The Role of Higher Education in Adapting to Climate Change in Africa

Edited by

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1 OVERVIEW

1.1 INTRODUCTION

Adaptation to climate change has emerged as one of the most important concerns in the global development agenda today. Changes to, and variability of the climate and ecosystems are already being observed by scientists and local communities. In Africa, with its diverse natural environment and social systems, these changes are affecting different areas in different ways. This poses significant implications for developmental planning. How Africa adapts, and the solutions it creates to overcome adverse climate change risks, must be developed locally, while being supported by regional and global knowledge and experience. Key to this is an educated and technically-skilled labour force that can conduct the necessary research and develop effective solutions to eventually create a truly adaptive and resilient society. Africa already has a vast pool of human talent; such human capacities can be further cultivated and sustained through dynamic scientific and technical educational institutions.

1.1.1 *Challenges to Adaptation*

How to adapt to climate and ecosystems change is not easy. Firstly there is still a great deal of uncertainty on climate change: including the rate of change, causes, and influences from other of earth's mechanisms and its interplay with human-induced climate change - factors that are not yet explicitly considered in forecasting models. Secondly, climate change predictions are made at the global scale using coarse spatial resolutions; however, fine local spatial resolutions are required in order to correlate past observations with predictions of future weather changes, and thus provide a more accurate assessment of climate change risks. At this stage, technical and scientific capacities have to progress much further before accurate predictions can be made. Thirdly, climate change is a gradual process, making it difficult to notice the changes until the accumulated impacts have become significant and responses to effectively deal with it have arrived too late. Fourthly, accurately assessing at the local and regional level, the socio-economic impacts of global climate change remains an unresolved challenge. Climate change is a global process - what happens in one part of the globe can have significant impacts elsewhere. Research that is conducted in geographic isolation without considering global processes will always remain inadequate. At the same time, climate and biodiversity are local phenomena that depend on the geographical, bio-physical and socio-economic characteristics of a particular location. As such, adaptation to climate change is very much a localized action. Therefore, strategies to address climate risks must consider local solutions, while also being linked to global research. Also, approaches needs to work from both the bottom-up and top-down, it cannot be assumed that adaptation will just simply occur

without addressing how the social, economic, and ecological systems can adapt. For adaptation strategies to evolve locally, local capacity development is essential, especially in the developing countries. In this regard, the higher education sector fulfills a vital role.

1.1.2 *Role of higher education*

The contributions that the higher education sector can make for climate change adaptation are substantial. It will be Africa's universities that will produce the continent's highly-skilled human capital and the knowledge needed for tomorrow's climate-risk resilient societies. Africa has considerable expertise and experiences in climate science through collaborative research between independent research institutes and their external partners. The key step forward will be how to unite this expertise with the expertise of African universities to eventually build a bottom-up regional community of connected educators, researchers, students, practitioners, policymakers and local groups for climate change adaptation.

Ideally, higher education institutions are well-placed to:

Conduct applied postgraduate adaptation research in close partnership with implementing government and non-government agencies, as well as local communities.

Produce specialists with considerable expertise and knowledge in downscaling global forecasts to the local scale, and can produce impact assessments, and conduct climate modeling and forecasting.

Monitor the changes and collect adequate data over sufficiently long periods of time in order to calibrate and validate climate models and research.

1.2 BACKGROUND

A 3-day consultative conference and workshop on the Role of Higher Education in Adapting to Climate Change in Africa was held at the University of Ghana, Accra, from 16 to 18 October 2009 to develop an institutional platform of universities and partner institutions for advancing joint research and a regional curricula on climate and ecosytems change and adaptation. The aim of the event was for African universities to come together to:

- discuss the wide-ranging challenges to climate and ecosystems change, from an integrated science and social science perspective;
- share information on ongoing research, projects and initiatives;
- explore how to best develop and disseminate the necessary methods, tools, and data for assessing the impacts of climate change on society; and,
- identify priority areas that offer joint research opportunities and transdisciplinary educational programmes, and devise means to appropriately share already scarce resources to support them.

Ultimately, the long-term goal will be to develop strong partnerships across African universities, as well as with universities across the Asia-Pacific (through the UNCECAR Network that is being developed in

parallel). This initiative will also establish a framework that could implement the programmes and action plans coming out of the UNFCCC 15th Conference of Parties (COP15) in Copenhagen in December 2009, and the CBD 10th Conference of Parties (COP10) to be held in Nagoya in October 2010.

Representatives from eleven universities across Africa, as well as from European, Japanese and Indonesian universities, international and intergovernmental organizations, and NGOs attended. Around 150 educators, researchers, policy makers and administrators also participated.

The event was jointly organized by the United Nations University's "twin institutes" - the Institute for Sustainability and Peace (UNU-ISP) and Institute for Natural Resources in Africa (UNU-INRA) - in close partnership with the University of Ghana, the Institute for Integrated Research System for Sustainability Science (IR3S), and the Education for Sustainable Development Africa (ESDA) project.

The first day of the event, October 16, was a half-day public conference featuring four keynote speakers: Prof. Kazuhiko Takeuchi, Vice Rector of UNU (Tokyo); Prof. Bob Su, International Institute for Geo-Information Science and Earth Observation (ITC, Netherlands); Prof. Dr. Mohamed Tawfik Ahmed, Suez Canal University (Egypt); and Prof. Michael M. Tanu, Director General of the Ghana Meteorological Agency. Panelists were drawn from vice-chancellors and senior faculty from leading universities in Africa, and UNESCO.

The second day was a closed consultative workshop which opened with presentations from African universities on climate-related education and research currently offered within their institutions. The afternoon was followed by presentations from a Japanese university, climate change adaptation networks and international organizations. At the end of the day, a brainstorming session was organized along the following thematic areas:

- propose ideas for a regional program curricula for climate and ecosystems change and adaptation
- develop joint research projects

Both of which would facilitate greater faculty and student exchange, contribute to effective resource sharing and advance regional research in climate change

The event concluded with a commitment to further develop this initiative, with follow-up workshops to be held in 2010 in Egypt (to be confirmed).

1.3 PARTICIPATING UNIVERSITIES

All the participating universities and research institutions agreed to establish an institutional platform of universities and partner research institutions to further climate change adaptation agenda in higher education sector. Representatives from following lead universities or their affiliated institutions from the African region have consented to be a part of this platform:

1. University of Ghana, Ghana
2. Kwame Nkrumah University of Science and Technology, Ghana

3. University of Cape Coast, Ghana
4. University of Development Studies, Ghana
5. University of Dar es Salaam, Tanzania
6. Suez Canal University, Egypt
7. Department of Meteorology, University of Nairobi, Kenya
8. National Engineering School of Tunis ENIT, Tunisia
9. Environmental Science Programme, Addis Ababa University, Ethiopia
10. University of Cape Town, South Africa
11. Department of Agricultyure. Extension and Rural Development, University of Ibadan, Nigeria
12. University of Nagoya, Japan
13. Graduate Program on Sustainability Science/IR3S/TIGS, University of Tokyo, Japan
14. Institute for Sustainability and Peace, United Nations University (Secretariat)

1.4 OUTCOMES

1. Identify a focal point in each institution
2. Agreement to develop a Programme in Climate and Ecosystems Change Studies
3. Establish two steering committees made up of a panel of eminent scholars from Africa to guide the network's activities on the development of: (a) research projects and (b) programme curricula on Climate and Ecosystems Change Studies.
4. Develop a Terms of Reference and establish timelines
5. Establish task forces to conduct region-wide consultations and communicate with other networks
6. Establish UNU as the secretariat to the network, coordinating activities and acting as a repository for education programs and research outcomes

1.4.1 *Curriculum development*

Participants discussed what type of academic programme would be developed, and who would be the key beneficiaries. The first brainstorming session concluded with consensus to develop a programme in "Climate and Ecosystems Change Studies" was agreed upon.

The discussion raised a variety of issues, but of particular concern was whether to target masters or doctorate candidates. The general agreement was that, in order to provide maximum flexibility for students, the programme should be designed as a masters course with the possibility of a Ph.D for outstanding students. Additional issues raised include: academic requirements (coursework versus thesis), duration (number of years till completion) and how to provide for other groups who do not necessarily have the time nor resources to undertake a graduate degree (i.e. working professionals, farmers, etc) – expanding the programme to offer postgraduate diplomas was another option proposed. Identifying the needs of each sector and local community was highlighted as an important first step; one way to achieve could be through a baseline survey/needs assessment. However, how and who could conduct it efficiently and effectively given resource and other constraints was a concern. On the overall design of the curriculum, there was discussion on using the University of Dar es Salaam's curriculum 'model', which was presented by the Vice Chancellor.

Participants were also asked to briefly identify which of the existing courses in their university could be incorporated into the proposed programme. Subjects proposed ranged from hydrology, natural resource management, adaptive capacity analysis, to streamlined life-cycle analysis.

Potential delivery mechanisms such as e-learning; training needs; resource sharing etc was, while raised to the participants, needs further discussion.

1.4.1.1 *Needs:*

1. Element of flexibility as an essential component for any curricula on climate and ecosystems change and adaptation, in order to be applicable to a wide range of local circumstances. Recognizing that adaptation to climate change is going to be evolving and dynamic process, the curricula needs to be flexible while comprising of basic but fundamental principles.

2. Curricula should address needs of various groups using a transdisciplinary approach: students, citizens, communities, local governments and national policy makers, business. While a needs assessment can be undertaken, it is more important to prioritize needs given limited resources. Region-wide consultations will be important.

3. Courses should be accredited through internationally recognized agencies or group of academics or experts, and evaluated over time.

1.4.1.2 *Actions:*

1. Further develop the curriculum for the Programme in Climate and Ecosystems Change Studies that is both tailored for masters students and potential doctorate candidates. This includes, but is not limited to:
    - Academic requirements (thesis or coursework)
    - Accreditation and credit structure
    - Delivery mechanisms
2. Specify the suite of climate change courses (majors and minors, common and specialised electives) that will be offered under the programme with which potential users, departments, and institutions can select from to develop modules that meet their needs. Ensure a wide-coverage of cross-cutting and sector-specific areas and methodologies to encourage the development of transdisciplinary research.

1.4.1.3 *Steering Committee*

1. Suez Canal University
2. ENIT (National Engineering School of Tunis)
3. University of Nairobi
4. KNUST (Kwame Nkrumah University of Science and Technology)
5. University of Ghana
6. UNU-ISP

1.4.2 *Developing Joint Research Projects*

Prior to the workshop, participants were asked to complete a questionnaire on existing research projects in their institution. During the workshop, participants were also asked to identify important future research topics, training needs for research and opportunities and resources to share. The exercise revealed the diversity of research and institutions involved in climate change activities in the region. It provided a useful reference point for universities on areas of potential collaboration and where expertise can be pooled from. A benefit of creating joint research projects is it enhances opportunities for universities to receive further funds from funding agencies and international organisations seeking to target climate change initiatives in Africa. However a key challenge to this will be project sustainability; donor-driven initiatives often face difficulties in continuing once funding ceases.

1.4.2.1 *Needs*

1. Enhance linkages with other networks in the region that are also conducting climate change research, to avoid duplication, ensure value-add and the efficient use of resources.

2. Project sustainability. Universities must have ownership over research projects in partnership with local communities, and should take advantage of local expertise and knowledges.
3. Enhance transboundary cooperation, particularly between South-South countries and institutions. This can also reduce project dependence on donor-funding from developed countries

1.4.2.2 *Actions*

1. Develop an inventory/repository of projects, experts and networks in the region
2. Identify priority research topics that utilises the strengths of each institution.
3. Conduct joint scientific workshops to discuss specific needs and share information on local issues, and the latest scientific information from the global level.
4. Submit joint project proposals to funding agencies

1.4.2.3 *Steering Committee*

1. Addis Ababa University
2. UNESCO
3. University of Dar Es Salaam
4. START (global change SysTem for Analysis, Research and Training)
5. UNU-INRA
6. UNU-ISP

The following research areas were identified for potential collaboration:

1. Downscaling/upscaling studies; understanding global/local conditions
2. Vulnerability to extreme weather conditions/events/disasters (flooding, droughts)
3. Climate prediction and modelling for agricultural and water adaptation
4. Water resources management
5. Enhancing adaptive capacities for local communities
6. Understanding local social systems, and how to beneficially integrate modern techniques
7. Resilience of ecosystems and natural resources

1.5 GENERAL OBSERVATIONS

1. The demand for an integrated curriculum on climate and ecosystems change is very high.

2. Gaps exist in current curricula. Current approach of fragmented knowledge and skills is insufficient for addressing the complexities of climate and ecosystems change. Education and educators need to shift towards a new mindset that integrates multidisciplinary and transdicisplinary approaches in a proactive way.

3. COP15 meeting in December 2009 is expected to boost action on addressing climate change impacts in developing countries. Establishing this initiative offers a timely opportunity to both deliver the outcomes of COP15 and act as a bridge between decision-makers at the global and national level, with universities, citizens and communities at the local level.

2 CONFERENCE: OPENING REMARKS

2.1 CLIFFORD N.B TAGOE, VICE-CHANCELLOR, UNIVERSITY OF GHANA

The Chairman, Professor Edwin Gyasi;
The Rector of the United Nations University (UNU), Professor Konrad Osterwalder;
The Vice-Rector, Prof. Kazuhiko Takeuchi;
Members of the Diplomatic Corps,
Fellow Scientists, the Press, Distinguished participants,

Good Afternoon,

We are assembled here at the University of Ghana, this afternoon, to open three days of deliberation in the form of a conference of stakeholders on climate change, a process that has far-reaching implications for the sustainability of humankind. It is my singular honour to formally welcome you to this conference, which is organized by the United Nations University Institute for Sustainability and Peace (UNU-ISP) and Institute for Natural Resources in Africa (UNU-INRA) in partnership with the University of Ghana, and with the support of the Integrated Research Systems for Sustainability Science (IR3S), Tokyo.

A more timely and topical theme could not have been chosen for this conference than climate change. It has come to be widely recognized that, lately, the world's atmospheric condition is undergoing accelerated alteration popularly labeled climate change. Reportedly, climate change forms part of a general increased transformation of the global natural environment. The manifestations include land degradation, biodiversity loss, and ecosystems destruction. Each of these changes warrants scientific attention. But, today, and in the next two days, we choose to focus on climate change. As we shall learn during the conference, fore mostly the proven global warming manifests the apparent climate change. Climate change is a process of grave concern because global warming and other environmental disturbances, such as melting of the polar icecaps, rise in ocean levels, and extreme weather events, poses a threat to humanity. The threat is particularly ominous for developing countries of Africa such as Ghana, which lack the technological, financial and institutional capacity to cope. No wonder then, that, adaptation to climate change has emerged as a central issue in the global development agenda.

This University shares the common view that in the search for effective climate change and adaptation strategies, higher education has a leading role to play through research and teaching. A hallmark of the University of Ghana is its balanced multidisciplinary academic character that involves a diversity of Departments, Centres, and other units that are organized into Colleges, Schools and Faculties. Those whose research and teaching thrust bear most directly on this conference, which is dedicated toward establishing a regional network to develop

educational programmes in climate change adaptations, include the following:

- Department of Geography and Resource Development
- The Environmental Science Programme
- The School of Agriculture and Consumer Sciences
- School of Public Health
- School of Research and Graduate Studies.

Many Higher Educational Institutions, whose academic programme bear, one way or the other, on climate change, are affiliated to the University of Ghana. Scientists from the University of Ghana and from its affiliated and other associated institutions are strongly represented at this meeting. They and other academic colleagues stand ready to participate in projects aimed at enhancing adaptation to climate change.

The University of Ghana has been collaborating closely with the UNU through the United Nations University's Institute for Natural Resources in Africa (UNU-INRA), which is located at this Legon campus, and through UNU-supported projects and programmes such as the following:

- PLEC (People, Land Management and Ecosystem Conservation);
- SLaM (Sustainable Land Management to Mitigate Land Degradation);
- Plant Tissue Culture Training; and
- ProIRD (Programme on Integrated Environmental, Economic and Social Development in Rural Africa under the UNU Education for Sustainable Development in Africa- ESDA). These collaborative linkages provide building blocks for the envisaged programme in climate change adaptation and mitigation.

Clearly, Mr. Chairman, the academic character of the University of Ghana strongly favours this historic conference of stakeholders in climate change. Therefore, the University has pleasure in hosting the conference. I am happy to see you all at the University of Ghana, the premier university of Ghana. I extend a special welcome our foreign guests from within and without Africa. As we say in the Ghanaian Akan language, AKWAABA, welcome. Feel at home, and have a fruitful deliberation in the quest for answers to the challenges of climate change. God bless us.

Thank you.

2.2 KONRAD OSTERWALDER, RECTOR, UNITED NATIONS UNIVERSITY

Your Excellencies,
Prof. Tagoe, Vice-Chancellor of the University of Ghana,
Invited overseas university representatives,
The members of the board of UNU-INRA and UNU council members,
Distinguished guests, Ladies and Gentlemen,

Thank you very much Professor Gyasi for the kind introduction. On behalf of the United Nations University, it is a great pleasure for me to welcome you all to this important symposium on "adapting to climate change". This is a pre-event to the discussions we will have tomorrow on the "Role of Higher Education in Adapting to Climate Change – in Africa". Dealing with climate change is the most important challenge the world is facing today. The evidence, compiled by UN IPCC, shows clearly that anthropogenic activities are responsible for the high levels of green house gases in the atmosphere that are warming our planet to unprecedented levels. If present trends continue, the global energy and water cycles could well be drastically altered. This would make our climate and weather patterns unable to support the life styles we now take for granted. Therefore, it is imperative that the leading policy makers meeting in Copenhagen in December come out with concrete agreements to lower the emission rates and make the planet safe for future generations. In this regard, the industrialised countries must take the lead. At the same time, we must all do our share, no matter how small, in mitigating climate change by making sure that our life styles and our development activities will not lead to a further increase of green house gases. While we make these efforts, we should also recognise that there is already a significant amount of green house gases in the atmosphere. They will not go away soon, even if we are successful in reducing emission rates. The time has come for us to discuss seriously how we should prepare for a change in the climate. We need "to adapt" to deal with weather patterns that may be different from the weather we have known throughout our lives.

Adapting to change is not new. It is practised widely, especially in the fields of natural resources management or disaster risk reduction. However, adapting to climate change is different in several ways. Firstly, there is still a great deal of uncertainty about climate change. We have to depend on computer simulations to anticipate what future climate may be. However, forecasting models provide a simplified representation of the earth system that introduces a great deal of uncertainty into the future scenarios we develop. Secondly, climate change is a gradual process making it difficult to notice the changes until they are too late. Thirdly, there is a difficulty in relating predictions made at the global scale to our local heterogenous conditions. In addition, adaptation is treated differently in different disciplines. In the natural sciences, it is often linked with the concept of risk. Both hazard and vulnerability play an important role in assessing risk. In the social sciences and climate change field, adaptation is associated more with vulnerability. Even then, vulnerability is defined in different ways. To social scientists,

vulnerability is related to socio-economic factors. For climate scientists, vulnerability is the likelihood of occurrence and impacts of weather and climate-related events. It is clear that we need platforms to promote interdisciplinary interactions to make full use of the strengths of various disciplines. This will help broaden our visions and better prepare us to design appropriate adaptation strategies.

An important point to note about adaptation to climate change is that it is a local phenomenon. It depends on the local hydro-meteorological, bio-physical and socio-economic conditions. Solutions, therefore, have to be developed locally, supported by global knowledge and experiences. For this, we need to develop local capacity. This can only be done by way of postgraduate education where the necessary research can be conducted through applied research projects in partnership with development agencies and local communities. Higher education should give direction and leadership in assessing climate change impacts. It should help in establishing effective frameworks where affected communities can work with specialists in planning appropriate strategies.

Finally, our focus on adaptation should go beyond climate change concerns. Indeed 'adaptation' is directly linked with sustainability. In such dynamic systems as our Earth, sustainability can only be achieved by adapting to the levels of currently available resources and services. Therefore, adaptation becomes a pre-requisite for sustainability. We must design innovative development strategies that are climate change resilient and at the same time flexible enough, so that we can 'adapt' not only to climate change, but also to other future 'global changes'. I am therefore very pleased to note the linkages already established between this adaptation platform initiative and the sustainability science approach. As you know, this two-day programme is a joint activity of the United Nations University and the Integrated Systems for Sustainability Science initiative of the University of Tokyo, co-organised by the University of Ghana. Here, I would like to express my sincere appreciation to the excellent support provided by our co-organiser, the University of Ghana. I am very much grateful to its Vice-Chancellor, Professor Tagoe, for his enthusiastic support and Professor Gyasi, the local coordinator and our long standing partner which has made this meeting possible.

Before concluding, let me thank the three invited speakers, Professor Bob Su from our Associated Institution, ITC of The Netherlands, Professor Mohamed Tawfic from Suez Canal University, and Mr. Juati on behalf of the Director General and the Meteorology Agency of Ghana, for kindly accepting our invitation to deliver keynote presentations. I am also very much grateful to the Representatives of the 12 universities from the Africa region who has kindly accepted our invitation to join the workshop in designing a platform for adaptation research and capacity development.

Finally, I would like to mention another important milestone. This year, the United Nations University's Institute for Natural Resources in Africa developed a joint set of activities and cooperation with its proposed sister institute, The Institute for Sustainability and Peace in Tokyo. With this alliance, we will embark on an increased UNU presence in Ghana. We look forward to strengthening this cooperation

further in our future activities. I wish you all success in this worthy endeavour. Thank you very much.

3 CONFERENCE: SUMMARIES OF KEYNOTE SPEECHES

3.1 PROMOTING CLIMATE AND ECOSYSTEMS CHANGE ADAPTATION RESEARCH AND EDUCATION

Kazuhiko Takeuchi, Vice-Rector, United Nations University (UNU)
Director, UNU-Institute for Sustainability and Peace (UNU-ISP)
Deputy Executive Director
Integrated Research System for Sustainability Science (IR3S)

Founded in 1975, the UNU serves as a "think-tank" for the United Nations system and its member states. Its aim is to produce and disseminate the latest research and knowledge to practitioners, and develop capacities of individuals and institutions. A key area of focus for the UNU is how to achieve and promote a better understanding of sustainability. The UNU regards the problems faced by the world today as a crisis in sustainability. Addressing the crisis will require integrated approaches that consider the global, social, and human systems that drive it. In this regard, under the new strategy of Rector Osterwalder, the UNU established the Institute for Sustainability and Peace (UNU-ISP) in 2009 with a mandate to promote research and education initiatives across the three cross-cutting themes of global change, development, peace and security.

Through the integration of the natural and social sciences, the UNU hopes to develop a new field of "sustainability science" that addresses global problems in a holistic manner and offers comprehensive solutions that encompass both social reforms and technological innovations. The application of sustainability science is expected to have important implications for the complex and multidimensional subject of climate change. Given the importance of adaptation to climate change as discussed in the United Nations Framework for Climate Change Convention (UNFCCC) and that of increasing *natural resilience of ecosystems to climate change* as discussed in the Convention on Biological Diversity (CBD), what is needed is the type of science that can merge these aspects together – this is where the potential of sustainability science lies. At the very least, sustainability science aims to provide a vision for a future sustainable society.

Creating sustainable societies will involve:

- developing an integrated system that can assess societies' CO_2 and other greenhouse gas emissions path; the impact of climate change on human ecosystems; and the effectiveness of mitigation and adaptation measures;
- developing regional adaptive strategies; including disaster prevention, ecosystems and urban regeneration strategies that are consistent with a low-carbon society;

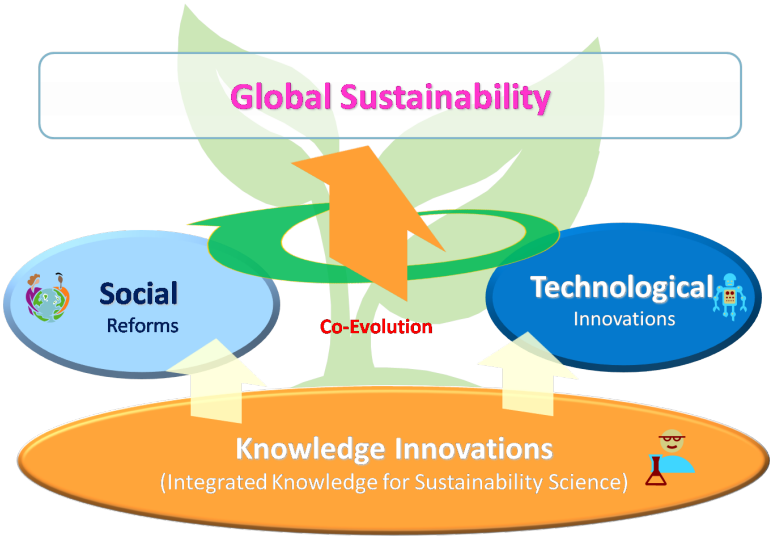


Figure 1: Co-evolution of social reforms and technology for sustainable development

- assessing the effects of large-scale investments in green infrastructure, particularly whether it will have positive effects on the employment sector (through diversification of labour skills and new jobs) and the revitalization of local economies; and
- establishing new national land planning policies that integrates long-term climate change mitigation and adaptation strategies with urban and rural regeneration.

Developing countries mired by poverty face extreme risks from climate and ecosystems change. Africa in particular, is already suffering from deteriorating ecosystem services and desertification caused by drought and land degradation. Its population relies heavily on rain-fed agriculture and water resources that are already facing severe scarcity. However, understanding the impacts of, and developing strategies to address climate change, will depend on local circumstances. Thus, adaptation measures must be compatible with local social systems, culture and development planning. To support these measures will require local human resources and technical capacities and skills.

The UNU, in partnership with the University of Tokyo's Integrated Research System for Sustainability Science (IR3S) has chosen to focus on enhancing higher education institutions – society's key source of skilled and educated labor. This year, the UNU and IR3S established the *University Network for Climate and Ecosystem Change Adaptation Research* (UN-CECAR) initiative, targeting universities across Africa and Asia. The Network hopes to provide an institutional bridge between local communities, academia and the United Nations, for the dissemination of scientific knowledge, development of (south-south and north-south) collaborative and multidisciplinary initiatives, and provide opportunities for postgraduate students, educators and professionals to obtain a wider understanding of relevant issues.

The UN-CECAR initiative will also be linked with the already established 3-year Education for Sustainable Development in Africa (ESDA)

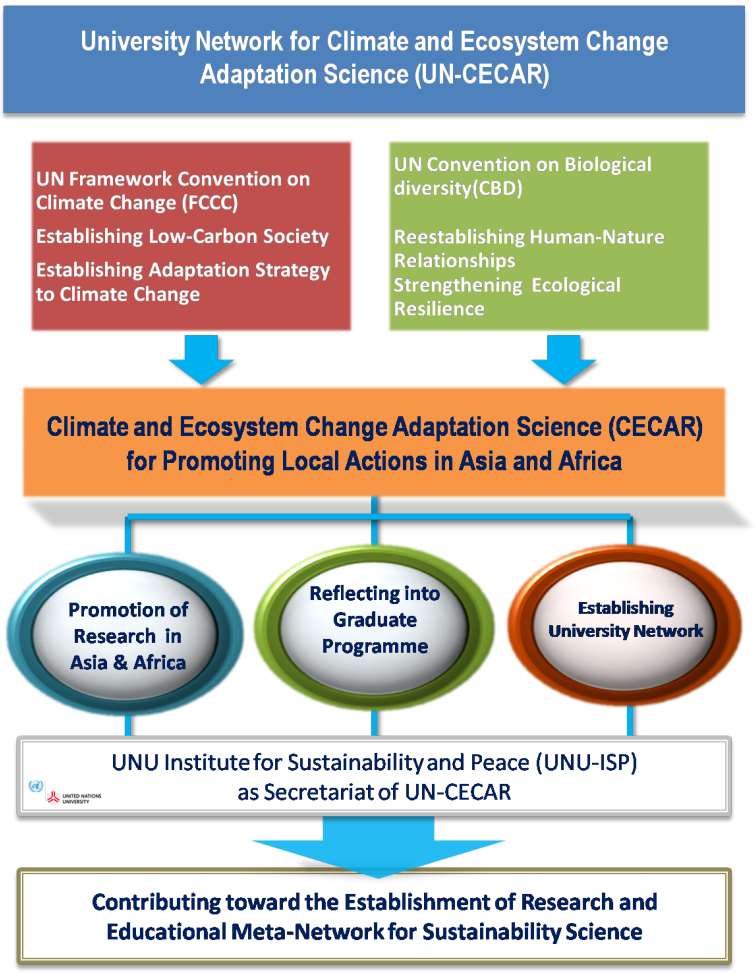


Figure 2: University network framework for local action

project that is funded by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT). The ESDA Steering Committee currently consists of 7 universities from Japan and Africa engaged in 3 working groups: integrated environmental, economic and social development in Africa, community-based innovation for sustainable urban development in Africa, and the management of mining and mineral resources for sustainable development in Africa. Together, UN-CECAR and ESDA will establish regional centers of expertise in ESD with the combined participation of universities, schools, local government, industries and NGOs.

To further strengthen joint research and educational programmes with Africa, UNU-ISP is forming twin institutes with the UNU Institute for Natural Resources in Africa (UNU-INRA), based in Ghana.

The aim of this symposium is to discuss some of the major issues confronting Africa today, and what needs to be done. The consultation workshop that follows will focus on the role of higher education sector in developing local capacities for designing appropriate adaptation strategies. It will focus on two key questions:

- What are the appropriate frameworks to collaborate on climate change adaptation research among educational institutions in Africa
- What are the appropriate mechanisms to adapt global knowledge and experiences to the local context

3.2 CLIMATE CHANGE IMPACTS AND ADAPTATION NEEDS

Bob Su
International Institute for Geo-Information Science and Earth Observation (ITC)
Netherlands

Climate change is arguably the greatest challenge facing mankind in the twenty-first century. Observational records and climate projections provide abundant evidence that freshwater resources are vulnerable and have the potential to be strongly impacted by climate change, with wide-ranging consequences on human societies and ecosystems. Some major impacts include: large-scale hydrological cycle (i.e. increased precipitation intensity and variability); risks of flooding and drought in many areas; changes in water quantity and quality to affect food availability, stability, access and utilization. Globally, the negative impacts of future climate change on freshwater systems are expected to outweigh the benefits. Such assessments of impacts are however very uncertain in particular at regional and local scale where the resources need to be managed and adaptations made.

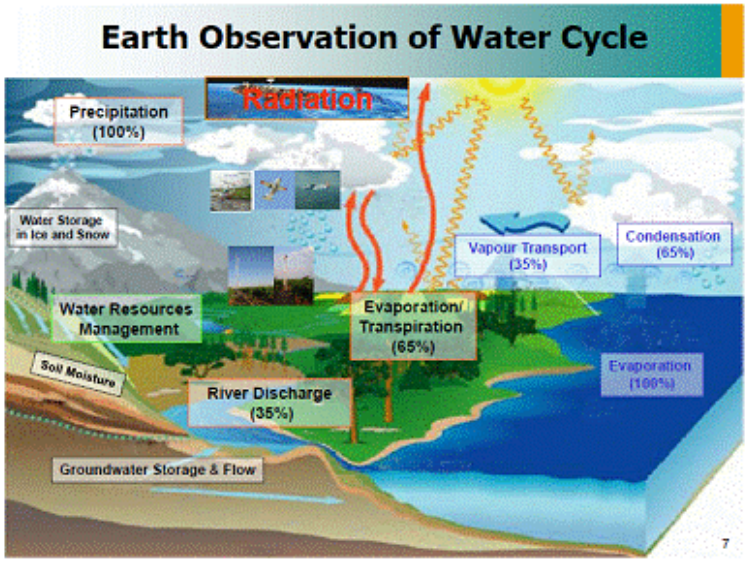


Figure 3: Water Cycle

Climate change also challenges the traditional assumptions in water resource management, (for example, assumptions like "past hydrological experience provides a good guide to future conditions"). Current water management practices may not be robust enough to cope with the impacts of climate change on water supply reliability, flood risk, health, agriculture, energy and aquatic ecosystems. New knowledge needs to be developed. Water-related adaptation to climate change must also include sectors such as: ecosystems and biodiversity; agriculture and food security, land use and forestry; human health; water supply and sanitation; settlements and infrastructure; economy: insurance, tourism, industry, transportation; security: war & peace.

Taking one example in of the many possible causes and effects of global change, we have seen recently many disastrous floods in China, Europe, Bangladesh, Africa and in many other places. These floods have caused large losses in human life and economic development. According to the Science magazine - one of the most well known scientific publications, "black carbon - that is the black smoke - particles are causing changes in precipitation and temperatures over China and may be responsible for the tendency toward increased floods and droughts". If this is the case, the next logical question to ask is how about Europe and elsewhere? What are the causes and the impacts? In this regard, earth observations will be critical for finding a solution. At present major gaps in knowledge exist in terms of observations and research-needs related to climate change and water. These include observational needs; understanding climate projections and their impacts; understanding and projecting climate change; water-related impacts; and adaptation and mitigation.

By observing and measuring all the major driving factors for climate change at the local scale, we will significantly improve our understanding of the different processes that is occurring and evolving over time. With the help of satellite data, we can scale our local knowledge to the regional scale, the continental scale and then finally to the global scale. Ultimately it is this goal, “From Process Understanding to Global Applications” that the Earth Observation unit at ITC is ambitiously trying to achieve.

Through some examples, the ITC is trying to synthesize some major issues in the assessments and predictions of climate change impacts for water resources, and also recommend some strategies that have demonstrated to be successful. Finally ITC also provides some outlooks that might be very promising for the UNU efforts in establishing an African regional network to develop postgraduate educational programmes on climate change adaptation. ITC Capacity Building expertise will also be integrated within the Global Earth Observation activities which are all open source. UNU efforts to establish an African regional network for the development of postgraduate educational programmes on climate change adaptation is both timely and deserves strong support.

3.3 DRYLAND ECOSYSTEMS AND CLIMATE CHANGE: AN AFRICAN PERSPECTIVE

Mohamed Tawfik Ahmed, Director, Environmental Impact Assessment and Professor, Faculty of Agriculture, Suez Canal University

A Generic View of Dryland Ecosystems

Dryland ecosystems are limited by soil moisture - the result of low rainfall and high evaporation. These areas show a gradient of increasing primary productivity, ranging from hyper-arid, arid, semi-arid to dry sub-humid areas. Egypt itself is not an arid country, but a hyper-arid country.

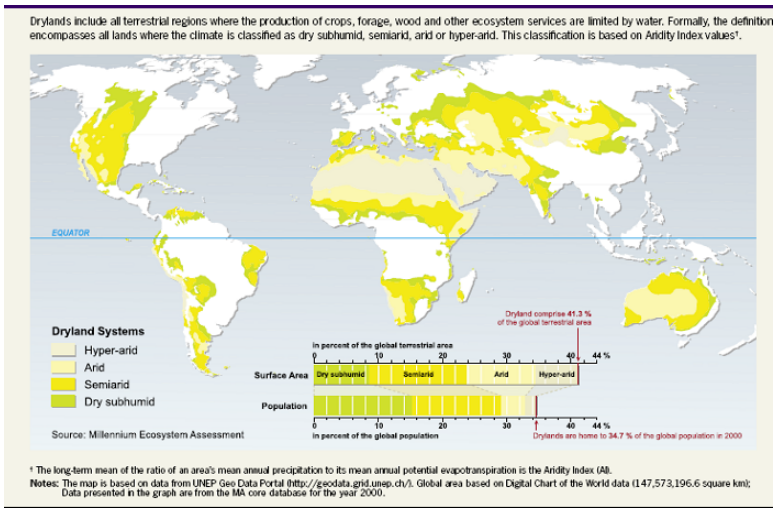


Figure 4: Distribution of drylands

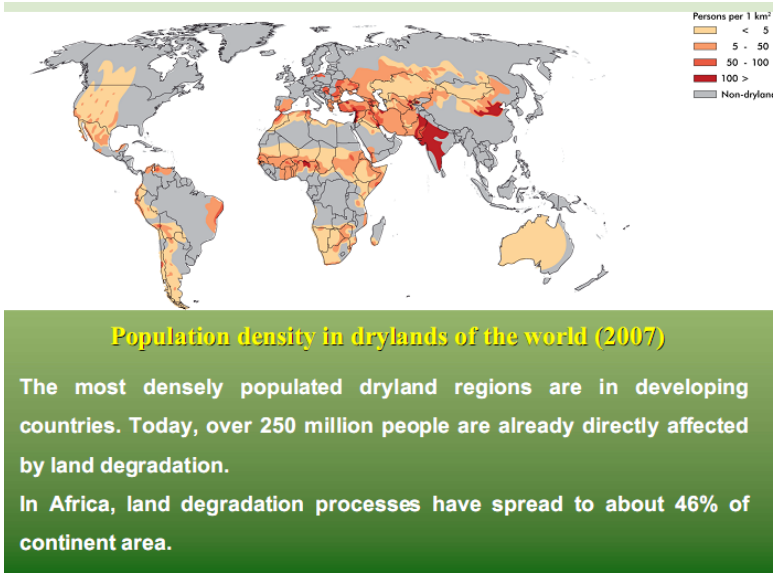


Figure 5: Dryland population distribution

According to the Millennium Ecosystem Assessment (MEA), dryland ecosystems cover about 41% of the earth's land surface. They are inhabited by more than 2 billion people, or approximately one third of the world population. Two-thirds of Africa can be classified as either drylands or desert.

The current socioeconomic condition of people in dryland systems, of which about 90% are in developing countries, lags significantly behind that of people in other areas. As such, the distribution of dryland areas is not spread equally between poor and rich countries. 72% of the global dryland area occurs within developing countries and only 28% within the developed world. Furthermore, the proportion of drylands occupied by developing countries increases with aridity; reaching almost 100% for the hyper-arid areas. Consequently, the majority of dryland people live in developing countries (ranging between 87% to 93%, and only 7-15% live in developed countries.

Dryland Ecosystems Goods and Services

There is a strong link between ecosystem services and human well-being. The MEA report identifies ecosystems services as the benefits people obtain from (a) provisioning services such as food and water; (b) regulating services such as regulation of floods, drought, land degradation, and disease; (c) supporting services such as soil formation and nutrient cycling; and (d) cultural services such as recreational, spiritual, religious and other non-material benefits. All of which are critical for human security, provides the basic material for a good life (adequate livelihoods, shelter, sufficient nutritious food and access to goods), health, and cohesive social relations.

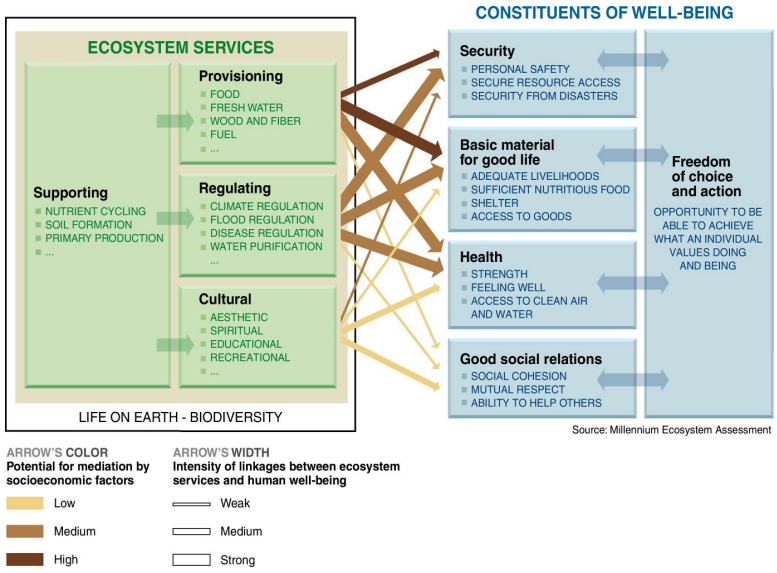


Figure 6: Ecosystem services for well being

Dryland ecosystems have naturally arid climates in which droughts are a normal occurrence. Water scarcity is the key limiting factor for sustainable development of dryland areas. Traditionally, people living in these areas depend mainly on livestock (pastoralists, grazing), and some

plants and fruits. Agricultural production is sporadic as it depends heavily on water and other inputs, and is therefore seldom sustainable. However the biodiversity that exists in drylands are uniquely adapted to the climatic and environmental conditions. Despite the aridity, these drylands can still offer ecoservices that mankind (and nature) can benefit from. There are opportunities for example from solar and wind energy generation. The Sahara desert alone, with an area of 9.1 million km2, receives about 20 million TWh of heat per year, which, even with the today's 10-15 % solar energy/electricity conversion efficiency, is ten times more than the overall energy consumption in the world. Drylands can also provide excellent conditions for wind generation.

In Ashegoba, north of Ethiopia, a 120 megawatt wind farm is currently being built, one of the largest in Africa, and is expected to generate 15% of the nation's power sources. Before this, Ethiopia had depended on its hydroelectric power generated by dams, but severe droughts have effectively halted the country's power resources to a standstill.

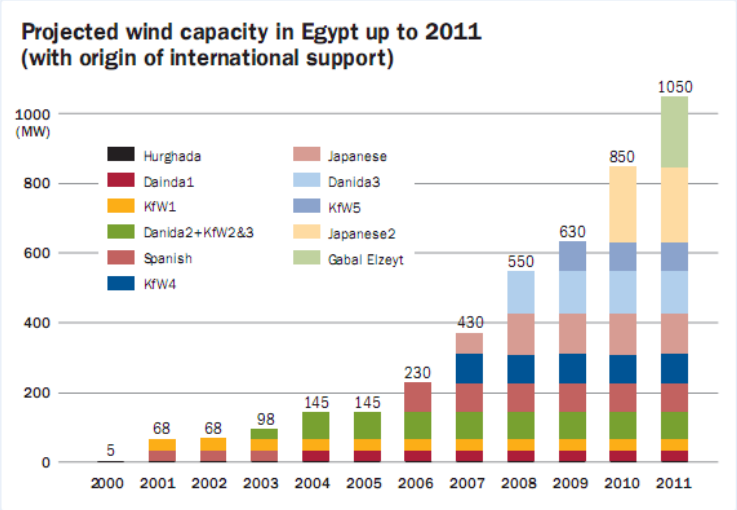


Figure 7: Rising wind power

The potential for wind energy generation is also excellent in the Suez Gulf where wind speeds can exceeds 10 m/sec. Several projects (pilot, demonstration and commercial) have already been established in Egypt with the support of international donors, with some also funded as part of the Kyoto Protocol's Clean Development Mechanism. The projected combined wind capacity of Egypt by 2011 is expected to reach 1050 MW.

Another important ecoservice that drylands provide is its carbon storage (carbon sequestration) potential. Despite the low amount of plant biomass per unit area compared to other terrestrial ecosystems, dryland soils contain a total of 35% of the total carbon stock in terrestrial ecosystems – primarily due to its large surface area. However, dryland soils have lost a significant amount of carbon already due to environmental degradation and desertification.

Drivers of Ecosystem Changes: Case Study of El Maghara Ecosystem, Egypt Eastern Desert

As part of the Millennium Ecosystem Assessment report, Suez Canal University with funding by the Ford Foundation and UNEP, assessed the state of the El Maghara ecosystem to identify the main drivers of ecosystems and ecoservices change. Ecosystems services assessed included: water, floral diversity, medicinal plants, mineral resources, agriculture, grazing, and soils. Located in the northern part of west Sinai, the assessment region was chosen for its landmark biodiversity as it is one of the most important centers of medicinal plants in the Middle East (61% of its flora is classified as medicinal). Special local plants are also used by the local communities to build houses. The area is populated mostly by a Bedouin population who have a unique traditional knowledge of these plants and its uses. The geography of the region contains diverse landforms, water resources, rocks and aridity conditions. The climate in summertime tends to be hot, winters are mild, and evaporation is high. It receives up to only 20-50mm of rain per year. The assessment was conducted in the remote Uplands sub-region, which is characterised by widespread poverty and where human activities have degraded the ecosystems and biodiversity. The El Maghara ecosystem and ecosystem services have been threatened by land-use activities such as acid mine drainage and other polluting sources such as coal mining, construction of roads and other infrastructure (sometimes unauthorised) for mining and quarrying activities, particulate dust pollution and loss of aesthetic value (visual pollution) from the mining and quarrying activities, over-exploitation of water resources, and continued land degradation. As a result of this and other activities, the land-cover of El Maghara has undergone significant changes over the past two decades.

	Land Cover Type	Area, 1986 (m2)	AArea, 2000 (m2)	Avg. Annual Change (m2)
1	Soil cover of different classes	48,794,020	47,631,352	83,047
2	Exposed bed rock surface	114,390,972	114,390,972	NO change
3	Sand dunes and sand sheet.	86,815008	88,013,304	85,592
4	Intensive vegetative cover "mostly medicinal plants"	89,703	69,413	1,450
5	Range lands mostly covered by grazing shrubs	Not detected	347,386	Not detected*
6	Quarrying activities	0.0	3,677,873	262,705
7	Crop land	1,716,837	2,650,565	66,700
8	Mining tailings solid wastes	0.0	375,119	26,800
9	Liquid waste	0.0	122,816	8,772
10	Polluted soil	6,670,713	8,413,937	124,516

Table 1

Climate Change and Dryland Ecosystems

Drylands are highly vulnerable to climate change. Dryland regions already experience more intense climate variability, natural resources are at unsustainable levels, has high population growth-rates whose livelihoods depend on climate-sensitive sectors, low-levels of human well-being and poor climate observation data. Drought and desertification are already affecting Africa's dryland regions. In the future, precipitation, more than temperature that will be the cause of greatest uncertainty. Economically, climate change impacts are projected to wipe-out 2.7% of Africa's GDP in 2030. For biodiversity, land use change as well as changing patterns of precipitation and evaporation brought about by climate change and can cause shifts in the distribution of plants and animals, create barriers to movement, rapid changes in species interaction, shift seasons, coastal margins, and warmer oceans. There are already claims that one-third of the planet's species diversity may be lost by 2050, while increasing the rate of invasive species. In El Maghara, floral species such as Astragalus Boeticus (used to treat asthma) and Haplopyllum Tuberculatum (one of the most important plants for treating rheumatic pain and arthritis) are fast disappearing. Alien species that have been increasing in Sinai include the Mesembrayanthemum Crystallinum, a pest weed that infests orchards and crops in Sinai, causing serious economic damage.

These feedback loops can potentially accelerate risks. However, scientific evidence for climate change feedback loops remains a hotly contested area (such as the extent of carbon dioxide absorption by

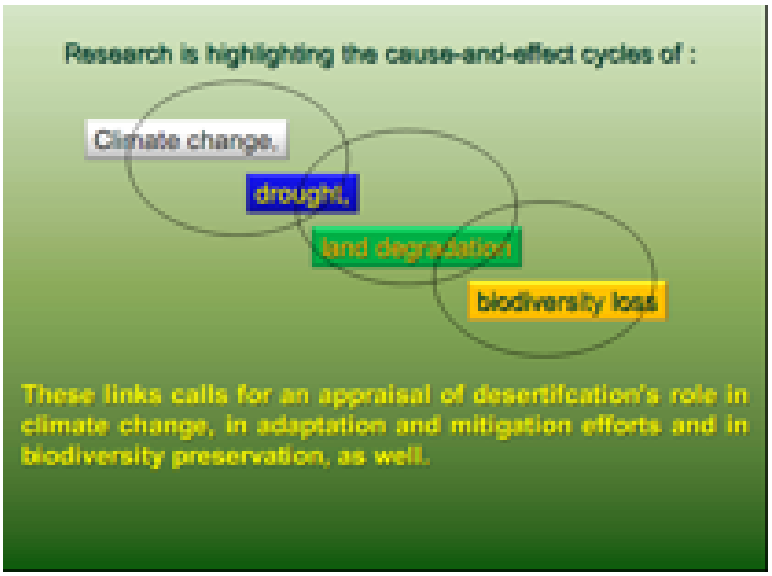


Figure 8

plants). Nonetheless, many have agreed that there is a need to adopt a *precautionary approach* in any case. There needs to be greater research in the cycles of cause-and-effect between climate change, drought, land degradation and land-use, and biodiversity loss, in order to develop effective strategies for biodiversity conservation, adaptation and mitigation. Finally, the other side of climate change Ð human suffering, must not be forgotten, particularly the linkages between climate change and human migration and conflict.

3.4 CHALLENGES TO CLIMATE CHANGE ADAPTATION AND MITIGATION IN GHANA

MICHAEL M. TANU
DIRECTOR GENERAL, GHANA METEOROLOGICAL AGENCY
Delivered by the Director for the Ghana Meteorological Agency
Mr. Ayilari-Naa A. Juati

Climate Change has become in recent times, the most widely talked about event in all corridors of human endeavour. In fact, it is a subject matter that has been much publicized, much argued about and mostly misunderstood. Most people mistake climate variability as climate change. While climate variability could actually be the manifestation of climate change; the two do not mean the same thing. As a matter of fact, short-term fluctuations such as the El Nino Southern Oscillation (ENSO), the Pacific Decadal Oscillation, the North Atlantic Oscillation, and the Arctic Oscillation represent climate variability rather than climate change. Climate change is the upward and persistent shift in the mean weather parameters - usually in the temperature and rainfall, since the beginning of the industrial revolution, through to the present time, and into the next 50 to 100 years. This information has been obtained from climate models have estimated what will happen to our climate in the next 50 to 100 years under certain scenarios.

It is worthy to mention that Ghana's climate change scenarios were developed with the assistance of the Netherlands Climate Change Studies Assistance Programme (NCCSAP). Modelling simulations have been undertaken and the impacts assessed of a changing climate on water resources, food production, coastal habitation, and on biodiversity and ecosystems more broadly.

With the impending changes to the earth's ecosystems and biodiversity, mankind has to adjust to these changes. Hence, mankind has to either adapt to the changing climate, or it has to carry out certain actions that will decelerate the rate of climate change, if not stop it all together.

As a matter of fact, the driver to climate change has been mankind's profligate use of the environmental resources endowed by nature. We have vandalized the environment and in the process increased green house gas emissions beyond the allowed threshold for a perfect and meaningful existence. The result is the frequency and severity of extreme weather events like floods, droughts, dwindling water resources, and increase in human conflict situations. Once such a destructive feedback loop is triggered, humanity has little chance of halting runaway climate change. A colleague of mine in the water sector once said that, the third world war could be triggered by competition for water, if mankind fails to act now.

Scientists believe that in the absence of GHGs, the average temperature on earth would be around minus 18 degrees Celsius. Hence some amounts of GHGs are relevant for keeping the atmosphere warm and pleasant for human habitation. However, they are also quick to stress that, according to natural effects like solar cycles and volcanic activity;

the earth should be in cool-down phase, and not in the heating phase that we are currently observing.

We need to be aware that climate change adaptation minimizes the impacts of climate change, but does not address its causes. It is climate change mitigation that addresses these causes. Climate mitigation involves all efforts aimed at curbing the increase in anthropogenic GHG emissions. It envisages a future in which global warming is reduced by deliberate actions. The goal of climate change mitigation therefore is the restoration of the atmosphere to nearly its pre-industrial condition, with the belief that protracted deviation from these conditions could produce irreversible changes after which there is no other alternative than adaptation.

Scientists say over the past 100 years, the temperature has increased by 1 degree Celsius and that out of the 20 warmest years on record, 19 have occurred since 1980; with 3 of the hottest years ever observed had occurred in the last 8 years. The crucial question however is: is climate change mitigation feasible under the present conditions in the Ghanaian context? This question is very difficult to answer given the current levels in anthropogenic emissions and the growth rate of Ghana's: population, high poverty levels, high-dependence on an agricultural economy, increased use of fossil fuel, soil erosion and nutrient depletion, water pollution and sedimentation, salinization, river desiccation, urbanization and encroachment and many more. In the face of all these I have no option than to say the answer is no.

Our economy is fossil fuel driven hence enhancing the emission of CO2 and nitrous oxide -both major GHGs. Agriculture employs close to 70% of Ghanaians, mostly in small holder farms that are rain-fed. There is an increase in the use of fertilizers because the soils are becoming infertile year by year. These fertilizers are a source of nitrogen which can convert into nitrous oxide - a GHG. Hence, mankind's *binge* on fertilizers and fossil fuel has increased the release of nitrous oxide into the atmosphere. These fertilizers also leach into our only surviving freshwater bodies polluting them beyond use. Mining activities both surface and underground has exacerbated the problem. Deforestation is on the increase, as the increasing population puts a stress on arable land for farming and fuel wood. Methane, another important GHG, is emitted from livestock farming and from rice paddies, as well as faecal matter and other decaying matter. Agricultural activity has increased as a result of an increasing population and with the increasing need for high food production for survival. The release of GHGs into the atmosphere is eminent.

Although, the Environmental Protection Agency (EPA) normally conducts environmental impact assessments for development projects, they seem to be overwhelmed by the avalanche of development activity in the country. In fact they need to involve other stakeholders in these assessments like the Ghana Meteorological Agency, the National Disaster Management Organization, the Planning Authorities and other allied stakeholders. Monitoring of GHG emissions has been the core business of the EPA and only a few days ago, I got to know that the Ghana Standards Board also conducts some measurements and monitoring of GHGs. These two bodies need to work together if successful monitoring of emission levels in Ghana can be achieved. One major problem we're

experiencing in Ghana is the monitoring of emissions from non-point or diffuse sources of GHGs. How much do households emit, for instance, and how can this be monitored?

The generally accepted view of mitigation is that of the need to move away from fossil fuel use and rely on renewable energy sources like solar, wind, tidal, geo thermal, energy efficient systems and hydropower. In fact most climate scientists are of the view that reliance on clean technology or green technology - strictly put, a low carbon revolution, is the way forward for mitigation of climate change. Unfortunately exploring the potential for this is in Ghana is still a mirage. Ministries, Departments and Agencies (MDAs) who are mandated to wade into this kind of venture either do not have the critical mass of human capital to do this or their budgets cannot support these laudable investments. Most of the time, it's the lack of both. The business and finance market in Ghana do not understand climate change and its impacts and so will not release venture capital for this purpose.

Hence, awareness creation of the impacts of climate change needs to take centre stage if we have to succeed in mitigating Climate change in Ghana. Institutions like the Ghana Meteorological Agency, the Environmental Protection Agency, the National Disaster Management Organization, the Energy Commission, the Forestry Commission the Water Resources Commission, to mention but a few, that are at the forefront *marketing* or creating the awareness of climate change and its impacts need a paradigm shift, in the way forward. They need not only to sensitize the general public, but also reach down to the local or indigenous people who are the most vulnerable, and communicate the impacts of climate change impacts, as well as mitigation and adaptation strategies. These institutions do not have to carry mitigation measures to the people, but they have to find out from these indigenous people, how they have been coping and what needs to be done in the face of further challenges brought about by climate change.

We need to develop the culture of water harvesting. If you build your house make sure you have water reservoirs for harvesting rainwater. This means the building code has to change to make our buildings more energy efficient. Roofing government buildings with solar panels can be an attractive option and will serve as a starting point. Research also needs to be conducted into the effects of aerosols in cooling the atmosphere needs to be conducted; the results of which will serve as a decision support system for policy makers.

The definition of adaptation to climate change is a complex topic. The IPCC offers us a starting point by providing a broad definition of adaptation: *adjustment in natural and human systems to actual or expected climate stimuli or their effects which moderates harm or exploits beneficial opportunities.* It is worthy of note that adaptation is a process and not an event. Climate change does affect every facet of the economy, society and environment. This means we need behavioural change, change to our laws, our institutions, our livelihoods, our infrastructure, our policies etc in response to experienced or expected climate events.

Unfortunately, this does not seem to be happening at the level that is expected to have an impact on adaptation. Our institutions presently cannot adjust in terms of flexibility, our management systems to deal with uncertainties, future changes or expected changes. The National

Disaster Management Organization for instance, does not have the legal authority to demolish buildings that are built in waterways or flood plains. NADMO and other key institutions cannot plan adaptation by carefully thinking about what systems will function in the short, medium and long term. Development is the key to economic growth. But these two are closely linked and this linkage is critical to reducing vulnerability to climate change. Economic growth improves health, water resources, economic livelihood and people's quality of life. It also puts Ghana in the right frame to adapt to climate change.

Ghana's economic growth rate last year of about 7% is a welcome sign that we are on the right path. However, this development should not be the *business as usual* type to make it impossible to adapt to climate change. Unfortunately, Ghana has a long way to go in this effort. Buildings, roads and dams and other infrastructure are constructed with inadequate stakeholder consultation on how to incorporate adaptation measures. This often happens only after failures have occurred. These are processes that initially look like a response to a hazard but ultimately tend to exacerbate the vulnerability of the hazard. Human development is the concern of adaptation measures, because the same factors that constrain and facilitate development are the same factors that constrain and enable human development.

Mainstreaming adaptation should find meaning in development plans. Unfortunately this is not the case in Ghana, because policymakers do not understand climate change and its impact. Cross-sectoral approach to mainstreaming climate change adaptation is virtually missing here in Ghana. For instance, the VRA may decide to build a new dam, like the Bui dam, for hydropower, whilst the Ministry of Agriculture may advocate for expanded irrigation downstream. This is certainly an inconsistency as there could be adverse consequences for downstream farmers whose downstream water supply might become unreliable. These are different approaches to adaptation which tend to be mutually exclusive.

Adaptation to climate change and disaster risk reduction is conceptually linked. However, it appears on the ground these two approaches in Ghana are handled by entirely different institutions, individuals, methodologies and even policy frameworks. In fact the two need to be linked so that all stakeholders can act together because both adaptation and disaster risk reduction are about economic, social and physical factors that determine the magnitude of the threat that both are dealing with.

There is another key area in adaptation that needs urgent attention in Ghana. The *no money syndrome* often echoed by the Ministry of Finance in most requests for funds is a serious impediment. Adaptation will certainly require substantial funding which is estimated to be in the order of billions of US dollars. However, we also agree that Ghana cannot self-finance adaptation, and so there is the need to look for other sources. Some of these adaptation measures entail regional co-operation for example through the ECOWAS Secretariat but whether this is being done is yet to be seen. The Anglophone Francophone divide in the sub-region, a colonial legacy is not doing us any good.

Another vital issue of great concern is how to map areas of vulnerability. Different areas have different vulnerabilities. Have we tapped

the local expertise in these areas to see how we can strengthen the adaptation strategies of these localities? Are we just waiting for the disastrous events to happen and then we rush to do some *fire fighting* only to come back the next time round to fight the same event?

Finally, as I have said before, some of our decision makers and other stakeholders in development planning have little knowledge about climate change. Even if they do, they think that this is a temporary perturbation in the climate system and that the system will return to its equilibrium state after a short while, so why address it. It is in the light of this that I completely identify with the theme for this Consultative Conference: *the role of higher education in adapting to climate change: Africa.*

It is true that Ghana lacks that critical mass of climate experts who will be at the forefront of this struggle to save mother earth from total devastation from climate change. I hope that this conference will take this issue of the lack of human capital in the field of climate and climate change very seriously and find ways to address it as a matter of urgency. These climate change experts will continually monitor the climate in the various localities to see the direction of change. This is very important because the world is trying to shoot at a moving target, whose movement path is highly uncertain, hence the need for close monitoring. In fact, I wish climate and environmental studies could be extended to the lower levels of education so that our children grow up with the idea that they need to fight climate change in full gear. This could happen through new curricula that include issues of climate and the environment.

3.5 SUMMARY OF PANEL DISCUSSION

In the panel discussion entitled limate *Change Adaptation Ð Challenges and Opportunities for Higher Education in Africa*, Prof. Srikantha Herath, Senior Academic Programme Officer, UNU-ISP, acted as the facilitator.

Prof. Rwekaza S. Mukandala, Vice Chancellor, University of Dar es Salaam, highlighted the importance of adapting to climate change, robust relationship between science and policies, mainstreaming climatic change and interdisciplinary approaches in dealing with climate change.

Prof. Zoubeida Bargaoui, National Engineering School of Tunis ENIT, Tunisia, discussed the important role higher education need to play in addressing climate change and proposed that theres is an important demand to develop a range of educational materials that should be collectively tackled by a coalition of universities.

Prof. Janice Olawoye, Department of Agricultural Extension and Rural Development, University of Ibadan, provided a social science perspective of climate change in Africa, and the challenges faced by the higher education sector and academia, with a special reference to Nigeria. She emphasized the need to incorporate social, behavioral, justice and political aspects of finding appropriate solutions; be consideration of demographic characteristics like gender, population size, density and distribution; the danger of importing in solutions from outside and donor driven research and the need for more assertive response from local academia and officials.

Dr. Mekuria Argaw Denbuba, Assistant Professor, Environmental Science Programme, Addis Ababa University, Ethiopia, discussed the main challenges facing climate change. He identified addressing complexity, assessing impacts, developing the needed expertise and preparedness as the most important elements in minimizing adverse impacts from climate change.

Dr. Abou Amani, Assistant Programme Specialist in Natural Science, UNESCO, Ghana, discussed the need to improve the scientific understanding of the conditions in Africa, improving local predictions in order to assess the impacts accurately and develop appropriate response plans. He briefly introduced the African Monsoon Multidisciplinary Analyses (AMMA) Initiative, which is a coordinated international project aimed at improving knowledge and understanding of the West African monsoon (WAM) and its variability, with an emphasis on daily-to-inter-annual timescales and the activities of UNESCO international hydrologic program. These programs are providing valuable contributions to develop local capacity and enhance the forecasts for local conditions. Prof. Francis Mutua, Associate Professor, Department of Meteorology, University of Nairobi, Kenya stressed the importance of ownership by African universities on climate change studies. He discussed the impact of future uncertainty on our daily life, plans and aspirations. Climate change is creating a similar scenario with respect to human development and the future of the planet. It is imperative that this threat be turned to an opportunity by planning well in advance to relieve the future generations from anxiety and present them with new possibilities and opportunities.

In closing the panel discussion, Prof. Herath identified seven key messages that emerged from the panel discussion.

1. Adaptation to climate change is a priority for Africa.
2. Knowledge of earth system and future forecasts at local scale is needed to assess impacts.
3. Holistic approach involving all sectors is required. Interdisciplinary approaches should be promoted
4. Capacity development for much needed expertise to deal with climate change is urgently required. Integrated capacity development approaches involving research, practice and communities should be promoted.
5. Improving research methodologies and approaches to meet the complex and multi disciplinary nature of climate change impacts is needed.
6. Coordination among institutions and sectors is essential to maximize benefits from limited human and financial resources.
7. Climate change should also be viewed as an opportunity and implement longterm policies for the benefit of future generations

4 CONSULTATIVE WORKSHOP : OPENING REMARKS

4.1 INTRODUCTION TO THE WORKSHOP PROGRAMME

Srikantha Herath
Senior Academic Programme Officer, UNU-ISP

Prof. Herath gave a brief introduction of the motivation and history of the initiative.

Africa is experiencing, and will continue to experience, the adverse impacts of climate change. According to the IPCC, by 2020, between 75 and 250 million Africans are projected to be exposed to increased water stress due to climate change. Yields from rain-fed agriculture could be reduced by up to 50% and agricultural production, including access to food, in many African countries is projected to be severely compromised. By 2080, an increase of 5-8% of arid and semi-arid land in Africa is projected under a range of climate scenarios; by the same period densely-populated and low-lying mega-deltas of Africa will experience floods every year due to sea-level rise.

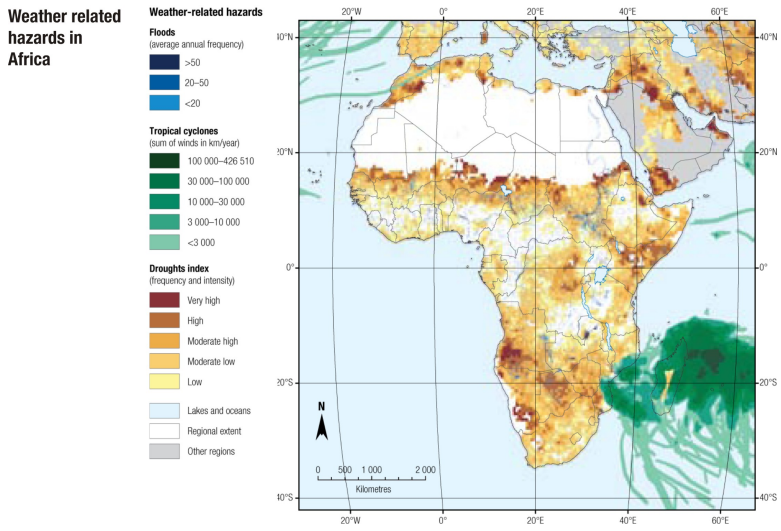


Figure 9: Disaster risks in Africa. Source: GAR, ISDR

Many of Africa's critical water resources also come from transboundary river basins. The way in which water is used and consumed in one country will have major consequences for neighbouring countries that rely on the same water source. International cooperation and a coordinated approach to water resource management and adaptation will become increasingly vital.

On the history of the initiative, Prof. Herath explained how the initiative was first launched in Asia, at a conference in Tokyo, 10-12 June 2009. The structure and theme of the conference and following 2-day consultative workshop was similar to that of this event in Ghana:

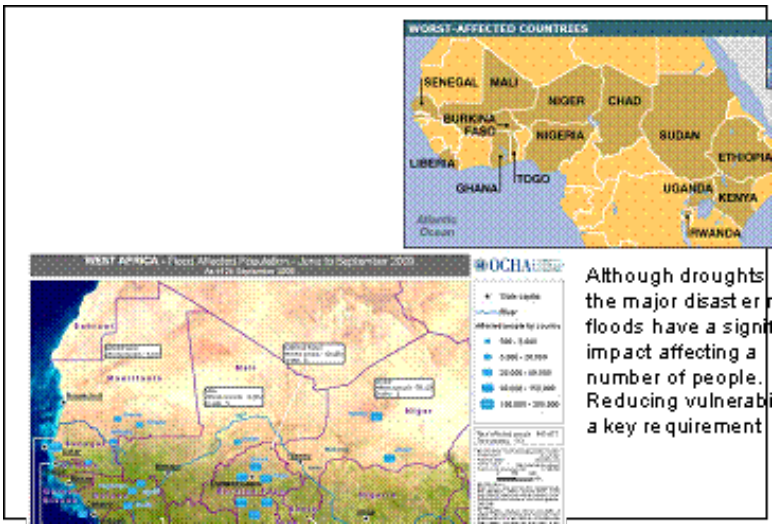


Figure 10: Floods are cause significant damage in Africa when looked at in local scale

"the role of higher education in adapting to climate change". Key outcomes of the June event were: the establishment of a University Network: Climate and Ecosystems Change Adaptation Research, agreed Terms of Reference, and a defined network structure. Members will contribute and share to the development of joint programs, facilitated by the following mechanisms: repository, database, web portal, video conferences and annual meetings.

This workshop is expected to discuss:

- The role of higher education in climate change adaptation
- The assessment of climate change impacts
- Agriculture and water sector
- Economy
- How to design adaptation strategies: What are the constraints?
- Involvement in national planning
- Implementation
- How to link up local communities with the global knowledge, solutions and programs?
- What is expected from the international community?

The brainstorming session held in the afternoon will be divided along two sessions:

1. Session 1: Climate change education in post graduate education
   - Current status: Priority, short and long term needs
   - Type of Programs (joint, credit transfer, double)
   - Curriculum (focus, specialization, etc.)

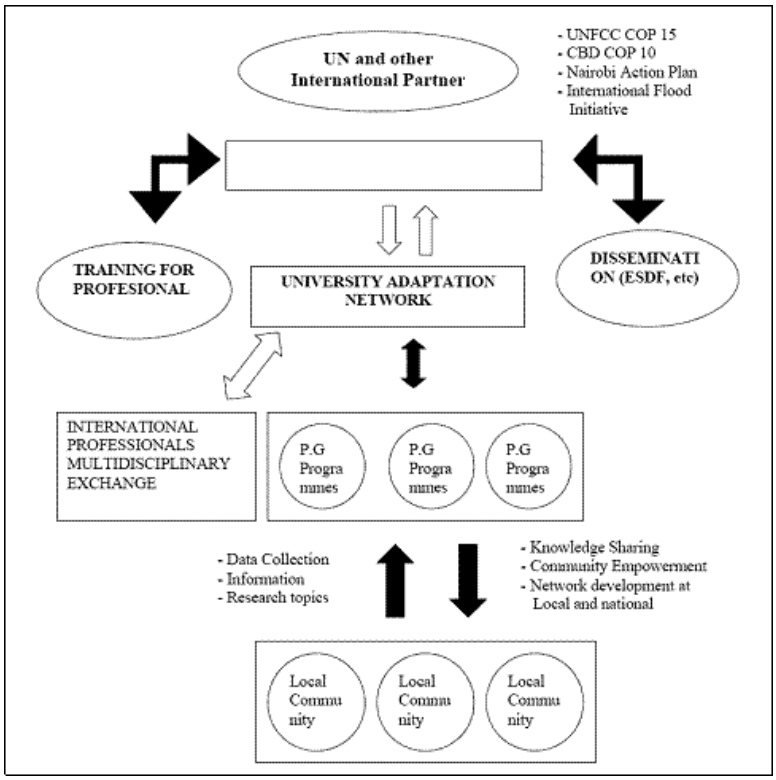


Figure 11: Proposed framework for University Network in relation to Global and Local stakeholders

2. Session 2: Climate change research in post graduate education
    - Current status (post grad programs, research opportunities,)
    - Needs (priority topics, mechanisms, coordination, joint programs/linking)

The discussion session at the end of the day will focus on the way forward, such as mechanisms for collaboration, existing programs and possible linkages, strengthening/support required and the proposed framework.

5 CONSULTATIVE WORKSHOP : UNIVERSITY PRESENTATIONS

5.1 UNIVERSITY OF DAR ES SALAAM

Challenges of Climate Change Adaptation in Africa and Role of Higher Education

Rwekaza S. Mukandala
Vice Chancellor, University of Dar Es Salaam
Tanzania

Climate change is increasingly becoming one of the key global challenges for sustainable development and human survival in the 21st century. In the last one hundred years the climate has changed dramatically with abnormal global warming. Different scientific studies and observational evidence have shown that warming of the climate system is unequivocal and it is human induced. This warming is positively correlated with the build up of greenhouse gases in the atmosphere. Vulnerable sectors include: water, health, agriculture, and biodiversity. There is clear evidence of the increased intensity & frequency of extreme weather. This is leading to increasing costs of disaster management beyond affordable limits.

These climate change impacts are already undermining our sustainable development. The poor, in particular, are extremely vulnerable.

Some of the regional challenges that Africa faces are institutional weaknesses and weak technical capacity. With regards to the first, institutional weakness, this is due to: a lack of political awareness by decision makers on climate change impacts, weak institutional framework to deal with climate change challenges; inadequate broader public awareness on climate change impacts and vulnerability; and inadequate capacity to participate in key international agreements & institutions. On the second issue, technical and scientific capacities remain weak, and are compounded further by lack of coordination among administrative & regulatory bodies at the national level.

At the global level, developing countries are affected by the inadequate implementation (inadequate & unpredictable funding and capacity building initiatives) or compliance requirements imposed by developed countries, as well as poor access to technology.

The Role of Higher Education in Climate Change Adaptation

The generation of knowledge occurs through research, capacity-building, and training. Research is essential for effective understanding of climate change impacts, vulnerability to climate change; and adaptations options. Education is one of the most powerful tools that African countries have at their disposal for breaking the cycle of poverty. Development of

a sound education system is therefore crucial for economic growth as it contributes to:

- the development of effective responses to multiple threats generated by climatic and non-climatic drivers of environmental change;
- better adaptation to innovations and newer technologies; and
- the generation of a robust and dynamic knowledge base capable of providing information to policy makers at scales that are relevant to adaptation planning

There is a need for strong regional centres for climate change education in order to enhance education and scientific capacities in the region, generate scientific knowledge, as well as ensure effective participation in dialogues and decision processes aiming at adaptation to climate change. However, there are critical impediments to advancing climate change education in Africa. In particular, the lack of appropriate curricula in colleges and universities for graduate and undergraduate education, and the delay in curriculum review to address emerging issues on already on-going programs. Other contributing impediments include:

- Fragmented donor's support on Global Environmental Change (GEC) education programs
- Lack of well established e-learning resource library for GEC teachers and researchers;
- No strong coordination on sharing existing programs and ICT among African universities
- Insufficient physical infrastructure

Nonetheless, opportunities are available and should be utilised to improve climate change education. Examples include established institutional frameworks such as, the International Council for Science (ICSU), a non-governmental organization with a global membership; START (global change SysTem for Analysis, Research and Training), a non-governmental international research organization; the African Academy of Sciences (AAS), an Africa-wide, professional, nonpolitical, and non-profit organization of senior scientists, science policy experts and science managers, and the Union for African Population Studies (UAPS) – another pan-African non-profit scientific organization that aims at promoting research and the utilization of findings to improve policies and programs on population and development in Africa. To summarise the way forward, there needs to be greater promotion of regional programs, creation of regional research centres, and established mechanisms for sharing regional human and infrastructural resources for higher education and research.

Climate Change programmes and research at the University of Dar Es Salaam

The University of Dar Es Salaam has been proactive in establishing and participating in various climate change research projects and degree

programs. It currently offers climate-related subjects for students undertaking a: M.Sc. Natural Resource Assessment Management (NARAM), M.Sc. Integrated Water Resources Management (MIWRM), and M.Sc. Integrated Environmental Management (MIEM). The table below provides a list of some joint research projects on climate change by the University. The top 5 research priorities for climate change adaptation in Tanzania which the University considers needs to be addressed urgently are (in order): 1. Climate change and agricultural productions/yields; 2. Climate change and water resources management; 3. Climate change and biodiversity conservation; 4. Climate change knowledge transfer (Community awareness to adaptation mechanisms); 5. Climate change and weather forecasting

Project Title	Type	Participating Countries
Assessment of Impact of Climate Change on Food Security in Food Insecure Areas in Tanzania	Community-based/ Agriculture/ Impacts & knowledge assessment	Tanzania
Strengthening local agricultural innovation systems in less favored and more favored areas of Tanzania and Malawi to adapt to the challenges and opportunities arising from climate change and variability	Community-based/ Agriculture/ Impacts & knowledge assessment	Tanzania Malawi
Capacity-Building program for managing biodiversity in a changing climate in the Albertine Rift Countries (Tanzania, Rwanda, Burundi, Uganda and DR-Congo)	Community-based/ Education	Tanzania Uganda Rwanda Burundi DR-Congo
Exploring urban-rural social and environmental interdependence and impacts of climate change and climate variability and responding through enhanced agricultural food and security innovation systems	Community-based/ Impacts & Knowledge assessment/ Social Systems	Tanzania Malawi
Climate Change and Variability in Tanzania: Assessment of Impacts, Vulnerability and Adaptive Capacity of Natural and Social Systems	Community-based/ Social Systems	Tanzania
Dynamic Interactions among People, Livestock, and Savanna Ecosystems under Climate Change	Ecosystem/ Social systems	Tanzania Uganda Kenya

The African Climate Change Fellowship Program	Education	Africa
Technical Backstopping to Support the Assessment of Investment & Financial Flows to Address Climate Change in Developing Countries	Governance/ Finance	Gambia Namibia Niger Algeria
Understanding The Findings Of The Intergovernmental Panel On Climate Change (IPCC) Fourth Assessment Report "Climate Change 2007" – Integrating Climate Change Adaptation and Mitigation in Development Planning	Governance/ International	Tanzania Burundi Rwanda
Building Long-Term Capacity for Managing and Adapting to Climate Change in Africa and Asia	Governance/ International	Tanzania Kenya Uganda Ethiopia Rwanda Mozambique Burkina-faso Mali
Impacts of climate change on water resources and agriculture - and adaptation strategies in Tanzania (CLIVET)	Impacts & knowledge assessment/ Governance	Rufiji Basin, Tanzania
Assessment of Impacts and Adaptation to Climate Change (AIACC) in Lake Victoria Basin Countries	Impacts & knowledge assessment/ Health	Kenya Uganda Tanzania
Rungwe Environmental Science Observatory Network A natural and sustainable laboratory platform of interactions between Volcanism, Climate, Environment and Human activities in Africa	Monitoring	Tanzania
Regional Climate Change Program (RCCP)	Monitoring/ Governance/ Community-based	SADC Region

5.2 CLIMATE CHANGE AT SUEZ CANAL UNIVERSITY

Mohamed Tawfik Ahmed
Director, Environmental Impact Assessment
Professor, Faculty of Agriculture

The power point Presentation of Professor Tawfik continues from next page.

Climate Change at Suez Canal University, A Bird's Eye View

Mohamed Tawfic Ahmed

MESA University Partnership

Mainstreaming Environment and Sustainability in African Universities Partnership

The Education for Sustainable Development Innovations Course

– for Universities in Africa -

outcomes

1: ***Conceptualise the relevance of ESD in relation to teaching, research, community services and management …***

2: ***Design and apply innovative approaches to teaching, research and /or community services that reflect principles and values of SD, enhance learning and use of ICT***

3: ***Develop and apply innovative strategies to strengthen institutional capacity for responding to environmental and development issues …***

Global Virtual University / United Nations University

- Performing two training workshops, E Learning of Environment Courses, with Special Emphases on Water and Climate Change, February, and November, 2007

Water Resources Management in Drylands

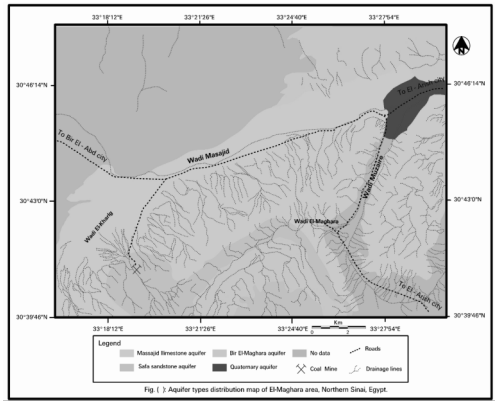
- A Master course in which a number of international universities would participate
- The course was supposed to be coordinated by GVU/ UNU

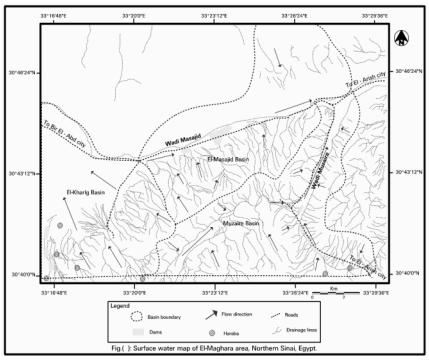
Research Activities

- Water Management in Climate Change Vulnerable Areas

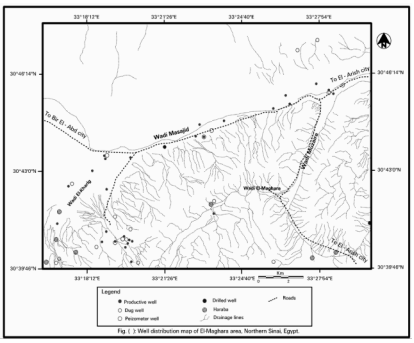
Water Provision, Trends and Conditions

- Mapping aquifers, drainage network, recharge capabilities and others, in Sinai, one of the most vulnerable areas of water scarcity



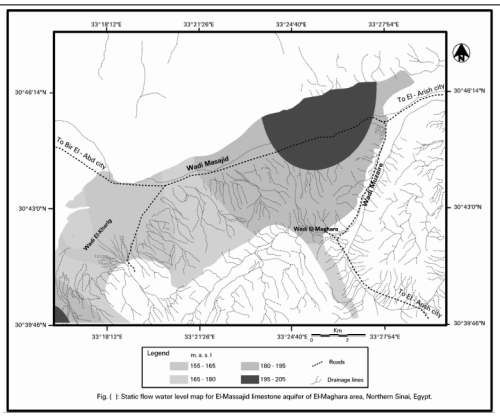


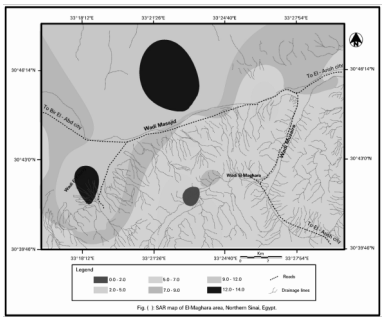
Drainage basins and surface water distribution map constructed from ETM image



Distribution of water points from different aquifers.

Fracture sets facilitate surface and groundwater flow (wadi El-Maghara)





Sodium absorption ratio (SAR) map of all aquifers in the study area.

Natural Springs In the Vicinity of the Assessment Site

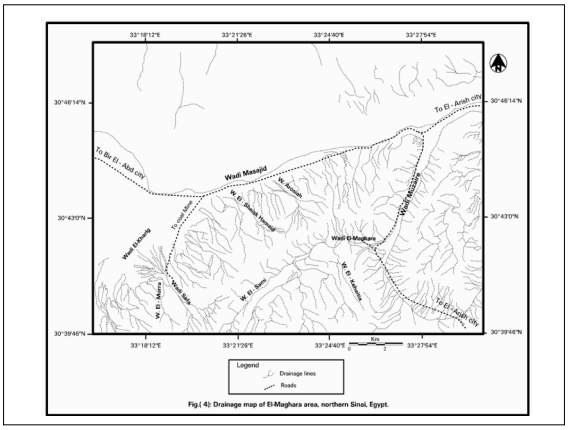


Fig.(4): Drainage map of El-Maghara area, northern Sinai, Egypt.

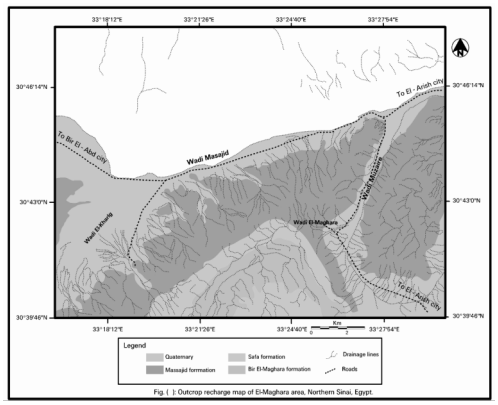


Fig. ( ): Outcrop recharge map of El-Maghara area, Northern Sinai, Egypt.

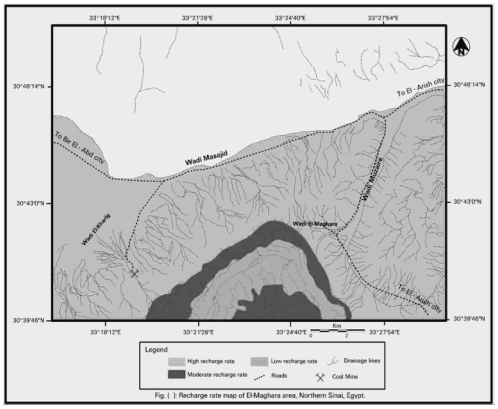


Fig. ( ): Recharge rate map of El-Maghara area, Northern Sinai, Egypt.

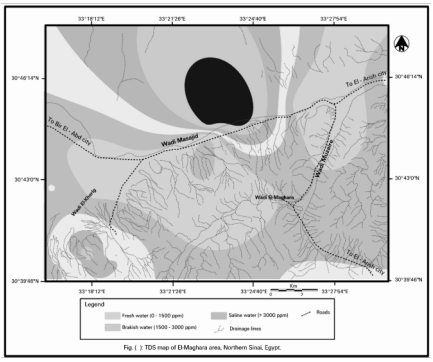


Fig. ( ) TDS map of El-Maghara area, Northern Sinai, Egypt.

Salinity distribution map of all aquifers in the study area.

Concentration of some heavy metals ppm in
Some wells in the study area

Sr. NO.	Local name	Mn	Fe	Ni	Cu	Co	Pb
1	Bir 5	0.06	0	0.4	0.06	1.43	0.26
2	Bir 12	0.06	0.22	0.4	0	0.71	0.26
3	El Feteh 1	0.06	0.15	0	0		
4	El Feteh 2	0	0	0	0		
5	El Masoura	0	0	0	0		
6	Bir Raghwi	0.09	0.22	0	0		
7	coal mine (w. Massajied)	0.09	0.19	0	0		
8	Coal mine (w. El Safa)	0.09	0.76	0.4	0	1.79	0.4
9	Bir Umwerib	0.06	0	0	0	0	0
10	Bir El-Maghara	0.12	0	0.8	0		
11	Bir El-Hedoud	0.06	0	0.8	0		
12	Cistren (Haraba)	0.32	0.72	0	0		
13	Bir El-Malhi	0.09	0	0	0	0	0
14	Bir El-Masoutia	0.09	0.31	0	0	0	0

Well No	Iron Fe	Stranchium Sr	Arsenic As	Cadmium Cd
Well 12	<0.0054	3.07	<0.0001	<0.001
Well 5	<0.0054	4.222	0.0055	<0.001
El Masaged	<0.0054	3.255	0.0085	<0.001
El Masoura	<0.0054	1.041	0.0247	<0.001
El Fath	0.0357	0.948	0.0041	<0.001
El Soutia	0.052	5.53	0.0111	<0.001
El Mangam	<0.0054	6.56	<0.0001	<0.001

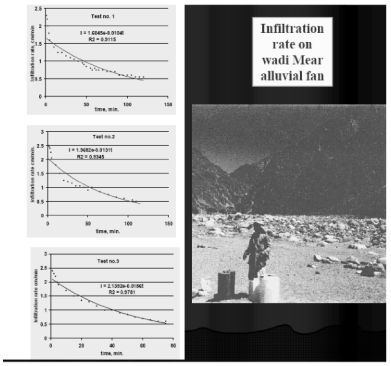
Residues of Some Heavy Metals in Water Samples Collected from El Maghara (Manganese, Iron, Nickel, Copper, Cobalt, Lead)

Sr. NO.	Local Name	Manganese ppm	Iron ppm	Nickel ppm	Copper ppm	Cobalt ppm	Lead ppm
1	Bir 5	0.06	n.d	0.4	0.06	1.43	0.26
2	Bir 12	0.06	0.22	0.4	n.d	0.71	0.26
3	El Feteh 1	0.06	0.15	n.d	n.d.	n.d.	n.d.
4	El Feteh 2	n.d	n.d	n.d	n.d	n.d.	n.d.
5	El Masoura	n.d	n.d	n.d	n.d	n.d.	n.d.
6	Bir Raghwi	0.09	0.22	n.d	n.d	n.d.	n.d.
7	Coal Mine (w. Massajied)	0.09	0.19	n.d	n.d	n.d.	n.d.
8	Coal Mine (w. El Safa)	0.09	0.76	0.4	n.d	1.79	0.4
9	Bir Umweib	0.06	n.d	n.d	n.d	n.d	n.d
10	Bir El Maghara	0.12	n.d	0.8	n.d	n.d.	n.d.
11	Bir El-Hedoud	0.06	n.d	0.8	n.d	n.d.	n.d.
12	Cistren (Haraba)	0.32	0.72	n.d	n.d	n.d.	n.d.
13	Bir El-Malhi	0.09	n.d	n.d	n.d	n.d	n.d
14	Bir El-Masoutia	0.09	0.31	n.d	n.d	n.d	n.d

A Proposal to Enhance Natural Aquifer Recharge in Sinai, Egypt

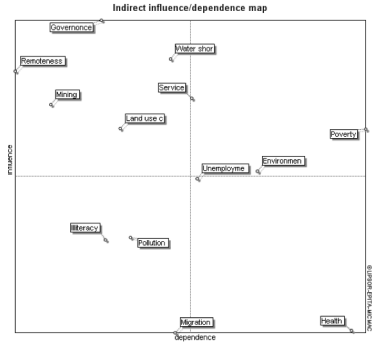
Rationale

- Flash Floods & droughts are frequent
- Destruction by flash flood water and losing it through evaporation or drainage to the sea
- Urgent need for fresh water supply
- Natural aquifer recharge is meager (about 90% of rainfall events return back to atmos.
- Long term drought has negative impacts on Ecosystem natural resources and threat the sustainability of development projects



Water Scarcity Scenarios

	1 : Unemployme	2 : Remoteness	3 : Illiteracy	4 : Mining	5 : Service	6 : Environmen	7 : Health	8 : Migration	9 : Poverty	10 : Governonce	11 : Water shor	12 : Land use c	13 : Pollution
1 : Unemployme	0	1	2	1	1	2	2	3	3	1	1	1	0
2 : Remoteness	2	0	2	2	3	2	2	2	2	2	2	2	1
3 : Illiteracy	2	0	0	1	1	2	2	0	2	1	0	1	0
4 : Mining	2	1	0	0	2	3	2	1	2	2	2	2	2
5 : Service	2	2	2	2	0	2	2	2	2	1	2	2	2
6 : Environmen	1	1	0	1	1	0	2	1	2	1	2	2	3
7 : Health	1	0	1	0	0	0	0	0	2	1	0	0	0
8 : Migration	1	0	1	0	0	0	0	0	2	0	1	0	0
9 : Poverty	2	2	2	1	2	2	3	3	0	1	2	1	1
10 : Governonce	2	2	2	3	3	3	3	1	3	0	2	2	2
11 : Water shor	3	0	2	0	3	3	3	3	3	2	0	3	3
12 : Land use c	1	1	0	2	2	2	2	1	2	2	2	0	2
13 : Pollution	0	0	0	0	2	2	3	0	2	1	2	0	0



Indirect Influence / Dependence Map

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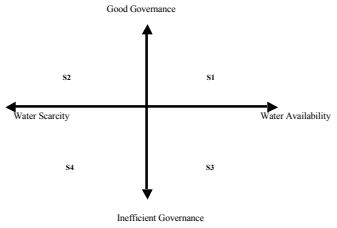

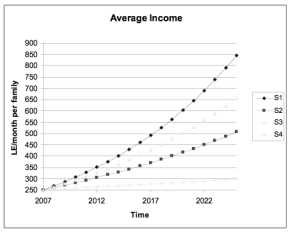

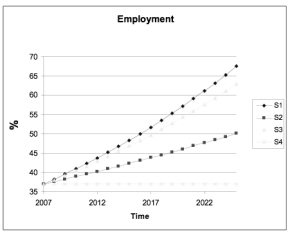

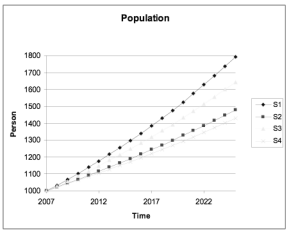

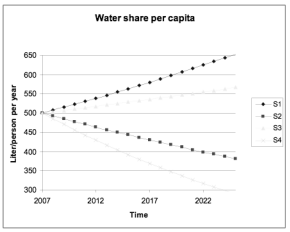

Thank You and See You in Egypt

5.3 UNIVERSITY OF IBADAN, NIGERIA

Specializing Post graduate programs and multidisciplinary research for climate change at University of Ibadan, Nigeria

Janice Olawoye
Professor
Department of Agricultural Extension and Rural Development

The power point Presentation of Professor Olawoye continues from next page.

Specializing Postgraduate Programmes and Multi-disciplinary Research for Climate Change at Univ. of Ibadan, Nigeria

Professor Janice E. Olawoye
University of Ibadan, Nigeria

1

2

Vision and Mission of UI / Relevance to Training & Research to CC Adaptation

- ***Vision:*** *To be a world-class institution for academic excellence geared towards meeting societal needs.*
- ***Mission****: To expand the frontiers of knowledge through provision of excellent conditions for learning and research; To produce graduates who are worthy in character and sound judgment; To contribute to transformation of society through creativity and innovation; To serve as a dynamic custodian of society's salutary values and thus sustain its integrity.*

3

Focus on Postgraduate Programmes at UI

- UI is the premier university in Nigeria – having just celebrated 60th anniversary, being established in 1948
- Current emphasis at UI is on postgraduate programmes with a goal of achieving a 60 / 40 ratio of postgraduate / undergraduate students.
- At present, the University has 1,200 faculty, with over 300 in the professorial cadre

4

UI Performance in PG Training

- Since 1962, the University of Ibadan has awarded **45,709** higher degrees, including 2 DSc, 4,366 PhDs, 36 MD/MS, 4,700 MPhil/Professional Master's Degrees, 32,324 Academic Master's Degrees, and 4,281 Postgraduate Diplomas.
- UI has a major role in capacity building for other universities by training academic & administrative staff for other universities. The Postgraduate School at the University of Ibadan presently awards 90% of all graduate degrees produced in Nigeria.

5

Relevant PG Programmes at UI

- *PG Programmes are either academic or 'professional' in nature: professional PG certificates / degrees cannot be equated to academic qualifications to proceed to academic Masters' or Ph.D.*
- *A number of 'professional' PG programmes are offered in many disciplines across the Faculties: including PG Diplomas in Agricultural Extension and Agricultural Policy in Faculty of Agriculture and Forestry.*
- *Other specialized, relevant programmes are found in each of the Faculties including programmes in Development Economics, Natural Resources Management, Public Health, etc. .*

6

Existing Specialized Masters' Programmes at UI sponsored by External organizations

- Africa Regional Centre for Information Science (ARCIS) sponsored by the Association of African Universities (AAU), Ghana, established in 1990 to run postgraduate (master and doctoral) programmes in information science. Students are drawn from all over Africa.
- Centre for Peace and Conflict Studies (CEPACS) sponsored by the Economic Commission for Africa (ECA) and established in January 2000 to run Master and Doctoral Programmes in Humanitarian and Refugee Studies. Students are drawn from all several countries in Sub-Saharan Africa
- The Master in Strategic Studies (MSS) Programme, a special programme for very senior defence personnel drawn from Nigeria and other countries in Africa and Asia sponsored by the Federal Government of Nigeria.
- Joint Ph.D. programme in Economics sponsored by the African Economic Research Consortium (AERC) with students drawn from all over Africa.

7

Emphasis upon Practical Training Opportunities

- The University of Ibadan has partnerships and affiliations with local outreach programmes and specialist centres that will provide students practical training opportunities. Such partnerships include:
  - Ibarapa Rural Programme (a medical outreach programme),
  - Agricultural Practical Training Programme, Ile Ogbo,
  - Radiation Protection Centre,
  - International Institute of Tropical Agriculture (IITA),
  - World Bank Afforestation Projects in Ogun and Ondo States, among others.

8

Special Focus upon UI Rural Development Project at Ile Ogbo

- Special relationship with local community for over 20 years
- Provides opportunity for undergraduate and postgraduate students to have practical training in areas of agricultural and rural development
- Staff also conduct field-based research

In the area of teaching, as well as research for CC or any topic of local relevance, it is important to have field laboratory

9

Current Efforts to Develop Masters' in Development Practice (MDP)

- The University of Ibadan is currently mounting a programme known as MDP. It has been selected for sponsorship by the MacArthur Foundation, USA, in collaboration with Columbia University.
- This programme shares many of the same objectives and guiding principles as ESDA and would be a good avenue to incorporate CC concerns.
- Example of the MDP can offer some lessons for the development of a curriculum for programme of training for CC

10

Courses to be Offered in MDP

- The MDP programme will be based on a course system. Courses will be taught under five broad categories reflecting the key areas of development practice: health sciences, natural sciences and engineering, social sciences and management sciences. The fifth category will be general courses.
- Altogether, there are 25 units of compulsory courses, 15 units of required courses and 43 units of electives, making a total of 83 course units.

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Courses for MDP at UI

- Public Health and International Nutrition
- Health Planning and Management
- Foundations and Principles of Family and Public Health
- Communicable Disease Epidemiology
- Population Science
- Agriculture, Forestry and Fisheries Management
- Agribusiness, Entrepreneurship & Development

12

Courses for MDP cont.

- Energy and Sustainable Development
- Public Infrastructure
- National and Global Chemical Environmental Issues
- Sustainable Production and Management of Renewable Resources and Fertilizer Use
- Delivery Science
- Political Economy of Development
- Development Economics

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Courses for MDP cont.

- Literacy and Agricultural Development
- Research Methods
- Budget Planning and Financial Management
- Geographic Information System and Development
- Institutional and Human Resources Management
- Project Design, Evaluation and Management
- Information System Design and Management

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Courses for MDP cont.

- African Development Information Sources and Systems
- Culture, Leadership and Sustainable Development
- Communication, Negotiation and Conflict
- Social and Pubic Policy
- Internship
- Seminar
- Special Project

There is potential for mainstreaming CC issues into many of these courses.

15

Universities need to respond to contemporary importance of CC

- Challenges of CC cross many disciplines – it involves us all, but we have seen little collaboration between disciplines, universities or other institutions.
- Limited response to CC has been largely from organizations outside the region or outside academia (international donor agencies, NGOs, etc) – which should not be so. Research & teaching activities of University staff have been more donor-driven than initiated by universities – such as my recent work on Gender & CC Toolkit for NigeriaCAN.

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Cases of partnerships between universities, NGOs, research institutes, etc. in Nigeria

- Example of Nigerian Environmental Study / Action Team (NEST), an environmental NGO with network of researchers from universities, institutes, etc. to draw upon for research activities. Has done significant work in research on CC and enlightenment campaigns for policy-makers
- Nigeria Climate Action Network (NigeriaCAN) a coalition of NGOs – supports research activities, but focused more on advocacy

17

Response of Universities to CC Challenge in curriculum

- Very limited: At University of Ibadan, I could only identify one course in Geography Dept. that specifically looks at CC.
- However, CC topics are covered in the content of other courses across several Faculties. For example, in Faculty of Agriculture and Forestry some courses in agronomy, looking at delay in rains, etc. or in animal science, considering effect of heat stress upon livestock, may discuss CC in looking at farmers' production activities, but not in a systematic way
- It is time for universities to take the lead in designing programmes for capacity-building of policy-makers, development practitioners and other relevant stakeholders.

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Which option: Programmes specifically on CC or CC mainstreamed into other courses?

- Benefits from both:
  - Specific course on CC could produce persons fully knowledgeable about the many implications of CC events and become advisors to policy-makers, etc.
  - Mainstreaming CC into existing courses would produce persons from different sectors who could apply knowledge in specific areas: i.e. training agricultural extension personnel to be better advisors to farmers.

19

Target Stakeholders

- Who are the target groups that need to be trained about CC and what level of understanding do they need? When we can answer that question, we can decide upon type of programme, specialized trainings, courses to be taught, etc
- What kind of research topics should be undertaken and which types of expertise are needed?

20

Need for Collaboration / Cooperation within and among universities

- Nigeria has about 80 universities – including Federal, State and Private
- These institutions are spread over all agro-ecological zones which facilitates locality-specific training & research. This would greatly improve our ability to enhance adaptation capability as CC challenges also vary by locality.
- Teaching and Research would be even more effective with collaboration across countries.

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5.4 UNIVERSITY OF NAIROBI, KENYA

Climate Change Research and Training in the Universities in Kenya

Francis Mutua
Associate Professor, Department of Meteorology
University of Nairobi, Kenya

Africa has complex climate drivers which translate into complex weather systems and climate variabilities. In the past, most of the emphasis for understanding climate over Africa was the ITCZ and the four high pressure cells, namely, Arabian, Mescaline, St Helena and Sahelian Highs, in relation to the wind patterns on the moisture sources over the Congo Basin, the Indian and the Atlantic Oceans and other major moisture controls (Lakes and mountains). This drew a lot of academic interest locally but also abroad. This led to the formation of WMO Regional Meteorological Training Centers (RMTCs) in different parts of Africa. The RMTC in Nairobi Kenya was established in 1964/65 as one of these RMTCs. It serves the Anglophone Africa. The RMTC in Kenya, is divided into two components, namely, the Institute for Meteorological Training and Research (IMTR) located on the grounds of the Kenya Meteorological Department (KMD) which is involved with the basic meteorological research and WMO Class II-IV training and the University of Nairobi component (Department of Meteorology) which specializes in R&T for WMO Class I, MSc and PhD training. In this set-up, the University of Nairobi is privileged to access the most up-to-date data and information for meteorological research and training.

Through the efforts of the University of Nairobi and all the other institutions that it collaborates with, locally (ICPAC, KMD, DMC-Harare, ACMAD, Cairo Climate Centre, University of Cape Town, etc) and abroad, both the general climate sciences as well as the African climate systems are better understood today. This has led to quality training and very reliable seasonal forecasts in the region. All this has been achieved albeit the presence of a myriad of real challenges in the delivery of research and training of the climate science processes in the university's academic and administrative environments.

The majority of the challenges hinge on the weakened structures of the national knowledge systems, pedagogies and incentives provisions in the university. The introduction of climate change disciplines in the climate curricula in the university has only complicated the efficiency of delivery of the desired climate change socio-economic and academic products.

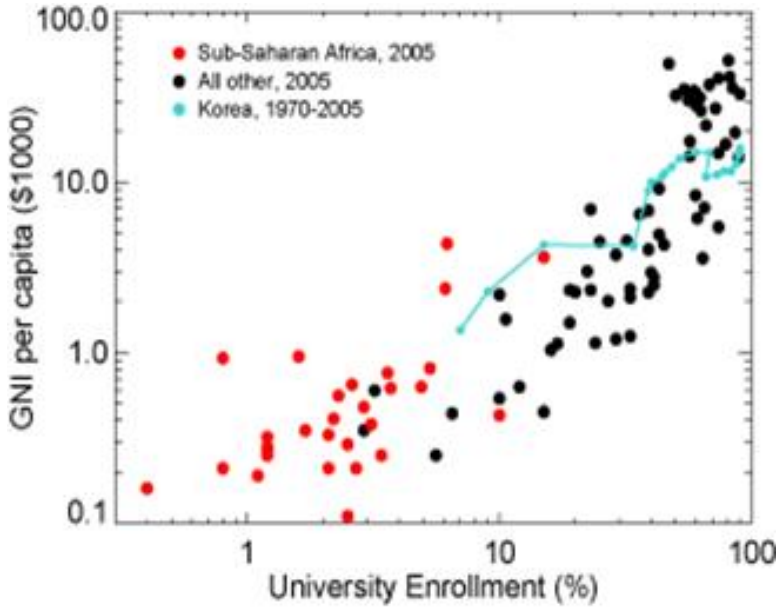


Figure 12

Some of the key challenges to climate research and training include:

- Lack of institutional/policy framework for collaboration
- Low incentives for multi-disciplinarily and trans-disciplinary research
- Donor-driven research agenda due to dependency on external donors for R&T funding
- Low investments by national governments to invest in science, technology and innovation programs and scientific equipment
- Perceived superiority of Western Science and Western Scientists
- Perceived and real demand for international experts by governments and private sector
- Focus by African politicians on short-term value addition
- Multiple ministries and government parastatals handling various aspects of the innovation system each with different agenda,
- Difficulties of dealing with uncertainty,
- Colonial structures and curricula still being maintained in most higher education establishments,
- Research Assessment Exercise (RAE) is still based on foreign criteria, for example, publications in international journals;
- Insufficient legal frameworks for Intellectual Property Rights, and other knowledge appropriation strategies, etc.
- Low quality of science leading to failed predictions & lack of trust in Kenyan science by stakeholders,

- Lack of systemic, holistic & interdisciplinary approaches in Kenyan science,
- Poor incentives: Salaries & equipment
- Ban on recruitment of young minds to replace the "tired" minds

Graph: Institutional dimensions for climate Training and Research

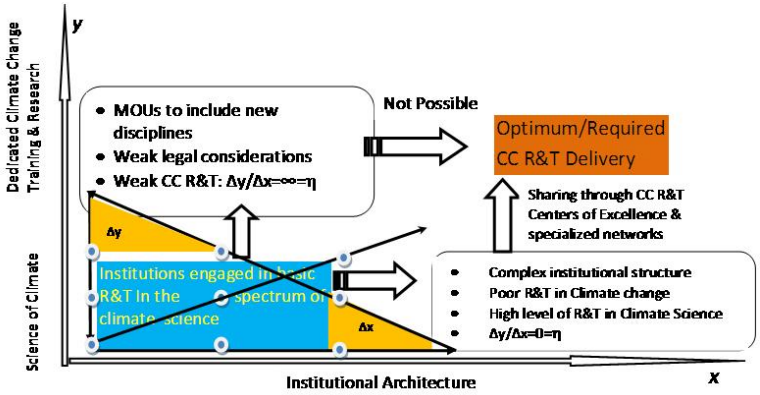


Figure 13

Research and training of climate change adaptation in the institutions of higher learning in Kenya are intended to contribute to sustainable development in the country. However, this can happen if and only if the university contributes effectively to meeting the social, economic and biophysical needs of the present and future generations of Kenyans.

Understanding the importance of improved social coping and adaptive capacities for climate change, and from the concepts of responsible innovation systems as the platform for development and the nexus between the social, biophysical and economic aspects of environmental flows, Kenya needs to build effective platforms for effective integration and collaboration within and among all national and international knowledge centres of climate change and to build appropriate incentive structures for effective valorisation of science are necessary conditions for sustainable development in the country.

Policy Proposals

PEDAGOGICAL REFORMS: to move from disciplinary science to transdisciplinary science;

STRUCTURAL REFORMS: to move from current models of science & technology knowledge transfer to providing collaborative platforms for responsible innovation, such as Centers of Excellence, Innovation Incubation Centers, etc;

MINDSET REFORMS: to move from sector based approaches in teaching and learning (silo thinking) to integrated holistic approaches in knowledge generation and knowledge circulation (systems thinking);

GOVERNANCE REFORMS: to move from knowledge hierarchies to participatory governance and full socialization of scientific and technological research

INCENTIVE STRUCTURES REFORMS: to move from "publish or perish" to a more inclusive impact based incentives and reward systems including publications, but also societal relevance / local impacts, co-patents and co-publications, private sector citation index, proximity to specialized knowledge centers, relevance to national policy simulations and formulations, etc., and

POLICY ENVIRONMENT REFORM: to provide favorable policy environments and legislative frameworks to enable cultures of innovation to thrive and flourish at national, regional and global levels.

5.5 ADDIS ABABA UNIVERSITY, ETHIOPIA

The role of higher education in adapting to climate and ecosystem change from the Ethiopian higher institutes perspective

Mekuria Argaw Denbuba
Addis Ababa University, Ethiopia

The Ethiopian context

Ethiopia has a large population (over 80 million) which is projected to increase to 120 million by 2025. The economy is largely agrarian based and rain-fed. The agricultural sector employs 85% of the labour force, and accounts for more than 90% of the country's exports – which itself is heavily dependent on a single crop – coffee. Ethiopia has a diverse agro-ecology and agro-climatic regions. More than 70% of the country is in arid and semi-arid regions with erratic rainfall. It also has fragile and climate-sensitive ecosystems such as fire hazard-Bale. With respect to environmental degradation, soil erosion has become severe in the highlands (the "power house" of Ethopia's economy), deforestation rates are high (16 – 2 %), and there is persistent overgrazing and mismanagement of land.

Ethiopia experiences severe impacts from climate change in all its sectors, particularly the agriculture and energy sectors as both depend on natural rainfall. In particular, food insecurity (increased number of an already vulnerable population), power shortages (from reduced water levels in reservoirs), economy-wide impacts (in all sectors-agriculture, energy, industry, water, etc), ecological impacts (degradation of critical watersheds - Bale and Kefa which are causing severe downstream impacts on important ecosystems), and social impacts (increased conflict over resource use-water and grazing land).

There are also many indicators of climate change in Ethopia:

- Extreme weather events (increased frequency of floods and droughts)
- Increased variability in rainfall (in amount, spatial and temporal distribution)
- Shift in cropping regimes (dramatic change of the cropping calendar-June to August)
- Shift in favourable agro-climatic range of crops and diseases (e.g., lowland crops in highlands-sorghum belt in highlands, malaria zone in the highlands)
- Shift in livestock composition in pastoral areas (from grazers to browsers)
- Change in ecosystems (rangelands to bush lands-borana, forest lands to bushlands-Koga, drying of wetlands-Fogera plain, Changing of freshwater lakes into saline lakes-Ziway and Abijata)

Adaptation is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Adaptation is not a once-off

intervention and not a single stand-alone activity. It is a process that needs to be taken as part of an overall development policy, program and projects in a country. Communities at the local level might have been doing this for long time, but information on local adaptation practices is lacking. Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to lessen potential damages, to take advantage of opportunities, or to cope with consequences. However, is there enough knowledge and expertise to design effective adaptation programs?

Adaptation programs and building adaptive capacity require scientific knowledge and expertise. Currently there is inadequate research and analysis on the both the extent of the effects of climate change (except for common knowledge, there is insufficient hard data) as well as the spectrum of impacts (sector, geographical, region, agro-ecology, social groups, habitats, ecosystems, etc.) Clear national and local adaptation mechanisms and coping strategies are also lacking.

Despite knowledge gap on the impacts of climate change and the need for expertise in the field, the higher education institutes' (HEIs) curricula currently have no, or little, climate-related themes. Within Addis Ababa University (AAU) itself, only the following faculties were identified as having a climate change component:

- Introduction to Climate (Dept. Geography and Environmental Science)
- Climate Change (Environmental Science – a new module)
- Applied Climatology (Dept. Natural Resources Management MU)

Except for scanty number of student thesis research works (which focus mainly on prediction and trend analysis, not in adaptation) and research projects on climate change adaptation are largely absent in the HEIs, unlike in some non-teaching research institutes. Though HEIs are primarily for knowledge generation and transfer, this is not the case in climate change issues.

While these are clear gaps, there is a suitable opportunity to effectively integrate climate change in the curricula. At the moment, many of the universities are in the process of major nation-level structural and governance reforms including curriculum review for post graduate studies. In some of the new programs, climate change is taken up as a single course and still not a major stream of specialization. The current policy direction is also favourable towards climate studies; for example, Ethiopia is active and vocal in the climate justice negotiations.

In Ethiopia, climate change-related research and training are conducted by both HEIs and non-academic research institutes. Some examples of research projects by Ethiopian HEIs include:

- Re-thinking water storage for climate change adaptation in sub-Saharan Africa (Ethiopia and Ghana)

  Selected watersheds in the Blue Nile Basin (Ethiopia) and the Volta basin (Ghana)

  Partners: IWMI-Addis Ababa and Ghana, ZEF-University of Bonn, Arba Minch University, Climate Impact Research-Germany, Water Research Institute, University of Ghana, Ghana Volta Basin Authority/ Water Resource Authority

- Capacity Building in Integrated River Basin Management in Higher Learning Institutes

  A research and training project at PhD and MSc levels, by developing new curriculum for the program in which climate change is major theme.

  Initiator and coordinator: Horn of Africa Regional Environment Centre/Network Partners: Addis Ababa University, 8 other Ethiopian universities, UNESCO-IHE Amsterdam University

- Bio-resource innovations network in Eastern Africa (Uganda, Kenya, Rwanda, Burundi, Tanzania, Ethiopia-Addis Ababa University)

  A regional research and training project on bio-resources.

  AAU: country focal point and partly coordinates the initiative

  Partners: various academic and research institutes in member countries

- Staff research projects: small grant projects on climate change adaptation and community responses, Food security and climate change,

A variety of research is also being conducted by non-academic research institutes, like: the International Policy Research Institute (IFPRI-Addis Ababa), International Livestock Research Institute (ILRI-Addis Ababa), Ethiopian Economics Association, and the Forum for Social Studies (on policy and adaptation).

The lack of collaborative projects and joint training programs, particularly on climate issues, limits the institutional capacity to render state-of-the art training on climate change. Since climate change impacts are trans-regional, trans-boundary and complex, its study thus requires bringing the knowledge and experiences across borders to a common training and information sharing platform through joint training and research programs by designing a common curricula. This is in the best interest of our institute.

With respect to the objectives of this workshop, the AAU has the following existing programs which can potentially be incorporated into the proposed region-wide interdisciplinary curricula: the Environmental Science Program (which has upcoming areas of specialization in: atmosphere, energy and climate change adaptation, environmental planning, and environmental resources management), biotechnology program and food science.

In proposing ideas for new region-wide programs, the AAU would like to suggest the establishment of an Ecology and Natural Resources Management course (taking climate change as a minor) and/or Ecosystem and Ecological Change Adaptation (with a focus on ecosystem resilience). For joint or dual-degree programs, the AAU has a Bio-earn Project (for some courses and field research work) and Dry land Research Project (courses and field research); both of which can have the potential for incorporating climate change adaptation research. To create a common curriculum, common needs will need to be satisfied and the target groups identified (which disciplines). The objectives, contents and organization, teaching strategies, mode of delivery, and evaluations and requirement processes, also need to be established. With

regards to the delivery mechanisms, the AAU considers the following as important:

- Regional platforms for research and information-exchange (with free access sources)
- Regional projects (specialization or discipline oriented) coordinated at a sub-regional level (e.g, southern , eastern, western, horn, central) on adaptation
- Regional workshops (by HI in collaboration with international organizations like UNEP-the MESA initiative) to support the curriculum development process on a regional and sub-regional level
- Inter-institutional collaboration among higher learning institutions

5.6 UNIVERSITY OF CAPE TOWN

Sustainable Development for 4th year chemical engineering students

Jean-Paul Franzidiz
Professor, Department of Chemical Engineering
South Africa

The power point Presentation of Professor Franzidiz continues from next page.

UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

Sustainable Development for 4th year Chemical Engineering Students

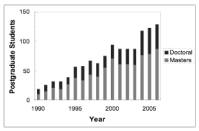
J-P Franzidis
Director, Minerals to Metals Initiative

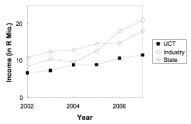
The University of Cape Town

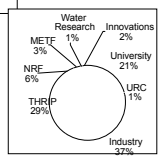
- Oldest university in S Africa
- Highest ranked research university in S Africa
- 21500 students (15500 u/g) in 6 faculties
- 4300 international students from 104 countries (20%)
- 12 % registered in Science
- 17 % registered in Engineering & Built Environment

Department of Chemical Engineering

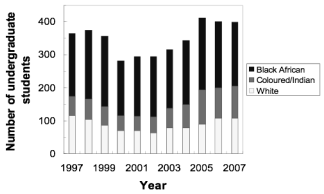
Academics	14/23
Research & support staff	ca.50
Undergraduate students	407
Postgraduates	140
Postdoctoral fellows	11







Undergraduate program



Graduating class 2007 (69):

Black African:	46%
White:	32%
Coloured/Indian:	22%

Graduate employment

- A small but vibrant Chemical Engineering profession
- Graduates are employed by process industries, technology providers, business and the service sector.
- Some 200 graduates p.a. in SA, of which ± 50-60 from UCT

Resource processing	**Manufacturing**
< 10% of GDP (ZA)	27% of GDP (ZA)
Unique, high IP demand	In global competition
Large environmental footprint and legacy	
Apartheid labour practice legacies (overcome?)	

ChemEng graduates: Agents for change

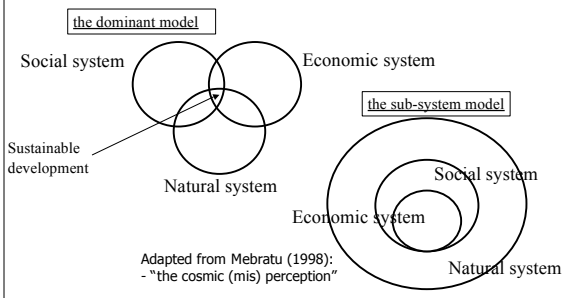
- ChemEng graduates have the potential to become influential agents of change:
  - Extraordinary young people;
  - Destined for challenging careers and positions of responsibility.
- Will be faced by expectations of:
  - Employers;
  - Society at large.
- To meet these expectations, graduates need:
  - Skills that will enable them to make contributions to the sustainable development of the country and region;
  - A critical attitude.

Process Industries in South Africa

- Mining accounts for ~18% of SA's total electricity consumption - almost equivalent to the total domestic/residential demand.
- Historically, cheap electricity has encouraged the growth of energy-intensive industries, such as aluminium smelting, and production of iron, ferrous metal alloys, stainless steel and titanium slag.
- As the generation of electricity is largely coal-based, this has serious implications on *CO_2 emission issues*, solid and liquid waste disposal, etc.

Sustainable Development:

Why "natural" and "social" cannot be overlooked



New course in "Business, Society and Environment" (2003+)

- Up to 2003: Engineering Economics, *complementary knowledge and skills* to help
  - Meet the employer's profit objectives.
- New course since 2003, *complementary knowledge and skills* to
  - Meet the expectations of the employer and society (including demands for development, health and safety, wealth, clean environment…).

Challenge

How can we introduce students who are immersed in a single, natural-science based discipline to the multi-disciplinarity of sustainable development?

New kind of learning needed

- Not just knowing facts, and manipulating and applying factual knowledge to problem solving, but …
- *Active, student-based* learning, and
- *Deep*, as opposed to surface learning, plus
- Being able to judge the value or quality of decision outcomes (i.e. *critical thinking*)

Central element: benefit and risk

Benefit

("Engineering is the application of science for human benefit")

To employers
- Return on investment
  - e.g. NPV

To society (stakeholders)
- Improved quality of life
  - e.g. HDI, employment, environment, safety, ….

Risk

To employees, neighbours, customers, the environment

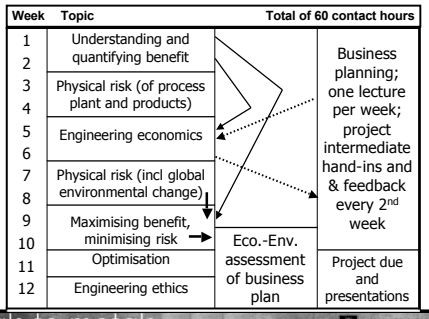
Focus on physical risk
- Fire, explosion, toxic release
- Case-study approach
  - Bhopal
  - Piper Alpha
  - Minamata Bay
- Accidental versus planned release

Financial risk covered in passing

Teaching approach

- Strong use of seminars, prepared and presented by the students (particularly on physical risk topics and other case studies, e.g. cleaner production), and multimedia (videos)
- Business planning project, which runs through the whole course
- Integration with a professional communication course running in parallel

Course Topics (2003)



Business planning project (example)

- Explore a business opportunity, which can be in any South African location, to recover high-value metals contained in special wastes, e.g.
  - nickel and lithium from spent rechargeable batteries
  - rare earth elements from fluorescent tubes
  - precious metals from electronic waste
  - chromium and nickel from spent hydrochloric acid
  - platinum and palladium from auto-catalysts
- The business opportunity must have elements of:
  - innovation
  - high potential
  - chemical engineering!

Business planning project (other examples)

- Investigate and develop a process opportunity from agricultural wastes in the Western Cape
- Use gas from Lake Kivu to provide services to new plant and settlements around the new fertiliser plant

Lecturer observations

- Many students lack the reading and writing skills important to sourcing materials and synthesizing a critical position on topical issues (for many students, English is a 2nd language at best
- In-class seminars delivered by pairs of students generally well prepared (although there is wide variability in the seminars)
- Directed tutorials and project feedback sessions result in good engagement with the material

Lecturer observations (cont).

- Course content uncertainty:
  How to assess? What to "learn"? Big trade-off between breadth and depth
- Students have little to no basis to build on from earlier years
  (this is being addressed, by including some material earlier in the course)
- Good engagement with business planning group project
  (very challenging, open-ended, the business project is often ill-defined, or the topic is not defined at all)
- Problem with pressure from other "more Chem Eng" courses

From the student "learning logs"

"Chemical engineers have a role to play in improving people's quality of life and serving society."

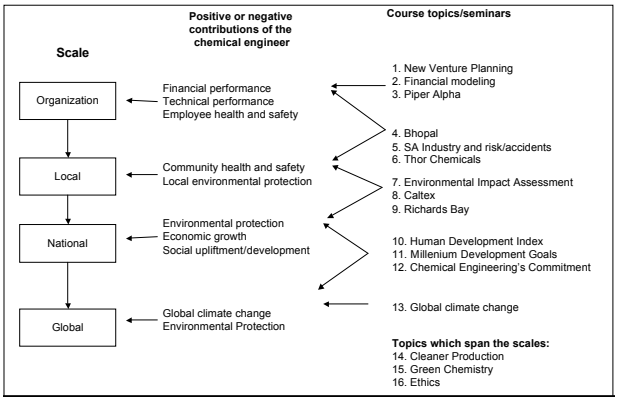
"Chemical engineers should advance the economic and social development of society."

"Chemical engineers make use of scarce resources to provide society with daily necessities and luxuries which improve people's quality of life."

"Chemical engineers have a responsibility to protect the environment and promote sustainable development."

Modifications to the course (2005+)

- Benefit vs risk tackled at various scales – plant, local, regional, national, global
- Summaries of seminars (ppt + 2-pager)
- Guest lecturers (life skills learning)



Conclusions

- "Disaster" case studies draw good interest, provide a good platform from which to explore the issues and relationships
- Tutorial exercises essential to enforce student learning
  - Case studies
  - Economic-environmental evaluation of business plans
- Project is taken seriously because of marks
- Course is 'language intensive'; difficult for non-English students
- Ideas being incorporated into new ChemEng curriculum from 2011 : "design" from first year (IChemE accreditation)

Acknowledgements

- Prof Harro von Blottnitz, Dr Brett Cohen (course conveners)
- Prof Sue Harrison, Prof Jennifer Case, for support and stimulating 'tea room' discussions.
- The permission of the students to quote their reflections on the course is also gratefully acknowledged.

Other UCT activities on climate change & environment

- Africa Earth Observatory Network (AEON)
- Marine Research Institute (MA-RE)
- Africa Centre for Climate and Earth System Science (ACCESS)
- African Centre for Cities
- Climate System Analysis Group (CSAG)
- Environmental Evaluation Unit
- Centre of Criminology
- Percy FitzPatrick Institute

Other UCT activities on climate change & environment

- Environmental Economics and Policy Research Unit
- Energy Research Centre
- Chair in animal evolution and systematics
- Department of Botany
- Department of Archaeology
- Department of Historical Studies
- Social Anthropology
- CSIR/UCT MoU

Thank you!

The Millenium Development Goals

- Eradicate extreme poverty and hunger
- Achieve universal primary education
- Promote gender equality and empower women
- Reduce child mortality
- Improve maternal health
- Combat HIV/AIDS, malaria and other diseases
- Ensure environmental sustainability
- Develop a global partnership for development
  - http://www.developmentgoals.org/

Degree Outcomes

The UCT Chemical Engineering graduate:

1. Applies knowledge of mathematics, science and engineering to the recognition, formulation and solution of engineering problems
2. Analyses available data and designs and executes appropriate experiments
3. Synthesizes processes and designs experiments using modern engineering tools
4. Develops novel approaches which go beyond standard procedures in the practice of engineering
5. ***Practices engineering with due concern for its impact on the environment and safety***

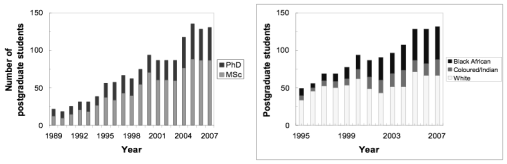
ECSA, 2004

Degree Outcomes (cont.)

The UCT Chemical Engineering graduate:

6. Works with confidence and purpose, both as an individual and in teams
7. Communicates information effectively
8. Engages in lifelong learning
9. ***Acts in a professional manner***
10. ***Acts in an entrepreneurial manner***

Postgraduate students



Step change with move into new facility (2004)
Growth mainly in Black African PG-students

Department currently at capacity

Climate Change; How deep is the current understanding in Ghana?

Leonard K. Amekudzi
Department of Physics
Kwame Nkrumah University of Science and Technology, Ghana

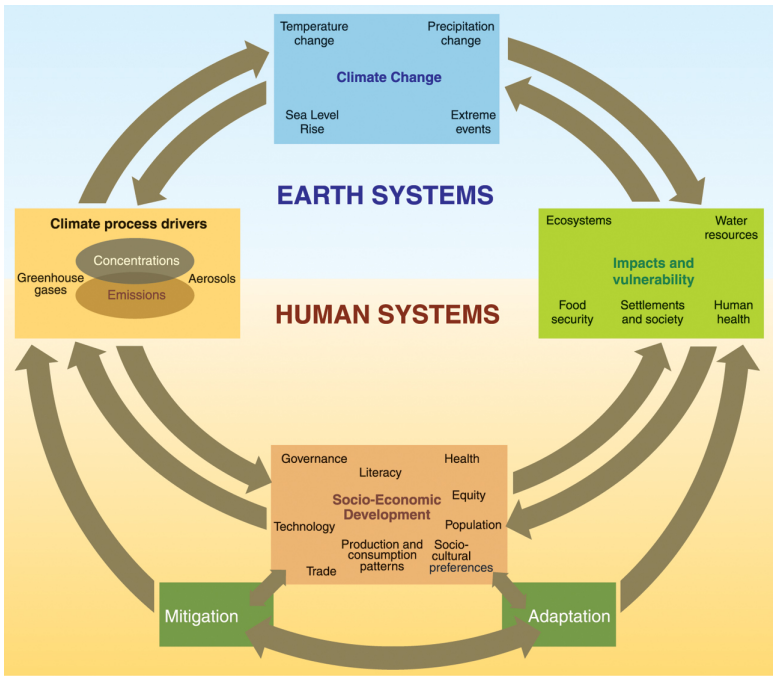


Figure 14

Climate forcing (in Wm-2 units) is a change imposed on the planetary energy balance that has the potential to alter global temperature. For example, changes in solar radiation, in CO2 concentrations, etc. Climate response is the meteorological results of climate forcing (e.g. global temperature change, rainfall changes or sea level rise). There is a close link between the climate and atmospheric chemical processes; multiple interactions occur between tropospheric chemical processes, biogeochemical cycles and the climate system. In turn, atmospheric chemical processes are also influenced by human systems through the release of millions of tonnes of greenhouse gases and aerosols into the atmosphere from industrial production and land-use change. These emissions have profoundly modified the chemical composition of the atmosphere. How this will affect the earth's system is still largely uncertain, but what is known, and can be observed today, is that the earth's climate is undergoing rapid changes.

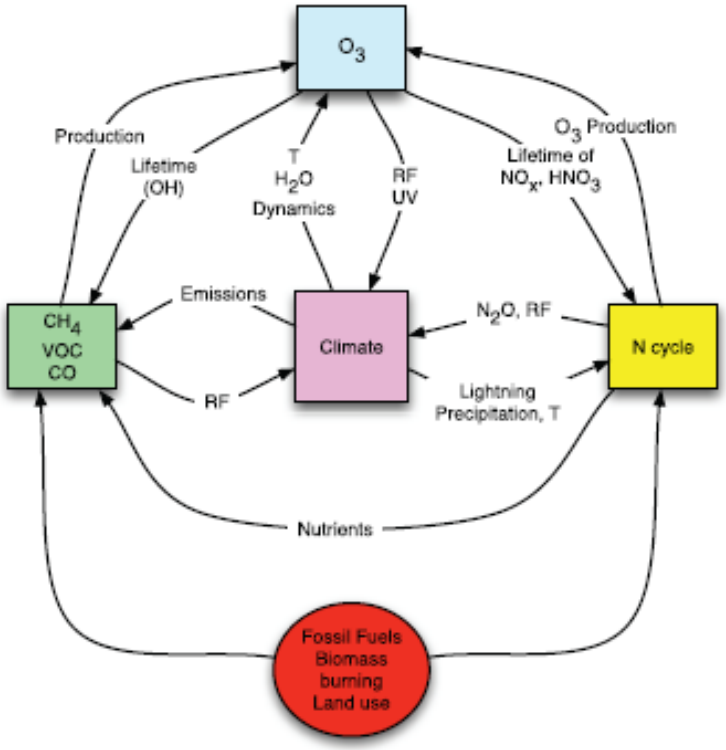


Figure 15

Sub-Saharan Africa's contribution to global climate change (albeit at a lower level to industralized nations) are from emissions produced by poor waste management (burning of refuse emits various gaseous compounds and particulate matter into the atmosphere) and air pollution from increased domestic emissions (e.g., cooking) which consist of CO, NOx, VOCs, particulate material, and toxic materials.

Overview of major chemical species in the West African Monsoon region

The African continent is the largest global source of both mineral dust aerosols and biomass burning aerosols. This is particularly significant when one considers that emissions from biomass burning are three times greater than fossil fuel combustion emissions. Consequently, as satellite images have shown, CO2 concentrations in the atmosphere tend to be the highest in regions where signficant biomass burning occurs Biomass burning also has a strong seasonal cycle.

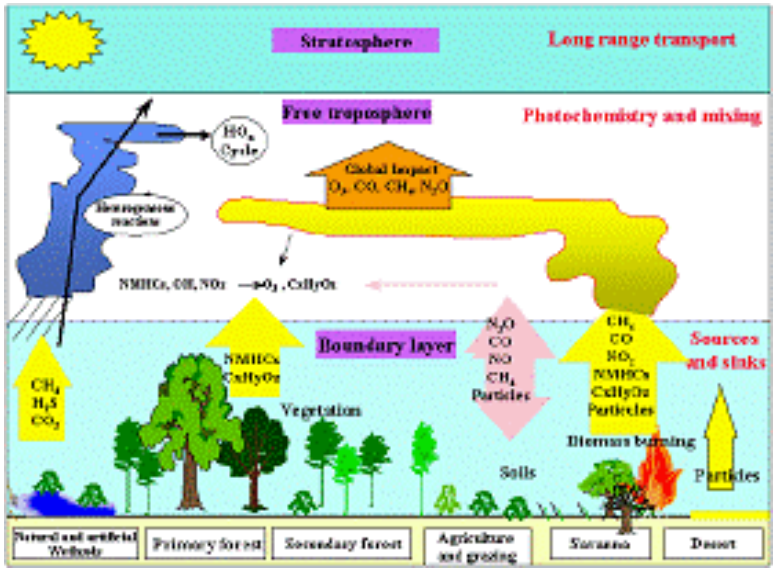


Figure 16

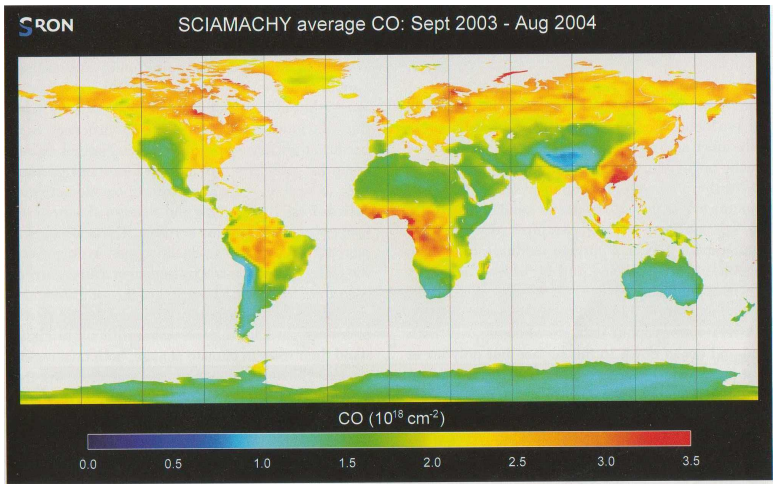


Figure 17

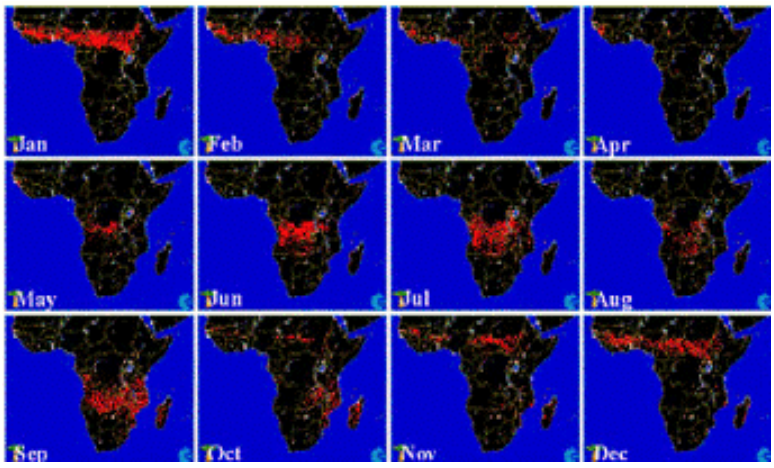


Figure 18

In Ghana, and Africa more broadly, the scientific understanding of climate forcing is still very low. Observation inventories and climate records are poor. This is also due to the fact that there are no FTIR atmospheric monitoring and measurement sites in Africa (two sites are being planned, one in Ghana and the other in east Africa). To further improve our knowledge of climate forcing and climate responses, there needs to be greater monitoring and collection of remote sensing data, particularly in Africa, coupled with advancements in local research and technical capacities. Improved climate projections and prediction models can contribute to more informed policy choices. Adaptation and mitigation actions should also include improvements in proper water resource management, better agriculture methologies, better ecosystem management and the fasst development and implementation of adaptation technologies. All sectors should be involved in the development of climate change actions, as well as collaboration with local and international institutions in order to enhance resource and knowledge-sharing.

Climate Change Education and Research at KNUST:

KNUST currently offers the following climate-related programmes and projects:

- B.Sc degree course in meteorology and climate science
- AMMA Project: Climate impact on human health: climate change and malaria prevalence over Ghana
- Study to understand rainfall and temperature variabilities over Ghana (One PhD and One M.SC)
- Modelling studies of NO_2, SO_2 and O_3 over Accra-Tema metropolis (ICTP/UNESCO sponsored PhD program)
- First Ewiem-nimdie Summer School 2008: Introduction of meteorology and climate science
- (Prepared proposal) Impacts of Anthropogenic Activities on Air Quality, Climate, Livelihoods and Quality of Life in Cities in Sub-Saharan Africa

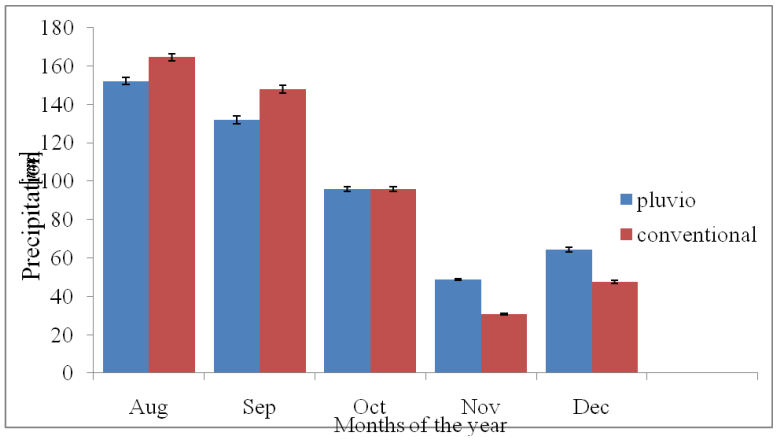


Figure 19

- (Prepared proposal) M.Sc. in meteorology and climate science

The department is also conducting a climate-monitoring project in partnership with the University of Leeds (UK/ British Council), University of Cologne and Unversity of Bremen, Germany, Adrian Tompkins (ICTP), Ghana Meteorological Agency, Energy center (KNUST), and the Mathematics Department, KNUST. Some preliminary observation results are graphed below.

The outlook for the new Meteorology and Climate Science Institute in Ghana will be to:

- develop more experiments (FTIR spectrometry) to measure GHG and tropospheric pollutants (seeking for further collaboration and funding)
- Obtain more sun-photometer instruments to measure aerosol properties and O_3 and NO_2 and H_2O (also seeking for collaboration and funding)
- Enhance man-power training (M.Sc. and PhD studentship. Seeking for collaboration and funding)
- Form a very strong local research group (in the process)
- Conduct education/ Public Seminars on climate-related issues

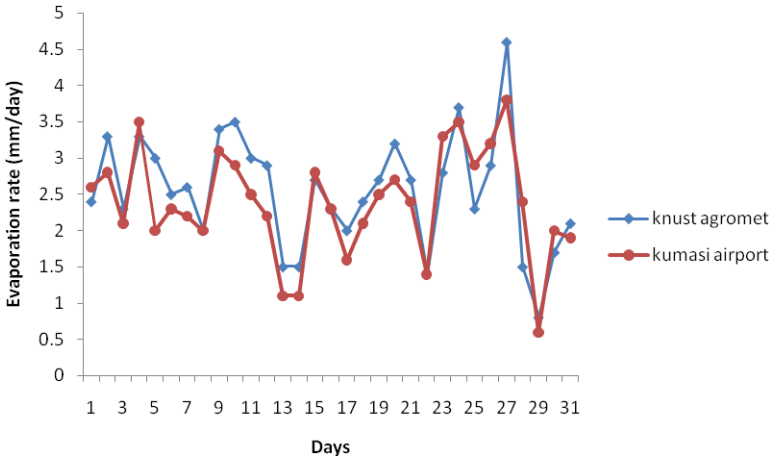


Figure 20

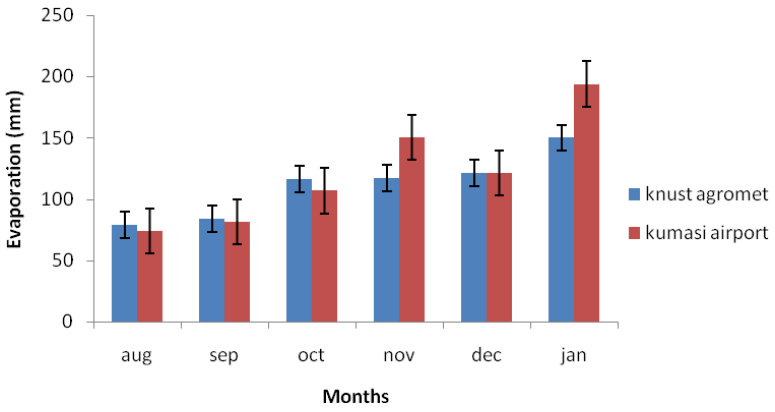


Figure 21

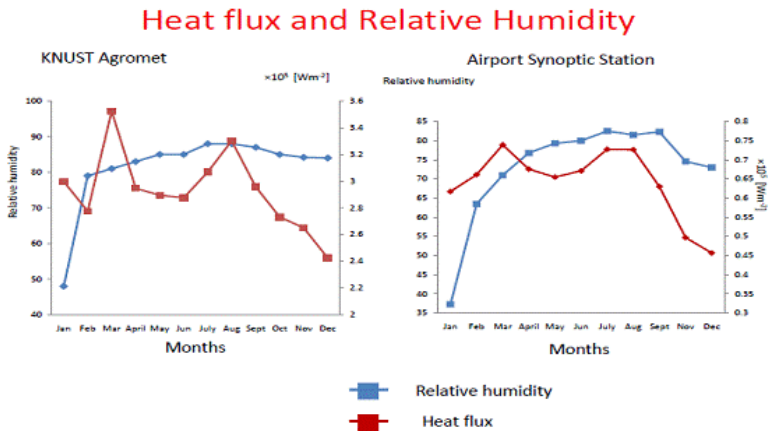


Figure 22

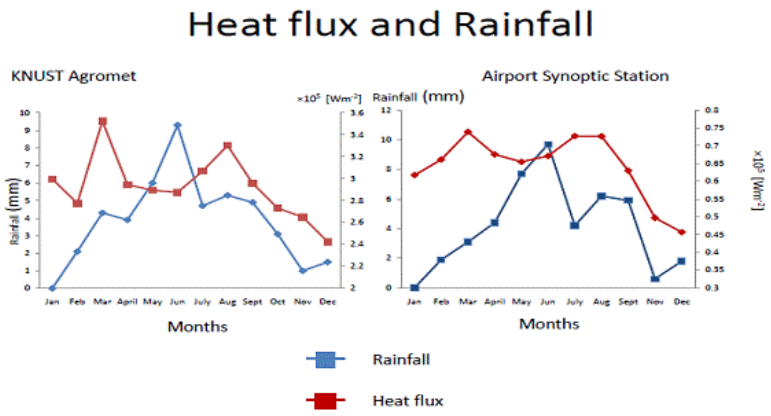

Heat flux and Rainfall
KNUST Agromet
Rainfall (mm)
Months
Airport Synoptic Station
Rainfall (mm)
Months
Rainfall
Heat flux

Figure 23

5.8 UNU-INSTITUTE FOR SUSTAINABILITY AND PEACE

Srikantha Herath
Senior Academic Programme Officer
Institue for Sustainability and Peace
United Nations University, Tokyo, Japan

As the "think-tank" for the United Nations, the UNU acts as a link to both governments (in the capacity of a UN organization) and academia (university faculty). It provides support to developing countries, focusing on strengthening the higher education sector. There are 14 UNU Centers world-wide with well-established links to 22 associated institutions (existing academic institutions). The UNU conducts joint research projects in partnership with a network of faculties.

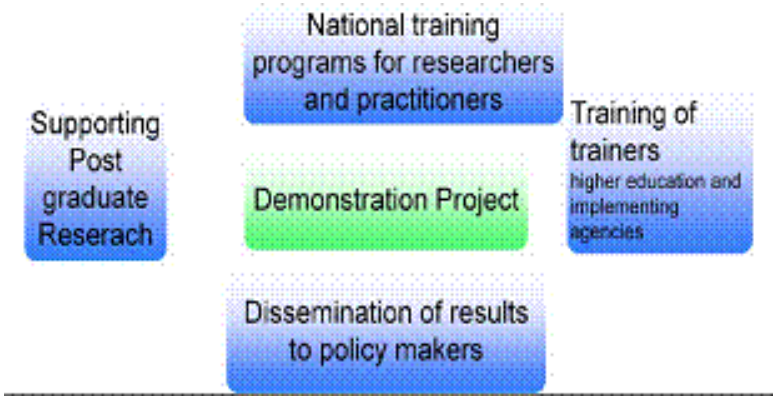


Figure 24

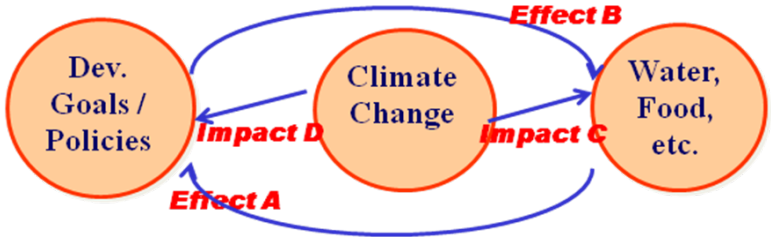


Figure 25

Presently, UNU's Capacity Development Programmes are structured as a regular short-duration training courses and workshops (up to 2 months); regular long-duration training programmes (3 months-1 year); or a Masters/Ph.D/Postdoctoral programmes (including Ph.D internships). The aim of UNU's Capacity Development System is to:

- Enable the flow from research to implementation
- Enhance capacity of the higher education sector
- Conduct multi-disciplinary studies

As an example, UNU's Multi-Disciplinary Study on Climate Change Impacts is a comprehensive Asian-wide training initiative focused on

how to design appropriate adaptation measures. Target groups include scientists (by customizing existing knowledge to suit local conditions supported by global experiences), professionals and practitioners (by introducing new methods, tools, standards), and administrative/local government officials (by providing an over view of technology and sciences). It focuses on asking " how to assess 'Climate Only' impacts"? and "how to prioritize measures and avoid 'mal adaptation'?"

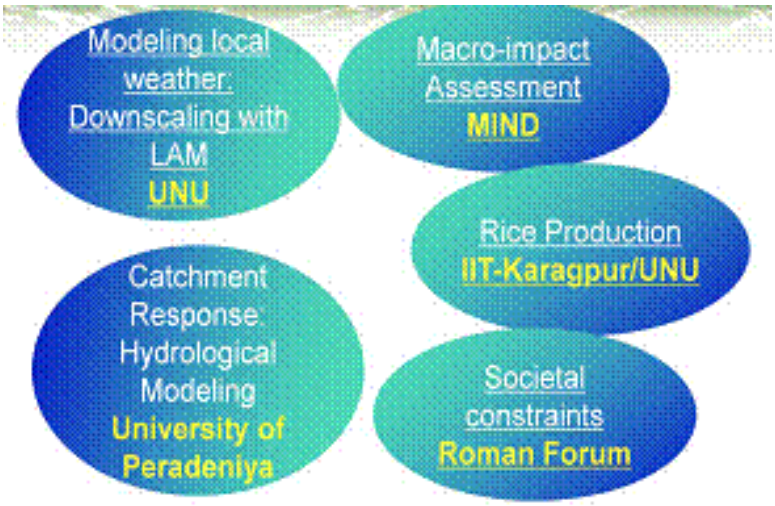


Figure 26

Effects of Water Using Sectors on Development (WED-AIM) in SL with CC Impacts

		Vulnerability, Impacts & Adaptation (VIA) in Water Using Sectors				
		(1)	(2)	(3)	(4)	
		Agriculture	Hydro Power	Water for Humans (Esp. Poor)	Water for Bio- & Eco-logical Res.	Row Totals (With CC)
(S0)	Status (No CC impacts)*	-1	0	-1	-1	
(S1)	Status (+CC Impacts =>)**	-2	-1	-3	-2	
=> Dev. Goals/Policies (+CC Impacts)						
(A)	Growth	-3	-1	-2	-2	-8
(B)	Poverty alleviation	-2	-1	-3	-1	-7
(C)	Food Security	-3	-1	0	-1	-5
(D)	Employment	-2	0	-1	-1	-4
(E)	Trade & Globalisation	-1	-1	0	-1	-3
(F)	Budget Deficit Reduction	-1	-1	-1	-1	-4
(G)	Privatisation	0	0	0	-1	-1
Column Totals (With CC)		-12	-5	-5	-7	

* Row (S0) is used ONLY as the baseline to estimate Row (S1).

** Row (S1) is used to estimate impacts on goals/policies in the matrix cells below it

Water using VIA areas that are most harmed

Development Goals/Policies that are most damaging

Key matrix cells that need policy interventions

NOTES

Water for Humans (Esp. Poor) => drinking, health, livelihood, etc.

Water for Bio- & Eco-logical Res. => forests, wetlands, coastal zones, biodiv., etc.

Figure 27

The initiative is organized in partnership with the University of Peradeniya, MIND, the Indian Institute of Technology Kharagpur (IIT-Kharagpur), and the Roman Forum.

One of the key components of the initiative is the use of the Impact Action Matrix method (IAM) which demonstrates to trainees the complex relations among development goals and impacts on different sectors.

A major challenge is to synthesize the latest knowledge, data and methodologies related to climate change and translate it easily to practitioners so that it can be applied in a broad scale, and within in a short space of time. In developing countries, special attention is needed to link the higher education and government sector together when customizing methods and technologies. When comparing how research is funded and implemented in developed versus developing countries, it is clear that collaboration between all three sectors: government, higher education and business, is much larger in developed countries. Also in developing countries, particularly in the Asia-Pacific region, sectors which receive the most R&D investments are government, with a small proportion going to the higher education sector.

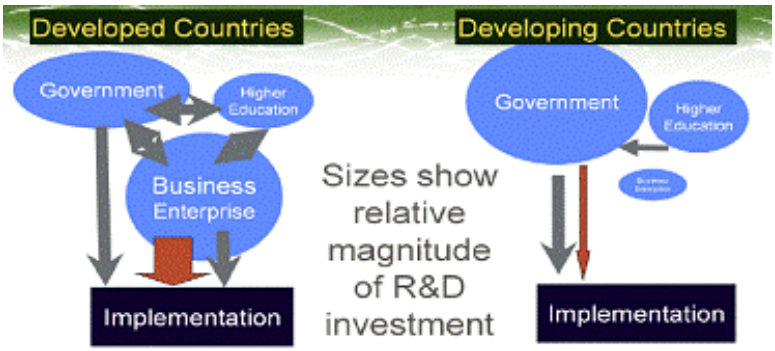


Figure 28

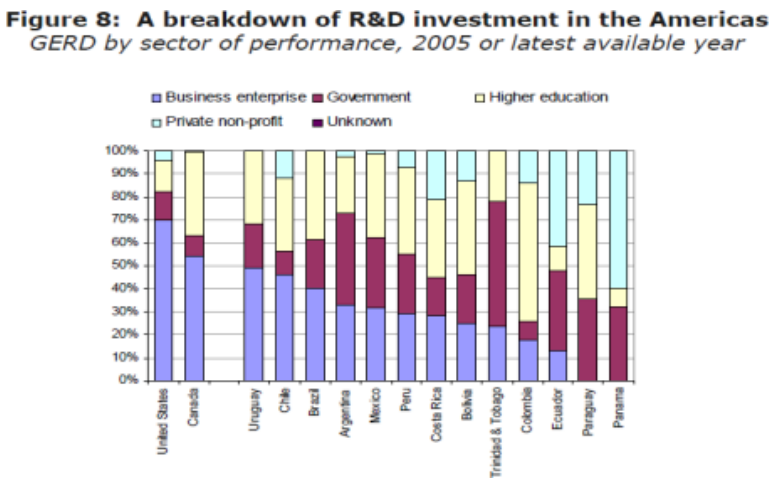


Figure 29

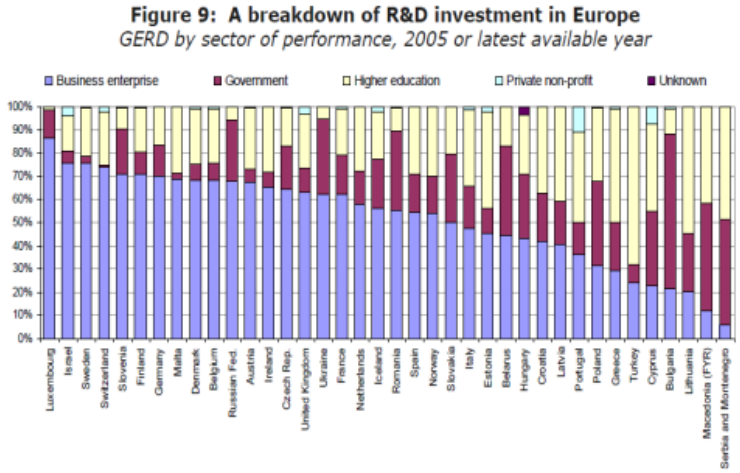


Figure 30

Figure 10: A breakdown of R&D investment in Africa, Asia and the Pacific
GERD by sector of performance, 2005 or latest available year

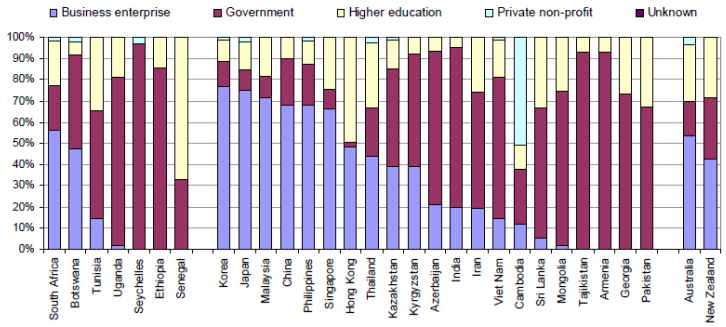


Figure 31

Source: UNESCO

The UNU offers 3 modules as part of its training workshops. Module 1: down-scaling system (involving global forecast from GFS data sets and using NCAR's model for Weather Research and Forecasting (WRF) for downscaling); Module 2: Inundation Modeling (which assists participants to design models for estimating future flood damage), and Module 3: GIS Systems. Two National Workshops have been held so far in Sri Lanka (2008) and Viet Nam (2009).

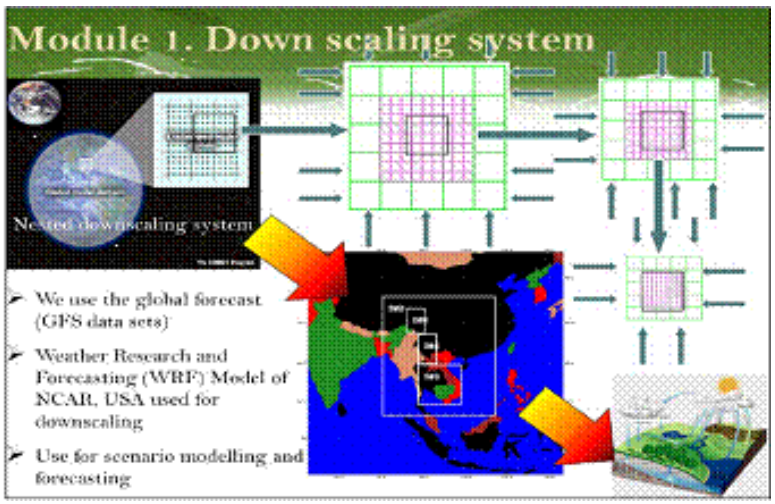


Figure 32

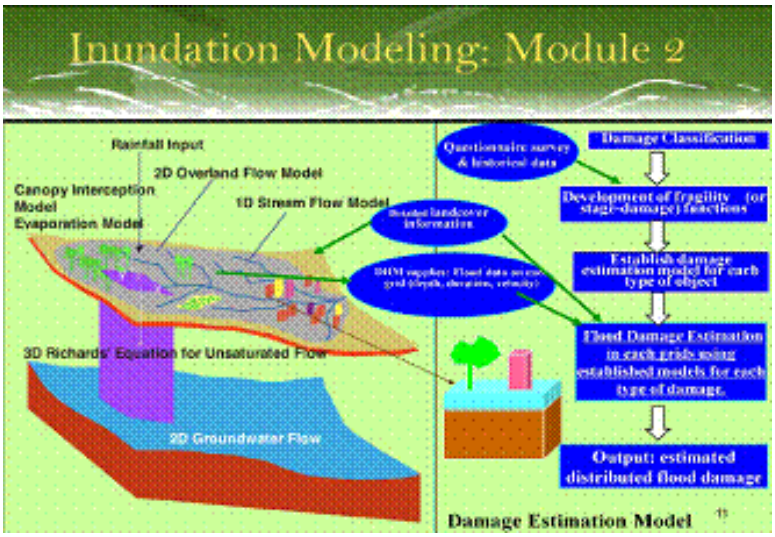


Figure 33

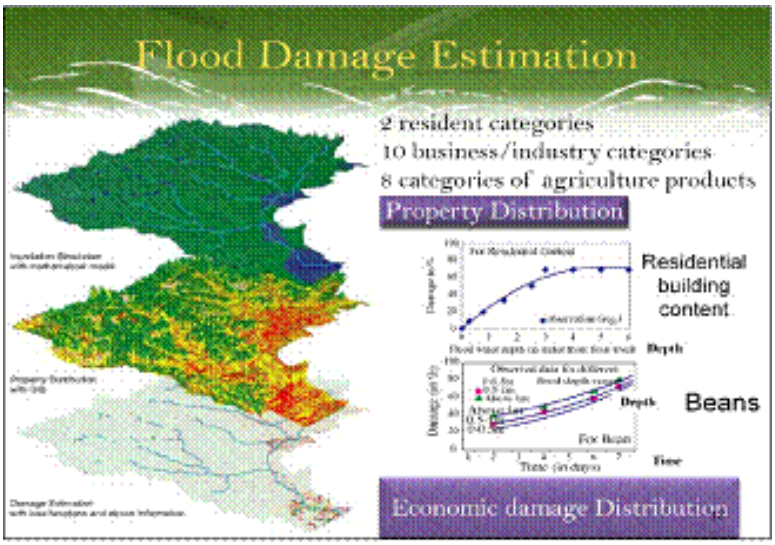


Figure 34

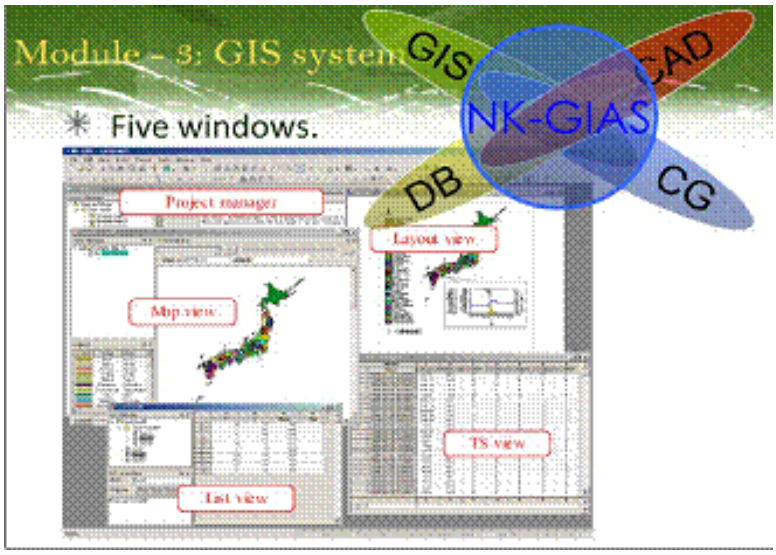


Figure 35

Starting from 2010, UNU will begin awarding postgraduate degrees with a strong multidisciplinary orientation. In addition to the UNU degree program, UNU is planning other mechanisms to support postgraduate programs in other institutions and regions. On such examples is the development of a common curriculum on climate change adaptation as part of the *University Network for Climate and Ecosystems Adaptation Research (UN-CECAR)*

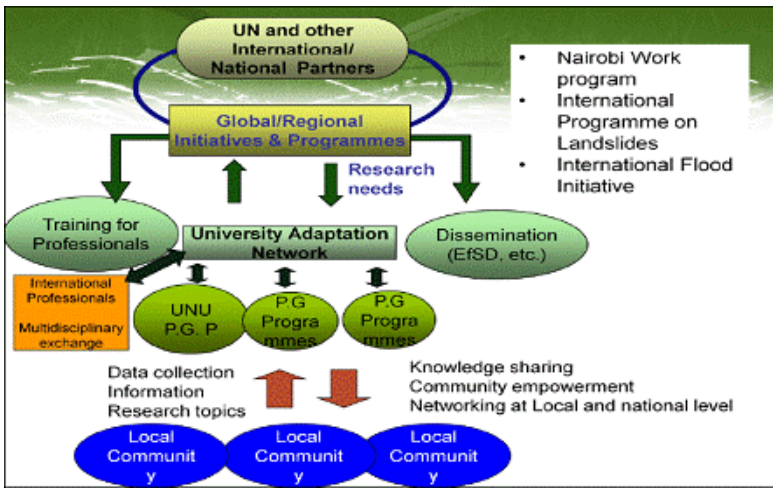


Figure 36

UNU's key contribution to the Adaptation Network will be:

- the utilization of existing training programs (on risk assessment)
- provision of project based postgraduate fellowships
- Supporting the development common curriculum for climate change adaptation planning

- Facilitating a platform to exchange information and match resources with needs (workshop, calendar, repository, etc.)

5.9 UNU-INSTITUTE FOR NATURAL RESOURCES IN AFRICA

The Role of UNU-INRA in Promoting Climate Change Adaptation Networks

Yvonne Idun
Institute for Natural Resources in Africa (UNU-INRA)
United Nations University
Ghana

Introduction

UNU-INRA is a Regional Training Center of UNU, which specializes in Natural Resources management in Africa. Activities include, training through conferences, seminars, workshops and project implementation within the field of environment.

Ways in Which UNU-INRA Can Promote Relevant Networks

- Being more involved with universities in developing curricula of programmes at Bachelors, Masters, Doctoral and Post Doctoral Levels. More Doctoral and Post Doctoral fellowships in this area, not just within a few universities in East and Southern Africa, but in all other Universities all throughout the continent. More emphasis on International Environmental Law, Environmental Sciences and other relevant areas.
- Through more collaboration with African universities, ensure that at all levels, including Bachelors level, studies on climate change adaptation does not become largely confined to theoretical work. However, greater emphasis should be put on exposing students to extensive fieldwork of practical significance, to compliment all the lessons learned during lectures. Such field work could include: participation in various research projects, attachment to relevant institutions, international agencies and international academic institutes such as the UNU, UNDP and visits to communities which are discussed in studies. Participation in conferences, workshops and seminars of these agencies as well as internships, research opportunities and fellowships, to add credits to their study modules are also recommended.
- Students need to be more exposed to various films and videos on climate change adaptability from case studies and challenges- for instance, in Bangladesh and Uganda, as well as other parts of the world. From this, encourage comparative studies to be conducted from other developing and developed countries, for lessons learned to bend for the situation of each African country
- Promote more exchange programmes on climate change between African universities for students, as well as academic staff, with lessons to learn from each other
- Ensure a smooth and regular flow of communication amongst academic staff themselves from, different African universities, as

well as between them and government, policy makers, NGOs and leaders of local communities.

- For curricula of training colleges, liaise with Ministries of Education and Environment, to train teachers (primary and high school) on basic principles in this area. See for instance, UNU-INRA project on ESD
- Involve Environmental Divisions of AU, ECOWAS, EAC, SADC, COMESA, Arab League and IOC in these academic activities, with more collaborative work between these agencies and our university network, and ensure that all the above mentioned activities have a trickling down effect on rural communities.

5.10 AMMA AND UNESCO-IHP

Abou Amani
Assitant Programme Specialist
Accra Office
UNESCO

Dr. Amani gave an overview of the African Monsoon Multidisciplinary Analyses (AMMA) Initiative. AMMA is a coordinated international project aimed at improving knowledge and understanding of the West African monsoon (WAM) and its variability, with an emphasis on daily-to-inter-annual timescales. Presently it is difficult for climate models to represent the WAM and monsoon climates in general; we need better understanding to improve the parametrisation of our models, and for this we need finer and more accurate observations. AMMA takes a pluridisciplinary and multiscale approach. It is pluridisciplinary because it links climate and impacts across the geophysical sphere to the human sphere with the ultimate aim of informing decision-making; and multiscale as it covers climate observations at the global scale down to the sub-meso scale. Two key advantages of AMMA is its integrated regional approach and the sheer number of scientists participating over a long-term (more than 500 scientists from 30 countries, covering more than 140 institutions in Africa, Europe and USA).

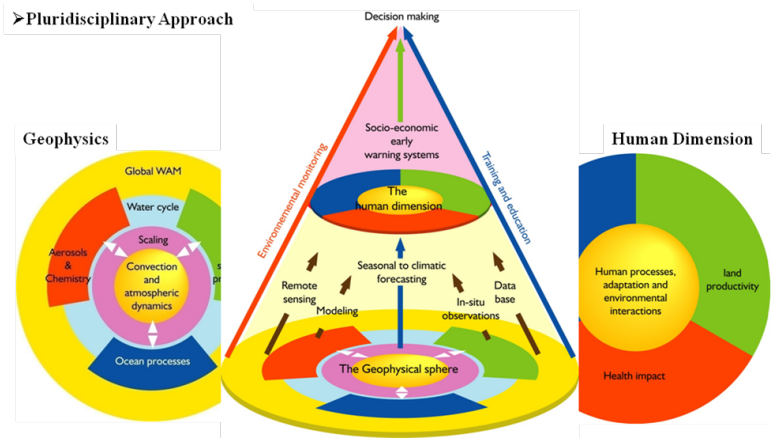


Figure 37

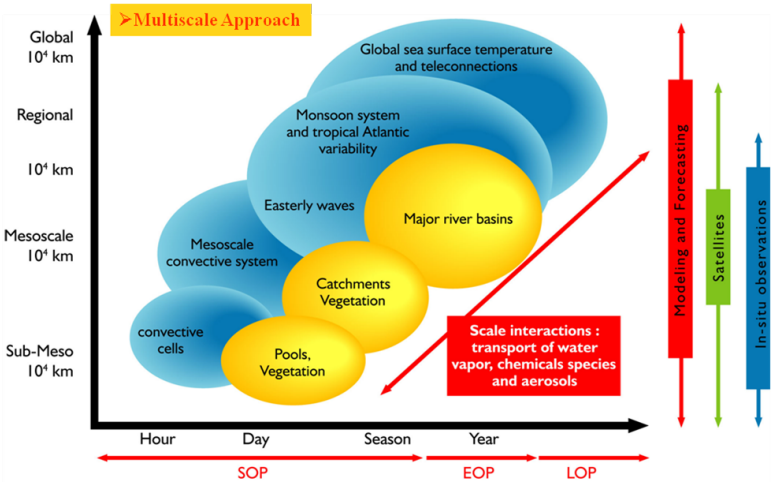


Figure 38

AMMA consists of five working groups covering three cross-cutting issues (Climate modeling, observations and capacity-building). The working groups are:

- West African Monson and Global climate aerosol and chemistry
- Water Cycle
- Surface atmosphere feedbacks
- Predictions of climate impacts
- High impact weather prediction and predictability (THORPEX)

Data collected so far include: climate, atmosphere, hydrological, ocean, land use changes, models outputs , and remote sensing – all of which are available at various scales from local to regional on AMMA's database: (http://amma-international.org/database)

Achievements and Future Plans

- Established AMMA-Afrique (AMMANET) with a scientific plan and a coordination body - CSAM
- Held three international conferences
- Will organize three summer schools; the third one will be on climate change and water resources to be held in Dakar, 9-23 November, 2009
- Important scientific production including five special issues published in an international journal. The last special issue was in the Journal of hydrology on the West African water cycle
- Various students trained
- A new plan for the next 10 years of AMMA Phase II has been confirmed, with a focus on impacts.

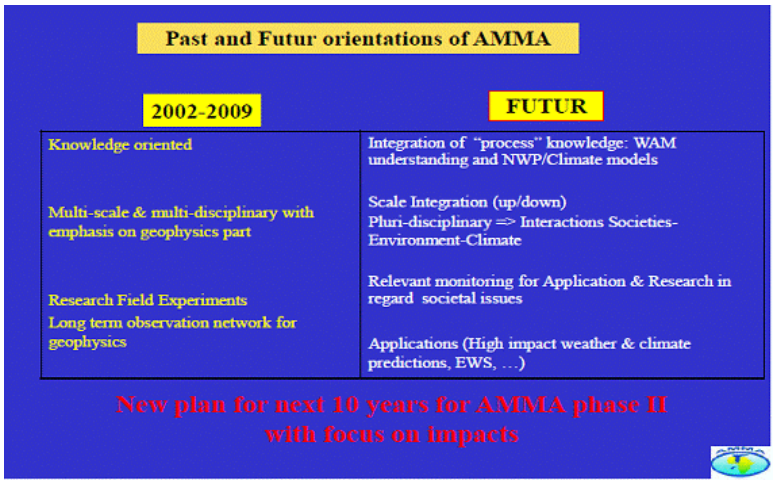


Figure 39

AMMA-AFRICA (AMMANET) is a Network of African scientists who are, or who would like to be involved in, and would like to be involved in the AMMA program. AMMANET offers opportunities for scientists to propose and present project proposals, create synergies among projects within the region, provide assistance for responding to proposal calls, exchange information, data and tools, and enhance the capacity of young scientists. AMMANET consists of a Coordinating Scientific Committee (15 scientists), African Executive Office (Five senior scientists), National AMMA Committees in various countries (involving a National coordinator or focal point, multidisciplinary team with various research projects, and students with Masters, Ph.D, etc), and an African Governance Committee. AMMANET has also produced a Science Plan which focuses on impacts. It contains 89 project proposals and involves 200 scientists and more than 30 Ph.D students from 70 African institutions across 18 countries (West and Central Africa). The main themes addressed by the Plan are:

- Perceptions of climate variability and change by local communities
- Climate change/variability, impacts and adaptation strategies
- Gender and climate change
- Energy, demography and Climate Change
- Health and Climate Change
- Water resource and climate change
- Land use, Land cover and Land productivity
- Agriculture, food security and climate change
- Coastal and marine ecosystems
- Inland wetlands and climate change
- Forestry and climate change

- Urban areas, African megacities and climate change
- Wildfires, biodiversity, atmospheric chemistry and climate change
- Socio-economy and Climate Change/variability
- Climate change/variability and disaster risk reduction
- Other relevant networks in Africa that are closely associated with AMMA include:
- FRIEND (Flow Regimes from International Experimental Networks Data) with 3components in Africa (AOC, Southern and Nile basin)
- GRAPHIC (Groundwater Resource Assessment under the Pressure of Human Activity and Climate Change): An African network was launched in June 2008.
- ANSTI: African Network of Science and Technology Institutions

5.11 A NEW INTERNATIONAL GRADATE PROGRAMME OF NAGOYA UNIVERSITY, JAPAN

Yuto Kitamura
Associate Professor
Nagoya University, Japan

Prof. Kitamura presented on Nagoya University's Global Environmental Leaders Program (Master's Program), beginning with a brief background on Nagoya City and Nagoya University. Nagoya city is located in Japan, at an intermediate position between the Tokyo and Osaka-Kansai areas. Nagoya and its periphery is the third largest urban area in Japan, following Tokyo and Osaka. In recent years, the Nagoya area has been the most economically active area in Japan, with many world-class industries, such as carmaker – Toyota, located in this area.

Figure 40

Nagoya University (NU) was established as the 7th imperial university in 1939, just before World War II. In 1949 after the war, Nagoya University restarted under the new education system, and has continued to grow in accordance with the growth of Japan. However, two years ago, Nagoya University was restructured to be an independent corporation from all other national universities in Japan. NU has around 10,000 undergraduate students and 6,000 graduate students. Among them are more than 1,100 international students (or 7% of the whole student body). NU also has nine schools and thirteen graduate schools.

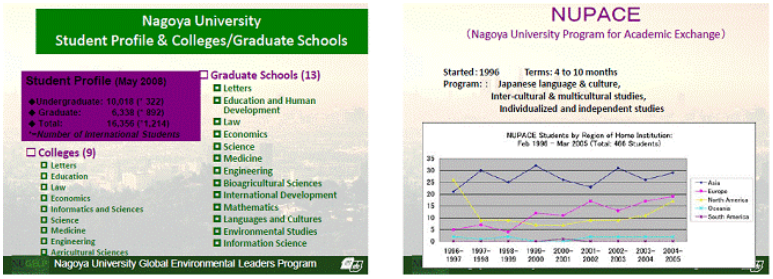


Figure 41

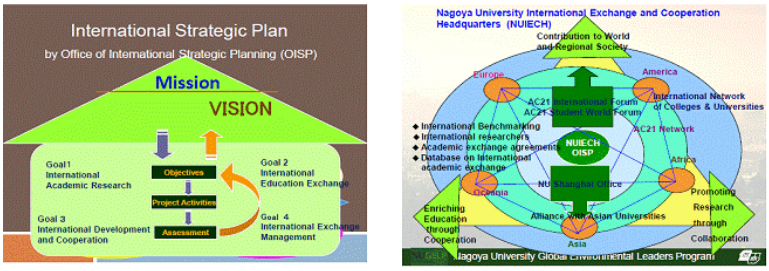


Figure 42

International Networking and Environmental Studies of Nagoya University:

As part of NU's International Strategic Plan, NU is actively pursuing collaborative research through development assistance projects such as:

- Graduate School of International Development (GSID)
- Center for Asian Legal Exchange (CALE)
- International Cooperation Center for Agricultural Education (ICCAE)

Support is also provided by the Japan Ministry of Education for the initiative on Support and Coordination Project for University Cooperation in International Development.

To enhance climate change education and research capacities in African and Asian developing countries, NU has established a Global Environmental Leaders Program (Master's program). The objective of the Program is to: "foster future environmental leaders who are able to deal with global environmental problems, especially in Asia and Africa". Three focal areas include: climate change mitigation and adaptation, water and waste management, and biodiversity conservation.

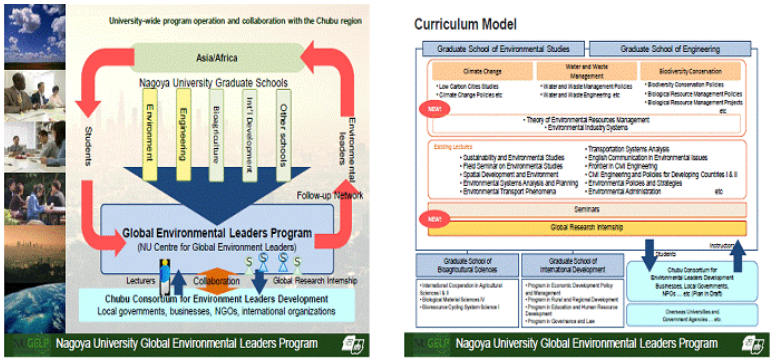


Figure 43

Figure 44

Prof. Kitamura ended his presentation by quoting a few useful tips by Roger Prichard on how to establish a successful network.

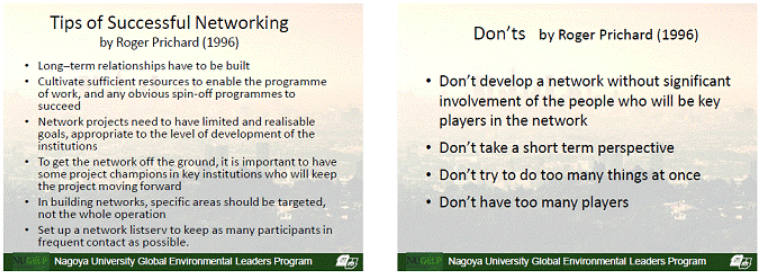


Figure 45

A

WORKSHOP PROGRAM

UNU-ISP, IR3S and UoG Consultation Conference on

Role of Africa higher education institutions in climate change adaptation

For 'Establishing a regional network to develop postgraduate educational programmes on climate change adaptation'

16-18 October 2009

Conference Hall, Noguchi Memorial Institute, Accra, Ghana

Note: Only the first day of the programme (16 October) will be open to public.

Adaptation to climate change has emerged as one of the most important concerns in the global development agenda. How we adapt, and the solutions we create to overcome the adverse impacts of climate change must be developed locally, while being supported by regional and global knowledge and experiences. For adaptation strategies to evolve locally, local human resources and technical capacities should be developed, particularly in the vulnerable regions of the world. This can be achieved through postgraduate education, where the necessary research can be conducted in partnership with implementing agencies and local communities. Africa has considerable expertise and experiences in climate science through collaborative research between independent research institutes and their external partners. The key step forward will be how to unite this expertise with expertise of consortium of African universities to build a bottom-up regional community of connected educators, researchers, students, practitioners, policymakers and local groups for climate change adaptation.

Currently, the knowledge gap on adaptation is vast. Knowledge and expertise remains primarily at the international level and is failing to reach those in the developing world who need it most. Higher education institutions in developing countries do have a critical role to play. To enable this, closer cooperation is needed between higher education institutions, through partnerships, interdisciplinary research, student and faculty exchanges, and collaborative degree programs. These would connect stakeholders and support the sharing of experience and data necessary for effective adaptation in the Region.

The United Nations University Institute of Sustainability and Peace (UNU-ISP), Institute for Natural Resources in Africa (UNU-INRA) in partnership with the University of Ghana and the support of the Integrated Research Systems for Sustainability Science (IR3S), Tokyo, will organise a consultative conference from October 16-18, 2009 on how higher education institutions in Africa could significantly support its societies to adapt to climate and ecosystems change.

The first day of the Consultative Conference is a public event composed of four keynote lectures by renowned experts on the themes of conceptualizing adaptation, climate change impacts and adaptation needs, mainstreaming adaptation to development, and innovation for climate change adaptation. The workshops on the second and third days are by invitation-only and will centre on identifying priority areas with joint research opportunities and transdisciplinary educational programmes, joint course design and curriculum development; and sharing information on ongoing research and project initiatives by consortium of universities from Africa.

For up-to-date information about the conference please visit the UNU website at <wm.hq.unu.edu/?q=node/48>, or <http://www2.ir3s.u-tokyo.ac.jp/UNU-IR3S/index.html>

Please participate in our "climate change adaptation and higher education" research survey!
If your institution has educational or research programmes related to climate change adaptation, you are cordially invited to contribute to a short survey we are conducting at <wm.hq.unu.edu/?q=node/45>. You are equally well welcome to contribute to the survey even if you cannot attend the conference. This information will help us to grasp ongoing activities, and identify needs and gaps.

DAY ONE, 16 October 2009

Venue: Conference Hall, Noguchi Memorial Institute, Accra, Ghana

Setting the stage: Adaptation To Climate Change		
13:00 - 13:40	OPENING	(Master of the Ceremony: Prof. Edwin A. Gyasi)
	Opening remarks: "Climate change and higher education"	Prof. Konrad Osterwalder, Rector, UNU
	Welcome Address	Prof. C.N.B Tagoe, Vice-Chancellor, UG, Legon
13:40 – 14:20	**Keynote speech 1** Climate Change and Sustainability	Prof. Kazuhiko Takeuchi, Vice Rector UNU & IR3S
14:20 – 14:30	Discussion, Q&A	Open
14:30 – 14:45	Coffee Break	Noguchi Hall, Noguchi Memorial Institute
14:45 – 15:25	**Keynote speech 2** Climate Change Impacts and Adaptation needs	Prof. Bob Su, International Institute for Geo-Information Science and Earth Observation (ITC), Netherlands
15:25 – 16:05	**Keynote speech 3**	
16:05 – 16:20	Discussion, Q&A	Open
16:20 – 17:00	**Keynote speech 4** Challenges to Climate Change Adaptation and Mitigation in Ghana	Prof. Michael M. Tanu, Director General, Ghana Meteorological Agency
17:00 – 17:10	Discussion, Q&A	Open
17:10 – 18:00	Panel Discussion: Climate Change Adaptation – Challenges and Opportunities for Higher Education in Africa **Facilitated by Prof. Srikantha Herath, Senior Academic Programme Officer, UNU-ISP** • Prof. C.N.B Tagoe, Vice-Chancellor, UG, Legon • Prof. Rwekaza S. Mukandala, Vice Chancellor, University of Dar es Salaam, Tanzania • Dr. Joelisoa Ratsirarson, University of Antananarivo, Madagascar; Visiting Researcher, University of Cambridge, UK • Prof. Zoubeida Bargaoui, National Engineering School of Tunis ENIT, Tunisia • Mr. Abou Amani, Assistant Programme Specialist in Natural Science, UNESCO, Ghana • ……(tbc)	
18:00 – 18:25	Discussion (Q&A) with panelists	Open
18:25 – 18:30	Vote of Thanks	Prof. Kazuhiko Takeuchi, Vice Rector UNU & IR3S
Dinner Reception		

DAY TWO, 17 October 2009

Venue: Conference Hall, Erata Hotel, Accra

Day two of the conference is devoted to **a Full-Day Workshop** where there would be presentations by renowned climate change adaption experts from 10 African Universities, other networks and international organisations in the following four broad priority areas:

a. **Current activities and expectations, examples of existing curricula and gaps**
b. **Establishing interdisciplinary studies**
   - integrated environmental, economic and social development programme
   - Joint or dual degree programmes open for credit sharing schemes.
c. **Elements of a common curriculum**
   - identify elements of joint curriculum planning and investigation
   - concept of curriculum development
d. **Resource and information sharing**
   - Research/project initiatives, experimental fields and facilities, modeling and forecasting systems, etc.
   - appropriate sharing opportunities to support common curriculum and short-term training programmes

9:00 - 9:15 **Opening: Introduction to Programme**

9:15 - 10:30 **African University I (15min. each):**
- Prof. Rwekaza S. Mukandala, Vice Chancellor, University of DAR es Salaam, Tanzania
- Dr. Mohamed Tawfik Ahmed, Suez Canal University, Ismailia, Egypt
- Prof. Janice Olawoye, Department of Agric Extension and Rural Development, University of Ibadan, Nigeria
- Prof. Francis Mutua, Department of Meteorology, University of Nairobi, Kenya
- Dr. Mekuria Argaw Denbuba, Environmental Science Programme, Addis Ababa University Ethiopia

10:30 – 11:00 **Break and Group Photograph Section**

11:00 - 12:30 **African University (15min. each):**
- Prof. Francis Petersen, University of Cape Town, South Africa
- Prof. C.N.B Tagoe, Vice-Chancellor, University of Ghana, Legon
- Prof. Robert Abaidoo, Provost, College of Agriculture/Natural Resources, Kwame Nkrumah University of Science and Technology, Member TWG, ESDA ProIRD
- Dr. Joelisoa Ratsirarson, Vice Dean, School for Agricultural Science, Madagascar
- Prof. Zoubeida Bargaoui, National Engineering School of Tunis ENIT, Tunisia

12:30 – 13:30 **Lunch**

13:30 - 15:00 **Climate Change Adaptation Networks (15min. each):**
- Department of Science & Technology, South African Government
- United Nations University - Institute for Sustainability and Peace (UNU-ISP)
- United Nations University - Institute for Natural Resources in Africa (UNU-INRA)
- Education for Sustainable Development Africa (ESDA)
- Integrated Research Systems for Sustainability Science (IR3S)
- Dr. Abou Amani, Kenya, UNESCO office, Accra

15:00 - 15:30 **Break**

15:30 - 16:30 **Brainstorm Section**

16:30 – 17:30 **Brainstorm Section**

17:30 - 18:30 **Discussing the Way Forward and Closing Remark: Prof. Herath Srikantha, UNU-ISP, Japan**