Opportunities for Collaboration with Uganda Institutions in Climate Change Education & Development of Adaptation Strategies

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Outline of Talk

• Some opportunities for sectorial application of climate change information in Uganda
  - Agriculture, Livestock & Tourism Sectors
  - Forestry Sector
  - Health Sector
  - Infrastructure & Insurance Sectors
  - Lake Victoria Transportation Safety, Fisheries & Water Quality Sectors
  - Water & Hydroelectric Energy Sectors
  - Development of climate risk management education content for key social economic sectors (case of the North Carolina, USA)
• Collaboration of North Carolina State University & Institutions in Uganda
• Concluding remarks
Land Grant University founded in 1887
- 89 undergraduate fields of study
- 80 master's degree areas
- 51 doctoral degree programs
- Enrollment is 33,819 students (~19% graduate students)

**Raleigh** is the state capital (population ~390,000)
**Research Triangle Park** bounded by NCSU, Duke, and UNC
Department of Marine, Earth and Atmospheric Sciences (MEAS)

- 35 faculty; 100 grad students; 240 undergrads
- Only Ph.D. atmospheric sciences program in the Carolinas
- One of largest interdisciplinary environmental sciences departments in U.S.
- High level of sponsored research (~$6M/year)
- Faculty participation in IPCC assessment.
Opportunities for Application of Climate Change Information
Agriculture Livestock & Tourism Sectors in Uganda
Assessment shows that very late start of the rains was responsible for the 2005 disaster

Analysis also clearly detects the severe 1998-1999 drought
Crop failure due to drought
Climate Change Impacting Biodiversity
I’m supposed to be nursing. But, it is too hot out there!
Decadal Mode for Rainfall Based on the EOF Method

- (N-E-W) Uganda, Turkana: large % increase
- Most of C-Uganda, Wajir, Garissa: transition zone
- Masaka, Kitui, Serengeti: large % decrease

*Fig.12:* Possible climate change finger-print mode (EOF-2). Over Masaka, Kitui, Serengeti, this mode tends to offset the large increase in rainfall associated with the El-Nino mode.
Climate Model

Based on Laws of Physics

- Zonal momentum
- Meridional momentum
- First law of thermodynamics
- Conservation of mass
- Hydrostatic equation
- Conservation of moisture
- Equation of state

Model Horizontal Grid

\[ \dot{A}_{i,j,k,n} = \frac{A_{i+1,j,k,n} - A_{i-1,j,k,n}}{2\Delta \lambda} \]
African Anomaly: Temperature

Satellite-based Surface Temperature


RegCM (50km resolution)
Regional Climate Projections

Result on LHS must be undertaken by countries involved - eg Uganda

Rainfall projections (A2: 2071-2100 average) minus (RF: 1961-1990 average) for the Oct-Dec short rains: (left) RegCM3 (40 km grid); (centre) 2-member FvGCM ensemble average; (right) eight IPCC GCM super ensemble average. Units, mm.
Significance of the equatorial forests may be appreciated by replacing the tropical rain forest with reduced vegetation – Rossby Wave train affecting the southern Africa Monsoon Region
Malaria spreads to Central Kenya highlands because of climate change
Opportunities for Application of Climate Change Information
Infrastructure & Insurance Sectors
Combined Natural/human erosion
Opportunities for Application of Climate Change Information
Lake Victoria Transportation Safety, Fisheries & Water Quality

Fig. 1a: RegCM3-POM: December 1988 lake surface temperature

Fig. 1b: RegCM3-POM: December 1988 lake surface water circulation
Opportunities for Application of Climate Change Information
Water & Hydroelectric Energy Sectors

Aerial view of Nalubaale-Kiira Dam Complex: Uganda
Climate Modeling Application to Energy Sector
Lake Victoria Water Balance Model
Prediction of Lake Levels

Lake Victoria Net Basin Supply (100 years average)
A FRAGILE WATER BALANCE

*Note: Figures for any particular year may vary sharply from these long-term averages
THE JUMP: Due to Commissioning of Owen Falls Dam & 1961/62 Record Indian Ocean Dipole (famous flood)

Lake Victoria’s water level on 12/27/2005 is approximately 10.69 meters, lowest water level since 1951.

Data Source:
Historical water level gauge data from Jinja, Uganda (near Lake Victoria’s outlet).
Satellite radar altimeter data from USGS/NASA/UMD at:
http://www.pecad.fas.usda.gov/cropexplorer/global_reservoir/

U.S. Department of Agricultural (USDA) Foreign Agricultural Service (FAS) Production Estimates & Crop Assessment Division (PECAD)
Actual and Agreed Curve – “prescribed total releases at Nalubaale and Kiira Dams for 9/04 to early 3/06. From 9/04 to 3/06, actual releases were 194% of those prescribed by the agreed curve: almost double” from Daniel Kull
Changes in annual rainfall from 2001 to 2004 (East African Community Lake Victoria Basin Commission special report on the Declining of Water Levels of Lake Victoria, EAC Secretariat, Arusha, Tanzania, April 2006)
Regional Climate Projections

Rainfall projections (A2: 2071-2100 average) minus (RF: 1961-1990 average) for the Oct-Dec short rains: (left) RegCM3 (40 km grid); (centre) 2-member FvGCM ensemble average; (right) eight IPCC GCM super ensemble average. Units, mm.
Ten year running mean of Lake Victoria observed levels (blue) compared to estimates based on our modified version of Tate et al (2004) water balance model for Lake Victoria with observed rainfall from six rain gauge stations (red); (center) Ten year running mean of Lake Victoria observed levels (blue) compared to estimates based on our modified version of Tate et al (2004) water balance model for Lake Victoria with rainfall from RegCM3-20km resolution reference run (red); (right) lake levels projections (2071-2100) based on rainfall input from RegCM3 (20km grid) A2 simulation. Since the initial level of the lake for 2071 is unknown, we assume multiple initial conditions for the hydrological model. All initial states converge to the same projection curve after about 10 years.
Potential Collaboration of North Carolina State University & Institutions in Uganda

- Investment in climate change research
- Optimization of communication with Policymakers
- Investment in development of adaptation strategies
- Investment in Climate Observational Network
- Investment in capacity building
Investment in Research

Need to invest more research, & its infra-structure --- because research is the driver for climate services

Research
• Many disciplines involved
• Establish resilience of natural systems (upper & lower thresholds)
• What are governance changes required to address climate change
Optimization of Communication with Policymakers

And perceptions of risks may differ
Adaptation strategies to lake level rise

Adaptation strategies

1990

Retreat

Accomodation

Protection
Investment in Climate Observational Network

Nature Morte Vivante, Salvador Dalí
Investment in Climate Observational Network
Drifters for surface currents (@ 2k) + boats for relocation & synoptic measurements

ADCP: Acoustic Doppler Current Profiles (3 @ $30K)

CTD: Conductivity, Temperature and Depth (3 @ 10K)

Ship transects

Land-based temporary meteorological stations
Investment in Climate Observational Network

DRIFTER: MONITORING WATER CURRENTS OVER LAKE VICTORIA
North Carolina State University
Masters Degree in Climate Change & Society

• Objective of the program is to provide students with background in climate science and the practical experience in the development & implementation of adaptation strategies to global climate change

• One academic year of courses (Spring & Fall Semester) plus a summer internship/research project
quickTime™ and a TIFF (LZW) decompressor are needed to see this picture.
# North Carolina State University Master Degree Curriculum in Climate Change & Society

## NCSU PSM in Climate Change & Society (CCS) Curriculum Outline

<table>
<thead>
<tr>
<th>SEMESTER/YEAR</th>
<th>FULL TIME STUDENTS</th>
<th>PART TIME STUDENTS</th>
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| FALL1         | - Fundamentals of Climate Change Science; [NCSU 309 New]  
- Decision Modeling & Statistics; [NCSU ST-513 3cr]  
- Geographic Information Systems (GIS); [NCSU NR-531 3cr]  
- Environmental Economics; [NCSU ARE-436 3cr] | - Fundamentals of Climate Change Science; [NCSU UNCA CCS-309 New]  
- Decision Modeling & Statistics; [NCSU ST-513 3cr] |
| SPRING1       | - (Climate risk analysis for adaptation, NCSU CCS-602 3cr New): Provides practical hands-on experience for professionals in analyzing climate risks and developing adaptation strategies in climate sensitive sectors. Instructional content will rely heavily on case studies in hydrology, health, and energy transportation sectors. The course will be team taught by faculty instructors in climate science, GIS, engineering, communications, economics, statistics, hydrology, and health disciplines.  
- Approved elective - [NCSU MEAS, CVM]  
- Environmental Policy; [NCSU COM-436 3cr]  
- Communications; [NCSU COM-529 3cr]  
- Research Ethics; [PHI 816 1cr] | - (Climate risk analysis for adaptation [NCSU CCS-602 3cr New]): Provides practical hands-on experience for professionals in analyzing climate risks and developing adaptation strategies in climate sensitive sectors. Instructional content will rely heavily on case studies in hydrology, health, and energy transportation sectors. The course will be team taught by faculty instructors in climate science, GIS, engineering, communications, economics, statistics, hydrology, and health disciplines.  
- Approved elective - (from CEE, MEAS, CVM)  
- Environmental Policy; [NCSU COM-436 3cr] |
| SUMMER1       | Internship/Research [NCSU 6cr] | Internship/Research [NCSU 6cr] [or during Summer 2] |
| FALL2         | N/A | - Geographic Information Systems (GIS); [NCSU NR-531 3cr]  
- Environmental Economics; [NCSU ARE-436 3cr] |
| SPRING2       | N/A | - Communication; [NCSU COM-529 3cr]  
- Research Ethics; [PHI 816 1cr] |
| SUMMER2       | N/A | Internship/Research [NCSU 6cr] [or during Summer 2] |
Primary & Secondary School Education + Informal Informal

- Inform people what climate change is about
- That all society is on board
- Prepare society for young people who are willing to invest their future in climate change

QuickTime™ and a TIFF (LZW) decompressor are needed to see this picture.
Opportunities for Collaboration
Inform Development of Climate Change Adaptation Policy

- **Research** (knowledge for country to assert is role in global agreements & development of optimal adaptation)
- Climate Observational Network
- Communication with Policymakers & stakeholders
- Development of adaptation strategies
- **Capacity Building and Training (formal & informal)**
Perhaps we can put a smile on this man ....
THANK YOU