Water Management Issues in Africa

Conference Proceedings

Scientific Conference held in collaboration with
NASAC, MAST, KNAW and Leopoldina

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Contents

I. Introduction

Water is a crucial resource with great implications for Africa's development. Climate change coupled with increasing population growth has led to an increase in water demand. In most African countries the demand outstrips the available water resources. As water availability constantly declines, partitioning of water for domestic consumption, agriculture and other forms of water use is becoming a subject of serious concern. Sound management of Africa's limited water resources is becoming increasingly important to help meet a fast rising population and increasing demand for food, while ensuring the health of water ecosystems.

The Academies of Science of G8+ countries (May 2011) stressed that accessibility, quality and protection of water resources are fundamental to human health in rural and urban areas worldwide. Interventions to tackle such priority issues are the concern of all stakeholders (governments, policy makers, scientists, civil society, and, regional and international organizations). In order to identify scientific strategies and policy options to adapt, the Network of African Science Academies (NASAC), in collaboration with the Royal Netherlands Academy of Arts and Sciences (KNAW) organized a conference on Water Management issues in Africa.

The conference brought together some of the best scientists (senior and young) to exchange ideas and experiences on Water Management Issues in Africa. Aspects that were covered include baseline data and a range of pertinent sectoral water issues, combining knowledge and research work, water governance and policy, water use efficiency, and water protection and conservation. In addition the roles of governmental, public, private and nongovernmental sectors including rural communities in ensuring that water management issues in Africa was addressed.

II. NASAC-KNAW- LEOPOLDINA 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

Opening Session

KNAW-NASAC collaboration is to strengthen the capacity 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 in 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).

Additionally, in 2011 NASAC established a strategic partnership with the Germany National Academy of Sciences Leopoldina. Through this partnership NASAC was able to get additional funding to support the NASAC-KNAW climate change activity on water. The funds supported the involvement of African policy makers' representatives to attend and make presentations during the Science-Policy Dialogue sessions held at the conference on Water Management Issues in Africa. The NASAC–Leopoldina collaboration further aspires to draw from the meeting deliberations and recommendations for use in future Science-Policy dialogue meetings on water and culmination into a NASAC Policy document on water. Building on NASAC's regional water status reports the Leopoldina will in many ways help to link with the wider water science network that has been established by European and German water scientists and experts.

III. Executive Summary

With 15% of the global population, Africa has only 9% of the global renewable water resources. Water is unevenly distributed through the continent; Central Africa alone accounts for 48% of the continent's total internal water resources while Northern Africa only has 1.5%. Groundwater resources represent 15% of the total water in the continent but supply about 75% of its population with drinking water. Africa has

Left to right Hon. Dr. Rashid Beebeejaun (Minister of Public Utilities Mauritius) Prof Soodursun Jugessur (MAST), Dr. Arjoon Sodhoo (MAST), Prof. G. Mohamedbhai, Jackie Olang (NASAC), Dr. Jeroen Frietman (KNAW)

63 international river basins that cover about 64% of the land area and contain 93% of its total surface water resources. This poses a challenge to the development and equitable sharing of water resources.
Water is a crucial resource with great implications for Africa's development. Increasing population and economic growth has led to an increase in water demand. As per capita water availability declines, partitioning of water for domestic consumption, agriculture and other forms of water use, while ensuring the health of water ecosystems, is becoming a subject of serious concern.

It is now well established that water security is affected by climate change, environmental pollution, and unplanned development. Small Island Developing States (SIDS) and many other countries in Africa are more vulnerable

to the effects of climate change with regard to water security.

In May 2011, the Academies of Science of G8+ countries emphasized that accessibility, quality and protection of water resources are fundamental to human health in rural and urban areas worldwide. Interventions to tackle such priority issues are the concern of all stakeholders (governments, policy makers, scientists, civil society, and regional and international organizations). In order to identify scientific strategies and policy options, the Network of African Science Academies (NASAC), in collaboration with the Royal Netherlands Academy of Arts and Sciences (KNAW), the Mauritius Academy of Science and Technology (MAST), and the German Academy of Sciences Leopoldina, organized a conference on water management issues in Africa.

There is need to meet the growing water demand and to achieve the water-related Millennium Development Goals. Development of water resources is inadequate, prices to access water are generally distorted and water provision is highly inefficient. In order to address these issues, it was noted that there is need to study technological options, develop inland waters, promote hydropower, promote rain water harvesting and develop decentralized low cost water treatment plants – using indigenous natural resources.
Discussions on sectoral water issues highlighted the need for small-scale and low-cost water treatment that can help towards achieving the objective of providing safe drinking water in African countries, especially in remote areas. Concerning transboundary water sharing it was concluded that countries concerned will need to learn from successful treaties to initiate discussions among themselves, which should consider both water quantity and quality.

In addressing climate change related issues the following recommendations were made:

- Countries should enhance proper infrastructure, including human resources, development and funding mechanisms to improve water access and keep it affordable;
- There is a need to promote safe sustainable groundwater resources development;
- Sanitation for all should be treated as a priority issue at policy level;
- Implement proper measures in order to enhance food security issues particularly with regard to availability of water;
- Promote efficient and judicious use of fertilizers and pesticides in agriculture;
- Upgrade water storage capacity at national level;
- Countries should promote the development of a robust and sustainable mix of energy sources including hydropower;
- Countries should initiate dialogues with respect to transboundary water sharing;
- Develop and adopt measures to address the negative impacts of climate change in agriculture and the water sector, taking into consideration lessons learnt from other countries that have already embarked on climate change adaptation measures.

The Science Policy dialogue sessions revealed that stakeholders of critical challenges are developing effective and reliable strategies for coping with climate variability and change, growing water scarcity and the disappearance of water bodies. Science-Policy dialogue discussions indicated that the challenges experienced by policy makers were similar to those of researchers because all of them aim to ensure equitable supply of water to all, improve water quality and sanitation, tap into all sources of water and avoid conflicts over water bodies.

IV. Key Points

The key questions tackled during the conference 'Water Management Issues in Africa' aimed at addressing this issue through three critical themes, namely:

1. Resources availability: What is the current status of Water Resources Availability in Africa? Why is it important to adopt an ecosystem approach? What importance is given to water quality? How can Africa promote best water use practices? How does production of Biofuels compete with water resources availability?
2. Sectoral Water Issues: How can low cost water treatment methods help to increase access to safe drinking water in

the most remote areas of Africa? Why is it important to consider social benefits in the cost benefits analysis of small scale drinking water interventions? How can water and food security be addressed through drought tolerant crop varieties? How can experience gathered in other countries help Africa to devise effective adaptation measures to face the impacts of climate change?

3. Integrated Water Resources Management: How have small-island developing states adapted to the changing rainfall pattern in the field of agriculture? Why is there a need to use climate model to forecast climate change scenarios? How are concerned countries transboundary issues shaped up by both conflict and cooperation strategies?

V Structure of Meeting and Key Points Adduced

Session 1: Water Resources Availability

The most important issue that emerged from this session was that Africa is facing a number of challenges in the water sector. Though much progress has been made in providing safe drinking water, provision of safe sanitation was still a major challenge. Land degradation and its negative impacts on the quality of water is a growing challenge as countries aim to address food security. Transboundary issues are characterized by both conflicts and cooperation strategies which tend to co-exist.

Session 2: Sectoral Water Issues

Small scale and low cost water treatment can help towards achieving the objective of providing safe drinking water in African countries, especially the remote areas. Agricultural practices need to adapt to the decreasing water resources availability, in terms of drought resistant crop varieties. Africa could benefit significantly from lessons learnt from other countries which have already implemented adaptation measures to climate change impacts.

Session 3: Integrated Water Resources Management

Small island developing states have no other choice than adapting to climate change, such as the practice of mulching to minimise soil evaporation. Climate models can be a good tool for forecasting how climate change will be impacting a country so that adequate adaptation measures can be identified. With regard to transboundary issues, conflict and cooperation co-exit. Countries concerned will need to learn from successful treaties to initiate discussion among countries on transboundary issues which should consider both water quantity and water quality.

VI. Keynote Addresses

(1) Water Resources Availability and Sectoral Issues in Africa By Prof. Salif Diop

Prof. Salif Diop

Africa is one of the driest continents in the world. With 15% of the global population, Africa has only 9% of the global renewable water resources. Water is unevenly distributed through the continent; e.g., Central Africa alone is accounting for 48% of the continent's total internal waters while Northern Africa accounts only for 1.5%. Groundwater/ aquifer resources represent 15% of the total water but supply about 75% its population with most drinking water. Africa's borders pose a challenge to equitable sharing and developing water resources. Africa's 63 international river basins cover about 64% of

the continent land area and contain 93% of its total surface water resources.

The Africa water vision 'An Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional cooperation, and the environment', will be a reality when the following challenges will be addressed:

(a) Provide safe drinking water: Africa as a whole is not expected to meet this MDG drinking water target; of its 53 countries, only 26 are on track to meet it. The high incidence of water-related and waterborne diseases related to the lack of safe drinking water is a drain on human and financial resources.

(b) Ensure access to adequate sanitation: Exploding peri-urban and slum areas, economic growth and higher demand, geographical isolation, dearth of public utilities and regulation, and high costs of water provision, render the need to provide for adequate sanitation a strong challenge for Africa.

(c) Foster cooperation in transboundary waters; Africa should adopt an approach towards recognizing and building on water as a binding factor between otherwise hostile states; and learn from successful transboundary cooperation efforts and agreements among Africa states.

(d) Provide water for food security; Agricultural growth is the mainstay of most African economies; agriculture is the greater user of water. Presently there is inadequate water use for sustainable food production; Africa suffers from food security and already 30 percent of the population lives with chronic hunger.

(e) Develop hydropower to enhance energy security: The capacity to generate hydropower is unequal across the continent; climate change will exacerbate rainfall variability and hinder hydro potential; and hydro dams will need to avoid the environmental and social impacts historically characteristic of large dam developments.

(f) Meeting growing water demand: Demand for water is increasing with population growth and economic development; development of water resources is inadequate; prices to access water are generally distorted; and water provision is highly inefficient

(g) Prevent land pollution and water degradation: Lack of valuing of ecosystem services; political instability and conflict within and between countries; poor agricultural practices and farming on marginal lands that affect water use or water resources; and lack of structured water monitoring and governance.

(h) Manage water under global climate change: Global warming and its human cause are undeniable; warming patterns in Africa are consistent with global ones; Africa is already subject to important spatial and temporal rainfall variability; drought in Africa is common and some regions are becoming drier; Africa's repeated drought cycles kill thousands of people each event; and floods also occur regularly with severe impacts on peoples' livelihoods.

(i) Enhance capacity to address water challenges: Africa faces a situation of economic water scarcity; and current institutional, financial and human capacities for managing water are lacking. Inadequate and unsustainable funding arrangements for water resources management; insufficient knowledge base; lack of an effective research and technology base; and weak institutional arrangements and

legal frameworks for the ownership, allocation and management of water resources.

Key note Speech 1 – Discussion

1. Relatively few countries have ratified the convention on transboundary issues. Most transboundary treaties tend to favor some countries. These treaties do not seem to benefit the countries through which the major rivers pass. Transboundary issues will also need to take into consideration pollution issues as well.

2. High top level authorities like AMCOW will need to look into transboundary issues. The time has now come to move towards conventions regarding transboundary issues related to groundwater exploitation. UNESCO is involved in the development aspects of the Congo basins.

3. There is a need to assess the success of the Nile River Basin Treaty, especially in order to evaluate the success of this treaty, so as to formulate conventions which will be more acceptable and beneficial to all concerned.

4. SADC has a protocol on shared water basins, and this could be considered in transboundary issues.

5. Africa is fast developing and also has a high population growth rate. Not much consideration is being given to pollution problems currently and this will need to be reviewed.

6. Managing pollution is also a transboundary issue and it will be up to all regional countries to address the issue at both local and regional level.

(2) The Trans African Hydro Meteorological observatory (TAHMO)
By Nick Van De Giesen, Rolt Hut, John Selker, Marc Andreini

Prof. Nick Van De Giesen

Understanding of current climate change and the trends moving forward are essential to managing food production, disease, and land management.

This is true globally, but is furthest from being realized over the African continent, where the opportunity for improved management is vast. The status quo is unacceptable, but how the provision of this data can be made is an open question. Key obstacles include; measurement hardware poorly suited to African environmental challenges, high cost equipment, lack of technical staff and infrastructure to maintain stations; regulatory obstacles to collection and dissemination of environmental data.

Yet, the opportunities have never been greater, as afforded by broad access to cellular communication networks; radical decreases in sensor costs; and commitment to continent-scale issues in Africa.

The TAHMO project is dedicated to making research-grade raw and mapped climatic data freely available to students and the

public at large, in the African Continent. The design will be developed and tested in the African Context by an open consortium with present partners from Ghana, Ethiopia, Zambia, South Africa, India, USA and the Netherlands, to evaluate implementation with respect to social, technical, and governance issues. Data from 20,000 stations will be collected via cell networks available throughout rural Africa. Data from the network of stations will be assimilated with remote sensing to provide accurate and continuously updated maps of temperatures, precipitation, solar radiation, humidity and wind as are needed for prediction of crop yield, disease occurrence and propagation, and planning for future land use. The station's host will primarily be science educators. They will be compensated for their efforts according to the quality of data obtained, will be provided with diverse educational materials for science education that make use of their stations and the entire network.

Key Note Speech 2 – Discussion

1. This project has involved re-designing some of the climatic stations to create an appropriate network and this was complex and costly.

2. The equipment and associate systems will need to be robust for the successful evaluation of the project.

3. The World Meteorological Organization will be contacted for the success of the project at national level in a country.

4. There will be a need to involve existing hubs in order to promote the benefits that will arise from this project.

VII Conference Session

Session 1: Water Resources Availability

Session Chairs: **Denis JUIZO and Dr. Marcel RUTTEN**

Speakers:

Sunita FACKNATH *(University of Mauritius, Mauritius)*
Mohamed ABOUBAKAR *(University of Poitiers, Djibouti)*
Ousmane Coly DIOUF *(University Cheikh Anta Diop of Dakar, Senegal)*
Denyse SNELDER, *(Centre for International Cooperation, VU University Amsterdam, Netherlands)*
Graham JEWITT, *(University of KwaZulu-Natal, South Africa)*

The Ecosystem Approach to Water Management: A Sustainable Option in the Context of Climate Change

Sunita FACKNATH *(University of Mauritius, Mauritius)*

Natural and managed ecosystems provide food for all life on our planet, e.g. capture fisheries, forest products (natural systems), crop and animal agriculture, aquaculture, and agro forestry (managed systems). Sustainable development is not possible without healthy and functioning ecosystems. In fact, water is the blood life of ecosystem functioning and hence, water security is at the core of sustainable ecosystem management.

We need to change the way we presently manage water resources in order to ensure water for ecosystems and ecosystems for water. For any development, ecosystems must be reckoned as a water user as any other related activity that requires water. The two main concepts to managing water systems in a manner that does not undermine their ecosystems services are:

i. The integrated water resources management concept, which is a holistic approach to coordinated water development and management, which aims to maximize economic efficiency of water use, ensure access equity, and maintain environmental and ecological sustainability and

ii. The Environmental Flows concept, which refers to the quantity, quality and timing of water flows necessary to sustain ecosystem services, in particular, those related to downstream wetlands and aquatic habitats and the human livelihoods and well-being that depend on them. While being widely accepted, this concept is not very easy for many countries to implement.

Current global water use figures estimate that people are already using about 50 percent of accessible freshwater, and this may increase to 75 percent by 2015. Agriculture uses almost 70 percent water globally. Water equivalent for production of 1 head of cattle has been estimated to be 4000 per m3, fresh poultry 6m3 per kg, while that for cereals and pulses 1.5 and 1.0m3 per kg, respectively. Dietary changes in developing countries are increasing the demand for meat and dairy products (which are water-intensive foods), which is increasing agricultural water demand. An ecosystem approach focuses on the multifunctionality of the landscale, instead of focusing solely on production, and can improve system resilience and reduce vulnerability of food production to climate change.

Major ion hydrochemistry, environmental isotope data and multivariate statistical analysis as a tool to assessing groundwater dynamics in a fractured Dalha basalt aquifer, southwest of Djibouti, Republic of Djibouti

Mohamed ABOUBAKAR *(University of Poitiers, Department of Hydrogeology, UMR 6269)*
Jalludin MOHAMED *(CERD, PB 486, Republic of Djibouti)*
Moumtaz RAZACK, (University of Poitiers, Department of Hydrogeology, UMR 6269)

Groundwater resources in South-West area of Djibouti (Republic of Djibouti), particularly in fractured Dalha basalts aquifer, show a qualitative and quantitative deterioration developing in time. This is the joint result of both natural constraints (semi-arid climate with low amount of rainfall) and anthropic activities (pumping rates higher than the present recharge, largely increased for urban and domestic supply). Water samples have been collected in October 2010. The non-conservative chemical and physical parameters (temperature, pH, electric conductivity) have been measured in the field.

The other chemical analyses were done at the University of Poitiers (France). Major cations and silica were analysed by flame atomic absorption spectrometry using a double beam VARIAN AA240FS spectrometer. Major anions were determined by using ionic chromatography using an ICS-1000 DIONEX Chromatography, HCO3 was analysed by titration method. The accuracy of the analyses was estimated from the ionic balance error which is within 5 percent for the majority of samples. The 2H and 18O analyses, done at the Addis Ababa University, according to the classic protocol of Epstein and Mayeda are reported in conventional notation in δ per mil with regard to the international standard. Descriptive and multivariate analysis were performed using the STATISTICA data analysis software version 7 on twelve hydrochemical variables.

Unconfined Quaternary Sandy aquifer in Dakar region (Senegal): study of the recharge in relation to change in rainfall

By Ousmane Coly DIOUF, *(University Cheikh Anta, Diop of Dakar, Senegal)*

A study was carried out in the region of Dakar, Senegal, in order to estimate recharge rates using precipitation data. Rainfall is distributed very irregularly both in time and space in this region. From the geological standpoint, the region of Dakar belongs to the Senegalese-Mauritanian basin, the largest coastal basin of the northwest Africa. The quaternary sand aquifer located in Dakar region plays a major role in supplying drinking and irrigation water, especially for rural areas. The use of this aquifer began in the 50s with periods of higher and lower flow rates pumped. During the last two decades, the pumping was greatly reduced due to the pollution of the aquifer induced by the rapid urbanization in the region since the 70's. This high urbanization occurred without improvement of the drainage sanitation which results in a strong contribution to wastewater into the groundwater recharge.

Daily piezometric levels were collected using thalimedes in two piezometers in 2010. Water table fluctuation method was used to estimate the groundwater recharges. Daily rainfall was correlated with piezometric levels between 1970 and 2008. To determine the chlorine and humidity contents in the unsaturated zone, a sampling campaign was performed. The gravimetric method was used to determine the water content of the soil samples. A rainwater collection campaign was also performed during the winter 2008 in collaboration with the Senegal National Meteorological Agency (ANAMS). Water samples in the unsaturated zone and rainfall were analysed in chemistry laboratory. Chloride concentrations of rainwater and pore waters from the unsaturated zone were used for the application of the Chloride Mass Balance (CMB) method.

The chloride concentrations in rainwater were between 3.2mg/l and 53.4mg/l. Those from the unsaturated zone were in the range from 65.71mg/l to 735.66 mg/l. The recharge obtained by the CMB method ranged between 8 to 86mm per year across the study area. They are high in the urban area and relatively low in rural areas. The daily piezometric levels in the urban areas indicated that the recharge rates vary between 29 to 139mm/year. A hydrogeological modeling of the study area noted that the recharge rates varied from 1.7x10-4 to 1.5x10-4 m/day in the southeastern part of the aquifer. However in the urban areas, the recharge rte varied from 3.2 x 10-4 to 8.1 x10-4 m/day between 1969 to 2008. The increase in recharge in the urban area where there is a lack of sanitation drainage is due to the infiltration of domestic wastewater.

Water Harvesting Technologies Revisited: Potentials for Innovations, Improvements and Upscaling in Sub-Saharan Africa

By Denyse SNELDER, Douglas Gumbo, William Critchley & Sabina Di Prima *(Centre for International Cooperation, VU University Amsterdam, Netherlands).*

One of the major challenges for Africa is to address poverty and hunger by promoting agricultural growth in general, and specifically by increasing productivity per unit area. Recent water management assessments reveal that farmed areas solely dependent on rainfall offer significant potential for improving agricultural productivity and this is especially the case in Sub-Saharan Africa (SSA). An estimated 70-85% of the rainfall on SSA dry land farms is lost through non-productive evaporating, surface runoff and drainage. Innovative water harvesting technologies (WHTs) represent a key new intervention to strengthen productivity of rain fed agriculture. Traditionally, rainwater harvesting technologies have been used throughout SSA. Yet these need to evolve with the times, taking into account environmental, economic and demographic change.

The WOCAT Questionnaires on Approaches and Technologies were used, with slight modifications to allow for application to study past and present conditions of selected water harvesting technologies. Field visits were made to observe, measure and record changes in technologies and interview a selected group of farmers and local key experts, preferably those involved in past studies, to complete the WOCAT questionnaires. A standard graded contour primarily designed to safely divert runoff water was adopted at a wider scale after its introduction and enforcement by the Zimbabwe Natural Resources Act in 1941. The standard graded contour is a low cost technology, making use of manual labour. With time, this method was improved into what was known as the dead-level or zero-gradient contour channels that have been proved to be more effected in water harvesting and soil water storage, reducing crop failures due to dry spells. In addition, intercropping is commonly practiced in fields with dead level contours. The dead level contours are generally constructed in sandy, clayey and medium-textured soils of low fertility.

Up to 1988, the innovations and adjustments of the standard graded contours leading to dead level contour were farmer driven. In 1988, farmer innovators shared their knowledge in a meeting of the indigenous Soil and Water Conservation in Africa project. After that, the technology of dead level contour was spread, and the number of adopters increased. In the recent decade the implementation and maintenance of dead level contours have also suffered from the political tumult and economic crisis. About 40 percent of the farmers have been able to continue using and maintaining this technology without extended support.

Integrating Green and Blue Water Flows to Assess the Impact of Biofuel Feedstock Production on Water Resources

By Graham JEWITT, Michelle Warburton, Caren Jarmain, Richard Kunz & Subira Munishi *(University of KwaZulu-Natal, South Africa) & Paul Viola (Faculty of Agronomy, Eduado Mondlano University, Mozambique)*

Many parts of Africa are being targeted for biofuel production by international investors because of the availability of large areas of seemingly suitable land. However, in Africa, society is largely dependent upon that land for its survival, and plans for production of food, fibre, fodder now fuel both nationally and internationally mean that the land is subject to huge pressures. Utilising a variety of feedstocks, many African countries have already instigated and accepted foreign investment in biofuel projects, many on the scale of 1000's of hectares. Water resources planning and management already faces conflicts between environmental goals on the one hand and food and livelihood goals on the other. The production of biofuel feedstocks and other high biomass producing crops could exacerbate these.

The study proposed a framework for the assessment of potential land based impacts on water resources. The framework has two clear steps, the first of which is intended to identify whether a new land use, including biofuel feedstock production is likely to impact on water resources or not, and the second more comprehensive step to assess the extent of any impact identified and the trade-offs and management approaches to implement or reject these.

Summary of Participants Feedback from Session 1

1. To what extent development of water resources already take into consideration the ecosystem approach, to what extent is this approach a challenge in a country or a

must for a country, is key to sustainable development of water resources in a country.

2. The most appropriate technique for rainwater harvesting is currently being investigated by the ongoing research project whereby revisit study is being conducted in order to learn from the field study. And the final results will come out as a co-package.
3. Crop residues are being used for soil tillage purposes, but agro-forestry is an issue that needs to be further researched, though some difficulties have already been noted in this regard.
4. The results of the rainwater study need to be made available to a wider community of users through extension programmes, but meanwhile feedback have been received from the vital stakeholders.
5. Brown water has much potential in agriculture, since grey water is often not allowed to be used for irrigation of crops.
6. Hydrochemistry studies in fractured aquifers do indicate that impacts of land use on groundwater quality and can serve as a scientific basis for decision makers.
7. Estimates of groundwater recharge is best calculated using at least two different methods and this information can be used to guide towards groundwater protection.

Session 2: Sectoral Water Issues

Session Chairs: **Nelson MATSINHE & Gilbert OUMA**

Speakers:

Stella INYA-AGHA, *(University of Nigeria, Nigeria)*
John CAMERON, *(International Institute of Social Studies, Netherlands)*
Rasha Adam OMER, *(Kenyatta University, Kenya)*
Daan LOUW, *(University of Stellenbosch, South Africa)*
Meine Pieter van DIJK, *(UNESCO-IHE Institute for Water education, Netherlands)*

Dry season turbid Well-water made fit for use by Moringa oleifera seed extract in Enugu Metropolis, Nigeria

By Stella INYA-AGHA, *(University of Nigeria, Nigeria)*

Access to potable water is one of the major problems confronting developing countries and contributing significantly to the disease burdens and ill health. The unavailability of potable water to rural and urban dwellers in Nigeria in addition to pollution due to petrochemical especially in the coastal areas is a major issue of concern. Enugu is the capital city of Enugu State, south eastern Nigeria and is a modern town accessible by air, rail and road. The geological structure,

Dispersion of M. oleifera seed extract in turbid well- water

M. oleifera showing pods and seeds

made up of ancient hard rocks, of the area contributes essentially to poverty of water resources.

With the ultimate objective of contributing to the improvement of the quality control of drinking water, water for domestic use and to facilitate compliance to regulation, we report here, the main application of Moringa oleifera seed extract in the treatment of 25 natural underground well-water samples randomly collected from those three most populous cities in Enugu Metropolis. The assessed parameters were salinity, pH, conductivity total dissolved solids (TDS), total solids (TS), total suspended solids (TSS), turbidity and microbial load before and post-treatment with both alum (as a standard agent) and M. oleifera aqueous and ethoanolic extracts at equal concentrations of 60mg/l.

The results showed the ability of M. oleifera seed extract to remove organic matter (natural humic substances and micropollutants) thereby avoiding water degradation (mainly bad odours and taste, formation of disinfection by-products such as trihalomethanes), in addition to having a potent microbial activity which alum naturally lacked. The alum treated water samples showed increased salinity and pH in addition to other by-products, in agreement with the recent discovery of a number of snags concerning the use of alum salts, residual alum and other conventional coagulants in treated water. The study recommends more planting of this miracle plant, Moringa oleifera to ensure cheap availability, reproducibility and sustenance in water research across the world.

Defatted Carica papaya seeds: An efficient Adsorbent for the removal of Micropollutants from water and Waste water

By Emmanuel Iyayi UNUABONAH, *(Redeemer's University, Nigeria)*

Although water covers approximately 70% of the earth, less than 1% is available as freshwater for use by man. Many industrial processes release heavy metal ions as byproducts of these processes. For example the tanning, steel, and photographic industries releases Cr(III), the lead battery, paint production, and gold mining industries release Pb(II), Cd(III) released from corrosion of galvanized pipe and discharge from metal refineries as well lead battery production industry. Color in effluents can also cause problems in several other ways: dyes can have acute and/or chronic effects on exposed organisms depending on the exposure time and dye concentration; they can interfere with the growth of microorganisms and hinder photosynthesis in aquatic plants. Some dyes have been known to be carcinogenic.

A number of technologies are available with varying degree of success to clean water. Some includes coagulation, foam flotation, filtration, ion exchange, aerobic and anaerobic treatment, advanced oxidation processes, solvent extraction, adsorption, electrolysis, microbial reduction, and activated sludge. The most common adsorbent used in the removal of micropolluants from aqueous solution is the activate carbon, which is quite expensive in the developing world.
In this study, the micropollutant adsorption efficiency of the Carica papaya seeds have investigated. The pHpzc and specific surface area (SSA) of the seeds was found to be 6.25 and 143.27m2/g respectively. Fourier transformed analysis showed that the defatted seeds contain unsaturated ketone, ketone esters and lactones, quinines and carboxylic acid. Surface chemistry study showed that defatted seed sample is more acidic than basic with phenolic-OHcontributed more to the acidity of these ample than either carboxylic acid or lactones. Defatted Carica papay seed is recommended as good alternative for activated carbon in the removal of micropollutants from water and waste water solutions because it can easily be sourced, its preparation is cost effective and its use as an adsorbent demonstrates that it is highly efficient.

South Africa Field

Economic assessments of small-scale drinking water interventions in pursuit of MDG 10

By John CAMERON, *(International Institute of Social Studies, Netherlands)*

This framework is for assessing any safer drinking water intervention using an applied case study of a rural safer water intervention, in rural South Africa. The case study empirical material was collected using a wide range of techniques including direct observation of people's activities, engineering assessments of technical performance, laboratory pathogen counts, quantitative questionnaires on episodes of diarrhea, plus group, and individual semi-structured interviews to understand people's wider experiences associated with the drinking water intervention.

The results of the data collection were used in the form of measures of time made available for other activities, time sick when reported ill, costs for a sustainable water supply of good quality and increased schooling time and deaths prevention. All these changes due to the intervention were then given 'shadow prices' converting market prices into estimates of the 'true' social value of the changes in resource use oer time for wider South African economy. The paper suggests analysis of data could be conducted at three levels using a discounting approach to the value of time. A cost-efficiency level in which all feasible ways of achieving a goal of well specified goals in physical units, a cost-effectiveness level in which a safer water intervention's physical outcome in terms of time made available for other activities and a social cost-benefit analysis level in which point estimates are made of baseline values of flows of benefits and costs.

Cloning and Characterization of Annexin-like Genes for Use in Enhancement of Drought Stress Tolerance in Maize

By Rasha Adam OMER, *(Kenyatta University, Kenya)*

Maize (Zea mays L) has become localized staple food for the communities in Sudan. Maize is produced using traditional or mechanical methods in Sudan. Maize production is effected by abiotic and biotic factors. Biotic factors include weeds such as striga (Striga hemontica) and insects. Low yield is a major factor that affect maize crop leading to lack of adequate food and repeated spell of hunger leading to malnourishment and related diseases among the population. Alternative demand for maize for animal feed

and bio fuel has further alleviated maize demand as source of food due to the better price provided by industrial users. Maize yield is often inadequate due to abiotic stress such as drought, high temperature, or scarcity of nutrients. Drought is the main abiotic constraints of maize production.

Traditional plant breeding methods used to achieve drought tolerance are time consuming and many unwanted traits are transferred along with the desired ones. Besides they are limited to the exiting narrow gene pool within the maize genotypes. Organisms adjust to abiotic stressed through morphological, physiological and biochemical adaptations. The genes that confer tolerance to drought or diseases can be isolated, and cloned and introduced into important crops e.g. maize. Such transformed crops are able to perform well under water defect conditions.

In this study Annexin P35 gene was isolated and cloned into PNOV vectors, drought tolerance genes were engineered into Sudanese maize Germplasm, with specific focus on important inbred lines in the maize breeding program in Sudan. The drought tolerance genes were introduced to Sudanese maize using Agrobacterium temefaciens method.

Managing climate risk for agriculture and water resources development in South Africa: Quantifying the costs, benefits and risks associated with planning and management alternatives

By Daan LOUW, *(University of Stellenbosch, South Africa)*

The Western Cape is an extremely important region to the economic development of South Africa. Almost all of the high value land that is farmed in this region is under irrigation. The Western Cape is one of the few regions to demonstrate consistent projections of changes in climate under standard (SRES) Intergovernmental Panel on Climate Change (IPCC, 2007) forcing scenarios. These scenarios suggest a future reduction in available rainfall, which will exacerbate an already water-stressed region.

An integrated modeling framework to investigate the costs and benefits of various adaptation strategies towards climate change were developed. The integrated framework includes downscaled climate change data, hydrological data, bulk infrastructure simulation and agricultural and urban water demand modules that maximizes the economic value of the net returns to water from agricultural and urban water users on a monthly basis over a 20-year (or longer) time horizon. The output of the model consisted of:

- Benefits and costs of structural and non-structural water management options.
- Water values and water tariffs (prices).
- Reservoir inflows, storage, transfers, releases and evaporation.
- Water use by the urban and agricultural water use sectors.

In general the results show that where means of rainfall (and runoff) increase, the variability decreases. This implies that under wetter conditions, rainfall becomes less erratic. The divergence in runoff results between high and low scenarios for the distant future implies greater uncertainty which must be incorporated in planning decisions. In contrast, there is much greater variability regarding the changes expected for temperature and potential evaporation. The results also show why it is so important for an integrated multi-sectoral approach to the evaluation of adaptation strategies.

Climate Change and farmers responses in rural China, the role of incentives and governance structures, lessons for Africa

By Meine Pieter van DIJK, *(UNESCO-IHE Institute for Water education, Netherlands)*

How does China deal with the consequences of climate change and can we learn from that experience in Africa? Important external

drivers in China such as rapid economic growth, urbanization, climate change and a growing awareness of environmental degradation have contributed to a shift in governance structures. The developments have contributed to a shift in governance structures. These developments have created enabling environment for famers to take more initiatives. Furthermore, the involvement of NGOs and CBOs in China and new opportunities for initiatives for farmers at the local level is coming up. An analysis of the multi-level governance structures in place shows the role of local government and governance structures and helps to assess to what extent the implementation of policies and programs is happening at the provincial or the local level.

This research took place in the Lanchang River, where seasonal droughts have become more important recently. The Chinese situation can be described as a multi-level governance structure for drought management, the major consequence of climate change in China. At least seven levels can be distinguished between the national and the natural village level where farmers develop initiatives to deal with climate change. We observed a shift in governance structures, resulting in more opportunities for participation and local initiatives. Governance is shifting because of a different environment, economic incentives and urgent events such as climate change and a growing awareness that another approach is needed than the top-down and command and control approach.

We learned that external drivers result in shifting governance, which is also shifting because of more decentralization, involvement with NGOs and CBOs in China and new opportunities for initiatives by farmers and other entrepreneurs at the local level. The effectiveness of policies to cope with drought is limited by financial challenges, organizational challenges, participation challenges and market mechanism challenges.

Summary of Participants Feedback from Session 2

1. Moringa Oleifera has several health benefits and research is currently under way for prevention of pollution from petroleum products, and cost of water treatment is presently very high, and alternatives need to be given due consideration.
2. Research studies on Carica Papaya are ongoing in the field of wastewater treatment also, as one gram of the composite product can treat up to one litre of water and is therefore cost effective. Good results have been obtained with studies on metal ions and organics.
3. The qualitative parameters of the model have to be quantified through participatory approaches, and the model needs contextual data for more realistic results.
4. Climate models are associated with uncertainties, but the models are helping to improve the understanding of the systems and this consequently makes a huge difference in water management.
5. For a more effective participation, stakeholders have been convened in a working group on water resources in order to identify the pertinent issues in the water sector.

Session 3: Integrated Water Resources Management

Session Chairs: **Christopher OLUDHE & Berhanu ALEMAW**

Speakers:

Bhanooduth LALLJEE, (University of Mauritius, Mauritius)
Mxolisi SHONGWE, (South African Weather Service, South Africa)
Yaekob Mekuria ABAWARI, (University Rotterdam, Netherlands)
Dr Moctar DIAW, (University Cheikh Anta Diop (UCAD), Senegal)
Jordi GALLEGO-AYALA, (Water Research Institute of Mozambique, Mozambique)
Pieter R. van OEL, (University of Twente, Netherlands)

Water Security and Climate Change – Vulnerabilities and Adaptation Strategies for SIDS and Developing Countries

By Bhanooduth LALLJEE, (University of Mauritius, Mauritius)

Out of 1.4billion km3 of water of water on earth only 2.5% is suitable for human consumption. Water security is more important than food security, and water security is being affected by climate change, environmental pollution, unplanned development. Water demand has increased six fold in the past century. Three billion people live in areas where demand exceeds supply. The effects of climate change are already being felt. According to the IPCC, land classified as very dry as doubled since 1970. Climate change has caused unprecedented flooding in some areas and long spells of drought in others. The ongoing flooding in Bangkok presently is evidence of this phenomenon.

Small Island Developing States (SIDS) and other developing countries are more vulnerable to the effects of climate change and water security as they have small land areas, limited resources, limited institutional capacity, high dependence on external trade, and water demanding economic sectors (e.g. tourism and agriculture). Several SIDS are already feeling the effects of climate change on their water resources and water availability. The island of Mauritius is presently experiencing unprecedented drought and the major reservoirs are almost dry. Rainfall pattern has changed; there is insufficient rain falling on the catchment areas of the island's reservoirs, and regions hitherto considered as arid are beginning to see more rainfall. Mauritius has recorded a deficit of about 50mm annual rainfall over the last 50 years.

The paper presents the adaptation being adopted or envisaged in order to cope with the situation. This included Government policies, coping strategies by the tourism industry, by agriculturalists and by the general public, and include ground water extraction, water harvesting, waste water treatment and recycling, desalination, water storage, water transfer, soil water conservation, improved irrigation and farming practiceds.

Projected changes in mean and extreme precipitation in Africa under global warming: Implications for terrestrial water resources

By Mxolisi SHONGWE, *(South African Weather Service, South Africa),*

G. J. Van Oldenborgh (Royal Netherlands Meteorological Institute)**,**
B. J. J. M. Van Den Hurk, *(Institute of Marine and Atmospheric Research Utrecht, Netherlands)* and
M. K. Van Aalst, *(Red Cross/Red Crescent Climate Centre, The Hague, Netherlands)*

Changes in the mean and variance of a myriad of climate parameters are occurring in many parts of the globe. These changes have been attributed to enhance radioactive

forcing resulting from anthropogenic modifications of the chemical composition of the earth's atmosphere. Several studies have investigated probable changes in the mean precipitation over may parts of the globe. Over and above the changes in the man precipitation are changes in its variance. These have implications for changes in the frequency and intensity of extreme events such as droughts and foods. For this reason research efforts directed to the understanding extreme precipitation characteristics in the present and future climate are on the increase. In Africa, precipitation exhibits a pronounced spatial variability partly in response to the localized forcing features. Regionally specific studies, while warranted, are still few. This provided the motivation for the present study. Outputs from the AR4 models form the major input to the analysis of changes in precipitation patterns. From these models, the output of which has been made available as part of the World Climate Research Program (WCRP) Coupled Model intercomparison Project Phase 3 (CMIP3) datasets, a subset of 12 coupled general circulation model (CGCM) simulations, driven by the intermediate SRES A1B scenario, has been selected.

The peak over-threshold or generalized Pareto distribution (GPD) is adopted as the extreme value model in the study. Using Bayes theorem and making certain assumptions, it is possible to objectively assign weights to different climate models leading to a probability distribution of future climate change. These assumptions, related to model bias, model independence and the similarity of physical mechanisms determining the unforced and future climate.

Changes in mean precipitation during the long-rains (MAM) have generally the same sign but higher magnitudes than those simulated for the short-rains. The Bayesian weighted model simulations project more than 10 percent increase in mean precipitation rates over much of East Africa. The upper confidence limit exceeds 30 percent over a large area to the north. Implications of the climate change for water resources in Africa is assessed on the basis of a detailed atmospheric water budget analysis focusing on the pattern of precipitation minus evaporation, and its possible spatial and temporal variance. Over East Africa, evaporation increases will most likely offset the projected increases in surface water from precipitation.

Conflict and Cooperation in the Nile Basin: From Hydromet (1967) to the Nile Basin Initiative (2010)

By Yaekob Mekuria ABAWARI, *(University Rotterdam, Netherlands)*

The main focus of this research is the Nile Basin Initiative (NBI), an inter-governmental organization created in 1999 as an interim institution responsible for founding legal and institutional infrastructures. The NBI was thus expected to smooth the process of basin wide negotiation until such a time as the cooperative framework agreement (CFA) could be put in place. Studies show that the annual per capita water availability in Nile river basin countries is dropping significantly; the increasing scarcity of water is compounded by the exponential population growth projected for the next two decades. As it is stated, 'the demographic booms, development imperatives, climatic fluctuations and poor water management are among some of the factors that have cause water shortage'.

Several countries depend on the River Nile and projected water availability in the River Nile for year 2025 indicates significant drop offs. On top of that the river basin has been classified as an at risk basin areas. Wolf identified, as major causes of conflict in at risk basin areas, uncoordinated development projects, the absence of common law and institution, and general animosity among parties. By the same token, the River Nile has not basin-wide agreement and governing body, as other major international rivers do. In order to create the Nile River Commission,

various as yet unsuccessful attempts (Hydromet, UNDUGU, TECCON and NBI) have been undertaken by the Nile River riparian states. Lastly, the Nile riparian states, including Egypt, took an initiative to establish a permanent legal institution which would be responsible for Nile Water Programme. After a decade's negotiation, mediated by the World Ban, six riparian countries signed the CFA, while Egypt and Sudan refused to do so. The research paper tried to analyse the implication of signing the CFA.

In answering the above questions, the researchers employed a methodology that draws its theoretical tools from existing literature on conflict and cooperation. Database sources for this study include, but not limited to, Transboundary Freshwater Dispute (TFDD) of Oregon State University, Inventory of Conflict and Environment (ICE), World Bank and World Water War database. Findings were structured around a number of points pertaining to water war, conflict or cooperation, and conflict and cooperation. In relational to the theoretical underpinning of this research, it was found that neither 'water wars' nor 'conflict or cooperation' approaches could fully explain the present situation of the Nile River Basin. A key finding of this study, considering from realist and liberalist perspective, has shown that resorting to water war is unrealistic to the Nile riparian countries; and hence they would not go to water war. The study has shown that a 'conflict and cooperation coexist' can best address the situation in the Nile River Basin for the River Basin is a place in which both conflict and cooperation coexist.

Status of water resources in Senegal: Potential, issues and opportunities, policy and strategy

By Moctar DIAW, *(University Cheikh Anta Diop (UCAD), Senegal)*

Senegal, situated in the western part of Africa has a sahelian climate and is characterized by two seasons; a rainy season from June to October and a dry season. During the period 1921 to 1967, Senegal received, an average total, 162.3 billion m3 rainfall which decreased to 130 billion m3 during the period 1968-2009. The document review and stakeholders interviews were carried out to understand the status progress and problems of IWRM, towards improving water management, evaluating social and political circumstances in order to identify relevant stakeholders and anticipate difficulties in establishing an operational IWRM and appropriate measures. The State ensures the water resources administration by using several variants of organization modes. The state defines sector policy and develops the legal and regulatory framework. The water resources ministry is responsible of the preparation and policy implementation in water sectors.

Multicriteria Decision Analsysis of Integrated Water Resources Management for public management of water resources in Mozambique

By Jordi GALLEGO-AYALA, *(Water Research Institute of Mozambique, Mozambique)*

The development of water resources management for the member states of the Southern African Development Community (SADC) is a central element for setting, the regional economy in motion. In spite of the still limited water resources utilization in the region, SADC established a regional-framework for water resources development, management and use. The framework advocates for the adoption of Integrated Water Resources Management (IWRM) principles and tools by all SADC member states, as a common platform to achieve regional integration. The IWRM framework itself is still subject to debate.

In order to implement and adapt the IWRM at the local context it is important to apply methodologies that allow identifying the fundamental factors affecting the implementation of the IWRM framework at

country and river basin level. This paper aims to present two methodological approaches whose foundations are based in the Multi Criteria Decision Making (MCDM) theory for the support of policy decision-makers in the design and adaptation of the IWRM framework at the local level and in the implementation of the most suitable process to improve water governance at national and river basin level. The hybrid multi-criteria decision method A'WOT. This tool allows identify and establish a priority ranking of the fundamental factors affecting the implementation of the IWRM framework in Mozambique. For factors affecting IWRM implementation at river basin level, the AHP, an MCDM tool, was used in order to differentiate the relative importance of base indicators used to construct the index.

The results revealed the following ranking of group priority; opportunities (group weight 40.1%), weaknesses (25.2%), threats (17.4%) and strengths (17.2%). Comparing the results in each SWOT group, the results obtained for the opportunity group reveal that the factors weights in this category are ranked according to the priority. With regards to the weaknesses group, the top three key factors are: low human resource capacity building in water sector institutions, weak financial structure and inexistence of water resources management plans at river basin level. The threats group noted the brain drain in the water sector. The only factor within the group of strengths which received a weight above average priority is the existence of adequate institutional arrangement to gather data.

An integrated assessment approach for the governance of a socio-ecological system facing water scarcity: the case of the Lake Naivasha basin, Kenya

By Pieter R. van OEL, *(University of Twente, Netherlands)*

Many integrated water resources management (IWRM) tools enable an improved understanding of the consequences of human interventions at different levels and a better evaluation of water demand management alternatives. However, only few model applications take into account the effect of integrations between socio-economic processes and ecological systems, let alone doing this in a spatially-explicit way. Interdependencies may be very important, especially in case of strong variations in water availability and quantity in time and space. Consequently, for the sustainable governance of river basins natural and human subsystems need to be studied jointly and knowledge from different scientific disciplines should be assembled using an Integrated Assessment (IA) approach.

As an example the Lake Naivasha basin (Kenya) was studied. In this study, knowledge gaps were identified and conflicts of interest that result from trade-offs between sustainability indicators were described and discussed. The disciplines covered in this study were hydrology, limnology, ecology, socioeconomics, and governance. Finally a framework for IA was assembled around a proposed set of sustainability indicators for the Lake Naivasha Basin.

The study noted that for a high quality integrated assessment subsystems need to be studies in depth while considering the different interests that are addressed in a joint effort of scientist and stakeholders.

Summary of Participants Feedback from Session 3

1. Mulches reduce soil evaporation significantly, and sugar cane leaves are very effective as mulches.
2. Water pricing is not a technology, but it is a measure that can be used to promote effective use of water.
3. Expert's participation is key to identifying weight age that is important in the multi criteria decision making tools.
4. Power differences exist at the level of different stakeholders, but the approach stresses on the objective side of the study. In addition, the findings

of the project are made available to all, through online data information systems.

5. With regards to the drought resistant varieties of maize, the GMOs used in this type of study are acceptable unlike the case of those used in antibiotics. Informed local farmers are already testing this product.

Group discussion

VIII Working Groups

1. Water resources assessment

This group addressed water use issues, environmental issues, anthropogenic issues and socio-economic issues. The tools need to address these issues were environmental education, applied research studies on geographical information systems, remote sensing, integrated numerical models, isotopic studies, water re-use and recycling, water harvesting, underground storage, desalination, low cost water treatment and water accounting tools. The knowledge gaps identified were about capacity building, inadequate continuous training, lack of mainstreaming of environmental education, and the poor dissemination of research results. As recommendations to Policy Makers, the group noted the following:

- Support water research activities
- Inclusion of scientists in development and water policies
- Partner with national & regional academies
- Enforcement of policies
- Invest in human capacity building

2. Sectoral water issues

This working group addressed the following issues, overarching goal – meet the water demand MDGs, the nexus of a list of priorities the Water & Health, Food, Energy, Economics, Ecosystem and Governance. In order to address these issues, the group noted the need for the following, to investigate in Technologies – inland waters, to promote hydropower / solar energy rather, promote rain water harvesting, decentralized low cost water treatment plants the need to build smart solutions – using indigenous natural resources. In terms of knowledge gaps, it was noted that there is a need to tap into the huge database within the region – countries that have made significant progress in water treatment, to generate adequate information, the need for legal and institution aspects and to promote Awareness – private & public sectors As recommendations to Policy Makers, the working group noted the following:

- the need to address the identified knowledge gaps
- the need for more investments in R&D – Research institutions need to play a key role in addressing the knowledge gaps and
- the need for the research community working more closely with decision making.

3. Integrated water resources management

This working group discussed the following issues, Access to information, Quantity & quality, Environmental impacts, Sharing benefits of water ,Value of water, Low level of investments, Indigenous knowledge, Dominant structures – who does what? And what level for decision? What strategies? How to implement them, conflict v/s competition. In order to address the issues, the group noted the need for scientific knowledge – systems models, integrated decision making models, and the dissemination of information, data. The working group came up with the

following recommendations to Policy Makers

- Increasing access
- Reduce water consumption
- Pricing water
- Valuing water
- Better research support is needed.

IX Closing Session

Contribution from the Participants

The key points noted during the presentations have been grouped as presented below:

Variability of Rainfall

- Innovative rainwater harvesting systems – Disseminating the information so that farmers are aware to their benefits a priority for the success of the study.
- Droughts are likely to become more severe over the western parts of southern Africa where mean precipitation decreases exceed that of evaporation => less available terrestrial water & East Africa is projected to become wetter (climate modeling, Africa).
- The situation show a general decrease trend which mainly attributed by the Occurrence of sequences of severe drought during periods 70-90s, which is responsible marked character of climatic and hydrologic regimes. (Senegal).

Water Quality

- Basaltic aquifers exhibit wide spatial variation in geochemical characteristics & both the conventional methods (Piper diagram, scatter plots) and multivariate statistical analysis (HCA, PCA) are well-suited for analyzing geochemical data (Geochemical studies, Djibouti).

Water Quantity

- The increased of the recharge in the urban area where there is a lack of sanitation drainage is due to the infiltration of domestic wastewater (Hydrogeological modeling study, Dakar, Senegal).
- Effective low cost treatment of water (physico-chemical & microbiological) - investigated using Moringa seeds (Nigeria).
- Effective low cost treatment (removal of micro-pollutants) using carica papaya (Nigeria).

Sanitation

- Approximately seventy five percent of people in urban areas have access to drinking water and only fifty seven percent of them to a sanitation system (Africa).
- Sixty four percent of households have access to drinking water and 17% to sanitation in rural areas (Senegal).

Water & Food Security

- In addition to mulching, minimum tillage, increasing OM and mixed cropping, other sustainable agricultural technologies, used in combination with each other, is the way forward for small holder African farmers for increasing water use efficiency (Mauritius, UoM).
- The mulching experiment in Rodrigues showed that banana mulch was the most effective and in Mauritius showed that the sugarcane mulch was the most effective & community participation only ensures adoption of technology by farmers (Mauritius, UoM).
- Development of drought tolerant maize to farmers in the ECA region to enable them to cope with drought (Kenyatta University).

Transboundary

- Negotiation is the only way to settle the Nile river disputes (Nile).
- Disputed Article should be constructed in accordance with International water law agreements, principles and conventions (1997) (Nile).
- Senegal must to enhance Water Cooperation and Partnerships between countries sharing common water basins (Organization for the Development of the Senegal River and Organization for the Development of the Gambia River) (Senegal).

The Integrated Approach this can be arranged

- Use of the MCDA, for the monitoring of the implementation of the IWRM

stimulates the good performance of RBOs in implementing the IWRM (Mozambique).
- The need to adopt the Ecosystem approach in Water Management (Mauritius-UoM).
- Promoting innovative rainwater harvesting systems – a sound approach towards addressing food security (Zimbabwe).
- Appropriate legislation should ensure - Biofuels development should not be at the expense of people's essential rights (including access to sufficient food and water, health rights, work rights and land entitlements) (South Africa).
- Socio costs benefit analysis approach for assessing the impact of small scale drinking project.
- Hydro-meteorological observatory has the advantage of being cheap and affordable (Keynote 2)
- Existing data collections at times cheap but not robust (Keynote 2).
- National working group on Water – find solutions for water issues locally (Mauritius, MRC)
- Climate change adaptation policies not effective unless adequate institutional framework & community involvement (China)
- The water sector in Senegal is at a critical stage, hence the urgent need to promote a new approach on the means and ways to manage the water resources and develop appropriate institutional, legal and financial mechanisms to ensure that water policy and its implementation are a catalyst for sustainable social progress and economic growth (Senegal).
- Agent Based Models involving local processes that lead to emergent patterns at a global level and autonomous (interacting) agents can provide an integrated approach towards water management (Naivasha basin, Kenya).

Points noted during general discussion sessions

- Most treaties on River Basins tend to favor some countries – Conflict issues are prevailing.
- Countries will have to address water pollution at transboundary levels.
- Translating the Ecosystem approach into actions will be challenging.
- Fracture density studies to be carried out together with the hydrochemical studies on basaltic aquifer for improved analysis.
- Hydrogeological modeling studies are data intensive and this influences the accuracy of the model.
- Water pricing mechanisms an economic instrument but which can be used to optimize use of water.
- Cooperation is the way forward in transboundary issues.
- Integrated models can only be reliable when there is participatory approach to assign weight age to governing factors within a basin.
- Genes used to produce drought resistant maize acceptable for research (unlike those used for studies on antibiotics).
- Transition from farmland to forest land: - Forest land use less water than other crops e.g. tea. Frees labour for industry (20 million annually migrate to urban).
- Promoting sustainable development in Mauritius: The Maurice Ile Durable Project has been launched already in terms sustainable development (i.e. solar panels for electricity/power generation, wind power).

X Findings / Outcomes of the Conference

The deliberations of the work of the three thematic working groups (Water Resource Availability, Sectoral water Issues, and Integrated Water Resources Management) highlighted recommendations based on the main challenges facing the African continent, namely:

- Providing safe drinking water.
- Ensure access to adequate sanitation.
- Provide water for food security.
- Prevent land degradation and water pollution.
- Meeting growing water demand.
- Manage water under global climate change.
- Develop hydropower to enhance energy security.
- Foster cooperation in transboundary water basins, and
- Enhance capacity to address water challenges.
- Water conflict and resolutions

1. Providing safe drinking water.

Background

Africa has the lowest percentage of safe drinking water in the world. Africa's annual per capita water availability is lower than other regions of the world.

Recommendations

- Improve safe drinking water supply from ground water sources.
- Promote low cost water treatment facilities.
- Promote rainwater harvesting technologies (e.g. rooftop).
- To consider closing the water cycle (the Singapore model)
- Promote water treatment and clean water supply
-

2. Ensure access to adequate sanitation.

Background

- Only 57 percent of Africa's Urban population have access to safe sanitation system and the percentage is much lower for rural inhabitants

Recommendations

- Sanitation should be treated as a priority issue at policy level.
- Promote and provide low cost sanitation solutions (absorption pits, ecosan).
- Create awareness of the impact of poor sanitation on water quality and the associated human health hazards.

3. Provide water for food security.

Background

Water is essential for life as well as for promoting agricultural production and sound post harvest technologies. This includes increase in productivity per unit area with more efficient water use (more crops per drop). In addition we need to have sound strategies to help strike the right balance between agriculture for food and agriculture for biofuel.

Recommendations

- Policy makers should implement measures to address food security issues and in particular availability of water should be considered as top priority.
- Promote best agricultural practices that encourage the efficient use of rainfall, mulching and water efficient irrigation techniques
- Promote use of treated wastewater for crop production.

4. Prevent land degradation and water pollution.

Background

- Sustainable development of land and water resources is not possible without judicious land use practices and sound water protection and conservation measures.

Recommendations

- Policy makers should promote use of planning tools (environmental impact assessment and environmental management systems) in land use and water management.
- Raise awareness of the importance

of forests to avoid deforestation and encourage agro forestry and afforestation of non-alien species.
- Promote efficient and judicious use of fertilisers and pesticides in agriculture.
- Adapt measures to minimise soil erosion and flooding.

5. Meeting growing water demand.

Background
- Increased water demand is becoming a crucial issue in all African countries. This is compounded by other factors such as increase in population and impacts of climate change.

Recommendations
- Policy makers should take strong steps to:
  1. Upgrade water storage capacity at national level.
  2. Develop the potential of groundwater in a sustainable manner.
  3. Promote alternative water sources such as desalinated water and treated wastewater.
  4. Promote water conservation and demand management strategies.

6. Manage water in the context of global climate change.

Background
- Climate change adaptation measures are a priority for Africa since this is the region that is predicted to be worst affected by climate change. An important component of an effective response strategy is to develop more inclusive water governance models in particular focused on community participation.

Recommendations
- Climate change adaptation strategies need to be incorporated in development plans and programmes.
- Develop and adopt measures to address negative impacts of climate change in agriculture and the water sector.

7. Provide hydropower to enhance energy security.

Background
- Many African nations have a per capita electricity consumption of less than 80 kWh/yr which is less than one percent of that in OECD countries. Africa has high potential to develop hydropower.

Recommendations
- All countries should promote the development of a robust and sustainable mix of energy sources including hydropower.

8. Foster cooperation in transboundary water basins, and

Background
- Africa's borders pose a challenge to equitable sharing and developing water resources. Africa's 63 international transboundary river basins cover approximately 64 percent of the continent land area and contain 93 percent of its total surface water resources. The SADC protocol on shared water courses provides a good example of regional cooperation on water.

Recommendations
- Promote cooperation among agencies and stakeholders to find solutions for transboundary issues at regional level.
- Concerned countries should initiate discussions/dialogues with respect to water availability.
- New policies and strategies should be developed from lessons learnt from existing international River Treaties and initiatives.

9. Enhance capacity to address water challenges.

Background

- It is now well established that water security is affected by climate change, environmental pollution, and unplanned development. Water demand has increased six fold in the past century. Small island developing states (SIDS) and many other countries in Africa are more vulnerable to the effects of climate change with regard to water security.

Recommendations

- Provide an appropriate institutional framework to ensure effective water resource development and sound management.
- Devise short and long term action plans to ensure water security for all relevant economic sectors.
- Countries should enhance proper infrastructure including human resources development and funding mechanisms for water access and affordability.
- managing water related data (spatial and non spatial) better and make it available
- role of better GIS capacity in Africa as a key, to this data management is crucial for Africa not to lag behind

XI Policy Dialogue

What are the critical Water issues according to Policy makers

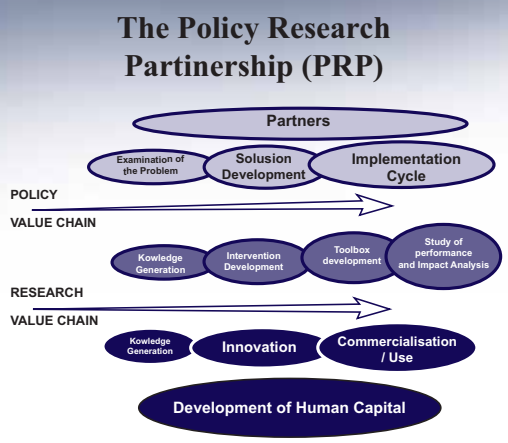
Summary by Dr. Takalani Rambau

One of the objectives of the conference was to explore how scientists and policy makers could work together in ensuring that national policies on water management issues are informed by scientific-based data. The session was conceptualised through collaboration between NASAC and German National Academy of Sciences-Leopoldina. The Leopoldina Academy sponsored African science academies representatives to attend and make presentation during the Science – Policy Dialogue.

The session was dedicated to discussing ways in which policy makers and scientists can work together in addressing water challenges experienced within the continent. A representative from African Ministerial Council on Water (AMCOW) was invited as a representative of an institution that has an overarching decision making as it includes Ministers of Water of all African Countries. The policy makers were invited through science academies which meant that only countries that have national academies were represented in the conference. The policy makers participated in three panels divided by regions (Eastern, Southern and Western Africa). The eastern region was represented by Ethiopia, Kenya, Tanzania and Uganda, the southern region was represented by Mauritius, South Africa, Zambia and Zimbabwe while the western region was represented by Nigeria, Senegal, Ghana and Cameroon.

The first presentation by the AMCOW programme coordinator, Dr Salisu Abdulmumin, who shared with the audience how AMCOW is structured for scientists to determine their point of entry when engaging the council. He mentioned that policy making is driven by the goals to provide sustainable access to safe and adequate water supply and sanitation. An important aspect to consider is that water is linked to food and energy security and to poverty alleviation which makes it at the centre of global and regional priorities. The policy making should consider political visions such as Millennium Development Goals (MDG), Africa Water Vision 2025, Sharam-el –Sheik and Ethekweni Declarations. Different organisations have outlined challenges experienced within the regions which the Ministers of Water are well familiar with, their critical challenges are developing effective and reliable strategies for coping those challenges such as climate variability and change, growing water scarcity and the disappearance of water bodies. Other challenges already at the attention of African Ministerial Council on Water include reforming and establishment of water management institutions, financing water research, infrastructure and human capacity. The structure of AMCOW presents an opportunity for scientists to engage policy makers in the General Assembly, Technical Advisory Committee and the Secretariat. There are also regional programme officers who could assist in tackling regional water issues and escalate them within the secretariat to programme coordination or Executive Secretary of AMCOW for action.

The second presentation by Mr. Design Naidoo from South Africa focused on modalities for an interface between policy makers and scientists. He pointed out that there is a knowledge chasm characterised by the outputs of scientists not reaching the intended users (society and economy) (Insert a picture of knowledge chasm). Based on his experience as a government official responsible for drafting policies and working with researchers at universities, Mr Naidoo discovered that the government needs data in a specific way for them to use for policy making while researchers have a particular way in which they package their data making it inaccessible to policy makers. Other imperatives also influence the way policy makers view data produced by researchers and South Africa was used as an example. After 1994, the country experienced many post apartheid challenges such as wanting



to supply water to all citizens but the infrastructure and capacity did not meet the demands. The government wanted data that can inform policies for redressing inequalities and unsustainable initiatives but the research fraternities were not ready to provide such data because the country has just made a drastic change. What preoccupied policy makers was to engage in national water dialogue to realise constitutional imperatives and to introduce policies that could drive research behavioral change as well as alignment of water institutions to the government mandate and agenda. During this period there was no institution that can provide authoritative evidence-based advice apart from individual researchers who focused on their specific area of concern. This serves as an indication of disjuncture between policy makers and researchers. The disjuncture could be addressed by adopting a Policy Research partnership (PRP) which will enable both the policy makers and researchers to collaborate from situation analysis, intervention development to performance assessment and impact analysis.

Panel Discussion 1

Science - Policy Dialogue on Water Management Issues in the Eastern Africa

Science-policy dialogue on water management issues in Kenya is not formalized although there is a Ministry of Water and Irrigation (MWI) responsible for policy making, there is no formal process in place to provide evidence-based policy advice apart from individual researchers who serves as consultants to the Ministry. Kenya National Academy of Sciences (KNAS) has the potential to provide evidence-based policy advice given its convening power to the Ministry, Water Resources Management Authority and Water Services and Regulatory Boards. The critical challenge for Kenya is that 33% of inhabitants lack access to safe water and 50% of disease burden and hospital visits is due to poor water supply and sanitation. Trans-boundry water basin is an issue in Kenya as it shares water bodies with Tanzania, Ethiopia and Uganda.

In Tanzania, the ministry of Water is responsible for policy making and has enacted a number of policies to manage water issues. There is no formalised science-policy dialogue on water management issues but there is an academy of science which could convene water experts and provide scientific-based policy advice to the Ministry and National Water Boards. The critical water challenges experienced in Tanzania include acute water shortage and water conflicts in some part of the country. It shares water bodies with Kenya, Uganda, Burundi, Malawi, Democratic Republic of Congo, Zambia and Mozambique. Tanzania relies on water basins, rainfall water and ground water (borehole) and these sources are affected by spatial and seasonal variables.

The Ministry of Water and Environment in Uganda is responsible for policy making on water management issues. The Uganda National Academy of Science is active in evidence-based policy advice. The academy introduced a pairing scheme for scientists and parliamentarian which is essential for harnessing science-policy dialogue on water issues. Both the science academy and the ministry should encourage this scheme for pairing a water expert and the parliamentarian responsible for water management issues. Uganda is well endowed with water resources even though it is challenged by seasonal and spatial variability. Rapid population growth, urbanization, increased agricultural and

industrial activities result in depletion and degradation of water resources as well as environmental carelessness result in forests to be cut down, soils are eroded, wetlands are drained, channels and reservoirs are silted and water bodies polluted. Uganda shares its water bodies with Tanzania, Kenya, Burundi and most importantly the Nile river connect them with Ethiopia, Sudan and Egypt which is potential source of water conflict.

In Ethiopia, the Ministry of Water and Energy is responsible for policy making. A science academy has been recently established which presents a potential for scientists and policy makers to work together. They share water bodies with Egypt, Kenya, Somalia, Erithria and Sudan. The country relies on river basins and ground water which makes hydropower development and trans-boundary conflicts their critical challenges on water management issues. Droughts, irrigations, water supply and sanitation as well as water pricing.

Desktop studies are being conducted in the Eastern and Northern African regions with Kenya National Academy of Science taking a lead. The study is sponsored by Leopoldina and NASAC and a report is expected before the end of 2012 and it will be integrated with the existing studies.

Panel Discussion 2:

Science – Policy Dialogue on Water Management Issues in the West and Central Africa Region

High and rapid population growth in Nigeria presents the National Ministry of Water and Resources and Federal Ministry of Water and Resources with serious challenges. The National Council on Water Resources and the Federal Ministry of Water and resources are responsible for policy and strategy development. Nigeria Water Resource Management Commission is responsible for basin strategy, waste discharge and regulation of water abstraction. The Nigeria Hydrological Services Agency is accountable for water assessment, data and information management while the National Water Resources Institute is responsible for manpower development, capacity building and research and development. The Nigerian Academy of Sciences is active and could serve as a body that connects scientists and policy makers on water management issues. Amongst the water challenges are hydrological such as spatial and temporal variability, climate change, prolonged droughts and desertification. The country also experienced socio-economic challenges such as increasing urbanisation, increasing poverty and inefficient irrigation practices. Environmental challenges in Nigeria includes degraded water courses, water pollution and infestation of aquatic destructive weeds, excessive and uncontrolled exploitation of groundwater and poor environmental sanitation and hygiene practices. The trans-boundary challenges include interstate river basins, downstream of international shared water and weak regional efforts to resolve conflicts.

In Ghana, the Ministry of Water Resources, Works and Housing is responsible for policy making and general management of water resources. The Ghana Academy of Arts, Science and Technology is responsible for mobilising scientists to contribute to scientific-based policy advice. The Ghana water policy is driven by water supply and access, water for food security and other non-consumptive use. The country also relies on ground water, rainfall water and river basins.

The Ministry of Water and Energy in Cameroon is responsible for water management and policy making. The Cameroon Academy of Sciences also has potential to mobilise water experts to contribute to policy development and review. The water sources for Cameroon consist of groundwater, rainfall and river basins. Four of the five hydrological basins in Cameroon are trans-boundary which makes water conflicts with countries sharing water basins a challenge. Water pollution and climate variability also poses a challenge for the country.

A presentation on the State of Water Resources in West Africa was made by Professor Cheikh Gaye representing Senegal Academy of Science. The report on the State of Water Resources in West Africa highlighted opportunities and challenges experienced by countries with regard to water management issues within the West Africa region. The report highlighted numerous challenges experienced in the region such as low water related education, low water quality in relations to surface water resources, ground water resources, climate change threats such as flood and droughts, trans-boundary water management issues, inadequate data and poor instrumentation, inadequate supply of qualified human capital and weak research base as well as low investment in the water sectors. The desktop study also identified opportunities such as adequate water availability in West Africa, available training institutions, stable political environment and awareness on the water plays in the socioeconomic development of a country. Other opportunities include cooperation on water resources management at the sub-regional level and government support for Integrated Water Management and Resources. A full integrated report will be published toward the end of 2012.

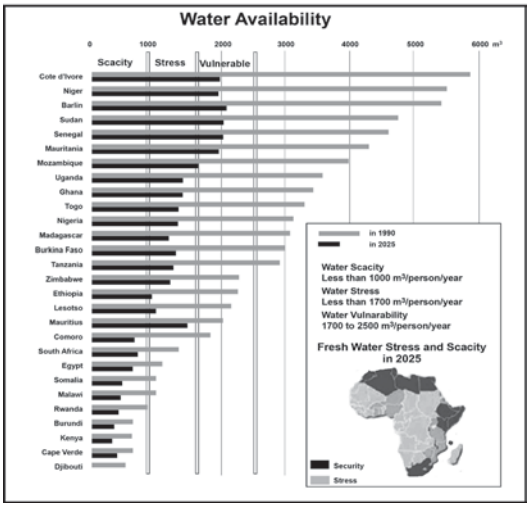
Panel Discussion 3:

Science - Policy Dialogue on Water Management Issues in the southern Africa Region

In Mauritius, the Ministry of Water and Resources is responsible for policy making and water resource management. The country relies on rainfall water, surface water and ground-water. It is free from continental influences because it is an island and does not experience water conflicts. Sugar plantations are the greatest consumers of water through irrigations. The country experience challenges such as high variation in rainfall temporally and spatially, water shortage in dry months, rapid runoff because of topography, saline intrusion in the ground water, high conveyance and distribution losses in water supply system and private water rights. The 2012 water conference played a crucial role in introducing the Mauritius Academy of Science and Technology to policy makers and the relationship will ensure that the dialogue ensues.

The Zimbabwe Ministry of Water Resources Development and Management is responsible for policy making on water management issues. All water is vested in the President and private ownership is not allowed. The Zimbabwe Academy of Sciences through its water experts serves as an advisor to the Ministry of Water Resources Development. The academy is devising a plan to collaborate with the government ministries which include water. Although legislations have been introduced, the government struggles to enforce compliance due to resource constraints. Amongst other challenges, the country shares its water bodies with South Africa, Botswana, Zambia, Mozambique and Swaziland which emanates to trans-boundary water issues. The water sources include ground water, rainfall and water basin. Due to recent socio-economic and political situation in Zimbabwe, the country experienced loss of trained human resources to the neighboring countries, decline in agricultural activities resulting to reduced water income, declining institutional infrastructure and other resources and inadequate information on ground water resources exasperated water challenges.

Projected Population growth and water stress in Africa, 1990 - 2025



In Zambia, the Ministry of Energy and Water Development through the Department of Water Affairs is responsible for policy making on water management issues. The country relies heavily on ground and surface water as their key focus areas. The Zambia Academy of Sciences is at its infancy stage but has potential to coordinate collaboration between policy makers and scientists. The country faces challenges of enforcing compliance to the legislations, dilapidated infrastructure, no recognition for sanitation and water pricing. The country shares borders with Zimbabwe, Malawi, Tanzania, Botswana, Angola, Democratic Republic of Congo and Mozambique. This in itself presents trans-boundary water challenges.

The Department of Water Affairs in South Africa is responsible for policy making supported by number of institutions. The Water Research Commission is positioned to identify research priorities emanating from policy reviews and water management needs. The water policy advisory space in South Africa is should also consider the existence of the Academy of Science of South Africa, National Advisory Council on Innovation and the Department of Science and Technology. The Academy of Science of South Africa has a standing committee on Water responsible for reviewing the status of water in the country and advising on the future needs. Urbanisation and population growth in the country exasperated by migration from neighboring countries creates serious challenges in terms of water supply. Other challenges include acid mine drainage, extension of water services and funding for infrastructural development. South Africa shares water basins with its neighbors, Lesotho, Namibia, Botswana, Swaziland, Zimbabwe and Mozambique which require a high level facilitation to avoid water conflicts.

The Academy of Science of South Africa (ASSAf) conducted a study on the State of Water in the Southern Africa on behalf of the NASAC and Professor Rivka Kfir made a presentation of the findings. The report revealed that that the sub region is experience challenges such as climate variability, trand-boundary river basins, underdeveloped water resources infrastructure, water supply and sanitation need improvement, ground water potential and sustainable abstraction need improvement, there is need for access to reliable data, human resource capacity building in management and technical fields, appropriate financial recourses and financial mechanisms, maintenance and further development of infrastructure, the need for further research to understand adaptation and mitigation of climate change potential impact and mechanisms to understand the link between water and food security. The report has also identified a number of opportunites such as cooperation among the subregional countries, abundance of water resources and commitment from governments to address water resource management issues. A full report will be published together with other findings from East and Central regions, West Africa and North Africa region.

Conclusion

The discussions during the Science-Policy dialogue indicates that the challenges experienced by policy makers are similar to those that are facing researchers because all of them want to ensure equitable supply of water to all, improve water quality and sanitation, tap into all sources of water and avoid conflicts over water bodies. The figure below indicates shrinking water sources by 2025 which will enormously increase the

current challenges.
From the science-policy dialogue, it was emphasized that scientist should have a good understanding of the global, regional and national political vision for alignment with water research agendas and take into cognition that societal challenges such as water for food and energy security drive policy formulation. It is not only policy makers who should come to scientists, researchers themselves should find ways of letting the policy makers know that they are willing to work together. There are existing ways which other countries could adopt to encourage science-policy dialogue like the model used in Uganda where a scientists is paired with parliamentarian responsible for water management issues. The South African model as well could encourage science-policy dialogue where water scientists serve on a standing committee and meet regularly with officials of the department responsible for water policy making.

During the dialogue many challenges were identified but could be summarized in the following categories:

- Rain and ground water harvesting
- Trans-boundary water basin issues
- Water quality issues
- Financing of water sector
- Dilapidated infrastructure
- Inability to implement existing legislation
- Inadequate capacity to address water challenges
- Inadequate (sharing of) data
- Climate change and climate variability

For Africa to meet the Millennium Development Goals on access to safe water by 2015 and the 2020 Water Vision, policy makers and scientists should court each other and regularly meet to devise strategies for fast-tracking initiatives for addressing water challenges. Working together will help in averting water conflicts resulting from downstream – upstream confrontations and will ensure that trans-boundary issues are resolved amicably.

As it indicated during the discussions, science academies have an important role to play in ensuring that policies on water management issues should be informed by scientific evidence. Opportunities for addressing water management issues within the region include:

- Africa has an overarching continental policy making body supported by regional and sector specific regional bodies. The African Union (AU) as an overarching body is complimented by regional economic bodies such as SADC, ECOWAS etc and sector specific such as AMCOW, AMCOST, etc. These policy making institutions could play a critical role in ensuring that challenges affect sustainable water resources management are given attention and collaborate with scientists through science academies.
- The willingness from NASAC development partners to support initiatives on water resources management is an opportunity for sustainable development that needs to be exploited fully.
- The need for annual meetings between scientists and policy makers is an ideal chance for NASAC and its partners to embrace develop and address water management issues in Africa further.

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Prof. S. Bhoojedhur
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Dr. Y. Ramma
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Dr. M. D. Nowbuth – General Rapporteur

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RESSOURCES EN EAU | Rashid Beebeejaun :

« Remettre en question nos mauvaises habitudes »

Il est du devoir de tous les Mauriciens de ne pas gaspiller l'eau et de l'utiliser de manière judicieuse, affirme le Deputy Prime Minister et ministre des Services publics Rashid Beebeejaun. « ***Nous devons la gérer de manière responsable*** », a-t-il soutenu à la presse à l'issue de la cérémonie inaugurale, hier, de la conférence sur la gestion de l'eau en Afrique organisée par la Mauritius Academy of Science and Technology (MAST) au siège du MSIRI à Réduit.

« *Il nous faut remettre en question nos mauvaises habitudes concernant l'eau car ce n'est pas une ressource infinie, elle est précieuse et disponible en quantité limitée* », déclare M. Beebeejaun. Le gouvernement, dit-il, s'est embarqué dans un programme de réforme en profondeur du secteur de l'eau qui prendra son temps car il faut le faire scientifiquement. « *Nous nous sommes, jusqu'à présent, occupés de la* non-revenue water *en remplaçant les tuyaux dans certaines régions. Il nous faut faire davantage. Nous avons demandé à nos amis singapouriens de nous suggérer le plus vite possible ce que nous devons faire pour la région de Mare-aux-Vacoas* ». Pour lui, la population doit réaliser que si on a beaucoup parlé de Mare-aux-Vacoas, trois autres réservoirs, La Ferme, Mare-Longue et Piton-du-Milieu, sont également déficitaires en eau. Ce qui signifie que ces régions également sont en manque de pluies. « *Avec les dernières pluies, nous arrivons à environ deux tiers de la normale pour le mois de mars, on reste donc loin de 100 %. Les dernières pluies vont aussi faire remonter le niveau des nappes souterraines* ».

Interrogé sur l'utilisation des eaux usées pour la production d'eau potable et la réticence de certains agriculteurs à y avoir recours pour la production vivrière, M. Beebeejaun répond : « *De temps à autre, il y a des problèmes techniques ainsi que des difficultés d'identification des sources de certaines pollutions après que cette eau est mélangée avec celle du réservoir. Au lieu de mettre cette eau traitée dans les nappes souterraines, ce que l'on fait actuellement dans le Nord, nous demandons aux agriculteurs d'accepter de l'utiliser pour l'irrigation des plantes. Nous les rassurerons sur la qualité de cette eau.* »

S'agissant du comportement de certaines personnes, surtout dans le nord de l'île, qui déverseraient les eaux usées en provenance de leurs toilettes dans les puits, le Deputy Prime Minister a dit ne pas être au courant de la chose. « *Maintenant que vous me l'avez dit, je vais voir. C'est inacceptable car ces eaux usées détruiront nos nappes souterraines* ».

Répondant à une autre question de la presse, M. Beebeejaun a mis en garde les camionneurs qui sillonnent l'île à la recherche d'eau qu'ils vendent aux particuliers et à des hôtels en la faisant passer pour l'eau de la Central Water Authority (CWA). « *Il n'y a aucune garantie en ce qui concerne la qualité de l'eau qu'ils vendent* », souligne-t-il.

NASSEEM ACKBARALLY

Le Deputy Prime Minister et ministre des Services publics Rashid Beebeejaun s'entretenant avec des délégués étrangers à la conférence de la Mauritius Academy of Science and Technology

SCIENTIFIC CONFERENCE OFTHE NASAC-KNAW COLLABORATION INITIATIVE ON

"WATER MANAGEMENT ISSUES IN AFRICA"

28 – 31 March 2012, Boname Hall, MSIRI, Reduit, Mauritius

OBJECTIVE

To exchange ideas and experiences on water management issues in Africa, amongst researchers, policy makers, Governmental Organizations, Non-Governmental Organization, the private sector and other stakeholders.

PROGRAMME

Day 1: Wednesday, 28 March 2012

08:30 - 09:30	**Registration**	**Secretariat Staff**

LEAD CONFERENCE RAPPORTEURS:
Dr. Manta Nowbuth, Associate Professor at the Univ. of Mauritius &
Dr. Vikram Bissonauth, Mauritius Research Council

Opening Ceremony		
09:30 – 10:45	**Welcome addresses:** 1. Mauritius Academy of Science and technology (MAST **Prof. Soodursun Jugessur (President)** 2. Royal Netherlands Academy of Arts and Sciences (KNAW) **Dr. Jeroen Frietman (Policy Officer)** 3. German Academy of Sciences Leopoldina **Prof. Peter Fritz (Member)** 4. Network of African Science Academies (NASAC) **Prof. Oyewusi Ibidapo-Obe (Vice-President)** 5. Conference Overview by Organizing Committee Chair **Dr. Yousuf Maudarbocus (OC Chair)** **Opening Address:** 6. Government of Mauritius **Hon. Dr. Rashid Beebeejaun** (Deputy Prime Minister and Minister of Public Utilities)	Facilitator: **Dr. Michael Atchia** Rapporteur: **Dr. Yashwant Ramma**
10:45 – 11:15	**Refreshment break and Group photo**	

Session 1

WATER RESOURCE AVAILABILITY

11:15 – 11:45	**KEYNOTE 1:** Water resources availability and Sectorial issues in Africa	**Salif DIOP** (UNEP,Nairobi, Kenya)	Facilitator: **Dinis Juizo** Rapporteurs: **Eva Tabuaa Gyamfi** and **Maxwell Anim-Gyampo**
11:45 -11:55	**Plenary Discussion on Keynote presentation**		
11.55 – 12:15	The Ecosystem Approach to Water Management: A Sustainable Option in the Context of Climate Change	Sunita FACKNATH (University of Mauritius, Mauritius)	
12:15 – 12:35	Major ion hydrochemistry, environmental isotope data and multivariate statistical analysis as a tool to assessing groundwater dynamics in a fractured Dalha basalt aquifer, southwest of Djibouti, Republic of Djibouti	**Mohamed ABOUBAKAR** (University of Poitiers, Djibouti)	
12:35 – 12:55	Unconfined Quaternary Sandy aquifer in Dakar region (Senegal): study of the recharge in relation to change in rainfall	**Ousmane Coly DIOUF** University Cheikh Anta (Diop of Dakar, Senegal)	
12:55 – 13:10	**Plenary Discussions**		
13:10 - 14:00	**Lunch Break**		
14:00 – 14:20	Water Harvesting Technologies Revisited: Potentials for Innovations, Improvements and Upscaling in Sub-Saharan Africa	**Denyse SNELDER** (Centre for International Cooperation, VU University Amsterdam, Netherlands)	Facilitator: **DR. MARCEL RUTTEN** Rapporteurs: **Mercy Aku Anagbogu** and **Birhanu Zemadim Birhanu**
14:20 – 14:40	Integrating Green and Blue Water Flows to Assess the Impact of Biofuel Feedstock Production on Water Resources	**Graham JEWITT** (University of KwaZulu-Natal, South Africa)	
14:40 – 15:00	Plenary Discussions		

Session 2

SECTORAL WATER ISSUES

15:00 – 15:20	Dry season turbid Well-water made fit for use by Moringa oleifera seed extract in Enugu Metropolis, Nigeria	**Stella INYA-AGHA** (University of Nigeria, Nigeria)	Facilitator: **Nelson Matsinhe** Rapporteurs: **Moses Mwangi** and **Monika Ambrus**
15:20 – 15:40	Defatted Carica papaya seeds: An efficient Adsorbent for the removal of Micropollutants from water and Waste water	**Emmanuel Iyayi UNUABONAH** (Redeemer's University, Nigeria)	
15:40 – 16:00	Economic assessments of small-scale drinking water interventions in pursuit of MDG 10	**John CAMERON** (International Institute of Social Studies, Netherlands)	
16:00-16:20	**Plenary Discussions**		
16:20 – 16:40	**Refreshment Break**		
16:40 – 17:00	Cloning and Characterization of Annexin-like Genes for Use in Enhancement of Drought Stress Tolerance in Maize	**Rasha Adam OMER** (Kenyatta University, Kenya)	Facilitator: **Gilbert Ouma** Rapporteurs: **Masengo Ilunga** and **John Ejiet Wasige**
17:00 – 17:20	Managing climate risk for agriculture and water resources development in South Africa: Quantifying the costs, benefits and risks associated with planning and management alternatives	**Daan LOUW** (University of Stellenbosch, South Africa)	
17:20 – 17:40	Climate Change and farmers responses in rural China, the role of incentives and governance structures, lessons for Africa	**Meine Pieter van DIJK** (UNESCO-IHE Institute for Water education, Netherlands)	
17:40 – 18:00	**Plenary Discussions**		
19:00-21:00	**Welcome Dinner**		

Day 2:

Thursday, 29 March 2012

Session 3

INTEGRATED WATER RESOURCES MANAGEMENT

09:00 – 09:30	KEYNOTE 2: Trans-African Hydro-Meteorological Observatory: An opportunity for technology leapfrogging in the environmental sciences	**Nick van de Giesen** (TU Delft, Netherlands)	Facilitator: **Carinous Mizinga** Rapporteurs: **Ihejirika Chinedu Emeka** and **Seyni Ndoye**
09:30 – 09:40	**Plenary Session**		
09:40 - 10:00	Water Security and Climate Change – Vulnerabilities and Adaptation Strategies for SIDS and Developing Countries	**Bhanooduth LALLJEE** (University of Mauritius, Mauritius)	
10:00 – 10:20	Projected changes in mean and extreme precipitation in Africa under global warming: Implications for terrestrial water resources	**Mxolisi SHONGWE** (South African Weather Service, South Africa)	
10:20 – 10:40	Conflict and Cooperation in the Nile Basin: From Hydromet (1967) to the Nile Basin Initiative(2010)	**Yaekob Mekuria ABAWARI** (University Rotterdam, Netherlands)	
10:40 – 11:00	**Plenary Discussions**		
11:30 – 11:50	**Refreshment Break**		
11:30 – 11:50	Status of water resources in Senegal: Potential, issues and opportunities, policy and strategy	**Dr Moctar DIAW** (University Cheikh Anta Diop (UCAD), Senegal)	Facilitator: **Josephine Ngaira** Rapporteurs: **Ihsan Mutafa Ibrahim Abbas** and **Catherine Pfeifer**
11:50 – 12:10	Multicriteria Decision Analsysis of Integrated Water Resources Management for public management of water resources in Mozambique	**Jordi GALLEGO-AYALA** (Water Research Institute of Mozambique, Mozambique)	

12:10 – 12:40	An integrated assessment approach for the governance of a socio-ecological system facing water scarcity: the case of the Lake Naivasha basin, Kenya		
12:40 – 12:55	**Plenary Discussions**		
12:55 – 13:05	Constitution of the working groups		
13:05 - 14:00	**Lunch Break**		
14:00 – 16:00	Parallel working groups discussions		
16:00 – 16:30	**Refreshment break**		
16:30 – 18:00	**Poster presentations**		
From 19:00	Dinner and Launch of the Policymakers Booklet by ASSAf		

Day 3: Friday, 30 March 2012

Session 4
SCIENCE-POLICY DIALOGUE SESSION

09:00 – 09:30	Working Group 1 report: Water resources assessment (Plenary Discussion)		Facilitators: **Thameur Chaibi, Ralph Mills-Tettey and Abed Peerally**
09:30 – 10:00	Working Group 2 report: Sectoral water issues (Plenary Discussions)		
10:00 – 10:30	Working Group 3 report: Integrated water resources management (Plenary discussions)		
10:30 – 11:00	**Refreshment break**		
11:00-12:00	Recap of day 1 and 2 A systematic overview of the main scientific challenges for water management issues in Africa	Conference Chair and Rapporteur Salisu Abdulmumin (AMCOW) SADC representative (TBC)	Facilitator: Pieter **van der Zaag**

12:00 – 13:00	"Tackling Water Management Issues as a Policy-Maker" • 20-minute-presentations by 2 policy-makers from		Rapporteurs: **Dickson Andala** and **William Goriwondo**
13:00 – 14:00	Lunch Break		
14:00 – 14:30 14:30 - 15:00	Findings on desktop-study on Water issues in Southern Africa - Science, Water and Sanitation: Supporting equitable and sustainable development Findings on desktop-study on Water issues in Western Africa - Water issues in Western Africa	**Rivka Kfir** (Academy of Sciences of South Africa) **Cheikh Becaye Gaye** (ANSTS – Senegal Academy)	Facilitators: **Daniel Olago** and **Albert Rugumayo** Rapporteurs: **Alex Oduor** and **Mohamed Rouai**
15:00 -15:15	**Plenary Discussions on the second presentations**		
15:15 -15:55	Africa (total 40 minutes) • 20-minutes Question and Answer session (10-minutes per presentation) **Policymakers' roundtable :** • Eastern Africa o **Mr. Lister Kongola** (Tanzania) o **Eng. Nebert Wobusobozi** (Uganda) o **Prof. Josephine Khaoma Ngaira** (Kenya) o **Mr. Abiti Getaneh Gebremeskel** (Ethiopia)		
15:55-16:30	**Plenary Discussions**		
16:30-17:00	**Refreshment break**		
17:00 – 17:30	Policymakers' roundtable : • Western and Central Africa o **Samuel Foto Menbohan** (Cameroon) o **Mr. Daniel Adjetey Adjei** (Ghana) o **Dr. Dogara Bashir (Nigeria)**		
17:30-17:45	**Plenary Discussions**		
17:45 onwards	**Free evening for participants**		

Day 4: Saturday, 31 March 2012

CONCLUSIONS AND CLOSING SESSION

09:00 - 09:40	Policymakers' Roundtable • Southern Africa o **Mr. Dhesigan Naidoo** (South Africa) o **Mr. Carinous Mizinga** (Zambia) o **Dr. M. J. Tumbare** (Zimbabwe) o **Dr. D. Deepchand** (Mauritius)	Facilitators: **Michael Ahlheim** and **Takalani Rambau**
09:40 -10:00	**Plenary Discussions**	
10:10 -10:40	Overall discussions on the main issues of science-based policy advise	
11:40 - 11:00	**Refreshment Break**	
11:00 - 11:30	Recommendations and Way-forward with a focus on • Thematic aspects of water management issues as highlighted in the Scientific Conference (Yousuf Maudarbocus) • Science-policy dialogue summary (Alick Muvundika); and • Expected next steps (Jackie Olang and Christiane Diehl)	Rapporteurs: **Moses Mwangi** and **Aissata Delphine Bama Nati**
11:30 - 12:00	Closing remarks Dr. Volker ter Meulen (German Academy Leopoldina) Dr. Hans Chang (Royal Netherlands Academy of Arts and Sciences - KNAW) Hon. Dr. Rajeshwar Jeetah (Mauritius Tertiary Education, Science, Research & Technology	Facilitator: **Michael Atchia**
12:00 - 12:30	**Vote of Thanks** **Oyewusi Ibidapo-Obe** (NASAC) **Arjoon Suddhoo** (MAST)	
From 12:30 onwards	**Farewell Lunch**	


WATER MANAGEMENT ISSUES IN AFRICA 28.31.March 2012 Mauritius

Group Photo

THE NETWORK OF AFRICAN SCIENCE ACADEMIES (NASAC)

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. (www.nasaconline.org)

KNAW

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. (www.knaw.nl)

LEOPOLDINA

The Deutsche Akademie der Naturforscher Leopoldina has been the German National Academy of Sciences since 2008. It addresses key issues of particular significance for the future of society from a scientific perspective and independently of economic or political interests, shares its findings with policymakers and the public and puts these issues up for discussion on a national and international level. (www.leopoldina.org/en)

MAURITIUS ACADEMY OF SCIENCE AND TECHNOLOGY (MAST)

Mauritius Academy of Science and Technology is a non governmental body dealing with issues of Science and Technology for the development, bringing together some of the best brains in the country and the Diaspora, under one association, willing to give an independent and studied opinion on issues of concern. Its mission is to promote excellence in the fields of Science, technology and innovation for Human Development and welfare