# Workshop Report: International Workshop of Experts on Global Environmental Change (including Climate Change and Adaptation) in sub-Saharan Africa

**Date: 09 – 11 February 2009**

**Venue: Roode Vallei Country Lodge, Pretoria, South Africa**

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## Acronyms

| | |
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| AEJ | African Easterly Jet |
| AfricaNESS | African Network of Earth System Science |
| AMCOST | African Ministerial Council on Science and Technology |
| AMMA | African Monsoon Multidisciplinary Analyses |
| APINA | Air Pollution Information Network for Africa, |
| AU | African Union |
| CEO | Chief Executive Officer |
| DAAD | German Academic Exchange Service (Deutscher Akademischer Austausch Dienst) |
| DST | Department of Science and Technology |
| ECMWF | European Centre for Medium Range Weather Forecast |
| EGEE | Enabling Grids for E-sciencE |
| ENSO | El Niño-Southern Oscillation |
| GDP | Gross Domestic Product |
| GHGs | Green House Gases |
| GIS | Geographical Information Systems |
| GM | Genetically Modified |
| HACCP | Hazard Analysis and Critical Control Points |
| HIV/AIDS | Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome |
| IASA | Institute of Applied Science of Asia |
| ICSU | International Council for Science |
| ICSU ROA | International Council for Science Regional Office for Africa |
| IFS | International Foundation for Science, |
| IPCC | Intergovernmental Panel on Climate Change |
| ITCZ | Intertropical Convergence Zone |
| IUFoST | International Union of Food Science and Technology |
| IYPE | International Year of Planet Earth |
| MAGICC | Model for the Assessment of Greenhouse gas Induced Climate Change |
| NAPA | National Action Programme of Adaptation to climate change |
| NGO | Non-Governmental Organization |
| NRF | National Research Foundation |
| PM10 | Particulate Matter of 10 µm or less in aerodynamic diameter |
| PM2.5 | Particulate Matter of 2.5 µm or less in aerodynamic diameter |
| PNBA | Park National du Banc d'Arguin |
| RegCM3 | Regional Climate Model version 3 |
| RIPIECSA | Recherches Interdisciplinaires et Participatives sur les Interactions entre les Ecosystèmes, le Climat et les Sociétés en Afrique de l'ouest |
| SAAFoST | South African Association for Food Science and Technology |
| SADC | Southern African Development Community |
| SAFNet | Southern Africa Fire Network |
| SCENGEN | global and regional SCENario GENerator |
| SIDA | Swedish International Development Cooperation Agency |
| SIDS | Small Island Developing States |
| SST | Sea Surface Temperature |
| SWOT | Strengths, Weaknesses, Opportunities and Threats |
| THORPEX | The Observing-System Research and Predictability Experiment |
| TRMM | Tropical Rainfall Measuring Mission |
| UNEP | United Nations Environment Programme |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNFCCC | United Nations Framework Convention on Climate Change |
| WAM | West African Monsoon |
| WMO | World Meteorological Organization |
| WWRP | World Weather Research Programme |
| YSSP | Young Scientist Summer Programme |

# Session 1: Opening Session

## 1.1 Welcome Remarks (Sospeter Muhongo, ICSU ROA)

Prof Sospeter Muhongo, the Executive Director of the International Council for Science, Regional Office for Africa (ICSU ROA) welcomed the delegates and appreciated the efforts they made to attend the workshop. He recognised the presence of Dr Albert van Jaarsveld, the Acting President and Chief Executive Officer (CEO) of the National Research Foundation (NRF), South Africa. He then invited Dr. Van Jaarsveld to officially open the workshop.

## 1.2 Official Opening of Workshop (Albert van Jaarsveld, NRF)

Dr Albert van Jaarsveld, President and CEO of the NRF, thanked Prof Sospeter Muhongo and the ICSU ROA staff for the successful organisation of the workshop. He welcomed the workshop participants and hoped that the gathering will emerge with a focused research agenda for the continent. He noted that Africa is most concerned with issues of vulnerability and adaptation to climate change, and urged the delegates to come up with explicit research goals to be achieved in this regard.

Dr van Jaarsveld pointed out that from the NRF's point of view, Africa needs a singular and consolidated voice on the continent's research agenda in order to attract international funding. On this background, he urged the workshop participants to produce a consolidated plan for global environmental change research for Africa that can be implemented in collaboration with partners from other parts of the globe. He also noted that such a plan would enable the continent to take its rightful place in the global climate change research community.

He wished the participants a happy stay in South Africa and fruitful deliberations at the workshop. He then declared the workshop officially open.

## 1.3 General Introduction & ICSU ROA Science Plans (Sospeter Muhongo, ICSU ROA)

Prof Sospeter Muhongo gave a brief historical background of ICSU dating since 1931, with roots that can be traced as far back as 1899. He explained the membership structure of the organisation which consists of both National Scientific Bodies (116 Members) and International Scientific Unions (30 members). He noted that the composition of its members makes ICSU a powerful scientific organisation in representing world scientists. Prof Muhongo explained that the ICSU Regional Offices were established to prop-up the ICSU agenda in the developing world and that the ICSU Regional Office for Africa was the first to be established in 2005.

He discussed the mandate of ICSU ROA which consists of: (i) promoting the activities of the ICSU family on the continent and scientifically linking Africa to the rest of the world, and (ii) promoting research and collaboration among African scientists/institutions, guided by the continent's priorities. He stated that ICSU ROA, after taking into consideration the economic and social reality of the continent, identified four focus areas for sub-Saharan Africa, namely: Sustainable Energy; Natural and Human-induced Hazards and Disasters; Health and Human Well-being; and Global Environmental Change (including Climate Change and Adaptation). He explained the procedure of the preparation and publication of the four ICSU ROA science plans and their subsequent implementation. He stated that for the first three science plans (Sustainable Energy; Natural and Human-induced Hazards and Disasters; and Health and Human Well-being), workshops of experts were organised, projects were proposed and the project proposals are being finalised. He then called on the workshop participants to discuss the fourth science plan (Global Environmental Change (including Climate Change and Adaptation) and come up with long-term fundable research projects.

Prof Muhongo emphasised ICSU ROA's policy of collectively working together for a common purpose, whereby, the activities of ICSU ROA are meant to compliment and not to compete with those of other programmes. He informed

the audience that ICSU ROA has an open system and thrives to bring in new generation of scientists on board, especially female scientist. He noted that ICSU ROA is working closely with the African Union (AU), Economic commission for Africa, African Development Bank, UNESCO Regional Office for Africa, Association of Africa Universities and remains willing to bring everyone on board. He further stressed the need to explore the expertise in the international scientific unions and work with them for the benefit of the continent.

### 1.4 ICSU ROA Science plan on Global Environmental Change (including Climate Change and Adaptation) (Daniel Nyanganyura, ICSU ROA)

Dr. Daniel Nyanganyura outlined the fundamental principles of ICSU Strategic Plan for 2006 – 2011 and explained the purpose of the ICSU Regional Offices. This, he said, was to ensure that the voice of scientists form the developing countries influences the international scientific agenda and that, scientists from the South are fully involved in international research guided by regional priorities. He then pointed out some of Africa's priorities that guided the selection and preparation of the four inter-related ICSU ROA science plans.

Dr Nyanganyura stressed the key research areas in the Global Environmental Change (including Climate Change and Adaptation) science plan that include Land Degradation, Biodiversity Loss and Human Well-being in Africa; Climate change and its impact on rainfall in Africa; Resilience of Food Supply Systems; Water Resources and their Governance; Atmospheric Composition Change; and Africa's Oceanographic Uniqueness. He discussed the drivers of land degradation and biodiversity loss together with how they adversely affect soil and crop yields as well as their direct and indirect impacts on human well-being, food insecurity, wealth and economic development of nations.

He noted that the challenges of climate change in Africa were discussed in terms of the temperature trends over the past hundred years and how the increase in temperature could affect the rainfall patterns, agro-ecological zones and in turn the production of food and fibre. He also discussed the increase in the frequency and intensity of extreme weather events like floods and drought, and stressed the need to come up with reliable forecasts for these events. He urged the workshop participants to come up with project proposals that would lead to the formulation of sound policies for mitigation and adaptation.

Dr Nyanganyura also discussed the changes in the atmospheric composition by looking at the natural and anthropogenic sources. He noted that, depending on their atmospheric concentrations, air pollutants modify local and regional precipitation, adversely affect the vegetation and human health. He pointed out that although humans have little control over natural emissions such as volcanic eruptions, air pollutants from human related activities can be minimised. Delegates were called upon to propose projects that would lead to formulation of policies that will be directed towards reducing emissions, allowing continuous assessment of the atmospheric composition, monitoring trans-boundary air pollution, as well as establishing national, regional and continental pollution legislations.

Dr Nyanganyura further pointed out that Africa is the only continent that is influenced by both the Atlantic and the Indian Oceans, and that scientists should take advantage of this uniqueness and the associated phenomena such as the Thermohaline circulation, to improve fishery activities in the coastal regions. The need to focus on monitoring and minimising ocean pollution and degradation was emphasised.

**Discussions**

An observation was made that there is a weak link between African scientists and the policy makers, as a result of which it has remained difficult to pass scientific information from the science community to policy bodies. In responding to this observation, it was noted that ICSU ROA is guided by the 2006-2011 ICSU strategic plan, in which one of the main goals is to integrate scientific information in policy making. In this light, African Ministers of science and technology were invited to the 29$^{th}$ ICSU General Assembly in Maputo, Mozambique, where they met with scientists from all over the continent. It was further pointed out that at the continental level, platforms like the African Ministerial Council on Science and Technology (AMCOST) help to develop policies and set priorities on science, technology and innovation for development of the continent, while also bridging the gap between politicians

and scientists. It was further suggested that scientists should publish scientific information in local media to have a greater impact on the communities and decision makers, rather than in academic journals.

A concern was raised with regard to the inter-relatedness among the science plans for which separate project proposals were being developed. The response was that ICSU ROA will harmonise the project proposals through in-house editing and consultation, to avoid duplications between projects. This harmonisation may involve merging some projects as will be deemed necessary by the experts in the respective fields.

A question was asked about how the complex global environmental issues were reduced to only six themes. In response, it was explained that the choice of the six themes was made by a scoping group comprised of scientists from all over Africa, based on their potential to solve major environmental problems faced by African societies, while considering ICSU's comparative advantage to make the greatest impact, and at the same time avoid duplication of on-going programmes on the continent. It was indicated, however, that the participants, being experts in the field, could include other ideas to those presented in the ICSU ROA science plan.

## Session 2: Keynote Presentations: Global Environmental Change (including Climate Change and Adaptation)

### 2.1 Land Degradation, Biodiversity Loss and Human Well-being (Francis P Gudyanga, Zimbabwe)

Prof Gudyanga outlined the importance of land and highlighted the impact of land degradation on soil quality and water resources, and its consequences on agricultural production, food security and human well-being, as well as on the earth surface-atmosphere interaction. He enumerated the causes of land degradation which include natural phenomena such as landslides, mudflows, erosion and siltation, as well as human-induced factors such as overpopulation, deforestation, poor land management practices and mining activities especially open field small scale mining. He noted that human actions often lead to irreversible losses in bio-diversity which affects human well-being. He explained the direct relationship between the extent of land degradation and its impact on agricultural productivity, noting that strongly degraded land is difficult to reclaim since it has lost most of its original biotic function. He suggested that actions to mitigate land degradation should include maximising land cover to prevent erosion; replacement of nutrients removed; preventing accumulation of harmful substances; and good agricultural practices.

As a measure for conservation of biodiversity, Prof Gudyanga suggested, among others, creating protected areas where regional ecosystems are well represented; market tools such as transfer of ownership rights to private individuals; prevention and early intervention measures; strong institutions at all levels to support biodiversity conservation; and awareness programmes to inform the society about the benefits of conserving biodiversity.

**Discussions**

A question was raised on whether there could be a potential use of invasive species. To this, Prof. Gudyanga referred the audience to on-going programmes in Namibia and Tanzania where water hyacinths were being harvested and used as a source of biomass energy. He also noted that in Mauritius, species that are considered invasive in other parts of the world are being used either for medicinal purposes or as bio-pesticides. The participants were therefore, encouraged to come up with research proposals that consider the potential uses of "invasive species" to turn problems into opportunities.

On biodiversity conservation, a suggestion was made to explore the possibility of establishing biodiversity corridors; an approach already envisaged in the framework of activities of the International Year of Planet Earth (IYPE). It was recommended that the biodiversity corridors approach should also include aspects of mineral and water resources.

A concern was raised about the weak information links among various parties involved with land degradation and biodiversity loss issues. The need was expressed for a sustainable and comprehensive communication strategy

between the different stakeholders. It was recommended that ICSU ROA takes the responsibility of addressing this issue.

A remark was made that the efforts deployed to selectively support the survival of humans on earth compared to other species may compromise the concept of bio-diversity. The response to this was that the essence is to improve the management of the earth's resources so as to sustain the population there-on. It was further noted that the human population in Africa is still very low and life expectancy is very short.

In conclusion, the need was emphasised, to apply science for improved productivity of the available land resources.

## 2.2 Climate Change and its Impact on Rainfall, and on Water Resources and their Governance (Joseph K Kanyanga, Zambia)

Dr Kanyanga gave an overview of climate change and its science with emphasises on the earth's natural climate and the earth-atmosphere energy balance. He noted that the radiation balance is affected by atmospheric constituents especially the greenhouse gases (GHGs) emitted into the atmosphere mainly as a result of human activities. He discussed the impact of GHGs on the earth's energy system leading to global warming. He also discussed the impact of climate change on the amount, temporal and spatial distribution of rainfall; the availability and sustainability of water resources; and the food security in Africa. He pointed out that in the Sahel region, warmer and drier conditions are persistent, and affect the agro-ecological zones and changes in biodiversity. In southern Africa, it was noted that longer dry seasons and more uncertain rainfall pose a danger to food security. Along the African coasts, sea-level rise and human development are together contributing to losses of coastal wetlands and mangroves and increasing damage from coastal flooding in many areas were noted. He pointed out that resilience of many ecosystems is likely to be adversely affected due to the combined effects of human activities, climate change, and associated disturbances such as flooding, drought, wildfires, insects, and ocean acidification.

Dr Kanyanga gave a summary of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) which stated that the observed global warming over several decades has been linked to changes in the large-scale hydrological cycle. He noted that water supplies stored in glaciers and snow cover are projected to decline in the course of the century due to global warming, and that the changes in water quantity and quality due to climate change are expected to affect food availability, stability, access and utilisation. These changes are expected to lead to decreased food security and increased vulnerability of poor rural farmers, especially in the arid and semi-arid tropics.

He noted that several gaps in knowledge exist between the observations and research needs in the current environment where observational data networks are shrinking. Dr Kanyanga emphasised the need to improve the understanding and modelling of climate changes related to the hydrological cycle at different scales and to pass this information on to the decision makers. He encouraged participants to come up with adaptation options and mitigation measures that aim at reducing the magnitude of impacts of climate change on human well-being.

**Discussions**

It was noted that climate variability is also essential to consider when discussing climate change issues, as the variability of climate also impacts on the water resources. The importance of understanding the mechanisms that control precipitation in Africa and of increasing the knowledge of the trend of rainfall variability in the context of climate change was recognised. It was also noted that the low migratory capacity of humans reduces their flexibility in options for adaptation to climate change, and that this calls for the development of appropriate policy interventions, guided by scientific evidence.

Asked weather a network exists in Africa where meteorological information can be shared, Dr. Kanyanga explained that all the national meteorological stations are linked through the World Weather Watch, a Global

Telecommunication System that makes all data available for sharing. He noted, however, that data sharing is constrained by the increasing tendency towards data commercialisation.

On the question of efforts to bridge data gaps in the scientific understanding of climate change, it was noted that several networks do exist and they hold data into which ICSU ROA could tap to create a centralised and coordinated data bank.

Air Pollution Information Network for Africa (APINA) and Southern African Fire Network (SAFNet) are examples of organisations that form links between the continent's air pollution scientific community and policy makers at national and regional levels. These networks act as conduits of knowledge and data derived in the scientific programmes and existing research to influence policy. Scientists were encouraged to tap into such networks to improve their access to data analysis and influence decision makers.

## 2.3 Resilience of Food Supply Systems (Sunita Facknath, Mauritius)

Dr Facknath described the challenges facing Africa's agricultural sector in the 21$^{st}$ century. Key among these is the need produce more food to feed an increasing population while at the same time, conserve the environment in the face of limited soil and water resources. This is exacerbated by the growing pressure associated with socio-economic development, and climate change. She noted the vulnerability of the current agricultural system as demonstrated by the recent increases in food prices and the immediate impact on food security. She blamed the current commodity cost crisis on climate extremes that caused a decrease in food production by key exporting countries and expressed concern over the fact that these factors (climate extremes) are projected to increase in frequency and severity in coming decades. She recommended that the scientific community should give priority to modifying agricultural activities to produce food for the people and to provide a primary source of livelihood in the face of climate change.

Dr Facknath discussed the four dimensions of food security that include food availability; food accessibility; food utilization; and food systems stability. She noted that the impacts of climate change on food security include, among others, the increase in frequency, duration and intensity of dry spells and droughts; the gradual changes in precipitation patterns; and the increase in the frequency and intensity of extreme weather events. She also discussed the potential impact of the projected increase in temperature and changes in the rainfall regimes on the distribution of pests, diseases and disease vectors, as well as the threats of these changes on food security, food safety and human health.

She further discussed the physical impacts of climate change on the marine environment, with particular attention to ocean current dynamics, sea surface temperature rise, eutrophication, and sea level rise. These changes are likely to modify marine species composition and distribution, thereby altering the functioning of coastal and marine ecosystems.

Dr Facknath recommended that the mitigation strategies should include improved nitrogen fertiliser application techniques to reduce $N_2O$ emissions; dedicated energy crops to replace fossil fuel use; improved energy efficiency; improved agricultural technologies to increase crop yields (for example, through adjustment of planting dates and development of adapted varieties/breeds); use of multi-purpose tree species for food, fodder, energy; crop relocation; improved land management; and soil conservation strategies including tree planting.

**Discussions**

It was noted that some countries, especially in the developed world, produce excess food which is not used for human consumption. It may be necessary to review food trade policies giving priority to food distribution for human consumption. Adaptation of food supply systems should not be restricted to the climate change related interventions but should also include aspects of policy, education and training.

The need was expressed to consider alternative technologies such as the use of Genetically Modified (GM) foods. The GM food technology is known to face a controversial debate around the world, with tangible pros and cons. Some disadvantages of GM technology in agriculture are the monopoly of seed production and over-dependence of farmers on seed companies, the cost of GM research, and the health implications of GM food to humans. It is noted, however, that with good policies and intentions, this technology can help to improve food security but this will require much research, especially to develop the technology for the poor farmers, and to outline the potential side effects.

A suggestion was also made to recover indigenous genetic material despite its low yield potential, for the sake of preserving bio-diversity and improving resilience to disease outbreaks.

# Session 3: Keynote Presentations: Global Environmental Change (including Climate Change and Adaptation)

## 3.1 Atmospheric Composition Change (Sara B Feresu, Zimbabwe)

Prof Feresu outlined the main causes of air pollution which are urbanization, motorization, economic activity, use of wood and charcoal for energy, biomass and waste burning, and many other human activities. She pointed out that major pollutants emitted during such processes include particulate matter (PM10 and PM2.5), sulphur dioxide, nitrogen oxides, ammonia, volatile organic compounds, Ozone, heavy metal oxides, carbon dioxide and carbon monoxide. She noted the adverse effects of these pollutants on human health; the damage they cause to the environment, ecosystem and structural material; and the economic loss associated with their impact on crop yields and corrosion of materials. Indoor air pollution was highlighted as a major concern in the developing nations where exposure to particulate mass and gases released from cooking stoves can cause pneumonia in children and chronic respiratory diseases in adults.

Prof Feresu recommended that atmospheric composition change and its consequences should be studied at the local, regional, hemispheric and global scales. She also noted that synergies should be explored that allow integrated strategies to get a better insight of global environmental change issues.

She elaborated on the activities of APINA in the area of air pollution on the continent. These include introducing the Better Air Quality process for urban air pollution issues across the whole of sub-Saharan Africa; using computer models to track trans-boundary air pollution; creating emission inventories for the region; monitoring air pollutant deposition; assessing the impact of air pollution on human health, crops, ecosystems and corrosion of essential materials; and helping in regional urban air quality monitoring and management. She also mentioned APINA's desire to collaborate with other organizations such as ICSU ROA in areas of air pollution and its effects on the climate; to establish regional/continental agreements on air pollution based on good science; and to raise awareness of the populations on the air pollution risks they are exposed to, and how these can be mitigated.

**Discussions**

Dust was recognised as the most important air pollutant in West Africa where it causes reduced visibility and severe respiratory problems. A recommendation was thus made to study the characteristics and consequences of dust storms as well as to develop appropriate adaptation strategies and technologies. It was noted, however, that this issue is already being addressed in one of the ICSU ROA sub-projects on Hydro-meteorological hazards and disasters. The importance of awareness raising and information dissemination about air pollution and its consequences was reiterated with emphasis on using the local and national press to send messages to policy makers, communities and other stakeholders.

### 3.2 African Ocean Environment: Uniqueness and Issues of Concern (Regina Folorunsho, Nigeria)

Dr Folorunsho discussed the importance of understanding and properly managing the two Oceans that influence the continent. She highlighted the values of the oceans and seas to the environment, economy and climate of the coastal areas and entire African continent. These include fisheries, sea side tourism, the cruise industry and off-shore oil drilling.

She pointed out that the growing socio-economic activities coupled with large coastal population are causing widespread degradation of the coastal and marine areas of Africa, leading to pollution of the oceans, coastal erosion, modification of maritime ecosystem, and over exploitation of fishery resources. She also noted that climate change will adversely affect African costal communities where habitats are disappearing. She stated that human societies are both the perpetrators and victims of these destructions. Dr Folorunsho highlighted the susceptibility of people living along the coasts to sea level rise, changes in weather patterns, ocean dynamics and coastal erosion.

She stressed that an understanding of the ocean system in Africa should be encouraged through dedicated research efforts. As an illustration of such activities that have increased the knowledge of the African ocean system, Dr Folorunsho presented results from the open ocean measurements that were carried out during the AMMA/EGEE cruise campaigns in the Gulf of Guinea, during which parameters such as ocean surface temperature, salinity and current profiles were measured.

Dr. Folorunsho further noted that sustainable management of the oceans and coasts in developing nations requires capacity building for scientists, coastal managers and practitioners, as well as the creation of enabling environments in which these stakeholders can work. She emphasised the need to develop and strengthen ocean research and observational capacity involving human resources, the necessary institutions, and a framework that supports and sustains the systems for observation, data analyses, forecast, and information dissemination. She also pointed out the need to develop regional modelling and forecasting capabilities to provide additional protection against extreme events, oil spill and other coastal hazards.

**Discussions**

The need was identified to develop policies for economic incentives for the private sector to invest in research. For example, the Oil Companies that exploit oil along the African coasts should provide funding for research to improve the life of the coastal communities while safeguarding the environment. It was recommended that the AU should develop mechanisms for governments and private companies to get actively involved in research, and for investments of big companies to translate into social development of the continent.

## Session 4: Other Keynote Presentations

### 4.1 AfricaNESS: A Strategy for Global Environmental Change Research in Africa Science Plan and Implementation Strategy (Cheikh Mbow, Senegal)

Dr Mbow gave a brief background of the AfricaNESS science plan and its relationship with the ICSU ROA science plan on Global Environmental Change (including Climate Change and Adaptation) and other Global Environmental Change research initiatives on the continent. He called on the audience to consider aspects of the AfricaNESS science plan that can complement the ICSU ROA science plan in driving a single and all-inclusive global change research agenda for the continent. He also pointed out that the principles behind a common science agenda will favour a limited number of multi-year coordinated research programmes over a large number of short-term and independent projects (a programmatic approach); promote inter-disciplinarily, multi-institutional and regional research; develop science-policy-practice interfaces; ensure that the products of scientific research are credible, salient and legitimate; build lasting human and institutional capacity; contribute to the global research agenda from an African perspective; and recognise and develop indigenous knowledge and capacity.

He further noted that the AfricaNESS Science Plan describes the areas of global environmental change research that are of particular importance and interest for Africa; it highlights the basic research needed to support decisions on adaptation and mitigation, and lays out options for the support structures needed to facilitate and implement the research.

Dr Mbow stressed the need for ICSU ROA and AfricaNESS to work together in promoting the participation of the African scientists in environmental change programmes and activities while avoiding duplication and bridging the language gap on the continent. He called for an all-inclusive approach in the implementation of Global Change research in Africa. He recommended a dialogue between ICSU ROA and AfricaNESS and pledged his willingness to champion this course.

**Discussions**

A question was raised on the level of involvement of African scientists and governments in the AfricaNESS initiative. Dr Mbow informed the participants that many African scientists from all over the continent were involved in the development of the AfricaNESS science plan. He explained that the initiative was started by Kenya and South Africa, and eventually, the scientists from other countries were brought on board. He believed that the science plan was developed through broad consultation.
A dialogue between ICSU ROA and AfricaNESS towards harmonising the implementation of the two science plans was emphasised.

### 4.2 Achievements and Perspectives of AMMA Programme (Jean-Luc Redelsperger, France)

Prof Redelsperger gave an overview of AMMA-Africa programme, its strategy, activities, achievements as well as the future plan. He presented AMMA-Africa as an international long term programme that involves about 500 scientists from 30 countries and approximately 140 institutions from Africa, Europe and the USA. It has been endorsed by major international programmes and works in collaboration with international organisations and programmes such as WMO, ICSU, UNEP THORPEX, and WWRP.

He discussed the objectives of AMMA-Africa which include: improving the understanding of the West African Monsoon (WAM) and its influence on regional and global environment; providing the underpinning science that relates WAM variability to societal issues that will help the definition and implementation of relevant monitoring and prediction strategies; and ensuring that the research carried out in AMMA is effectively integrated with prediction and decision making activities in the Western African region. He also noted that AMMA-Africa has managed to conduct field experiments that include land and sea measurements, and has created a database of local activities, satellite information and modelling data.

As an illustration of the outputs of the AMMA-Africa programme, Prof Redelsperger mentioned the weather forecast and analysis products tailored to West and North Africa, and which might also be extended to the Southern Africa synoptic forecast. He also presented some data showing the impact of assimilating microwave observations over land; characterization and understanding of the intra-seasonal variability such as the periods and frequency of dry spells, the onset and end of the monsoon, and the rainfall distribution during the monsoon; the inter-annual rainfall variability in the West African Sahel over the last decade; and the analysis of last IPCC simulations over the Sahel region and the uncertainties on future rainfall trends.

He concluded by expressing the intention to extend the activities and field observations of AMMA-Africa to cover all of the Sahel region as well as other regions of Africa. This would assist in building a wider network of African and international scientific communities as well as integrating knowledge and work across disciplines.

**Discussions**

Asked on the challenges faced in running a regional network such as AMMA, Prof Redelsperger explained that AMMA-Africa works with existing networks and coordinates the activities of these networks. AMMA links African

scientists with their northern counterparts and introduces them to the instruments used in field experiments. It was also noted that the programme facilitates an understanding of the benefits of working together in a network that spans over several disciplines, institutions and countries.

### 4.3 South African Global Environmental Change Science Plan (Leluma Matooane, South Africa)

Mr Matooane discussed the rationale for developing a South African national Science Plan for Global Environmental Change. He mentioned that the science plan will focus mainly on the understanding of the complex regional environmental system in Africa south of the equator, together with the adjacent areas. He pointed out that the objective of the South African Global Environmental Change Science plan is to come up with adaptive response mechanisms within the people-land-ocean-atmosphere system at a regional scale.

He stated that the main research areas envisaged in this initiative will include the Earth system science; system resilience; adaptive capacity; and science policy interface. The specific research topics include adaptation of ecosystems to climate change; alternative energy and the environment; atmospheric aerosols and pollution; biogeochemistry and ecosystem functioning; coastal zone processes; implications of global change on food security and human health issues; geological earth system science; internal institutional, policy and legal frameworks relating to both natural systems that will be affected by global change and socio-economic systems; international institutional policy and legal frameworks in relation to global change; land degradation; societal-ecosystem systems; surface energy and water cycles; society's interactions with ecosystem services; southern oceans observatory; and space science with a focus on the upper atmosphere.

**Discussions**

Questioned on the relationship between the proposed South African Global Environmental Change Science plan and that of ICSU ROA, Mr Matooane explained that the proposed South African science plan has a national and regional (southern Africa) focus, and that there has been an attempt to align it with the ICSU ROA science plan as some of the leading authors are involved in the development of both documents.

### 4.4 South African Association for Food Science and Technology Programme (Nigel Sunley, South Africa)

Mr Nigel Sunley gave a general overview of the South African Association of Food Science and Technology (SAAFoST) as well as its relationship with the International Union of Food Science and Technology (IUFoST). As food production and supply are influenced by the changes in the global environment, he encouraged the participants (global environmental change experts) to take part in the SAAFoST/IUFoST activities especially the up coming 15$^{th}$ World Congress of Food Science and Technology that will be held on 22 – 26 August 2010 in Cape Town, South Africa.

Mr Nigel Sunley informed the audience that SAAFoST won the bid (in 2005) to host the 15$^{th}$ World Congress of Food Science and Technology: the first time such an event is on the African continent since the establishment of IUFoST in 1962. He noted that the scientific programme of the congress is comprehensive and caters for both academic and commercial scientists. He presented a synopsis of the content of the programme for the congress and called on the global environment scientists to register and be part of this great event.

**Discussions**

Participants were encouraged to attend the 15$^{th}$ World Congress of Food Science and Technology especially the young African scientists and female scientists. To have a good representation of African scientists at the congress, participants were urged to disseminate the information to their colleagues and friends. It was also noted that this

congress is hailed as one of the success stories of ICSU ROA which has successfully attracted to Africa, several large conferences and congresses of the International Scientific Unions of the ICSU family.

# Session 5 Poster Session

During the poster session, 17 posters were displayed by scientists from different regions of the continent. Each of the authors gave a brief presentation of the content of the posters. The abstracts for the posters are presented in Appendix A.

# Session 6: Working Group Sessions

The core business of the workshop was tackled during this session where workshop participants broke up into working groups to consider the project themes proposed in the science plan and the presentations discussed in preceding sessions, and come up with project concept notes for preparation of long-term fundable projects that cut across difference disciplines, institutions and countries. The working groups were provided with guidelines to direct their discussions. These include the key questions to be considered during the discussions and the characteristics of the project concept note.

# Session 7: Reports from Working Groups

After one-day group discussions and brain-storming, the individual groups came up with the project proposals that are presented in the following sections.

## 7.1 Theme GEC 01: Land Degradation, Biodiversity Loss and Human Well-being in Africa

The group analysed the causes of land degradation and biodiversity loss, the driving forces behind them (natural and anthropogenic), the impacts on the environment and human well-being as well as the possible response mechanisms. Based on this analysis, the following project was proposed:

**Project GEC 01: Land Vulnerability Assessment and Adaptation**

**Objectives**

The main objective of the proposed project is to improve sustainable management of land resources in Africa. The specific objectives are as follows:

- To collect baseline data on factors influencing land vulnerability and develop indicators of vulnerability;
- To develop networks and synergies between similar on-going projects and institutions;
- To develop adaptation strategies and options;
- To develop a model for interaction between policy makers, scientists and society.

**Proposed activities**

To accomplish these objectives, the following activities were proposed:

- Assessing soil type, depth, temperature and properties;
- Monitoring and assessing vegetation, land use, fire frequency and crop maps;
- Capacity building, traditional / indigenous knowledge system;
- Studying catchments, water bodies, wetlands and floods;
- Demarcating environmentally sensitive areas.

**Expected outcomes**

The proposed deliverables include:

- Database of factors influencing land vulnerability in Africa;

- Vulnerability maps (soil, topography, biodiversity loss, etc.);
- Networking framework and a adaptation strategies;
- Reports, publications and conference papers;
- Communication and capacity building strategies;
- Model for interaction and communication.

**Duration and budget**

The project is expected to last for 5 years and the provisional budget is US$ 50 Million

**Discussion**

The issue of the project implementation sites was raised and it was agreed that it might not be practical to have research in all African countries. It was therefore suggested to identify potential regional research centres that will serve as focal points (regional centres) for the research activities. These centres will concentrate on the major land degradation issues in the respective regions to which all other countries/institutions will be linked. However, since there may be no unique institution on the continent to handle land vulnerability issues on a regional scale, it was proposed to establish a database to record all the information on land vulnerability for each country. A recommendation was made to identify already established institutions/individuals who may champion the implementation of the proposed project. This should be done during the preparation of the detailed project proposal. It was proposed to use remote sensing tools, with particular emphasis on capacity building for analysis and management of satellite data.

It was suggested that the project activities should include human capacity building as well as an inventory of the spatial and temporal variability of biodiversity on the continent. An inventory of the continent's biodiversity was also recommended, as this would provide the basis for subsequent conservation programmes. It was also suggested that the activities of the projects should not be limited only to sub-Saharan Africa, but should cover the continent as a whole. Due to the linkages between the processes, some activities in the proposed project may need to be merged with similar activities in projects from the other science plans, in order to avoid duplication.

## 7.2 Theme GEC 02: Climate Change and its Impact on Rainfall in Africa

The working group considered the recent trends in climate change and its impact on rainfall regimes in Africa, and proposed the following project:

**Project GEC 02: Enhancing African Capabilities in Rainfall Variability Assessments in the Context of Climate Change**

**Objectives**

The general objective of the project is to enhance the understanding of rainfall variability over Africa in the context of climate change. The specific objectives were noted as:

- To enable African scientists to access climate related databases;
- To understand rainfall variability at different time and spatial scales, as affected by climate change, in order to improve the quality of forecast at various scales;
- To enhance applicability of forecasts in decision/policy making processes;
- To analyse selected IPCC climate scenarios and establish their implications on rainfall parameters in Africa;
- To formulate an effective communication and information dissemination strategies on rainfall variability in order to facilitate program coordination and policy orientation.

**Proposed activities**

The following activities were proposed for the implementation of the project:

- Data collection, climate monitoring (including use of satellite technology) and identifying information and data gaps;

- Arranging for a formalised meta database and protocols for accessibility to existing databases by the African science communities;
- Support monitoring meteorological stations working for climate assessment;
- Undertake statistical analysis to establish the rainfall climatology and variability at different scales over the five regions of Africa (Central, Eastern, Southern, Northern & Western Africa), and determine linkages and differences;
- Undertake a users' need assessment to determine the user-based forecast products;
- Update forecasting knowledge in line with modern methodologies and new research findings;
- Use consensus model to project future rainfall variability scenarios and occurrence of extreme events;
- Use selected regional climate models and other techniques to derive local and regional climate scenarios.

**Deliverables**

The group proposed the following as the expected outcomes from the project:

- Access to climate database by African scientists through established meta database and memorandums of understanding for data exchanges;
- Advance knowledge on rainfall variability over Africa through publications and other communication tools;
- Statistical analyses report on rainfall climatology and variability over Africa;
- Statistics on extreme events (drought, dry/wet spells, floods) over Africa;
- Better understanding of mechanisms controlling rainfall variability through documentation;
- Improved forecast accuracy and contribution to early warnings systems;
- Improved interaction between research, operational and user communities to deliver more suitable forecast products;
- Established networks for knowledge and information exchange;
- Scenario projections over Africa for local and regional applications.

**Duration and provisional budget**

The project is expected to last for 5 years and cost US$ 13 Million

**Discussions**

It was suggested that the strategies for adaptation to rainfall variability should be included in the project to bring out the temporal and spatial precipitation patterns. It was also suggested that as Africa has different regions with different climatic conditions, it would be useful to have regional adaptation strategies that can be replicated in other regions, and adjusted according to regional specificities. The need to improve communication among the climate change working groups as well as with the end-user communities was noted. Regional outlook forums, such as the Drought Monitoring Centre in Southern African Development Community (SADC) should help in producing well packaged national seasonal forecasts for easy use by the local communities.

## 7.3 Theme GEC 03 Resilience of Food Supply Systems

The group built on the project proposal on a similar theme developed from the Health and Human Well-being science plan. This proposal represents a cross-cutting project between the two science plans.

### Project HB/GEC 03: Improving food and nutrition security in Africa in the context of Global Environmental Change

The main objective of this project is to improve food supply systems on the continent in the face of global environmental change, with the aim of ensuring availability, accessibility and utilization of safe and nutritionally balanced food in sufficient quantities to all people at all times. The project consists of 6 sub-themes.

***Project HB/GEC 03.1 Sustainable improvement of food production***

**Objectives**

The main objective of this sub-project is to increase food production in a manner that is environmentally and economically sustainable. The specific objectives are:

- To revalorize indigenous/traditional knowledge on sustainable methods of food production;
- To modernise and professionalize production through research and development into new technologies and systems.

**Proposed activities**

- Transferring and adapting modern technologies for improved agronomic practices such as zero tillage, mechanisation, integrated pest and nutrient management;
- Developing new and high-yielding pest/disease-tolerant and drought resistant crop varieties;
- Developing freshwater and marine aquaculture;
- Developing improved scientific methods for cultivation of less-known vegetables and fruits, as well as agro-forestry.

**Expected outcomes**

- A Manual describing scientific basis of indigenous/traditional knowledge on sustainable methods of food production;
- Adoption of improved technologies by farmers;
- Package of site-specific technologies for sustainable increase in crop production;
- Improved crop yields;
- Increased production of planting materials using tissue-culture technology;
- Availability of pest and drought-tolerant varieties of selected crops, including genetically modified crops where appropriate;
- Established organic standards, norms and legislation, as well as certification bodies for organic products;
- Package of cropping practices and techniques for less-known vegetables and fruits;
- Leaflets and hand books for farmers.

**Project duration and budget**

This will be a 5 years project with a budget of US$ 20 Million

***Project HB/GEC 03.2 Sustainable increase in livestock production (including fisheries, aquaculture and non-conventional mini-livestock)***

**Objectives**

The main objective of this sub-project is to improve the quality and quantity of livestock, fisheries and aquaculture production in a sustainable manner, as a strategy to attain food and nutrition security on the continent. The project will also explore non-conventional livestock production. The specific objectives of the project are:

- To reduce the impact of diseases and pests of economically important livestock on human food and nutrition security;
- To increase the scope of diversification of the farmer's sources of food and income generation;
- To promote the conservation of biodiversity through the introduction of non-conventional livestock species;
- To explore the potential use of local and readily available feed resources to formulate balanced and low cost diets for improved livestock nutrition;
- To investigate appropriate and efficient control strategies against animal diseases of economic importance;
- To develop technologies for producing disease-tolerant livestock breeds, especially of cattle;
- To explore the potential for practice of ethno-veterinary.

**Proposed Activities**

- Developing technologies for feed formulation from local feed resources to produce balanced and low cost feeds for lean meat production in mono-gastric animals and for lean meat and high milk production in ruminants;
- Producing balanced and low cost feed for fisheries and mini-livestock species from readily available local sources, including agro-industrial by-products or wastes;
- Investigating intensive livestock production options that favour conservation of biodiversity;
- Developing production techniques for less-known sources of meat, e.g. snails, frogs, etc;
- Exploring the practice of integrated agro-forestry to promote sustainable production of small ruminants;

**Expected outcomes**

- Improved livestock health and increased production of meat, milk and other animal products;
- Package of production technologies for less-known sources animal protein, such as edible snails and frogs;
- Increase in revenue generation through improved livestock production;
- Sustainable production of non-conventional livestock species;
- Improved conservation of biodiversity in the wild;
- Improvement of institutional capacity, research infrastructural development and increase in trained human resources.

**Duration and budget**

The project will last 5 years at the cost of US$ 25 Million

***Project HB/GEC 03.3 Improving post harvest technologies***

**Objectives:**

- To revalorize indigenous/traditional knowledge for post harvest and storage methods;
- To develop adequate and modern tools and technologies for conservation, preservation and processing food after harvest;
- To develop environmentally sustainable and healthy food packaging technologies;
- To develop appropriate food storage facilities.

**Project activities**

- Investigating the scientific bases of indigenous knowledge claims, and develop and replicate efficient technologies among farmers;
- Developing facilities for monitoring and quality control of processed and stored food;
- Developing a strategic plan for setting up and operating centralised storage facilities available to farmers at guaranteed minimum cost;
- Developing a mechanism to encourage cottage industries for eventual up-scaling to industrial levels.

**Expected outcomes**

- A Manual describing the scientific basis of indigenous/traditional knowledge and technologies for post harvest handling and storage of food;
- Generic methods for preservation, conservation and processing food after harvest;
- Analytical facilities (laboratories, equipment, trained manpower);
- Adequate modern storage facilities at community, village, district and national levels;
- Transfer of technology to industrial scale;
- Training of farmers on storage techniques and tools.

**Duration and budget**

The project will last for 4 years and its proposed budget is US$18 Million

***Project HB/GEC 03.4 Food safety and quality nutrition***

**Objectives**

- To study dietary management of diseases and disorders;
- To determine food requirements of people at all stages of life;
- To develop methods for preparing complementary foods using local foods;
- To promote breast-feeding in communities in the context of HIV/AIDS.

**Project Activities**

- Developing human and institutional capacity for analyses of food for nutrient content (including micronutrients), pesticide residues, nitrates, mycotoxins and other toxins and anti-nutritional factors (especially in indigenous foods) through training and establishment of well equipped laboratories;
- Exploring opportunities in emerging technologies to improve the speed and efficiency of screening procedures for timely detection of food contaminants (toxins and human pathogens);
- Developing capacity for traceability of food and for monitoring of food quality and compliance with Hazard Analysis and Critical Control Points (HACCP) standards;
- Determining food and nutritional requirements of different household members;
- Promoting awareness of appropriate methods of food preparation;
- Determining relationships between feeding patterns/habits and diseases or disorders;
- Developing methods for preparation of complementary foods using local food stuffs;
- Promoting of breast feeding in the context of HIV/AIDS;
- Exploring the potential for practice of ethno-veterinary (use of local herbs as prophylactic treatment of livestock against gastrointestinal micro organisms) to reduce the risk of zoonotic diseases.

**Expected Outcomes**

- Equipped laboratories and trained staff with analytical skills and capabilities to test for HACCP and other standards and norms;
- Established mechanisms for food traceability;
- Database of nutrients, micronutrients, and anti-nutritional factors in different foods;
- Data and information on the food requirements of all household members in all stages and conditions of life, and for people with malaria and HIV/AIDS as well as other infectious diseases, non-communicable diseases and mental health;
- Educational and outreach promotional materials describing appropriate methods of food preparation that will help retain nutrients and other health factors;
- Data and information on the effect of diseases and parasitic infestations on food utilisation/assimilation;
- A Manual for preparation of complementary foods for infants, using local foods;
- Properly packaged information for sensitisation with regard to breast-feeding in the context of HIV/AIDS;
- Improved consumer confidence with regard to consumption of safe, healthy and nutritious food.

**Duration and budget**

The project will last for 5 years and has a budget of US$30 Million

***Project HB/GEC 03.5 Adaptation of agricultural production systems to climate change***

**Objectives**

The main aim of this project is to mitigate the impact of climate change phenomena on agricultural production in sub-Saharan Africa. The specific objectives are:

- To predict the dynamics of plant and animal diseases and pest outbreaks in response to climate change, and adjust control protocols accordingly;
- To monitor the impact of temperature rise on the physiological performance of crops and livestock, and develop appropriate adaptation strategies;

- To develop human and institutional capacity to reliably predict climate change trends and inform policy- and decision-makers;
- To develop decision support tools to guide policies on efficient water management in agriculture;
- To build capacity to apply modern bio-technologies in developing drought-tolerant, short-cycle and high-yielding crop varieties, as well as livestock breeds;
- To reduce methane emission and nitrous oxide from livestock activities and paddy rice cultivation.

**Proposed activities**

- Application of conventional breeding and modern bio-technologies to develop drought-and heat-tolerant livestock breeds;
- Application of conventional breeding and modern bio-technologies to develop short-cycle and drought-tolerant crop varieties;
- Climate change simulation and screening of newly developed plant varieties and livestock breeds for acclimatisation to atmospheric temperature rise;
- Developing models for predicting changes in habits and/or virulence of plant and animal pests as well as pathogens as a consequence of climate change;
- Development of soil moisture conservation, water management and water use-efficient technologies;
- Designing, testing, and demonstrating water-efficient irrigation systems;
- Developing efficient waste management to reduce methane and nitrous oxide emissions and promoting a better management of fertilizer and water in paddy rice cultivation;
- Developing hazard preparedness, and risk mitigating strategies, as well as reliable early warning and response systems;
- Providing support to develop innovative insurance and re-insurance schemes that cover weather-based disasters;
- Advocating for changes in food preferences and feeding habits.

**Expected outcomes**

- Well trained engineers to design and produce efficient and low cost (affordable by farmers) irrigation equipment for more efficient water use in agriculture;
- Extensive adoption of water-use-efficient irrigation techniques;
- Reduced methane and nitrous oxide emission from livestock activities and paddy rice cultivation;
- Improved disaster preparedness and mitigating strategies, and reliable early warning and response systems;
- Improve innovative insurance and re-insurance schemes;
- Integrated institutional structures are established;
- Changes in food preference and habit.

**Duration and budget**

The project is expected to last for 5 years and has a proposed budget of US$20 Million

***Project HB/GEC 03.6 Improving accessibility to food***

**Objectives**

The main objective of this sub-project is to develop mechanisms of facilitating access to food among African communities. The specific objectives are as follows:

- To establish a fair trade system;
- To develop strategies for wealth-generation to ensure access of all people to adequate food;
- To promote intra-household food distribution;
- To advocate for improvement in infrastructure for food distribution (transportation, roads, rail, etc.).

**Activities**

- Developing mechanisms for setting up well-organised government-regulated auctions at village, district, national levels to prevent exploitation of farmers by middlemen, and to ensure good quality food;
- Developing and promote income generating activities (for example, off-season planting, alternate activities) at household level;
- Determining food requirements of different members of a household;
- Educating and training people to ensure appropriate distribution of food in households;
- Advocating for infrastructural development to facilitate food distribution;
- Conducting socio-economic studies to provide evidence that would inform internal food and external food trade regulatory policies.

**Expected outcomes**

- An established mechanism for fair trade and a policy paper on improvement of infrastructure for food distribution;
- A strategic plan for wealth generation to ensure access of all people to adequate food;
- Guidelines for appropriate distribution of food within households;
- Training materials for household members on food and dietary requirements;
- Increased household income and assets;
- Inclusion of infrastructural needs (transportation, roads, rail, etc.) in Government development plans.

**Duration and budget**

Duration of project is 5 years and will cost US$15 Million

**Discussions**

Based on the current trend of decreasing rainfall, shrinking of inland water bodies (rivers and lakes) and decreasing food availability, it was recommended to include in the research, integrated farming involving the use of fibre as fish tongs. The project should also include training of local communities in aquaculture. It was also noted that the use of antibiotics and vitamins in aquaculture should also be considered. This would require a good understanding of fish diseases. The use of remote sensing technology to monitor biomass availability was also recommended.

It was further suggested to link this project to that proposed by the working group 2: “Enhancing African Capabilities in Rainfall Variability Assessments in the context of Climate Change”; considering the commonalities between the two projects.

A recommendation was also made to identify and assess on-going activities on the continent, in order to identify the gaps that need to be bridged, the weaknesses that need to be corrected, and the strengths that can be built upon. Such inventory will also facilitate networking and partnerships in new interventions.

The use insurance as a measure of adaptation to climate change was also proposed.

## 7.4 Theme GEC04 Water Resources and their Governance

The working group for this theme considered the issues discussed in the science plan on this subject and agreed to focus on integrated management of water resources in relation to the impact of rainfall and water resource availability on food security and rural development. The group also considered threats to ground water recharge and pollution. In view of these, the following project was proposed:

**Project GEC 04 Integrated trans-boundary water resource management in the context of climate change**

**Objectives**

- To understand the availability and nature of water resources;
- To map the potential uses and users of water;
- To establish vulnerability maps for water availability (water scarcity or water stress);
- To promote communication among stakeholders and involvement the local communities;
- To develop a decision support system for water management.

**Activities**

- Analysis, modelling and assessment of water resources, their variability and uses; and study of the driving forces behind the changes;
- Evaluation of trends in Climate Change using downscaling of scenarios, assessment of the potential impacts, vulnerability and design adaptation measures;
- Analysis of stakeholders (local, national and international, institutional and legal frameworks);
- Institutional, human and managerial capacity building;
- Design of a Decision Support System.

**Expected outcomes**

- Physical and biological metadata;
- Hydrological, hydro-geological and socio-economic models for water resource management;
- Catalogue of good water management practices adapted to climate change;
- Map of vulnerability;
- Strengths, weaknesses opportunities and threats (SWOT) analysis for existing institutional and legal frameworks of water management;
- A water management decision support system.

**Duration and budget**

The project will last for 4 years with a budget of US$ 5.5 Million

**Discussions**

It was suggested that the implementation of the project should be carried out through pilot projects that focus on the specificities of particular river basins across the continent. Such pilot projects will need to extend beyond the countries located in the river basins, and cover down-stream coastal countries as well. An alternative to the pilot project approach would be to take a commonality approach by focusing on the commonalities among the various river and lake basins on the continent.

Communication strategies were recommended for inclusion in the project proposals in order to enable outreach to the local communities/end users.

## 7.5 Theme GEC05 Atmospheric Composition Change

The working group considered the various earth surface–atmosphere interactions and how these are influenced by human activities as well as the impact of climate change and other natural forces. They proposed the following project:

**Project GEC 05 Atmospheric Composition Change**

The project comprises of the following three sub-projects:

***Project GEC 05.1 Air pollution assessment in African cities***

**Objective**

- To assess the air quality of major African cities and conduct case studies on impacts of air pollution on human health and on corrosion of structural materials.

**Activities**

- Selecting six sub-Saharan cities (2 each in West/Central Africa, East/Central Africa and Southern Africa);
- Conducting training workshops on the rapid urban air quality assessment methodology;
- Conducting rapid urban assessments in the six cities using mini-vols in conjunction dust-tracks to particulate matter, and passive samplers for the other pollutants;
- Conducting case studies on impacts of air pollution on corrosion of structural materials and conduct a 'stock at risk' assessment;
- Carrying out a cost-benefit analysis of impacts of air pollution on human health using SIMair as well as co-benefit analysis of reducing air pollution and study outcomes of using different fuel types;
- Develop Strategic Frameworks on Air Quality management for the cities.

**Expected outcomes**

- Reports on the urban assessments incorporating different scenarios for managing air pollution in the cities;
- Strategic Frameworks for Air Quality Management for major cities including recommendations on town planning and management of traffic in the cities;
- Case study reports on impacts of air pollution on human health with recommendations on mitigation of pollution;
- Case study reports on impacts of air pollution on corrosion including results of the "stock at risk" assessment and cost benefit analysis of reducing air pollution;
- Policy briefs.

**Duration and budget**

Duration of the project is 5 year with a provisional budget of US$ 10 million

***Project GEC 05.2 Monitoring and modelling of trans-boundary atmospheric aerosols due to anthropogenic and natural sources Africa***

**Objective**

The objective of the sub-project is to monitor trans-boundary transportation and deposition of particulate matter and air pollutants in sub-Saharan Africa and their impacts on climate change, human health and structural materials.

**Activities**

- Studying the sources and transport of black carbon, desert dust, volcanic particles and other important aerosols in sub-Saharan Africa;
- Determining the aerosols' characteristics and atmospheric circulation flow pattern of pollutants from rural to urban areas and vice versa;
- Determining the emission sources, transfer, deposition, concentration of PM2.5 including indoor signal at urban and regional scales;
- Monitoring and modelling the deposition of the aerosol and determine their sinks;
- Assessing the impacts of aerosols on their various sinks such as water bodies, solar radiation balance, structural materials, visibility, ecosystems and human health;
- Disseminating information on aerosols and their impacts to all levels of stakeholders.

**Expected outcomes**

- Scoping report on sources and work done on black carbon, desert dust, volcanic particles and other important aerosols in sub-Saharan Africa;
- Scientific publications on the aerosols' characteristics and their sources, transfer and deposition;
- Scientific publications on impacts of aerosols on their various sinks such as water bodies, solar radiation balance, structural materials, visibility, ecosystems and human health;
- Adaptation and mitigation measures to reduce the impacts of aerosols.

**Duration and budget**

The project will last for 5 years will cost US$10 Million

***Project GEC 05.3 Ground level ozone in Africa and its influence on agricultural production***

**Objective**

This sub-project is aimed at determining the spatial distribution of ozone in sub-Saharan Africa and its impacts on crops, food security and ecosystem services.

**Activities**

- Carrying out a passive sampler campaign across sub-Saharan Africa including active monitor measurements at selected sites and active monitors;
- Determining the volatile organic compounds and nitric oxides emissions from vegetation, fires, transport and industry
- Modelling the dispersion and deposition of pollutants based on measured data and satellite information;
- Performing high and low technology experiments to determine the impacts of ozone on crops and ecosystems;
- Carrying out experiments with economically important crops at strategically selected sites across sub-Saharan Africa to encompass both high and low ozone regions;
- Performing socio-economic risk assessments of impacts of ozone and climate change on crop yields and food security;
- Identifying ecosystem risk areas by overlaying risk maps of ozone, acidification and Nitrogen deposition, rainfall and temperature change;
- Conducting training workshops on ecosystem assessment methods and conduct case studies on air pollution impacts at high risk sites;
- Assessing mitigation measures and carrying out an integrated assessment linking to future emission scenarios.

**Expected outcomes**

- Scientific publications on ozone concentration and dispersion;
- Scientific publications on impacts of ozone and climate change on crops under different scenarios;
- Scientific publications on impacts of ozone and climate change on ecosystem services;
- Policy briefs.

**Duration and budget**

The project will last for 5 years with a budget of US$ 10 Million

**Discussions**

It was noted that air quality in the continent is also affected by biomass burning (a seasonal occurring phenomenon in Africa), and that the gases emitted from forest fires depends on the vegetation fuel It was, therefore, suggested that biomass burning as source of pollutants should be included in the study. It was also pointed out that it would be useful to characterise the type of gases emitted in relation to the type and quantity of biomass burnt. Such a study would require involvement of bio-geographers. It was noted that the knowledge from such study would advise the controlled burning by the communities. It was also suggested that assessment of air quality in the urban areas should also include the urban heat island effect and its effect of the human comfort index. Recommendations were

made for the establishment of real-time and long term air concentration monitoring systems in the urban areas as well as in the country side.

## 7.6 Theme GEC 06: Africa's Oceanographic Uniqueness

The working group on this theme focused mainly on the impact of the marine environment on coastal zones and how it is affected by climate change. They proposed the following project:

**Project GEC06: The Impact of Climate Change on the Coast of Africa**

**Objectives**

- To establish networking (framework) among scientists in various disciplines related to African oceanography;
- To identify gaps on climatic data (observed and satellite) in the different African countries;
- To acquire cost-effective and affordable devices for monitoring purposes;
- To monitor productivity from the ocean and adapt it to climate change;
- To assess the effects of erosion and frequency of storms, sea level rise on coastal communities;
- To carry out vulnerability assessment based on measured data, satellite information and models.

**Activities**

- Establishing and coordinating the network to facilitate the securing and sharing of data related to the marine environment and climate change;
- Analysis of changes in seasonal chlorophyll vs. sea surface temperature and wind as well as the up-welling indices;
- Monitoring and modelling of coastal erosion, sea level rise, storm surges;
- Provision of bathymetric data/information, and information on mitigation options.

**Expect outcomes**

- Established coordinated network African oceanographers;
- Development and application of vulnerability assessment models;
- Prediction models for vulnerability assessment, coastal erosion, sea level rise, storm surges;
- Identified key indicators for monitoring purposes and establishing baseline monitoring in areas where gaps are identified;
- Relationships between long term fisheries data sets with data sets on climate indices (ENSO, SST, rainfall) and development of alternative livelihoods for coastal communities;
- Adoption of mitigation and adaptive measures (imported or indigenous).

**Duration and budget**

The project will last for 5 years and has a proposed budget of US$ 10 Million

**Discussions**

It was acknowledged that establishing networks was an important activity as it would pave the way forward. It was further suggested that marine culture should be included as separate venture and the activities in this project should include collaborators from already established organizations.

## Session 8: Closing session

### 8.1 Workshop Overview, Concluding Remarks and the way Forward (Sospeter Muhongo, ICSU ROA)

Prof Muhongo emphasised on the importance of team work and stressed that Africa should work as a single entity to produce good quality science of international standards. He pointed out the need for African scientists to work in collaboration with international partners, noting that ICSU ROA has already engaged several potential partners who are ready to collaborate and are waiting for the project proposals. He appreciated the work accomplished at the workshop, stating that this was the preliminary stage in the implementation of the ICSU ROA science plan on Global Environmental Change (including Climate Change and Adaptation). This preliminary work, he noted, will be developed further by expanded teams of experts covering all the areas of competence required for the projects.

Prof Muhongo assured the participants that ICSU ROA will explore all possible funding avenues for implementation of the projects. This will include contacting African governments and regional economic commissions. He also mentioned that some of the projects fall in line with activities already being carried out by other programmes and that ICSU ROA will harmonise the proposed projects with activities of the on-going programmes such as the International Year of Planet Earth. Prof Muhongo informed the workshop participants that the ICSU ROA secretariat will consider the projects proposed by the working groups together with comments made during the plenary, and will retain a few large-scale projects that cover all the issues raised and keep out duplications. This exercise will also bear in mind the activities of the projects developed from the other three ICSU ROA science plans.

### 8.2 Vote of Thanks (Robert Kriger, NRF)

Mr Robert Kriger appreciated the fact that workshop participants considered the African continent as a whole rather than restricting their discussions to sub-Saharan Africa. He acknowledged the successful deliberations during the workshop while also appreciating the contributions of various competences in developing the science plan that served as a guide to the discussions.

Mr Kriger noted the commitment of the Department of Science and Technology (DST), South Africa, to provide funding for the running of the ICSU ROA secretariat. He also noted the commitment of the National Research Foundation (NRF), South Africa, to support the functioning of ICSU ROA in various forms, including provision of staff salaries. He further acknowledged the dedicated responses by international partners such as UNESCO, IFS, DAAD, SIDA, and others, to promote the activities of ICSU ROA on science for Africa.

He suggested that ICSU ROA could link up with the Institute of Applied Science of Asia (IASA) for such activities as database development and large scale modelling. He noted that such a strategic partnership could meet most of ICSU ROA's needs. He also recommended partnership with the Young Scientist Summer Programme (YSSP) for capacity building activities.

Mr Kriger appreciated the dedicated commitment of African scientists in developing the ICSU ROA science plans and for continuing to drive the process of their implementation. He also appreciated the dedication of African Higher Education institutions which have undertaken to participate in the implementation of the science plans.

Mr. Kriger commended the work done by ICSU ROA staff in organising the workshop and ensuring its success. He also appreciated the contributions of the participants in the fruitful deliberations during the workshop.

## Acknowledgements

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## Appendix A: Poster Abstracts

### Beyond the Land, another Approach of the Environment

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Sub-Saharan Africa, with a growing demography, is subject to pernicious and increasing effects of climate variability and change. In Burkina Faso, the concept of "land management" appeared in the early seventies. During more than three decades, scientists, technicians, politicians and populations adopted an approach derived from this concept and worked on to apply it in order to reduce the harmful effects of growing imbalances between mankind and his environment thanks, to a better management of natural resources.These natural resources being the actual factors of development of the rural world, and as such, of the country, were used to build up successively, the notions of sustainable development, sustainable human development, sustainable and fair human development, environment and biodiversity protection and currently eradication of poverty.

Though, the analysis of the environment, which can be performed using tools like cartography and geographical information systems (GIS), considering the geomorphological data, makes it possible to find, beyond the land, another way to apprehend and manage the natural resources without restriction, through a common and shared space combining watersheds and structural and residual sets.

### Climate Change Patterns, Land Degradation, and Human Well-Being in the SIDS: the Case of Mauritius

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Climate change has direct effects on land, land degradation and on human health and well-being. The developing countries, in particular the Least Developed Countries and the Small Island Developing States (SIDS) are expected to be most affected by climate change. This paper illustrates the actual climate changes occurring in the island state of Mauritius, and their consequences on land degradation, human health and well being, food security, and the economic and social well-being of the Republic.

Long term observations of the weather by the meteorological station have shown that Mauritius has lost about 100 mm annual rainfall over the last 50 years (Fig. 1).

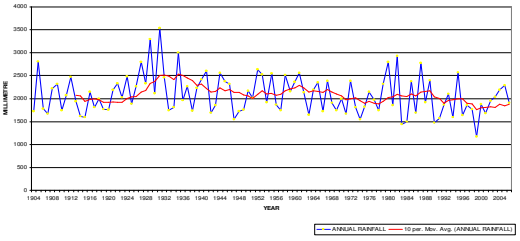


Fig. 1: Rainfall trend in Mauritius

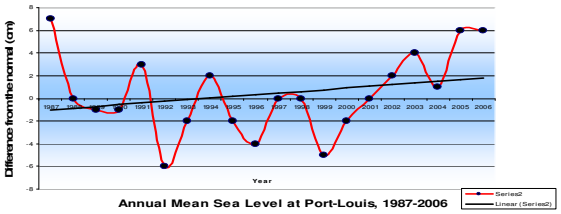


Fig. 2: Mean sea level in Mauritius

The island has experienced severe droughts (in 1995, 1997) and very heavy downpours, causing human fatalities (in 2007). Flash floods have washed enormous quantities of top fertile soil into the lagoon, reservoirs and the port. Consequently, the storage capacity of reservoirs has been decreased substantially, e.g. the Nicoliere Reservoir has lost its storage capacity by more than 25%. Large amounts of money are being spent for desilting the only harbour of the country. Such a mega project not only involves huge expenses for the economy, but also has social implications in terms of unrest among fishermen due to reduction in their daily fish catch.

Long term observations on at least two sites have demonstrated that the sea level is indeed rising (Fig. 2). Various scenarios have been constructed and it has been estimated that even with this small extent of sea level rise, the island will lose a substantial part of its coastline and coastal scenery, which is in fact the most attractive part of the country and responsible for its tourist arrivals.

The island is also beginning to experience unprecedented hot summers. The present torrid summer has never been experienced in the history of the island before. Fig. 3 shows the long term moving temperature average at two sites on the island. Such extremes of weather, further compounded by the flash floods and extreme droughts, have resulted in the outbreak of new diseases in the island, e.g. Chikungunya, vectored by the Anopheles albopictus mosquito. This caused a scare in the tourist industry when tourist arrivals fell drastically in 2006 by almost 25%. It also reduced the labour productivity. Flooding in the inner regions of the island reduced crop production drastically by causing water logging, and the resultant anaerobic conditions, production of toxic compounds such as sulphides, nitrites, etc. , in the soil.

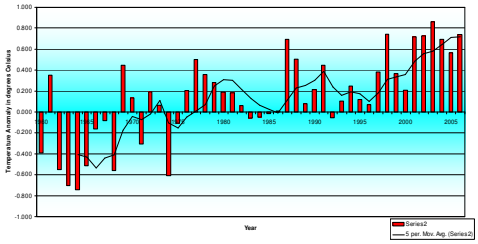

Fig. 3: Temperature trend in Mauritius

**Climate variability and change and its impact on rainfall in Burkina Faso**

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The geographical position of Burkina Faso in the centre of the Sudano-Sahelian zone of West Africa makes it particularly exposed to the uneven harmful effects of climate change. It has a very weak economy with a GDP of 330US$ per capita, principally based on agriculture and animal productions. The population is in full growth (2.4% per annum) and 46.4% live below the poverty line.

Climate variability and change has been analysed trough two parameters: temperature and rainfall. The climatic tendencies through the use of the climatic models and the scenarios of climatic changes (MAGICC/SCENGEN) represent a rise in the average temperatures to 0.8°C around 2025 and 1.7°C by 2050, a reduction of the annual rainfall pattern of -3.4% in 2025 and -7.3% in 2050. In 2025 the estimates indicate a reduction in the annual volume of rain water of Comoé river and Mouhoun river as compared to the normal one from 1961 - 1990. On the other hand, annual volumes of water of the Nakanbé and Niger basins will increase because of reduction in the infiltrations in favour of the streams following the increased degradation of vegetation cover. In 2050, the phenomena observed into 2025 will tend to worsen.

**Flooding of the islands of Banc d'Arguin and the risks on the biodiversity**

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Banc d'Arguin is an estuarine system with no freshwater incoming from inland. The delta is protected by a large sandbank situated some 50 km offshore. Sediment inputs are of wind and marine origins. The whole area depends on a dynamic balance between oceanic currents (Canary and Gulf of Guinea), the input of arrival mineral and organic materials of different sources. It is crucial to follow the flows (wind sediment inputs, local and oceanic currents) in order to anticipate the general evolution of the environment and its resources. Due to its specificity Banc d'Arguin is extremely vulnerable to climate change. Changes of its ecological integrity could cause a depletion of resources of the entire regional ecosystem.

The sea threatens the islands which are one of the key components of the ecosystem of Banc d'Arguin. Since 2003, there has been regular seasonal flooding of the islands of Cheddid, Touffat, Nair and Zira with tides of average amplitude. The marine floods which were recorded in 2008 outside the periods of equinox are spectacular and have caused the destruction of birds' nests particularly spoonbill (endemic subspecies balsacii). To counteract the effects of these floods, the PNBA has carried out some confinement in order to prevent the rise of water. This experience constitutes a first adaptation strategy and must be pursued in the future on the other coastal islands threatened. Installation of artificial nesting platforms is of utmost importance.

Given these multiple risks which are beginning to grow, it has become urgent to establish a monitoring system on the changes observed in the environment of Banc d'Arguin. The studies to be conducted must allow a prospective assessment, identify the origin of the phenomena recorded, evaluate its intensity, and predict its future evolution to evaluate potential impacts on biodiversity.

**Population, Deforestation and Future Prospects of Environment in Tanzania: A Survey of Literature**

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Tanzania forests and woodlands are estimated to cover 33.5 million ha which makes 40% of the country's total land area. Forest resources in the country are important source of livelihood as it provide direct benefit like firewood, charcoal, fruits, poles, timber, traditional medicine and many others. A part from direct benefit, the forests have very important and critical ecological values and area sources of vital services such as conserving soils and water sources, harboring rich biodiversity, providing bee fodder, ameliorating climate, provide habitats for wildlife, have important genetic resources, provide a wide range of cultural, spiritual and recreational benefits and are important sinks for removing $CO_2$ from the atmosphere. However, literature review shows that population growth (at an annual growth rate 2.8) coupled with high population density in relation to a limited forest resources, leads to over exploitation of the resource at varying degrees from place to place in the country. The rate of degradation in natural forests in Tanzania is estimated at 91000 ha per annum. By the growing population, deforestation is expected to continue, posing a major threat to the existing forest resources. This paper attempts to synthesize available literature to identify major deforestation issues and future expectation of environment in the country. It reviews studies, research reports and national policies. Bearing in mind, population growth which is associated with high demand on forest products and encroachment to forests land as a result to deforestation, this paper recommends the following; farmers to be encouraged to practice agroforestry, promotion of village and community forests, introduction of tree planting competitions, provision of technical and financial support to afforestation programmes, to provide education on land use plan, water conservation and the importance of natural resources particularly forests, and to initiate and support afforestation groups and clubs in villages and schools. Further, local communities need to be provided with the education training on how to tackle the forest fires and there is a need to have institutional coordination in order to avoid conflicting interest over the forest resource. More studies have to be done on why deforestation still exists despite much effort made by the government and other institution in combating deforestation.

**Role De L'agroforesterie A Base De L'anacardier Dans La Dynamique De L'occupation Du Sol Dans Le Centre Du Benin**

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L'association des cultures vivrières ou de rente avec l'anacardier (agroforesterie à base de l'anacardier) fait partie de plus en plus, des pratiques culturales des producteurs du Centre du Bénin. Il est donc important d'examiner les incidences de cette nouvelle forme d'utilisation des espaces agricoles dans la dynamique de l'occupation du sol dans un contexte où la dégradation inquiétante des écosystèmes naturels du fait principalement des activités agricoles fait l'objet des débats à toutes les échelles nationales et internationales. Les données utilisées sont obtenues par la documentation et les investigations de terrain auprès des différents acteurs (producteurs, agents du développement rural, etc.). L'utilisation de la statistique descriptive et des outils cartographiques a aidé à traiter les données et informations collectées et d'analyser les résultats obtenus.

La recherche montre que la pratique agroforestière basée sur l'anacardier a permis de reboiser les jachères agricoles et contribue à freiner l'itinérance des producteurs à la recherche de nouvelles terres agricoles. Cette nouvelle pratique permet ainsi une gestion plus durable des espaces agricoles. Elle mérite d'être encouragée car elle semble constituée un système beaucoup plus durable susceptible de constituer une alternative à la technique de culture itinérante traditionnellement pratiquée.

**WWRP/THORPEX Africa: Implementation activities**

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African Regional committee: 1co-chair, Senegal National Meteorological Agency; 2co-chair African Center of Meteorological Applications for Development; 3Nigerian Meteorological Agency, -Ghana Institute of Economic Affairs; 4Ethiopian Meteorological Agency, 5Institute for Research and Development; 6Ghana Meteorological

Services Department; 7Morocco National Meteorological Service; 8University of Nairobi; 9South African Weather Service; 10THORPEX-IPO; 11WMO/WWRP.

WWRP-THORPEX Africa is the African regional contribution to the international THORPEX programme. The implementation of the WWRP-THORPEX programme for Africa is expected to start in 2009 following a 3-year planning period (2006-2008).WWRP-THORPEX Africa aims at providing scientific research to reduce the adverse effects of weather- and climate-related natural disasters in Africa and to promote multidisciplinary collaboration between research, operations and user communities to deliver the benefits of improved earth observations, advanced communications and improved forecast systems. Priority sectors of application include disaster and water management, agriculture including food security, health issues (e.g. meningitis, water borne diseases, etc) and transportation (e.g. aviation).

The major expected deliverables are: an Information system for African high impact weather including related losses, damages and other socio-economic or environmental impact data; a Catalogue describing typical high-impact weather events in Africa; optimal and realistic observing system and communication strategies for Africa; reports on the use and impact of probabilistic forecast information for decision making in identified priority sectors; guidelines and success stories on Forecasts Demonstration Projects and communication of uncertainties; and reports on new knowledge and understanding of Africa's high impact weather events and related processes or phenomena. These deliverables are expected to provide better tools for decision and policy making such as better early warnings including estimates of expected impacts, advisories for food security, agriculture, energy production, and water and disaster management. Overall, THORPEX-Africa is expected to further reduce deaths, infrastructure and property damage, poverty, and environmental degradation, due to high-impact weather and climate events.

**The RIPIECSA program: A Support to Interdisciplinary and Participatory Research on Interactions between Ecosystems, Climates and Societies in West Africa**

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The program RIPIECSA, for interdisciplinary and participative research on interactions between ecosystems climates and societies in West Africa, is a "Priority Solidarity Fund" of the French Ministry of Foreign and European Affairs, managed by the "Agence Inter-établissements de Recherche pour le Développement" (French Agency of Research for Development), with a 3.2 millions Euros budget for 4 years (2007-2010), to provide sciences based information for adaptation policies to climate changes. This Priority Solidarity Fund is open to universities, research institutions, regional application centres and national operational services applying alone or in consortium. These institutions must be located in a West African country and may submit partnership projects with NGOs, international organizations, local associations. Partnership with the Maghreb (Morocco, Algeria and Tunisia) is recommended as well as collaborations with institutions located in France or in the European Union countries.

The program was launched by a workshop held in Bamako (Mali) from 5 to 7 March 2007. This workshop gathered more than 120 West African scientists, including researchers, representative of research and environmental Ministries, members of multilaterals organisations. This workshop enabled participants to identify scientific questions and priorities to be endorsed by the RIPIECSA process. Two sets of projects were launched in 2007 and 2008 concerning respectively (i) "enhancement and endorsement observing systems for monitoring climate variability and its impacts" in synergy with AMMA International program on the West African Monsoon, and (ii) "interactions ecosystems and societies in a context of climate change and variability". The RIPIECSA project innovates by (i) instituting collaboration among social sciences, environmental sciences and climate sciences, (ii) promoting interdisciplinary researches that involve civil society and decision makers in order to raise awareness and (iii) reinforcing the capacities of local researchers by support to training, observation and data exchange.

RIPIECSA funded and follows 25 projects over West Africa, involving 62 institutions dealing with the study of human, ecological and climate dynamic factors involved in the environmental and climate changes and the identification of possible scenario of future evolutions. In all cases, it is a matter of taking account in the analysis of the risks threatening the natural resources both the social and political dimensions in addition to climatic, physical, biological (biodiversity and its potential) factors and those related to rural productions (agricultural, water resource, livestock). The interdisciplinary methodology inside each project is crucial to integrate these various factors in order to understand the past and ongoing changes as well as their impacts and to propose acceptable results for the

populations and to formulate helpful tools for the decision makers. With the different African expertise involved on ongoing projects and in close collaboration with AMMA community, RIPIECSA is interested in contributing to the implementation of the ICSU ROA science plan on Global Environmental Change (including Climate Change and Adaptation) in sub-Saharan Africa.

**Sensitivity of the simulated African Monsoons of summer 1993 to convective parameterization schemes in RegCM3**

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In this study, the International Center for Theoretical Physics Regional Climate Model version (RegCM3) was used to simulate the African summer monsoon during the rainy season 1993. Four different convection and cumulus parameterization schemes of Anthes Kuo, Grell and Fristish Chappell, Grell and Arakawa Schubert and MITEmmanuel were used to study the sensitivity of monsoon to cumulus effects. The model was integrated from a period of five months, starting from 1 May 1993 to 30 September 1993 using the European Centre for Medium Range Weather Forecast (ECMWF) Reanalysis data as input boundary conditions. The 6 hourly reanalysis data were used to provide the lateral boundary conditions, and the observed weekly Reynolds Sea Surface Temperature interpolated to 6h was used as the lower boundary forcing. The results show that Fristish Chappell and MITEmmanuel schemes were able to capture the diurnal cycle of precipitation and the zonal averages of stratiform rain fraction as observe in Tropical Rainfall Measuring Mission (TRMM) although there was overestimation of rainfall amount. Arakawa Schubert and Anthes Kuo have patched rainfall patterns over continental areas as opposed to the observed zonal pattern. However, the spatial distribution of rainfall was found to be shifted about 3°– 5° northward for all schemes and its quantity was different in all the schemes. The Anthes Kuo scheme underestimated the rainfall. The Arakawa Schubert scheme captures well the maximum as shown by observation. The Fristish Chappell and EM schemes reproduce well the rainband although theirs overestimations amount. It was found that the northward shift of the rainband is accompanied by the northward shift of the African Easterly Jet (AEJ). Simulated rainfall and AEJ position depend on the soil moisture via soil albedo.

**Precipitation and Temperature Variations in Zambia – Evidence of Climate Change**

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Although fewer studies have been undertaken at national levels to ascertain climate change over sub-Sahara Africa, results from GCMs as reported by IPCC 4$^{th}$ Assessment Report, show significant climate change occurrence over the region. This study employed statistical analytical methods supported by GIS to assess the evidence of climate change over the nine provinces of Zambia using rainfall and temperature data. Results show that for precipitation, infrequent occurrence of droughts and floods are observed over all the nine provinces. However, the long term trend shows a decrease in seasonal rainfall amounts, implying a general tendency for drought occurrence over the country. Results also show that when above normal rainfall occurs, the magnitudes are relatively high resulting in floods. For temperatures, both the maximum and minimum, show a general warming trend. Areas of low temperatures show a decline while those for high temperatures are widening. These results have implications on various weather sensitive socio-economic sectors in the country. In particular, crop production and food security is threatened in the face of these changes in climate patterns since Zambia depends mostly on rain-fed agriculture.

**Adapting to rainfall Variability in Zimbabwe: The use of climate information**

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This project seeks to improve incentives and opportunities for households in Eastern and southeastern Zimbabwe to cope with climate change. It also addresses the need for the farming community in particular and the public in general to use weather information since some parts of the country are prone to floods and droughts. Since droughts and floods, out-of-season rain and dry spells continuously affect the welfare of millions of Zimbabweans, there is need for the Zimbabwe Meteorological Service Department to design products that suit the end users especially short and medium range forecasts and not the users suiting to the products. As such there is need for

research in the use and acceptance of climate information (with special emphasis on rainfall variability) by the farming community in particular and the public in general. The ultimate goal is to come up with ways of enhancing the usefulness and relevance of climate related advisory in agriculture and disaster management. There is a clear need to integrate better understanding of biophysical drivers of variability (e.g. ENSO, El Niño, ITCZ, La Niña and Tropical cyclones) with actions to strengthen the capacity of agriculture and water managers to deal with rainfall variability and extremes. The idea is to make the capabilities rather than the vulnerabilities of the poor the starting point for moderating the negative effects of climate change on agricultural production.

**Water for development and ecosystems in the context of climate change – Case study of the river basin of Taheddart, Morocco**

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In the Mediterranean region, water availability is one of the limiting factors of economic development. In Morocco, water resources are strongly affected by aridity and a rainfall presenting a high variability both in spatial distribution and in seasonal and annual intensity. This irregularity is becoming more acute in the context of global change and climate warming. To develop a decision making support system at a river basin scale which is homogenous physical unit, we need to understand the complex interactions existing between the biophysical and socio-economical aspects, complementary and conflicting ones, regarding water resources management. For this reason, we need an integrated approach and a prospective vision to all the issues pertaining to water resources in the river catchments.

The river basin of Taheddart is a Mediterranean catchment influenced by its proximity to the Atlantic Ocean. It is the greatest hydrographical entity of Tangiers area with a surface of 1190 km², a population of 130 000 inhabitants (96% rural and 4% urban), and containing a wetland of international importance (Ramsar site). The water in the basin, provided mainly by two dams, is for domestic, industrial, agricultural and natural habitats uses. There are many conflict situations between water users and uses threatening in the long run both ecosystems integrity and human well being in the river basin. To deal with the complexity of socioeconomic and natural ecosystem issues in the Taheddart basin (i.e. economic growth and population needs, deforestation and soil erosion, increasing scarcity of water, climate change…), there is a need to set up a global dialog between stakeholders in order to step toward an integrated water resources management at the basin scale taking into account endogenous and exogenous driving forces of change. This study consists on a contribution to the determination and analysis of stakeholders, water uses, living resources, human activities, natural phenomena characterizing the study area, as well as the interaction between the whole system components in order to have background information for an integrated water management vision.

**Adaptation of Chad to climate change: Role of local communities in the determination of vulnerability and identification of potential adaptation measures in the NAPA context**

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For the last centuries, previous signals of hazardous natural and climatic imminence to global level have been very late understood to avoid the crisis such as the case of Chad country which since its independency by elaborating its development plans did not sufficiently integrate climatic aspects, their effects and eventually suitable measures coping with these effects. The phenomenon events from 70ies and particularly the 1972-73 and 1984-85 droughts revealed the lack of national adaptation measures existing. Nowadays, the ignorance is not a pretext because the knowledge does exist for a better advance coping to forecasted climatic danger.

This why, taking account of the negative hazardous effects on rural activities, economical basis, had signed and ratified United Nations Framework Convention on Climate Change (UNFCCC) in 1992 et 1993 respectively. Among the commitments, Chad carried out the initial national communication in 2001 on the climate change climate and is completing the National Action Programme of Adaptation to climate change (NAPA) in its final step. The drawing up of NAPA has received a wide opinion of involved stakeholders in the process by respecting the working methodology on three approaches among which of them related to the participating and advisory ones. This approach associates of involved stakeholders in the process like as local collectivities and communities, private

sectors members, NGOs and civil society. Through the approach recommended by Least Expert Groups, these stakeholders have really played the role by determining the vulnerability elements of their bioclimatic zones and also by identifying adaptative potential options coping to future hazardous. This presentation is intended to share the lessons and experiences from Chad of the stakeholder's role in NAPA process drawing up matter.

**Urban climate and air quality in Akure, Nigeria**

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The nature of the urban canopy heat island (UCHI); the characteristic higher air and surface temperatures observed in cities (urban areas) compared to their rural (nonurbanized) surroundings and air pollution in Africa are poorly understood This paper report results from studies investigating the spatio-temporal variation of air temperature and carbon monoxide (CO) at a medium size humid tropical city, Akure in south-western Nigeria. The paper focuses on the description of air temperature measurements during the monsoon (wet) seasons of 1997 and 2007, and also carbon monoxide measurements using mobile transects and fixed points at a rural site and the urban core during the 2007 pilot study.

The characteristics of the UCHI in Akure were assessed using a network of mercury-in-glass hygrometers in 1997 and shielded electronic temperature and CO loggers in 2007. The pattern of the contours of the temperature distribution of the Akure UCHI deviates from the simple idealized concentric structure around the thermal centre, mainly because of the location of the central business district (CBD), meteorological factors, anthropogenic activities and local geographical features. In 1997 relatively warm regions extend over the CBD in the south and cooler regions are located in the more vegetated northwest and eastern directions. Also of interest is the influence of Ala river that tends to split the temperature distribution into two distinct heat and cool islands during the day. This pattern is less evident during the wet season in 2007, where a more vigorous cool island is observed over the parks area and intensively vegetated government and administration areas to the southeast. The UCHI has been found to occur throughout the day and night with the highest intensity occurring during the day. Though the cool island observed in 1997 still exists, an increase in the UCHI intensity and spread in 2007 compared to 1997 is also evident, where the hitherto cooler vegetated regions in the northeast and northwest have now been replaced with warmer regions as a result of land use change from agriculture to urbanization.

Results from the first measurements of CO for both fixed and mobile transect show considerably higher values in the city core compared to the rural reference site. CO concentration in the city center exhibited a bimodal peak during the morning and evening rush hours with an average value of 22ppm slightly lower than the WHO guideline for maximum 1 hour exposure of 26ppm, however instantaneous levels during these high traffic rush hours exceeds this guideline with peaks up to 100ppm. Instantaneous peak concentration at the rural site did not exceed 20ppm with a unimodal peak of 8.5ppm. Average night time concentration at both sites was less than 5ppm. This result suggests that vehicular traffic is a major source of CO in the city and also highlights the cooling impact of vegetation as a potential UCHI and climate change mitigation tool in Akure.

**Inter-annual variation of the Saharan dust particle size and concentrations in Kumasi near the Gulf of Giunea**

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The particle size distribution characteristics of the Saharan dust that is transported and deposited over many countries in the West African atmospheric environment (5°N) during the months of November to March, known locally as the Harmattan, have been determined over an 11-year period between 1996 and 2007, using a location at Kumasi in central Ghana (6° 40′N, 1° 34′W) as the reference geographical point. The particle size distributions and concentrations are discussed. Within the particle size range measured, the average inter-annual mean particle diameter, number and mass concentrations during the northern winter months were determined. The measured particle concentrations outside the winter period were consistently less than 10 $cm^{-3}$. These experimental values correspond to the total dust loads. The size range covered by the optical particle counter was 0.5 μm – 25 μm. The

overall dust mean particle diameter over the 11-year period was found to be about 1.5 µm. The particle size distributions exhibited the typical distribution pattern for atmospheric aerosols with a coarse mode diameter situated at about 3.5 µm. The experimental results reported in this study will be important in validating satellite based observations and simulation models of the African dust plume towards the Gulf of Guinea during winter.

**Extension of the Distributional Range of Coastal Fish Species along the East Coast of South Africa: an Effect of Climate Change?**

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Increasing sea surface temperatures around South Africa may have a range of implications for coastal fish species. The most obvious will be shifts in the distribution and abundance of individual species or species assemblages according to their thermal tolerance and ability to adapt, particularly as many aquatic organisms are thermo-conformers, and therefore respond rapidly to changes in ambient temperature. The fishes of the warm-temperate East Kleinemonde Estuary (33°32´42˝S, 27º03´05˝E) have been sampled bi-annually, in summer and winter, since December 1995. Six new species of tropical fishes (Valamugil cunnesius, Valamugil robustus, Liza alata, Liza macrolepis, Glossogobius giuris and Terapon jarbua) were recorded in the catches from 1999 onwards, with V. cunnesius and L. macrolepis recorded in catches almost every year since 2002. Mean annual sea surface temperatures recorded along the adjacent coast have increased at a rate of 0.09ºC per year over the past decade and may have facilitated the southward extension of tropical marine fishes into the warm-temperate biogeographic zone. Similarly, the diversity and dominance of tropical species in the Mngazana Estuary (31°41'29"S;29°25'24"E) have increased when compared with a similar study conducted 25 years earlier. Although changes in abundance of species have not been reported, climate change may eventually result in marked changes in coastal fish communities.

**Dynamics of environment parameters in the noerthern Benguela current ecosystem**

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Northern Benguela, known for its highly productive, complex and variable ecosystem has depicted environmental variability that could linked to climatic change. The frequency of “warm events” off southern Angola and northern Namibia had increase in the past decade or so. There has been a persistent change in the onset of seasonal warming in the north, which has potential consequences for increased hypoxia de-oxygenation of water on the Namibian shelf. In this respect, it is thought that a major low oxygen event off Namibia in the 1990’s had a severe and long-lasting impact on some of the resources, which have not recovered despite conservative management actions. Winds trends which follow decadal cycle are currently in a low wind phase and this may lead changes in the productivity of the system. Current production levels are estimated to be high while abundance of pelagic stocks is considerably low. It is not clear that these changes are linked exclusively to climate change, or to inherent natural long term cycles.

**How AMMA can contribute to the diffusion of the information about the West African monsoon variability and its societal impacts?**

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African Monsoon Multidisciplinary Analysis (AMMA) is an international programme to improve our knowledge and understanding of the West African Monsoon (WAM hereafter) and its variability with an emphasis on daily-to-interannual timescales. AMMA is producing high level scientific knowledge and need to develop the diffusion of its information to insure their utilization for the society. Think about better channels to assure an efficient transmission have to be the next step of every climatic change programme. AMMA aims to build the African community working on AMMA to include users and decision makers in addition to the scientists. Indeed, the need to engage more with users and decision makers is a priority for AMMA in a second phase. Both internal and external communications of

AMMA based on scientific challenges for human issues have to be more effective to ensure a better information flow towards end user and decision makers.

It is important that AMMA develops closer ties with local and regional organizations working on adaptability of climate variability impacts. Links have also to be established with African institutional and political bodies and International bodies to create a communication network about climatic change issues and adaptation. A second pass, linked to another type of communication, is the development of capacity building. The enhancement of capacity building efforts in Africa need to be pursued with vigour and based on the objectives of the AMMA programme. It is important that AMMA coordinates these activities with all relevant bodies. The effort ongoing in AMMA on training has to be pursued. More sustainable program is necessary including Masters and PhD Schools joined between African and European Universities.

## Appendix B: List of Participants

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