COMMUNITY BASED WATERSHED MODELING IN NIGERIA

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Brooklyn College
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Outline

- **Background:**
  - Research goals and objectives
  - Study area

- **SWAT**
  - Research framework for community involvement
  - Data sets and collection
  - Initial model development

- **Next steps**

- **Community capacity building**
Why Nigeria?
Citizen Science in Developing Countries
GLOBE contacts provide

- Network of schools – teachers and students
- Universities: Bowen University and Federal University of Technology (FUTA)
- National and State Government support (to some extent)
Needs are great in Nigeria (and throughout Africa and other places in the world)

- Poverty, food and health
- Poor infrastructure for environmental monitoring
- Lack of data!
- Science and technology capabilities limited. Get diversified support:
  - Universities
  - Government
  - NGOs
Devise research project

- Provides scientific data for water resources and climate change
  - Useful for basic research and management
  - SWAT: creating database/research framework
- Involves citizens
  - Secondary schools
  - Universities
  - NGOs
- Builds local capacity
Water Resources: Urban
Water Resources: Rural
Impact in Africa - Water Resources and Climate Change
IPCC 2007 report

- Climate change is likely to directly impact children and pregnant women because they are particularly susceptible to vector- and water-borne diseases, e.g., malaria is currently responsible for a quarter of maternal mortality. Other expected impacts include: increased heat-related mortality and illness associated with heat waves (which may be balanced by less winter-cold-related deaths in some countries);

- Increased prevalence of some vector-borne diseases (e.g., malaria, dengue fever), and vulnerability to water, food or person-to-person diseases (e.g. cholera, dysentery) (see Section 9.4.3);

- Declining quantity and quality of drinking water, which worsens malnutrition, since it is a prerequisite for good health;

- Reduced natural resource productivity and threatened food security, particularly in sub-Saharan Africa (see Sections 9.4.3, 9.4.3, 9.4.4, 9.6.1).

Rainfall Isobars

Source: Andersen et al., 2005. Niger River Basin: Vision for Sustainable Development
Pilot Study Area

Approx: 4.2N, 7.6°E
Annual precip: 800-1200 mm
Annual temp: 28°C
Topography: rolling hills, ranging 80-540m
Soils: largely sandy; highly weathered iron rich - Ferrasols, Lixisols, Acrisols, Nitisols
LULC: mainly agriculture and forest/shrubland
Agriculture: corn, yam, cassava, plantain/banana, legumes
Weather Data

Climatograph

- Monthly rainfall
- Mean temp
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Data sources: DEM

- ASTER
- 30 m resolution
- Free downloadable
- Warehouse Inventory Search Tool (WIST)
  - [https://wist.echo.nasa.gov/~wist/api/imswelcome/](https://wist.echo.nasa.gov/~wist/api/imswelcome/)
Data for LULC

- Landsat
- 30 m resolution
- Free, downloadable
- USGS Earth Explorer
Creating a LULC Map

- Input for SWAT
- Idrisi software
- Landsat data: study area covers 4 scenes
- Unsupervised clustering (so far)
- Accuracy assessment
- Iterative process
Landsat Scenes
Clustering methods

- Spectral classification using bands 2, 3, 4, 5, 7
- Each scene classified separately and then brought into ArcGIS and mosaiced
- Initial LULC identification based on field data collected in May 2010 and Google Earth
- USGS NLCD classification scheme
  - Integrates well with SWAT
Idrisi Clustering Methods

- Variety of unsupervised and supervised methods offered
- Initially using unsupervised
- CLUSTER method chosen with 15 classes that were later reduced to 6
Land Use/Land Cover

- field sites
- forest
- agriculture
- shrubland
- low density
- high density
- water

[Map showing land use/land cover with various color-coded areas and symbols for different land types]
Soil Data

- Soil map of Nigeria
- 1:1,300,000 scale
- Pdf downloadable at European Digital Archive of Soil Maps (EuDASM);
Soil Data Processing

- Field soil samples taken for texture analysis to update model inputs.
- For initial model development, used US comparable soil datasets
- **ArcGIS**
  - Georeference
  - Digitize soil type polygons
  - Create raster file
Soil Data

- Soil data based on US data – STATSGO
- Made best estimates of Nigerian soils in US database based on the Nigerian map, soil samples and personal knowledge of the area.
Weather Data

- Created custom weather generator
- Local Hobo data loggers since Sept. 2009
- NOAA global daily summary
  - Nigeria datasets very incomplete
  - Used dataset in Save, Benin along a similar latitude and climatic regime, although still considerable missing data
Hobo Data Loggers

**Data**: air temperature, rainfall, relative humidity, barometric pressure, insolation, leaf area index, and soil moisture and temperature at 3 depths (10, 30, and 50 cm)

Will be installing wind speed and direction in August or September

Loggers collecting data every 5 minutes

Graduate students and teachers download data and send via email
Watershed delineation

Sub-basins and Reaches

8000 km²
63 sub basins
Defining HRU

- At this stage, trying different thresholds
- Trying to get a “feeling” for the best way to characterize the HRUs
Challenges with Data Inputs

- Non-US applications
- Specific data formatting
- But now that I have been working with the program for a bit, getting a better understanding of how it works; large learning curve
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Immediate Next Steps

- Improve LULC data input through ground validation
- Edit management parameters: tillage, soil moisture, plant growth
- Quantify water use: collected initial survey data
- Explore use of remote sensing data
- Analyze soil samples collected to improve soil inputs
  - Brooklyn College now USDA approved facility to bring in foreign soils
- More weather data – longer term datasets and other variables
- Experiment with SWAT simulation
- Sensitivity analysis, calibration, validation?
Ultimately

- Develop realistic watershed budget?
- Refine process for Osun State; working with new Governor – hopefully establishing one or more science centers
- Find funding to apply approach in other communities northward along the moisture gradient – great challenge – US tax $ for US interests; better chance with Nigerian counterparts
- Model impacts of climate change scenarios on these watersheds
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Community Involvement and Capacity building

- Workshops
- Field campaigns
- Development of new and adaptation of materials for African context
- Student research – flexible approach allows for diverse environmental data collection to be put to use
Field Campaign: May 2010

Where do you think mosquitoes breed around here?
### Osogbo Workshop Format

<table>
<thead>
<tr>
<th>Day</th>
<th>Activity</th>
<th>Science Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to materials; learning data collection techniques</td>
<td>Asking questions, making predictions and hypotheses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Developing sampling strategy and field logistics</td>
</tr>
<tr>
<td>2, 3, 4</td>
<td>Divided into two groups and sampled in urban and rural environments</td>
<td>Data collection</td>
</tr>
<tr>
<td>5</td>
<td>Group discussion, graphing and mapping</td>
<td>Data analysis and synthesis, interpretation</td>
</tr>
<tr>
<td>6</td>
<td>Student and teacher presentations</td>
<td>Communication of results</td>
</tr>
</tbody>
</table>
Days 2, 3, 4: Data Collection
Day 5: Data Analysis
Impacts on Teachers

“Initially before this exercise, I used to have the impression that all these things we are doing in sciences are not practicable… it is not real. Even when I was in secondary school, I used to think that all we are doing is magic... But going through these exercises makes me know and believe that all we are doing is practicable, that we can equally derive an hypothesis, prove it and even put it into law.”
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