The Network of African Science Academies (NASAC) is an autonomous scientific Network whose main objective is to act as an independent African forum that brings together academies of sciences in the continent to discuss the scientific aspects of problems of common concern, to make common statements on major issues relevant to Africa and to provide mutual support to member Academies.

As the forum, conscience, and voice of the arts and sciences in the Netherlands, the Royal Netherlands Academy of Arts and Sciences (KNAW) promotes the quality of scientific and scholarly work and strives to ensure that Dutch scholars and scientists make the best possible contribution to the cultural, social, and economic development of Dutch society. On an international level the KNAW promotes and engages in scientific cooperation in order to enhance the quality of Dutch and international science and its role in finding solutions to global societal problems.

The African Academy of Sciences (AAS) is an Africa-wide non-profit organization whose vision is to be the engine driving scientific and technological development in Africa. AAS seeks to honor S&T achievers and facilitate development of scientific and technological capacity for science-led development in Africa, while promoting excellence and relevance.

The Kenya National Academy of Sciences (KNAS) was established under the auspices of the National Council for Science and Technology (NCST), a government organization responsible for advising the Kenyan government on all matters related to science and technology. The mission of KNAS is to mobilize the entire scientific community in the creation, maintenance, and advancement of knowledge in all fields of human endeavour, to effectively inform policy, build capacity in research and innovation, and to provide solutions to improve the quality of life.

The Impact of and Adaptation to Climate Change in Relation to Food Security in Africa

Conference Proceedings

Scientific Conference of the NASAC-KNAW Collaboration Initiative
held at the Hilton Hotel, Nairobi, 23rd-25th February 2011

Contents

The Impact of and Adaptation to Climate Change in Relation to Food Security in Africa

I Introduction

Most science academies (and members of NASAC) in Africa are under-resourced and have limited institutional capacity, while their potential role in society is significant, in particular when it comes to offering independent and evidence-based advice to government and promoting science and science education. The public and even scholars are often unfamiliar with the role and potential of academies. By organizing international conferences and conducting stakeholder forums and focused in-country workshops, academies in Africa can become more visible. Regional and international networking also provides new opportunities to science academies.

Institutional capacity building in basic skills (resource mobilization, organizational development and communication and public relations) is a precondition for being able to develop a strong track record of policy-advisory activities. Moreover, there is a felt need to revitalize existing science academies, for instance by involving young and more dynamic members. Increasing the number of "centres of competence" in Africa would improve the career prospects of young, talented scientists, helping to counterbalance or even reverse a further "brain drain". By jointly hosting this conference, the Royal Dutch Ministry of Foreign Affairs and The Royal Netherlands Academy of Arts and Sciences (KNAW) aimed at assisting the African academies in scientific capacity enhancement.

Through this cooperation, NASAC and KNAW planned to organise two scientific conferences. This conference is the first of two, with a second one planned to be hosted in Mauritius in 2012 on Water Management Issues in Africa. At each conference, the partner academies are actively involved in learning and sharing experiences on the interface of scientific excellence and policy formulation. The conferences aspire to strengthen international networking among scientists of different expertise and enhance mobility of African scientists. To this end, scientists originating from Africa but currently in the Diaspora are involved. The best young scientists that Africa and the Netherlands have to offer are also supported to participate.

II NASAC-KNAW cooperation (History/Work plan 2010-2013)

On 12 July 2010, NASAC and KNAW signed a cooperation agreement to jointly enhance the role of science academies in providing policy advice on issues that are pertinent to the African continent. NASAC's contribution to the initiative was made possible through financial support provided by The Royal Dutch Ministry of Foreign Affairs under the contract of June 2008.

The overall aim of the KNAW-NASAC collaboration is to strengthen the capacity of and role of science academies in Africa. Scientifically, the focus for the 3-year cooperation is on one broad overall theme: 'Climate Change'. The involvement of young excellent scientists in the planned activities is considered important. With regard to institutional capacity building, the training of academy staff is central, concentrating specifically on improving their communication skills. The main impact sought is to increase the profile of science academies through direct interaction with policy and decision makers Africa as well as with Dutch scientists involved in Climate Change and related issues. The main instruments used for this purpose under this cooperation are scientific conferences and the electronic-communication.

Beside the general involvement of NASAC and KNAW members, the specific partnership is with four science academies in different stages of development that is: (i) two moderately-established academies – the Kenya National Academy of Sciences (KNAS) and the African Academy of Sciences (AAS); and (ii) two newly-established academies – the Academy of Sciences of Mozambique (ASM) and the Mauritius Academy of Science and Technology (MAST).

III Key points

The key questions tackled during the conference 'The Impact of and Adaptation to Climate Change in Relation to Food Security in Africa' aimed at addressing this issue through three critical questions on:

1. Impact: What are the impacts on food security?

Impacts were analysed and assessed based on scientific evidence provided on the related topics. Gaps on impacts were identified and listed in order of significance.

2. Adaptation: What are priority adaptation measures that are needed? Best practices, strengths and weakness of existing adaptation strategies were identified, as well as opportunities for new integrated measures.
3. Interventions: What interventions are needed from policy makers, decision makers, the scientific community and other stakeholders?Key short term, medium term and long term recommendations were identified and the resources needed were specified. International and regional collaboration was considered with reference to priority research projects.

Structure of Meeting and Key Points Adduced

Session 1: Potential impacts of climate change on food systems and food security

The most important issue that emerged from this session was the need to understand how climate change is affecting plant pests and pathogens. As such, models that explain the effect of climate change on agriculture should stress the role of pest management (including biological forms of pest and insect control).

Session 2: Possible climate change and adaptation responses on food systems and food security

In this session, a key issue that arose out of the discussions was the strong case made for water harvesting and the need to reduce the environmental impact on fisheries and aquaculture as a result of climate change.

Session 3: Interventions, strategies, policies, and funding

Part of the salient issues of debate revolved about the need to build resilience and nurture adaptation strategies. The planting of drought and pest resistant crops and crop diversification, is one way of building resilience. Governments need to create a wholesome policy environment that supports efforts that have been –put in place to adapt to and mitigate against the impacts of climate change.

IV Keynote Addresses

(1) Policy Perspectives on climate change and food security

By: Prof. Ton Dietz (University of Amsterdam)

It is evident from data that rainfall variability is there but the trends remain unclear and for Africa contradictory. Increased vulnerability during a crisis hits the poor more than the rich, but the poor are more risk averse and has fewer taboos with regards to extreme coping behavior.

According to climatologists, every society faces risks associated with climate, some of which are risks related to 1) peak rainfall, 2) peak river discharge, 3) severe storms, 4) heat, 5) drought, and 6) frost. Climate change however adds additional risks to these, making situations more severe. The situations in this case are such as:

- Gradual change to higher temperatures resulting in higher evaporation and evapotranspiration rates, higher heat risks and lower frost risks;
- Changing rainfall patterns, whereby there is more rain resulting into higher risks of flooding, more variability and more unpredictability;
- Rising sea levels, more severe coastal storms and more extreme weather events that threaten coastal cities and near-coast zones of intensive agriculture and tourism;
- Causing changes of ecozones, agro-ecozones, and biodiversity with impact on livelihood options.

For Africa the main climate change risks include:

Species extinction, forest and vegetation destruction;

Human and animal death, crop losses;

Damage to property and physical infrastructure;

Threatened livelihood and livelihood options;

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- Negative impact on GDP and government budgets;
- Threatened lives, mainly by floods and social unrest.

Social scientists dealing with the impact of climate change add the threat to the fabric of society as being more threatening. They say that climate change:

- Can lower the resilience and lower the innovative capability among people;
- Can create lower insurance buffers in society;
- Can lead to the collapse of the social trust system that can result into violence and threatened livelihoods;
- Agricultural production might be threatened because of heat, drought and floods that may in turn result into transportation and trade problems. This will cause food insecurity and could result into environmental refugees, higher food prices and social unrest.

Next to climate change, there are many other drivers of change; therefore the climate change agenda should not be isolated, but should be carefully combined with the agricultural, biodiversity, economic growth and poverty reduction agendas. They should not be treated as separate domains.

In 2002, a West African panel was asked to list the most important policy priorities; they gave the following:

- Better early warning systems, better information and better communication about its findings;
- Integrate knowledge about changing nature and changing behavior (do not separate natural sciences from social sciences – they ought to be combined);
- Develop more adaptive agricultural, pastoral, sylvicultural and horticultural practices;
- More attention to and support for social security networks for diversified livelihood profiles for migration and remittances;
- More attention for entitlement changes (e.g. land, water and forest rights) and for conflict prevention between groups with different identities (e.g. cultivators versus herders).

With regards to the above, currently the following is in place:

- Many African countries now have agencies responsible for mitigation measures and participating in the global climate negotiation meetings;
- There is growing awareness in Africa of the need for systematic thinking about adaptation, but mainly oriented to extreme events (floods, storms, and droughts) and some connection with poverty reduction agendas;
- Here and there: there is a start of a 'sustainable cities' concept;
- Often a major external push (Northern aid, NGOs), lack of African ownership;

Between 2002 and currently, there has been one major change in the agenda whereby the connection between climate change and health risks became high in WHO's policy agenda. It made the threats to health as a result of climate change clear, such as loss of food production, contamination of water supplies, increased risks of infectious diseases, etc. These health risks are more powerful in influencing public opinion and policy than many of the other aspects. The last 10 years has seen more emphasis being placed on the availability of adequate and healthy water systems; however it still remains an uphill task in growing cities.

Plenary and Discussion

Comment: Some major issues that have not been mentioned are the educational aspect of our development and the consumerist aspect of all this development. On the educational aspect, over the last 100 years we have been following a pattern where people have been encouraged to move out of the rural to the urban areas – this was taken as a model of development. The educational curriculum has also not been made appropriate to the needs of the local, rural settings. These aspects have to be researched thoroughly on whether the line we are following is appropriate.

Comment: 3 billion people face food insecurity – we need to know what measures and policies should be adopted to counter this.

Question: What is the connection between the food needs and crop production?

Comment: Good governance goes with good policies, which can create a better way to address some of the problems created by climate change. We need to come up with ways on how to integrate common African communities who have local practices that may create both negative and positive aspects – how can they be brought on board to be partners in this process?

Comment: We need solutions for Africa – by creating a mechanism or modalities for development whereby continental institutions such as the AU are empowered to address the problems of the continent – we need to have an African representative body to address the issues facing the continent.

Comment: Africa needs a conservation scheme around the germ plasm – policies therefore need to be centered on this.

Comment: We need to appreciate the fact that Africa has a low production by small scale farmers – thus the need for science to improve this – we need to increase production in Africa and scientists should be organized around this goal.

Response to comments and questions by Prof. Dietz

1. How many people in Africa should be rural, urban or agricultural? If urbanization is happening everywhere then the questions remains, "Is it wise to have people in the rural areas move to the cities"? Educational systems should be better geared towards agricultural areas – this is a policy choice;
2. What can be done to change the future urban lifestyles – we need to fight the aspect of consumerisms and lifestyles - this is unsustainable ;
3. Africa has dedicated institutions that are preserving germ plasm, e.g. KARI in Kenya. We need to take advantage fully of what is present;
4. Food and Agriculture Organization (FAO) figures on African production – the average cereal harvest are still quite low compared to the rest of the world; however between 1960 and 2010 the cereal production has doubled. Innovation has therefore taken place. For Africa the per capita food availability is now higher than it was in 1960, despite an enormous population growth.

(2) Food Security in the Face of Changing Climate

By: Prof. Shem Wandiga University of Nairobi)

Food security is the availability of food and one's access to it. The growth in the global food production has been greater than population growth – food per person has increased between 1961- 2005; however the question remains, "Where is this food?"

Food shortage leads to chronic hunger, malnutrition and stunted growth. With food production being purely dependent on water, the water crisis is therefore critical. Some of the causes of food shortages include the following:

- Export restriction and panic buying
- The global population growth
- Loss of agricultural land to residential and industrial development
- Growing consumer demand in China and India
- Climate change
- Increased farming for use in biofuels

Of the available 98% of water, only 2% of the water is fresh and available for human consumption, but of this 2%, 1% is stuck in glaciers and snow caps. So what is readily available for all use by humans is only 1%. The water crisis therefore refers to the 1% of fresh water available. It is now becoming increasingly more difficult to maintain food and water security in a world beset by a confluence of "peak" phenomena whereby the peak geological water and food peak is reached after which production begins to decline.

Some of the causes of food insecurity include:, 1) the global water crisis with evidence showing that water tables in both small and large countries is declining, 2) land degradation through e.g. intensive farming that leads to exhaustion of soil fertility and decline of the crop yields – approximately 40% of the world's agricultural land is seriously degraded, 3) climate change – as a result of the melting of glaciers on top of high mountains will reduce the flow of water for agriculture to the lowlands, especially during the dry seasons. In the next 20 years the glaciers and snow capped mountains may be a thing of the past as a result of climate change, 4) Introduction of new crop diseases that eventually have a huge effect on the yield, 5) Land deals whereby rich governments and corporations buy up the rights to millions of hectares of agricultural land in developing countries in an effort to secure their own long-term food supplies, resulting into poor countries producing food for the rich, 6) New pests population pattern resulting from a climate change, 7)dictatorship and kleptocracy – there is need for a governance system to ensure that the productivity of its populace to be realized. A dictatorial system puts the price of grain and other food items at an artificial low price so that the poor cannot be attracted to farming. Therefore high input costs, low output prices dissuade farmers from maximizing the land and producing the needed food.

Conclusion:

- Sciences has improved the production of food to cope with increasing population growth – we therefore need to use it to feed the increasing populations
- Food insecurity is caused by many factors, some of which are at the control of individuals, international markets and lately at the whim of the weather
- Governance structure and policies on farming and food distribution are essential for food security.

Response to question and comments by Prof. Wandiga

1. What are the actions that we need to do that range from our areas of expertise and collective judgments in all these areas – e.g. by improving food production, making farming professional and profitable.
2. The division of land into small sections dissuades younger people from farming resulting in to people moving to the towns, because there is no land to farm. There is need to make farming profitable and attractive – this can be done by educating the community in improving their farming practices and methods – e.g. use of farmyard manures and proper seeds
3. We need to fully understand what the energy implements that are needed to carry out farming and what is supplying that energy at present – which in this case is fossil fuel. We also need to know what happens when this energy is depleted. We need to look at energy as the main contributor to the ability to produce food in large scale
4. Who are we speaking to? We all need to take the lead and implement what has been learned in this conference, e.g. by talking to policy makers and people in the community to improve their methods of production and also get their needs and translate them into policies. We need not be silent, as being silent is what is killing us.

V Conference Sessions

Session 1: Potential Impacts of Climate Change on Food Systems and Food Security

Session Chair: Prof. Felix Luti (Kenya National Academy of Sciences)

Speakers:

Prof. V.T Langenberg (Deltares -Delft Hydraulics, Netherlands) and Prof. E. Odada (University of Nairobi, Kenya)

Dr. S. Facknath (University of Mauritius)Prof. N.A. Gworgwor (University of Maiduguri, Nigeria)

Prof. T.A. Kabanda (North West University, South Africa)

5.1 A Review of the Impact of Climate Change on East African Lake Productivity: Implications for Future Carrying Capacity:

Prof. V.T Langenberg (Deltares -Delft Hydraulics, Netherlands) and Prof. E. Odada (University of Nairobi, Kenya)

Approximately 50 million Africans depend on fisheries for survival, a source of livelihood that is, facing huge threats. Over the past 50 years, water quality in lakes has deteriorated due to pollution, catchment developments, agricultural expansion, growing populations, urban-industrial input and the sprouting of invasive species. What is more, global warming is altering the structure and functioning of the ecosystems of lakes, a process that is impairing the capacity of lakes to generate nutrients, algae and planktons necessary to produce good quality fish.

Sustainable use of Great African Lakes needed
Photograph Lake Victoria by Dr. S. Marijnissen

In conclusion, there is urgent need to check the quality threats to lakes, two initiatives of which are justifiable. 1) close monitoring of current trends in environmental change of Africa's lake basins in order to govern the health and productivity of these ecosystems and 2) new, strategic, interdisciplinary research that can deliver to the lake communities the knowledge and supporting information necessary to assess the changes they are facing from climate warming, and to understand how they may effectively mitigate unwanted changes and at the same time cope with the changes that they cannot manage.

Developing Africa in a changing environment Photograph by Dr V T Langenberg

5.2 Climate Change Impacts on Crop Pests and Their Natural Enemies:

Dr. S. Facknath (University of Mauritius)

Damage to food production as a result of pests is devastating, not only does it cut down production, but it also increases production costs (pest control inputs). As it is, pesticides can be harmful to people and the environment (pesticide residues in food and feed).

Most models on the impact of climate change on agriculture and forestry have limited conceptual power lacking as they do stringent and comprehensive assessments on pest damage to crops. Models such as CLIMEX, BLASTSIM, and CERES-RICE, treat temperature as a short-term variable and not as a climate change variable. The reason models, including those that focus on smallholder and subsistence farming households of dry land tropics, do not incorporate pest damage is that there is lack of sufficient data on how insects react to external factors, and to various biotic and abiotic factors, which are highly variable and unpredictable. But since high temperate and humidity are known to influence life cycle duration and to aggravate the damage incidence on host crops, one can safely presume that climate change would be a major causal factor in increasing pest damage to crops. Increasing outbreaks of key pests due to changing climate is "virtually certain" (IPCC, 2007). With regard to food security, increasing pest damage is predicted to result in significant losses in food production and food supplies.

Climate change is influencing insect migration to higher altitudes (Europe and US), while changes in the water regime is presumed to have variable effects on insect incidence and damage. High temperatures and droughts also make forest trees more susceptible to insect attack while many drought-induced plant characteristics are attractive to insects. Climate change also affects the natural enemies of the pests negatively, reducing their pest control efficacy. The effects of climate change are expected to act directly on all the trophic levels as well as indirectly on soil, water, the host crop, and hyper parasitoids. While the final possible outputs are very difficult to predict with any degree of certainty, a decoupling of the long evolved relationships between pests and natural enemies can be expected.

Accordingly, pest management should be included in any assessment of the impacts of climate change on agricultural production. Increased understanding of the impacts and interactions among crops, pests and natural enemies will help in developing effective adaptation strategies towards climate change.

In conclusions the following additional recommendations hold true:

- Studies are needed to understand the combined effects of CO2+ temperature+ precipitation + UV on pests and natural enemies.
- Research into alternative sustainable methods of pest control is imperative.
- Investments to national extension services and farmer training should increase.
- Community-based adaptation strategies should be encouraged.
- Rapid and efficient data sharing mechanisms should be encouraged.
- The capacities for early warning and better forecasting, early detection and early control systems for pests should be developed.
- Farmer participatory approaches for pest surveillance and monitoring should be deepened.
- Regional co-operation, especially among countries within same ecological zones should be cultivated.

5.3 The Potential Impact of Climate Change on Weed Infestation in Crop Production and Food Security in Sub-Saharan Africa:

Prof. N.A. Gworgwor (University of Maiduguri, Nigeria)

The Striga hermonthica is a root parasitic weed on sorghum (Sorghum bicolor L.) Moench, pearl millet (Pennisetum glaucum L.) R. Br., maize (Zea mays L.), sugar cane (Saccharum spp.), rice (Oryza sativa L.) and grasses mainly found in tropical Africa and Asia. It is host specific and germinates by stimulation from a chemical substance (strigol) released by the host plant. It is the biggest biological hindrance to grain production, especially in Africa. Ecologically, it manifests in soil of low fertility, in areas with high temperature, and with erratic and low rainfall resulting in intermittent drought. Its spread and intensification will thus be encouraged by climate change.

Adaptation measures that can be carried out to fight climate change could entail taking measures such as physical and ecological approaches to monitor and evaluate species and ecosystem stability, check degradation of soils and land resources by afforestation and regulating grazing areas. From an agricultural standpoint, it is justifiable to advocate for the use of drought, pests and disease resistant crops. Communities need to be educated on climate change and exhorted to pursue community-based afforestation and also embrace alternative tillage methods and husbandry practices. They also need to be alerted on weather dangers through the provision of proper meteorological services. Local authorities also need to implement policies that safeguard natural resources. In conclusion, NGOs and Corporate organizations should participate in fighting the effects of climate change.

Striga hermonthica in sorghum

Striga hermonthica in rice

5.4 Impact of Climate Change on Agriculture: Collapsing of Dry Land Potato Farming in South Africa:

Prof. T.A. Kabanda (North West University, South Africa)

The formation and development of orographic rainfall, which is a local-scale feature that feeds the summertime convection, is impacted by vegetation cover change (VCC). Cloud fields induced by orography would not extend further in the absence of VCC. The VCC over the Soutpansberg Mountain (the study area) is responsible for preferential formation of clouds and contributes to the observed rainfall reduction in this region.

Dry land potato farming has been taking place around Soutpansberg Mountain area from the 1920's until recently. During the 1950s, the Soutpansberg Mountain area was fertile with distribution of dense deciduous woodlands and evergreen montane forests. In areas near the mountain, increasing population pressure and a shortage of cultivable land led to the migration of people from the south-eastern parts of the Soutpansberg Region upslope. With this rise in population came large-scale deforestation on and around the mountains, mainly through increased agriculture, firewood use and urban expansion. This move interfered with rainfall dynamics and thermodynamics.

In all likelihood, this trend points to decreased i productivity of dry land potato production (Potato South Africa, 2005). Relative to the production

costs of irrigated potatoes, the production costs of potatoes for dry land production is ~50% less (R20, 915 per ha), seemingly making it attractive to emerging small-scale farmers. However, due to climate change small-scale farmers, in particular, are susceptible to yield losses. Climate change can however be slowed down by increasing sinks (removing greenhouse gases from the atmosphere by say afforestation) and decreasing sources of greenhouse gases.

Summary of Participants Feedback from Session 1

1. High temperatures foster the decomposition of nutrients within the lakes. The levels of lakes are dropping due to evaporation, irrigation, and deforestation. There is need to reduce solid or sediments flowing into these lakes as they absorb more heat leading to increased stratification. There is need to determine the quantity of such sediments that lakes can handle.
2. Since adaptation strategies to deal with pest control are now available, communities need to be encouraged and equipped to apply these preventive strategies, both for pest control and climate change.
3. Current research needs to be adaptive in nature and produce results that meet the end user needs.

Summary of Key Emerging Issues

1. Models that assess the impact of climate change on habitats should use complex tools and should include the stealthy and destructive role of pests and pathogens to food production.
2. Communities ought to be considered as vital and intrinsic to efforts to roll back the impact of climate change. They thus need to be empowered with incentives and resources accordingly.

Session 2: Possible Climate Change Adaptation Responses on Food Systems and Food Security

Session Chair: Prof. Tayo Fakiyesi (University of Lagos)

Speakers:

Dr. G. Sterk (Utrecht University, Netherlands)

Ms. J. Kalungu (South Eastern University College, Kenya)

Dr. M.E. Shongwe (Ministry of Tourism & Environmental Affairs, Swaziland)

Prof: J.O. Ogunji (Ebonyi State University, Nigeria)

5.5 Water Harvesting for Improved Rainfed Agriculture in Sub-Saharan Africa:

Dr. G. Sterk (Utrecht University, Netherlands)

According to estimates of 2007, Sub-Saharan Africa has a total of 800 million people, 41% (328 million) of whom live in dry lands (arid, semi-arid and dry sub-humid areas). For their income, these people rely on rain-fed agriculture, and thus rely on water, however, drylands suffer from large variations in rainfall and all the water that comes in form of rain is inefficiently used for agriculture.

Water availability in Africa is declining: between 1974 and 1990, it fell by 180% per capita. Poor rainfall is the main obstacle to crop production: only 5-15% of the rainfall is available for crop production. There is need to increase green water use efficiency (GWUE) by reducing surface run offs and soil evaporation, reducing non-productive flows, augmenting the transpiration structure, by tapping water harvesting and by improving the soil structure. The soil moisture storage also needs to be enhanced by tackling soil degradation.

Techniques used to exploit rainwater harvesting include the following: (1) collection of surface runoff and storage for use in supplementary irrigation, (2) refined micro (infield systems) or macro catchment systems, (3) greater conservation in the root zone, and (4) maximizing plant water uptake. Increased water harvesting has been shown to increase crop varieties in Northern Ethiopia. There is need to make rainfall more productive and add to the GWUE in Sub-sharan Africa.

[5] *Green Water Use Efficiency (GWUE) is the fraction of rain water that is used for plant transpiration that results into crop yield*

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5.6 Food Security Dilemma: Responding to the Challenges of Population Growth and Global Warming:

Ms. J. Kalungu (South Eastern University College, Kenya)

Africa is the second continent with the highest population growth worldwide. In Kenya, the population has increased by 23.3 million between 1979 and 2009. High population strains water resources and causes land pressure and environmental degradation. Moreover, the effects of climate change are harmful on ecological areas that have already suffered degradation. As African countries develop, the populace is consuming more fossil fuel and producing more waste, which is not being recycled satisfactorily. There is a correlation between Environmental degradation and poverty. Many poor people engage in environmentally destructive practices such as charcoal burning and poor farm practices due to lack of alternative economical activities.

Therefore efforts are needed to develop community adaption measures as well as raise community awareness and encourage community participation in climate change issues. Improving water availability through rainwater harvesting, soil and water conservation measures, harnessing the use of drought resistant crops and adopting crop diversification are powerful adaptation strategies. In this light, there is also need to amplify the use emerging technologies, make greater use of renewable energy and enact appropriate policies on climate change.

5.7 Global Warming and Climate Change: Implications for Agricultural Production and Food Security in Swaziland:

Dr. M.E. Shongwe (Ministry of Tourism & Environmental Affairs, Swaziland)

Southern Africa has witnessed temperature rises and irregular and unpredictable rainfall. The region has also experienced an increased number of dry days within the rainy season, sometimes in excess of 40 days. Although the days of rainfall are fewer, precipitation is more intense. The probability of crop failure and food shortage has risen. Consequently, the contribution of agriculture to GDP has been declining. Therefore, crop failure and food shortages are growing threats. Possible adaptation options around this would include (1) shifting planting periods, (2) planting early maturing and drought tolerant crops, and (3) growing forage species under irrigation.

5.8 Climate Change and Fish Production: A Look at Aquaculture Environmental Impact Assessment and Likely Adaptation Methods:

Prof. J.O. Ogunji (Ebonyi State University, Nigeria)

Fisheries and aquaculture contribute significantly to food security. Fish provides essential nutrition for 3 billion people and at least 50% of animal protein and minerals to 400 million people from the poorest countries (World Fish Centre 2008). Over 500 million people in developing countries depend, directly or indirectly, on fisheries and aquaculture for their livelihoods. Aquaculture is the world's fastest growing food production system, expanding at 7% annually (FAO 2009). World aquaculture production has increased from 1.7 million tones in 1957 to 68 million tones in 2008 (FAO, 2009, 2010). This expansion reflects the expansion of culture areas, increased knowledge in husbandry, and advances in production technologies and resource application. Furthermore, this expansion is referable to greater use of production-inputs such as land, water, feeds, energy, therapeutants and chemicals, actions that have occasioned meant higher airborne and waterborne emissions from the farms, leading to environmental distress.

Climate change will worsen the living conditions of farmers, fishers and forest-dependent-people who are already vulnerable and food insecure (FAO 2008). Everett and Garcia (2010) outlined the likely results of climate change-related warming more specifically for fisheries and aquaculture as follows:

- longer growing seasons and increased rates of biological processes;
- greater risk of oxygen depletion;
- higher probability of migration of species to more warmer and perhaps less-oxygenated waters;

- re-deployment or re-design and relocation of coastal facilities.

Fisheries and aquaculture contribute considerably to greenhouse gas emissions. The build-up of carbon dioxide and other greenhouse gases in the atmosphere is changing the earth's climate and ecosystems. In the last two decades, however, multi-impact methods have been developed to provide holistic impact assessment of such changes. The most common environmental assessment tools used in aquaculture include:

1. Procedural (e.g. EIA & TA)-methods are complex and incorporate the analytical, legal, and decisional facets
2. Analytical tools (e.g. EF & LCA) - focus primarily on linear areas of study.

The multi-impact methods used in aquaculture (EF & LCA) should be deployed to gather data on the state of aquaculture systems in Africa to enrich mitigation strategies.

The following are aquaculture based climate change adaptation strategies: (1) domestication of wild fish species; (2) adoption of alternative protein (plant) sources. Besides, housefly maggot meal (Magmeal) is a good alternative meal for fish: and seems to have no oxidative stress generating effect on fish metabolism.

Conclusion:

- Assessment of the environmental impacts of aquaculture should be done urgently;
- Multi-impact assessment tools (which are analytical) should be preferred in carrying out assessments: these analytical tools include EF and LCA;
- Research is needed to explore alternative protein sources to replace fishmeal;
- Funding should be availed to support inquiries into adaptation options including the domestication of wild fish species.

Summary of Participants Feedback from Session 2

1. Climate change research needs to be inter-sectoral and interdisciplinary.

2. Extrapolation of the model on resolution cell (Swaziland) may not be quite useful. However, if input data on local environmental forces are captured in a large-scale model, results may be useful for the local areas. Although long-term predictions are important, it is helpful to produce data for the short term too.
3. Progress has been made regarding empowering the community in Kenya's Kitui county on food security, this has involved the setting of demonstration sites that allow the community to see firsthand what is being proposed and how it is being done. The political will to implement various methods is in place.
4. Analyzing climate change for the next 10 to 20 years will require the use of models from IPCC (AR 5 is superior to AR4). Even so, there is need to project on how climate change will play out in the next two to five decades. This kind of information would be useful to policy makers.

5. Policy makers in Kenya need to invest more resources in water harvesting through the numerous water boars that are active in the country. Indeed, a rainwater harvesting policy is needed. There is need to lobby governments (in SSA) to use innovation and technology to boost crop yields. Governments need to assist farmers to implement such innovations.

6. Not only do scientists need to share information more widely, but also, they need to engage in policy advocacy. NASAC and AAS should package simple advocacy messages for policy makers

7. Policy advocacy regarding climate change has been a burning issue in several scientific fora. In many cases when policy makers

have been invited to scientific forums, they fail to show up. Participants in this conference should use the findings of this conference as tools with which to lobby their governments to pay more attention to climate change and its effects on food production.

Summary of Key Emerging Issues

The raft of measures proposed to help communities adapt to and mitigate against the impact of climate change depends largely on the goodwill and co-operation of two key players: communities and governments.

Session 3: Interventions, Strategies, Policies, and Funding

Session Chair: Prof. Aminata Sallo Diallo (Academie Nationale des Sciences et Techniques du Senegal)

Speakers:

Dr. B.T. Kassie (Wageningen University)

Dr. M. Khuoma (IDEV-ic consultancy office ex-Senagrosol, Senegal)

Dr. C.W. Gitau (Charles Sturt University, Australia)

5.9 Exploring Alternative Strategies for Responding to Current and Future Climate Change Risk to Crop Production in Ethiopia:

Dr. B.T. Kassie (Dr. B.T. Kassie (Wageningen University)

Ethiopia is vulnerable to climate variability and change. Climate change has resulted into recurrent famine, depleting water resources, reducing crop productivity, and occasioning frequent flash floods. Little ground has been covered in assessing the impact of climate change.

The AlterCLIMA Project is an agro-climatic modeling endeavor that aims to improve adaptation of agricultural systems to climate risks by assessing yield variability and gaps for major cereals in two case study regions. The project seeks to analyze agricultural coping strategies to climatic risks in selected cereal based systems of Ethiopia and to assess alternative adaptation options for cereal-based agro-ecosystems under different climate change scenarios.

Communities in Ethiopia are responding to climate change in the following ways: (1) by growing diverse crops including drought resistant crop varieties, (2) by replanting and changing the crop type strategy, (3) by changing agronomic practices, including minimizing fertilizer use, using high seed rate, water harvesting, moisture conservation, and spate irrigation, (4) by changing consumption behavior through shifting to relatively lower food items, (5) by disposing of assets, e.g. livestock,(6) and by reducing their number of livestock.

Some of the planned adaptation Initiatives includes:

- Establishment of area closures and enrichment plantations;
- Implementation of micro basins-moisture conservation;
- Harnessing of the huge potential for irrigation (over 3.5 million hectares).

The following initiatives would be welcome:

- New farming practices and livelihood strategies;
- Sharing of knowledge about traditional technologies and critically evaluating modern solutions in terms of costs, environmental impact, and long-term sustainability;
- Making food security more robust by designing adaptation plans based on best practices through community participation;
- Mainstreaming climate change in national development agenda's, research systems and in academic curricula to develop climate resilient agricultural systems.

5.10 Adaptation Strategies for Food Systems and Food Security in Africa:

By Dr. M. Khouma (IDEV-ic consultancy office ex-Senagrosol, Senegal)

Climate change affects all four dimensions of food security: (1) availability, (2) accessibility, (3) utilization, and (4) systems stability. It is injurious to human health and development. Africans are the most vulnerable people to climate change and least able to adapt to its effects (FAO, 2003). Some of the adaptation strategies that might be

applied in Africa, to better manage risks of climate change, include the following (Howden, et al, 2007):

- Altering the timing or location of cropping activities;
- Diversifying income through altering integration with other farming activities like livestock raising;
- Broadening the use of technologies to "harvest" water, conserve soil moisture (e.g., crop residue retention), and use and transport water more effectively where rainfall decreases;
- Implementing better water management practices to prevent water logging, erosion, and nutrient leaching where rainfall increases;
- Reallocating water between users to increase water productivity; Artificial recharge of groundwater is also critical;
- Improving the effectiveness of pest, disease, and weed management practices through wider use of integrated pest and pathogen management and developing crop varieties that resist pests and diseases.

-Better farm-level management in rain fed systems - in savannah farming systems in sub-Saharan Africa, less than 30% of rainfall is used as productive transpiration by crops. On severely degraded land, this proportion can be as small as 5% (Rockstroem et al., 2009). Thus, crop failures commonly blamed on "drought," might be prevented in many cases through better farm-level water management.

- Development of crop varieties that can cope with water stress and temperature increase.
- Building a climate resilient agriculture.
- Encouraging local production; and non fossil fuel source of power in agriculture (hydropower, solar and wind power, and biofuels that do not compete with food).
- Enhancing the capacity of stakeholders to manage climate risk.
- Raising awareness to help farmers make free but informed decisions.
- Development of weather risk insurance capabilities for agriculture.
- Efficient early warning and risk management systems

5.11 Management of Plant Pests and Pathogens under Climate Change in Africa: Lessons for Africa from Australasia:

Dr. C.W. Gitau (Charles Sturt University, Australia)

The impact of pests and pathogens in a changing climate has largely been ignored. Yet, plant pests and pathogens have increased sharply and are colonizing new habitats.

Increase in temperatures in a changing climate encourages pests and pathogens to generate more frequently thereby magnifying damage to food crops. Some of the key issues for pest and disease management in Africa include the unavailability of updated management options for farmers, lack of appropriate technological solutions and strategies, low adoption rates of new technologies, limited research funding and inadequate attention to pest management at early stages of school education.

Pest control and management is critical. Some of the approaches that can be used towards proper pest management include: - 1) Ecological Engineering which mainly involves habitat management 2) Biological control programs 3) Bio-security

The following are some key lessons on pest and disease management from Australasia:-

- Training on pest identification should include farmers and extension workers
- Use of an integrated systems approach to dealing with pests and diseases.
- Identification of key areas for research and extension
- Area wide management specific for each region.
- Surveillance and quantification of economic impact by pests that involves participation of farmers.
- Strong links between research institutions and availability of

[6] Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

[7] Resilience in this context describes the amount of change a system can undergo, the degree to which it can re-organize and the extent to which it can build capacity to learn and adapt.

information to farmers through magazines, short messaging systems and internet.

- Priority to seek natural enemies; as such, regulated chemical use is a secondary option.
- Enforcement of strict phytosanitary measures within borders and across regions within individual countries.
- Embrace organic agriculture and other alternatives to agricultural praxis
- Strategic focus on prevention of pests through habitat management.

To manage pests and diseases, attention needs to be directed on prevention, e.g. through 1) habitat management and maintenance of natural enemies, 2) monitoring of crops including pests (surveillance), 3) regulation of pesticides and their formulation instead, introduction of biological control agents should be a priority 4) need for education on pests and pathogens (taxonomy) and emerging issues on pest ecology and management 5) more funding towards pests and disease research.

Summary of Participants Feedback from Session 3

1. Funding towards taxonomies has drastically reduced both in Africa and in the west. There is need for collaboration with other institutions and scientists across borders that may already have developed traditional and molecular identification tools.
2. Farmers should consider adapting forms of livestock, such as goats and sheep, whose energy intake is low.
3. There is need to mainstream climate change and adaption signs into the curricula in higher education institutes. The Australian and Dutch experience shows that the academia in these countries value agriculture and food security. In these countries, a strong link exists between the creation and application of scientific knowledge and innovations.

Summary of Key Emerging Issues

1. Farmers need to be encouraged to apply new farming practices that are consistent with the goal of reducing the impact of climate change. New crop varieties, drought and pest resistant, are one such way.
2. Australia has good practices that Africa can model regarding pest management. For one, there is a strong link between the creation and application of scientific knowledge and innovations, working links between research centers and farmers, and even training of farmers and children at a younger age on pest identification and effects of pests and diseases on food security.
3. Tentative evidence suggests that climate change is triggering the spawning of pests and insects that damage crops; indeed, global warming is encouraging their spread and destructive force. As such, the nexus between global warming and the intensification of the activity of plant pests and pathogens needs to be highlighted in scholarly and policy discourse.

VI Working Groups

Participants broke into four working groups to deliberate on climate change and adaptation to food security under the following topics.

1. Resilient Agro-Ecosystems
2. Land Management and Governance
3. Arid and Semi-arid Lands
4. Human dimensions, migration, health and nutrition

1. Resilient Agro-Ecosystems

Building resilience in agro systems includes (1) rolling back damage to the habitat, (2) boosting the yield from the aquaculture and agriculture, and (3) encouraging the social development of communities. This form of resilience requires the following ranked measures: sound land, water, crop, pest, and disease management, including biological disease control.

Scientists need to deliver best practices to farmers and help them make informed farming choices. Likewise, they need to develop the tools to assess ecological functioning in light of global warming, adopting an

eclectic approach apropos climate change research, fusing indigenous and scientific knowledge.

Scientists should engage in policy advocacy and criticism nationally and regionally. They also need to do the following:

1) Advocate for the inclusion of climate change in the curricula from the primary level
2) Draw from the experiences of research centers like CGIAR
3) Build a database on climate change with disaggregated data at various levels of administration for the benefit of researchers and policy makers

2. Land Management and Governance

The poor governance structures in Africa are instrumental to its ecological and environmental degradation. The weak waste, environmental, and land laws (including zoning criteria), are illustrative. In addition, farming systems and methods in Africa are still primitive, inefficient, and environmentally unfriendly. Better farming practices are needed urgently. Governments need to draw and implement policies to roll back systems and practices that degrade the environment or that stymie food production: in particular, there is a need for a movement that encourages or enjoins communities to participate in efforts to tackle food insecurity. Governments also need to do more to invest in the infrastructure to facilitate food security. On their part, agricultural scientists need to develop crop varieties that can thrive in marginally productive agricultural areas, saline or semi-arid areas. Research is needed to provide insights to manage ground water. The African Academy of Sciences needs to redouble efforts in policy advocacy about climate change and food security.

Some suggested policies, interventions and/or solutions are:

- Clearly defined land zoning systems
- Enforcement of land regulations
- Addressing issues of competing claims, e.g. the economic value of agriculture vis a vis tourism in a specified land area
- Development of salinity tolerant crops (agri-engineering) and those adapted to arid and semi arid lands
- Provision of incentives for water use efficiency, agroforestry etc.
- Design of new farming systems that are climate-proofed
- Improved information dissemination.

3. Arid and Semi-arid Lands

The arid and semi-arid areas in Africa are expanding. In tandem, water and food scarcity, land degradation, crop and human diseases (including invasion by alien weed species), human settlement changes (including rural to urban migration), and rural poverty are growing. Increased aridity is likely to trigger conflicts scarce resources. There is need for the application of innovative farming methods and practices, the introduction of drought resistant crops, new livestock breeds, and even the intensification of urban agriculture. Greater attention should also be placed on the following:

1) Building strategic capacity for food storage
2) Refining of early warning systems and weather forecasting
3) Higher budgetary allocations to support adaptation projects related to climate change
4) Development of indicators for monitoring child health and nutritional problems
5) Increasing efficiency of extension services and making them multi-disciplinary
6) Boosting collaboration between universities, governments, training institutions, the private sector, farmers, and businesses

4. Human Dimensions, Migration, Health, and Nutrition

Food insecurity is grievous to human life and health. Some of the major areas of risk include increased burden of rural to urban migration, transfer of diseases, diminished water availability, and loss of traditional species and medicines. At a micro level, food insecurity engenders poverty and harms the cognitive development of children. Remedial efforts should be directed at improving farming methods, promoting indigenous or organic farming methods, boosting surveillance to monitor and regulate livestock movement, the domestication of fish and urban agriculture and

[8] *See Appendix 2 for detailed Group Feedback*

aquaculture, and strengthening of health systems. Given the human dimension of climate change, climate change research needs to be multidisciplinary. In addition, small-scale farmers need incentives to improve on food production. International focus and energy is needed in combating issues migration, which has socio-economic implications. Other issues meriting international efforts include dealing with emerging diseases and exploiting high yielding crops and animals, and greater use of indigenous farming practices.

Participants Feedback from Session VI

1. It was proposed that the conference should have covered more ground around the following areas:

- Capacity building in terms of human resources, equipment, consumables, farmer empowerment
- Data sharing,
- Crop and livestock breeding,
- Intellectual property rights,
- Aquaponics,
- The impact of climate change in post harvest technologies,
- New technologies for improving post harvest technologies.

In addition, the conference should have covered much ground on the social science component of climate change and on the issue of coastal and island development, an important topic in the East African region and around Lake Victoria.

2. With regards to the GMO issue, there is need for flexibility as some of the traditional methods are not producing the expected outputs. More research is needed around GMOs as many medicines including Insulin are GMO products. Many areas around genetic engineering can improve food security.
3. To improve African agriculture productivity without the use of fertilizers, all recommendations made at past scientific conferences need to be reviewed before urging governments to implement specific steps.
4. Efficient use of fertilizers in Africa needs to be encouraged to increase the crop yield.
5. Population control dynamics is an important factor that needs to be considered around climate change.

Summary of Key Emerging Issues in Session VII

Climate change does not deal with simple generalizations. Instead, it has serious implications on human health and livelihoods. Policy advocacy initiatives need to be grounded on such realities.

VII Closing Session

The following 4 issues stood out during the conference:

1. Climate change in relation to the food security/problem

- There is plenty of knowledge available on this topic, yet there are limited opportunities to share them,
- Analysis on the impact of climate change vis a vis food security is still unclear and localized,
- Communities are aware of the changes in weather conditions, they have empirical knowledge of climate change,
- Scientists need to learn on how best to adapt to climate change and communicate the same to farmers. These adaptation measures ought to be implemented at household levels.

2. Food security is related to climate change, however, there are many other risks and threats to food security that need to be isolated and resolved. There is need for linkages or synthesis on the various variables attached to food insecurity.

3. The Academies of Science need to adopt the following roles:

- Identify knowledge gaps and prioritize subsequent analytical endeavors,
- Determine whether research biases or priorities are being pursued as envisaged. It is important for collaboration to take place between scientists in the various disciplines for purposes of coming up with concrete solutions around problems,

- Climate change discourse should have a community focus ,
- Develop conceptual and forecasting skills to consider all scenarios of climate change,
- Apply and come up with appropriate analytical mechanisms,
- Integrate the social sciences into the climate change debate,
- Collaborate with scientists from China and Brazil as they are now moving into Africa to carry out scientific research.

4. The knowledge gap between researchers and policy makers: Researchers need to evaluate how best to influence governments on the scientific issues in their countries that need to be prioritized and addressed and provide them with practical solutions – as governments are always faced with competing agendas.

Contribution from Participants

5. Scientists need to take an interest in waste management. Example: In Uganda nutrients that were being lost through waste are now being stored up for use in urban agriculture.
6. The conference lacked media coverage which is a key ingredient for such an important meeting. Policy makers should also have been invited and be involved in this conference.
7. Social and physical Scientists need to collaborate in examining climate change.
8. A more aggressive strategy is needed to market and enhance the visibility of climate change in Africa, showing both its benefits and effects around the continent.
9. There is also a need to engage and synergize with ongoing initiatives such as the African Satellite constellation that is a new initiative with one of its focus areas being climate change.
10. A voice for Africa is needed around the topic of climate change e.g. NASAC or the African Academy of Sciences.
11. The climate change agenda needs to be made a priority issue.

VIII Findings of the Conference

The most important outcomes concluded by the conference participants are:

1. Include African culture and heritage in scientific programmes
2. Use indigenous knowledge and underpin it with scientific evidence
3. Link up with relevant existing (national and international) programmes like CAADP, FARA, CGIAR, ICSU, AGRA and so on
4. African countries need to start exchanging available (scientific) information more
5. Stimulate multidisciplinary, integrated scientific programmes
6. Include all relevant stakeholders in setting the scientific agenda
7. Focus on projects that contribute to both short term and long term solutions
8. Develop programmes at a regional level that link projects on local/community level
9. Stimulate research toward empowering extension services
10. Take into account the geographical scale when tackling the Climate Change/Food Security issues (practically, it is best to divide Africa up in sub-regions and sub-projects)
11. Identify and use champions to promote climate change adaptation
12. Create yield- insurance possibilities for small scale farmers
13. More attention should be paid to actual implementation of (existing) policies
14. Vigilance on how bio fuel industry develops and react with protective measures in case too much land is lost to non-food purposes
15. Promote Science to Policy communication (engagement between scientists and policy makers)
16. Promote Science to Stakeholders communication (farmers, NGOs, society, private companies) - inform farmers about options; inform scientists about needs
17. Stimulate the formation of African networks between scientists addressing similar issues
18. Attempt closer collaboration between all sectors: universities,

governments, training institutions, farmers and the private sector to concentrate and/or coordinate efforts to alleviate climate change implications in arid and semi-arid areas

19. Identify best practices in Africa
20. Develop assessment systems that can be used to evaluate and quantify best practices
21. Set up a shared African data-base with relevant scientific information
22. Revise university curricula towards more climate change awareness
23. Stimulate plant breeding for more resilient crops (pest and disease resistance, drought or flooding tolerant and/or short cycle crops)
24. Focus on improving agronomic methods towards a higher resilience of farming systems
25. Stimulate production of non-wood products in forest (increase agro-forestry systems)
26. Develop efficient agricultural water management technologies (soil and water conservation -explore possibilities for mixed farming or mulching)
27. Stimulate rainwater harvesting practices
28. Focus on waste management, preventing loss of water and soil available for agriculture
29. Develop better early warning systems
30. Improve seasonal weather forecasts
31. More attention towards entitlement changes (e.g. land, water and forest rights) and for conflict prevention between groups with different identities (e.g. farmers/herders)
32. The need for close monitoring of the current trends in environment change of Africa's lake basins in order to govern the health and productivity of the ecosystem

a. New, strategic, interdisciplinary research is needed that can deliver to the lake communities the knowledge and supporting information necessary to assess the climate changes and enable them understand how they can effectively mitigate unwanted changes

b. Conduct studies around the combined effects of CO2+ temperature+ precipitation + UV on pests and natural enemies

33. Because of climate change farmers need to be made aware that it may be vital to alter the timing or location of cropping activities
34. A more aggressive strategy is needed to market and enhance the visibility of climate change in Africa, showing both its benefits and effects around the continent

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The Impact of and Adaptation to Climate Change in Relation to Food Security in Africa

SCIENTIFIC CONFERENCE OFTHE NASAC-KNAW COLLABORATION INITIATIVE ON

"IMPACT OF AND ADAPTATION TO CLIMATE CHANGE IN RELATION TO FOOD SECURITY IN AFRICA"

23-25 February 2011- Hilton Hotel, Nairobi, Kenya

OBJECTIVE

To exchange ideas and experiences on climate change impacts and adaptation measures in relation to food security in Africa, amongst researchers, policy makers, Governmental Organizations, Non-Governmental Organization, the private sector and other stakeholders.

PROGRAMME

Day 1: Wednesday, 23 February 2011

Opening Ceremony			
09:00-09:40	Welcome address by representatives from: 1. Kenya National Academy of Sciences 2. African Academy of Sciences 3. Netherlands Academy of Arts and Sciences 4. Network of African Science Academies 5. Government of Kenya	1. Prof. Joseph Malo 2. Dr. Shem Arungu-Olende 3. Mr. Jeroen Frietman 4. Prof. Paul Mugambi 5. GoK Official	**Chair:** Prof. Dominic Makawiti **Rapporteur:** Dr. John Ilukor
09:40-10:00	Keynote 1: **Science perspectives on climate change and food security**	PROF. SHEM WANDIGA **(Kenya)**	
10:00-10:20	Keynote 2: **Policy perspectives on climate change and food security**	PROF. TON DIETZ **(Netherlands)**	
10:20-10:30	Plenary Discussions		

Session 1: Potential impacts of climate change on food systems and food securit			
11:00-11:30	*A review of the impact of climate change on East African lake productivity: Implications for future carrying capacity*	PROF. V. T. LANGENBERG **(Netherlands)** PROF. E. ODADA **(Kenya)**	**Chair**: Prof. Orlando Quilambo **Rapporteur**: Dr. Opportuna Kweka
11:30-11:50	*Climate Change Impacts on Crop Pests and their Natural Enemies – Implications for Food Security and Environmental Sustainability*	DR. S. FACKNATH **(Mauritius)**	
11:50 -12:10	*The Potential Impact of Climate Change on Weed Infestation in Crop Production and Food Security in Sub-Saharan Africa*	PROF. N. A. GWORGWOR **(Nigeria)**	
12:10-12:30	*Impacts of Climate Change on Agriculture: Collapsing of dry land potato farming in South Africa*	PROF. T. A. KABANDA **(South Africa)**	
12:30-13:00	Plenary Discussions		
13:00-14:00	*Lunch Break*		

Session 2: Possible climate change adaptation responses on food systems and food security			
14:00-14:20	*Water harvesting for improved rainfed agriculture in Sub-Saharan Africa*	DR. G. STERK **(Netherlands)**	**Chair:** Prof. Tayo Fakiyesi **Rapporteur:** Dr. Dominic Blay
14:20-14:40	*Food Security Dilemma: Responding to the Challenges of Population Growth and Global Warming*	DR. J. KALUNGU **(Kenya)**	
14:40-15:00	*Global Warming and Climate Change: Implications for Agricultural Production and Food Security in Swaziland*	DR. M. E. SHONGWE **(Swaziland)**	
15:00-15:20	*Climate Change and Fish Production: A Look at Aquaculture Environmental Impact Assessment and Likely Adaptation Methods*	PROF. J. O. OGUNJI **(Nigeria)**	
15:20-15:50	Plenary Discussions		
15:50-16:20	*Refreshment Break*		

Session 3: Interventions, strategies, policies and funding			
16:20-16:40	*Exploring alternative strategies for responding to current and future climate risk to crop production in Ethiopia*	DR. B. T. KASSIE **(Ethiopia)**	**Chair:** Prof. Aminata Sall Diallo
16:40-17:00	*Adaptation strategies for food systems and food security in Africa*	DR. M. KHOUMA, **(Senegal)**	**Rapporteur:** Dr. Elder Moonga
17:20-17:40	*Management of Plant Pests and Pathogens under climate change in Africa: Lessons from Australasia*	DR. C. W. GITAU **(Australia)**	
17:40-18:00	Plenary Discussions		
18:00-18:10	Registration for Working Groups		
19:00-21:00	**Welcome Dinner (Carnivore Restaurant)**		

Day 2: Thursday, 24 February 2011

Time	Activities	Facilitators/Convenor
09:00-11:00	Working group discussions	Prof. K. Mshigeni Prof. C. Mutambirwa
11:00-11:30	*Refreshment break*	
11:30-12:00 12:00-12:15	Working Group 1 Report: **Resilient Agro-Ecosystems** Plenary Discussions	Profs. Bhoojedhur and Loffler
12:15-12:35 12:35-12:50	Working Group 2 Report: **Coastal and Island Development** Plenary Discussions	Profs. Elahee and Mavume
12:50-14:00	*Lunch Break*	
14:00-14:20 14:20-14:35	Working Group 3 Report: **Land Management and Governance** Plenary Discussions	Profs. Zoomers and Olago
14:35-14:55 14:55-15:10	Working Group 4 Report: **Arid and Semi-arid Lands** Plenary Discussions	Profs. Mutemi and Peerally
15:10-15:30 15:30-15:45	Working Group 5 Report: **Human dimensions: migration, health and nutrition** Plenary Discussions	Drs. Ouma and Essel
15:45-16:15	*Refreshment Break*	
16:15-16:30	General Discussions on conference findings/ resolutions/recommendations	Prof. A. Zoomers Dr. Olivier Crespo
16:30-17:00	Highlights of next steps Vote of thanks Closing Remarks	Dr. Dan Olago Ms. Jackie Olang KNAS/AAS officials
From 17:00	***End of Scientific Conference***	

Day 3: Friday, 25 February 2011

POSTERS & NASAC EXHIBITION and ORGANIZING COMMITTEE MEETING

Time	Activities	Facilitator(s)
09:00-10:30	*NASAC -Ten Years and Beyond*: • Highlights on NASAC activities in Africa • Strategic Plan 2011-2015 • Vision 2021	Jackie Olang Doyin Odubanjo Takalani Rambau
10:30-11:00	*Refreshment break*	
11:00-13:00	Poster session and NASAC exhibition starts	Closed meetings starts: • Organizing Committee Meeting • NASAC Strategic Planning Committee Meeting
13:00-14:00	*Lunch break*	
14:00-17:00	Poster session and NASAC exhibition continues	Closed meetings continues: • Organizing Committee Meeting • NASAC Strategic Planning Committee Meeting
	Refreshment Break	
15:45-17:00	Poster session and NASAC exhibition concludes	Closed meetings concludes: • Organizing Committee Meeting • NASAC Strategic Planning Committee Meeting