

NASA DEVELOP National Program

2019 Fall Project Proposal

Virginia – Langley

New York City Urban Development

Mapping Hotspots using NASA Earth Observations to Inform Future Green Initiatives in New York City

Project Overview

Project Synopsis: This project, in collaboration with the New York City Mayor's Office of Resiliency, seeks to identify the location of hotspots throughout New York City by analyzing land cover and land use change over time, and relating that change to daytime surface temperature across the city. The project will utilize data from Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI/TIRS, and MODIS to produce a geodatabase of hotspots, land use, and land cover from 1990-2019. This information will be integrated with demographic information and zoning data maintained by the city to help inform decision-makers about priority areas for future green infrastructure. All of this information will be integrated into an ArcGIS workflow that will synthesize land cover, surface temperature, and demographic information to provide a powerful spatial visualization of vulnerable areas in the city that could benefit the most from heat-risk interventions.

Community Concern: New York City, the most populous and densest urban center in the United States, has experienced steady growth for the last two decades and is likely to reach nine million inhabitants by 2040. In the same time frame, average temperatures in New York City will likely rise higher than ever before, with an average increase of up to 5.7 degrees Fahrenheit across the city. Today, about 130 New Yorkers die each summer from intense heat, and hotter temperatures may leave even more people at risk. Older adults, low income populations, non-Hispanic black residents, and those with pre-existing health conditions are all more susceptible to heat-related illness or death. Some crucial steps to increase community resiliency and promote equity are to carefully steward urban vegetation and to strategically prioritize the implementation of green infrastructure.

Source of Project Idea: The project originated from discussions between the DEVELOP Center Lead at Maryland – Goddard and Daphne Lundi at the New York City Mayor's Office of Resiliency, who subsequently submitted a project request form. Future communications between the DEVELOP Acting Center Lead at Virginia – Langley and Daphne Lundi solidified the project objectives and scope.

National Application Areas Addressed: Urban Development, Health & Air Quality

Study Location: New York, NY

Study Period: 1990 – 2019 (April – October)

Advisor: Dr. Kenton Ross (NASA Langley Research Center)

Partner Overview

Partner Organization:

Organization	POC (Name, Position/Title)	Partner Type	Boundary Org?
City of New York, Mayor's Office of Resiliency	Daphne Lundi, Senior Policy Advisor	End User	Yes

End-User Overview

End User's Current Decision-Making Process: The New York City Mayor's Office of Resiliency (MOR) currently produces a Heat Vulnerability Index (HVI) that incorporates social and environmental factors into a

statistical model that estimates the risk of heat-related death across NYC neighborhoods. This index includes social factors, such as poverty and race, and environmental factors, such as daytime summer surface temperature and green space. Land cover information is acquired from infrequently-captured orthoimagery and a city-wide 2017 LiDAR capture. The HVI is used to target vulnerable communities for intervention programs, such as planting street trees and installing CoolRoofs.

End User's Capacity to Use NASA Earth Observations:

City of New York, Mayor's Office of Resiliency – The end user has a working knowledge of ArcGIS products and foundation in GIS concepts, and a few members of the organization have experience using Landsat and LiDAR data. The MOR uses these products as they relate to the HVI, but do not update their orthoimagery or land cover products regularly.

Collaborator & Boundary Organization Overview

Dissemination by Boundary Organizations:

City of New York, Mayor's Office of Resiliency – The MOR collaborates frequently with the New York City Department of Health and Mental Hygiene (DOH) regarding heat-related risks and potential interventions, and will likely share the results and methodologies of this project with the DOH and other related organizations. The MOR is also interested in creating a visually compelling summary of these findings to communicate with other city organizations, urban planners, and city residents to raise awareness about the risk of heat-related illnesses or death and to garner quantitative support for future green infrastructure initiatives.

Project Communication & Transition Overview

In-Term Communication Plan: The Langley Fellow and Science Advisor will coordinate an introductory meeting between the DEVELOP team and city officials during the first week of the term. The Project Lead will be the primary POC throughout the term and will provide regular updates with partners in New York on a weekly or bi-weekly basis using the NASA DEVELOP teleconference line and periodic emails.

Transition Plan: The Project Lead will coordinate with the end users to schedule a virtual handoff meeting that will include a brief overview of the end products, a tutorial of the methodology, and an overview of the model builder in ArcGIS.

Earth Observations Overview

Earth Observations:

Platform & Sensor	Parameters	Use
Landsat 5 TM	Land cover and temperature	Classify land use/cover and daytime surface temperature from 1990-2011.
Landsat 7 ETM+	Land cover and temperature	Classify land use/cover and daytime surface temperature from 2011-2013.
Landsat 8 OLI	Land cover	Classify land use/cover from 2013-2019 and in future analyses.
Landsat 8 TIRS	Temperature	Calculate daytime land surface temperature for 2013-2019 and in future analyses.
Terra MODIS	Temperature	Reference and validation data source to compare with Landsat derived temperature products.
Terra ASTER	Temperature	Reference and validation data source to compare with Landsat derived temperature products.

Ancillary Datasets:

- US Census Bureau American Community Survey – Map demographic data to identify distribution of vulnerable populations

- New York City Zoning and Land Use Map – Analyze correlation between zoning and land use with identified hotspots
- New York City LiDAR Capture (2017) – High resolution LiDAR for land cover/use validation
- National Weather Service Weather Station Data – Validation of remotely sensed temperature products
- United States Geological Survey (USGS) National Land Cover Database (NLCD) – Land cover maps

Software & Scripting:

- Esri ArcGIS – Create geodatabases of hotspots and land use/cover change, as well as a model builder, to share directly with partners and allow partners to reiterate this methodology in the future

Decision Support Tool & End Product Overview

End Products:

End Product	Partner Use	Datasets & Analyses	Software Release Category
Geodatabase of Hotspots from 1990 - 2019	The city will use this database to analyze historical hotspot location throughout the city, explore spatial relationships over time, and identify vulnerable communities that may be prioritized for intervention.	Landsat and MODIS data will be combined with temperature data from the National Weather Service and New York City zoning information to create this geodatabase of hotspots and associated land use information.	N/A
Geodatabase of Land Use Change from 1990 - 2019	The city will use this database to analyze historical land use patterns and identify areas of significant change to explore how this relates to hotspots and heat vulnerability.	Landsat imagery and high-resolution LiDAR provided by the City, in conjunction with maps from the USGS NLCD, will be used to map land use change during the study period.	N/A
ArcGIS Model Builder Workflow for Identifying Hotspots	This workflow will allow city officials to easily incorporate land cover data with surface temperature information when new images are available, and integrate that information with demographic data to visualize hotspots and identify vulnerable populations that could benefit from interventions.	This workflow will incorporate the most up-to-date Landsat 8 data and demographic information from the American Community Survey for future hotspot analysis.	N/A

End-User Benefit: These end products will provide a historical record of hotspot locations that can be used to study how hotspots are correlated with changes in land cover, and consequently, inform decision makers about how planned changes in land cover may result in surface temperature fluctuations. These map products will help guide the end-user's decisions about where to incorporate green infrastructure and how zoning changes may impact vulnerable communities from both an environmental and health perspective. The resulting ArcGIS model builder will supplement current vulnerability mapping by incorporating finer spatial and temporal resolution information into present intervention workflows. The end user aims to use these products to communicate heat risk information more effectively to city planners, decision makers, and the public.

Project Timeline & Previous Related Work

Project Timeline: 1 Term: Fall 2019

Related DEVELOP Work:

- 2019 Summer (AL) – Mobile Urban Development: Evaluating Urban Heat Islands and Flooding to Enhance Green Infrastructure Initiatives in Coastal Communities in Mobile, Alabama
- 2019 Spring (LaRC) – Providence & Elizabeth Urban Development: Utilizing NASA Earth Observations to Explore Heat and Flood-Related Vulnerability in Urban Settings
- 2018 Spring (ARC) – Richmond Urban Development: Quantifying Changes in Urban Tree Canopy Cover and Land Surface Temperature to Understand Their Impacts on Neighborhoods throughout Richmond, California
- 2018 Summer (AZ) – Washoe County Urban Development: Utilizing NASA Earth Observations to Assess Urban Heat Island Reduction Strategies in Washoe County, Nevada
- 2018 Fall (AZ) – Tempe Urban Development: Utilizing NASA Earth Observations to Assess Thermal Landscapes and Prioritize Greening Initiatives in Tempe, Arizona

Notes & References:

Notes: The team can experiment with demographic data from the American Community Survey, LandScan from Oak Ridge National Laboratory, and SEDAC GPWv4 to find what works best for this project. The team can also evaluate existing land cover resources to determine if Landsat scale is appropriate for the city. Another potential useful product would be a bivariate histogram to relate hotspots and demographic information. The team can evaluate the temporal aspects of this project further, but the initial plan is to generate 5-year aggregates for the hotspot and land cover change maps to ensure that enough observations are included. It may also be useful for this project to normalize absolute temperature, which would allow the team to aggregate imagery and remove the effects of clouds on surface temperature.

References:

- The City of New York. (2015). OneNYC 2050: Building a Strong and Fair City. Volume 7 of 9: A Livable Climate.
- The City of New York. (2015). Cool Neighborhoods NYC: A Comprehensive Approach to Keep Communities Safe in Extreme Heat.
- Madrigano, J., Ito, K., Johnson, S., Kinney, P. L., & Matte, T. (2015). A Case-Only Study of Vulnerability to Heat Wave-Related Mortality in New York City (2000 – 2011). *Environmental Health Perspectives*, 123(7), 672-678. //doi.org/10.1289/ehp.1408178