EnviroAtlas Use Case

EnviroAtlas contains ecological, economic and demographic datasets for two spatial extents—the contiguous U.S. and featured communities. This use case demonstrates how EnviroAtlas data can be used along with other data sources to explore one solution for minimizing the negative impacts of excessive summer heat due to urbanization. The analysis was conducted for Portland, Oregon and the surrounding area, and can be applied to any other location.

www.epa.gov/enviroatlas

EPA United States Environmental Protection Agency

Using EnviroAtlas to Identify Locations for Urban Heat Island Abatement

An aerial photo of Portland, Oregon. Source: http://oregonaerialphoto.com

A use case walks through an example demonstrating how EnviroAtlas might be used in different decision contexts. Each use case presents a real-world scenario, a central issue, and a way to address the issue using EnviroAtlas data, in conjunction with other available data or resources. Use cases may be hypothetical or based on actual uses of EnviroAtlas.

Background

The Concern

Excessive heat in the summer months can be dangerous to human health and increases demand for water and electricity. In urban areas, cement and asphalt absorb and radiate heat, and are slow to cool at night, thereby raising nighttime and daytime temperatures. Urban structures also trap the radiation of heat by blocking the sky. This phenomenon of increased heat in developed areas is called the urban heat island (UHI). Older people and young children as well as those with existing health conditions tend to be more vulnerable. Across a city, access to green spaces – areas of grass, trees and other vegetation in an urban environment – may be distributed unevenly; thus the UHI affects some neighborhoods more than others.

One Solution:

Vegetation and trees can help reduce the UHI effect. In certain locales and conditions, trees can cool sidewalks and provide more comfortable roadways for pedestrians, bicyclists and motorists, among other benefits like aesthetic appeal, water filtration and uptake. We recognize that trees may introduce other disadvantages, like debris, reduced near-surface wind speed, and thereby reduced pollutant dispersion. However, the ability of trees to help reduce the UHI effect can also potentially lead to significant health benefits, such as:

- lessened symptoms of respiratory distress and chronic obstructive pulmonary disease,
- lower risk of heat stroke, dehydration and heat exhaustion,
- lower risk of heat-related mortality, especially of the elderly, and
- fewer anxiety- and mental health-related hospital admissions.

The aesthetic contrast is stark between a tree-less street with above-ground powerlines and a street with a lawn and trees. The environmental benefits can be different between the two as well. Sources: www.oregonlive.com and www.thedesertecho.com/blog/now

Visit https://www.epa.gov/enviroatlas/enviroatlas-eco-health-relationship-browser to learn more about eco-health relationships, or https://www.epa.gov/heat-islands to learn more about urban heat islands.

Background

Objective of Use Case:

For the metropolitan region of Portland, Oregon, this use case demonstrates how city planners could use EnviroAtlas data with a map of the UHI to identify areas that might benefit from heat mitigation through additional street trees. Street trees are one option, and other solutions include rooftop gardens and green roofs. Using remote sensing and geospatial analysis, we calculate differences in land surface temperature that we attribute to the urban heat island effect.

Why Focus on Portland?

Multnomah County, which contains the cities of Portland and Gresham, is one the focal areas of US EPA's Making a Visible Difference in Communities strategic priority. Residents have highlighted the East Portland area as in need of support and investment to revitalize the community while also addressing environmental justice concerns. For example, the revitalization plans could incorporate increased access to green space and sustainable solutions.

One particular issue the community raised is the lack of trees, which contributes to significantly warmer temperatures in developed areas compared to the surrounding natural areas. In other words, East Portland is more affected by UHI than other neighborhoods.

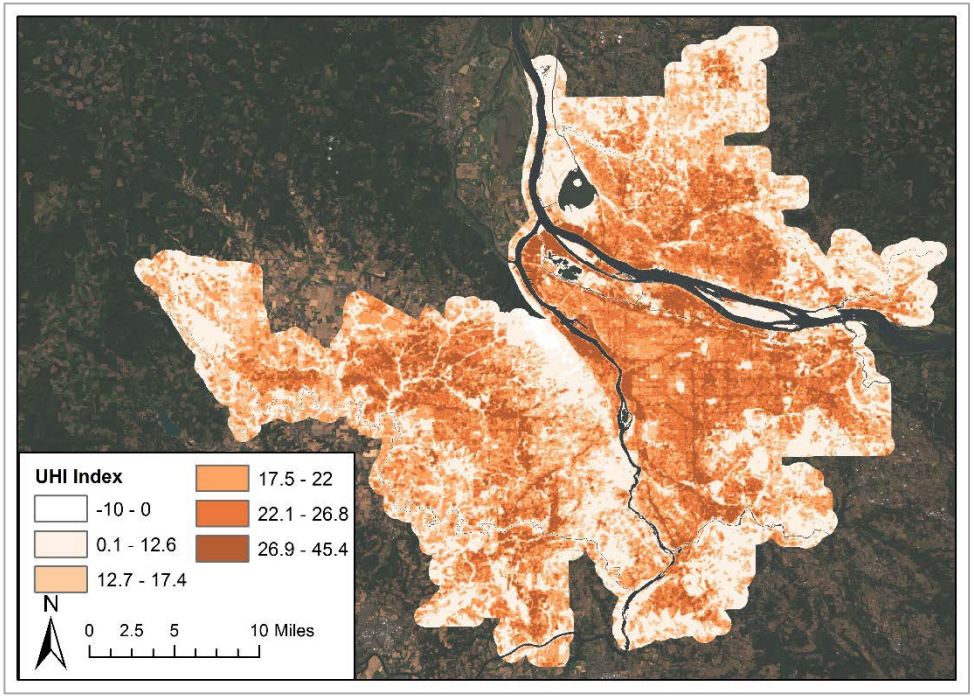
On NE Siskiyou Street, trees and vegetation can keep the streets and sidewalks cooler and are visually appealing.
Source: Kevin Robert Perry, https://www.asla.org/awards/2007/07winners/506_nna.html

Learn more about US EPA's Making a Visible Difference efforts by visiting https://www.epa.gov/smartgrowth/making-visible-difference-communities.

Seeing the Urban Heat Island

To visualize the concern about excessive heating in certain neighborhoods, we created a map of UHI for the whole Portland metropolitan region. Based on estimated land surface temperature, this map is an index of summer daytime surface UHI. The thermal information originally comes from Landsat 8. This map immediately allows us to recognize areas that experience higher heat (darker orange) or stay cooler (pale orange) in summer. Residents can validate from first-hand experience where the sidewalks and streets of their neighborhood become very warm in summer.

One might instead choose to collect actual air temperatures to measure the UHI effect. This way, the effect of UHI would be less pronounced, but air temperature perhaps more closely reflects how residents experience UHI. For our surface UHI approach, the thermal data from Landsat 8 is free and publicly available for immediate download. While we can't explicitly calculate how surface temperature differences translate to differences in ambient air temperatures, we know that they are correlated.

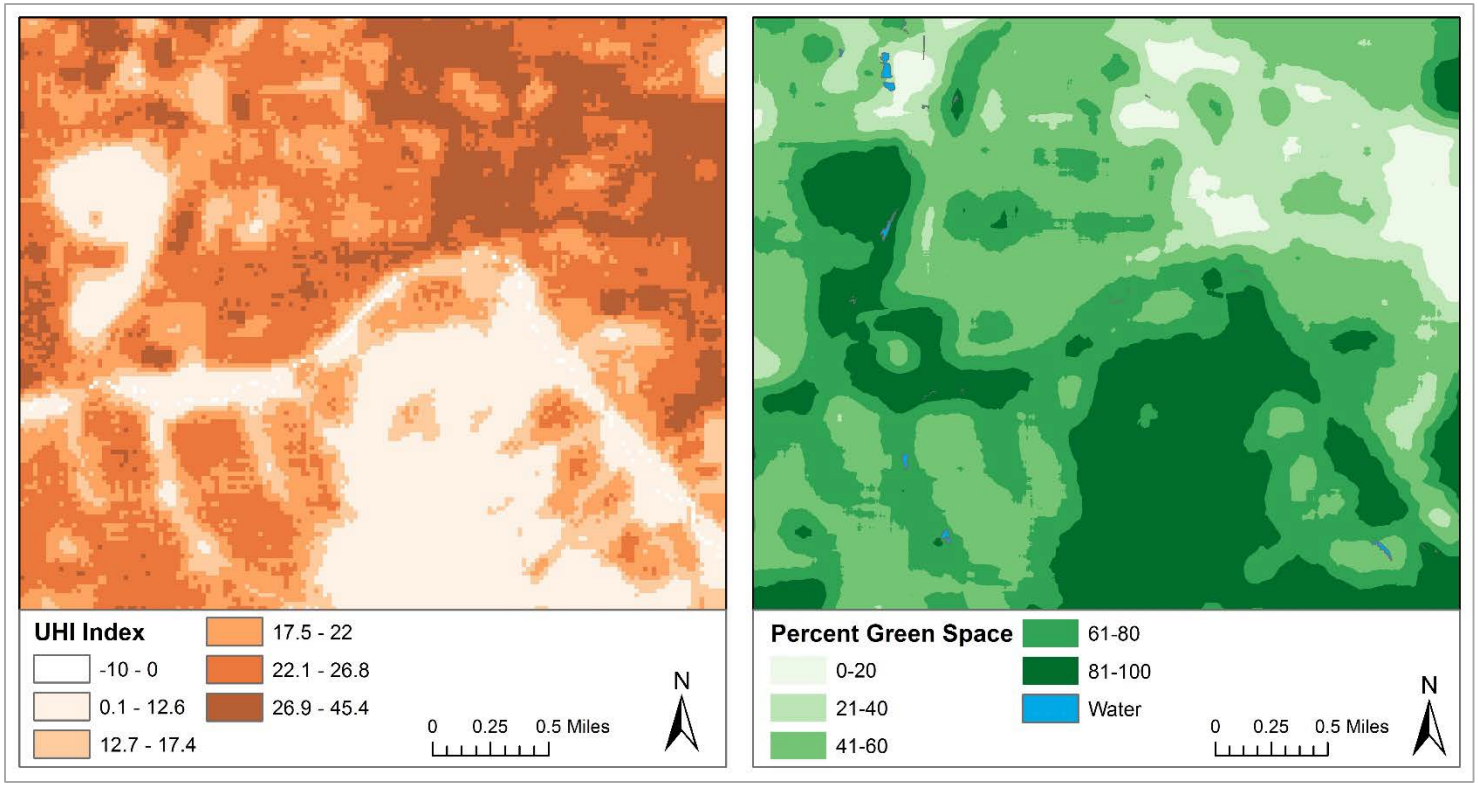


Thermal infrared information from Landsat 8 is used to create an index of the surface urban heat island effect during summer in Portland.

For a technical description of methods, visit the complementary document:
https://www.epa.gov/sites/production/files/2017-06/documents/technicalguidance_uhi.pdf

Seeing the Urban Heat Island

When we compare the UHI map (left) to the amount of vegetation and trees (right), we find a close association between the two, which supports our solution of increasing trees in Portland to lessen the UHI effect. As the amount of vegetation and trees increases, the UHI effect decreases in Portland. The EnviroAtlas data layer shown below (right) is called "Percent green space within ¼ square kilometer." This comparison also demonstrates that in lieu of resources to acquire satellite imagery and derive land surface temperature oneself, planners could reference some measure of vegetation as a proxy indicator of surface UHI, depending on the location.



As the amount of vegetation and trees increases, the UHI effect decreases in Portland.

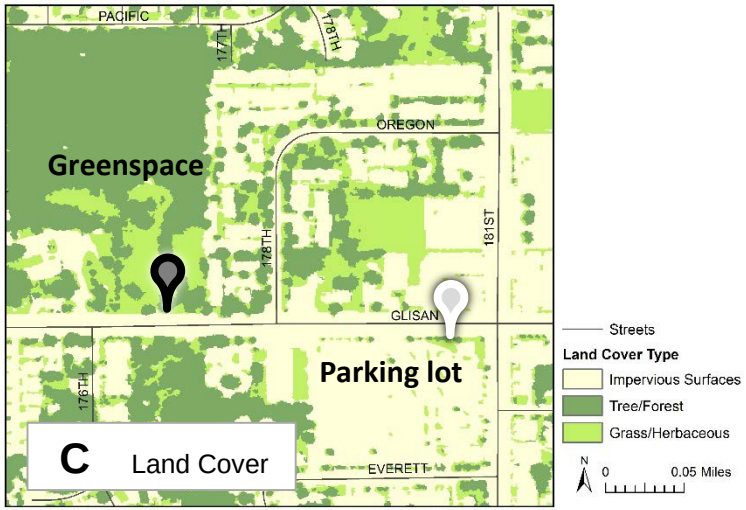
Seeing the Urban Heat Island

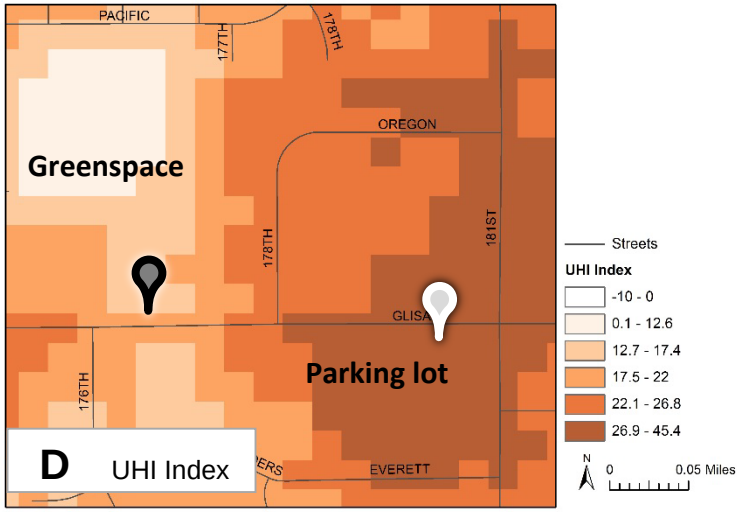
We can zoom in to the Rockwood neighborhood where residents are concerned about having fewer trees and experiencing excessive heat. The Rockwood neighborhood is only 17% covered by trees, compared to 29% for the Portland metropolitan region overall. The images below support their concern that the lack of trees can create an UHI.

The greenspace in Photo A was viewed from the map location marked by the black pin. The parking lot in Photo B was viewed from the map location marked by the white pin. The highly vegetated greenspace tends to stay cooler. In contrast, the sparsely-vegetated parking lot tends to be warmer. Generally, developed places have more impervious surface (e.g. pavement, asphalt), which warms up during the day and takes longer to cool down at night.

A Greenspace (Google Earth Street View)

B Parking lot (Google Earth Street View)



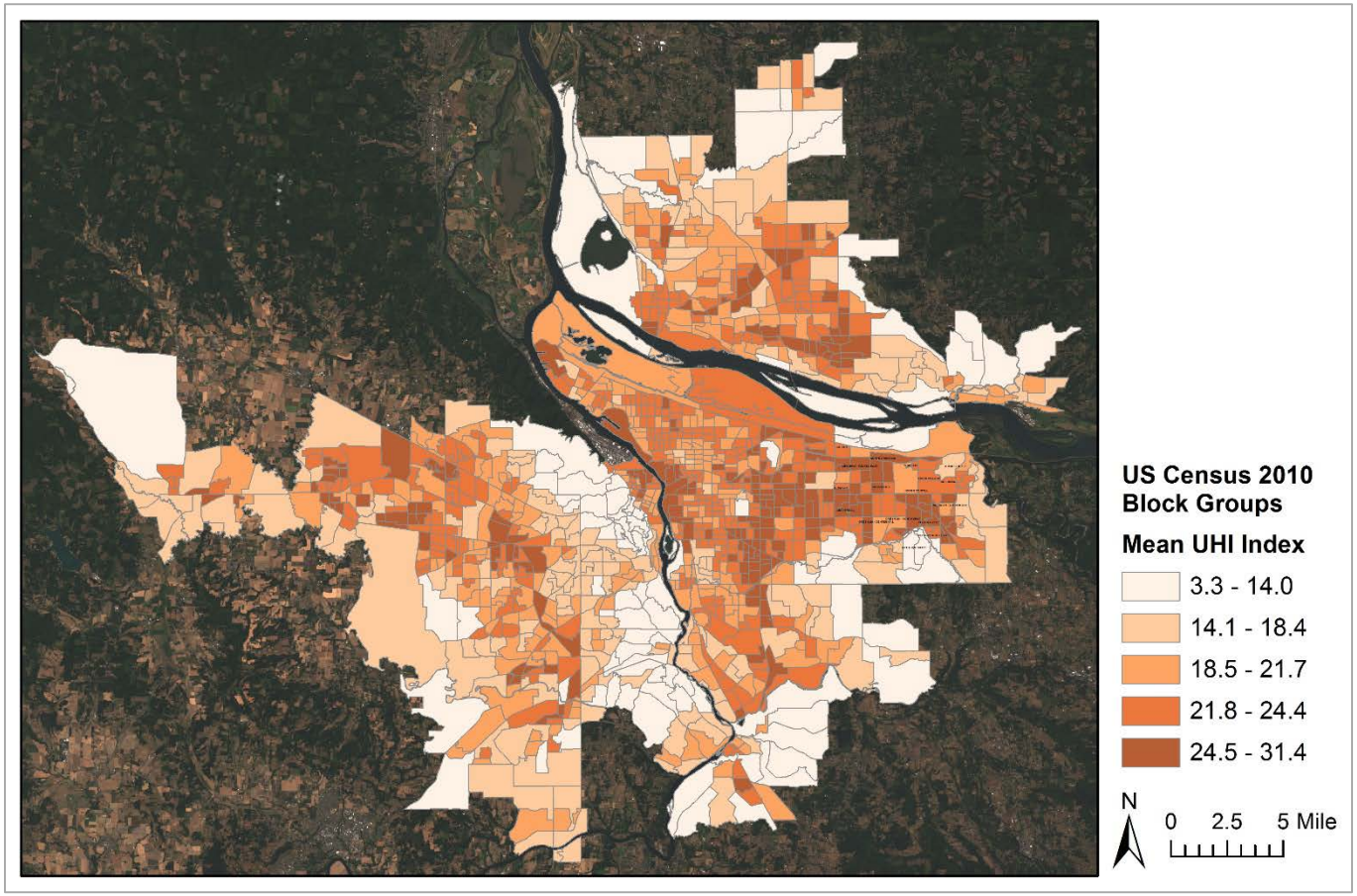


We can see how vegetation-less areas like parking lots tend to be warm while greenspaces full of trees and vegetation stay cooler.

Priority Neighborhoods

To better target warmer neighborhoods for planting additional trees, we can look at the average UHI index summarized by census block groups. Seeing the difference among block groups from coolest (pale orange) to warmest (dark orange), we can more easily identify the block groups that would benefit most from additional green infrastructure (e.g. street trees, rooftop gardens, green rooftops).

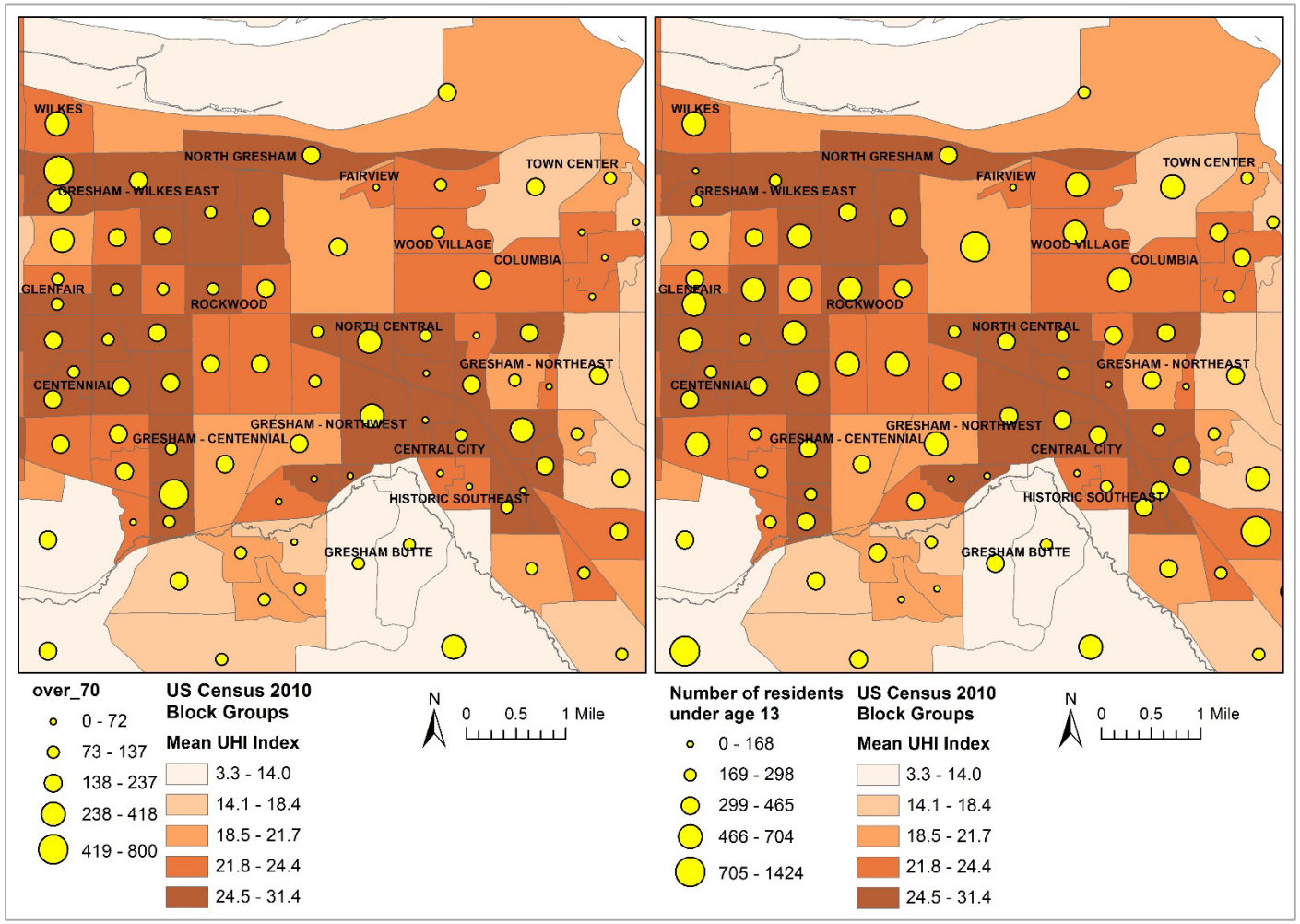
Because block groups are the mapping unit for community information in EnviroAtlas, we can easily combine this map with additional related EnviroAtlas data layers, such as demographics and public health information.



We can summarize the UHI index as its mean per census block group to more easily identify the neighborhoods that need to be considered for additional street trees.

Priority Neighborhoods

If we had a particular demographic we intend to assist, we could include related EnviroAtlas data layers about the residents. As with other health concerns, the elderly and children are some of the most vulnerable to negative effects on health and well-being due to UHI. Showing two demographic layers from EnviroAtlas, the maps below display the number of residents over age 70 per block group (left) and the number of residents under age 13 per block group (right), whom the UHI abatement actions will directly benefit.

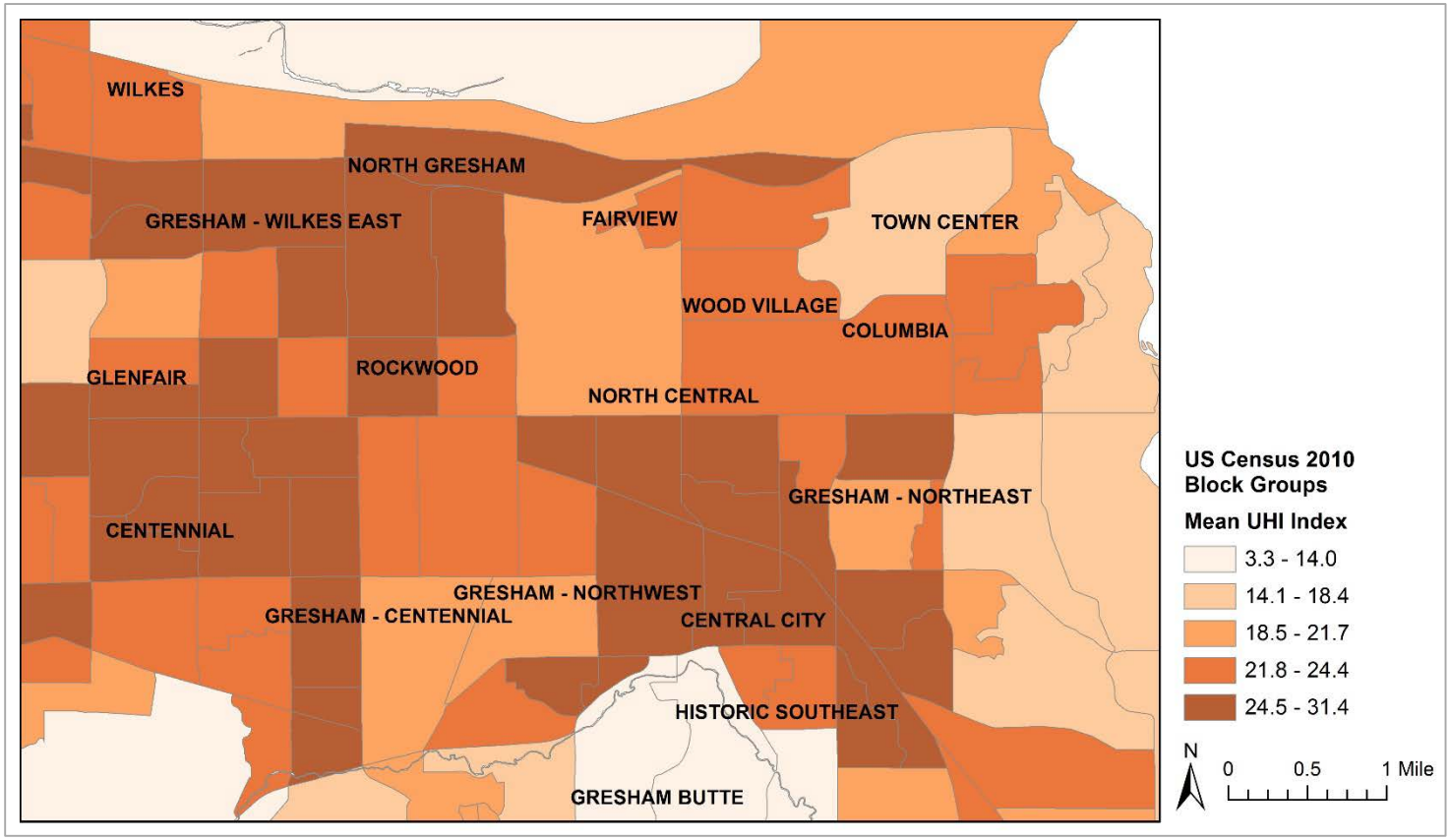


EnviroAtlas provides a variety of demographic and public health data layers for select communities that are provided as a summary by census block group. Two examples are the number of elderly and child residents.

Priority Neighborhoods

Zooming into East Portland, we can better pinpoint neighborhoods with a high UHI index. From Portland's Metro Data Research Center, a data layer of the neighborhoods guides us to select the block groups of most interest to stakeholders working with the US EPA Making a Visible Difference initiative.

By viewing the average summer UHI index for each block group, we can identify a number of block groups that have a high UHI index. We believe these warmer block groups, shown in red, would greatly benefit from green infrastructure and revitalization efforts.

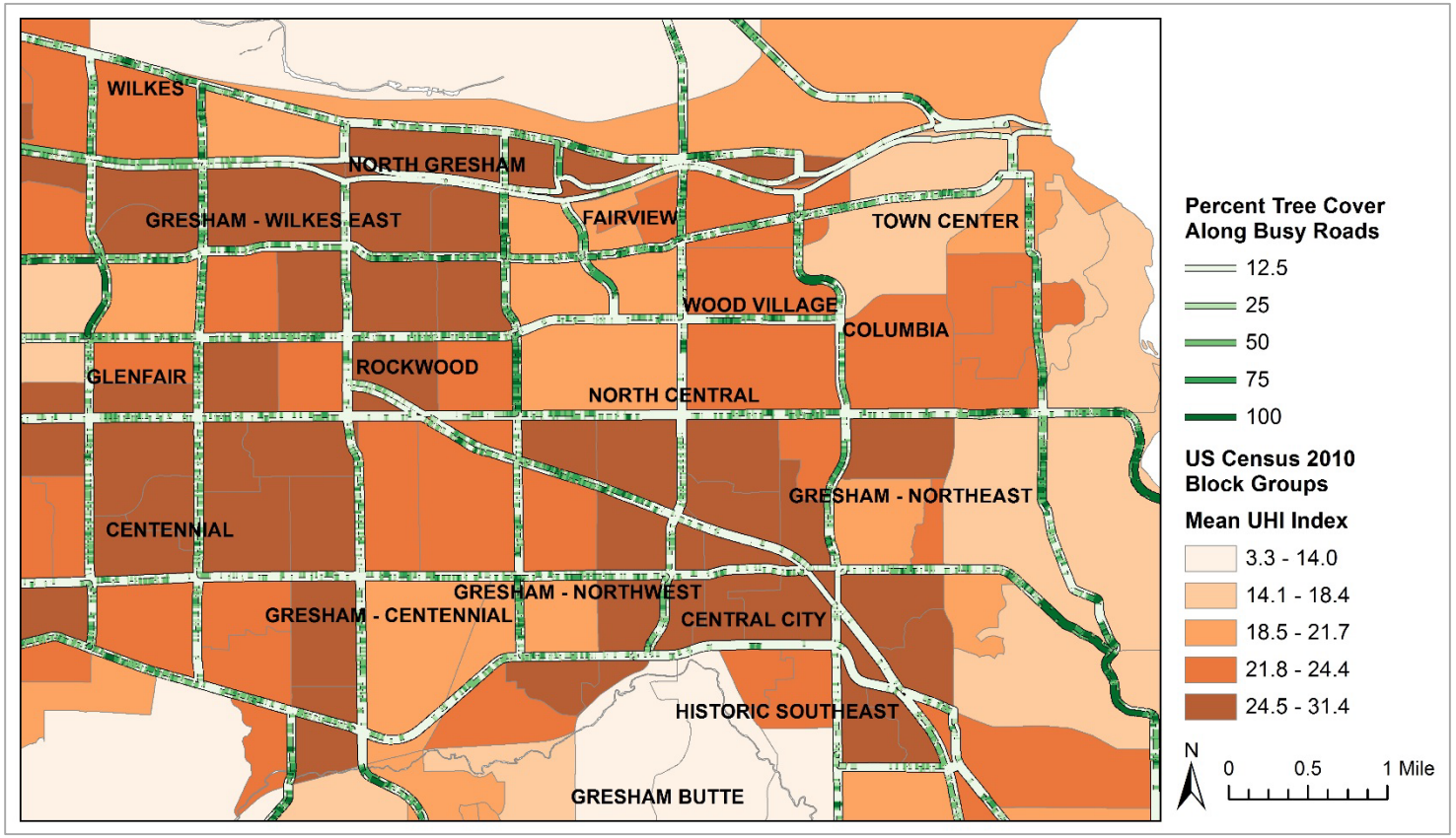


With the UHI index summarized by census block group, we can easily identify the warmest neighborhoods that may benefit most from additional street trees.

Street Tree Locations

Next we incorporate information on the existing trees and built environment. By adding one of several estimated tree cover layers from EnviroAtlas, we can see Rockwood and adjacent neighborhoods have very little tree cover along major roadways. We can identify particular stretches of road that would benefit most from street tree plantings, using the following selection criteria:

- Block groups that are highly warmed by UHI effects.
- Busy roadways that have very little existing tree cover.



To plan our solution of adding street trees, we want to know where trees already exist. The EnviroAtlas layer "Estimated % tree cover within 26m of a road edge" shows us where along major roads there is a lack of tree cover.

Street Tree Locations

After finding stretches of major roads that lack roadside tree cover in block groups with higher heat index values, we can look at corresponding locations using Street View on Google Maps for additional information. The Street View images reveal information about utility lines and existing available planters in our study area. Local governments can aid street tree planting and redevelopment projects by burying utility lines, which are often significant obstacles to tree growth. Therefore, to help determine whether trees can be planted sooner rather than later, we added two criteria for our candidate locations:

- The utility lines are underground.
- There are existing areas that could be planted.

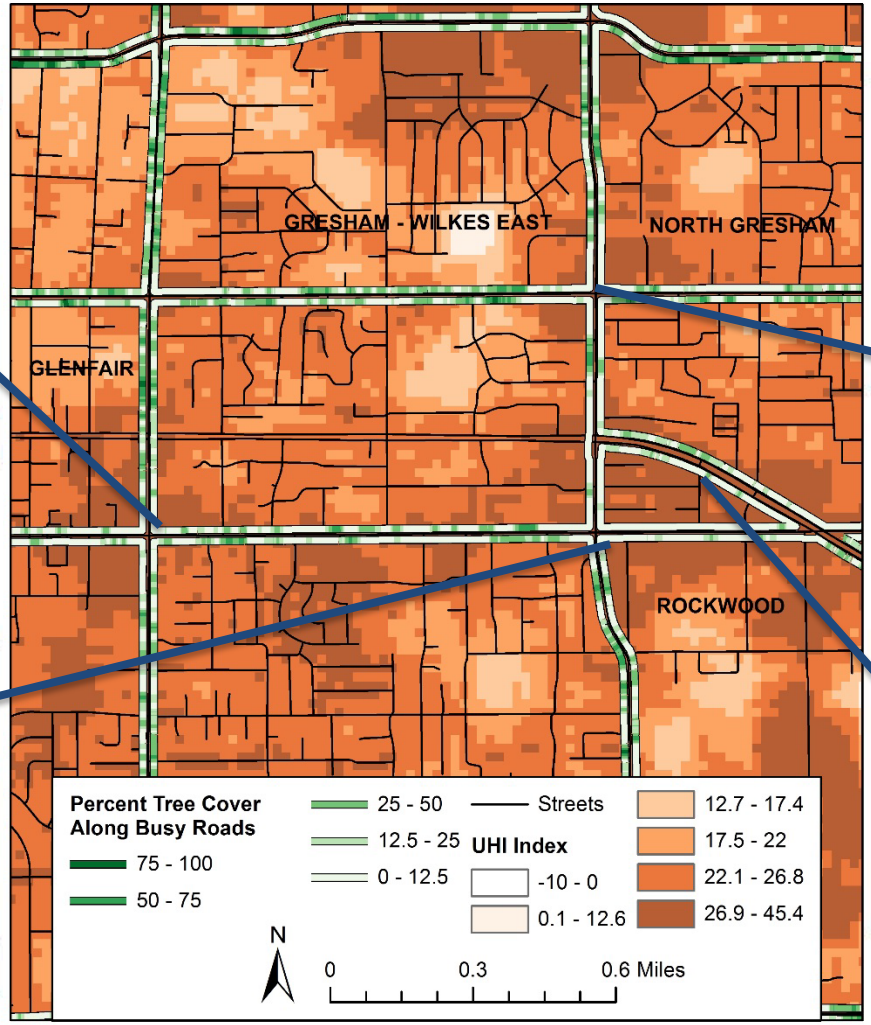
We looked for stretches of major streets with low tree cover, like 82nd street shown here, as places where additional trees might mitigate UHI. Source: AP, http://www.columbian.com/news/2015/dec/16/advocates-argue-portland-should-do-more-to-prevent-gentrification/

Street Tree Locations

We found that the warmest spots along major roadways occur along Stark Street, Burnside Street, Glisan Street and 181st Avenue. Because these locations experience the greatest UHI effect, taking action to plant new street trees here will have the greatest impact through heat mitigation for the community. In addition to heat mitigation, increased tree coverage can provide other benefits, such as reducing exposure to harmful UV rays and improving pedestrian safety.

Stark and 162nd Ave

Stark and 182nd Ave



Glisan and 181st Ave

Burnside and 185th Ave

We selected four locations where additional trees might help reduce the UHI effect in neighborhoods within East Portland.

Summary

- An area's high amount of impervious surface can contribute to higher temperatures compared to the surrounding natural area, a phenomenon known as an urban heat island (UHI).
- Vegetation and trees can help reduce the UHI effect.
- Green spaces – areas of grass, trees and other vegetation in an urban environment – may help reduce the UHI effect, but may be distributed unevenly across a city. Thus, UHI affects some neighborhoods more than others.
- We created a new data layer for Portland, OR and vicinity that is an index of daytime UHI in the summer months. The source for this information was free and publicly available satellite thermal infrared imagery (Landsat 8). We provided instructions for how to calculate an UHI index for other areas in a separate technical document.
- The Heat Island effect can be mitigated to a certain extent by the addition of green infrastructure.
- Combining our new UHI data layer with others from EnviroAtlas and local agencies, we identified neighborhoods, census block groups, and sections of major roads that may be good candidates for adding green infrastructure to decrease the effect of UHI.
- Local governments can aid street tree planting and redevelopment projects by burying utility lines, which are often significant obstacles.
- Reducing the UHI in these areas can provide numerous health benefits to the community, including a lower risk of heat stroke and heat-related mortality. Cooler roadways provide safer, more comfortable commutes for all.
- Additional trees would provide other co-benefits such as air and water pollution reduction and aesthetic value.

After creating a map of Portland's urban heat island, we combined it with EnviroAtlas data layers to identify four locations where additional trees might help reduce the urban heat island effect. Source: David Mark, Pixabay.com

This use case was developed by Stephanie Panlasigui, ORISE Participant, and Jessica Daniel, Environmental Protection Specialist, in support of US EPA's Making a Visible Difference in Communities efforts with the community in Portland, Oregon.

Access EnviroAtlas at www.epa.gov/enviroatlas

EnviroAtlas Use Case

For this use case, we incorporated information from five data layers provided by EnviroAtlas:

- Portland, OR Meter-scale Urban Land Cover
- Estimated percent of tree cover within 26m of a road edge
- Block Groups – US Census 2010 (available for EnviroAtlas communities)
- Population over 70 years old
- Population under 13 years old
- Percent green space within ¼ square kilometer

More EnviroAtlas data layers are available that are related to urban heat islands and the communities vulnerable to them:

- Tree cover per capita (m^2/person)
- Average reduction in daytime ambient temperature (Celsius) by tree cover
- Average reduction in nighttime ambient temperature (Celsius) by tree cover
- Percent population other than White, non-Hispanic
- Percent population with income below twice the poverty level

People walk to public transit in Portland. Source: http://trimet.org/projects/pednetwork/index.htm

Learn more about urban heat islands by visiting https://www.epa.gov/heat-islands.
For a technical description of methods, visit the complementary document:
https://www.epa.gov/sites/production/files/2017-06/documents/technicalguidance_uhi.pdf