Virtual Environmental Justice Portland Urban Development
Quantifying and Visualizing Urban Heat Island and Compounding Vulnerabilities in Portland, Oregon to Support Community Depaving Initiatives

Project Team

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Project Overview

Project Synopsis:
Our project supported community-based efforts to combat urban heat in Portland, Oregon through an Environmental Justice framework. We partnered with Depave, a Portland-based nonprofit that works alongside communities to replace pavement with greenspace in historically disenfranchised areas. Using NASA's Earth observing Landsat 8 TIRS data, we quantified and visualized the environmental and social impact of community depaving and regreening projects. Our analysis demonstrated the significance of local urban heat mitigation efforts and proposed next steps for conducting inclusive and intentional research that highlights the lived experiences and resilience of frontline communities.

Abstract:
Urban heat is a pressing concern in Portland, Oregon as climate-change induced heat waves increase. Cities experience higher temperatures due to the urban heat island effect (UHI), and environmental injustice and disenfranchisement in minority communities expose low-income and Black, Indigenous, and People of Color (BIPOC) residents to more extreme and debilitating heat events. Our team identified Portland's communities on the frontlines of urban heat impacts by overlapping environmental and social vulnerabilities using NASA Earth observations. We partnered with Depave, a Portland-based nonprofit that works alongside communities to replace pavement with greenspace in historically disenfranchised areas. Using Landsat 8 OLI and TIRS imagery, we mapped Land Surface Temperature (LST) and developed a heat-specific Social Vulnerability Index (SVI) through a Principal Component Analysis (PCA) to identify Portland's communities with the highest potential heat vulnerability. Then, we calculated the temperature change of depaving in six case studies to quantify Depave's efforts in heat mitigation and environmental justice. Our analysis

demonstrated that, throughout Portland, there are frontline communities experiencing high potential social vulnerability to extreme temperatures due to environmental injustices and over-pavement. Finally, Depave's impact on urban heat is observable and quantifiable using remote-sensing data and tools, with an average of 1°F decrease across the six case studies. We illustrated the significance of local urban heat mitigation efforts and propose next steps for conducting inclusive and intentional research that highlights the lived experiences and resilience of frontline communities.

Key Terms:
Environmental Justice, frontline communities, remote sensing, Landsat 8 TIRS, urban heat island (UHI), land surface temperature (LST), social vulnerability index (SVI), principal component analysis (PCA)

National Application Area Addressed: Urban Development
Study Location: Portland, OR
Study Period: 2013 to 2023 (June to August)

Community Concerns:

- Portland, Oregon is an urban heat island and extreme heat is experienced disproportionately across the city.
- Historically disenfranchised low-income and communities of color face systematic barriers that decrease their access to resources, such as personal air conditioning, and restrict them to areas with less tree canopy and more pavement.
- To continue their local heat mitigation initiatives, Depave required quantitative data and visualizations that demonstrate the environmental and community impacts of their depaving and regreening projects.

Project Objectives:

- Develop a Land Surface Temperature (LST) urban heat map using NASA Earth Observations
- Aggregate socio-environmental implications of urban heat through social vulnerability mapping
- Analyze specific case studies of past Depave projects to understand lived experiences and impact of depaving work

Partner Overview

Partner Organization:

Organization	Contact (Name, Position/Title)	Partner Type
Depave	Katya Reyna, Co-Director; Katherine Rose, Communications & Engagement Coordinator	End User

Decision-Making Practices & Policies:
Given their intimate knowledge of the neighborhoods and communities on the ground in Portland, Depave has an experiential and relational understanding of where frontline (i.e. vulnerable) populations are in the area they serve. In planning their projects, Depave currently focuses on neighborhoods that have been historically disenfranchised. This approach is commendable and essential from an Environmental Justice perspective, but to date, the organization has not significantly considered exposure to heat as a factor in identifying new site locations and they have not measured or framed their work around the cooling benefits of their urban re-greening efforts. One of the barriers Depave faces regarding the incorporation of quantitative data, specifically around heat, is that they currently have very limited capacity, expertise, and access to software and resources necessary to make use of GIS data and tools. Addressing this lack of capacity was the primary motivation for Depave's partnership with DEVELOP, as Depave is interested in understanding in more detail, and empirically, where vulnerability and heat exposure intersect in the region. The information

provided by our project will help Depave site future project locations and provide quantification of their projects' benefits, which we hope will help them secure future funding.

Earth Observations & End Products Overview

Earth Observations:

Platform & Sensor	Parameter(s)	Use
Landsat 8 TIRS	Band 10, Level 2, Collection 2, Tier 1 (Thermal Band)	To create a map of land surface temperature (LST) we called TIRS data into Google Earth Engine for a time horizon of five years between the months of June to August with a cloud mask. The median temperatures were collated, and the resulting raster was exported for further analysis.

Ancillary Datasets:

- Depave Site Footprint Shapefile – Overlayed onto LST to for case studies
- NOAA Climate at a Glance: City Time Series – Input into R for climate stripes graphic on poster deliverable
- Mapping Inequality Homeowners' Loan Corporation (HOLC) Neighborhood Redlining Grades – Boundary data for analyzing the relationship between historic redlining and exposure to heat
- American Community Survey (ACS) TidyCensus (RStudio Package) 5-year Estimate Socioeconomic Data – Input into Principal Component Analysis for vulnerability index
- Center for Disease Control (CDC) PLACES Health Data – Input into Principal Component Analysis for vulnerability index
- Oregon Metro RLIS US Census Tract Shapefile – LST Map; Vulnerability Index
- Oregon Metro RLIS Portland City Boundary Shapefile – LST Map
- Oregon Metro RLIS Urban Growth Boundary (UGB) Shapefile – LST Map
- Oregon Metro RLIS Outdoor recreation and Conservation Areas (ORCA) – Calculated access to greenspace per census tract for Vulnerability Index

Software & Scripting:

- Google Earth Engine – Land Surface Temperature (LST) map creation and case study analysis
- RStudio 2023.06.0+421 – Principal Component Analysis for Social Vulnerability Index
- ESRI ArcGIS Pro 3.1 – Final LST and Social Vulnerability visualizations
- QGIS 3.32.0 – Depave GIS shapefile updates and final case study visualizations

End Product(s):

End Product(s)	Earth Observations Used	Partner Benefit & Use
Portland Urban Land Surface Temperature (LST) Maps	Landsat 8 Thermal Infrared Sensor (TIRS)	These maps illustrate the geographic distribution of heat in Portland. Depave can use these to supplement their storytelling of heat experiences and support site selection of areas most affected by heat.
Portland Urban Social Vulnerability and Bivariate Maps	Landsat 8 Thermal Infrared Sensor (TIRS)	These maps illustrate the geographic distribution of social vulnerability to heat in Portland.

		They can help further build the narrative of urban heat experiences and contextualize Depave's current efforts in environmental justice.
Case Study Shapefile and Analysis	Landsat 8 Thermal Infrared Sensor (TIRS)	Our case study analysis comprises of images and quantitative data that demonstrate the impact of Depave on LST and urban heat mitigation. This data can be used to support Depave's initiatives and hopefully help to secure future funding.
General GIS data and Updated Depave Shapefiles	N/A	We compiled relevant GIS data layers of boundaries (Portland City, Census Tracts, UGB), land surface temperature (raster and vector by census tract), and social vulnerability to heat (subcomponents and composite) to support Depave's future capacity-building. We also updated existing shapefiles provided by Depave of site points and footprints.

Product Benefit to End User:
Using remotely sensed imagery from Landsat 8 TIRS and sociodemographic data from the US Census, our team illustrated the city-wide importance of community depaving and the integration of greenspace to mitigate urban heat island. By evaluating the change in land surface temperature before and after community depaving from 2013 to 2022, we demonstrated that Depave's community-driven efforts in pavement removal and regreening can decrease local urban heat. Further, we identified that the large-scale case study sites exhibit a clear difference in LST compared to neighboring regions. Our quantitative data in the form of our case studies, LST, social vulnerability index, and bivariate maps provides Depave with further resources to support their efforts. In the short-term, our analyses can inform their site-selection process and supplement community narratives of urban heat experiences. In the future, our work can hopefully provide quantifiable backing for their important community work to support funding efforts for next projects.

References

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