Using NASA Earth Science Datasets for National Climate Assessment Indicators: Urban Impacts of Heat Waves Associated with Climate Change

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Proposed Indicators

• Exposure indicators:
  - *Urban Heat Wave Indicator:* To the extent possible, quantify the intensity and total duration of heat waves in metropolitan region (i.e. periods of 3+ days) within a given year
  - *Urban Heat Island Indicator:* Quantify the temperature difference between the urban and rural areas during periods of extreme heat
  - *Air Quality Indicator:* Examine the impacts of heat events on the air quality, as a proxy for health impacts (not directly related to the heat)

• Sensitivity indicator:
  - *Urban Socioeconomic and Hotspot Indicator:* Determine where populations are most vulnerable to extreme heat events

• Adaptive capacity indicator:
  - *Urban Adaptation Effectiveness Indicator:* Quantify how adaptation/improvement plans are affecting local UHI
Tasks

• Task 1. Identify and Engage Stakeholders
• Task 2. Refine Indicator Methodology
• Task 3. Calculate Indicators
• Task 4. Visualize the Indicators and Vet Results
• Task 5. Finalize the Indicators and Assess National Scale-Up
TASKS 1 & 2:
Identify and Engage Stakeholders and Refine Indicator Methodology
Task 1: Advisory Group of Stakeholders

Meeting on January 30 in Philadelphia, PA

- Participating organizations:
  - University of Pennsylvania
  - Franklin Institute
  - PA Dept. of Public Health
  - PECO
  - Philadelphia City Planning
  - Azavea
  - Others

- Presentation of the indicators, proposed methodology, Philadelphia-specific considerations, and communication and dissemination strategies
Task 1: Stakeholder Input

• There is an interest in **spatially disaggregated indicators** that can identify status and trends in localities

• There is an interest to use the spatial indicators to evaluate whether Philadelphia's efforts at tree planting and "cool roofs" are resulting in lower surface temperatures

• There is interest in using the spatial indicators in a mapping tool for **public communication** at the Franklin Institute; one participant suggested 3D mapping and fly-throughs of the heat island

• Heat impacts on health associated with poor air quality are major concerns in Philadelphia
  
  ▪ **Health impact mapping** may be more difficult because data are restricted owing to confidentiality concerns
Task 2: Refining the Indicators

Based on Stakeholder Feedback

• Make indicators more policy relevant and locally significant → map trends to adaptation programs in the area

• Define vulnerability → review the literature to refine the definition of and methodology for calculating vulnerability

• Make the indicators turn-key and user-friendly → review options for mapping and visualizing
TASKS 3 & 4: Calculate and Visualize Indicators
Urban Heat Wave Indicator

Duration of Heat Waves

- Heat wave is defined as 3 or more consecutive days where the average ambient temperature is above the 85th percentile threshold
- Cumulative sum of days per year classified as being part of a heat wave
Urban Heat Wave Indicator

Minimum Temperature Threshold

- Number of days per year where the average minimum ambient temperature is greater than the 85th percentile threshold for minimum temperature
Urban Heat Island Indicator

• Calculate the average LST difference between urban and non-urban areas (unit: °F)
• Possible additional indicator:
  ▪ Estimate the area and/or population affected by the UHI
    – Calculate how much of the urban area has temperatures that are in excess of the average non-urban temperatures (unit: mi²). How many people are affected by the increased temperatures?

Notes: Results presented are for July 20 – 27
Map shown is 2011
Air Quality Indicator

Methodology

• During heat events, calculate the average daily maximum 8-hr ozone concentration for stations within the metro area. How does it compare to times not during heat events?
• Could also be looked at in terms of AQI
  ▪ # of days of orange/red AQIs
Urban Socioeconomic and Hotspot Indicator

Methodology

• Develop an indicator that combines the socioeconomic factors with NDVI observations to estimate how ‘vulnerable’ a census block group population is to extreme heat.
  
  ▪ e.g.:
    
    - Median Income / Poverty Level
    - Education (% HS/College Graduate)
    - Age (% young children, % elderly)

  ▪ Review existing studies to determine best algorithm for calculating vulnerability index in urban areas.

• How does the distribution of vulnerability relate to areas often affected by UHI?
Urban Adaptation Effectiveness Indicator

Methodology

• Calculate local trends in NDVI and LST with respect to time

• Work with advisory group to identify completed, ongoing and proposed programs/plans/policies that could potentially affect impacts due to extreme heat
  - *E.g. Greening, storm water management, social improvements, etc.*

• Compare NDVI and LST with periods prior to program implementation
  - Have efforts increased greenness?
  - Quantify the changes in LST
Urban Adaptation Effectiveness Indicator Data
Urban Adaptation Effectiveness Indicator

Implications

• Provides a quantitative measure of the positive effects of programs implemented.

• Allows for the creation of metrics and visuals that city organizations can use to present to management and decision-makers

• Can be used to extrapolate estimated effects of program expansion or reduction

• Also allows decision-makers to see effects of development and increases in impervious surfaces
NEXT STEPS
Next Steps

• Finalize calculations and visualizations of indicators for the Philadelphia region
• Quarterly calls with the AG to ensure that the indicators are relevant to Philadelphia and other urban areas more broadly throughout the revision and calculation process
• Apply methodology to second pilot city
• Assess national scale-up and NCA relevance
• Identify areas for study expansion and future work