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**PAN AFRICAN START COMMITTEE (PACOM)
PAN AFRICAN START SECRETARIAT (PASS)**

BY

*Eric O. ODADA
Programme Director, PASS
University of Nairobi, KENYA*

*Daniel O. OLAGO
Programme Officer, PASS
University of Nairobi, KENYA*

THE PACOM ANNUAL REPORT (2001/2002) TO START SSC

Table of Contents

Page No.

Forward: Africa - Environmental Challenges and Responses	3
General Introduction: Overview of PACOM/PASS Activities	5
SECTION 1: RECENTLY INITIATED/PLANNED ACTIVITIES	8
1.1 START/PACOM Global Change Fellowship Awards	8
1.2 AIACC - An Assessment of Vulnerability and Adaptation to Climate Change Impacts on Water Resources, Health and Food Security	8
1.3 Initiative on Recharge and Sustainable Use of Groundwater in Arid and Semi-arid Africa (START / IGBP / CAR)	11
1.4 An Assessment of Vulnerability and Adaptation to Climate Change Impacts on Water Resources, Health and Food Security	
SECTION 2: ON-GOING ACTIVITIES	14
2.1 The Miombo Network	14
2.2 CLIMAG West Africa Project	15
2.3 LOICZ AfriBASINS II: African River Catchment/Coastal Zone Interaction and Human Dimensions (Impacts of land-based activities on coastal seas of Africa)	16
2.4 The Kalahari Transect Project SEARCH/APD Project	18
2.5 Southern Africa Fire Research Initiative (SAFARI) 2000	19
2.6 IDEAL - the International Decade for the East African Lakes	21
2.7 SEARCH/African Pollen Database (APD) Project	22
2.8 Land Use Change Impacts and Dynamics (LUCID)	24
2.9 Global International Waters Assessment (GIWA) in Sub-Saharan Africa	25
SECTION 3: RESEARCH PROJECTS	27
3.1 Greenhouse Gas and Climate Change Studies in the East African Rift Valley and on Mount Kenya	27
SECTION 4: START FELLOWSHIPS/VISITING SCIENTIST AWARDS	28
SECTION 5: UPCOMING ACTIVITIES	29
5.1 Science-Policy Conference on Global Change and the Vulnerability of Land and Water Resources in Africa	29
SECTION 6: RECENT/UP-COMING PUBLICATIONS	30
APPENDIX	31
PACOM Committee Members	31
Meetings Calendar	32

FORWARD: Africa - Environmental Challenges and Responses

BACKGROUND

At the beginning of the new millennium Africa is characterized by two interrelated features: rising poverty levels and deepening environmental

degradation. Africa is the poorest region of the world. It has the largest share of people living on less than US \$1 per day. Almost 40% of the people in Africa live below the poverty line. At least one-third of Africa's population is undernourished and that number is also growing. Africa is the only region of the world where poverty is projected to rise during this century if adequate measures are not urgently taken. Of the 45 countries on the UNDP list of Low Human Development Indicators, 35 are in Africa. Indeed two-thirds of the 48 countries included in the list of Least Developed Countries are in Africa.

Related to the rising poverty is the degradation of the environment and increasing loss of the region's natural resources. UNEP's *Africa Environment Outlook* (AEO) report observes that conditions in natural habitats and fragile ecosystems have been deteriorating resulting in diminishing biodiversity. There are high rates of exploitation of such resources as freshwater, forests, and coastal and marine stocks continue to be used at rates beyond their viable rates of replacement. Land degradation, natural as well as human-induced environmental disasters and invasive alien species continue to be major problems in Africa. Natural disasters, such as floods, droughts, earthquakes and landslides cause considerable human suffering and economic damage in the continent. On the whole, environmental degradation undermines prospects of fighting poverty, economic growth and sustainable development in Africa. The vicious circle between poverty and degradation of the environment needs to be addressed in a comprehensive manner.

NEPAD

The New Partnership for Africa Development (NEPAD) adopted by the African Heads of State and Government is an initiative in which the leaders pledged "based on a common vision and a firm and shared conviction, that they have a pressing duty to eradicate poverty and to place their countries, both individually and collectively, on a path of sustainable growth and development, and at the same time to participate actively in the world economy and body politic." NEPAD recognizes that the range of issues necessary to nurture the region's environmental base and sustainable use of natural resources is vast and complex, and that a systematic combination of initiatives is necessary in order to develop a coherent environmental programme.

The New Partnership for Africa's Development (NEPAD) recommends the development and adoption of an environment initiative - a coherent action plan and strategies - to address the region's environmental challenges while at the same time combating poverty and promoting socio-economic development. This Environmental Action Plan for the first decade of the 21st century is a response to address such challenges. It is prepared through a consultative and participatory process under the leadership of the African Ministerial Conference on Environment (AMCEN). The plan is about Africa's common and shared sustainable development problems and concerns. It is a body of collective and individual responsibilities and actions that African countries adopt and will implement to maintain the integrity of the environment and ensure the sustainable use of their natural resources through partnerships with the international community. It provides an appropriate framework for the establishment of a strong partnership for the protection of the environment between Africa and its partners based on the commitments contained in the United Nations Millennium Declaration.

Natural Resources

Africa has a wealth of natural resources, including minerals, biological diversity, forests, fisheries, water, land and wildlife. It has the largest tropical rain forests and the second largest freshwater lake in the world. The region's forests cover 520 million hectares and constitute more than 17% of the world's forests. They range from the dry tropical forests in the Sahel, Eastern and Southern Africa, humid tropical forests in Western and central Africa, diverse sub-tropical forest and wood formations in Northern Africa and the southern tip of the continent, as well as mangroves in the coastal zones. These forests are however facing increasing deforestation and degradation. Africa has lost 66 million hectares between 1980 and 1995 with 65% of this deforestation during the 1990s.

The region has more than 50,000 known plant species, 1,500 species of birds and 1,000 mammals. For example, South Africa has an estimated 20,000 plant species, Kenya has at least 8,000 and Cameroon has more than 15,000. Other African countries such as Madagascar and the Democratic Republic of Congo are known for their rare internationally recognized plant and animal species. Fauna and flora form the foundation of social and economic development of the region and its people. Africa's agriculture is

however founded on a narrow range of plant and animal species. Some of Africa's plant species have contributed immensely to the world's pharmaceutical industry. Such plants as *Ancistrocladus korupensis* found in Cameroon, *Pausinystalia yohimbe* (from Nigeria, Cameroon and Rwanda) and *Catharanthus roseus* from Madagascar are being used in pharmaceutical research by industrialized country institutions.

Environment

The African coastline is vast and traces a variety of habitats - from open ocean, near-shore waters, and sandy and rocky islands to beaches, lagoons, sand dunes, mud and sand flats, rocky cliffs, sea grass beds, coral reefs, and mangroves. Some of the waters surrounding Africa, particularly those from the Straits of Gibraltar to Guinea, are among the richest fishing grounds in the world, and the marine areas from Angola south to the Cape also contain great wealth. Diversity of fish species is high, with more than 4,000 species reported. Some of the most numerous and economically most important fish species are tuna, marlin, and billfish; tuna is a significant source of foreign exchange for a number of countries. Marine and coastal ecosystems contribute significantly to the economies of its countries e.g. in Namibia, the fisheries sector contributes more than 35% of GDP and employs some 12,000 people.

Africa contains the world's largest expanse of drylands, covering roughly 2 billion hectares of the continent or 65 per cent of Africa's total land area. One third of this area is hyper-arid deserts, while the remaining two thirds consists of arid, semi-arid, and dry sub-humid areas-home to about 400 million Africans, two thirds of the continent's total. Although reliable data is lacking, it is estimated that some 500 million hectares of land in Africa has been affected by soil degradation since 1950, including as much as 65% of agricultural land.

Wetlands cover about 1 per cent of Africa's total surface area. The largest include the Zaire swamps, the Sudd in the Upper Nile, the Lake Victoria and Chad basins, the Okavango Delta, and the floodplains and deltas of the Niger and Zambezi rivers. The diversity of flora and fauna of wetlands in Africa is immense and in many places unknown, with endemic and rare plant species and wildlife, including migratory bird species.

Although abundant on a regional scale, water is unevenly distributed by nature and unfairly allocated by man. The total amount of water

utilized in Africa is about 90-100 billion cubic meters that represents 2-3% of surface and ground water resources in the continent. Agriculture is probably the largest user of water in the region. At least 6% of Africa's cultivated land is under irrigation in contrast to more than 30% in Asia. A few African countries have high annual averages of water per person but many others already or soon will face water stress or scarcity conditions. Recent studies indicate that more than 300 million people in Africa lack access to safe water. In sub-Saharan Africa about 51 per cent of the population have access to safe water and 47 per cent to sanitation. In general, urban residents have better access to safe water and sanitation than rural inhabitants.

Climate Change

Africa's contribution to the global pool of greenhouse gas emissions is still relatively low. It is estimated that the region contributes to only 3.8 percent of the world's total carbon dioxide emissions. Despite the region's comparatively low volumes of emissions to the global greenhouse gas emissions, Africa's economic, ecological and socio-political systems are vulnerable to climate change. Climate change impacts on the countries will be varied, irreversible and long-term. They include: severe climate variability, severe drought, increased erosion and sedimentation of dams leading *inter alia* to changes in patterns of hydro-electric production; sea-level rise endangering coastal zone and small island economies; shifts in agro-climatic zones which would affect biomass production patterns; and general changes in habitats affecting both human and animal population patterns. These impacts could generate irreversible economic and socio-political problems with severe impact on the food security of the continent already affected by a serious food deficit.

THE CHALLENGES

Africa is experiencing an array of serious environmental challenges and problems. Unsustainable exploitation and degradation of forests, soils, wildlife, fresh water, and other natural resources threaten to undermine the region's economic development prospects. For example, the continent is most severely affected by desertification that threatens more than 33 percent of Africa's land area particularly in the Sudano-Sahelian region, Southern Africa and Mediterranean Africa. Recurrent droughts are largely a manifestation of land degradation in the

region.

Despite growing recognition of the importance of natural resource conservation and numerous governmental commitments to environmental protection dating back to 1960, Africa's environment continues to deteriorate. Existing national, sub-regional and regional environmental laws, plans, policies, and institutions have proven inadequate to arrest current trends, including the lack of adequate financial resources.

THE RESPONSES

In addition to the efforts of regional bodies such as SADC, ECOWAS, ECA, IGAD, UNEP-ROA, AMCEN and AMCOW, the PACOM/PASS is

promoting regional global change science and enhancing the capacity of individuals and institutions in sub-Saharan Africa to address common environmental problems of the region.

The programmatic activities described in this annual report are based on the workplan for calendar year 2001/2002 that was approved by PACOM, the START SSC and the International START Secretariat.

Eric O Odada
Programme Director

General Introduction: Overview of PACOM/PASS Activities

PACOM has provided over the past year an effective mechanism for implementation and coordination of START projects in the Pan African region. It has also collaborated with IGBP-BAHC and UNEP-AMCEN to develop and foster cooperative research on recharge and sustainable use of groundwater in arid and semi-arid Africa as well as with and LOICZ Afribasins project on the study of impacts of land-based activities on coastal seas of Africa.

PACOM has enhanced regional cooperation in global change research linked to international science programs. It is collaborating with PAGES, IDEAL, NSF, EU and ICDP in deep-drilling on lake Malawi and Tanganyika to study the linkage between tropical Africa and the high latitudes at orbital and longer- period scales. It is also cooperating with Miombo Network, NASA, WWF, EU, GECP, SADC, IGBP-DIS, CIFOR, and LUCC on Global Observation of Forest Cover (GOFC) Programme in the Miombo woodlands of Southern and Central Africa. START/PACOM is also collaborating with regional agencies, such as the African Ministerial Conference on the Environment (AMCEN), Southern Africa Development Council (SADC), Economic Community of West African States (ECOWAS) and Economic Commission for Africa (ECA).

PACOM has enhanced exchange of data, information and communication of research results through collaboration with WDC in Colorado and the European Database at MEDIAS- France. It is

working closely with UNEP-GRID and other GIS databases in Africa such as that of the Africa Water Resources Forum. PACOM has also been involved in the identification of emerging regional priorities such as water resources management and impact of land-use change. It has established partnerships with Medias-France, SAFARI 2000 and IDEAL, as well as with the World Data Center and European Database Center. for capacity building and data exchange. More recently PACOM is collaborating with GIWA and UNEP on the Global International Waters Assessment in sub-Saharan Africa.

The Norwegian Agency for Development Cooperation (NORAD), which supports The Global Change System for Analysis, Research and Training (START Int.) in the operation of the Pan Africa START program, held its mid-term review with START/PASS officials in Nairobi, Kenya, in the last week of June 2002. This review was held back-to-back with the 5th PACOM meeting, and the NORAD-appointed representatives had the opportunity to sit in on the deliberations of PACOM. The NORAD team was comprised of two experts from the Norwegian Pollution Control Authority and the Directorate for Nature Conservation. The purpose of the review was assess to what extent Pan African START Programme succeeds in carrying out the activities and reaching results and objectives as outlined in to the plans and in the terms of the Agreement. The review also provided an opportunity for NORAD to be acquainted with the START and Pan-African START network.

The main aim of the NORAD review was to assess the overall implementation status of the Program, using the following evaluation elements:

- ◆ *Efficiency*: Outputs related to inputs (results of the resource use), including assessment of project progress compared to the work plans
- ◆ *Effectiveness*: The extent of objective achievements so far in relation to the target, (including expected time of achievement)
- ◆ *Impact*: Other direct and indirect effects (positive and negative) caused by the project
- ◆ *Relevance*: The degree to which the objectives and activities are still in line with and relevant to the national priorities and needs
- ◆ *Sustainability*: To what degree the positive effects of the project are expected to continue after the external donor support is terminated (in terms of policy support, economically and financially, institutionally, technologically, environmentally, and in terms of socio-economic/gender aspects)

The team outlined PACOM strengths and weaknesses, and made recommendations as follows:

STRENGTHS	<ul style="list-style-type: none"> ◆ The Pan-African START programme is efficient in disseminating information from all their activities, such as workshop, training programmes and expert meetings. This is done in the form of reports, brochures and the web site and in general active personal networks. ◆ The programme has in general achieved its objectives according to the work plans. ◆ The programme seems to have high credibility in the research community, judging from the participation of prominent researchers in the Pan-African START Committee (PACOM) and in the PACOM meeting. ◆ There is an obvious need for a facilitating organisation in the complex scientific community in the region, and the Pan-African START programme seems to fill this gap efficiently. ◆ Based on discussions with key persons and the discussions at the PACOM meeting, the Pan-African START programme appears to have a good understanding of the programme's role as a facilitating mechanism. This includes an understanding of delineating their role relative to that of other actors working on global change, such as UNEP. There does not seem to be any direct overlap between the Pan-African START and other organisations. ◆ The programme has been successful in providing "seed money" in that the initial funding of workshops etc has resulted in project proposals that have attracted funding elsewhere. ◆ The choice of a strategy with a focus on clearly defined, small-scale activities with a large probability of successful completion, has been successful. ◆ The programme benefits from very skilled key persons in the secretariat. ◆ The programme seems to have established well-functioning networks with the research communities in the region.
WEAKNESSES	<ul style="list-style-type: none"> ◆ The organisation is small, and therefore vulnerable with respect to keeping key personnel. ◆ The Pan-African START programme has had limited direct contact with relevant management authorities at the national level. The programme needs to ensure that its activities are in accordance with national and regional priorities and to keep focus on achieving results that can contribute to decision-making. ◆ The programme has had problems in communicating efficiently with the policy community. There seems to be a need for a better strategy for science-policy interaction.
RECOMMENDATIONS	<ul style="list-style-type: none"> ◆ The Pan-African START should continue to focus on its role as a facilitator and be careful in extending its niche. The programme's resources should go towards stimulating the scientific community in developing scientific projects and proposals and in supporting African scientists in developing contact with the larger scientific community, such as in IPCC processes, without taking direct responsibility for the implementation of projects. ◆ The programme should continue to emphasize capacity building through fellowships and various scientist grants, with a priority on PhD grants. Long-term capacity building, including a follow-up of students, should have priority. ◆ The programme should give priority to research needs identified by the African research community with respect to global change. ◆ The programme activities should be carried out in accordance with national priorities, and with an understanding between the Pan-African START and national research policy bodies.

Conclusions

The review team concluded that there is apparently still a need for an organisation that can contribute to building network in the scientific community in the field of global change, support in developing research proposals and provide both long and short-term fellowships and grants across the region. They noted that the Pan-African START programme has proved to be an efficient organisation in this regard, with a well-developed network and necessary credibility in

the scientific community, and that this called for continued support of the program, particularly to ensure a stable and predictable funding of fellowships and a working secretariat. The team therefore recommended that support for the START programme continues.

SECTION 1: RECENTLY INITIATED AND PLANNED ACTIVITIES

1.1 START/PACOM Global Change Fellowship Awards

The START/PACOM Global Change Fellowship Awards for doctoral and post doctoral research, tenable in African universities, are supported by funding from the Norwegian Agency for Development (NORAD) provided to START for regional capacity building for global environmental change research in Africa. These fellowships represent opportunities for outstanding African scientists undertaking global environmental change research, the main aim being to build regional expertise in global environmental change in Africa. The awards are granted for up to two years of study leading to completion of Ph.D. dissertation or for the final year of graduate study and one-year of post-doctoral research. Priority topics for the first call (made in April 2002) were on environmental change and water resources or environmental change and land–use, terrestrial ecosystems in Africa. There was an overwhelming response to this call with over 100 applications. A list of awardees can be found in Section 4.

Subsequent calls will focus on additional aspects of environmental change. The second call will be made before the end of 2002 and it is expected that the response will be far much greater as the information on these opportunities reach more and more people.

For more information, contact:

Prof. Eric O Odada

Programme Director, Pan African START Secretariat, University of Nairobi – Chiromo

Campus, Department of Geology, P O Box 30197, Nairobi, Fax: 254-2-449539

Email: pass@uonbi.ac.ke or eodada@uonbi.ac.ke

1.2 AIACC - An Assessment of Vulnerability and Adaptation to Climate Change Impacts on Water Resources, Health and Food Security

The AIACC initiative aims to fill the gaps in scientific and technical capacity as well as in knowledge about climate change vulnerabilities and adaptations. The initiative is funded by the Global Environment Facility (GEF) and is a joint project of START, the Third World Academy of Sciences (TWAS), the United Nations Environment Programme (UNEP), and the IPCC. Twenty regional studies are being funded to carry out three-year investigations of climate change vulnerabilities and adaptations in developing countries. Eight projects have been funded in Africa, and the outputs are expected to contribute to the national communications of the participating countries, and to feed into future IPCC assessments for the region.

The project was launched in February 2002 in Nairobi, Kenya. The objectives of the kick-off meeting were to (i) encourage and facilitate reevaluation and refinement of regional study designs (ii) develop plans for technical support and training (iii) identify opportunities for cross-study collaboration (iv) discuss possible AIACC products that summarise and synthesise methods and results of AIACC regional studies and (v) sort out administrative issues related to implementing the studies.

The AIACC Africa Regional Studies

Impacts and Adaptations to Climate Change by the Biodiversity Sector in Southern Africa

(Robert Scholes, CSIR Division of Water, Environment and Forest Technology, South Africa)

Three case studies, representing different environments and data limitations, will serve as demonstrations of techniques developed to provide more realistic predictions of plant, animal, bird, and reptile species response to changing climate in a changing and fragmented landscape. The project will develop, test, and promote tools for planned adaptation in the biodiversity conservation sector and include professional biodiversity managers and policy-makers. This project will take place in South Africa, with applicability to southern Africa and elsewhere.

Environmental Strategies for Increasing Human Resilience in Sudan: Lessons for Climate Change Adaptation in North and East Africa.

(Balgis M. Osman and Nagmeldin Goubti, Higher Council for Environment and Natural Resources, Sudan, and Erik Spangarsiegfried, Stockholm Environment Institute, USA)

To increase the resilience and adaptive capacity of vulnerable communities and agricultural systems in Sudan and other drought-prone countries, cost effective environmental management measures will be identified. Through this research, the project may succeed in bringing to light those environmental management measures that can provide a 'triple dividend'- decreased climate-related disaster vulnerability, reduced demand for international humanitarian assistance in disaster response and recovery, and achievement of national and global sustainable development objectives.

Food Security and Climate Change in Sub-Saharan West Africa

(James Adejuwon, Department of Geography, Obafemi Awolowo University, Nigeria)

This project will build on the existing capacity to predict climate variability on time scales ranging from weeks (intra-seasonal) to months (inter-seasonal), to years to improve management and decision-making in the production of food crops in West Africa. Based on demonstrated sensitivity of major crops to climate variability, a suite of options will be developed and evaluated as responses to the various categories of predictable upcoming seasonal and annual weather to enhance crop yields

and food production. This project will involve researchers from Nigeria and Niger Republic and is closely related to the ongoing EU/ENRICH and START-sponsored CLIMAG project in Mali.

Integrated Assessment of Miombo Region: Exploration of Impacts and Adaptation Options in Relation to Climate Change and Extremes

(Manuel Ferrao, Centro Nacional de Cartografica e Teledeteccao, Mozambique and Paul Desanser, Department of Environmental Sciences, University of Virginia, USA)

Climate variability and extreme events in the Miombo region, including areas of Malawi, Zambia, Zimbabwe, and Mozambique that lie within the drainage basin of the Zambezi River, have devastating impacts on the natural, economic, and social structures of local communities. An interdisciplinary team of social and natural scientists, managers, policy advisors, and the general public will form a regional team to assess vulnerability and explore adaptation options. Primary emphasis will be on land use and its impacts on food production systems and food security, as well as impacts on land use changes on water, all within the context of climate change.

Impacts of Climate, Vulnerability, and Adaptation Capacity in the Limpopo Basin of Semi-Arid Land Southern Africa: The Case of Eastern Botswana

(Opha Pauline Dube, Department of Environmental Science, University of Botswana, Botswana)

A detailed assessment of impacts of climate change on water and food resources in the Limpopo basin in the eastern part of Botswana will ascertain the degree of vulnerability and capacity to adapt to climate change and identify strategies to enhance locally based adaptation options. An integrated assessment approach will be used to elucidate linkages in food and water with respect to climate factors, land use activities, socio-economic, political and cultural factors. Results will form the basis for valuing the likely loss, where adaptation measures are not implemented, from climate change impacts on the Limpopo basin, estimated in monetary value to the national GDP.

Capacity Building in Analytical Tools for Estimating and Comparing Costs and Benefits of Adaptation Projects in Africa

(Ogunlade Davidson, Energy and Development Research Centre, University of Capetown, South Africa)

Within Africa, there is a dearth of knowledge and institutional capacity to develop and implement Research analytical tools for adaptation frameworks in key economic sectors. Building upon previous research, the focus will be on development and application of an adaptation cost/benefit framework in Southern and West Africa. Sectors to be considered include: agriculture, energy supply and demand, fresh water resource supply, freshwater resource quality, flooding of freshwater bodies, and sea-level rise. Results from the study will contribute to the development of international climate change policies and programs, particularly in regard to adaptation activities in developing countries under the United Nations Framework Convention on Climate Change (UNFCCC).

Development of Regional Climate Change Scenarios for Sub-Saharan Africa

(Bruce Hewitson, Climate System Analysis Group, University of Cape Town, South Africa)

Africa, one of the most vulnerable to climate change, is likely the most under-resourced continent for climate change research and a region where climate dynamics are still poorly understood. In response, this project will extend existing capacity among Africa scientists in issues of method and implementation for regional scenario construction from GCM climate change simulations. The scenarios will be focused on spatial and temporal scales appropriate to the primary vulnerability sectors in Africa, and incorporate computationally efficient empirical downscaling and the demanding regional climate models. This will provide for the first time a comprehensive scenario base for IPCC and related impacts activities in Africa.

Assessing Global and Regional Climate Change Scenarios for West Africa

(Amadou Gaye, Laboratory for Atmospheric Physics, Cheik Anta Diop University, Senegal)

Scientists will assess climate change scenarios for West Africa from GCM and RCM simulations, determine if these change scenarios are realistic for the West African climate system, and provide model output to other disciplines for incorporation into impact assessments at national and regional scales. Incorporating a strong focus on capacity building, the Laboratory for Atmospheric Physics at Cheik Anta Diop University will serve as a regional hub for research and training and will host a regional climate model workshop to show participants how to use the regional climate model

analyze regional and global climate model output that is relevant for West Africa, and produce visualization of this data.

An Assessment of Impacts and adaptation to Climate Change: A Case Study of Malaria and Cholera Occurrence in the Lake Victoria Region, East Africa

(Shem Wandiga, Kenya National Academy of Sciences, Nairobi, Kenya)

The focus of this project is to improve the understanding of the relationship between climate change parameters (precipitation and temperature) and the incidences of malaria and cholera in the Lake Victoria region (Kenya, Uganda and Tanzania). It will identify priority risk groups based on exposure potential, work with pilot populations (representative of priority risk groups) to distinguish risk management strategies and select preferred options to inform policy. From the experiences gained the project will implement preferred adaptation strategies to strengthen local coping capacity and monitor performance. The project will start with characterization of baseline temperature and precipitation variability and apply existing General Circulation Models (GCM) (IPCC, SRES and other appropriate models), in order to estimate possible perturbations to these conditions. GIS layers will be constructed using historical data on climate, malaria and cholera incidences in order to select pilot sites. Time series analyses will be used to correlate the relationship between climate and disease incidences. Identification and engagement of stakeholders using participatory methodologies will be used to assess vulnerability of pilot groups. This will be supplemented with analyses from socio-economic surveys and data on water resources and time activity patterns of the pilot population. Use will be made of the retrospective and prospective data analysis to estimate the excess risk of malaria and cholera that may be attributable to future climate change. The project will incorporate capacity building in global change research in all its activities, by engaging stakeholders and scientists in the region.

For more information, contact:

*Ms. Sara Beresford,
AIACC Project Coordinator, International START
Secretariat, Florida Avenue, NW – Suite 200,
Washington DC 20009 USA; Fax: 202-457-5859
Email: sberesford@agu.org*

1.3 Initiative on Recharge and Sustainable Use of Groundwater in Arid and Semi-arid Africa (START / IGBP / CAR)

Preface

The Initiative on Recharge and Sustainable Use of Groundwater in Arid and Semi-arid Africa starts from a global change perspective, assessing regional impacts of global change effects such as climatic and land use changes, population increase, urbanization and other. It is a contribution to the larger Joint Water Project. The initiative is product oriented. It synthesizes and evaluates scientific information for application in groundwater management and development within an IWRM (Integrated Water Resources Management) context. This information is made available in a user-friendly form to various stakeholder groups. The Groundwater Initiative fosters and promotes new research in order to close knowledge gaps and it promotes transfer of knowledge and experience in groundwater management. With that it will complement ongoing related activities (see section III). The initial focus will be on the arid and semi-arid regions in Southern Africa. The kick-off workshop held in June 2002 confirmed the need for such a Groundwater Initiative. The Groundwater Initiative will contribute integrated knowledge and provide decision support tools for sustainable groundwater management and development in the context of the Joint Water Project. Below we outline some proposals that have been submitted to GEF for funding.

Proposal: “Framework for Groundwater Recharge Estimation in Southern Africa”

Background

In Southern Africa, and especially the arid and semi-arid regions, groundwater is a strategic resource of national and international importance. Groundwater recharge is a key factor in determining the sustainable management of groundwater resources. Only if recharge exceeds the sum of basic human and environmental needs in a catchment plus groundwater outflow necessary to sustain the same needs downstream, may groundwater be allocated for other uses.

The increasing demand for groundwater for both drinking water and agricultural activities in semi-arid Africa may not be sustainable in the long term as groundwater resources are limited. Precise determination of groundwater recharge is becoming

increasingly important in order to set limits for groundwater development and thus to avoid over-exploitation and deterioration of the quantity and quality of the resource.

Groundwater recharge from rainfall in semi-arid areas is generally small but shows high temporal and spatial variability. It is difficult to measure groundwater recharge precisely and therefore ideally more than one method should be applied for proper assessment of this component in these areas.

Despite the large volume of scientific papers and several books on estimation of groundwater recharge published in the past two decades (see references) there is a clear need for developing a user-friendly framework for groundwater recharge assessment.

Objective

The main objective of this project is to develop a user-friendly framework for determining groundwater recharge in Southern Africa for region-wide application in groundwater management.

Outputs

- ♦ Two manuals on groundwater recharge assessment in Southern Africa. The first manual will present methods and underlying assumptions and uncertainties whereas the second manual will focus on the use of recharge assessment results within an IWRM context.

- ♦ Computer aided decision support system for choosing the appropriate and cost-effective technique(s) for quantifying groundwater recharge;
- ♦ Computer aided toolbox with commonly practised techniques to quantify groundwater recharge;
- ♦ A database with groundwater recharge case studies from the region;
- ♦ Improved low-cost and cost-effective methods and approaches for recharge assessment; and
- ♦ Knowledge transfer workshops for recharge assessment for both groundwater professionals and practitioners

Target Group

The project targets both groundwater professionals and practitioners in the SADC Region at government and applied research institutions and at universities. Groundwater professionals are described as academically trained hydro-(geo)logists, and water resource engineers. Water practitioners represent a much larger group of stakeholders ranging from water resource policy and decision makers, Catchment managers, through to water resource technicians.

The first, second and last outputs are targeting both groundwater professionals and practitioners whereas the other outputs primarily aim at groundwater professionals.

Project Team

The proposed project is a collaborative effort of the Council for Scientific and Industrial Research

(CSIR-Environmentek - Groundwater Group) and the University of the Western Cape (UWC-Department of Earth Sciences – Groundwater Group).

For more information, contact:

Dr Hans E. Beekman
 CSIR-Environmentek
 Water Programme, P.O.Box 320
 Stellenbosch 7599, South Africa
 Tel.: +27-21-8882598, Fax: +27-21-8882682
 e-mail: hbeekman@csir.co.za

Prof. Dr Yongxin Xu
 Department of Earth Sciences
 University of the Western Cape
 Private Bag X17
 Bellville 7535, South Africa
 Tel.: +27-21-9593882, Fax: +27-21-9592438
 e-mail: yxu@uwc.ac.za

Proposal: "The Strengthening of Natural Resource Accounts to Promote Efficient and Sustainable Groundwater Utilisation"

Introduction

Water problems in Southern Africa are becoming more severe. Water scarcity is growing due to growth of the population and the economies and the costs of water supply are escalating. In addition, water pollution reduces the availability of potable water. This situation poses large challenges to water management such as:

- ♦ To what extent can water supply be further expanded in a sustainable manner and at what costs?
- ♦ How can people's basic needs for water be met and which other uses should be given priority?
- ♦ What is the optimal allocation of water resources to benefit people's livelihoods and support economic growth?

The UNSO has recommended the adoption of NRA by countries. Several Southern African countries have used Natural Resource Accounting as a tool to:

- ♦ monitor water stocks and uses;
- ♦ determine the economic benefits of water consumption by economic activity;
- ♦ assess cost-recovery through water charges;
- ♦ identify emerging water management issues; and
- ♦ provide insights in current and future welfare levels.

NRA offers a good framework for the integration of physical and economic data and for unlocking data that exist, but are not routinely used in water resource management. The experiences of Namibia, Botswana and South Africa have demonstrated the potential of the method to support

water management at the national and regional level. For example, at the national level, NRA found that trends in water consumption deviated substantially from demand scenarios and that the intended increased cost-recovery in the water sector is not achieved. Furthermore, the NRAs showed that current water allocations are not based on the economic returns per M³ of different economic sectors: agriculture receives the lion's share of water and yet generates relatively low economic returns. At the regional level, the comparison of NRAs found that Botswana has the lowest water consumption per capita, and the highest economic returns per M³. The reasons for this are not yet clear, and require further policy analysis. In addition, a pilot trans-boundary NRA study has been carried out for the Orange river. In brief, NRA is a useful tool for integrated water resources management.

While NRAs have proven their value, they still have major weaknesses, particularly related to

ground water. Firstly, figures for the stock of groundwater and annual recharge are inadequate, and therefore ground water stocks are missing. Secondly, treated effluent is not considered as a (secondary) stock of water. The potential of this 'third source' for artificial ground water recharge or to reduce pressure on ground water resources, is not yet recognised in NRAs. Thirdly, cost data are incomplete and therefore the costs and benefits of different supply and demand management options cannot be compared. This hampers the optimal use of ground water resources. Fourthly, ecological water needs are not yet incorporated, even though they are prioritised in water management policies of countries like South Africa. Fifthly, water quality aspects are not incorporated, and therefore the impacts of ground water pollution cannot yet be traced. Finally, no distinction is made between 'domestic' and 'shared' water stocks. This distinction is important given on-going policy initiatives to manage shared surface and ground water resources at the regional level.

Objective

The objective is to conceptually and empirically improve the coverage of ground water resources in NRAs in Southern Africa by incorporating stock and recharge data as well as value and cost data. The next goals would be to carry out scenario analysis –based on different IWRM option- and to link these with decision support model that improves water management, and optimises the role of ground water.

Outputs

- ◆ Product 1: Paper on the Role of Ground water in Integrated Water Resources Management: Key Economic, Social and Environmental Policy Challenges.
- ◆ *Product 2 (based on task 1): Paper on the current and proper coverage of ground water in Natural Resource Accounts.* The paper be written for NRA professionals as well as NRA users and contain recommendations as to how the coverage of ground water can be improved and what policy benefits will be derived.
- ◆ Product 3 (based on tasks 1-2): Exploration of long-term IWRM scenarios to sustain people's welfare and economic growth.
- ◆ *Product 4 (based on 1-3): development and application of a decision-support model to assist water managers choosing the optimal mixture of development and distribution of ground and surface water sources .*

The project team

The proposed activity is a collaborative effort of the Centre for Applied Research, New York University and the University of Pretoria. The core team comprises Dr. Glenn-Marie Lange (New York University), Prof. Rashid Hassan (University of Pretoria; availability to be confirmed) and Dr. Jaap Aartsma (Centre for Applied Research and project

co-ordinator). In addition, junior researchers at the Centre for Applied Research and the University of Pretoria would participate.

For more information, contact:

*Dr. Holger Hoff, BAHC Project Office
Email: hoff@eik-potsdam.de*

SECTION 2: ON-GOING ACTIVITIES

2.1 The Miombo Network: Operationalizing GOFc in the Miombo Region and Questions of Carbon

A detailed report on this activity was provided in the PACOM Report 2000/2001. Research and training continues to be undertaken under the core themes summarised below:

This pilot GOFc project for the Miombo Dry Tropical Region of Southern Africa is seeking to understand the role of Miombo in the carbon budget, as well as provide baseline land cover information to support ecosystem assessment and natural resources management. The overarching science goal is to quantify carbon in the Miombo system and estimate carbon fluxes due to land use/land cover changes, and explore the question about whether the Miombo region is a source or sink of carbon over a forest management horizon (10 to 20 years, using the 1990-2000 as an initial test period). Related to this, the project is exploring the feasibility of community-level carbon projects that would satisfy Kyoto forests.

This project is addressing the following NASA ESE scientific questions:

- a) what are the changes in land cover and/or land use (monitoring/mapping activities),
- b) what are the consequences of LCLUC (in terms of carbon).

On-going activities include:

1. Mapping the miombo region using Landsat 7 data by working in conjunction with Southern African national mapping agencies;
2. Measurement of carbon densities in representative land cover/forest cover types of the region, while building upon existing forest inventory and national biomass studies;
3. Development of a carbon accounting model that will quantify carbon pools in the miombo region for 1990 and the year 2000, and the major C fluxes due to land cover changes;
4. Development of a regional spatial database for site characterization; and

5. Development of an information management system that will distribute satellite data for the miombo region, and serve as a database archive for field data about the miombo region, such as forest inventory records and site data for image classification.

The Miombo GOFc project will provide leadership in application of satellite data in the Miombo Network, and expects to engage as many user groups as possible. The acquisition and distribution of satellite data to as many user groups within the Miombo Network is a very important service to the community designed to maximize benefit from remote sensing.

Recent Developments in the Miombo Network

Main projects in the Miombo Network remain centered around issues of land use and impacts of climate change. Current activities include:

- ♦ a GOFc/GOLD pilot activity that is developing updated characterization of land cover for Mozambique and a regional picture of carbon in miombo systems
- ♦ an AIACC project looking at impacts of climate change especially climate variability and extremes in the miombo region
- ♦ activities being coordinated by the Southern Africa Fire Network (SafNET) to develop methods for routine monitoring of fires using remote sensing
- ♦ A new project is starting in August 2002 under the Southern African Millennium Assessment project to assess the status of goods and services in the Zambezi River Basin. This project will run for 2 years, and is expected to produce land use change scenarios for the Zambezi region taking into account projections of main drivers of land use change including population demography, climate change and economic development

New products

- ♦ Regional Map of Forest/non-Forest for 4 countries of the Miombo Region (see Figure attached as a jpeg – higher resolution image available).
- ♦ Southern African country-wide mosaics based on 1990 Landsat data from Earthsat available (processed from individual UTM panels provided by Earthsat). The country mosaics provide overlaying capabilities with other baseline information.
- ♦ The Miombo Network has produced an updated GIS database for Southern Africa to improve upon the very successful Miombo CD (previously released in 1997 under LUCC). Data are available online, and a CD-ROM version is expected later this summer.
- ♦ New Landsat 7 data have been acquired to complete coverage of Mozambique. Data are available by contacting the Miombo Network coordinator.
- ♦ A land use change simulator called MELT is available for testing. It has a user friendly graphic interface that allows customization of outputs, analyses and submodels. MELT will be used in upcoming workshops in the region and it is expected students will develop country versions in the coming 1-2 years.

Capacity Building

Following the MIMOSA (Meso-scale Integrated Model of Southern Africa) Training Workshop in April 2000 (see PACOM Report for 2001/2002), integrated regional assessment project proposals were developed for submission to the African Development bank and EU/ENRICH, GEF, Millennium Assessment, and the AIACC project. The AIACC project has been funded for three years. Others are pending.

Workshops

The Miombo Network has secured funding from the US National Science Foundation for a Land

Use Synthesis workshop later this year. Dates will be finalized, but it is expected to be around November 2002 or during early 2003. The workshop will initiate the process of a Miombo Land Use Change Synthesis.

For more information, contact:

*Paul V. Desanker, PhD
Global Environmental Change Program - Africa,
Department of Environmental Science, University
of Virginia/Clark Hall, 291 McCormick Rd., P.O.
Box 400123, Charlottesville, VA 22904-4123, USA
Email: desanker@virginia.edu;
<http://miombo.gecp.virginia.edu>
<http://africaclimatechange.org>*

2.2 CLIMAG West Africa Project

NORAD support was utilised for a project planning meeting to design a strategy for implementing a focused CLIMAG effort in Sahelian West Africa in 1999. Following this, a regional network of collaborating institutions, including ICRISAT(CGIAR)/Mali, The African Center for Meteorological Applications for Development (ACMAD), the International Research Institute for Climate Prediction, national meteorological and agricultural agencies and the farming community in the region, was developed. Thirteen regional and international institutions, including the above, were incorporated into the follow-on project. The representatives (approximately 25 persons) were actively engaging in CLIMAG activities in the region. Linkages are currently being established

with other regional projects, including those of UN, WMO, and others.

The workshop report was distributed to all participants and was used as a basis of development of the current research project. It was also distributed to various stakeholders. Distribution of the workshop report to various stakeholders.

Proposals were developed and forwarded to EU and NOAA OGP for longer-term follow-up collaboration between regional scientists / institutions and colleagues in Europe and the USA. A 3 year proposal involving the regional network partners was funded by EC/ENRICH from March 2001. In addition, NORAD support utilized to support the follow-up for Mali regional

related to the EC/ENRICH project to increase technical capacity in the region.

of Global Change Impact in Sudano-Sahelian West Africa. G. Maracchi, M. Paganini, F. Sorani and R. Tabo (eds.). Initial Workshop Proceedings, 23-25 April 2001, Bamako, Mali.

For more information contact:

Publications

CLIMAG - West Africa; A Network for Harmonisation of Climate Prediction for Mitigation

Ramadjita Tabo, ICRISAT, Bamako, Mali

Amy Freise, International START

Email: afreise@agu.org

2.3 LOICZ AfriBASINS II: African River Catchment/Coastal Zone Interaction and Human Dimensions (Impacts of land-based activities on coastal seas of Africa)

LOICZ AfriBasins II Workshop on African Rivers Catchment/Coastal Zone Interaction and Human Dimension Impacts of Land-based Activities on Coastal Seas of Africa, 29 October 2001 to 1 November 2001, UNEP, Nairobi, Kenya

Details of the aims, objectives and expected outputs of the above workshop were given in the PACOM Report for 2001/2002. We, therefore, provide a summary here, and also outline the AfriCAT proposal which was developed following discussions at the meeting and that will be submitted to EU for funding.

Indicators established:

- ◆ Provide a refined state of the art report of river catchment – coastal sea interactions including the human dimensions of coastal change issues and a first ranking of key pressures and state change settings providing a data entry for upscaling purposes on regional scale.
- ◆ Upscale the information to broader sub-regional and finally regional synthesis by identifying and clustering areas of similar coastal change features using the DPSIR framework and the ranking for classification of sites and regions.
- ◆ Strengthen a regional Africa BASINS network with a commitment to continue the proposal development and project co-ordination and to improve existing and seek new value added links to other projects and organizations such as UNEP, GIWA, IOC-UNESCO, START and IHDP.

Results Achieved

Based on the preparatory work in phase I, AfriBasins II produced a LOICZ Reports and Studies (R&S) series volume (which also forms the basis for the first LOICZ synthesis in 2002).

AFRICAT Proposal

A draft follow-up proposal was developed aimed at cross-disciplinary (i.e. combining natural and social science) pilot studies complementing parallel developments in the other regional BASINS effort - as a template the European "Eurocat" project was

used. The proposed project is based on an integrated natural and social science methodology linking impacts on the coastal sea to human activities in river basins. Using the unifying

framework of DPSIR*, state changes in the coastal zone generated by land-based material fluxes are connected back to individual socio-economic drivers and individual sub-basins at the catchment scale. Scenarios will be developed to derive and assess gains and losses connected to the implementation of different mixes of natural change and control measures. To derive this link a first set of indicators for catchment and coastal zone functions is to be developed. This set of indicators will not only be based on ecological criteria but additionally (and where applicable) on existing international and national regulations and on a survey of the local stakeholders and their criteria for such functions/services. The critical load concept will be used to link these targets to material fluxes into the coastal zone and to the socio-economic drivers in the catchment and their sub-basins. A coupled set of existing models will be established. This modelling set can be used in the inverse mode to determine the impact, losses and gains of future human activities in the catchments and related coastal zones. This novel methodology, based on coupled natural and social sciences models, will make it possible to evaluate and improve strategic planning and management at the catchment level.

To provide a pan-African dimension, contrasting river catchments and coastal seas in different climatic and geomorphologic settings were selected (based on the "expert typology" developed during the LOICZ AfriBASINS I&II regional assessment and synthesis). Regional case studies have been chosen in such a way that they focus on particular issues, have potential to benefit from each other, and allow for the extrapolation to other coastal regions and basins experiencing similar issues (upscaling across sub-regions in Africa and beyond). Existing or planned initiatives in other basins, such as the Volta, Incomati and Maputo Bay areas, will be associated with Africat as appropriate.

The *Nile* basin was selected because of its transboundary nature, and the existence of a well documented and implemented water use regime and damming activities that reflect the strong economy oriented catchment modifications since the 1960ies. Two catchments in Morocco and their associated estuaries and coastal seas are examples of smaller African river system in an arid climate regimes that have experienced a rapid and multiple change in water and material flow regimes due to intense damming action with corresponding

changes in coastal biogeochemistry. The Senegal, Volta and Niger catchments are transboundary rivers under serious human pressure and with plans for further catchment based driving activities.

Transboundary diagnosis of water issues are the objective of a respective PDFB grant for the Volta and complementation with a coastal zone oriented BASINS case study is expected to value add to the scientific knowledge needed for River – Coastal Sea integrated management. Tana and Zambezi rivers have been reselected to represent catchments of different size along the East coast that are either subject to huge damming or where such plans are existing and that should either become subject to integrated assessment (Zambezi) or to an advanced data and information synthesis for scenario development. The Incomati river is the transboundary target site that is the target area for integrated management along the ICARM outlines as proposed recently at a multinational meeting in Maputo. Africat is expected to have potential to provide a platform for implementation. Further sites are the rivers draining into Maputo Bay and, subject to the capacities available, smaller catchments in East Africa representing those with high flushing seasonality in monsoonal regimes under various degrees of anthropogenic forcing. Through funding from USGCRP, START is sponsoring four pilot activities to initiate the AfriBASINS project. These will focus on the Rufiji River (Tanzania), Senegal River (Senegal), Tana and Sababi Rivers (Kenya), and the Sebou and Moulouya Rivers (Morocco).

Last but not the least, users and stakeholders from the sub-regional and African level will be involved throughout the project. This is considered essential recognizing that some of the scientific products developed in the course of the project are too complicated to be of direct use to all local managers. Hence their practical expertise is required in order to effectively disseminate findings and products outside the scientific community. Their role will be advisory on project deliverables.

Few examples exist of the close co-operation between natural and social scientists envisaged in this project. It has, however, been demonstrated elsewhere that such interdisciplinary collaboration can provide new insights. The combination of the disciplines in this project in sub-regional or if possible transboundary consortia would thus be a strongly innovative feature. A significant increase of the internal knowledge base is therefore an expected part of project based capacity building. It will allow participants to anticipate and carry out

* DPSIR stands for Driver-Pressure-State-Impact-

management in their regions. The integrated approach will fill a market niche and allow them to

improve the funding situation by extending their development potential.

Capacity Building

In a parallel but related effort under a USGCRP grant, START is supporting 2 African researchers at the University of New Hampshire to develop a prototype digital water atlas for selected catchment basins in West Africa.

Publications

The LOICZ report produced for the region has been incorporated into the overall LOICZ synthesis

(2002 – book to be published by Springer-Verlag). The Report serves as a contribution into international “BASINS” framework with regional projects in South America, Europe, and East Asia.

For more information contact:

Russell Arthurton

Email: rarthurton@btinternet.com

2.4 The Kalahari Transect (KT) Project: Climate Change and Sustainable Livelihood

This report details out progress that has been made by the Kalahari Transect initiative that is co-ordinated from the Department of Environmental at the University of Botswana. From the onset, it must be made clear that the Kalahari Transect should be seen in a broader context of research initiatives taking place in Southern Africa which include the EU-funded Subsistence Rangelands Project (SRP) and SAFARI 2000. All these research initiatives tend to overlap and complement each other. Some of the research activities of the SRP and SAFARI 2000 have been undertaken within the Kalahari Transect, although none of the work has been funded under the auspices of the Kalahari Transect initiative.

On-going Activities

As mentioned earlier, there are a number of research activities along the KT sponsored by various organisations that have made good progress. The most notable of these are the Subsistence Rangelands Project and SAFARI 2000. Many KT scientists participate in these projects.

◆ Subsistence Rangelands Project

This project has three research sites, one each in Botswana, South Africa and Lesotho, with the first two situated on the Kalahari Transect. The main purpose of the project is to assess the status of and

changes in, subsistence rangelands and how these have affected the livelihoods of the users. The project attempts to relate the dynamics in rangeland condition to both physical and socio-economic drivers of change (e.g. climate desiccation and government policies). The investigations have therefore been conducted in an interdisciplinary and integrated manner. The project has made good progress and most fieldwork has been done both for the biophysical environment and the socio-economic dimensions. Scientists involved in the project are busy analysing their results and writing up. The project results will be disseminated at a workshop in Maseru, Lesotho in December 2000.

◆ Southern African Regional Science Plan Initiative: Safari 2000

The Southern African Regional Science Initiative – SAFARI 2000 – is an international science initiative aimed at developing an integrated understanding of selected aspects of the southern African earth-atmosphere-human system. The foundations of the study were laid during 1998 at a series of stakeholder workshops involving scientists from southern Africa, the United States and Europe. The goal of SAFARI 2000 is to identify and understand key linkages among the physical, chemical, biological and anthropogenic processes underpinning the functioning of the

biogeophysical and biogeochemical systems of Southern Africa.

This project also involves a number of KT scientists and so far very intensive field campaigns by scientists from the USA, Canada, UK, Australia and Southern Africa were undertaken in March 2000 where a number of measurements on the biophysical environment were taken. Air-borne campaigns were carried out in September 2001. It is hoped that a regional data centre will be developed for the region that will assist in decision-making regarding the use and management of regional natural resources.

Capacity Building

The above-mentioned projects have enabled the KT scientists to interact with scientists from other countries and hence have afforded them a chance to share experiences and knowledge. It is assumed that the capacity to carry out research will be strengthened through this international collaboration.

The KT initiative greatly appreciates the high performance computer donation made by START to the project. The computer has enhanced our super highway information skills and thereby being able to communicate with colleagues from other parts of the world. Our computer capability has therefore been enhanced.

Reports or Publications

The most important reports and publications for the KT are:

- ← START Report No.2, 1998. *Towards Sustainable Natural Resource Management in the Kalahari Region*: Abstracts and report from the Kalahari Transect Regional Scientific Workshop. Gaborone Botswana 10-13 June 1998. Edited by R. Chanda, S. Ringrose, and L. Magole.
- ← *Towards Sustainable Natural Resource Management in the Kalahari Region: Some Essential Background and Critical Issues*. START (IHDP.IGBP.WCRP). Edited by S. Ringrose and R. Chanda and Published by Directorate of Research and Development, University of Botswana, Gaborone, Botswana.

See the following website for publications update and other issues.

<http://www.ub.bw/news/ktworkshop/MainPage.htm>

For further information contact:

*Dr O. Totolo and Dr R. Chanda
University of Botswana, Department of
Environmental Sciences, University of Botswana
Private Bag 00704, Gaborone, BOTSWANA
Email: totoloo@mopipi.ub.bw or
chandar@mopipi.ub.bw*

2.5 Southern Africa Fire Research Initiative (SAFARI) 2000

The SAFARI 2000 project has more or less wound up. Here we present the highlights of the campaign.

Coordination and Results Meetings

December 2001

- ✦ American Geophysical Union Fall Meeting: SAFARI 2000 special session held in San Francisco, USA.
- ✦ First major exposure of results to broader community.

September 2002

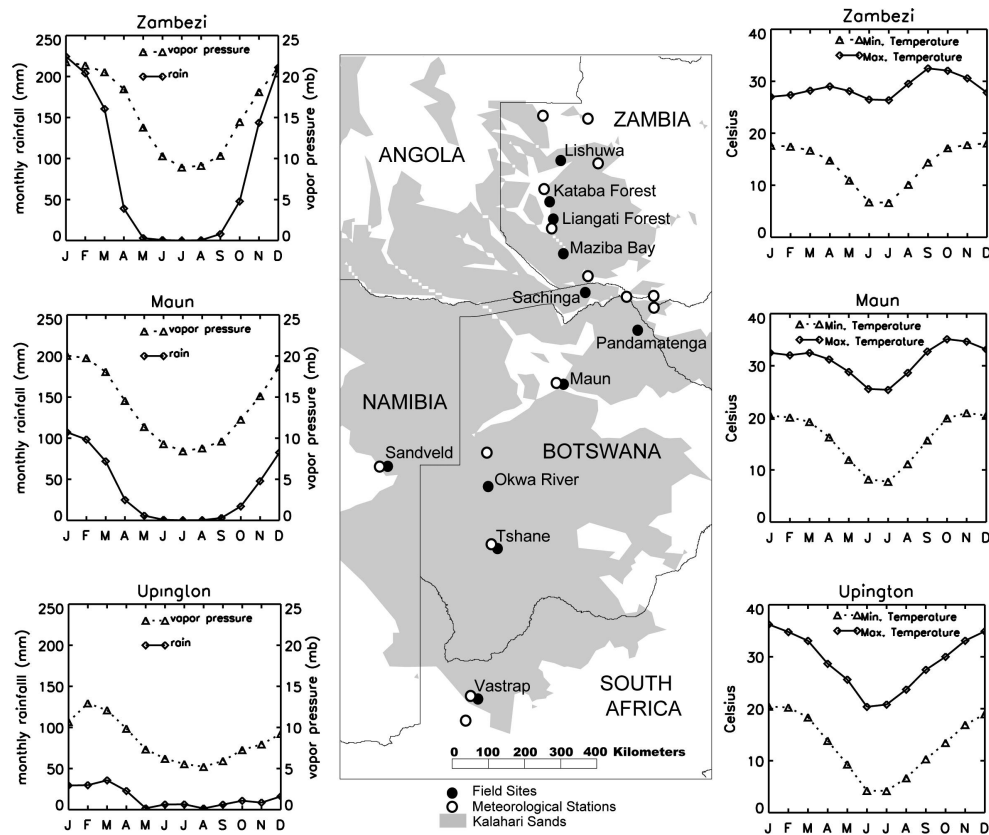
- ✦ IGAC Conference in Crete – no special SAFARI session but a regional projects section where another group of SAFARI data will be presented.

October 2002

- ✦ SAFARI 2000 conference in Charlottesville, USA.
- ✦ Synthesis conference for SAFARI 2000 and development of working groups for the production of a SAFARI 2000 results book.

Publications

- ◆ South African Journal of Science : 4 overview papers have been published.
- ◆ Special issue of *Global Change Biology* (in review): about 10 papers relating to SAFARI wet season campaign data
- ◆ Special issue of *Journal of Geophysical Research*: results presented at the AGU meeting. To date 36 papers have been submitted
- ◆ Special issue of the *International Journal of Remote Sensing* has also been organized
- ◆ Aside from these many individual papers have been submitted/published in other journals
- ◆ In terms of the South African component there were 17 published papers, 41 submitted or in preparation and 38 presentations at scientific meetings



Capacity development

- ◆ Funding was obtained from various sources to get regional participants to attend workshops and campaigns.
- ◆ New collaborations between universities were developed during SAFARI 2000: University of Virginia (USA) – University of the Witwatersrand (SA) – Eduardo Mondlane University (Mozambique) - University of the Witwatersrand (SA) – University of Botswana.
- ◆ Many regional and international students (an estimated 50 – 70) registered for higher degrees using SAFARI related data.
- ◆ In terms of South Africa alone a total of 18 students have been awarded or are in the process of completing their higher degrees.

Activities for the future

- ◆ SAFARI 2000 synthesis conference in October 2002.
- ◆ Presentation to Air pollution Information Network for Africa (APINA) in early 2003.

APINA is a policy forum that is viewed by SAFARI 2000 as a major stakeholder and conduit for passing scientific findings on to the SADC policy environment. A policy maker's summary of SAFARI 2000 will therefore be presented to APINA members.

For more information, contact:

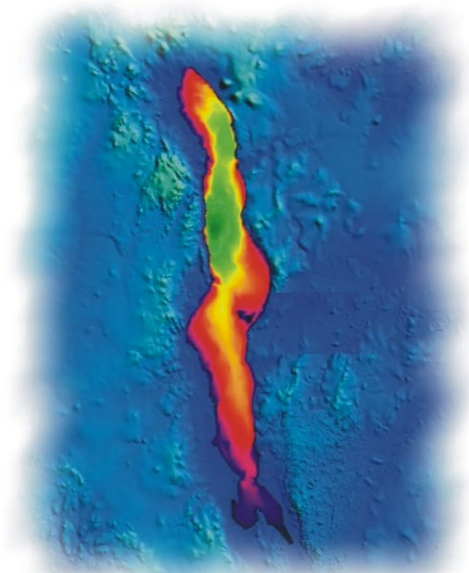
*Luanne Otter:
University of the Witwatersrand, South Africa.
Email: luanne@crg.bpb.wits.ac.za*

2.6 IDEAL - the International Decade for the East African Lakes: The Lake Malawi Drilling Project

IDEAL, the International Decade for East African Lakes, is a ten-year multi-national, multi-disciplinary investigation of the biological, geological, chemical, and physical limnology of the East African Lakes, taking into special account the Great Lakes of the East African Rift Valley and the climatology and paleoclimatology of the Rift Valley itself. The main activity now is the deep lake drilling project, starting with Lake Malawi, and then moving on to the other large lakes.

Introduction

The U.S. National Science Foundation and the International Continental Scientific Drilling Program have decided to support a major drilling campaign on Lake Malawi during 2002. The project will support drilling on sites in the southern, central and northern basins of the lake, using the new GLAD800 drilling rig, operated by DOSECC.



**Digital Elevation Model of Lake Malawi
and the Surrounding Rift Valley**

The Lake Malawi Drilling Project seeks to undertake a scientific drilling campaign on Lake Malawi, to recover a series of ~400 m-long continuous sediment cores for paleoclimate studies. Lake Malawi is situated at the southern end of the East African Rift Valley, and has long been recognized as an outstanding laboratory and archive for the study of tropical paleoclimatology,

extensional tectonics, and evolutionary biology. Along with Lake Tanganyika, Lake Malawi holds the promise of a high-resolution paleoclimate record of unparalleled antiquity in the continental tropics. Lake Malawi is one of the world's largest, deepest (maximum water depth of 700 m), and oldest lakes (2-7+ ma), and is the largest lake in the

southern hemisphere (9°-14°S) after Lake Tanganyika.

Site Selection and Drilling Strategy

The top priority site is situated in the central basin, southeast of the deepest part of the lake. It is here that seismic reflection site survey data indicate the best prospects for continuous cores of hemipelagic sediment. Such a depositional setting, in an area with no major stratigraphic hiatuses, offers the best chance to recover a continuous section of high-quality paleoclimate proxy records back through the Bruhnes-Matuyama boundary. A core through this site will allow us to construct a detailed chronostratigraphy, and be a basis for correlations between other sites that may contain punctuated paleoclimate records.

A site in the southern part of the lake (13°S) will allow us to record a southern hemisphere tropical signal, as well as nearshore facies that developed during lake lowstands. We intend to recover a series of cores along a northern basin "offset drilling transect" that will allow us to extend the stratigraphic record far back into the Pliocene or perhaps Miocene. In addition, a northern basin site

is most likely to recover a section of finely laminated or varved sediments.

Book Publications

Johnson, T.C. and Odada, E.O., (eds.) 1996. The Limnology, Climatology and Paleoclimatology of the East African Lakes. Gordon and Breach Publ, Amsterdam, 664 pp.

Lehman, J.T., (ed.), 1998. Environmental Change and Response in East African Lakes. Kluwer Academic Publishers, 236 pp.

Odada, E.O. and Olago, D.O. (eds.) 2002. The East African Great Lakes: Limnology, Paleolimnology and Biodiversity. Advances in Global Change Research Book Series, Kluwer Academic Publishers. 586pp.

For more information, contact:

*Professor Thomas C. Johnson
Large Lakes Observatory, University of Minnesota,
Duluth, MN 55812, USA
Tel: (1-218) 726-8128; Fax: (1-218) 726-6979; E-mail: tcj@d.umn.edu
<http://www.d.umn.edu/llo>*

2.7 SEARCH/African Pollen Database (APD) Project

The SEARCH Project has now come to an end, but the APD Project continues using the networks and capacity building that has been developed through SEARCH. In the context of the SEARCH project, PASS has been able to further develop its regional research network for the development and coordination of indigenous capacity to undertake global change research in Africa. This has been accomplished through the establishment of a state-of-the-art database centre in Nairobi, hosting various databases of relevance to global change research, and by interaction with other regional projects in order to develop the capacity for research in global change. Within this context a lot of training activities have been carried out for scientists throughout Africa. Our tasks and deliverables have been fully implemented, though a lot of scope exists to expand the network of state-of-the-art database centres to other African regions.

1. Database Centre

The PASS Database Center is now equipped with data processing open to the Internet (mail, web, and ftp). The network services carried out have already facilitated the mirroring of the paleo-database of the Boulder World Data Center, <http://wdc.uonbi.ac.ke>. The PASS Database Center is currently developing its own web page, and will develop a web magazine as well as install other own and mirrored databases. The SEARCH web page has been installed at the following site: <http://medias.meteo.fr/search>. It contains in particular: 1) general information relating to SEARCH and ENRICH, as well as links to the web sites of the research programs related to SEARCH (APD, Miombo, Kalahari); 2) meetings and missions. Improvements of this site are underway, in particular, access to the data banks.

The PASS web site (<http://pass.uonbi.ac.ke>) is hosted on one of the Linux servers using Apache web server. The African Global Change scientist

on this site. The database contains over 1000 records of African scientists involved in global change research. Each record contains the scientist contacts, Academic qualifications and areas of research. This database can be searched by scientist's country of origin, subjects of interest or using a combination of the two. The url for the database is <http://pass.uonbi.ac.ke/scientistdb/index.html>. The PASS web site also contains a mirror of the African Pollen Database (APD). The Database is developed and maintained at MEDIAS France. The url for the Database is <http://pass.uonbi.ac.ke/apd>. General information on the search project can be found at <http://pass.uonbi.ac.ke/recent-planned/SEARCH/index.html>. General information about the Pan-African START Secretariat (PASS) and its activities can also be found on the site.

In addition to hosting the APD mirror site, the database also hosts the WDC/NOAA Palaeoclimatology mirror site, under the enhancement and expansion programme of the WDC/NOAA Program Mirror Sites. Currently, our mirror site is being upgraded to the latest version of the operating system, Redhat Linux 7.2. Over the past year, 996 users from the African region have accessed the Nairobi site.

2. Workshops

The third and final workshop, the Nairobi Showcase Workshop, was held in Nairobi from 22 to 26 October 2001. The meeting was a special forum for interaction among scientific and technical communities dealing with global change studies, (paleo)-environmental knowledge and database management. It was held jointly with introductory and advanced tutorials, and provided researchers with the opportunities to learn more about database management. The meeting was an outstanding scientific event in African Environmental Studies. There were over 30 participants from participating countries and institutions, and there were also the representatives of organisations that were sponsoring various aspects or components of SEARCH-APD. Fruitful discussions were held on the way forward for development of the network and global change research in Africa.

3. Perspectives for the Future

The objectives of the cooperation between African Pollen Database (APD) and the Search network which we would like to develop further include (1) collection of data on environmental

vegetation (2) provision of paleo-vegetation data as a test for ecosystem models, and (3) reconstructing the long-term effect of human land use on soil character and processes, in support of developing management strategies for the conservation and sustainable use of biodiversity and natural resources.

We would like to further develop the PASS Database Center in Nairobi to include databases on palynology (APD), palaeohydrology, groundwater resources, Miombo etc. This is necessary for enhancement of data exchange, and the development of joint, interdisciplinary research. The development of mirror sites of the Database Center in western Africa is considered a priority action to enhance collaboration between French-speaking and English-speaking researchers, and also to ease access to information for western Africa.

4. Publications

Olago, D.O. (2001). Vegetation changes over palaeo-time scales in Africa. *Journal of Climatic Research*, Vol. 17(2): 105-121.

Olago, D.O. and Odada, E.O. (2001). Palaeoecology of Eastern Africa Mountains. *PAGES News*, Vol. 9 No. 3, pp. 19-21.

Odada E.O. and Olago, D.O. (Editors) (2002). *The East African Great Lakes: Limnology, Palaeolimnology and Biodiversity*. In *Advances in Global Change Research Book Series*, Kluwer Academic Publishers, Amsterdam. 586 pp.

IDEAL Reports are accessible from the IDEAL website at URL <http://lrc.geo.umn.edu/IDEAL/>. Copies of recent and past Bulletins are available from that site for download and viewing in Acrobat pdf format.

For more information, contact:

*Dr. Michel Hoepffner
MEDIAS-FRANCE, CNES-18, Avenue Edouard-Belin, BP1 2102, 31401 Toulouse Cedex 4,
FRANCE
Fax: +33-561 282 905; Email:
michel.hoepffner@medias.cnes.fr*

*Professor Eric O. Odada
Pan African START Secretariat (PASS), University of Nairobi, Department of Geology, Chiromo*

Campus, Riverside Drive, P O Box 30197, Nairobi, Kenya

Tel: (+254-2) 447 740; Fax: (+254-2) 449 539;
Email: pass@uonbi.ac.ke; eodada@uonbi.ac.ke

2.8 Land Use Change Impacts and Dynamics (LUCID) : Land Use Change Analysis as an Approach for Investigating Biodiversity Loss and Land Degradation

This UNEP-GEF funded project provides an umbrella for various research activities occurring in sites across East Africa, and at the East Africa regional level. The Land Use Change Impacts, and Dynamics (LUCID) project team includes CGIAR scientists and scientists from East African, U.S. and French research and academic institutions. The project's goal is to contribute to the conservation of biodiversity and prevention of land degradation by providing useful instruments to identify and monitor changes in the landscape associated with biodiversity loss and land degradation, and identify the root causes of those changes.

The research sites include : 1) Mt. Kilimanjaro and its surrounding rangelands in Kenya and Tanzania, 2) the eastern slopes and adjacent lowlands of Mt. Kenya , 3) Rubale, a highland to lowland gradient in south-western Uganda , 4) Lake Mburu National Park and surroundings in Uganda, 5) Sango Bay on Lake Victoria in Uganda, and 6) the East African region as a whole. The site research will be described in more detail by country below.

The project's duration is 2001 to 2003. The first year has been devoted to field research to fill gaps needed provide direct cross-site comparisons. The second and third years will be spent conducting analyses at the site and regional levels, constructing, testing and linking models, and developing the framework and guide described in the objectives above. The project's regional coordination office and the Kenya national office is based at the International Livestock Research Institute in Nairobi, Kenya, the Tanzanian national office is based at the University of Dar es Salaam in Dar es Salaam, Tanzania, and the Ugandan national office is based at Makerere University in Kampala, Uganda.

Planned activities:

Among the planned activities is a project to study climate change and land use processes in east Africa.

In a recent conference bringing together climatologists, meteorologists, agricultural and socio-economic scientists, and decision makers, it became clear that a key concern is the vulnerability of agricultural production and of natural systems. The climatic effect of widespread land use/ land cover change, such as deforestation and bush clearance, is also of high concern. Decision makers also expressed a need for data on the relationship between land use change and carbon sequestration, baseline data required for policies to support carbon trading. In this context, the challenge to scientists is to provide sound, regionally-specific information that is useful and relevant to decision makers and producers. The challenge to decision makers is to facilitate effective responses. The collective focus is an understanding of the interactions between climate and human activity through an integrated assessment of societal and biophysical systems.

Through the development and testing of models and other approaches, this project will provide a generic research protocol for regional assessments of the impact of land use change and the impact of medium and long-term climatic variability and change on livelihoods, biodiversity and land degradation. With strategic carbon measurements, models will be parameterised to provide statistics on the links between land use and sequestered carbon.

The project will apply the data and methodologies concerning the links between land use change, land degradation and biodiversity in East Africa developed by the UNEP-GEF LUCID project, with other state of the science models, data and information. Although East Africa is unusual because of the availability of existing analyses and databases on land use change, current climatic patterns, change in biodiversity and land degradation, the methodological and analytic approaches developed by this project will be applicable to other African regions.

Capacity building

3 PhD and 4 masters students whose research contribute to Lucid objectives, and who are partially supported financially by the project are on their study programmes. Post-doctoral training of an east African at Land Use Research Institute, Scotland (on land use modelling and land degradation monitoring) has also been supported by lucid

For more information, contact:

Dr. Joseph Maitima, j.maitima@cgiar.org, and

Dr. Jennifer Olson, j.olson@cgiar.org.

2.9 Global International Waters Assessment (GIWA) in Sub-Saharan Africa: Synthesis Report

Rationale and Objectives of GIWA

Recognizing the fundamental importance of water, and the challenges in ensuring that waters are utilized in a sustainable manner, the Global International Waters Assessment arose from a desire to build a comprehensive, global picture of water-related issues which would allow a clear view of the most effective means of ensuring environmentally, socially and economically sustainable use of these vital resources for the benefit of all. A primary aim of GIWA is to identify priorities for effective, action-driven interventions, which will bring about real and meaningful improvements, both within the natural and the socio-economic environments. GIWA is

thus set to contribute significantly towards improving livelihoods, and provides a sound basis for the sustainable development that is the cornerstone of the process of African development.

GIWA in Sub-Saharan Africa

GIWA is being implemented in 45 sub regions grouped in nine- mega regions across the world. Sub Saharan Africa is one of the nine-mega regions and hosts eight sub regions, Canary Current, Gulf of Guinea Current, Lake Chad, Benguela Current, Agulhas Current, Indian Ocean Islands, Somali Coastal Current and East African Rift Valley Lakes (see map).

Canary Current

The southeastern boundary of the sub region runs along the water divide separating the Senegal and Niger River Basins. The southwestern limits include Cape Verde and Canary Island.

Gulf of Guinea

The northern boundary of the Gulf of Guinea Current is at the Cape Verga (located approximately at latitude 11°N, longitude 16°W) in Bissagos Islands, Guinea Bissau. In the interior, the northern boundary covers the uppermost end of the Niger Benue River with tributaries and Volta River catchments. The southern limit is at Cape Lopez (latitude 0° 41'S, longitude 8° 45'E) in Gabon.

Lake Chad

The sub region covers the hydrographic Lake Chad basin including all the trans-boundary surface water systems (Chari-Logone-El Beid; Hadejia-Jama'are-Komadugu/Yobe; and the Lake) as well as the regional groundwater aquifers (Quaternary, Middle Pliocene and Continental Terminal/Himadien).

Benguela Current

The northern most boundaries include Cabinda Province, which is part of Angola. The boundary does not include rivers draining into the Congo Basin. The seaward boundary is taken as the 200-mile Exclusive Economic Zone.

Agulhas Current

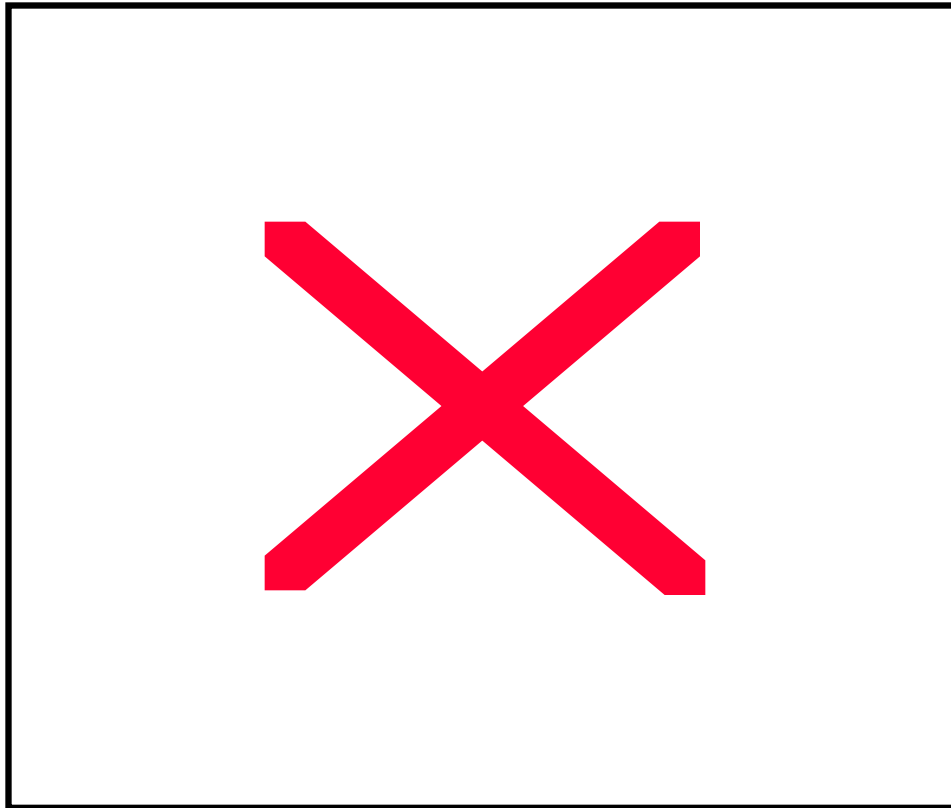
Marine components include Mozambique and South African continental shelves (approximately 5000 km of coastline) and Mozambique and South African Open Ocean EEZ region of each country. Freshwater components include the Zambezi, Okavango system, Limpopo, Pungoe, Buzi, Save, Incomati, Umbeluzi, Maputo, Pongola and Tugela rivers.

Somali Coastal Current:

The major rivers in the sub region include Juba/Shebelle (Somalia), Tana and Athi/Galana (Kenya), Pangani, Wami, Ruvu, Rufiji and Ruvuma (Tanzania). The catchment of Ruvuma River and tributaries forms the southern boundary of the sub-region.

East African Rift Valley Lakes:

GIWA assessment is being carried on the following transboundary lakes and their basins; Malawi, Tanganyika, Kivu, Victoria, Turkana and Edward. Other lakes, which are not focal lakes for the GIWA assessment but are important shared lakes in the region are: Natron, Jipe, Albert and Chala.



An initial workshop was held in April 2002 of the synthesis team members to gather materials from each project and coordinate development of the synthesis document. The workshop included representatives from the projects including experts on freshwater and marine systems, socio-economics, law and health. The output from this exercise was a regional waters assessment document that was distributed at the recently concluded WSSD meeting in South Africa. This document will contribute to policy statements

including national communications to the United Nations Framework Convention on Climate Change.

For more information, contact:

*Prof. Eric O Odada
Pan African START Secretariat, Department of
Geology, University of Nairobi, P O Box 30197,
Nairobi, KENYA.*

E-Mail: Pass@uonbi.ac.ke or
eodada@uonbi.ac.ke

Phone: 254-02-447740 Fax: 254-02-449539

SECTION 3: RESEARCH PROJECTS

3.1 Greenhouse Gas and Climate Change Studies in the East African Rift Valley and on Mt. Kenya

There have been only a few studies of water column trace gases in the lakes of the East African Rift and other parts of northern Africa but none on **sediment gases**. It is likely that sediment gases in some of the African Great Lakes will be in very high concentrations as observed in other lakes world-wide that are undergoing various conditions of fertilization by agriculture in the watersheds (this is termed eutrophication). Recent studies on Lake Nakuru, one of the important Rift Valley lakes, indicate high levels of gases when sediment cores exploded during our processing. Gas measurements are critical to understanding the pathways of carbon and nitrogen production and consumption in lakes, in evaluating deoxygenation problems from oxygen-consuming substances and for determining the role of lake surfaces as sources of greenhouse gases to the troposphere.

Capacity Building

Two graduate students (S. Ochola and L. Olaka) from the University of Nairobi have already been attracted to assist in the research being conducted in East African Rift lakes. This research on sediment gases and climate change should provide for an important continuation of research already conducted in East African Rift valley lakes. This will also aid in building cooperation with African colleagues and graduate students and will develop the required research infrastructure.

Objectives for 2002/3

- ♦ to assess the concentrations of sediment greenhouse gases in two of the East African Rift Valley lakes - Naivasha and Nakuru,
- ♦ to quantify the diffuse fluxes of these gases from the sediments in order to evaluate the losses of these gases to the water column, and their potential for deoxygenation of the lake's bottom (hypolimnetic) waters, and their emission from lake surfaces to the atmosphere,
- ♦ to initiate a program with Dr. Daniel Olago, Department of Geology and Pan-African

START Secretariat (PASS), University of Nairobi, for sampling sediment gases in Sacred Lake, Mt. Kenya,

- ♦ to start work on joint publications with graduate students and scientific colleagues.

Anticipated Outcomes for Future Research

Long term arrangements for future greenhouse gas studies in Africa, in cooperation with African, U.S. and European scientists, are already being considered in other parts of Africa. A proposal is being developed for deep drilling at Lake Bosumtwi, Ghana, in 2004. There is also the potential for participation in wetland greenhouse gas emission studies at the Okavango Delta in Botswana, additional coring and gas analysis on Lake Victoria with Professor Eric Odada and assisting in a doctoral research project with Oguttu Hannington Wogenga'h at the Fisheries Resources Research Institute, Jinja, Uganda. Lastly, both Drs. Tom Johnson, Director of IDEAL (International Decade of East African Lakes) and Eric Odada are planning a coring project on Lake Turkana, and sediment gas measurements would be critical to these studies.

Publications

Adams D.D. and Ochola S.O. 2002. A review of sediment gas cycling in lakes with reference to Lake Victoria and sediment gas measurements in Lake Tanganyika. In: *The East African Great Lakes: Limnology, Paleolimnology and Biodiversity* (edited by E.O. Odada and D.O. Olago), Kluwer Publishers, Amsterdam.

For more information, contact:

*Professor Donald Adams,
Professor of Environmental Science, Center for
Earth & Environmental Science (New York), State
University of New York, Plattsburgh, New York,
U.S.A. 12901
Email: donald.adams@plattsburg.edu*

SECTION 4. START FELLOWSHIPS/VISITING SCIENTIST AWARDS

START/PACOM Doctoral Fellowship Award Program (Round 1)

1. Mohamed Awer Mohamed (Nationality: Kenyan, Institution: Egerton University, Kenya) – research on the hydrologic characteristics of the Perkerra River that feeds Lake Baringo
2. Agnes Bbugara (Nationality: Ugandan, Institution: University of Witwatersrand, South Africa) – research on the vulnerabilities of rural societies to climate perturbations in different climatic regions of Botswana
3. Anne Barrable (Nationality: South African, Institution: University of Witwatersrand, South Africa) – research on the impact of climate change on soil erosion and land degradation in South Africa
4. Dennis Dlamini (Nationality: Swaziland, Institution: University of Natal, South Africa) – research on the development and testing of water poverty indices at the meso-catchment scale
5. Benjamin Dovie (Nationality: Ghanaian, Institution: University of Witwatersrand, South Africa) – research on the linkages between woody species biodiversity and livelihoods of rural households in Southern Africa
6. Francis Mugabe (Nationality: Zimbabwean, Institution: Midlands State University, Zimbabwe) – research on the influence of climatic characteristics and land use on groundwater resources of semi-arid catchment basins
7. Lawrence Ngorora (Nationality: Zimbabwean, Institution: University of Cape Town, South Africa) – research on seasonal climate forecasting for Southern Africa
8. Jane Olwoch (Nationality: Rwandan, Institution: University of Pretoria, South Africa) – research on the impact of climate change on tick-host relationships and its implication for disease propagation
9. Mohamed Abdel-Aty Sayed (Nationality: Egyptian, Institution: Ain Shams University) – research on the effect of climate change on rainfall runoff processes over the Nile River basin
10. Louis Zapfack (Nationality: Cameroonian, Institute: University of Yaounde I) – research on the impact of land use change on the botanical diversity of semi-deciduous rain forests and quantification of carbon biomass contained therein

START Fellowship/Visiting Scientist Award Program (Round 10)

1. **Nicholas Azza**, Directorate of Water Development, Uganda. Fellowship to the International Institute of Hydraulic & Environmental Engineering, The Netherlands - research on the effects of climate change on Lake Victoria.
2. **Tonderayi Makumire**, University of Zimbabwe. Fellowship to the Centre for Ecology and Hydrology, United Kingdom - research on African woodlands and hydrology.
3. **Patrick Mushove**, Servicos Provinciais de Florestas e Fauna Bravia, Mozambique. Fellowship to the University of Witwatersrand, South Africa - research on land use and land cover change in Mozambique.
4. **Mohammed Umer**, University of Addis Ababa, Ethiopia. Visiting scientist award to the University of Wales, United Kingdom - palynological research on crater lakes in Ethiopia.

Young Scientist Awards for Sub-Saharan Africa, 2001/2

1. **Ben Arimah**, Centre for Urban and Regional Planning, University of Ibadan, Nigeria. Paper: "Energy transition and its implications for environmentally sustainable development in Africa." *International Journal of Sustainable Development and World Ecology* (2000) 7: 201-206.
2. **Brahim Damnati**, Department of Earth Sciences and Oceanology, Abdelmalek Essaadi University, Tangier, Morocco. Paper: "Holocene lake records in the Northern Hemisphere of Africa." *Journal of African Earth Sciences* (2000) 31(2): 253-262.
3. **Zewdu Eshetu**, Department of Botany, University of Cape Town, South Africa. Paper: "Reconstruction of forest site history in Ethiopian highlands based on ¹³C natural abundance of soils." *Ambio* (2000) 29(2): 83-117.
4. **Evans Kituyi**, African Centre for Technology Studies, Kenya. Paper: "Biofuel consumption rates and patterns in Kenya." *Biomass and Bioenergy* (2001) 20: 83-99.

SECTION 5: UPCOMING ACTIVITIES

5.1 Science-Policy Conference on Global Change and the Vulnerability of Land and Water Resources in Africa

To effectively link the research and policy communities within Africa, the Pan-African START Committee decided during its meeting in April 2001 to work collaboratively with the African Ministerial Conference on the Environment (AMCEN). This body is made up of the environment ministers of 52 African nations and is an effort to strengthen cooperation among African nations on economic, technical, and scientific activities to halt the degradation of Africa's environment and satisfy the food and energy needs of the continent's people. This does not exclude working with other regional policy bodies.

PACOM wishes to bridge the science-policy gap by:

- ♦ Offering advice to countries through transfer of latest scientific and technical knowledge on vulnerabilities and adaptive capacity of African ecosystems to environmental change for incorporation into national and regional policy setting.
- ♦ Establishment of a long-term dialogue between local and international experts on the impacts of global change in Africa
- ♦ Introduction of new opportunities for international collaboration to African environmental change scientists

In 2001-2002, the focus of AMCEN has been on preparations for the upcoming World Summit on Sustainable Development (August-September 2002). Because of these preparations, AMCEN and START had decided to postpone the Science-Policy Conference until the next AMCEN meeting. This envisioned meeting was, however, not possible due to time limitations in the very tightly scheduled AMCEN meeting. UNEP-ROA in conjunction with PACOM is working towards having a meeting with AMCEN and other policy officials later on this year (November) after the WSSD Meeting in South Africa, or early next year (2003).

For more information, contact:

Professor Eric O. Odada
Pan African START Secretariat (PASS), University of Nairobi, Department of Geology, Chiromo Campus, Riverside Drive, P O Box 30197, Nairobi, Kenya
Tel: (+254-2) 447 740; Fax: (+254-2) 449 539;
Email: pass@uonbi.ac.ke; eodada@uonbi.ac.ke

5.2 The Pan-African Digital Water Resources Atlas: Prototype Capacity Building

Background

It has been estimated that 1.3 billion people or one-quarter of the world's population live in countries experiencing moderate to high water stress, many of which reside on the African continent. According to the UN and other prominent national and international agencies, it is inevitable that during the first half of the next century water shortages will be among the most important global problems, linking issues as diverse as food security, international diplomacy, poverty alleviation, public health, energy production, and ecosystem

protection. All of these issues are of importance and concern to human society.

Water scarcity is an important measure of environmental stress that necessitates significant investment in water infrastructure. In many parts of arid and semi-arid Africa, the shortage of water is already a critical limit to economic development and has been identified as a potential, major source of international conflict. Even in the humid tropics, dry season water shortages have been intensified by extreme weather events.

In the face of such water scarcity, the provision of reliable data on African water supply, water resource and socioeconomic indicators remains a critical but unmet challenge. As but one indication of the current state of affairs, there has been a 90% reduction over the last 10 years in the reporting of African river discharge -- an important source of water supply -- to relevant international agencies such as the World Meteorological Organization, leaving us with little concrete information about the state of current African water resources. High quality socioeconomic data are even more scarce. Developing more accurate agricultural water use estimates is key because irrigation is responsible for the bulk of all water consumed yet there are few standardized methods to distinguish water withdrawals from water consumption, which is likely to significantly bias estimates of the amount of water consumed by irrigation.

Recent gatherings by the International Geosphere-Biosphere Program, International Association of Hydrological Sciences, UNESCO's International Hydrological Program, UN World Water Assessment Program, and UNEP Global Environmental Monitoring System (Water) have all concluded that the situation is even more urgent with respect to water quality, public health, and

pollution data. High quality information on the state of inland waters is critical to water planning agencies throughout Africa.

Data, in fact, do exist today on the water resources of Africa but taken as a whole these information resources represent a variety of spatial scales, are of disparate and often questionable quality, and are likely to represent only short-duration or temporally fragmented coverage. At the pan-African scale, a number of reports have been published that estimate the distribution of water resources and hence water scarcity across the entire continent, but these suffer from two faults. First, since estimates are often at the country-level, they cannot easily be disaggregated by watershed or sub-watershed, which are much more meaningful units of analysis for the purposes of water management. Second, water use estimates are often simply educated guesses and highly inaccurate. As a consequence, water planning and infrastructure development must rely on a broad range of data whose reliability is questionable. A spatially and temporally-harmonized data set for the entire continent is clearly advantageous for the coherent development of water resources systems in Africa.

Goal Statement

This proposed project will be cast as a prototyping effort to explore the conjunctive use of local and regional-scale expertise with information and information systems that are globally-available. Training of African scientists will take place at the University of New Hampshire's Institute for the Study of Earth, Oceans, and Space. The overall effort will attempt to consider a simultaneous biophysical and socio-economic approach to the water resources question and will be cast at local, regional, and pan-African scales. Our long-term goal is to develop:

• A high spatial resolution Digital Water Resource Atlas and Early Warning System for the pan-African continent to support both scientific capacity-building and water infrastructure planning.

The Digital Atlas will be derived from three major sources of information:

- ♦ a large number of regional-to-global scale biophysical data sets, high resolution digital map products of water budgets, and observed hydrography time series available currently as part of existing global change studies from around the world; these data sets are spatially, temporally, and methodologically harmonized to permit transboundary assessments to be made with consistency and improved rigor; and,
- ♦ more local-scale, district, and country-level archival data that will be submitted to the Atlas as part of funding agreements of participating institutes in the US and Africa; the data base will include both water supply as well as socioeconomic data and information on water use, efficiency, and infrastructure development.

- ♦ and ultimately, operational hydrometeorological data sets derived from numerical weather prediction models.

We have the capacity to map the geographical distribution of water availability and its variability over time with high spatial resolution. These outputs will be merged with improved water demand estimates, and thus water scarcity, through partnerships with invited experts from the water sector.

The work proposed here is to carry-out

A prototype Atlas development effort focused initially on the Senegal river basin, which seeks, through intensive 6-month training, to work with two West African scientists and produce a set of value-added biogeophysical products relating to water status across the Senegal basin.

We anticipate coverage over the Senegal using tools and data sets available through the UNH Global Hydrological Archive and Analysis System (GHAAS) (see: <http://pyramid.sr.unh.edu/csrc/hydro/welcome.html> ; <http://www.R-hydronet.sr.unh.edu/> for continental and regional-scale examples). Country-level, district, and local-scale data sets will be developed from regional partnerships such as with the IUCN regional offices in Burkina Faso for which we

anticipate a prototype study cast at the regional and sub-regional scale. The PI's involvement in a host of international outreach efforts (e.g. International Geosphere-Biosphere Program, . Millenium Ecosystem Assessment, UN World Water Assessment Program, UNESCO International Hydrological Programme, International Association of Hydrological Sciences) will facilitate further collaborations and the enlistment of water experts in support of this work.

Outputs and Deliverables

Several specific training and joint database development activities are envisioned:

- ♦ Train participants in use of current system including GIS and river basin analysis tools
- ♦ Working with participants, create a country and basin-specific data bundles for the Senegal Basin from the dozens of data layers already available.
- ♦ Use the data bundles to generate user-specified water resource indicators at the resolution of the pan-African holdings -- 8km currently.
- ♦ Increase the resolution to the highest possible resolution (1km for several data sets) and recompute the customized indicators for the Senegal.
- ♦ Compare results from steps (3) and (4).
- ♦ Compare results from steps (3) and (4) to the "local data".
- ♦ Assess the realism of the global and continental scale data sets, contrasted against higher resolution data sources from the participating partners.
- ♦ Summarize in a peer-reviewed paper.
- ♦ Permit participants to present results at a major national or international meeting.
- ♦ Embed results into GEF proposal.

This project will be carried out at the Water Systems Analysis Group at the University of New Hampshire's Institute for the Study of Earth, Oceans, and Space. This research team has a long history of developing and providing state-of-the-art water information that have supported a broad range of scientific studies on the global water cycle, the development of regional and basin-scale hydrology simulation models, nutrient chemistry and pollution studies. The Group has also been active in hydrometeorological capacity-building in

the developing world, most recently collaborating with the UNESCO Regional Office for Science and Technology (Montevideo URUGUAY) and the Water Center for the Humid Tropics (Panama City PANAMA) on workshops for the exchange of water data using a WWWeb-based system. Frequent communication with the Pan-African START initiative will help to ensure continued relevancy.

For more information, contact:

Charles Vörösmarty
Director, Water Systems Analysis Group
Complex Systems Research Center
Institute for the Study of Earth, Oceans, and Space

University of New Hampshire
Durham, NH 03824 (USA)
Tel: 603-862-1792 (FAX: -0188)
charles.vorosmarty@unh.edu

SECTION 6: RECENT/UP-COMING PUBLICATIONS

1. Regional Environmental Change: Multidisciplinary Syntheses from Southern Africa. South African Journal of Science, March/April 2001, Vol. 97 No.3/4.
2. Africa and Global Climate Change. Climate Research Special 8, edited by P. Desanker, 2001. ISSN 0936-577X.
3. The East African Great Lakes: Limnology, Palaeoclimatology and Biodiversity. E.O. Odada and D.O. Olago (Editors), Advances in Global Change Research Book Series, Kluwer Publishers, Amsterdam, 2002.
4. Freshwater Resources in Sub-Saharan Africa with Emphasis on Regional Scale Interactions of Land Use and Climate. Edited by: M. Fosberg, J. Gash, E. Odada and R. Schulze. Freshwater Resources BAHC/IHDP Book Series, 2000.
5. Global-Regional Linkages in the Earth System. Edited by: P.D. Tyson, R. Fuchs, C. Fu, L. Lebel, A.P. Mitra, E. Odada, J. Perry, W. Steffen and H. Virji. Springer-Verlag, Berlin, 2002. ISBN: 3-540-42403-2.
6. Towards Sustainable Management in the Kalahari Region: Some Essential Background and Critical Issues. S. Ringrose and R. Chanda (eds.), Directorate of Research and Development, University of Botswana, Gaborone, Botswana.
7. GIWA Synthesis Report for Sub-Saharan Africa. Prepared by Eric Odada, Kim Prochazka, Edith Mussukuya, Renison Ruwa, Kassim Kulindwa. To be submitted to the WSSD in Johannesburg, South Africa, August 2002.
8. Climate Change for Africa: Science, Technology and Capacity Building. Pak Sum Low (ed.), Kluwer Academic Publishers (in press).
9. PEPIII Publication. Proceedings of the PAGES-PEP III Meeting, August 2001, Aix-en-Provence, France. Edited by Rick Batterbee. To be published by Elsevier Science, December 2002.
10. LOICZ Afribasins Report (in press, 2002).

APPENDIX

PACOM MEMBERS

Prof Shem Wandiga

University of Nairobi, Department of Chemistry
P O Box 30197, Nairobi, KENYA
Tel: 254-2- 336173 / 219420
E-Mail: knas@iconnect.co.ke

Prof Michel Boko

Interfaculty Centre for Training and Research in
Environmental Sciences for Sustainable
Development, Universite National du Benin
01 – BP 526, Cotonou – 01, Republique du Benin
Tel: (229) 304763 / 360061
Fax: 229-360028/61
E Mail: mboko@syfed.bj.refer.org,
mboko50@hotmail.com

Dr. Ramadjita Tabo

ICRISAT, Bamako
BP 320, Bamako, MALI
Phone (223) 223375 Fax: (223) 228683
E-Mail: r.tabo@icrisatml.org

Dr Yinka Adebayo

Programme Officer
UNEP, P O Box 47074
Nairobi, KENYA
Tel: 254 –2-623444
E-Mail: yinka.adebayo@unep.org

Dr Bubu Jallow

Acting Director
Department of Water Resources
7, Maumarr Al Ghadaffi Avenue
Banjul, THE GAMBIA
Tel (220) 228216 (Direct) (220) 226154 Ext 301
Fax (220) 225 009
E-mail: bubujallow@hotmail.com

Dr Pius Yanda

Institute of Resource Assessment
University of Dar es Salaam
P O Box 35097
Dar es Salaam, TANZANIA
E-Mail: tanric@udsm.ac.tz

Mr Patrick Mushove

Servicos Provinciais de Florestas e Fauna Bravia
42 Josina Machel Road, Caixa Postal 36
Nampula, MOZAMBIQUE
E-Mail: pmushove@nampula.imoz.com

Dr Bekele Shiferaw

Agricultural University Norway
Department of Economics & Social Sciences
1432 Aas - NLH
P O Box 5033
NORWAY
E-Mail: bekele.shiferaw@ios.nlh.no

Dr Luanne Otter

Division Environmentek
Council for Scientific and Industrial Research
P O Box 395
Pretoria 0001, SOUTH AFRICA
E-Mail: lotter@csir.co.za

Professor Eric O. Odada

Pan African START Secretariat
KNAS/Department of Geology
University of Nairobi
PO Box 30197 Nairobi, KENYA
E-Mail: pass@uonbi.ac.ke; eodada@uonbi.ac.ke

Meetings Calendar

October: 2001

Date	Meeting:	Venue:
:		
1-3	GWA Scaling and Scoping Workshop Sponsors: UNEP/GWA Secretariat	Nairobi, Kenya
6-8	IDHP Meeting; The 2001 Open Meeting of the Human Dimensions in Global Environmental Change Research Community	Rio de Janeiro Brazil
9-11	GWA General Assembly	Kalmar Sweden
15-18	15 th START SSC Meeting	Washington
22-26	SEARCH/APD Show Case Workshop; Past Landcover Changes; The Human Impact – An African Database and SEARCH Network Symposium	Nairobi
29-1Nov	LOICZ AfriBASINS Meeting; Workshop on African River Catchment/Coastal Zone Interaction and Human Dimensions Sponsors: IGBP/LOICZ, NORAD, IOC/UNESCO	Nairobi

November: 2001

Date	Meeting:	Venue:
:		
19-23	GOOS Africa Workshop	KMTC, Nairobi
27-29	Water Resources Research in the Rift Valley – CIFEG (France) Sponsors: French Ministry of Foreign Affairs	Addis Ababa Ethiopia

February: 2002

Date	Meeting:	Venue:
:		
6-8	GEF-STAP Editorial Board Meeting	GEF Secretariat Washington DC, USA
11-15	AIACC Implementers Workshop	Nairobi
18-20	STAP Expert Group Workshop on Adaptation and Vulnerability	UNEP HQ

April: 2002

Date	Meeting:	Venue:
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9-11	GWA SRFPs and Detailed Assessment Workshop	Kisumu, Kenya

May: 2002

Date	Meeting:	Venue:
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29 May – 1 June	LOICZ Synthesis and Future Meeting	Miami USA

June: 2002

Date	Meeting:	Venue:
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24-30	NORAD Mid-Term Review and 5 th PACOM Meeting	Nairobi, Kenya

July: 2002

Date	Meeting:	Venue:
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15-18	GIWA Detailed Assessment meeting	Nairobi, Kenya

August: 2002

Date	Meeting:	Venue:
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26-4 Sept	WSSD	Johannesburg, South Africa

September: 2002

Date	Meeting:	Venue:
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10-13	UNESCO/MAB-SCOPE workshop on Emerging Ecosystems	Carmen de la Victoria Spain
26-28	27 th General Assembly of the ICSU	Rio De Janeiro, Brazil
26-27	World Lake Vision Workshop	Japan

October: 2002

Date	Meeting:	Venue:
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14-16	16 th START SSC Meeting	Hanoi, Vietnam