Applications of ECOSTRESS Data

1. TVA water temperature monitoring

2. Nature Conservancy of Canada Norfolk & Long Point 500 ha+ Oak Woodland restoration project

3. GeoHealth Project - A geospatial surveillance and response system resource for vector borne disease in the Americas

4. Improving Malaria Decision Support with Earth Observations

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TENNESSEE VALLEY ENERGY

Assessing the Hydrothermal Outputs of Nuclear Power Plants Along the Tennessee River with NASA Earth Observations

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Lisa Dong
BFNP: EXTENDED POWER UPRATE

- Completed in **2019**
- **Increased power** output of each unit by **120%**
- Uprate coincides with **predicted increase in surrounding water temperature** of the Tennessee River
PROJECT OBJECTIVES

- Visualize *yearly* and *seasonal* water surface temperatures through time-series maps to identify surface temperature spatial variation over time

- Compare *satellite performance* between BFNP and SNP

- Analyze *river flow rate, air surface temperature*, and *power output* impacts on water surface temperatures through statistical analyses

- Improve the *TVA’s Delft3D model* by showing spatial variation in river surface temperature

- Illustrate the feasibility of using NASA Earth observations to monitor water surface temperatures through a *tutorial*

- Wrap up project through a *story map*
TEMPERATURE THRESHOLDS

- **93 °F**
  - 1-Hour average threshold

- **90 °F**
  - Daily Average threshold

- **10 °F**
  - Daily average limit relative to ambient
IN SITU MONITORING

- Browns Ferry Nuclear Plant
- Tennessee River
- Temperature Stations
- Mixing Zone

Image source: Dong, L.; Ding, J.
Combined $R^2 = 0.97$
Temperature Accuracy at BFNP

Temperature Accuracy at SNP
CONCLUSIONS

- **River flow rate** has a **significant impact** on water surface temperature. **Earth observations can demonstrate spatial trends** at varying flow rates.

- NASA Earth Observations can **benefit thermal effluent model calibration**.

- Satellite imagery cannot replace **in situ** temperature reporting for compliance due to **low temporal & spatial resolutions**.
Nature Conservancy of Canada Norfolk & Long Point 500 ha+ Oak Woodland restoration project

We compared 12 years of vegetation data with thermal data from Landsat 5, 7, 8 and ECOSTRESS

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Nonequilibrium thermodynamic hypotheses concerning ecosystem development

- Exergy utilization will increase
  - $R_n/K^*$ will increase
  - Surface temperature will decrease

- Internal equilibrium will increase
  - Spatial variation in surface temperature will decrease (Beta index increases)
  - Temporal variation in surface temperature will decrease (TRN increases)
Restoration cooled the land by about 4.5 °C in 12 years (summer day-time temperatures)

Each line is a field before and after restoration. Before restoration there is no significant pattern. After restoration 30 out of 31 fields get colder.

Data from Landsat 5, 7, 8 and ECOSTRESS

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Controlling for biomass and shade, an increase in native vegetation biodiversity decreased temperatures more than an increase in exotic species diversity.

A
\[
\text{coeff. } = -5.09, p < 0.0001, R^2 = 0.37
\]

B
\[
\text{coeff. } = -1.68, p = 0.34, R^2 = 0.01
\]

Restoration treatments
- Active
- Passive

Data from Landsat 5, 7, 8 and ECOSTRESS

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Night-time temperatures increases with restoration

ECOSTRESS – daytime imagery

ECOSTRESS – night-time imagery

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Variation between day-time and night-time temperatures decreases by 5 °C over 8 years as more, and more diverse vegetation holds energy.

This comparison would have been impossible without ECOSTRESS, as Landsat returns around noon every day. Night time measurements are very interesting from an a perspective of energy flow in ecosystems.

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Combining ECOSTRESS and Landsat imagery can provide cost-effective monitoring of large-scale and fragmented restoration areas

Map of mean day-time summer temperature change between 2014 and 2018 imagery. Most restoration areas (magenta) have decreased in temperature, except area 3-E, this area may require further management to increase vegetation cover and diversity.

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GEOHEALTH PROJECT

A geospatial surveillance and response system resource for vector borne disease in the Americas

SMAP image (Brazil) with ECOSTRESS overlay on Sao Paulo.
Red points represent visceral leishmaniasis (VL) cases.

Next phase includes creating VL risk models based on SMAP and ECOSTRESS extractions.

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Improving Malaria Decision Support with Earth Observations

John Beck, PI, UAH, John Painter, Co-I CDC, Udaysankar Nair and Todd Berendes, Co-I, UAH, Jeffrey Luvall (Co-I) & Walter Petersen, MSFC unfunded collaborator

District Health Information Software 2 (DHIS2)

- DHIS2 is the preferred health management information system in 60 countries across four continents worldwide including all sub-Saharan African countries with whom CDC works.
- DHIS2 is used by the CDC, the European Union (EU), and other health facilities and government organizations to monitor diseases, provide vital health data, and support disease-control decision making.
- Malaria has been selected for the case study because of the well-established impacts of environmental factors on transmission of the disease.
Highlight:

- MoSquito aims to improve malaria control decision making in sub-Saharan Africa by developing and deploying technology for incorporating the latest NASA Earth observations for surface temperatures, precipitation, and vegetation health into the District Health Information Software 2 (DHIS2) used worldwide, including all sub-Saharan African countries.
- Objectives include:
  1. Enhanced health decision making for malaria control by integrating the latest relevant NASA Earth observations into an existing decision-making activity
  2. Developing and deploying technology solutions that will provide a path to long-term sustainability for the use of NASA Earth observations to end-user health decision makers.

Relevance:

- Incorporating environmental data into the most frequently used geo-referenced disease surveillance platform, District Health Information System (DHIS2)
- Making information from Earth Observations available to countries to improve malaria intervention evaluation, assessment of malaria burden and trends, and resource allocation
- Malaria decision-makers will be better able to assess malaria trends in the context of environmental factors that drive malaria risk in their area.

Figure 1: Example DHIS2 Interface illustrating health information from Sierra Leone, likely one of the MoSquito project collaborating countries.
MODIS Temperature Datasets

MOD11A2 – 1km MODIS derived Land Surface Temperature (LST), 2017 average