The East African Great Lake Environments Climate Change Project

State of the Science climate prediction tailored to serve regional stakeholder needs

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EAGLE Project Overview

2015-2020 African Great Lakes project (EAGLE) is a collaborative effort by US universities, NCAR and WCS-Uganda, funded by the MacArthur Foundation

Goal : Apply state-of-the-science models with high spatial resolution to evaluate how human activity and climate change are impacting natural and human systems across East Africa.

Outputs : Predictive products of climatic conditions likely to occur over coming decades across the lake watersheds, and show their potential impacts upon natural systems, humanity, agriculture, lake ecology and ecosystem services.

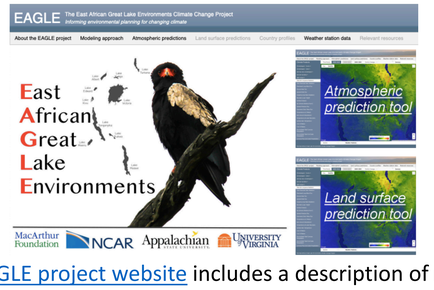
Project Purpose

Over coming decades, climatic variability, climate change and socio-economic development will have profound effects on human well-being, ecosystems and biodiversity across East African Great Lakes watersheds. To date, however, adaptative planning for climate change has been hindered by the lack of baseline data resources and modeling guidance of adequate spatial resolution to serve conservation planning needs.

The EAGLE project is motivated by the need for time- and location-specific prediction of environmental changes likely to occur as a consequence of anthropogenically-driven climate change. We aim to generate meaningful state-of-the-science guidance through earth system modeling designed to improve integration of disparate drivers of change.

We also recognize the need to make predictive products ***accessible***, ***understandable*** and ***usable*** to all stakeholder audiences. Our primary goal is to provide conservation and development planners working with long time horizons with the best-available climate and environment predictions to help them create adaptive management strategies, and to tailor model outputs to serve their informational needs.

Website and data portal



The EAGLE project website includes a description of methods, data products generated and data access tools where users can select specific regions of interest and examine and compare predictions for a variety of environmental variables across the course of the 21st century. In addition, the full WRF simulation data files are now available at NCAR's Climate Data Gateway.

Website: http://eagleclimate.org/dev/#
WRF outputs : https://www.earthsystemgrid.org/dataset/ucar.ral.eagle.html

Modeling Approach

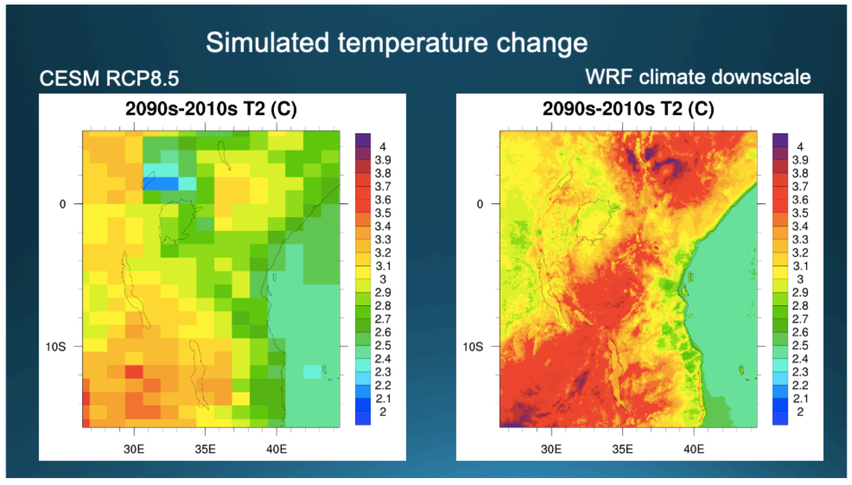
Land surface: **Community Earth System Model (CESM)**

- Vegetation, carbon stocks, fire occurrence and crops out to 2100
- Global emissions under 2 Representative Concentration Pathways (RCPs)
- Human development and population under 2 Shared Socioeconomic Pathways (SSPs)
- More favorable (RCP 2.6 & SSP 1); less favorable (RCP 7.0 & SSP 3)

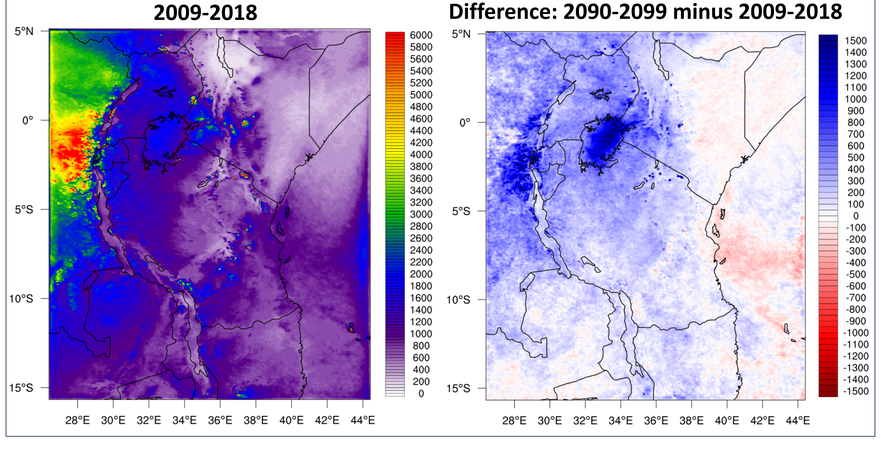
Atmosphere: **Weather Research and Forecasting model (WRF)**

- Present day (2009-2018), mid-century (2055-2064), and end-of-century (2090-2099)
- Dynamically downscaled CESM using RCP 8.5 for future, RCP 4.5 for present
- 10 km outer domain, convection-allowing 3.33 km inner domain
- 44 different output fields archived
- 3 decadal periods of hourly, 3km data stored in netCDF files using CMIP5 convention

Downscaled simulations provide greatly enhanced resolution



Mean annual precipitation



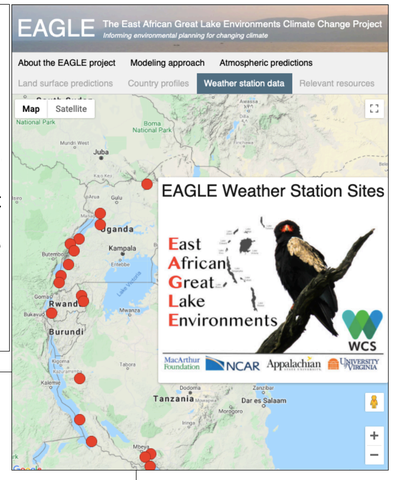
Applications of project outputs – some examples

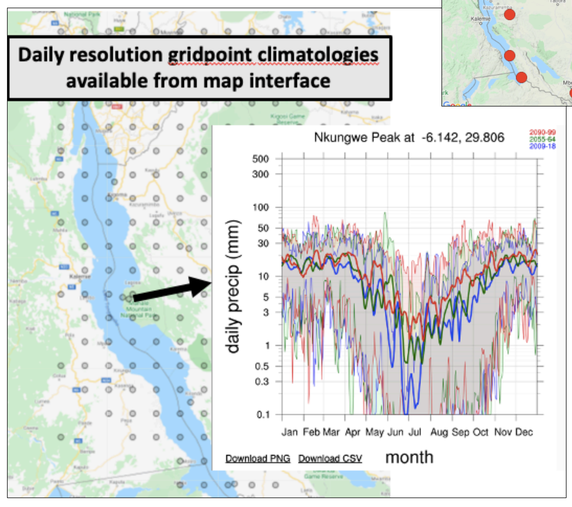
EAGLE Weather Station Network

The project maintains a network of 18 automatic weather stations to improve in situ monitoring and provide a means of validating model accuracy for present day simulations. All AWS data is available through our website.

To optimize WRF, a series of 18 sensitivity test were performed, comparing model output with EAGLE mesonet observations, before the full simulations were conducted.

For details, see NCAR Technical Note:
https://opensky.ucar.edu/islandora/object/technotes:584





In addition to mapped products presented at monthly and annual resolution, users can select gridpoint climatologies for the present day and future at daily resolution for:

- precipitation rate
- vapor pressure deficit
- solar radiation

Through such products, East African stakeholders can better understand how natural and human systems potentially will be impacted by:

1. **Climate, through changes in:**
   - **Temperature** impacts on vegetation through photosynthesis responses, agriculture through flowering and grain fill; people through heat stress and disease.
   - **Precipitation** that impacts surface hydrology; vegetation and agriculture through water availability; streams and lakes through changes in runoff.
   - **Relative humidity and wind speed** that impact potential evaporation, the vapor pressure deficit response of vegetation, and fire ignition, intensity and spread.
2. **Atmospheric CO_2 concentration through changes in:**
   - **Photosynthesis,** with higher CO_2 resulting in higher productivity.
   - **Water use efficiency**, with less water loss for the same carbon uptake. .
3. **Land Cover Change:**
   - **Deforestation** for agricultural expansion of crops and pastures.
   - **Wood harvest** for timber production along with other forest disturbance.
   - **Conservation and afforestation** for carbon storage and biodiversity protection.
   - **Biofuel production** from forests and crops.
4. **Land Use Management:**
   - **Changes in crop production** resulting from cropping area, fertilizer application, irrigation use and crop selection.
   - **Changes in carbon storage** in response to crop practices.
   - **Changes in water availability** in streams and lakes through irrigation withdrawal and water management.