How to use and analyze geospatial data for climate research and teaching

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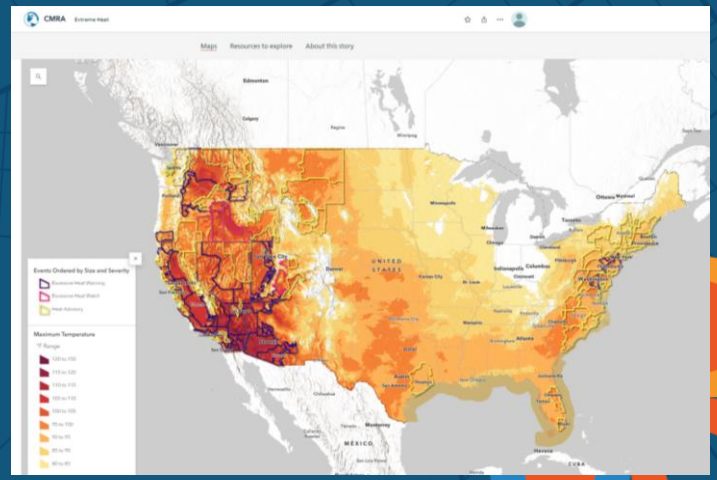
Objectives

--Build skills in effectively finding, using, and analyzing climate data in a geospatial context to enhance research and instruction

--Foster critical thinking skills about data, including ethical considerations in mapping

--Foster skills and confidence in modern GIS methods: data as streaming services, analytics in the cloud, real-time feeds, sharing, web maps and apps

--Give confidence to pursuing your future learning



Our World

Is Now Being Challenged

Extreme Heat

Ocean Warming

Water Crises

Severe Droughts

Population Growth

Food Shortages

Human-Induced Climate Changes

Steep Decline in Biodiversity

Loss of Nature

Ecological Instability

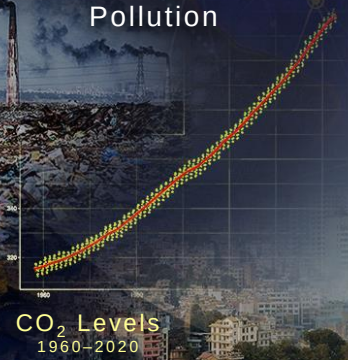
Natural Disasters

Wildfires

Social Conflict

Pollution

Unconstrained Development



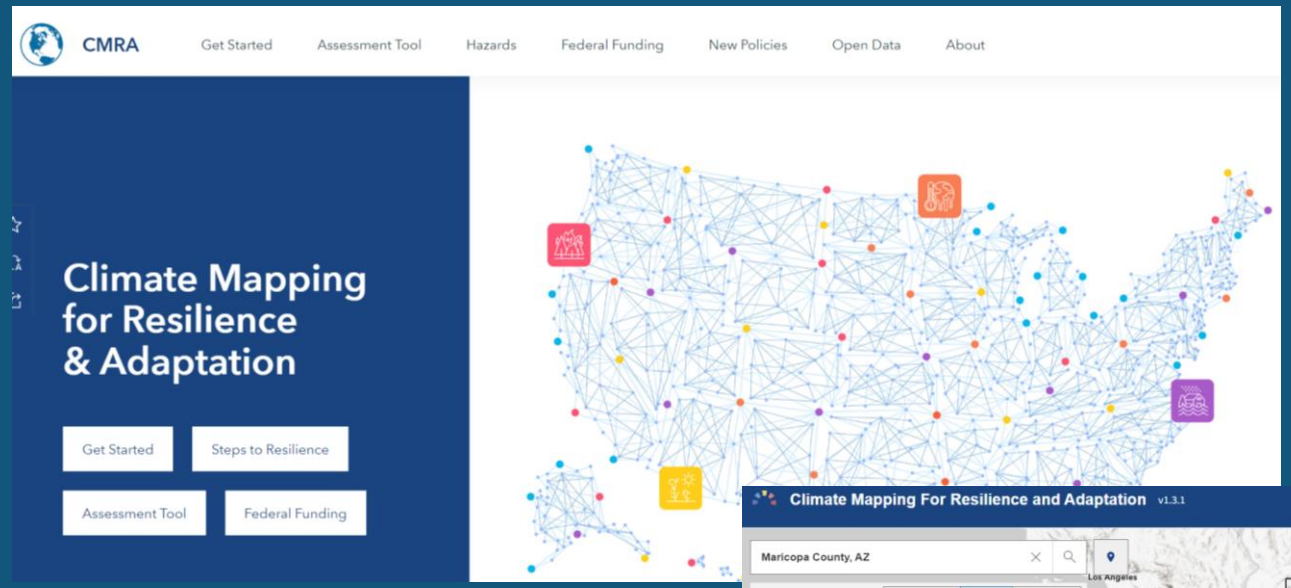
Humans Are Living Recklessly . . .
Beyond Our Means . . .
. . . Unsustainably

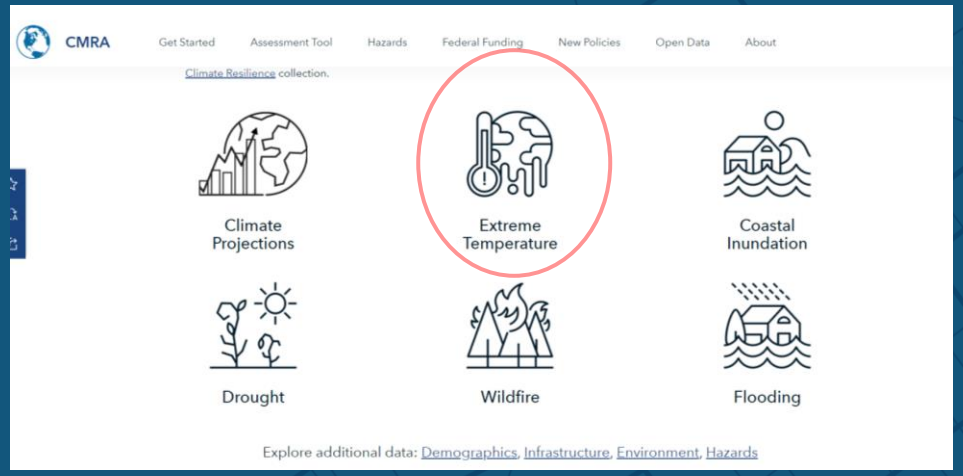
Decision-makers do use these approaches and data

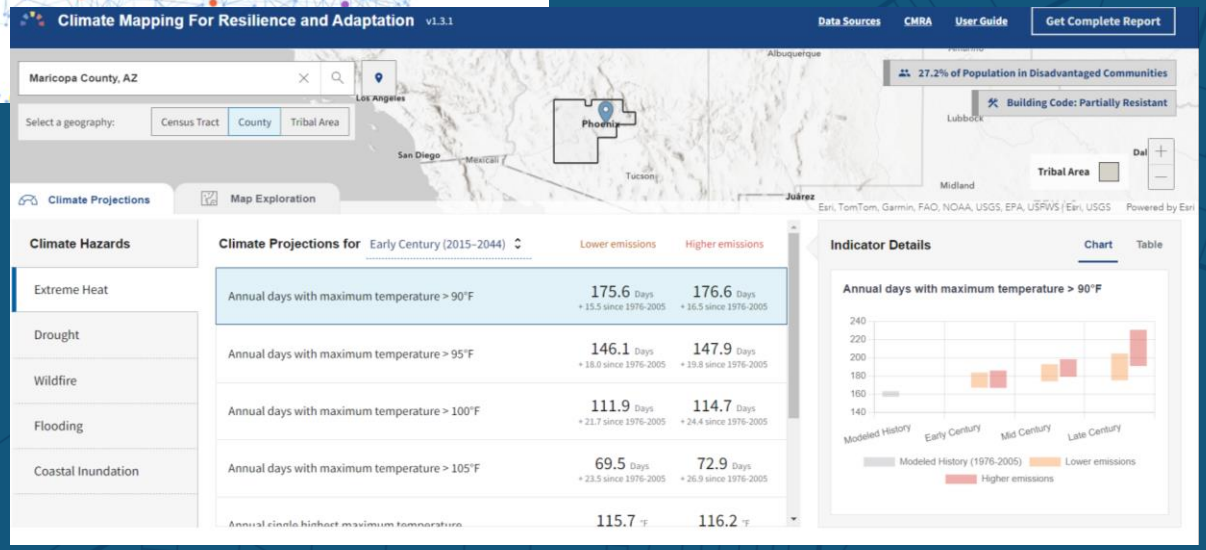
Software products	→	Platforms and APIs
2D	→	2D/3D/4D AR/VR
Client/server	→	Web Services and apps
Standalone desktop	→	Connected devices
Printed maps	→	Web maps, dashboards, other apps
Static data	→	Data services, live streams, big data
Custom applications	→	Interoperable packages, libraries
Single, all-purpose application	→	Focused apps
Proprietary data	→	Open Data & Shared Services
Using data created by others	→	Combining others' data with our own
Limited sharing	→	Many ways to share
Niche technology	→	Ties to larger IT community: GitHub
Some attention to societal concerns	→	Much attention to societal concerns
Mapping department	→	Integrated across the business

…GIS has changed.

Climate Mapping for Resilience and Adaptation (CMRA)



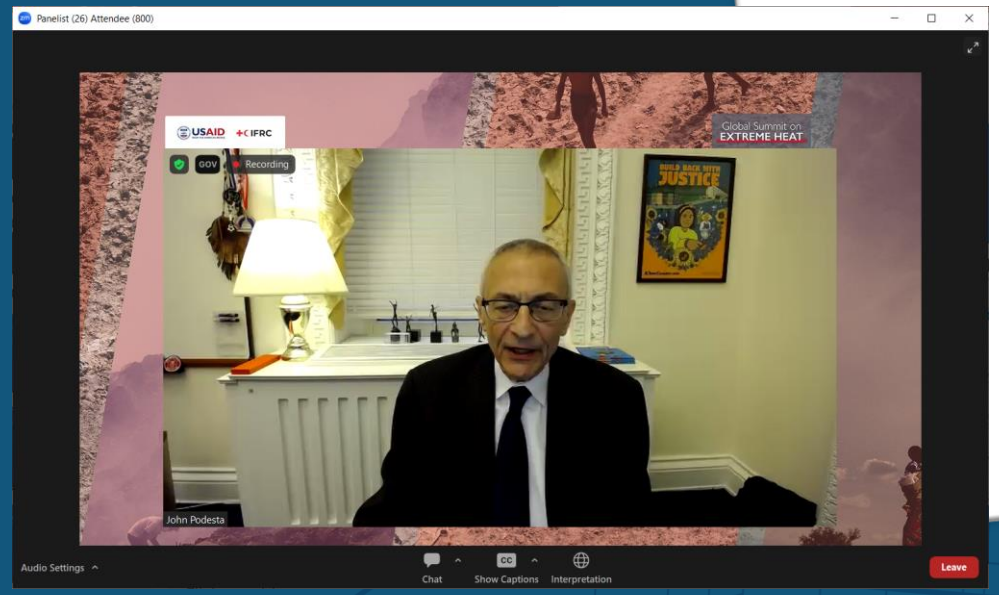




Extreme Heat

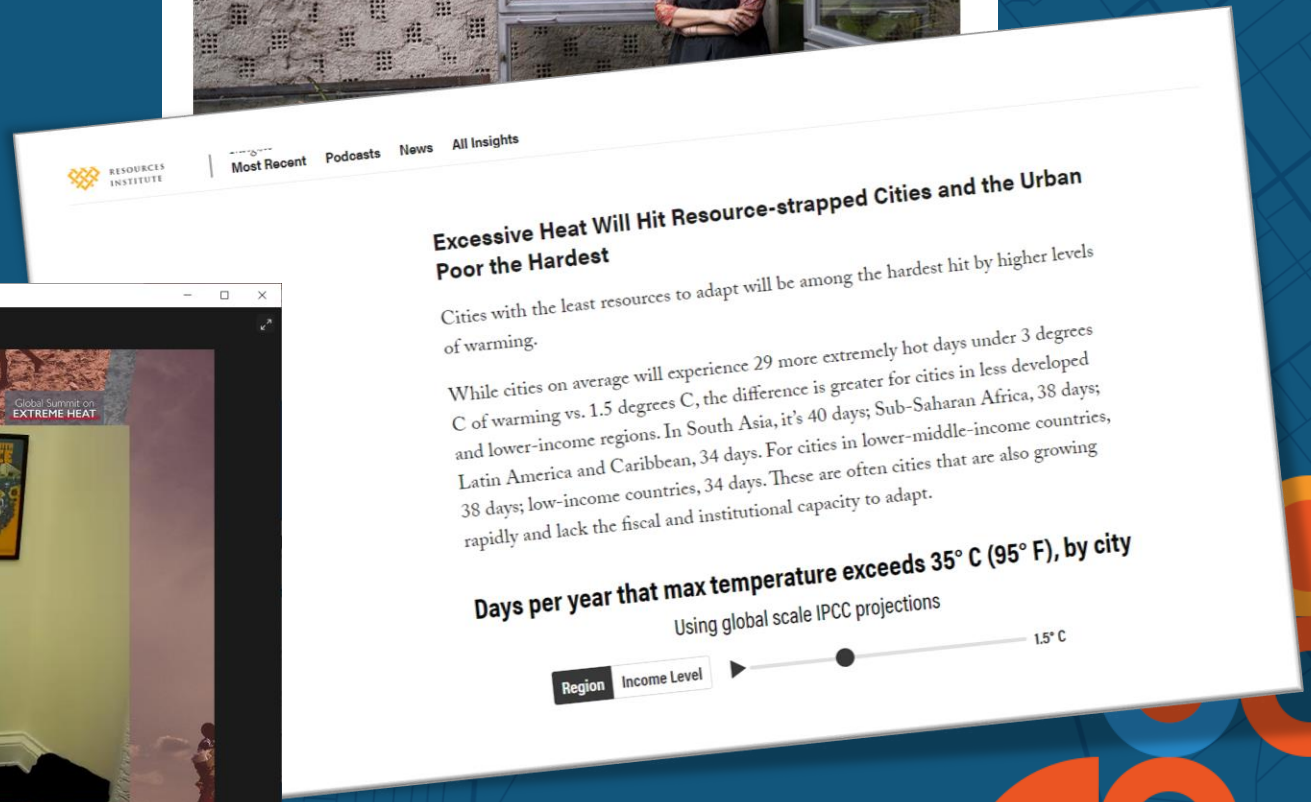
A concern we all share…

- Affects Agriculture
- Affects Public Health
- Affects Economic Productivity



Europe's first chief heat officer warns our cities are not prepared for what's coming

From painting apartment blocks in light colours to reusing wastewater, Athens' former heat guru Eleni Myrivili explains how cities can adapt to rising temperatures



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Excessive Heat Will Hit Resource-strapped Cities and the Urban Poor the Hardest

Cities with the least resources to adapt will be among the hardest hit by higher levels of warming.

While cities on average will experience 29 more extremely hot days under 3 degrees C of warming vs. 1.5 degrees C, the difference is greater for cities in less developed and lower-income regions. In South Asia, it's 40 days; Sub-Saharan Africa, 38 days; Latin America and Caribbean, 34 days. For cities in lower-middle-income countries, 38 days; low-income countries, 34 days. These are often cities that are also growing rapidly and lack the fiscal and institutional capacity to adapt.

Days per year that max temperature exceeds 35° C (95° F), by city

Using global scale IPCC projections

Region | Income Level | 1.5° C

The affected cities are ‘creeping North’ (and South)

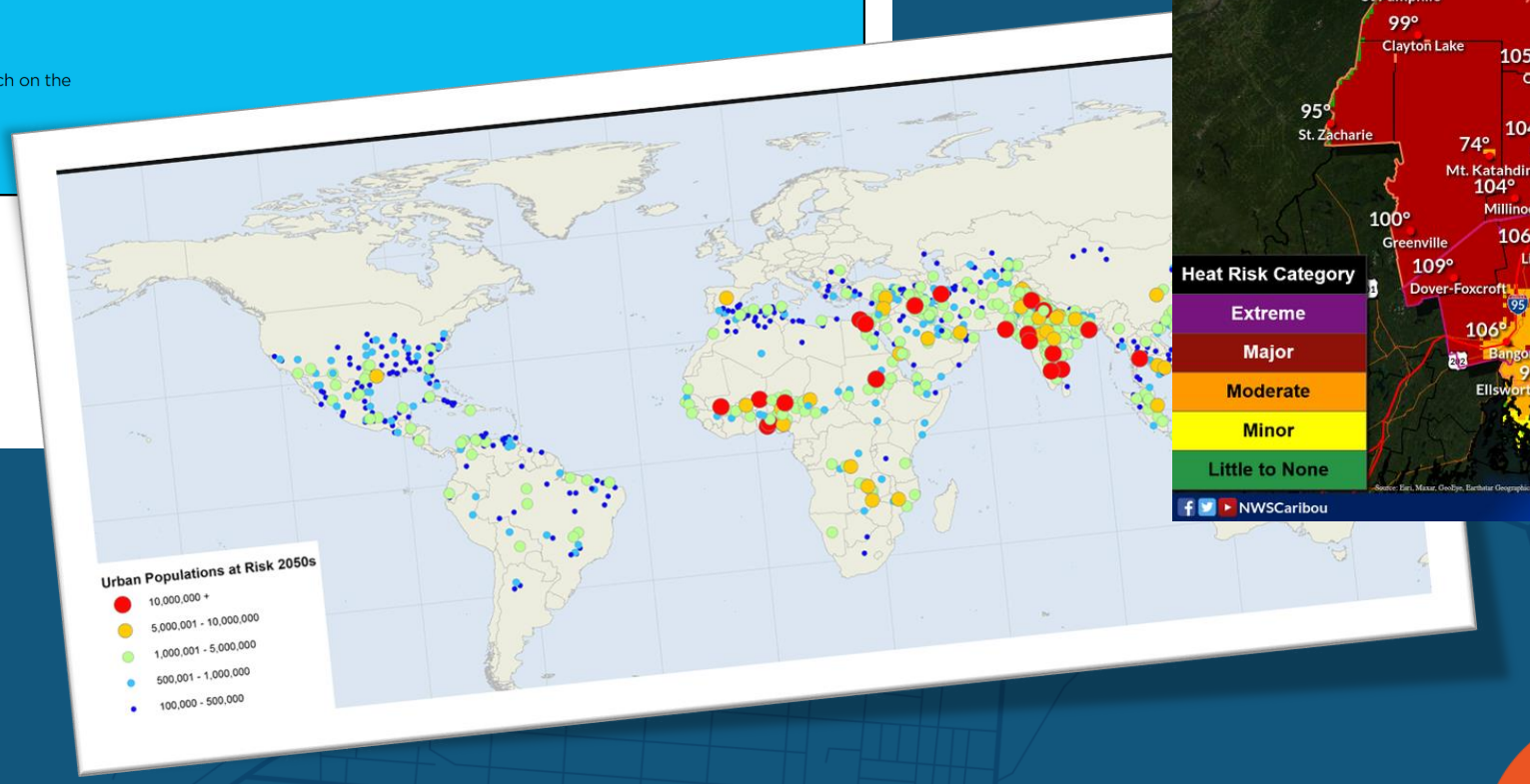
C40 CITIES

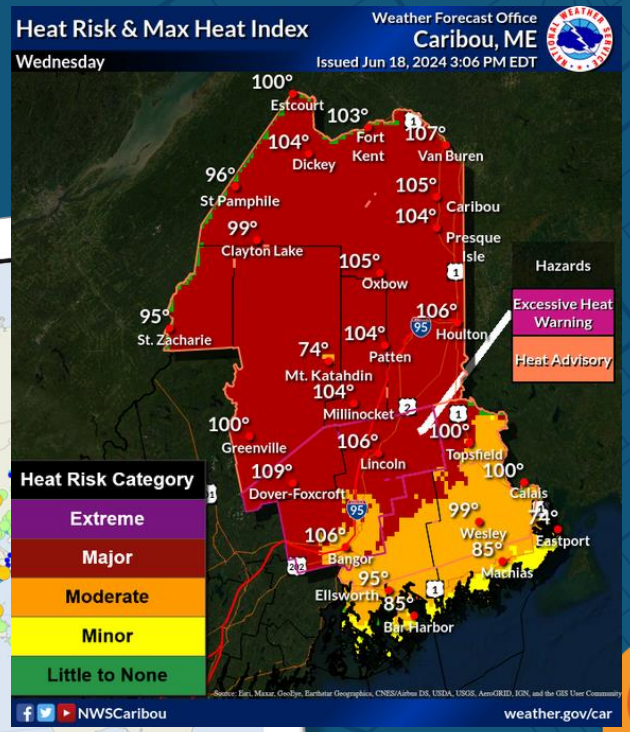
WHO WE ARE ▾ WHAT WE DO ▾ OUR CITIES LATEST ▾ SUBSCRIBE ▾

Heat Extremes

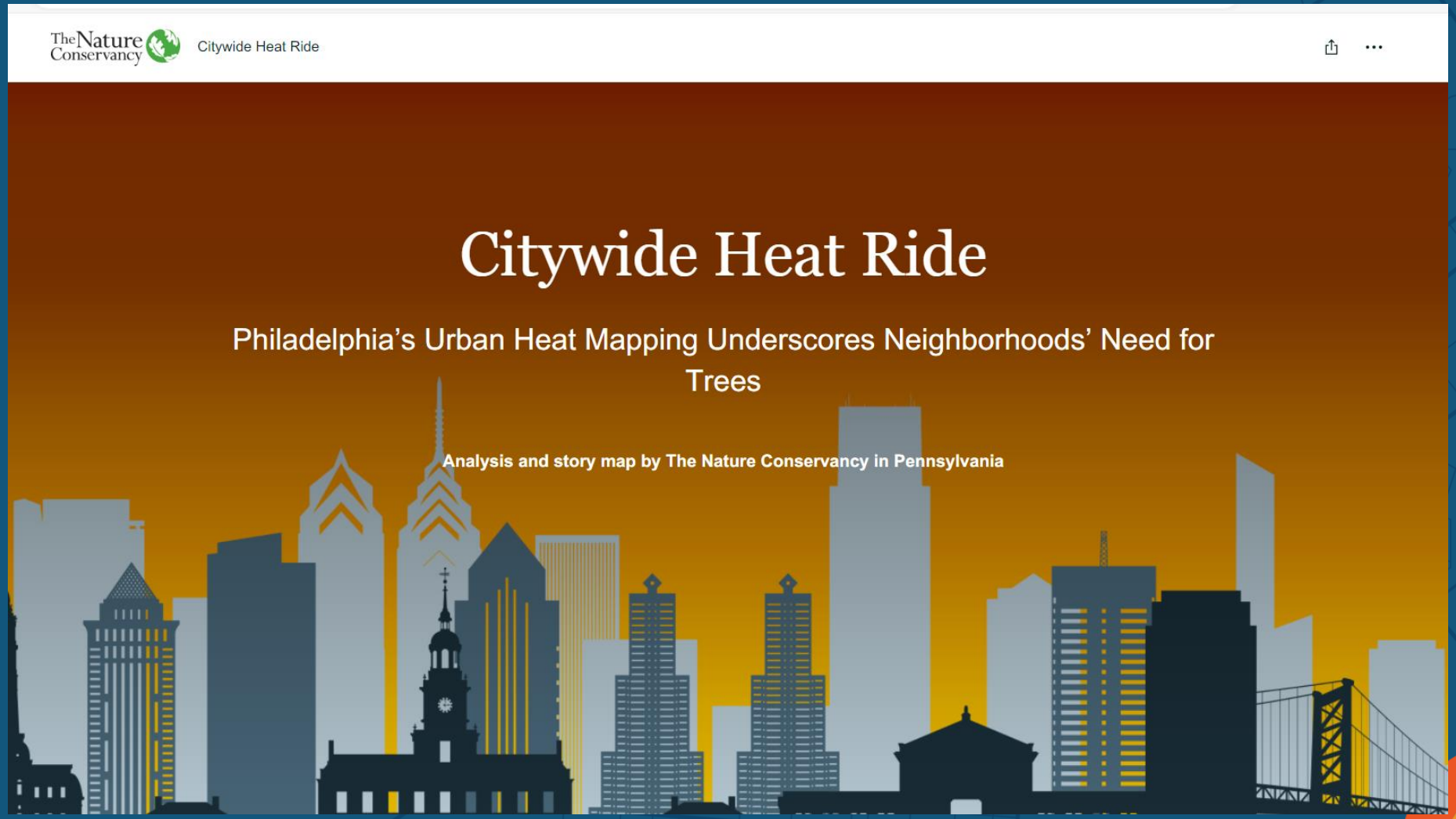
A summary of The Future We Don't Want research on the dangers of increasing urban heat.

The number of cities exposed to extreme temperatures will nearly triple by 2050





Citywide Heat Ride (arcgis.com)



Extreme Heat Plans

How to prioritize efforts; Data-driven decisions; Storytelling

Huang et al 2024

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but last year and continuing this year, state employees may staff cooling centers with pay.

Extreme Heat Preparedness Long-Term Recommendations focus on the following categories:

- Safe, Affordable Housing
- Adapting and updating emergency response
- Cooling Center Network improvements and support recommendations
- Data sets, knowledge, and workforce development

Read the full Extreme Heat Preparedness Plan **HERE**

Read Extreme Heat Preparedness Plan FAQs **HERE**

Read the Governor's LIHEAP Letter **HERE**

Governor Hobbs

Offices of the Governor

News

Priorities

Connect

Arizona 2024

12. INCORPORATE EXTREME HEAT IN COUNTYWIDE RESILIENCE HUB PLAN.

GOAL 3: Cool our neighborhoods Reduce the excessive heat burden in urban areas by expanding the tree canopy and vegetation, improving access to water features and shade structures, and cooling our surfaces.

13. CREATE A BOLD TREE PLAN.

14. COOL OUR COMMUTES.

15. COOL OUR SCHOOLS.

16. EXPAND ACCESS TO WATER AND SHADE.

17. PLANT AND PROTECT TREES ON COUNTY LAND.

18. PILOT AND SCALE COOL PAVEMENTS.

19. RAMP UP ENGAGEMENT AND CITIZEN SCIENCE.

Miami 2022

GIS can contribute to Extreme Heat Plans

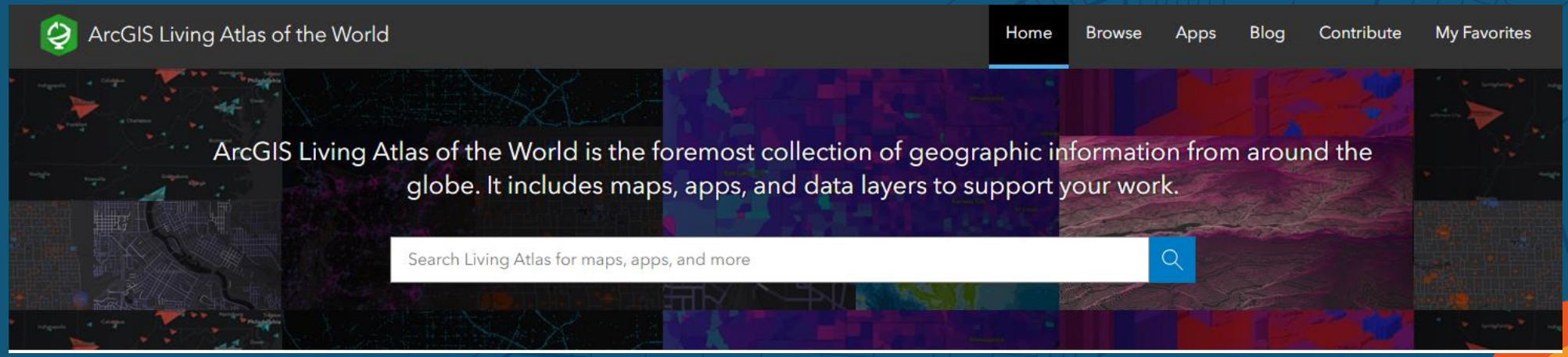
For data-driven decisions

- WHERE (and When) is there Extreme Heat?
  - Advanced step: WHERE might it be in the future?
- WHERE are there nature-based solutions (that have emissions reduction co-benefits?)
  - Tree canopy cover, Water, Green spaces, Shadows/Shade, …
- WHERE are the Populations affected?
  - Raw population, Vulnerable populations
  - Census and other survey data, Satellite-based pop estimates
- WHERE is Remedial Action possible/optimal
  - Mobile Cooling Centers, Land use Changes, Transportation Changes,…

LA Times

Web GIS can enable understanding

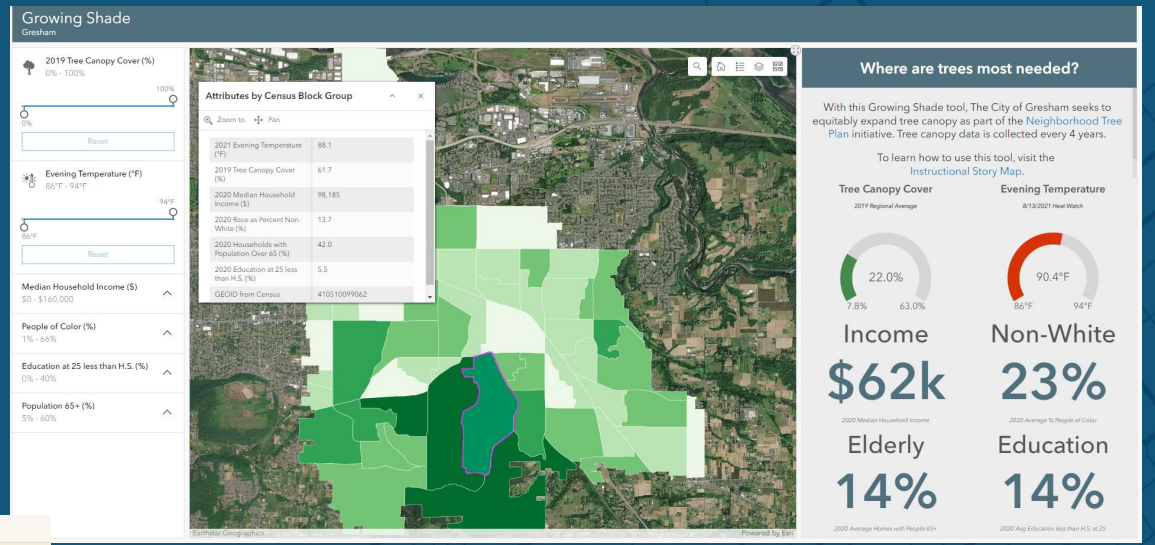
- Discover valuable data sets, in government portals (Hub sites, other libraries)
  - And on the ArcGIS **Living Atlas of the World**
- Publish your own data layers and apps:
  - On ArcGIS Online
  - In ArcGIS Hubs
  - Also **contribute** to the Living Atlas
- Then, to dig deeper > ArcGIS Pro, and the ArcGIS Pro <> R Bridge.

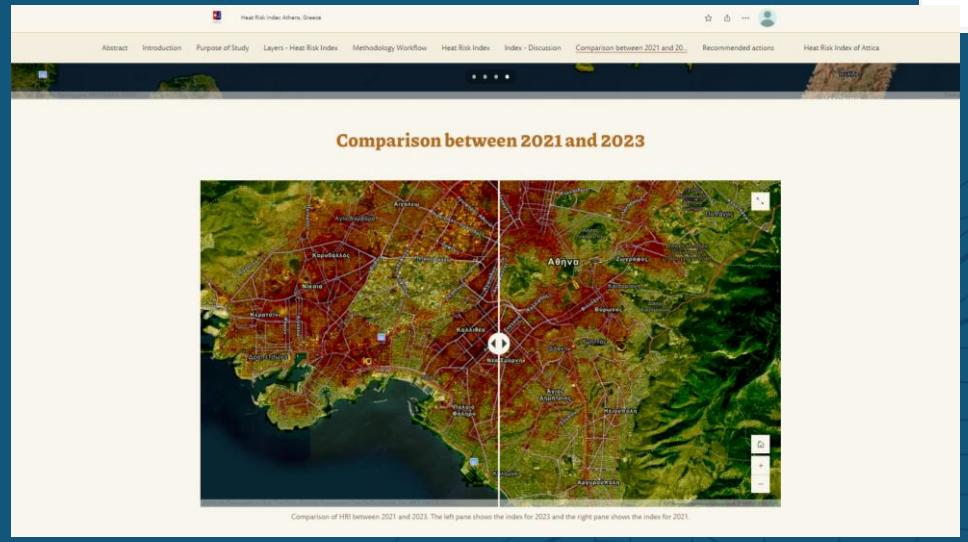


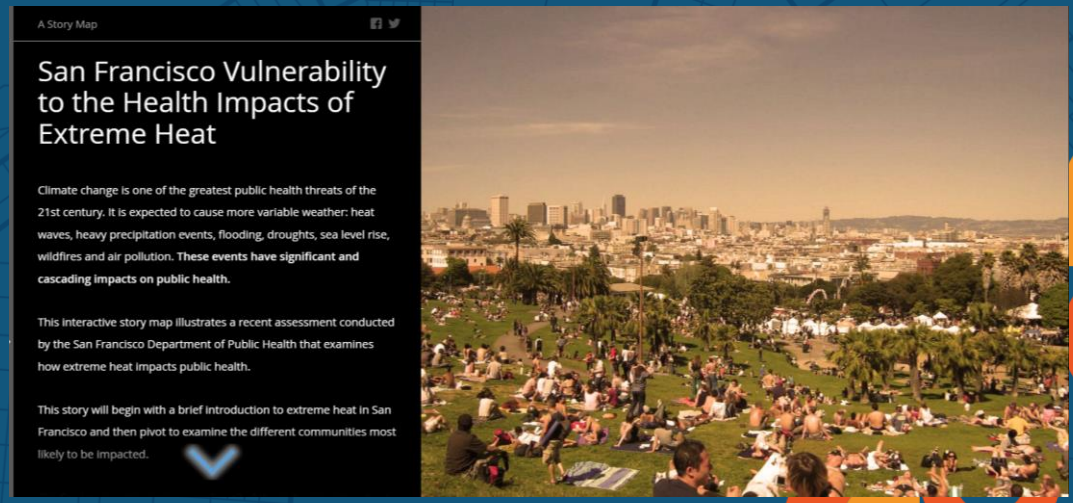
Map, analyze, then Tell your Story

A form of Climate Action

- StoryMaps
- Instant apps
- Infographics
- Dashboards

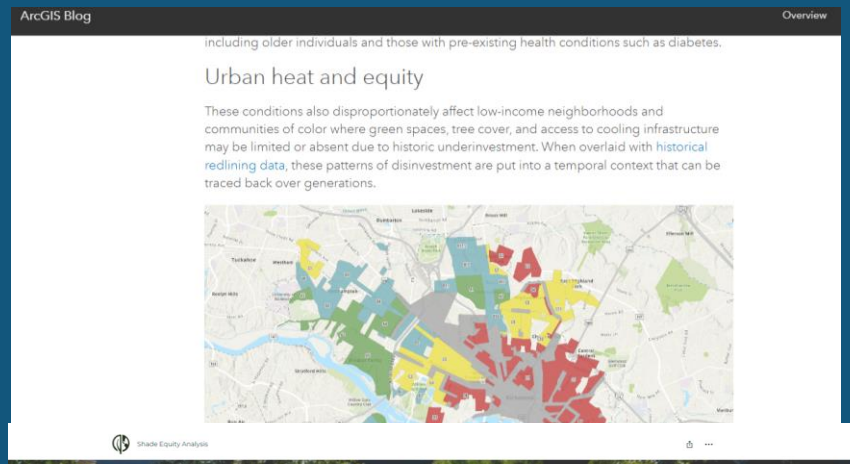


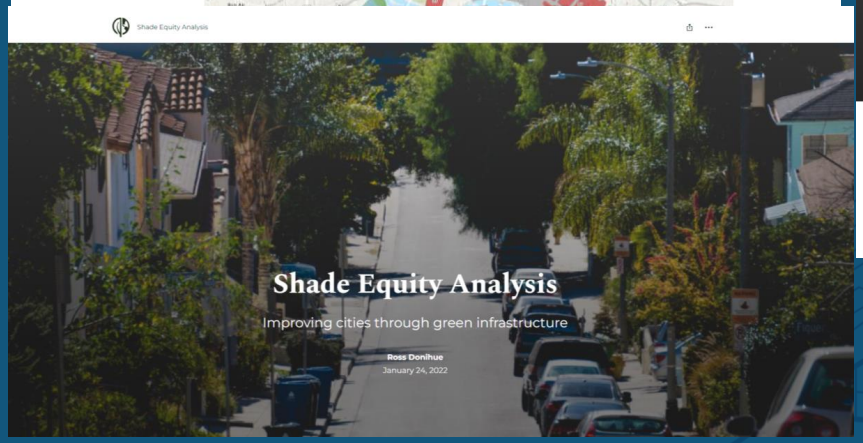


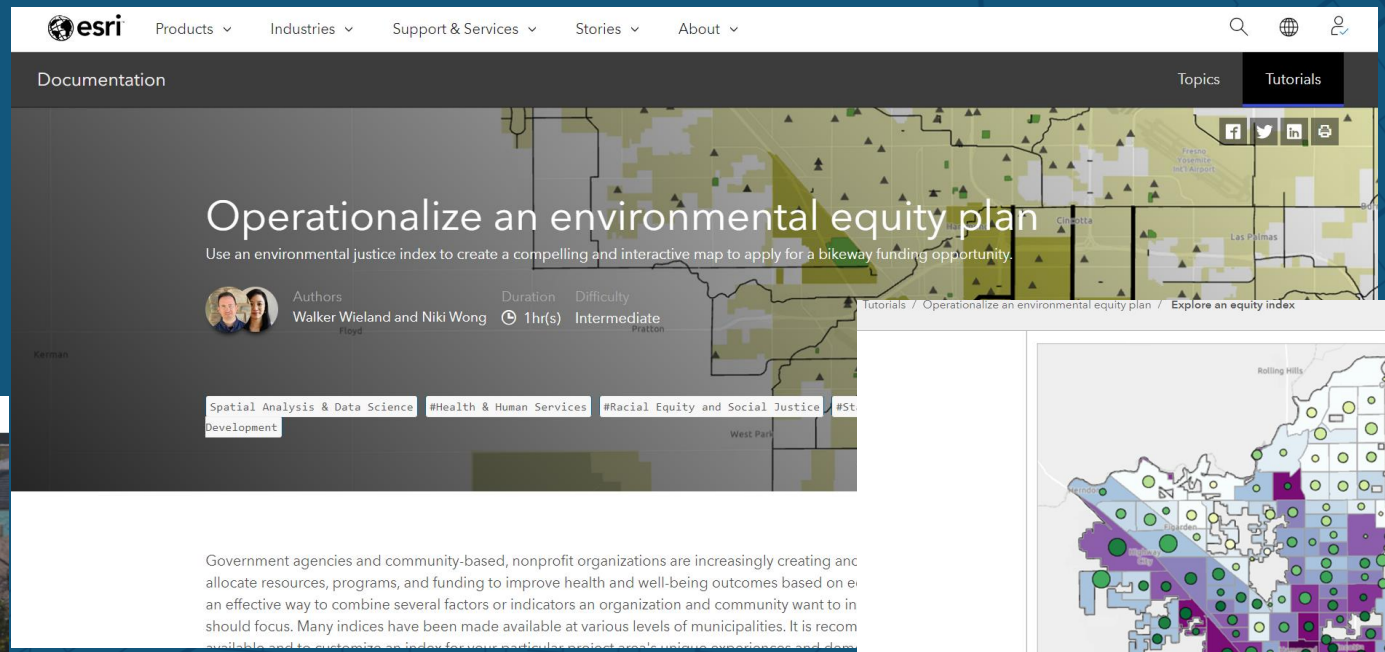


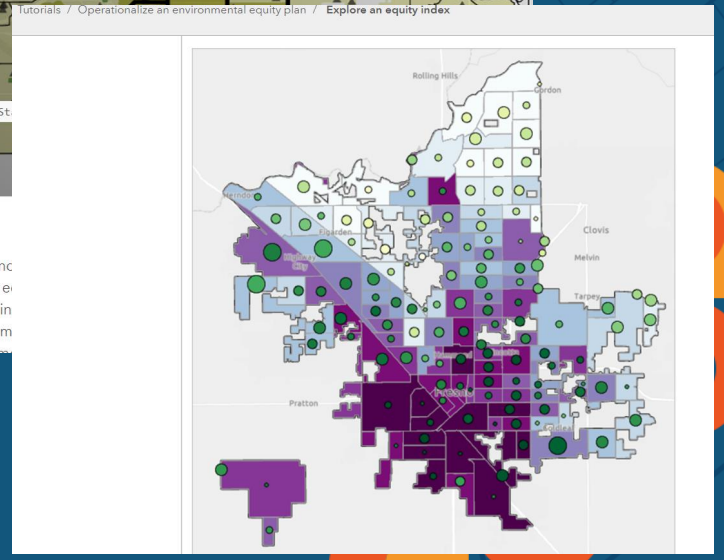
Urban Heat Equity

Citywide Heat Ride: https://storymaps.arcgis.com/stories/1a131b1d4dd74143a47ae556809c72b3









Selected Studies

Flathead Reservation, Montana: Understanding climate change:

https://www.esri.com/en-us/industries/blog/articles/understanding-climate-change-on-the-flathead-reservation/

Athens, Greece:
https://storymaps.arcgis.com/stories/b37837ed9b544bf3b2e881171626dedf

These use ArcGIS story maps to tell the story.

Activity 1: Explore Data Sources and Strategies

Libraries and databases, including those powered by ArcGIS Hub

Examine this book and blog about how to find spatial data, how to assess its quality, and societal issues surrounding spatial data:

https://spatialreserves.wordpress.com

Including 10 exercises: finding, loading, and analyzing spatial data in ArcGIS Pro.

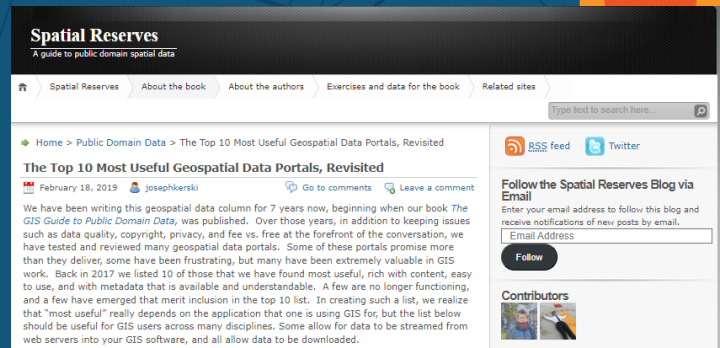
Examine these top 10 most useful geospatial data portals:

https://spatialreserves.wordpress.com/2019/02/18/the-top-10-most-useful-geospatial-data-portals-revisited/

Examine this Modern Strategies for finding geospatial data:

https://spatialreserves.wordpress.com/2024/01/22/modern-strategies-for-finding-geospatial-data-updated/

Examine ethics, location privacy, copyright, and other societal issues, such as these case studies and this on location privacy.



Activity 2: Focused Data Examination

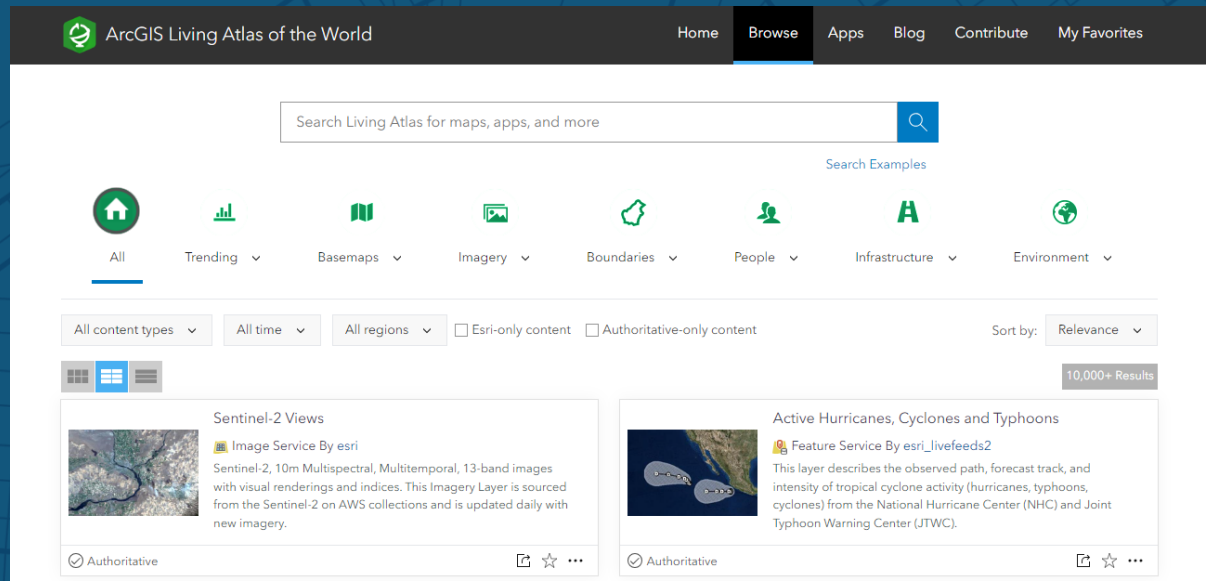
Go to the ArcGIS Living Atlas of the World: https://livingatlas.arcgis.com

Examine Weather and Climate layers:
https://livingatlas.arcgis.com/en/browse/#d=2&categories=Weather+and+Climate

Example: World Terrestrial Ecosystems.

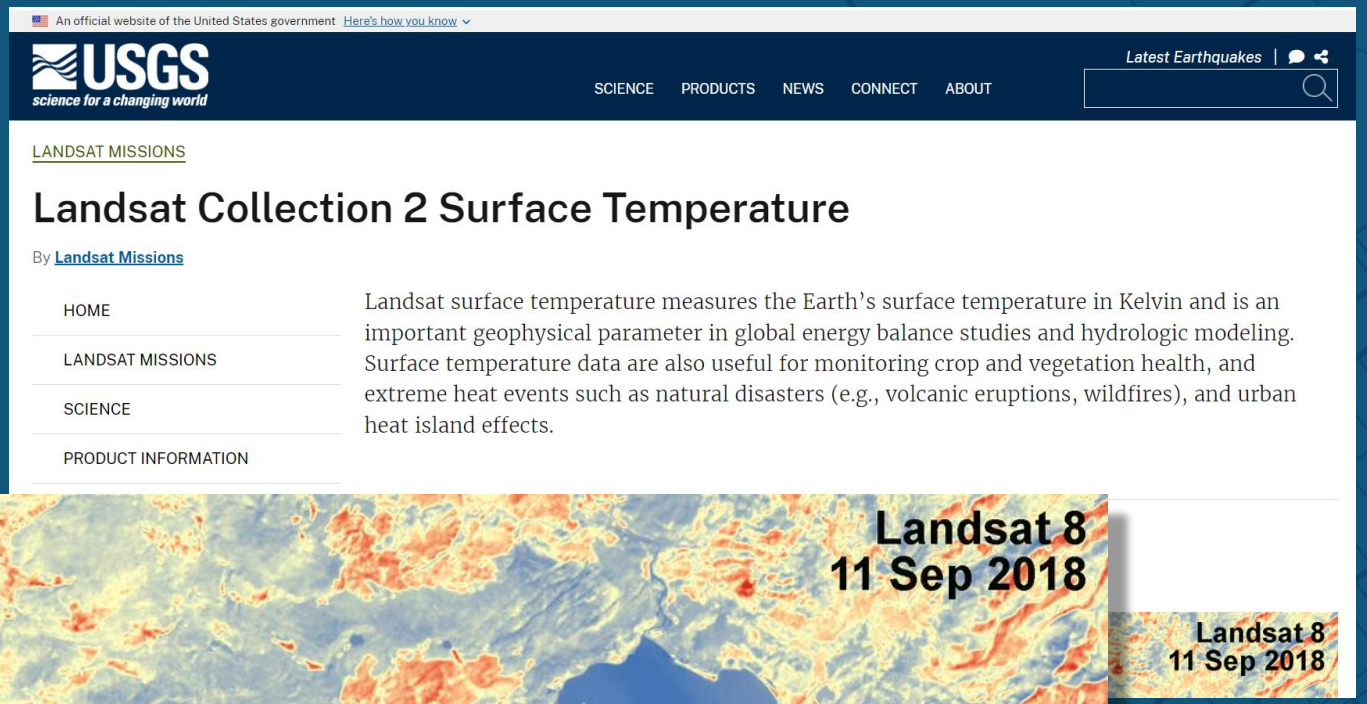
Examine 18 new hosted feature layer ítems for building community science resilience, focused on extreme heat, wildfire, inland flooding, and sea level rise:

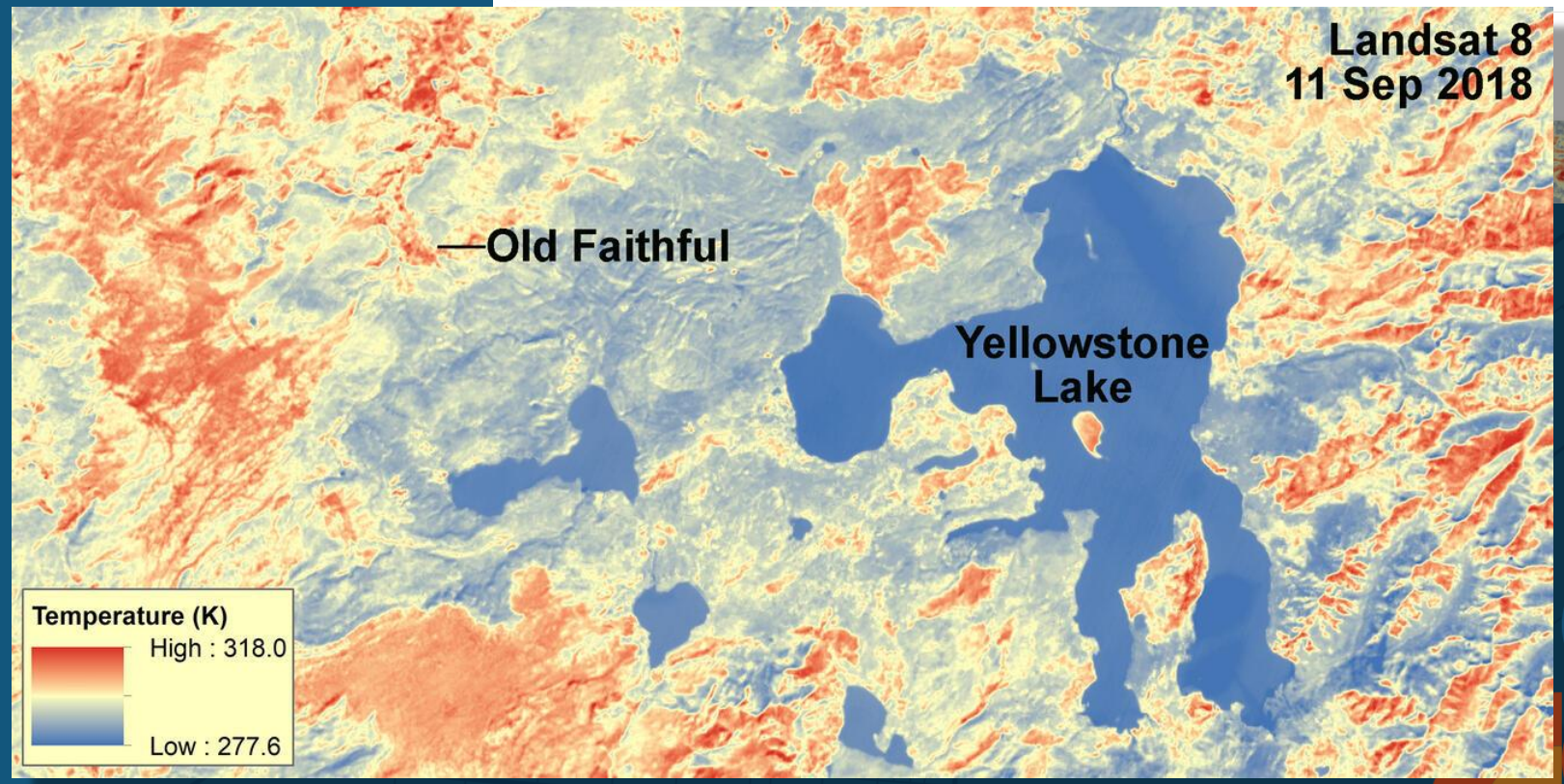
https://www.esri.com/arcgis-blog/products/arcgis-living-atlas/announcements/tools-for-building-community-climate-resilience/



Identifying Heat

- Thermal infrared bands of satellite imagery
  - Landsat, ASTER
- And/or in situ sensors…
  - CAPA is 10m res.





Heat.gov

Built on ArcGIS Hub

HEAT.gov

National Integrated Heat Health Information System

Home | News & Events | Learn | Urban Heat Islands | Tools & Information | At Risk Groups | Planning & Preparing | Funding Opportunities | About

Afternoon Heat Index in Cities - Urban Heat Islands

NOAA VizLab
NOAA GeoPlatform

View Data | Download | More

Summary

Afternoon Heat Index for U.S. cities for use in urban heat island mapping. Source: NOAA/CAPA Strategies.

Urban heat islands are small areas where temperatures are unnaturally high - usually due to dense buildings, expansive hard surfaces, or a lack of tree cover or greenspace. People living in these communities are exposed to more dangerous conditions, especially as daytime high and nighttime low temperatures increase over time.

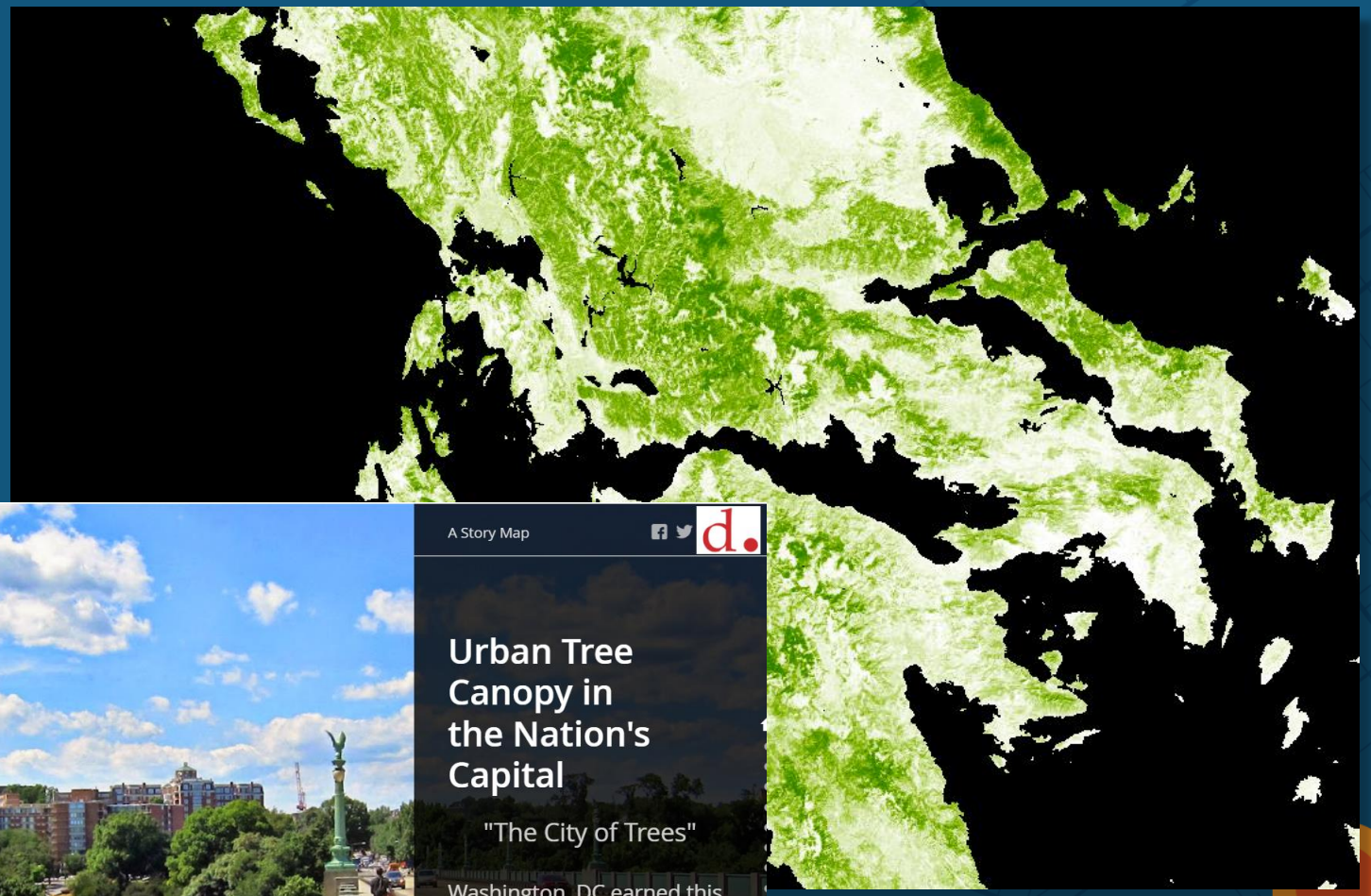
Details

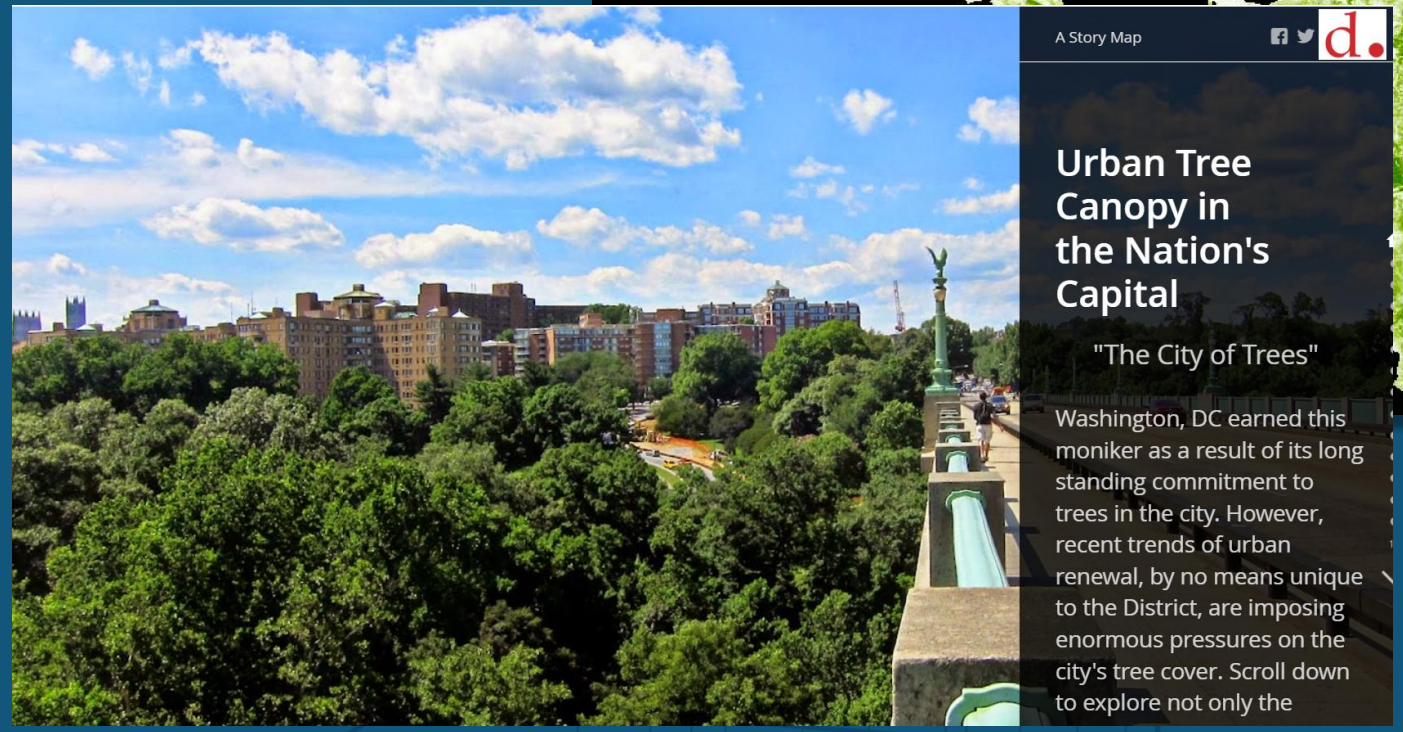
Imagery Dataset
Image Service

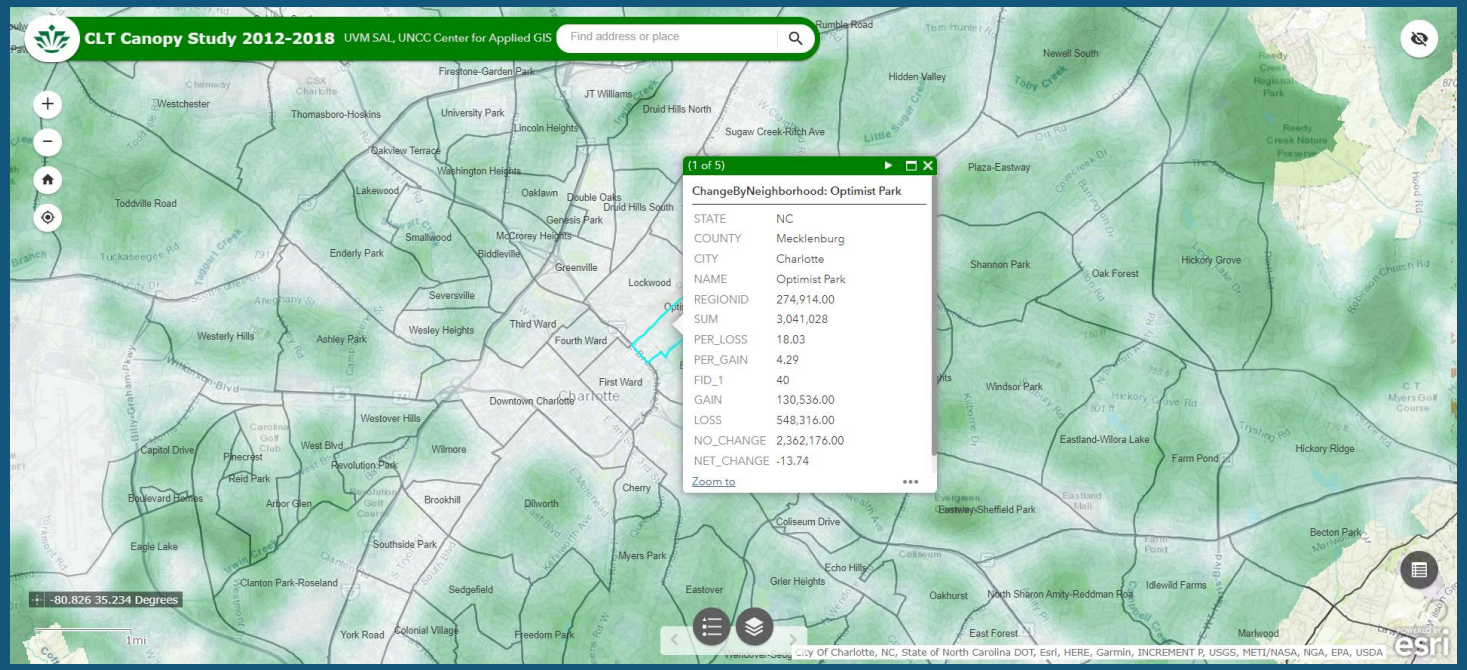
August 2, 2023
Info Updated

Identifying Tree Cover

- Classified landcover images
- NAIP and other imagery
- NDVI
- UAVs

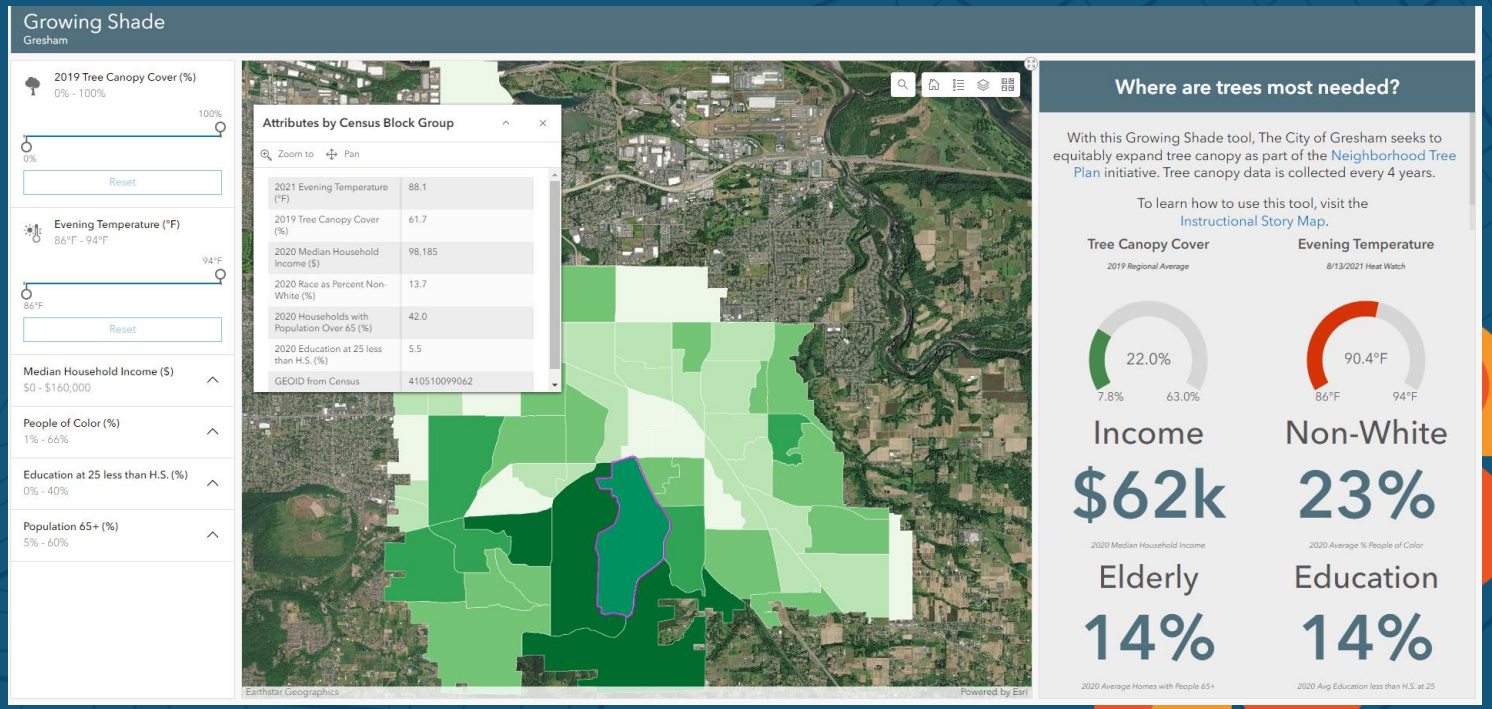






Charlotte NC

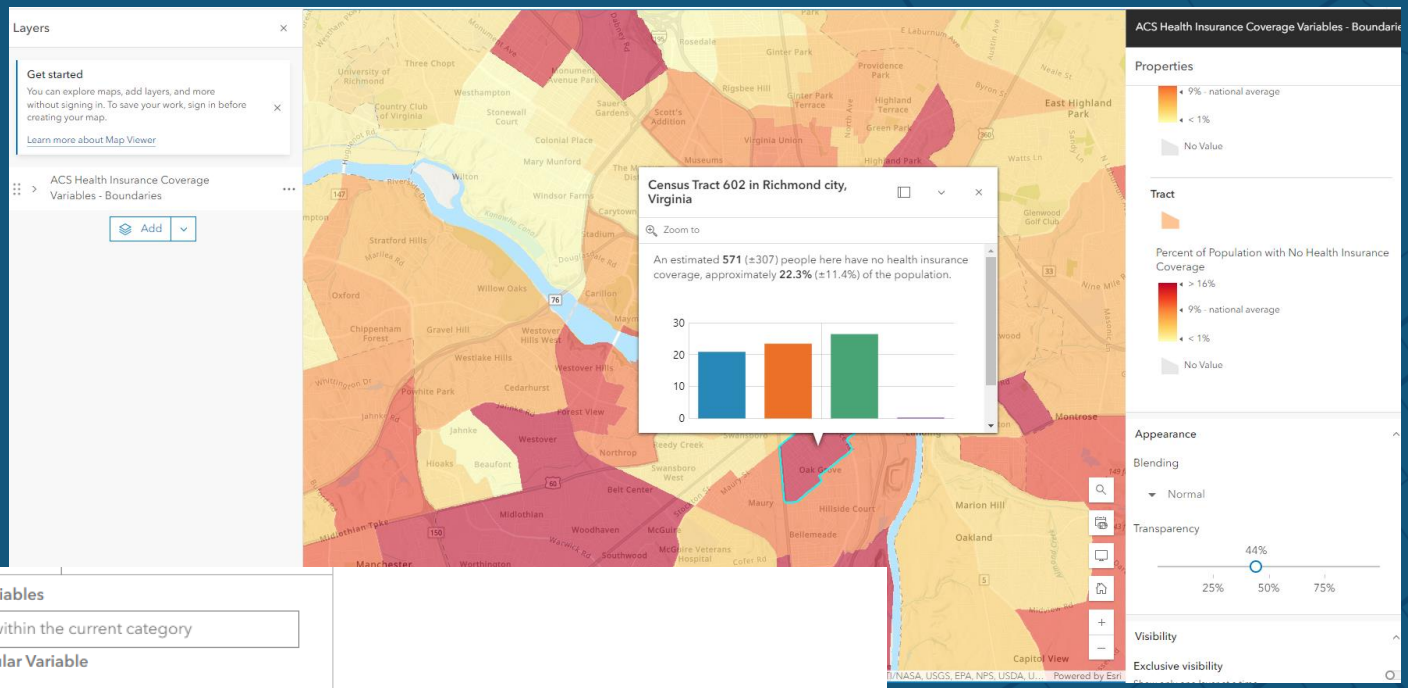
Gresham OR

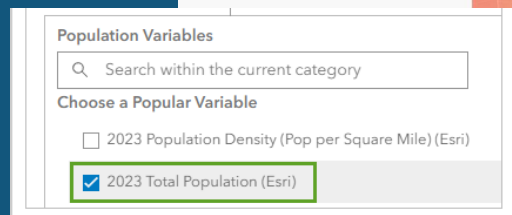


Population Data

Who is affected by extreme heat?

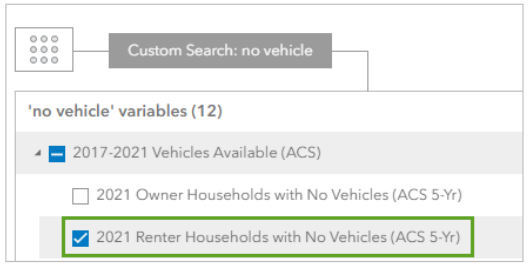
- Raw population
- And specific cohorts
- ACS in the US
- Esri demographic data
  - “Enrichment”
- Michael Bauer data
- WorldPop global data





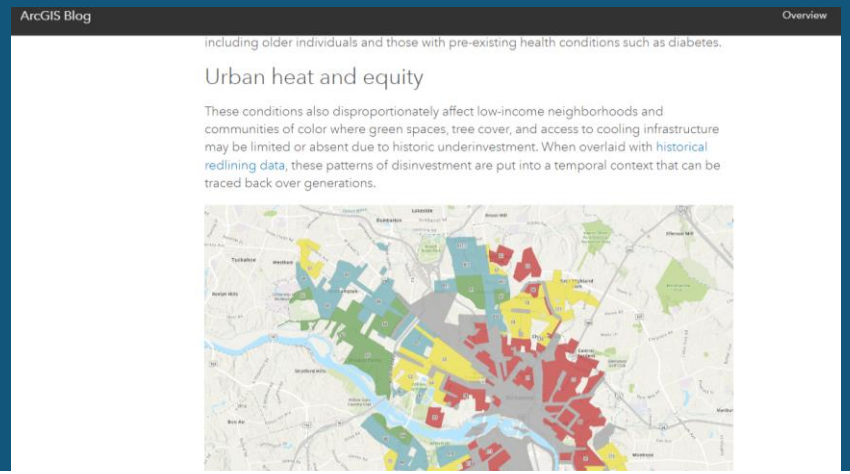
Next, you will add variables related to vulnerable populations. People who do not have access to a vehicle or have incomes below will have fewer resources to cope with potential extreme heat events.

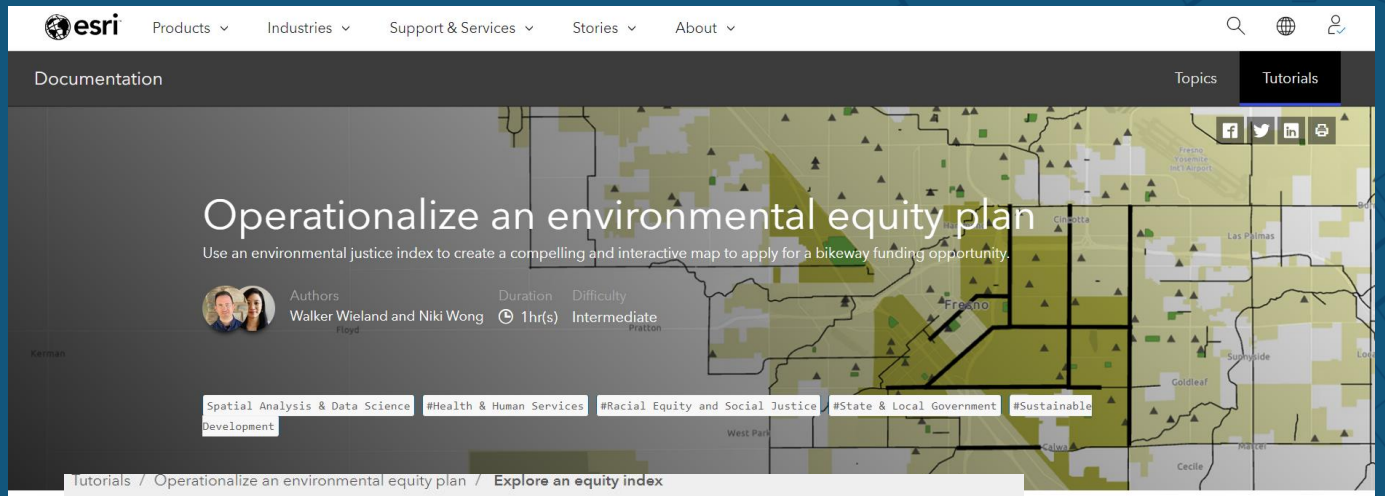
Click the **Back** button. In the search bar, type `no vehicle` and press Enter.

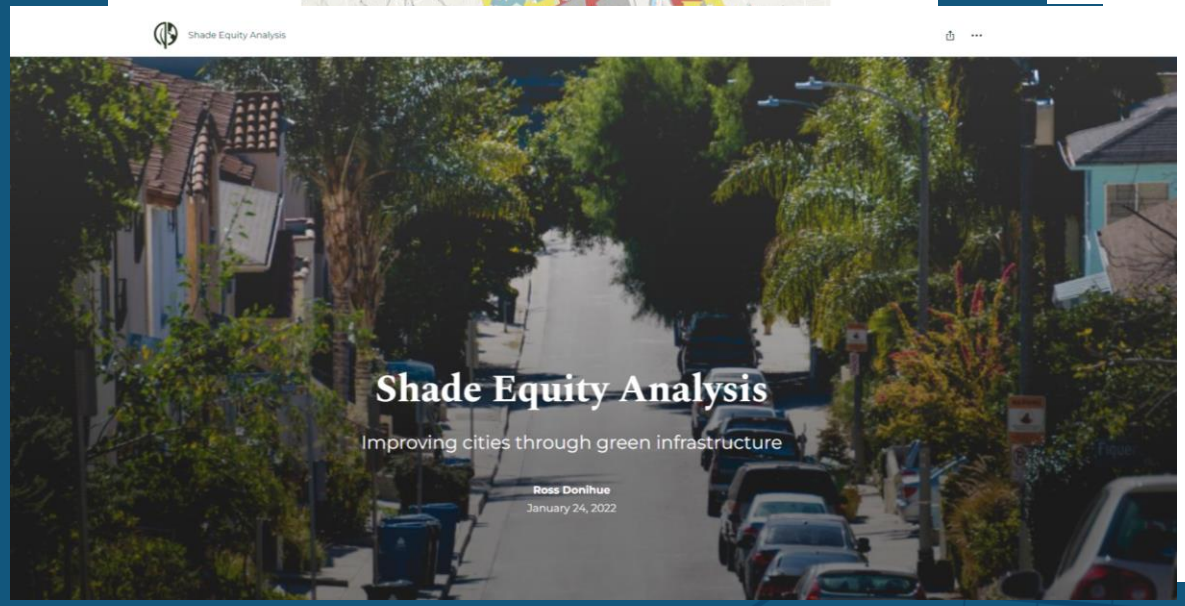


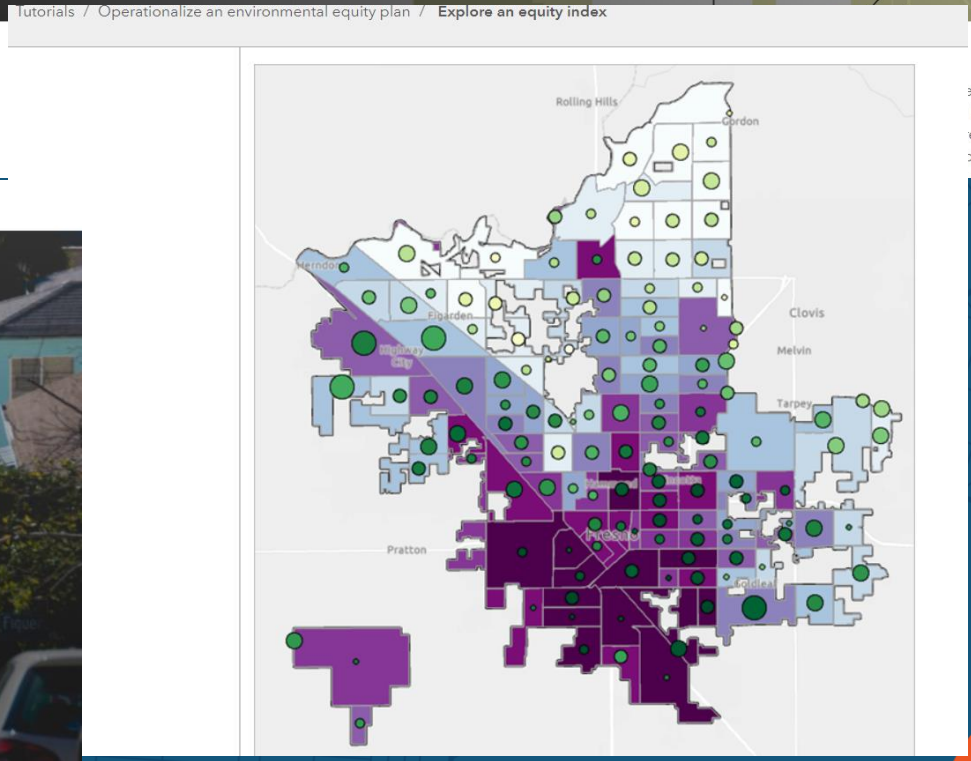
Expand **2017-2021 Vehicles Available (ACS)** and check the box for **2021 Renter Households with No Vehicles (ACS 5-Yr)**.

Urban Heat Equity





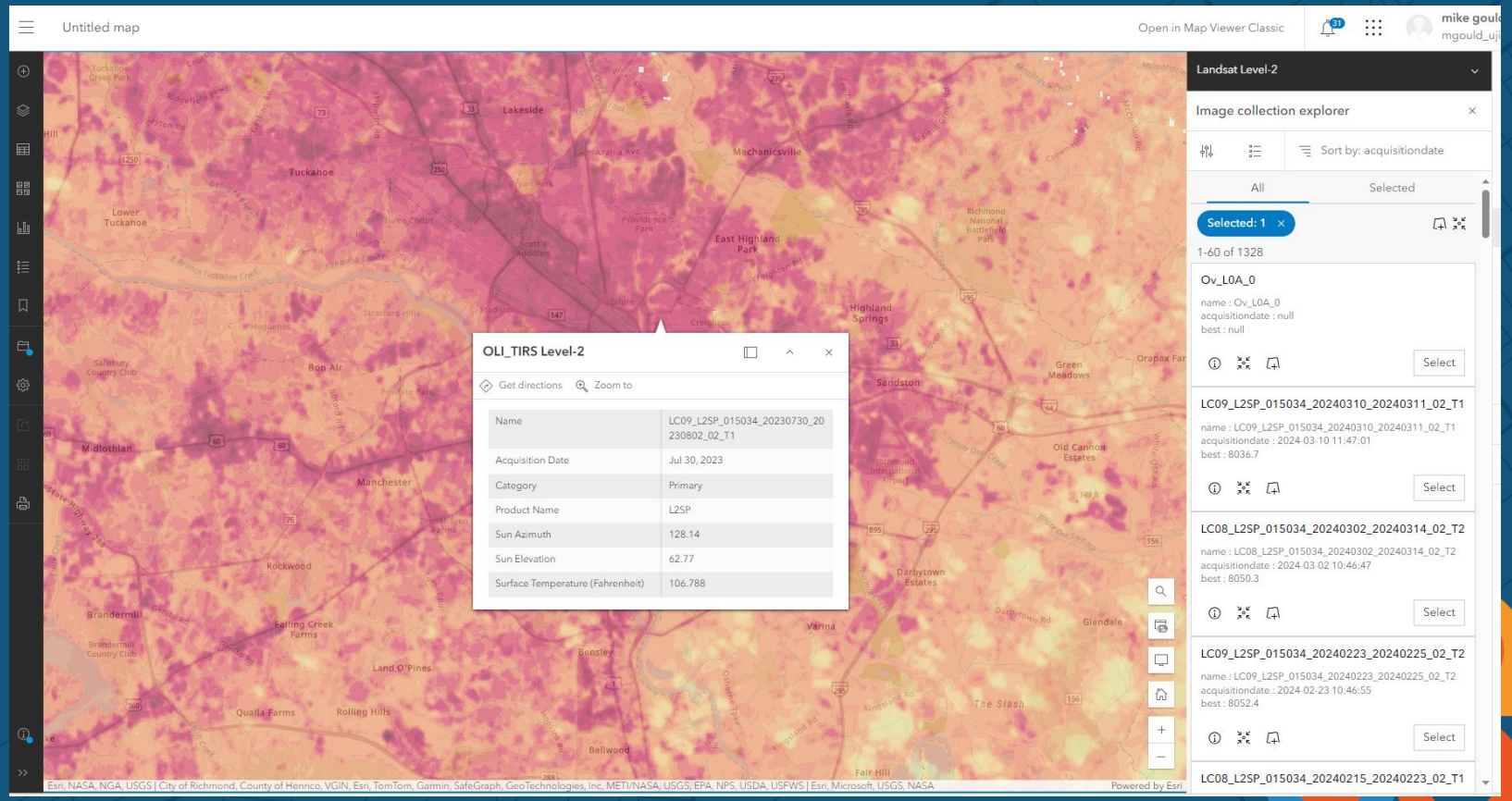




ermine where to best
directives. Indices are
e an intervention
ocal a level of data as

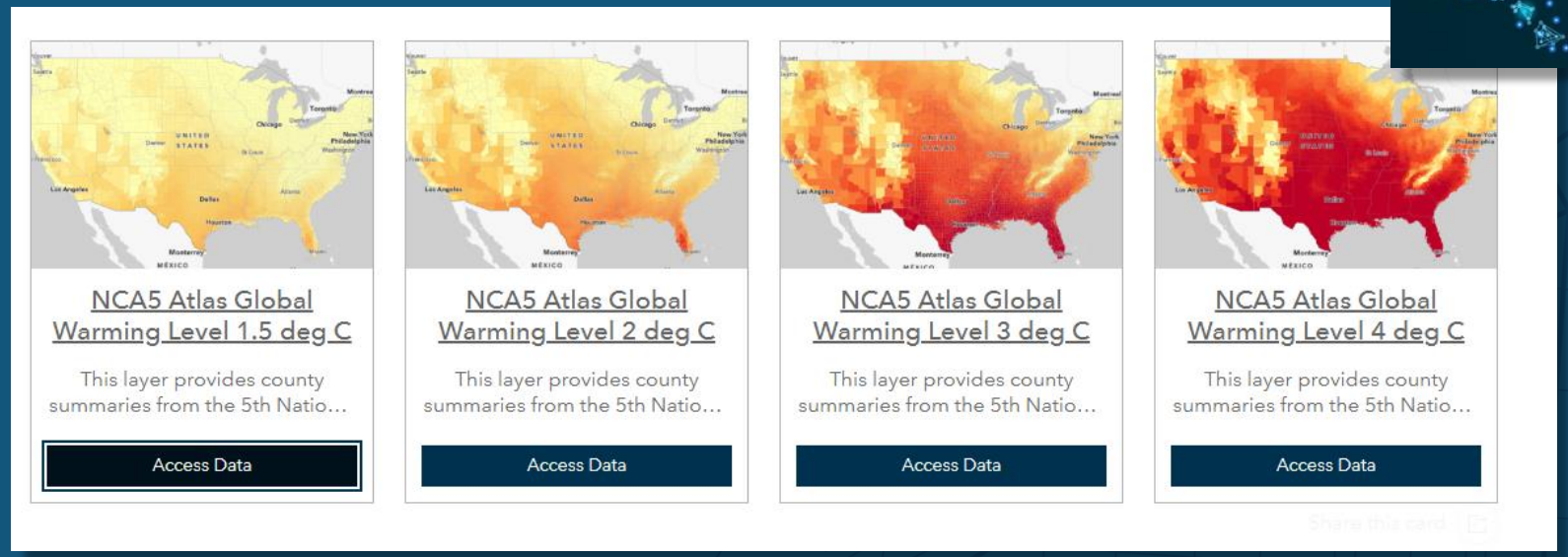
Surface Temp: From Landsat Level-2

- Thermal (TIR) Bands 10,11
- Resampled at 30m
- Land Surface Temp (LST)
  - Not ambient temp
  - But a good global proxy
- Landsat Level-2 imagery available on the *Living Atlas of the World*
- Which image to use?
  - Landsat Explorer can assist



National Climate Assessment

https://toolkit.climate.gov/
https://toolkit.climate.gov/#tools
https://toolkit.climate.gov/tool/nca-interactive-atlas

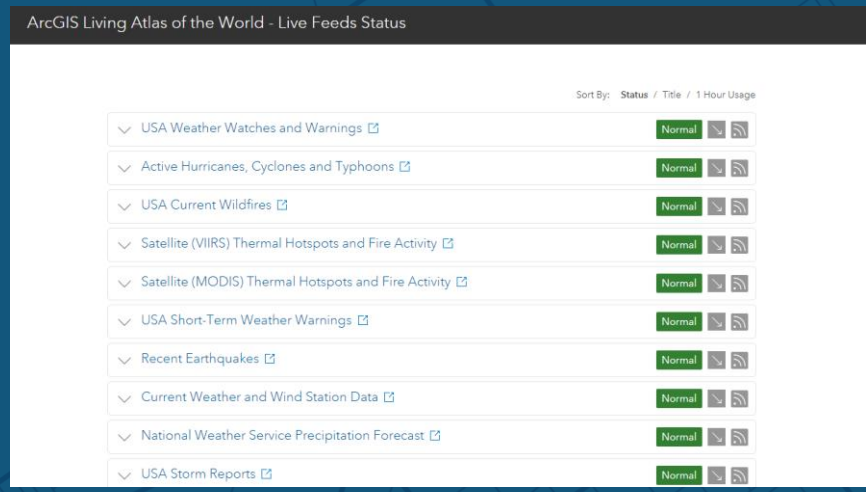


Activity 3: Explore the ArcGIS Living Atlas apps

Drought Aware, Water Balance, Sentinel-2 Cover Change, Landsat Explorer

Activity 4: Examine ArcGIS Living Atlas Real Time Feeds

1) Go to the Living Atlas: https://livingatlas.arcgis.com/en/home/ > Browse > Search on Live Feeds > Open the Live Feeds Status Page > View.
2) Click on Live Stream Gauges > Examine metadata > open in Map Viewer. This will open the contents in the www.arcgis.com ArcGIS Online Map Viewer.
3) Observe global pattern. Zoom to USA > select a gauge > observe popup. Edit popup > Remove organization. Add media to popup > Bar chart > on field Flow (cfs) > Make horizontal orientation > Done > test popup.
4) Filter on > Status is Major Flood. Observe patterns.
5) Add data from ArcGIS Online > Base reflectivity Radar time enabled: Compare to flooding gauges. Add data from URL: This URL for radar base reflectivity.: https://mapservices.weather.noaa.gov/eventdriven/rest/services/radar/radar_base_reflectivity/MapServer



Activity 5: Identify Climate Hazards with a Web Mapping App

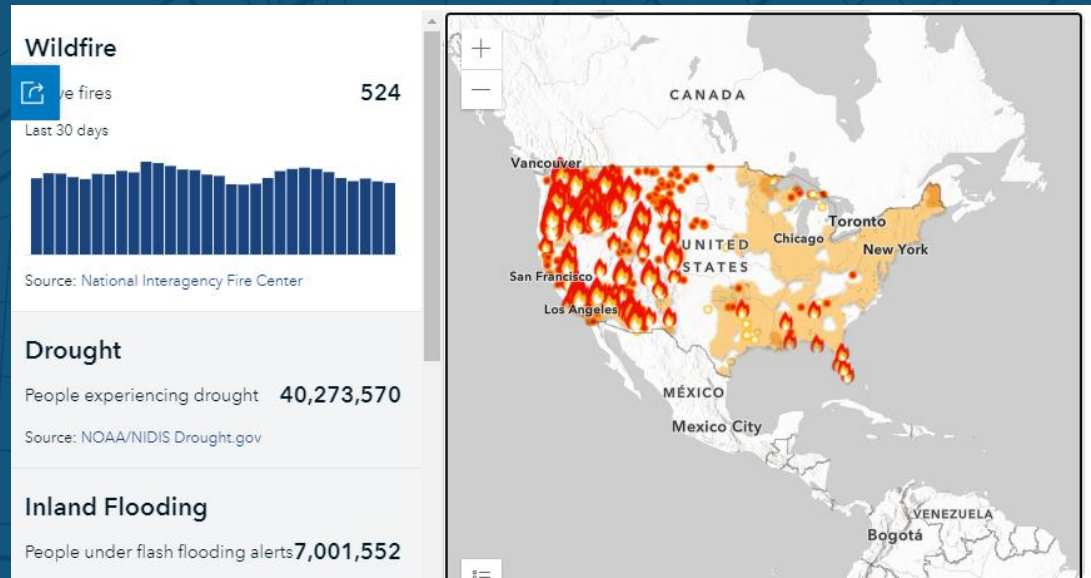
1) Go to this mapping app and scroll down to Identify Climate Hazards:

https://gis-for-climate-resilience-learngis.hub.arcgis.com/pages/community-action

2) Answer these questions: Which of these 5 climate hazards is currently affecting the most people? Are there any hazards currently affecting your community, region, or state?

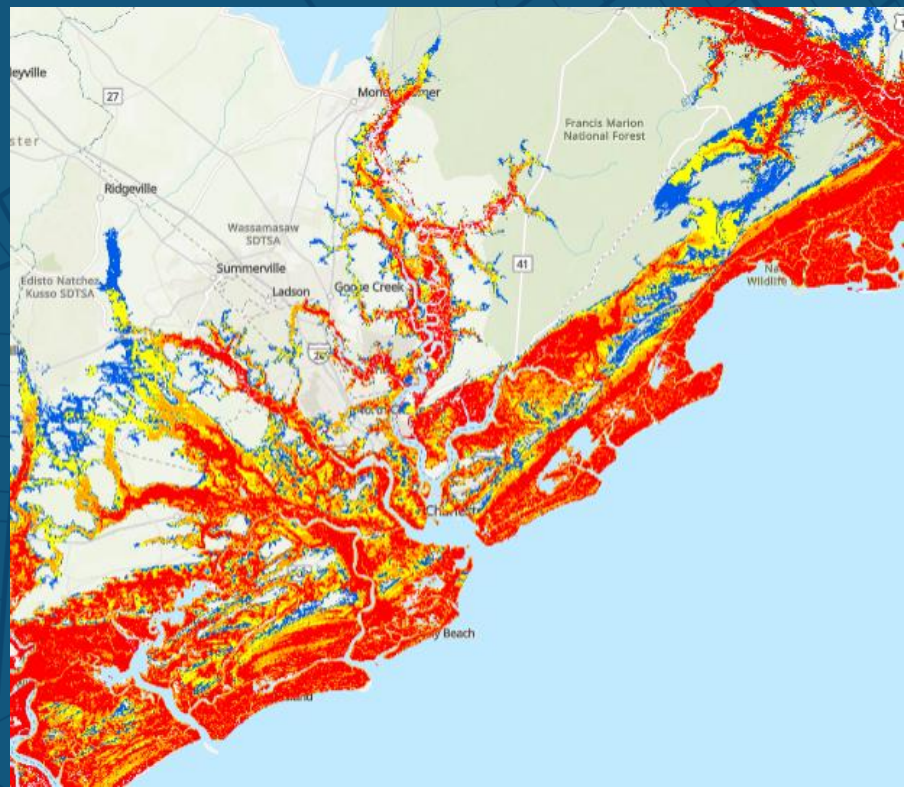
3) Which hazard poses the greatest threat to your community, region, or state? Note: Conditions vary seasonally. Consider how all four seasons might affect hazards like wildfire, extreme heat, and flooding.

4) How could you make your **own** web mapping applications? Instant apps, dashboards, story maps, Experience Builder apps.



Activity 6 Part 1: Analyze Coastal Hazards and Habitat in ArcGIS Online

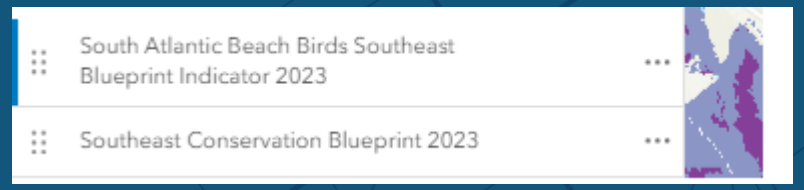
1) Open this map in ArcGIS Online: Map Viewer (arcgis.com) : https://www.arcgis.com/apps/mapviewer/index.html?webmap=4cd40122c95c4fed9266cf28a30d2abe
2) Explore the map via the 3 bookmarks and the 2 vector layers (schools and OSM buildings) and 3 raster layers (storm surge and hábitat). The storm surge data is basad on the National Weather Service SLOSH model maximum for Category 2 and 3 hurricanes. The OSM is a crowdsourced layer from the Open Street Map initiative. Can you determine some spatial relationships between buildings, habitat, the coastline, and the SLOSH data?

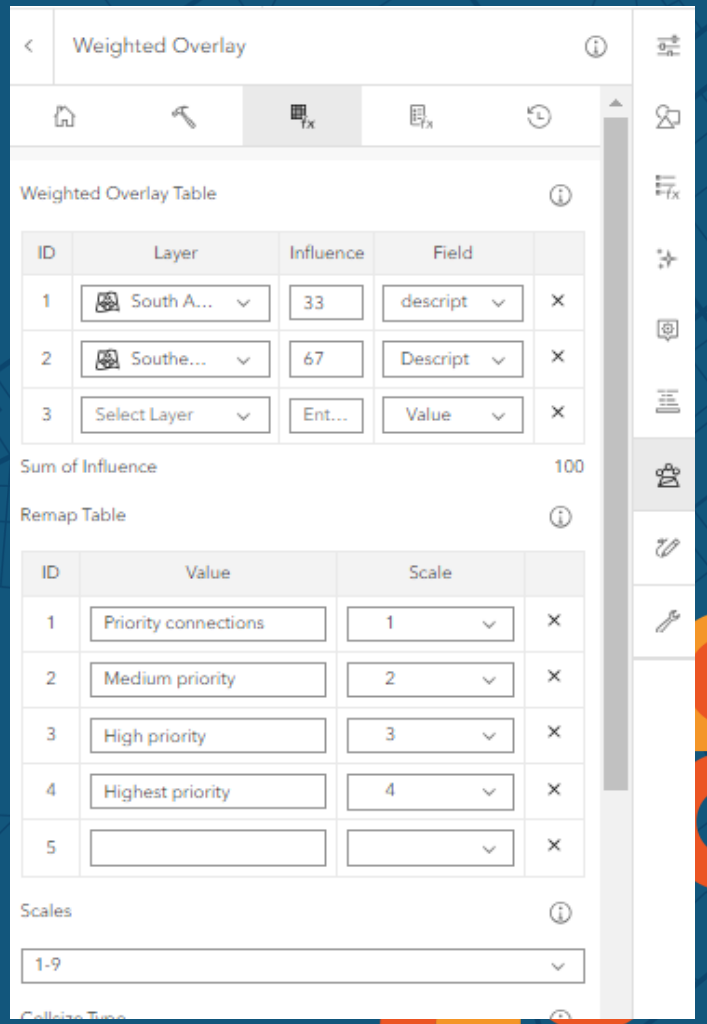


Activity 6 Part 2: Analyze Coastal Hazards and Habitat in ArcGIS Online

3) Using the raster tool “weighted overlay”, you could determine the areas that are high priority for Southeast Conservation blueprint **and** are high priority for the South Atlantic Beach Birds, using the parameters at right and weighting the conservation layer at 33% and the birds layer at 67%.

4) This tool takes awhile to run, so to just see the results, examine this final map, here.





Activity 7 Part 1: Analyzing IPCC Scenarios 2001-2100

Open the following map in ArcGIS Online Map Viewer:

https://www.arcgis.com/apps/mapviewer/index.html?webmap=24bdf1aedb1b41b9a5ddf02f54f9ad1c

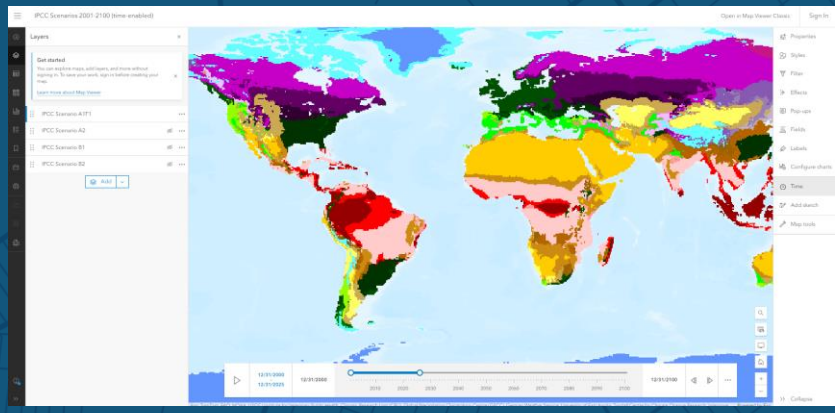
(1) Examine the metadata for the map and layers.

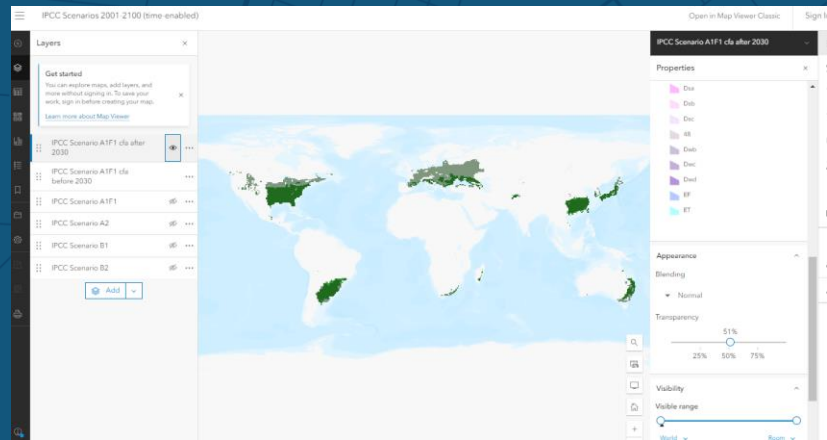
(2) Play time tool and observe patterns. Select each scenario layer (A1F1, A2, B1, B2), play time tool, and observe patterns over time and across different models. What difference(s) do you note?

(3) Focus on A1F1: Note expansion of cfa (Warm temperate, fully humid, hot summer) in eastern North America and Europe but not in China. Which other climate zones are predicted to expand? Which are predicted to contract? Why?

(4) Search for Ottawa Canada and add to new sketch. Add text to this point that says “Ottawa” Play timeline for 4 IPCC scenarios. Observe global patterns. Observe scenario for Ottawa through 2100. Zoom in to Ottawa and create a bookmark called “Ottawa”

(5) Repeat step 4 for another city of interest. Then turn off “time” tool. Then zoom to world and create a bookmark called “World”.





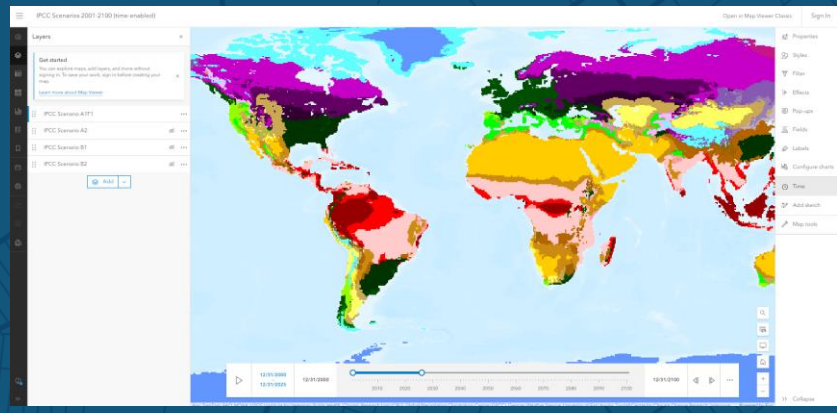
Activity 7 Part 2: Analyzing IPCC Scenarios 2001-2100

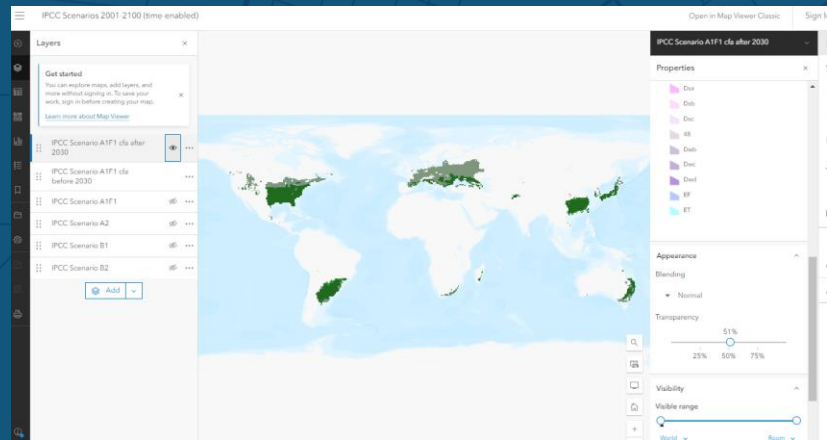
Open the following map in ArcGIS Online Map Viewer:

https://www.arcgis.com/apps/mapviewer/index.html?webmap=24bdf1aedb1b41b9a5ddf02f54f9ad1c

6) Make IPCC A1F1 the active layer > Filter on All of the following are true: GRIDCODE is Cfa and End_Year is before 8/1/2030 > Save. Observe pattern. Duplicate layer and name duplicate IPCC A1F1 cfa before 2030. Filter IPCC Scenario A1F1 > All true: GRIDCODE is Cfa and End_year is **after 8/1/**2030. Duplicate layer and name it IPCC A1F1 cfa after 2030. Drag the “before” layer below the “after” layer.

7) Use Styles > Style options > change color of cfa after 2030 to a different color. Toggle and compare cfa time snapshots. Use Properties > Transparency and make “after” layer semi-transparent. Compare. For example map, click here.





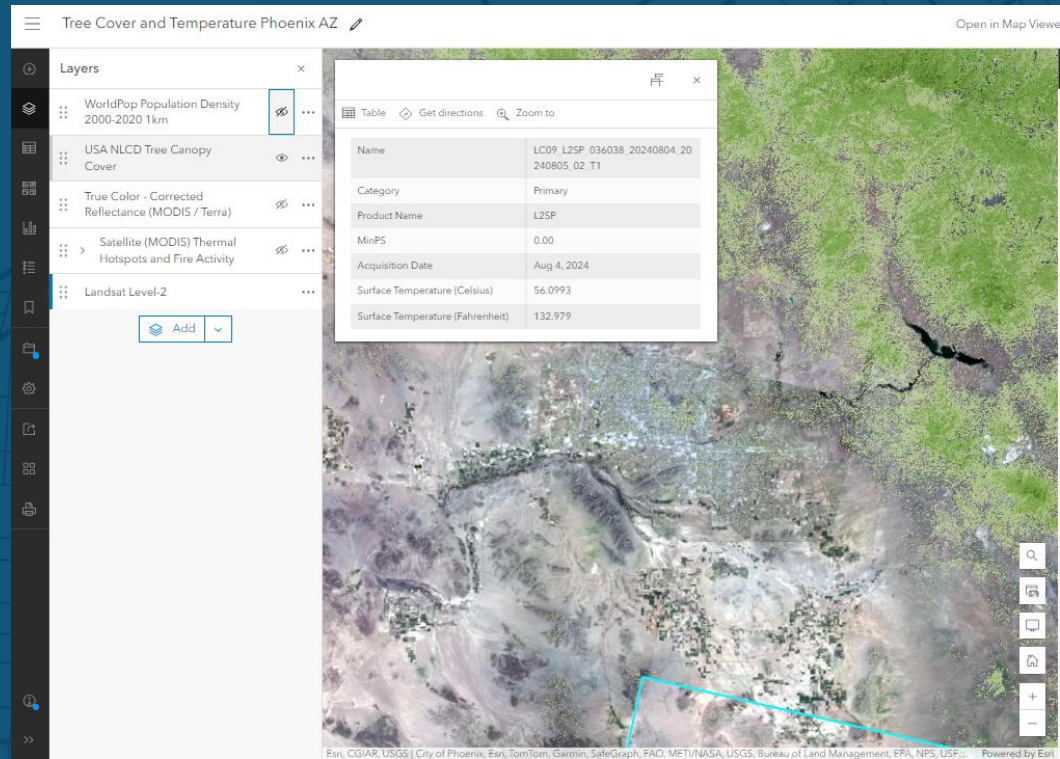
Activity 8: Explore and render raster data in ArcGIS Online

(1) Start ArcGIS Online (www.arcgis.com) > Sign In > Search for and zoom to Phoenix AZ.

(2) Add 3 layers from the Living Atlas: [A] Landsat Level-2. [B] USA NLCD Tree Canopy Cover. [C] WorldPop Population Density.

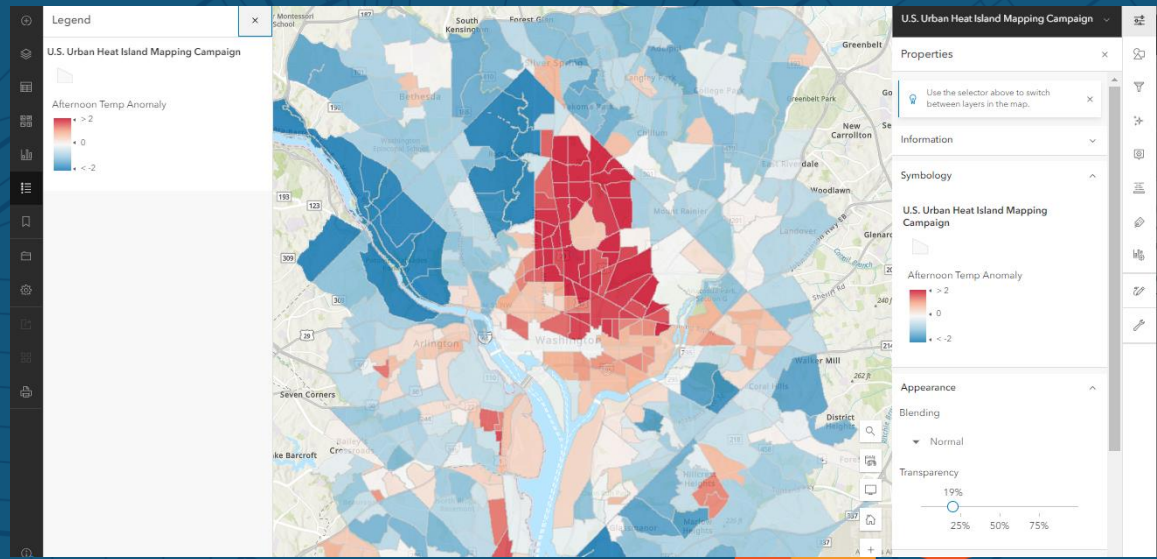
(3) Configure popups for Landsat to indicate Surface Temperature in C and F, Click here for sample map (you'll need to sign in to view it). Popups > Disable "display topmost image only".

Examine relationships and patterns. Experiment with transparency settings.



Activity 9 Part 1: Examining heat using the composite index tool

1) Examine the metadata for the US Urban Heat Island mapping campaign (temperautre, enviro, demographic information): https://www.arcgis.com/home/item.html?id=777502ece2b343f7b3ec54170f0d972e and then open it in the ArcGIS Online map viewer.
2) Sign in to ArcGIS Online and save your map.
3) Zoom to Washington DC and note how neighborhood temperature compares to the city-wide temperature. Since climate and weather don't vary much over short distances, the temperature anomalies across the city are due to differences in the landscape, such as the amount of tree cover or development.



Activity 9 Part 2: Examining heat using the composite index tool

4) Analysis > Calculate composite index > Input features: Urban heat islands campaign.
5) In Input variables, select these 3 variables – one that indicates exposure to heat, and two that indicate vulnerability to heat:

Afternoon Temp Anomaly, with a Weight of 2. The weight of this variable is 2 x more important than the others as it's a critical factor in determining the risk of high heat events > Add > Poverty %, with a Weight of 1 > Add > 65 and older %, with a Weight of 1.

6) In Index settings, combine scaled values (mean) > change the Minimum to 0 and the Maximum to 100: Output will be rescaled to make the minimum value 0 and the maximum value 100, to be more interpretable. Use defaults for the rest of the parameters. Output: Provide an appropriate name such as Urban Heat Risk Index Wash DC.
7) Analyze results: Darkest purple color where the aft temperature anomaly is higher, and where a higher % of people are in poverty and a higher % of people are over 65+.

Activity 9 Part 3: Examining heat using the composite index tool

8) Run results of index through Find Outliers tool to gain insights on spatial patterns: Find Outliers > Use Index – Mean field as the analysis field > Use defaults for other parameters. Result layer: Provide meaningful name such as Find Outliers Urban Heat Index Wash DC

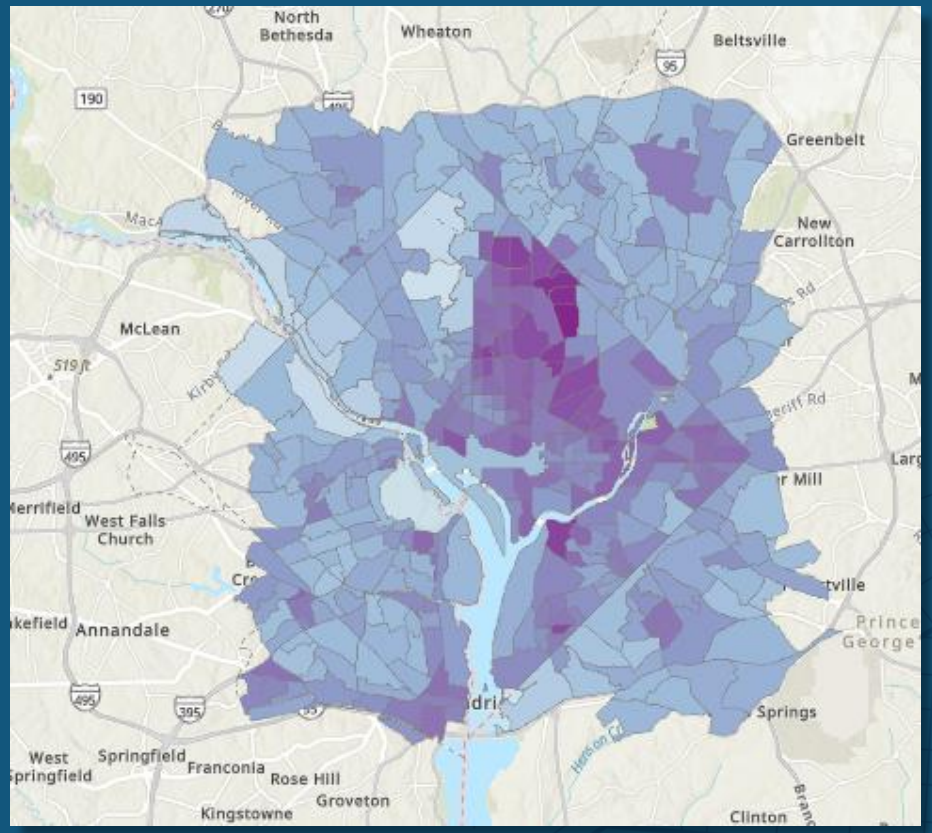
9) The output of this tool shows different types of clusters and outliers in the index: Pink locations are hot spots where the index results are high. The pale blue locations are cold spots where the index results are low. The dark blue locations are low high outliers – the index result is low relative to the neighboring census tracts. The red locations are high low outliers – the index result is high relative to the neighboring census tracts.

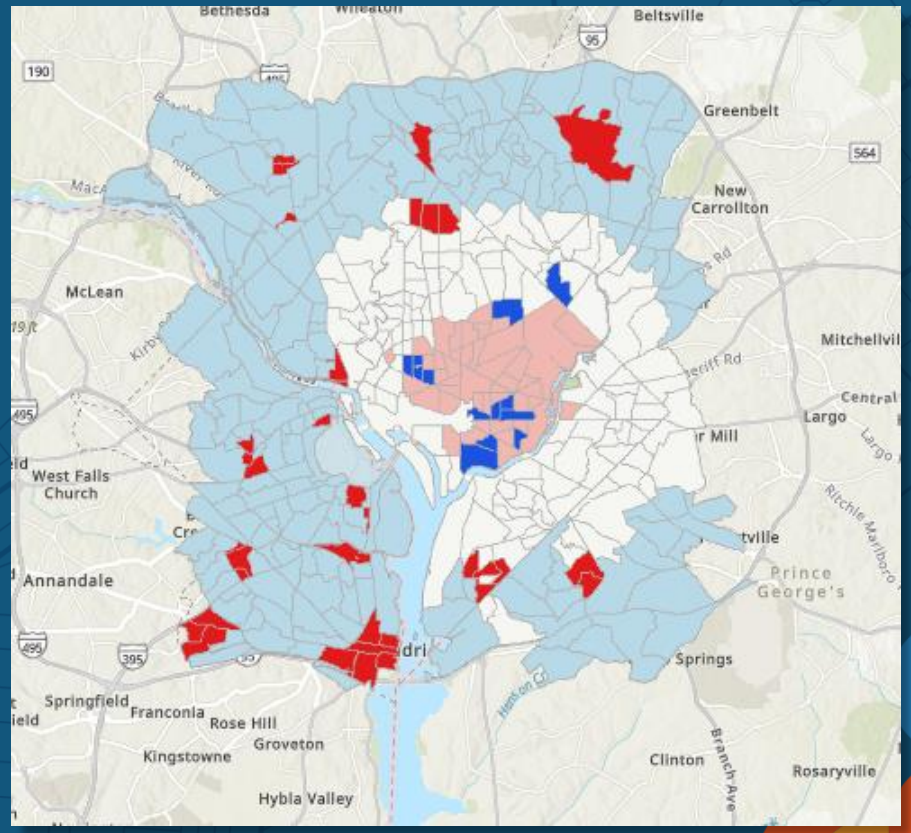
How could this inform action? For example, we might decide that the pale blue areas have less need for cooling centers, but any cooling centers we do add in the city should be in the red locations as these have higher risk relative to their surroundings.

Activity 9 Summary: Examining heat using the composite index tool

For more, see best practices on creating composite indices:

https://www.esri.com/content/dam/esrisites/en-us/media/technical-papers/creating-composite-indices-using-arcgis.pdf





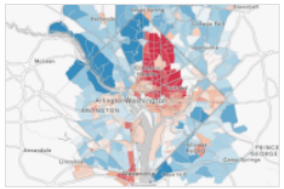
NOAA Urban Heat Island Campaign data

Often referred to as CAPA data (Produced by CAPA Solutions and NOAA

Overview Pricing Map Scene Help Sign In

U.S. Urban Heat Island Mapping Campaign

Overview Data Visualization



NOAA Urban Heat Island campaign to map temperatures has been summarized by neighborhood and includes environmental and demographic information.

Feature layer from Esri
Managed by esri_environment

Item created: Jul 15, 2021 Item updated: Oct 13, 2023 View count: 34,695

Authoritative Living Atlas

Open in Map Viewer

Open in Scene Viewer

Open in ArcGIS Desktop

Description

Cities in the U.S. are getting hotter, and that is causing significant health risks, especially to minorities, the elderly, and impoverished. There is significant spatial variation in temperature across a city due to changes in the landscape (elevation, tree cover, development, etc).

NOAA has been engaged in a nationwide effort with CAPA Strategies to use a combination of Sentinel-2 satellite data along with temperature readings recorded from car- and bike-mounted sensors to generate detailed maps of the urban areas most impacted by heat. These measurements have been combined into single raster layers for morning, afternoon, and evening temperatures. As of 2020, 27 cities (26 in the U.S) have been mapped; a total of 50 cities will be mapped by the end of 2021.

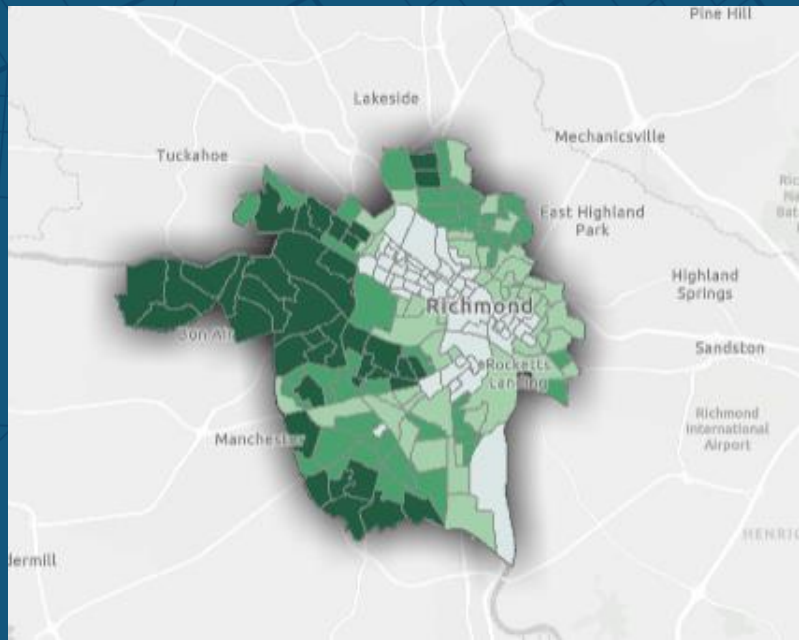
This layer shows the census tract (neighborhood) averages for those temperatures, along with additional information calculated for each neighborhood including:

Details

Source: Feature Service
Data updated: Jul 16, 2021, 4:38 PM
Schema updated: Jul 16, 2021, 4:38 PM
Size: 0 KB
ID: 777502ece2b343f7b3ec54170f0d972e

Activity 10 Part 1: Analyzing the urban heat effect

1) Open the Richmond urban heat islands map: https://www.arcgis.com/apps/mapviewer/index.html?webmap=3ef53b0b8a194b2c913a13497f7fe0c4 Sign in to ArcGIS Online > save map > view the map's layers.
2) First, calculate the maximum evening air temperature for each census block group. The Zonal Statistics as Table tool will allow for extracting the values from the air temperature layer, which contains raster data, and summarize this information to each census block group to understand how air temperature changes by neighborhood: Analysis > Tools > type "zonal" to find and choose Zonal Statistics as Table > For Input zone raster or features, choose Census Block Groups - For Zone field, choose GEOID - For Input value raster, choose Evening Temperature - Under Statistical analysis settings, for Statistic type, choose Maximum – for output table name: EveningTemp_BG (for block group) > Run.



Activity 10 Part 2: Analyzing the urban heat effect

3) You should now have a new table in the map: Go to Contents > Tables > open your new table. This table shows maximum evening air temp for each block group in degrees F. Note the range of temperatures across block groups. Later, you will use the Join Features tool to join this table to the Census Block Groups layer.

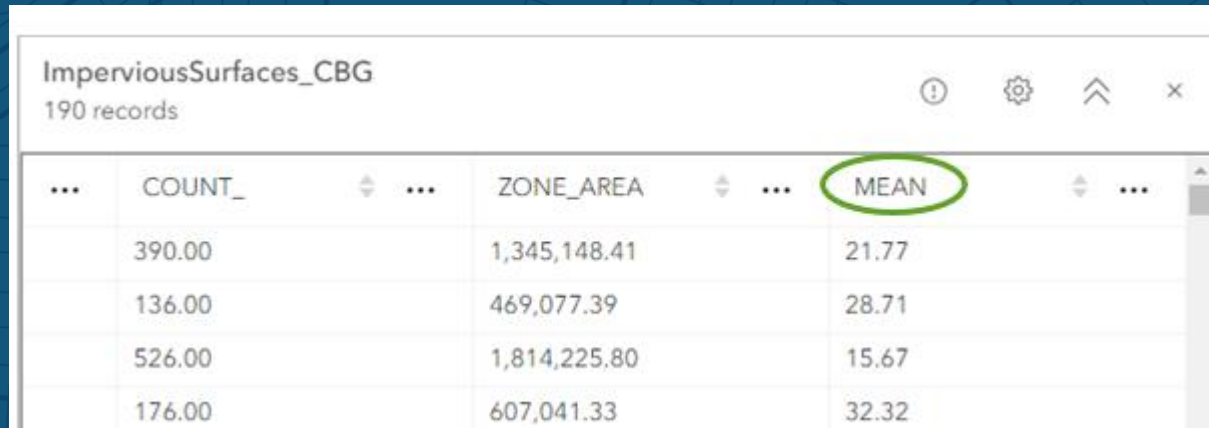
4) Next, determine a baseline value of evening air temperature by calculating the mean value for the whole city: Again access Zonal Statistics as Table tool > For Input zone raster or features, choose City Boundary – For zone field: OBJECTID - For Input value raster, confirm it is set to Evening Temperature - Under the Statistical analysis settings, for Statistic type, choose Mean – Output Table name: EveningTemp_Mean_<your initials> > Run.

5) Open your new “mean” table – this contains evening air mean temperature for single day of collection across the city: 87.63 deg F. You can now compare this median value to max temps within each block group and determine if a particular block group is warmer or cooler than the rest of the city.

Activity 10 Part 3: Analyzing the urban heat effect

6) Impervious surfaces are present in developed spaces and absorb and retain heat, contributing to the urban heat island effect. Using the Zonal Statistics as Table tool, you will now calculate mean percent of impervious surfaces within each census block group. You can later calculate the percentage of impervious surfaces in each census block group. Use the tool Zonal Statistics as Table again > For Input zone raster or features, choose Census Block Groups - For Zone field, choose GEOID - For Input value raster, choose Impervious Surfaces – Under statistical analysis settings: Statistic type: Mean – Output Table name: ImperviousSurfaces_BG_<your initials> > Run.

7) Open new ImperviousSurfaces_BG table and note the mean, which is the mean % of impervious surface in the block group.


ImperviousSurfaces_CBG
190 records

COUNT_	ZONE_AREA	MEAN
390.00	1,345,148.41	21.77
136.00	469,077.39	28.71
526.00	1,814,225.80	15.67
176.00	607,041.33	32.32

Activity 10 Part 4: Analyzing the urban heat effect

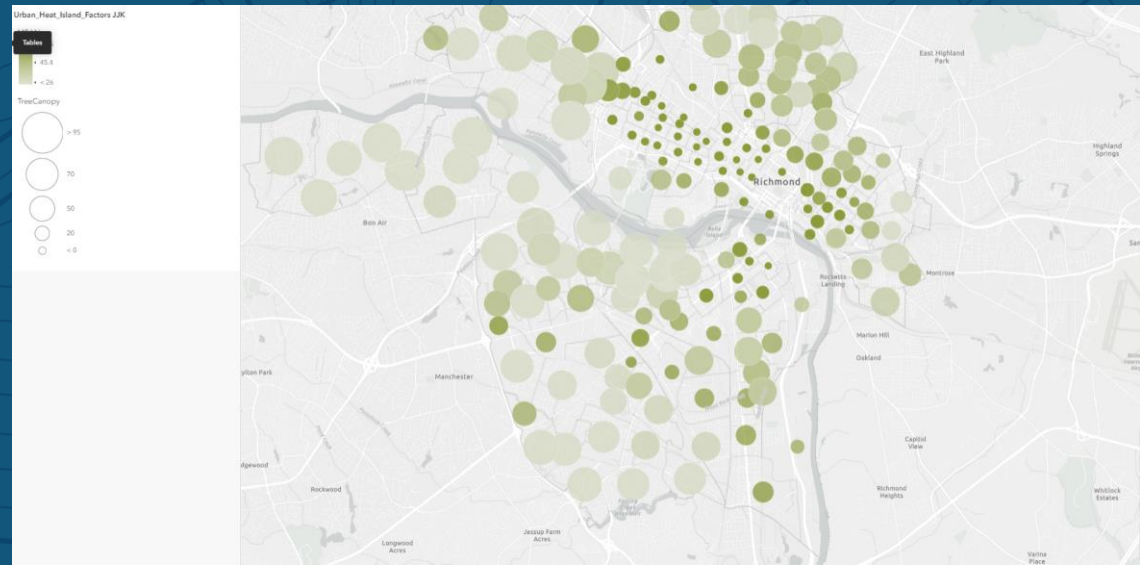
8) Now that you've summarized air temperature and impervious surfaces by census block group, you will join the analysis results into a single layer showing where potential heat islands are located across the city: Analysis > Search for and open the Join Features tool > In the Join Features tool pane, for Target layer, choose Census Block Groups. For Join layer, choose Evening Temp BG – zonal statistics table. Join settings: For Target field and Join Field, choose GEOID. Leave the other default settings as they are. Result layer: Output Name: BG_Temp_<your initials> > Run. When done, observe your new layer.

9) Now you will join the data from the impervious surface table to the BG_Temp layer. In the Join Features tool pane, enter the following: For Target layer, choose BG_Temp - For Join layer, choose ImperviousSurfacesBG- your zonal stats table - Under the Join settings section, for Target field and Join field, choose GEOID. Leave the other defaults as they are - For Output name: BG_Temp_Surfaces _ < your initials> > Run.

10) The BG_Temp_Surfaces layer now contains data for the max evening temp **and** mean impervious surface value for each block group.

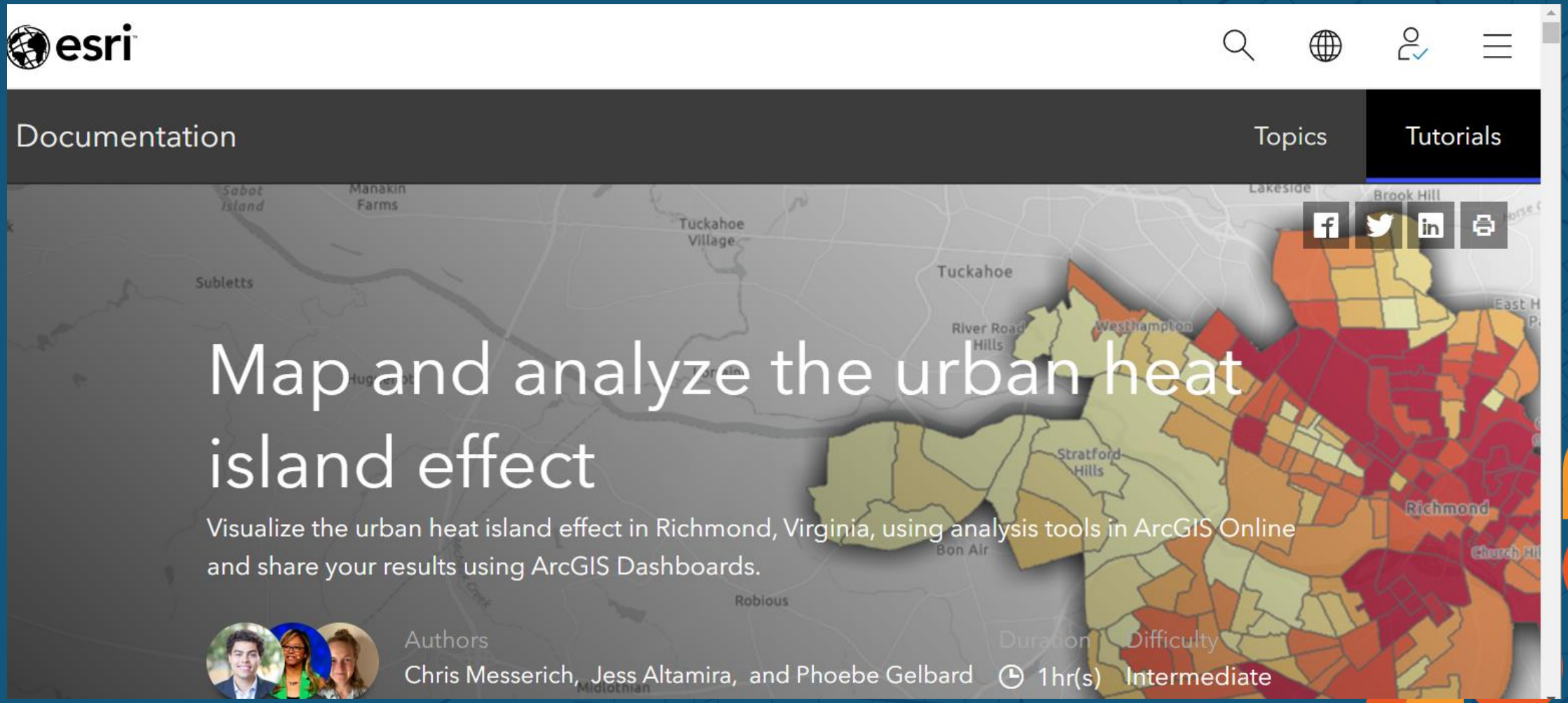
Activity 10 Part 5: Analyzing the urban heat effect

11) For the final join, you will join tree canopy data to the BG_Temp_Surface layer: Join Features tool: Target layer: BG_Temp_Surfaces. For Join Layer: Percent Tree Canopy. Join Settings: Use Attribute Relationship: Target Field and Join Field: GEOID. Output Layer: Urban_Heat_Island_Factors_<your initials> > Run.
12) Observe your final urban heat island factors map. You now have a layer that can visualize the urban heat island effect factors by census block groups.
13) Change style on your final map on “MEAN” as a choropleth map. Then, style > add field TreeCanopy to make a bivariate map. What patterns do you notice?
14) For a sample final map, click here.



For more detail, see this lesson:

https://learn.arcgis.com/en/projects/map-and-analyze-the-urban-heat-island-effect/



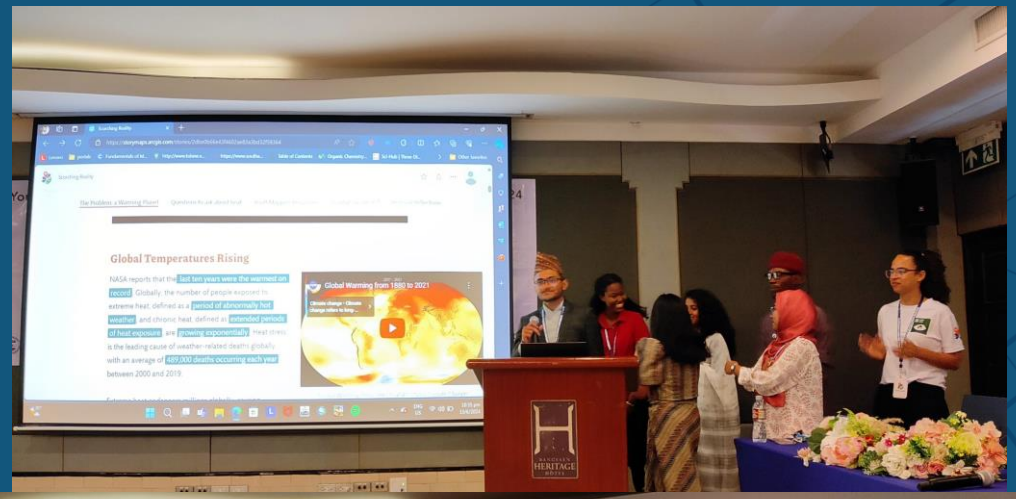
Perfecting the Resilience Model

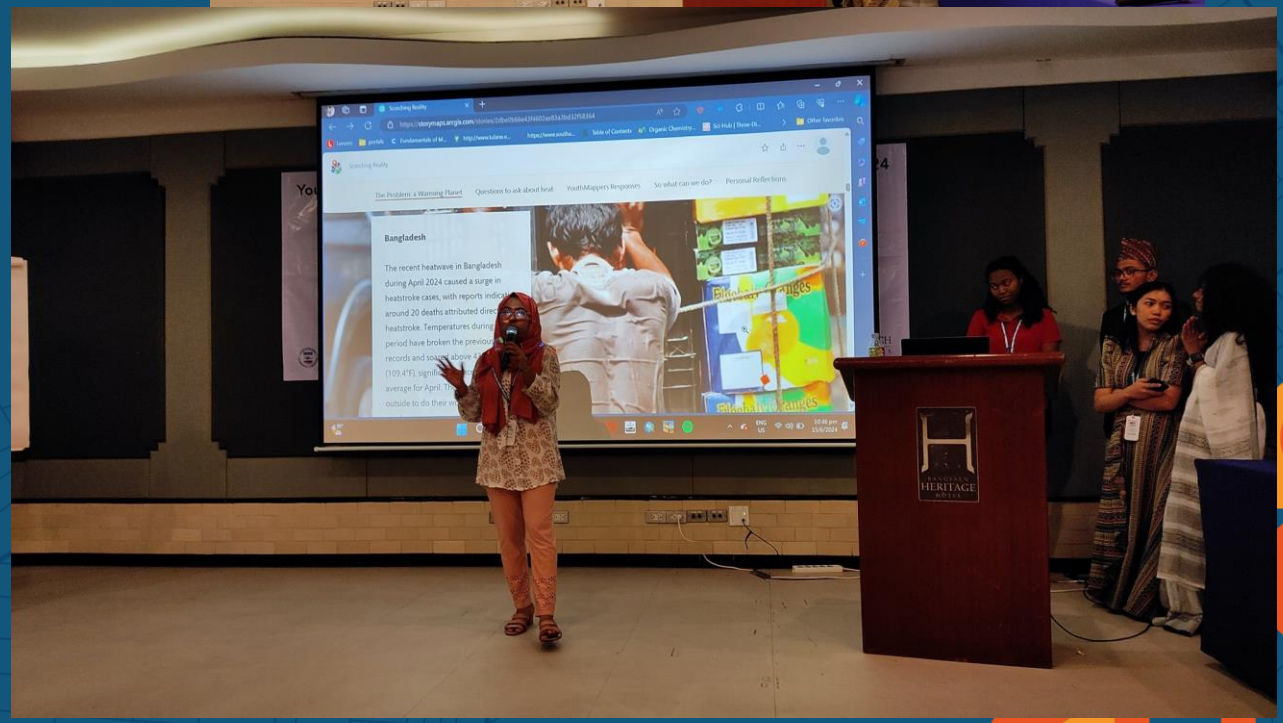
GIS is more than just mapping…

- Clever GIS people can imagine a host of analysis options
- Automate the processing of Land Surface Temperature each day/week
- Walk-time or Drive-time analyses
  - Who lives within a 15-minute walk to cooling stations or shady parks?
- Where to locate new (or mobile) cooling centers? (Is there wifi coverage?)
- Extract features (DL) such as mobile homes, pools and fountains,…
- Resource allocation: how to cover 80% of the vulnerable population with cooling solutions
- Analysis of commuting options: bus stops, car parking, etc.
- More detailed demographic and shopping behavior analysis

YouthMappers

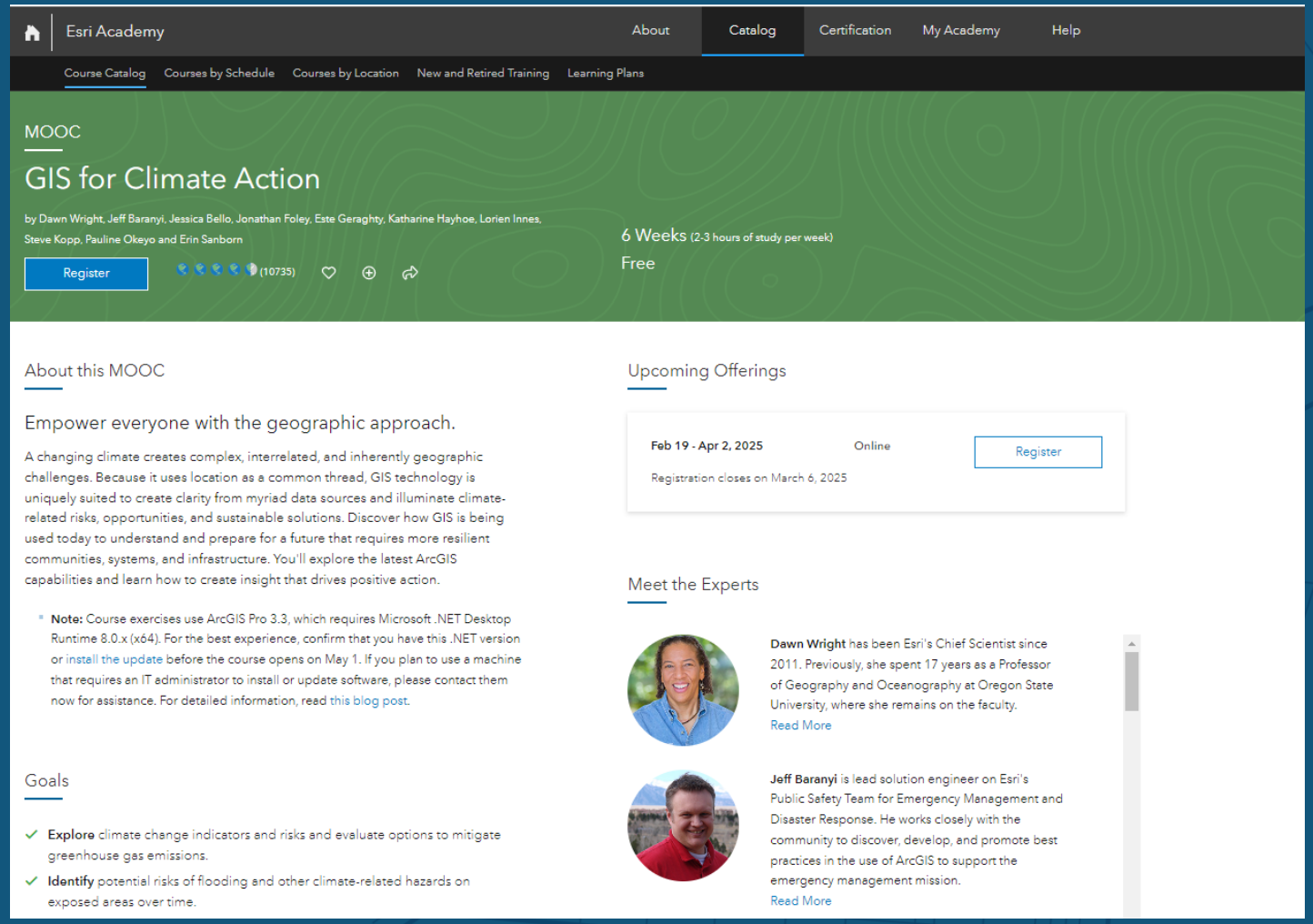
- >400 university chapters
- OSM plus other mapping
- Pictured: June leadership training Bangkok
- SDG13 team worked on extreme heat mapping



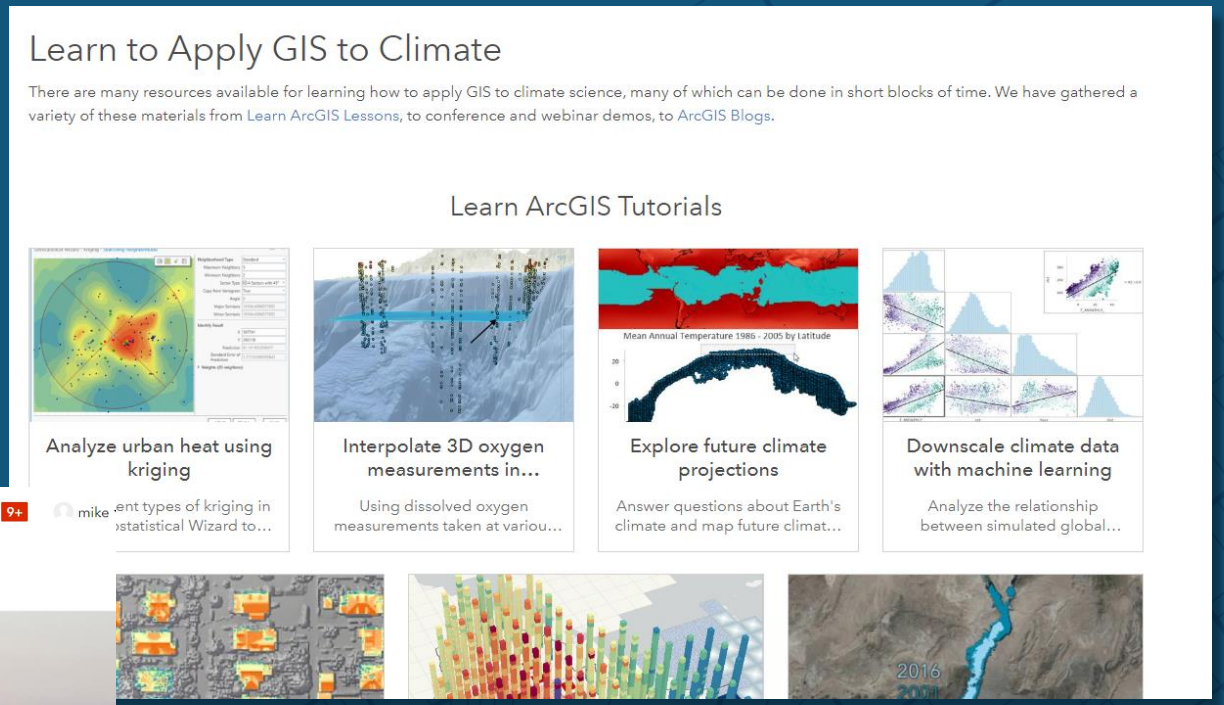


Learning Resources: Climate Action MOOC

3rd offering: February 2025. Includes a heat mapping section and much more.



Tutorials on https://learn.arcgis.com

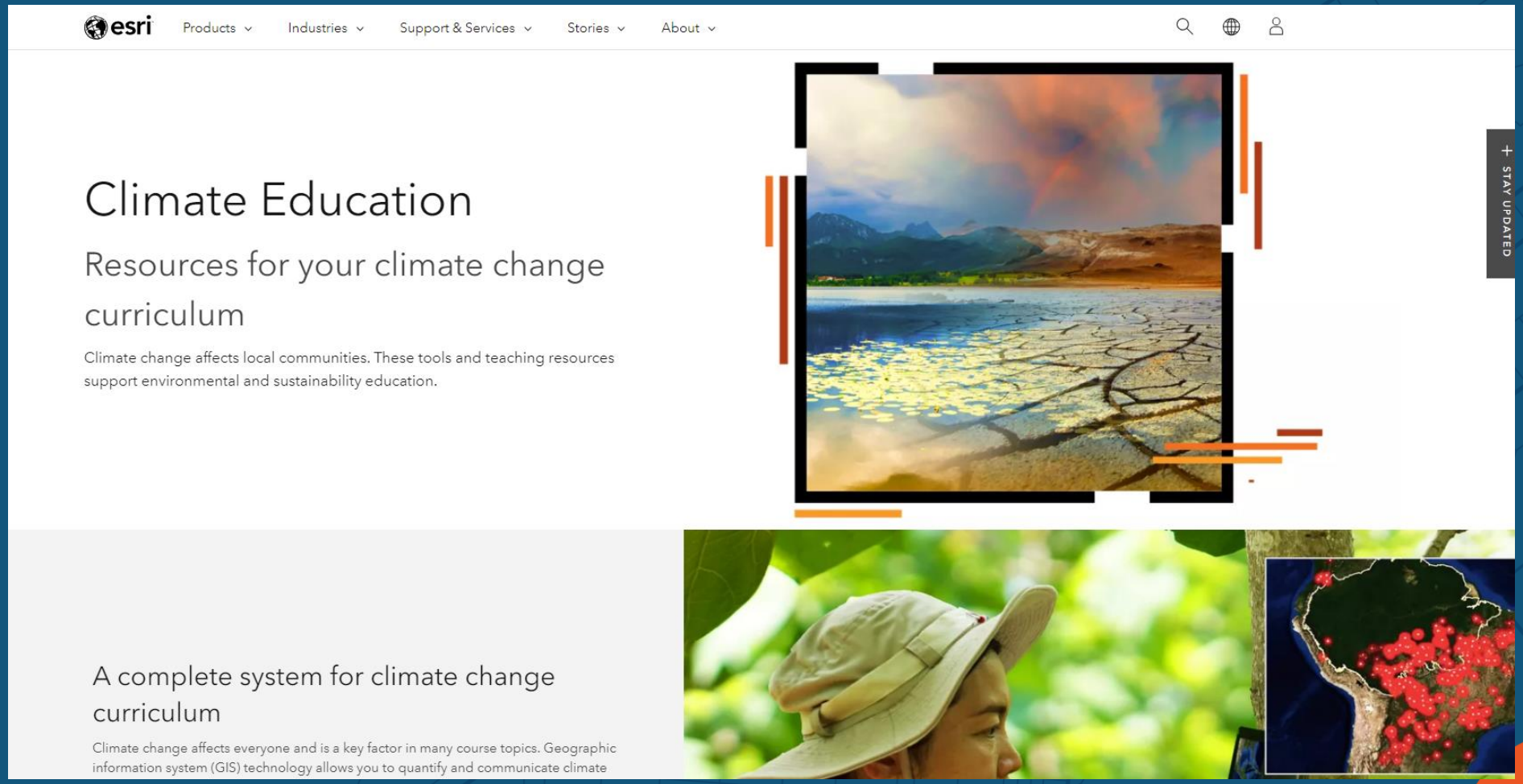


How to teach and learn about these topics?

https://community.esri.com/t5/education-blog/using-webgis-to-teach-climate-resilience/ba-p/1266780
Mike Gould, Joseph Kerski

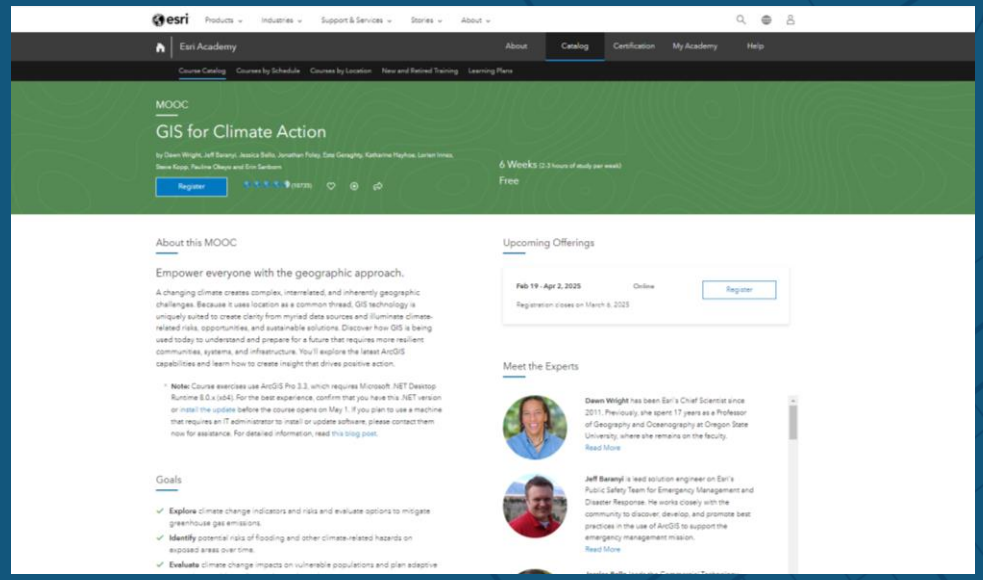
Additional Instructional Resources

https://www.esri.com/en-us/industries/higher-education/climate-education



Upcoming Events

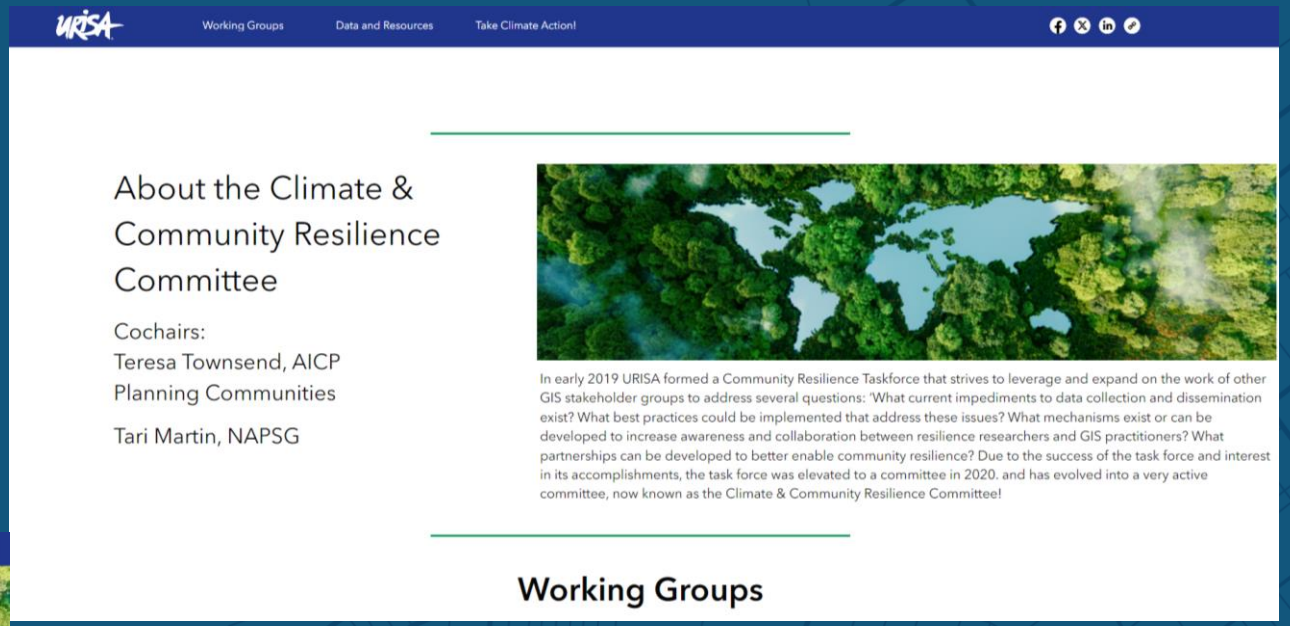
- Climate Action MOOC (Feb 2025)
- Esri Education Summit, July 2025
- Esri UC, July 2025
- Innovate4Cities (GCOM, UN-Habitat), Montreal 10-12 September
- URISA GIS Pro, October 7-10
- UN Data Forum, 12-15 Nov
- Ongoing: Esri Higher Education chats, 1st Tue of every month.
- Ongoing: Esri Education blog space.



Naciones Unidas
FORO MUNDIAL DE DATOS
MEDELLÍN, COLOMBIA
12-15 NOVIEMBRE 2024

Organizations to partner with

- URISA
- AASHE
- Esri
- UCAR



Take-Aways

Teaching and learning about climate with GIS

- Perfect time for teaching and researching climate with GIS
- Perfect time for taking action on climate related topics such as Urban Extreme Heat
- ArcGIS can be a valuable tool and approach: Many possible, related workflows
- Many relevant Data Sets available (Living Atlas of the World)
- Many relevant Best Practice examples to tap into the collective wisdom
- Many Learning Resources exist for moving ahead