

A PROTOTYPE FOR THE APPLICATION OF CLIMATE INFORMATION TO IMPROVE HIGHWAY AND INFRASTRUCTURE PLANNING IN THE COASTAL REGIONS OF LAKE VICTORIA

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- Sudden increase in levels
 1961-64
- Lake Victoria levels declining: 1964-2006
- March 2006: Lowest levels in 80 years
- Levels increasing since 2006



East African Climate Paradox

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Low-pass filtered rainfall (>10yr) MAM average over Greater Horn of Africa



Composite of CRU Rainfall for dry (1985-2000) minus wet (1970-1985)-MAM



[•] Possible Explanations:

- Anthropogenic Climate Change
 - Natural Oscillations in Indo-Pacific

Sea Surface Temperature

Atlantic Meridional Oscillation
 (SSTs) - May



Prototype for Application of Climate Information

The prototype comprises the following modules:

- 1) Downscaling of IPCC Global Climate Model (GCM) output,
- 2) Use of a hydrological water balance model for Lake Victoria to translate the IPCC GCM output into Lake Victoria Levels,
- 3) Digitization of flood potential across the near coastal region of Lake Victoria
- 4) A web-based visualization interface for users based on GIS.

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Meteorological Data

- Precipitation:
 - Ground truth: Station precipitation 1961-90 for 6 stations: Jinja, Entebbe, Kisumu, Musoma, Bukoba, Mwanza.
 - Temporal extension: Climate Research Unit (CRU) TS 3.0 gridded precipitation

- Projected Precipitation
 - Ensemble of 9 IPCC AR4 global climate models (interpolated to 2.8 degree resolution)



Satellite-based Data

• Lake Victoria Levels:

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- Combined data set: 1949-May 1998 using gauge levels from Jinja, Uganda, extended using TOPEX/POSEIDON and Jason-1 satellite altimetry. (http://www.pecad.fas.usda.gov/cropexplorer/global_reservoir/)
- Digital Elevation Model (DEM):
 - Shuttle Radar Topography Mission (SRTM) 90 m digital elevation model (http://edcsns17.cr.usgs.gov/EarthExplorer/)



- Results for precipitation over Eastern Africa based on A2 climate scenario (on higher end of CO₂ emissions)
- Largest projected climate change signal over Lake Victoria for all three types of projections

Hydrology of Lake Victoria

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 To understand lake variability several water balance models have been developed based on the equation:

 $\Delta S = P - E + (Qin - Qout)/A$

- Precipitation (P) and Evaporation (E) are almost balanced.
- Evaporation is reasonably constant.
- Inflow (Qin) is based on precipitation,^{™™}
 Outflow (Qout) is based on lake level.



A FRAGILE WATER BALANCE



e: Figures for any particular year may vary sharply from these long-term averages



Projected Lake Levels from Water Balance Model

IPCC Ensemble

RegCM3





year

Application: Lake Flood Zone Map

Flooding around northwest side of Lake Victoria

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road Lake Increase Current Lak



Flooding near Kampala, Uganda



Current La

Legend



56,000 28,000 0 56,000 Meters

Online Map Application

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The results of the digitization of flood potential are then converted, along with road, power plant and electrical transmission line ArcGIS shapefile data from African Development Bank Group into a web application using Web AppBuilder for ArcGIS.



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Online Map Application

- The red potential flood zone regions are smoothed and shown as a more transparent red when one zooms in so that the layers and map under the flooded region can be viewed more clearly.
- Within the web application, a stakeholder can zoom in to an area of interest, or explore bookmarked areas, as well as make measurements between points of interest.
- Layers not of interest to the stakeholder are able to be turned off.
- As further data becomes available or models are updated, data layers can be added or updated in the web application.

Future work

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- In the future, each of the four modules will be improved in order to develop • both a short-term prediction system in order to show potential flooding such as during EI Nino events and a decadal projections systems for longer-term changes.
- Use larger range of climate models to show climate uncertainty •
- Use of a more dynamical hydrological model. •
- Calculate uncertainty over entire chain of steps from collection of data to • uncertainty in water balance model and how this uncertainty cascades from data to impact.
- Calculations of areas that remain land even though the lake levels have • increased.

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Thank you!



http://placepics.triposo.com/Nalubaale_Hydroelectric_Power_Station.jpeg

Seasonal Rainfall (Regional Average, GPCC)

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MAM









Year



East African (Monsoon) Climate Paradox



