IDRC/CCAA CAPACITY BUILDING WORKSHOP ON

"INTEGRATED CLIMATE RISK ASSESSMENT"

WORKSHOP TRAINING MANUAL

TABLE OF CONTENTS

Title **Page**

Title **Page**

Title **Page**

Executive Summary

According to the latest fourth IPCC Assessment Report released in 2007 (AR4), the Africa region still stands out as the most vulnerable continent. AR4 has continued to confirm that threat of climate change is real, and Africa together with the other developing countries are expected to be hit hardest due to the current high vulnerability and low coping capacity levels. The limited adaptive capacity of Africa to climate change has been noted as key factor in continent's high vulnerability to climate change. Thus there is urgent need to strengthen the adaptive capacities of all stakeholders in Africa including researchers, policy makers, community groups, etc in order to collectively develop strategies for reducing vulnerability to the adverse impacts of climate change, and to seize the opportunities that climate change may present. The Climate Change Adaptation in Africa (CCAA) Program, a joint program of Canada's International Development Research Centre (IDRC) and the United Kingdom's Department for International Development (DFID), aims to significantly improve the capacity of African people and organisations to adapt to climate change in ways that benefit the most vulnerable members of society.

CCAA has strong commitment to capacity development aimed at (a) supporting research that is African-led, relevant, and that translates improved understanding into appropriate policies and action; (b) enhancing the capacity of individuals and institutions, as well as for learning, development and governance. These efforts are expected to help in creating a pool of climate change researchers and integrate the institutions in to the wider international academic community. The overall purpose of the CCAA programme is to *significantly improve the capacity of African countries to adapt to climate change in ways that benefit the most vulnerable*. This overall purpose is broken down into four objectives to (a) Strengthen the capacity of African scientists, organizations, decision makers and others to contribute to adaptation to climate change; (b) Support adaptation by rural and urban people, particularly the most vulnerable, through action research; (c) Generate a better shared understanding of the findings of scientists and research institutes on climate variability and change, and (d) Inform policy processes with good quality science-based knowledge.

CCAA has education and training activities that are delivered through capacity building workshops, hands-on training awards and Fellowships. The workshop on Integrated Climate Risk Assessment is aimed at providing CCAA projects proponents with foundations of the science of climate change, vulnerability and adaptation assessments and research methods. The first Integrated Climate Risk Assessment capacity building workshop was conducted between 27 – 31st August 2007 in Nairobi. This manual is compilation of the materials that were used at this first workshop, and will form the basis for future training workshops.

The overall approach of the training workshop was through an integrated action and participatory approach. The entire workshop was based on development of capacities with direct and active contribution of all the participants. This approach was generally driven by short presentations, interventions by participants, practical exercises together with demonstration and case studies. Creativity and innovation in the delivery of the workshop presentation was encouraged throughout the entire workshop. To ensure the originality and close interactions, contributions and sharing of experiences from participants was emphasized.

Training materials were also provided. The intention is to avail the participants with relevant materials covering key issues within each of the topics. To assist in this process, a comprehensive Selected Bibliography has been provided at the end of the manual to enable the participants to have access to the main sources of information that were used to compile this manual. Books and articles on the various topics have been included for this purpose. Participants are strongly encouraged to use these bibliographies as sources for further and more specialized reading as relevant to their areas of specialization.

The Manual has been divided into five Modules. The topics covered within these Modules include General Concepts of Climate Risk Management; Methods and Tools for Integrated Climate Risk Management; Adaptation strategies in Integrated Climate Risk Management; Mainstreaming Climate Risk Management in development policies; Capacity gained and benefits by the CCAA funded Projects.

The IGAD Climate prediction and Applications Centre (ICPAC) in Nairobi, and the Regional Centre for Agrometeorology and Hydrometeorology (AGRHYMET) in Niger were the coordinating institutions for the English and French components of the workshop. The Laboratory of Atmospheric and Ocean Physics at University Cheikh Anta Diop Dakar was the Lead coordinating Institution for the workshop. The three institutions worked closely in order to ensure that the proponents got exposed to all French and English speaking experts and training materials. It is hoped that this manual will be useful to a wider range of readership interested in the aspects related to Climate Risk Management.

Module One

General Concept of Climate Risk Management

This Module presents some basic concepts and terminologies that are fundamental for addressing integrated climate risk management issues. These include risk, climate variability, climate change, climate risk management among others. Details of these concepts and definitions are contained in the IPCC, ISDR, UNDP, World Bank among other literatures that has been listed in the bibliography given at the end of this manual. The module also sets scene by providing some climate change fundamentals.

1.1 Some Definition of Key Terms

The definitions of some of the key terms that are commonly used in this manual are included in this section.

Risk: The Intergovernmental Panel on Climate (IPCC) defines risk as a function of probability and consequences of an event, with several ways of combining these two factors being possible. There may be more than one event; consequences can range from positive to negative and risk can be measured qualitatively or quantitatively. UN International Strategy for Disaster Reduction (ISDR) defines risk as the probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable conditions. Thus risk can be presented as a function of hazards and vulnerability.

Hazard: A potentially damaging physical event, phenomenon or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. It should be noted that natural hazards such cyclones / hurricanes, severe winds; heavy rains; rainfall failures; etc cannot be stopped from occurring. Reducing the risks of their negative impacts would depend on how well we know their space-time behaviors and our capacity to mitigate their shocks.

Vulnerability: IPCC and ISDR have defined vulnerability in terms of systems, as ‘the degree, to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. It can also be defined as a set of conditions and processes resulting from physical, social, economical and environmental factors, which increase the susceptibility of a community to the impact of hazards.

Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.’ Vulnerability is therefore a reflection of the state of the individual and collective physical, social, economic and environmental conditions at hand that are shaped continually by attitudinal, behavioral, cultural, socio-economic and political influences at the individuals, families, communities, and countries.

Coping Capabilities/Capacity and Resilience: The manner in which people and organizations use existing resources to achieve various beneficial ends during unusual, abnormal, and adverse conditions of a disaster event or process. The capacity of a system, community or society to resist or to change in order that it may obtain an acceptable level in functioning is referred to as resilience. This is determined by the degree to which the social system is capable of organizing itself, and the ability to increase its capacity for learning and adaptation, including the capacity to recover from a disaster.

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

Risk management: IPCC defines risk management as the culture, processes and structures directed towards realizing potential opportunities, whilst managing adverse effects. ISDR defines disaster risk management as the systematic process of using administrative decisions, organizations, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards.

Risk Assessment: ISDR defines risk assessment as a methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend. The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios.

Disaster risk reduction: The concept of risk management has already been provided that aims at managing adverse effects of the hazards. The concept of disaster risk reduction is referring to the systematic development and application of policies, strategies and practices to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) adverse impact of hazards, within the broad context of sustainable development. The process would ensure that systems are in place for addressing the complex challenges of the hazards so that they do not turn into disasters and interfere with sustainable development.

Preparedness: Activities and measures taken in advance to ensure effective response to the impact of disasters, including the issuance of timely and effective early warnings and the temporary removal of people and property from a threatened location.

Early warning: The provision of timely and effective information, through identified institutions, that allow individuals at risk of a disaster, to take action to avoid or reduce their risk and prepare for effective response.

Mitigation: These are structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards as well as climate change in general. It should be noted that mitigation in terms of the United Nations Framework Convention on Climate Change (UNFCCC) refers to stabilization of the emissions of the human induced gases into the atmosphere. It is evident from the above concepts that good knowledge of the past, present and future patterns of the hazards are critical information for the development of any effective risk management and risk reduction system. According top IPCC, Mitigation is an anthropogenic intervention to reduce the *sources* or enhance the *sinks* of *greenhouse gases*.

Climate variability and climate change: Climate variability refers to the commonly observed departures of every day weather and climate from the usual expectations that are often manifested as droughts, severe storms such as hailstorms, floods, etc. These events occur naturally, and recur year by year**.** Climate change on the other hand refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer).

Climate change is manifested in the changes in the traditional patterns of every day weather and climate including extreme events such as high/low temperatures, droughts, hailstorms, floods, etc. Climate change may result from natural processes or from direct or indirect human activities resulting into changes in the composition of the green house gases in the atmosphere or through changes in *land use*. IPCC definition of climate change is restricted to climate change induced by human activities.

1.1.1 Understanding Risk

Risks are part and parcel of every day life. Awareness of risk is therefore a necessary condition to engage in climate risk management. The focus on risk management reflects a proactive way of dealing with potential threats to social and materials assets, before they are damaged or totally lost. Understanding risk relates to the ability to define what could happen in the future, given a range of possible alternatives to choose from. Assessing risks, based on vulnerability and hazard analysis is a required step for the adoption of adequate and successful disaster risk reduction policies and measures.

The levels of risk awareness depend largely upon the quantity and quality of available information and on the difference in people's perceptions of risk. People are more vulnerable when they are not aware of the hazards that pose a threat to their lives and assets. Risk awareness varies among people, communities, agencies and governments, according to their particular perceptions. These can be influenced by the knowledge of hazards and vulnerabilities, as well as by the availability of accurate and timely information about them. Two elements are essential in the formulation of risk: *the probability of occurrence for a given threat – hazard*; and *the degree of susceptibility of the element exposed to that source – vulnerability*. The negative impact, or the disaster, will depend on the characteristics, probability and intensity of the hazard, as well as the susceptibility of the exposed elements based on physical, social, economic and environmental conditions. Several equations have been presented for the quantification of risks, but most of them are functions of Hazard, Vulnerability and coping Capacity (ISDR, 2002).

1.1.2 Concepts of Risk Assessment

This is a process to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend. Risk assessments include detailed quantitative and qualitative information and understanding of risk, its physical, social, economic, and environmental factors and consequences. Risk assessment encompasses the systematic use of available information to determine the likelihood of certain events occurring and the magnitude of their possible consequences.

As a process, it includes the following activities:

- Identifying the nature, location, intensity and probability of a threat
- Determining the existence and degree of vulnerabilities and exposure to the threat.
- Identifying the capacities and resources available.
- Determining acceptable levels of risk.

Figure 1 gives a representation of the interaction of the risk and vulnerability factors.

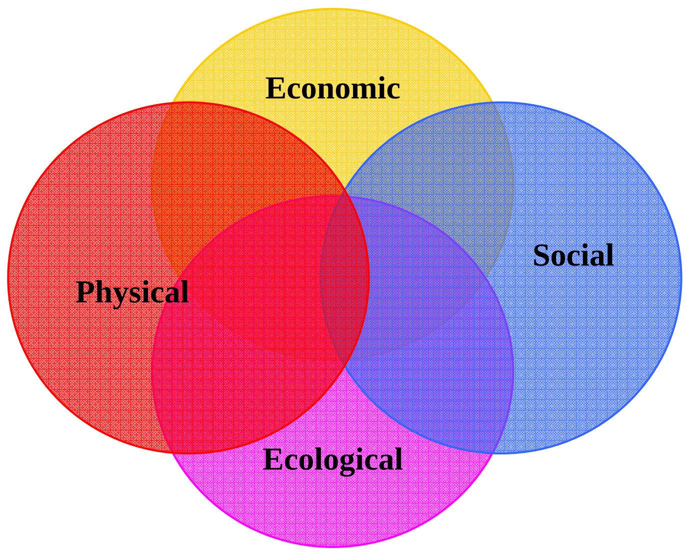

Figure 1: Interaction of Vulnerability factors (Adopted from ISDR, 2002)

Details of methods and tools for risk assessment are discussed under Module 3. The section below discusses hazards concepts.

1.1.3 Concepts of Hazards

One of the key components of risk assessment is a good understanding of the past, present and future characteristics of hazards. A wide range of geophysical, meteorological, hydrological, environmental, technological, biological and even socio-political hazards, individually or in complex interaction, can threaten living and sustainable development. (ISDR, 2002). Hazards can be divided into natural, human-induced technological and increasingly negative effects of environmental degradation are being added to this list. Natural hazards on the other hand can be divided largely into hydrometeorological, geological and biological types. It should be noted that natural hazards cannot be stopped from occurring. We need long period data to enable us learn about their past characterizes, their changing patterns, compute their baseline statistics, and build models to try to predict their future patterns. Table 1 gives some classification of the hazards (ISDR, 2002).

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Hazard Classification	
ORIGIN	**PHENOMENA/EXAMPLES**
Geological Hazards	• Earthquakes, Tsunamis; • Volcanic activity and emissions; • Mass movements, i.e. landslides, rockslides
Hydrometeorological Hazards	• Floods, tropical cyclones, storm surges, hailstorms, wind storms, thunder, lightning etc • Droughts, desertification, wildfires, heat waves, sand or dust storms
Biological Hazards	• Outbreaks of epidemic diseases
Technological or anthropogenic Hazards	• Technological or industrial accidents • Infrastructure failures • Industrial pollution • Nuclear accidents and Radioactivity • Toxic wastes • Dam failures • Transport accidents
Environmental Degradation	• Land degradation • Deforestation • Desertification • Climate Change • Ozone depletion

Table 1: Hazard Classification (*Adopted from ISDR, 2002*)

1.1.4 Concepts of Climate Risk and climate risk management

Climate is also closely linked with most environment resources that derive the local livelihoods and socio-economic systems including health, water resources agriculture /food security, water, hydro-energy, wild life and tourism, among many others. Climatic variability, especially climate extremes often lead to disasters that have far reaching environmental and socio-economic impacts, as is often witnessed during the periods of floods and droughts, especially in the developing countries such as Africa. Extreme climatic events pose risks to people and organizations year after year. These risks arise from the ‘normal’ day-to-day, seasonal, and year-to-year variability in climate as well as regional climate differences.

Climate risks are therefore associated with the threats of the climate hazards, especially the extremes such as floods, droughts, high/low temperatures, hailstorm, etc. Climate Risk Management (CRM) is an approach to coping with past / present climate variability and adaptation to future climate changes through climate-sensitive strategies and decision makings. The principle calls for systems that would cope with current climate variability and at the same time ensure adaptation to the changing climate if sustainable development were to be achieved in any nation with high degree climate variability and change like in Africa. The approach seeks to promote sustainable development by reducing the vulnerability associated with all climate risks.

1.1.5 Concepts of Integrated Climate Risk Management

The hazards also sometimes occur in multiples and the recurrence period of some of them are long. It is therefore not possible for sustainable development to be achieved without an effective and well coordinated multi hazards risk management. The complexity of the risk and vulnerability factors is highlighted in figure 1. Thus the concept of Integrated Climate Risk Management (ICRM), concept calls for an integrated multi-hazards system that can address all hazards and vulnerabilities that threaten the local livelihood systems. These range in scale from actions to manage the local manifestations of local, regional and global climate risk, to measures to reduce multi non climate risks.

1.1.6 Synthesis, Experiences and Lessons Learnt

This is a plenary sessions involving both the French and English groups in order to assess and provide a synthesis of the various topics that have been covered within the Module. It involves brief presentations by the raporteurs of the two groups followed by comments and discussions from the participants and the other experts present. Lessons and experiences from the individual countries, and participating institutions such as ICPAC were briefly presented and discussed.

1.1.6.1 Synthesis

Brief presentations were made by the raporteurs of the two groups followed by comments from the participants and other experts that were present. It was agreed that in general, the documents and presentations made by various experts in the module were quite adequate and were also easy to follow. Few observations were however made that included:

(i) **Time limitations.** Some participants indicated that time allocations for the module were not adequate, since the subject of climate risk was quite new to them.

(ii) **More examples and lessons in some concepts**. Some participants would like to have more examples and lessons on certain concepts such as risk, climate risk, climate change, etc. They appreciated examples that were given for insurance risks, but would like to have examples from countries and specific sectors on the risks associated with the impacts of some recent climate extremes such as drought, floods, tropical cyclone, etc.

(iii) **Documents for the module:** It was noted that several documents that were circulated were in either French or English. The participants were informed that the training was conducted in the two languages to facilitate effective coverage of all aspects of climate risk assessments. It was further noted that the final training manual that will be sent to all participants will be translated in both English and French.

1.1.6.2 Experiences and Lessons

The French and English participants provided some experiences and lessons from their countries and institutions. Some experiences and lessons were also provided by IGAD Climate Prediction and Applications Centre (ICPAC), the Regional Centre for Agrometeorology and Hydrometeorology (AGRHYMET), among many other institutions. Presentation by the AGRHYMET will be included in the French draft of the training module. Only ICPAC experiences and lessons are included here.

1.1.6.2.1 Experiences and Lessons from ICPAC

ICPAC is a specialized climate risk reduction institution for the seven IGAD member countries and three countries in Greater Horn of Africa namely Tanzania, Burundi and Rwanda. The seven IGAD member countries include Djibouti, Sudan, Ethiopia, Eritrea, Uganda, Somalia and Kenya. The main objective of ICPAC is for enhancing regional capacity for mainstreaming climate information in development. ICPAC works with the National Meteorological and Hydrological Organizations (NMHSs) in capacity building, operational research, and to provide regional climate tools for climate risk reduction. ICPAC also works with the sub regional socio-economic groups in mainstreaming climate in sustainable development of the region. For the IGAD countries, the key challenges of ICPAC and NMHSs are how to provide climate information and tools required for food security ; environmental protection; Infrastructure development; Humanitarian Affairs; conflict prevention, resolution and management.

Other climate risk reduction related activities at ICPAC and NMHSs that were presented to the participants include their activities in the following areas:

- Operation research for understanding regional climate and determination of the causes of climate extremes;
- Providing information on the characteristics of the past and present climate hazards
- Identification, and mapping of climate hazards;
- Modeling, prediction, and early warning of future hazards at various time and space scales including climate change time scales;
- Downscaling climate products for sector specific applications;
- Capacity building of climate scientist and sector specific users of climate information;
- Education and awareness;
- Partnerships and regional cooperation;
- Climate change including climate change science such as detection ad attribution of regional / national change signals and development of regional scenarios; impacts ; vulnerability and adaptation.
- Advocacy and catalyzing climate / disaster risk reduction policies.

1.2 Setting the Scene: Climate Change Context

This second session of the module sets the scene for the training by providing fundamentals of some the key climate change issues. These include among others:

- General presentation of climate change science (detection and attribution), impacts, adaptation, mitigation
- Climate change evidence from past and present observations
- Climate Change in Africa and their impacts
- United Nations Framework Convention on Climate Change (UNFCCC and its instruments: Kyoto Protocol, Clean Development Mechanism (CDM), National Adaptation Programme of Action (NAPA), National Communications, Conference of Parties (COP), and Least Developed Countries Fund (LDCF).
- Climate Risks and vulnerability of specific sectors in Africa including agriculture, health, water resources, economy
- General concept on climate change adaptation strategy.

It should be noted that much of the materials used for this module were borrowed from various sources, especially several publications of the IPCC, ICPAC, UNEP and UNDP. Details of these are listed in the annexed bibliography.

1.2.1 Introduction to the Science of Climate Change

The Fourth IPCC Assessment Report (AR4) released in early 2007 had unequivocal identification of human activities finger prints in the changing climate of the planet earth. The attributions of the climate change signals were much clearer compared to the IPCC First Assessment Report (FAR), Second Assessment Report (SAR), and Third Assessment Report (TAR). The fourth assessment has clearly documented much progress that has been made in the understanding of the human and natural drivers of climate change, Observed Climate Change, Climate processes and attribution, and Estimates of projected future climate change. Some of the key climate change fundamentals that may be relevant to the training manual are highlighted below.

1.2.1.1 Detection and Attribution of Climate Change

Detection of climate change is the process of demonstrating that climate has changed in some defined statistical sense, without providing a reason for that change. Attribution is the process of providing the most likely causes for the detected change. Both detection and attribution rely on accurate, long-period observational data and some new generation model outputs. It also requires good understanding of the global climate system and the interactions with the regional and local factors. Some of these are highlighted in figure 2.

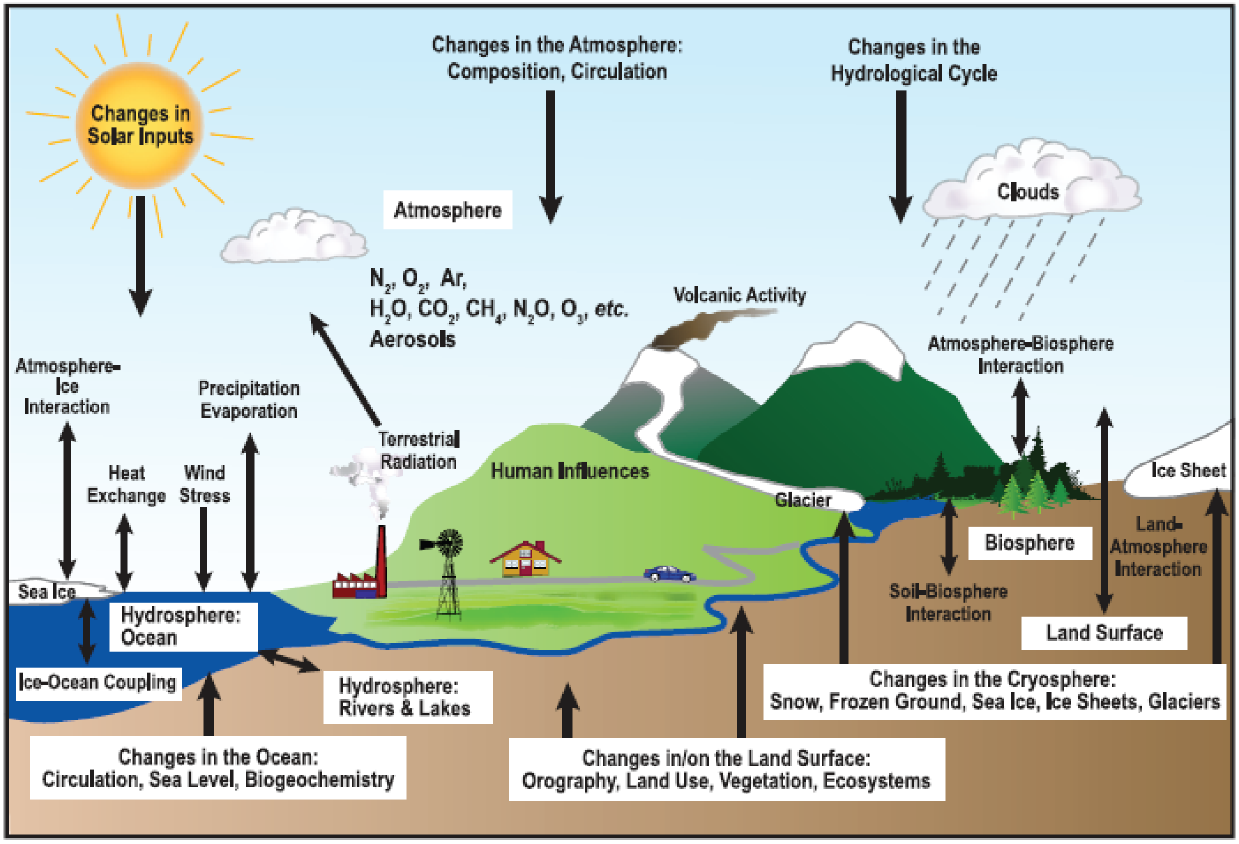


Fig 2: Schematic diagram of the interaction between the various components of the climate system (IPCC, 2007)

1.2.1.2 Climate Change Evidences from Past and Present Observations

Detection of past climate patterns requires accurate, long-period and representative records of the components of the global climate system. In most regions, such records are missing. The situation is worst in Africa. Most of the current information on climate change is largely based on the last three IPCC reports. This section will provide some highlights from the fourth IPCC assessment that was a joint receiver of the 2007 Nobel Award with Al Gore.

1.2.1.2.1 Greenhouse gases trends

Climate change has been associated with human activities particularly the burning of fossil fuels (oil, coal and natural gas) and land use activities that have continued to increase the concentration of greenhouse gases in the atmosphere including CO_2, CH_4, CFCs, O_3 and H_2O. Figure 3 gives the observed concentrations of the some of the Greenhouse gases (GHGs) over the last 10,000 years.

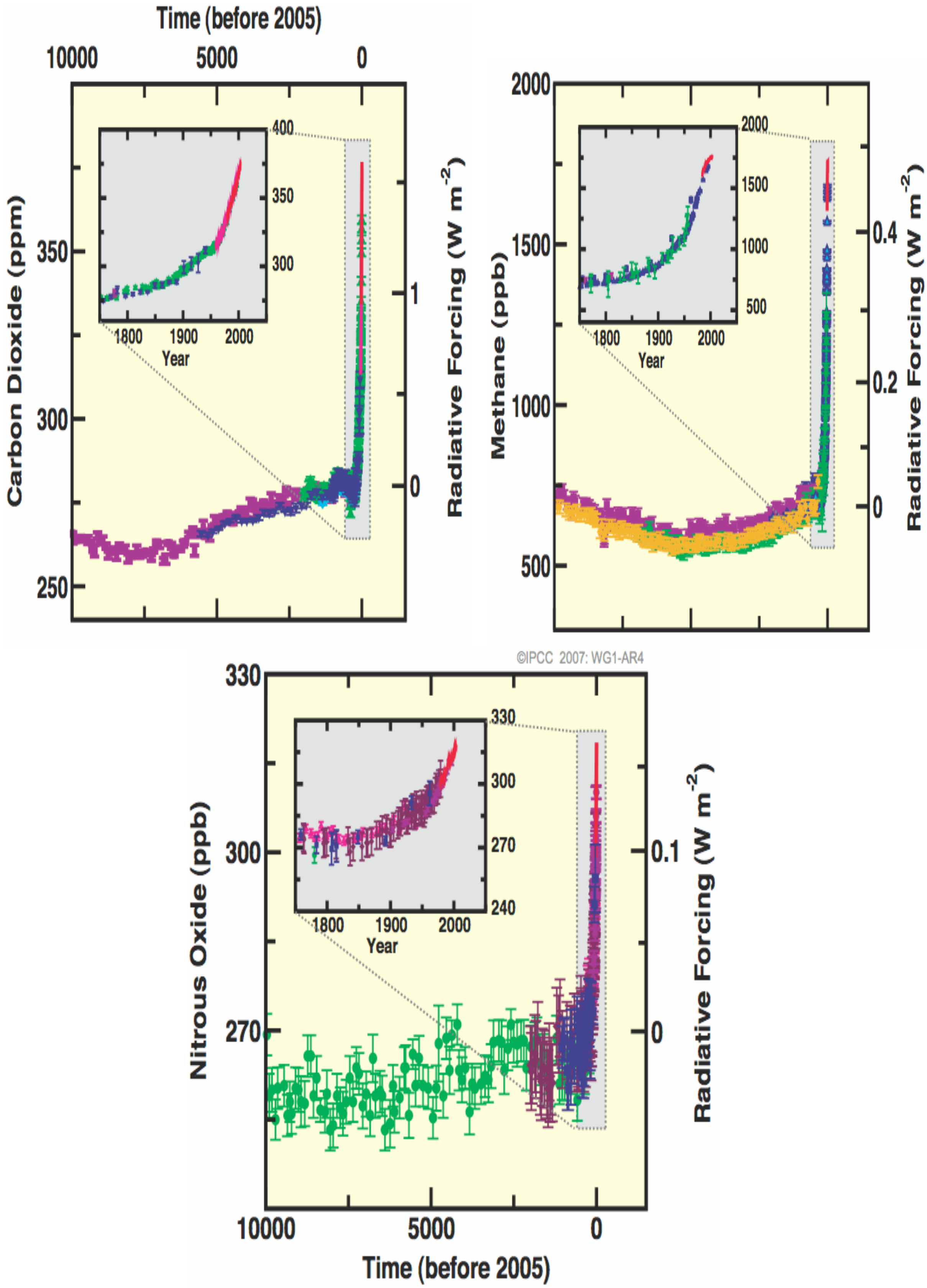


Fig. 3: Observed GHG concentrations (Source: IPCC, 2007)

IPCC (2007) has for example reported that:

- The global atmospheric CO_2 concentration increased from 280 ppm (pre-industrial) to 379 ppm in 2005. The 2005 value exceeds by far the natural range over the last 650,000 years (180 to 300 ppm). Annual CO_2 concentration growth-rate (average 1.9ppm/yr) was larger during the last 10 years (1995 – 2005) than it has been since the beginning of continuous direct atmospheric measurements (1960–2005 average: 1.4 ppm per year)
- The global atmospheric concentration of CH4 increased from 715 ppb (pre-industrial value) to 1,732 ppb in the early 1990s, and was 1,774 ppb in 2005. The 2005 value exceeds by far the natural range of the last 650,000 years (320 to 790 ppb);
- The global atmospheric concentration of N_2O increased from 270ppb (a pre-industrial value) to 319 ppb in 2005.
- The combined radiative forcing due to increases in carbon dioxide, methane, and nitrous oxide is +2.30 [+2.07 to +2.53] W m–2, and its rate of increase during the industrial era is *very likely* to have been unprecedented in more than 10,000 years;

1.2.1.2.2 Past climate changes

Both instrumental and geological evidences show that the global climate has changed substantially in the past. The geological time scale changes can be attributed largely to changes in the natural forces that control global climate system such as changes in the Earth’s orbital parameters which affect changes in the intensity of solar radiation received by earth, earth-sun distance, daily and seasonal earth movements, gravitational force, Earth’s magnetic force, meteor impacts, volcanic eruptions and natural changes in ocean temperatures and circulations. Figure 4 below shows significant changes in temperature over parts of the world over the last 1000 years, while some trends from instrumental records are shown in figure 5, (IPCC, 2007).

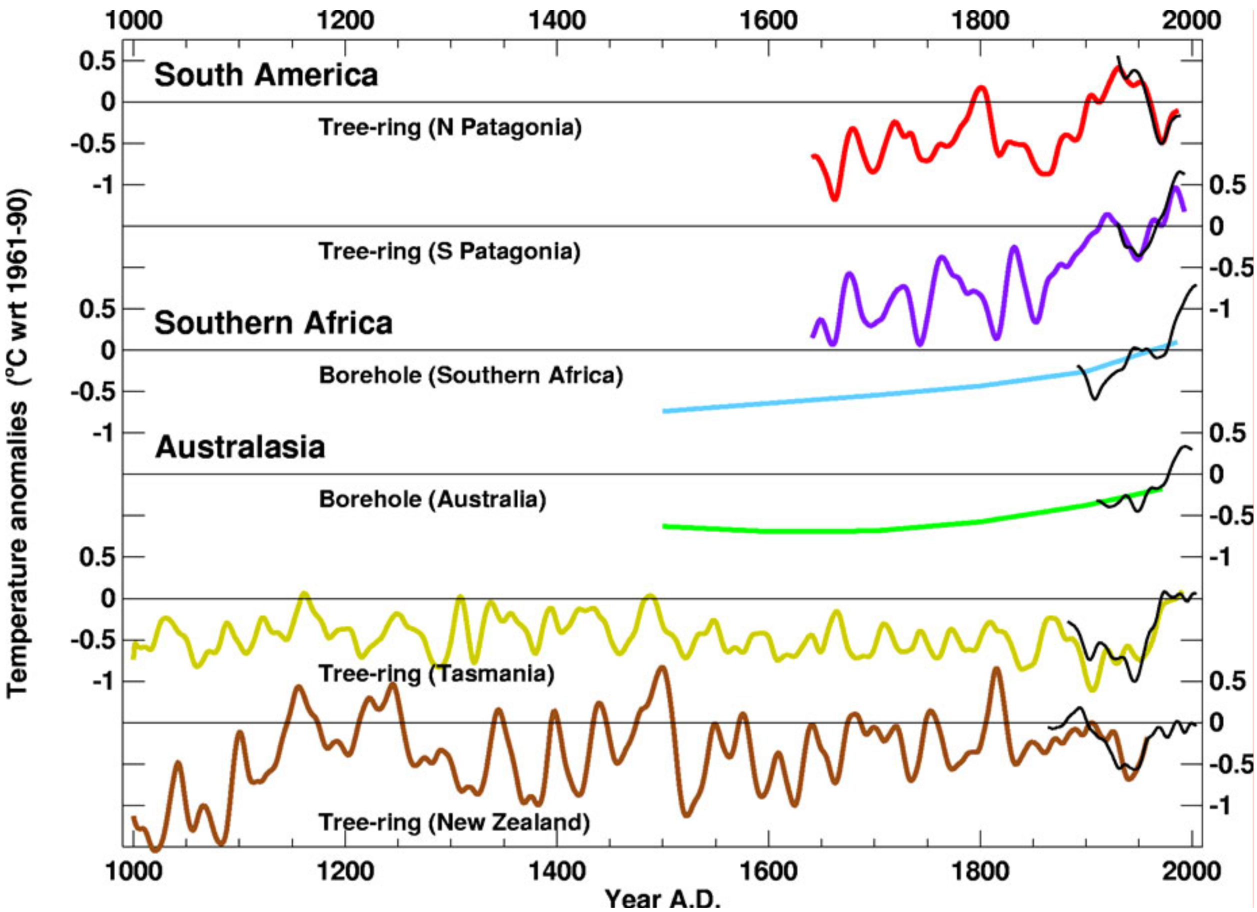


Figure 4: Temperature reconstructions for some regions in the Southern Hemisphere (IPCC, 2007)

It has been noted that since pre-industrial era, human activities particularly the burning of fossil fuels (oil, coal and natural gas) and the clearing of forests, have continued to increase the concentration of greenhouse gases in the atmosphere including CO_2, CH_4, CFCs, O_3 and H_2O that trap the energy received from the sun thereby acting as a blanket thus warming the earth. Figure 5 shows global and hemispheric series of combined SST and land surface air temperature. Increasing temperatures since pre-industrial period has been documented by last four IPCC assessments.

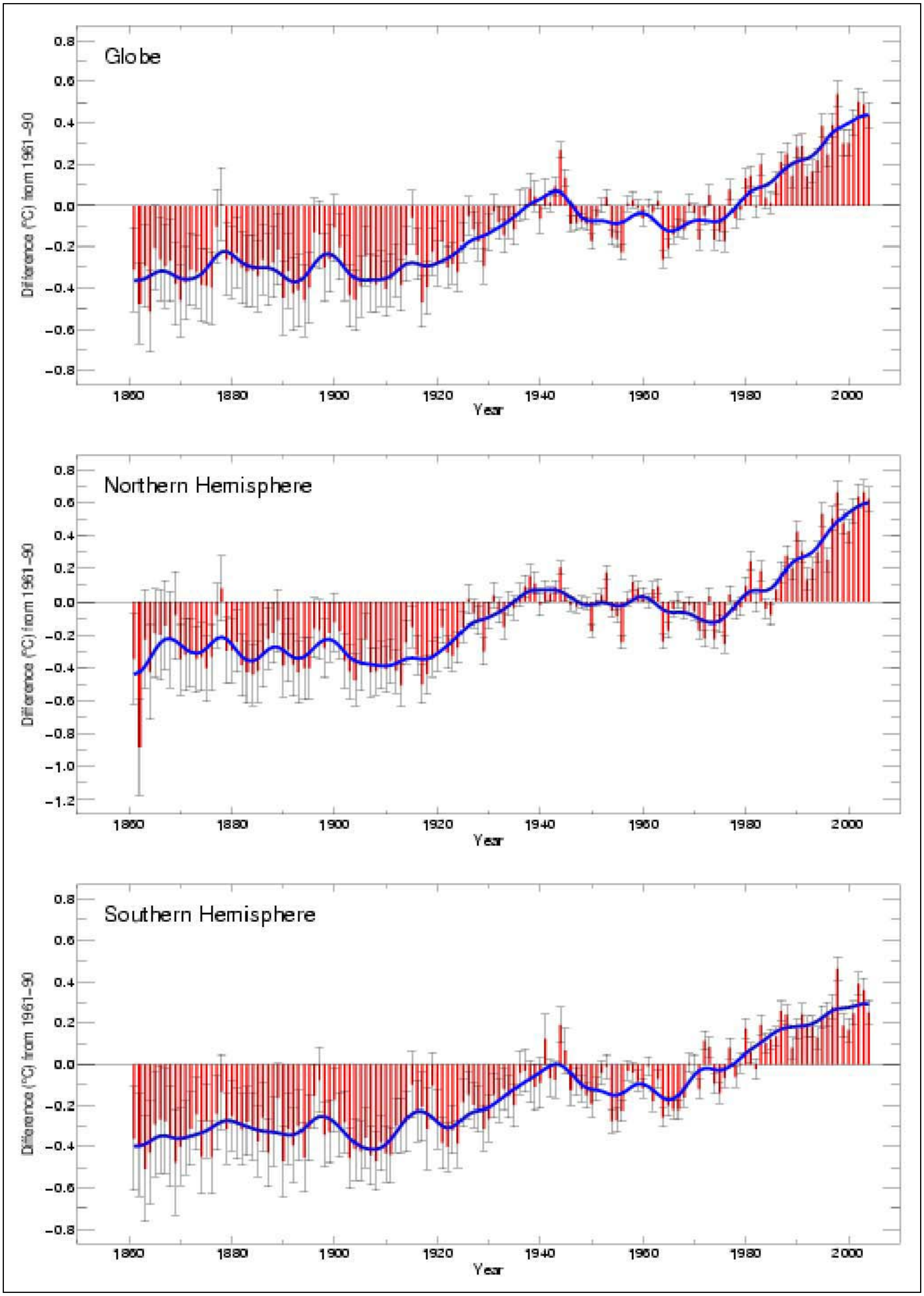


Figure 5: Global and hemispheric series of combined SST and land surface air temperature (IPCC 2007)

IPCC fourth assessment report has found that warming of the climate system is unequivocal. Evidences from observations indicate increases in both global average air and ocean temperatures, leading to widespread melting of snow and glaciers, global mean sea level rise, and changes in the regional climate patterns including extreme climate events such as drought, flood, cyclones, etc. IPCC (2007) has for example reported that:

- The updated 100-year linear mean global temperature increasing trend (1906 to 2005) is about 0.74°C. The linear warming trend over the last 50 years 0.13°C per decade) is nearly twice that for the last 100 years;
- Widespread changes in extreme temperatures have been observed over the last 50 years. Cold days, cold nights and frost have become less frequent, while hot days, hot nights and heat waves have become more frequent;
- Eleven of the last twelve years (1995–2006) rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850);
- Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level;
- Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations;
- Global average sea level rose at an average rate of 1.8 [1.3 to 2.3] mm per year over 1961 to 2003. The rate was faster over 1993 to 2003: about 3.1
- Observations since 1961 show that the average temperature of the global ocean has increased to depths of at least 3000 m and that the ocean has been absorbing more than 80% of the heat added to the climate system;
- The average atmospheric water vapour content has increased since at least the 1980s over land and ocean as well as in the upper troposphere.
- Mountain glaciers and snow cover have declined on average in both hemispheres.
- At continental, regional and ocean basin scales, numerous long-term changes in climate have been observed. These include changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones;
- Long-term trends from 1900 to 2005 have been observed in precipitation amount over many large regions. Significantly increased precipitation has been observed in eastern parts of North and South America, northern Europe and northern and central Asia. Drying has been observed in the Sahel, the Mediterranean, southern Africa and parts of southern Asia. Precipitation is highly variable spatially and temporally, and data are limited in some regions. Long-term trends have not been observed for the other large regions assessed;
- More intense and longer droughts have been observed over wider areas since the 1970s, particularly in the tropics and subtropics. Increased drying linked with higher temperatures and decreased precipitation has contributed to changes in drought;

- The frequency of heavy precipitation events has increased over most land areas, consistent with warming and observed increases of atmospheric water vapour;

- Temperatures of the most extreme hot nights, cold nights and cold days are *likely* to have increased due to anthropogenic forcing. It is *more likely than not* that anthropogenic forcing has increased the risk of heat waves

The next section addresses climate variability and change in Africa.

1.2.2.3 Past Climate Variability and Changes in Africa

The climate of most parts of Africa can be classified as arid or semi arid which is a hot spot in terms of high degree of inter-annual rainfall variability. The driest parts of the continent include Kalahari and Sahara deserts with virtually no precipitation throughout the year. It is therefore not surprising that most of the continent is prone to extreme events such as droughts and floods with far reaching socio-economic devastations that include damage to infrastructure, loss of life, mass migration of people and animals, poor crop yields, food shortages, famine, malnutrition, and many other socio-economic miseries (ICPAC/UNDP, 2007).

The climate extremes often wipe out decades of national development investments, and infrastructures and often force many African nations to re redirect most of their scarce resources planned other national development activities to disaster response and recovery including relief programmes. Climate change leading to changes in the space-time patterns is yet another threat to Africa's development efforts. It brings with itself impacts on human populations, natural resources, ecosystems, etc which will bring new risk levels requiring new or modified coping strategies

The systems that control the space-time patterns of climates of Africa include the Inter-Tropical Convergence Zone (ITCZ) characterizes, Monsoonal wind systems, Subtropical anticyclones, cyclones , Squall lines, North Atlantic Oscillation (NAO), extra tropical weather systems, and teleconnection with global climate systems such as El Niño-Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), among many others. Climate change will result into changes in the space-time variability of these African climate controlling systems. Some examples of the recent trends and climate change signals in African are shown in Figures 6-9.

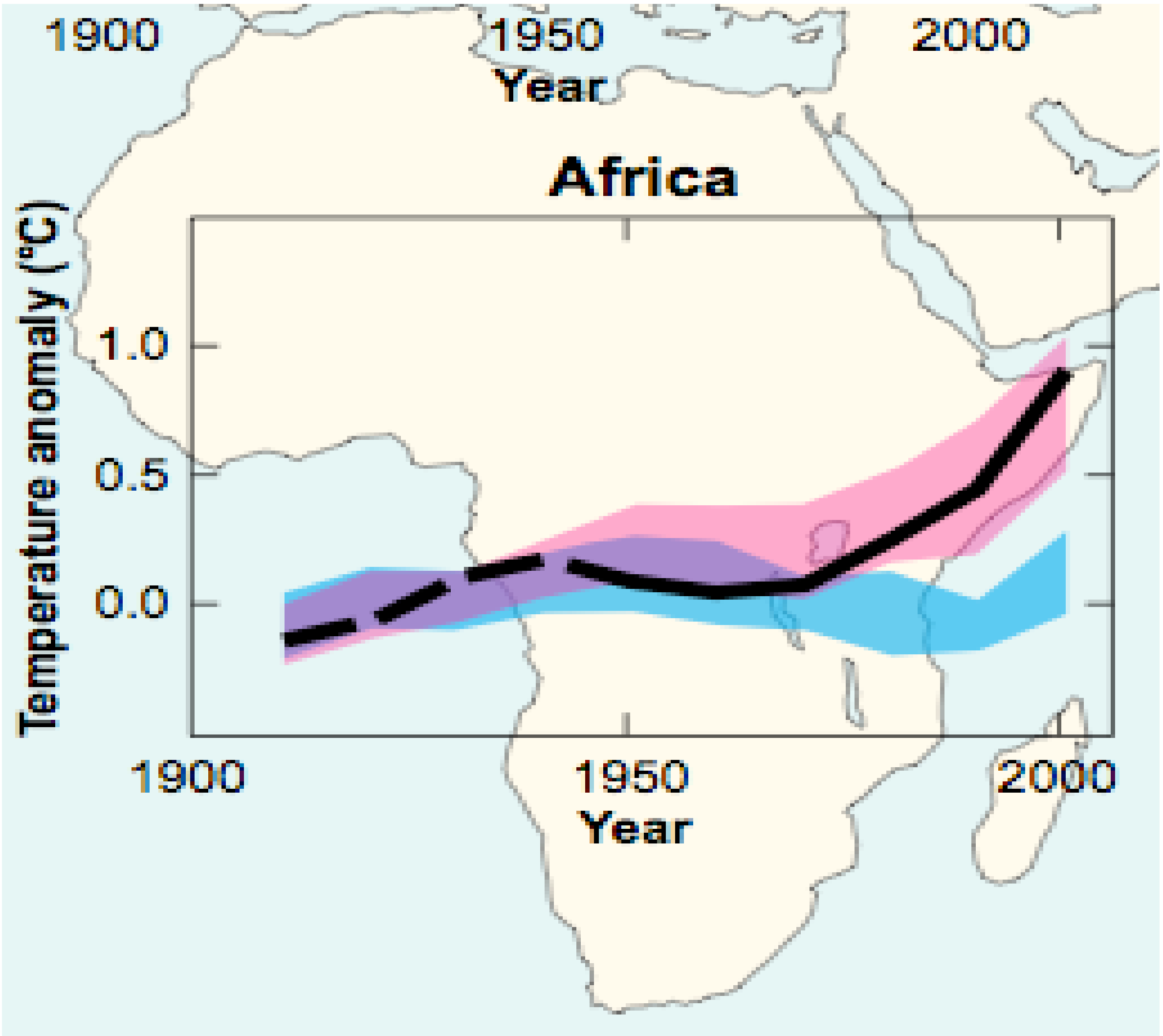


Fig 6: Mean annual temperature trend in Africa: (black line); (IPCC, 2007)

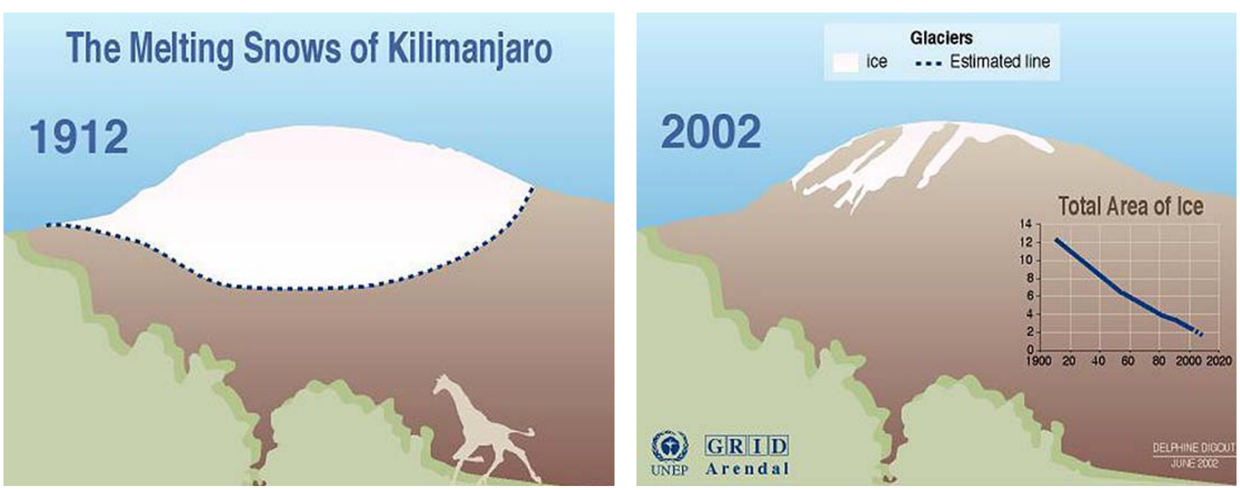


Figure 7: Rapid disappearance of Mt. Kilimanjaro glaciers (UNEP)

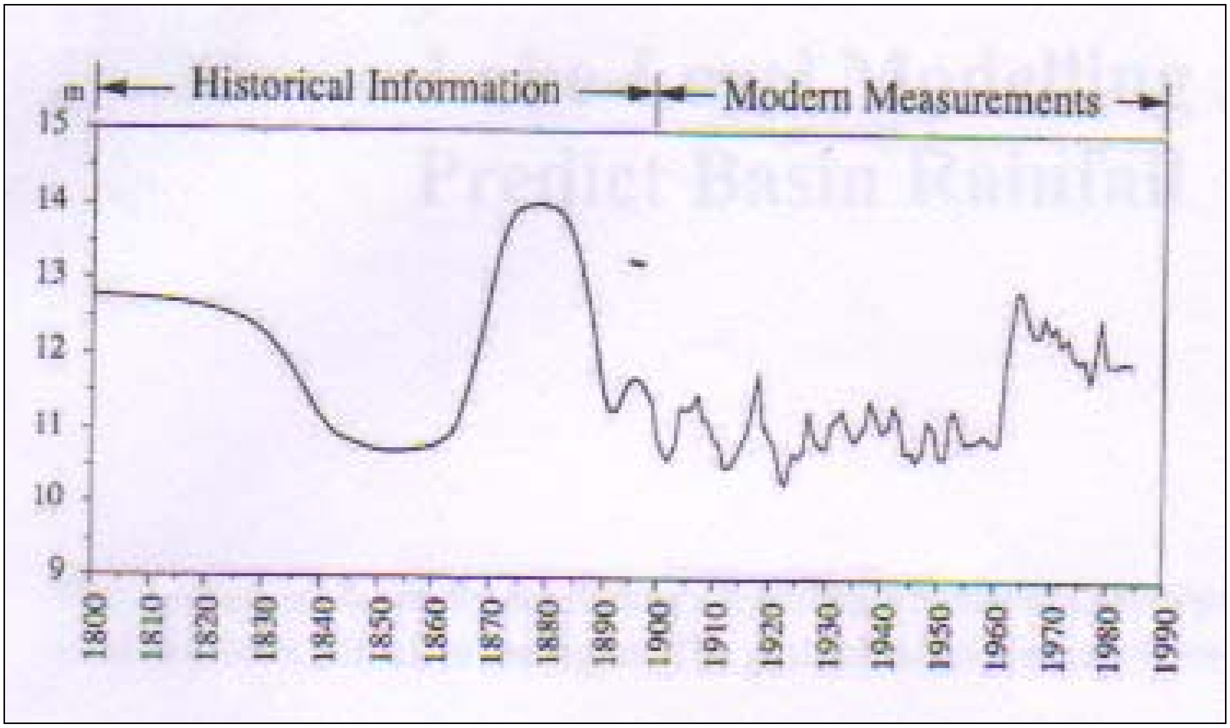


Figure 8: Long-term fluctuations of Lake Victoria, based on both historical information and modern measurements at Jinja, Uganda (IDEAL 1996)

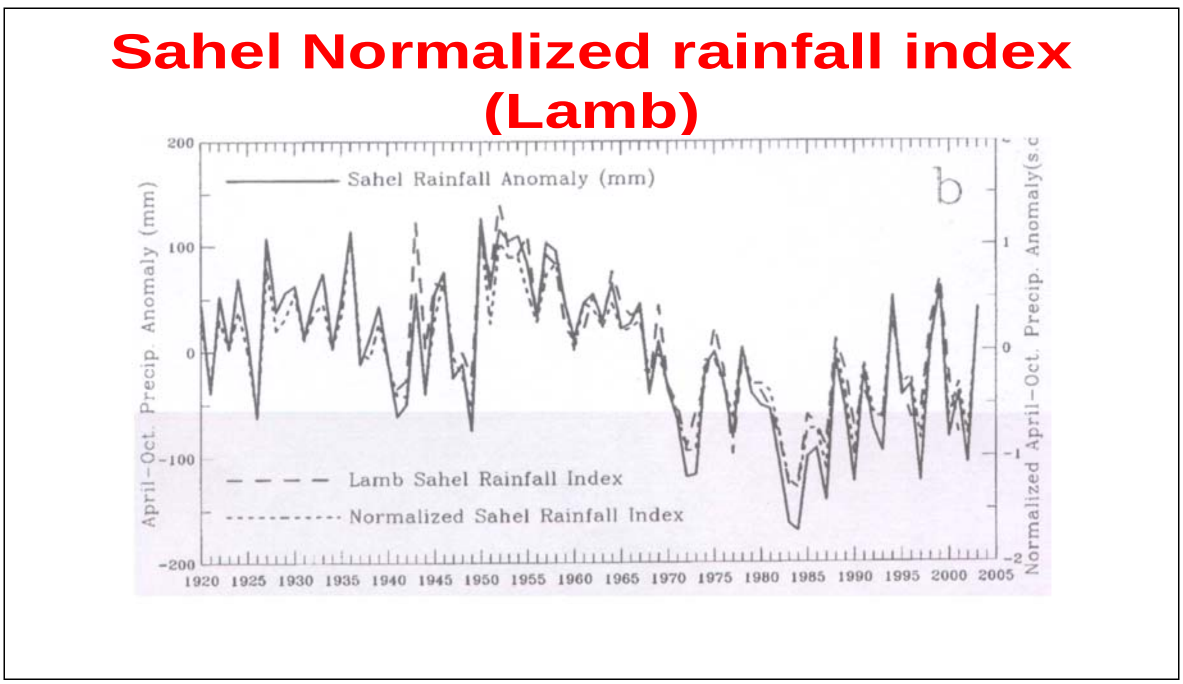


Figure 9: Sahel rainfall trends (Lamb 2003)

Observational records show that the continent of Africa is warmer than it was 100 years ago. Warming through the 20th century has been at the rate of about 0.05°C per decade (see Figure 6). The 5 warmest years in Africa have all occurred since 1988, with 1988 and 1995 the two warmest years. This rate of warming is not dissimilar to that experienced globally, and the periods of most rapid warming, the 1910s to 1930s and the post-1970s, occur simultaneously in Africa and the world.

The semi-arid areas of the Sahel, the Kalahari, and the Karoo historically have supported nomadic societies that migrate in response to annual and seasonal rainfall variations. Nomadic pastoral systems are intrinsically able to adapt to fluctuating and extreme climates provided they have sufficient scope for movement and other necessary elements in the system remain in place. However, the pro-longed drying trend in the Sahel since the 1970s has demonstrated the vulnerability of such groups to climate change: they cannot simply move their axis of migration when the wetter end already is densely occupied and permanent water points fail at the drier end. The result has been conflicts, widespread loss of human life and livestock, and substantial changes to the social system.

The gradual, yet dramatic disappearance of glaciers on Mount Kilimanjaro is a result of global warming (IPCC, 2007). An estimated 82% of the icecap that crowned the mountain when it was first thoroughly surveyed in 1912 is now gone. According to recent projections, if recession continues at the present rate, the majority of the glaciers on Mount Kilimanjaro could vanish in 15 years (See Figure 7). The snow and glaciers of Mount Kilimanjaro act as a water tower, and several rivers are drying out in the warm season due to the loss of this frozen reservoir. Other glaciers in Africa (Ruwenzori in Uganda and Mount Kenya) are also under similar threat.

It should be noted that future climate change projections will be discussed in the later sections, after the discussion of regional climate change scenarios.

1.2.2.4 The United Nations Framework Convention on Climate Change (UNFCCC) and Its Instruments

The section provides some information on the United Nations Framework Convention on Climate Change (UNFCCC), its associated instruments, together with other related subjects.

1.2.2.4.1 The United Nations Framework Convention on Climate Change (UNFCCC)

Climate change is considered to be one of the most serious threats to sustainable development, with adverse impacts expected on the environment, human health, food security, economic activity, natural resources and physical infrastructure. Global climate varies naturally, but scientists agree that rising concentrations of anthropogenically emitted greenhouse gases in the Earth's atmosphere are leading to changes in the climate. The international political response to climate change began with the adoption of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. The UNFCCC sets out a framework for action aimed at stabilizing atmospheric concentrations of greenhouse gases in order to avoid "dangerous anthropogenic interference" with the climate systems. The UNFCCC entered into force in March 1994.

1.2.2.4.2 The Kyoto Protocol

In 1995, the first meeting of the Conference of the Parties (COP 1) established the Ad hoc Group on the Berlin Mandate, and charged it with reaching agreement on strengthening efforts to combat climate change. In December 1997 in Kyoto Japan, delegates agreed to a Protocol to the UNFCCC that commits developed countries and countries making the transition to a market economy (Annex 1 Parties) to achieve quantified emission reduction targets. It contains legally binding emissions targets for Annex I countries for the post-2000 period. These countries commit themselves to reduce their collective emissions of six key greenhouse gases by at least 5% below 1990 levels between 2008 – 2012 (the first commitment period) with specific targets varying from Country to Country.

Each country's emissions target is to be calculated as an average over the five years. "Demonstrable progress" towards meeting the target must be made by 2005. Cuts in the three most important gases – carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_20) - will be measured against a base year of 1990 (with exceptions for some countries with economies in transition). The Protocol also established three mechanisms to assist Annex 1 Parties in meeting their national targets cost-effectively namely: an emissions trading system; Joint Implementation (JI) of emission – reduction projects between Annex 1 Parties; and a Clean Development Mechanism (CDM) that encourages projects with sustainable development benefits to be hosted by Non-Annex 1 (developing Country) Parties. The Kyoto Protocol came into force on 16th February 2005.

1.2.2.4.3 The Conference of the Parties (COP) and Subsidiary Body for Scientific and Technical Advice (SBSTA)

The Conference of the Parties (COP) is the 'Supreme body' of the Climate Change Convention. It is responsible for keeping international efforts to address climate change on track. It reviews the implementation of the Convention and examines the commitments of Parties in light of the Convention's objective, new scientific findings and experience gained in implementing climate change policies. A key task is to review the National Communications submitted by Parties. Based on this information, the COP assesses the effects of measures taken by Parties and the progress made in achieving the ultimate objective of the Convention.

The Convention also established two standing 'subsidiary bodies': the Subsidiary Body for Scientific and Technical Advice (SBSTA) and the Subsidiary Body for Implementation (SBI). These bodies give advice to the COP and each has a specific mandate. SBSTA's task is to provide the COP with advice on scientific, technological and methodological matters relating to the Convention. It serves as the link between the scientific information provided by expert sources such as the Intergovernmental Panel on Climate Change (IPCC) on the one hand, and the policy-oriented needs of the COP on the other. The SBSTA works closely with the IPCC, sometimes requesting specific studies from it. The Conference of the Parties (COP) of the Convention also serves as the meeting of the Parties (MOP) for the Protocol. This structure has been established to facilitate the management of the intergovernmental process. Parties to the Convention that are not Parties to the Protocol will be able to participate in Protocol-related meetings as observers.

1.2.2.4.4 The National Communication (NC)

The National Communication (NC) is a collective effort of relevant stakeholders for highlighting the national actions needed in addressing climate change issues, including adaptation options for addressing adverse climate change impacts and GHG mitigation options in various socio-economic sectors. Data and information reported would have implications for national planning and for future funding of projects (e.g., CDM, etc), and hence they must be as accurate as possible. It is a useful document that should be fully integrated with the national sustainable development plan.

The National Communication should contain the following among others a national inventory of anthropogenic emissions by sources and removal by sinks of all GHGs; a general description of steps taken or envisaged by the non-Annex I Party to implement the Convention and any other information considered relevant to the achievement of the objective of the .

1.2.2.4.5 The Clean Development Mechanism (CDM)

The purpose of the Clean Development Mechanism (CDM) is to assist parties not included in Annex1 of UNFCCC in achieving sustainable development and in contributing to the ultimate objective of the Convention and to assist Parties included in Annex 1". One issue of great concern to African countries is the lack of CDM projects in sub-Saharan Africa and the resulting imbalance in the geographical distribution of the CDM. Africa accounts for less than three percent of the value of total CDM transactions worldwide, and sub-Saharan Africa for less than 2 percent.

There are a number of causes contributing to the lack of CDM projects in Africa and these include:

- Lack of enabling CDM investment environments;
- Inadequate access to commercial credit;
- Low level of fossil fuel use resulting in few opportunities to reduce emissions.

1.2.2.4.6 The Least Developed Countries Fund (LDCF) and the National Adaptation Programmes of Action (NAPA)

Adaptation is vital, even if countries reduce their greenhouse gas emissions, and also sustainable development attained in any country. Any successful adaptation strategy needs to be based on sound scientific assessment. In response to this need, the Nairobi work programme on impacts, vulnerability and adaptation to climate change was launched in 2005. The objective of the five-year programme is to help countries improve their understanding of the impacts of climate change and to make informed decisions on practical adaptation actions and measures.

Developing countries are the most vulnerable to climate change impacts. A number of developing countries have drawn up adaptation plans or are in the process of finalizing them. This includes the National Adaptation Programmes of Action (NAPAs) of least developed countries. The NAPAs allow identification of priority activities that respond to immediate needs and concerns for adaptation to climate change. They build upon existing coping strategies at the grassroots level and promote the use of relevant traditional knowledge and practice.

The Least Developed Countries Fund (LDCF) was also established to assist Least Developed Country Parties (LDCs) carry out, inter alia, the preparation and implementation of National Adaptation Programme of Action (NAPA). In order to address the urgent adaptation needs of LDCs, NAPAs focus on enhancing adaptive capacity to climate variability, which itself would help address the adverse effects of climate change
(See http://unfccc.int/essential_background/kyoto_protocol/items/1678.php)

1.2.2.5 Millennium Development Goals (MDGs)

The world's concern about the human condition in the 21st Century is voiced in the Millenium Declaration, which calls on governments to put in place actions that will lead to noticeable improvements in the human condition by 2015. The dream of making significant differences in human well being by 2015 is given concrete expression in the Millenium Development Goals (MDGs); a set of quantified and time-bound targets for reducing poverty by 2015.

The MDGs give governments a common framework for structuring policies and practices. The framework facilitates speed and efficiency in complying with the MDG spirit in planning, budgeting and monitoring at the national level. The MDGs also bring clarity to the shared and individual roles and responsibilities of key actors: of Governments to achieve or enable the achievement of goals and targets; of the network of international organizations to marshal their resources and expertise in the most strategic and efficient way possible to support and sustain the efforts of partners at the global and country levels; and of citizens, civil society organizations and the private sector to engage fully in tremendously improving human conditions by 2015. The goals are as listed below:

- Goal 1: Eradicate Extreme Poverty And Hunger.
- Goal 2: Achieve Universal Primary Education.
- Goal 3: Promote Gender Equality And Women Empowerment.
- Goal 4: Reduce Child Mortality
- Goal 5: Improve Maternal Health.
- Goal 6: Combat HIV/AIDS, Malaria and Other Diseases.
- Goal 7: Ensure Environmental Sustainability
- Goal 8: Develop Global Partnership For Development.

The next section examines the climate change risks and vulnerability on the Socio-economic sectors in Africa.

1.2.2.6 Concept on Impacts and Adaptation in Africa

IPCC fourth assessment report has shown that any change in climate will have more adverse socio-economic impacts in Africa than in other parts of the world, due to the vulnerability of society and the sensitivity of the environment. Hazards such as floods, drought, desertification, locust infestation, infectious diseases, epidemics, and resources based armed conflicts continue to inflict loss of property, injury, death, food insecurity, health hazards, environmental degradation, poor economic performance, displaced people, environment refugees, and among many other disasters.

Extreme climate events such as floods and droughts account for most of the natural disasters in the continent. Although drought is a slow onset hazard, it is impacting on more people in Africa than most hazards. Climate change is projected to increase the risk of drought over many parts of Africa in the 21st century, partly through altering the frequency of El Niño events. Drought impacts are often aggravated by poor policies, or alternatively, conflicts over limited water, food and grazing resources. Floods occur in arid areas as well as humid areas. In some tropical areas floods results from tropical cyclones.

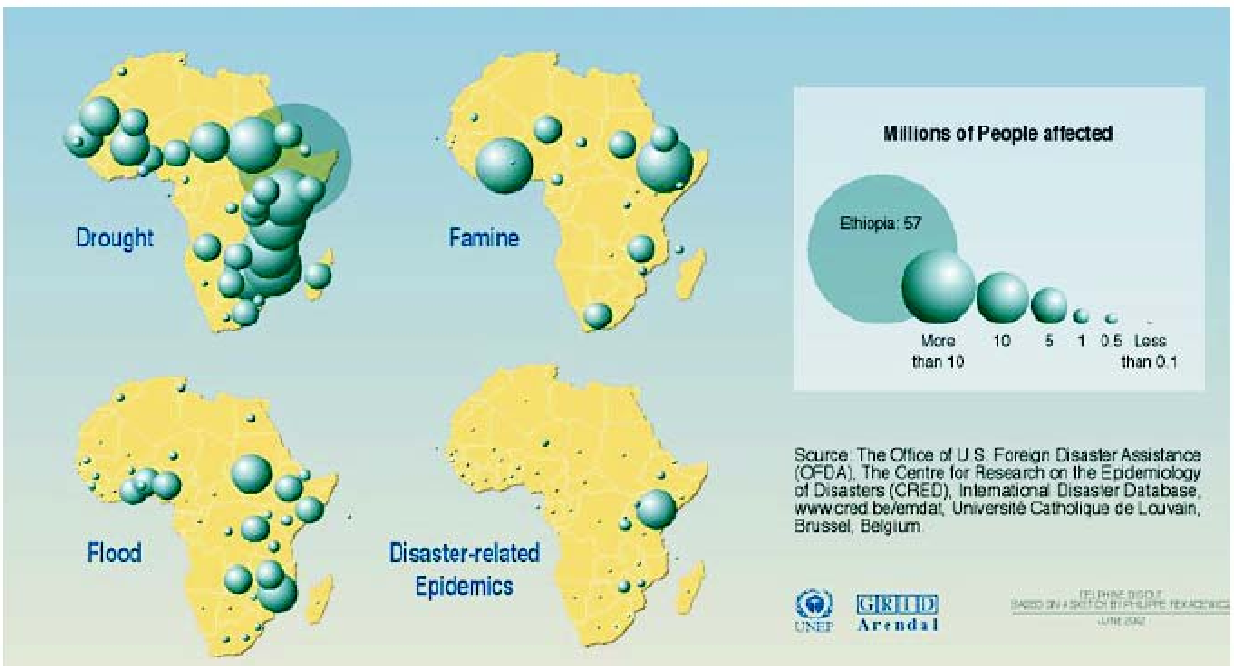
Tropical cyclones are associated with very strong winds; heavy rainfall and flooding, Strong surges and waves. The devastation Floods and sea level rise are key threat to low lying coastal regions, low river basins and small islands. Various forms of agriculture are the key sources for food and livelihoods for most societies in Africa The economy of most countries in Africa rely on rain fed agriculture that is highly vulnerable to extreme weather and climate events such as floods and droughts. The impacts of the extreme climate events therefore significantly affect the welfare of the communities and tend to escalate poverty in the region. Furthermore, the economies of most of the countries in Africa dependent on climate sensitive sectors like agriculture, tourism and hotel industry, among others. The freshwater resources are distributed unevenly across Africa. Some rivers start from the humid climate trek many kilometers through desert countries as the only source of water for all uses.

A good is example is the Nile River that starts from Lake Victoria and Ethiopian highlands, then run through Sudan and Egypt into the Mediterranean. The demand for available freshwater resources increases year by year due to the fast population growth. Climate factors, especially rainfall has significant impacts on availability and quality of water resources systems of the region (IPCC, 2001).

Climate change leading to reduced rainfall and freshwater resources ability could be one of the major sources of conflicts in Africa. Flooding of such river basins would also affect water quality due to siltation and destruction of the rich low river basins that support most livelihoods. In addition, increased frequency of flooding and drought will also stress freshwater systems and pressurize water supply networks. Most energy for industrial and urban areas in many locations in Africa is derived mainly from hydropower. The resource is highly dependent on and sensitive to extreme climatic fluctuations such as droughts and floods. Droughts are known to be accompanied with low water levels in the major dams while floods bring a lot of silt into the dams and can sometimes lead to destruction and damage to the turbines.

A variety of tropical diseases common in Africa are sensitive to changes in meteorological parameters such as rainfall, temperature, and humidity. These include malaria, cholera, and Rift Valley Fever (RVF), and meningitis among other others. Climate change therefore has critical health implications. Changes in rainfall will affect the presence and absence of vector- and water-borne pathogens). For example, Malaria is normally spread by a certain type of mosquito, whose survival and multiplication depends to a large extent on specific environmental and climatological conditions.

In recent times, significant variations in climate extremes have been observed over parts of the region that may have effects of the disease. It has for example been observed that some areas that were once classified as cold and malaria free zones are now becoming warmer and good breeding sites for mosquitoes and hence frequent malaria epidemics. Climate variability change would have far reaching impacts on health as has been recognized by many recent attempts to address health related MDGs (IPCC, 2001). Figure 10 below highlights some of the recent impacts associated to climate extremes in Africa between 1971 and 2000, which signifies the devastating consequences of future climate changes in Africa if no adaptation measures at taken today.



Source: UNEP – Vital Water Graphics, 2005

Figure 10: People affected by natural disasters between 1971 and 2000 (UNEP, 2006)

Thus any climate change would have far reaching socio-economic implication in Africa. Africa also has low institutional and financial capacity for adaptation to climate changes. The vulnerability of Africa to extreme climate variability and change calls for an urgent need to address adaptation issues in Africa. Climate change adaptation concept calls for the development of measures that would help reduce the vulnerability of natural systems, human population and economies to future climate changes for environment management and sustainable development.

1.2.2.7 Synthesis, Experiences and Lessons Learnt

The second major plenary session for the two groups was convened where the rapporteurs provided synthesis of what has been covered in this module. These were followed by discussions and interventions from the two groups of participants and the experts present. Lessons and experiences from participating institutions were also discussed. Translation was provided in all plenary sessions. The session also assessed the progress of the training.

The concerns by the participants in this module were quite similar to those raised for the first module, especially time limitations for presentations. Participants also gave some highlights on the national experiences and lessons. Regarding vulnerability of the continent to multiple risks, it was noted that most countries in Africa cannot deal even with minor urban fire risks very well in the slums. It was recommended that community risk management systems be enhanced in all countries. The need for the continent to increase Africa's adaptive capacity at all levels was also recommended in order to reduce the current high level of vulnerability of the society. Participants agreed that Africans should not wait any longer because any delayed action may lead to higher costs of adaptation in the future risks. The approach should be ensure availability of an effective community based multihazards risk management systems.

Among the other issues that were raised by the participants include the following:

- Africa needs to draw on all stakeholders (scientist, academia, civil society organizations, government and the people) to tackle climate risk dilemma in development.
- Africa needs to tap on its local scientists in order to enhance contributions to the climate change knowledge and global conventions and debates, e.g. renegotiation by UNFCCC that is expiring in 2012. Africa can no longer afford to shy away from the political debates of environmental issues.
- The need to build adaptive capacity around ability to reduce people's vulnerability. The scale of analysis is also important (intra-household, household, community, national, regional or global).
- It was agreed that Africa needs to be working towards some positions in order to have some common stand during the renegotiation of UNFCCC.

Module Two

Methods and Tools for Integrated Climate Risk Assessment

This module presents fundamental of the evaluation methods and tools to evaluate impacts of, and vulnerability and adaptation to climate change. Some of the methods and tools can be obtained from:

- IPCC workshop on adaptation to climate variability and change
- IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations
- UNEP Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies
- UNDP Adaptation Policy Framework (APF)
- Assessment of Impacts and Adaptations to Climate Change in Multiple Regions and Sectors (AIACC)
- Guidelines for the preparation of National Adaptation Programmes of Action (NAPA)
- IPCC-TGCIA Guidelines on the Use of Scenario Data for Climate Impact and Adaptation Assessment.

Further information can also be obtained from various IPCC, ISDR, World Bank Reports, UNDP, WMO, and UNEP reference among others. Details of the references are listed in the annexed bibliography.

2.0 Climate Risks Evaluation Methods

The concept of Climate Risk was highlighted in this Module as a function of climate hazards and vulnerability. Evaluation of climate change hazards and assessment of the associated vulnerability and adaptation, require information from a wide range of physical, biological, social science among many other disciplines, and would consequently employ variety of methods and tools including those for evaluating the impacts. Climate risks evaluation methods must therefore include techniques for evaluating and mapping the past, present and future patterns of hazards, their impacts and vulnerability or coping capacity. It also requires there need to know and evaluate the risks arising from local scale climate hazards and vulnerability such as climate triggered drought, floods, epidemic and other impacts.

The basic dimension underlying evaluation of risks including those associated with the following among others:

- Specification and desired consequences
- The probability of reoccurrence of the risk
- Perceived risk
- Re-affirming the judgments and estimates;
- Ranking the risks in terms of their severity;

- Screening out minor risks that can be set aside and which would otherwise distract the attention of management; and
- Identifying those risks for which more detailed analysis is recommended

For the development of an effective climate risk evaluation system accurate and adequate data and information are required on Hazard, Vulnerability (social, economical, environmental) and Capacity. Figure 11 below shows some linkages between climate change and risk. For instance, if one considers temperature as the climate variable, then in the event of climate change, the number of hotter days will become more common and this will put more pressure on the demand for cooling facilities and the risk will be the inability to meet the demands, if no adaptation strategies were initiated, as normal component of development plan.

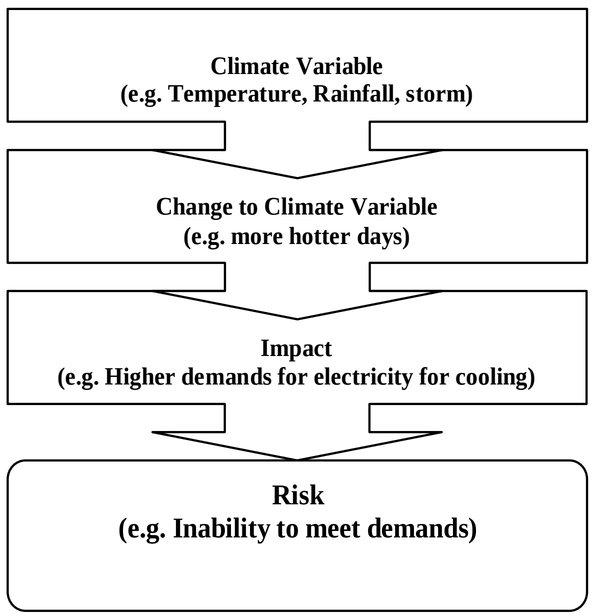


Fig. 11: Linkages between climate change and risk
(Source, Australian Greenhouse Office (AGO), 2006)

In order to be able to evaluate the risks, one must first understand the detailed characteristics of the hazards of climate change, Identify and evaluate the risks (Figure 12). One needs also to consider various scales of risks inkling the mega ones in the country or locality. It should be noted that not all risks have negative effects; some could be beneficial to certain segment of the population while others are not.

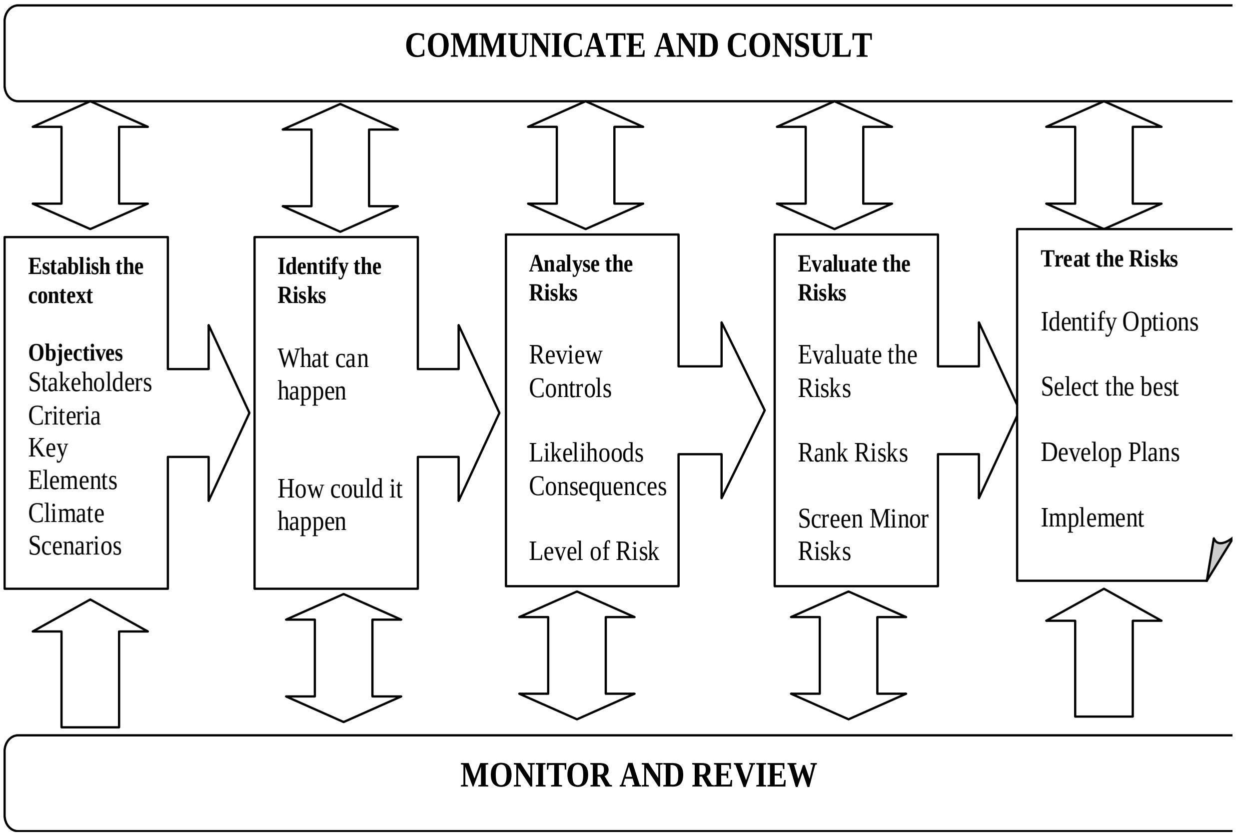


Fig. 12: Steps in the risk management process (Source, Australian Greenhouse Office, 2006)

Some of these are highlighted in this Module. Issues related to the need for realistic climate change scenarios for impacts, vulnerability and adaptation studies; data availability and quality; together with roles of remote sensing and GIS tools will also be highlighted in this Module.

2.1 Evaluation of Climate Change Hazards

Section 1.1.3 provided some general concepts of the hazards. This section will be devoted to some evaluation methods for climate hazards that may be generated from climate variability and/or climate change. Such hazards will be manifested ranging from the 'normal' day-to-day, seasonal, and year-to-year variability in climate like those shown in figure 13 below, as well as global and regional climate change. It should be noted that climate change need not only be manifested in changes of the long term average, but can also be modulated in changes in the climate variability patterns including, intensity and frequency.

Figure 13 below show some examples of changes in long term mean trend and interannual variability patterns. Such changes can be quantified in terms of changes in various parameters of the frequency distribution of the climate variable by computing the mean, mode, median, variance, skewness, kurtosis, and the other higher order moments of the time series. Several time series analyses methods are also available for examining statistical significance of trends, and cyclical nature of the inter-annual occurrences of extremes.

(i)Changing frequencies and amplitudes

(ii) Changing trend plus some extremes

(iii) Changing trend, Frequencies and amplitudes

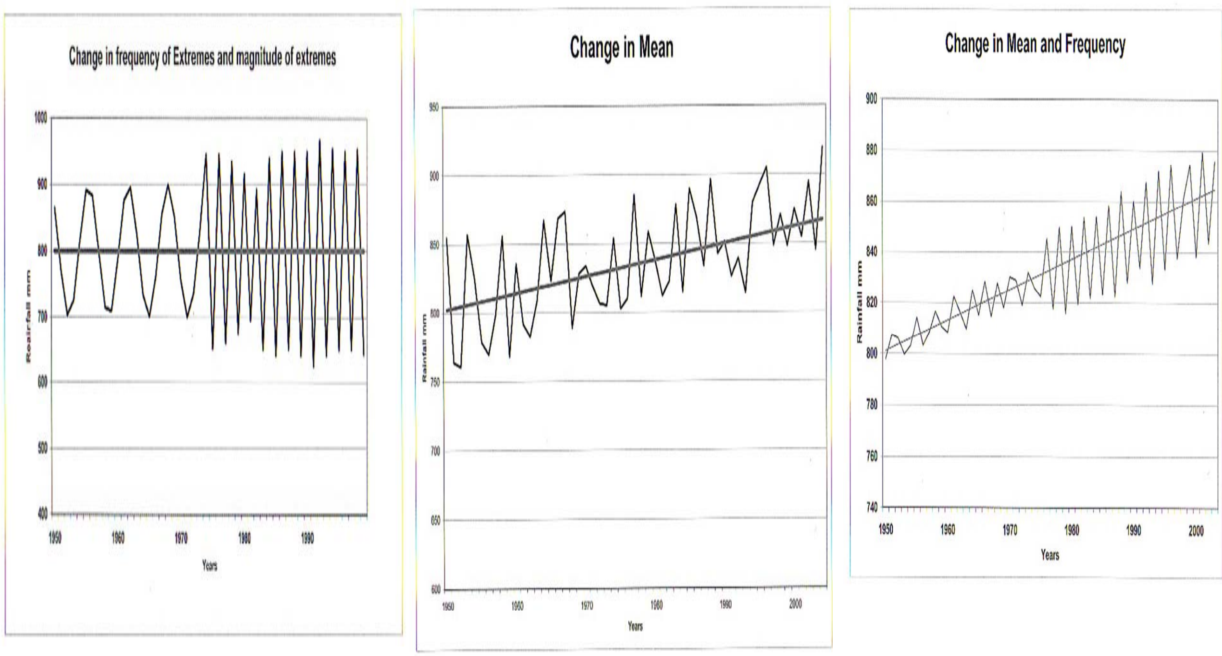


Fig. 13: Climate Variability and Change Signals

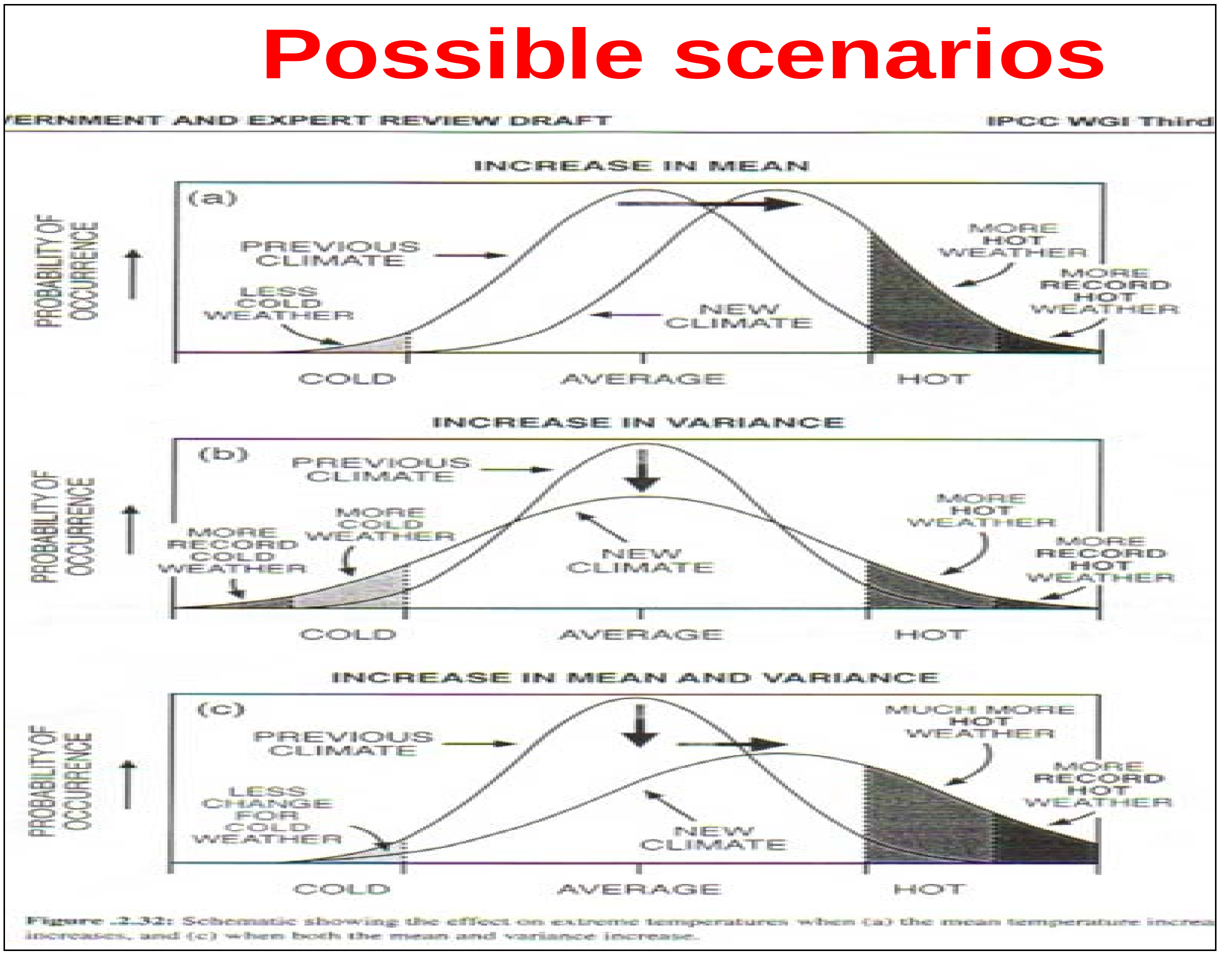


Figure 14: Changes in frequency distribution e.g. mean variance, skewness and kurtosis (IPCC, 2001)

Figure 14 above also shows some specific examples of climate change manifestations. Details of these can be obtained in the last four IPCC assessment reports, that have also provided some methods for climate change detection and attributions.

Recent assessment by ISDR, UNDP among others indicate that in the 20th century, disasters associated with climate related hazards have been estimated to be seven times as frequent as those involving non climatic factors. Hazards globally and accounted for nine times as many deaths. The economic losses associated with climatic hazards were three times higher than those associated with non climatic hazards and the number of people affected 55 times greater. These impacts affect the ability of developing countries to achieve Millennium Development Goals.

Figure 15 highlights different types of climate related hazards that communities world wide are often exposed to. The time and space patterns of the hazards are highly variable, and sometime they occur in series or multiples. Climate change will change their space-time patterns with far reaching implications on society and development.

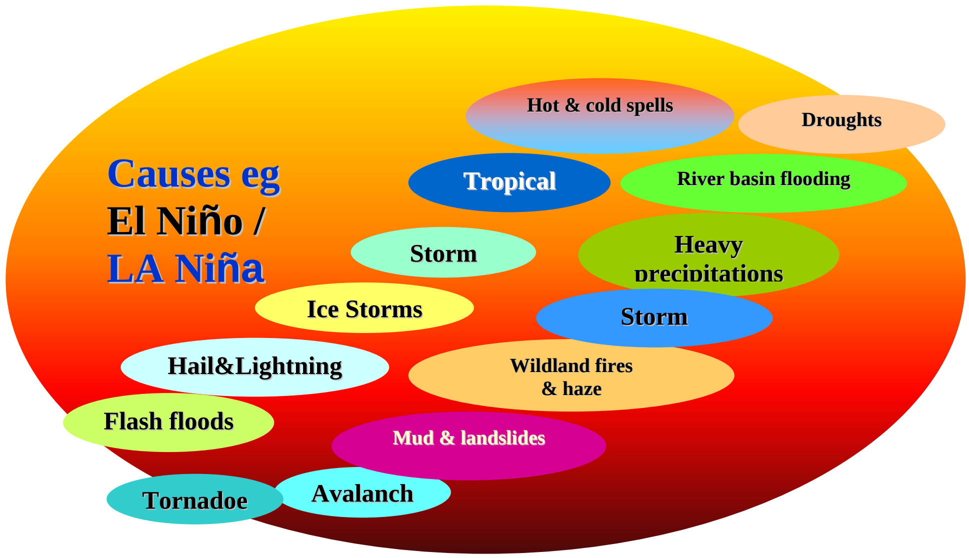


Fig. 15: Climate related Hazards of the world (WMO, 2005)

Evaluation of the hazards requires high quality , well distributed, long period climate data I order to derive detailed space-time characteristics of the hazards, especially their extremes such as floods and droughts that are very common in Africa. Some of these have been associated for example with El Niño/La Niña; North Atlantic Oscillation (NAO); Indian Ocean Dipole (IOD) events, anomalies in the monsoonal winds, etc. IPCC assessment have noted that their frequency and magnitude of the extreme climate events increasing due to changing climate.

Good knowledge of the climate hazards can be derived from various time series analysis methods to delineate the past and present climate patterns, also model and predict the future scenarios.

2.1.2 Tools for Past and Present Climate Analysis

It was mentioned earlier that climate change can be manifested in the changing of the severity, frequency and other characteristics of climate extremes. The available tools for examining past and present climate data sets is mainly time series analysis. A time series involves analysis of a collection of past observations taken at specified times, usually at equal intervals. This could be hourly, daily, weekly, monthly, seasonally or annual series of meteorological elements such as precipitation, temperature, and humidity etc.

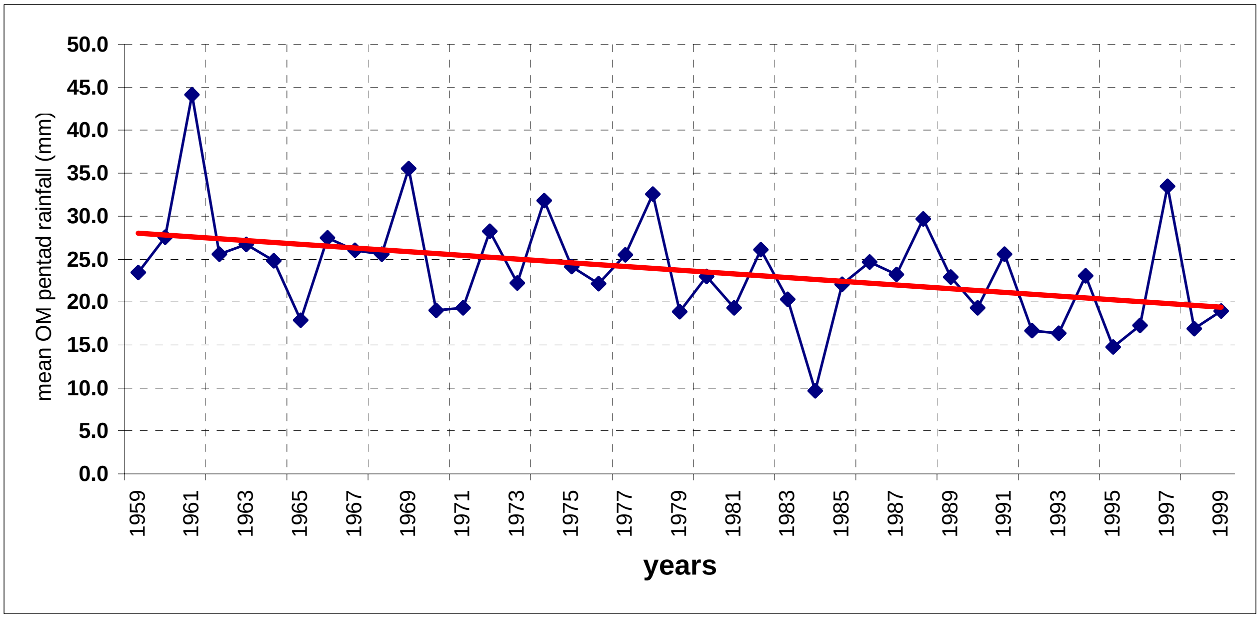


Fig 16: Time series indicates trend of rainfall at that location

Many time series show certain characteristics or variations in their temporal behaviour and the analysis of such movements can be used to examine the past climate and describe the present as well as forecast the future movements of the time series. Figure 16 above is a graphical example of a time series display of the rainfall trend over some given location. The characteristic movements or components of a time series can be classified into four major types, namely: Trend (Long term fluctuations or movements); Seasonality (Seasonal fluctuations); Cyclical inter annual patterns like recurrences of floods, droughts, and El Niño signals; and random fluctuations. Many standard statistical methods are available for analysis of the various components of the time series.

The next section gives a brief discussion on seasonal climate prediction that is very pivotal for early warning and development of climate risk evaluation tools.

2.1.3 Predicting Climate on Seasonal to Inter-annual Time Scales

Recent advances in the science of weather and climate prediction and in particular, seasonal to inter-annual prediction has made it possible to predict climate with improved accuracy in a time-spans ranging from seasons to over one year in advance. Such knowledge is extremely useful for early warning and the development of many climate risk management strategies. These have successfully been used for many sector specific sector decision-making.

Many of the operational seasonal forecasts are based linkages with El Niño, sea surface temperatures (SST), and other climate variables with long period memories. Several statistical approaches, Dynamical approaches and/or combination of the two approaches are now available at all the global meteorological centers and advanced research / monitoring institutions that make routine global forecasts. The global model forecasts are however too coarse to be of great value to local community users who require detailed forecasts at specific farm lands or water catchment basins.

Regional climate modeling has recently emerged, as one means of down scaling large scale products to regional and local products that are required for specific risk management applications. There are still various challenges with the skill of regional/ local scale climate products. Examples of approaches that are being used at ICPAC are shown in Figure 17.

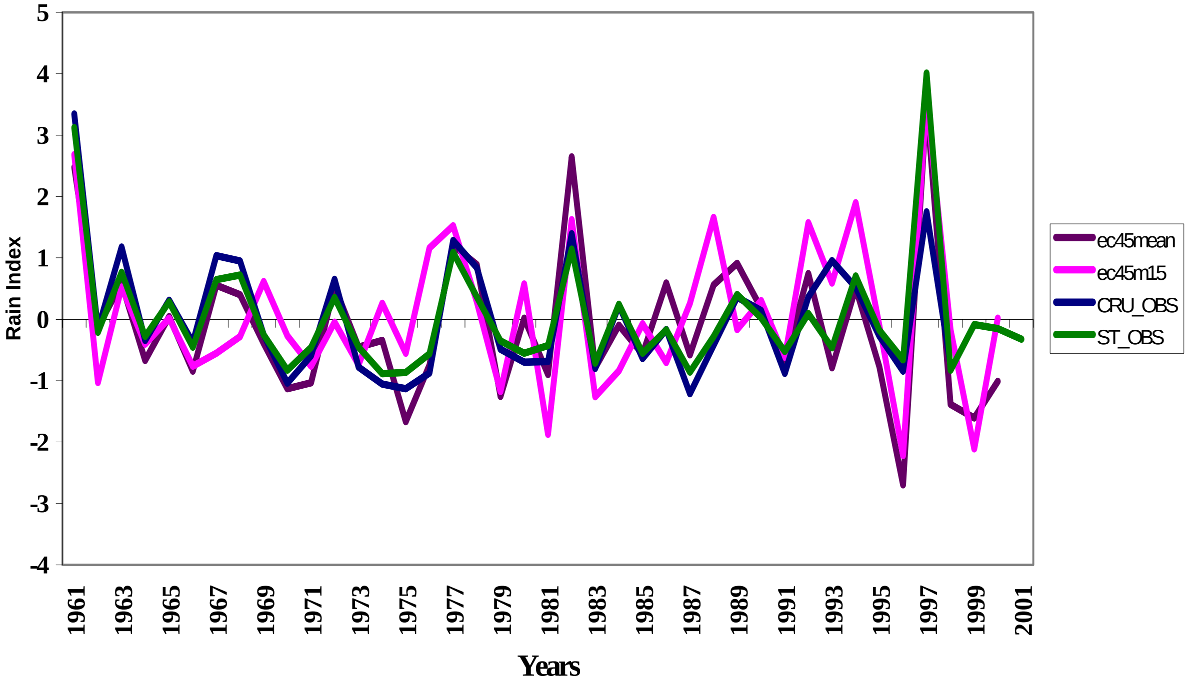


Figure 17: The ECHAM4.5 model simulation of Interannual variability for the October to December rainfall season over Eastern Africa at ICPAC.

2.2 Assessment of Climate Change Impacts

Many socio-economic sectors in Africa are climate-sensitive e.g. agriculture, water resources, food security, health, and livelihoods. Thus better management of climate related risks are key to disaster risk reduction, climate change adaptation, and sustaining socio-economic development.
IPCC assessments have shown that human socio-economic development activities have led to increase in the concentration of greenhouse gases in the atmosphere that are causing climate change such as global warming, changes in patterns of precipitation, sea level rise, climate extremes, changes in frequency and amplitude of the extreme weather events (IPCC 2007).

Climate variability and change are taking place when global population is increasing and globalization of economic processes is also leading to increased competition over resources and new vulnerabilities. The developing countries, especially Africa is more vulnerable to the negative impacts of climate variability and change. The impacts of these changes will continue even if the stabilization of the greenhouse gases emissions in the atmosphere is achieved, due to the long residence period of some of these gases in the atmosphere. Assessment of climate change impacts would enable realistic adaptation strategies to be developed.

Impact assessments is meant to evaluate the potential effects of one or several climate change scenarios on one or more impact domains, and compare them to a hypothetical constant climate scenario. Figure 18 below depicts the main concepts considered in an impact assessment and their relationships. The assessment is based of a range of scenarios of either emissions or atmospheric concentrations of greenhouse gases (and aerosol precursors) such as the often assumed 2 × CO2 case, etc. Climate models translate these emission scenarios into projections for future anthropogenic climate change. Details of the impacts assessment and the development of realistic regional climate change scenarios have been documented well by the last three IPCC assessment reports. Some of the details will be addressed in Module 3.

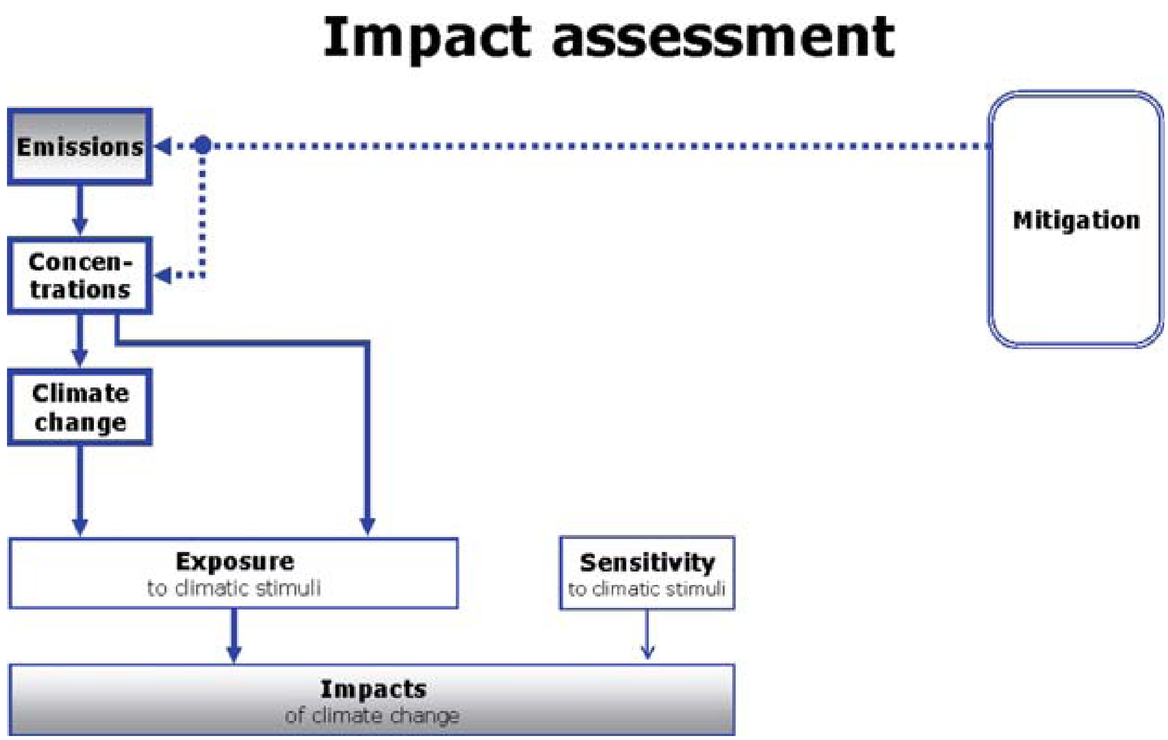


Fig 18: Climate Change Impacts Assessment diagram (Adopted from Fussel and Klein, 2006)

2.1.2 Climate Change Vulnerability Assessment and Mapping

Vulnerability, according to the IPCC definition, is an integrated measure of the expected magnitude of adverse effects to a system caused by a given level of certain external stressors. Assessments of the vulnerability to climate change are aimed at informing the development of policies that reduce the risks associated with climate change. The two fundamental response options to the risks posed by anthropogenic climate change are *mitigation* of climate change and *adaptation* to climate change.

Mitigation refers to limiting global climate change through reducing the emissions of greenhouse gases (GHGs) and enhancing their sinks. *Adaptation* primarily aims at moderating the adverse

effects of unavoided climate change through a wide range of actions that are targeted at the vulnerable system. Mapping of the impacts extreme climate events such as floods, droughts, heat waves, among others is essential and are integral part of vulnerability assessment strategies.
Thus, an analysis of vulnerability requires integrating information on climate, society capacity, environment etc. Assessment of climate change vulnerability thus depends on good knowledge of the hazards including character, magnitude, and rate of variation; the associated impacts, and development of realistic adaptive capacity. Figure 19 below depict the main concepts considered in vulnerability assessment.

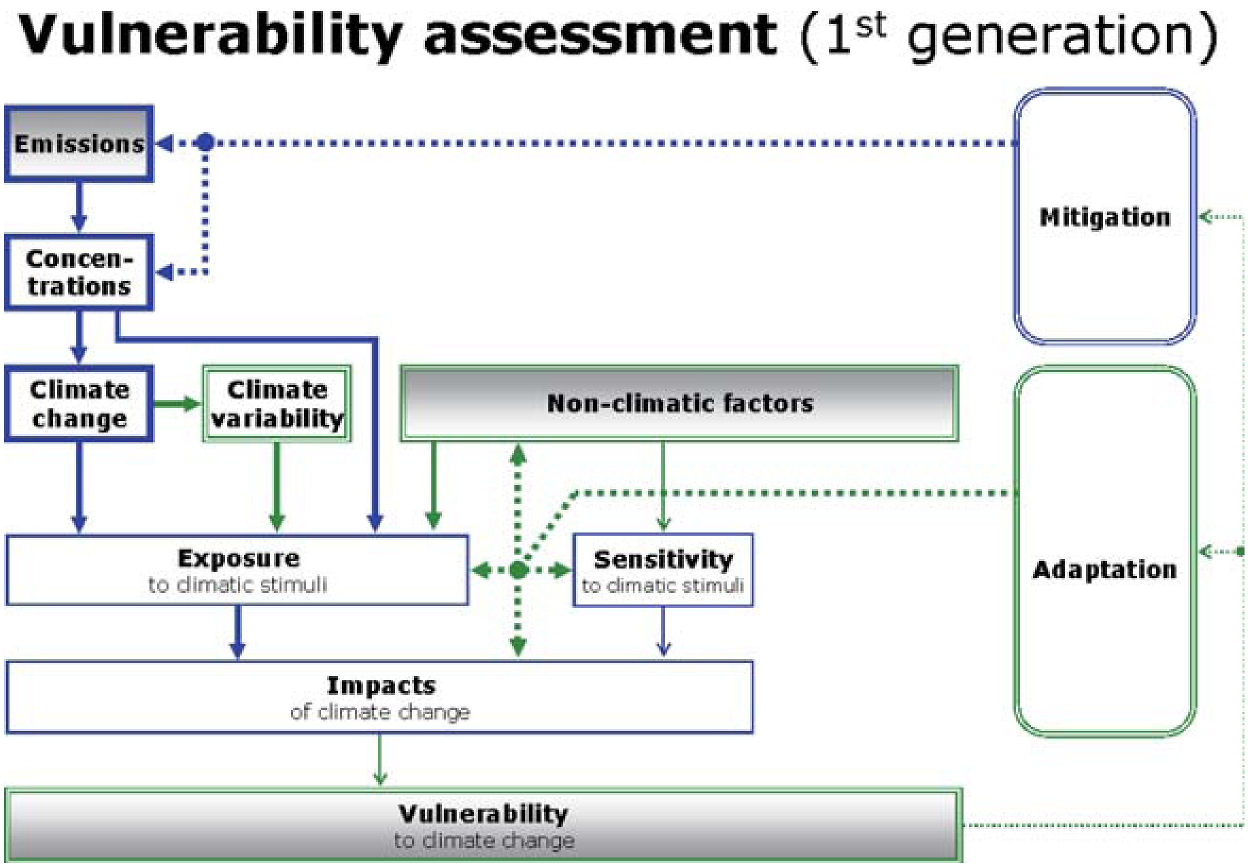


Fig 19: The *first-generation* vulnerability Assessment Diagram (Adopted from Fussel and Klein, 2006)

Fussel and Klein (2006), IPCC (2007) among others have presented climate vulnerability assessment as an extension of a climate impact assessment. Some authors have made some distinction between two generations of (climate) vulnerability assessments. The *first-generation* vulnerability assessment which is characterized primarily by the evaluation of climate impacts in terms of their relevance for society and by the consideration of potential adaptation. For the *second-generation* (Figure 19) vulnerability assessments include thorough assessment of the adaptive capacity of people, thus shifting the focus from potential to feasible adaptation.

It should be noted that "Non-climatic factors" shown in both figures 19 and 20 comprise of a wide range of environmental, economic, social, demographic, technological, and political factors which can affect the *sensitivity* of a system to climatic stimuli as well as its *exposure*.

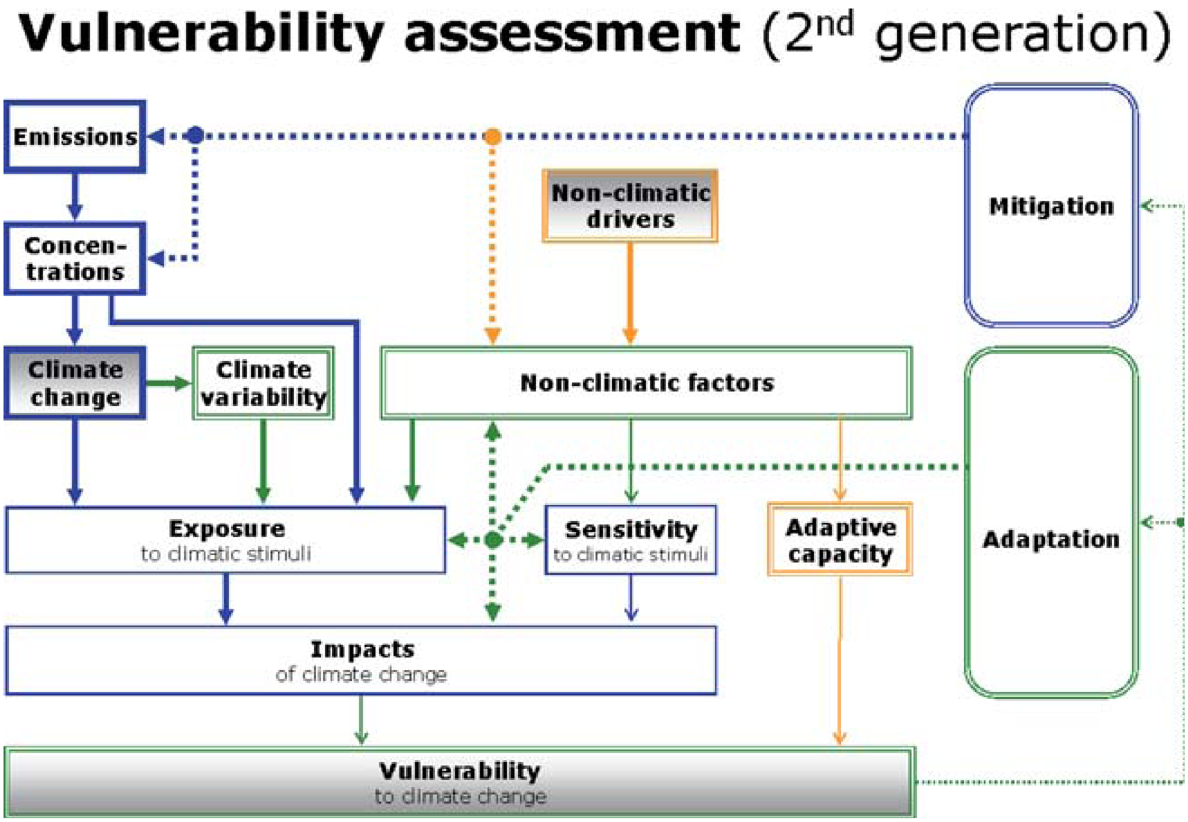


Fig 20: The *second-generation* Vulnerability Assessment (Adopted from Fussel and Klein, 2006)

2.1.3 Climate Change Adaptation Assessment

The ultimate goal of adaptation is to develop flexible and resilient societies and economies that have the capacity to address both the challenges and the opportunities presented by changing climatic conditions. Because climate change could alter historical patterns of both climate variability and extreme events in unknown ways, societies need to become more flexible and resilient to a wider range of impacts if they are to adapt to these potential changes.

From an integrated point of view that takes into account impacts on both the natural environment and society, adaptation may also be seen as those measures that enable the natural systems and communities to cope with the adverse effects of climate variability and change. It therefore incorporates a wide range of measures that would increase the resilience of the environment and communities to the possible adverse effects of climate variability and change. Thus, adaptation strategies are an integral part of sustainable development and should improve the society's ability to cope with changes in climatic conditions across time scales, from the short term (e.g., seasonal to annual) to the long term (e.g., decades to centuries) (UNDP, 2002). Figure 21 below depicts the main concepts that are considered in adaptation assessments. It requires realistic assessments of climate hazards, impacts and vulnerability. Some fundamentals of adaptation assessment can be obtained from the last four IPCC assessment reports; Fussel and Klein, 2006; among others.

Details of the adaptation policy assessment are discussed in Module 3 (See also figure 31).

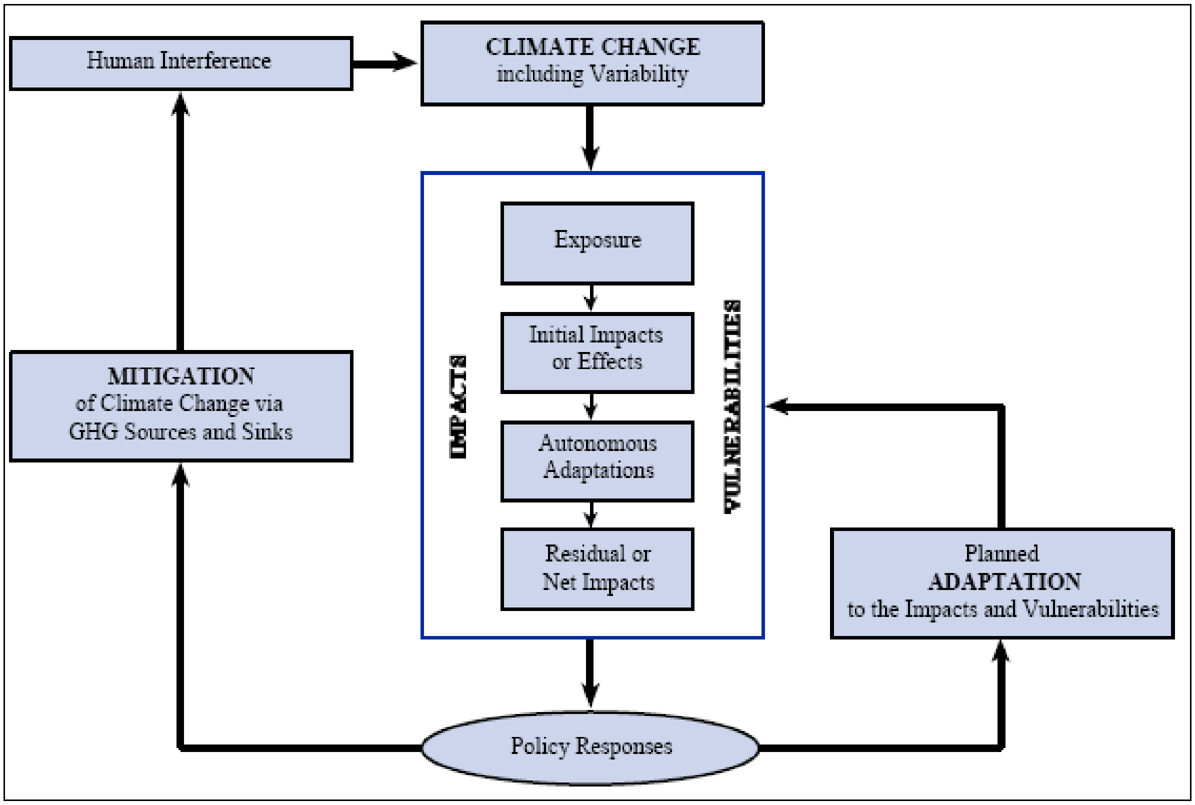


Fig 21: Main Concepts that are considered in Adaptation Assessments (IPCC, 2001)

It should be noted that assessment of the hazards, impacts and vulnerability are integral part of any climate change adaptation assessment.

2.2 Tools for Integrated Climate Change Risk Management

The last section addressed various methods for climate risk assessment. The basic tools that are required for effective implementation of the various methods are highlighted in this section. The major tools in climate change studies are the General Circulation Models (GCMs), which are used to generate future climate scenarios. The GCMs are driven by future greenhouse gas (GHG) emissions and other socio-economic forces such as demographic development, socio-economic development, technological change, etc. It is therefore important that some knowledge of climate change scenarios is provided.

2.2.3 Climate Change Scenarios

A scenario is a coherent, internally consistent, and plausible description of a possible future state of the world. A distinction should be made between climate scenarios, which describe the forcing factor of focal interest to the IPCC, and nonclimatic scenarios, which provide the socioeconomic and environmental context within which climate forcing operates.

Nonclimatic scenarios describing future socioeconomic, land use, and environmental changes are important for characterizing the sensitivity of systems to climate change, their vulnerability, and the capacity for adaptation. Such scenarios only recently have been widely adopted in impact assessments alongside climate scenarios (IPCC, 2001). Socioeconomic scenarios have been used more extensively for projecting GHG emissions than for assessing climate vulnerability and adaptive capacity. Most socioeconomic scenarios identify several different topics or domains, such as population or economic activity, as well as background factors such as the structure of governance, social values, and patterns of technological change. Scenarios make it possible to establish baseline socioeconomic vulnerability, preclimate change; determine climate change impacts; and assess post-adaptation vulnerability.

GCMs are the major tools for generating future climate scenarios. The Intergovernmental Panel on Climate Change (IPCC) developed long-term emissions scenarios in 1990 and 1992, driven by future GHGs emissions and other socio-economic forces. These scenarios are used in the analysis of possible climate change, its impacts, vulnerability and adaptation options to mitigate climate change. Future greenhouse gas (GHG) emissions are the product of very complex dynamic systems, determined by driving forces such as demographic development, socio-economic development, and technological change. Their future evolution is highly uncertain. In 2000, the IPCC completed a *Special Report on Emissions Scenarios* (SRES) to replace the earlier set of six IS92 scenarios developed for the IPCC in 1992. Details of the Climate change scenarios can be found from the last four IPCC assessment reports.

These newer scenarios consider the period 1990 to 2100 and include a range of socioeconomic assumptions (e.g., global population and gross domestic product). Their implications for other aspects of global change also have been calculated; some of these implications are summarized in the Table below. *The SRES scenarios and their implications for atmospheric composition, climate, and sea level. Values of population, G D P, and per capita income ratio (a measure of regional equity) are those applied in integrated assessment models used to estimate emissions*

Date	Global Population (billions)[a]	Global GDP (10^{12} US\$ yr^{-1})[b]	Per Capita Income Ratio[c]	Ground-Level O_3 Concentration (ppm)[d]	CO_2 Concentration (ppm)[e]	Global Temperature Change (°C)[f]	Global Sea-Level Rise (cm)[g]
1990	5.3	21	16.1	—	354	0	0
2000	6.1–6.2	25–28	12.3–14.2	40	367	0.2	2
2050	8.4–11.3	59–187	2.4–8.2	~60	463–623	0.8–2.6	5–32
2100	7.0–15.1	197–550	1.4–6.3	>70	478–1099	1.4–5.8	9–88

A set of scenarios have been developed to represent the range of driving forces and emissions in the scenario literature so as to reflect current understanding and knowledge about underlying uncertainties. Four different narrative storylines were developed to describe consistently the relationships between emission driving forces and their evolution and add context for the scenario quantification. Each storyline represents different demographic, social, economic, technological, and environmental developments, which may be viewed positively by some people and negatively by others. Figure 22 which give the characteristics of the four SRES storylines and scenario families. IPCC (2001) have developed a set of six global emission scenarios that can be used in climate change studies.

Four qualitative storylines yield four sets of scenarios called “families”: A1, A2, B1, and B2. The set of scenarios consists of six scenario groups drawn from the four families: one group each in A2, B1, B2, and three groups within the A1 family, characterizing alternative developments of energy technologies: A1FI (fossil fuel intensive), A1B (balanced), and A1T (predominantly non-fossil fuel) (AR4, 2007).

These are known as SRES scenarios given as A1FI, A1T, A1B, A2, B1 and B2. These scenarios cover a wide range of the main demographic, economic, and technological driving forces of GHG and sulfur emissions. Each scenario represents a specific quantitative interpretation of one of four storylines. Altogether 40 SRES scenarios have been developed by six modeling teams. All are equally valid with no assigned probabilities of occurrence.

The “A” scenarios have more of an emphasis on economic growth while the “B” scenarios emphasizes on environmental protection. The “1” scenarios assume more globalization while the “2” scenarios assume more regionalization. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B) (where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end use technologies) (IPCC, 2007)..

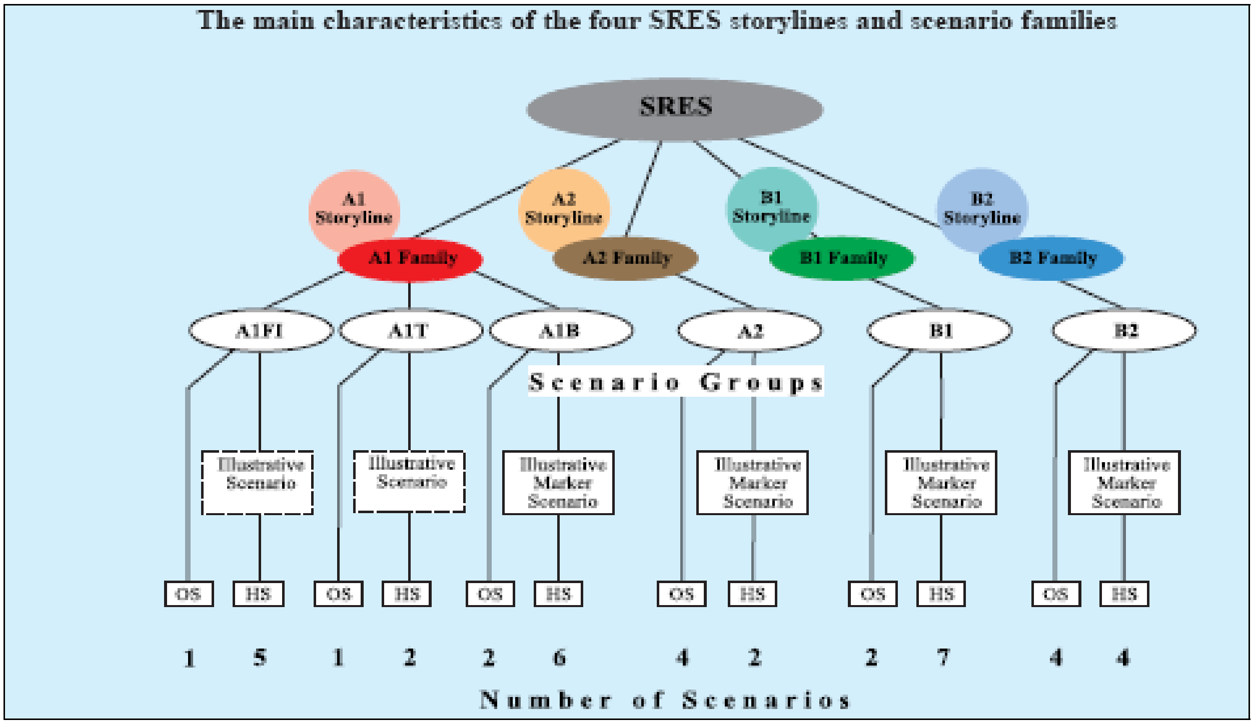


Fig. 22: Scenario Characteristics (Source, IPCC 2007)

Within each family and group of scenarios, some share “harmonized” assumptions on global population, gross world product, and final energy. These are marked as “HS” for harmonized scenarios. “OS” denotes scenarios that explore uncertainties in driving forces beyond those of the harmonized scenarios.

The number of scenarios developed within each category is shown. For each of the six scenario groups an illustrative scenario (which is always harmonized) is provided. Four illustrative marker scenarios, one for each scenario family, were used in draft form in the 1998 SRES open process. Two additional illustrative scenarios for the groups A1FI and A1T are also provided and complete a set of six that illustrates all scenario groups. All are equally sound.

Figure 23 below gives the direction and steepness of each of the scenario families.

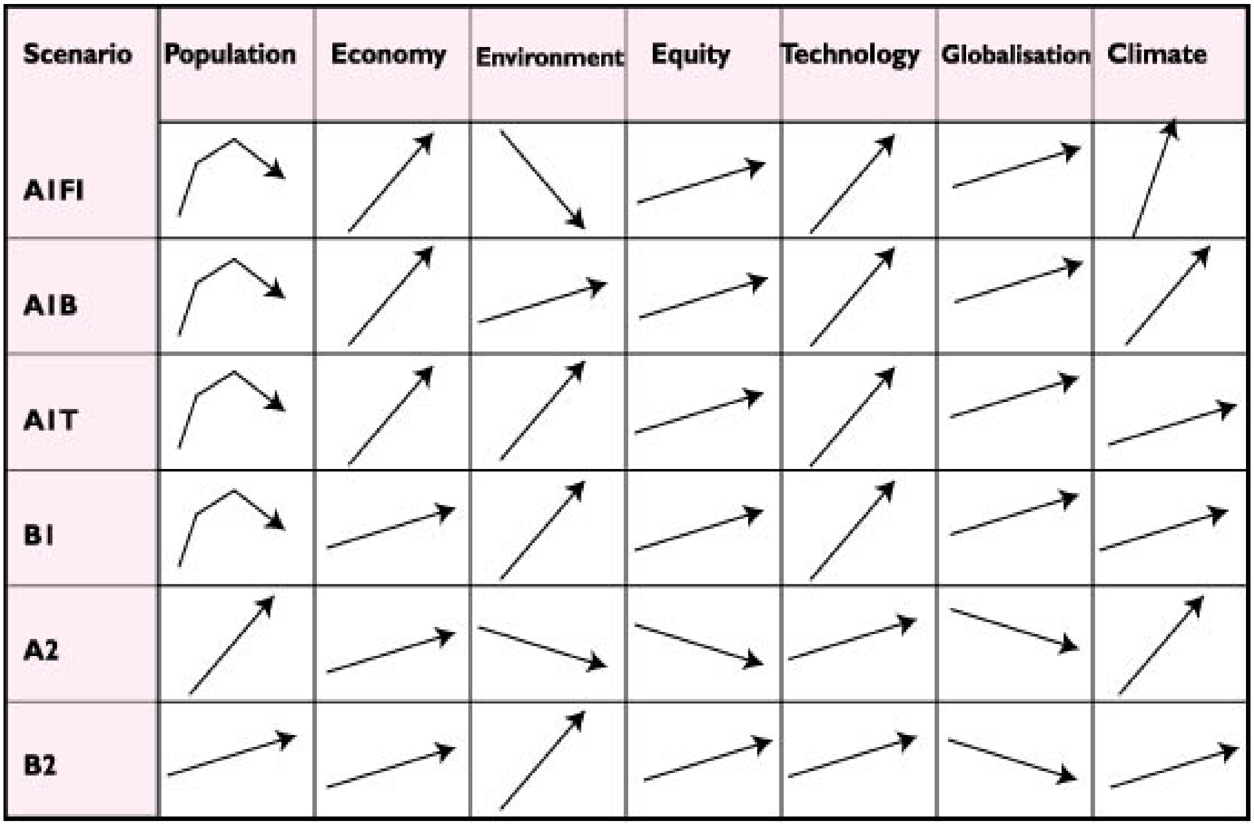


Fig. 23: Scenario direction and steepness (Source, IPCC AR4, 2007)

Most assessments of the impacts of future climate change are based on results from impact models that rely on quantitative climate and non-climatic scenarios as inputs. The data sources being used for scenario building include:

- Population data
- Economic development data
- Energy production and energy consumption
- Mitigation of climate change
- Levels of , and concentrations of greenhouse gases in the atmosphere
- Temperature increase levels arising from the socio economic assumptions

Figure 24 presents the future projection by CO_2 concentrations up to the year 2100 while Figures 25a and 25b gives the corresponding projections of global temperature and mean sea level rise.

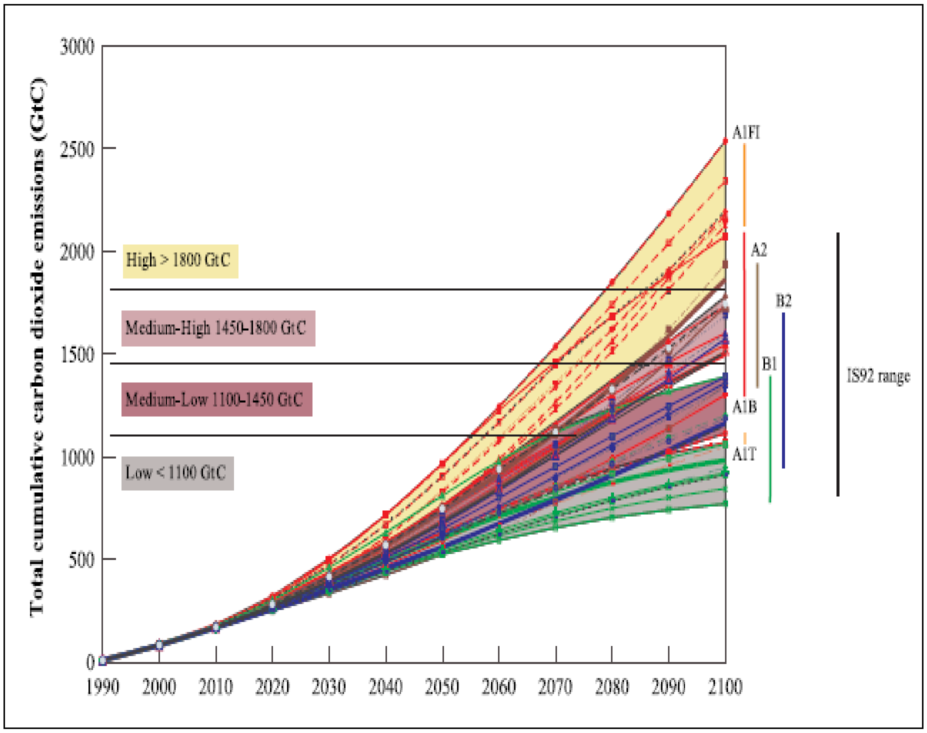


Figure 24: Projection of Global CO2 concentration up to 2100 (IPCC, 2007)

Figures 25a and 25b below gives some idea about the future patterns of temperature and Sea level rise as a result of increase in CO_2 concentrations.

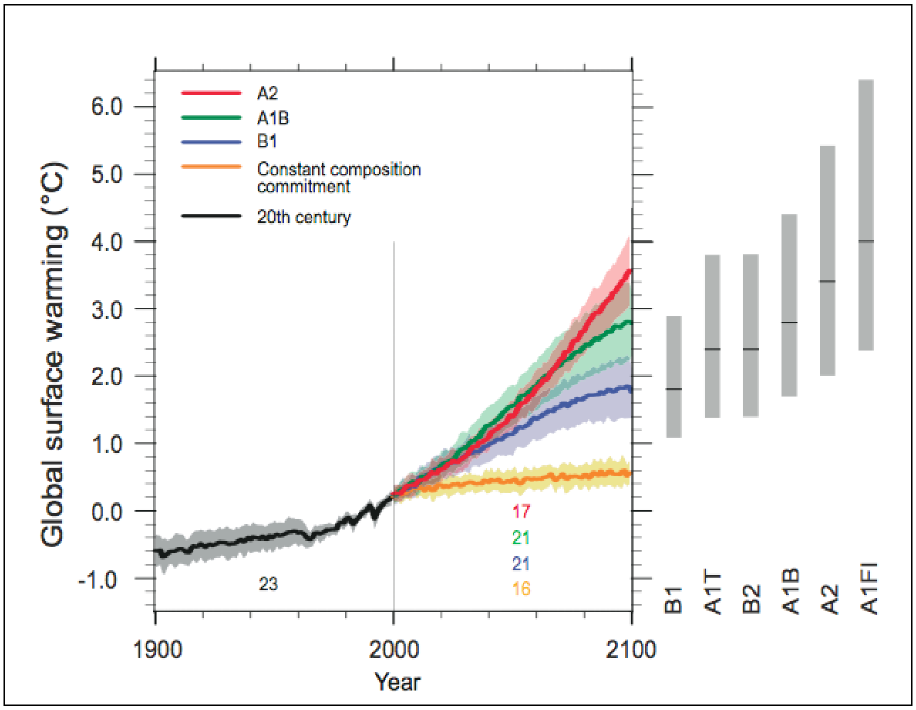


Figure 25a: Projection of Sea Level Rise up to 2100 (IPCC, 2007)

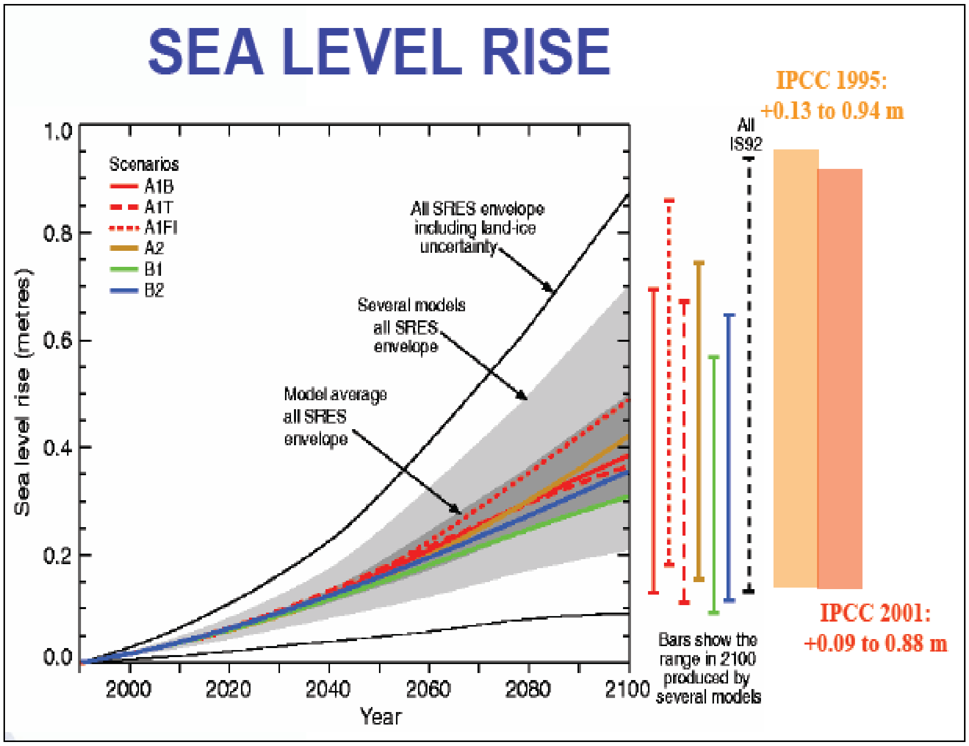


Figure 25b: Projection of Sea Level Rise up to 2100 (IPCC, 2001)

Projections of future mean global climate change from IPCC 2007 have for example shown that:

- The equilibrium climate sensitivity which is represented by a doubling of carbon dioxide concentrations indicate a mean global temperature increase to be *likely* in the range 2°C to 4.5°C with a best estimate of about 3°C, and is *very unlikely* to be less than 1.5°C.
- Best estimates and *likely* ranges for six SRES emissions marker scenarios all show global average surface air warming. For example, the best estimate for the low scenario (B1) is 1.8°C (*likely* range is 1.1°C to 2.9°C), and the best estimate for the high scenario A1FI) is 4.0°C (*likely* range is 2.4°C to 6.4°C). C), they are not directly comparable
- For the next two decades, a warming of about 0.2°C per decade is projected for a range of SRES emission scenarios. Even if the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected.
- Projected warming in the 21st century shows scenario-independent geographical patterns similar to those observed over the past several decades. Warming is expected to be greatest over land and at most high northern latitudes, and least over the Southern Ocean and parts of the North Atlantic Ocean
- Linearly with global average temperature change, the upper ranges of sea level rise for SRES scenarios would increase by 0.1 to 0.2 m.
- Significant changes in the patterns of extreme climate events such as droughts, floods, etc. For example it is *very likely* that hot extremes, heat waves and heavy precipitation events will continue to become more frequent. Based on a range of models, it is *likely* that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures.

- Projected warming in the 21st century shows scenario-independent geographical patterns similar to those observed over the past several decades. Warming is expected to be greatest over land and at most high northern latitudes, and least over the Southern Ocean and parts of the North Atlantic Ocean

There are significant regional variations in the projected regional patterns. Projections of regional climate change scenarios require availability of realistic regional climate change scenarios.

2.3.1 Regional Climate change Scenarios

The availability of realistic regional and local scale climate change scenarios is critical for assessment of the impacts and vulnerability for the specific socio-economic sectors; and the development of appropriate adaptation strategies. The majority of scenarios represent changes in mean climate and these may not be very realistic at regional and local levels due to the difficulty in projecting the required scenarios parameters at these levels. Regional climate change scenarios down scale the outputs from general circulation models (GCMs). Development of regional climate change scenarios involve down scaling of the coarse GMCs products to regional and local levels. The most common downscaling methods include

- Statistical Downscaling
- Dynamical Downscaling
- Weather Generators

Statistical downscaling first derives statistical relationships between regional/local variables and larger (GCM) scale variables, using statistical methods such as correlation and regression analyses. Future values of the large scale variables obtained from GCM projections of future climate are then used to drive the statistical relationships and so estimate the smaller-scale details of future climate.

Dynamical downscaling uses high resolution GCMs, a limited-area model (a regional climate mode) driven by boundary conditions from a GCM to derive smaller-scale information.

. A weather generator is a statistical model used to generate realistic daily sequences of weather variables such as precipitation, maximum and minimum temperature, humidity, etc. Such data are often referred to as synthetic data. Weather generators are not, strictly speaking, downscaling techniques, but provide crucial information that can be used in assessing uncertainties associated with the chaotic nature of daily weather variability.

Other downscaling techniques and regional models that have been highlighted by IPCCC and UNFCCC include:

- MAGIC/SCENGEN
- COSMIC2
- PRECIS

2.3.1.1 MAGICC/SCENGEN

MAGICC/SCENGEN is a coupled gas-cycle/climate model (MAGICC) that drives a spatial climate-change scenario generator (SCENGEN). MAGICC has been the primary model used by IPCC to produce projections of future global-mean temperature and sea level rise. SCENGEN, a global and regional SCENario GENerator is not a climate model; rather it is a simple database that contains the results of a large number of GCM experiments, as well as an observed global and four regional climate data sets. These various data fields are manipulated by SCENGEN, using the information about the rate and magnitude of global warming supplied by MAGICC and directed by the user's choice of important climate scenario characteristics.

MAGICC/SCENGEN is a user-friendly software package that takes emissions scenarios for greenhouse gases, reactive gases, and sulfur dioxide as input and gives global-mean temperature, sea level rise, and regional climate as output. MAGICC is a coupled gascycle/climate model. It has been used in all IPCC reports to produce projections of future global-mean temperature and sea level change, and the present version reproduces the results given in the IPCC Third Assessment Report (TAR). MAGICC can be used to extend results given in the IPCC TAR to other emissions scenarios. SCENGEN is a regionalization algorithm that uses a scaling method to produce climate and climate change information on a 5° latitude by 5° longitude grid. The regional results are based on results from 17 coupled atmosphere-ocean general circulation models (AOGCMs), which can be used individually or in any user-defined combination. Figure 26a below gives a schematic diagram of the MAGICC/SCENGEN.

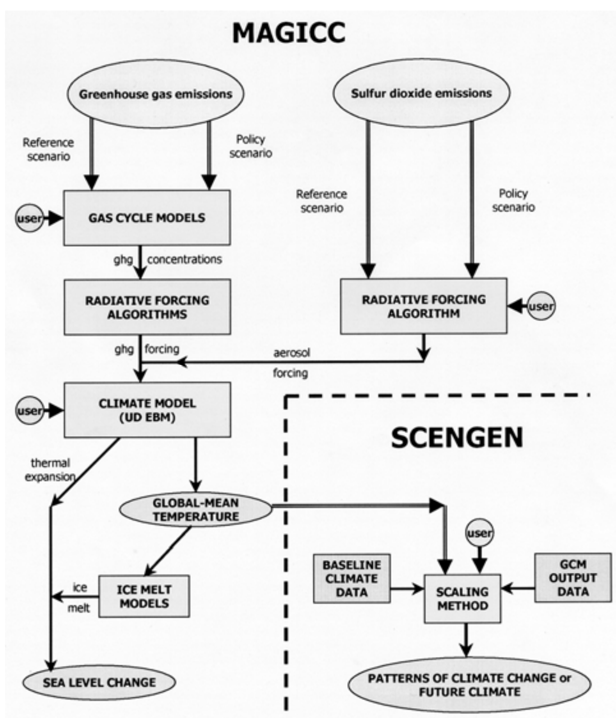


Fig. 26a: MAGICC/SCENGEN

Some examples of the output from MAGICC/SCENGEN as applied to Kenya, Ethiopia and Malawi is shown in figure 26b below:

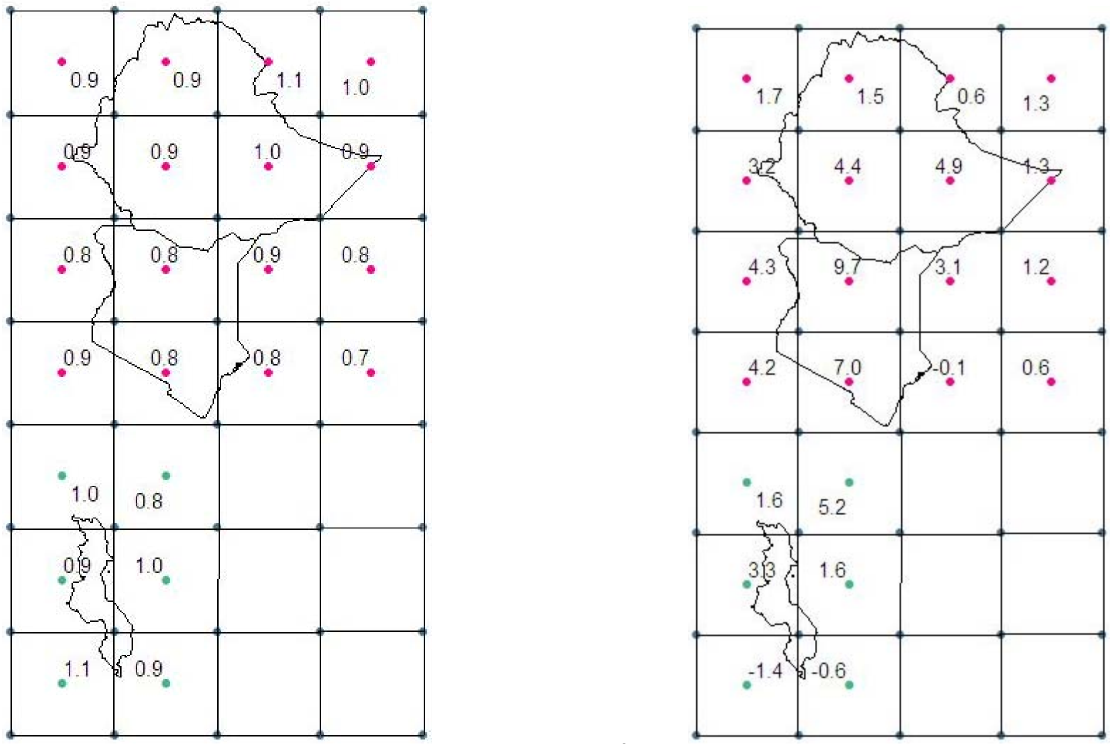


Fig 26b: Change in Mean Annual Temperature (^{0}C) and Rainfall (mm) by 2030 (Source: ICPAC/WORLD Bank)

2.3.1.2 COSMIC2 (Country Specific Model for Intertemporal Climate Vers. 2)

The Country Specific Model for Intertemporal Climate Vers. 2 **(**COSMIC2) provides climate-change impact modellers and policy analysts a flexible system that can produce a full range of dynamic country-specific climate-change scenarios. It can provide easy access to developing countries with limited computing power with credible climate-change scenarios that are consistent with the state-of-the-art, fully coupled, transient ocean-atmosphere GCM simulations.

This model calculates alternative transient climate scenarios for use in country specific climate change impact analyses. There are 29 alternative GHG emission scenarios along with a number of user selected parameters that define a COSMIC2 run. The output of the COSMIC2 model is written to a text file. This output file contains global climate change information along with country specific monthly average temperature and precipitation data from year 2000 up to the final year. The final year is selected by the user and can be anything between 2000 and 2200. This output data file can be used as the climate change driver for research on climate change impacts at the national level.

Figure 27 gives an example of the output from COSMIC2 model. The blue curve is the temperature distribution as for the year 2000 while the red curve gives the projection for the year 2100.

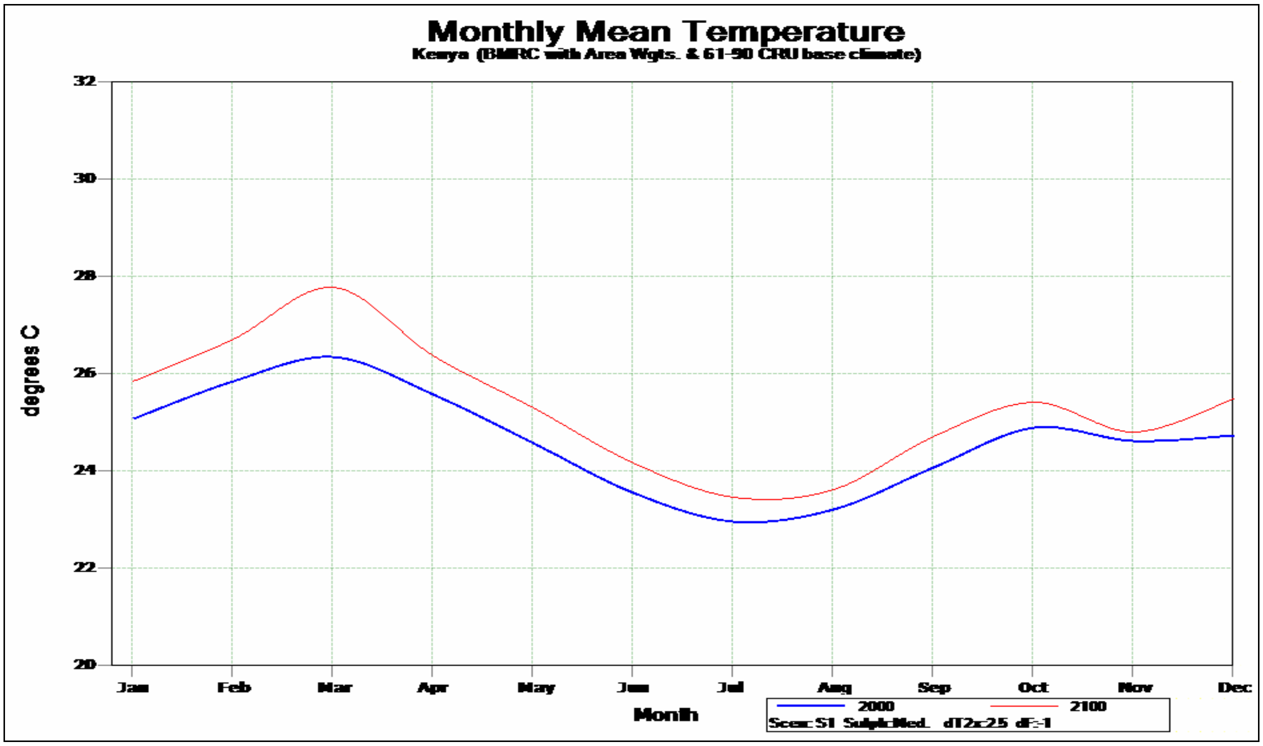


Fig 27: An example of the output from COSMIC2 model.

2.3.1.3 PRECIS (Providing Regional Climates for Impacts Studies)

Providing **Re**gional **C**limates for **I**mpacts **S**tudies is essentially a regional climate modeling system. It is based on the third generation of the Hadley Centre's regional climate model (HadRM3), together with user-friendly data processing and visualization interface. Its flexible design allows for applications in any region of the world. Like any other regional climate models, PRECIS is driven by boundary conditions simulated by General Circulation Models (GCMs). To facilitate the application, boundary conditions simulated by the Hadley Centre GCM experiments forced by four SRES marker scenarios are supplied with the software (PRECIS, UK MET Office 2006).

PRECIS can be run over any area of the globe on a PC to provide regional climate information for impacts studies. The idea of constructing such a flexible regional modeling system originated from the growing demand of many countries for regional-scale climate projections. Figure 28 gives an example of the output from PRECIS model for southern Africa.

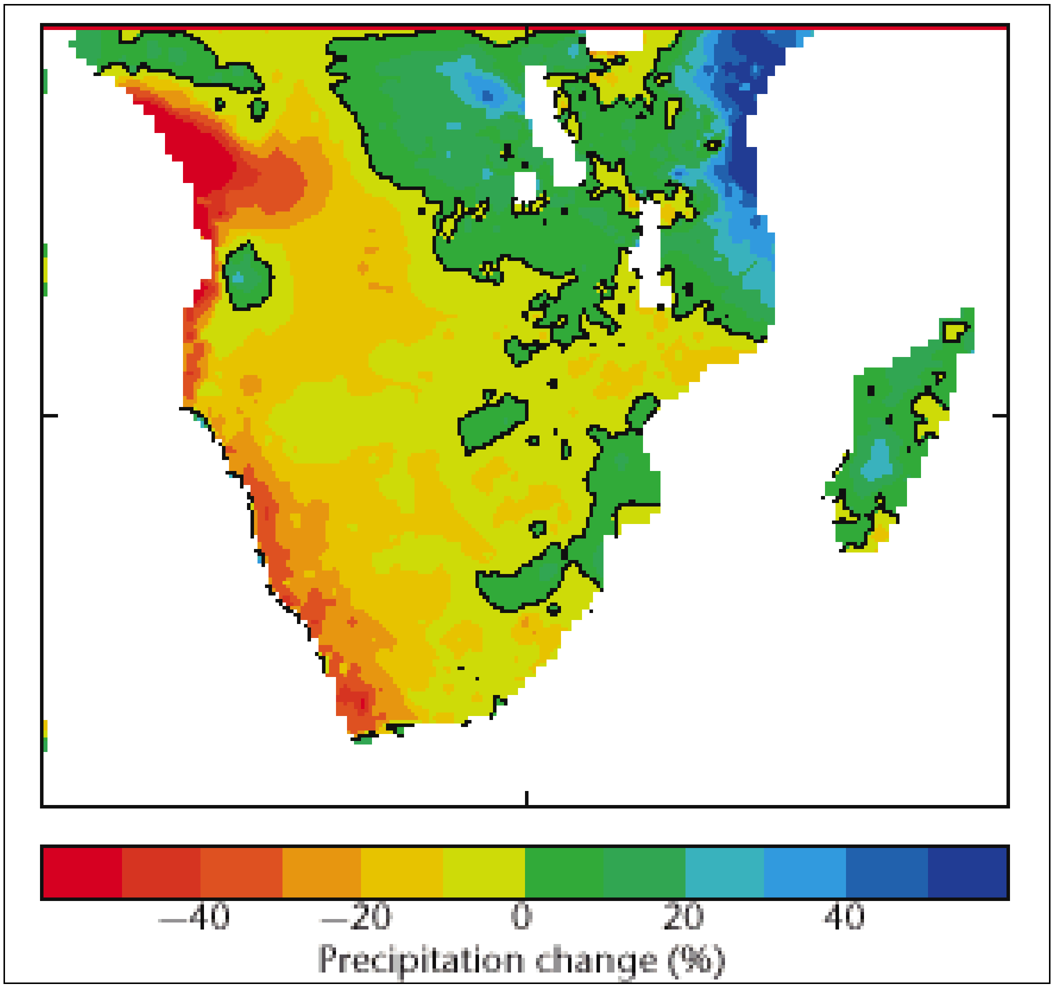


Fig 28: Precipitation change over southern Africa for the 2080s, relative to the present day, for SRES A2 emissions.

The IPCC and UNFCCC have also provided various decision tools and approaches for different sector specific analysis. Some of these include:

(i) Development of Socioeconomic scenarios

- Developing Socioeconomic Scenarios: For Use in Vulnerability and Adaptation Assessments
- Adoption of Existing Socioeconomic Scenarios
- Qualitative and Quantitative Scenarios Emphasizing Stakeholder Input

(ii) Decision Tools for:

- Policy assessment
- Benefit-Cost Analysis and Cost-Effectiveness
- Multicriteria Analysis (MCA)
- Tools for Environmental Assessment and Management (TEAM)
- Adaptation Decision Matrix (ADM)
- Screening of Adaptation Options

(iii) Stakeholder Approaches such as:

- Stakeholder Networks and Institutions
- Vulnerability Indices
- Livelihood Sensitivity Exercise
- Multistakeholder Processes
- Global Sustainability Scenarios

(iv) Water Sector Tools such as:

- Water Evaluation and Planning System (WEAP)
- Interactive River and Aquifer Simulation (IRAS)
- Spatial Tools for River Basin Environmental Analysis and Management (STREAM)
- Methodology Decision Support Models: COSMO
- Dynamic Interactive Vulnerability Assessment (DIVA)
- Shoreline Management Planning (SMP)

(v) Human Health Sector Tools such as

- Environmental Burden of Disease Assessment
- UNFCCC Guidelines
- Mapping Malaria Risk in Africa (MARA) Low-end Information Tool (LITe)

(vi) Terrestrial Vegetation Sector Tools such as **:**

- Lund-Potsdam-Jena Model (LPJ)
- Integrated BIosphere Simulator (IBIS)
- Medrush Vegetation Model
- Integrated Model to Assess the Greenhouse Effect (IMAGE)
- Agro-ecological Zones Methodology (AEZ)
- Carnegie-Ames-Stanford Approach Model (CASA)
- Terrestrial Ecosystem Model (TEM)

Deals of these can be obtained from the listed bibliography references as well as UNFCCC website: http://unfccc.int/files/adaptation/methodologies_for/

2.4 Data Requirements for Climate risk management

Availability of long-term, high quality data with good spatial coverage is a prerequisite for any climate change analysis. The needs for climate data include:

- Understand, monitor, modelling and predict future climate
- Initialization ,validation and verification of forecasts
- Development of baselines and generating of scenarious

2.4.1 Types of Observed Climate Data

Data and observations are important not only for monitoring the climate system, but also for detecting and attributing climate change, for assessing the impacts of climate variability and change, and for supporting research toward improved understanding, modelling and prediction of the climate system.

Data can be collected on all aspects of the climate system including on the physical, chemical and biological properties and atmospheric, oceanic, hydrologic, cryospheric and terrestrial. All climate observations are being under taken by the National meteorological and hydrological services within the framework of the World Meteorological organization (WMO). Efforts to enhance and integrate observations of the global climate system are now being undertaken within the framework of the Global Climate Observation system (GCOS), Global Terrestrial Observation system (GTOS), and Global Oceans Observation system (GOOS). A brief description of some of the observations platforms is presented below.

Atmospheric Observations

The principal global networks for atmospheric observations are: GCOS Surface Network (GSN), the GCOS Upper Air Network (GUAN), and Global Atmosphere Watch (GAW) Initialization of models. GSN and GUAN are part of WMO's World Weather Watch and provide data on meteorological parameters, including temperature, pressure, precipitation, wind velocity, and humidity. The GAW programme collects information on: Greenhouse gases (carbon dioxide, methane, CFCs), Ozone, ultraviolet radiation, aerosols, and acid precipitation.

The Global Climate Observing System (GCOS) was established in 1992 to ensure the availability and improvement of climate observations and information necessary to address climate-related issues for all potential users. It is an internationally sponsored and coordinated global framework for obtaining the climate data needed for climate monitoring (detection and assessment of impacts of climate change), research, policy formulation, and national economic development.

Oceanographic Observations

Oceans are key drives of the climate processes world wide. The ocean data include both for surface and under surface.

- Both space-based and *in situ* networks measure Sea Surface Temperature, Winds, Waves, Salinity, Sea level, Sea ice properties, Surface and sub-surface currents
- Ocean observing networks are not as developed as atmospheric networks, and large and significant network gaps exist across vast expanses of ocean space, especially in the Southern Hemisphere.

Terrestrial Observations

- Include terrestrial properties and attributes that control the physical, biological, and chemical processes affecting or affected by climate (vegetation, albedo etc)
- Global-scale terrestrial networks have not been developed to the same extent as atmospheric networks
- Important recent advances in terrestrial observations have only occurred in global permafrost, glacier, terrestrial carbon, and hydrology networks.

Satellite Observations

- Conventional surface-based observations cannot provide *all* of the data required for investigating climate
- Satellite observations are a practical source for *estimates* that cannot be made any other way, such as ocean topography and the extent of polar ice sheets
- "Ground truth" of satellite observations is needed.

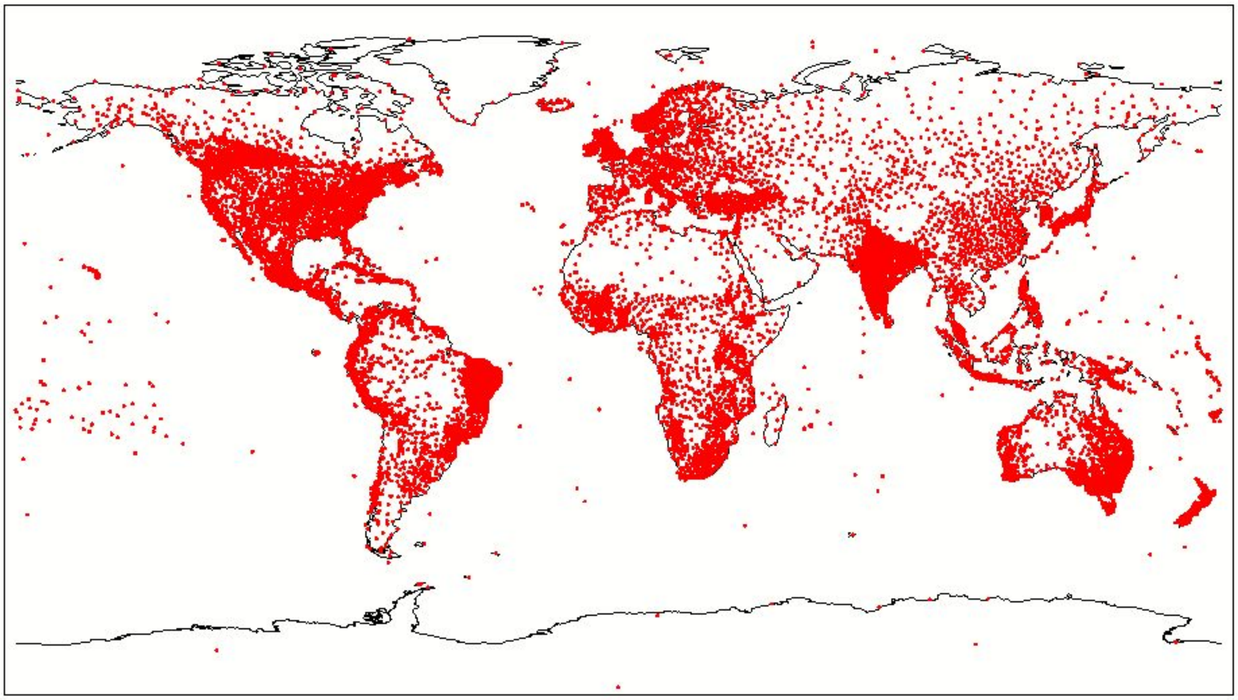


Fig. 29: Rain Gauge Network 1950-2000

Lack of observational climate data in Africa is a major constraint to understanding current and future climate variability. Significant gaps exist at many locations, especially in areas with hash climate (See figure 29). In order to address this evident gap, coordinated effort to start collection of reliable climate observations.

2.5 Remote Sensing and Geospatial Information Systems (GIS) needs for Integrated Decision Making

Data sources from instrumental records are very limited, and spatially distributed. Remote sensing offers big opportunity. Remote sensing is the taking of observations about a phenomenon without being in physical contact with the phenomenon. Such methods include Radar, Sodar, Lidar, and satellite. Satellite technology is widely used in global climate monitoring. Several satellites observations for weather and climate are currently being coordinated within the framework of the World Meteorological Organization (WMO). An example is shown in figure 30a.

OMM

WMO

Figure 30a: EXAMPLES OF SATELLITE OBSERVATION NETWORK WITHIN WMO SYSTEM

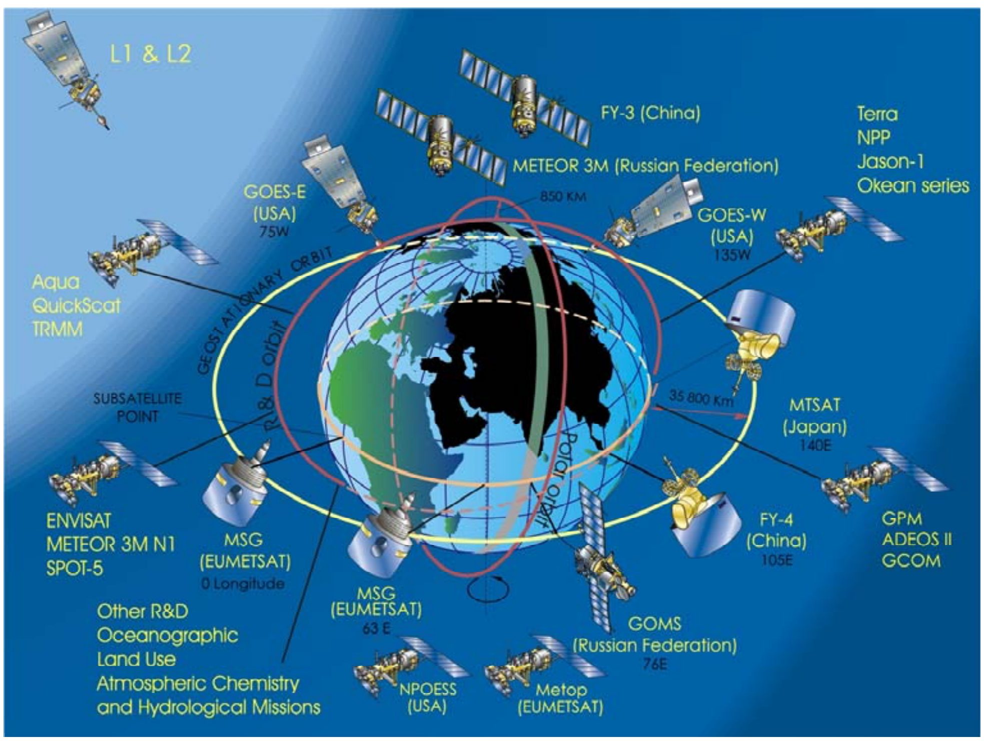


Figure 30a: Example of satellite observation systems for within the WMO weather and climate monitoring system (WMO, 2002)

2.5.1 Geospatial Information Systems (GIS)

Geospatial Information Systems (GIS) is one of the recent tools for integrated information management. A GIS consists of a database, map information, and a computer-based link between them. It is flexible enough to be used for ad hoc query and analysis (in space, about place) and can do analysis, modeling and prediction. Figure 30b below gives a schematic description of the concepts of GIS and its modeling capabilities.

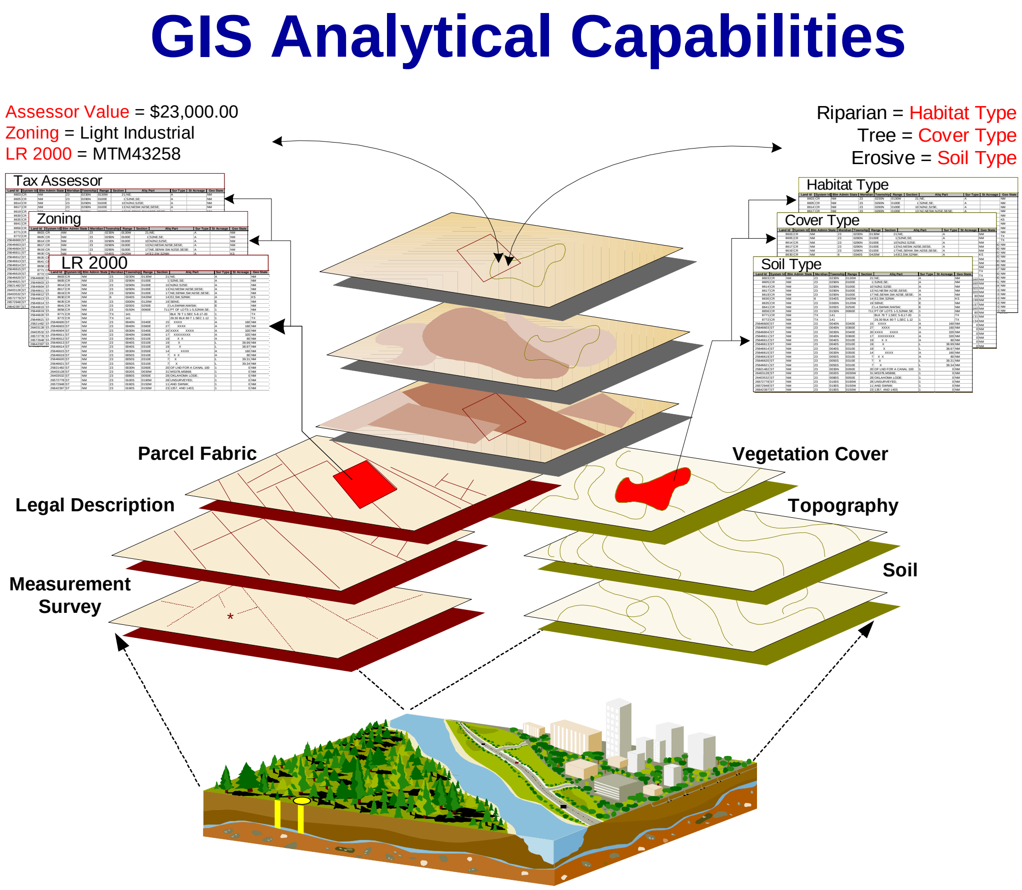


Fig. 30b: Description of GIS capabilities and layers (Adopted from RCMRD, 2005)

Some of the capabilities of GIS include the following:

- Provision of Early Warning for Climate related hazards
- Detecting problems before they escalate and rapidly providing broad perspectives on regions affected which may help decide what appropriate actions to put in place.
- May help to quickly locate and quantify the area most affected and make early estimates of relief requirements.
- Utilize Multiple Image Sources
- Help in Precision Agriculture
- Monitor dynamic water levels
- Indicator of water quality at local level
- Help in Vulnerability Assessment and Mapping.

2.6 Synthesis, Experiences and Lessons Learnt

The rapporteurs presented synthesis of what was covered in this module. These were then followed by discussions and interventions from participants and the experts present. The major points that arose from the various discussions by the participants included the followings:

- That modeling as well as scenario building is very important for the various CCAA projects.
- The need for capacity building in Africa on regional climate change scenarios was agreed on, and ICPAC was requested to invite the participants to its future relevant workshops. It was reported that ICPAC, UK MET Office, ICTP, and WMO were organizing a workshop on PRECIS for Africa starting from the following Monday after the CCAA workshop. The meeting recommended that ICPAC should circulate invitation to future similar workshops to all participants.

Participants also noted limitations in the data used in for building climate change scenarios. The participants debated and agreed on several other issues including:

- Build capacity for scaling down global scenarios to address local regional and issues and reflect local livelihood conditions;
- Need for adaptation strategies to conform we national development process ;
- Institutional constraints for multidisplinary climate change research in Africa;.
- Need to encourage the various African governments to increase their participation in climate change Fora , and negotiations;
- The CCAA sponsored projects, should find some ways of sharing or storage of critical data, especially for the use in the next IPCC report;
- It was agreed that ICPAC could allow CCAA projects PIs to use their facilities if formal request is made

The other issues discussed at the plenary included:

- Participants expressed their concern on the status of climate related risks strategies in most countries of Africa. It was noted that in urban centers even small fire causes havoc; and recurrent drought are still being managed on emergency basis, due to lack of policies, and poor planning;

- **Experience from Sudan:** As a way of managing climate risks and climate change, there are various policies and strategies that include irrigation, integration of climate prediction information to select crops and timely disseminate of information to end users;

- It is important to understand how every sector of development is impacted by climate change related hazards such as droughts, so that it can be planned for consistence in any development plan. The adaptation strategies should be integrated within the national development plans by ensuring that all possible vulnerabilities are consistent with it. There is need to prepare for the climate related shocks by relating them to how they can affect the communities. This can only be appropriately done at the design of the development plans. It was however, observed that planning for adaptation is not that simple and need not be undertaken in isolation but integrated across all sectors such that the resources required can be well planned for.

Module Three

Adaptation Strategies in Integrated Climate Risk Management

This Module examines some of the strategies that can be applied to adapt to changes in climate. Climate change is never abrupt but its signals are indicated by way of extreme variability. The information provided in this module was mainly drawn from various reference sources such as ISDR, World Bank Reports, UNDP, IPCC, ICPAC and UNEP among others.

3.0 Adapting to Climate Variability and Extremes

The adaptive capacity varies considerably among within regions, countries and socioeconomic groups and will vary over time. The ability to adapt and cope with climate change impacts is a function of wealth, scientific and technical knowledge, information, skills, infrastructure, institutions and equity. Countries with limited economic resources, low level of technology, poor information and skills, poor infrastructure, unstable or weak institutions and inequitable empowerment and access to resources have little capacity to adapt and are highly vulnerable. It is important to note that coping with the day to day climate variability is one way of being able to cope with future changes in climate. Using today's information on climate variability can greatly assist in finding solutions to coping with the future changes in climate. Table 2 highlights some potential impacts of future climate changes that adaptation strategies have to address.

Adapting to current climate variability and future climate changes would require the development of systems that are capable of absorbing the current climate shocks and at the same time integrate future climate change risks in the society, economic and environment systems in ensure sustainability of the social, economic and environment systems. Adaptation measures include a series of policies that reduce the vulnerability of natural systems, human population and economies to climate stresses and climate change.

There exist a wide variety of measures that could enhance the adaptive capacities in the event of climate change. These may include among others:

- Developing sustainable development policies;
- Reducing population pressure on resources and environmental degradation;
- Fostering community-based development and resource management initiatives, including maintaining the role of traditional knowledge and practices in adaptation;
- Promoting education and awareness creation to enhance adaptation;
- Promoting environmentally sound technologies;
- Strengthening the flood control systems;
- Promoting crop diversity and agro-forestry systems;
- Improving the early warning systems including the use of technical and traditional warning systems.

Some details of adaptation strategies will be addressed in the next module. The next section highlights some Climate Change adaptation assessment options.

Table TS-2: Examples of impacts resulting from projected changes in extreme climate events.

Projected Changes during the 21st Century in Extreme Climate Phenomena and their Likelihood[a]	**Representative Examples of Projected Impacts**[b] *(all high confidence of occurrence in some areas*[c]*)*
Simple Extremes	
Higher maximum temperatures; more hot days and heat waves[d] over nearly all land areas (*Very Likely*[a])	• Increased incidence of death and serious illness in older age groups and urban poor • Increased heat stress in livestock and wildlife • Shift in tourist destinations • Increased risk of damage to a number of crops • Increased electric cooling demand and reduced energy supply reliability
Higher (increasing) minimum temperatures; fewer cold days, frost days, and cold waves[d] over nearly all land areas (*Very Likely*[a])	• Decreased cold-related human morbidity and mortality • Decreased risk of damage to a number of crops, and increased risk to others • Extended range and activity of some pest and disease vectors • Reduced heating energy demand
More intense precipitation events (*Very Likely*[a] over many areas)	• Increased flood, landslide, avalanche, and mudslide damage • Increased soil erosion • Increased flood runoff could increase recharge of some floodplain aquifers • Increased pressure on government and private flood insurance systems and disaster relief
Complex Extremes	
Increased summer drying over most mid-latitude continental interiors and associated risk of drought (*Likely*[a])	• Decreased crop yields • Increased damage to building foundations caused by ground shrinkage • Decreased water resource quantity and quality • Increased risk of forest fire
Increase in tropical cyclone peak wind intensities, mean and peak precipitation intensities (*Likely*[a] over some areas)[e]	• Increased risks to human life, risk of infectious disease epidemics, and many other risks • Increased coastal erosion and damage to coastal buildings and infrastructure • Increased damage to coastal ecosystems such as coral reefs and mangroves
Intensified droughts and floods associated with El Niño events in many different regions (*Likely*[a]) (see also under droughts and intense precipitation events)	• Decreased agricultural and rangeland productivity in drought- and flood-prone regions • Decreased hydro-power potential in drought-prone regions
Increased Asian summer monsoon precipitation variability (*Likely*[a])	• Increased flood and drought magnitude and damages in temperate and tropical Asia
Increased intensity of mid-latitude storms (little agreement between current models)[d]	• Increased risks to human life and health • Increased property and infrastructure losses • Increased damage to coastal ecosystems

[a]Likelihood refers to judgmental estimates of confidence used by TAR WGI: *very likely* (90–99% chance); *likely* (66–90% chance). Unless otherwise stated, information on climate phenomena is taken from the Summary for Policymakers, TAR WGI.
[b]These impacts can be lessened by appropriate response measures.
[c]Based on information from chapters in this report; high confidence refers to probabilities between 67 and 95% as described in Footnote 6 of TAR WGII, Summary for Policymakers.
[d]Information from TAR WGI, Technical Summary, Section F.5.
[e]Changes in regional distribution of tropical cyclones are possible but have not been established.

Table 2: Highlights of the potential impacts of future climate changes (Source, IPCC, 2007).

3.1 Assessment of Adaptation Options to Climate Change

The assessment of adaptation options is usually undertaken at three levels namely: short term, medium term and long term. Short term adaptation focuses on the current climate. The assessment addresses the current climate variability and the required measures to reduce its impacts on the various socio-economic sectors and communities. Typical examples are seasonal floods associated with events such as El-Niño rains or tropical cyclones. Another example is the possible impacts of seasonal rainfall deficiencies that lead to droughts and food shortage.

The most crucial factor in the short term adaptation strategies is skillful seasonal climate forecasts that are issued with lead time that provides for sufficient early warning. In this regard regional climate centres and national meteorological services need to develop seasonal forecasting skills and incorporation of seasonal climate forecasts into routine weather forecasts. These forecasts should include analysis of expected impacts both positive and negative ones with appropriate advisories to national decision makers and communities. The effectiveness of short term adaptation strategies is dependent upon cooperation between meteorological services, national and regional governments' specific sectors and communities for timely dissemination of climate information that is socio-economically valuable. Public education on the best practices for using climate information is also essential for effective short term adaptation.

Mid term adaptation options are those that focus on reduction of impacts of climate change variability over a longer period of time. For example if rainfall deficiencies are expected to occur over and over again, development of drought resistant crops may be one of the options that will lead to food sufficiency. Conservation of water resources and irrigation may supplement the other adaptation strategies for responding to the recurrent droughts. Soil conservation measures may respond to the recurrent heavy rainfall as well as drought related land degradation.

The long term adaptation options focuses mainly on the impacts of the mean climate. A typical example is adaptation strategy for responding to sea level rise and coastal land degradation. The most effective and sustainable adaptation options are those that integrate the three types of strategies. For example while some short term options may be specific to an identified hazard. Others should be undertaken with the aim of responding to medium term impacts. Similarly construction of dykes to control floods respond to short and medium term impacts and even lays the foundation for long term adaptation strategies. National development plans that address adaptation in the three time frames are more effective in comprehensively responding to the impacts of climate change. (UNDP, 2002). Some of the adaptation strategies are highlighted in the next section.

The most effective adaptation measures are those that are integrated into the national development plans. Figure 28 below depicts the main concepts that are considered in adaptation policy assessments. It should be noted that *Climate change* is just one of the drivers of an adaptation policy assessment, along with *climate variability* and other *non-climatic drivers*. Another important input is current *adaptive capacity*, which determines both the scope and the need for future *adaptation*.

The main results of an adaptation policy assessment are recommendations for specific *adaptation* strategies, including both *facilitation* and *implementation* measures, rather than estimates of future *impacts* or *vulnerability* to climate change. However, accurate assessments of impacts and vulnerability are critical in providing realistic adaptation assessments (Fussel and Klein, 2006).

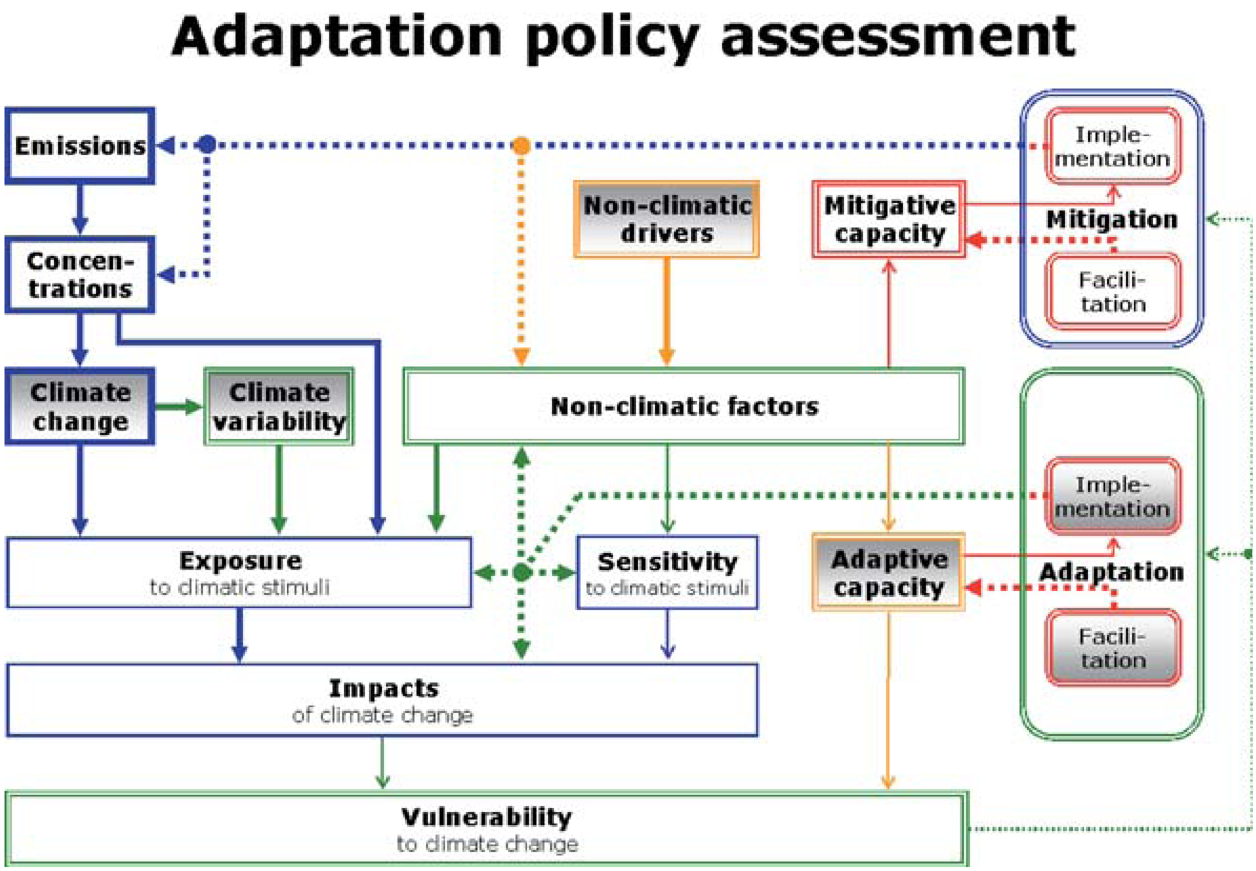


Figure 31: Conceptual framework for an adaptation policy assessment (Adopted from Fussel and Klein, 2006)

3.2 Strategy for Adapting to Climate Change

Adapting to climate change will entail adjustments and changes at every level – from community-based to national and international. IPCC has highlighted that the range of practices that can be used to adapt to climate change is diverse, and includes changes in behavior (e.g. in water use or farming practices), structural changes (e.g. in the design specification of bridges and roads), policy based responses (e.g. integrating risk management and adaptation into development policy), technological responses (e.g. increased sea defences, improved forecasting) or managerial responses (e.g. improved forest management and biodiversity conservation.)

Enhancement of adaptive capacity reduces the vulnerabilities and promotes resilience and sustainable development. Adaptation to climate change involves among others:

- Adjustment in behaviour or the economic structure that reduces the vulnerability of society to climate change, in all climate systems.
- Changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate.
- It involves adjustments to reduce the vulnerability of communities, regions/sub-region, or activities to climatic change and variability.

Adaptations may differ from one individual/ areas/country/region to another based on the specific hazards of the location, experience, observation, and speculation about alternatives that might be. Adaptation measures would depend on among others:

- Hazards, impacts and vulnerability / resilience level of the society
- Wealth / poverty
- Education
- Human capacity and skills
- Technology and technological capacity
- Infrastructure
- Access to resources
- Indigenous adaptation knowledge
- Management skills
- Development plans, future population demographics, sectoral policies
- building resilience in human, economic and natural systems
- Integration of indigenous adaptation knowledge and practices
- Approaches to adaptation include identification of barriers and policy needs.

It should be noted that barriers and policy needs in one sector can also serve as a barrier in another related sector, or can contribute negatively in another sector. Barriers can include among others:

- Policy
- Trade
- Legislative
- Institutional; technical and human capacity.

Assessment of resilience for example requires among others include practical response actions that can address particular vulnerabilities, such as:

- Identify hazards, impacts and vulnerability types and causes
- Identify Actions required to reduce or eliminate the identified particular vulnerability
- Develop alternative options to achieve same
- Identify technology implications in the identified options/actions?

3.3 Integrating Adaptation Strategies in climate risk management

Risk management involves proactive '*no regrets*' strategies aimed at maximizing positive and minimizing negative outcomes for communities and societies in climate-sensitive areas such as agriculture, food security, water resources, and health. The '*no regrets*' aspect of climate risk management (CRM) means taking climate-related decisions or action that make sense in development terms anyway, whether or not a specific climate threat actually materializes in the future. The concept of integrated climate risk management (ICRM) was discussed in section 1. It involves addressing and managing all aspects of climate risks as it is manifested in extreme events and impacts us today and at the same time strengthening the capacities to deal with changing climate in the future.

Integrated climate risk management (ICRM) includes elements of anticipatory risk management (ensuring that future development reduces rather than increases risk), compensatory risk management (actions to mitigate the losses associated with existing risk) and reactive risk management (ensuring that risk is not reconstructed after disaster events) and also takes into account both potential impacts on socio-economic and environmental systems.

The success of ICRM will depend on some of the following among others:

- High-quality climate data and information
- Appropriate climate services including prediction and early warning systems
- User-friendly decision-support tools and methods that show how climate variables will affect specific development outcomes
- Sufficient resources to allow decision makers to use information effectively.
- Full stakeholder participation
- Effective communication channels and links between stakeholder groups

Thus climate change adaptation should therefore be an integrated component of ICRM

3.4 Field Excursion

The session was devoted to practical interactions with local communities in order to learn about the local community copying strategies. The team visited Maasai who is of the most vulnerable communities in Kenya.

3.4.1 The Coping Capacity of the Maasai Community in Kenya to Climate Change

The trip to Kajiado district which is adjacent to the Nairobi’s metropolitan area is approximately two hours by road. The participants were shown locations which are being impacted by the expansion of Nairobi enroute to the actual fieldwork site. The district is largely inhabited by the Maasai pastoralist community. The theme of this excursion was to see how the Maasai were adopting to the harsh conditions of climate.

The Maasai communities visited are living in the Oiti and Murantawua areas of Kajiado. The Oiti and Murantawua communities make up for the 13 villages in Lorngosua location, Kajiado District and are some of the most prone locations to drought effects. Both communities share one earth dam constructed some years ago through their own self-help project, which is not reliable due to its small size and the erratic rainfall patterns. Their shallow water wells, about 3-4 km away, were running dry at the time of visit. The nearest water points are Lorngosua borehole which is about 10km away, and is very overpopulated and over-relied, Bissil Township shallow well which is 15km away, and Imarba shallow well [10km away].

The communities depend solely on livestock for their livelihoods. The main use of land is nomadic pastoralists which are seen as the most efficient method of exploiting the range lands. The recurrent droughts render almost impossible the problem of uplifting the standard of living of the population. During the last drought of the years 2005/6, the communities lost 95% of their livestock. This rendered the whole population food insecure.

There are no restocking programmes in place. The livestock economy collapsed following reports of the outbreak of Rift valley fever and other diseases like lump skin disease. Tick borne diseases (ECF) has also increased. Foot and Mouth disease has also become frequent, even to the extent of affecting goats and sheep. The resilience of the community has therefore been terribly eroded.

Some members of the community had their herds completely wiped out due to the drought. This has pushed them to subsistence crop farming. Maize and beans are being planted and some families had relatively good harvest to last a month or two from the last season. Most families could not change their lifestyles and are finding it hard to cope. The vulnerability of the community is further complicated by:

- Occupation of marginal degraded lands by other communities who have converted
- Low education and skill level
- Limited access to employment opportunities, credit and other resources
- Lack of assets and savings

Conflict over depleting resources has increased particularly on pasture and water. Some had to relocate to the nearest town centres to live in poor environment to sell local illegal brews. Some hired whole land parcels to non-residents for charcoal burning. Lorngosua Location and Kajiado Central in particular has now become the sole supply of charcoal for Nairobi and its environs. 30% of the population is already on Government feeding programme during normal shortages.

The photos below give some highlights of the trip, and some of the areas the participants visited.


Participants arriving at one of the market centres in Kajiado


Posing with the Maasai community in Kajiado.

Environmental conditions in Kajiado

Human dug wells for livestock and domestic use in Kajiado.

Poster showing "selling wealth to buy poverty"

3.3.2 Mid course evaluation, Synthesis, Experiences and Lessons Learnt

The first part of the session was devoted to mid course evaluation of the workshop by the participants under the guidance of the consultant. This involved some unique mapping of the individual marks given to various aspects of the workshop by the participants. A ten point scoring scale was used. The score was quite high for both groups. The participants were quite happy with the workshop content, coverable, presentations, logistics, etc.

The rapporteurs of the two groups (French and English) also provided synthesis of what has been covered in this module. This was then followed by discussions and interventions by participants and the experts. Lessons and experiences from the visit of the Maasai community were also discussed. Translation was provided for the session like for the other plenaries.

The participants were amazed at how the Maasai community is able to cope with the harsh climatic conditions, as the district is plagued with frequent droughts and severe water stress both for domestic consumption and for their livestock. Climate change is likely to exacerbate a situation which is already difficult. The district was a good choice for demonstrating adaptation problems of a traditional pastoral community. It was considered an educative trip for the participants who clearly showed enthusiasm for learning more about the areas problems first hand.

The Maasai communities rely on limited emergency handouts by the government and NGO groups during the frequent drought episodes and the perpetual scarcity of water for domestic purposes and for their livestock. In practice the following were observed:

- The Maasai still resort to traditional adaptation techniques where modern lines of assistance fail. This was eminently demonstrated when our team was told of how the cattle from the area are moved long distances to for grazing and water during the droughts. The team was also briefed by community on the community land management system.
- Although water from a well was available it was not enough for Bissel settlement and the nomads were forced to resort to using deep wells with very little water in them for watering their remaining livestock consisting of sheep and goats. There are strict rules and regulations on the use and sharing of the limited resources.
- In an area close to Bissel the Government constructed borehole was dry, and the pumping machine had long been removed.
- In the vicinity charcoal burning was very much in practice for the Nairobi market. This is what was referred to in a poster as **selling wealth to buy poverty,** noting that they were destroying the local environment by cutting the limited trees and shrubs for charcoal. Desertification would follow up leading to the reduction of the biological productivity of the land
- The Maasai had more confidence in their ability to solve their problems through community than rely on the Government.

It was concluded that it would interesting to learn more from the Maasai community coping and how they have been able to adapt to such hash conditions. Some climate risk interventions were also recommended for the Maasai community that could include:

- Continue and strengthen UN-ISDR facilitated project to provide weather information as an early warning measure
- Development of diverse income-generating activities (e.g. horticulture, forestry and participatory wildlife or tourism management)
- Range and water management ; Strengthening of current range management structures and the construction of water dams in the area to ensure high livestock yields and availability of water during dry periods.
- Livestock research and extension services to ensure high livestock yields by improving breeds and resistance to diseases and prolonged drought.

National Experiences were presented for Nigeria, Tanzania, and several other African countries and compared with the Maasai.

Module Four

Mainstreaming Climate Risk Management into Development Policies

This Module broadly looked at Climate Risk Management and strategies of coping and adapting to these risks. This module covers various topics on mainstreaming climate risk information in development plans.

4.0 Mainstream climate information in Development plans

There exist linkages between climate, economy, society, environment and various development processes. Climate is a major driving factor in most of the social economic sectors in much of Africa as climate related disasters accounts for more than 80% of all disasters of natural origin in Africa. The impacts of climate variability differ according to social, economic and environmental characteristics of the region in question. The arid and semi arid areas with less economic strengths are likely to experience more severe impacts than the generally wet and economically developed areas.

In much of Africa climate variability is a critical factor in socio-economic development because extreme climate events such as droughts and floods have negative impacts. Droughts are often associated with lack of pasture, food, water, energy, loss of society livelihoods, negative national economic growth and many other socio-economic miseries. On the other hand floods lead to destruction of property, infrastructure, settlements, loss of life; environmental degradation, mass migration of animals and people, and outbreaks of diseases such as cholera, malaria and rift valley fever among others.

Climate change would therefore be devastating in Africa. Recent assessments indicate that in the 20th century, disasters associated with climate related hazards have been estimated to be seven times as frequent as those involving non climatic factors. Hazards globally and accounted for nine times as many deaths. The economic losses associated with climatic hazards were three times higher than those associated with non climatic hazards and the number of people affected 55 times greater. These impacts affect the ability of developing countries to achieve Millennium Development Goals. Due to the multi-hazard nature of the climate risks, no single sector can manage these disasters. It therefore requires an integrated approach where various sectors work together to manage the risks.

The understanding of the climate system is continuing to grow, and society is becoming more aware of the potential opportunities and threats from this knowledge thus increasing demand for new and better climate services. Climate services are linked to planning and early warning. The public benefit from climate services come from its contributions to safety of life and property in the events of extreme climate events and from its contributions to future development. In many socio-economic sectors quantified and specially tailored climate services enhance decision-making.

These applications require the development of special decision system that recognize critical times in the activity cycle, or critical value of vital climate variables. Effective climate services must bridge disciplines and combine expertise needed to understand the totality of any problem and to analyze how to use the information wisely. Some examples of climate mainstreaming activities in Africa are given in the following sections.

4.1 ICPAC's Activities related to climate risk reduction

The major climate hazards in GHA are floods, drought, high/low temperatures, dust storms, frost, etc. Climate related risks are linked to complex interactions between climate hazards and vulnerable/capable conditions of the society. They trigger devastating socio-economic impacts, and are key threats to sustainable development in the Horn of Africa (GHA). In a bid to adequately address the negative climate impacts and take advantage of the good years, seven countries in the Horn of Africa (GHA) namely Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan and Uganda, within the framework of the Inter-Governmental Authority on Development (IGAD) formed IGAD Climate and Applications Centre (ICPAC). Three other Non-IGAD countries include Rwanda, Burundi, and Tanzania. ICPAC is a specialized institution of IGAD.

ICPAC's strategic plan has considered how best to work with the NMHSs to provide maximum support to the overall objectives of IGAD that include: Food security and environmental protection; Infrastructure development; conflict prevention; resolution and management; and Humanitarian Affairs. ICPAC's main goal is to develop improved and enhanced sub-regional / national capacities for the use of climate knowledge towards providing Climate Information, Prediction Products and Services, Early Warning, and related applications, in support of economic integration and Sustainable Development in the IGAD Sub-Region.

ICPAC's Integrated Climate Risk reduction related activities include providing information on the characteristics of the past and present climate hazards including mapping of the hazards; providing outlooks of future patterns of hazards at various time and space scales; Down scaling climate products for specific sector applications; Capacity building; Education and awareness; Partnerships and advocacy; Advocacy and catalyzing climate / disaster risk reduction policies, among others. Some of these will be highlighted in the next sections.

4.1.1 Mapping Past and Present Patterns of Climate Hazards

Databases at ICPAC and NMHSs have been used to generate various risk maps, especially for rainfall, and also including the use of space based information. Such data are also fundamental in the understanding of the space time patterns of the hazards. They are also critical for modeling, prediction and early warning. Data and observation network is however very sparse for risk identification activities at the vulnerable community levels. ICPAC also produces several products that can be used for monitoring ay changing patterns of climate hazards. These ICPAC products include:

- Climatological summary of temperature, rainfall, vegetation conditions and drought severity over the last 10 days, month, 3 months
- 10 days, monthly and seasonal outlooks
- Socio-economic conditions and impacts

- A synthesis publication known as the *climate watch* is usually released regularly to provide updated information regarding any unique climate events and associated impacts in the sub-region.

ICPAC's 10-day, monthly and seasonal products are being used to timely monitor, detect/map any new climate stress and hot spots. Monitoring, prediction and early warning advisories have been given to some of the recent floods and droughts that were related to the Indian Ocean Dipole (IOD) circulation; the 1997-98 / 2002-03 / 2006- 07 El Niños together with 1999-2000, and 2007-08 La Niñas.

4.1.2 Development of New Prediction and Early Warning Tools

Improved regional climate diagnosis, prediction and early warning tools have been developed at ICPAC in collaboration with many partners including WMO and IRI. Most of the tools have been developed through capacity building by the experts from the member countries. Such tools have included the use of both simple empirical and dynamical climate products. The tools have shown that the region has high seasonal prediction skill during October to December, especially in the years with large Sea Surface Temperatures (SST) anomalies like during El Niño and La Niña.

Seasonal climate outlooks are provided at the beginning of each season through regional capacity building workshops that are often followed by a regional climate outlook forum that include participation of all ICPAC partners. The climate outlook forums have been adopted as one of the new strategies for the generation and application of climate information and prediction products/services for sustainable socio-economic development.

These forums bring together climate scientists, policy makers and the general user community to participate in the formulation of the consensus climate outlook and develop potential impacts of the outlook on various socio-economic sectors of the national economies. The Forums have made enormous contribution to the improvement of the quality of the seasonal rainfall outlook. The interaction of users from various sectors has improved the dissemination of climate information and prediction products for early warning and disaster management.

4.1.3 Downscaling Climate Products for Specific Sector Applications

ICPAC has partnerships with several sectors for down scaling climate information for sector specific applications.

4.1.3.1 Agriculture and food security

ICPAC’s challenges collaborate with relevant agricultural institutions to provide climate information that are required by the rural peasant and other farmers for sustainable agriculture production and food security of the member states. Support to agriculture sector in the region has included:

- Improve linkages and interactions between climate and agriculture/livestock/food security experts through training workshops in order to translate probabilistic climate prediction information into useful agriculture and livestock production products.
- Some efforts are being made for relating regional climate anomalies with for regional forage expectation.
- Agriculture and food security outlooks are now being provided by FEWS NET including seasonal climate outlook information from ICPAC.

4.1.3.2 Water Resources sector

ICPAC provides climate information required in flood /drought forecasting and risk early warning for sustainable water resource management in the GHA. ICPAC contribution in addressing water resources management problems in the GHA include:

- Working with relevant hydrological institutions and partners such as USGS, FEWSNET, and WMO in development of tools for stream flow modeling, forecasting and early warning of low / high flows for pilot basins.
- Enhanced collaboration between climate and water experts through capacity building workshops, awareness workshops, and pilot projects.
- Strengthening the regional human resource capacity for application of space based technology in water resources assessment and other applications: e.g. use of Rainfall Estimate (RFE) data and Geographical Information System (GIS).

4.1.3.3 Hydropower Sector

ICPAC provides climate information, prediction and early warning services that can be used for sustainable hydropower generation. Some of ICPAC's activities with other partners in the hydropower sector include:

- Developing simple rainfall/runoff prediction models for early warning and risk assessment in hydropower generation.
- Capacity of the hydropower experts to use downscaled seasonal climate outlook products to provide improved hydro energy modeling and early warning systems.
- Enhancing the interactions between climate scientists and the hydropower experts in the region through pilot application projects.

4.1.3.4 Disaster Management

ICPAC, member states, USAID/OFDA, USAID/REDSO, NOAA/OGP, WMO, ISDR, IRI, EU and many other partners have initiated several efforts addressing disaster risk reduction challenges in the GHA, especially the need to factor climate information in national and regional disaster management activities through pilot projects, assessment of the status of the disaster management in the region, and support to national disaster management policy development. Other applications are highlighted below.

- ICPAC's database has been used in mapping national and regional rainfall risk zones.
- ICPAC's database has also been used to develop regional drought / flood risks maps associated with some of the major anomalies in the global climate system such as El Niño, La Niña etc.

- Enhancing linkages between disasters and climate through capacity building workshops, joint application pilot projects, and close involvement of the national disaster management experts in the ICPAC's seasonal climate forums, that are held at least twice a year, mainly at the beginning of the major rainfall season.
- Increasing awareness of the governments, public and other users of climate products on the need for integrated national/regional disaster management including factoring of climate information in disaster risk reduction policies. These are carried through public lectures, bulletins, information exchange, workshops, etc. The Awareness has been created on the need for integrated national/regional disaster management including factoring of climate information in disaster risk reduction policies.
- Integration of Indigenous knowledge in climate risk reduction strategies
- Initiated activities for mainstreaming gender and youth

4.1.3.5 Health Sector

A variety of tropical diseases common in the Greater Horn of Africa are indirectly or directly associated to climate, especially the extremes. Some of climate health risk related activities include:

- Working with health sector, NMHS and other partners on seasonal malaria risk early warning. Seasonal malaria outlook is now part of the seasonal climate outlook forums;
- Enhancing interactions between health and climate experts through capacity building and awareness workshops
- Research on regional climate change impacts on health sector, and adaptation strategies for malaria.

4.1.3.6 Capacity building

ICPAC's training modules include group training of national experts using local staff and international experts invited to address specific areas, secondment of national staff to ICPAC, and attachment of national experts advanced countries centres.

- Many climate national experts have been trained at ICPAC, especially on data management, modeling, seasonal prediction and early warning. ICPAC's capacity building activities have proved beyond doubt that it is much cheaper to provide group training of experts within the region.
- The national experts have been able to calibrate and apply models to suit national / regional conditions.
- Capacity building activities have provided opportunities for the experts from the region to share experiences regarding some successes, failures and impediments in national / regional disaster risk reduction.
- Capacity building activities have also enabled enhanced interaction with the users and increasing awareness on many issues including mainstreaming of climate on development.

4.1.3.7 Education and Awareness

Most of the public and even experts from specific application sectors affected by climate in the region are not aware of the climate and other disaster management products that are available within the specific countries and the region. Most of those who are aware find it difficult to interpret the available information. ICPAC's activities in this area include:

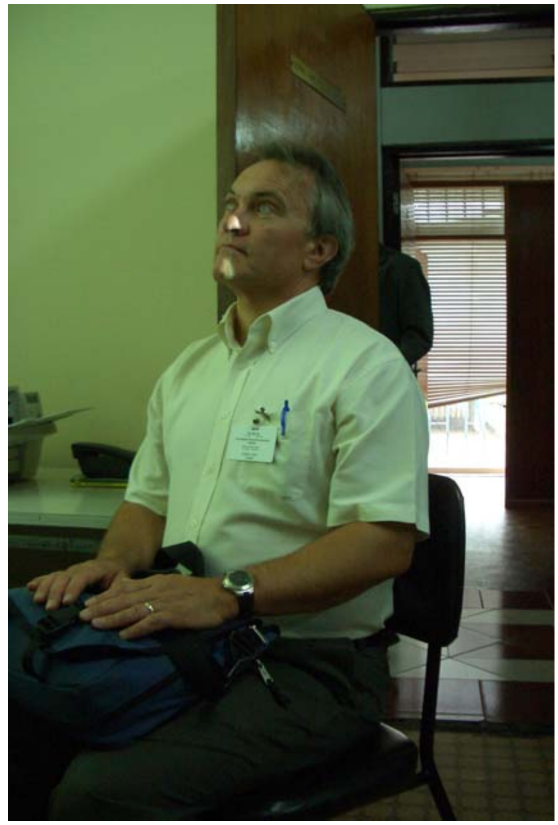
- Education and awareness is part of Climate Outlook Fora that are held at least twice a year, mainly at the beginning of the major rainfall season.
- ICPAC in partnership with NMHS, ISDR, WMO, NOAA, USAID and other partners, has created awareness through National workshops pilot applications projects, etc.
- Capacity building activities have provided opportunities for the experts from the region to share experiences regarding some successes, failures and impediments in national / regional disaster risk reduction.
- Enhancement of the role of the media, and the interactions with the climate experts in demystifying technical climate and disaster management jargons. National and regional media workshops have been undertaken together with some pilot projects. Regional media – climate expert association NECJOGHA has been formed with national chapters

4.1.3.8 Conflict Early Warning

Conflicts over resources including water, food and grazing land are key threat to security and development in GHA. ICPAC works closely with the IGAD conflict centre CERWARN for providing early warning of climate related conflict indicators.

.4.2 Demonstration on Integrated Climate Risk Management at ICPAC

Participants from the workshop had an excursion to ICPAC where they were able to see the different facilities, and at the institution. Several demonstrations were also provided**.** The photographs below were taken when the participants visited ICPAC.



The first photograph shows Prof. Ogallo explaining a point to one of the participants from South Africa while in the second, Dr. Stephen Tyler listens attentively to one of the Pre-COF discussions at ICPAC.

Participants touring the facilities at ICPAC.

Demonstrations and hands experience on some of the integrated climate risk management activities that have been addressed in the course were provided at ICPAC including development of regional climate change scenarios; data management and mapping of risks; modeling, seasonal prediction and early warning; applied research; sector specific applications; documentation, among others.

4.3 Synthesis, Experiences and Lessons Learnt

A plenary for this session was convened and the rapporteurs gave a synthesis of what has been covered not only in this module. This was then followed by discussions and interventions from participants and the experts present.

The participants were impressed by the activities regarding mainstreaming of climate risk management that were taking place at ICPAC. They realized that ICPAC had better facilities for climate modeling, prediction and an up to date GIS computer laboratory. The library had useful information on climate issues among others.

The participants recommended that collaboration between ICPAC and other similar institutions should be strengthened as well as the need to have participants to be attached to the centre for capacity building initiatives. The participants requested ICPAC to avail its facilities to CCAA project respondents

Module Five

Capacity Gained and Benefits by the CCAA funded Projects

This module is devoted to giving a summary of the presentations that have so far been funded by CCAA. These were presented by the project team leaders. Not all project team leaders made presentations. They indicated that the invitation letter did not reach them on time to enable them prepare the presentations. Some of the presentations made at the workshop by the CCAA project respondents are summarized below.

5.0 Managing climate Risk For Agriculture And Water Resources Development In South Africa

Project Objectives include:

- This project will address two significant problems related to adaptation to climate change in the water resources sector of African countries.
- The first is that relevant and important information from climate change forecasts is not being disseminated to water resource managers, nor is it being integrated into water resources policy, planning and management in a systematic way for agricultural and human use in Africa
- The second, related problem is that there is currently a shortage of integrated approaches for evaluating and making adaptation decisions related to water resources in Africa.

Progress so far:

- First challenge to set up contractual agreements between the lead consultant (UFS) and three other participating research institutions
- Inception workshop – feedback on Addis and review work program
- Raised awareness of the project: Letters to Gov. Departments and other NGO's, the Berg River CMA reference group (all role-players are represented here), articles in local popular press (2), interviews on local and national radio stations (2), national TV (8 minute program) on our project
- Other awareness: information days, agricultural unions, industry bodies
- Revisited the existing agricultural and urban water use database – started with update
- Identification of PhD students and Post Doc – difficult to find suitable students
- Preparations for major farm survey – including all farm typologies, design of questionnaire
- Set up farmer database – this is a daunting task but necessary to make a statistical representative farm survey.
- Identification of students to conduct the farm survey
- Organised visit for Directors of the IDRC - , Dr Connie Freeman, and Dr Micheal Clarke
- Preparations for major visit from IDRC Governors on 15 November 2007
- Attended several climate related workshops in SA, Addis and Nairobi
- Will be attending all the other IDRC workshops – Cairo, Jhb, Dakar

Challenges:

- To refine climate change scenarios – downscaling and the impact on the hydrology
- To develop integrated models – CC scenarios, hydrology, environment and economics to be used to objectively analyze the costs and benefits of CC adaptation strategies
- Share of knowledge and capacity between African countries and collaboration with non-African countries
- Buy inn and participation of all economic sectors (agric/non agric) and role-players – use existing institutions
- To treat all agricultural typologies equally – subsistence, emerging commercial and commercial – the one needs the other
- To make provision to ensure that genders issues are properly addressed
- To address rural and urban adaptation in a balanced integrated way.
- To find a balance between water supply options vs water demand management options
- Balance between economic growth policies and social support policies
- Bottom line is to protect the most vulnerable (mainly women and children) and simultaneously develop CC adaptation strategies that will protect and grow the economy and thereby - reduce vulnerability through maintaining jobs and creating new ones and through increased welfare
- The key challenge for CCA and sustainable economic development is to find a balance between adaptation to climate change and development – this is the main focus of our project

What is to be take away

- A much better conceptualisation of the link between CC scenarios, risk, vulnerability and adaptation
- Better understanding of CC scenario development methodology, downscaling and the problems with data and capacity in Africa – hence a strong need for collaboration to adapt to limited capacity
- Better understanding of risk evaluation methods and tools – although we think there is a need for a more intense workshop on this issue
- Confirmation of the need for a integrated approach – multi-disciplinary - multi-sector therefore holistic and balanced.
- Also the importance of the link between adaptation strategies, policy and institutions
- What we don't take away – not enough shared experiences of success stories and failures of adaptation in Africa – the only drawback of the workshop
- Friendship and companionship – nobody called us "white-ties" – good indication that we are getting rid of the past – CC will add strength to the glue that bind us together as Africans

5.1 Strengthening Local Agricultural Innovation Systems in Less Favoured and High Potential Areas of Tanzania and Malawi to Adapt to the Challenges and Opportunities Arising From Climate Change and Variability (Tanzania and Malawi). Institute of Resource Assessment (IRA), University of Dar es Salaam

In many sub-Saharan African countries, poverty is linked to low agricultural productivity, which accelerating climate change and variability threatens to make even worse, notwithstanding the implementation of several initiatives aimed at boosting agricultural production. In Tanzania and Malawi, a key challenge for decision makers is to understand the context and strategies of farmers and other stakeholders in agriculture for adapting to climate change and variability.

One reason for this is the lack of interaction between researchers, policy makers and vulnerable farming groups. This action research project seeks to foster processes for effective engagement amongst these stakeholders to develop agricultural innovation systems that are better able to adapt to climate change and variability, using case studies of communities in two different agro-climatic sites in Tanzania and Malawi.

The research intends to facilitate a process of interaction and learning where information/ knowledge from different sources (local, national, regional and international) is shared and integrated in a way that results in its novel use by stakeholders in agricultural innovation systems to better adapt to climate change and variability.
It will contribute directly to capacity strengthening primarily at the local scale through improving the ability of participating individuals, organizations and systems to utilize knowledge more effectively, efficiently and sustainably in addressing local, national and regional priorities that will contribute to adapting to climate change. The process will systematically identify and share lessons with key decision makers for further capacity strengthening to enhance innovation and adapt to climate change in ways that benefit the most vulnerable.

The specific objectives for this project were to:

- Strengthening farmers capacity to access and use quality information training and products in order to adapt to climate change and climate variability
- Strengthening the capacity of private and public sector stakeholders to make agricultural innovation systems work more efficiently, equitably and responsibly to climate change and climate variability.
- Learn and share lessons for scaling up successful strategies for capacity strengthening (individual organizations and systems) within the agricultural innovation system to adapt to climate change and climate variability.

Progress to date

- We have so far had an inception workshop in June 2007 in Tanzania where participating institutions from both Malawi and Tanzania attended. These included government agencies, NGO's, Private sector and Input Supply agencies. The purpose of the workshop was for participating partners to agree on project documents and action planning to achieve the objectives. The Outcome of the workshop was agreed, action plan, methods and tools to be used in achieving the project documents. literature review has been undertaken and Stakeholder identification put in progress.

Challenges

- Breaking institutional barriers since various institutions will be involved in the project
- Researchers and policy makers to learn from communities.
- To mine results to policy making.

The project will take home the knowledge on Science of Climate, Climate Change Adaptation in Africa and have shared useful experiences form other countries and projects. It is also important to say here that the representatives from Tanzania and Malawi are now in a better position to explain issues concerning climate change and variability to fellow project team members.

5.2 Managing risk, reducing vulnerability and enhancing productivity under a changing climate (Tanzania, Kenya, Ethiopia, Eritrea, Sudan), Sokoine University of Agriculture (SUA)

The countries of the Greater Horn of Africa (GHA) are particularly vulnerable to droughts, which characterize the region with increasing economic impacts. This vulnerability is further exacerbated by factors such as widespread poverty and over-dependence on rain-fed agriculture. Even with normal rainfall, the region does not produce enough food to meet its needs and this reinforces the endemic poverty in the region. Consequently, the region experiences frequent climate-induced famines and related disasters.

Governments in the region often address drought problems using short-term emergency measures. Little or no strategic attempt has been made to encourage primary producers and others to adopt self-reliant approaches to prepare for these droughts.

This project recognizes that opportunities exist to reduce the impacts of droughts and consequently poverty in the region by formulating effective and efficient adaptation strategies aimed at reducing the vulnerability of the marginalized, safeguarding livelihoods threatened by droughts, increasing the flexibility in management of vulnerable systems, and enhancing inherent adaptability among smallholder farmers.

Using case studies in Tanzania, Kenya, Ethiopia and Sudan, this action research project seeks to contribute to the development of such strategies by:

- Establishing an informational database that is necessary to understand vulnerability to droughts within different social, political, and economic contexts;
- Developing robust decision making tools for improved strategic and tactical decision making to reduce vulnerability.

5.3 Building Adaptive Capacity to Cope With Increasing Vulnerability Due to Climatic Change (Zambia and Zimbabwe), Midlands State University

This project focuses on the drier regions of southern Zambia and southwest Zimbabwe, and seeks to improve incentives and opportunities for households to cope with and adapt to the increasing vagaries of climate by investing in improved crop production practices of more practical value to diverse groups of small-scale farmers. The adoption of these options will be stimulated by linking their dissemination with complementary investments in climate forecasting, and building linkages to other projects that have either a humanitarian relief focus, or are involved in the development of input and product markets.

The general objectives were to develop education, research and extension competencies to be able to create strategies that facilitate rural communities to increase their adaptive capacity to cope with risks and opportunities associated with climate change and variability.

The specific objectives of the project are to:

- Establish existing perceptions of climate risk by poor smallholder farmers that can be used by change agents and meteorological services to better target their interventions
- Determine how rural communities have coped with existing climate variability and extremes and develop appropriate strategies for adapting to present and future climatic changes
- Build capacity and competency within Zambian and Zimbabwean institutions to use simulation and climatic forecasting tools for predicting climate variability in order to facilitate rural communities in developing and evaluating improved coping strategies
- Use farmer participatory research approaches linked with simulation and climate forecasting methods to develop and evaluate scenarios with farmers that enable adaptation of their agricultural production systems to climate variability
- Develop, test and disseminate climatic risk communication materials and appropriate delivery interventions to all stakeholders

5.4 Lack of Resilience in African Smallholder Farming: Exploring Measures to Enhance the Adaptive Capacity of Local Communities to Pressures of Climate Change, University of Zimbabwe

This proposed work assesses the vulnerability of smallholder farming communities in Sub-Saharan Africa (SSA) to the effects of climate change and variability on agricultural productivity and livelihoods and identifies opportunities for enhancing the adaptive capacity of different categories of households and communities. SSA is characterized by high prevalence and intensity of poverty, indicating high vulnerability of the populations to the potential negative impacts of climate change and variability, particularly among rural and peri-urban populations who depend on an already degrading environment. Any short- or long-term climate change will force farmers to adopt new agricultural practices including choice of crop varieties, timing of major operations and designing of alternative food supply systems.

The project thus focuses on enhancing capabilities of households, communities and relevant institutions to appropriately respond to these changing circumstances in order to reduce vulnerability and future threats to food security and environmental integrity in Sub-Saharan Africa. Combining participatory action research and integrated systems analysis, the proposed project aims to enhance the knowledge and capabilities of households and communities to adapt to the effects of climate change and variability on agricultural productivity and livelihoods, and to stimulate development of the much-needed expertise among collaborating institutions and stakeholders.

The project builds on current research initiatives in major climatic zones of Africa, and takes advantage of active coordinating role of regional networks. It is being implemented in by a consortium of 7 countries, namely Zimbabwe, Zambia, Tanzania, Uganda, Mali, Ghana and Mozambique. The Project objectives were five fold, namely:

- The first objective is to characterize livelihood profiles of smallholder farming communities in Africa according to their relative capabilities to respond to climate change and variability, paying particular attention to the most vulnerable groups in the context of food security.
- The second objective is to quantify the biophysical, institutional/policy and economic thresholds that determine sustainability of smallholder farming systems under changing climatic conditions of major contrasting zones in Africa.
- The third objective is to identify and promote appropriate combinations of institutional x technical options that reduce vulnerability and enhance sustainable development of smallholder farming systems within the context of climate change and variability
- The fourth objective is to build capacity in integrated systems analysis to evaluate approaches to sustainable intensification and diversification of smallholder agriculture among regional research and development partners.
- The fifth objective is to disseminate thresholds of sustainability and mitigation options to decision makers.

5.5 Transferring Malaria Epidemics Prediction Model to End-Users in East Africa

The Objectives of the project is to build capacity in East African Countries: Kenya, Uganda and Tanzania, to use the model at operational level. The Collaborating Agencies are the Ministry of Health (MoH) and Kenya Meteorological Services (KMD). The Specific Objectives include to:

- Characterize immune profile of some highland vulnerable population in relation to topographic (Kenya alone). This is meant to improve the model.
- Establish topographic factors that influence malaria transmission that result into epidemics

The project will have a Training component. The challenges are securing quality data which timely for running the model. The home is the Assessment tools for vulnerability assessment.

5.6 Evaluating the efficacy of Radio Drama as a means to strengthen the capacity of smallholder farmers to adapt to climate change. African Radio Drama Association (ARDA), Country: Nigeria

Smallholder farmers in Nigeria, particularly female farmers, are highly vulnerable to the impact of climate change. While Nigerian farmers are adapting and developing some coping strategies independently, there is a need to produce and disseminate information that helps them adapt their farming methods and mitigate the impact of climate change on their livelihoods. A major challenge facing governments, research institutions, civil society organizations and donors is providing such information to large numbers of people, many with limited literacy, cost-effectively.

Radio broadcasts could help address this challenge because they are spoken-word, often in local languages, building on Africa's oral culture and therefore not constrained by illiteracy. The technology for broadcasting and receiving broadcasts are widely available and affordable.

This two-year project proposes to test the efficacy of radio drama to strengthen the capacity of smallholder farmers towards adaptation to climate change, in relation to two projects in Nigeria that have a strong climate change dimension. A twenty-six episode radio drama will be produced locally in two local languages and will be broadcasted weekly by five radio stations over a period of six months. Meetings with focus groups before, during and after the broadcast period will help define the most adequate content of the radio dramas, evaluate the efficacy of the radio dramas and catalyze an action-research process. The scripts of the radio drama will be available in English and in French.

The project will be led by the African Radio Drama Association (ARDA) in collaboration with the Women Farmers Advancement Network (WOFAN), the Developing Countries Farm Radio Network (DCFRN) and the University of Guelph.

It was recommended that all project respondents should provide progress report in all future workshops.

5.7 Follow up Measures

The following were some of the issues raised and proposals made on the follow up measures with the participants of the workshop:

- Regular updates and information sharing (CCAA, ICPAC)
- Continuing networking with participants and info sharing: website?
- Exchange visits between projects / sites
- Documentary support for exchanging case study info
- Workshops / training / collaboration on modeling
- Workshops specifically for policy makers
- Workshops to facilitate research-policy maker interaction and awareness (national, regional, Africa)
- Tutorials for risk management, scenario building and vulnerability mapping
- Opportunities to develop future joint research proposals
- Interactions with vulnerable groups on adaptation issues
- Additional funding from IDRC for detailed climate data acquisition
- Support for curriculum development
- Networking of PIs
- Regional thematic workshops:
- Capacity building on climate models, scenarios (delivery, training, research)
- Field schools for vulnerability, adaptation: case studies
- Need to develop communication, knowledge and public awareness strategies
- Issue of publication
- Engagement with Policy makers, local communities
- Data/methods exchanges between projects;
- Learn lessons, web site, email list, Newsletter,
- How to share information, tools, data , etc
- Need for capacity building for scaling down global scenarios to address local regional and issues and reflect local livelihood conditions for all project respondents;

- Need to enhance Institutional capacity for multidisciplinary climate change research in Africa. Centres like ICPAC and AGRHYMET could be strengthened to play such roles;
- The CCAA sponsored projects, should find some ways of sharing or storage of critical data, especially for the use in the next IPCC report;
- It was agreed that ICPAC and AGRHYMET should allow CCAA projects PIs to use their facilities if formal request is made. This could require the development of learning contracts between participants, and UCAD/AGRHYMET/ICPAC

5.8 Final evaluation of the workshop

To ensure that the workshop achieved its objectives, there was a built in evaluation process at various stages of the workshop. Workshop evaluation was done during 2 sessions: mid-term session and end of the meeting. Evaluation forms were distributed to the participants and they were asked to make comments on their observations as candidly as possible. The evaluation process was to consider various items as listed below:

- Overview/General considerations
- Evaluation of the objectives of the workshop, its design and structure
- Evaluation of training material and style of presentations
- Evaluation of Interactive sessions, field trip session and facilities

The workshop managers (Lead and Collaborating Institutions) synthesized the information and gave presentations on the results of the evaluations during the plenary sessions. In addition to the built in evaluation of the achievements of the workshop, a structured final evaluation was also carried out. Participants were requested to provide a feedback that would improve future workshops. They were requested to fill the questionnaire which given below. The results of their feedback are presented at the end of this section.

Circle one response for each question, with 0 the lowest / most negative and 3 the highest / most positive rating. Thank you!

1. **This workshop met my expectations in terms of content and learning.**

0	**1**	**2**	**3**

2. **The format of the workshop allowed me to share my knowledge and experience effectively.**

0	**1**	**2**	**3**

3. **I will be able to take away some specific ideas or suggestions for my organization to consider from this workshop.**

0	**1**	**2**	**3**

Comments:

What would have improved this workshop for you?

Do you have any specific suggestions for the Climate Change Adaptation in Africa program, in regards to its activities funding research, building capacity and sharing knowledge?

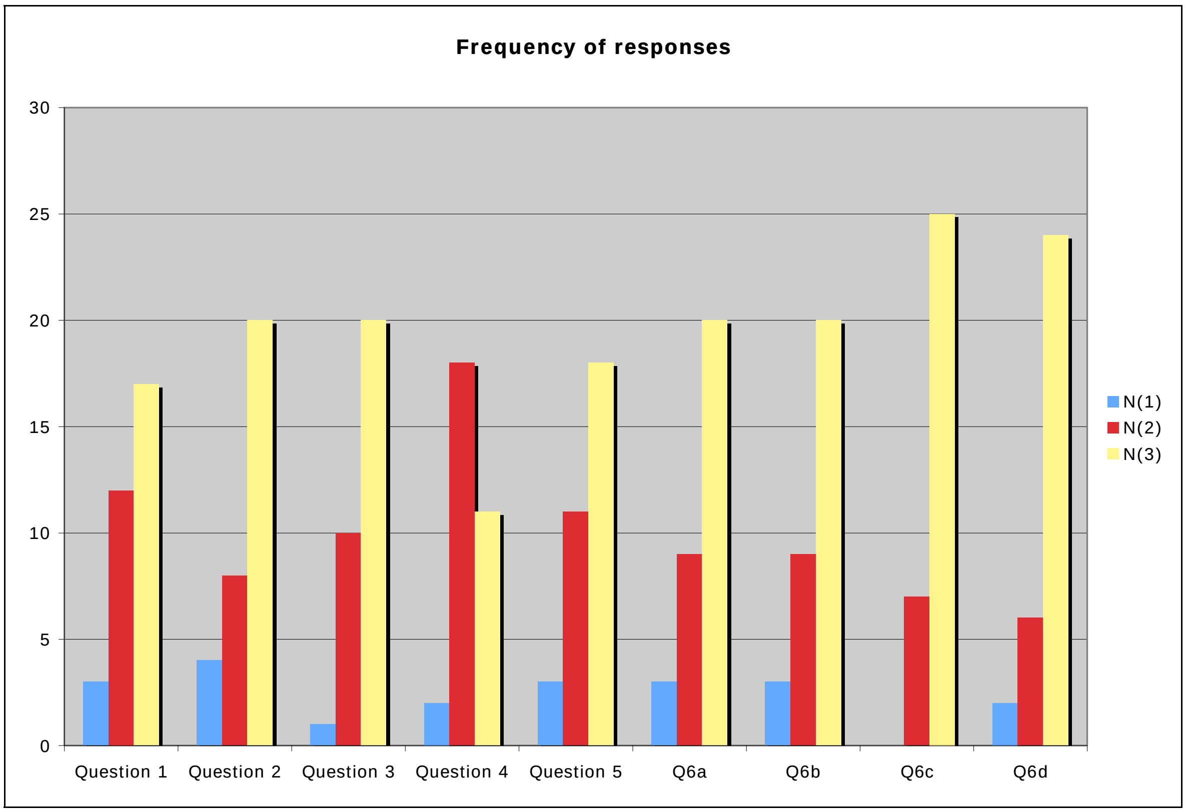
To which group do you belong (please circle the one that fits best)

Researcher	Regional or international organization	National government agency	Other

Which region of Africa do you work most in:

North	West /Central	East	South

5.8.1 Results of the Responses to the questionnaire for Participants



Response from participants of the climate risk management workshop

The following were some of the key issues that the participants would have liked to see more during the coming workshops:

- Better information in advance of the workshop
- Documentary summaries of historical situation in advance to save time in presentations
- More specific sectoral examples from different countries (risk assessment, tools application, successes and failures)
- Group exercises, work on practical examples (e.g. using software)
- Sharing of cases and relevant websites
- Examples of data treatment for application in models
- Step-by-step integrated risk assessment (with examples)
- Modeling and risk assessment for adaptation

- Scenario building
- Discussion of *processes* of adaptation and innovation with stakeholders, rather than just analytical methods
- Application of tools and methods with vulnerable groups
- Presentations oriented to the topics covered in CCAA projects
- Better explanation of the purpose, themes, issues covered in field visits
- Round-table discussions in small groups
- More translation of discussions
- Examples of agricultural adaptation in dryland farming systems

The following were some of the key issues that the participants would have liked to see less during the coming workshops:

- Presentations (should be shorter, fewer)
- Climate science and theory
- General background
- Science of assessment (in the context of more on *process of adaptation*)
- Discussions were dominated by a small number of people

Individual concerns:

- Difficult location: minor shopping or variety of dining experiences impossible
- Division of groups (Francophone / Anglophone) may have missed some useful interactions
- Workshop was too long (3 days max)

6.0 Selected Bibliography

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6.3 Vulnerability to Climate Change

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4. Various resources on tools and methods vulnerability and adaptation assessments of climate change (AIACC): www.aiaccproject.org
5. Various resources on methods, tools and case studies for vulnerability and adaptation assessments of climate change (START): www.start.org
6. Various resources on case studies, examples and tools for vulnerability and adaptation assessments (Vulnerabilitynet): www.vulnerabilitynet.org
7. In-Session Workshop on Impacts of, and Vulnerability and Adaptation to, Climate Change Presentations: http://unfccc.int/meetings/workshops/other_meetings/items/2950.php
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18. IPCC Intergovernmental Panel on Climate Change: www.ipcc.ch
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21. Linking climate adaptation www.linkingclimateadaptation.org
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7.0 Course Outline

Module 1: Introduction and concepts

Session 1: General concepts in climate risk assessment

- Some common terminologies and definitions
- Understanding Risk including risk in insurance and risk perception by stakeholders
- Concepts of Risk Assessment
- Concepts of Hazards
- Concepts of Climate Risk and climate risk Management (CRM)
- Concepts of Integrated Climate Risk Management
- Synthesis, Experiences and lessons (Module summary by rapporteurs; comments by participants, experts, and institutions)

Session 2: Setting the scene: Climate Change context

- Introduction to the Climate Change (causes, impacts, and adaptation)
  - Detection and Attribution of Climate Change
  - Climate Change evidences from Past and Present Observations (Greenhouse gases trends; Past global climate changes; Climate past Variability and Changes in Africa)
- UN Convention on Climate Change (UNFCCC) and Its Instruments
  - The Kyoto Protocol
  - The Conference of the Parties (COP) and Subsidiary Body for Scientific and Technical Advice (SBSTA)
  - The National Communication (NC)
  - The Clean Development Mechanism (CDM)
  - The Least Developed Countries Fund (LDCF) and the National Adaptation Programmes Of Action (NAPA)
- Millennium Development Goals (MDGs)
- Concept on Climate Change impacts and Adaptation in Africa
- Synthesis, Experiences and Lessons Learnt

Module 2: Methodology and tools for integrated climate risk assessment

Session 3: **Climate risks evaluation methods**

- Climate Risks Evaluation Methods
  - Evaluation of Climate Change Hazards
  - Assessment of Climate Change Impacts
  - Climate Change Vulnerability Assessment and Mapping
  - Climate Change Adaptation Assessment

Session 4: **Climate Risk evaluation tools**

- Tools for Integrated Climate Risk Management
  - Tools for Past and Present Climate Analysis
  - Predicting Climate on Seasonal to Inter-annual Time Scales

Session 5 Climate Change Scenarios

- Introduction to Climate Change Scenarios
  - Regional Climate Change Scenarios
- Data Requirements for climate risk management
  - Climate Observations and data types
  - Remote Sensing and Geospatial Information Systems needs for Integrated Decision Making

Module 3: Adaptation strategies in Climate Risk Management

Session 6: Adaptation strategies

- Adapting to Climate Variability and Extremes
- Assessment of Adaptation Options for Climate Change
- Climate Change Adaptation Strategies
  - Adaptation Strategies in Integrated climate risk management (ICRM)

Session 7: Field Excursion

- Field excursion on vulnerable environment and communities
- Mid term evaluation-Questionnaire
  - The Coping Capacity of the Maasai Community in Kenya to Climate Change
  - Synthesis: Group wrap up exchanges
  - Experiences and Lessons Learnt

Module 4: Mainstreaming Climate Risk Management into Development Policies

Session 8: mainstreaming Climate Risk Management into Development

- Mainstreaming Climate Risk Management into Development Policies
  - Mainstream climate information in Development plans
  - Examples of mainstreaming of in Integrated Climate Risk Reduction Activities
  - Experiences and Lessons Learnt

Session 9: Demonstration and hands on experience on integrated climate risk management

- Visit to ICPAC for demonstrations and hands experience on some of the integrated climate risk management activities that have been addressed in the course

Module 5: Lesson learned and Conclusions

- Lesson learned from all modules of the workshop and Conclusions

Session 10: **Capacity gained and benefits by the projects**

- CCAA Brief on funded project (CCAA)
  - Project presentation by participants: climate risk management needs; expectations and limitations including follow up needs

Session 11: Final evaluation of the workshop

- Comment/Discussions
- Closure of the workshops

8.0 Coordinators of Manual Preparation

The manual is an integration of presentation by various expects, and other materials from the listed documents listed in section 7. The coordinators of the manual preparation are given in section 8.1. The experts who contributed to the workshop are listed in sections 8.1 and 8.2.

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8.3 List all the experts for various sessions as per the programme

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Important note: Presentations by the experts listed in section 8 at the workshop, and materials from documents listed in section 6 were integrated in some part s of the manual.