**NASA DEVELOP National Program**

**2024 Spring Project Proposal**

**Massachusetts – Boston**

**Bridgeport Urban Development**

*Leveraging NASA Earth Observations and Sociodemographic Data to Assess Urban Heat Vulnerability and Inform Cool Corridors in Bridgeport, Connecticut*

**Project Overview**

***Project Synopsis*:** Bridgeport, Connecticut historically served as a hub for manufacturing and industry in the region, and this legacy continues to be seen on the east side of the city with a high concentration of industrial area. In addition to this density of impervious surfaces, buildings, roads, and other infrastructure, the area also experiences a lack of tree canopy and green space. Groundwork Bridgeport is concerned about the area’s resiliency to urban heat as the climate crisis intensifies, as well as the disadvantaged East Side communities’ heightened vulnerability to this environmental hazard. By combining satellite data from Landsat 8 OLI and TIRS, Landsat 9 OLI-2 and TIRS-2, and ISS ECOSTRESS with sociodemographic and –economic data, the DEVELOP team will analyze the city’s urban heat island effect and create urban heat vulnerability maps. Ultimately, these end products will support Groundwork Bridgeport in identifying areas to connect with residents for their Cool Corridors project and other cooling interventions.

***Study Location:*** Bridgeport, CT (focus on the East Side with census tracts 735, 736, 738, 739, and 740)

***Study Period:*** 2013 – 2023 (June – September)

***Advisors:*** Dr. Kenton Ross (NASA Langley Research Center) kenton.w.ross@nasa.gov, Lauren Childs-Gleason (NASA Langley Research Center) lauren.m.childs@nasa.gov

**Partner Overview**

***Partner Organization(s):***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** | **Sector** |
| **Groundwork Bridgeport** | Christina Smith, President and CEO/Executive Director | End User | Non-profit |

***End User Overview***

***End User’s Current Decision-Making Process & Capacity to Use Earth Observations:***Groundwork Bridgeport’s decision making is rooted in multi-level, community-driven planning processes. For the Cool Corridors project, they are hosting multiple public gatherings with the community to identify highly traveled routes and public opinion about resiliency and intervention techniques (of present and potential future). Additionally, they will do initial planning and analysis using existing data from the US Census Bureau and Environmental Justice (EJ) mapping tools and collaborations with Yale Urban Design Workshop (UDW) and MetroCOG to design interventions and provide GIS and mapping support. The collaboration with DEVELOP will contribute to GIS and mapping efforts, as well as help build Groundwork Bridgeport’s capacity to understand the applicability of Earth observations. Following and throughout these stages, Groundwork Bridgeport’s youth program participants will validate and ground truth data. Ultimately, Groundwork Bridgeport is simultaneously working on initiatives at neighborhood, street, and network levels and emphasizes accessibility in all that they do, from providing bilingual materials, ensuring communication is jargon-free, and putting in place community support to attend meetings.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI** | Surface reflectance (for albedo) | OLI will provide thermal analysis data for daytime land temperatures. |
| **Landsat 8 TIRS** | Land surface temperature (for temperature anomaly) | TIRS will provide thermal analysis data for daytime land temperatures. |
| **Landsat 9 OLI-2** | Surface reflectance (for albedo) | OLI-2 will provide thermal analysis data for daytime land temperatures. |
| **Landsat 9 TIRS-2** | Land surface temperature(for temperature anomaly) | TIRS-2 will provide thermal analysis data for daytime land temperatures. |
| **ISS ECOSTRESS** | Land surface temperature, evapotranspiration | ECOSTRESS will be used for evapotranspiration and thermal analysis for nighttime temperatures. |

***Ancillary Datasets:***

* National Land Cover Database (NLCD) – Calculate the percentage of open space and building intensity per census tract for heat vulnerability calculations
* National Land Cover Database (NLCD) Percent Tree Canopy Cover and Developed Imperviousness 2016 – Calculate the percentage and landcover per capita for each census tract
* NASA Socioeconomic Data and Applications Center (SEDAC) Population Count v4.11 – Create vulnerability index and map exposure
* US Census Bureau American Community Survey (ACS) Data, 2020 5-Year Survey – Create vulnerability index and map exposure
* Home Owners’ Loan Corporation (HOLC) Neighborhood Redlining Grades – Analyze the relationship between redlining and urban heat disparities
* CT specific datasets TBD

***Modeling:***

* NASA DEVELOP [UHEAT 1.0](https://github.com/NASA-DEVELOP/UHEAT) (POC: Dr. Kenton Ross, NASA Langley Research Center) – Compile and average surface temperatures (heat mapping algorithm in UHEAT 1.0 is dated and should not be used, but the program is open source and a useful reference)
* NASA DEVELOP [UHEAT 2.0](https://gitlab.developprogram.org/developcodecatalog/2022/spring-2022/pup_uheat) (POC: Dr. Kenton Ross, NASA Langley Research Center) – Compile and average surface temperatures
* Stanford’s Natural Capital [Integrated Valuation of Ecosystem Services and Tradeoffs](http://releases.naturalcapitalproject.org/invest-userguide/latest/en/urban_cooling_model.html#data-needs) (InVEST) Urban Cooling Model (POC: Dr. Kenton Ross, NASA Langley Research Center) – Calculate heat mitigation indices and assessment of potential mitigation scenarios
* [ENVI-met](https://www.envi-met.com/) (POC: Dr. David Hondula, Arizona State University) – Model outdoor thermal comfort, simulate climatological interactions, and analyze building and vegetation impact to evaluate potential mitigation scenarios at a high-resolution scale
* [SOLWEIG](https://umep-docs.readthedocs.io/projects/tutorial/en/latest/Tutorials/IntroductionToSolweig.html) (SOlar and LongWave Environmental Irradiance Geometry) (POC: Dr. Mehdi Heris, Hunter College) – Model outdoor thermal comfort through the mean radiant temperature at a high-resolution scale

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |
| --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** |
| **Urban Heat Assessment Map Package** | These maps, time series, and visualizations displaying empirical urban heat distribution in Bridgeport will assist partners in their urban heat analysis and help inform their outreach initiatives to decide cooling intervention strategies and locations. | Parameters of Landsat 8 OLI and TIRS, Landsat 9 OLI-2 and TIRS-2, and ISS ECOSTRESS will create urban heat maps of Bridgeport’s census tracts. |
| **Urban Heat Vulnerability** **Map Package** | These bivariate maps build upon the urban heat assessment maps by creating and integrating a vulnerability index, which will include sociodemographic, socioeconomic, and public health indicators relevant to partner interest. These end products will support partners in vulnerability assessment and the prioritization of certain areas for cooling interventions and advocacy.  | Building upon the heat assessment and map which utilizes parameters of Landsat 8 OLI and TIRS, Landsat 9 OLI and TIRS-2, and ISS ECOSTRESS, this vulnerability map package will also include overlays of ancillary sociodemographic, socioeconomic, and public health data to understand the intersections of social and environmental vulnerability relating to urban heat and highly frequented corridors. |
| **Urban Heat** **Intervention Modeling or Case Study** | Depending on partner interest and team bandwidth, there is also potential to model tree canopy interventions through the InVEST Urban Cooling Model and/or the experience of urban heat through ENVI-met or SOLWEIG. | Landsat 8 OLI and TIRS, Landsat 9 OLI-2 and TIRS-2, and ISS ECOSTRESS parameters would be integrated into a model, along with other data the model necessitates, such as building footprints.  |
| **Creative Communication Deliverable****[optional]** | [This creative communication deliverable] with impactful visuals and storytelling about urban heat and public transportation will support the partners in their community engagement and education efforts.  | Imagery derived from Landsat 8 TIRS and 9 TIRS, as well as ISS ECOSTRESS, should be prominently featured, alongside additional data visualizations generated by the team. |

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2024 Spring

***Similar Past DEVELOP Projects***:

* 2023 Summer (VEJ) – Portland Urban Development:
* 2023 Spring (VEJ) – New York City Transportation & Infrastructure: <https://appliedsciences.nasa.gov/what-we-do/projects/assessing-urban-heat-island-effects-bus-stops-new-york-city-support-cooling>
* 2022 Fall (VEJ) – Milwaukee Urban Development II\*: <https://appliedsciences.nasa.gov/what-we-do/projects/assessing-climate-vulnerability-through-invest-model-urban-cooling-milwaukee>
* 2022 Fall (VEJ) – Wichita Climate II: <https://appliedsciences.nasa.gov/what-we-do/projects/quantifying-and-mapping-urban-heat-inform-equitable-and-sustainable-urban>
* 2022 Summer (AZ) – Albuquerque Urban Development: <https://appliedsciences.nasa.gov/what-we-do/projects/enhancing-urban-cooling-interventions-modeling-urban-forestry-through-nasa>
* 2021 Fall (AZ) – Yonkers Urban Development II\*: <https://appliedsciences.nasa.gov/what-we-do/projects/leveraging-nasa-earth-observations-support-modeling-urban-cooling-interventions>
* 2021 Spring (MA) – Cincinnati & Covington Urban Development\*: <https://appliedsciences.nasa.gov/what-we-do/projects/assessing_urban_heat_in_the_cincinnati_and_covington_area_using_nasa_earth_observations>
* 2021 Spring (AZ) – San Diego Urban Development: <https://appliedsciences.nasa.gov/what-we-do/projects/utilizing_nasa_earth_observations_to_identify_drivers_of_extreme_urban_heat_and_generate_a_high_resolution_vulnerability_index_for_urban_planning_and_climate_resiliency_in_san_diego_california>
* 2020 Spring (AZ) – Philadelphia Health & Air Quality: <https://appliedsciences.nasa.gov/what-we-do/projects/assessing_land_surface_temperature_vegetation_cover_and_compounding_vulnerability_factors_to_identify_high_priority_areas_for_cooling_initiatives_in_philadelphia_pennsylvania>
* 2019 Summer (SSC) – Mobile Urban Development\*: <https://appliedsciences.nasa.gov/what-we-do/projects/evaluating_urban_heat_islands_and_flooding_to_enhance_green_infrastructure_initiatives_in_coastal_communities_in_mobile_alabama>
* 2019 Spring (LaRC) – Providence and Elizabeth Urban Development\*: <https://appliedsciences.nasa.gov/what-we-do/projects/utilizing_nasa_earth_observations_to_explore_heat_and_flood_related_vulnerability_in_urban_settings>
* 2018 Summer (LaRC) – Richmond (VA) Health & Air Quality\*: <https://appliedsciences.nasa.gov/what-we-do/projects/quantifying_changes_in_urban_tree_canopy_cover_and_land_surface_temperature_to_understand_their_impacts_on_neighborhoods_throughout_richmond_california>
* 2018 Spring (ARC) – Richmond (CA) Urban Development\*: <https://appliedsciences.nasa.gov/what-we-do/projects/quantifying_changes_in_urban_tree_canopy_cover_and_land_surface_temperature_to_understand_their_impacts_on_neighborhoods_throughout_richmond_california>

\* = Groundwork urban heat project

**Notes & References:**

***Notes*:** Excerpted from a grant Christina wrote about the Cool Corridors project, “the goal... is to identify the travel routes that residents are using most on a daily basis... and then implement interventions, as prioritized by the community, to help residents mitigate urban heat island effects. We imagine a connected route lined with nature-based interventions such as trees, bioswales, and planted tree lawns, along with other interventions e.g. murals painted with cooling reflective paints, cooling bus shelters... that not only protect people against the heat but also make it a ‘delight’ to walk, bike, skateboard, or scoot along.” In regards to the EJ landscape, Bridgeport is one of the four cities in Connecticut with the highest counts of affecting facilities of all EJ communities (Connecticut Department of Energy and Environmental Protection, n.d.). Review these websites for additional information:

* Connecticut Department of Energy and Environmental Protection (DEEP)’s Environmental Justice Program Overview: <https://portal.ct.gov/DEEP/Environmental-Justice/Environmental-Justice-Program-Overview>
* DEEP's Environmental Justice Affecting Facilities: <https://ctdeep.maps.arcgis.com/apps/webappviewer/index.html?id=7783574e2cd94d388124b54cdb82a34e>

***References:***

Connecticut Department of Energy and Environmental Protection (DEEP). (n.d.). *Overview - Environmental Justice Program*. CT.gov. <https://portal.ct.gov/DEEP/Environmental-Justice/Environmental-Justice-Program-Overview>