**Louisville Urban Development**

*Utilizing NASA Earth Observation to Assess the Overall Greenness and Land Surface Temperature of Cities in Relation to Public Health Outcomes*

**VPS Title:** Beyond Steel and Cement: A Green Approach to Combating Urban Health Issues

**Project Team**

***Project Team:***

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***Advisors & Mentors:***

Dr. David Hondula (Arizona State University)

Dr. Kenton Ross (NASA Langley Research Center)

**Project Overview**

***Project Synopsis:*** Research has shown that people with access to nearby natural settings are found to be healthier overall than other individuals. To provide decision-makers with a “greenness” metric, we assessed the Normalized Difference Vegetation Index (NDVI) using NASA’s Earth observation, Landsat 8. With higher land surface temperatures being associated with health-related issues and heat-related illnesses, we also incorporated a land surface temperature (LST) metric into our analysis. We created a tutorial for assessing NDVI and LST for our City Health Dashboard (CHD) partners so they can replicate our analysis for all 793 (500 current and 293 proposed) cities on their website.

***Abstract:***

Greenness and land surface temperature (LST) have been extensively correlated to urban public health. Chronic diseases such as diabetes, asthma, and cardiovascular illnesses have been linked to regions of high LST and areas lacking urban green spaces. One of our partners, the University of Louisville Envirome Institute, champions the importance of urban green spaces. Their research has pioneered efforts in increasing the area and accessibility of urban parks and greenspaces as a way to improve public health and combat environmental inequality. Louisville, Kentucky, is currently working to plant and manage urban trees. Our team used NASA Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) imagery to calculate the Normalized Difference Vegetation Index (NDVI) in Louisville at the census tract level and automated the process for use in other cities. The New York University School of Medicine’s City Health Dashboard displays public health metrics across 500 US cities and will use our methods to complete the NDVI analysis for all of these locations plus an additional 293 cities they are adding to their dashboard in the near future. Our NDVI and LST calculations will allow cites across the US to make informed decisions about reducing environmental inequality by focusing on areas with low NDVI and high LST.

***Keywords:***

remote sensing, normalized difference vegetation index, greenness, land surface temperature

***National Application Area Addressed:*** Urban Development

***Study Location:*** Louisville, KY

***Study Period:*** June 2013 to September 2019

***Community Concerns:***

* Research has correlated the loss of green space to increased LST.
* Louisville experiences one of the largest heat island effects in the country.
* Louisville has had a history of heat-related issues. In 2012, 86 people in Louisville died due to a large heat wave.
* Research has shown urban green spaces reduce the risk of certain chronic illnesses including cardiovascular and respiratory diseases. Some of these diseases can be exacerbated by an increase in urban temperatures.

***Project Objectives:***

* Provide NDVI and LST values at the city and census tract levels
* Create replicable methods that can be used to quantify NDVI and LST across 793 cities
* Introduce NASA Earth observation capabilities to our partners to inform public policy pertaining to environmental and public health

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **City Health Dashboard, New York University School of Medicine** | Peggy Hsieh, Research Analyst | End User | Yes |
| **University of Louisville, Envirome Institute** | Dr. Ted Smith, Deputy Director | End User | Yes |

***Decision-Making Practices & Policies:***

The City Health Dashboard (CHD) provides frequently updated data that aids city leaders in creating equitable health policies. Scientists at the University of Louisville Envirome Institute provide actionable knowledge to help build healthier cities and reduce health inequities. Both end users provide publicly available research and tools often used by public policy decision-makers. Currently, Louisville is implementing the Green Heart Louisville program to scientifically assess the impact of green space on air quality and health in urban communities. This project has focused on the greening and monitoring of six residential areas in Louisville over the course of four years. Louisville is also addressing the effects of urban heat on public health. In 2016 they completed a regional climate and health assessment through the Urban Climate Lab of the Georgia Institute of Technology.

***Project Benefit to End User:***

This project will first serve as a tool for decision-makers in the City of Louisville. The use of NASA Earth observations will complement our partners’ work in providing rigorous data regarding urban environmental parameters and public health, thus enhancing further public policy decision-making in conjunction with its current programs. Additionally, the end goal is to enhance the capacity of the CHD to utilize NASA Earth observation and to enable them to replicate our methodology for all 793 cities. Our analysis will help create a dataset of urban NDVI and LST in large cities across the nation and will demonstrate the potential of utilizing NASA Earth observations for future city health metrics.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 8 OLI / TIRS** | NDVI, LST | Landsat 8 imagery was used to generate values for peak NDVI and LST across Louisville and within each city census tract. |

***Ancillary Datasets:***

* 793 Cities Dataset – Shapefile provided by the CHD used to define city boundaries.
* 32,482 Census Tracts Dataset - Shapefile provided by the CHD used to define the census tract boundaries.

***Software & Scripting:***

* Google Earth Engine API – Calculation of peak NDVI and LST from 2015 to 2019
* Esri ArcGIS Pro 2.4 – Map creation for NDVI and LST analysis by census tract
* Esri ArcMap 10.6.1 – Visualize data and map creation
* QGIS 3.0.2 – Visualize data, map creation and video animation

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Excel Spreadsheet of Census Tract NDVI Values for 793 Cities** | Landsat 8 OLI/TIRS | The partners can use this metric to determine which census tracts could be targeted for greenness initiatives. This data format can be directly imported into the CHD website. | N/A |
| **Excel Spreadsheet of City Level Average NDVI Values for 793 Cities** | Landsat 8 OLI/TIRS | The partners can use this metric to compare the greenness of different cities. This data format can be directly imported into the CHD website. | N/A |
| **Excel Spreadsheet of Census Tract Land Surface Temperature Values for 793 Cities** | Landsat 8 OLI/TIRS | The partners can use this metric to determine which areas may benefit from cooling initiatives. | N/A |
| **Excel Spreadsheet of City Level Average Land Surface Temperature Values for 793 Cities** | Landsat 8 OLI/TIRS | The partners can use this metric to compare the average land surface temperatures of different cities. | N/A |
| **General Methods Tutorial** | Landsat 8 OLI/TIRS | This tutorial will provide an overview and description of our methods for immediate use by the partners. It does not include any code. | N/A |
| **Greenness and Heat Toolkit (GrHeat) Methods Tutorial** | Landsat 8 OLI/TIRS | This tutorial of our methodology for determining NDVI and LST will allow our partners to reproduce our methodology for other cities in Google Earth Engine. | III |
| **GrHeat Google Earth Engine Code with Annotation** | Landsat 8 OLI/TIRS | This code will allow our partners to replicate our methods for any cities added to the CHD website in the future. | III |

**Project Handoff Package**

***Transition Plan:*** The end products were presented during our video chat handoff meeting and delivered to the partners at the Universityof Louisville Envirome Institute and the CHD team via Google Drive and email. The team held an additional meeting with the CHD partners to conduct an in-depth tutorial on the use of the team’s Google Earth Engine code, which was screen recorded for future reference by the CHD. All end products containing visible code will be sent to the partners after software release.

***Software Release Plan:*** The team prepared the CHD partners for a delay in the delivery of the code during the first partner meeting and reminded them throughout the term. Once the code was released, the AZ Fellow emailed the code and the code methods tutorial (in written and video format) to the partners.

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***Handoff Package:***

* Excel Spreadsheet of Census Tract NDVI Values for 793 Cities
* Excel Spreadsheet of City Level Average NDVI Values for 793 Cities
* Excel Spreadsheet of Census Tract Land Surface Temperature Values for 793 Cities
* Excel Spreadsheet of City Level Average Land Surface Temperature Values for 793 Cities
* General Methods Tutorial
* Tech Paper
* Project Video

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