**New Orleans Health & Air Quality**

*Monitoring the Urban Heat Island Effect on the Health of Residents in the New Orleans, Louisiana Metropolitan Area with Landsat Land Surface Temperature Products*

**VPS Title:** Let the Cool Times Roll: Monitoring Urban Heat Island Effects in New Orleans, Louisiana

**Project Team**

***Project Team*:**

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***Advisors & Mentors*:**

Joseph Spruce, Science Advisor (Science Systems & Applications, Inc.)

Dr. Kenton Ross, Science Advisor (NASA Langley Research Center)

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**Project Overview**

***Project Synopsis*:** This project used sensors to analyze land surface temperature and identify urban heat islands within the New Orleans metropolitan area. These data also allowed for a vegetative canopy assessment that identified areas with extensive gray infrastructure. The processed imagery was combined with socioeconomic data to create a heat vulnerability index. The Louisiana Public Health Institute (LPHI) can use the end products from this research to understand which segments of New Orleans’ human population are most vulnerable to severe urban heat and to inform future heat mitigation and resilience strategies.

***Abstract*:**

The urban heat island (UHI) effect occurs when non-vegetated surfaces trap heat during daylight hours, increasing the overall temperature of urbanized cities relative to adjacent rural areas. Excessive heat can increase the likelihood of heat stroke or dehydration, especially in vulnerable populations without access to adequate cooling mechanisms and in residents with medical complications that reduce heat endurance. This research used remotely sensed imagery from Landsat 5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper Plus, Landsat 8 Operational Land Imager (OLI), and Landsat 8 Thermal Infrared Sensor (TIRS) to map land surface temperature (LST) in relation to urban and vegetated surfaces. The team produced a land cover classification of the New Orleans metropolitan area to quantify the extent of gray infrastructure and tree cover canopy. The team then produced snapshot LST datasets to visualize annual heating trends for the summer months of each year between 2000 through 2018. These LST data, overlaid with NDVI and land cover classification maps, identified “hot spot” areas prone to excess heat and calculated their proximity to urban areas and vegetated surfaces. Finally, the team produced a heat vulnerability analysis map that determined spatial relationships between areas prone to severe urban heat and Census Tracts with large populations of residents identified as vulnerable due to income, age, and education. Our project provided the Louisiana Public Health Institute with end products that will be used in combination with clinical health data to improve New Orleans’ heat mitigation strategies and sustainability efforts.

**Keywords:**

Heat vulnerability analysis, social vulnerability, land cover classification, Normalized Difference Vegetation Index (NDVI), public health, remote sensing

***National Application Area Addressed:*** Health & Air Quality

***Study Location:*** New Orleans, LA

***Study Period:*** 2000 – 2018 (April – September)

***Community Concern:***

* Urban areas comprised heavily of impervious paved surfaces, dark roofs, and grey infrastructure contribute to a phenomenon known as the UHI effect.
* Sustained temperatures exceeding 90 degrees Fahrenheit can be detrimental to the quality of life and health for urban residents, especially those that are more vulnerable to heat related illnesses.
* Extreme heat can increase the rate of hospitalization, stroke, tiredness, respiratory difficulties, fainting, and the risk of mortality due to heat related illnesses for at-risk demographics.

***Project Objectives:***

* Create a land cover classification of New Orleans from Landsat data to identify municipal zones that contain higher grey infrastructure density and lower urban tree coverage
* Provide a qualitative assessment of vegetative canopies
* Visualize trends of annual satellite-based LST change throughout the study period by compiling a time series analysis for New Orleans, Louisiana
* Identify regions experiencing anomalous temperatures, defined as being either higher than 90 degrees Fahrenheit or lower than 70 degrees Fahrenheit
* Visualize LST data overlaid with a Social Vulnerability Index map in order to identify areas within New Orleans that have higher concentrations of vulnerable citizens at risk of heat related illness or mortality
* Provide prepackaged data of LST in an easy to use format for our partner organization LPHI

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Louisiana Public Health Institute** | Dr. Thomas Carton, Chief Business Development Officer;  Jamie Clesi, PMP Associate Director | End User | Yes |

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

The Louisiana Public Health Institute studies possible determinants of health using statistical evidence, along with the needs of impacted communities, to promote and inform public health policy. The institute partners with local and regional organizations to inform risk mitigation strategies using environmental evidence that assists local communities’ resiliency to public health threats. The institute focuses on uncovering complementary connections across sectors to combine the social, economic, and human capital needed to align action for managing and mitigating health risks. LPHI is familiar with NASA Earth observations; however, the organization has not previously utilized geospatial tools to assess the UHI effect and the extent of its impacts on human health.

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

The spatial data processed by the team, in conjunction with demographic data, was utilized to examine the effects of excessive heat concentrations on vulnerable populations of varied socioeconomic status. Maps created by the team identified temporal changes in heat concentrations in New Orleans by comparing snapshot analysis of summer-month LST alongside seasonal trends and meteorological-related anomalies over the past two decades. Hot spots, or areas with LST exceeding 90 degrees Fahrenheit, were analyzed in relation to Census Tracts that were identified as highly socially vulnerable. This analysis can enhance the capabilities of LPHI to predict and mitigate heat related illness within the city of New Orleans; this information can be used to inform possible strategies and planning initiatives that reduce heat concentrations within the city.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 8 OLI** | Surface Reflectance, NDVI | Land cover classification and NDVI products derived from Landsat 8 OLI were used to identify municipal zones with high gray infrastructure density and low urban tree canopy coverage. |
| **Landsat 8 TIRS** | LST | Landsat 8 TIRS thermal bands were used to generate LST data products that evaluated annual and seasonal changes in surface temperature within New Orleans. Land cover classification maps were produced at 6-year intervals and overlaid with LST data to investigate the relationships between land cover type and LST. |
| **Landsat 7 ETM+** | Land Cover Classification, NDVI, LST | Landsat 7 ETM+ imagery and thermal bands were used to generate land cover classification, NDVI, and LST data products. These datasets were used in concert with Landsat 5 and 8 data products identify variations in the vegetative canopy and to render locations of UHIs. |
| **Landsat 5 TM** | Land Cover Classification, NDVI, LST | Landsat 5 TM imagery and thermal bands were used to generate land cover classification, NDVI, and LST data products. These datasets were used in concert with Landsat 7 and 8 data products identify UHIs and examine correlations between heat and vegetative canopies, or lack thereof. |

***Ancillary Datasets:***

National Agricultural Imagery Program (NAIP) County Mosaic – high resolution (1m) aerial imagery from 2013 and 2017 was used to produce land cover classifications of the New Orleans metropolitan area

Social Vulnerability Index, University of New Orleans Center for Hazards Assessment, Response, and

Technology (UNO CHART), the Federal Transit Administration, and the City of New Orleans – identified spatial relationship between Census Tracts that have large populations of individuals with high social vulnerability (low income, non-English speaking, over 65 or under 5 years old, lacking education) and areas experiencing the effects of UHIs

***Software & Scripting:***

Esri ArcGIS Pro 2.0.0 – raster manipulation, map product generation, and image classification development

QGIS – raster manipulation, land cover maps compilation, and geospatial data visualization

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Landsat Surface Heat Analysis** | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 TIRS | The Landsat Surface Heat Analysis provides the LPHI with a time analysis of LST, identifies areas with higher concentrations of urban heat indexes, and evaluates UHIs impact on a communities’ health. The analysis allows partners to identify and monitor areas prone to extreme heat and, thus, better target interventions. | N/A |
| **Urban and Vegetation Canopy Assessment** | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI | The Urban and Vegetation Canopy Assessment provides the LPHI with a land cover classification of urban geographies and vegetation canopies to evaluate the correlation between the city’s land surface characteristics and the concentration of urban heat over time. | N/A |
| **New Orleans Heat Vulnerability Analysis** | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 TIRS | The New Orleans Heat Vulnerability Analysis identifies areas vulnerable to severe urban heat by comparing the produced heat analysis products to various community characteristics. | N/A |
| **Methods Manual** | N/A | The Methods Manual documents the workflow utilized by the Fall 2018 DEVELOP team in a step-by-step format. This manual enables LPHI to repeat the processes required to generate LST and land cover classification data using Landsat imagery. |  |

**Project Handoff Package**

**Transition Plan:**

The team met with LPHI representatives in New Orleans during the week of November 12 to present project methodologies and final end products. Additionally, the team provided the project partner with access to all deliverables via a shared Google Drive folder.

**Team POC:** Madison Murphy, madison.murphy@me.com

**Partner POC**: Dr. Thomas Carton, tcarton@lphi.org

**Handoff Package:**

* Technical paper
* Poster
* Presentation
* Project video
* Remote sensing tutorial
* Landsat Surface Heat Analysis
* Urban and Vegetation Canopy Assessment
* New Orleans Heat Vulnerability Analysis
* Methods Manual

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