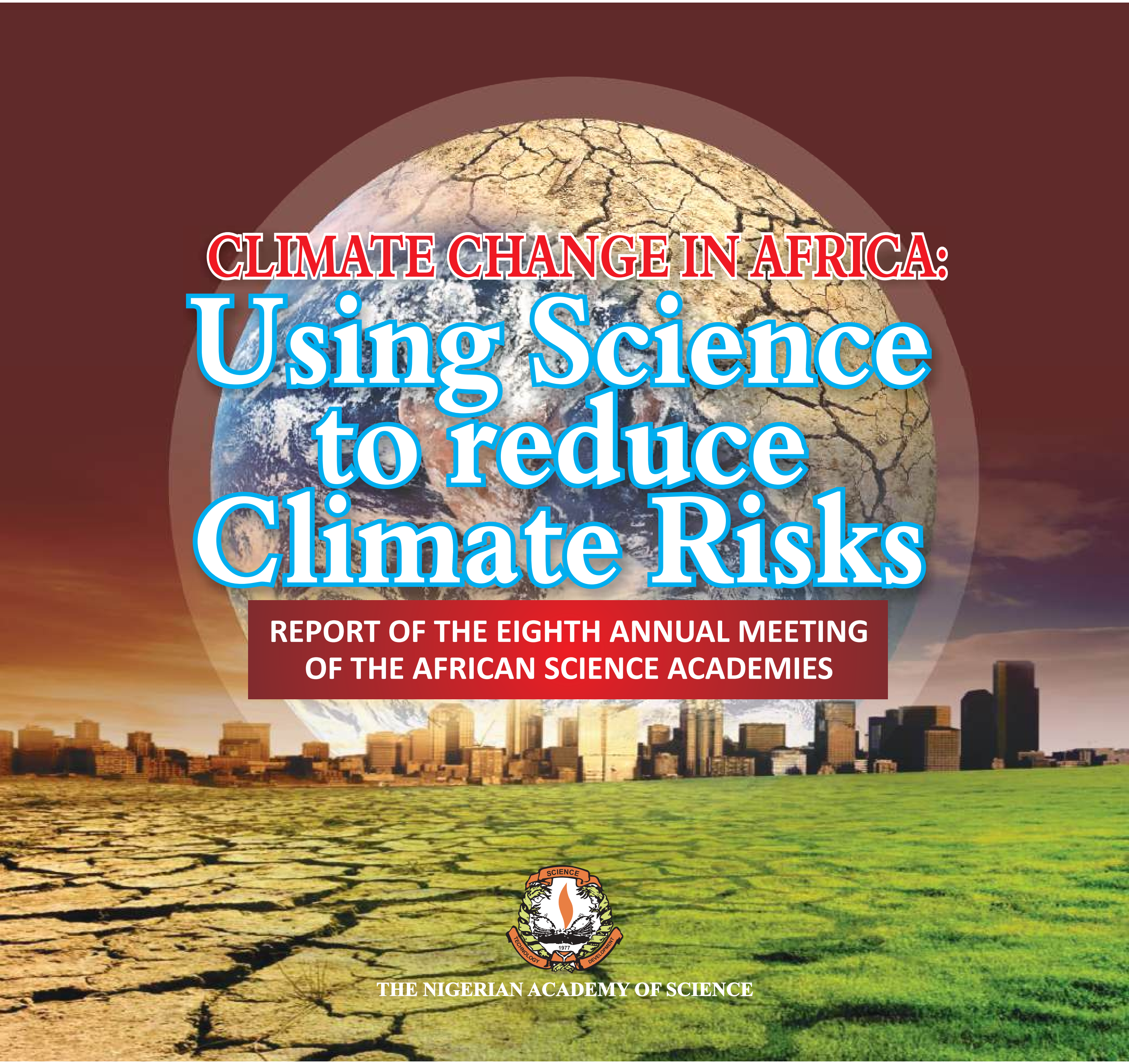
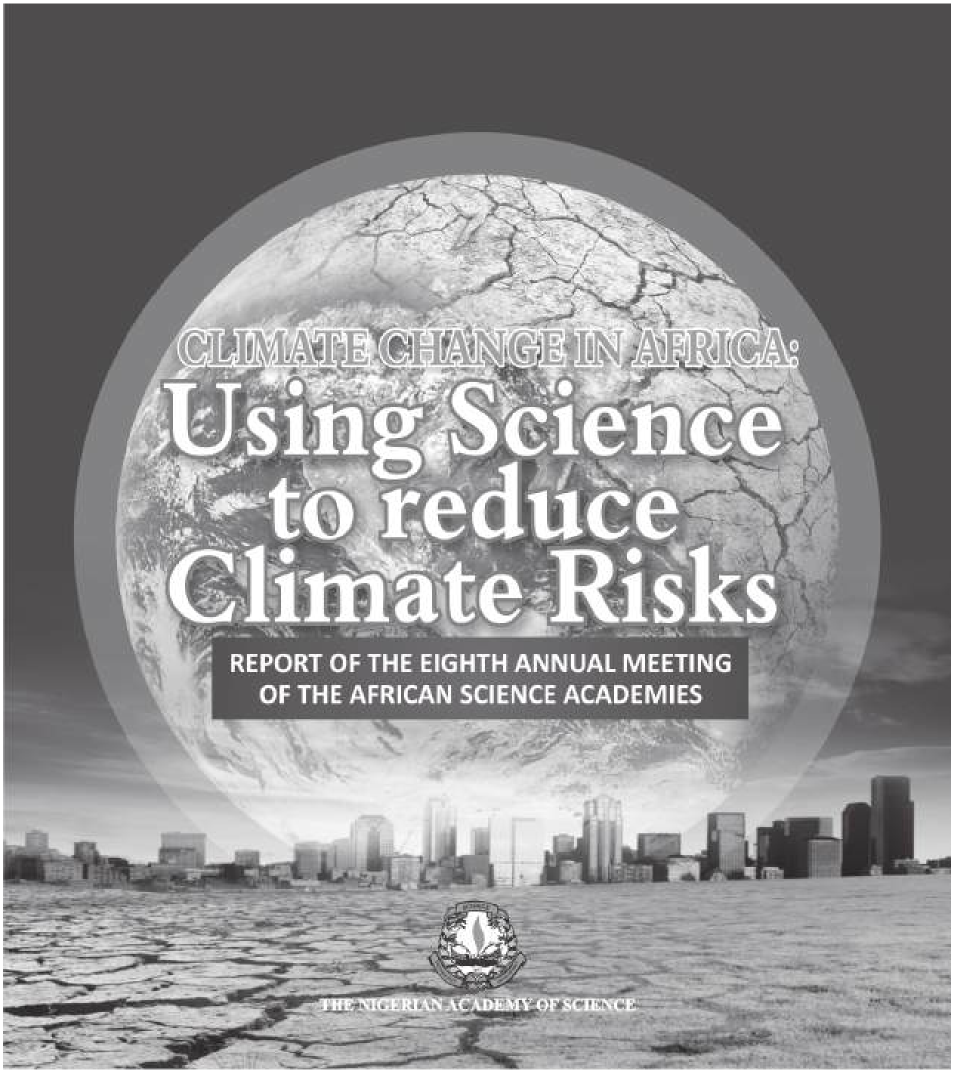


CLIMATE CHANGE IN AFRICA:
Using Science to reduce Climate Risks

REPORT OF THE EIGHTH ANNUAL MEETING OF THE AFRICAN SCIENCE ACADEMIES

THE NIGERIAN ACADEMY OF SCIENCE


CLIMATE CHANGE IN AFRICA:
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THE NIGERIAN ACADEMY OF SCIENCE

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THE NIGERIAN ACADEMY OF SCIENCE

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PREFACE

The Conference, AMASA 8, reported by this publication was born out of a strong feeling that the scientific voice of Africa on climate change had remained largely silent, although it was widely known that Africa would be disproportionately more negatively impacted, than other regions of the world, by the raging environmental challenges of climate change. One consequence of the silence is that Africa has not effectively participated in setting the agenda in the global debate, or benefitted adequately from available global opportunities, for addressing climate change. AMASA 8 was held to begin to reverse this trend and set African scientists, led by the Academies, on the trail of a long term engagement with their governments and other stakeholders in addressing climate change. Particularly desirable and expected is that African scientists will intensify efforts to provide data to fill gaps that have created so much uncertainty in predicting and understanding the impacts of climate change on the continent.

The Conference opened with an overview of the science of climate change, highlighting its current and expected impacts and responses in terms of mitigation and adaptation, and the role of scientific research in informing policy for action. The technical sessions, which followed and formed the bulk of the Conference, covered observed and expected impacts of climate change in Africa, using examples from West and South Africa; the challenges posed by climate change to the health, agriculture and food security sectors and approaches for meeting these challenges; the question of human and scientific capacity in Africa for responding to climate change; the question of securing investment for effectively addressing climate change; and, in a panel format, the key areas for action, issues of communicating climate science to non-scientists and the role of the science academies in providing policy advice.

Besides the very effective editing that has concisely reported the, sometimes voluminous, conference presentations, a very welcome feature of this report is the introduction written to each technical session, stating the objectives of the session in terms of what we know, what we need to know and how best to close the gaps, and a succinct summary of the presentations in the session. Equally welcome is the conclusion of the main body of the report with a summary of the key messages from the Conference, and the inclusion, as an appendix, of the joint statement by the academies on the theme of the Conference that formed one of the highlights of the Conference.

Altogether, this publication faithfully reports the efforts of the more than 120 participants, drawn from scientists mostly from African science academies, policy makers, government, non-governmental organizations, the private sector and the general public, that met at Four Points by Sheraton, Lagos, on the 13th and 14th November, 2012, to deliberate on how to raise the scientific voice of Africa in combating the environmental challenge of climate change that threatens world development, with disproportionate severity on Africa.

The compilers of the report are to be congratulated for producing an elegant highly readable report. Credit must also be given to the international planning committee set up by the Nigerian Academy of Science that, among other things, assembled the experts that made the presentations reported in this publication. Ultimately it is the hope that this report will be widely circulated and read, to stimulate both policy action and greater scientific attention to climate change in Africa.

D. Okali, FAS

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Professor Chryss Onwuka
Federal University of Agriculture Abeokuta, Nigeria

The review of the report was overseen by the NAS leadership, who was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures, and that all review comments were carefully considered. Although the reviewers provided many useful comments, they were not asked to endorse the final draft of the report.

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LIST OF ACRONYMS

ACCFP	African Climate Change Fellowship Program
ACMAD	African Centre for Meteorological Applications and Development
AfDB	African Development Bank
AMASA	Annual Meeting of African Science Academies
AMCEN	African Ministerial Conference on the Environment
ASIS	Agricultural Stress Index System
CAHOCSS	Conference of African Heads of States and Government on Climate Change
CCAA	Climate Change Adaptation in Africa
CCAFS	Climate Change, Agriculture and Food Security
CDM	Clean Development Mechanism
CGIAR	Consultative Group on International Agricultural Research
CIF	Climate Investment Fund
Co_2	Carbon Dioxide
CSA	Climate Smart Agriculture
CSP	Climate Smart Practices
ECOWAS	Economic Community of West Africa States
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
GCF	Green Climate Fund
GCMs	Global Circulation Models
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHGs	Greenhouse Gases
GIEWS	Global Information and Early Warning System on Food and Agriculture
GMET	Ghana Meteorological Agency
GRPs	Graduate Research Programs
HIV	Human Immunodeficiency Virus
ICPAC	Intergovernmental Climate Prediction Centre

ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communication Technology
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IRS	Indoor Residual Spraying
ITN	Insecticide Treated Net
LPG	Liquefied Petroleum Gas
MOSAICC	Modelling System for Agricultural Impacts of Climate Change
MRPs	Masters Research Programs
NAPA	National Adaptation Plan of Action
NGO	Non-Governmental Organizations
NHMS	National Hydrological and Meteorological Services
NIMET	Nigerian Meteorological Agency
NOAA	US National Oceanic and Atmospheric Administration
RCMs	Regional Climate Models
SARVA	South African Risk and Vulnerability Atlas
SAWAP	Sahel and West Africa Program
SRES	Special Report on Emission Scenarios
SREX	Special Report on Managing the Risks of Extreme Events
START	Global Change System for Analysis, Research & Training
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
US/USA	United States of America
WASCAL	The West African Science Centre for Climate Change and Adapted Land Use Program
WB	World Bank
WECARD/CORAF	West African Council for Agricultural Research and Development
WHO	World Health Organization
WIBI	Weather Index-Based Insurance
WMO	World Meteorological Organization

Executive Summary

Between the 12th and 14th November 2012, eminent scientists from across Africa converged in Lagos, Nigeria for the Eighth Annual Meeting of the African Science Academies (AMASA-8). The theme of the meeting was "*Climate Change in Africa: Using Science to Reduce Climate Risks".* The goals of the meeting were to bring together key stakeholders to focus on the occurrence of climate change in Africa and its impact on public health and food security; to advocate for an inclusive science based agenda on adaptation to, and mitigation of climate risks in Africa; to initiate a process for the long term engagement of African science academies with their governments and relevant stakeholders on climate change issues; and to discuss ways to mobilize finance for addressing climatic effects in Africa. Over 120 participants drawn from science academies, research institutes, universities, non-governmental organisations, and the private sector were present. This report is a summary of the presentations made and discussion held during the meeting.

The AMASA-8 meeting was held at the Four Points by Sheraton Hotel, Victoria Island, Lagos. It was declared open on the 12th of November 2012 in a colourful opening ceremony at which welcome speeches and goodwill messages were given by several Nigerian dignitaries including the Honourable Minister of Science and Technology, Professor Ita Okon Bassey Ewa; who represented the President of the Federal Republic of Nigeria, Dr. Goodluck Ebele Jonathan.

Six scientific sessions were held between November 13th and 14th, at which distinguished speakers presented stimulating papers. The opening session set the tone for the rest of the meeting by highlighting the science behind climate change and its potential effects on human health, agriculture, industry, and infrastructural development under different emission scenarios. Adaptation and mitigation strategies were highlighted with particular attention paid to the role of scientific research in influencing policy change. Other strategies that were emphasized as critical to the mitigation of climate change effects include capacity building, institutional strengthening, inter-sectorial collaboration, and strong national and regional coordination mechanisms.

Various sessions of the meeting focused on specific aspects of challenges presented by climate change. Session 1 examined the observed and potential effects of climate change in Africa, using the examples of the West African and Southern African sub-regions. It was noted that the impacts of climate change on most countries in Africa are exacerbated by poverty, institutional and infrastructural weaknesses, poor access to capital, and degradation of the ecosystem, leading to weak adaptive capacities. Robust evidence-based sustainable development policies are therefore required to provide the framework to address and adapt to climate change on the African continent.

Session 2 focused on the health effects of climate change, which include immediate effects such as heat and cold-related conditions, physical injury during extreme weather events, and changes in communicable disease transmission; as well as secondary effects such as malnutrition occasioned by crop failure. Emergency preparedness and response, which includes being prepared to address the potential impacts of climate change, are core functions of public health which require human and capital investments. Presently, the capacity of public health systems to mitigate the health impacts of climate change in Africa is inadequate, with low awareness and limited surveillance capacity for climate and health conditions. Investments must be made in building collaborative cross-sectorial partnerships for research and capacity building, improved health services and health facilities, steady provision of medicines, and effective communicable disease control. Vulnerability to adverse health impacts can also be reduced by improving general health and standard of living through cross-sectorial action in agriculture, employment, urban planning policies, and infrastructural development.

Session 3 looked at the effects of climate change on agriculture and food security. The presenters shared examples of mitigation and adaptation strategies already being implemented as well as efforts still in the pipeline. Building agriculture-based livelihoods' resilience entails supporting farmers to understand climate variations and develop a buffer capacity to cope with losses due to reduced yield or extreme events. Climate Smart Agriculture is an approach to sustainable agricultural development that can increase agricultural productivity and incomes and promote resilience of livelihoods and ecosystems in the face of climate change. Weather Index-Based Insurance is a useful climate risk management measure that can help small farm holders adapt to the risks of climate change Farmer networks or cooperatives also help to provide support and enhance open sharing of capacities and technology. Countries are encouraged to seek partnerships with the various regional institutions that offer technical capacity and funding to pilot and implement these and other similar approaches.

Session 4 built on Sessions 2 and 3 by examining the level of human and scientific capacity available in Africa to deal with climate change, and outlined the various initiatives and training programs that are working towards filling in the capacity gap. The present human resource capacity for climate science research in Africa is inadequate to prepare the continent to develop effective adaptation and mitigation strategies to the challenges of climate change. In particular, there is a dearth of scientists with a specialization in the health and agriculture related effects of climate change. The existing capacity building institutions need to be empowered and supported to grow the number of middle and high-level scientists with expertise in climate change issues.

Session 5 examined the investment opportunities available to address climate change, with specific focus on carbon markets and clean development funds from the World Bank and African Development Bank. There are significant resources that have been mobilized to support climate action in developing countries. However there is intense competition for these resources amongst countries, therefore proposed projects are coming under increased scrutiny. African countries will need to strengthen their readiness for planning and project design to attract a significant share of these resources. Collaborative partnerships between research institutions and universities, policy makers and other stakeholders will facilitate the development of high quality proposals wit high chances of success.

Finally, Session 6 pooled all the presentations and discussions together with panel discussions on the roles of the various stakeholders in addressing the effects of climate change. There was consensus that the academies of science have a key role to play in facilitating rigorous scientific discourse to arrive at an unbiased scientific position through a rigorous process of discussion, peer review and declaration of interests; and communicating this to various relevant audiences such as the wider public, national governments, regional/sub-regional entities

The key points highlighted during the meeting are summarized in the final chapter of this report titled "*Key Messages from AMASA-8*"

Keynote Addresses

I. Overview of Climate Change in Africa

Professor Ogunlade R Davidson
University of Sierra Leone
Former Minister for Power, Sierra Leone

The Impacts of Climate Change: The fact that there is warming of the earth's atmosphere is now unequivocal. It is also generally agreed that this warming is human induced. Science has demonstrated correlations between the rising levels of carbon dioxide, methane and nitrous oxide and the rising temperature of the earth. These 'greenhouse gases' (GHGs), are produced by human activities in increasing levels, as populations grow and modernize. As temperatures rise, the various ice caps around the world are melting and sea levels are rising. Weather patterns are also changing, with adverse weather events such as flooding, storms, droughts and wildfires becoming more frequent and severe.

The impacts of climate change are felt in many sectors, including health, agriculture and ecosystems (Figure 1). Increasing temperatures put humans at increased risk of heat stress and heat stroke. In moist tropical areas with high latitudes there is an increased availability of water, while at lower latitudes and in semi-arid areas, there is a decreased availability of water. Overall, the number of persons suffering from water stress is increasing. Crop production is rising for selected crops and decreasing for others. The biodiversity of habitats is also affected, with amphibian populations decreasing and corals becoming bleached. Changes in agricultural productivity have effects on food security and nutrition, while changes in biodiversity affect vector populations and can lead to increased frequency of vector borne diseases. Modelling predicts that as temperatures rise, all these effects will become more pronounced.

Mitigation potentials exist for climate change. Between 1970 and 2004, GHG emissions increased by 70%. Projections using SRES (Special Report on Emission Scenarios) have predicted that GHG emissions will increase between 25-90% by 2050, but could be offset if all countries implement mitigation measures across building, industry, energy, transport, agriculture, and waste management sectors. The United Nations Framework Convention on Climate Change (UNFCCC) has set targets for reduction in GHG emissions for various regions of the world which must be met in order to achieve a reduction in worldwide carbon dioxide concentrations. Most countries in Africa were classified as Non-Annex 1 countries due to their relatively low levels of development, and were not assigned targets under this protocol. They are however expected to achieve substantial reductions from their baseline (1992) GHG emission rates by 2050. The overall objective of UNFCCC is to stabilize atmospheric GHG concentration to prevent dangerous levels and enable economic development to progress in a sustainable manner whilst ensuring that food production is not threatened.

The Changing Climate of Africa: Africa is a growing continent with many drivers of economic growth including abundant natural resources, a large land mass, and a growing youthful population which provides a strong labour force but can also lead to increased consumption. According to the World Bank forecast for 2012, the growth rate of GDP of sub-Saharan Africa has been put at 5.3 % for 2012 and 5.6 % for 2013. The IMF (International Monetary Fund) reports that in the last decade, 6 out of the 10 fastest growing economies were in Africa; this number is expected to rise to 7 by 2015.

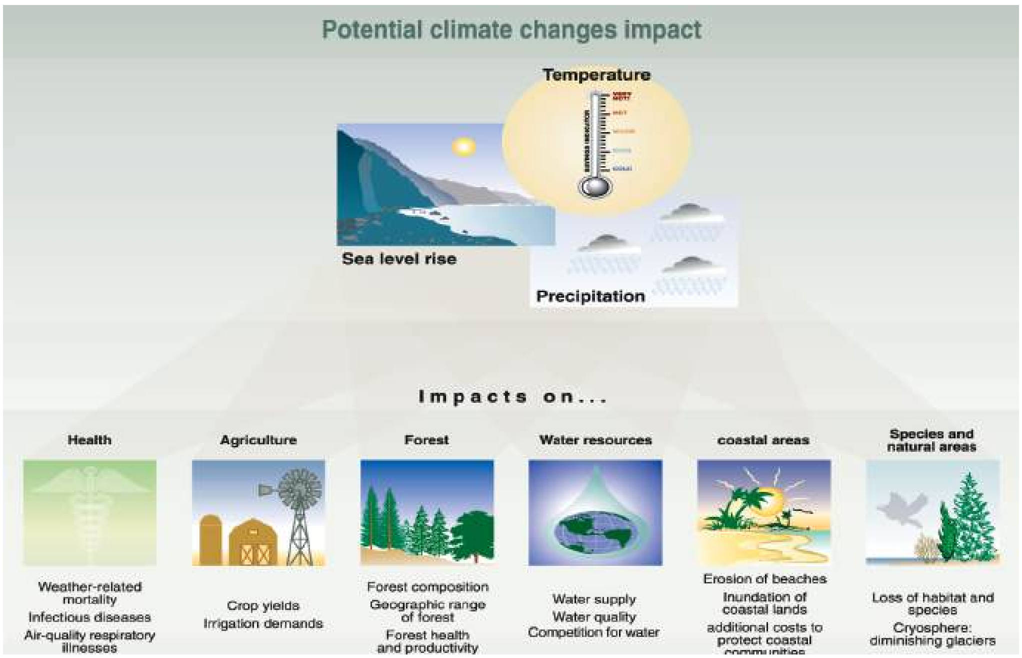

Figure 1: Effects of Climate Change. (Source: United States Environmental Protection Agency, 2010)

Climate change has the potential to slow the gains of development in Africa. The continent is faced with real climate change challenges, particularly extreme weather events and sea level rise which cause losses and damages beyond the ability of African nations to cope, thus undoing some of the development gains. The glaciers and snow caps of Mount Kenya and Mount Kilimanjaro are receding and causing water runoffs in the region. In the Sudan, the Gum Arabic belt has shifted southwards and the June - August rains now occur a month later, thus affecting agricultural practices in the region. A 25 % decrease in average rainfall has been observed over the Sahel region in the past 30 years. Precipitation has fallen by up to 2.4 % per decade in tropical rainforests since the mid-1970s, with deforestation of about 5million hectares per year across many parts of the continent. Lake Chad which was Africa's third largest fresh water basin has reduced from 15,000 km^2 in 1972 to 500 km^2 in 2012. Lake Faguibine, in Mali has dried up due to diminished rainfall. There have been repeated droughts and floods in eastern Africa resulting in major economic losses. The Mozambique floods in 2000 affected 4.5 million people, caused 700 deaths and economic losses estimated at $US 500 million, and resulted in a decline in GDP growth rate from 10% to 2%. A similar situation occurred with repeated droughts in 1968, 1994, and 2005 in Ethiopia.

Addressing Climate Change in Africa: A number of mitigation and adaptation technologies are available to address the climate change problem. Estimates show that 50 billion cubic metres of natural gas is flared or vented per year on the continent. Algeria, Libya, Nigeria, and Angola flare over 60-70% of the natural gas produced during oil extraction. The gas can be harnessed to provide large quantities of electricity for one or more countries. The Medgaz pipeline connecting Algeria and Spain is one example of a project that will facilitate trade in natural gas between two countries.

Bio-fuels based on agricultural and forest wastes, urban waste, and non-food crops offer a potential sustainable energy source for Africa. With adequate finance and technology transfer, Africa can produce bio-fuels for both consumption and exports. This will require a prior assessment of the benefits of trade, use and production of bio-fuels in each country, followed by development of a policy development and monitoring mechanism. Countries interested in using bio-fuel will need to increase their investments in research and development, and build human capacity to manage issues relating to the production of bio-fuels such as water, land and other inputs.

Liquefied Petroleum Gas (LPG) is also gaining ground as a viable energy source in Africa. LPG has largely displaced firewood in urban and rural Botswana, and there is exponential growth in the use of LPG in Sudan and Senegal. In Ghana, LPG cylinder manufacturing systems and LPG distribution systems have been established. Policy price regimes are needed to support this growth in more countries. Renewable energy systems based on wind or sunlight can also be developed. As with bio-fuels, investments must be made into research, infrastructure, and technology development.

Building climate change adaptation capacity in Africa requires a multi-faceted approach. Capacity building must consider both institutional/organizational capacity as well as human capacity. Regional, sub-regional and national networks will be required to maximize existing knowledge and experiences, and to attract financing. Enhanced capacity for baseline assessments, environmental monitoring, early warning systems, and proactive development planning (climate proofing) are all critical. Also important are activities to raise awareness of stakeholders, policy makers, and the general public. Synergies will need to be built with institutions and organizations that address biodiversity, deforestation/desertification, and land degradation. Linkages are also required with disaster management and humanitarian response agencies. Major policies and measures by government are required, including incentives for private sector investment in new technologies, tax credits, standard setting, market creation, and development. Interlinked policies on air quality, clean fuel, insurance, bank lending, and trade will provide the enabling environment for climate change mitigation. An effective carbon-price signal could realize significant mitigation potential.

Financing for CDM (Clean Development Mechanism) projects can be mobilized locally through government bonds, the local share market, or through insurance funds. Donor aid and Foreign Direct Investments can be sought for specific priorities. African countries can also access carbon financing from the World Bank (WB) for CDM projects. In the past, Africa's access to carbon finance has largely been marginal, but in recent times has been increasing. As of March 2012, 23 African countries had submitted a total of 204 CDM projects to the WB, amounting to 2.6% of the total projects financed.

Conclusion: Africa emits just 3.8 % of world GHGs, but will suffer the most from the climate change threat. The impacts of climate change on Africa are exacerbated by poverty, institutional and infrastructural weaknesses, poor access to capital, and degradation of the ecosystem, leading to weak adaptive capacities. Mitigation and adaptive potentials exist; however, the continent must invest in human and technological capacity development for sustainable growth. National and regional coordination mechanisms are crucial for the mobilization of external funding. Well-structured markets that can attract investments are also needed. Robust, evidence-based sustainable development policies will provide the framework to bring together the necessary elements to address and adapt to climate change on the African continent.

II. Raising the African Voice on Climate Change

Dr. Youba Sokona
Coordinator and IPCC WGIII Co-Chair for AR5
African Climate Policy Centre

The Impacts of Climate Change in Africa: Africa is warming, as evidenced by scientific observations. The observed warming is already exceeding levels that can be explained without integrating greenhouse gases in global models. The range of projected warming is very serious, and mitigation measures are slow and sparse. The impacts of climate change in Africa include changes in rainfall and storms, changes in water availability, changes in ecosystem range and species location, agricultural changes, and health issues linked to climate change. Adaptation has started, but further adaptation is now unavoidable. Without the mitigation of greenhouse gas emissions, it may be impossible to achieve meaningful adaptation where it is most needed.

The impacts of climate change in Africa will be costly. By 2030, climate change could cost up to 2.7 % of the GDP in Africa (Figure 2). Regional variations are significant; losses are likely to be greatest in North and West Africa, and will rise with time. However there is a lot of uncertainty around the precise effects of climate change. Small changes in temperature will see average river flows and water availability *increase* by 10-40 % in some sub-regions, while in others there will be a *decrease* of 10-30 %.

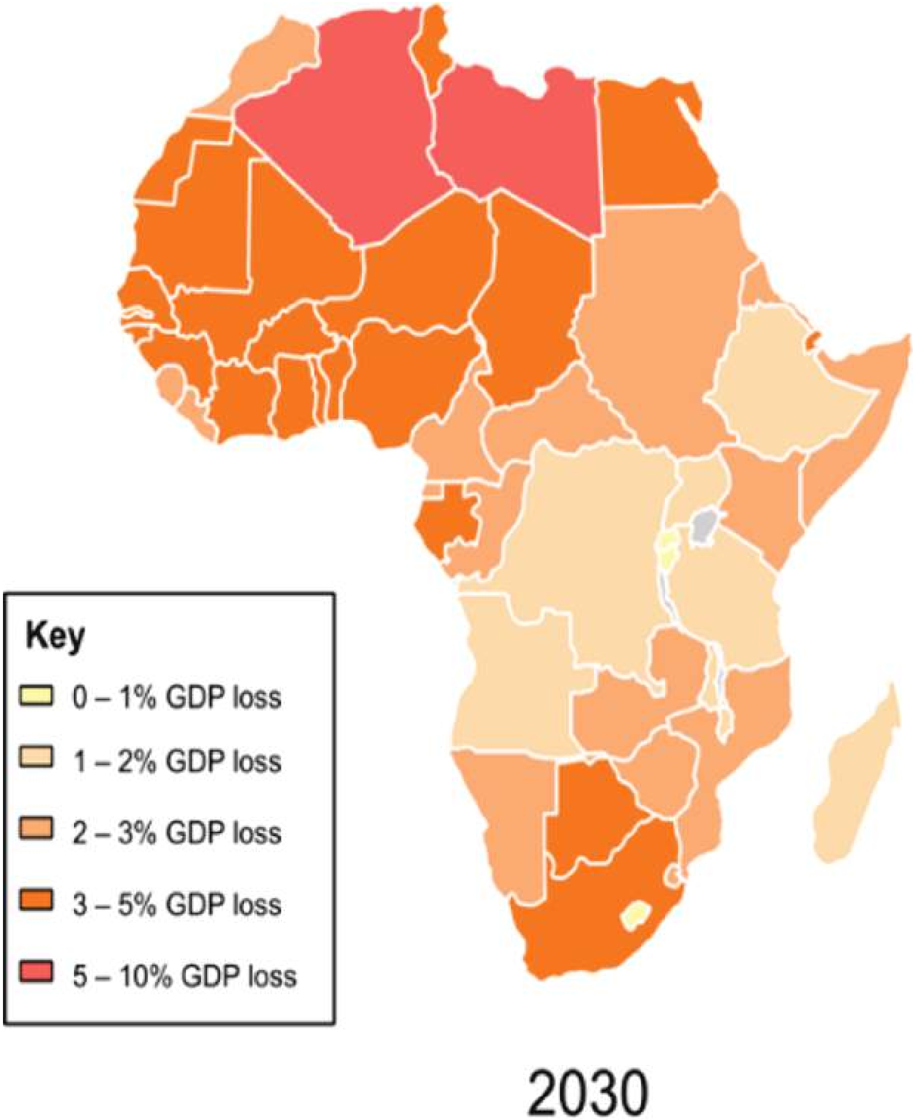

Figure 2: Projected GDP losses in Africa due to Climate Change (source: UNEP, 2012)

Climate change increases developmental challenges. Almost half of the African population lives on less than $1.25 dollars per day. Only about 31 % of the population in sub-Saharan Africa has access to electricity with about only 14 % electrification in the rural areas. Traditional biomass accounts for between 70-85 % of primary energy supply in many sub-Saharan countries. The economic growth experienced in the last decade has failed to generate significant employment. Africa needs to grow in order to meet the challenges of urbanization and industrial development, but must also mitigate and adapt to the challenges of climate change. Scientists at a recent climate conference in Denmark in 2009 were of the opinion that under the current situation, a 2°C rise in temperature will be impossible for Africa to manage. Risks of different mitigation pathways increase dramatically if action is delayed. Africa needs to adapt right away.

Africa's Response to Climate Change: So far, many climate change efforts and policy experiments are underway across Africa. Examples of successful programs include CCAA (Climate Change Adaptation in Africa), AfricaAdapt, the African Adaptation Programme, and the ClimDev-Africa Programme/African Climate Policy Centre. There are many networking groups such as the African Ministerial Conference on the Environment (AMCEN), the Conference of African Heads of State and Government on Climate Change (CAHOSCC), the African Group of Negotiators on Climate Change, the United Nations Framework Convention on Climate Change and related instruments (UNFCCC), and the AMCEN Comprehensive Framework for Climate Change.

This is a positive trend, but major gaps remain between current efforts and climate stabilization targets. The African climate change research agenda is not most of the time set by Africa. There are no or very limited linkages between the African research community and policy makers and/or practitioners. Africa's participation in the IPCC process, such as the authorship, review, comments and approval of submissions needs serious attention.

Managing such a complex situation as climate change in Africa requires raising awareness with policy makers, academics and practicing stakeholders; effectively integrating climate change concerns into development policies, strategies, programs and practices; and efficiently articulating Africa's concerns, priorities and position in climate change negotiations. Proactive dialogue must exist between the policy community a*t regional, sub-regional, national, sub-national levels; the sectorial departments, businesses, communities, media and civil society including NGOs and community organizations that u*ndertake economic, social and environmental activities and contribute to development through practical action; and the research community comprising universities, and research institutes that study interactions between society, the economy and the environment including climate and generate knowledge for change.

To better understand climate change, we need to be able to attribute observed impacts to specific changes in weather patterns. We need to ascertain what proportion of the social, economic and ecological impacts of climate are due to periodic climate variations versus actual climate change. By understanding how much impact climate change is having today, we can better assess the potential impact of climate change in the future. We can also begin to assess the economics of climate change adaptation. This requires that local capacities are built to be able to gather data and conduct research analysis. New frameworks, strategies and plans are needed that bring together the policy, research and practice communities to form research partnerships and technical co-operations for knowledge generation, advocacy and consensus building. Policies on climate finance and economics are also critical to provide the enabling environment for low-carbon climate resilient development projects.

Conclusion: Transformational development and sustainable development pathways are a cost-effective and climate effective way forward which may help balance the tensions between climate risks, costs of mitigation, and developmental aspirations. While designing and implementing these programs, attention must be given to regional/national differences in risks, capabilities, and opportunities. For Africa's voice to be heard at international climate change agenda-setting level, African scientists should be proactive in setting the international negotiation agenda; proactively participating in negotiation with robust scientific arguments, and proactively leading the implementation of activities at various levels in the continent. The African science academies can play a proactive role in this regard by serving as a rallying point for dialogue and action.

SESSION 1:
CLIMATE CHANGE RISKS ACROSS AFRICA

Introduction/Overview: Session 1 looks at climate change in different regions of Africa. Two papers were presented, one from the West African sub-region and the other from Southern Africa. The objectives of the session were to discuss:

- What we know and need to know about risks of climate change across Africa
- How climate change risks relate to extreme weather and disasters
- The tools and/or methods needed to fill the knowledge gap of climate risks across Africa

Dr. Adelekan presents some data on the changing climate in West Africa and gives examples of extreme weather events that have recently occurred in the sub-region. She also highlights that most countries in West Africa are more vulnerable to climate change because of high levels of poverty and low capacities for research and policy formulation.

Professor Diab focuses her presentation on the specific impacts of climate change on health, water, and agriculture in South Africa. Although South Africa is relatively advanced compared to many other African countries, the HIV and tuberculosis dual epidemic is weighing down the health system, leaving few resources to address the health consequences of any catastrophic weather events. The effects of climate change on agriculture and water resources vary according to region, making it necessary for adaptation strategies to be specific to the different local circumstances. South Africa does have some policy frameworks in place to address climate change, such as the Water for Growth and Development Framework and the National Climate Change Response Strategy; however there still remains much to be done, especially in the area of research.

I. CLIMATE CHANGE RISKS IN WEST AFRICA

Dr Ibidun Adelekan
Department of Geography
University of Ibadan, Nigeria

The West African sub-region covers approximately 5 million square kilometres. It comprises of 16 countries, 12 of which are coastal. Fifteen of the 16 countries are in the fourth quartile and among the poorest countries in a ranking of the 230 countries of the world by GDP per capita. Urbanisation in West African countries, with the exception of Mauritania and Mali, is one of the fastest in the world. Urbanization rate increased from 7.5% of the total population in 1950 to 31.5% in 2000.

Climate change scenarios in West Africa vary across the region, with some areas experiencing more marked changes than others. Broadly however, greater amounts of rainfall have been recorded in the region since the beginning of the twenty-first century. Even the relatively drier areas such as the western portion of the Sahara-Sahel have recorded increased rainfall amounts since the end of the 1990s. There also appears to be an increased incidence of extreme weather events and weather-related disasters. In September 2009, Ouagadougou in Burkina Faso experienced severe floods of a magnitude which had not been seen since 1919. In one day, Ouagadougou received 263 mm of heavy rain, which is the equivalent of a quarter of Burkina Faso's typical total annual rainfall of 1,200 mm. In July 2011, Lagos in Nigeria also experienced floods of unprecedented magnitude after a heavy rainfall of 233.3mm which lasted about 16 hours. Records obtained from the Office of the United Nations Coordinator for Humanitarian Assistance indicated that the number of people affected by flooding has increased sharply over the last decade, from 77,000 in 2005 to over 2 million in 2012 (Figure 3).

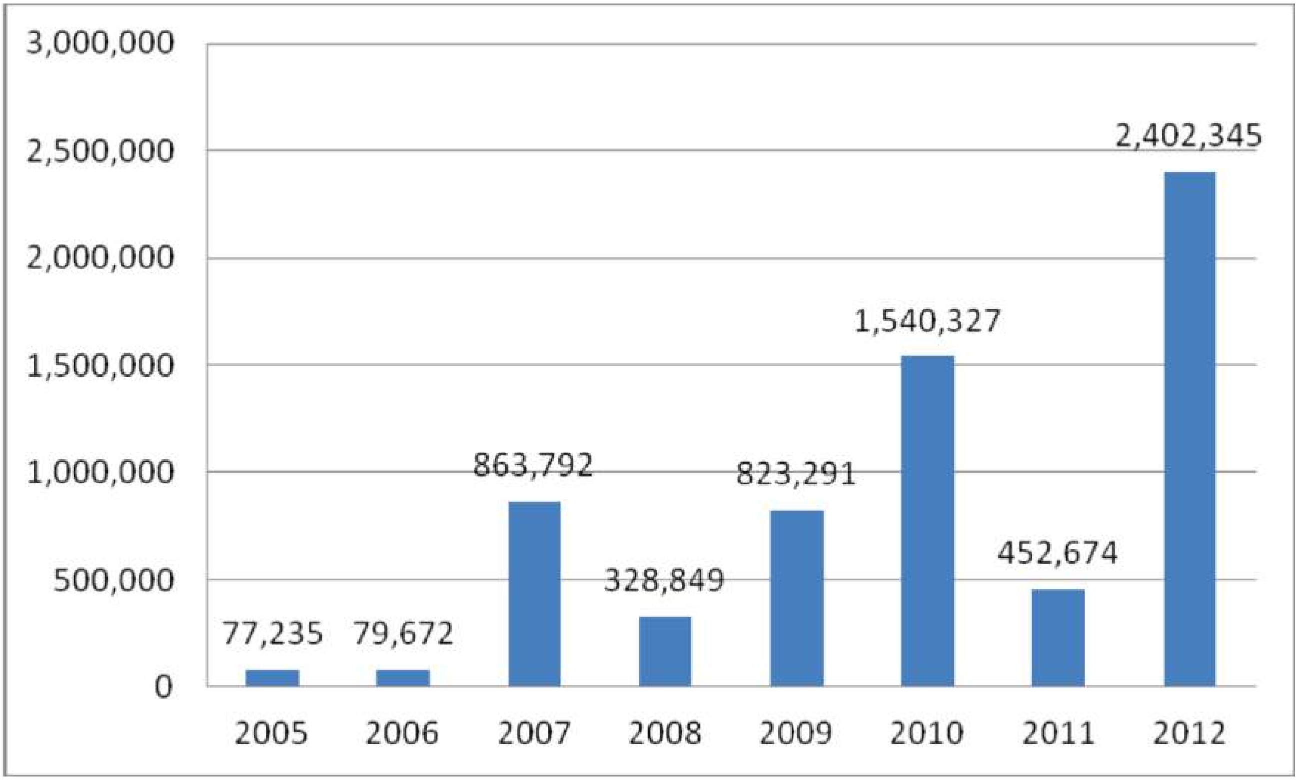

Figure 3: Total population affected by floods in West Africa, 2005-2012. (Source: Source: UN-OCHA, 2012)

The concept of "risk" in climate change is a function of the level of exposure to climate change hazards, and the vulnerability of the people. Those most affected are the poor, who tend to live in hazard prone areas and have very little ability to cope with the impact of weather or climate-related disasters. Another key element of vulnerability is the level of infrastructural development. This is typically poor and substandard especially in low-income settlements along flood plains and coastal areas. Basic amenities such as water supply, sanitation, housing, and social services are absent in many of these communities. There are also few or absent early warning systems and emergency response and recovery services in place. This places the population at increased exposure to extremes of climate and also raises the risk of suffering and illness in the event of a climate-related disaster.

The type of economic activities engaged in by the people can also predispose them to higher risks due to climate change. Subsistence agriculture and related value chains, which provide livelihood for millions of people in West Africa, are particularly vulnerable to changing weather patterns and extreme weather events. Droughts, storms, and floods can wipe out an entire season's crops, leaving whole communities without food and without seed stocks for the following year. Such communities often require external assistance to survive in the short term and to recover their livelihoods in the longer term.

Understanding vulnerability is a prerequisite for understanding risk and developing risk reduction and adaptation strategies to extreme events. There are however marked knowledge gaps in our understanding of risk. Assessing risk involves carrying out regular monitoring and analyses of weather patterns and geological/hydrological assessments, and mapping of vulnerabilities not just according to location but also according to socio-cultural, economic, institutional, and governance characteristics of populations. Various tools and methods exist for this, such as risk and hazard mapping, participatory vulnerability assessments, land use and territorial planning, risk communication, forecasting and warning systems, hazard preparedness, and insurance and micro credit schemes to mitigate livelihood impacts. Capacities need to be built up in the various institutions to be able to perform these functions.

Conclusion: According to the Intergovernmental Panel on Climate Change (IPCC) 2012 SREX Report, "High vulnerability and exposure *(to climate hazards)* are generally the outcome of skewed development processes, such as those associated with environmental mismanagement, demographic changes, rapid and unplanned urbanization in hazardous areas, failed governance, and the scarcity of livelihood options for the poor." This quote is a succinct summary of the situation in most parts of West Africa. Urgent measures incorporating policy, advocacy, capacity building, institutional strengthening, and inter-sectorial collaboration are required to reduce the risks of adverse effects of climate change on the people of West Africa, particularly the poor.

II. CLIMATE CHANGE RISKS ACROSS SOUTHERN AFRICA

Professor Roseanne Diab
Executive Secretary
Academy of Science for South Africa

Impacts of Climate Change in South Africa: Models of projected seasonal temperature change in South Africa (in degrees Celsius) for the period 2070-2100 compared with 1975-2005 under the A2 SRES scenario of moderate to high growth in GHGs show a projected increase in median temperature of greater than 3 degrees Celsius over the central and interior regions of South Africa, and a smaller increase of about 2 degrees Celsius over the coastal regions. The greatest temperature increases will be in autumn and winter. Under the same scenario, South Africa will become drier overall within the next 100 years, with strengthening of the subtropical high pressure belt. However, it will be wetter over the east coast in spring and summer. These changes will have impacts on human health, water distribution, and agriculture.

Impacts on health: The impacts of climate change on human health include direct impacts, such as heat stress, and indirect impacts as a result of disasters like floods and fires. Populations may be displaced by changes in climate or extreme events, leading to all the health challenges of internally displaced persons. There may also be changes in the epidemiology of infectious diseases or emergence of new infectious diseases. A significant percentage of the South African population suffers from a unique disease complex, comprising HIV and tuberculosis infection, complicated by water-borne and chronic respiratory diseases, and underpinned by malnutrition and poor indoor air quality. South Africa has the largest burden of HIV in Africa with approximately 5.7 million people living with HIV. Another 6-10 million people are infected with *Mycobacterium tuberculosis, with a significant proportion of those being* multi-drug resistant. As a result, a large proportion of the health budget is spent on ARV and tuberculosis therapy, leaving little to address climate change impacts on health.

Building resilience for the effects of climate change on health will require improvements in air quality to reduce the incidence of respiratory disease, food security and sound nutritional policies, public awareness campaigns on health risks of high temperatures and appropriate responses, and strengthened information and knowledge of linkages between disease and climate change through research. A South African Risk and Vulnerability Atlas (SARVA) has been produced; a health data-capturing system that will feed into this atlas is required.

Impacts on the Water Sector: Water plays a critical role in development in South Africa. The country is water-scarce with a highly variable climate and one of the lowest run-offs in the world. This will be exacerbated by climate change. There is some uncertainty about the net effects of climate change on water availability. Rainfall and runoff is expected to become more variable with an increase in extreme events like flooding and droughts. Increased rainfall intensity in the eastern and coastal parts of the country may exacerbate scouring in rivers and sedimentation in dams, potentially impacting on water supply and treatment infrastructure. Higher temperatures, combined with higher CO_2 levels will promote increased growth of algae and faster evaporation rates, both negatively impacting water resources.

Changes to the water cycle will have secondary impacts across many sectors. The agricultural sector is highly vulnerable as it consumes 62% of total water resources in the country. Based on current projections, South Africa will exceed the limits of economically viable land-based water resources by 2050. Sustainable growth is possible only if water issues are integrated into the planning process across all sectors.

The negative impacts of water scarcity will be felt by people, ecosystems and the economy. Water availability is key to climate change-related vulnerability. Basic water services have been provided to over 9 million people since 1994, mainly in the urban areas. There is therefore already an unmet demand for potable water. The water sector must balance allocation of limited water resources amongst major users whilst simultaneously addressing equity issues and ecological issues. The response of the South African government to these challenges is two-pronged. In the short term, climate change will be used as a catalyst for addressing urgent shortcomings in the water sector and implementing effective management measures. This has been outlined in the National Water Resource Strategy.

The long-term strategic focus (up to 2030) is addressed by the Water for Growth and Development Framework. This framework provides for the integration of climate change considerations across relevant sectors including agriculture, industry, and economic development etc. It calls for the strengthening of water-related research as well as capacity development in all aspects of climate change to ensure availability of high quality data and tools. The framework also proposes the implementation of best practices in water catchment and water management to ensure water security and resource protection under changing climatic conditions and calls for exploration of new and unused water resources such as groundwater, re-use of effluent, and desalination. Water adaptation measures are addressed from a regional perspective given the trans-boundary nature of major rivers.

There remain significant gaps in knowledge about water demand, storage, and supply under climate change drivers. More research is also needed to understand the vulnerability of the poor to water scarcity and contamination, such as those living on floodplains and in coastal areas. Improved projections are required to balance urban water demand against irrigation and agricultural demand, and to match this to supply. Integrated hydrological models that assess the impacts of demand and supply changes on surface and below-ground water resources need to be developed. There is also a gap in integrated catchment management approaches in particularly stressed catchments.

Agriculture: Primary agriculture fulfills a prominent role in South Africa's economy, providing 8-9% of total employment. Primary commercial agriculture generates 2.5 % of GDP, but through linkages with other sectors agriculture contributes up to 12% of South Africa's GDP. Agriculture is a major earner of foreign exchange. Adverse climate change effects will have wide-ranging repercussions since the agriculture sector accounts for about 60% of water utilization. Changes in water demand and availability will significantly affect farming activities with the western regions predicted to have 30% reduced water availability by 2050. Irrigation demand will increase in these areas, increasing the pressure on water resources.

There are a range of peculiar vulnerabilities to climate change in the agricultural sector in South Africa. There is a high variability of rainfall, with 90% of the country being sub-arid, semi-arid, or sub-humid, while 10% is hyper-arid. Analyses of agricultural production trends related to climate change suggest that for every 1% reduction in rainfall there is a decline of 1.16% in maize production and 0.5% in wheat production. Small-scale subsistence farmers rely on dry land food production and have limited capital to invest in fertilizer, seeds, disease control and irrigation. They are therefore especially vulnerable to changes in rainfall patterns.

Building resilience in agriculture requires investment in climate-resilient rural development planning to address food security, sustainable livelihoods and biodiversity. Vulnerability and risk studies are needed to develop short-, medium- and long-term climate-resilient adaptation scenarios. Investment is required for research into water, nutrient and soil conservation technologies and techniques and climate-resistant crops and livestock. Agricultural production, ownership, and financing models can be developed that promote the development of "climate-smart agriculture" that lowers agricultural emissions, is more resilient to climate changes, and boosts agricultural yields. There is also a need for early warning systems to give timely warnings of adverse weather and related pests and disease occurrence. This will require instituting education and awareness programs in rural areas and linking these to agricultural extension activities.

Conclusion: The South African government has shown commitment in responding to the challenges of climate change. A National Climate Change Committee has been constituted and a National Climate Change Response Strategy has been prepared. South Africa is also active in various intergovernmental networking groups on climate change. There are climate change adaptation considerations in many sector plans such as water and forestry, provincial and local government plans and some private sector plans, such as the sugar industry. Key challenges remain in understanding how climate change risks relate to extreme weather events, and in defining attributions of climate events.

SESSION 2:
CLIMATE CHANGE AND HEALTH

Introduction/Overview: Three papers were presented in this session. The session objective was to highlight the climate change risks faced by the health sector, and to answer the following questions:

- What do we know about the links between climate change, vector diseases, epidemics, and other health concerns?
- How can we best address these health concerns given what we know?
- What is the burden of these climate change effects on the health system?

Dr. Sally Stansfield examines the health impacts of climate change with a focus on Africa as a continent. She highlights how the health effects of climate change are linked to its effects on water, agriculture and the general socio-economic situation of the people. The underdeveloped health systems in many parts of Africa raise serious concerns about the levels of preparedness to deal with climate change. She uses the World Health Organization's six health system building blocks as a frame work to illustrate how climate change considerations can be mainstreamed into the regular planning system for the health services.

Professor Shibru Tedla looks at the health risks of climate change from the Ethiopian perspective. The Ethiopian health system is weak and ill-prepared to deal with additional effect of climate change on human health. In addition, Ethiopia has high poverty levels which exacerbate any potential health impacts. Climate change has altered the transmission patterns for malaria in Ethiopia, resulting in increased transmission of malaria; however this is being controlled with support from the Global Fund and the World Bank.

Dr Andrew Githeko focuses on the effect of climate change on vector-borne diseases in East Africa. As noted in the case of Ethiopia, the patterns of some mosquito-borne illnesses are changing as climates become warmer and mosquito breeding grounds expand. Epidemics of malaria in previously unexposed populations can be severe, therefore targeted malaria prevention activities are recommended as a priority intervention. The importance of continuous monitoring of disease patterns to identify changing trends is also highlighted.

I. ADAPTATION TO CLIMATE CHANGE: A MATTER OF HEALTH AND SURVIVAL

Dr Sally Stansfield
Delloitte Consulting, USA

Health Consequences of Climate Change: Africa is especially vulnerable to the health impact of climate change. This is because many African countries are already burdened with high levels of poverty and existing stresses on health and well-being such as HIV and malnutrition. Poor economic and social infrastructure, heavy reliance on climate-sensitive sectors of the economy such as agriculture, low education levels, low access to credit and technology, and poor governance all exacerbate the effects of climate change and can hinder adaptation and mitigation efforts. Currently, 300 million people in Africa do not have access to safe drinking water; reductions in rainfall mean that water demand may exceed supply in some countries by 2025. Rising temperatures and evaporation rates and decreased rainfall will reduce runoff and lake and dam storage, putting up to 600 million people at risk of living in a water scarce environment. Agricultural yield is also projected to fall in most parts of Africa.

Climate change presents numerous risks to health. Extreme weather events such as storms and floods can cause death by drowning or other physical injury. Forest wildfires can cause burns and respiratory disease. Both water and fire related events destroy homes and livelihoods, especially for populations engaged in subsistence agriculture. This leaves large numbers of people exposed and vulnerable. Droughts and desertification can cause both acute and chronic food insecurity and under-nutrition, and can also lead to mass migration of populations towards more fertile areas. Climate change, by displacing large numbers of people and also by altering disease transmission mechanisms, can predispose humans to epidemics of diarrhoea, malaria, dengue, meningitis, Rift Valley fever, schistosomiasis, leismaniasis, echinococcosis, and respiratory disease. Migrations can also lead to conflict situations as people fight for available land and other resources.

There are also some potential positive impacts of climate change on health in Africa. These include a reduction in cold related illnesses such as respiratory infections as temperatures rise, and a contraction in the range of vectors responsible for the transmission of certain diseases, such as some species of malaria carrying mosquitoes. As some regions become drier, there will potentially be a reduction in the incidence and the transmission season of some water borne and water related diseases, such as schistosomiasis, filariasis, and some types of enteritis, among the resident population. These gains are however outweighed by the larger potential for negative impact.

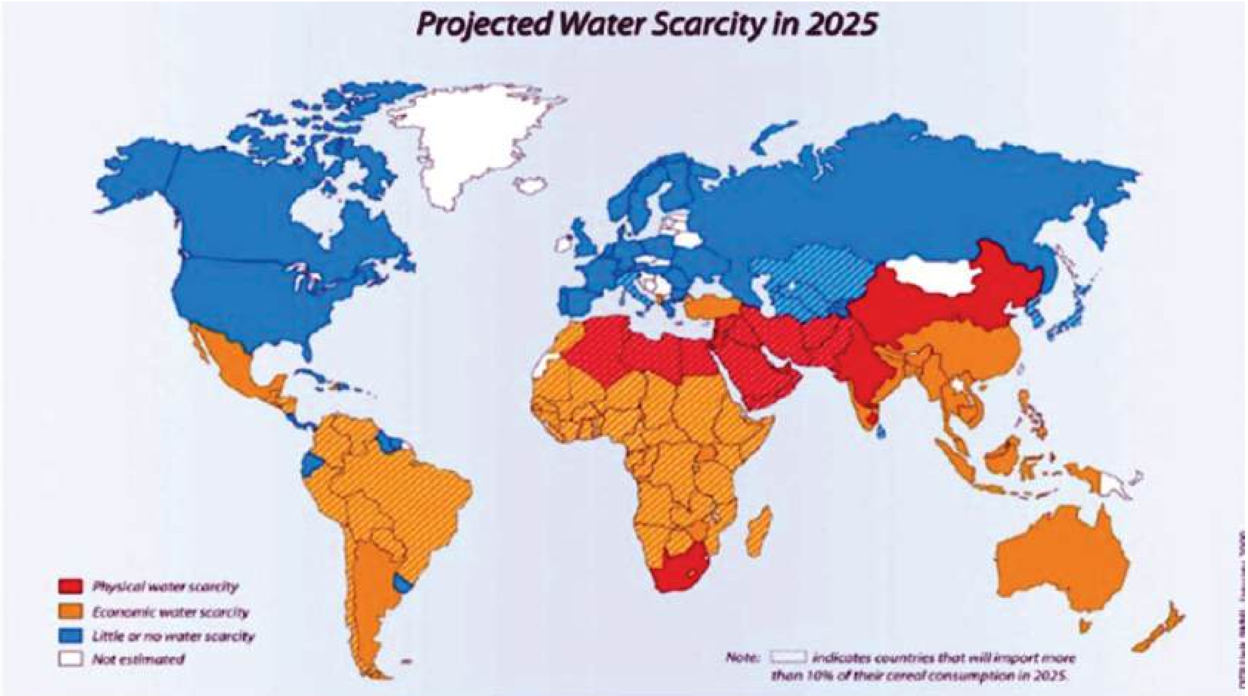

Figure 4: Projected water scarcity in Africa by 2025. (Source: The World Water Vision, 2010)

Public Health Systems in Africa: The core capabilities of a public health system, namely surveillance, prevention, detection, and response; and the underlying core functions, namely human resource development and training, communication, dissemination of information, and management of resources are key for dealing with climate disasters. A functioning health system comprises six essential building blocks: healthcare governance, healthcare financing, health information management, human resources, medicines and technology, and health service delivery. These elements need to be prepared to address the potential impacts of climate change on health.

Governance: Policies and institutions should be in place to promote adaptation, reduce vulnerability and increase resilience. Health system policymakers should raise awareness of the impact of climate change and the need to promote sustainable development. A policy framework and guidelines should be in place for the conduct of health impact assessments for all development projects that will potentially affect greenhouse gases.

Financing: Universal health coverage that allows all persons to access the health services they need without the fear of impoverishment will improve the resilience of covered populations. The expense of special relief efforts in the event of humanitarian emergencies can bankrupt communities and nation states. This effect is mitigated in a population that has significant health insurance coverage.

Information Systems: Individual health records should be digital, interoperable and portable. Surveillance is required to monitor changes in incidence of climate-associated illness and malnutrition. Routine health ICT infrastructure will improve outreach, alert, and rescue in extreme weather events. Emergency management information systems should be in place and tested periodically.

Human Resources: Adequately trained health personnel and community workers will improve resilience of populations to the adverse effects of climate change. Specially trained emergency personnel can be instrumental in reducing morbidity and mortality during extreme weather events and in the event of forced migration. Workers trained in surveillance and epidemic investigation in the context of climate change will enable early detection and control of emerging or epidemic diseases.

Medicines and Commodities: Stocks of lifesaving medicines and supplies should be planned with climate-related illness and emergencies in mind. Emerging diseases and changes in the prevalence of endemic diseases may require the development of new vaccines and drugs and/or changes in policies and guidelines.

Health Service Provision: A fully functioning health system will reduce vulnerability to climate-related adverse health impacts. Guidelines for treatment may require adjustment for climate-related illnesses or emergencies.

Conclusion: Emergency preparedness and response, including the potential impacts of climate change, are core functions of public health. Health systems should be assessed and priorities established for their strategic strengthening. Research and development are needed for improving the safety and resilience of housing and public infrastructure, transportation systems, food security, and emergency management. Vulnerability to adverse health impacts is reduced by improving general health and standard of living through cross-sectorial action in agriculture, employment, urban planning policies, building and infrastructural development, and healthcare. Development assistance programs should help countries build their own capacity for climate change resilience, including individual and institutional capacities.

II. CLIMATE CHANGE AND HEALTH: THE CASE OF ETHIOPIA

Professor Shibru Tedla
Ethiopian Academy of Sciences

Climate change and health risks in Ethiopia: The magnitude and rate of current climate change in Ethiopia, combined with additional environmental, social and political issues, are making many traditional coping systems and strategies ineffective and unsustainable, amplifying environmental degradation and food insecurity, and forcing communities to rapidly find new livelihoods strategies. Associated with this climate change are a number of health impacts which are exacerbated by changing weather patterns and climatic conditions, leaving populations ill prepared for new health challenges (Figure 5). For example, climate change may affect health through increased frequency and intensity of extreme weather events which affect agricultural productions and therefore cause hunger and malnutrition. Similarly, extreme weather events can expose affected persons to increased risks of disease transmission. An epidemic of cholera following the extreme floods in Ethiopia in 2006 led to widespread loss of life and illness.

Rising temperatures affect pathogen life cycle and range, thereby altering the rate of infections, especially vector-borne diseases. A variety of tropical diseases common in Ethiopia such as malaria, cholera, yellow fever and meningitis are sensitive to changes in weather conditions such as rainfall patterns, temperature, and humidity. Areas once considered free of malaria because of temperature conditions have become warmer and conducive to the transmission of malaria. A close association has been observed between the increasing incidence and prevalence of malaria and concomitant warming in many parts of the country. Malaria has a serious impact on the country's economic productivity as its transmission increases during planting and harvesting seasons.

Variations in the health effects of climate change from one region to another can be quite marked, due to differences in geography, micro climate, socio-economic conditions, quality of existing health infrastructure, communication capacity, and underlying epidemiology.

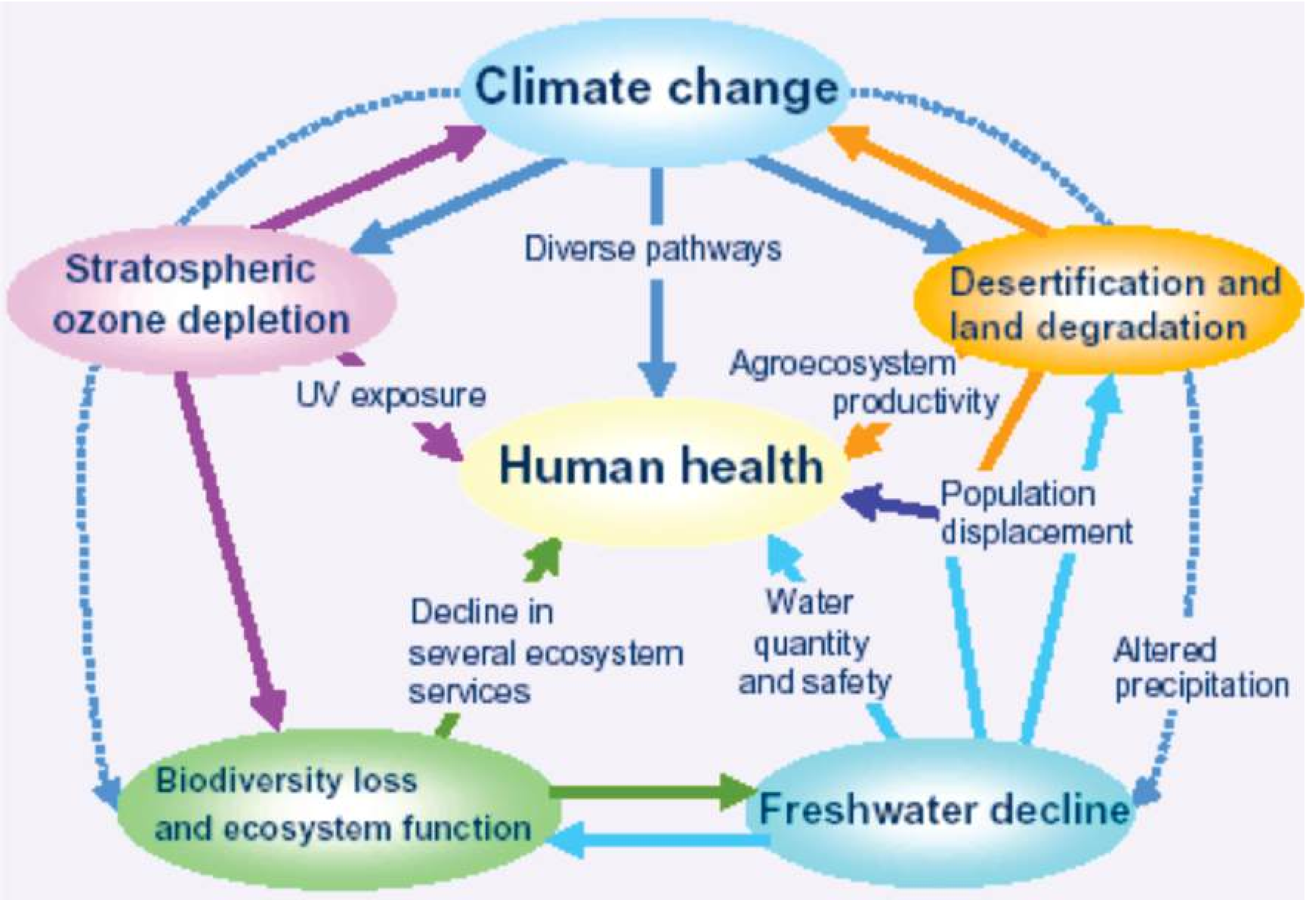

Figure 5: Health Effects of Climate Change. (Source: World Health Organisation, 2012)

Science to Policy Response: Ethiopia faces many challenges in dealing with the health risks of climate change. First of all, there is a very low level of awareness about climate change.

Surveillance systems are weak, and the quality and availability of information on vulnerable areas is inadequate. There are very few partnerships in relation to climate change, with significant gaps in the capacity to respond to emergencies and extreme weather events. The health system is also weak with low staff capacity and lack of medicines and equipment to deal with the adverse health impacts of severe climate events and disasters.

In order to deal with the impacts of climate change, the health sector needs to develop a new framework incorporating climate change considerations. WHO emphasizes strengthening of healthcare systems' infrastructure, implementing epidemiological surveillance systems and to increase capacity to respond to vector borne diseases. Tools and methods are needed to obtain estimates of the future scale and nature of health vulnerabilities to enable planning. Integration of policies and strategies for the environment, development and health is encouraged. Healthcare leaders should take active part in advocacy for policies that improve overall human health. This would include policies that engage non-health sectors such as educational and social institutions both on national and local levels to reduce health risks from environmental pollution and hazards.

Ethiopia has taken some policy and institutional strengthening steps to respond to the health impacts of climate change. In 2011, Ethiopia developed a Climate Resilient Green Economy Policy. A National Committee on Climate Change exists with a mandate to identify best practices in addressing climate change. A program to build capacity in Climate Risk Management has been introduced at Mekelle University. Ethiopia has formulated a National Adaptation Plan of Action (NAPA) in place which identifies a list of priority activities in the area of health, including research into adaptation options; raising public awareness on the urgency of adapting to the adverse effects of extreme weather events and building capacity for the health system response to climate change.

Malaria control provides an example of a health sector intervention that addresses the health risks of climate change. Insecticide Treated Nets (ITNs) have been widely distributed within Ethiopia to protect households from mosquitoes in an attempt to stem the rising malaria incidence. These programs which are supported by the Global Fund and the World Bank have prevented thousands of deaths from malaria. The Ethiopian government has also been implementing indoor residual spraying (IRS) programs in malaria epidemic-prone areas.

Nevertheless, lack of effective utilization of vector control tools is observed at the individual and community levels. This is a serious problem that requires follow-up.

Conclusion: Ethiopia is vulnerable to many of the potential health risks of climate change. This is compounded by low awareness and limited surveillance capacity for climate and health conditions. In order to adapt to the changing morbidity and mortality patterns occasioned by climate change, investments must be made in building collaborative cross-sectorial partnerships for research and capacity building. Improved health services and health facilities, steady provision of medicines, widespread use of mosquito nets, health extension, and environmental sanitation services will help to reduce underlying vulnerabilities and reduce the burden in the event of severe climate events.

III. CLIMATE CHANGE AND VECTOR- BORNE DISEASES

Dr Andrew Githeko
Kenya Medical Research Institute

Climate change and climate variability have different effects on the transmission of vector borne diseases. Climate change can increase the suitability of new areas to disease transmission, and can also decrease the suitability of an area where disease transmission was previously high. Climate change events can also precipitate epidemics of vector borne diseases. Vector-borne diseases exhibit varying levels of sensitivity to climate change. Vector-borne diseases that are highly sensitive to changes in climate include malaria, dengue fever, Chikungunya virus fever and rift valley fever. These are all mosquito borne illnesses. Vector borne diseases with low sensitivity to climate change include schstosomiasis, filariasis, leishmania, trypanosomiasis and yellow fever.

Malaria is a good example of how climate change affects the transmission of vector-borne diseases. Malaria has recently spread to the Central Kenya highlands as a result of a rise in average temperatures. The higher temperatures promote increased mosquito breeding, and also accelerate development of the malaria parasite in the mosquito. Increased transmission of malaria in areas where malaria prevalence has previously been low carries a risk on increased severity of illness as the majority of the population will have low immunity. In such areas malaria infection rates can quickly assume epidemic proportions. Climate variability can increase the number of malaria cases by 100-700% and mortality by 500%. The areas most affected by these epidemics are the highlands of Kenya, Uganda, Tanzania, Ethiopia, Rwanda, Burundi and Madagascar.

Malaria transmission is also affected by water runoff and drainage. In "U" shaped valley formations there are typically many episodes of malaria in a year. The "U" shape encourages the formation of stagnant water where mosquitoes breed. In "V" shaped valley ecosystems, there is usually good drainage which reduces mosquito breeding. Flooding episodes can lead to large bodies of stagnant water, resulting in increased mosquito breeding and more episodes of malaria.

To adapt to the changing patterns of vector-borne illness due to climate change, it is necessary to continuously monitor the epidemiology of malaria cases in order to identify new areas affected by malaria transmission. Climate based early epidemic prediction models have been developed and can be adapted to different transmission patterns. These models, coupled with surveillance data, can help to identify epidemic-prone areas before the number of cases escalates too high. Once epidemic hotspots are identified, control measures can be applied. In the highlands 98% of the malaria mosquitoes are found in houses less than 500 meters from breeding habitats at the valley bottom. Targeting these houses for indoor residual spraying is highly effective and efficient strategy for malaria epidemic control, in conjunction with large scale campaigns to increase the use of insecticide treated bed nets.

Conclusion: The changing face of vector-borne diseases is typified in the shifting patterns of malaria transmission in East Africa. Epidemics in previously malaria-free areas carry a high risk of morbidity and mortality due to low immunity levels against malaria infection. Predictive modelling is necessary for early identification of epidemic-prone areas and institution of targeted control programs. Other vector-borne diseases can be approached similarly with due consideration for their particular epidemiology.

SESSION 3:
CLIMATE CHANGE AND AGRICULTURE/ FOOD SECURITY IN AFRICA

Introduction/Overview: In session three, climate change is discussed in relation to agriculture. The objectives of the session are to articulate priority climate change-related risks in agriculture and food security, and to discuss measures to improve resilience.

Dr. Louise Setshwaelo of the Food and Agriculture Organization (FAO) outlines some of the projected effects of climate change on agriculture. Although the impacts are projected to be positive for some crops, the overall effect will be a net decrease in productivity. She discusses the concept of 'Climate Smart Agriculture' (CSA), a research intensive initiative that focuses on agricultural practices that increase productivity and enhance resilience while reducing greenhouse gas emissions and increasing carbon sequestration. She gives examples of tools and processes developed by the FAO for use in CSA programs.

Dr. Speranza focuses on the projected effects of increasing variability of rainfall, temperature and other climate indices on small farm holders' crop yield, and the need to build resilience among these subsistence farmers. She explains the concept of Weather Index-Based Insurance (WIBI) as a resilience-building mechanism and discusses some of its advantages and challenges, using the example of a WIBI program for groundnut farmers in Malawi.

The third presentation by Robert Zougmoré looks at some of the numerous initiatives developed by the CGIAR research program on Climate Change, Agriculture and Food Security (CCAFS) to address the challenges of climate change. These include establishing collaborative research platforms, mainstreaming gender, engaging stakeholders in climate change scenario-planning exercises, and strengthening the capacity of National Hydrological and Meteorological Services to produce and deliver timely and useful climate information to local farmers.

I. CLIMATE SMART AGRICLTURE AND FOOD SECURITY IN AFRICA

Dr. Louise L. Setshwaelo
Food and Agriculture Organization

Agricultural production and food security in Africa are likely to be severely compromised by climate change. Problems currently being encountered in Africa include land degradation, landslides, erosion, drought, burning, and declining yields. These challenges are likely to escalate as the earth warms. Most African countries are already net importers of food. Over 50% of North Africa's food requirement is imported, while between 25% and 50% of the food consumed in sub-Saharan Africa comes from outside the continent. Africa's cereal imports were estimated at USD 21.748 billion in 2008. Further declines in food production will very likely result in challenges with food supply stability and food access constraints at household level. In North Africa and the Sahel, increasing drought, water scarcity and land overuse could lead to a loss of 75% of arable, rain-fed land.

In order to adapt and mitigate the effects of climate change, African countries should be promoting carbon sequestration; increasing the efficiency of resource use; and reducing agricultural system vulnerability by increasing resilience through zero/reduced tillage practices, protective crop cover and rotations, and sustainable land management practices. There is an urgent need to promote practices that optimize soil and water management in high potential systems and marginal agricultural areas, and in intensive and extensive systems. Resilience is key and can be approached through the promotion of agricultural biodiversity and diversified adapted farming systems.

Climate Smart Agriculture and Food Security in Africa: The Climate Smart Agriculture (CSA) approach combines policy, technology, and financing to achieve sustainable agricultural development under climate change. CSA directly incorporates climate change adaptation and mitigation into agricultural development planning and investment strategies. Scaling CSA practices requires facilitation through institutional and governance mechanisms. There are three pillars of CSA:

1. Increasing productivity and incomes.
2. Enhancing resilience of livelihoods and ecosystems.
3. Reducing and removing GHG emissions and increasing carbon sequestration.

Climate-Smart Agriculture is research capacity intensive. It requires the development of protocols for quantifying GHG emissions and evaluating the mitigation potential of smallholder agricultural activities. This involves designing research that combines field measurements, landscape and household surveys, and satellite imagery to develop data on indicators relevant to production, mitigation & adaptation. Based on the research findings, a menu of Climate Smart Practices (CSP) is developed, and training and awareness materials and programs are then built around these practices.

The Food and Agricultural Organization (FAO) has developed a number of technical tools, programs, and analysis systems for use in CSA programs. A few examples are presented below:

Agricultural Stress Index System (ASIS): ASIS is a real-time global drought monitoring system that feeds information to the Global Information and Early Warning System on Food and Agriculture (GIEWS). ASIS assesses the severity (intensity, duration, and spatial extent) of the agricultural drought and expresses the final results at administrative level, giving the possibility to compare them with the agricultural statistics of the country. A national-level standalone ASIS system is being developed, which would allow for crop-specific results and calibration using national statistics. This could be used as a basis for crop insurance systems, where historic patterns and real-time alerts to insurance pay-out triggers are required. The standalone version of ASIS will monitor agricultural drought and risk management at country and regional levels.

Modeling System for Agricultural Impacts of Climate Change (MOSAICC): MOSAICC is an agricultural modelling system designed by the FAO comprising software and training. It provides information to support climate change adaptation planning and decision-making at national level. MOSAICC enables users conduct integrated impact assessments on crop yields, from climate data handling to economic assessment (Figure 6). It can analyze the findings of quantitative assessments at sub-national spatial resolutions and aggregate these to national level. MOSAICC is delivered to national institutions with training for national experts. The assessments are carried out by national experts from institutions of different disciplines.

Ex-Ante Carbon balance Tool (EX-ACT): Ex-ACT provides ex-ante estimations of the impact of agriculture and forestry development projects on GHG emissions and Carbon (C) sequestration, indicating the effects on the C balance. It guides the project design and decision-making process, and complements ex-ante economic analysis of investment projects.

Conclusion: Climate Smart Agriculture is an approach to sustainable agricultural development that can increase agricultural productivity and incomes and promote resilience of livelihoods and ecosystems in the face of climate change. CSA promotes the incorporation of climate change considerations into agricultural investment programs. It requires a multi-sectorial collaborative approach in order to be effective. African countries are invited to work with the FAO to identify opportunities for CSA investments in Africa.

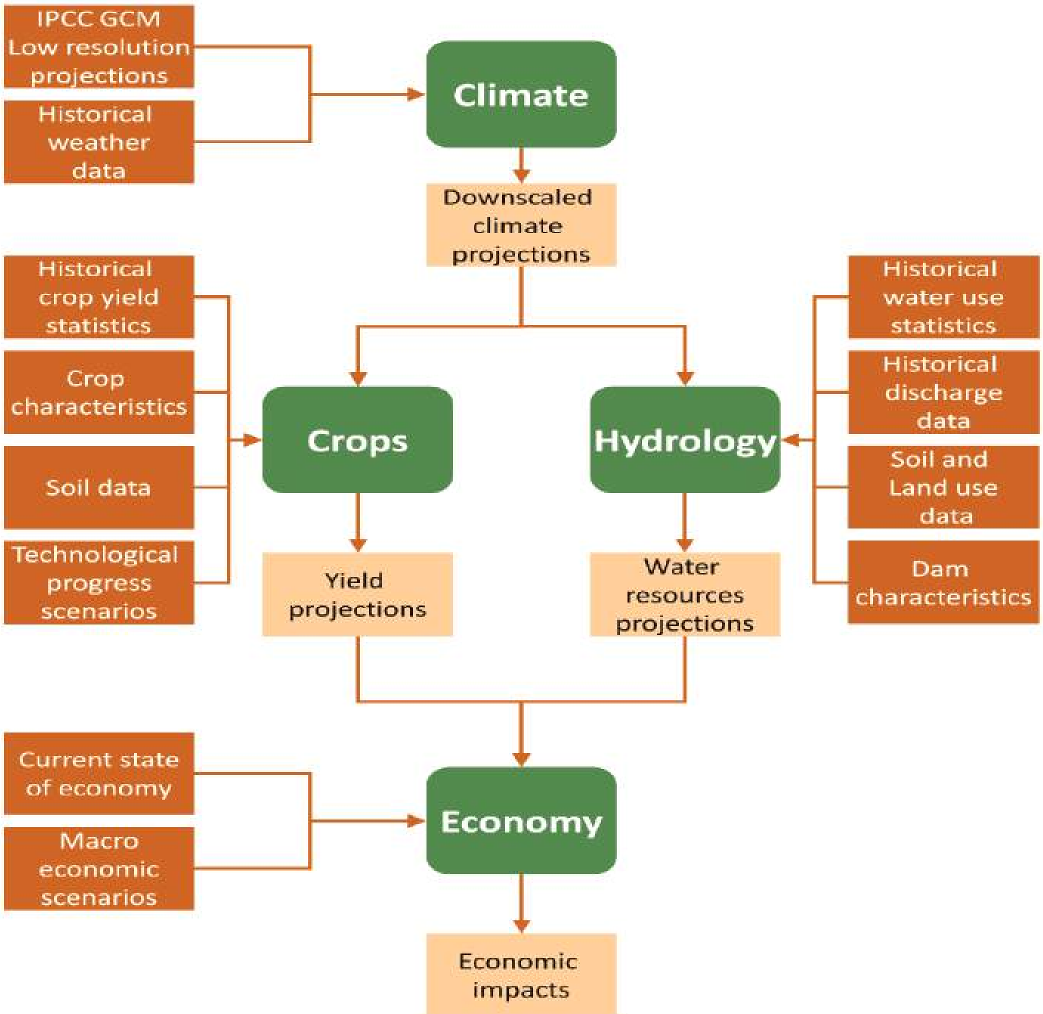

Figure 6 : Schema showing data inputs in MOSAICC modelling system (Source: FAO, 2011)

II. CLIMATE RISK MANAGEMENT IN AFRICAN AGRICULTURE: LESSONS FOR IMPROVING RESILIENCE

Dr Chinwe Ifejika Speranza
University of Bern, Switzerland

Understanding Climate Risks in Africa: Many locations in Africa have high rainfall variability in both space and time. The coefficient of variation of seasonal rainfall is as high as 50% in many parts of Africa. This is a major challenge for farmers in semi-arid and sub-humid areas. Farmers usually plant before the rains to take maximum advantage of available moisture; however, a farmer could plant and then see very little rainfall compared to previous years. This leads to crop losses, which in turn translate to loss of income and food.

Climate change will likely increase this variability. To remain economically viable, small scale farmers in Africa will need to adapt to the increasing variation in the onset, duration, and end of seasons as well as the increased occurrence of extreme events such as droughts and floods. An additional challenge is that rainfall variability tends to overshadow or mask the effects of climate change, making it difficult to differentiate between climate trends and climate change. Looking closer at climate data is thus crucial for designing adaptation measures for local levels.

"Building Resilience" to climate change: Resilience refers to the capacity to accommodate *stresses and disturbances while retaining or improving essential basic structures and ways of functioning.* In relation to agriculture building resilience is about retaining or improving the capacity of agricultural systems to provide agricultural goods and services despite climate risks.
Building agriculture-based livelihoods' resilience entails three components: developing a buffer capacity, improving organization, and building a capacity for learning. Buffer capacity refers to ownership or access to assets by smallholder farmers which can carry them over periods of losses or low yield. Buffer capacity also includes diversity of crops, site specific knowledge on how to reduce losses, and the existence of institutions that can provide a safety net in the event of an extreme event. Organization refers to the engagement of the farmer in networks or cooperatives that can provide support, as well as to their own ability to be self-reliant and flexible. The capacity for learning comprises knowledge identification, sharing and transfer capacities as well as the openness to experimentation.

Weather Index-Based Insurance (WIBI): WIBI is insurance linked to an index, such as rainfall. If the rainfall amount is below the earlier agreed-upon threshold, the insurance pays out, i.e. farmers involved in an insurance scheme are paid. The advantage of this over traditional crop insurance is that there is no need to visit farmers' fields to assess damages which lowers transaction costs, allows for rapid payouts, and facilitates disaster planning. WIBI also addresses two problems associated with traditional crop insurance: perverse incentives or moral hazard, where a farmer may let a crop die in order to get an insurance payout; and adverse selection, in which insurance is priced based on the risks of the entire population but only the most vulnerable farmers purchase insurance.

The limitations of WIBI include the fact that it requires good quality historical climate data; it usually provides only partial protection, and depending on design, it may become too costly. So far the focus on WIBI in Africa has been on drought. Programs have been implemented as pilot programs and have generally been successful. Up-scaling of these programs is required. Another limitation is that there have been no feasibility studies yet of flood index insurance in Africa.

The Malawi WIBI-Groundnut Scheme: This WIBI is part of a production loan bundle. To be eligible, a farmer must be within 20km of one of the meteorological stations in the program. The loan comprises a budget for seed, insurance premium and tax. After signing the contract, each farmer receives a bag of groundnut seed for 1 acre of production and an insurance policy with a maximum payout of the loan size plus interest. Prices of the bundle vary by weather station and crop. Farmers are organized into joint liability groups of about 10-20 members. At season end, farmers provide their yields to the association, which markets the yields. The proceeds are used to pay off the loan and the profits returned to the farmer.

The Malawi WIBI is a collaboration between a number of international and local organizations. The international partners are the World Bank and the US National Oceanic and Atmospheric Administration (NOAA). Other partners include the Malawi Meteorological Service, ICRISAT, the Insurance Association of Malawi, the Malawi Rural Finance Company Limited (MRFC), Opportunity International Bank of Malawi (OIBM), the Chitedze Agricultural Research Station, the National Smallholder Farmers' Association of Malawi (NASFAM), and some local farmer groups.

The program has resulted in enhanced access to improved seeds and fertilizer for participating farmers. It seems to work best when integrated into a comprehensive Disaster Risk

Management program. The WIBI program was perceived mainly as an external intervention as it was not "explicitly" demand-driven by farmers. As a result some of the farmers did not really value the insurance component of the bundle. Further research is needed on conditions under which specific farmers would adopt WIBI and feel a sense of ownership of the program. Capacity building is also needed for local design/adaptation of insurance contracts and other institutional and legal/regulatory arrangements. Lastly, there is a gap in the availability of weather station networks, climate and other data needed to support evidence-based actions.

Conclusion: Building agriculture-based livelihoods resilience entails supporting farmers to understand climate variations and develop a buffer capacity to cope with losses due to reduced yield or extreme events. Farmer networks or cooperatives help to provide support and enhance open sharing of capacities and technology. Weather Index-based Insurance is a useful climate risk management measure that can help small farm holders adapt to the risks of climate change. It has been used with some success in pilot programs in a number of African countries. Lessons learned include the need for strengthened institutional frameworks to govern the insurance scheme and better weather monitoring systems to provide data for evidence-based decision-making. Research is required into ways in which the program can be structured to enhance a sense of ownership among farmers.

III. CLIMATE CHANGE IN AFRICA: IMPLICATIONS FOR AGRICULTURE AND FOOD SECURITY

Dr Robert Zougmoré
CGIAR Research Program on Climate Change and Food Security

In 2012 the Commission on Sustainable Agriculture and Climate Change delivered its final report, which called for urgent action on climate change and agriculture. This Commission was made up of 13 international experts, and was chaired by Sir John Beddington the UK Chief Scientist. In the words of the report: "*Business as usual in our globally interconnected food system will not bring us food security and environmental sustainability…. the window of opportunity to avert a humanitarian, environmental and climate crisis is rapidly closing….* "(IPCC 2012).

Agriculture stands at the nexus of three of the greatest challenges facing humankind in the 21st century. The first challenge is related to achieving food security for the world's population. A billion people in our world go hungry. Another billion suffer nutrient deficiencies. Meanwhile, another billion over-consume. In 15 years' time there will be another billion people to feed. It is estimated that 100% more food will be needed by 2050, assuming current trajectories of diets and populations. This has major implications for land cover change.

The second challenge relates to adapting to climate change, with the agricultural sector being one of the most impacted by climate change. The Intergovernmental Panel on Climate Change (IPCC) projections for Africa include a temperature increase of between 1.5 and 4 ^{0}C in this century; resulting in fewer cold days and nights and more frequent hot days and nights. Arid areas will become drier, while humid areas will become wetter. There will be an increase in droughts and floods, sea levels will rise and high levels of desertification and soil salinization will be observed in some countries.

By 2090 vast areas of Africa will have experienced a more than 20% reduction in growing season length. Huge areas will experience a 5-20% reduction. Almost no areas will have elongations of growing season. This illustrates the magnitude of potential impacts on agriculture from climate change. Crop suitability will fall in many areas. On a global scale, maize and wheat are already showing negative impacts for several major producers and global net losses of 3.8% and 5.5% relative to what would have been achieved without the climate trends in 1980-2008. In absolute terms, these losses equal the annual production of maize in Mexico and wheat in France respectively.

Projections suggest that food prices are likely to increase considerably in the 21st century (Figure 7); this is unlike what happened in the 20th century, where prices fell or remained constant. These projections are for an optimistic temperature rise – a two degree warmer world. The third challenge for agriculture relates to its environmental footprint. Recent compilations suggest that food systems contribute 19-29% of global greenhouse gasses, including those through land cover change.

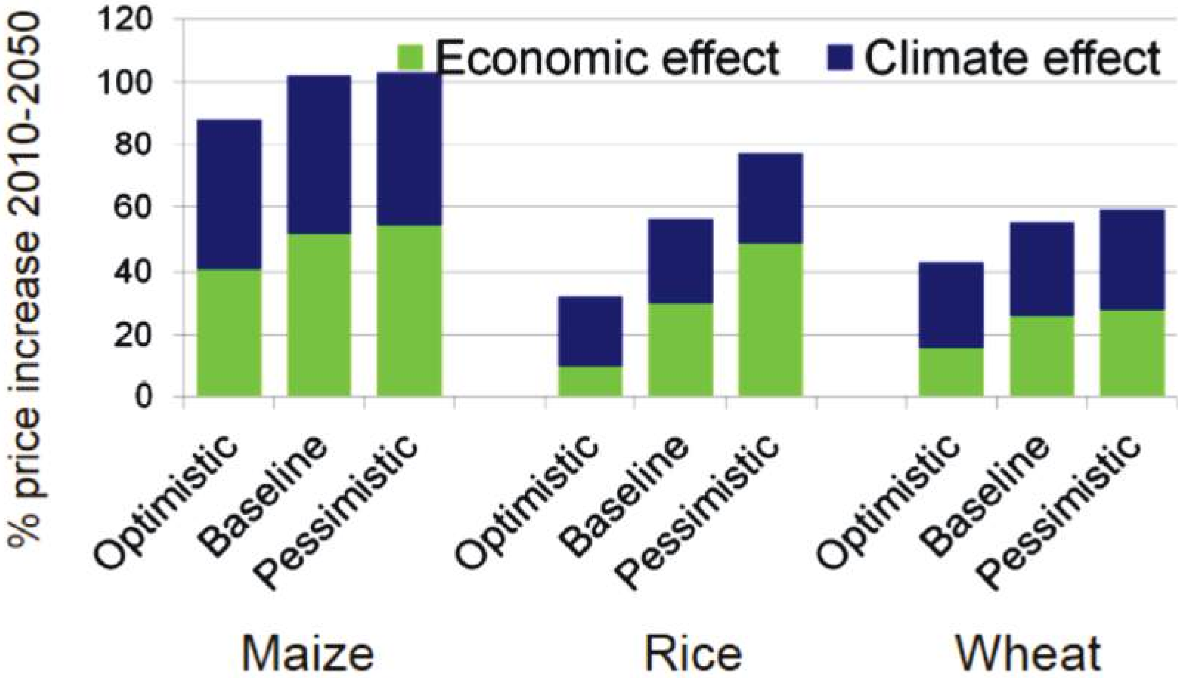

Figure 7: Projected crop price increases due to economic and climate changes, 2010-2050 (Source: Nelson et al., 2010)

Finding Solutions: Some of the initiatives and priorities of the CGIAR research program on Climate Change, Agriculture and Food Security (CCAFS) are presented below:

1. Making research accessible: CCAFS launched its West Africa Regional Learning Platform on Climate Change in 2012. This initiative is trying to develop research programs that are as demand-driven as possible. Regional learning platforms comprising 16 key stakeholders in the region (government, civil society, farmers' organisations etc) have been set up. These are the key stakeholders on the climate change impact pathways. The platform helps build capacity for knowledge co-generation and sharing, and helps identify research priorities. Co-learning is crucial for building adaptive capacity. CCAFS also held national science-policy meetings in its three target countries, bringing policy and research communities together to set priorities.

Much of the site work in CCAFS is through action research, so even at the site level; farmers are close partners in defining objectives and suggesting technologies to be tested. Program components include designed diversification; community management of resources; capacity building; mitigation and carbon sequestration; weather insurance; and climate services.

2. Focusing on achieving outcomes: Illustrative 3-yr outcome targets or CCAFS are as follows:

i. *CCAFS (and partner) science used by key stakeholders to ensure that agriculture is appropriately incorporated into the international climate agreements;*

ii. *CCAFS (and partner)-produced tools and approaches used by the UNFCCC in the guidelines for national adaptation planning and used in adaptation planning in at least 10 countries;*

iii. *CCAFS (and partner) science used by at least 6 major global agencies to provide incentives for women and men to do pro-poor mitigation.*

With the outcomes defined, the next step will be determining what partners need to collaborate to ensure the outcomes, what strategies will ensure science goes into action, and what research products are needed.

3. Focusing on women farmers: Women are crucial for food security. When women have more power, access and earnings, more income in the household is allocated to food, child nutrition and education. Climate shocks impact women more than men. The CCAFS baseline survey has also shown that women have less access to climate information than men. CCAFS is committed to giving major attention to gender-related research. . Gender work is mainstreamed into all CCAFS theme and regional work. A joint FAO-CCAFS collaboration has produced a training guide for gender related research on climate change and agriculture.

4. Visioning the future, together: regional socio-economic scenarios for West Africa: *CCAFS has d*eveloped socio-economic scenarios for West Africa for food security, environments and livelihoods. These are multiple plausible future conditions in form of narratives, conceptual models, images, videos or graphs, maps, and interactive models used to test policy planning and research. CCAFS West Africa combines socio-economic scenarios created by key regional actors with economic modelling and with climate scenarios. These allow regional actors to explore key socio-economic uncertainties for future food security, environments and livelihoods under different contexts of state, private sector and civil society power and policy priorities, and work together to make collaborative decisions on priority actions. The scenarios inform global agricultural economic models (such as IMPACT, GLOBIOM) linked to climate models. The program incorporates wide media engagement to alert the public on future challenges and uncertainties and on new collaborative actions of process partners.

5. Scaling up climate information services: *CCAFS is engaged in s*trengthening the capacity of National Hydrological and Meteorological Services (NHMS) in forecasting and tailoring climate information to the needs of farmers. 42 NHMS staff from ECOWAS countries have been trained to produce seasonal forecasts and disseminate these in the form of bulletins. Another 140 farmers, extension workers, and NGOs staff were trained to understand seasonal forecast information and make management decisions.

6. Strengthening the capacity of stakeholders: *CCAFS is engaged in d*ocumenting indigenous practices for climate change adaptation and mitigation and producing videos on this for educational purposes. Some research is also being carried out on identifying social and cultural barriers to the adoption of climate smart techniques.

7. Securing finance to make it happen: *Both adaptation and mitigation finance are relevant to all CCAFS programs. This is because investing in a*gricultural development can and usually does increase productivity, which inevitably reduces greenhouse gas (GHG) emissions per unit of food produced.

8. Improving knowledge on GHGs in smallholder systems: *It is not known how much GHG small farmers produce. New ways of understanding this and measuring it better is a focus of CCAFS. There is also a need to develop a shared protocol for GHG emissions across the region.*

Conclusion: To assist food insecure people, a major transformation of the world's food systems is required. Moving towards a “sustainable food system” means going well beyond production towards climate smart agriculture. Actions are needed in the areas of political voice, rights and entitlements, safety nets, economic opportunities and access to services. Building comprehensive adaptive capacity of this nature requires a mix of governance and institutions; social capital, knowledge and skills, income and assets, access to information, infrastructure and technology.

SESSION 4:
DEVELOPING HUMAN AND SCIENTIFIC CAPACITY TO RESPOND TO CLIMATE CHANGE

Introduction/Overview: The objective of session 4 is to discuss the development of the knowledge base needed to address the impacts of climate change across Africa.

The first presentation by Dr. Omotosho examines the state of climate change education in Africa. Although there are some institutions in Africa offering high quality training in climate science, these institutions are not sufficient to meet the needs of the entire continent. A notable gap is the absence of any training program that addresses the health impacts of climate change. There is also a need for more collaboration between the various training centres.

Dr. Oladipo looks at the state of knowledge in climate change in Africa and points out that there still remains a lot of uncertainty about what the effects of climate change will be on the various sectors and in the various regions. There are whole areas of climate change that are yet unstudied. This is due to a combination of a lack of manpower, a lack of financing, and insufficient numbers of climate science research institutions. He calls for an appropriate policy environment that will encourage the growth of science to support policy making for climate change interventions.

Professor Roland Schulze focuses his presentation on modelling in climate change. He provides examples of various digital modelling and mapping techniques, illustrates their usefulness, and explains the importance of generating continuous, quality controlled measurements of climatic data to feed into the database. He explains that most of the models used to predict the effect of climate change in Africa were developed in temperate climates and are not always appropriate for use in African countries. Growing capacity among African scientists to build home grown models is therefore a priority.

I. DEVELOPING HUMAN RESOURCES TO RESPOND TO CLIMATE CHANGE IN AFRICA

Professor Jerome A. Omotosho
West African Science Center on Climate Change and Adapted Land use (WASCAL)

The Intergovernmental Panel on Climate Change (IPCC) defines *Climate Change* as any change in climate over time, usually over 30 or more years, whether due to natural variability or as a result of human activity. The IPCC was jointly established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP). Over the past 20 years IPCC has issued a number of independent assessments of the state of knowledge on climate change.

Climate change education – where is Africa? Climate change is studied using Global Circulation Models (GCMs) and Regional Climate Models (RCMs) developed from a set of physical processes (derived from physics and mathematics) that govern atmospheric motion, using 'what if' conditions referred to as scenarios. Despite the progress made in recent years in developing models and carrying out model assessments, the climate of many parts of Africa is still not fully understood. *This is because models developed for climate change studies are meant for the mid-latitudes and are only later adapted for African use.* Therefore there is a strong need for a holistic study of African climates by Africans, through a locally developed regional climate model with local peculiarities factored in, rather than the models adapted from other advanced countries.

There are over 50 institutions offering meteorology and/or climate-related programs in Europe, more than 60 in USA and over 20 in South-east Asia, but less than 12 in the whole of Africa. Africa therefore needs to develop her intellectual capital and potential, through aggressive capacity building to address the threats and negative impacts of climate change and variability on agriculture; health; water resources and environmental management, energy; and natural disaster management.

Climate change is multi-dimensional and so requires a multi-disciplinary approach involving meteorologists and climate scientists, hydrologists, socio-economists, policy makers and target beneficiaries especially from rural communities. This demands a new approach to capacity building.

What is capacity building? Capacity is defined as "the ability of people, institutions and societies to perform functions, solve problems, and set and achieve objectives" (UNDP 2004). Capacity development is the process whereby individuals, groups, and organizations enhance their abilities to mobilize and use available resources in order to achieve their objectives on a sustainable basis. Efforts to strengthen abilities of individuals, groups, and organizations can comprise a combination of human skills development; changes in organizations and networks; and changes in governance/institutional context.

There are some existing well-known capacity-building institutions for climate change education in Africa: These include the following:

1. Federal University of Technology Akure (FUTA), Nigeria: This University has a full-fledged Department of Meteorology with a strong component in climate science studies. The department offers undergraduate and post-graduate level studies. It is a World Meteorological Organization Regional ManpowerTraining Center for West Africa.

2. Universite Cheihk Anta Diop (UCAD), Dakar, Senegal: This University offers only post-graduate level climate science studies.

3. University of Nairobi, Kenya: Has a full-fledged Department of Meteorology with a strong component in climate science studies. The Department offers undergraduate and post-graduate level studies. It is a World Meteorological Organization Regional ManpowerTraining Center for East Africa.

4. University of Cape Town, South Africa; Climate System Analysis Group: This unit offers post-graduate studies under a strong regional climate change centre housed in the Department of Environmental and Geographical Science.

5. Federal University of Technology, Minna, Nigeria: This University houses a Climate Change Center. There is also a remote sensing studies unit under the Department of Geography.

6. Kwame Nkrumah University of Science and Technology, Kumasi, Ghana: Offers Meteorology and Climate Science studies under the Department of Physics. The degrees are under-graduate level for now.

7. WASCAL (West African Science Service Center on Climate Change and Adapted Land Use): The WASCAL Graduate Research Programs (Ph.D GRPs) in Climate Science hosted by four (4) Universities across West Africa took-off in October 2011. Two new GRPs and two Masters Research Programs (MRP) also took-off on 01 October 2012.

There are also some international collaborative efforts in capacity building in Africa. Notable among these are the following:

1. *International Center for Theoretical Physics (ICTP)*
2. *The World Academy of Sciences (TWAS)*
3. *Global Change SysTem for Analysis, Research and Training (START)*
4. *Intergovernmental Authority on Development (IGAD) Climate Prediction Center (ICPAC) - Nairobi, Kenya*
5. *African Center of Meteorological Applications and Development (ACMAD) - Niamey, Niger*
6. *World Meteorological Organization (WMO)*
7. *The WASCAL Project*

Case Study I: Global Change SysTem for Analysis, Research & Training (START): START, founded in 1992, promotes capacity building through activities that include grants and fellowships for research and assessments, curricula development, advanced training institutes, and multi-stakeholder dialogues that promote outreach to decision makers. On an annual basis, START engages over 1,000 scientists, policy-makers and practitioners from developing countries to work in these areas. The African Climate Change Fellowship Program (ACCFP) is an important example of START's work on enhancing capacity for global environmental change education and research. Participating Fellows receive small grants that enable them to undertake extended visits to universities and research centers within Africa thereby fostering collaboration within Africa. There are over 450 participants from 21 African countries in various START programs.

START, working with partners engaged scientists, policy makers and others in science-policy dialogues in nine countries in 2010. The purpose of the dialogues was to enable decision-makers to better integrate climate change issues into development planning and poverty reduction measures. The dialogue topics included agriculture and food security, human health, biodiversity, ecosystem services, urbanization, and disaster risk reduction. It is notable that START has no definite program on health.

Case Study II: The German Initiative – WASCAL: The West African Science Service Center on Climate Change and Adapted Land Use Program (WASCAL) gives support to selected African universities and research institutions to synergize climate change efforts on a regional basis through high-level training of climate scientists from various disciplines. It aims to strengthen the research, educational and policy capacity and competency of West African countries to adequately deal with the threats and negative impacts of climate change and variability through the training of a critical mass of scientists in relevant fields. As at 01 October 2012, there were 6 Graduate Research Programs (GRPs) and 2 Masters Research Programs (MRPs) in operation with total of 60 PhD and 20 Masters students. All programs are fully funded, including staff, student, infrastructure and equipment costs.

WASCAL carries out research work in all areas of climate change impacts in Africa: the climate system, agriculture and food security, water resources, socio-economic systems, land use, health, biodiversity and energy. Each of the GRPs and MRPs has a German university partner and an international Advisory Board. The GRP in Mali was specifically created to look into issues concerning Agriculture and Food Security. Health does not feature as a clear and specific issue.

The way forward – an intergrated approach: Both START and WASCAL are capacity building initiatives with different levels of emphasis on various components of climate change work. The START approach is essentially field and community focused and based, with some education, research and analysis components. WASCAL is particularly focused on education analysis and research-focussed with some field work and community-based element. The West African Council for Agricultural Research and Development (WECARD/CORAF) is strongly involved in activities that can effectively link WASCAL and START programs. A platform for this collaboration should be initiated by WECARD/CORAF. WECARD/CORAF can also be encouraged to collaborate with START in community programs and to support WASCAL and START by engaging their graduates. Other capacity-building programs should also be a part of this collaboration.

Sub-regional and national agencies such as ACMAD, ICPAC and the various meteorological agencies such as GMET and NIMET, should partner with universities and training institutions such as WASCAL and START to sponsor specific research for improved prediction models for Africa and conduct research into methods for sustainable agricultural practices.

Climate science education institutions are very few in Africa. Therefore, climate science education curriculum, particularly for increased and sustainable agricultural production, food security and health, should be promoted in more universities. There is a serious capacity-building gap in the area of health impacts of climate change. Curriculum and capacity building programs are greatly needed in this area.

African Governments and Intergovernmental Agencies (e.g. WMO, ACMAD, ICPAC) and similar organizations need to key into capacity-building efforts. They can facilitate fellowships and exchanges, and provide financial support to establish new capacity-building programs.

Conclusion: The present human resource capacity in Africa is grossly inadequate to prepare the continent to develop effective adaptation and mitigation strategies to the challenges of climate change. Existing capacity building institutions need to be empowered and supported to increase the middle and high-level manpower in climate change issues, particularly for agriculture and health. Health particularly needs urgent attention. An integrated collaborative approach to climate change education that involves all stakeholders, including the community is suggested.

II. DEVELOPING SCIENTIFIC CAPACITY TO RESPOND TO CLIMATE CHANGE

Professor Emmanuel Oladipo
Department of Geography, Ahmadu Bello University, Zaria
IEM NIGERIA/NIGER PROJECT

The current state of climate change knowledge: Climate change continues to be an overarching issue threatening global development efforts. There is increasing potential for the effects of climate change to affect every part of the globe. The 2012 devastating floods in Nigeria and hurricane “Sandy” in the USA are examples. Global and national policies will be properly guided by deeper understanding of the natural and human-induced drivers of climate change processes and their interactions.

Science has made enormous inroads in understanding climate change and its causes. There is credible scientific evidence that the climate is changing at an unprecedented rate (Figure 8) and that these changes are in large part caused by human activities. Science is also beginning to develop a strong understanding of current and potential impacts that will affect people today and in coming decades. Science is also helping to improve our understanding of how we can respond and enhance our adaptive ability. This understanding is crucial because it allows decision makers to place climate change in the context of other global development challenges and focus on the imperative for sustainable development.

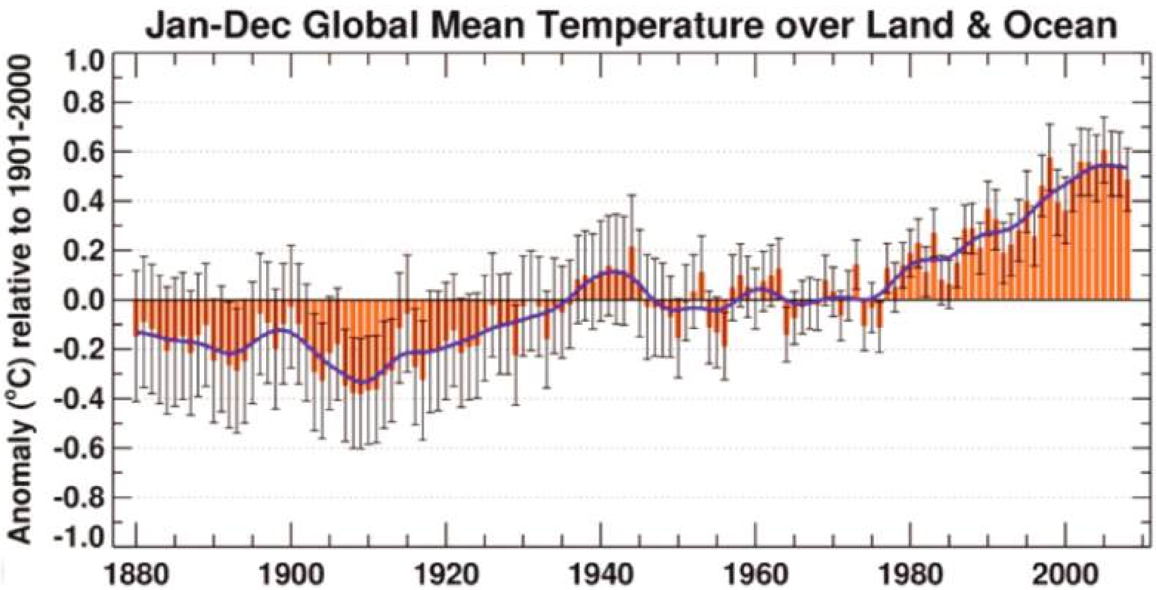

Figure 8: Mean 20th Century Average Temperatures. (Source: US National Climate Data Center. National Oceanic and Atmospheric Administration, 2008)

In spite of all the knowledge available, uncertainties persist due to the complex nature of the earth's climate system. Much remains to be learned in understanding the scientific basis of climate change. There are many areas where there is some consensus, but also significant uncertainty. It is clear that greenhouse gas emissions drive climate change. Scientific models predict that with a complete cessation of emissions of CO_2 today, it would take several millennia for CO_2 concentrations to return to pre-industrial concentrations. Part of the CO_2 being emitted by human activity is taken up by the oceans, soils and plants; however the proportion of CO_2 taken up by each of these individually, or how this will evolve over time, is less well known. It is also known that there are some natural drivers of climate change, such as volcanic eruptions and natural forcing due to sustained variations in the energy emitted by the sun; however the magnitude of this is not known (The Royal Society, 2010) .

Climatic sensitivity to rising GHG levels is also poorly understood. Averaged globally, the earth's surface has warmed by about 0.8oC since 1850. Each decade since the 1970s has been clearly warmer than the one immediately preceding it. The decade 2000-2009 was, globally, around 0.15oC warmer than the decade 1990-1999 (figure 8). These and other climatic observations have been incorporated into models that predict future temperature increases across different scenarios. The upper limit of projected temperature increases by 2100 from various models is 1.8 - 7.1°C; however, there remain significant uncertainties as to the accuracy of these predictions. Observations are not yet good enough to quantify some aspects of the evolution of either climate forcing or climate change, or for helping to place tight bounds on the climate sensitivity. It is also not known how much the melting and retreat of the ice sheets on Greenland and West Antarctica will contribute to sea level rises for a given temperature increase. The possibility of large changes in the circulation of the North Atlantic Ocean cannot also be assessed with confidence.

Other knowledge gaps in climate change science include understanding and predicting future changes in greenhouse gases; better projections of future precipitation/rainfall, evaporation and other climate features that affect our water resources; climate change influences on coasts and oceans, future extreme events including hurricanes/cyclones, flooding rain and storm surge; processes in the atmosphere such as cloud physics that limit our ability to predict future climate; vulnerability assessment methodologies; and mitigation and adaptation technologies.

Required capabilities to address the challenges: In order to fill these gaps, more skilled workers and improved infrastructure are required in earth system modeling, supercomputing, and ocean and hydro-meteorological observations and networks. Climate change must be given the required level of attention and financing in both developing and developed countries. Dynamic, long-term planning mechanisms are needed to research into and manage the inherent uncertainties of climate change, while leadership capacities and institutional frameworks to evaluate and manage climate change risks and opportunities in an integrated manner should be strengthened at the local, national, regional and international levels.

An appropriate policy environment in which climate-resilient policies are implemented in priority sectors and at all levels is also key. For this to happen there must be a flexible national development policy that can fully incorporate climate change risks and opportunities across all levels. Lastly, financing options to meet research, mitigation and adaptation costs must be expanded at the local, national, regional and global levels. A typical national framework must provide a platform for scientific expertise to be encouraged and brought together with policy-making bodies to deliver the essential climate science interventions needed for an effective response to the climate change challenge.

Conclusion: Science plays an important role in increasing our understanding of the complex climate system and its interactions with humanity. Science will continue to be relevant to answer the critical questions of "*what is happening and what we can do about it?*" To continue to unravel the complexities and increase the adaptive capacity of communities and nations, improved scientific knowledge is critical. Climate change science capabilities must be built and developed to deliver the essential information and knowledge in some critical areas. Investment in building and developing appropriate capacity in climate change science will inform appropriate mitigation and adaptation policies and help shape a global solution to climate change.

III. BUILDING A SCIENTIFIC KNOWLEDGE BASE FOR CLIMATE CHANGE MODELLING

(Experiences from South Africa with Examples from the Agriculture, Health & Disaster Risk Management Sectors)

Professor Roland Schulze
Centre for Water Resources Research
University of KwaZulu-Natal

Climate change impacts are often event driven and not merely due to changes in averages. However, not every climatic event is climate change. In order to identify climate change, we need a valid reference point. We cannot project into the future without a solid baseline of present temporal and spatial -climatic conditions. We also need appropriate agro-hydro-climatic models in order to assess impacts.

Databases of baseline conditions: The first challenge in building a scientific knowledge base for climate change impact modelling is that we need appropriately fine-scaled temporal and spatial databases of baseline conditions as a point of departure. Temporal climate variables must be measured at time steps and local resolutions that matter, and stored in a database in a form that is easily retrievable and can be processed to provide useful information. An example is provided by the derivation of detailed temperature information from daily temperature records. First, daily temperature data from numerous sources all over the region is gathered, quality controlled and extended over a common 50 year period, such as 50 years. These data are then used to determine zones and regions of similar temperature, taking into account altitudes and other geographic indices. Lapse rates for Tmax and Tmin and lapse rates by variable are determined for each month and each region. Lastly, a digital evaluation model incorporating region, lapse rates and the quality-controlled temperature data is used to determine daily temperatures for 50 years at several thousand points. From this database we can make various derivations such as monthly means of daily temperature; heatwaves per year by region, maximum/minimum temperatures by region and many others, and these can be mapped for easy visualization.

Agro-hydrological models: Another challenge is the need to develop regionally relevant agro-hydrological models to capture and address processes and responses relevant to climate change. An example from agriculture is a spatial database of homogeneous agricultural and hydrological response zones. This database incorporates a 50 year record of daily rainfall, tmax, tmin, rhmax, rhmin, soils, runoff, land use and crop yields. Detailed soil and plant attributes are coded and "translated" into agro-hydrological model variables which can then be used to calculate and map indicators like total plant available water, soil erodibility factor, fraction per day of excess water, and so on. Other examples include accounting for potential evapotranspiration based solely on temperature; modelling storm flows and base flows, and modelling wetlands and riparian zone processes and reservoir water budgets.

In summary, there are several levels of change analysis that can be considered, and also numerous variables that go into each level of analysis. The use of digital models facilitates the process of examining multiple climate and agro-hydrological variables and the relationships between them.

Isolating key messages on relevant climate change impacts: The purpose of performing these measurements and calculating the various indicators is to generate information that can be used for planning. In the case of South Africa, these databases have been used to provide useful information whilst at the same time raising further questions. In the area of agriculture, it was noted that future year-to-year variability of rainfall and temperature will change, and this will have impacts on agricultral production. Some crops will be "winners" in that they may either enjoy an increased yield or their climatically optimum growth areas will expand; others may be "losers", and some may remain unchanged. This allows planners to make projections of the consequences on national food security.

As an example, the area where sugar cane can be grown is expected to expand; however the sugarcane harvest time is expected to shorten. These changes have implications for biofuel production, foreign exchange earnings, competition with food crops, labour availability, mill operations and transport logistics. Planning for these changes requires an assessment of the entire value chain including feed-forwards and feed-backs. Irrigation water demand is also projected to change, raising questions on how prepared South Africa is to deal with this. In 2010, this analysis was performed for several crops and an Atlas of Climate Change in the Agricultural Sector was produced.

The use of climatic measurements and modelling is not limited to agriculture. In the field of health, modelling has been used to develop a Human Discomfort Index and model this into the future. The models have predicted an increase in the future in the number of days in January (mid-summer) which are too hot / humid for human comfort. Other modelling questions that have been raised around human health include projections of changes in biological pollution (such as excessive *Esarerichia coli* counts); and changes in the annual life cycles of various pests and vectors of disease.

Modelling also helps to predict the occurrence of severe weather events in the future. The frequency, intensity and duration of heatwaves is predicted to increase over the next 40 years. Models are also currently being used to predict how changes in severe rainfall will affect runoff responses. This can be used to predict the occurrence of flooding.

Conclusion: Uncertainties abound in climate change; the only way to go about reducing uncertainties is by using sound science. We need to learn to ask smart questions about climate change impacts, vulnerabilities, and adaptive options. We must also have an integrated approach as climate change assessments cannot be undertaken by any individual sector. It is the responsibility of government, science, industry, and commerce to invest the country's scientific capacity and grow local centres of expertise, rather than becoming dependent on overseas expertise.

SESSION 5:
SECURING INVESTMENTS FOR AFRICA IN A CHANGING CLIMATE

Introduction/Overview: Session 5 examines strategies being employed by international development stakeholders in protecting present and future investments against the effects of climate change.

The first presentation by Amos Abu and Raffaello Cervigni explains how the World Bank engages and finances sustainable development projects. He highlights some of the projects presently being supported by the World Bank and also shares the priority areas of the World Bank for future work on climate change.

The second presentation by Dr. Nyong from the African Development Bank (AfDB) highlights some opportunities presented to Africa by the reality of climate change. He describes the current funding flows to Africa for climate change work and lists several agencies that provide funding for climate change projects. He discusses the process followed by the AfDB in screening, reviewing and selecting programs and describes the various funding instuments offered by the AfDB.

I. ADDRESSING CLIMATE CHANGE IN AFRICA: MOBILIZING KNOWLEDGE TO INFORM DEVELOPMENT ACTIONS

Dr Amos Abu / Dr Raffaello Cervigni
The World Bank

The World Bank and Climate Change: The mission of the World Bank (WB) is “Act Now, Act Together, Act Differently”. The WB is both a development organization and a global facilitator. The WB engages principally at regional level, and has developed a Climate Change Strategy for Sub-Saharan Africa which comprises 4 Pillars of Action:

1. Make adaptation and climate risk management a core component of development
2. Seize mitigation opportunities
3. Knowledge and capacity development
4. Scale up financing

This Regional Strategy is being implemented by integrating climate change into country strategies so that regular WB financing can support climate action and underpin efforts to mobilize climate finance. Several countries in Africa are also benefiting from the WBs Clean Technology Fund or Strategic Climate Fund. Some of the WB-supported climate change related projects in Africa are outlined below:

i. **The WB-Global Environmental Facility (GEF) Sahel and West Africa Program (SAWAP).** SAWAP is a climate and land investment umbrella that seeks to expand sustainable land and water management in targeted landscapes and climate vulnerable areas in the Sahel and humid West Africa. It includes 12 country-led operations now under development, which are backstopped by one regional project to strengthen information and land resource monitoring.

ii. **Comprehensive Africa Agriculture Development Programme (CAADP):** This is aproject that supports several climate smart agriculture actions.

iii. **Kenya Agricultural Carbon Project:** This project supports the adoption by small-holder farmers of "triple wins" agriculture practices.

iv. **Mozambique Cities and Climate Change:** The goal of the initiative is to strengthen the capacity of municipal authotities to enhance resilience to climate related risks

v. **National Plans for Disaster Risk Management:** Burkina Faso, Ethiopia, Ghana, Mali, Malawi, Mozambique, Senegal and Togo have been supported to develop national plans of action for disaster risk management.

vi. **Ethiopia Productive Safety Net Program:** This project aims to build capacity for an improved response to droughts and other events affecting food security.

vii. **Lagos Bus Rapid Transit Project:** This project is reducing congestion, creating jobs and reducing carbon emissions by 20%

viii. **Lighting Africa initiative**: This project targets 250 million sub-Saharan Africans by 2030 through high-tech compact fluorescent lamps (CFLs) and light-emitting diodes (LEDs) powered by renewable energy sources and mechanical means.

Analytical Work: The WB also supports research and analytical work and provides technical assistance for the implementation of projects. Between 2009-2012, there were over 100 tasks (1/3 of the total) in 34 sub-Saharan countries in several areas of the AGN research agenda. Some of the research areas include climate change implications for water resources, land management, transport; economics of Adaptation to climate change; drivers of deforestation in the Congo Basin; Climate Risks Analysis in the Niger Basin; and Climate Change and Infrastructure. The WB recently carried out a climate change assessment in Nigeria and produced a report on opportunities for low carbon developments as part of the Nigeria Vision 20:2020 plan.

Looking forward: Priority Areas for Further Work in Africa. The WB has identified three strategic areas to support further work in Africa:

1. Further integrate climate into development strategies and programs (e.g. infrastructure)
2. Step up efforts into highly vulnerable areas (e.g. dry lands)
3. Strengthen Africa's readiness for climate action at national and regional levels

In all of these, partnership with science organizations is key. New science suggests larger and less predictable impact of climate change, to which Africa stands out as highly vulnerable. The WB has commissioned a new flagship report on a 4 degree world intended to highlight the urgent need to mobilize science to cope with climate uncertainty and the imperative of enhancing the resilience of the infrastructure Africa badly needs to support growth.

Conclusion: There are resources available to address climate change. Under the Copenhagen and Cancun agreements, developed countries have committed to mobilize up to $100 billion/ year in support of climate action in developing countrises . This is in addition to the particular resources committed by the WB itself to climate-related initiatives. African countries will need to strengthen their readiness for planning and project design to attract a significant share of these resources.

II. INVESTING IN AFRICA IN THE FACE OF CLIMATE RISKS

Dr Anthony Nyong
African Development Bank

Africa's countries hold many opportunities for sustainable development. Biofuels have the potential to enhance export revenues while at the same time improving agricultural employment opportunities and producing a clean source of energy. The potential for wind and solar energy are also very high in most parts of Africa. In order to develop this potential, African countries need to be able to attract investments, thus addressing policy and regulatory barriers, reducing high transaction costs; providing sound standards and quality control and creating public awareness.

Sources of Public Climate Finance: Financing for climate change related activities is available from several sources. These include national budgets; Official Development Assistance (ODA); Foreign Direct Investments (FDI); emerging donors (e.g. China-Africa Partnerships); Climate Investment Funds (CIF); the Global Environmental Fund (GEF); The Green Climate Fund (GCF); Multilateral and Regional Development Banks; and Private-Public Partnerships. To present quality proposals, Africa needs to build capacity and integrate climate change into investment decisions and climate-proof investments. This in turn requires that accurate scientific information is available. There is a critical need for investments into research and development of appropriate technology which integrates indigenous knowledge. Good governance and political will are required to address related political and economic risks.

Climate Finance Flows to Africa. The current funding flow to Africa for climate change mitigation projects is about $300 million. The requirement for 2030 is about $25 billion. There is a huge gap in funding which highilghts the need for evidence to support prioritization. For adaptation, the current funding flow is less than $50 million against a requirement for 2030 of about $17 billion.

The Carbon Market is another potential source of funds for climate change projects in Africa. In 2009, the Carbon Market was worth about $143 billion. Very few projects in Africa have been financed through the carbon market although awarenss and interest in this mechanism is growing among African countries (Figure 9).

The African Development Bank's Climate Change framework is divided into three main elements:

1. **Low Carbon Development:** This is concerned with promoting sustainable land and forestry management, promoting sustainable transport, and enhanced investments in clean energy and energy efficiency.

2. **Climate Resilient Development:** This element deals with promoting sustainable land use and water resources management, building resilience in key infrastructure and urban systems , and climate-proofing of AfDB's projects.
3. **Financing Tools:** Financing strategies include mobilizing concessionary resources, catalyzing private capital, and maximizing market mechanisms.

AfDB offers financing through a range of instruments including sovereign and non-sovereign operations and lending using AfDB statutory funds, as well as AfDB-managed donor resources and external resources such as the Strategic Climate Fund. AfDB utlizes a Climate Safeguards System to screen all projects for technical soundness and climate risk, after which they are classified as vulnerable, less vulnerable or not vulnerable to climate risks. The last stage is the decision either to fund or not to fund the project which is based on the priority level and on alignment with AfDBs strategic objectives.

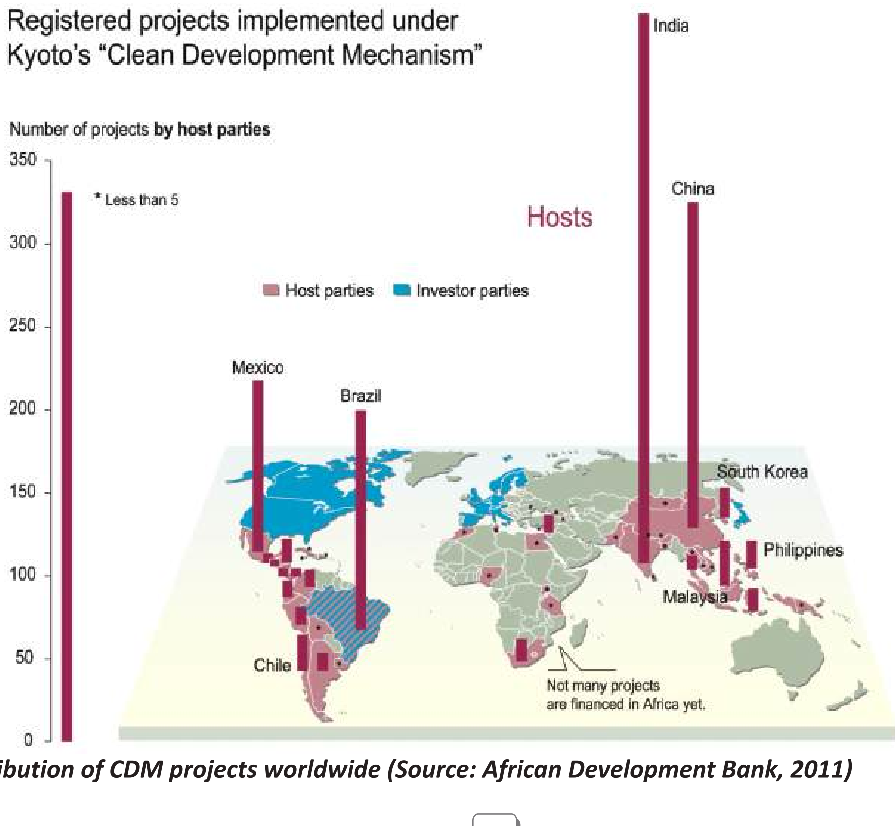

Figure 9: Distribution of CDM projects worldwide (Source: African Development Bank, 2011)

Conclusion: As needs grow and available financing fails to keep pace, funding becomes more competitive. Intended projects are coming under increased scrutiny to ensure soundness and climate resilience. Collabrative partnerships between research institutions and universities , policy makers and other stakeholders are more and more required in the development of projects. This is true not only of the AfDB but with other sources of finance as well. Africa is called to rise up to the challenge of developing capacities to provide accurate information for evidence based planning.

SESSION 6:
THE ROLE OF STAKEHOLDERS IN CLIMATE CHANGE RESPONSE (PANEL/GROUP DISCUSSIONS)

Introduction/Overview: This session comprises the output from panel and group discussions held on both days of the AMASA Conference on Climate Change. Key points from the discussions on both days were highlighted, together with some suggested action items. The panellists for the various discussions were:

1. ***Professor Ratemo W. Michieka***
   Kenyan National Academy of Sciences
2. ***Professor Jutta Schnitzer-Ungefug***
   German National Academy of Sciences Leopoldina
3. ***Professor Oyewale Tomori***
   The Nigerian Academy of Science
4. ***Ms. Jackie Olang***
   Network of African Science Academies
5. ***Dr. Ifejika Speranza***
   University of Bern

Discussion Topic 1:

It has been established beyond reasonable doubt that the threat of climate change is real and that Africa is especially vulnerable. Most of the impacts of climate change in Africa are negative, although there are a few positive impacts. What is needed for both adaptation and mitigation of the effects of climate change ?

- *More research is required in a large number of fields. A great need exists for climate change data that can be used to develop local models to predict climate change. There is also a need for better understanding of the complex systems involved in climate monitoring in Africa.*

- *All actors are implicated in the climate change response , especially in the area of science-policy dialogue. There is a need to integrate scientists, policy makers, the private sector, and a range of civil society stakeholders.*
- *More coordinationis required across sectors to maximize inputs and efficiencies and avoid duplications.*
- *Capacity is limited for scientific research into climate change especially in the area of health impacts of climate change, and climate change modelling and prediction. Urgent capacity building is required.*

The scientific community is not starting from scratch. There exist a number of bodies that are actively working on research, policy and implementation of climate change projects, such as:

i. *Science – Policy dialogue through National Academies of Science*
ii. *The WASCAL Initiative*
iii. *The AIACC programme*
iv. *The ACCFP programme*
v. *The ACCA programme*
vi. *START Small grants*
vii. *University departments*

The scientific community can build on these exiting programs to scale-up climate science capacity and programs.

Discussion Topic 2:
How can we better communicate Climate Science to non-scientists?

Communication is always targetted at a specific audience. The way we communicate with farmers, school children and traders may differ from how we communicate with the press or with politicians. However, what is common to all forms of communication is the need to be understood by the listener or reader.

Common Challenges in Communicating Science:

1. Scientists typically have little or no interaction with policy makers, politicians, opinion shapers, and civil society.

2. There is often skewed and biased reporting by the media. They do not understand climate science and tend to focus only on visible environmental pollution like piles of solid waste, e-waste, and polythene bags which are tangible and visible.
3. Several myths and beliefs about climate issues exist. For instance, some see extreme weather events as a God-induced catastrophe.
4. Scientists are not always good at communicating research findings to non-scientisits.

Suggestions for Action:

1. Advocate for a policy to be formulated which includes climate change issues in school curricula at lower and higher academic levels
2. Issue continuous updates on climate change through various media. Work with the relevant environmental agencies to request slots in the media to highlight specific damages caused by climate change.
3. Prepare evidence-based policy papers for distribution in ministries like Health, Agriculture, Natural Resources to continuously update policy-makers on occurrences due to climate change.
4. Organize training sessions for the media on how to review the information on climate change and write accurate and informative reports.
5. The relevant agencies should issue seasonal weather predictions as an ongoing exercise, and these should be publicized in the media.

Communicating Science simply:

1. Explain all terms used, especially the 'jargon' that are peculiar to that area of knowledge.
2. As much as possible, avoid acronyms. Use everyday language to express concepts and ideas
3. Illustrate points using practical and familiar examples, stories or anecdotes.
4. There may be a need to translate into various local languages if we are targetting the general public.
5. Provide opportunities where possible for questions to be asked by the audience.

Discussion Topic 3

What are the roles of the Academies of Science in policy formulation?

Academies of Science are organizations dedicated to the development and advancement of evidence-based science, technology and innovation policies. They are uniquely placed to bring scientific knowledge to bear on the policies/strategic direction of their country. They provide advice on specific problems of a scientific or technological nature presented to them by the government and private organizations

Roles of the Academies in providing policy advice:

1. Bringing together the leading scientists on a particular issue;
2. Trying to reach a common scientific position, through a rigorous process of discussion, peer review and declaration of interests;
3. Providing a completely independent viewpoint – neither political nor industry influences on science position;
4. Ability to address different relevant audiences: wider public, national governments, regional/sub-regional entities

Improving the provision of science-based policy advice

1. Academies of Science must declare explicitly their desire to make their scientific expertise useful to the wider society.
2. The Academies need to create the platform to engage regularly with policy-makers to supply the scientific view that is needed for creating adequate policies.
3. Academies should proactively bring to the attention of the government, it's agencies and private sector, problems of national interest that science and technology can help solve;
4. Understand existing government policy so as to make meaningful suggestions for changes;
5. Academies of Science work for the promotion of transparency and openness in governance, by ensuring that national policies are based on best and most unbiased evidence-based scientific data
6. Academies can also learn from one another about the provision of policy-advice. This is a particular advantage and strength of the Academy networks across various countries.

KEY MESSAGES FROM AMASA-8

Key points highlighted during the presentations and discussions included the following:

1. The evidence for climate change in Africa is unequivocal and its effects are widespread. They include amplification of temperature changes, abnormal levels of rainfall, increased frequency of extreme events, increasing desertification, and coastline erosion, with consequences for human and livestock health, crop and forestry production, food security, and sustainable development.

2. Africa, although not a major contributor to the emissions that are driving climate change, suffers disproportionately from its effects. This is as a result of the poor adaptive capacities occasioned by poverty, low levels of infrastructural development, and poor access to capital.

3. The effects of climate change vary widely from region to region; therefore national and regional research and monitoring institutes are essential to provide the location-specific data required to inform adaptation and mitigation approaches.

4. There are a wide range of climate change adaptation and mitigation strategies being applied across Africa, especially in the area of agriculture and food security. These include measures to improve agricultural productivity and yield, measures to reduce the carbon footprint of agriculture, and measures to protect farmers from the negative effects of climate change.

5. Capacity is growing within Africa to address the challenges presented by climate change; however there remain significant gaps, especially in the areas of building indigenous databases and prediction models, digital modelling and mapping, and research into the effects of climate change on health.

6. Significant resources are available to assist countries in Africa to adapt to climate change. For countries to take advantage of these opportunities, they must develop robust evidence bases on climate change in their locality, and must also build the capacity to interface with the various funding bodies and understand their financing and investment mechanisms and instruments.

7. Well organized national and regional coordination bodies and structures involving a mix of academia and research institutions, policy-making bodies, civil society organisations, and both large and small-scale private sector stakeholders, are essential to an effective response to climate change.

8. Academies of Science are well placed to raise awareness of the climate change agenda, serve as a rallying point for policy dialogue and action, and lead in the implementation of adaptation and mitigation programs at various levels. This will require the development of more effective methods of communicating science to the media, policy makers, the private commercial sector, and the general public.

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APPENDIX

I. AMASA-8 AGENDA

DAY ONE: OPENING CEREMONY & LAUNCH OF CLIMATE CHANGE REPORT STATEMENT

DAY TWO: TUESDAY, NOVEMBER 13TH 2012

Chair: Gabriel Ogunmola, FAS
Past President NAS

08:00-09:00 Registration

09:00-09:10 **Welcome Message**
Ralph Cicerone & Harvey Fineberg
President United States National Academies & President Institute of Medicine

Opening Keynote Addresses:

09:10-09:30 **Climate Change in Africa: Using Science to Reduce Climate Risks**
Ogunlade Davidson
Former Minister for Power, Sierra Leone

09:30-09:50 **Raising the African Voice on Climate Change**
Youba Sokona
Coordinator, African Climate Policy Centre

09:50-10:15 **Tea break & Networking**

SESSION 1: CLIMATE CHANGE RISKS ACROSS AFRICA

Session Objective: To articulate the risks and effects of climate change across Africa.
This session will discuss:
What we know and need to know about risks of climate change across Africa
How climate change risks relate to extreme weather and disasters
The tools and/or methods needed to fill the knowledge gap of climate risks across Africa

Moderator: Samuel Ayonghe
University of Buea, Cameroon

10:30-10:45 East Africa
Charles Basalirwa
Makerere University, Uganda

10:45-11:00 West Africa
Ibidun Adelekan
University of Ibadan, Nigeria

11:00-11:15 Southern Africa
Roseanne Diab
Academy of Science for South Africa

11:15-11:30 Discussion/Q&A

SESSION 2: CLIMATE CHANGE AND HEALTH

Session Objective: To highlight the climate change risks faced by the health sector:

- What do we know about the links between climate change and vector diseases, epidemics, and other health concerns?
- How can we best address these health concerns given what we know?
- What is the burden of these climate change effects on the health system?
- African Health Systems, Climate Change & Opportunities for Private Sector Collaboration

Moderator: Christian Acemah
United States National Academies

11:30-11:50 Sally Stansfield
Deloitte Consulting, USA

11:50-12:10 Andrew Githeko
Kenyan Medical Research Institute

12:10-12:25 Shibru Tedla
ECO Consult, Ethiopia

12:25-12:50 Discussion/Q&A

12:50-13:50 Lunch

SESSION 3: CLIMATE CHANGE, AGRICULTURE AND FOOD SECURITY

Session Objective: To articulate priority climate change-related risks in agriculture and food security. Issues to be discussed:

- Climate Change in Africa: Implications for agriculture/food security
- What is known about links between climate change, agriculture and food security
- Climate Risk Management in African agriculture : Improving resilience

Moderator: Chinedum Nwajiuba
Nigerian Environmental Study/Action Team

13:50-14:05 Robert Zougmore
Climate Change Agriculture &Food Security Program (CGIAR), West Africa

14:05-14:20 Louise Setswaelo
Food and Agriculture Organization

14:20-14:35 Chinwe Ifejika Speranza
Centre for Development & Environment, University of Bern, Switzerland

14:35-15:00 Discussion/ Q&A

15:00-15:20 Tea break

SESSION 4: DEVELOPING SCIENTIFIC CAPACITY TO RESPOND TO CLIMATE CHANGE

Session Objective: to discuss the development of the knowledge base needed to address the impacts of climate change across Africa:

Moderator: Roseanne Diab
Academy of Science for South Africa

15:20-15:40 *Capacity building and the way forward*
Lead Speaker: Olukayode E. Oladipo
Integrated Ecosystem Management, Nigeria-Niger Project

15:40-16:00 *Building Capacity in Climate Change Modelling*
Roland Schulze
University of Kwazulu-Natal, South Africa

16:00-16:20 *Developing Human Resources for Climate Change*
Adebayo Omotosho
West African Science Service Centre on Climate Change and Adapted Land Use

16:20-16:45 Discussion/Q&A

16:45-17:00 DAY 1 WRAP-UP: SETTING THE STAGE FOR DAY 2
Gabriel Ogunmola *FAS*
LOC AMASA-8

DAY TWO: WEDNESDAY, NOVEMBER 13TH 2012

08:00-09:00 Registration

Chair: Mosto Onuoha, FAS
Vice President, NAS

Opening Addresses

09:00-09:15 **Climate Change: Next steps for the scientific community**
Isabelle Niang
Pan-African Regional Committee for Global Change System for Analysis, Research &Training

09:15-09:30 **Linking Climate Change Science to Policy and Practice**
Anya O. Anya *FAS*
Past President NAS

SESSION 5: USING SCIENCE IN THE POLICY AREA TO REDUCE CLIMATE RISKS

Session Objective: To examine ways in which climate risks can be reduced and the roles of key stakeholders. Panel discussion to address:

- Communicating climate science to non-science stakeholders
- The scientific knowledge gaps to inform policy on reducing climate risks
- Applying the science of Climate Change in policies and programs

Moderator: Jide Alo FAS
University of Lagos

9:30-09:40 Youba Sokona
African Climate Policy Centre

09:40-09:50 Eziuche Ubani
Chairman, House Committee on Climate Change

09:50-10:00 Ratemo Michieka
Kenyan National Academy of Sciences

10:00 -10:30 Discussion/Q&A

10:30- 10:50 Tea break & Networking

SESSION 6: SECURING INVESTMENTS FOR AFRICA IN A CHANGING CLIMATE

Session Objective: To discuss strategies being employed by international development stakeholders in protecting present and future investments against the effects of climate change

Moderator: Njidda Gadzama *FAS*
University Of Maiduguri

10:50-11:00 Investments Keynote Address: Securing our Investments against Climate Risks
Donald Kaberuka
President, African Development Bank

11:00-11:15 Investing in Africa in the face of climate risks
Anthony Nyong
Compliance & Safeguards Division, African Development Bank

11:15-11:25 Marcel Mballa-Ekobena
Standard Bank

11:25 – 11:55 Discussion /Q&A

11:55 – 12:20 Closing Keynote Address: Climate Change in Africa-Taking the momentum forward
Makhtar Diop
Vice President World Bank-Africa Region

12:20 – 13:20 **Lunch**

13:20-14:00 SESSION 7: ROLE OF THE SCIENCE ACADEMIES IN CLIMATE CHANGE RESPONSE

Panel discussion: The role of the science academies in informing policy decisions.

Moderator: David Okali, FAS
Chair, AMASA 8 Planning Committee

- Jutta Schnitzer-Ungefug
  German National Academy of Sciences- Leopoldina

- Jackie Olang
  Network of African Science Academies (NASAC)

- Patrick Kelley
  United States National Academies (USNA)

- Oyewale Tomori *FAS*
  The Nigerian Academy of Science (NAS)

14:00-14:10 **RECAP OF DAY 2 DISCUSSIONS**
Mosto Onuoha
Vice-President, NAS

14:10-14:15 **CLOSING REMARKS**
Oye Ibidapo-Obe
President, NAS

II. JOINT REPORT STATEMENT
RAISING THE AFRICAN VOICE
CLIMATE CHANGE IN AFRICA: USING SCIENCE TO REDUCE CLIMATE RISKS

We, the Science Academies in Africa[†], issue this statement to draw attention to the special features of Africa in relation to climate change, the great uncertainties that exist in understanding how climate change impacts on Africa's climatic, natural and human systems, and the contributions that the scientific community can make in addressing the challenge and exploiting opportunities arising from climate change. We focus especially on impacts on the livelihoods of communities, as it relates to agriculture, food security and health, as well as on developing the capacity for mitigating these impacts and the increasing frequency and intensity of climate change-related disasters in Africa.

Background and Urgency

The realization that climate change will impact more severely on Africa, than on most other regions of the world, compels urgent action to understand the phenomenon better in relation to the peculiarities of the Africa region. Such understanding is a prerequisite to formulating effective responses to reduce the exposure and the vulnerability of the continent to climate change. Science-based information is critical in generating such understanding and formulating effective responses. A hallmark of science-based information is that it is founded more on critically analysed evidence than on experience. There is concern that the African continent has been short in contributing such science-based information to the global analysis, debate, and effort to combat climate change. As a consequence, Africa has not effectively participated in setting the agenda in the global debate, or benefitted adequately from available global opportunities, for addressing climate change.

Despite a few dissenting voices, there is a strong and growing scientific consensus that the current climate change stems from global warming, caused by the accumulation of greenhouse gases, notably carbon dioxide, methane, nitrous oxide, human-made CFCs (chlorofluorocarbons) and a few other gases, largely emitted into the atmosphere by human activity. Africa's contribution to these anthropogenic emissions that exacerbate global warming and climate change historically is minor (about 3% of total anthropogenic emissions) and, because of the continuing low level of industrial activity on the continent as compared with other regions, will continue to be minor far into the future. It is only when global emission is disaggregated by specific sources of emission, that Africa's emission from land use change goes up to 20% of world emission from this source, exceeding that of other regions. In sharp contrast to the low level of contribution to causing the problem, Africa will be disproportionately and severely affected by climate change because it has the least capacity, in terms of adequate information, awareness, preparedness, technology, financial resources, and freedom from other stresses, to adapt to the adverse effects of climate change, putting at great risk the development efforts of the continent towards combating poverty and meeting aspirations such as the Millennium Development Goals.

Special features of Africa in the context of climate change

When dealing with climate change, some features separate Africa from other regions. We focus here on features that have relevance for scientific intervention. First is the large (30.2 million km^2) land mass, stretching approximately from Latitude 37^0 North to Latitude 35^0 South. The land mass of Africa is greater than the land masses of the USA, UK, China, Spain, Germany, France, Italy, Eastern Europe, India and Japan combined[1], yet Africa contributes only three percent of the human emissions that accelerate global warming.

Geographic Variability of African Climates

Africa's land mass encompasses sub-tropical and tropical climatic regions covering a wide variety of climates that range from the humid tropics to the hyper-arid Sahara, and include winter rainfall regions at the northern and southern extremes. The existence of a variety of climates complicates the understanding of the climatic effects of climate change in Africa, especially as the various climates are regulated by different global drivers. While the whole of Africa is known to be warming in this century at a rate faster than the global average, the warming is not uniform in all parts of the continent. The Inter-Governmental Panel on Climate Change (IPCC) observes that the drier sub-tropical regions will be warming faster than the humid tropics. Effects on rainfall will also be varied, so that some parts of the continent will become drier while others become wetter. Most important for the role that science is expected to play is the existence of great uncertainties about how climate change will affect the climates of Africa, largely because of lack of adequate information.

Global Drivers of African Climates

The climates of Africa are driven by three global systems - the Inter-Tropical Convergence Zone, the El Nino Southern Oscillation and the West African Monsoon. Rainfall in the Sahel is also affected by changes in Sea Surface Temperatures. But how the global drivers interact and how they will be affected by climate change are not well understood, beyond the certainty that their outcomes will work to increase 'the incidence and severity of the droughts, floods and other extreme weather events they produce'[2]. The IPCC further identified shortcomings of models applied to understand the effects of climate change on the African climates to include:

- non- inclusion of vegetation and aerosol feedbacks;
- not taking account of land surface changes;
- poor understanding of the limitations of empirical downscaling models; and
- insufficient information for assessing possible changes in the spatial distribution and frequencies of tropical cyclones affecting Africa.

Planning to respond effectively to climate change requires that present and future climate conditions be described as accurately as possible. Global Climate Models do so reasonably well for climate conditions at the global scale, but are too coarse for application at regional or local levels. Therefore, global models must be made applicable, or "downscaled," to describe projections of climate conditions at local or regional scales. When local data are incorporated in the downscaling process, uncertainties can be greatly minimized. Local data are also needed to verify or validate downscaled projections.

In the shortcomings associated with models applied for understanding climate change in Africa, as identified by the IPCC, the importance of vegetation feedback and land surface changes is accentuated by the large land mass of the continent, over which the predominant economic activity is agriculture, which, though critically important for meeting food security needs and contributing to climate change mitigation, constantly interferes with vegetation and land cover. Aerosols are also a significant component of the African atmosphere given at least the dust storms that prevail over the Sahara desert, while the insufficiency of information for understanding downscaling limitations and the behaviour of tropical cyclones is a matter that can be addressed by intensifying local observations. It is emphasized that understanding the effects of climate change on the climates across Africa is fundamental for effective planning and design of responses to those effects.

Advantage from large land mass

The significance of Africa's large land mass spills over to the consideration of Africa's potential role in combating climate change through afforestation and reforestation (A/R), and through agriculture. Forests serve as sinks and reservoirs for the dominant greenhouse gas, carbon dioxide. Hence, together with agriculture, creating forests through afforestation and reforestation is an activity supported by the Clean Development Mechanism of the Kyoto Protocol for mitigation of climate change. The abundant land mass and large areas of past deforestation, coupled with relatively cheap labour, low land rents, and faster growth rate of trees that translates to shorter rotation time for achieving maximum accumulation of carbon, give Africa a distinct advantage over other key actors in climate change mitigation through A/R under the Clean Development Mechanism.[3] The same factors coupled with the strong traditional and cultural linkages of people with trees and forests in Africa, also give the continent a distinct advantage in embracing the emerging mechanism of Reducing Emission from Deforestation and forest Degradation in developing countries (REDD). But it is stressed that realizing the advantage conferred by the abundant land mass and supporting factors will depend on Africa meeting criteria, such as good forest governance and effective land use policies, laid down for participating in the two mechanisms. African scientists are challenged to raise persuasive scientific arguments, based on the great diversity and complexity of land use systems on the continent, to modify these criteria to permit greater participation of Africa in these and other UNFCCC financial instruments.

Climate Change, Agriculture and Food Security

Next to land mass as a special feature is the heavy dependence of the African economy on climate. Agriculture is the dominant economic activity employing more than 60% of the people and accounting for up to 50% of the GDP in some countries.[2] Most of the agriculture, both crop and livestock, is strongly weather- and climate-dependent and crop farming is dominated by small-scale subsistence farmers, augmenting their livelihoods by drawing from their natural resource base. Both agriculture and the natural resource base are highly susceptible to changes in temperature, precipitation, sea level rise and the incidence of extreme weather events that are associated with climate change. Artisanal fisheries and aquaculture are also susceptible to rising water temperatures, sea level rise and storm surges, while CO_2 fertilization from rising carbon dioxide levels in the atmosphere may partly offset adverse effects of other factors on plant production.

Climate change effects on agriculture may be direct or indirect. Direct effects include expected depression of crop yield and agricultural productivity by increasing temperature, in the African tropics and sub-tropics, where, more than in other regions, crops have reached their maximum tolerance limits[2,4]. Crop yields decline for any increase in temperature beyond these limits. Temperature changes also influence livestock productivity directly through effects on the balance between body heat production and heat dissipation, while crop and animal damage by extreme weather events such as flooding can also directly depress agricultural production. By interfering with the timing of farmers' operations, climate change-induced unreliability of the weather also directly affects agricultural production. Many effects of climate change on agriculture are indirect and are made manifest through (a) limitations on water availability caused by protracted reduction in rainfall, droughts and temperature-induced high evapotranspiration; (b) temperature–induced proliferation of crop and livestock pests, and increase in post-harvest losses in conditions of unrefrigerated storage; (c) deficits in soil moisture that translate to diminished soil nutrient supply, which in turn affect plant production, including production of feed and fodder for livestock, and (d) shortage of farm labour due to depressing effects of climate change on human health.

The high dependence of the rural poor on natural resources for livelihood is a special feature to note in considering effects of climate change in Africa. The natural ecosystems (mainly forests, woodlands and the Sahel) relied on for support, especially when climate change depresses agriculture, are themselves threatened by over-exploitation and now also by climate change. Deterioration in these natural systems is reflected in loss of biodiversity and degradation of catchment areas that are crucial for water supply to farmlands, rivers and humans. Degraded natural systems further diminish the capacity of rural people to cope with climate change.

By depressing agricultural productivity and eroding the natural resource base for augmenting agriculture, climate change has the potential to worsen the supply side of the food security equation. Urgent action is needed to build the resilience of the agricultural and natural resource systems in Africa to combat the effects of climate change. Science can positively intervene by informing the development of resilient crop varieties and animal breeds, improving the management of the resources that serve as necessary inputs in agriculture and helping to install sustainable management regimes for natural ecosystems. Developing drought-adapted crops and animals, flood-tolerant crops, as well as salt-tolerant varieties in the coastal regions; designing short-term weather forecasting facilities that can be readily operated by farmers, and refining such forecasts; devising better methods of water management and soil nutrient conservation; developing safer post-harvest products storage technologies; researching to expand the crop base for agriculture; enhancing efforts at supplementing agricultural production and exploitation from the wild with domesticated production, and developing sustainable methods of natural resources utilization, emerge as some of the critical ways by which science can intervene to counter the threat of climate change to food security in Africa. African scientists also recognize the importance of working to improve the integrated agro-production systems of the predominantly subsistence farmers on the continent, which combine conservation agriculture, organic farming, agro-forestry and traditional knowledge, to yield both adaptation and mitigation benefits.

Climate Change and Health

The stability of the health sector in Africa against climate change is already seriously compromised by a heavy burden of disease and disability. The Intergovernmental Panel on Climate Change cites Africa in commenting on the importance of the health of a population as an element of adaptive capacity. The Panel observes that the future of the HIV/AIDS epidemic in Africa, for example, will determine how well African populations cope with challenges like the spread of climate-related vector and water-borne infections, food shortages and increased frequency (and intensity) of storms, floods and droughts. The key concerns in the health sector are not only with the diseases, whose prevalence and virulence may be affected/exacerbated by climate change, but also with the health systems that could be readily overwhelmed by the health-care demands of populations impacted by climate change. We deal here with effects on diseases alone. For vector- and water-borne diseases, emphasis is on the effect of climate change on their transmission dynamics. Studies already show that changes in temperature and precipitation could alter the geographical distribution of malaria, with previously unsuitable areas of dense human populations becoming suitable for transmission. Scenario studies also project altitudinal shifts in malaria distribution in east African highlands by 2050, while a recent simulation study in Nigeria[5] found the risk of malaria epidemic to be linked with projected high relative humidity and rainfall, which support an increase in breeding sites. The point is readily made that by expanding conditions that are conducive to the existence of vectors or by leading to an increase in breeding sites, climate change may enhance disease risk. The exact nature of the impact of climate change on malaria and other diseases, however, remains to be firmly established by detailed concurrent historical studies of climate and each disease, taking account of the influence of interaction with other factors like immunity, drug resistance, malnutrition, poverty and even civil strife and war. The IPCC makes the point that many challenges remain in Africa for climatic- and health-impact and adaptation research.

Extreme Climate-related Events

The frequent prolonged droughts and famines that have ravaged the Sahel and other parts of Africa episodically since the 1970s are extreme climate-related events that cannot be ignored in discussing the impacts of climate change on the continent. Flooding from excessive rainfall, sea level rise and storm surges are climate -related extreme events currently ravaging many parts of the world, with devastating outcomes in Africa. Cases of land or mud- slides, wild fires or pest epidemics have also been reported. The consequences of these events include extensive destruction of settlements with their infrastructure, extensive damage of farmlands, fisheries and other means of livelihood, massive displacements and movements of people, food shortages, disease epidemics and the breakdown in social order sometimes leading to combative conflicts. Displacement and movement of people may occur internally within countries, creating the category of Internally Displaced Refugees (IDRs) or across borders among the 50 countries of the continental land mass of Africa in various patterns of migration. These extreme climate-related events create challenges for disaster risk reduction and management that need to be studied to understand how climatic extremes, human factors and the environment interact to influence disaster outcomes. Provision of the scientific bases for preparing against, and minimizing, the risk of these disasters is the primary challenge to Science.

Actions required of Science include contributions to the development of risk assessments and mapping for various anticipated climate-related extreme events. The refinement of modeling techniques, taking account also of natural systems and traditional knowledge, in developing early warning systems contributes to strengthen risk reduction. Science is also expected to intervene in developing effective and efficient disaster management systems. Ultimately, resolution of the uncertainties in the science of climate extreme - human factor - environment interaction, is the key to developing the adaptive capacity for meeting the challenges of climate-related extreme events on the continent. Detailed observations, assessments and models using climate as the driving factor are needed in this regard.

Role of African Science Academies

Science is well suited to address Africa's urgent developmental needs, including challenges presented by climate change. Global effort to combat climate change is based on the United Nations Framework Convention on Climate Change (UNFCCC), which primarily aims to stabilize 'greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. The current target, pursued by various local and global mitigation efforts, is to prevent global warming from exceeding 2^0C above pre-industrial levels. But the greenhouse gases already emitted into the atmosphere expose the world to global warming with the potential to cause the climate change impacts now being observed. Given the inertia in the climate system, benefits of successful emission reduction efforts are not likely to be realized for a long time. Meanwhile, current climate change impacts, which are more immediately apparent in Africa than they are in most other parts of the world where they are delayed and are not yet certain[2], continue to impede development in Africa. Africa will gain from its scientists working to improve on activities that yield both mitigation and adaptation benefits, such as the integrated agro-production systems that dominate land use on the continent. At the same time, there is need to address urgently climate change impacts that now threaten development on the continent, beginning with elevating the baseline understanding of what climate change means today and will mean to Africa in the future.

Filling the gaps in knowledge about the effects of climate change on the African climate system, so that future scenarios can be effectively modeled, is the first requirement for sound planning of adaptation measures. Extensive, systematic observation and monitoring of climatic events, over a much greater density of hydro-meteorological observation stations is needed to build up the mass of local observations needed to overcome the problems of downscaling global models to local levels. The resulting increases in local data, measurements, and observations could be used in downscaling processes and help reduce the uncertainties about the effect of climate change on African climates, and facilitate planning of interventions to moderate the impacts of climate change.

Expanded observation of local events correlated with monitoring of climatic elements can clear uncertainties and improve the understanding of the impact of climate change on health, agriculture and food security. It will also serve to improve understanding of the interaction of climatic-extremes, human factors and the environment in explaining the nature of climate-related disasters. Effective reporting of these observations will serve to elevate the African voice internationally in climate change debates and negotiations, and contribute to improving African participation in setting the agenda and in the utilization of opportunities for addressing climate change.

Individual scientists already play critical roles in assisting their countries in meeting obligations as parties to the UNFCCC. They are prominent in providing the information, especially the greenhouse gas inventories, required in returning national communications to the Convention. The scientific communities, through the science academies, should be prominent in helping countries formulate their climate change response strategies or plans, utilizing evidence-based information, developed from extensive observations and studies of the situation and the technical aspects of adaptation options in each country. In both the health and the agriculture sectors, the Science Academies are challenged to lead in the development of practices that moderate the adverse effects of climate change, take advantage of beneficial opportunities, and help to build the adaptive capacities and resilience of the people.

For addressing disasters caused by climate-related extreme events, the science academies are challenged to play a leading role not only in convincing their countries but also in working with their national or local governments to develop tools and approaches to better understand and reduce disaster risks, or for elevating resilience to disasters caused by extreme weather events related to climate change and their attendant conditions. Across Africa, increases in the intensity or frequency of floods, mud- or land-slides, drought, ocean surge along the coastlines, and pest and disease epidemics are expected. The Academies should also work to improve and make more effective local early-warning systems and effective ways of communicating early warnings to reduce the risk, losses, and costs of disasters on all African communities, especially those that are considered to be vulnerable. Disaster Risk Reduction work should be accompanied with intervention to improve Disaster Risk Management practices.

An effective platform for pursuing the roles outlined above is the emerging Future Earth initiative of the International Council of Science (ICSU), that builds on the success of existing programmes such as the International Geosphere-Biosphere Programme (IGBP). African Science Academies should be closely linked with this, and other similar programmes, for the study of global environmental change, of which climate change is part. Linkage through ICSU programmes will enable the academies to gain from networking and exchange of information and resources among themselves. Through such a platform, national science academies should maintain a continuing engagement with their governments for providing quality technical advice to decision-makers on climate change. African science academies should also open up to greater collaboration with social scientists in order to deal effectively with the multidisciplinary challenges presented by climate change Support from governments and the Africa Union is crucial for deepening and sustaining the engagement of the Science Academies on climate change research.

Key Messages

- Although Africa contributes marginally to anthropogenic greenhouse gas emissions that accelerate global warming and climate change, Africa will be more severely affected by climate change than most other regions of the world, because of her low adaptive capacity, engendered by inadequate information, low level of awareness and preparedness, inadequate technology, financial constraints and the burden of other developmental stresses especially widespread poverty.
- Africa's contribution of scientific information for understanding climate change has been meagre. In consequence, Africa has not effectively participated in setting the agenda in the global debate, or benefitted adequately from available global opportunities, for addressing climate change.
- The large land mass of Africa, which complicates the understanding of how climate change affects the climates of Africa, the heavy dependence of the African economy, led by agriculture, on weather and climate, and the heavy burden of disease and disability, which seriously compromise the stability of the health sector against climate change, separate Africa from other regions when dealing with climate change.
- Expanded observation of local events correlated with monitoring of climatic elements can clear uncertainties and improve the understanding of the impact of climate change on health, agriculture and food security. It can also serve to improve understanding of the interaction of climatic-extremes, human factors and the environment in explaining the nature of climate-related disasters.
- The greenhouse gases already emitted into the atmosphere expose the world to global warming with the potential to cause the climate change impacts now being observed. Given the inertia in the climate system, benefits of successful emission reduction efforts are unlikely to be realized for a long time. Meanwhile, current climate change impacts impede development in Africa. While working to improve activities that offer both mitigation and adaptation benefits, there is need to increase baseline understanding of current and future climate change in Africa, so that climate change impacts now threatening development on the continent can be urgently mitigated.

Science Academies in Africa are challenged to lead in helping their countries formulate their climate change response strategies or plans, utilizing evidence-based information, developed from extensive observations and studies of the situation and the technical aspects of adaptation options in each country. In both the health and the agriculture sectors, the Science Academies are challenged to lead in the development of practices that moderate the adverse effects of climate change, take advantage of beneficial opportunities, and help to build the adaptive capacities and resilience of the people.

- The scientific community in Africa, led by the Science Academies should intensify detailed observations, assessments and modeling, using climate as the driving factor to resolve the uncertainties in the science of climate extreme - human factor - environment interactions, ultimately helping to develop the adaptive capacity of the continent for meeting the challenges of climate-related extreme events.
- Governments in Africa and the Africa Union should provide and increase their support for scientific research on climate change, and foster a continuing engagement with national Science Academies for providing technical advice on climate change.

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