based on ex ante support to high-risk focus countries and ex-post assistance for accelerated recovery and risk reduction after a disaster.<sup>35</sup> The approach involves several potential activities aimed at mainstream disaster risk reduction — and related climate change adaptation — and linking early warning systems and contingency planning from international to national and local levels (Table 7-1).

#### 7.2.2 ENGAGE FOR THE LONG TERM AT THE NATIONAL LEVEL

215. **Commit for the long term.** Reducing the risk of disaster in SSA is long-term engagement in a select number of countries, starting with analytical and advisory activities and institutional development at a national level, while ensuring that the activities leverage on-going operations or lead to new investments. The focus should be on a few vulnerable countries — or river basins — and sectors at high risk, including in urban coastal areas, where there is political will and a leadership commitment. The focus will be on key hazards such as drought, floods, cyclones, and urban/coastal problems. Working with champions within the government and other stakeholders can play a key role in providing a vision, ensuring ownership, and implementing changes to existing planning and coordination systems. Within individual countries, the initial focus should be on identifying especially vulnerable groups, and particularly on vulnerable sectors or investments.

216. **Create an effective and comprehensive institutional framework.** Special attention should also be paid to efficient coordination mechanisms within sectors and among sectors for national planning and support structures, for example, through the National Platforms established under the Hyogo Framework of Action. It is important to link the national level to district and local-level entities, both for disaster risk reduction and climate change adaptation. For both agendas, the key entry point is regular development planning, either at the national or sector level, including contingency planning and early warning systems. Duplication among such efforts on disaster risk reduction and adaptation should be avoided because institutional competition wastes valuable resources, can confuse key stakeholders, and may even foment counterproductive interagency rivalry.

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35. GFDRR is a partnership of the World Bank, United Nations (ISDR), and major donors to support disaster risk reduction and recovery in disaster hot-spot countries.

Table 7-1. Measures to manage disaster risks

Investment and policy lending	Analytical and advisory activity and capacity building	Sub-region/ CMU/country
Investigate opportunities for DRR investments in priority countries under the DRM strategic framework for SSA	<p><i>Policy and institutional capacity building</i></p> <ul style="list-style-type: none"> <li>• Provide upstream review of PRSPs and Country Assistance Strategies in order to ensure that disaster risk reduction is addressed and incorporated in strategic policy and planning; reviews provide an opportunity to link disaster risk reduction with climate change adaptation</li> </ul>	<p><i>West Africa</i></p> <ul style="list-style-type: none"> <li>• AFCW1, AFCW2, AFCF1, AFCf2, including the following focus countries: Burkina Faso, Ghana, Mali, Niger, Nigeria, Senegal, Togo</li> </ul>
Invest in contingency planning and early warning and response systems	<ul style="list-style-type: none"> <li>• Develop policy and legal frameworks for disaster risk reduction – and related climate change adaptation (e.g., Madagascar, Malawi, Mozambique, Seychelles)</li> <li>• Prepare national strategies for disaster risk management (Ghana, Senegal)</li> </ul>	<p><i>Horn of Africa/East Africa</i></p>
Technical assistance and capacity building for local entities	<ul style="list-style-type: none"> <li>• Support institutional capacity building and national platforms for disaster risk management (e.g., Senegal)</li> </ul>	<ul style="list-style-type: none"> <li>• AFCE1, AFCE2, AFCE3</li> <li>• Ethiopia, Kenya, Malawi, Mozambique, Zambia</li> </ul>
Update infrastructure norms and standards in all new operations	<p><i>Risk assessments, early warning, and monitoring</i></p> <ul style="list-style-type: none"> <li>• Undertake country- or sector-level risk and vulnerability assessments</li> <li>• Develop plans for national to local level early warning systems, contingency plans</li> </ul> <p><i>Knowledge and capacity building</i></p> <ul style="list-style-type: none"> <li>• Develop institutional capacity, communication strategies, and public awareness</li> <li>• Further South-South cooperation in disaster risk management</li> <li>• Develop training programs on relevant topics for clients and staff</li> </ul> <p><i>Mainstream disaster risk reduction in key sectors and integrate water basin operations</i></p> <ul style="list-style-type: none"> <li>• Disaster risk financing and risk transfer</li> <li>• Develop programs for disaster risk financing and risk transfer at macro and micro levels</li> </ul> <p><i>Coordination of emergency operations and accelerated recovery</i></p>	<p><i>Eastern Southern Africa</i></p> <ul style="list-style-type: none"> <li>• Mozambique, Madagascar</li> </ul>

217. **Stakeholders at all levels and sectors need to participate.** Coordination should also include a wider range of stakeholders, including local government, the private sector, and NGOs, as well as households and communities. A social risk management perspective can help identify appropriate interventions at the micro level, possibly leading to broader investment at the macro level. Efforts should not be limited to plans and projects, but also include policy, legislation, regulations, as well as social risk management aspects.

218. **Innovative Bank operations to sustain a long-term program.** Over time, Bank engagement on risk reduction at the national level could even include development of

budget support operations based on climate risk management benchmarks. In cases where government and/or a sector is willing to engage in a long-term dialogue and invest in policies, capacity, awareness, knowledge, and tools, potentially the best way to mainstream climate risk management into regular planning and implementation would be to use programmatic approaches and budget support rather than project-based financing. A first phase of such long-term engagement may include establishing national or sectoral benchmarks for climate risk reduction, which could become the basis for subsequent financing phases (with disbursements tied to the achievement of agreed benchmarks).

### 7.2.3 INTEGRATE CLIMATE RISK MANAGEMENT INTO SECTOR OPERATIONS

219. **Integrate disaster risk management into Bank sector operations.** Incorporate risk management in sector operations, starting with analytical work, mainstreaming risk management into project design, and spinning off specific activities to manage climate and disaster risk. Sector projects provide the necessary conduit and grounding in regular sector dialogue and concrete investments, while the knowledge and experience generated, and possibly coordination structure setup, can be designed to have wider spin-offs, including replication in other Bank projects. More specifically:

- Incorporate disaster risk reduction in integrated water basin management (e.g., in Senegal, Niger, and Nile river basins);
- Integrate disaster risk reduction in key sector operations (e.g., water, agriculture, environment, health, social protection) across key focus countries;
- Develop disaster risk reduction in ecosystem, environmental management, and land-use planning (e.g., Niger, Nigeria, key water basins);
- Prepare community-based disaster risk management programs (e.g., Ghana, Togo);
- Develop urban disaster risk mapping and risk management (e.g., Senegal, Nigeria); and
- Assess economic impacts of disasters (e.g., Mozambique, Malawi, Madagascar).

220. **Natural hazard and risk assessment should be core elements of project design** and appraisal. For example, in East Africa where agriculture is at continuous risk from droughts and floods, agriculture investment projects would need to systematically screen for and include specific risk management interventions (such as drought-resistant crops, adjustments in irrigation systems to make them less vulnerable to flooding, empowering farmers with information). Additional benefits within the sector may be gained by including capacity building within the agriculture ministry, agricultural extension services, and in related knowledge institutes to supply appropriate risk information and early warnings to farmers and others in agribusiness. In many cases, the knowledge management and coordination structures needed for these sectoral applications may provide an impetus to streamline and enhance existing national coordination and knowledge exchange structures for disaster risk reduction and climate change.

221. **Integrate risk awareness.** One way to achieve attention for risk management in regular sector operations is to integrate risk awareness into the project preparation cycle and safeguards, for example, as part of environmental assessments.<sup>36</sup> Risk screening, such as with the ADAPT tool under development by the Bank’s global climate change team,<sup>37</sup> can flag projects at risk from natural disasters and climate change. Alternatively, analytical work for particular sectors and/or projects can provide entry points. Ideally such sector work is not limited to potential impacts of climate risks, but provides a clear menu of climate risk management interventions tailored to the sector and region at hand. Such work is already underway in the region to identify climate risk mitigation options in water resources and sustainable land management projects.

222. **Improve coordination of emergency operations and accelerated recovery.** It is essential to create greater awareness both within and outside the World Bank about its expanded role in emergency response. This requires, among others, efforts to:

- **Improve coordination of emergency operations** and ensure accelerated recovery and disaster risk reduction after an emergency through, for example, joint damage/loss/needs assessment with the UN; and
- **Prepare disaster preparedness and contingency plans** for more effective and efficient emergency responses.

### 7.3 Adaptation and climate risk management in key sectors

223. **Strategy is outlined by sector and country.** The measures recommended in this strategy, organized by sector and country, cover analytical and advisory activities, as well as investment and policy lending, are designed to inform both country assistance strategies and the development of projects that are susceptible and sensitive to those same weather, climate, and hydrologic variations and associated risks.

#### 7.3.1 URBAN GROWTH AND DEVELOPMENT

224. **Climate risks in urban areas are a multi-sector problem.** Urban population growth rates in Sub-Saharan Africa are the highest in the world, and urban population is forecast to exceed rural population by 2030. Cities and towns face twin risks from climate variability and change — domestic and industrial water supplies are vulnerable to droughts and seasonal variations in stream flow and groundwater availability; urban services, including housing, transport, health and safety, drainage, and wastewater, are vulnerable to floods, compounded in coastal areas by sea level rise (Table 7-2).

225. **Introduce new tools to urban planning and development processes.** Perhaps the single most important innovation in the face of these risks is to introduce the use of

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36. Traditionally, EIAs only look at risk of a project to the environment; however, EIAs can also be used to assess risks the environment may pose to a project, including existing natural hazards as well as the changing climate.

37. See also Burton and Van Aalst, 2004.



hazard maps into planning to ensure that urban services, including water supply, keep pace with this growth (World Bank, 2006c). This is particularly important given that slum dwellers represent 70 percent of the urban population in the region. These tools could be used to develop multi-sector risk management strategies and infrastructure plans (e.g., invest in and locate infrastructure outside of risk zone, flood-proof industrial and public buildings, redesign and relocate infrastructure that contributes to risk, and promote development in low-risk areas). These strategies would mitigate the huge increase in future hazard and disaster risk that will inevitably grow at a rate that may exceed urban population growth rates (Table 7-2).

**Table 7-2 Adaptation measures for urban development**

<b>Investment and policy lending</b>	<b>Analytical and advisory activity and capacity building</b>	<b>Sub-region/ CMU/country</b>
Invest in new infrastructure outside of risk zones (municipal services)	Assess long-term water supply availability, adequacy, and reliability under changed hydrologic regimes	<i>West Africa</i> <ul style="list-style-type: none"> <li>• Niger, Mali, Sudan Mauritania, Gambia, Guinea</li> </ul>
Redesign infrastructure that contributes to flood and drainage problems	<ul style="list-style-type: none"> <li>• Identify supply vulnerabilities and strategies to manage risks</li> <li>• Coordinate with river basin management organizations and other sectors on water allocation and water conservation</li> </ul>	<i>Horn of Africa/East Africa</i> <ul style="list-style-type: none"> <li>• Kenya, Ethiopia</li> </ul>
Invest in infrastructure to enable a shift in development (residential, commercial, industrial) away from risk zones	<ul style="list-style-type: none"> <li>• Flood and drainage (and cyclone) risk mapping for use in planning urban services                             <ul style="list-style-type: none"> <li>➤ Develop integrated (multi-sector) risk mitigation strategies</li> </ul> </li> <li>• Strengthen urban services management to implement these new strategies and policies</li> </ul>	<i>Southern Africa</i> <ul style="list-style-type: none"> <li>• Angola, Malawi, Lesotho, Zambia</li> <li>• South Africa</li> </ul>

226. **Mainstream hazard risk management in existing urban planning.** There is a strong need to make urban settlements more resilient and to mainstream hazard risk management in existing land-use planning. This requires that hazard zones and maps be integrated in the suggested land use for an area or region. Retrofitting existing housing stock and ensuring building safety in new construction through a combination of incentives and a regulatory framework must be addressed in national housing policies to ensure sustainable housing.

### 7.3.2 AGRICULTURE AND IRRIGATION

227. **Climate change may severely compromise SAA agriculture.** If no adequate adaptive actions are taken, the agriculture sector in most SSA countries is projected to be severely compromised by climate variability and change, disproportionately affecting the rural poor. The area suitable for agriculture, length of growing seasons, and yield potential, particularly in margins of semi-arid and arid areas, are expected to decrease significantly. Without adequate support, climate change threatens to undermine agriculture’s unique potential as a development tool. This would adversely affect growth objectives for the sector, and exacerbate food insecurity and malnutrition on the

continent. The IPCC (2007) estimates that the additional African population at risk of hunger could reach 200 million by 2080 (Table 7-3).

**Table 7-3. Adaptation measures for agriculture and irrigation**

Investment and policy lending	Analytical and advisory activity and capacity building	Sub-region/CMU/country
<ul style="list-style-type: none"> <li>• Increase efforts to integrate agricultural climate change aspects in developing poverty reduction strategy papers (PRSPs), National Adaptation Programs for Actions (NAPAs) and agricultural sector strategies</li> <li>• Include recommendations for addressing climate change in CASs</li> <li>• Invest in research and advisory services (as part of support to CGIAR, regional agricultural research programs, and support to NARS)               <ul style="list-style-type: none"> <li>➢ Develop and pilot new crop varieties, cropping patterns, and technologies (no-tillage, agroforestry) and stress-resistant livestock breeds (including maintenance or development of genebanks for crop genetic diversity)</li> <li>➢ Pilot and expand repertoire of irrigation technology options combined with water conservation and water management (including expansion of land under cost-effective irrigation)</li> <li>➢ Develop and test new risk management tools in combination with informal risk management approaches in food security and vulnerable areas, including weather-based insurance schemes, contract farming (e.g., Malawi, Ethiopia)</li> <li>➢ Develop and test ways to improve the productivity of rainfed farming and rangelands (including integrated nutrient management, integrated pest management; sustainable grazing management)</li> </ul> </li> <li>• Invest in land and water management and water conservation</li> <li>• Expand irrigation with cost-effective technologies</li> <li>• Expand conservation farming, watershed management to improve water availability</li> <li>• Develop and enhance early warning systems and safety nets for food</li> <li>• Support community-driven development for climate resilience in vulnerable regions (building on arid lands Resource Management Program in Kenya)</li> </ul>	<ul style="list-style-type: none"> <li>• Socioeconomic impact assessments of climate change on agriculture sector (building on ongoing work in Kenya, Box 7-3)</li> <li>• Generation of user-friendly and relevant climate information products</li> <li>• Map drought, flood, and drainage risk (current and future vulnerabilities) to identify opportunities and risks, and better integrate climate change into sector planning</li> <li>• Combine risk mapping with river and sub-basin water resource assessments</li> <li>• Build on studies on disaster insurance for drought relief (e.g., Ethiopia) and micro weather insurance schemes for smallholder farmers (e.g., Malawi)</li> <li>• Undertake hazard risk management studies for the rural sectors (build on work underway in Madagascar and Mozambique)</li> </ul>	<p>Sub-Saharan Africa</p> <p><i>West Africa</i></p> <ul style="list-style-type: none"> <li>• Niger, Chad, Mali, Nigeria</li> </ul> <p><i>Horn of Africa/East Africa</i></p> <ul style="list-style-type: none"> <li>• Ethiopia, Sudan, Kenya, Tanzania</li> </ul> <p><i>Southern Africa</i></p> <ul style="list-style-type: none"> <li>• Angola, Malawi, Mozambique, Zimbabwe, Zambia</li> </ul>

228. **Comprehensive approach to adaptation is needed.** Adaptation to climate change in the agriculture sector requires a comprehensive approach of climate-proofing most types of investment categories. Of particular importance is the generation and dissemination of climate-resilient technologies and practices by investing in research and

advisory services (such as heat-, flood-, and drought-resistant crops; and stress-tolerant livestock breeds). This requires investments in infrastructure and capacity building of global, regional, national, and sub-national research and advisory systems. The same institutions have to play an important role in the promotion and scale-up of sustainable land management practices which further increase the climate resilience of agricultural systems, including integrated nutrient and pest management, soil conservation, and agroforestry. At the same time, greater emphasis on investment in water conservation and harvesting, and provision of supplemental and full irrigation is needed. Given that the impacts of climate change are likely to be most severe in arid and semi-arid regions, livestock management has to be a key pillar of agricultural adaptation approaches, in particular in pastoralist systems.

**229. Climate information and knowledge products that reduce the uncertainty** which farmers face have the potential to improve livelihoods by enabling them to make informed decisions on adopting technologies and adjusting management practices. Investments in required tools and equipment by relevant institutions are needed, including those of meteorological services. At the same time capacity building of climate scientists, agricultural researchers, and advisory agents are required to generate and disseminate relevant and user-friendly climate information products for smallholder farmers. Another important element for increased adaptive capacity in the agricultural sector is investment in formal and informal risk management approaches (including early warning systems and safety nets). Risk management is an intrinsic element of rural and agricultural development and generally includes a mix of informal mechanisms and formal strategies to manage weather and market-induced stress on agricultural production and rural livelihoods. One innovative approach of formal risk management strategies that has drawn particular attention is weather-index insurance.

**230. Integration of adaptation into agriculture investment operations.** The generation and dissemination of knowledge, technologies, and practices aimed at increasing the adaptive capacity of agricultural producers needs to be integrated explicitly into relevant investment operations, such as agricultural research and advisory programs, sustainable agriculture land management programs, irrigation and watershed operations, livestock programs, and food security operations. However, the integration of climate change aspects into these operations should not change the general good practice design features of the respective programs. As an example, successful strengthening of national agricultural research systems (NARS) is generally based on demand-driven, pluralistic, and participatory approaches. The inclusion of climate change into these programs does not require a change of basic design characteristics, but needs to be fully integrated into successful models. The same principle applies for strengthening the adaptive capacity of agricultural systems and farmers as part of sustainable agricultural land management and food security operations, where community-driven development approaches have proven successful. These operations need to include an explicit “climate lens” rather than changing basic concepts and institutional setup that have proven to be successful in the past.

**231. Important role of livestock production systems.** Livestock are an important source of income and food, as well as a safety net and insurance during drought years

throughout SSA. Livestock production currently accounts for about 30 percent of the gross value of agricultural production in Africa. Seventy percent of the rural poor in Africa own livestock, including pastoralists living in arid and semi-arid zones. Of these, more than 200 million rely on their livestock for income (sale of milk, meat, skins) as well as draft power and fertilizer. As a key source of income for women and the landless, livestock also provide high-quality nutrition for families suffering from AIDS.<sup>38</sup>

232. **Climate change affects livestock when habitats or ecosystems change** and crops fail or grazing land is lost, but also through other factors such as land use, food security, feed production, disease distribution or their vectors, water availability, biodiversity, greenhouse gas emissions (methane), increased frequency of climatic extreme events (drought/floods), and soil degradation. The main sub-regions where livestock production is both important and vulnerable to climate hazards include mixed arid and semi-arid systems in the Sahel, arid and semi-arid rangeland systems in parts of East Africa, systems in the Great Lakes region of East Africa, the coastal regions of East Africa, and many of the drier zones of Southern Africa.

233. **Adaptation measures include strengthening institutional capacities** in several areas, among them: (i) management at both the sector and firm or enterprise level; (ii) biotechnology and bio-safety regulations in animal agriculture; (iii) introduction of new fodder resources and pasture and overgrazing management systems; (iv) improving biodiversity and wildlife conservation and management; (v) genetic improvement of indigenous breeds and crossbreeding; and (vi) control of livestock diseases/vectors.

### 7.3.3 WATER RESOURCES MANAGEMENT

234. **Water management is a strategic climate change adaptation.** Every sector discussed here directly or indirectly depends on water resources and water management. Water availability for domestic use, electricity generation, fisheries, and agriculture, or management and control of floods, groundwater recharge, drainage and maintenance of environmental services — all play a key role in adaptation. Water resources administrations and basin organizations can have a broad impact on how well a country is able to adapt to climate variability and change by focusing on three areas:

- Strengthen the knowledge base for the country's understanding of climate patterns and trends and develop the kind of knowledge products (early warning systems, flood forecasting, hazard maps) needed by policy makers to make timely decisions.
- Build institutional capacity to better manage climate variability, and strengthen multi-sector integrated basin planning to provide a framework for managing water resources to sustainably meet growing demand.
- Pilot and roll-out instruments for climate risk management, and invest in critical infrastructure and regulatory capacity needed to effectively manage water resources.

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38. Main statistics in this section drawn from FAOSTAT and <http://www.ifpri.org/2020africaconference/program/day2summaries/sere.pdf>.

235. **Because of the magnitude of the problems as well as needs,** a phased approach is recommended by prioritizing key factors — river and lake basins, urban water supply areas (e.g., African megacities), and infrastructure (e.g., large multi-purpose projects proposed in Ethiopia, Congo) (Table 7-4).

**Table 7-4. Adaptation measures for water resources management**

Investment and policy lending	Analytical and advisory activity and capacity building	Sub-region/CMU/country
<p><i>Investments</i></p> <ul style="list-style-type: none"> <li>• Scale-up rehabilitation of existing infrastructure and systems (e.g., watershed management, rainfed agriculture)</li> <li>• Plan for new water infrastructure (e.g., storage, power transmission to take advantage of hydrologic complementarities, irrigation)</li> <li>• Plan to improve water productivity and flexibility to improve robustness to climate risks</li> <li>• Improve systems to screen investments for climate risks</li> </ul> <p><i>Instruments</i></p> <ul style="list-style-type: none"> <li>• Finance (mitigation and adaptation financing)</li> <li>• Insurance</li> <li>• Water entitlements</li> <li>• Basin/inter-sector agreements to improve flexibility and climate risk management</li> </ul>	<p><i>Information</i></p> <ul style="list-style-type: none"> <li>• Initiate demand-driven Africa-wide program for hydro-meteorological data acquisition and management (including drought/flood/storm forecasting and communication)</li> <li>• Develop (based on appropriate institutions such as basin organizations) information management and analysis systems such as water resources planning decision support systems that can incorporate scenarios of climate variability/change (e.g., Nile DSS, Eastern Nile Planning Model)</li> <li>• Collate and disseminate knowledge base on historical climate variability and climate change scenarios</li> </ul> <p><i>Institutions</i></p> <ul style="list-style-type: none"> <li>• Facilitate and strengthen basin organizations: (i) transboundary river basin organizations; and (ii) within countries</li> <li>• Partnerships/awareness and capacity building: (i) train climate/basin institution staff in climate data management, climate change scenarios, and conversion to run-off, decision support systems, and forecasting (e.g., rainfall, floods, storms), and communications, and (ii) strengthen basin management (incorporating climate variability)</li> </ul>	<p>SSA</p> <ul style="list-style-type: none"> <li>• West Africa, Niger River basin, Senegal River basin, Lake Chad, Volta River basin</li> </ul> <p><i>Horn of Africa/East Africa</i></p> <ul style="list-style-type: none"> <li>• Eastern Nile basin</li> </ul> <p><i>Central Africa</i></p> <ul style="list-style-type: none"> <li>• Lake Victoria, Congo River basin, Southern Africa, Zambezi River basin</li> </ul>

#### 7.3.4 SUSTAINABLE LAND AND WATERSHED MANAGEMENT

236. **Necessity for integrated approach to adaptation and development.** Integrated solutions are needed where climate risks and vulnerabilities are influenced by the actions of multiple sectors. Land and watershed degradation, urban flooding risks, and competition for water resources are examples of problems that have the potential to exacerbate vulnerabilities to climate change and are created by a variety of socioeconomic and environmental factors. The sustainable management of land and watershed resources is essential to meet the challenge of climate change, particularly in Sub-Saharan Africa where livelihoods and economic development are heavily dependent on natural resources.

237. **SLM stresses capacity development and participatory approaches.** Sustainable land management works across multiple scales, recognizing efforts at the local, national, and regional levels. Strong emphasis is placed on capacity development, enhanced skills and technologies, and creating an enabling environment for investments

in sustainable land management practices. Participatory approaches are a central element to identify policies and practices best suited for facilitating sustainable land management at a particular location.

238. **Create greater awareness of risks and increase capability.** Sustainable watershed management (SWM) and sustainable land management (SLM) focus strongly on a range of key capacity building issues that introduce new skills and technologies and provide demand-driven investments (Box 7-1). The challenge is to create greater awareness of risks and options through capacity-building programs, and introduce to development processes the knowledge and options that would enable communities and farmers to enhance their adaptation to climate risk. This will require new mechanisms for collaboration across sectors to develop messages, knowledge, and options. It is essential that watershed management programs be scaled-up significantly to better manage erosion/sedimentation (that affects downstream infrastructure and services), as well as improve local livelihoods. This should have both climate mitigation and adaptation benefits.

239. **Integrated watershed and land management provides adaptation** and mitigation benefits. Sustainable land management enhances land productivity and ecosystem services by introducing appropriate management practices and building capacity through an integrated approach. Land users can maximize economic and social benefits while maintaining or enhancing ecological support functions of land resources. These practices improve carbon sequestration and reduce greenhouse gas emissions. Sustainable land management practices can help address climate change adaptation as well as mitigation concerns.

240. **Integrating watershed and management into investment operations across sectors.** The Bank's CC-Strategy supports mainstreaming SLM perspectives into investment operations, through support for soil and water conservation, productivity-improving agricultural technologies, diversification of productive activities, and preparedness for climate variability and extremes. The World Bank is a member of TerrAfrica, a multi-stakeholder platform focused on harmonizing policies and scaling-up investments concerned with SLM (Box 7-1). A range of projects is being developed that blends IDA and GEF financing to integrate climate risk management perspectives into larger-scale SLM project activities. In addition, a series of projects on SLM is being prepared under the GEF Strategic Investment Program (SIP). Each of these projects requires that climate risks are addressed in the project design (Box 7-2). Specific adaptation measures are outlined in Table 7-5.

### 7.3.5 FORESTRY AND BIODIVERSITY

241. **Climate change may decrease the natural adaptability of forests.** Forest ecosystems, especially biodiversity (90 percent of terrestrial biodiversity is found in forests) are threatened in a number of ways by climate variability and change. Increases in temperature and decreases in precipitation diminish the natural adaptability of forest ecosystems, induce changes in species composition, increase the risk of fire, and increase

vulnerability to pests. On the other hand, land use change, particularly through deforestation, is the main source of GHG emissions in Africa.

242. **Adopt an integrated approach to adaptation and mitigation.** In the forestry sector, adaptation and mitigation are closely linked and can be addressed simultaneously (see mitigation section below). In many parts of Africa, combined measures can be part of integrated approaches and operations. Although adaptation is the key concern for Africa, the focus on adaptation also would have significant benefits associated with opportunities to develop mitigation activities and take advantage of existing and emerging carbon finance instruments.

243. **Multiple benefits of adaptation.** While adapting plantations and forest management to climate change would have implications for selecting tree species and silvicultural practices, most measures that support sustainable forest management are good for adaptation and will conserve biodiversity and increase carbon stock in the biomass and sequester more carbon in the soil, thus contributing to mitigation of GHG emissions in the atmosphere (Table 7-6).

**Box 7-1. Sustainable land management and community development**

**Kenya.** The Adaptation to Climate Change in Arid Lands (KACCAL) project links GEF resources to the ongoing IDA-financed Arid Lands Management Project. By building on already functioning institutional structures of ALRMP, the project aims to strengthen the capacity to identify and implement activities aimed at reducing climate-related vulnerabilities. At the local level, emphasis is placed on reducing near-term vulnerabilities through early warning and seasonal forecasting systems and targeted micro-projects. Efforts at the district and national level are focused on strengthening the enabling environment to manage current climatic risks and build the knowledge foundation to strategically address the medium- and long-term implications of climate change for development in arid and semi-arid lands

**Mozambique.** The Zambezi Valley Market Led Smallholder Development project contributes to limiting land degradation and improving the ecosystem's resilience toward climate change in five districts of the Central Zambezi Valley. A 20,000 hectare increase under improved SLM is expected by project end. The project will invest in SLM in agriculture, agroforestry, and forestry, and promote SLM practices and measures that specifically address environmental benefits and adaptation to climate variability. The project will strengthen capacity of rural communities, district and provincial government staff, local NGOs, and private sector representatives, among others.

*Source:* World Bank ADP-SP team 2008

**Box 7-2. Increasing productivity and tolerance to climate shocks through sustainable land and rainwater management in Malawi**

As part of the Bank-financed Agricultural Development Project Support Program (ADP-SP), a conservation farming component aims to improve water and nutrient buffering capacities of the soil to: (i) increase sustainable crop productivity, (ii) increase crop tolerance to climatic variations and shocks, and (iii) decrease tillage and peak labor requirements (e.g., at planting and weeding). The project targets the expanded smallholder adoption of more environmentally sustainable maize-based cropping practices by adapting and scaling-up innovative conservation farming technologies. Researcher-led, on-farm trials will be used to raise farmer awareness about alternative cropping practices. Subsequently, the main investment helps 75,000 farmers experiment on their own farms with preferred practices using simple farmer-led and farmer-implemented trial dissemination techniques. As an incentive to invest in conservation farming experimentation and overcome a main entry barrier, participating farmers will be provided with technical support, and a "sustainable land management" voucher, for 100 kilograms of subsidized fertilizer and 10 kilograms of subsidized seeds (mainly legumes) to boost organic matter in the initial two seasons.

*Source:* World Bank ADP-SP team 2008

**Table 7-5. Adaptation measures for sustainable watershed and land management**

Investment and policy lending	Analytical and advisory activity and capacity building	Sub-region/CMU/country
<ul style="list-style-type: none"> <li>Scale-up livelihood-focused, participatory rural development projects</li> </ul>	Develop information base and operational tools for addressing climate risk in SLM	<i>West Africa</i> <ul style="list-style-type: none"> <li>Senegal, Niger, Mauritania, Mali, Ghana, Burkina Faso, Nigeria</li> </ul>
<ul style="list-style-type: none"> <li>Sustainable land management (Senegal, Ghana, Lesotho, Sudan, Ethiopia, Malawi)</li> </ul>	<ul style="list-style-type: none"> <li>Identify information and knowledge gaps, particularly knowledge products (e.g., maps), that would enable the introduction of options to cope with variability and climate change</li> </ul>	<i>Central Africa</i> <ul style="list-style-type: none"> <li>DRC, Rwanda</li> </ul>
<ul style="list-style-type: none"> <li>Watershed management (Ethiopia, Mozambique, Eastern Nile, Madagascar)</li> </ul>	<ul style="list-style-type: none"> <li>Collaborate with agriculture and other sectors in the development, testing, and introduction of new capacity-building messages and options</li> </ul>	<i>Horn of Africa/East Africa</i> <ul style="list-style-type: none"> <li>Ethiopia, Sudan, Kenya, Tanzania, Uganda</li> </ul>
<ul style="list-style-type: none"> <li>Community agroforestry (Niger, Mali, Kenya, Uganda)</li> </ul>	Hydrologic and climate surveillance agencies	<i>Southern Africa</i>
<ul style="list-style-type: none"> <li>Community livelihoods (Nigeria, Niger, Burkina Faso, DRC, Mozambique)</li> </ul>	River basin management organizations and agencies (Eastern Nile, Lake Victoria, Zambezi)	<ul style="list-style-type: none"> <li>Malawi, Mozambique, Lesotho, Madagascar</li> </ul>

244. **Conservation of biodiversity and wetland ecosystems is at the core** of the adaptation strategy. SSA is home to some of the most important biodiversity in the world, both terrestrial (e.g., Finbos biome in Southern Africa), and aquatic (e.g., Lake Victoria). Forest, grassland, and coastal and freshwater and agricultural ecosystems provide key services, including food, clean water, storage of atmospheric carbon, maintenance of biodiversity, and recreation and tourism opportunities. Climate change is likely to affect these ecosystems that are already overstressed and vulnerable because of over-fishing, creeping desertification, and destruction of coral reefs and forests (WRI, 2000).

245. **To help address these concerns**, the Bank will strengthen its actions by:

- Improving the available information and knowledge base to support ecosystem management and strengthening protected areas that contain significant genetic diversity, starting with GEF co-financed operations in Southern Africa (Cape Program), West Africa, and East Africa.
- Undertake pilot studies on the value of ecosystem services, subsidies with perverse impacts (usually unintended), and pricing ecosystem services (in South Africa, Ghana, and DRC). Strengthen the involvement of local communities in managing ecosystems in all natural resource management operations and clarify access and property rights.



**Table 7-6. Adaptation measures for sustainable forest management**

Investment and policy lending	Analytical and advisory activity and capacity building	Sub-region/CMU/country
<ul style="list-style-type: none"> <li>• Invest in conservation (protected areas, conservation concessions, etc.)</li> <li>• Support sector reform through policy lending to reduce pressure from other sectors (including agriculture)</li> <li>• Invest in sustainable management of large-scale plantations, rehabilitation of opencast mines, reduced impact logging (RIL), and certification</li> <li>• Invest in sustainable management of woodlands</li> <li>• Support afforestation/ reforestation around large cities or areas with high population densities</li> </ul>	<ul style="list-style-type: none"> <li>• Support development of land-use strategy/plan</li> <li>• Support country capacity to monitor deforestation and land-use change</li> <li>• Support institutional capacity, training, information systems, and law enforcement (FLEG)</li> <li>• Promote cross-sectoral approaches and coordination</li> <li>• Support the development of fire strategies and plans</li> <li>• Support the design and implementation of pest management plans</li> </ul>	<p><i>West Africa</i></p> <ul style="list-style-type: none"> <li>• Mali, Sudan, Cote d'Ivoire, Nigeria</li> </ul> <p><i>Horn of Africa/East Africa</i></p> <ul style="list-style-type: none"> <li>• Kenya, Ethiopia, Tanzania</li> </ul> <p><i>Central Africa</i></p> <ul style="list-style-type: none"> <li>• CAR, Congo, Gabon, Cameroon, DRC</li> </ul> <p><i>Southern Africa</i></p> <ul style="list-style-type: none"> <li>• Angola, Zambia, Mozambique, Zimbabwe, Madagascar, Botswana</li> </ul>

### 7.3.6 COASTAL ZONES AND FISHERIES

246. **Manage coastal areas for sea level rise and sustainable fisheries.** Sea level rise has the potential to directly affect millions of people living near Sub-Saharan African coasts; cause serious environmental harm, loss of important environmental services, and impede drainage; and worsen sedimentation of channels and flooding in deltas, tidal creeks, and rivers that flow to the sea. The destruction of coastal mangrove and salt and freshwater marshes caused by changes in tide, salinity, and sediment regimes would do serious harm to commercial fisheries.

247. **Effects of sea level rise extend well beyond the coast** and across sectors. Adaptation to far-reaching direct and indirect effects must rely on reducing vulnerability over an extended area and will go far beyond strengthening coastal defenses. The threats are most severe in coastal cities and economically important ports. Unlike most of the sectors discussed here, everyone is concerned about the effects of sea level rise on their areas of responsibilities or facilities, but no one agency is responsible for taking action or promoting the necessary adjustments and adaptations.

248. Countries with the most vulnerable coastal areas (those with the largest concentrations of people, infrastructure, and economic and natural resource assets in coastal areas) should begin by strengthening planning and the knowledge base to develop multi-sector strategies and plans to adjust and adapt to sea level rise. This strategy would provide a framework to coordinate policies and investments in all concerned sectors in each high risk area (Table 7-7).

Table 7-7. Adaptation measures for coastal zones and fisheries

Investment and policy lending	Analytical and advisory activity and capacity building	Sub-region/ CMU/country
Continue to increase financing and support for reducing over-exploitation of national fisheries, including co-management systems, while supporting regional fisheries management efforts through the use of the Bank's regional IDA instruments.	<p><i>Coastal areas</i></p> <p>Portfolio review of infrastructure and agriculture investments to determine vulnerability of investments to sea level rise, and need for 'climate-proofing'</p> <p>Support coastal zone planning and integrated management, building on existing country vulnerability and adaptation assessments and NAPAs</p> <p>Identify and include conservation of critical coastal habitats.</p> <p>Internally develop portfolio of possible 'soft engineering' and 'important areas' to invest in reduced vulnerability</p> <p>Undertake more detailed analyses, overlapping vulnerability to flooding and sea level rise with coastal poverty, particularly in urban areas.</p> <p>Undertake analytical work and technical assistance on the impacts of climate change on coastal zones, including: (i) coastal erosion in Senegal and Gambia; (ii) degradation of freshwater ecosystems in Lake Victoria biodiversity, (iii) risks to West Africa Regional Project for Fisheries from climate change; and (iv) agro-ecosystems and implications for adaptation</p>	<p><i>West Africa</i></p> <ul style="list-style-type: none"> <li>• Mauritania, Cote d'Ivoire, Senegal, the Gambia Guinea-Bissau, Cape Verde, Ghana, Liberia, Sierra Leone, Benin, Togo, Nigeria</li> </ul> <p><i>East Africa</i></p> <ul style="list-style-type: none"> <li>• Kenya, Comoros, Seychelles, Somalia</li> </ul> <p><i>Southern Africa</i></p> <ul style="list-style-type: none"> <li>• Madagascar, Mauritius</li> </ul>
Provide financing and technical support for alternative livelihoods for fishing communities in conjunction with strengthened fisheries management and greater monitoring and evaluation of fisheries.	<p><i>Fisheries</i></p> <p>Explore partnerships with research institutions and governments to strengthen monitoring and evaluation of specific fisheries and fisheries systems to better predict climate change effects and vulnerabilities</p> <p>Support institutional mechanisms to integrate response to climate risks with other pressures such as overfishing, pollution, and changing hydrological conditions.</p> <ul style="list-style-type: none"> <li>• Integrate research and management</li> <li>• Update regulations limiting access to resources to allow flexibility to respond to both the threats and benefits of future climate variability</li> </ul> <p>Support institutions to enable fishing interests (fleets, processing capacity, and quota ownership) to move within and across national boundaries to respond to changes in resource distribution. This implies developing bilateral and multilateral agreements, and only in the context of functional transboundary fishery governance regimes and effective systems to control illegal, unreported, and unregulated fishing.</p>	
Provide support for addressing coastal erosion, saline intrusion (in coastal freshwater aquifers), and coastal land use planning.		

### 7.3.7 TRANSPORT

249. **Climate change risks in the transport sector.** Road and rail systems, including related infrastructure such as bridges, rails, embankments, pavement, and drainage are directly affected by higher temperatures and adverse rainfall regimes in terms of failure,

frequent replacement, and higher maintenance costs. Increased frequency of natural disasters, especially floods and cyclones, threatens vital network connectivity.

250. **Changes to rainfall and stream flow.** The most important adaptation to climate variability and change is an adjustment to planning and design standards for transport infrastructure, including location. Most design standards are based on historical data and experience tempered by costs and budget considerations. The predicted trends in temperature, rainfall, and occurrence of floods, droughts, and cyclones suggest that design standards for river crossings, drainage, embankment construction, and pavement choices will need to be adjusted to avoid increased failures, damage, and maintenance costs. Greater use of flood hazard mapping and analysis of potential future flood regimes should be utilized to mitigate risks. More and longer droughts may shift economic activity and population that should be considered for strategic transport planning. Capacity building should concentrate on strengthening strategic planning, research, and building the knowledge base, and on new mechanisms to coordinate planning across sectors, especially in urban areas.

251. **Adaptations in the urban transport sector.** In the area of urban transport, the focus should be on: (i) providing infrastructure for non-motorized transport (principally pedestrians and bicycles) so that travel needs of the urban poor can be met and emissions from motorized traffic reduced; and (ii) promoting public mass transit systems and improving the efficiency of urban transport infrastructure. These recommendations are already being implemented in Nigeria and Ghana. The Lagos Urban Transport Project is financing the maintenance of main urban road sections, implementing traffic system management measures, and building a bus terminal. The Ghana Urban Transport Project will contribute to reducing GHG emissions from ground transport in the Accra metropolitan area, through promotion of a long-term shift from private modes to public transport modes, and the preparation of an integrated land-use transport plan.

### 7.3 8 HEALTH

252. **Climate and health.** People are affected in a wide range of direct and indirect ways by climate variability and change, especially by food shortages, scarce potable water, and poor hygiene that often result in malnutrition and increased morbidity and mortality. Of particular concern is the way in which climate change can cause major fluctuations and changes in vector-borne diseases, including introduction into new ecosystems where they did not previously exist, and the re-emergence of vectors in areas where they had previously been eliminated.

253. **Surveillance of areas where disease vectors could increase or re-emerge.** It will be important to expand and intensify surveillance of areas where disease vectors (e.g., malaria) could re-emerge or newly emerge as a result of shifting temperature, hydrologic, and climate regimes. Awareness of the risk of climate change needs to be incorporated into capacity building, particularly for staff located in district and community health delivery units. Not only can people be sensitized to what to observe

and how to react, but also in ways and mechanisms to collaborate with local officials in other sectors who are also concerned with the effects of climate change (Table 7-8).

**Table 7-8. Adaptation measures for health**

Investment and policy lending	Analytical and advisory activity and capacity building	Sub-region/ CMU/country
Invest in vector control and surveillance programs (with special focus on malaria)	Intensify surveillance of areas where disease vectors (e.g., malaria) could re-emerge or newly emerge as a result of shifting temperature, hydrologic, and climate regimes	<i>West Africa</i> • Niger, Mauritania, Sudan
	New mechanisms for collaboration and information exchange between health authorities, hydrologic, and climate surveillance agencies	<i>Horn of Africa/East Africa</i>
	Introduce new ways of using information and knowledge products (e.g., risk maps) to enable health authorities to identify, manage, and mitigate new risks	• Kenya, Ethiopia,
	Increase awareness at the district and community level of the health implications of climate change and improved collaboration with other district agencies to ensure the exchange of critical information and knowledge of options about emerging risks	<i>Southern Africa</i> • Zambia

#### 7.4 Social dimensions<sup>39</sup>

254. **The poor will be most affected by climate change.** The people most affected by climate change and who will find it hardest to adapt are the poor in low-income countries with weak or unstable states. Under these conditions the physical effects of climate change will considerably increase the negative effects on livelihoods, and in a vicious cycle increase the risks of mass migration, violent conflict, and further state fragility. Sub-Saharan Africa is particularly vulnerable, not only because of its low income and high incidence of poverty, but also because of the fragility of most state structures and the prevalence of violent conflict over the past decades.

255. **Increased food security and diminished access to safe water.** The degradation of ecosystems, including forests and coastal ecosystems that support livelihoods, desertification and droughts, and the increased frequency and severity of extreme weather events, will increase the fragility of many rural livelihoods and thus intensify human vulnerability. Africa is likely to be affected by greater food insecurity and diminished access to safe water.

256. **Poor depend on climate-sensitive sectors.** Although broad sections of society may face similar levels of exposure to climate variability, the degree of vulnerability to adverse impacts will be mainly shaped by livelihood opportunities, gender, age, disability, social class, and ethnicity. The poor tend to be most dependent on climate-sensitive sectors or activities, such as agriculture, fishing, and forestry, which will be severely affected in Sub-Saharan Africa, while at the same time they face fewer possibilities to diversify into less climate-sensitive activities. Indigenous peoples,

39. Social protection aspects are covered in Chapter 10 under risk management instruments.

although not as numerous in Sub-Saharan Africa as in other regions, are especially vulnerable to climate change effects on ecosystems due to their dependence on forests and other natural habitats.

257. **Adaptation is not new.** Societies and communities have a long record of adapting and reducing their vulnerability to the effects of weather and climate-induced changes. The projected impact of climate change and variability, however, suggests that a greater focus on adaptation and resilience will be required at the regional and local levels, irrespective of the extent and impact of mitigation efforts undertaken over the coming decades.

258. **The unpredictability of the future effects of climate change** suggests a need to focus on adaptive capacity, both to climate change and natural hazards. Vulnerability of livelihoods and the need to strengthen the adaptive capacities of vulnerable communities links the spheres of climate change and natural disasters, and their integration into development policy and planning. A vulnerability approach that focuses on increasing resilience and adaptation capacity of communities is sufficiently flexible to allow for uncertainty driven by natural hazards and climate change.

259. **Three aspects are key from a social development perspective:**

- Supporting effective adaptation to climate change requires understanding the impact of climate variability on poverty and vulnerability. Vulnerability is the result of multiple causes, both climate and non-climate-related stressors that often interact to make households and communities vulnerable. A first step therefore is to understand who is affected by climate change and how.
- Actions to mitigate climate change must benefit the poor and avoid exacerbating inequalities. Actions to mitigate the causes of climate change must strengthen the benefits and reduce the potential costs to the poor. In addressing the consequences of climate change, it will be important to build the adaptive capacity and resilience of communities, vulnerable groups, and the institutions that support them.
- Building adaptation and resiliency must be based on the capacities of affected communities themselves. Community-based approaches to adaptation can help to strengthen social capital, enhance livelihood options, and promote accountability of local governments and service providers.

260. **A strategy to build resilience and strengthen adaptation to climate change** must focus on the sustainability of development efforts. As the Stern Review points out (Stern, 2006), sustainable development itself brings the diversification, flexibility, and human capital that are crucial components of adaptation. Indeed, much adaptation will simply be an extension of good development practices and policies — for example, promoting overall development and poverty reduction, better disaster risk management and emergency response, water resource management, drought preparedness and mitigation, and community-based approaches to development, livelihoods, and the amelioration of economic and social vulnerabilities. In essence, a focus on sustainable development requires embedding adaptation within broader plans at all levels.

261. **Build community capacity.** From a social development perspective, an adaptation strategy for the Region should build on the capacity of communities to reduce their own vulnerabilities, diversify incomes and livelihood sources, and strengthen their capacity to cope with and mitigate the effects of climate variability. A community-based approach to adaptation should not be shaped as a stand-alone response to climate change, but rather be based on principles of empowerment and participation in effective community-driven approaches to development. The difference lies not in what the intervention is or what the community is doing, but why and with what knowledge. A community-based approach to adaptation introduces the community to the notion of climate risk and then factors that into their activities, with the aim of making communities more resilient both to immediate climate variability and long-term climate change.

262. **Combine mitigation with income generation.** Sustainable local development programs that help communities protect livelihoods and cope with the effects of environmental change are not climate change projects per se. A good example is the Western Kenya Community Driven Development and Flood Mitigation Project (Box 7-3), which combines measures to mitigate the impact of recurrent floods in the area with interventions to support income generation, diversification of livelihoods, and targeted assistance for vulnerable groups (see also Box 7-1).

263. **Local knowledge is critical.** Sustainable, community-based approaches also require the incorporation of local knowledge and experience in dealing with climate variability. Communities do not operate in an historical vacuum, and in most cases have built up considerable local knowledge and experience about their own vulnerabilities and coping strategies. Community-based approaches need to tap into this knowledge rather than impose external approaches that may be technically sound, but perhaps ill-adapted to local conditions and social contexts.

264. **The potential for armed conflict** over degraded and depleted natural resources will be greatly affected by the viability of state-based solutions and responses. In Africa it will be important to maintain and deepen efforts to strengthen state institutions and reduce the weakness and fragility of many states, a climate change strategy needs to acknowledge that in most cases limited state capacities will remain a reality for some time to come. Community-based approaches to climate change and variability should thus also focus on strengthening traditional, locally-based models for sustaining and mediating resource use rights. In situations where the state is fragile and unlikely to effectively resolve or mediate local-level conflicts over growing environmental scarcities, local mechanisms that can mediate local conflict and tensions over resources, especially water and land, will be particularly important (Table 7-9).

## 7.5 Gender dimensions

265. **Women have a greater role in food and nutrition than men.** Although rural women and men play complementary roles in guaranteeing food security, women tend to play a greater role in natural resource management and ensuring nutrition. In SSA women

often grow, process, manage, and market food and other natural resources, and are responsible for raising small livestock, managing vegetable gardens, and collecting fuel and water. Men, by contrast, are generally responsible for cash cropping and larger livestock (DFID, 2008).

**Box 7-3. Western Kenya Community Driven Development and Flood Mitigation Project**

Western Kenya, with a high incidence of poverty, is also the most flood-prone region in Kenya. The project aims to address the causal factors that produce recurrent floods and at the same time help communities improve and diversify livelihood opportunities. The CDD component supports community-prioritized investments to enhance livelihoods, income generating activities, and assistance to vulnerable groups. Targeting used GIS-based technology to address demographic and spatial considerations. The flood mitigation component supports flood plain management undertaken in close collaboration with communities to accommodate controlled seasonal flooding of fields, maintain soil fertility, increase agricultural incomes, and enhance the capacity of communities to own and maintain floodplain investments.

The project also establishes a community-based flood early warning system that links national and international information systems with local communities. The project supports livelihood activities for communities living within micro-catchments to reduce pressure on and exploit natural resources, and demonstrate the link between income-generating options and sustainable catchment management. A CDD approach, which is driven by local demand, was adopted as the best way to allow for the design and adoption of investments sensitive to local conditions, environmental sustainability, and local knowledge of communities.

Source: World Bank Project Team

**Table 7-9. Adaptation measures for social development**

Analytical and advisory activity and capacity building	Sub-region/ CMU/country
Support community-based approaches that factor in local adaptation to climate change and climate hazards, and enhance voice, empowerment, and capacity of affected communities to adapt	<i>Region-wide</i>
Factor in the social dimensions of climate change throughout Bank activities in the Region, including social assessments, PSIAs and social safeguards	<i>West Africa</i>
Generate lessons on different adaptation strategies and the social impact of climate change (TFESSD funding):	<ul style="list-style-type: none"> <li>• Senegal, Gambia, Guinea Bissau, Mauritania, Burkina Faso, Mali Sudan</li> </ul>
<ul style="list-style-type: none"> <li>• Lessons from community fisheries co-management and community development of strategies for coastal adaptation to climate change</li> <li>• Climate change-induced migration and its impact on youth in West Africa</li> <li>• Impacts of climate change on indigenous peoples and traditional knowledge</li> </ul>	<i>East and Southern Africa</i>
	<ul style="list-style-type: none"> <li>• Kenya, Ethiopia, Botswana, Namibia</li> </ul>

266. **Climate change increases inequality.** Despite the paucity of data, it is commonly recognized that climate change exacerbates existing inequalities in wealth, access to and understanding technologies, education, access to information, and access to resources. Therefore, the Bank’s response to climate change in SSA should be gender-sensitive, consistent with the World Bank’s strategy for mainstreaming gender-responsive actions into its development assistance work (World Bank, 2002a). In particular, the Bank will support two new pilot regional initiatives: (i) a pilot AAA to understand the

gender implications of disasters and related policies, with an initial focus on drought; and (ii) empowerment of women’s groups — within a rural development/CDD project (e.g., in Kenya) — with information on the threats of climate variability and change, and to undertake community research, risk mapping, and propose action plans for adaptation (Table 7-10).

**Table 7-10. Adaptation measures for gender issues**

<b>Analytical and advisory activity and capacity building</b>	<b>Sub-region/ CMU/country</b>
Operational approaches for mainstreaming gender in climate change programs (with a particular focus on watershed, NRM, and CDD projects)	Region-wide



## 8. Pillar 2 — Mitigation Opportunities

### 8.1 Role of mitigation opportunities in Sub-Saharan Africa

267. **Adaptation is the main priority for Sub-Saharan Africa** to deal with climate change. Despite the relatively low contribution of the Region to global greenhouse gas emissions, climate change mitigation is an important aspect of the CC-Strategy for several reasons.

268. **Few people have electricity.** With more than 550 million Africans without access to electricity and 25 of 48 Sub-Saharan Africa countries currently in power crisis, energy production and consumption, and its CO<sub>2</sub> emissions, are expected to soar in the future. Clean energy has a critical role to play in future power expansion in Africa that avoids or minimizes future GHG emissions. With lessons learned from developed countries of development first and clean-up later, SSA countries should adopt clean energy as much as possible.

269. **Clean energy is an integral part of the development agenda in Africa**, and is a “win-win” solution to mitigate climate change and promote sustainable development. Currently, the continent is facing two major challenges in the energy sector — a power shortage and a lack of modern energy services. Africa is also hard hit by high oil prices. Clean energy is a cost-effective option to mitigate power shortages and increase access to modern energy services in an environmentally friendly manner. The Bank can play an important role by helping clients meet growing energy needs with clean energy options and end-use efficiency measures.

270. **There are ample opportunities for clean energy projects in Africa.** A recent assessment looked at the technical potential of Clean Development Mechanism (CDM) project opportunities in 46 Sub-Saharan African countries (Box 8-1) (Gouvello, 2008). Preliminary results indicate more than 1,300 potential energy CDM projects for existing CDM methodologies. CDM projects would bring additional funding as a revenue stream to clean energy projects in the continent. However, this potential is not being realized primarily because the enabling environment does not provide sufficient incentives for private sector investment. The Bank is actively engaging clients to improve their policy and regulatory frameworks.

271. **South Africa, the largest CO<sub>2</sub> emitter in SSA, has a significant role** in global GHG emission mitigation efforts because its CO<sub>2</sub> emissions rank eleventh globally after China and India among developing countries. The Bank is helping South Africa to accelerate economic growth while controlling the carbon intensity of its development path.

272. **Increasing the amount of stored carbon.** While sustainable land and resources management enhance the adaptation capacity of communities by improving the resilience of land-use systems (increased organic matter and water cycling), it also offers opportunities to mitigate the effects of climate change by enhancing the amount of carbon

stored in soil and biomass and decreasing GHG emissions. The most significant activity that can be implemented over the next decades to mitigate climate change in Africa is to increase the amount of biologically sequestered carbon in biomass and soil organic matter. Building soil carbon in agricultural land is critical.

**Box 8-1. Clean Development Mechanism (CDM)**

CDM projects in developing countries provide an option to allow Annex 1 Parties to purchase emission credits and help them comply with their commitments under the Kyoto Protocol. CDM investments are market-driven in the sense that prices and volumes of emission reductions are negotiated between individual buyers and sellers. In addition to providing Annex 1 Parties and their entities with access to cost-effective emission reductions, the CDM allows 'carbon projects' that reduce or avoid GHG emissions into the atmosphere in developing countries.

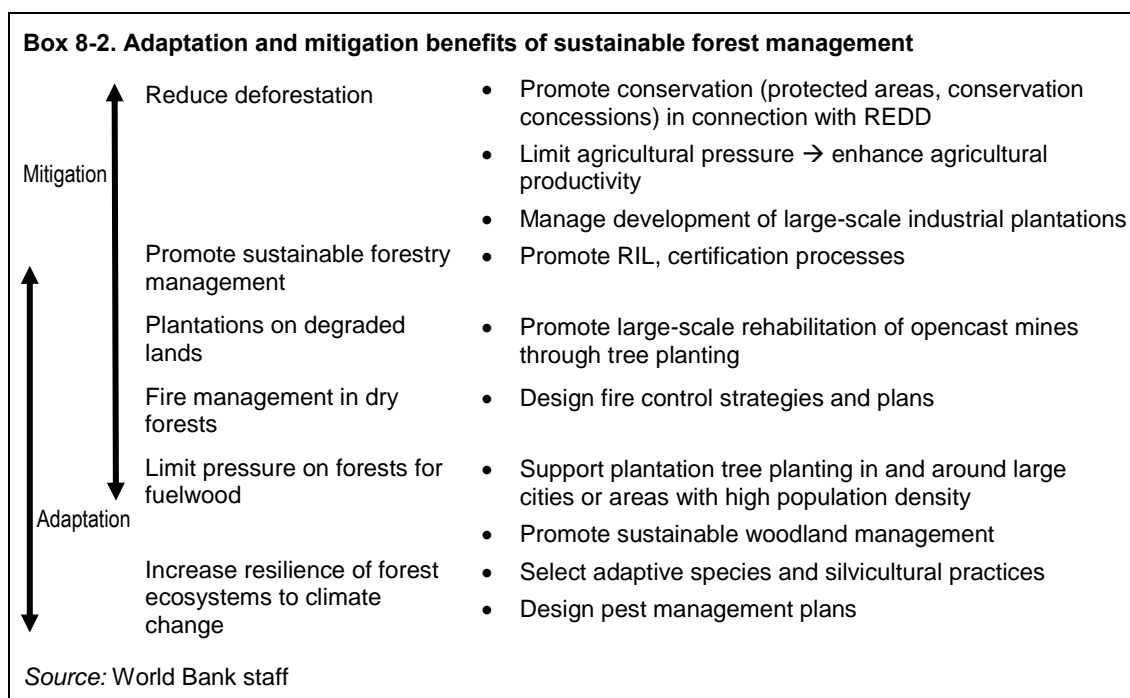
Examples of such projects include the use of renewable energy (such as wind, hydro, bio-thermal, or solar), the use of biomass residues (such as bagasse for electricity generation in a sugar factory), implementation of energy efficiency measures (such as the introduction of compact fluorescent light bulbs or more efficient cook stoves), and waste management practices (such as capturing methane emissions from waste water treatment plants, landfills, or animal waste). Thus, CDM projects are also supposed to promote sustainable development. CDM project developers must comply with relatively strict rules and procedures.

273. **Storing carbon in soils** based on sustainable agricultural land management presents an immediate option to reduce atmospheric carbon dioxide and slow global warming. According to the IPCC (2007), the global economic GHG mitigation potential in the agriculture sector is comparable to that of the forestry sector (including afforestation, reforestation, avoided deforestation, and sustainable forest management). However, under the CDM mechanisms established as part of the Kyoto process, sequestration of GHGs based on agricultural land use are currently not eligible emission reductions. Given that sustainable agriculture practices not only reduce GHGs, but — more importantly — increase productivity and can reduce farmer vulnerability to climate change, African countries could greatly benefit from inclusion of agricultural carbon in future compliance markets and from strengthening its role on the voluntary market. In addition, productivity-enhancing sustainable agriculture practices would reduce the pressure on forests and thereby contribute positively to avoided deforestation — another promising approach for GHG mitigation. Consequently, a more holistic landscape approach for GHG mitigation, which would include agricultural land management and avoided deforestation, seems to be most promising.

274. **Storing carbon in forests and agricultural soils** presents an immediate option to reduce atmospheric carbon dioxide and slow global warming. Governments, forest owners, and farmers who adopt practices that store carbon in soil may be able to “sell” the stored carbon to buyers seeking to offset greenhouse gas emissions. But before carbon credits can be sold, “owners” need to be able to verify that forests are managed sustainably and remain standing, and changing soil management has increased the soil organic carbon in agricultural fields.

275. **Forest losses yield GHG.** In addition to Brazil and Indonesia, the Congo Basin hosts the second largest remaining humid tropical forest in the world, which is water-rich and plays major economic and climatic roles. However, with forest losses estimated at

4.3 million hectares annually,<sup>40</sup> forest degradation is responsible for some 70 to 80 percent of human-induced GHG emissions in Africa, mainly from conversion of forests to croplands and shifting cultivation, and harvesting timber (Houghton, 2005; Laporte et al., 2007). These pressures are likely to be even more important in the future as requirements for food and biofuels increase. On the other hand, the development and growth of carbon markets may offer opportunities to finance the preservation and expansion of forest areas for carbon sequestration, alleviating poverty at the same time. Clearly, the management of forests for timber, carbon sequestration, biodiversity, and other ecosystem services is critical for both mitigation of, and adaptation to, climate change (Box 8-2).



276. **Avoiding deforestation is not currently eligible** under the Clean Development Mechanism. But under the Bali Action Plan, negotiations of a post-2012 international framework will consider policy approaches and positive incentives to promote and support reduced emissions from deforestation and forest degradation (REDD or Reducing Emissions from Deforestation and Forest Degradation). Given that sustainable agriculture practices can also contribute to sequestering significant amounts of carbon in soils and improve productivity, African countries could greatly benefit from development of incentive mechanisms that promote agricultural carbon on compliance and voluntary markets.

277. **Disaster risk reduction has much stronger ties to the adaptation agenda** than to the mitigation agenda. Nevertheless, there are several areas where climate change mitigation can have benefits for disaster reduction. A prime example is reforestation,

40. Chomitz (2007) reports that annual estimates of net forest loss in tropical Africa vary widely, from 5.2 million hectares to just 376,000 hectares.

which may stabilize hillsides and reduce the risk of flooding. In such cases, financing mechanisms for climate change mitigation can also reduce disaster risks.

278. **In the transport sector, there are also mitigation opportunities** through the use of cleaner fuels, energy efficiency, and multi-modal transport systems with a focus on improving public transport.

279. **More specific recommendations on mitigation opportunities** with strong development spillovers are presented below for energy, forestry, sustainable land management, and transport.

## 8.2 Energy sector

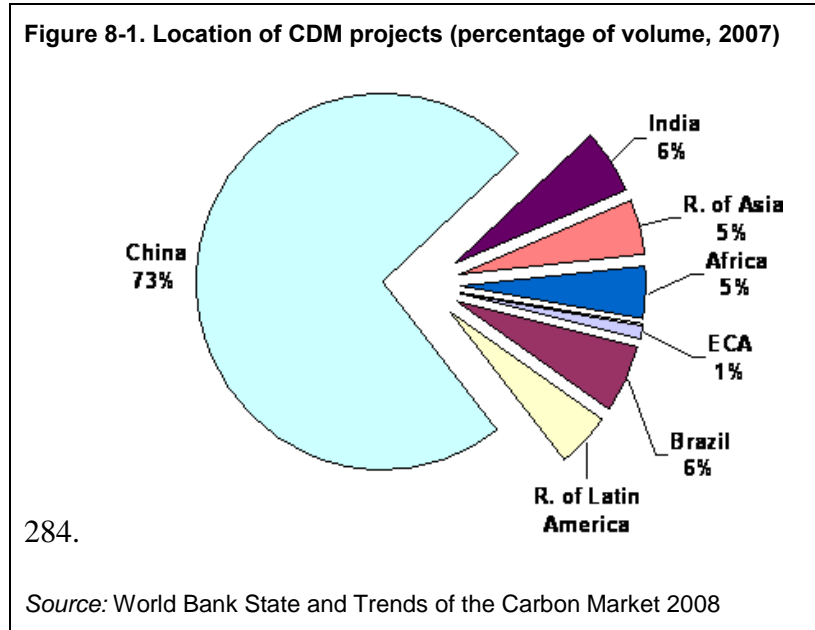
280. **Clean energy fits well with the Bank’s strategy in the energy sector.** Addressing power shortages requires both short-term measures of demand-side management and energy efficiency, as well as long-term measures of regional projects of large hydro, geothermal, natural gas, and clean coal technologies. Renewable energy has an important role to play in Africa, and also provides opportunities to attract carbon finance. However, because of the overriding imperative to improve energy access because of cost and sequencing issues, in some instances there will be no alternative in the short term to new coal-powered electricity generation.

281. **The present strategy calls for an enhanced Bank role** in assembling one package: (i) policy dialogue to help governments with sound policy and regulatory frameworks for clean energy; (ii) IDA, guarantees, and other WBG instruments to finance clean energy projects; and (iii) carbon credit as an additional revenue stream for clean energy projects. Moreover, it is important to ensure that carbon finance is fully integrated into the policy dialogue and up-front financing schemes.

282. **Taking advantage of GHG mitigation opportunities.** In addition to opportunities from mitigation facilitated by the creation of new mechanisms such as the CDM, the option presented by multi-purpose development of cross-border water resources can also help promote regional integration through regional power trading. Traversing borders through expansion of international transmission lines, greater trade, and stronger regional bodies would expand generating capacity, reduce overall capital and operating costs, and create more diverse and robust regional grid systems. For example, electricity generation could take place near ports — transmission of power is cheaper than transporting high volumes of fossil fuels inland by road and rail.

283. **Need to adapt and refine finance mechanisms.** Regrettably, the size and scope of CDM, as well as its design as a project-based mechanism, the related regulatory framework, and institutional infrastructure are insufficient for a successful contribution to global mitigation. The Carbon Partnership Facility (CPF) and Forest Carbon Partnership Facility (FCFP) approved by the World Bank (2007) last September are pioneering efforts to demonstrate how to scale-up GHG reductions dramatically through CDM-like market mechanisms, sector and programmatic (rather than project-level) transactions, and

financial incentives to reduce emissions from deforestation. Figure 8-1 shows how poorly Africa has been served by the CDM to date. It is important to remember that registered projects are not necessarily certified projects because certification of emission reductions (ERs), and subsequent payment for ERs is a process that follows verification that they actually exist. This regulatory process has been quite cumbersome and slow to date.



### 8.2.1 SUPPORT FOR LOW CARBON GROWTH IN SOUTH AFRICA

285. **South Africa’s energy priorities and options.** Because of its coal-intensive energy production and the size of its economy, South Africa is responsible for two-thirds of CO<sub>2</sub> emissions in SSA, and under a business-as-usual scenario, these CO<sub>2</sub> emissions are projected to increase four-fold by 2050. The priority mitigation options lie in the electricity, synthetic fuel, industrial, and transport sectors, which are the top contributors to CO<sub>2</sub> emissions now, and present the fastest growth in the future. Therefore, priority mitigation measures include industrial energy efficiency, nuclear, imported hydro, renewable energy, clean coal technologies, vehicle fuel efficiency improvements, and modal shifts in transport.

286. **Expand existing Bank support.** A Bank-supported Low Carbon Growth Study, which is now underway, will provide implementation support to the Government and utilities for a low-carbon development path. The South African government has prepared a long term strategy for climate mitigation, with broad-based consultation.<sup>41</sup> The Bank and the South African Government are also exploring opportunities to help finance South Africa’s public electric utility’s (ESKOM) huge investment needs for power generation, and identify clean energy investment opportunities with potential new financing instruments, including development policy lending and the Clean Technology Fund.

41. Energy Sector Note for Africa Climate Change Strategy (World Bank staff, January 2008)

## 8.2.2 INCREASE GENERATION CAPACITY AND REGIONAL TRADE

287. **Regional trade of hydropower (West, East, and Southern Africa).** The potential for Africa to develop a low-carbon trajectory by harnessing its hydro resources is huge, but the resources are largely untapped. At present, SSA exploits only 8 percent of its gross hydropower potential of 3.3 million gigawatt hours per year, about one-third of which has already gone through technical and economic feasibility analysis (World Bank, 2007). However, many of the continent’s energy resources tend to be geographically concentrated in a handful of countries that are often physically distant from the main centers of power demand. They are also economically too small to be able to develop those energy sources on their own (hydropower has a low annualized energy cost but is very capital intensive to develop). Regional power trading among neighboring countries would enable development of a higher number of large-scale hydro schemes that would not otherwise be viable at the national level.

288. **Transformative investments in large-scale energy capacity.** Developing these resources through large-scale “transformative” generation projects is the most promising solution. A regional perspective along with private sector participation and donor funding are essential. Regional power pools are paving the way for more widespread energy trade by providing an open platform to which neighboring countries can subscribe, adding individual projects in a consistent and least-cost approach, and setting-up institutional frameworks that provide comfort to private investors. Regional power trading would require political will and commitment to regional cooperation, as well as enhanced investments from both the public and private sectors to fulfill large financing gaps. The Bank is supporting expansion and development of the West African Power Pool (WAPP), East Africa Power Pool (EAPP), and the existing Southern Africa Power Pool (SAPP).

289. **GHG emissions impact regional power pools.** A recent Bank study, *Costing Power Infrastructure Investment Needs in Southern and Eastern Africa*, concluded that least-cost power trade leads to more hydropower, which lowers carbon emissions (World Bank, 2007). The total CO<sub>2</sub> emission reduction is estimated at 61 million tonnes resulting from power trading in SAPP and EAPP. According to the World Resource Institute<sup>42</sup> the total CO<sub>2</sub> emissions from all African countries was 520 million tonnes in 2004, growing at an annual average rate of 2.3 percent over the past two decades. Applying the same growth rate, estimated emissions would be 668 million tonnes in 2015. In other words, power trading in SAPP and EAPP alone would reduce Africa’s emissions by 10 percent.

290. **Geothermal energy (Kenya, Tanzania, and Malawi).** The geothermal energy potential in Africa’s Rift Valley using current technology is in the range of 2.5 to 6.5 gigawatts (Department of Energy, 1998; Geothermal Energy Association, 1999), whose development would represent from one-quarter to three-quarters of current worldwide production from geothermal sources. Currently, less than 5 percent of this resource potential is being utilized, primarily in Kenya. Geothermal power can reduce dependency on expensive imports of petroleum fuels, hedge hydrologic risk, and mitigate climate change through substituting and avoiding fossil fuels. However, while geothermal power

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42. [cait.wri.org](http://cait.wri.org).

has reached overall competitive prices, up-front detailed geological investigations and expensive drilling of geothermal wells require a major financial commitment while geological risks still exist, in spite of the progress made at the level of surface investigations. Therefore, financial support and commitment to share the resource risks of geothermal exploration and appraisal are essential to attract private sector investment in this area. In order to move this agenda forward, the Bank is preparing a GEF-funded African Rift Geothermal Development Facility project which will help bring down the cost of developing the technology.

291. **Natural gas and reduced gas flaring** (Nigeria, Chad, Cameroon, Angola, Equatorial Guinea, Gabon). In addition to holding 7.8 percent of the world's proven natural gas reserves in the Gulf of Guinea, SSA needs to tap into the huge amount of gas currently flared during oil production in the region, which if converted to electricity, could help meet a substantial share of Africa's power needs.

292. **Global Gas Flaring Reduction Partnership.** The Global Gas Flaring Reduction partnership (GGFR), managed by COCPO, has been working with major flaring countries and the oil industry on a global basis to raise awareness and address gas flaring in partner countries through demonstration projects and best practice dissemination of policies and regulation. The current strategy focuses on high-impact flaring countries and regions to minimize the waste of a valuable resource and mitigate its impact on climate change. The GGFR is facilitating private sector investments, supporting sector reform, developing carbon finance, and promoting stakeholder cooperation and best practice dissemination. A scale-up effort is planned within the context of the Clean Energy Investment Framework (CEIF), utilizing carbon finance and a combination of Bank and IFC instruments to address gas flaring reduction through joint WBG operations in key flaring countries, such as Nigeria.

293. **Flared gas is an energy opportunity.** Increased use of flared gas in Nigeria and other countries in the Gulf of Guinea is an opportunity to increase access to energy and support the transition to a low carbon economy. Currently, GGFR is working with the major stakeholders in Nigeria to coordinate flare reduction in line with the Government's deadline of 2008. The planned development of the Nigerian domestic gas market in the medium term to supply the power sector will also contribute to gas flaring reduction and help reduce the unrest in the Niger Delta, where most gas flaring in Nigeria occurs. Essential elements are a gas master plan, a new gas pricing policy, and a regulatory framework for the downstream gas sector. These are currently under preparation by the Nigerian Government. The power sector's ability to purchase gas and provide payment guarantees also needs to be addressed. The use of multiple WBG instruments could address this situation in a comprehensive way (Bank guarantees, followed by the involvement of IFC in PPP projects or private financing of an infrastructure network). GGFR is also working with the governments of Angola, Cameroon, Chad, Equatorial Guinea, and Gabon to reduce gas flaring in these countries.

294. **Clean coal technologies** (South Africa, Botswana, Mozambique, Kenya, Tanzania). A number of SSA countries plan to build coal-fired power plants in the near future as part of the power expansion plan, including South Africa, Botswana,

Mozambique, Kenya, and Tanzania. To mitigate the environmental impacts of coal power plants, the Bank should advise client countries to adopt clean coal technologies such as supercritical technology and carbon capture and sequestration whenever possible.

### 8.2.3 EXPAND ENERGY ACCESS

295. **Grid and off-grid electrification with renewable energy** (Ethiopia, Sudan Guinea, Kenya, Eritrea, Mali, Zambia). At present, 80 percent of the SSA population does not have access to electricity. Most of these consumers rely on kerosene and batteries in their houses, and diesel generators in businesses. Experience in many developing countries has demonstrated that consumers are paying up to 5 percent of their monthly household income for kerosene and batteries in areas without electricity. Given the high oil prices, the operating costs of diesel generators alone can be as high as 30 cents per kilowatt hour. Compared to these alternatives, grid extension of electricity networks lower-cost option with fewer carbon emissions, and can dramatically improve quality of lighting, increase convenience and safety, and provide better indoor air quality.

296. **Use of renewable sources of electricity in rural areas.** In remote rural areas, off-grid renewable energy options, including small hydro, biomass, solar, and wind, are often cost-effective approach to provide electricity with lower carbon emissions compared to kerosene and diesel. However, most renewable energy resources are nearly untapped in Africa in spite of rich renewable energy resources in many countries. There is limited resource information on small hydro in many countries, despite the rich hydro resources on the continent and well-developed technology. The Bank is helping a number of SSA countries to develop small hydro such as Ethiopia, Ghana, Tanzania, and Zambia. Biomass co-generation from agriculture and forest residues, a fully developed cost-effective technology, is almost untapped in Africa. Biomass co-generation not only generates electricity from a renewable energy source, but also reduces methane emissions from the residues. Wind is also underdeveloped in Africa. The key to developing these renewable energy resources is to establish legal, policy, and regulatory frameworks for the private sector to sell electricity to the grid and build capacities for local developers. Finally, the Bank is developing and implementing a number of solar PV projects for households and public institutions such as schools and clinics in Africa.

297. **Household biomass fuels.** In SSA, 60 percent of GHG emissions come from land-use change and deforestation. Traditional biomass, a dominant fuel for cooking and heating in SSA, is one of the main causes of deforestation and has resulted in serious indoor air pollution. Evidence has shown that indoor air pollution contributes to respiratory infections, accounting for up to 17 percent of deaths in children under 5 years old. To date, three strategies have attempted to address this issue: (i) improved stoves; (ii) fuel substitution with liquid and gas fuel alternatives such as LPG, kerosene, and natural gas; and (iii) sustainable forestry management. These measures can not only reduce GHG emissions, but also preserve forests', however, despite some successes, the results have been mixed, and there are social as well as institutional issues. Given the importance of this issue in SSA, the main recommendation is to undertake a comprehensive study to recommend solutions, particularly on project design and implementation.



298. **Access to affordable long-term financing is important.** Most rural consumers cannot afford the high upfront capital costs of off-grid renewable energy technologies. Increasing access to long-term financing for both renewable energy developers and end-use consumers is the key to address the affordability issue. In addition, technological innovation can sometimes provide the necessary solution. For example, the development of low-cost portable solar-powered Light Emitting Diode (LED) lanterns can provide basic power services to the poorest. The “Lighting Africa” initiative is already taking important steps in that direction.

#### 8.2.4 CROSS-CUTTING ISSUES

299. **Strengthen power utilities.** The poor governance of current SSA power utilities is reflected in their deficient operational performance. In well-run utilities around the world, system losses can be as low as 10 percent, but two-thirds of SSA utilities report losses in excess of 20 percent. Similarly, well-run utilities reach revenue collection efficiency rates of close to 100 percent, whereas 40 percent of SSA utilities collect less than 90 percent of the revenue owed them. Improving utility management is critical. Efficiency and operational improvement programs are needed to reduce the large losses stemming from high rates of technical, non-technical, and collection losses, as well as other inefficiencies. These can take a range of forms, including capacity-building and technical assistance to improve operational management, commercial business practices, and planning functions. In particular, a reduction of transmission and distribution losses from 20 percent to 10 percent in electric networks supplied by thermal power can lower carbon emissions by 10 percent. The Bank is helping power utilities in Nigeria, Ghana, and Tanzania with loss reduction and revenue improvement. Furthermore, there are ample opportunities for utilities to refurbish existing thermal power plants and increase supply-side energy efficiency as an effective means to increase revenues and reduce carbon emissions.

300. **Improve demand-side efficiency.** Energy efficiency is a “win-win” solution to mitigate climate change and address power shortages. Compact fluorescent lamps (CFL), for example, can enable energy savings of up to 80 percent. In Uganda, with less than a \$1 million investment, distribution of 600,000 CFL cut peak demand by 30 megawatts. ESKOM in South Africa is planning to disseminate 35 million CFLs, which can cut peak demand by 1,750 megawatts as a response to load shedding. In addition, plenty of opportunities exist to improve energy efficiency in the industrial sector such as motor efficiency, steam efficiency, more advanced and less energy intensive industry processes such as the cement industry, and waste heat recovery; as well as in the residential, commercial, and public sector with appliances and buildings. The Bank will work on helping to transfer international best practices in energy efficiency to Africa, raise awareness, and finance implementation.

301. **Biofuels.** A number of SSA countries have requested Bank assistance for biofuel production — ethanol and biodiesel. For example, in recent years sugar cane and maize, as well as jatropha, a low-cost plantation crop growing on marginal land, have shown

promise as feedstock for biofuel production.<sup>43</sup> Realistic and objective assessment of the feasibility of domestic biofuel production in niche markets, however, is lacking. The strategy calls for the Bank to first evaluate the experience and lessons learned in biofuel production in Africa, and then select a few SSA countries to conduct such assessments in terms of economic justification, feedstock supply, impact on food security, supply chain, market size, etc. It is perhaps also important to evaluate the relative merits of large-scale commercial biofuel growing and refining, versus biofuel as a supplemental crop, pursued profitably on a small scale by farmers who grow the crop to enable themselves, and possibly the immediate community, to become energy independent. An assessment of contract farming and grower experience with other crops in SSA may also be useful.

302. **Most current reliable data cover use of jatropha on marginal land** and preliminary research into long-term commercial viability. From a scientific perspective there is little proven data on issues such as crop yields and variety selection, for commercial application. Therefore, while it is reasonable to expect significant crop yields from *Jatropha curcas* per hectare, it is imperative to ensure that the botanical and agricultural assumptions surrounding the projected crop yield are sound (Strydom, 2006).

### 8.3 Transport sector

303. **Transport demand management.** Key measures include shifting from private vehicles to public mass transit such as bus rapid transit or to non-motorized transport (NMT). Some studies show that mode shifting might be the most cost-effective approach to reduce GHG. For example, a recent IEA report (IEA, 2002) indicates that “dramatic reduction in road space, fuel use and GHG emission can be achieved through displacing other vehicles with any bus, even the “Euro 0” typically sold in the developing world”. Among the many public transport modes — light rail, metro, bus, and bus rapid transit (BRT) — BRT proved to be the most cost-effect mass transit mode.

304. **Improve the quality of alternative transport modes.** African countries already have a high share of public transport and NMT,<sup>44</sup> but the quality of these systems is poor (slow, unsafe) and in most countries little investment is available for maintenance, upgrading, and expansion (SSATP, 2005). As incomes rise, improving the service of public transport and NMT will prevent the public from shifting to private vehicles. Some developing country cities such as Curitiba (Brazil) and Bogota (Columbia) have successful experience promoting public transport.

305. **Incentives to shift transport modes.** Incentive measures play a key role in modern transport demand management and reducing the use of private vehicles. They

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43. The Bank-financed study on “Using *Jatropha curcas* L. (physic nut) as an energy crop for land rehabilitation and enhancing biofuels energy in Kenya” was completed in June 2007 (World Bank, 2008i).

44. The vast majority of urban residents in SSA are from low-income households. The urban poor depend heavily on non-motorized transport (NMT) and their urban transport expenditures account for 10 percent (in the smaller cities) to 20 percent of their household incomes. Experience shows that NMT infrastructure investments are highly cost-effective.

include pricing (such as fuel tax), controls on parking, and traffic restraint measures (such as high occupancy vehicles). The implementation of such measures, however, requires strong regulatory and institutional capacity, and therefore could be part of a medium-term strategy.

306. **Increase vehicle fuel efficiency.** Key measures include replacing two-stroke motorcycles with four-stroke motorcycles; elimination of high-mileage polluting vehicles; and strengthening vehicle maintenance (because replacement of all inefficient vehicles is impractical, improving the maintenance of individual vehicles so that they can be more fuel-efficient). Training programs that promote behavioral measures for energy efficient operation of vehicles can reduce the energy consumption of vehicles by changing either driver behavior or inspection and maintenance behavior.

307. **Improve fuel technology.** Measures with indirect impact on GHG emissions but with important health benefits include elimination of leaded gasoline and reduction of sulfur in diesel. In addition, the use of alternative energy such hydrogen-powered cells and advanced biofuels should be considered by policy makers as they craft transport and fuel technology policies. At present, however, due to the high cost,<sup>45</sup> such technologies are not readily adoptable in SSA, but they need to be part of longer-term strategies.

#### 8.4 Urban sector

308. **Sources of GHGs in cities.** The direct sources of global emissions in cities include energy generation, vehicle use, industrial and point-source use of fossil fuels, and burning of biomass. Indirect sources include electrical energy produced for public lighting, transportation, industrial, and household consumption.

309. **Urban development measures that have mitigation benefits.** In the urban sector, a number of measures that are important for the welfare of the local population will also have climate change mitigation benefits, including:

- **Urban planning** — promote selective use of cost-effective renewable energy, use of sustainable building materials and products, better insulation of buildings, and improved energy efficiency standards for renovations and new construction.
- **Urban water and sanitation services** — improve pumping efficiency, improve efficiency of water supply management, including minimizing leaks, and manage GHG emissions from sewage treatment, and promote integrated energy-water management.
- **Waste management** — provide solid waste management, promote the collection and use of landfill gas (methane) for use in power generation, energy-efficient solid waste collection, waste stream separation and materials recovery, and composting.

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45. Available evidence suggests that the cost of fuel-based solutions ranges from about \$148 to over \$3,500 per tonne of CO<sub>2</sub>, while shifting transport mode from private vehicles to public transport costs between \$14 and \$66 per tonne of CO<sub>2</sub> (Draft Transport Sector Climate Change Note).

- **Urban air pollution** — in managing urban air pollution, major pollutants such as particulates and ozone are also important factors of climate change. Some of the airborne pollutants, notably volatile hydrocarbons and nitrogen oxides (NO<sub>x</sub>), contribute to the formation of ozone and thus to global warming. Climate change influences the emissions, transport, and chemical behavior of atmospheric pollutants, and air pollution influences greenhouse gas cycles. Climate change policies can have important benefits by reducing air pollution, and a combined approach to climate change and air pollution could have positive synergetic effects.

310. **Improving urban air quality.** It is important to address urban air pollution in key priority cities in SSA and develop air quality management (AQM)<sup>46</sup> studies with concrete action plans, including cross-sector investments. Air quality studies facilitate the preparation of future investments by the Bank or any other donors in the transport, urban, and environment sectors. The cities of Antananarivo (Madagascar), Cotonou (Benin), and Ouagadougou (Burkina Faso) have already been identified and have received support from the Bank Clean Air Initiative in SSA. This should be further developed in other cities of the Region (e.g., Lagos, Nigeria; Johannesburg, South Africa; Dar-es-Salam Tanzania; and Nairobi, Kenya).

## 8.5 Sustainable forest and land management

### 8.5.1 SUSTAINABLE LAND MANAGEMENT

311. **As indicated in Part 1 of this paper,** total emissions of greenhouse gases in Sub-Saharan Africa are low compared to other regions of the world, but emissions per unit GDP are high if land-use change is taken into account (Figure 2-4).

312. **Emissions from land-use, land-use change, and deforestation** are the largest sources of emissions in Sub-Saharan Africa (Table 8-1). Deforestation and forest degradation are responsible for some 15 to 30 percent of human-induced GHG emissions (Houghton, 2005). Forest losses each year are equivalent to an area four times the size of Belgium. Brazil and Indonesia are the worst, but six of the 10 largest forest losses are in Sub-Saharan Africa (DRC, Nigeria, Sudan, Tanzania, Zambia, and Zimbabwe). In Africa, forest loss from 1990 to 2003 was estimated at 15 million hectares (or some 4.3 million hectares annually).<sup>47</sup> Moreover, 89 percent of deforestation is driven mainly by the expansion of agriculture (Table 8-1).

**Table 8-1. Average annual emission of carbon for different land uses**

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46. At the city level, such AQM plans aim not only at facilitating preparation of a list of critical urban air pollutants and their sources, but also at analyzing the different options for reducing air pollution in consultation with the various actors. Air quality management plans offer a fail-safe mechanism for avoiding the adoption of solutions that may be too costly, ill-suited to problems, or would create difficulties at the implementation level (Clean Air Initiative in Sub-Saharan African Cities, CAI-SSA).

47. Chomitz (2007) reports that estimates of annual net forest loss in tropical Africa vary widely, from 5.2 million to 376,000 hectares).

	Cropland	Pasture	Shifting cultivation	Timber harvest	Forest plantations	Total
Million tonnes carbon/year						
West		1.5	25.6	8.5	-0.4	92.2
East	14.6	0.1	13.2	6.2	-0.1	34
Central	5.1	0.6	69.8	8.5	-0.2	83.8
South	23.4	2	45.5	6.5	-0.7	76.7
All SSA	100.1	4.2	154.1	29.7	-1.4	286.7
<i>Proportion</i>	<b>35%</b>	<b>1%</b>	<b>54%</b>	<b>10%</b>	<b>0%</b>	<b>100%</b>

Source: Houghton (2007)

313. **Carbon sequestration in forests and soils benefits land management.** The development and growth of carbon markets may offer opportunities to limit the pressure on forest ecosystems by financing forest preservation for carbon sequestration (Laporte et al., 2007). Allowing African tropical forests to grow and reducing deforestation by one-half would prevent some 150 million tonnes of carbon from being released into the atmosphere in the next century,<sup>48</sup> or about one-half of Africa’s current emissions, thus contributing to the global mitigation effort.<sup>49</sup> Storing carbon in forests and agricultural soils presents an immediate option to reduce atmospheric carbon dioxide and slow global warming. Governments, forest owners, and farmers who adopt practices that store carbon in soil through sound land management practices may be able to “sell” the stored carbon to buyers seeking to offset greenhouse gas emissions. But before carbon credits can be sold, “owners” need to be able to verify that forests are managed sustainably and remain standing, and that changing soil and land management practices have increased the organic carbon in agricultural fields and watersheds. The adoption of strategies by SSA countries to better manage land resources and protect natural forests would not only maintain a large carbon sink with associated benefits for the foreseeable future (for which there may emerge a market for their monetization), but would also provide a number of ecological services. These include enhanced groundwater recharge, improved surface water reliability for downstream users, and ecosystem integrity (Millennium Ecosystem Assessment, 2007).

314. **Potential for CDM incentives for good land management.** Avoiding deforestation is not currently eligible for financing under the Clean Development Mechanism. But under the Bali Action Plan,<sup>50</sup> negotiation of a post-2012 international

48. Still less than 1.5 percent of global emissions, but more than the total emissions from all other sectors combined in SSA.

49. For a more detailed analysis of the economics of avoided deforestation in SSA, see Bouzaher, Devarajan, and Ngo (2008).

50. At the United Nations Climate Change Conference in Bali in December 2007, governments from around the world — both developed and developing countries — agreed to step up their efforts to combat climate change and adopted the Bali Road Map, which consists of a number of forward-looking decisions that represent the various tracks that are essential to reaching a secure climate future.

framework will consider policy approaches and positive incentives to promote and support reduced emissions from deforestation and forest degradation (referred to as REDD or Reducing Emissions from Deforestation and Forest Degradation). Given that sustainable agriculture practices can also contribute to sequestering significant amounts of carbon in soils and improve productivity, African countries could potentially greatly benefit from development of incentive mechanisms that promote agricultural carbon sequestration. However, as we argue below, REDD is not without risks and it is important to undertake extensive economic analysis of the benefits and costs, as well as the political economy of adopting and implementing a REDD program.

#### 8.5.2 SYNERGY OF GOOD LAND AND FOREST MANAGEMENT

##### **315. Benefits of adaptation and mitigation from forest and land management.**

Protecting natural forests and sustainable agricultural land management in SSA not only maintains and increases a large carbon sink with associated benefits for the foreseeable future, but also would increase productivity, enhance climate resilience of land-use systems, and improve provision of a number of ecological services, including water recharge and reliability of supplies for downstream users, ecosystem integrity, etc. (Millennium Ecosystem Assessment, 2007). Including agriculture land management in land-use-based approaches for GHG mitigation would also reduce pressure on forests and thereby positively contribute to avoided deforestation. Hence, the CC-Strategy's recommendation is to apply a holistic approach to landscape GHG mitigation, which includes reforestation/afforestation, avoided deforestation, and agricultural land management.

#### 8.5.3 REDUCE DEFORESTATION AND FOREST DEGRADATION (NIGERIA CAMEROON, GABON, GHANA, LIBERIA, DRC, CONGO, CAR, MADAGASCAR, KENYA, SUDAN, TANZANIA, AND MOZAMBIQUE)

##### **316. Reducing deforestation could reduce GHG emissions by one-half in SSA.**

Allowing African tropical forests to grow and reduce deforestation by one-half would prevent some 200 million tonnes of carbon per year from being released into the atmosphere in the next century,<sup>51</sup> or about one-half of Africa's current emissions, thus contributing to the global mitigation effort. In addition, IPCC (2007) estimates that the technical and economic GHG mitigation potential based on agricultural land management

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The Bali Road Map includes the Bali Action Plan, which charts the course for a new negotiating process under the UNFCCC, with the aim of completion by 2009. It also includes the current negotiations under the Kyoto Protocol and their 2009 deadline, which focus on further quantified emission reduction commitments for industrialized countries, as well as negotiations on the ongoing work pertaining to key issues including technology, adaptation, and reducing emissions from deforestation. The Bali Action Plan was adopted by the Conference of the Parties (COP) in Bali in December 2007. It is centered on four main building blocks — mitigation, adaptation, technology, and financing (UNFCCC 2007).

51. Still less than 1.5 percent of global emissions, but more than the total emissions from all other sectors combined in SSA.

in Africa would be 970 million tonnes CO<sub>2</sub>e per year and 265 million tonnes CO<sub>2</sub>e per year by 2030, respectively.

317. **Promoting programmatic approaches.** Deforestation and forest degradation can be significantly tackled through a clear strategy on forest resources management designed to enforce environmental legislation, support economic options contributing to sustainable forest management, and build institutional capacity all over the national territory, including the most remote forest regions. A programmatic approach, rather than a project-based approach, is better designed to strengthen national capacities to ensure law enforcement and to efficiently and sustainably steer deforestation and degradation processes all over the territory.

318. **Programmatic approach in the Congo Basin.** Over the last four years, countries in the Congo Basin area — Cameroon is the most advanced — have provided substantial efforts to define a clear programmatic approach for their natural resources. Cameroon and Gabon have already elaborated a national program on forest and environment, with large support from the international community. This programmatic approach should be replicated in other countries.

319. **Work to limit the pressure on forests.** To limit pressure on forests, the Bank will work with client countries to ensure that macroeconomic and sector reforms as well as investments in other sectors (e.g., infrastructure, agriculture, and mining), do not negatively impact forests and forest peoples, and when they do, mitigation measures are used to offset or minimize potential impacts. In particular, the level of integration of major forest issues in the design of larger adjustments and cross-sectoral activities will need to be scaled-up.

320. **Support sustainable logging practices.** Sustainable logging practices are likely to significantly limit the degradation of forests, both qualitatively and quantitatively (biomass/carbon content). Therefore, support should be given to the governments that are willing to promote sustainable management rules at the national level. Additionally, the adoption and implementation of the principles and indicators of the certification system, at the company level, can also drive significant improvements in logging practices.

321. **Build capacities in forest monitoring.** The measurement of carbon stocks and their changes rely on methods combining satellite remote-sensing imagery with field data in the different types of forest ecosystems (primary forest, sustainably/heavily-logged forest, degraded forest). Such methods require data from national inventories. Up to now, appropriate land cover inventory systems in the Congo Basin countries are not operational and in some cases do not even exist.

322. **Some countries in the Congo Basin** have already set up a monitoring system of their forest cover. Partnerships between the forest administrations in Cameroun, Gabon, and Congo-Brazzaville, and the World Resources Institute initiative, Global Forest Watch, have been established for more than three years. Maps of the forest cover are available, also indicating the road networks. In the Democratic Republic of Congo, a joint

NASA-University of Maryland research project also provides some information on forest cover based on satellite imagery.

323. **Limited resources constrain these efforts.** Despite major efforts — mainly through GEF financing to establish protected areas for biodiversity conservation — the reality is that resources are still limited and most countries are reluctant to borrow funds for forest protection. Therefore, the strategy identifies two priority actions to support forest protection: (i) mobilizing significant resources, blending multiple sources (including highly concessional funding and grants); and (ii) promoting effective markets for ecosystem services, such as conservation concessions.

324. **Potential of carbon finance initiatives.** Carbon finance initiatives have a high potential to provide incentives to transform forest management. In addition to existing project-level financing (e.g., BioCarbon Fund), new and more programmatic instruments such as the FCPF can be blended to IDA or IBRD operations and have the potential to create new and recurrent incentives to back measures that improve governance, and institutional, legal, and policy reforms. Performance-based payments may become available from REDD — a new system of incentives that could compete with destructive uses of forests (see more details in the section below on financing).

#### 8.5.4 LIMIT PRESSURE ON WOODLAND ECOSYSTEMS (MOZAMBIQUE, KENYA, SUDAN, AND ETHIOPIA)

325. **Promoting sustainable management of woodlands for fuelwood** can significantly contribute to climate change mitigation through: (i) reduction of GHG emissions in the atmosphere by creating a “renewable” and sustainable source of domestic energy; and (ii) sequestration of carbon in sustainably managed woodlands and/or plantations. Another benefit is that sustainably managed woodlands are also key for an adaptation strategy in dryland areas by keeping the soils covered and thus reducing erosion

#### 8.5.5 PROMOTE ENVIRONMENTALLY- AND SOCIALLY-SOUND PLANTATIONS (SAHEL, EAST AFRICA, AND SOUTHERN AFRICA)

326. **Compared to South America and Asia,** plantations are not well developed in Africa (except in South Africa and Swaziland). However, when environmentally and socially well designed, plantations can drive local development by creating jobs. Large areas of degraded lands (opencast mines) are abandoned and could be rehabilitated through tree planting. These plantations are to be fully integrated and consistent with the rural development strategy of the country. In Africa, because the competition for land use and access is keen, consultations with the local population and stakeholders are a prerequisite to any plantation establishment.



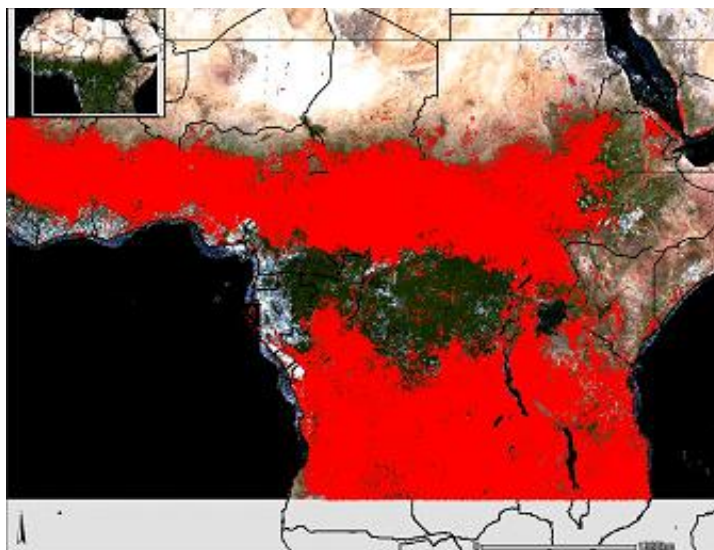
#### 8.5.6 MANAGE FIRES IN DRYLANDS (SAHEL, EAST AFRICA, AND SOUTHERN AFRICA)

327. **Very little attention has been given so far to fire management in drylands.** Bush fires are a traditional practice in the sub-tropical countries. Woodlands are adapted to this stress and can recover over a period of a few years, which is a balanced situation in the carbon cycle. However, due to potential drastic changes in climatic conditions, fires could become a threat to forest ecosystems not usually put under the fire stress and thus cause enormous destruction of both flora and fauna in East and Southern Africa (Figure 8-2).<sup>52</sup> Therefore, fire management should be practiced in the context of an integrated rural development strategy, with community-based interventions.

#### 8.5.7 MAINSTREAM CARBON SEQUESTRATION IN LAND MANAGEMENT (SENEGAL, NIGER, MALI, GHANA, BURKINA FASO, KENYA, ETHIOPIA, SUDAN, AND MALAWI)

328. **Sustainable agricultural land management offers opportunities** for climate change mitigation by enhancing the amount of carbon stored in soil and biomass and decreasing GHG emissions. The IPCC (2007) estimates that the economic GHG mitigation potential from agricultural land management in Africa could be 265 million tonnes CO<sub>2</sub>e per year by 2030. Land management practices and technologies that contribute to soil carbon sequestration can also increase yields and improve the climate resilience of agricultural systems.

Figure 8-2. Fires for the period February 2002 to February 2003



Source: MODIS from WHRC

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52. Although fires are a part of the natural cycle of the seasonally dry grasslands and savannas of Africa, their intensity and the frequency with which they return to previously burned areas affect both biodiversity and land quality. The massive amount of burning that occurs on Africa each year not only contributes to climate change through carbon dioxide and aerosol particles, but also creates a public health hazard through increased levels of ground-level ozone and other air pollutants.

329. **Benefits from improving and intensifying agricultural productivity.** The agriculture sector offers unique opportunities to realize synergies among productivity, adaptation, and mitigation objectives. To maximize these synergies, an agricultural mitigation strategy needs to be integrated with an adaptation strategy, which aims at a smallholder-based productivity revolution based on a climate-resilient technology changes. A comprehensive landscape approach to land-use-based GHG mitigation is recommended, including afforestation and reforestation, avoided deforestation, and agricultural land management. Because land resources are becoming scarce, increased agricultural productivity will be mainly realized through sustainable intensification. This sustainable intensification can not only reduce GHG in the atmosphere, but also reduce pressure on forests and thereby contribute positively to reforestation and avoided deforestation efforts.

330. **Need to operationalize agricultural mitigation.** To strengthen the role of agriculture in future compliance and voluntary markets, the potential for agricultural GHG mitigation to be operationalized must be demonstrated — how can the environmental service of GHG mitigation can be turned into a marketable carbon asset to benefit smallholders. The strategy recommends that this may include:

- Develop and implement of BioCarbon Fund pilot projects which demonstrate that emission reductions based on sustainable agricultural land management (SALM) are real and measurable (Box 8-3).
- Develop a technically sound and pragmatic carbon accounting methodology that outlines how to quantify additional emission reductions and how to monitor carbon stock changes.
- Prepare an assessment of the potential of various SALM practices to sequester carbon or reduce greenhouse gas emissions (already underway), including aspects of economic and financial attractiveness.
- Strengthen capacity of African institutions, communities, and organizations to meet the operational and technical requirements for accessing carbon funds from both the CDM and voluntary markets.
- Raise awareness about agricultural GHG mitigation potential and the links between mitigation and adaptation within SALM.
- Integrate carbon finance operations into the broader agricultural country programs and programmatic SALM frameworks (Box 8-3).

**Box 8-3. Carbon finance opportunities for smallholder farmers in Africa**

To demonstrate that “agricultural carbon” is measurable and can be an asset that is in demand in the market, the World Bank is supporting preparation of two innovative agricultural carbon finance operations in Kenya. The overall aim of these pilot projects is to develop carbon accounting and monitoring methodologies, demonstrate the direct benefits at the smallholder level, and remove implementation barriers that allow broad replication. One project will generate carbon off-sets from the adoption of sustainable agricultural land management practices on smallholder farms that produce staple crops in western Kenya. The project is being implemented by the NGO ViAgroforestry on about 100,000 hectares and promotes a range of productivity-enhancing practices which — as another benefit — will also sequester CO<sub>2</sub>. These

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practices include mulching, incorporation of crop residues, reduced tillage, agroforestry systems, and soil and water conservation measures.

The other project focuses on transformation of sun-grown coffee into shade coffee, combined with other sustainable land management practices. This project is being implemented on about 6,000 hectares of smallholder farmland in central Kenya by the advisory agency Sustainable Management Services (SMS). The introduction of new management practices is expected to increase coffee yields and quality and contribute to carbon sequestration. In both projects, the carbon pools under consideration are soil and above- and below-ground biomass. Carbon revenues will be directly distributed to farmers and cover part of the cost of the advisory services. These projects are expected to be officially included in the portfolio of the BioCarbon Fund of the World Bank in October 2008.

*Source:* World Bank (2008)



## 9. Pillar 3 — Knowledge and Capacity Development

331. **The third pillar of the strategy deals with knowledge and capacity building**, an area with significant deficits. Capacity development is a long-term challenge which is embedded in essentially all development initiatives by the Bank and other development partners. The problems of climate change add a layer of complexity to the existing capacity development challenges, and require integration and coordination among sectors. The overall focus of the strategy is therefore to help governments provide a policy framework and prioritize fiscal resources to:

- Improve climate modeling, weather forecasting, hydrology and water resources monitoring, land use information, and disaster preparedness;
- Identify investments in appropriate technology development and dissemination;
- Identify adaptation measures, costs and benefits of different actions, programs and policies, and priority sector actions;
- Strengthen capacity for planning and coordination, participation, and consultation; and
- Strengthen human resources.

332. **These measures are essential requirements** for helping to mainstream climate change into government programs and budgets, but will take time to develop.

333. **The strategy recommendations in this section complement** the more sector-specific recommendations presented in Chapters 7 and 8 on adaptation and mitigation. The focus here is on measures of a cross-cutting nature or of significant relevance in the SSA context — knowledge development and learning, capacity of forest institutions, and adaptation and disaster risk management.

### 9.1 Identify and fill key knowledge gaps

334. **Undertake regional projects and studies in key sectors.** A number of regional initiatives are needed to help create an information base and generate the knowledge necessary for operational design, client support, and building awareness, including:

- **Develop a climate information portal.** This initiative extends work already underway through two regional AAA initiatives: (i) the Africa Water and Climate Change, and (ii) the Sustainable Land Management and Climate Change in SSA. The initiative involves data collection of historic climate variability and predictions in Africa, and setting up a database that can be accessed both internally and by client countries and other stakeholders. Starting with basic data on temperature, precipitation, and run-off for a few river basins (Nile, Niger, Chad, Congo, Zambezi, and Lake Victoria), the information will be built over time to include evaluation of appropriate prediction models for Africa, and case studies on adaptation to climate change in the agriculture and NRM sectors, water resources management, implications of climate change for hydropower development and management, as well as a study

on the impacts of sea level rise. In addition, tools are being developed that are applicable to different country contexts, including methodologies for disaster risk assessment.

- **Increase the knowledge base through case studies.** To generate new knowledge, studies will focus on areas where Bank projects are being implemented, including Eastern Nile, Lake Victoria, Ethiopia's Gibe 3, Flood Preparedness in Malawi and Mozambique, and the Democratic Republic of Congo. The focus will be on adaptation strategies, hydrology risk assessment, operational implication, and analysis of the efficiency of rehabilitation versus building new infrastructure.
- **Promote networking among climate scientists and practitioners.** This initiative will bring together African scientists from relevant institutions (academia, government, regional institutions) to exchange expertise on practical aspects of data collection and analysis, applied research, and lessons learned from the case studies.
- **Set up a climate change risk assessment help desk.** This will be undertaken by engaging the service of relevant climate change experts (through CLIM-MATE similar to the BNWPP hydrogeology group GW MATE). The CLIM-MATE will provide in-depth expertise with support of a designated focal point. The CLIM-MATE will set up a Climate Change Risk Assessment help desk to provide on-time and reliable support to Bank staff and clients. This help desk will encourage knowledge sharing among various initiatives, Bank staff, and clients on climate-related matters.
- **Develop a pilot program for capacity building on energy and climate change.** To scale-up clean energy and accelerate implementation (as discussed in details in Section 6.2), capacity building for governments, utilities, the private sector, NGOs, and other local stakeholders is essential, particularly in the areas of raising awareness, introducing international experience, advisory services, and training.
- **Invest in analytical work on the economics of climate change adaptation and disaster risk reduction.** A number of pilot economic studies will be initiated (in Ethiopia, South Africa, Mozambique, Ghana, Sudan, and Uganda). These will test and develop methodologies and estimates useful for policies dealing with the economic impacts of climate variability and change, and the costs and benefits of adaptation. These studies will also feed into other regional global economic assessments, managed by the Bank's global climate change and GFDRR teams. Some of this work is already underway, focused on adaptation in Ethiopia (Box 9-1), and mitigation in South Africa (Box 9-2).
- **Develop an analytical and readiness base** to help countries identify and take advantage of carbon finance opportunities, using existing CDM-related instruments, or new initiatives (e.g., Forest Carbon Partnership Facility [FCPF]; Carbon Partnership Facility [CPF]). In addition, under this initiative a new focal area will aim to provide detailed information on the technical, economic, and institutional aspects of carbon sequestration in agriculture soils.

**Box 9-1. Economic impacts of climate change — the case of Ethiopia**

An economy-wide framework to analyze impacts from climate change and potential adaptation of policies was developed and applied to the case of Ethiopia (World Bank, 2008d). The approach modifies and extends a dynamic, single-country prototype Computable General Equilibrium (CGE) model to include stochastic elements characteristic of climate change, and a representation of the sectors — like agriculture — that are most likely to be affected. It builds on the work of Hope (2006), who developed the PAGE model that provided substantial input into the well-known Stern Report on climate change (Stern, 2006).

Ethiopia is heavily dependent on mainly rainfed agriculture (45 percent of GDP and 80 percent of the working population). Its geographical location and topography, in combination with low adaptive capacity, present high vulnerability to the adverse impacts of climate change. Historical data point unequivocally to a strong impact of climate outcomes on agricultural output with both negative and positive deviations from trends. Performance in agriculture also affects performance in other sectors of the economy, so there is a strong observable link between climate change variations and overall economic performance.

The study simulated climate shocks and their impact on Ethiopia's economy over a 25-year period and found that relative to the baseline:

- Climate shocks lower economic growth rates significantly;
- If the future is like the past (i.e., using historical variability as a guide), the impact of climate shocks on average growth rates is relatively modest but with significant impacts on variation of growth rates;
- As volatility increases and shocks become more negative, the impact results in significantly lower growth rates;
- Lower growth rates accumulate through time, leading to reductions in real GDP of some 30 to 50 percent at the end of the simulation period;
- The burden of adjustment appears to fall more heavily on consumers because the productivity shocks all occur in agriculture; and
- The negative impact is spread across the economy, suggesting the importance of using an economy-wide framework to analyze the impact of climate change shocks, even if the shocks are largely focused on a few sectors.

The simulation further indicates that effective adaptation measures are vital if Ethiopia is to sustain the per-capita growth rates required for achieving the MDGs. Adaptation policies designed to reduce vulnerability to climatic change are more likely to succeed if they are integrated with efforts aimed at poverty reduction and general economic growth strategies. Ethiopia's high level of unexploited water resources and low level of irrigated land suggest that investments in developing water resources should be an integral part of a strategy for climate-resilient growth. However, a rigorous quantitative analysis of alternative adaptation policy options that would allow formulation of specific policy recommendations requires further in-depth research into the expected costs and potential benefits of specific adaptation measures.

Source: World Bank (2008d)

9.1.1 SCREEN THE PORTFOLIO FOR CLIMATE RISK

335. **The objective of this exercise is to identify measures** that can improve climate resiliency and adaptation to climate change for development projects in the Africa region, based on an assessment of exposure to climate vulnerability and change in each country and the present project portfolio in key sectors. This information will be useful for estimating the additional costs of mainstreaming adaptation/CRM and/or mitigation opportunities into the region's project portfolio and pipeline. The approach will be to overlay the portfolio of active and pipeline projects with an assessment of the exposure to climate variability and change in each country, and to assess from this overlay the specific CRM challenges for such projects and for the sector.

**Box 9-2. Tax policy to reduce carbon emissions in South Africa**

Noting that South Africa may be one of the few African countries that could contribute to mitigating climate change, a World Bank study explores the impact of a carbon tax relative to alternative energy taxes on economic welfare. Using a disaggregated general equilibrium model of the South African economy, the structural characteristics of the energy sector are captured, linking a supply mix that is heavily skewed toward coal to energy use by different sectors and hence their carbon content. A “pure” carbon tax as well as various proxy taxes such as those for energy or energy-intensive sectors (such as transport and basic metals) are considered, all of which achieve the same level of carbon reduction.

In general, the more targeted the tax to carbon emissions, the better the welfare results. If a carbon tax is feasible, it will have the least marginal cost of abatement by a substantial amount when compared to alternative tax instruments. Furthermore, the welfare losses from a tax on carbon are small regardless of the elasticity of substitution in production. If the revenue generated by the tax can be used to reduce pre-existing tax distortions, the net welfare cost becomes negligible. If a carbon tax is not feasible, a sales tax on energy inputs is the next best option. Moreover, labor market distortions such as labor market segmentation or unemployment will likely dominate the welfare and equity implications of a carbon tax for South Africa. This being the case, if South Africa were able to remove some of the distortions in the labor market, the cost of carbon taxation would be negligible. An important insight provided by this pilot study is that the discussion of carbon taxation in South Africa can focus on considerations other than the economic welfare costs, which are likely to be quite low.

*Source:* World Bank (2009)

9.1.2 CAPACITY BUILDING IN INVESTMENT OPERATIONS WITH CRM COMPONENTS

336. **Capacity building will be done through country-level adaptation, including:**

- **Mainstream climate change** into PRSPs, CASs/CPSs, and sector strategies (Cameroon, Lesotho, Burkina Faso, Sierra Leone, Guinea, Botswana, South Africa). By systematically including climate risk in the policy dialogue in the fiscal years 2009 to 2012, the Bank will ensure that for countries with high exposure and vulnerability to climate risks, climate resilience is addressed in upcoming PRSP updates, country assistance/partnership strategies, and key sector strategies (agriculture, forestry, water, energy, health, and infrastructure). This will be undertaken in close collaboration with key development partners (DFID, EU, AfDB, etc.).
- **The Adaptation to Climate Change in Arid Lands Project in Kenya** aims to mainstream climate risk management within the ongoing Arid Lands Management Project.
- **The Zambezi Valley Market-led Smallholder Development Project** in Mozambique factors climate change into planning and implementation of new approaches to improve the livelihoods of small-scale farmers.
- **The Agriculture Development Program Support Project (ADP-SP)** in Malawi focused on food security and sustainable agricultural growth. As part of the ADP-SP, the World Bank is implementing a pioneering weather-index insurance scheme aimed at helping smallholder farmers to buffer against productive losses associated with climate variability in Malawi. This effort is complemented by a macro weather insurance scheme that helps transfer risk of severe national droughts to international markets and provides the government with timely funding if a contractually specified catastrophic rain deficit occurs during the cropping season. The project also finances capacity building in commodity risk management.



- **The Productive Safety Net Program (PSNP) in Ethiopia**, for the chronically food insecure, focuses on consumption smoothing, asset protection, and the creation of community assets through a public works program and direct support. A new drought risk management tool (Livelihoods, Early Assessment and Protection [LEAP]) will help predict and mobilize funding ahead of drought event (Box 9-3)
- **The Niger River Water Resources Development Project (WRDP)** will include climate adaptation activities in the different sectors, infrastructure, agriculture (including irrigation), environment, and energy that can be implemented by the riparian countries as part of their investment plans.

## 9.2 Building resilience to natural disaster risks (droughts and floods)

337. **This pilot program will use the horizontal Adaptable Program Loan (APL)** instrument with countries participating on a demand-driven basis. The program would support institutional and capacity building for effective natural disaster risk management and preparedness, help revise building codes and upgrade infrastructure investments, support natural-resource-based local development activities to reduce vulnerability to droughts and floods, and improve access of SSA countries to emerging financing instruments that will help address disaster and climate change risk. Two versions of the program would be piloted, one in the Niger River basin, and one in East Africa.

### **Box 9-3. Enhancing the protection for livelihoods in Ethiopia through drought risk financing**

The Government of Ethiopia, the World Bank, and the World Food Program collaborated to establish the Productive Safety Net Program (PSNP), designed to deliver timely livelihood protection to the chronically food insecure, and prevent household asset depletion and increased levels of destitution. A drought risk financing component was introduced in the World Bank's second phase of support (\$175 million) to provide immediate scaled-up financing in response to localized intermediate or severe drought. The concept is that this will form part of a coordinated pool of contingent resources that can be readily allocated in the event many more households become food insecure, or existing beneficiaries require additional assistance following weather shocks.

The Program uses a new tool called LEAP (Livelihoods, Early Assessment and Protection), specifically designed to predict and monitor the yield impacts of drought and excessive rainfall in a particular administrative unit in Ethiopia. LEAP converts ground and satellite rainfall data into localized crop production or and rangeland estimates, and livelihood stress indicators for vulnerable populations that rely on rain-fed agriculture or forage for livestock. This allows funding to be made available in a predictable and timely manner, lowering costs over the long-run and building resilience into the Government of Ethiopia's Productive Safety Net Program.

Source: World Bank (2008)

## 9.3 Strengthen the capacity to manage climate risk

338. **Most of the knowledge to manage climate risk should be generated** in a demand-driven fashion, feeding directly into country dialogue and/or sector operations. Nevertheless, there is also merit in collecting basic hazard and vulnerability information to identify major risks that can help raise awareness and provide a basis for longer-term dialogue with particular countries and in-country stakeholders.

339. **Skills and organizational capacity.** In addition to knowledge, there is a great need to enhance skills and organizational capacity. Capacity building to manage climate risk is needed at all levels, particularly within sector agencies, local government, the private sector, and non-governmental partners — not just among a few technical specialists in a central government agency charged with disaster risk reduction or climate change adaptation. In most cases, the key is not so much to identify information, but to apply it in an appropriate way to reduce risk. Both generation and application of knowledge about climate risk management requires close collaboration with other stakeholders and organizations that can play an intermediate role in reaching the private sector and the most vulnerable people.

340. **Increasing the relevance of climate change information and data.** A specific area of attention is the production and application of climate information, ranging from long-term climate predictions to short-term weather forecasts. Climate science agencies need to learn how to translate information to a form that can be understood by end users. In many parts of Africa, such efforts are starting, and there are clear economies of scale for a sub-regional basis.<sup>53</sup> The World Bank Institute (WBI) can facilitate integration of these two agendas by closely coordinating its climate change and disaster management offerings.<sup>54</sup>

341. **Strengthen regional climate and hydrologic institutions.** At a regional level, the Bank will collaborate with the World Meteorological Organization (WMO) in a GFDRR-financed project that focuses on strengthening information about current and future climate conditions in the greater Horn of Africa region. The WMO will work with national meteorological institutions and the Climate Predictions and Applications Center of the Intergovernmental Authority on Development in East Africa (ICPAC) to strengthen local and regional capacity to assemble observational climate information, and assess the validity of regional climate modeling methods that inform the design of adaptation and climate risk reduction strategies. In consideration of practical applications, the project will also emphasize the dialogue among information providers and users.

342. **At the national level, a capacity-building program on adaptation** and climate risk management, initiated in 2006 in Madagascar (Box 9-4), will be strengthened and replicated in at least two other countries. The program works with national champions and institutions by linking them with international centers of excellence.

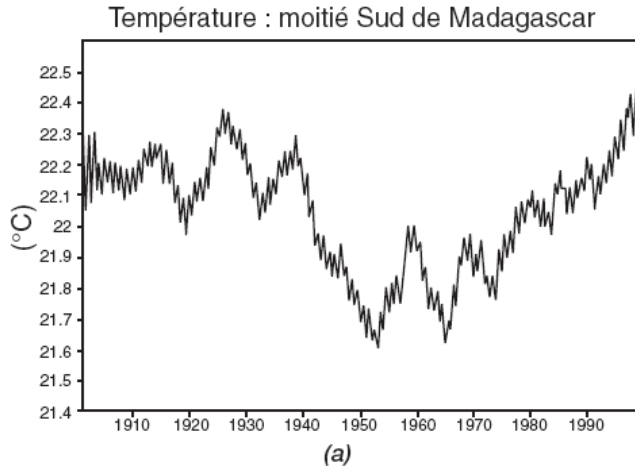
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53. This is supported by existing regional meteorology-oriented organizations such as ACMAD and OSS,

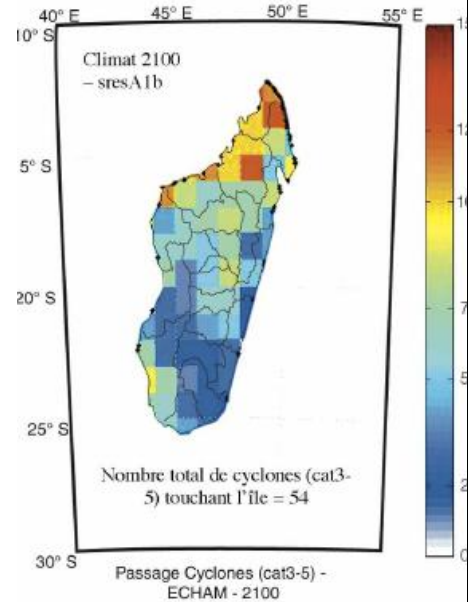
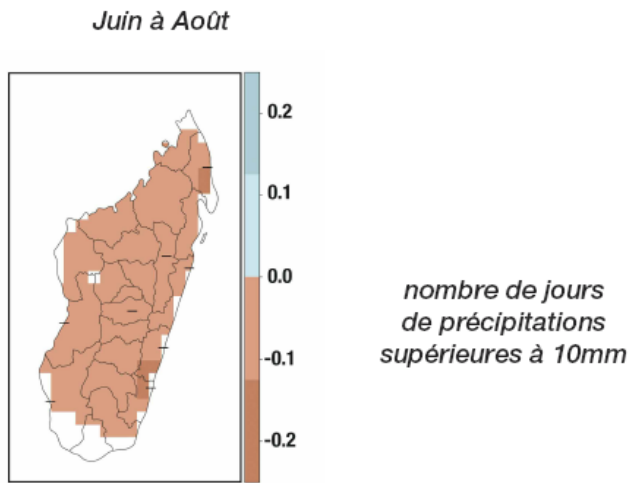
54. The WBI already offers a course on climate change and disaster risk management in the WBI natural disaster risk management category.

**Box 9-4. Adaptation and risk management program in Madagascar**

Since October 2006, the World Bank has been helping the Government of Madagascar on a program of Adaptation and Risk Management that is based on the principles of reinforcing the capacity of national champions and institutions, by linking them with international centers of excellence. The efforts are coordinated by an inter-ministerial committee at the Prime Minister’s Office, and have been funded by the Global Facility for Disaster Reduction and Recovery, TFESSD, BNPP, ProVention, South Africa TF, Bank Budget, and soon WBI. It has included the following main components:



**Climate change analysis** — In collaboration with experts from the University of Cape Town, the Directorate of General Meteorology published a policy-oriented report (in March 2008) analyzing daily historical trends for 21 meteorological stations (temperature and precipitation) for 1961 to 2005, as well as climate change projections to 2055. The study also included past and future cyclone trends to 2100, based on track simulations and global circulation models validated for the region. It is now considered the seminal report on climate change in Madagascar.



**Cyclone track simulation** — Since early 2007, the World Bank has helped the DG of Meteorology to purchase 11,000 simulation tracks from WindRisk Technology/MIT, simulating current and future cyclone tracks under five global circulation models. The simulation covers the region of Madagascar, Mauritius, Mozambique, and Comoros, and was needed given the paucity of historical cyclone records. Once finalized, the analysis will enable Madagascar to determine changes in expected future cyclone tracks, probability of Category 4 and 5 hurricanes, and expected maximum wind speeds for all major cities up to 2100 — a valuable basis to strengthen public works norms.

**Joint damage, losses and needs assessment** — In April-June 2008, the Government carried out an assessment of the 2008 cyclone season using damage and loss (DALA) ECLAC methodology (the first time it was fully applied in Africa), with the assistance of the Global Facility for Disaster Reduction and Recovery, World Bank, and the UN. The results allowed Madagascar to develop a baseline of assets potentially at risk and evaluate the socioeconomic impact of cyclones in all sectors of the economy, indicating that housing, agriculture, and transport were the most affected.



## 10. Pillar 4 — Expand Access to Financing

343. **As an unprecedented challenge to development**, Climate Change requires the international community to act differently with renewed urgency. In this regard, the Bank has taken urgent action and has already pioneered a number of innovative mechanisms to help meet these challenges particularly as they apply to Africa. **The new climate funds introduced by the** World Bank includes the Climate Investment Funds (CIFs), which consist of (i) the Clean Technology Fund (CTF) and the Pilot Program for Climate Resilience (PPCR); and (ii) carbon finance (CF), with two new instruments, the Forest Carbon Partnership Facility (FCPF) and the Carbon Partnership Facility (CPF).<sup>55</sup>

344. **As an added benefit, these funds have the potential** to unlock deeper sources of financing from a range of new and established mechanisms and properly scaled-up, could help catalyse a new era of development in Africa. Such sources would include concessional IDA funding with which the Bank has considerable experience in delivering concrete projects on the ground. This will constitute the bulk of the Bank's financing solutions given the specific needs of Sub-Saharan Africa. Further, through its long-standing relationships with African governments and with multilateral and bilateral funding sources, the Bank can tailor new and comprehensive climate financing packages to meet the demands of country-driven priorities for energy access and climate resilient-growth, whilst optimizing opportunities in mitigation financing.

345. **In addition, several new funds for climate change adaptation** and disaster risk reduction have recently been established or are coming online. On the climate change side, these include the GEF Trust Fund and its Special Priority on Climate Change, the Special Climate Change Fund, and the Least Developed Countries Fund under the UNFCCC, and the Adaptation Fund under the Kyoto Protocol.

### 10.1 Financing disaster risk reduction

346. **On the disaster risk reduction side**, the Global Facility for Disaster Reduction and Recovery (GFDRR) is a new and rapidly expanding vehicle. This includes GFDRR Standby Recovery Financing Facility (SRFF), which is a mechanism for an accelerated recovery that aims to mainstream disaster risk reduction and climate change in post-disaster operations. In addition, besides the regular Bank lending instruments, there are also several examples of the use of IDA grants for disaster risk management. Clearly, the changing climate should be taken into account in the design of these risk reduction efforts funded by the GFDRR and other DRR channels.

347. **Given the proliferation of different funds and initiatives** that is creating confusion and a potential for duplication of efforts, the Bank will guide its client countries in obtaining adequate information and accessing these funds. For the longer term, the Bank will encourage development of coherent and integrated funding mechanisms for SSA around IDA, consistent with the post-2012 climate change arrangements that eventually emerge.

348. **While the various funds co-exist**, and given the significant overlap between disaster management and adaptation, the CC-Strategy calls for close coordination between financing sources to allow disaster risk reduction investments to be financed under adaptation funds, and also to ensure that disaster risk reduction programs funded under the GFDRR pay appropriate attention to risk changes due to climate change. This requires close cooperation on development of guidance for these funds, and institutional cooperation among the various agencies managing these funds, both headquarters and at a country level (including coordination with other major donor initiatives in both areas). This approach is already being piloted in Madagascar, Mozambique, Malawi, and will be extended to Ethiopia, Kenya, Senegal, Niger, and Mali.

349. **Finally, given that funding levels** in the short and medium term are still inadequate, and most new funds are designed for piloting and learning (e.g., the PPCR), the Bank will continue to advocate for increases in international funding for SSA to support disaster and climate risk management in the context of regular investment operations, thus ensuring that international money can be programmed for effective risk reduction in the short and long term.

## **10.2 Financing and partnerships to support sustainable land management**

350. **The World Bank is a core member of the TerrAfrica platform**, a multi-stakeholder platform focused on harmonizing the scaling-up and harmonization of SLM investments.<sup>55</sup> This is to be achieved through three activity lines focused on: (i) coalition building, (ii) knowledge generation, and (iii) country-specific investments and activities. The work under TerrAfrica links to and is directly relevant to a range of Africa-led and global efforts. These include, for example, the NEPAD Action Plan for Environment and CAADP, UNCCD, UNFCCC, and the Paris declaration on Aid Effectiveness. The emphasis on harmonizing and scaling-up SLM investments in conjunction with links between climate change and land management represents an outstanding opportunity to strengthen international support for African efforts to advance sustainable development and address the challenge of climate change.

351. **The TerrAfrica Executive Committee (TAEC)**, which includes NEPAD, the World Bank, UN organizations, representative African countries, and civil society observers, explicitly recognized the importance of addressing the links between climate change and land management. A Specific Advisory Group (SAG) on land management and climate change is developing a set of knowledge generating activities under the leadership of the World Bank. Furthermore, TerrAfrica partners are working on the integration of climate risk management perspectives in Country Strategic Investment Frameworks (CSIFs) on SLM and specific operations. The GEF Strategic Investment Program (SIP) on SLM represents an integral component of TerrAfrica's operational work and requires that climate risks are addressed in the project design. This is complemented by a range of World Bank projects that blend IDA investments and GEF

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55. [www.terrafrica.org](http://www.terrafrica.org)

grant financing for climate change focused activities and includes large project components focused on sustainable land management issues (Box 10-1).

### 10.3 Tapping new funding mechanisms

352. **The Bank will support and guide its client countries in SSA** as they seek information, and help them prepare supporting documentation to access emerging new funds. More specifically, the Bank will focus on helping countries leverage IDA/IBRD/IFC/MIGA resources with (Box 10-1 summarizes the primary new sources of financing, and Figure 10-1 provides a summary of existing and new carbon finance and climate investment funds).

353. **Pilot program on climate resilience (PPCR)** (Zambia, Mozambique, and Niger.)<sup>56</sup> The PPCR is part of the Climate Investment Funds (CIFs) that have been approved and are being established by the World Bank jointly with the regional development banks (AfDB, AsDB, EBRD, and IDB) to promote international cooperation on climate change and support progress on the climate change regime. It is designed as a pilot project that will provide short-term financing for climate-resilient development in a few select pilot countries.

354. **The PPCR will provide scaled-up support to advance rapid learning** by doing on an integrated approach to climate resilience to provide lessons that will feed into operations of the Adaptation Fund under the Kyoto Protocol. With 11 countries (three in SSA) already selected to participate, the PPCR is already entering its first phase of implementation, and will support countries that make national development plans more climate resilient through significant investments. Individual pilots will be country-led and will build on National Adaptation Programs of Action (NAPAs) and other relevant country studies and strategies.

#### Box 10-1. Financing sources

- Main source of funding for adaptation and mitigation investments: IDA/IBRD/IFC
- Incremental financing for client capacity building and new business development
- World Bank/Multilateral Development Banks Clean Investment and Strategic Funds
  - Clean technology (CTF)
  - Pilot Program for Climate Resilience (PPCR)
  - Forestry
  - Clean Energy Fund
- WB carbon finance instruments
  - Forest Carbon Partnership Facility
  - Carbon Partnership Facility
  - Existing Carbon Funds

56. On January 28, 2009, the PPCR Sub-Committee announced the selection of eight countries to be invited to participate in the PPCR program (Bangladesh, Bolivia, Cambodia, Mozambique, Nepal, Niger, Tajikistan, and Zambia).

- Global Facility on Disaster Risk Reduction (GFDRR)
- African Development Bank: Congo Basin Partnership, ClimDev Trust Fund
- UNFCC/GEF: Adaptation Fund
- UNDP Adaptation Program for Africa
- Bilateral program

Source: World Bank staff

355. **The Forest Carbon Partnership Facility (FCPF).** The FCPF has been designed to set the stage for a large-scale system of incentives to reduce deforestation and forest degradation (REDD). It will help developing countries in their REDD efforts by adding value to standing forests. The facility, approved by the World Bank Board of Executive Directors in 2007, is already operational and has received expression of interest from 17 African countries. The FCPF includes two separate mechanisms:

- **Readiness mechanism.** This mechanism aims to build developing country capacity in tropical and sub-tropical regions to reduce emissions from deforestation and forest degradation, and prepare them to participate in a future large-scale system of positive incentives for REDD. The FCPF will provide support to: (i) establish a reference scenario for emissions from deforestation and forest degradation, based on historical emissions, and possibly model future emissions; (ii) elaborate a monitoring system for emissions and emissions reductions; and (iii) prepare a national REDD strategy, including a redistribution framework for potential REDD-related revenues. The targeted size of this fund is \$100 million; as of today, \$84 million has already been pledged.
- **Carbon finance mechanism.** A few countries that have successfully participated in the Readiness Mechanism may be selected on a voluntary basis to participate in the carbon finance mechanism, through which the FCPF will pilot incentive payments for REDD policies and measures by providing an incentive per tonne of carbon dioxide emissions reduced through specific reduction programs targeting the drivers of deforestation and forest degradation. The targeted size of this fund is \$200 millions; as of today, \$102 million has already been pledged.

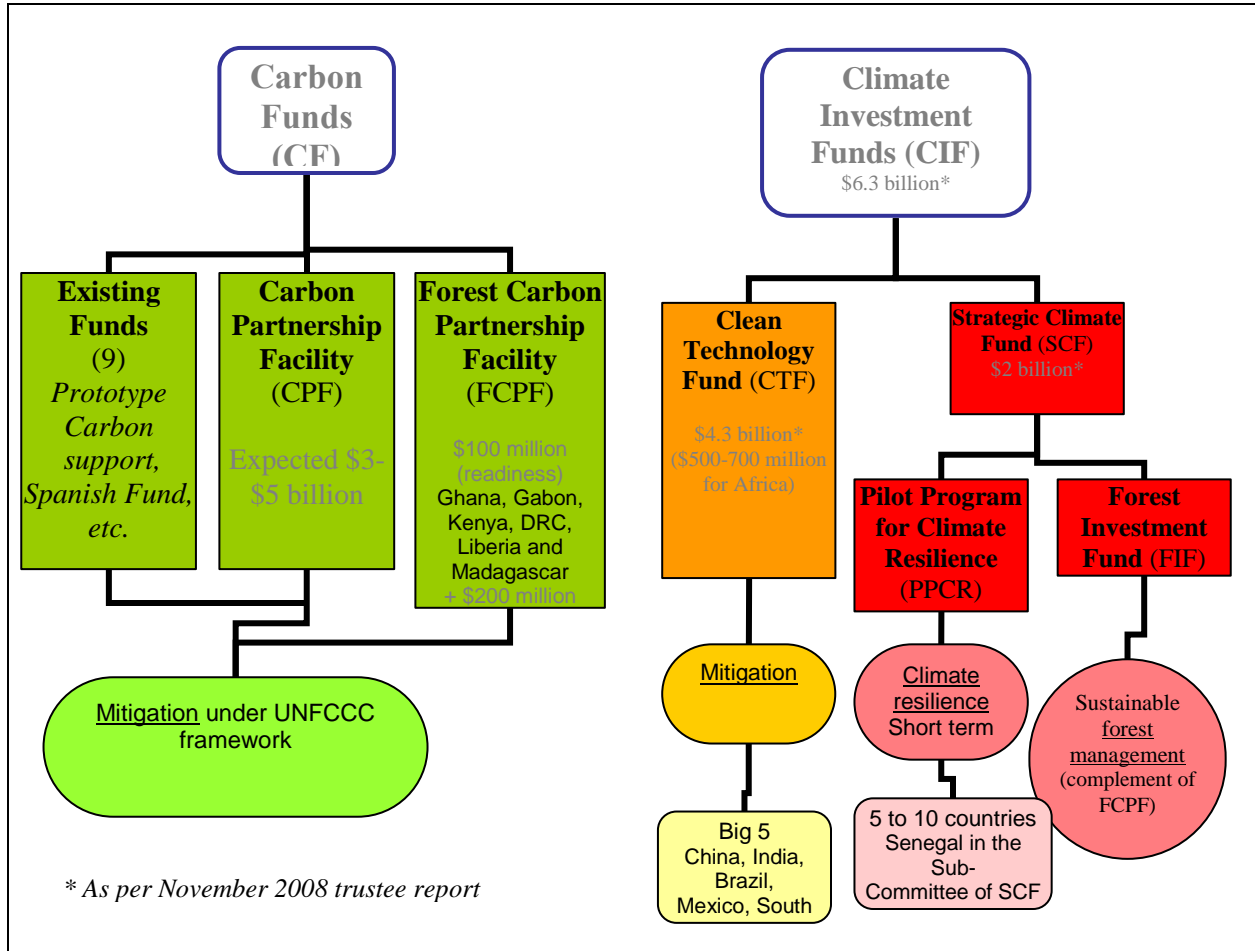
356. **Clean Technology Fund (CTF).** The CTF seeks to promote scaled-up demonstration, deployment, and transfer of low-carbon technologies in the power sector, transportation, and energy efficiency in buildings, industry, and agriculture. A clean technology under the CTF is defined as one that reduces GHG emissions to the atmosphere, and therefore, the carbon-equivalent intensity of economic development. It is anticipated that the main beneficiary of the CTF in Africa will be the Republic of South Africa because of the relatively large scale of greenhouse gas mitigation opportunities. It is also possible that sub-regional opportunities such as those related to the Southern Africa Power Pool (e.g., export power projects in Botswana and Mozambique) may also stand to benefit from the CTF. As of September 2008, about \$5 billion has been pledged to the CTF.

357. **Concessional financing instruments.** The CTF will utilize a range of concessional financing instruments such as grants, concessional loans, and risk mitigation instruments such as guarantees. The grant element in CTF financing will be tailored to



the identifiable additional costs of low-carbon investments, or risk premium, necessary to make a project viable.

Figure 10-1. Carbon and climate investment funds



Source: World Bank staff

358. **UNFCC Adaptation Fund.** The Adaptation Fund was established to finance concrete adaptation projects and programs in developing countries that are parties to the Kyoto Protocol. The fund is to be financed with a share of proceeds from CDM project activities and receive funds from other sources. (The share of proceeds is 2 percent of certified emission reductions [CERs] issued for a CDM project activity.) Interim arrangements include having GEF provide secretariat services and the World Bank as the trustee of the Adaptation Fund.

## 10.4 Supporting development of market-based financing mechanisms

### 10.4.1 CARBON FINANCE

359. **Support SSA to tap into emerging carbon markets.** Current carbon finance mechanisms have not delivered the needed resources to Africa. At the end of 2007, out of 2,700 CDM projects already under validation worldwide, only 12 are in Sub-Saharan African countries (excluding South Africa). The CC-Strategy will therefore support positioning SSA to tap into the expanding carbon market in the context of the CDM and through new instruments. Already, the World Bank has concluded 17 contracts for carbon finance projects, some of which will be officially submitted for validation in the coming months.

360. **Access depends on effective policy and regulatory frameworks.** This small carbon finance portfolio in SSA is primarily due to an absence of effective policy and regulatory frameworks to attract private sector investment in many African countries. A recent assessment by the Bank found that while the region's share in the CDM project pipeline is only 1.4 percent (53 out of some 3,900 projects), a large diversified range of CDM opportunities exists across the region, particularly in the energy sector (de Gouvello et al., 2008). The study also identified a number of barriers limiting the implementation of clean energy projects that need to be reduced or removed.

361. **Lack of frameworks is a barrier.** While Africa has a huge potential for CDM projects, many countries have not established legal, policy, and regulatory frameworks for the private sector to sell electricity to the grid. This is a major barrier for clean energy development in Africa. In addition, many opportunities exist to conserve energy in Africa. Again, there are limited policies and incentives available to improve energy efficiency. The Bank is actively conducting policy dialogues to help governments develop and implement frameworks that will attract the private sector to invest in clean energy.

362. **Constrained financing is another major barrier to scaling-up clean energy development in Africa.** While carbon finance can bring an additional revenue stream to clean energy projects, it cannot provide the much needed up-front financing. The Bank will adopt a sector-wide approach to scale-up financing in the energy sector, and will do more to integrate carbon finance in its mainstream business in the future.

363. **CDM financing may not be available in the short term.** Relying on the CDM for additional financial resources continues to be challenging until such time as the approval process is simplified. The CDM approval process is lengthy and risky. The Institute for Global Environmental Strategies prepared an analysis showing that in October 2008 the average time from start of project validation to first issuance of Emissions Reductions is 36 months. This hiatus speaks to the myriad of challenges faced by the Executive Board in terms of its task of regulating an unfamiliar and technically complex market, the interpretation of its political mandate, divergent views of its members, conflicting expectations of parties and stakeholders, and an overwhelming

work load, all contributing to a conservative attitude and sometimes slow progress. CDM methodologies are complicated and burdened with additionality requirements, determination of counterfactual baselines, boundaries and leakage concerns, and general difficulties to measure certain types of emissions. Project proponents find it difficult to interpret negotiated language and to fit their investment plans into the straightjacket of methodological and procedural requirements, as demonstrated by frequent requests for clarification, threats of litigation against EB members, deviation from and revision of methodologies, and a high number of project reviews by the board.

364. **A new CDM coordinator has been appointed to the UNFCCC** and his priorities are to: (i) improve the governance of the CDM and credibility of the regulator, (ii) oversee the design of the CDM post-2012 using programmatic and sectoral approaches, and (iii) create links with emerging cap-and-trade systems, in particular in the US market. It is critical that these measures be successful if the CDM is to serve developing countries in the manner envisioned at its inception.

365. **Role of the World Bank Group.** The two new Carbon Partnership Facilities can work to help the success of these measures through: (i) simplifying project design by piloting new methodologies and auditing processes that assess emission reductions on a more aggregate level, using technology or industry-wide benchmarks as baselines or conservative default values such as deemed energy savings instead of complex tonne-by-tonne monitoring; (ii) providing continuity and more sustained carbon market access to less developed countries that are often neglected by the private sector; (iii) engaging in emission reductions from deforestation and degradation; and (iv) leveraging other capital flows by linking with CIF and other RE funds.

366. **The Bank will scale-up efforts to systematically identify viable CDM opportunities** (and opportunities for the post-2012 funds) across the SSA energy sector, as well as in relation to biomass (e.g., bagasse, forest and forest industry residues, agriculture, and agro-industrial residues). The Bank will support projects in rural electrification (Ethiopia), electricity transmission and distribution (Ethiopia, Kenya, Nigeria), energy efficiency (Kenya, Ghana, Senegal), hydropower (Nigeria), waste-to-energy (Nigeria, Swaziland), agroforestry (Ethiopia, Congo), and carbon finance (Uganda, Rwanda).

#### 10.4.2 INSURANCE<sup>57</sup>

367. **Risk transfer can help mitigate some of the most severe impacts** of natural hazards, including the rising risks and uncertainties due to climate change. It may play a role at various levels — the government may use it to supplement its own contingency funds by transferring some of the risk to international financial markets. At the local level, there are encouraging pilots on index-based weather index insurance, which can help local farmers cope with climate variability and enhance investment opportunities.

368. **International financing may help jump-start** (or, in case of clearly rising climate risks, even subsidize) insurance mechanisms. The Caribbean Catastrophe Risk Insurance Facility is an example of such multinational pooling of risks, with reinsurance for damages above the capacity of the common pool. In addition to exploring the possibility of setting up such a stand-alone facility for SSA, the Bank will continue to support the piloting and rolling out of country-based risk insurance schemes, either as part of social protection programs (e.g., Ethiopia, Box 9-3) or as part of rural development and agriculture support programs such as in Malawi (Box 10-2), and index-based crop insurance products for small farmers (e.g., under development in Senegal).

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57. “A disaster response needs (i) flexible financing, (ii) targeting that recognizes contingent indicators of need, and (iii) flexible programs including the PRSP. The Bank has made major strides in the former in recent years as the report makes clear. Early warning systems can both trigger these as well as address the issue of targeting. Also on the flexible financing, better use of marketing contracts such as call options are generic risk instruments but are useful in addressing the variability associated with changing climates. Madagascar has explored cyclone insurance similar to that in place for the Caribbean, but for the financing issue to get to a safety net or to other means of risk management point (iii) above is also needed.

“That is, if the disaster triggers a financing instrument there must be a means to get to a programmatic response. Financing instruments could just be income transfers from the center (insurance at the individual level is still under exploration it appears unlikely to cover the poor in the near future) but this requires targeting and the necessary administration. Other programs require additional capacity. One of the lessons of the recent food crisis is that unless such capacity is in place beforehand (say with a modest program or a Social Fund/CDD) it is difficult to respond to sudden onset crisis in a meaningful manner. Thus, the Latin American and Caribbean Region of the World Bank, which has invested in safety nets in the last two decades, was far more effective in responding to the price shock than most other regions. Similarly, Senegal was able to include a nutrition program in the GFRP because it had one already in place; it scaled up rather than started up.” (Personal communication: Harold Alderman, Advisor, Social Protection, the Africa Region, World Bank).

**Box 10-2. Integrated approach to strengthening market-based agricultural risk management strategies in Malawi**

Malawi's Agricultural Development Program (ADP) investment strategy is placed at high risk when the country experiences severe flooding or drought. Financial and staff resources are drawn away from programs targeting productivity growth and reallocated to disaster management. Better planning and the application of several new tools for risk management in grain markets can help stabilize agricultural investment and national food supplies.

In collaboration with other development partners, the Bank's Support Project (SP-ADP) is helping to launch pilot initiatives related to use of weather derivatives and crop insurance linked with rainfall indices (weather insurance), price hedging, and warehouse receipts. The project will strengthen national capacities and institutionalize the use of these tools as a key component of national risk management systems linked to and/or within the national disaster management unit in the Office of the President and Cabinet (OPC).

**Index-based rainfall early warning models.** The World Bank has been working with the national meteorological service to strengthen its capacity to measure the relationship between rainfall and crop production. Historical models now provide an over 80 percent level of accuracy in predictions of maize harvests two to three months before the end of the season. The project will support a major upgrade in the national network of rainfall stations, along with associated data feed and analysis capabilities necessary to improve the quality and timeliness of rainfall data necessary for these models. The project will also support the integration of these results into national early warning systems through training in the interpretation and application of the underlying models.

**Macro weather insurance.** Index-based weather derivative contracts can be used to transfer the risks of severe national drought to the international markets. The aim of such a contract is to provide the Government with secure and timely funding if a contractually specified, catastrophic shortfall of rain occurs during the cropping season. In effect, the national maize crop can be insured against severe drought. The project will provide training in the mechanics of weather derivatives analytical procedures to evaluate the justifications for investing in macro weather insurance. The World Bank is expected to intermediate the purchase of the derivatives contract given the moral hazard created by the fact that the Government providing the weather data is the same entity benefiting from any payout. DFID and the EU have expressed willingness to pay this premium. The project will also support study tours for relevant Government staff to facilitate discussions with major stakeholders in the international weather derivatives markets in the United States, Europe, and Mexico.

**Micro weather insurance.** Micro weather insurance is an index-based rainfall insurance policy offering a payout offsetting agricultural credit costs in the event of drought. This will increase access to and reduce the cost of agricultural credit to smallholder farmers. Pilot activities over the 2005/06 and 2006/07 seasons have provided insurance-backed agricultural credit to more than 1,700 groundnut farmers linked with NASFAM. In 2007/08, this program expanded to include tobacco producers. This project commitment will provide funding to enhance rainfall-based crop models both for crops currently included in this program (groundnut, tobacco, and maize) as well as for a limited set of crops that may be added to the program over the next five years. These may include cotton, tea or paprika. The project will support the hiring of a business service provider necessary to ensure the index-based weather insurance concept is mainstreamed efficiently into the agriculture credit system. This service provider will help stakeholders develop their weather risk management business plans; help the Insurance Association of Malawi draft the index-based insurance policies, product design, and portfolio management strategies; broker partnerships among stakeholders; monitor the operational processes; and help the MoAFS track the performance of the program and appropriate milestones. The Reserve Bank of Malawi will be assisted with international expertise necessary to strengthen national regulatory frameworks necessary to cope with this insurance risk.

*Source:* AS-ADP Project – World Bank 2008



## 11. Implementation

### 11.1 Introduction

369. **Three main mechanisms will be used to implement** the World Bank’s CC-Strategy in Africa — mainstreaming climate risk management into country partnership strategies and Bank operations; using new financing instruments to augment IDA resources (the main platform for financing development and climate action); and strengthening partnerships and collaboration with African institutions and development partners (summarized in Figure 11-1).

### 11.2 Mainstreaming climate action into Bank operations

370. **The aim of the CC-Strategy is to ensure that the focus continues** to be on helping African countries achieve development outcomes while considering emerging constraints and threats that are posed by added risks and costs of climate variability and change. The key adaptation, mitigation, and capacity-building measures proposed in this strategy (described in Chapters 2, 3, and 4) will be gradually mainstreamed into Bank operations, and not undertaken through stand-alone activities. This will be done by:

- **Incorporating climate change dimensions into poverty reduction** and assistance strategy dialogue under the leadership of Country Directors, starting with PRSPs and CASs/CPSs due in fiscal years 2009 to 2011 and beyond (Table 11-1). Initially, the focus will be on countries that will be participating in the first batch of the Pilot Program for Climate Resiliency and the Clean Technology Fund (expected to be launched in early calendar year 2009).

**Table 11-1. Upcoming PRSPs and CASs/CPSs**

CAS/CPS (FY09-11)	Kenya, Rwanda, Benin, Cameroon, Lesotho, Burkina Faso, Sierra Leone, Guinea, Botswana, South Africa , Nigeria, Senegal
PRSP (FY09-11)	Chad, Eritrea, Madagascar, Sudan, Ethiopia

- **Mainstreaming climate risk management into sector policy dialogue** and using sector operations as the main vehicle for investment in adaptation and mitigation measures. While some institutional strengthening and disaster management measures are cross-cutting, the work programs of the agriculture, water, transport, urban, and health units of the Bank’s Africa Region will be the main vehicles for introducing specific climate risk management measures into country operations (Chapters 6 and 7).
- **Coordination, internal capacity building, and monitoring and evaluation.** To ensure quick implementation progress and adequate follow up, and building on the

strategy preparation phase, a regional climate change coordination (RCCC) team has been set up (Box 11-1).

**Box 11-1. Regional Climate Change Coordination team (RCCC)**

- A regional climate change coordinator/advisor, who will need to be located within the Region to monitor climate change activities across sector units, will prepare regional annual implementation reports and management briefs, advise teams on strategic and cross-cutting issues, facilitate information sharing within the region and across the Bank, and advise management on staff training, funding sources, and emerging issues. Sector focal points in each of the SDD units, PREM and HD, whose roles are to serve as technical experts within their sectors, coordinate sector reporting, and prepare input for the annual implementation report on the regional strategy, and advise unit managers.
- The regional focal points for Carbon Finance, Climate Investments Funds, and the regional coordinator of the GFDRR program.
- This setup will be periodically reviewed and adjusted as needed. In addition to supporting and monitoring the implementation of the region's CC-Strategy, the RCCC team will be responsible for coordination across the Bank, with client countries and external partners, as well as advising and helping design staff training in collaboration with SDN, ENV, and WBI.

### 11.3 Mobilizing additional resources

371. **While IDA and IBRD/IFC remain the main funding platform**, a key focus will be to help mobilize additional resources for adaptation (as discussed in detail in Chapter 10). In particular, support will be provided to IDA countries on a demand-driven basis, for preparing to access strategic funds under the CIFs, GEF resources, and UNFCCC's Adaptation Fund. A particular effort will be to undertake joint programming missions with AfDB and other partners to ensure coherence and efficient use of resources. The aim is to initiate adaptation programs for piloting and demonstrating climate-resilient development approaches in four to six of the most vulnerable countries by 2012.

372. **The Bank has experience in mitigation and mitigation financing** such as through GEF and Carbon Finance, with an initial focus on making the FCPF accessible to countries engaging in significant sustainable forest management programs. An additional focus will be on identifying opportunities for carbon finance in the energy, transport, and urban sectors through the existing carbon funds, as well as the newly established CPF and the Clean Energy Fund (under the CIFs). Rapid assessments will be initiated during fiscal year 2009 in sub-regions with significant Bank operations (e.g., East Africa, West Africa, and Southern Africa power pools).

373. **Given the need to strengthen the capacity for disaster risk management** as an integral part of building climate resiliency into development programs — starting with the most vulnerable countries — a special focus will use GFDRR resources to support the national priorities identified through the country policy dialogue, with a special focus on strengthening the capacity of meteorological agencies, municipal and local governments, and regional climate research and outlook centers.

374. **Finally, trust fund and other bilateral resources will be mobilized** (as they become available) to support the AAA program identified under the adaptation,



mitigation, and capacity development pillars of the CC-Strategy (as detailed in Chapters 2, 3, and 4).

#### 11.4 Strengthening partnerships

375. **The Bank is well positioned to work with African institutions** as well as other partners to support the efforts of vulnerable countries in incorporating climate risk management measures into their economic growth and poverty reduction programs. Because of the scope and cross-cutting nature of the problems and challenges, the Bank Group will contribute to strengthening existing partnerships and forging new ones through its multi-sector perspective, financial resources, working with the private sector through IFC/MIGA, global knowledge base and policy advice, convening power, and safeguard and fiduciary policies.

376. **Building on the feedback received** during the May-June 2008 joint World Bank-AfDB climate change strategy consultations, the following key partnership-building actions will help speed implementation and efficient use of resources:

- Build on the work already undertaken by countries, especially through the National Adaptation Plans of Action (NAPAs);
- Engage economic and finance ministries and help countries access existing (e.g., GEF, CDM) and new financial resources (e.g., CIFs, AF);
- Support regional initiatives such as CLIMDEV and regional climate centers (ACMAD, SADC's Drought Monitoring Center, etc.);
- Joint implementation with the African Development Bank, including collaboration on portfolio screening for climate risk, training program (both for staff and clients), joint programming missions to roll out the implementation of the PPCR, and joint/parallel financing;
- Close coordination with the African Union Commission, NEPAD, and regional economic communities (e.g., ECOEAS, COMESA, and SADC); and
- Close coordination and leveraging resources with UK/DFID, EC (notably through the LIMLETTE process), Japan/JICA (notably through the TICAD process), UN agencies (e.g., UNDP, UNEP, WFP, UNECA), WMO, the Arab Funds, and other partners and stakeholders.

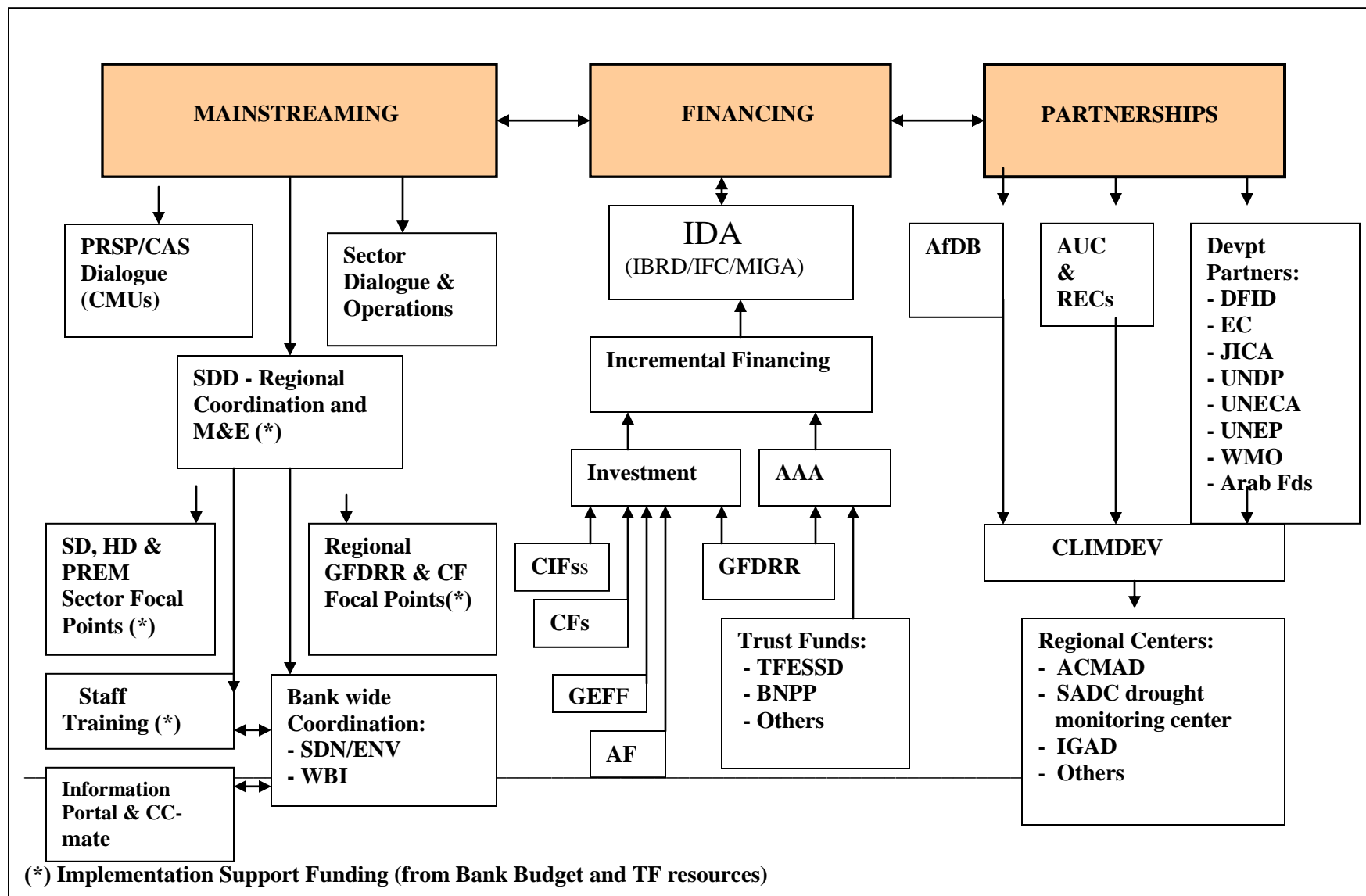
#### 11.5 Results monitoring

377. **Track climate resiliency over time.** While a framework to track climate resiliency over time (both measurement and indicators) will be developed as part of the results framework for the World Bank Group's Development and Climate Change Strategic Framework team and other regions, the main focus of the results framework of the Climate Change Strategy for Sub-Saharan Africa is on the following short- to medium-term horizon (2009 to 2012):

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- Implement enabling activities and actions at the country level (five countries with CC mainstreamed into PRSPs and CASs; five countries with disaster risk preparedness programs);
- Introduce adaptation measures into the portfolio (six projects with explicit climate change adaptation components or sub-components and associated incremental cost);
- Prepare an adaptation investment plan for funding under the PPCR (at least two countries);
- Prepare a sector plan for funding under the Clean Technology Fund (at least one country);
- Utilize carbon finance opportunities (five new projects get CDM approval, and five countries get REDD strategies prepared);
- Train Bank staff (150 regional staff);
- Conduct outreach activities with clients and partners: six workshops/regional events/dissemination (strategy, country briefs, climate data CDs, web page); and
- Construct framework to monitor and evaluate climate resiliency in Bank-funded operations (in collaboration with client countries and partners) developed and piloted in at least one country.

Figure 11-1. Implementation modalities



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Table 11-2. Making development climate resilient in Sub-Saharan Africa — results monitoring

Parameter	FY09	FY10	FY11	FY12
<b>Strategy development and coordination</b>				
• Undertake joint regional consultations with AfDB and key partners	X			
• Finalize and disseminate strategy report and related briefs	X	X		
• Develop program of collaboration with EC, UNDP, and DFID on East and West Africa		X	X	X
<b>Integration into Africa Action Plan</b>				
• Mainstream climate risk management in region's sector strategies:				
o Disaster Risk Management, Agriculture and Rural Development, Water Resources Management, Urban Development	X	X		
o Transport, Health	X	X	X	
o Energy	X	X	X	
• Institutional support				
o Strategy implementation, monitoring, and reporting	X	X		
o Staff training (in collaboration with other corporate programs)	X	X	X	X
<b>Policy and Operations</b>				
• Mainstream climate adaptation in PRSPs in three countries ( <i>Making the PRSPs more operational is a specific objective of the Africa Action Plan</i> )			• Zambia, Mozambique	• Niger
• Mainstream climate risk management in policy dialogue and four Country Assistance Strategies/Country Partnership Strategies/Interim Strategy Notes	• Cameroon, Burkina Faso, Sierra Leone		• Botswana, South Africa	
• Mainstream climate adaptation with disaster preparedness (enabling activities in at least 10 countries)	• Malawi, Mozambique, Madagascar		• Ethiopia, Zambia, Ghana, Kenya, Niger, Ghana	• Nigeria, Senegal, Togo, Mali
• Scale-up adaptation measures into the portfolio (10 projects with explicit climate change adaptation component or sub-components and associated incremental cost)	• Kenya, Ethiopia, Sudan, Mozambique, Malawi		• Niger, Mali, Burkina Faso	• Cameroon, Senegal
• Utilization of carbon finance opportunities (in five countries — projects and level of resources)	• Ethiopia, Kenya, Nigeria		• Ghana, Senegal, Swaziland	• Congo, Uganda, Rwanda

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Table 11-2. Making development climate resilient in Sub-Saharan Africa — results monitoring

Parameter	FY09	FY10	FY11	FY12
<b>Mitigation opportunities</b>				
<ul style="list-style-type: none"> <li>FCPF readiness facility operational in 10 countries (signed Participation Agreement)</li> <li>Low carbon growth studies completed in two countries</li> <li>Investment in hydropower generation operation in three countries</li> <li>Power grid connection extended to three countries</li> <li>Investment in energy efficiency in four countries</li> </ul>	<ul style="list-style-type: none"> <li>Dem. Republic of Congo, Ethiopia, Ghana, Madagascar</li> <li>Uganda, Sierra Leone</li> <li>Ethiopia, Kenya, Nigeria</li> <li>Kenya, Ghana, Senegal</li> </ul>	<ul style="list-style-type: none"> <li>Cameroon, Uganda, Kenya, Gabon, Liberia</li> <li>South Africa</li> <li>Ethiopia</li> <li>Nigeria</li> </ul>	<ul style="list-style-type: none"> <li>Botswana, Nigeria</li> </ul>	
<b>Knowledge development</b>				
<ul style="list-style-type: none"> <li>Development of a regional Climate Information Portal</li> <li>Analytical and advisory activities (AAA) — at least 10 studies and workshops</li> </ul>	<p>X</p> <p>Three reports</p>	<p>X</p> <p>Four reports</p>	<p>X</p> <p>Three reports</p>	<p>X</p> <p>Two reports</p>
<b>Toward Monitoring Climate Resilience</b>				
<ul style="list-style-type: none"> <li>Monitoring indicators for climate resilience developed in collaboration with Bank units, regions, and key development partners</li> <li>Enhanced resiliency in three countries in three sectors (pilot monitoring phase)</li> </ul>		<ul style="list-style-type: none"> <li>M&amp;E Framework for climate resilience developed</li> </ul>	<ul style="list-style-type: none"> <li>Ethiopia, Niger, Ghana, Mozambique, Zambia</li> </ul>	

## **Annex 1. Summary of Feedback from Joint World Bank-African Development Bank Climate Change Strategy Consultations**

As part of the preparation of their respective climate change strategies, and with a view of strengthening their collaboration, the World Bank and the African Development Bank undertook joint stakeholder consultations during the period May-June 2008.

The consultations were held as follows:

- May 9: Tunis, Tunisia, hosted by African Development Bank. Participants from 24 countries from across the continent (including North Africa) attended, including civil society and private sector.
- May 26: Pretoria, South Africa, hosted by Development Bank of Southern Africa (DBSA) in partnership with SADC. Participants from 12 countries attended, including civil society.
- May 31: Addis Ababa, Ethiopia, hosted by the Government of Ethiopia, COMESA, and UNECA and held at the U.N. Conference Center. H.E. Abera Derasa, State Minister of Agriculture and Rural Development launched the consultation workshop, and participants from 15 countries including civil society attended the event.
- June 4: Dakar, Senegal, hosted by the Government of Senegal. We were honored that H.E. President Abdoulaye Wade, the Prime Minister, and the Minister of State for the Interior participated in the workshop. Participants came from 12 countries, IFC, and civil society.
- In addition to the web-based facility that permits online feedback (and which is open until June 30, 2008 and will be extended to July 31, 2008), special follow-up videoconferences are being planned for countries which could not attend the regional consultations above (e.g., Nigeria, Ghana and Liberia)

Table 1 gives the schedule and information on participation in the consultations. The main objectives of the consultation were:

- Publicly consult on the content of the climate change strategy
- Listen to different views and obtain feedback from stakeholders as an input for informing and finalizing the strategies
- Pave the way for strengthened regional collaboration with key African institutions and development partners for implementing strategy recommendations

To help structure feedback (through group discussions), the following questions were used:

1. What do you think of the technical background underpinning each of the draft strategies presented by the World Bank and African Development Bank?

2. Please give us your views about the strategic focus of each institution's draft strategy:
  - For the World Bank, please comment on the six action pillars of the "Strategic Framework on Climate Change for Development (SFCCD)" which form the basis for the World Bank's global approach to climate change; and
  - For the African Development Bank, please comment on the two strategy pillars, especially the second pillar (support to countries); is there any other priority that needs to be covered under the second pillar?
3. What are your views on the proposed measures and activities outlined in the World Bank's strategy, and what might be missing?
4. What are your views on the financing approaches outlined in the World Bank's strategy for Sub-Saharan Africa? In particular, please comment on: (i) existing sources of financing (IDA/IFC/IBRD, ADF, GEF), and particularly the role of IDA (as already reflected in IDA 15) as the main platform for funding adaptation to climate change, and (ii) proposed new instruments such as Climate Investment Funds (CIFs), Forest Carbon Partnership Facility (FCPF), and the Adaptation Fund of the U.N. Framework Convention on Climate Change (UNFCCC)?
5. How can each of the institution's proposed climate change strategy for Sub-Saharan Africa be implemented effectively to respond to national priorities in order to help make development climate resilient?
6. Based on your sector specific experiences and country needs, what are the key priorities and areas where you would like the World Bank and the African Development Bank to provide support on a priority basis?

The main feedback from stakeholders can be summarized through five key broad messages, summarized below, and a number of more specific ones, which are included in the more detailed feedback from each of the consultations (Annex 1-4):

### **Broad messages**

**Message 1:** Overall African countries support the strategic focus of both institutions proposed climate strategies, and welcome the initiative of undertaking joint consultations and closer collaboration.

**Message 2:** African countries are frustrated and confused about available financing for climate change and how to access it. This includes both existing instruments (e.g., GEF and CDM), as well as new instruments (e.g., Climate Investment Funds, Carbon Finance, Adaptation Fund). Moreover, countries have unanimously requested support from the WB and AfDB on this issue, as well as on help accessing more grant resources for climate change.

**Message 3:** Next to the issues of financing, African countries support a greater emphasis on capacity building of both national and regional institutions, with a

priority to climate and meteorological information, as well as disaster preparedness and strategic planning.

**Message 4:** The issue of most concern to African countries is adaptation to the impacts of climate variability and change. But African countries are also willing to contribute to the mitigation agenda, but need technology and financial support to develop and make accessible renewable energy, as well as abundant coal resources.

**Message 5:** African countries would like to see WB and AfDB build on what countries have already identified as priorities in their NAPAs and PRSPS, and more attention given to community level issues.

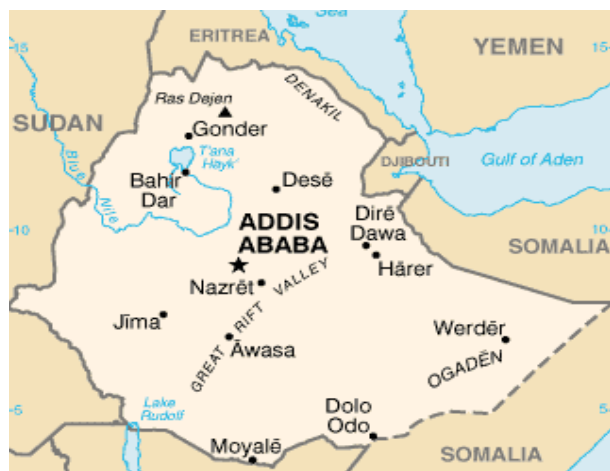
**Message 6:** African countries welcome the country-specific components--including financing and implementation plans--and support a joint implementation of the strategies of the WB and the AfDB.

**Message 7:** While countries welcome a strong role of the WB and AfDB in the climate change agenda, they want the two development institutions to remain focused on poverty reduction in Africa.

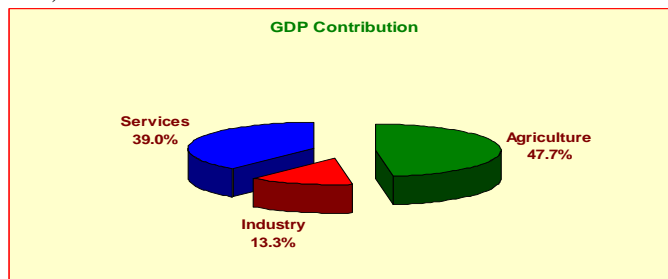
<b>Table A1-1. Summary information on consultations</b>			
<b>Regional meeting location</b>	<b>Date</b>	<b>Participating countries</b>	<b>Attendance</b>
Tunis	May 09, 2008	Burundi, Republic of Congo, Cote D'Ivoire, Djibouti, Egypt, Guinea Bissau, Madagascar, Mauritius, Mauritania, Namibia, Niger, Nigeria, Senegal, Seychelles, Swaziland, Chad, Tanzania, Tunisia, Uganda, Zambia, Zimbabwe	72
Pretoria	May 26, 2008	Lesotho, Swaziland, Botswana, Malawi, Zambia, Zimbabwe, Madagascar, Mauritius, Namibia, South Africa, Angola, Mozambique	78
Addis Ababa	May 31, 2008	Burundi, Central African Republic, Republic of Congo, Comoros, DRC, Gabon, Kenya, Rwanda, Sao Tome & Principe, Sudan, Uganda, Tanzania, Ethiopia	82
Dakar	June 04, 2008	Benin, Burkina Faso, Cote D'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Mali, Mauritanie, Niger, Togo	80



## Annex 2. Example of a Country Climate Brief: Ethiopia



GDP (US\$ billion; 2005) <sup>58</sup> :	US\$11.2
Population (million; 2005):	71.3
Population living on less than \$2/day (%) <sup>59</sup>	77.8
Land Area (1,000 sq km)	1,000
Agricultural land (percentage of total land area, 2005):	32



	Historical Climate Trends	Projected Future Climate Trends
<b>Temperature</b>	<p>The average annual temperature (1961-1990) was 23.08°C (Cline 2007). According to Koppen’s climate classification system, Ethiopia has 10 climate types, including: the Hot Arid, Hot Semi-Arid, Tropical with distinct dry winter, Tropical Monsoon Rainy with short dry winter, Warm Temperate Rainy with dry winter, and Warm Temperate Rainy without distinct dry season. Coldest temperatures - about 5°C (November to January) over the highlands of Central, North, and Southeast Warmest temperatures - about 37°C (March to May/June) in Northeast (Afar) and SE Lowlands</p>	<p>The projected annual average temperature between 2070-2099 will be 26.92°C. According to the country’s First National Communications to the UNFCCC, temperature across the country could rise by between .5 and 3.6 degrees Celsius by 2070</p>
<b>Rainfall</b>	<p>Annual mean rainfall ranges from about 2000 mm (SW) to about 100mm (NE Lowlands of Afar) . Present average precipitation is 2.04 mm per day, annual averages between 1961-1990 (Cline 2007)</p>	<p>Projected average precipitation will be 1.97 mm per day, annual averages between 2070-2099 (Cline 2007). Precipitation is expected to fall across the northern regions, while southern areas could see an increase of as much as 20%. Such changes – in particular, those leading to drier conditions – will undoubtedly create significant new pressures on sectors such as agriculture and forestry.</p>

### Current Sustainable Development Challenges:

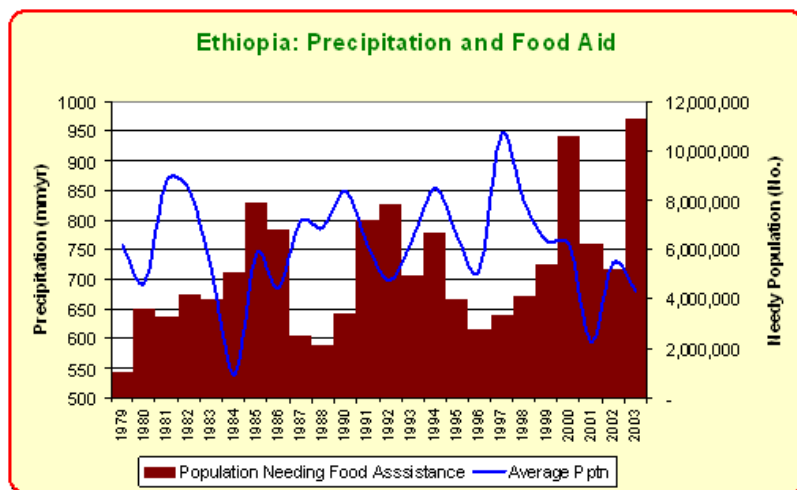
<p><b>Economic</b></p> <ul style="list-style-type: none"> <li>▪ The level of economic development is low</li> <li>▪ Access to basic services is poor (e.g. an avg. developed world resident consumes as much electricity as 400 Ethiopians)</li> <li>▪ Highly dependent on rainfed agriculture</li> </ul>	<p><b>Social</b></p> <ul style="list-style-type: none"> <li>▪ Population pressures are high (&gt;72 m population)</li> <li>▪ Poverty is high (about two thirds of the population earns less than \$2/day)</li> </ul>
<p><b>Environmental</b></p> <ul style="list-style-type: none"> <li>▪ Hydrologic variability is high</li> <li>▪ Land and water resources planning and use not optimal</li> <li>▪ Rich biodiversity areas (e.g. Lakes) at risk</li> </ul>	<p><b>Institutional</b></p> <ul style="list-style-type: none"> <li>▪ Environmental and resource knowledge base is poor (e.g. good quality computerized hydro-climatological databases)</li> <li>▪ Flood forecasting and communication systems are weak</li> </ul>

<sup>58</sup> World Bank, The Little Green Data Book, 2007.

<sup>59</sup> World Bank 2007, values are based on country surveys conducted between 1989 and 2005

## Sector Implications of Climate Risks:

**Agriculture:** Food insecurity is an integral part of poverty in Ethiopia. Climate change is projected to reduce yields of the wheat staple crop by 33% (NAPA). At present, agriculture dominates the Ethiopian economy, accounting for nearly half of GDP and for the vast majority of employment. While the country is highly dependent on the agricultural sector for income, foreign currency, and food security, the sector is dominated by small-scale farmers who employ largely rain-fed and traditional practices – a state which renders Ethiopia highly vulnerable to climate variability (as seen during past persistent drought), and thus to climate change. Desertification, brought on by human land-use pressures and recurrent drought, has consumed significant land area and continues to threaten arable land.



**Figure: The impact of drought shocks in Ethiopia**

	People in poverty (%)
Observed poverty	47.3
Predicted poverty with no drought shocks	33.1
Predicted poverty with no shocks of any kind	29.4

Ethiopia has experienced at least five major national droughts since 1980, along with literally dozens of local droughts. Cycles of drought create poverty traps for many households, constantly thwarting efforts to build up assets and increase income. Survey data show that between 1999 and 2004 more

than half of all households in the country experienced at least one major drought shock. These shocks are a major cause of transient poverty: had households been able to smooth consumption, then poverty in 2004 would have been at least 14% lower a figure that translates into 11 million fewer people below the poverty line (see figure below).

Agropastoral and pastoral households, which are reliant on livestock for their livelihoods, also suffer severe asset losses during droughts. As experience in Ethiopia has repeatedly shown, the consequences are likely to include adverse impacts for their terms of trade, with livestock prices falling sharply relative to cereal prices.

**Water Resources:** Water resources: run-off to Nile tributaries (Abay and Awash Rivers) is projected to be reduced by up to one third due to climate change. Ethiopia has twelve major river basins, including the Blue Nile. Its riparian systems, combined with its eleven major lakes, make Ethiopia the “water tower” of Northeast Africa. Climate change is projected to cause a drying of wetlands (affecting threatened bird species breeding sites). Although, Ethiopia has relatively abundant water, it has one of the lowest reservoir storage capacities in the world: 50 cubic metres per person compared with 4,700 in Australia (UNDP HDR, 2007/08). In Ethiopia and Kenya, two of the world’s most drought-prone countries, children aged five or less are respectively 36 and 50 percent more likely to be malnourished if they were born during a drought. For Ethiopia, that translates into some 2 million additional malnourished children in 2005 (UNDP, HDR 2007/08). In Ethiopia and Kenya, two of the world’s most drought-prone countries, children aged five or less are respectively 36 and 50 percent more likely to be malnourished if they were born during a drought. For Ethiopia, that translates into some 2 million additional malnourished children in 2005 (UNDP, HDR 2007/08).

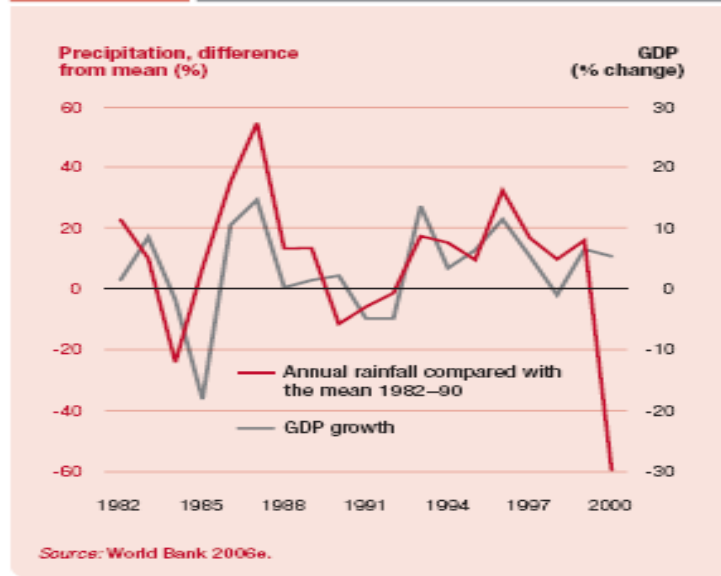
**Health:** Climate change is projected to cause encroachment of malaria from lower altitudes in Somalia and Afar regions to higher altitudes in Tigray and Amhara (NAPA 2007). The total population at risk of endemic malaria for the year 1990 in Ethiopia in areas where the climate is more than 75% suitable for malaria (malaria endemic; perennial or seasonal) was 6,508,530 (source: <http://www.mara.org.za/popatrisk.htm#Prev>)

In Ethiopia, an epidemic of cholera following the extreme floods in 2006 led to widespread loss of life and illness (UNDP HDR, 2007/08).

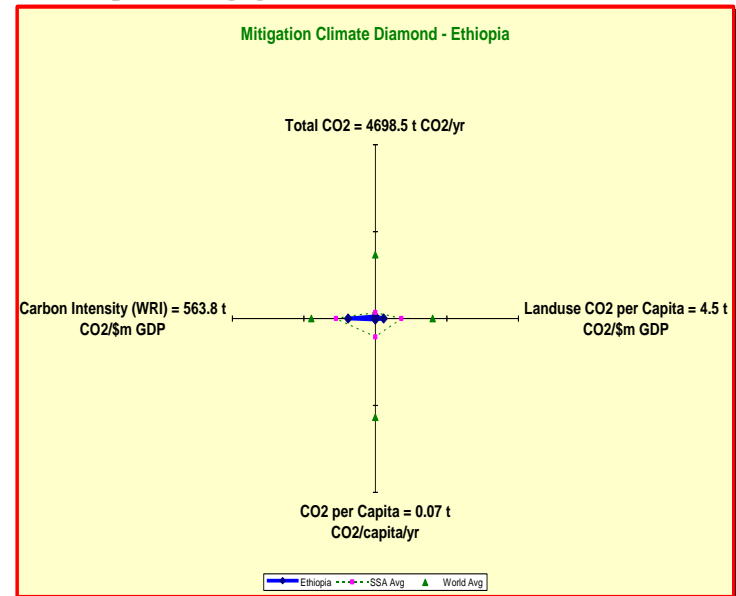
**Energy:** Deficits in access to modern energy can create a vicious circle of environmental, economic and social reversal. Unsustainable production of charcoal in response to rising urban demand has placed a huge strain on areas surrounding major cities such as Addis Ababa in Ethiopia. In some cases, charcoal production and wood collection has contributed to local deforestation. As resources shrink, dung and residues are diverted to fuel use instead of being ploughed back into fields, undermining soil productivity.

## Climate Change an Ethiopia: A Graphical Perspective

Income Variability trails rainfall variability in Ethiopia

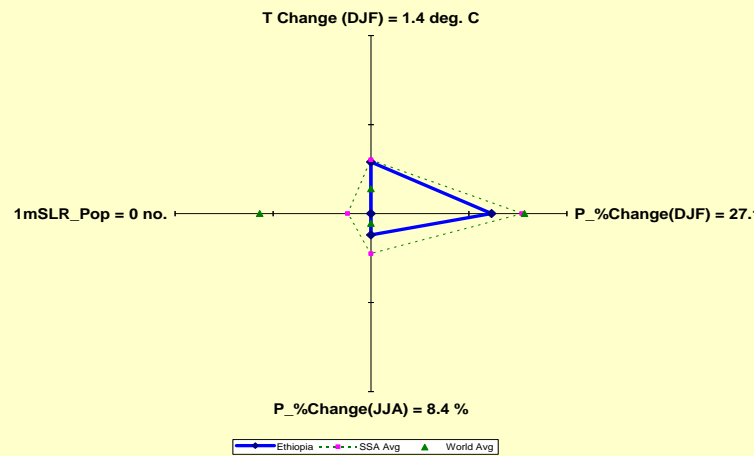


Ethiopia has negligible contribution to Greenhouse Gases



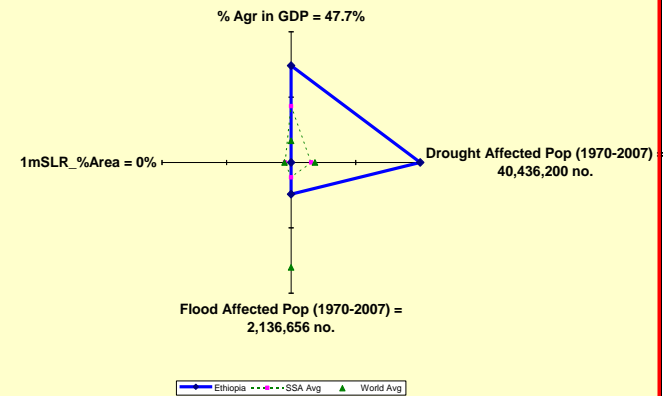
Precipitation & Temperature Risks are Significant

Climate Impact Diamond - Ethiopia



The largely rural agricultural population subsisting primarily on traditional rainfed agriculture are very vulnerable to repeated droughts and floods

Climate Vulnerability Diamond - Ethiopia





**Table A2-3. Selected measures to improve management of climate risks**

**Overall objective:** Improve climate-smart development through appropriate institutional and investment activities

Sector	Enabling environment/capacity building	Investments
<b>Capacity building &amp; cross-cutting</b>	<p>(i) Development and strengthening the knowledge base, including:</p> <ul style="list-style-type: none"> <li>• Data and information – acquisition, analysis, dissemination, utilization</li> <li>• Enhanced hydro-meteorological monitoring systems, and improved and expanded human resources in the hydrological and meteorological services</li> <li>• Analytical tools and products tailored to sector needs</li> <li>• Information on adaptation options based on pilots, field tests, and research</li> <li>• Development of early warning systems</li> <li>• Information exchange networks to enable access to and exchange of data and information between all levels of user and decision makers</li> </ul> <p>(ii) Regional and national networks – Networks of agencies and policy makers, experts, knowledge bases, data and information, research, and field experience (pilots, tests) is crucial to stimulating and facilitating investment in adaptation</p>	<ul style="list-style-type: none"> <li>• Introduce modern technology for data collection, transmission, and assessment. Introduce the use of compatible standards and systems to enhance data and knowledge sharing across sectors.</li> <li>• Strengthen and expand systematic observations of meteorological and hydrological parameters; strengthen the technical capacity of hydro-met services, including development and dissemination of knowledge products to enhance adaptation of project design and implementation to climate variability and change.</li> <li>• Strengthen and develop early warning systems for drought and flood hazards and natural disasters to improve preparedness, response, and recovery in all the sectors (agriculture, health, natural resources, and energy).</li> </ul>
<b>Agriculture (including irrigation, watershed management, &amp; community development)</b>	<p>(i) Develop flood, drought, and drainage risk maps to enhance sector development planning</p> <p>(ii) Combine risk mapping with river basin and sub-basin water resource assessments, including rainfall variability.</p>	<ul style="list-style-type: none"> <li>• Scale-up investment in research and extension services to enhance production and farm incomes with a new emphasis on adaptation to climate variability and change.</li> <li>• Invest in piloting new crops, cropping patterns (at farm scale), and new technology packages (both for adaptation and carbon sequestration) to enhance adaptation in areas with high climate variability and vulnerability to change.</li> <li>• Scale-up investment in the introduction of irrigation and water management systems and appropriate technologies, especially water conservation in drought prone areas.</li> <li>• Scale-up investment in livelihood focused participatory rural development, including sustainable land management, watershed management, and community-driven development (CDD) approaches.</li> </ul>

		<ul style="list-style-type: none"> <li>• Pilot risk insurance schemes, including indexed crop insurance.</li> </ul>
<b>Water Resources Mgt</b>	<p>(i) Improve technical capacity of water resource management agencies, including hydro-met and groundwater management services.</p> <p>(ii) Institutionalize multi-sector, integrated water resource planning and management.</p> <p>(iii) Strengthen the analytical and modeling capability of water resource agencies to utilize enhanced hydrologic and metrological data acquisition and monitoring networks, and support river basin and sector development and management planning.</p>	<p>Scale-up investment in:</p> <ul style="list-style-type: none"> <li>• River basin and sub-basin water resource assessments and the associated institutional capacity to sustain such programs on a continuous basis.</li> <li>• Systematic assessment of potential storage for irrigation, hydropower, water supply, flood management and wetland conservation, including strategic climate risk assessment.</li> <li>• Development of decision support systems (DSS), including hydrologic models and other analytical tools to enhance sector planning and risk assessment.</li> <li>• Implement new mechanisms to disseminate these assessments, DSS, and tools to support enhanced strategic planning in sectors that depend on basin natural resources</li> </ul>
<b>Energy</b>	<p>(i) Strengthen electricity utilities to improve their efficiency and financial viability</p> <p>(ii) Strengthen sector strategic planning to include a greater emphasis on climate vulnerability and climate change risk by introducing:</p> <ul style="list-style-type: none"> <li>• Assessment of vulnerability of supply systems, including hydropower and the development of other renewable sources less sensitive to climate</li> <li>• Assessment of climate change impacts on demand</li> <li>• Expand off-grid expansion opportunities (potential for renewable energy)</li> <li>• Grid extension</li> </ul> <p>(iii) Carbon finance opportunities</p>	<ul style="list-style-type: none"> <li>• Support the expansion and development of regional electricity grid interconnections.</li> <li>• Scale-up investment in electricity access and energy efficiency.</li> <li>• Review the effects of climate variability and climate change on the reliability and capacity of existing and potential hydropower facilities and developments.</li> <li>• Accelerate expanded pre-investment studies of hydropower and other renewable sources for grid and off-grid electricity supply.</li> <li>• Coordinate grid and off-grid electricity access planning with rural development and forestry sectors and SLM programs to support efforts to reduce fuelwood harvesting and use.</li> </ul>
<b>Transport</b>	<p>Enhance the capacity of road and transport sector agencies in the area of strategic planning to identify and incorporate climate vulnerability into sector plans and project designs.</p>	<ul style="list-style-type: none"> <li>• Review and revision of planning and design standards for river and stream crossings and cross drainage in regions with existing and potentially increased future flood hazards, including increases in high intensity rainfall.</li> <li>• Increase the use of flood, drought (greater access to network), and drainage risk mapping in sector planning in rural and urban areas.</li> <li>• Introduce risk assessment into the selection of design standards,</li> </ul>

		including pavement type.
<b>Urban Development, Water Supply and Flood Management</b>	(i) Enhance strategic supply planning capability of urban water supply utilities, including climate vulnerability and risk assessment of water supply sources (ii) Strengthen urban development planning based on improved flood and drainage hazard mapping	<ul style="list-style-type: none"> <li>• Invest in infrastructure upgrading and improvement to mitigate and adjust to changing flood and drainage hazard patterns</li> <li>• Invest in urban services to reduce flood and drainage risks, including housing relocation, reduced encroachment into flood hazard areas, and secure solid water management</li> </ul>
<b>Health</b>	(i) Develop/strengthen climate-related surveillance systems (as part of overall monitoring system). (ii) Increase awareness of health-related climate vulnerability and increase capacity to incorporate adaptation in the health care system.	<ul style="list-style-type: none"> <li>• Invest in disease vector control systems.</li> <li>• Invest in increased surveillance of existing and emerging threat areas affected by climate variability and climate change.</li> </ul>
<b>Forestry, Biodiversity and Coastal Zone Management</b>	(i) Strengthen capacity to monitor forest and biodiversity resources, evaluate their status and threats and formulate actions. (ii) Develop and test new governance arrangements for forest resources.	<ul style="list-style-type: none"> <li>• Invest in forest resource management to enhance climate resilience, enhance livelihoods of people living near and in forest areas, and promote resource conservation.</li> <li>• Invest in reforestation and afforestation, and in their sustainable management.</li> <li>• Invest in forest fire prevention, risk surveillance, and response.</li> </ul>

Note: As can be seen, many of these investments to reduce climate risks involve faster sustainable development, careful assessment of vulnerability, strengthening institutional capacity, and re-orienting investments.

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