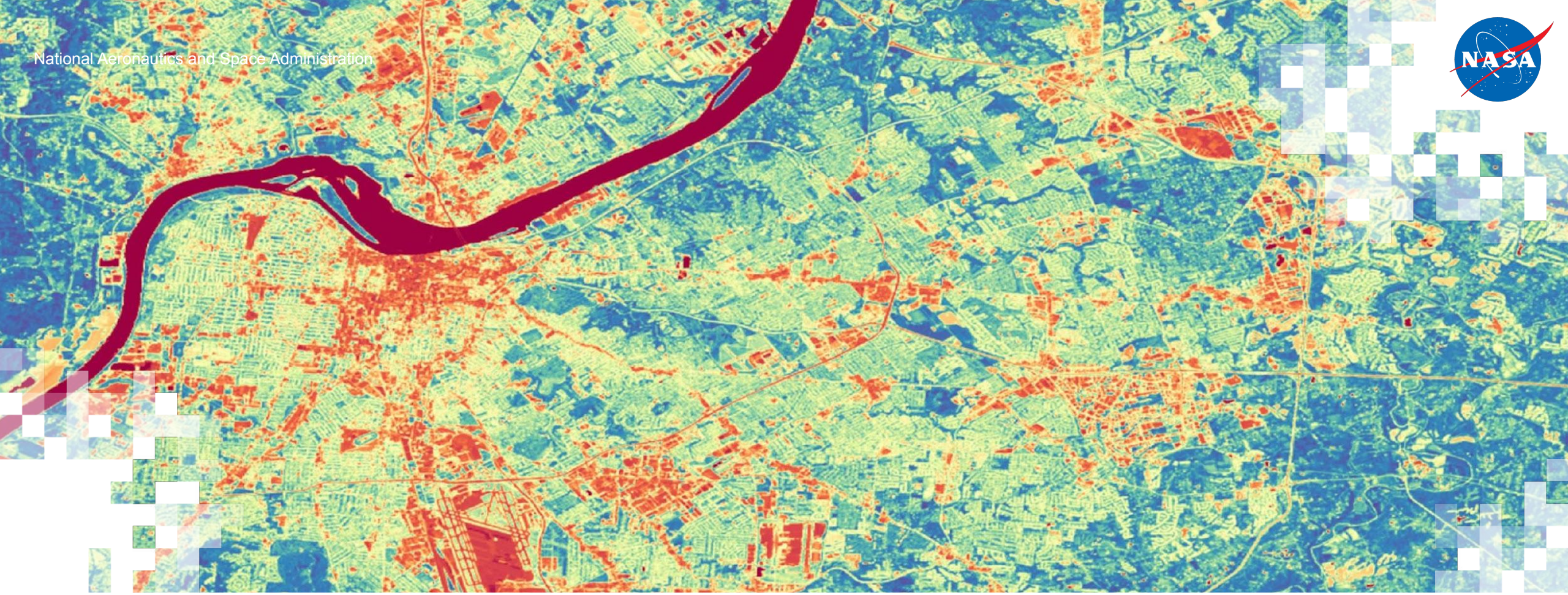


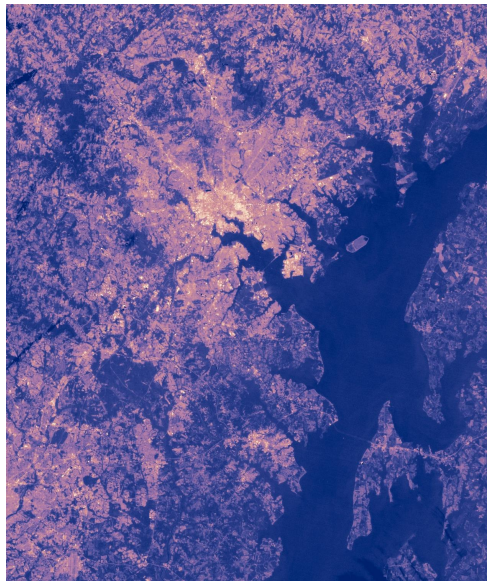
Satellite Remote Sensing for Measuring Urban Heat Islands and Constructing Heat Vulnerability Indices

Part 2: Integrating Socioeconomic Data with Satellite Imagery for Constructing Heat Vulnerability Indices (Session 2)

Kathryn Conlon, PhD, MPH & Evan Mallen, PhD, MUP – August 9, 2022

Training Outline

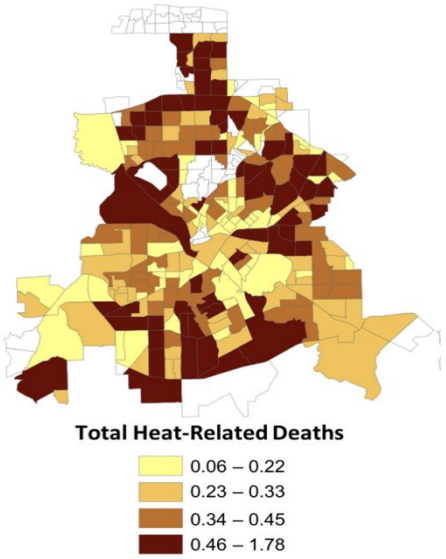
2 August 2022



Credit: NASA

Land Surface Temperature-based Urban Heat Island Mapping

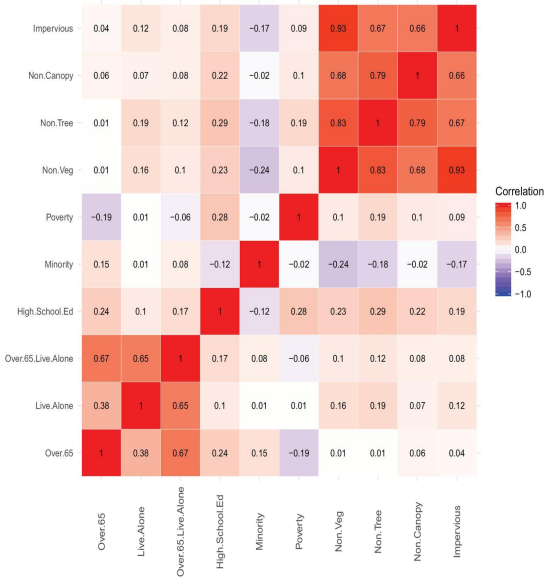
4 August 2022



Credit: Mallen et al., 2019

Integrating Socioeconomic Data with Satellite Imagery for Constructing Heat Vulnerability Indices - Session 1

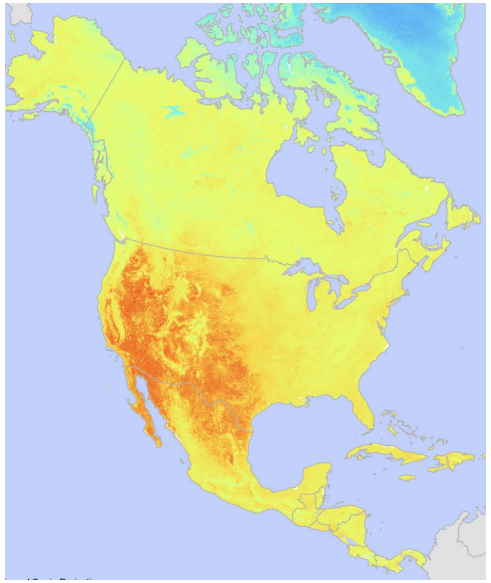
9 August 2022



Credit: Conlon et al., 2020

Integrating Socioeconomic Data with Satellite Imagery for Constructing Heat Vulnerability Indices - Session 2

11 August 2022



Credit: CIESIN

Using High-Resolution, Satellite Derived Hot-Humid Heat Estimates and Gridded Population Data to Map Extreme Heat Exposure Worldwide

Course Structure and Materials

- Webinar recordings, presentations, and the homework assignment can be accessed from the training page:
  - https://appliedsciences.nasa.gov/join-mission/training/english/arset-satellite-remote-sensing-measuring-urban-heat-islands-and

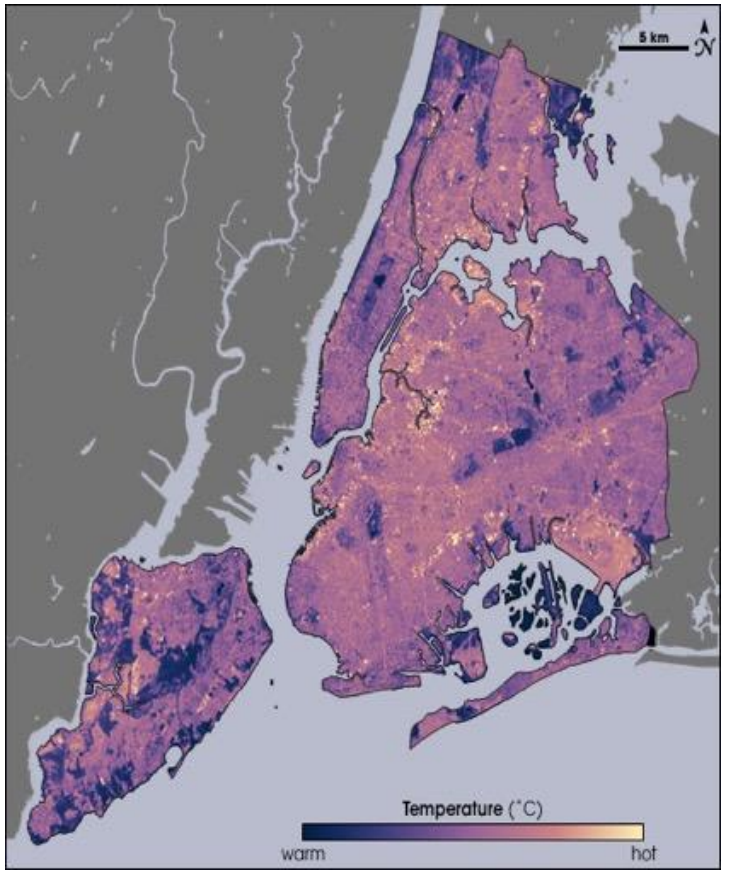
Homework and Certificate

- Homework Assignment:
  - There will be one homework assignment for this webinar series.
  - Answers must be submitted via instructions found on the training page.
  - Due date: August 25, 2022
- A certificate of completion will be awarded to those who:
  - Attend all live webinars
  - Complete the homework assignment by the deadline
  - You will receive a certificate approximately two months after the completion of the course from marines.martins@ssaihq.com

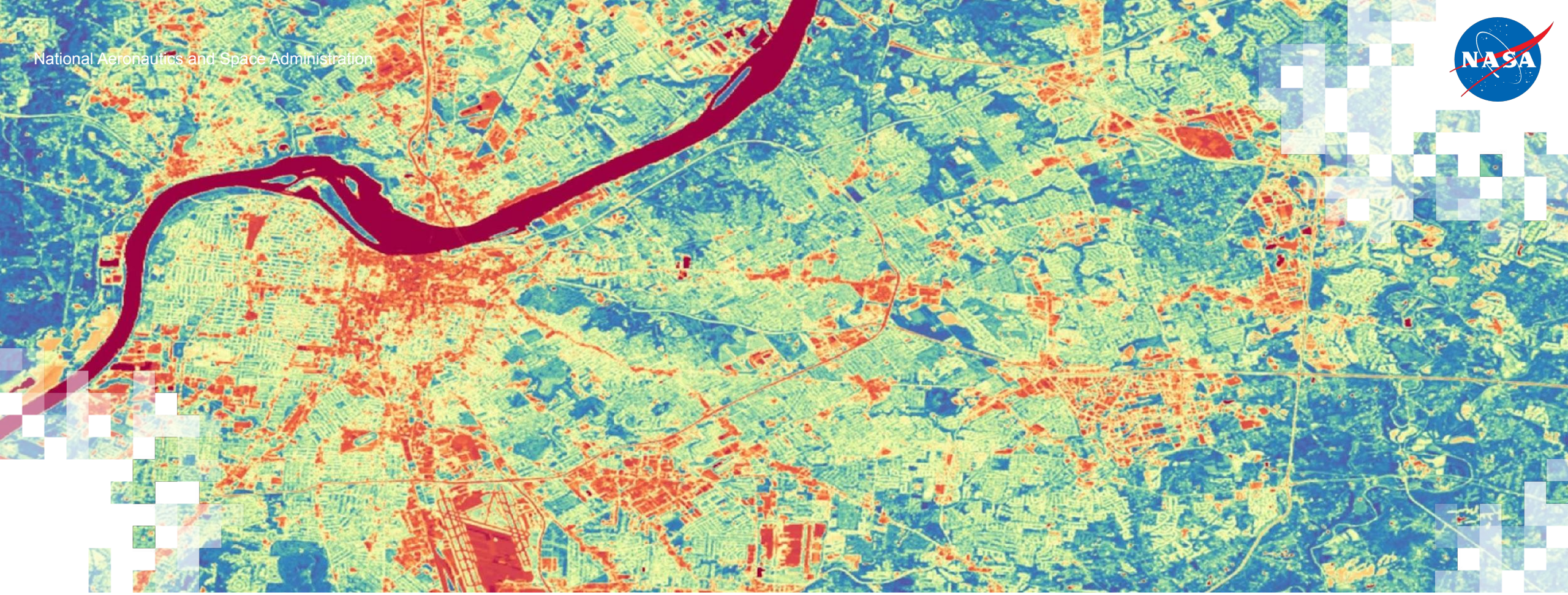
Learning Objectives

After participating in today's training, attendees will be able to:

- Identify data sources for creating heat vulnerability indices (HVI)
- Give examples of common methods used to create HVI
- Construct HVI for your own area of interest



Credit: NASA Earth Observatory



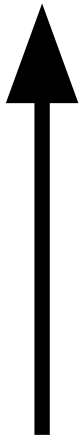
Constructing Heat Vulnerability Indices

HVI Construction

Important! Input variables:
- Unidirectional
- Confer vulnerability

Common HVI Methods

Complexity



Principal Components Analysis
Weighted Additive Overlay
Unweighted Additive Overlay
Individual Indicators

Remember: An increase in your indicators should lead to an increase in vulnerability

Common Vulnerability Indicators

Exposure	Sensitivity	Adaptive Capacity	Vulnerability
Hot/heatwave days	**Older adults**	Air conditioning access	
Consecutive hot days	Infants, young age	**Living alone**	
Min/Mean/Max temp.	Sex	**Income / wealth**	
Land surface temp.	**Diabetes**	Rental / homeowner	
Impervious surfaces	Cardiopulmonary	Unhoused	
Vegetation	Renal	**Education**	
Urban density	Respiratory	**Ethnicity**	
Land cover	Obesity	Language	
Land use		Foreign-born	
Homes w/o AC		Cognitive impairment	
Population density		Mobility / Transportation	

Common Vulnerability Indicators

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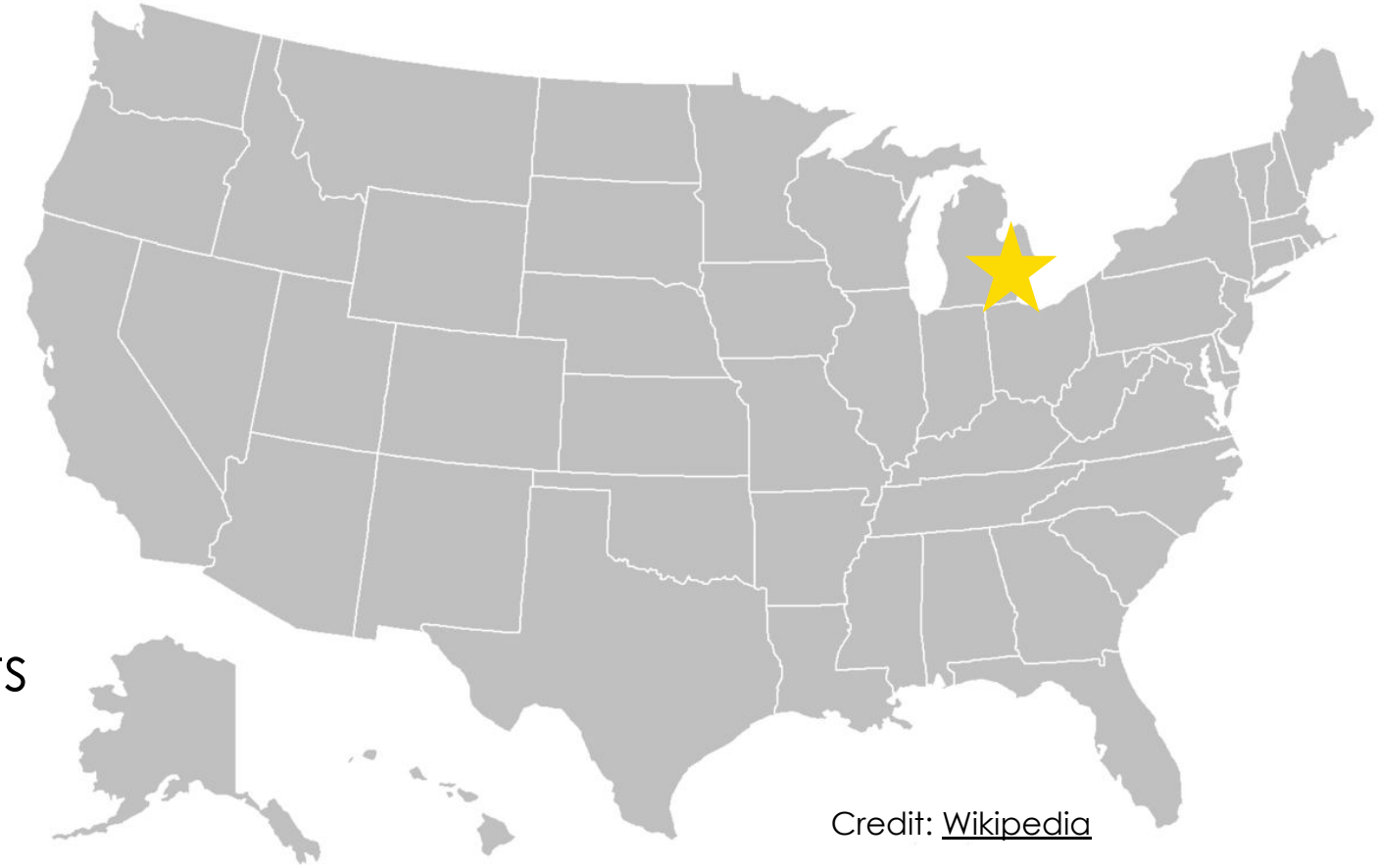
Population density		Mobility / Transportation	

Case Study: Detroit, Michigan, USA

- Cold winters
- Warm, humid summers
- Variation in green space
- Low air conditioning prevalence
- High sensitivity among residents to extreme heat

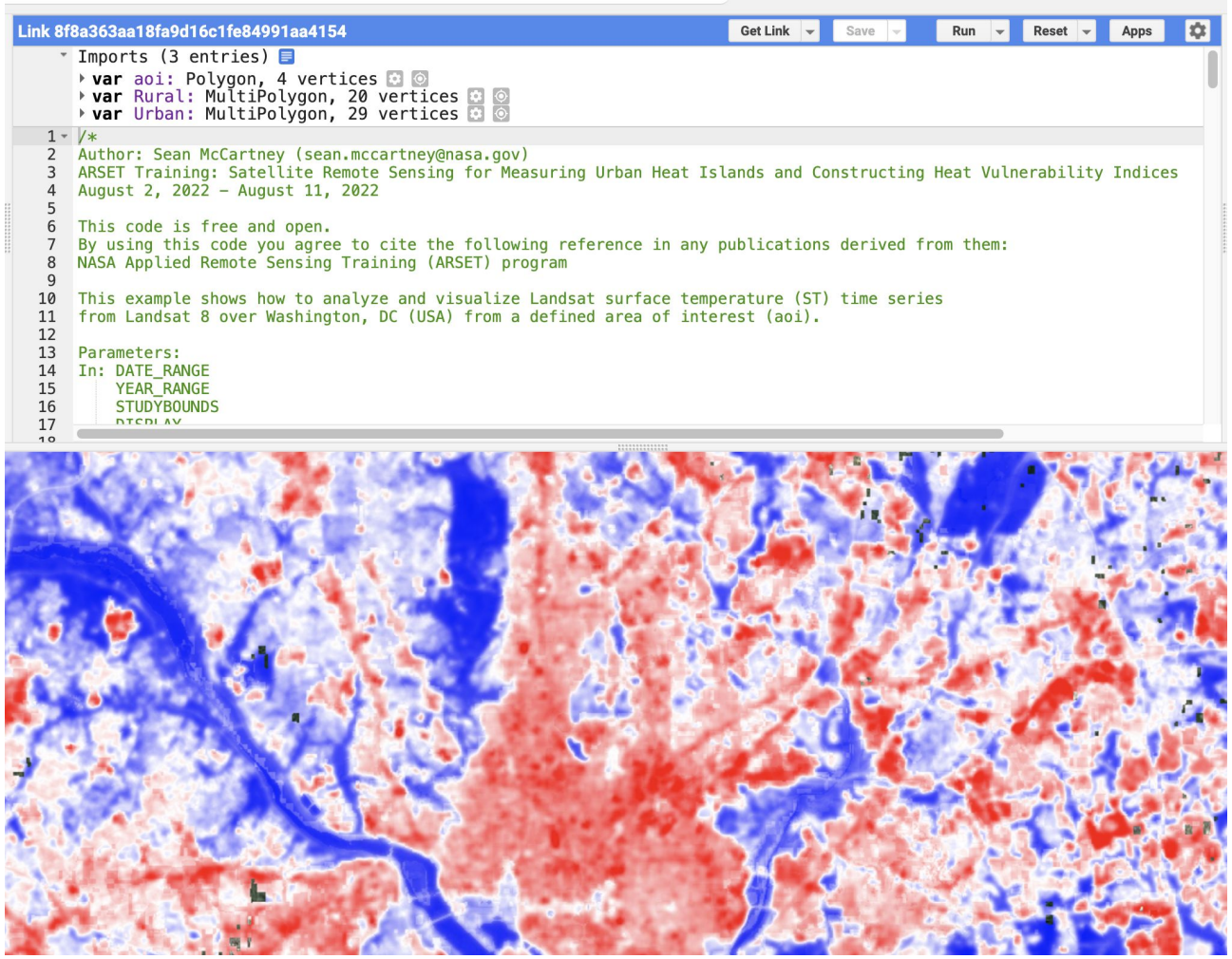


Credit: Wikipedia

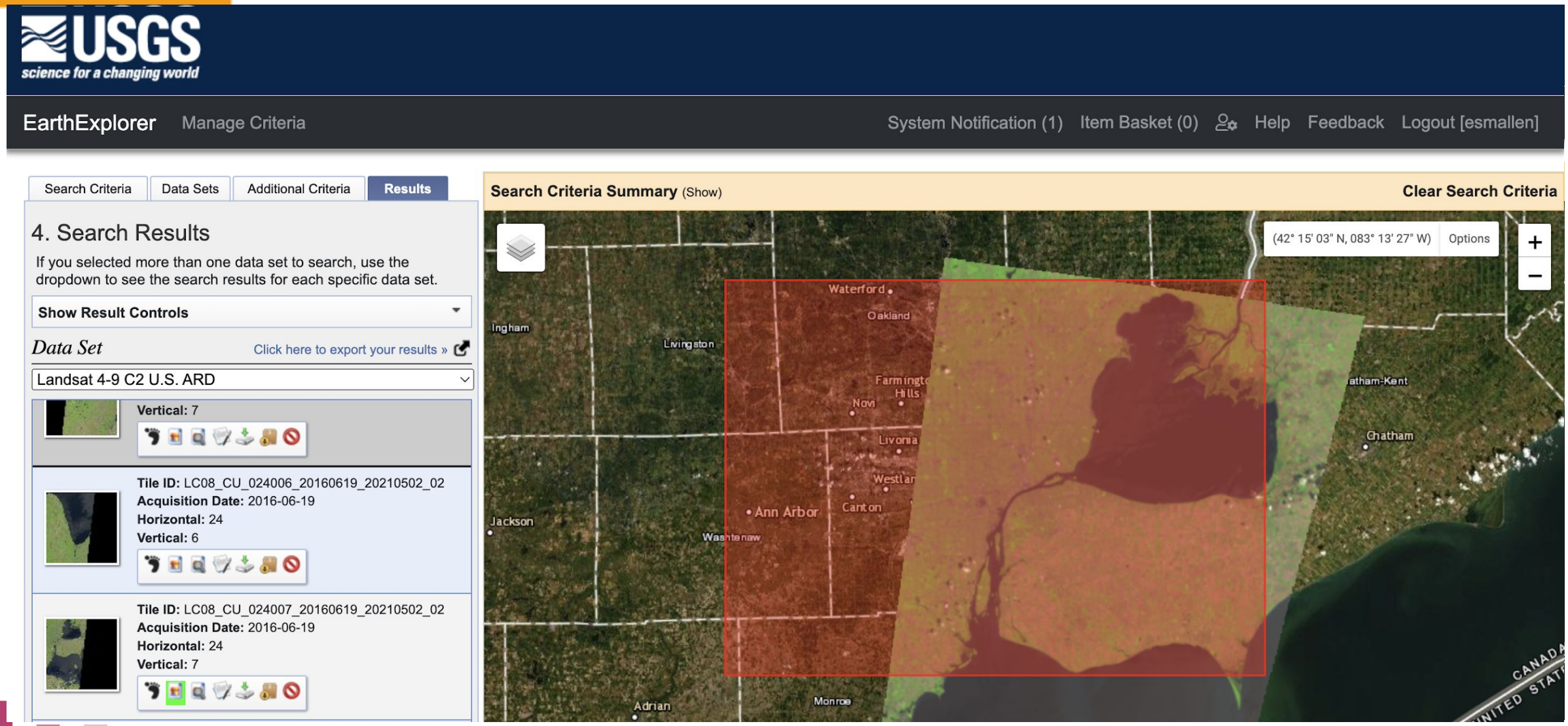
Exposure

For deriving areas of exposure to land surface temperature in Google Earth Engine using Landsat data, refer to **Part 1** of the webinar series: ***Land Surface Temperature-Based Surface Urban Heat Island Mapping:***

https://appliedsciences.nasa.gov/join-mission/training/english/arset-satellite-remote-sensing-measuring-urban-heat-islands-and

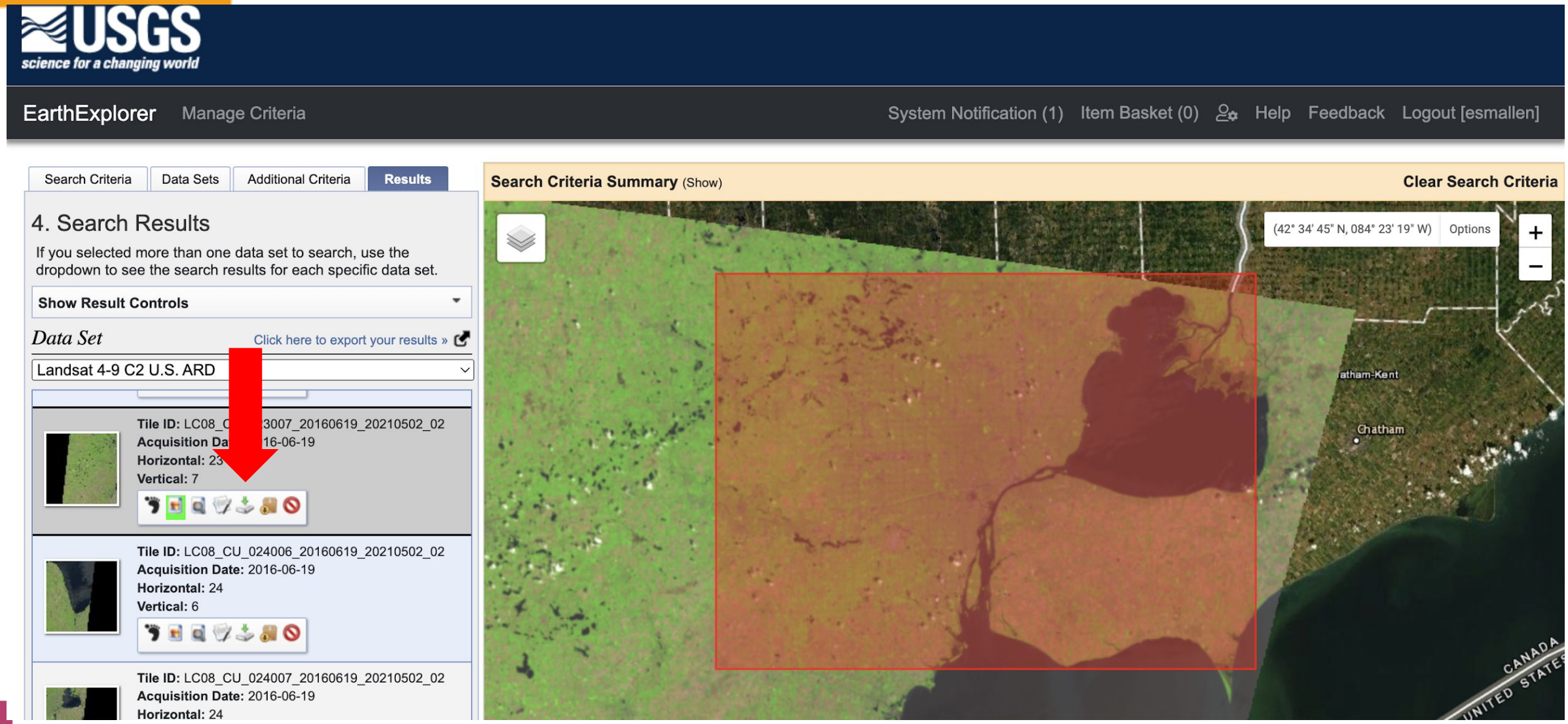


Earth Explorer – Land Surface Temperature



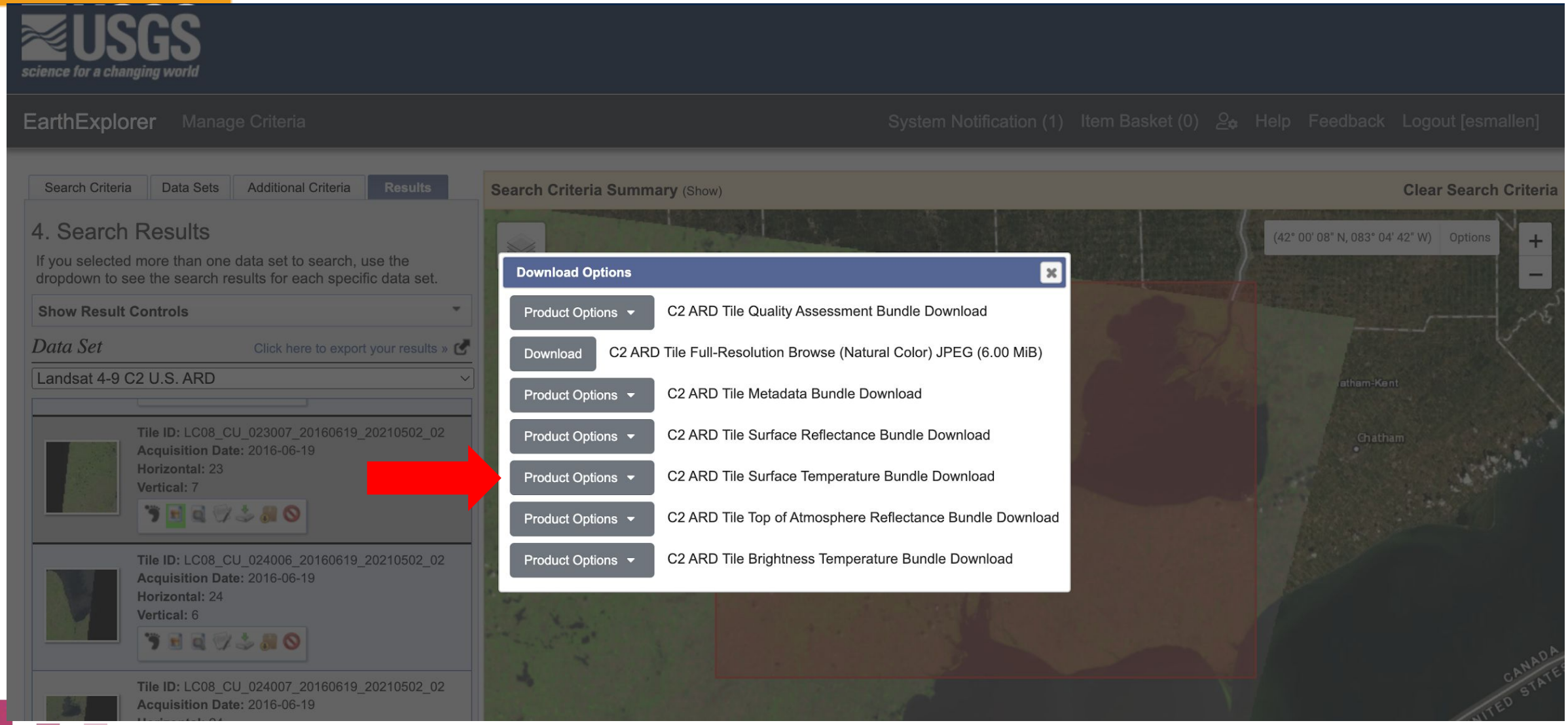
Credit: USGS Earth Explorer

Earth Explorer – Land Surface Temperature



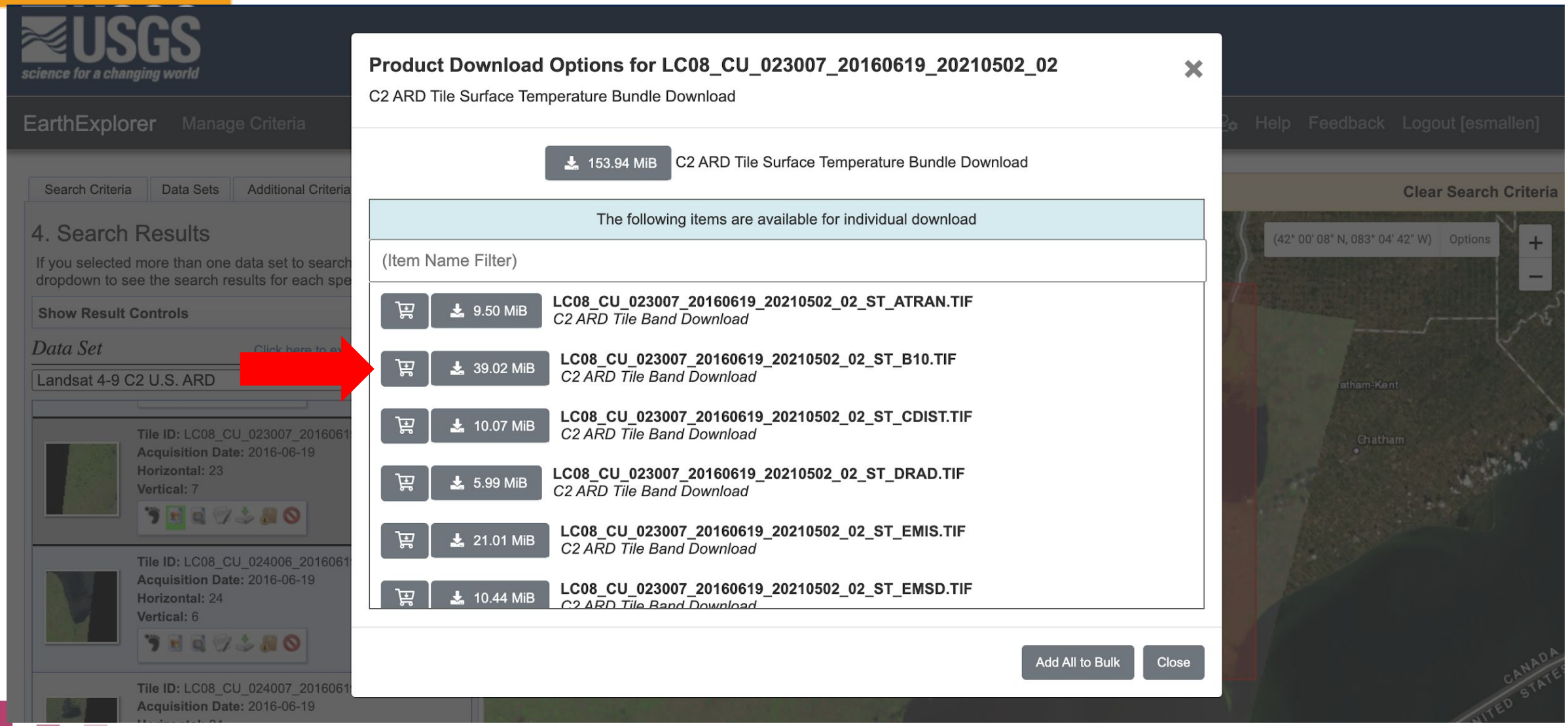
Credit: USGS Earth Explorer

Earth Explorer – Land Surface Temperature



Credit: USGS Earth Explorer

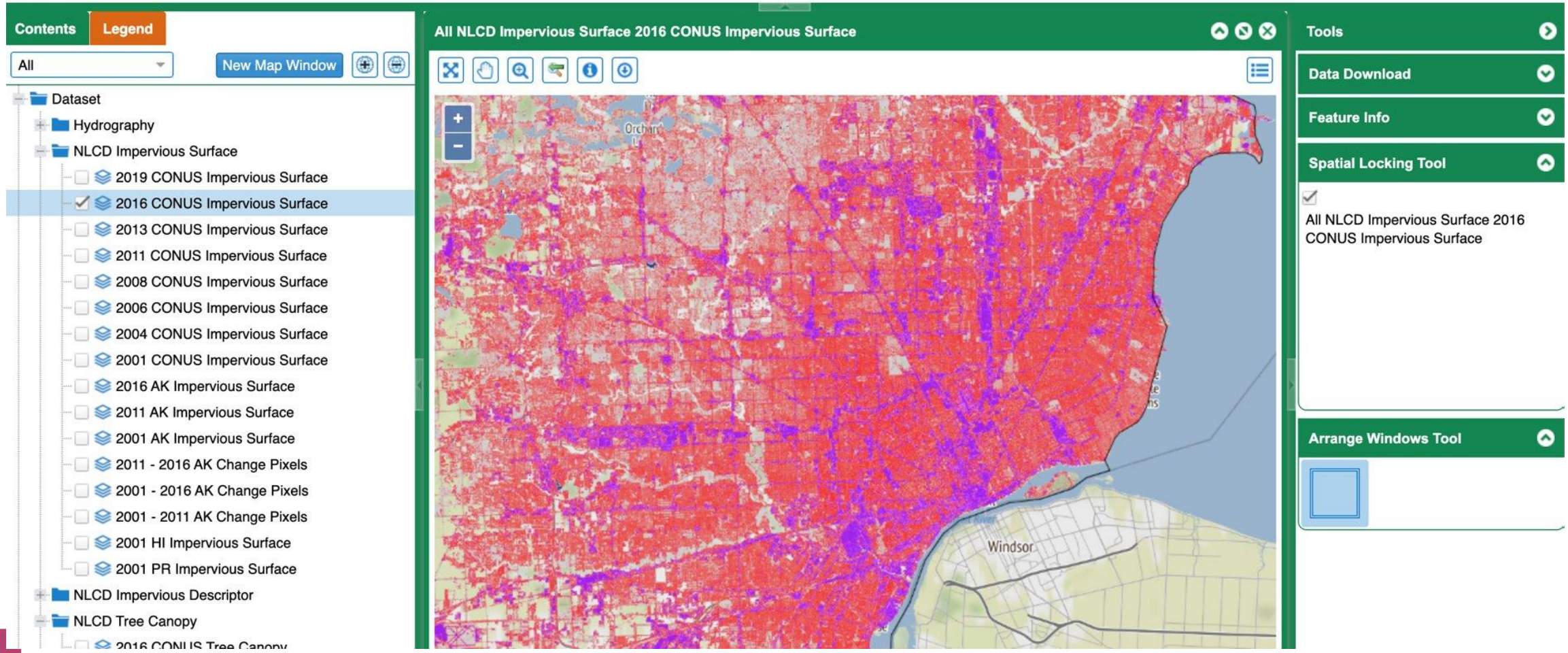
Earth Explorer – Land Surface Temperature



Credit: USGS Earth Explorer

National Land Cover Database – Impervious

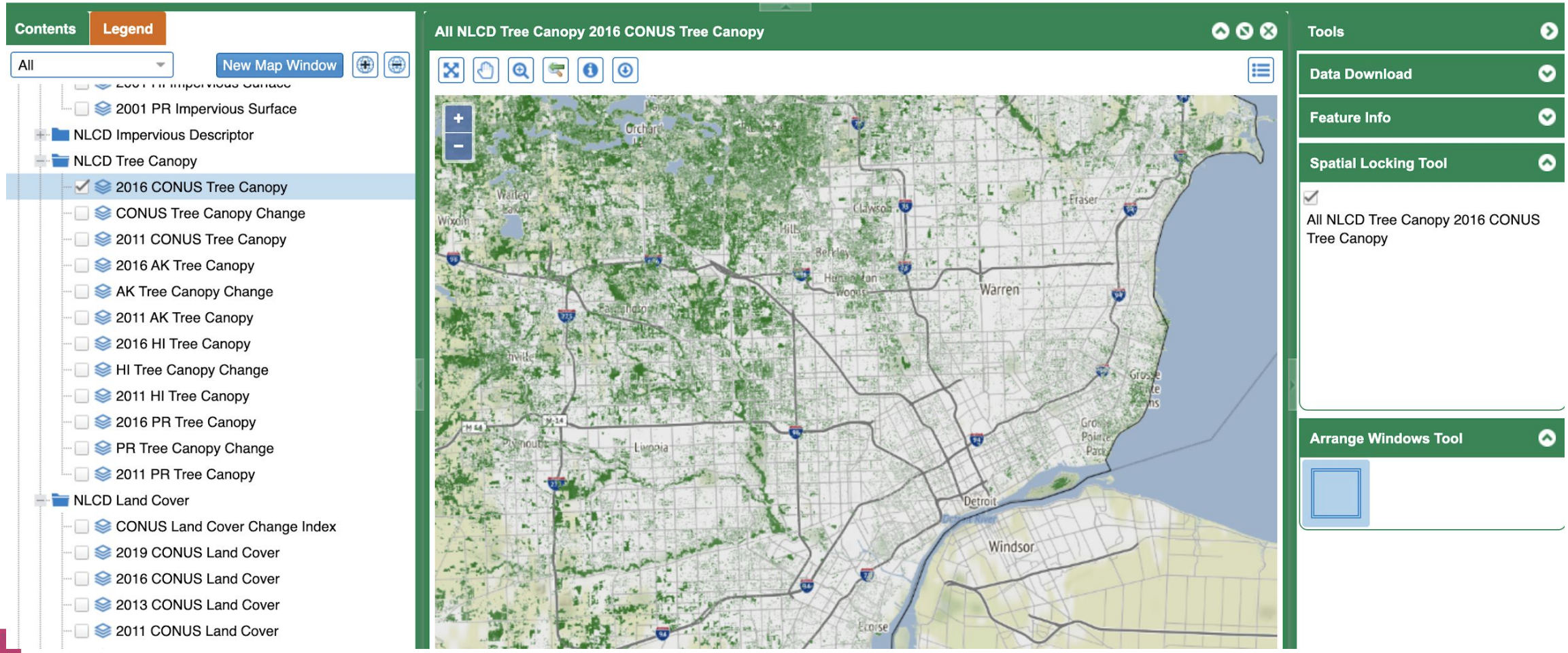
MRLC Celebrating 20+ years of Partnership
Multi-Resolution Land Characteristics Consortium



Credit: MRLC

National Land Cover Database – Tree Canopy

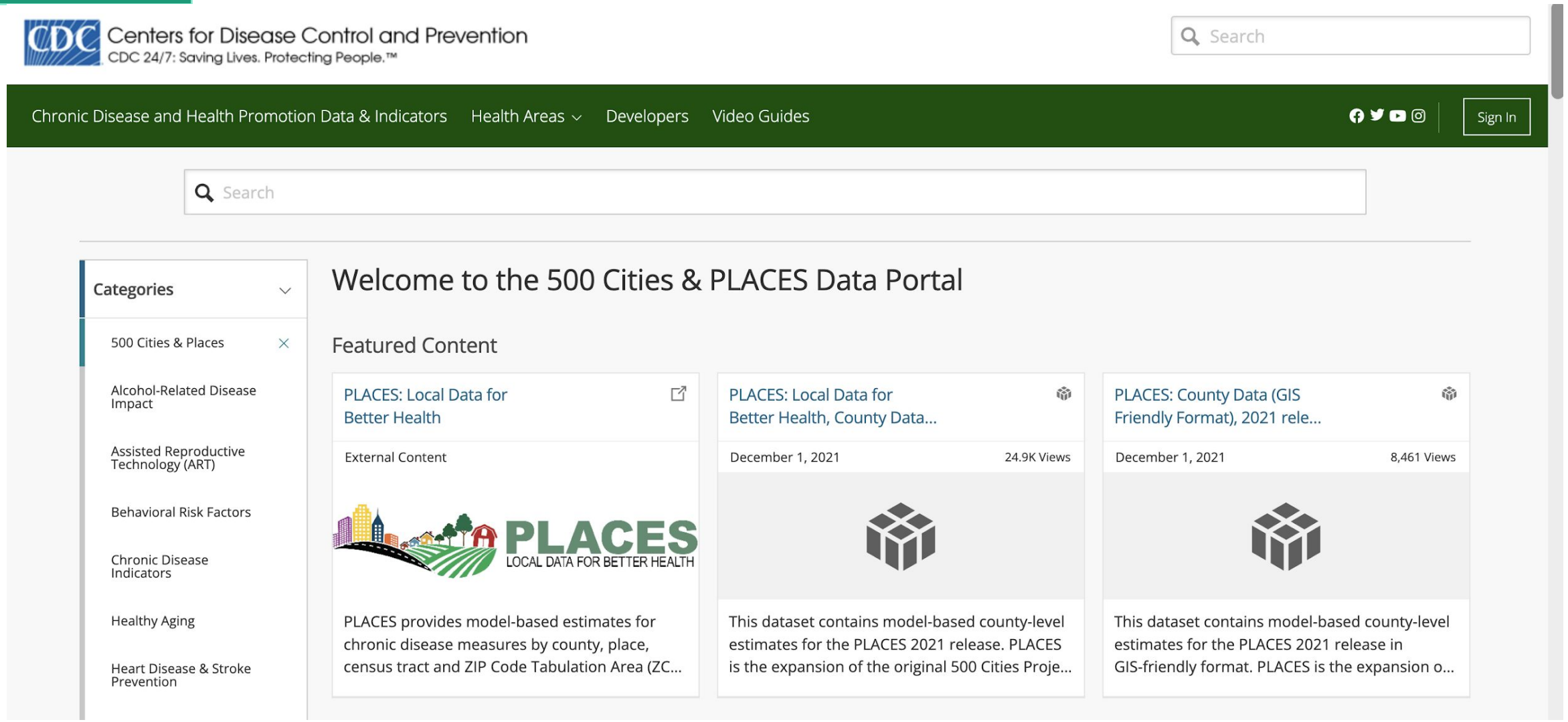
MRLC Celebrating 20+ years of Partnership
Multi-Resolution Land Characteristics Consortium



Credit: MRLC

Sensitivity

CDC 500 Cities – Disease Burden



Credit: CDC

Sensitivity

Adaptive Capacity

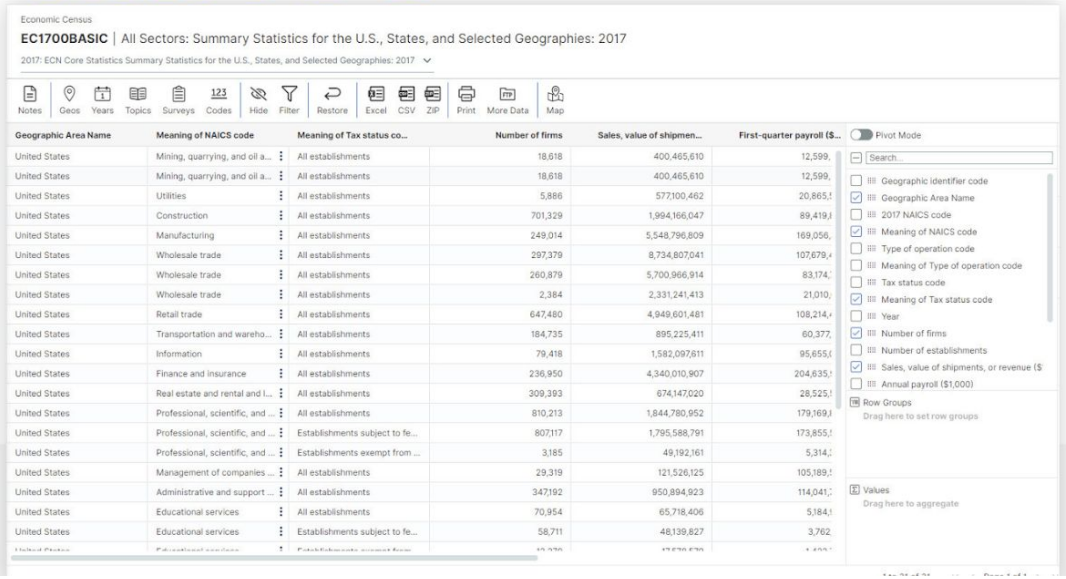
National Census

United States Census Bureau

Search

Tables Maps Pages Microdata

find tables



Explore the thousands of tables we have.
We are adding new tables every week.

Explore Tables

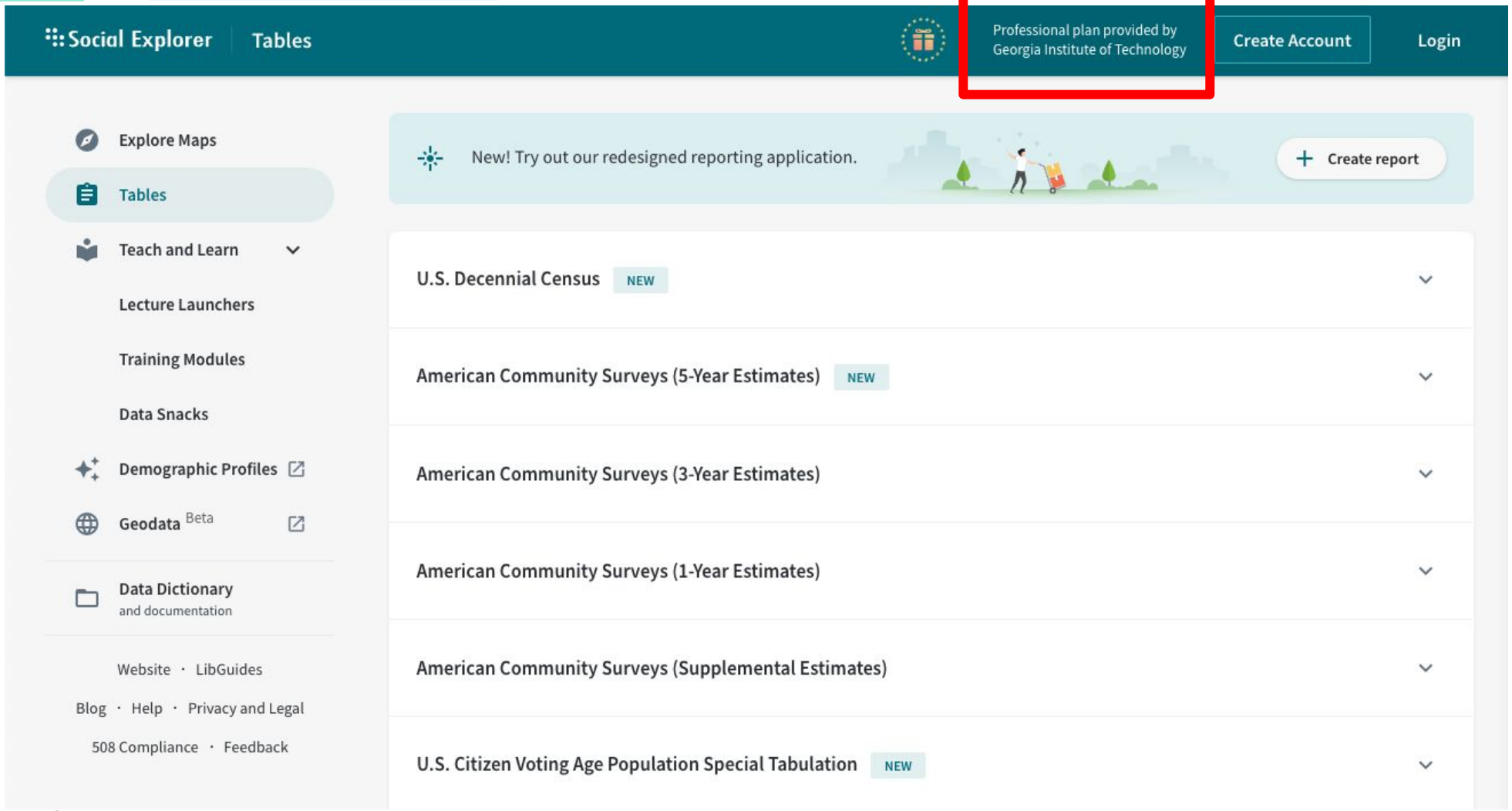
Credit: U.S. Census

Don't forget to include all geographic identifiers

Sensitivity

Adaptive Capacity

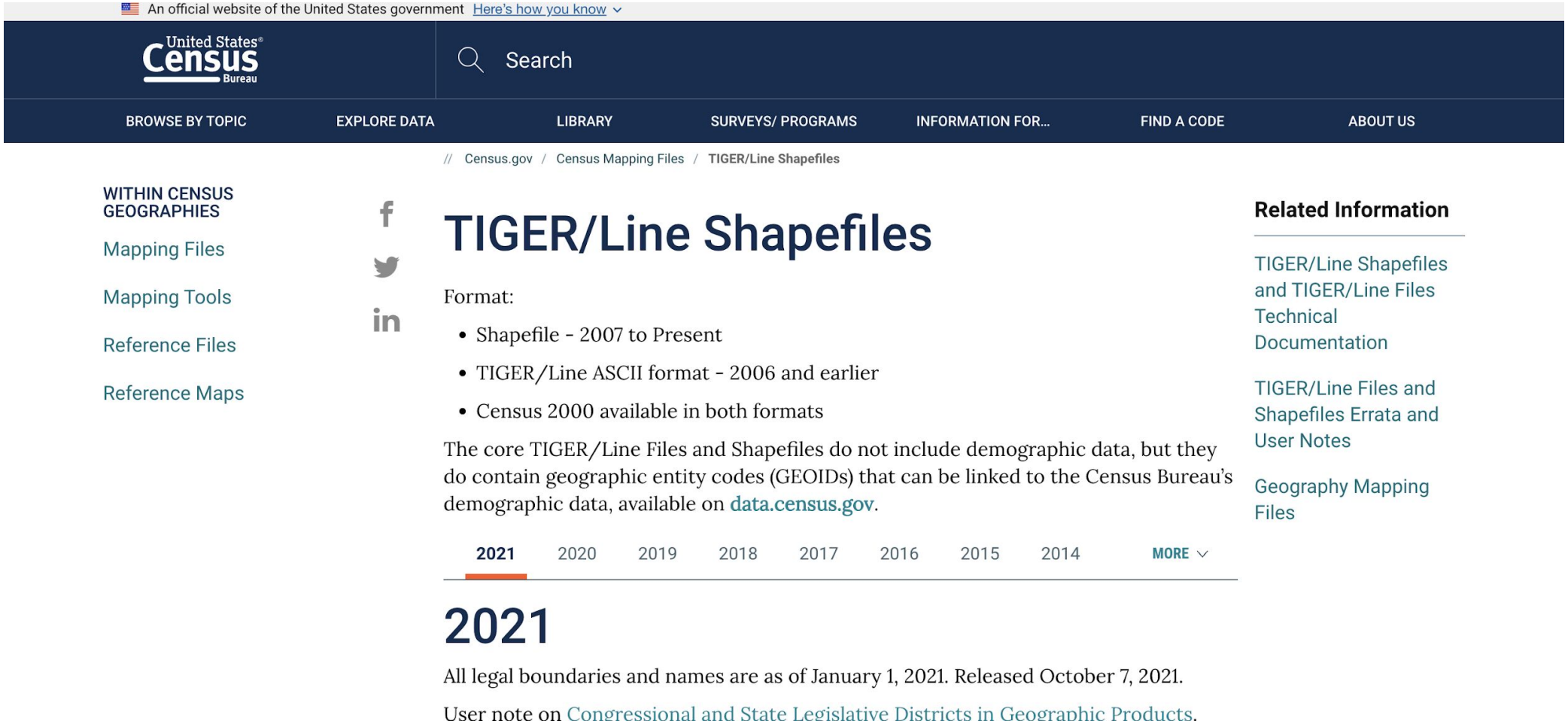
USA: Social Explorer



Don't forget to include all geographic identifiers

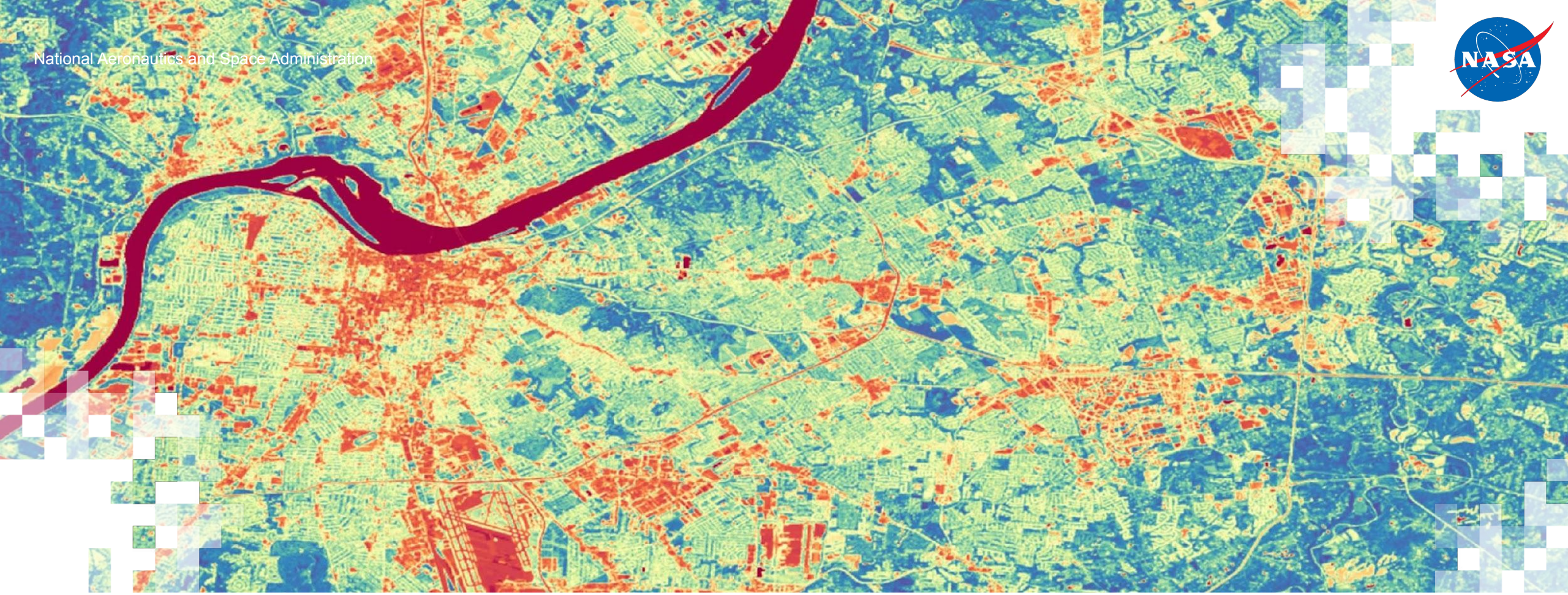
Credit: Social Explorer

HVI Mapping: Finding Shapefiles



https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html

US Census geographies were updated with the 2020 decennial census. Make sure your data and census shapefile dates match! Example: Disease prevalence data from 2016 should use 2010 census geographies.



Build Your HVI Dataset

Spatial Components in GIS

There are a variety of tools for processing and mapping HVIs, with more free and open-source options emerging.

ArcGIS

QGIS

R

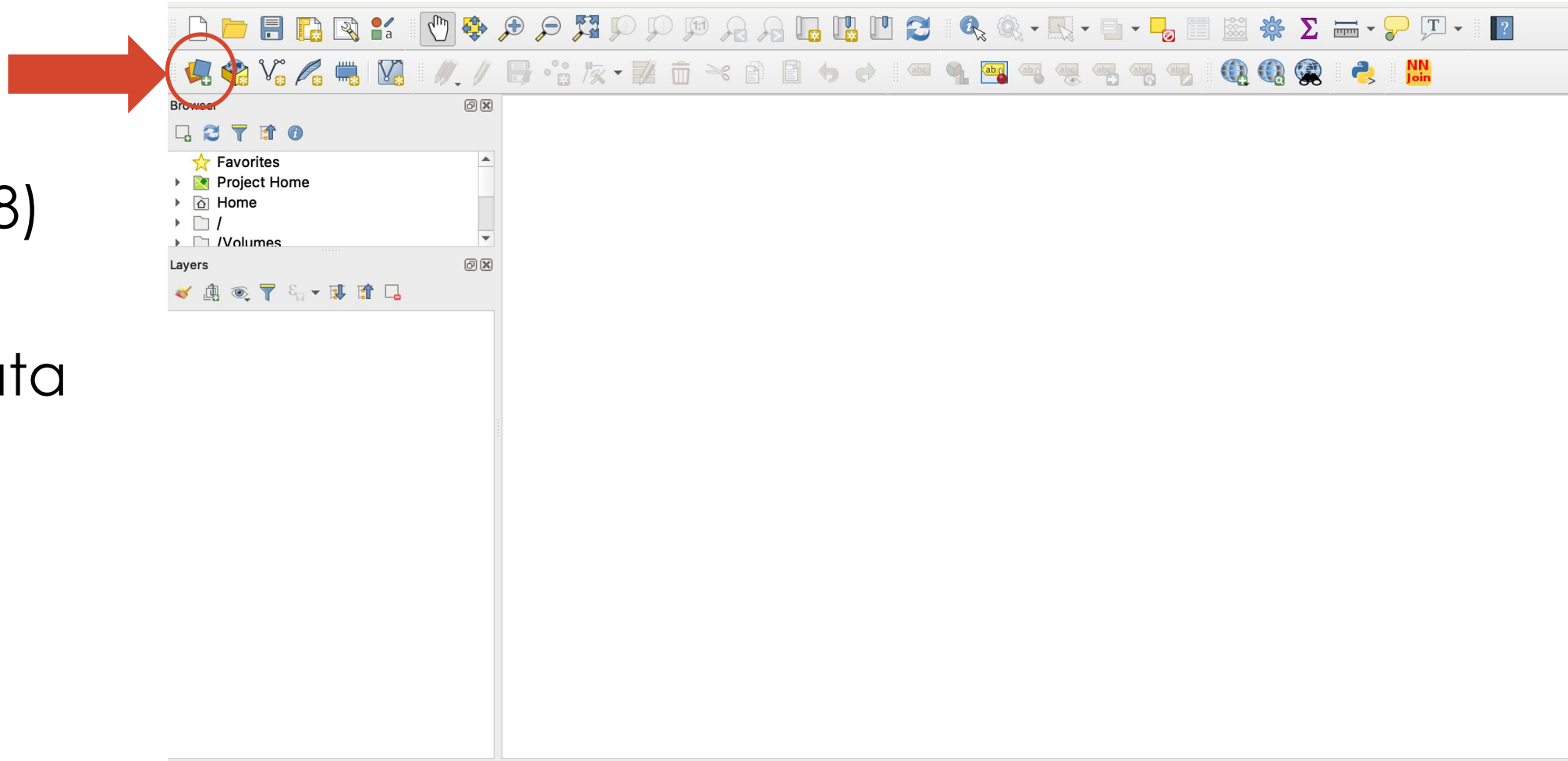
python™

Processing Spatial Components – Shapefiles

Example:

- QGIS (v3.8)

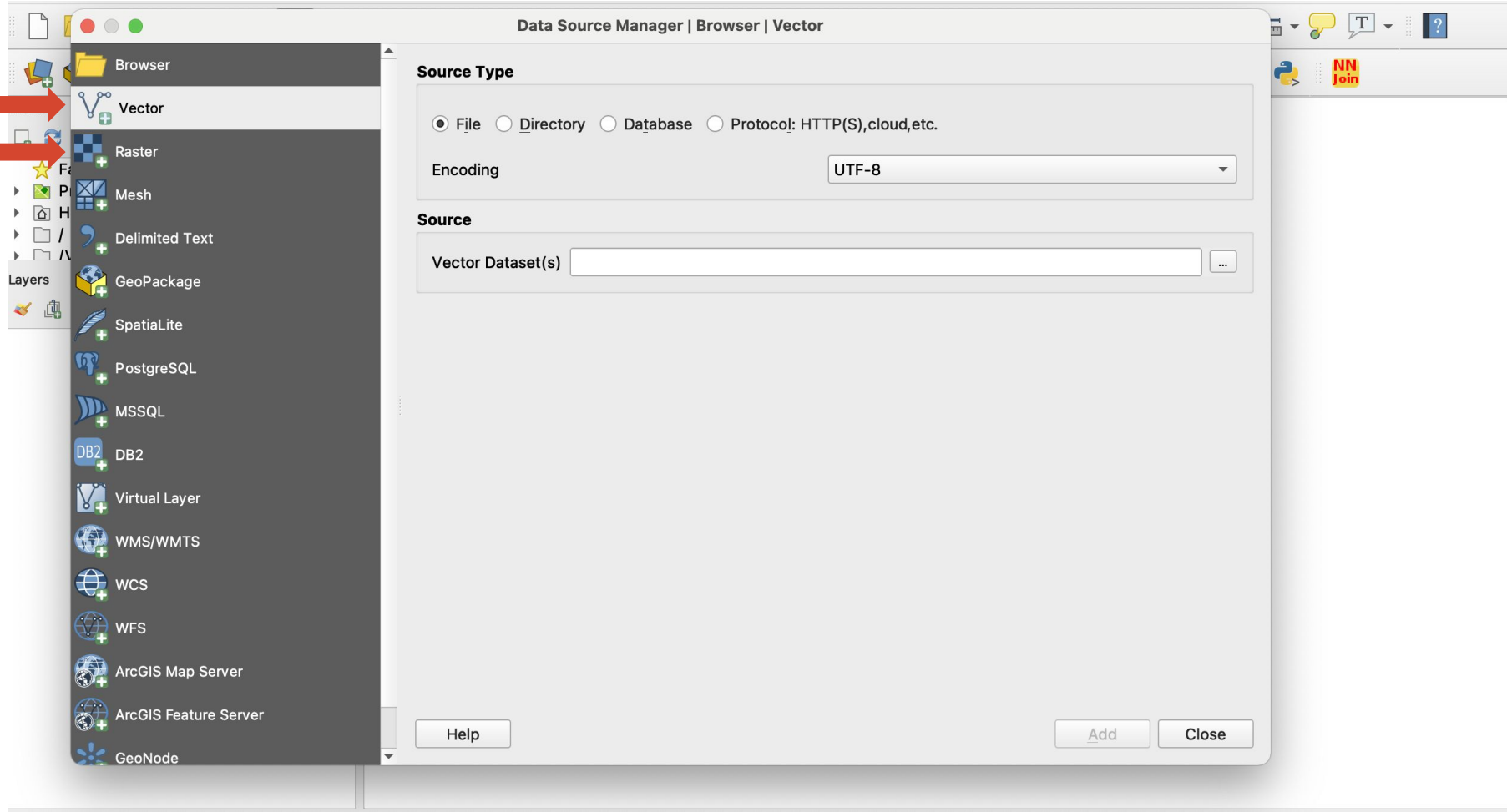
Add your data



Processing Spatial Components – Shapefiles

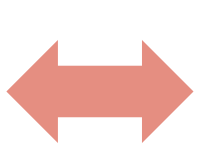
Boundary shapefiles

Exposure data (LST)



Joining Your Data

FIPS	HVI Indicator



QGIS

You can begin to consolidate your data in QGIS now to prepare for your HVI processing.

First, you will need a unique identifier (key) to join your data.

INPUT

OBJECT ID#	Landuse Code
1	2
2	0
3	1

Join Fields +

Landuse Code	Landuse Type
0	Unclassified
1	shrub
2	water

OUTPUT

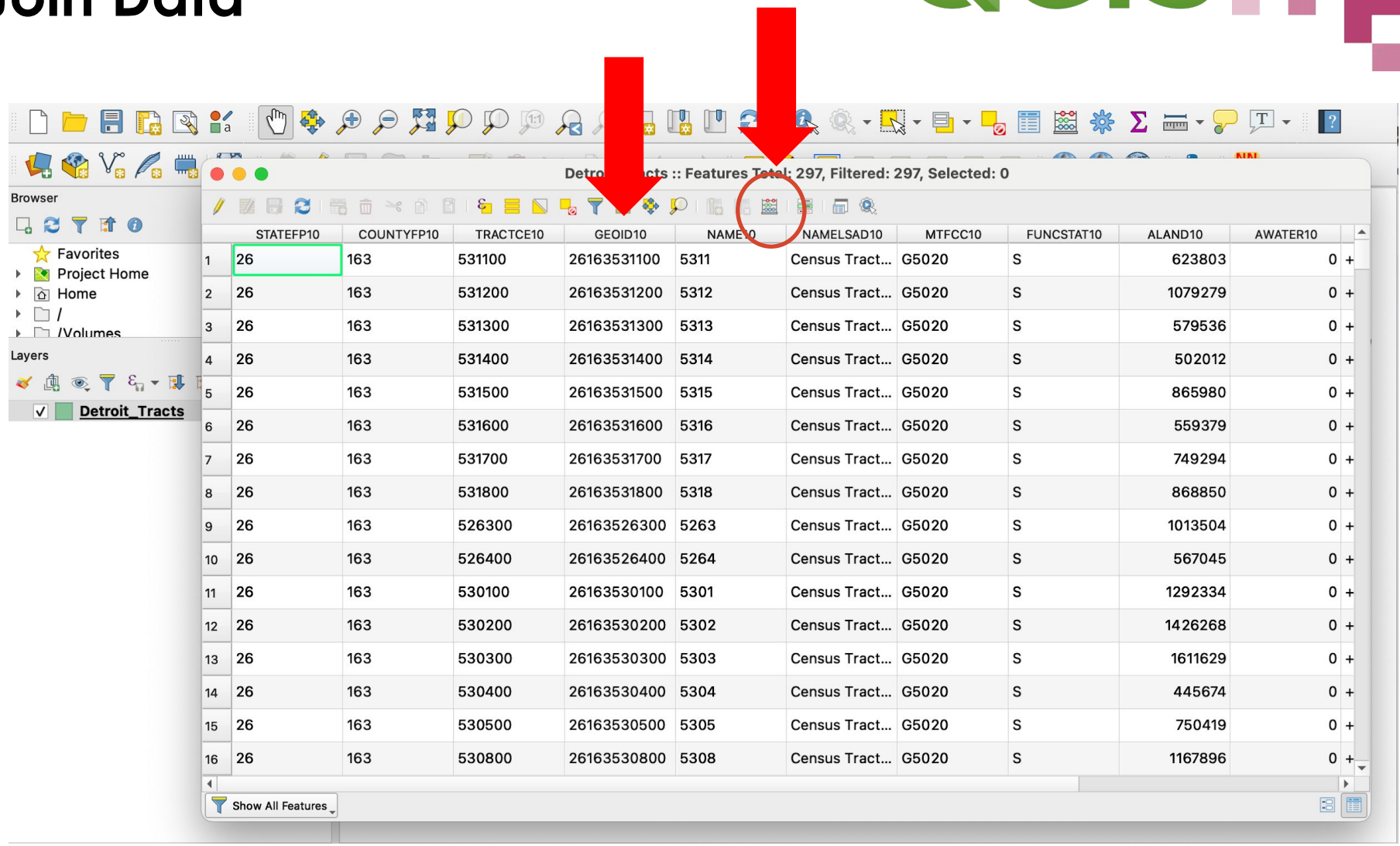
OBJECT ID#	Landuse Code	Join Table Landuse Code	Join Table Landuse Type
1	2	2	water
2	0	0	Unclassified
3	1	1	shrub

https://desktop.arcgis.com/en/arcmap/latest/tools/data-management-toolbox/add-join.htm

Creating a Key to Join Data

GEOID = FIPS

Convert to string for easier joining later



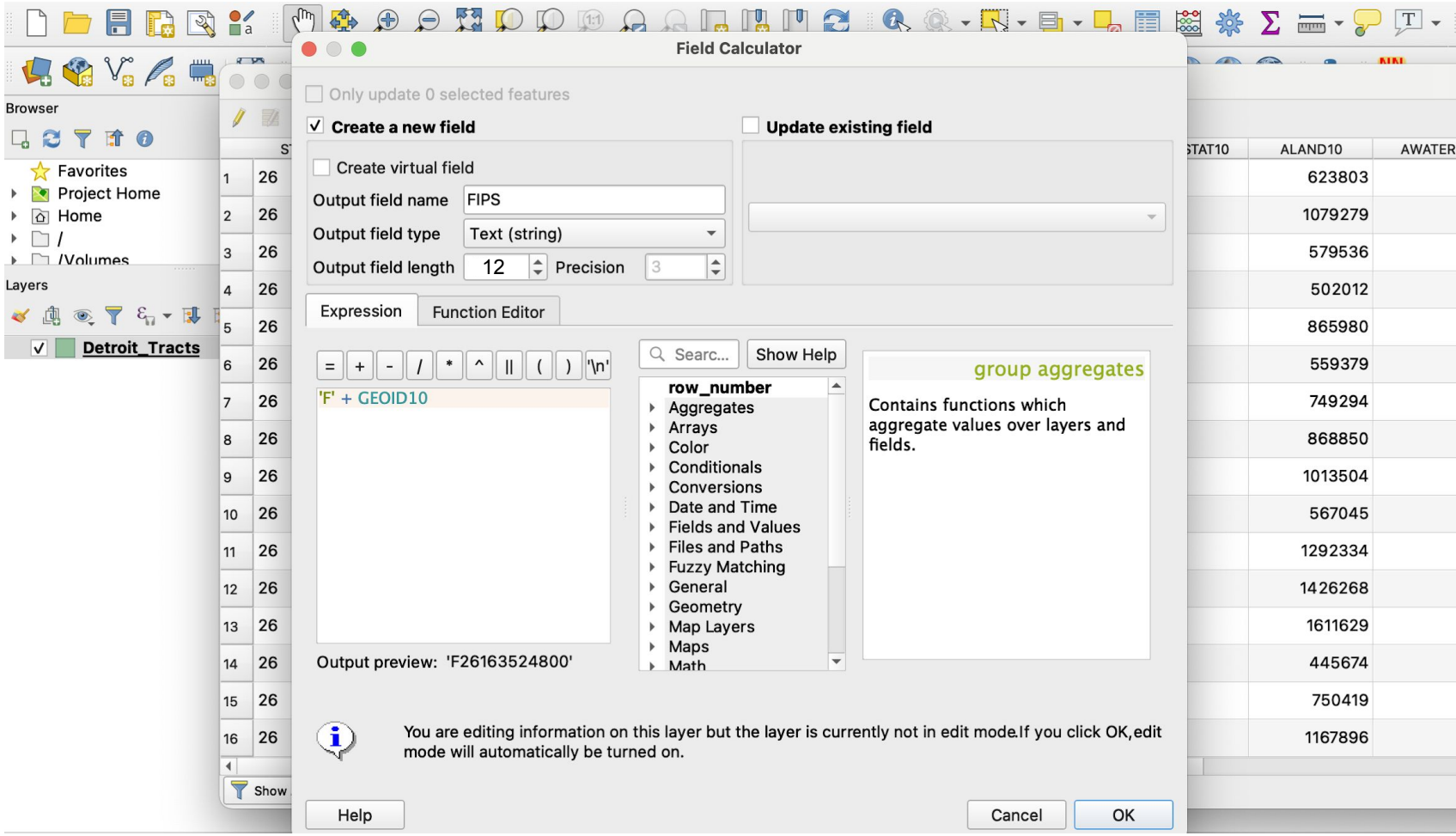
	STATEFP10	COUNTYFP10	TRACTCE10	GEOID10	NAME10	NAMELSAD10	MTFCC10	FUNCSTAT10	ALAND10	AWATER10
1	26	163	531100	26163531100	5311	Census Tract...	G5020	S	623803	0
2	26	163	531200	26163531200	5312	Census Tract...	G5020	S	1079279	0
3	26	163	531300	26163531300	5313	Census Tract...	G5020	S	579536	0
4	26	163	531400	26163531400	5314	Census Tract...	G5020	S	502012	0
5	26	163	531500	26163531500	5315	Census Tract...	G5020	S	865980	0
6	26	163	531600	26163531600	5316	Census Tract...	G5020	S	559379	0
7	26	163	531700	26163531700	5317	Census Tract...	G5020	S	749294	0
8	26	163	531800	26163531800	5318	Census Tract...	G5020	S	868850	0
9	26	163	526300	26163526300	5263	Census Tract...	G5020	S	1013504	0
10	26	163	526400	26163526400	5264	Census Tract...	G5020	S	567045	0
11	26	163	530100	26163530100	5301	Census Tract...	G5020	S	1292334	0
12	26	163	530200	26163530200	5302	Census Tract...	G5020	S	1426268	0
13	26	163	530300	26163530300	5303	Census Tract...	G5020	S	1611629	0
14	26	163	530400	26163530400	5304	Census Tract...	G5020	S	445674	0
15	26	163	530500	26163530500	5305	Census Tract...	G5020	S	750419	0
16	26	163	530800	26163530800	5308	Census Tract...	G5020	S	1167896	0

Creating a Key to Join Data

GEOID = FIPS

Convert to string for easier joining later

'F' + GEOID10

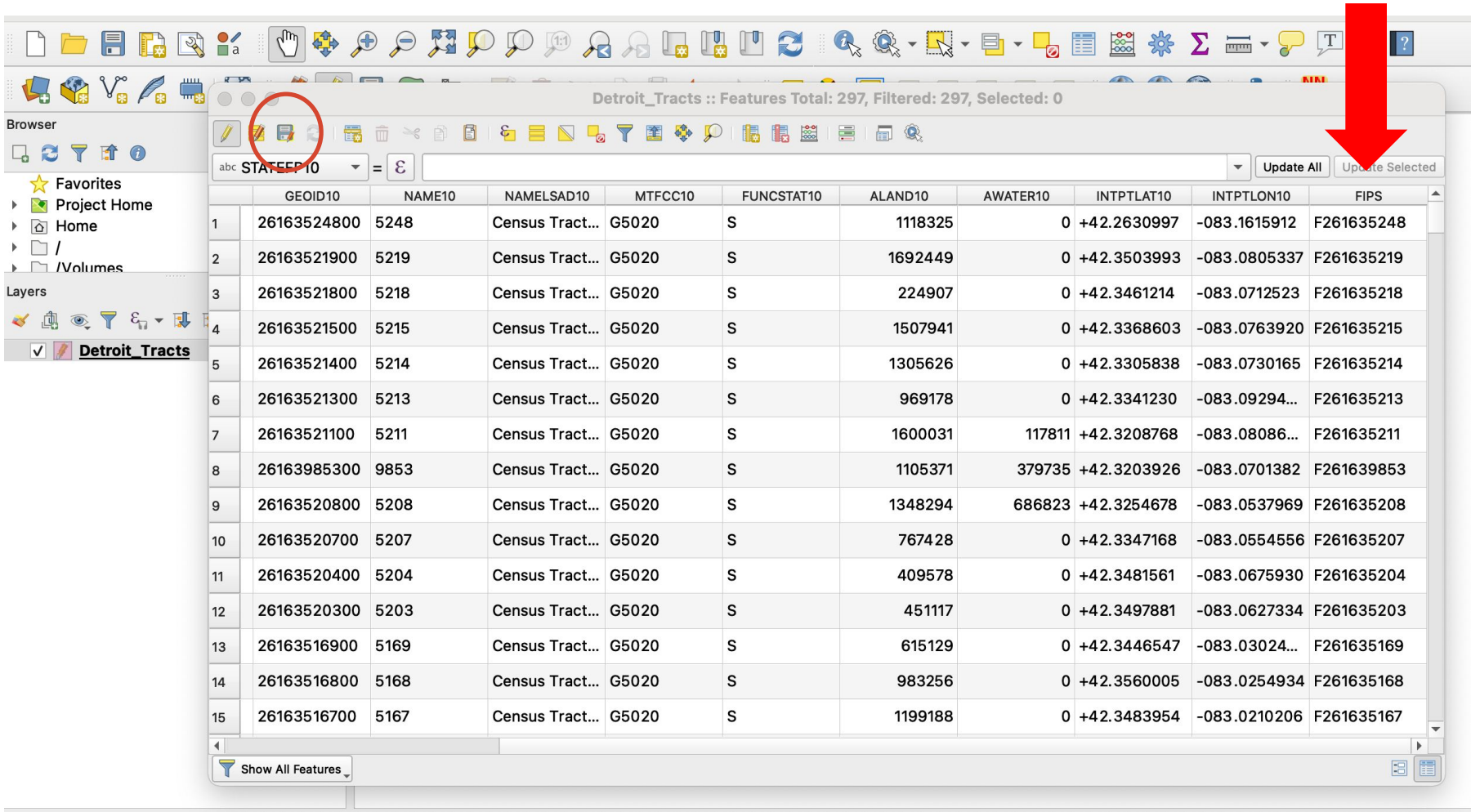


Creating a Key to Join Data

FIPS is now a string that will not drop leading zeroes.

Repeat in your additional data tables to ensure a clean join.

Don't forget to save your edits using the save button.



	GEOID10	NAME10	NAMELSAD10	MTFCC10	FUNCSTAT10	ALAND10	AWATER10	INTPTLAT10	INTPTLON10	FIPS
1	26163524800	5248	Census Tract...	G5020	S	1118325	0	+42.2630997	-083.1615912	F261635248
2	26163521900	5219	Census Tract...	G5020	S	1692449	0	+42.3503993	-083.0805337	F261635219
3	26163521800	5218	Census Tract...	G5020	S	224907	0	+42.3461214	-083.0712523	F261635218
4	26163521500	5215	Census Tract...	G5020	S	1507941	0	+42.3368603	-083.0763920	F261635215
5	26163521400	5214	Census Tract...	G5020	S	1305626	0	+42.3305838	-083.0730165	F261635214
6	26163521300	5213	Census Tract...	G5020	S	969178	0	+42.3341230	-083.09294...	F261635213
7	26163521100	5211	Census Tract...	G5020	S	1600031	117811	+42.3208768	-083.08086...	F261635211
8	26163985300	9853	Census Tract...	G5020	S	1105371	379735	+42.3203926	-083.0701382	F261639853
9	26163520800	5208	Census Tract...	G5020	S	1348294	686823	+42.3254678	-083.0537969	F261635208
10	26163520700	5207	Census Tract...	G5020	S	767428	0	+42.3347168	-083.0554556	F261635207
11	26163520400	5204	Census Tract...	G5020	S	409578	0	+42.3481561	-083.0675930	F261635204
12	26163520300	5203	Census Tract...	G5020	S	451117	0	+42.3497881	-083.0627334	F261635203
13	26163516900	5169	Census Tract...	G5020	S	615129	0	+42.3446547	-083.03024...	F261635169
14	26163516800	5168	Census Tract...	G5020	S	983256	0	+42.3560005	-083.0254934	F261635168
15	26163516700	5167	Census Tract...	G5020	S	1199188	0	+42.3483954	-083.0210206	F261635167

Creating a Key to Join Data

FIPS	HVI Indicator

Use the concatenate function to place an "F" before your Geo_FIPS code.

This forces the data into a string format to match the FIPS code in QGIS attribute table.

SUM =CONCATENATE("F",A3)

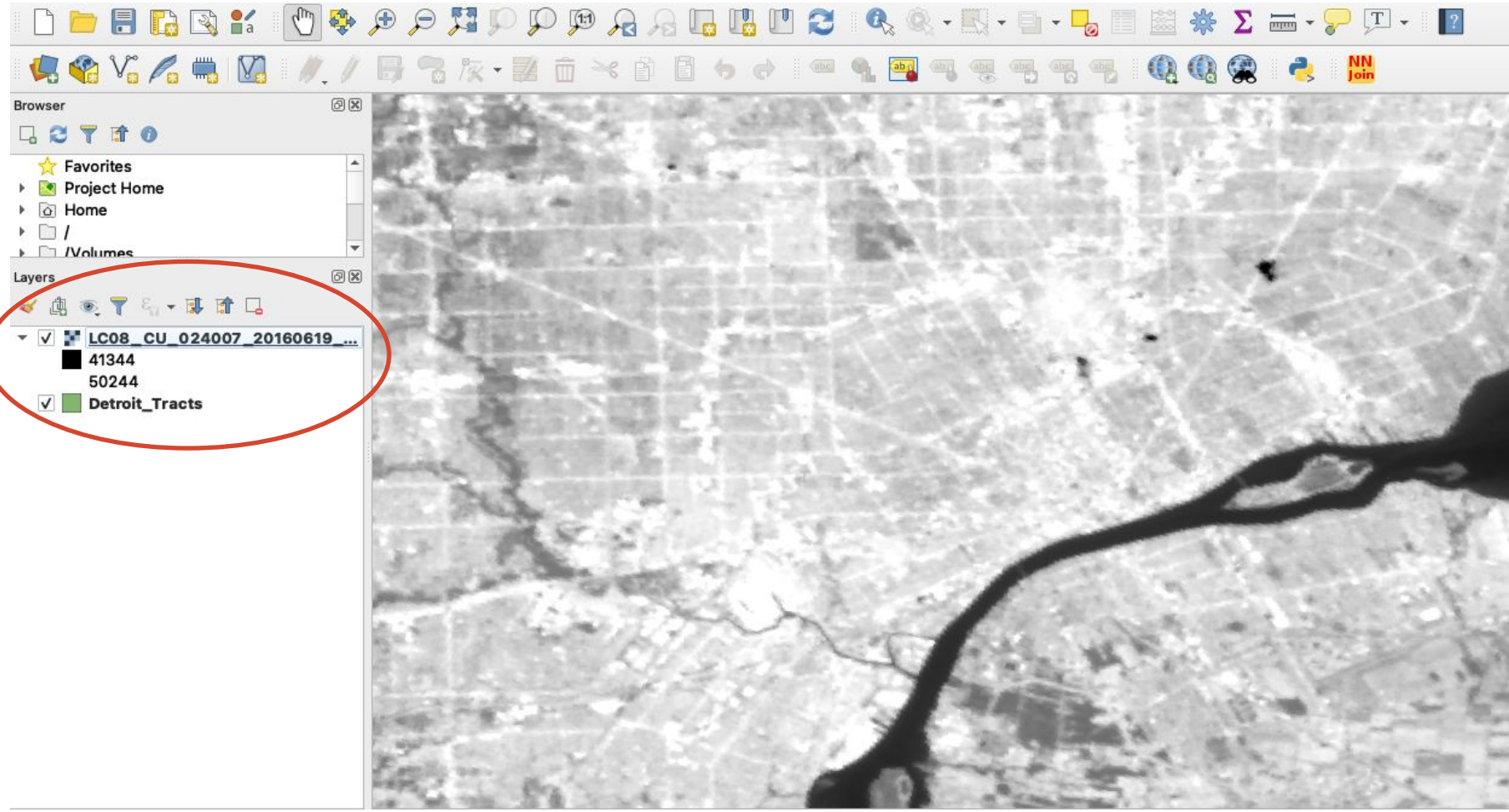
	A	B	C
2	GEOID	Geo_FIPS_calc	Geo_FIPS
3	26163985200	"F",A3)	F26163985200
4	26163985300	F26163985300	F26163985300
5	26163985400	F26163985400	F26163985400
6	26163985500	F26163985500	F26163985500
7	26163985600	F26163985600	F26163985600
8	26163985700	F26163985700	F26163985700
9	26163985900	F26163985900	F26163985900

Copy your key field and paste as values to preserve your key (Column C)

Processing Spatial Components – Exposure Rasters

Data such as Land Surface Temperature may not come in familiar units

Review all product documentation for scale factors and units before use.



Processing Spatial Components – Exposure Rasters

Data such as Land Surface Temperature may not come in familiar units

Review all product documentation for scale factors and units before use.

Scale factors, fill values, data type, and valid range for Lansat Collection 1 and Collection 2 science products

Science Product	Scale Factor	Fill Value	Data Type	Valid Range
Collection 1				
Surface Reflectance	0.0001	-9999	Signed 16-bit integer	0-10000
Provisional Surface Temperature	0.1	-9999	Signed 16-bit integer	0-10000
Collection 2				
Surface Reflectance	0.0000275 + -0.2	0	Unsigned 16-bit integer	1-65455
Surface Temperature	0.00341802 + 149.0	0	Unsigned 16-bit integer	1-65455

https://www.usgs.gov/faqs/how-do-i-use-scale-factor-landsat-level-2-science-products

Processing Spatial Components – Exposure Rasters

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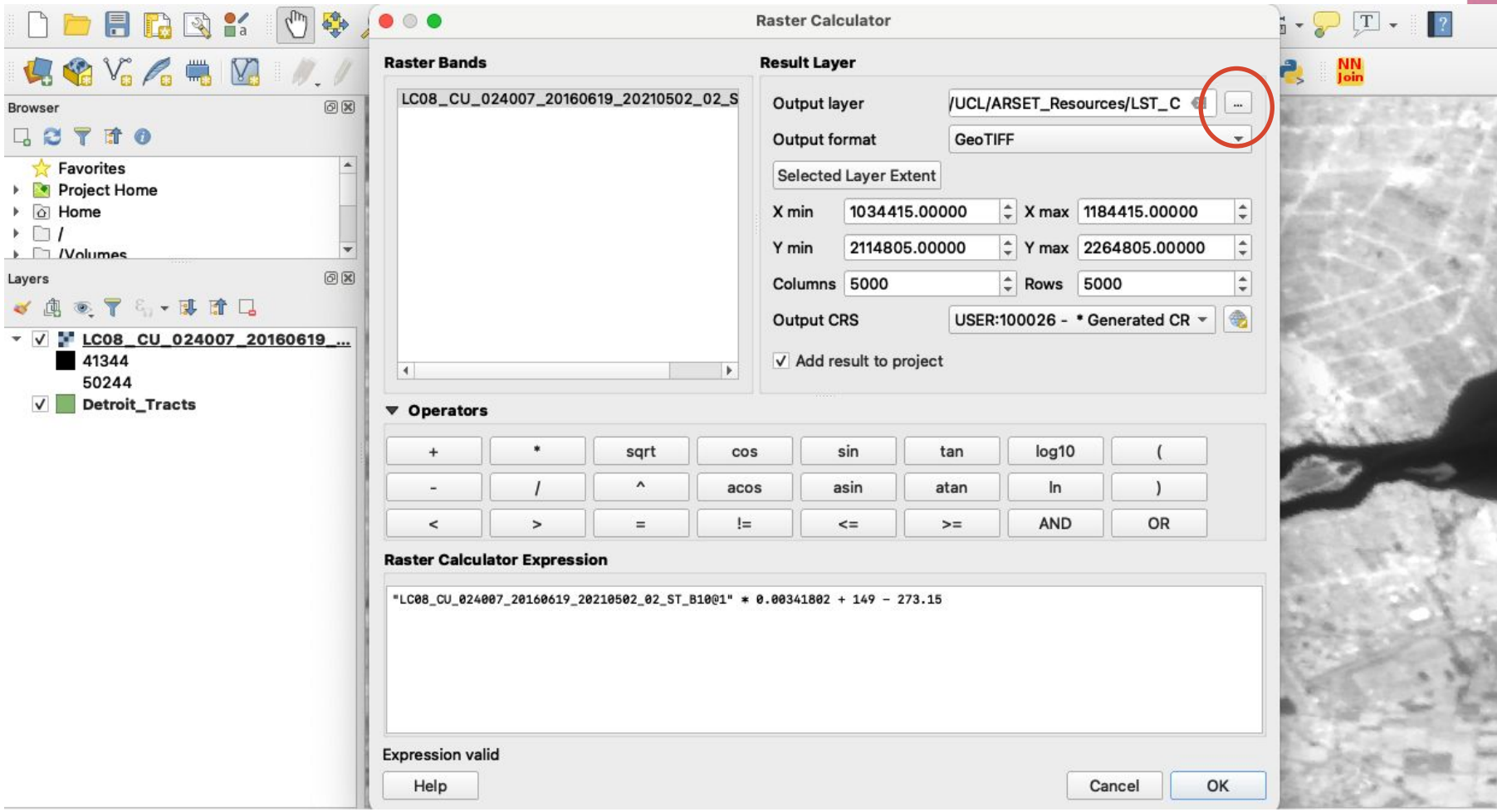


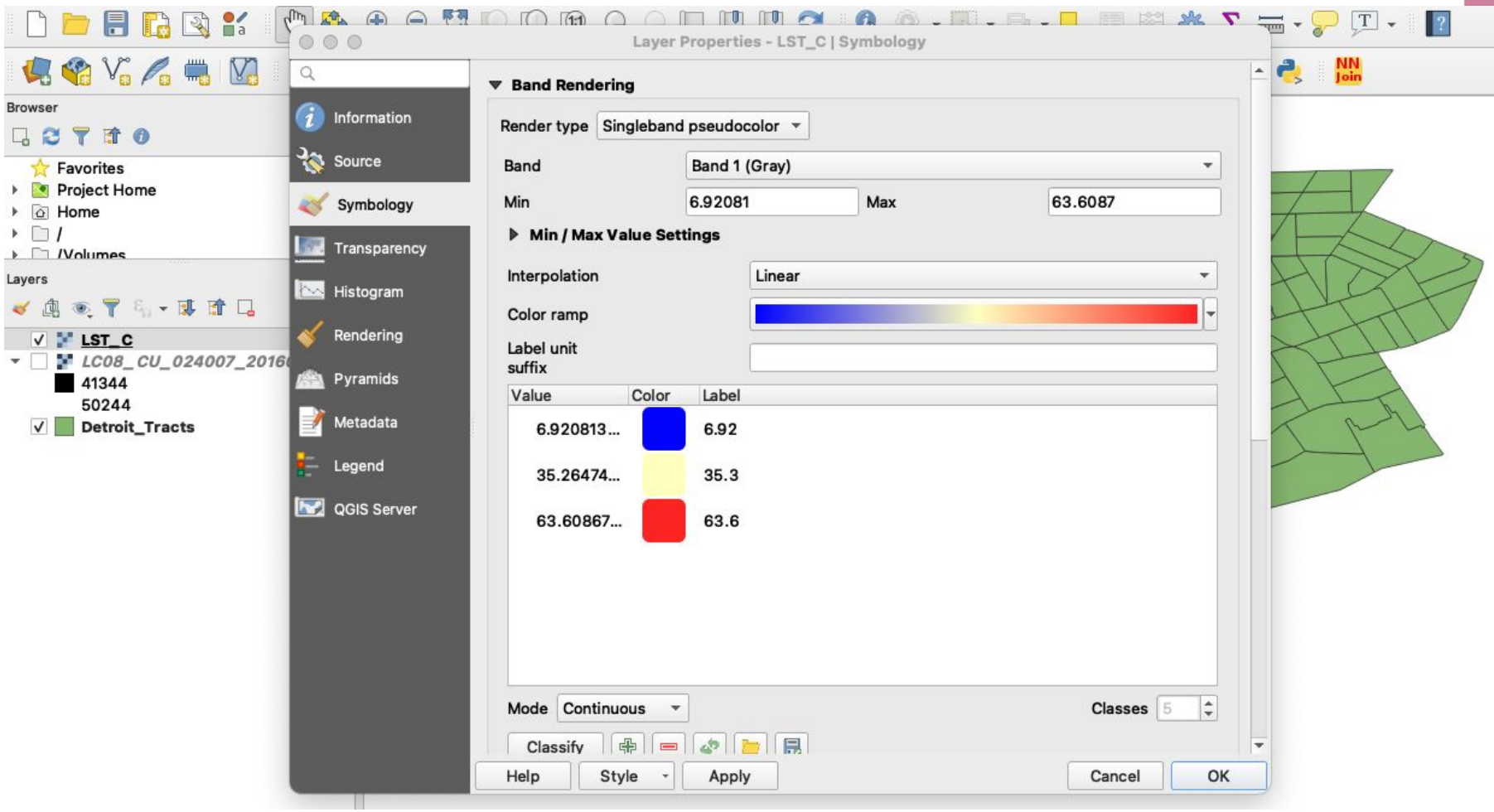
$$LST\_C = [LST\ Raster] * 0.00341802 + 149 - 273.15$$

Raw value to Kelvin

Kelvin to Celsius

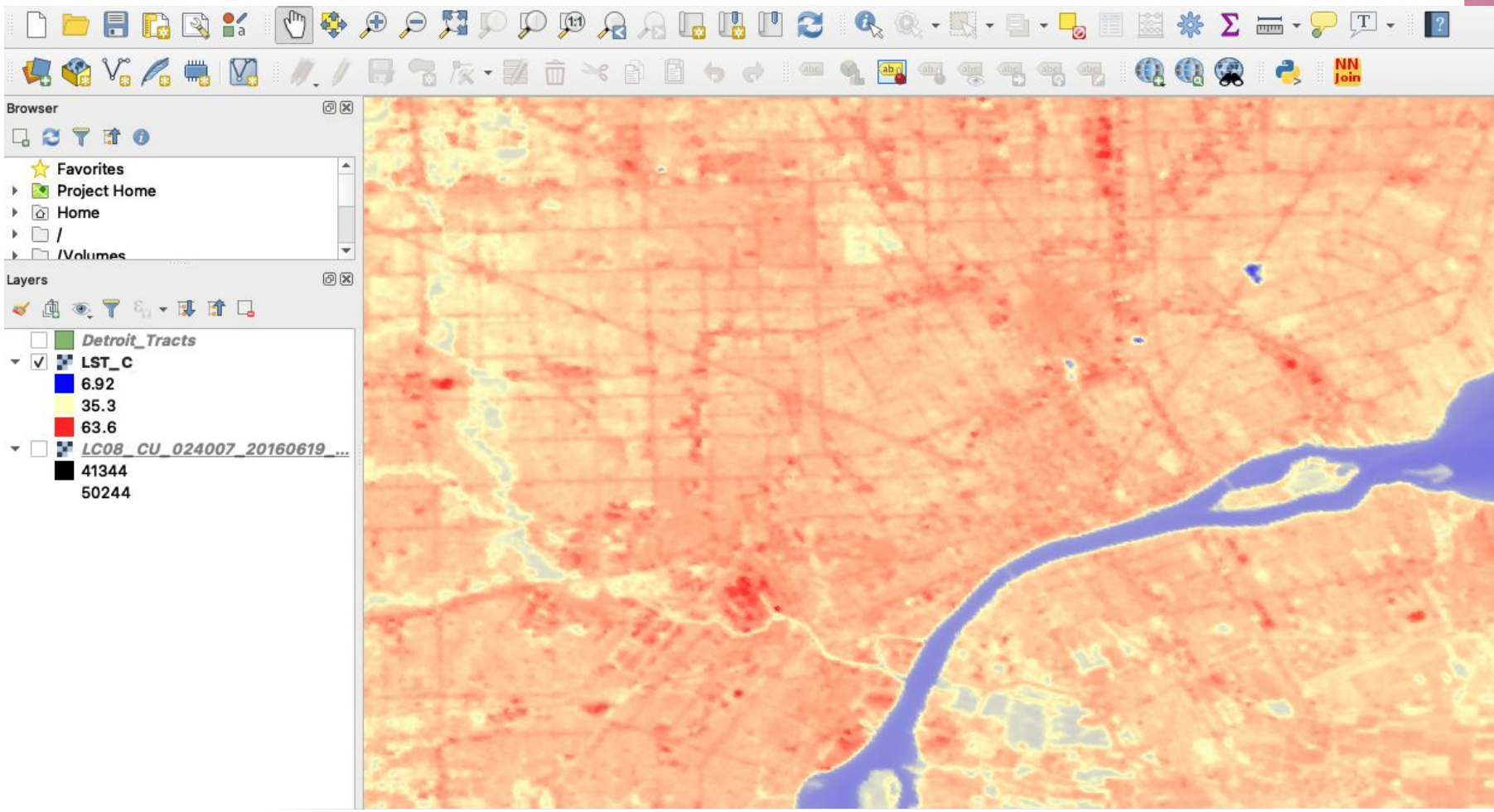
Processing Spatial Components – Exposure Rasters

Change the symbology in the layer properties for a more familiar color scheme.



Processing Spatial Components – Exposure Rasters

Change the symbology in the layer properties for a more familiar color scheme.

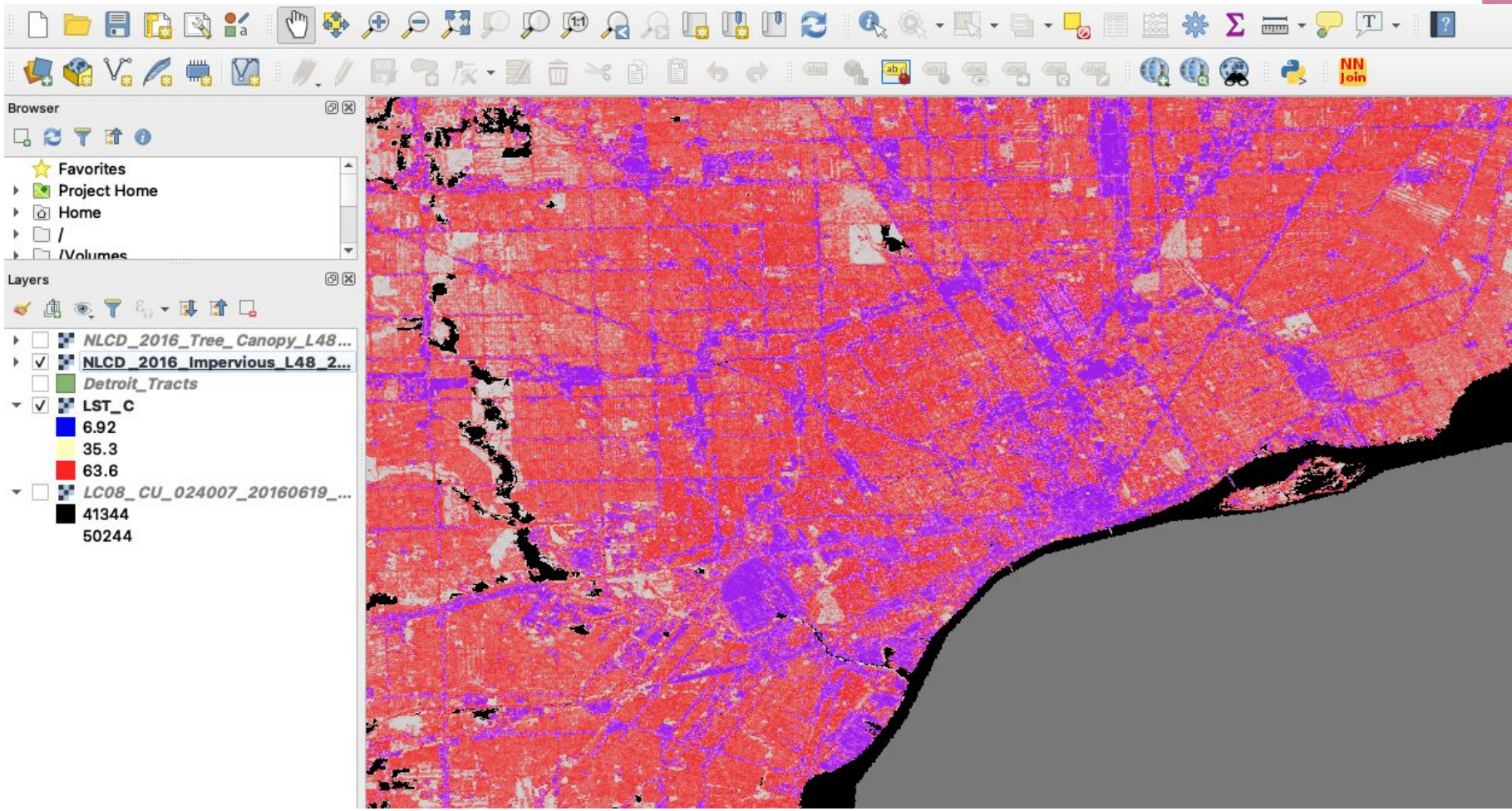


Processing Spatial Components – Exposure Rasters

Repeat with alternative exposure rasters if available

Listed here:

1. Tree canopy
2. Impervious surface

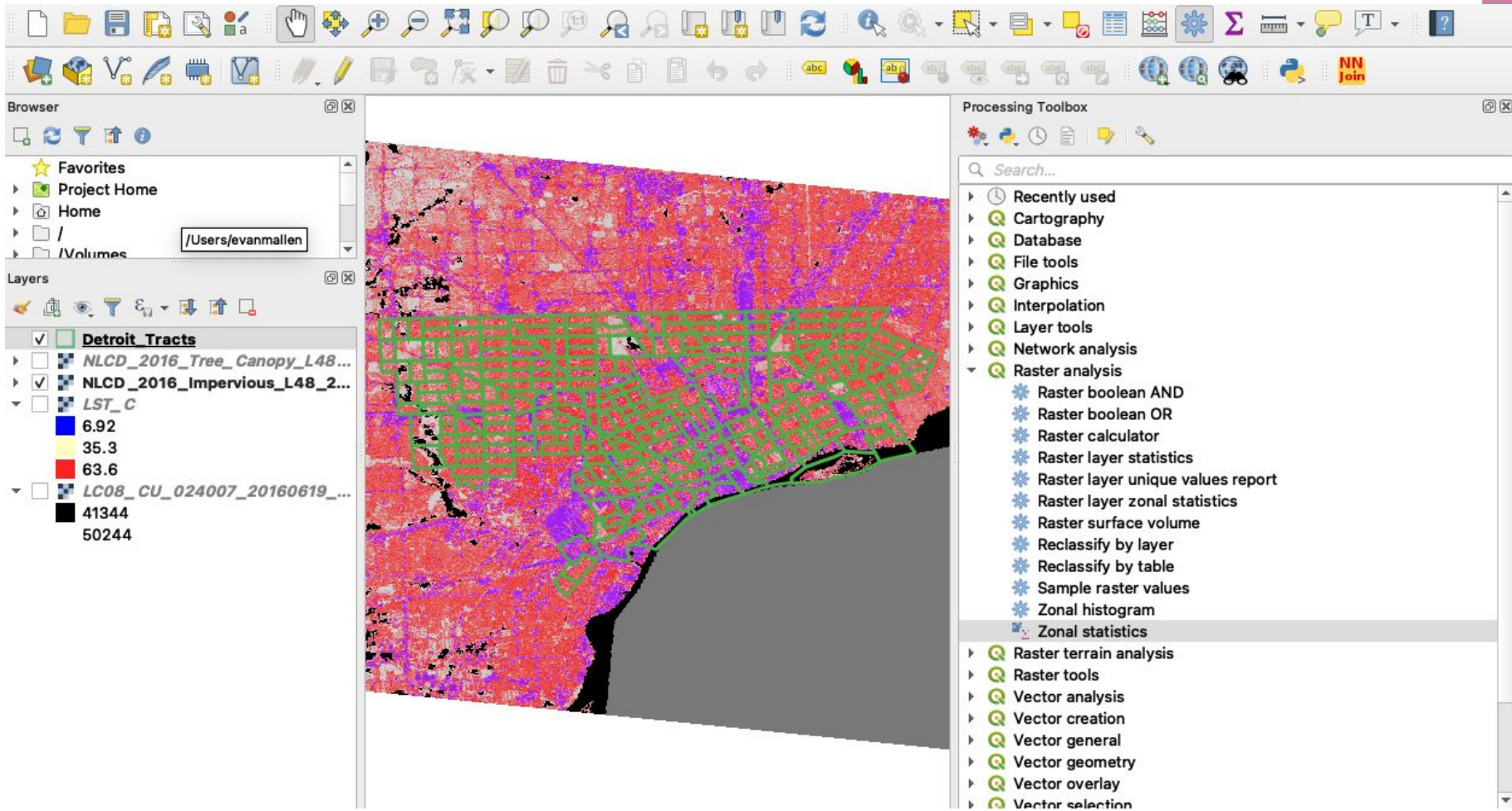


Summarizing Exposure – Zonal Statistics

Zonal Statistics summarizes the values of the raster layer by each unit of geography in the shapefile, or "zone."

Here, we'll use the mean for each exposure raster.

Access the **Zonal Statistics** tool using the **Processing Toolbox**.

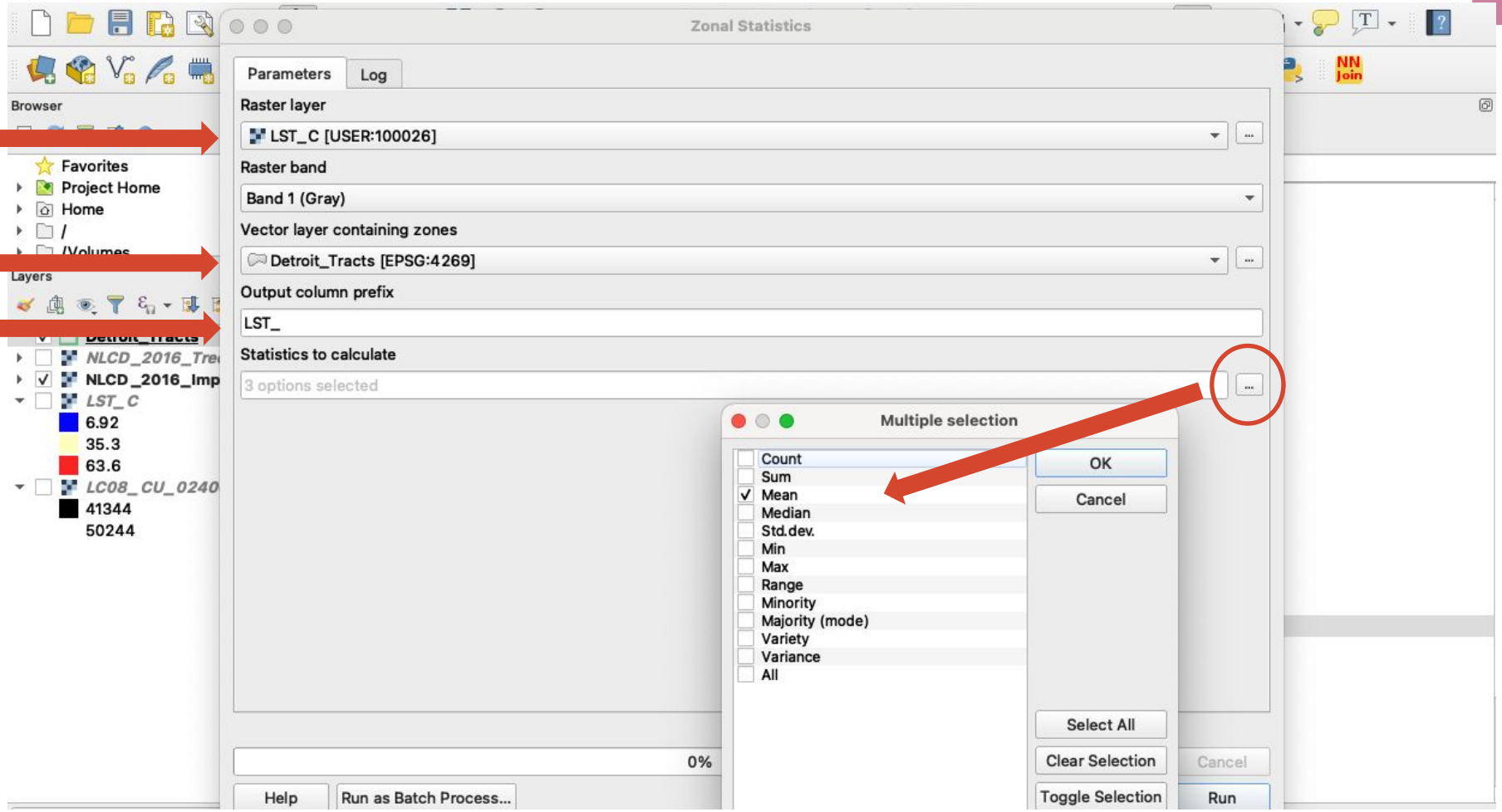


Summarizing Exposure – Zonal Statistics

Exposure data

Boundary shapefiles

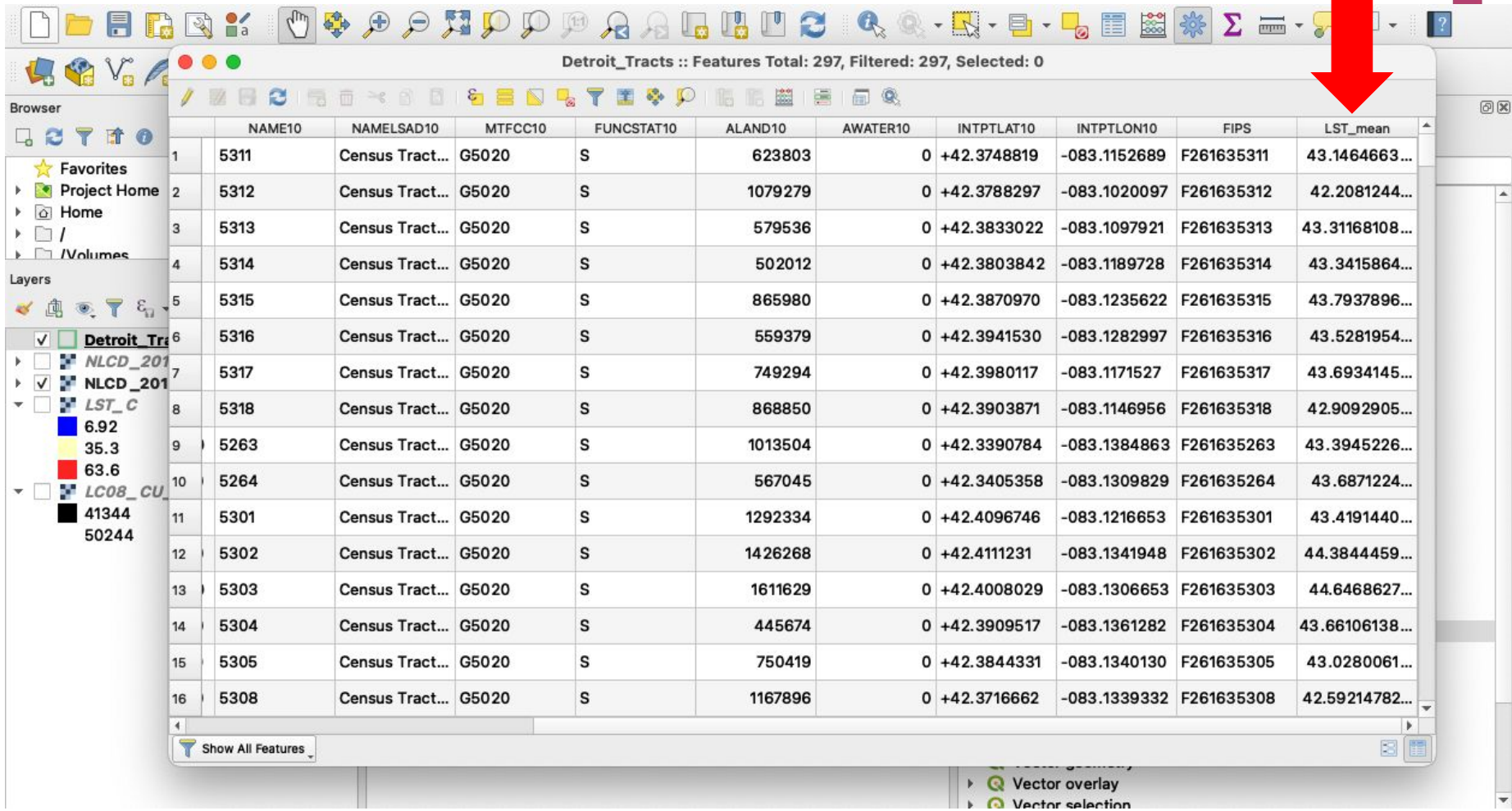
Select label for your input variable



Summarizing Exposure – Zonal Statistics

LST_mean is now placed directly into your input shapefile attribute table

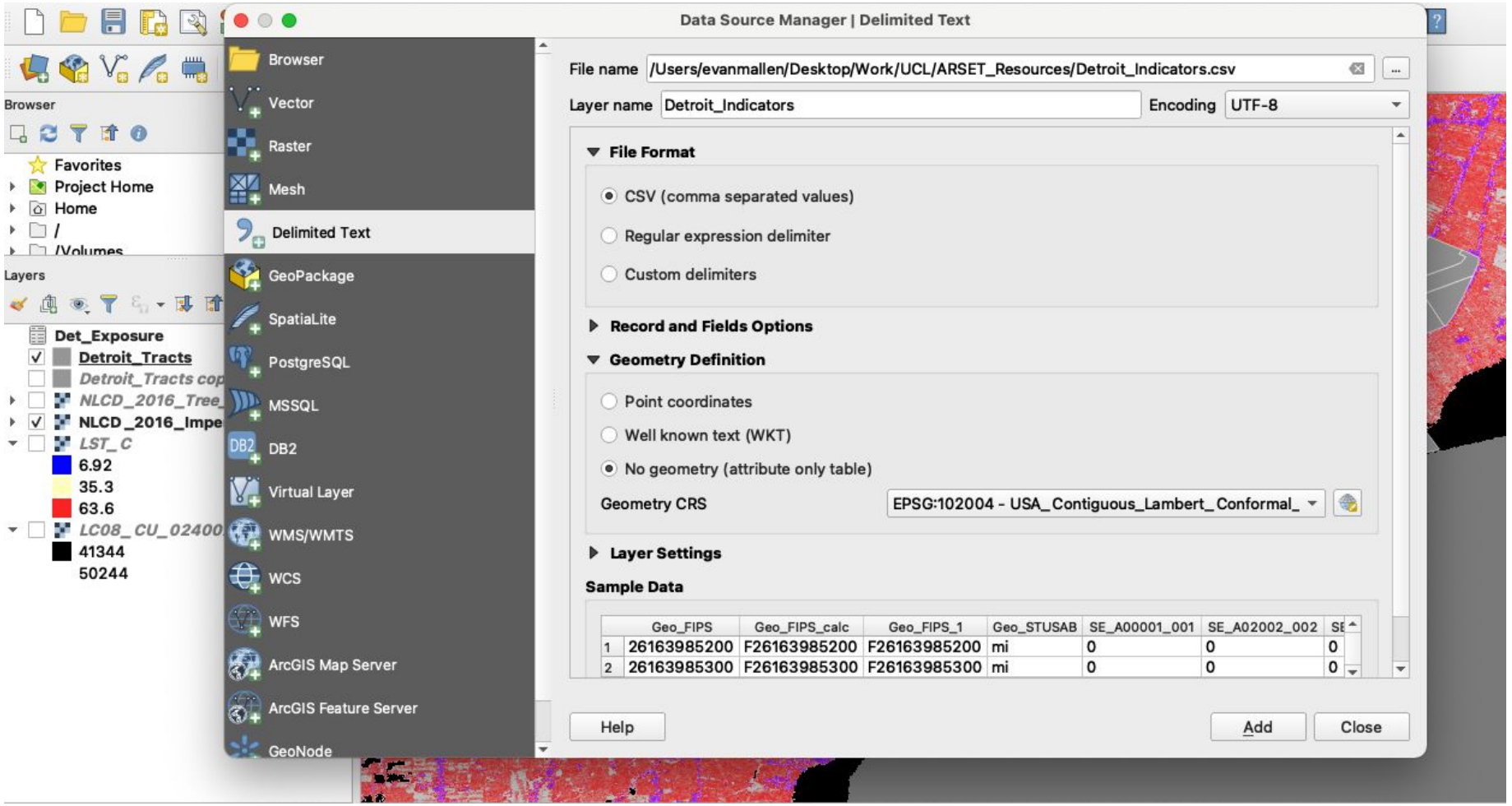
Repeat with other input exposure variables as needed



	NAME10	NAMELSAD10	MTFCC10	FUNCSTAT10	ALAND10	AWATER10	INTPTLAT10	INTPTLON10	FIPS	LST_mean
1	5311	Census Tract...	G5020	S	623803	0	+42.3748819	-083.1152689	F261635311	43.1464663...
2	5312	Census Tract...	G5020	S	1079279	0	+42.3788297	-083.1020097	F261635312	42.2081244...
3	5313	Census Tract...	G5020	S	579536	0	+42.3833022	-083.1097921	F261635313	43.31168108...
4	5314	Census Tract...	G5020	S	502012	0	+42.3803842	-083.1189728	F261635314	43.3415864...
5	5315	Census Tract...	G5020	S	865980	0	+42.3870970	-083.1235622	F261635315	43.7937896...
6	5316	Census Tract...	G5020	S	559379	0	+42.3941530	-083.1282997	F261635316	43.5281954...
7	5317	Census Tract...	G5020	S	749294	0	+42.3980117	-083.1171527	F261635317	43.6934145...
8	5318	Census Tract...	G5020	S	868850	0	+42.3903871	-083.1146956	F261635318	42.9092905...
9	5263	Census Tract...	G5020	S	1013504	0	+42.3390784	-083.1384863	F261635263	43.3945226...
10	5264	Census Tract...	G5020	S	567045	0	+42.3405358	-083.1309829	F261635264	43.6871224...
11	5301	Census Tract...	G5020	S	1292334	0	+42.4096746	-083.1216653	F261635301	43.4191440...
12	5302	Census Tract...	G5020	S	1426268	0	+42.4111231	-083.1341948	F261635302	44.3844459...
13	5303	Census Tract...	G5020	S	1611629	0	+42.4008029	-083.1306653	F261635303	44.6468627...
14	5304	Census Tract...	G5020	S	445674	0	+42.3909517	-083.1361282	F261635304	43.66106138...
15	5305	Census Tract...	G5020	S	750419	0	+42.3844331	-083.1340130	F261635305	43.0280061...
16	5308	Census Tract...	G5020	S	1167896	0	+42.3716662	-083.1339332	F261635308	42.59214782...

Joining Your Data

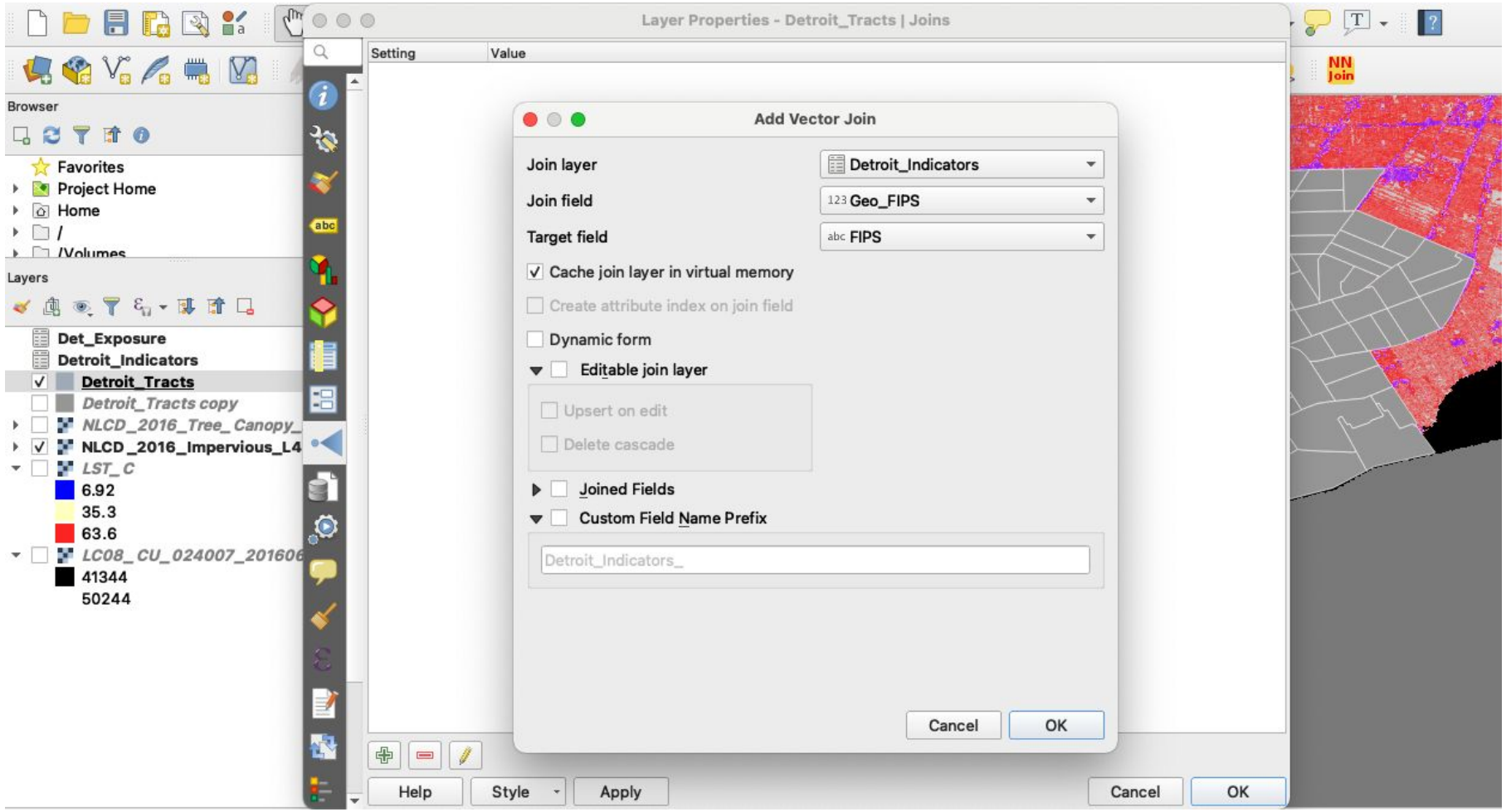
Save your additional data tables as CSV and load into QGIS using the "Delimited Text" option.



Joining Your Data

Right-click your shapefile and select **Layer Properties**, then the **Join** tab.

Click the + button to add a new join to your shapefile's attribute table.

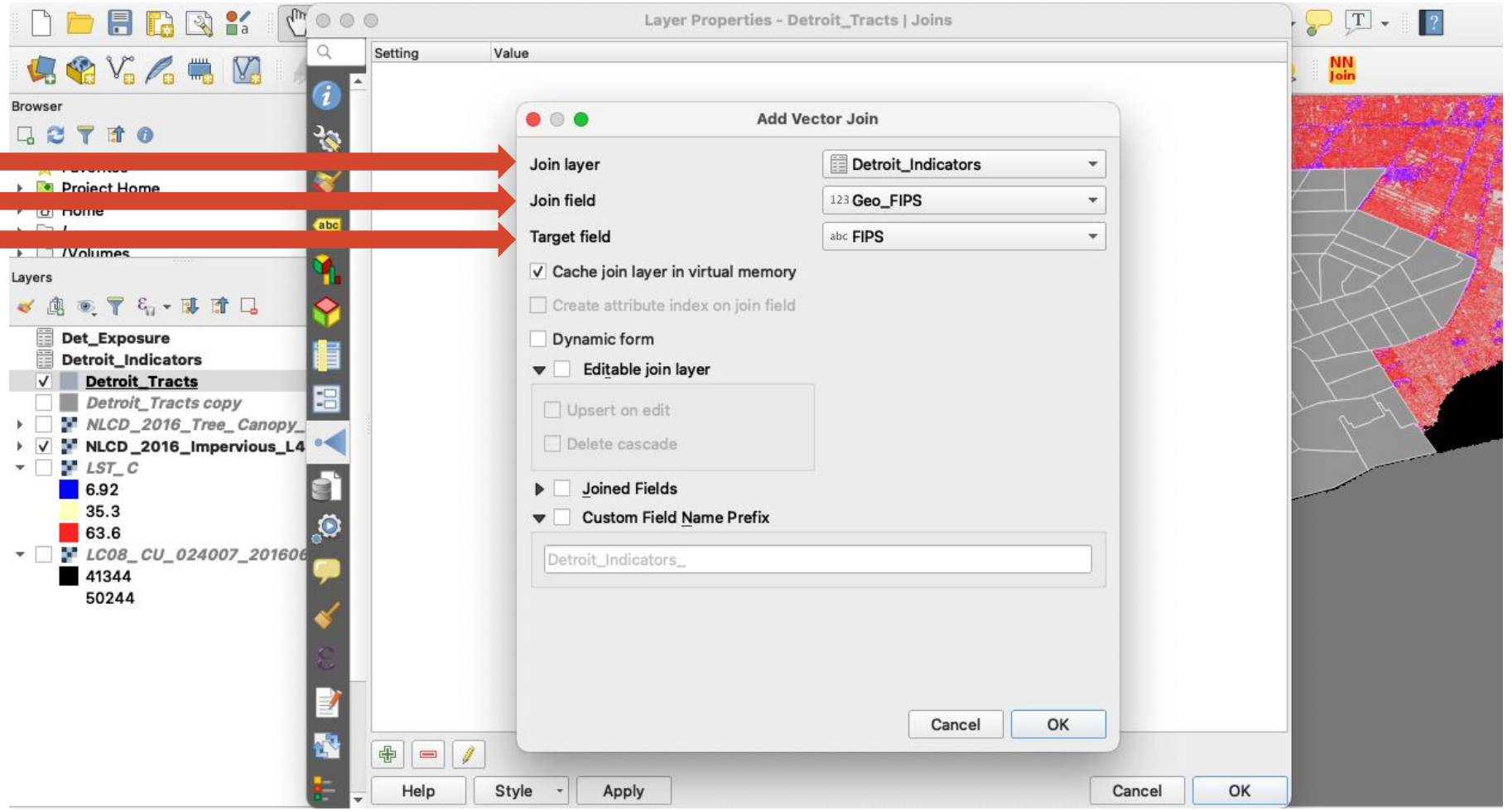


Joining Your Data

Table we will add to shapefile table

Key field in new table

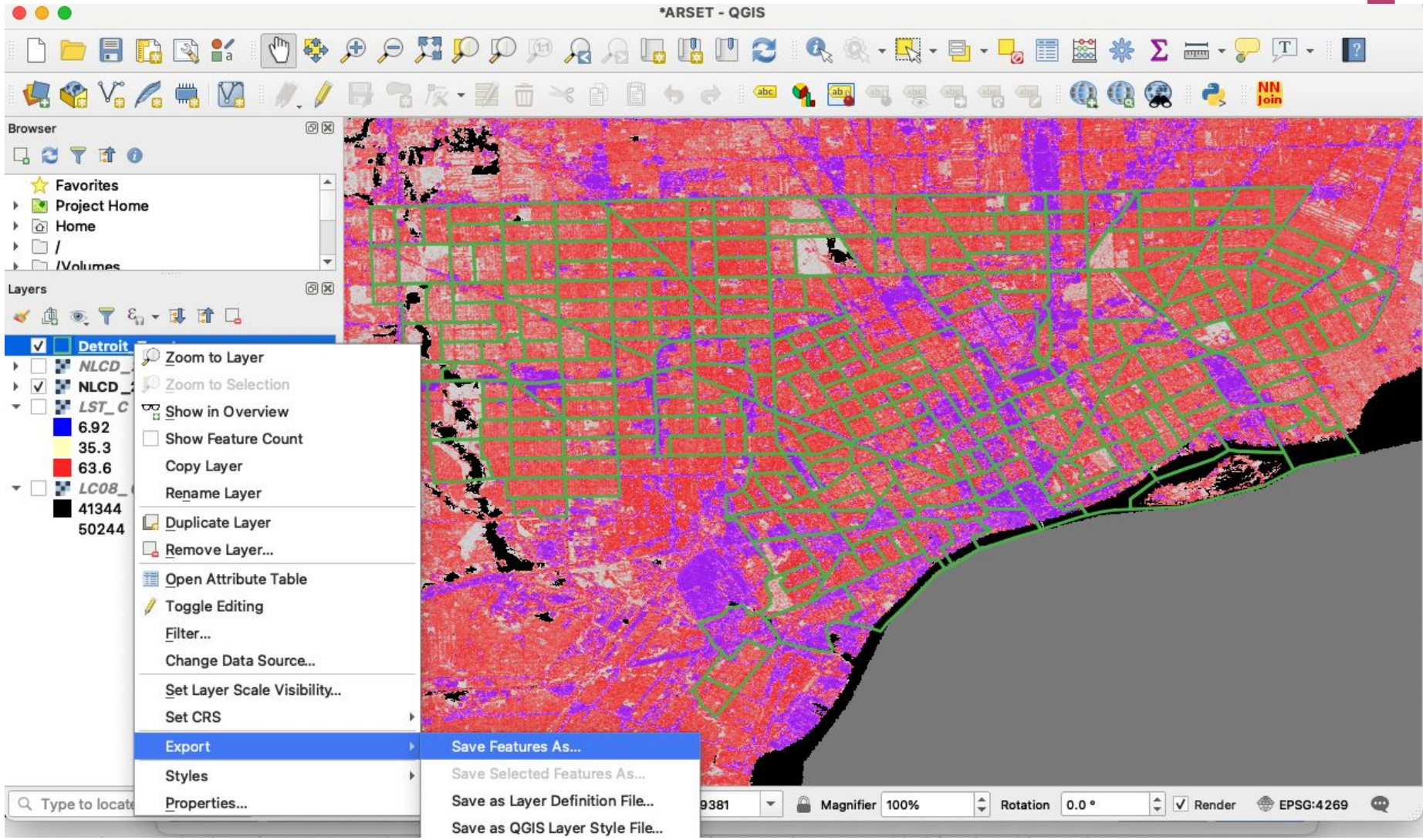
Key field in shapefile table



Repeat this process for any new data tables you'd like to add to your HVI dataset.

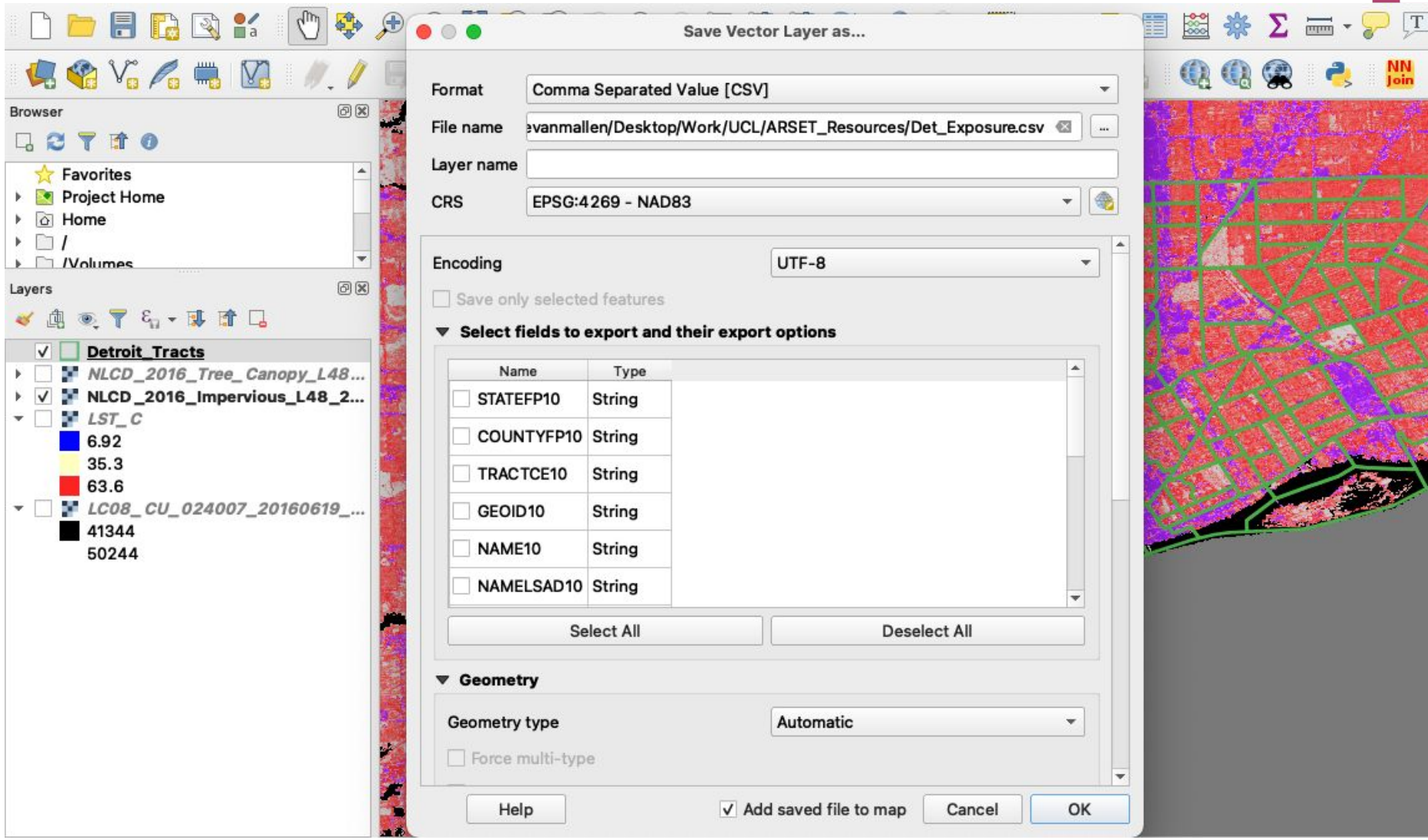
Exporting Joined Data Table

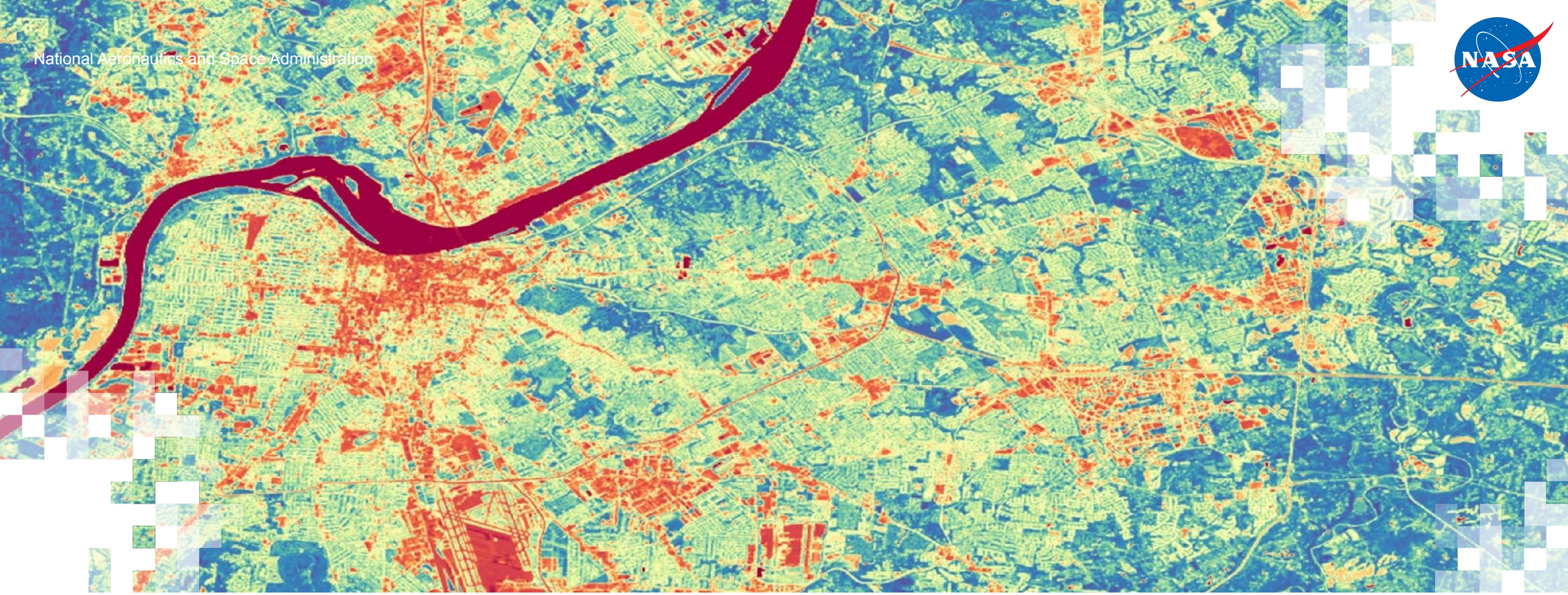
Export data as **Comma Separated Value (CSV)** to combine with other variables in spreadsheet editor.



Exporting Joined Data Table

Export data as **Comma Separated Value (CSV)** to combine with other variables in spreadsheet editor.



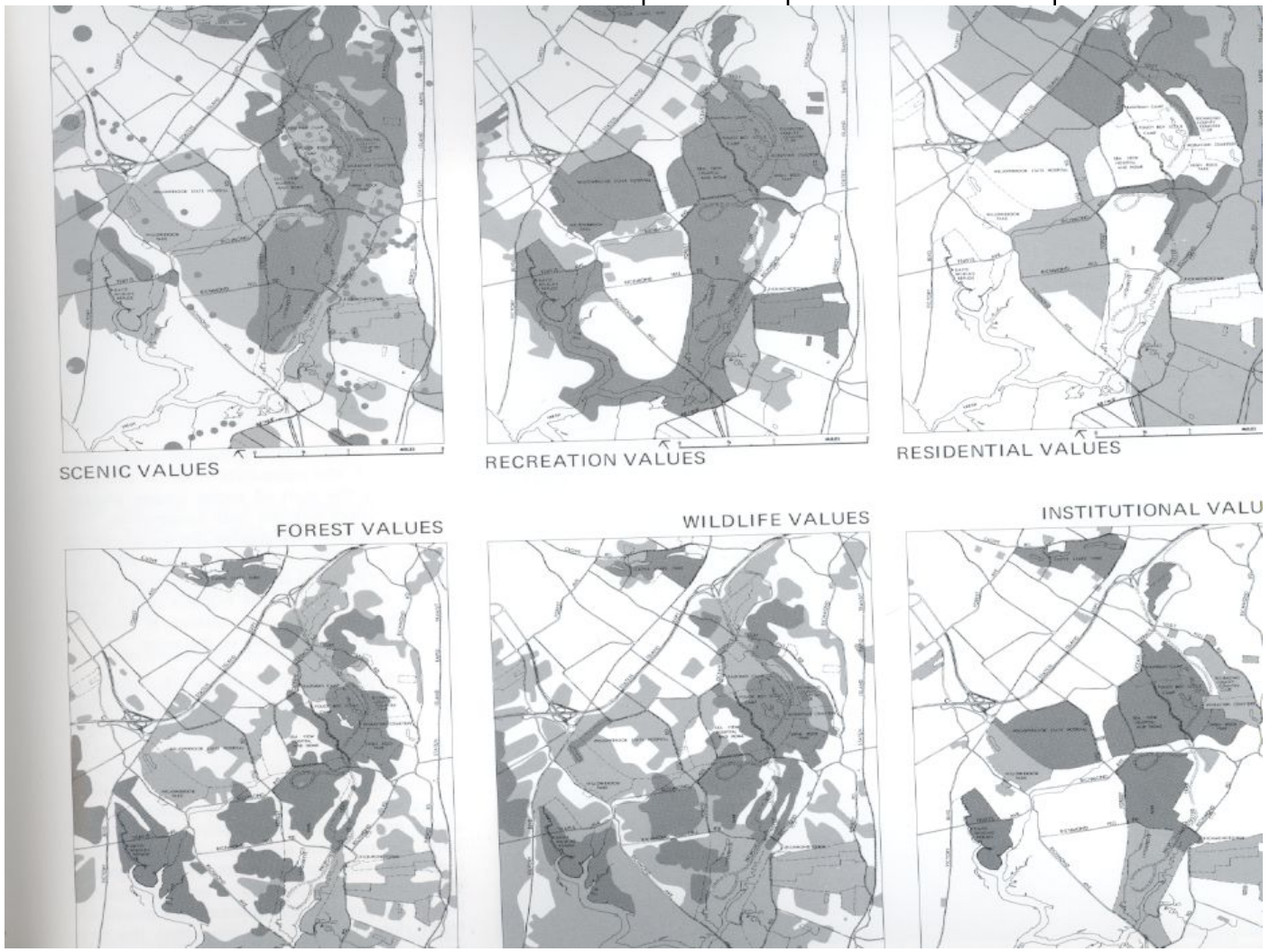


Constructing Your Heat Vulnerability Index

HVI Construction Considerations

FIPS	HVI Indicator

- What intervention do you want to implement?
- Which indicators will help locate high-priority areas for this intervention?
- Do you have (or need) a mix of vulnerability components?
- Are your indicators independent?
- Will you weight your indicators?



McHarg (1969)

HVIs and Heat Interventions

Sensitivity

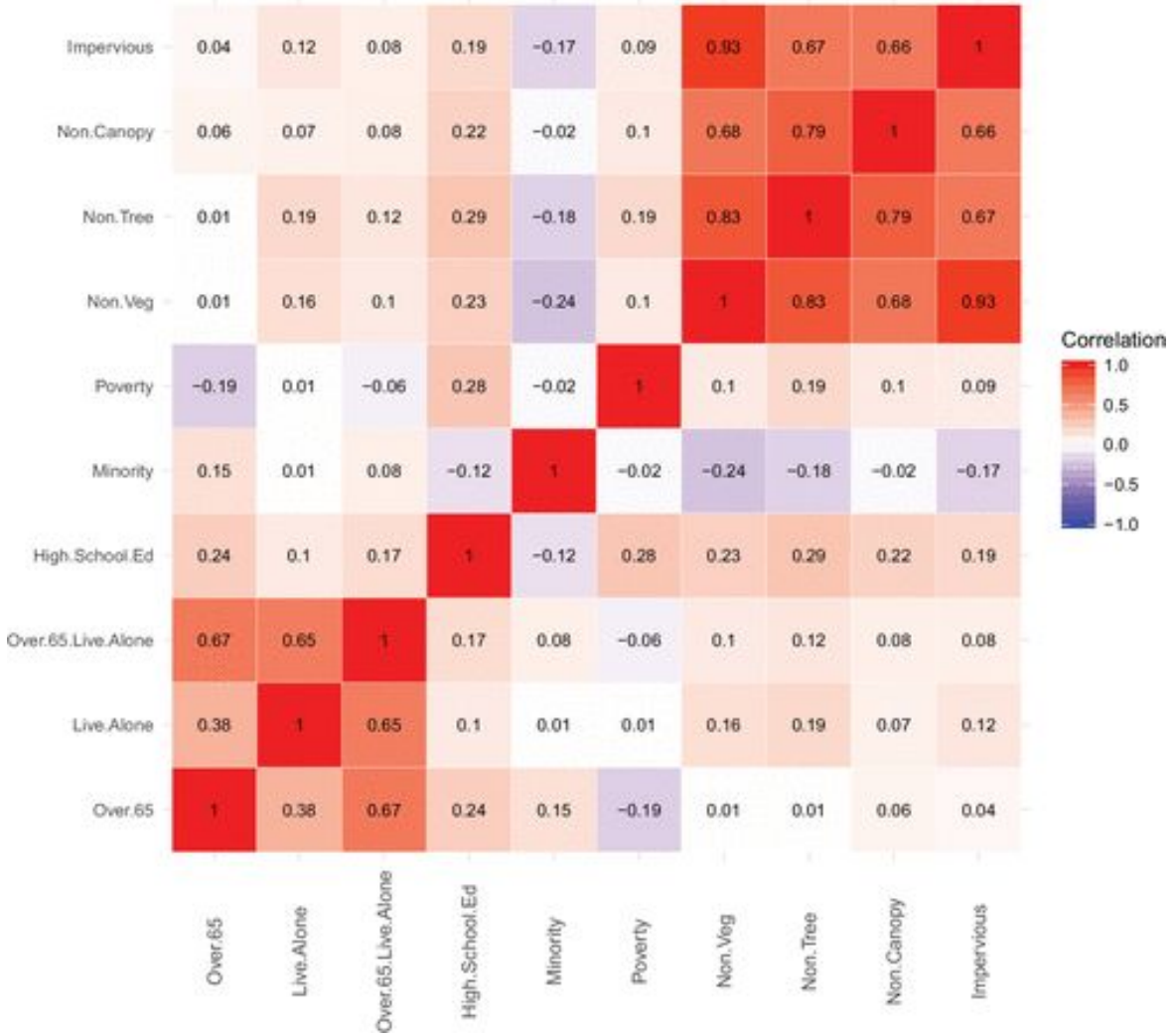
Adaptive Capacity

Exposure

Weighting Considerations

- Are your indicators independent?
- Correlation matrix
  - Highly correlated variables could be dropped

FIPS	HVI Indicator



Conlon et al. (2020)

Cleaning the Dataset

FIPS	HVI Indicator

Remove any rows with a total population of zero

- Cannot divide by zero in normalization steps
- Avoids #Div/0! errors

	C	D
2	Geo_FIPS	Total_Population
3	F26163985200	0
4	F26163985300	0
5	F26163985400	0
6	F26163985500	0
7	F26163985600	0
8	F26163985700	0
9	F26163985900	0
10	F26163990100	0
11	F26163990200	0
12	F26163985000	72
13	F26163985100	150
14	F26163518400	425
15	F26163545400	600
16	F26163518800	624

Normalization

FIPS	HVI Indicator

Identify your numerator and denominator

Numerator: Intervention population

Denominator: Total eligible population

Credit: Sales Layer

Eligible population is not always total population in the geography

Normalization

FIPS	HVI Indicator

Example:

Population over age 65

Numerator: Population cohorts with age > 65

Denominator: Total Population

	BX	BY	BZ
2	O65_pop	Total_Population	O65_p
3	226	3719	0.061
4	226	2985	0.076
5	133	2720	0.049
6	80	1306	0.061
7	171	1795	0.095
8	196	3366	0.058
9	219	4349	0.050
10	133	2795	0.048
11	225	4018	0.056

Eligible population is not always total population in the geography

Normalization

FIPS	HVI Indicator

Example:

Less than High School Education

Numerator: Population over age 25 who did not graduate high school

Denominator: Population over age 25

	CS	CT	CU
2	LHS_pop	O25_pop	LHS_p
3	340	1879	0.181
4	243	1672	0.145
5	227	1353	0.168
6	196	725	0.270
7	281	1206	0.233
8	327	1858	0.176
9	391	2288	0.171
10	171	1659	0.103
11	442	2464	0.179

Eligible population is not always total population in the geography

Checking Unidirectionality

FIPS	HVI Indicator

Ensure higher values means higher vulnerability for **all** indicators in your HVI.

Example:

Land surface temperature and impervious surfaces

	A	B	C
1	FIPS	LST_mean	Imp_mean
2	F261635248	43.71	59.67
3	F261635219	43.51	67.99
4	F261635218	44.97	69.93
5	F261635215	44.00	69.30
6	F261635214	45.76	82.10
7	F261635213	44.02	70.30
8	F261635211	43.11	73.39

Higher values → Higher heat exposure → More vulnerable ✓

Checking Unidirectionality

FIPS	HVI Indicator

Ensure higher values means higher vulnerability for **all** indicators in your HVI.

Example:

Tree Canopy

Need to flip this indicator!

	A	D
1	FIPS	TreeCan_mean
2	F261635248	3.41
3	F261635219	3.28
4	F261635218	0.06
5	F261635215	1.71
6	F261635214	0.80
7	F261635213	2.06
8	F261635211	5.54

Higher values → Lower heat exposure → Less vulnerable ✗

Checking Unidirectionality

FIPS	HVI Indicator

Ensure higher values means higher vulnerability for **all** indicators in your HVI.

Use complement of indicator to flip orientation.

NoCan = 100 - TreeCan

SUM ✕ ✓ *fx* =100 - D2

	A	D	E
1	FIPS	TreeCan_mean	NoCan_mean
2	F261635248	3.41	=100 - D2
3	F261635219	3.28	96.72
4	F261635218	0.06	99.94
5	F261635215	1.71	98.29
6	F261635214	0.80	99.20
7	F261635213	2.06	97.94
8	F261635211	5.54	94.46

Higher values → Higher heat exposure → More vulnerable ✓

Construction Mechanisms – Scoring

FIPS	HVI Indicator

Z-score: Number of standard deviations from the mean

$$\text{Z-score} = \frac{[\text{Observed value} - \text{mean}_x]}{\text{Std. deviation}}$$

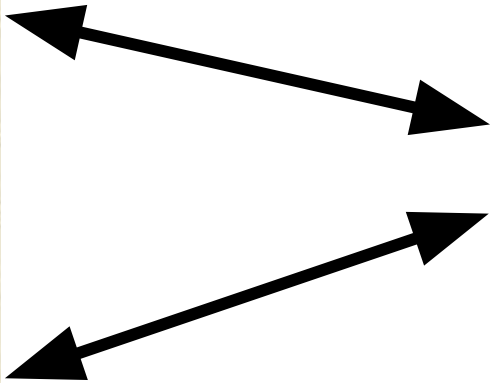
Range of Z-Score	HVI Component Score
-2 or lower	1
-2 to -1	2
-1 to 0	3
0 to 1	4
1 to 2	5
2 or higher	6

Reid et al. (2009)

Construction Mechanisms – Scoring

FIPS	HVI Indicator

	BZ	CA	CB
2	O65_p	O65_z	O65_HVI
3	0.061	-1.285	2
4	0.076	-1.008	2
5	0.049	-1.505	2
6	0.061	-1.276	2
7	0.095	-0.645	3
8	0.058	-1.332	2
9	0.050	-1.478	2
10	0.048	-1.530	2



Range of Z-Score	HVI Component Score
-2 or lower	1
-2 to -1	2
-1 to 0	3
0 to 1	4
1 to 2	5
2 or higher	6

Reid et al. (2009)

Construction Mechanisms – Scoring

FIPS	HVI Indicator

Repeat scoring scheme for each vulnerability indicator and combine.

Unweighted HVI is simply the sum of all individual HVI indicator scores.

SUM =SUM(CB3:CF3)

	CB	CC	CD	CE	CF	CG
2	LST_HVI	Diabetes_HVI	LHS_HVI	O65_HVI	Pov_HVI	UnWeight_HVI
3	1	2	6	2	3	=SUM(CB3:CF3)
4	4	2	3	2	4	15
5	4	2	4	2	2	14
6	3	5	5	2	2	17
7	2	4	2	3	2	13
8	6	3	1	2	6	18
9	4	2	3	2	4	15
10	2	3	3	2	3	13

Exposure Sensitivity Adaptive Capacity

Construction Mechanisms – Scoring

FIPS	HVI Indicator

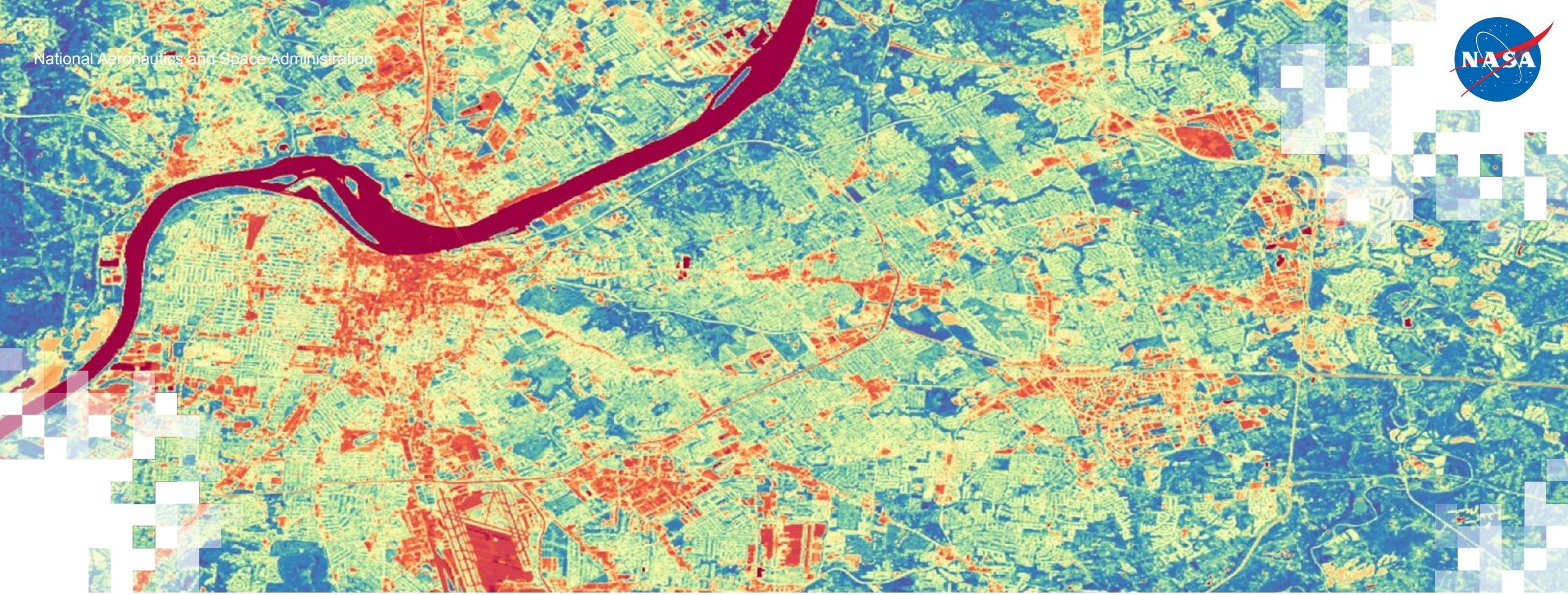
Weighted HVI will need to add weights to each indicator or collection of indicators.

Example: Each vulnerability **component** is equally weighted in this HVI.

SUM =CB3+CC3+(SUM(CD3:CF3)/3)

	CB	CC	CD	CE	CF	CH
2	LST_HVI	Diabetes_HVI	LHS_HVI	O65_HVI	Pov_HVI	Weight_HVI
3	1	2	6	2	3	CF3)/3)
4	4	2	3	2	4	9
5	4	2	4	2	2	9
6	3	5	5	2	2	11
7	2	4	2	3	2	8
8	6	3	1	2	6	12
9	4	2	3	2	4	9
10	2	3	3	2	3	8

Exposure Sensitivity Adaptive Capacity



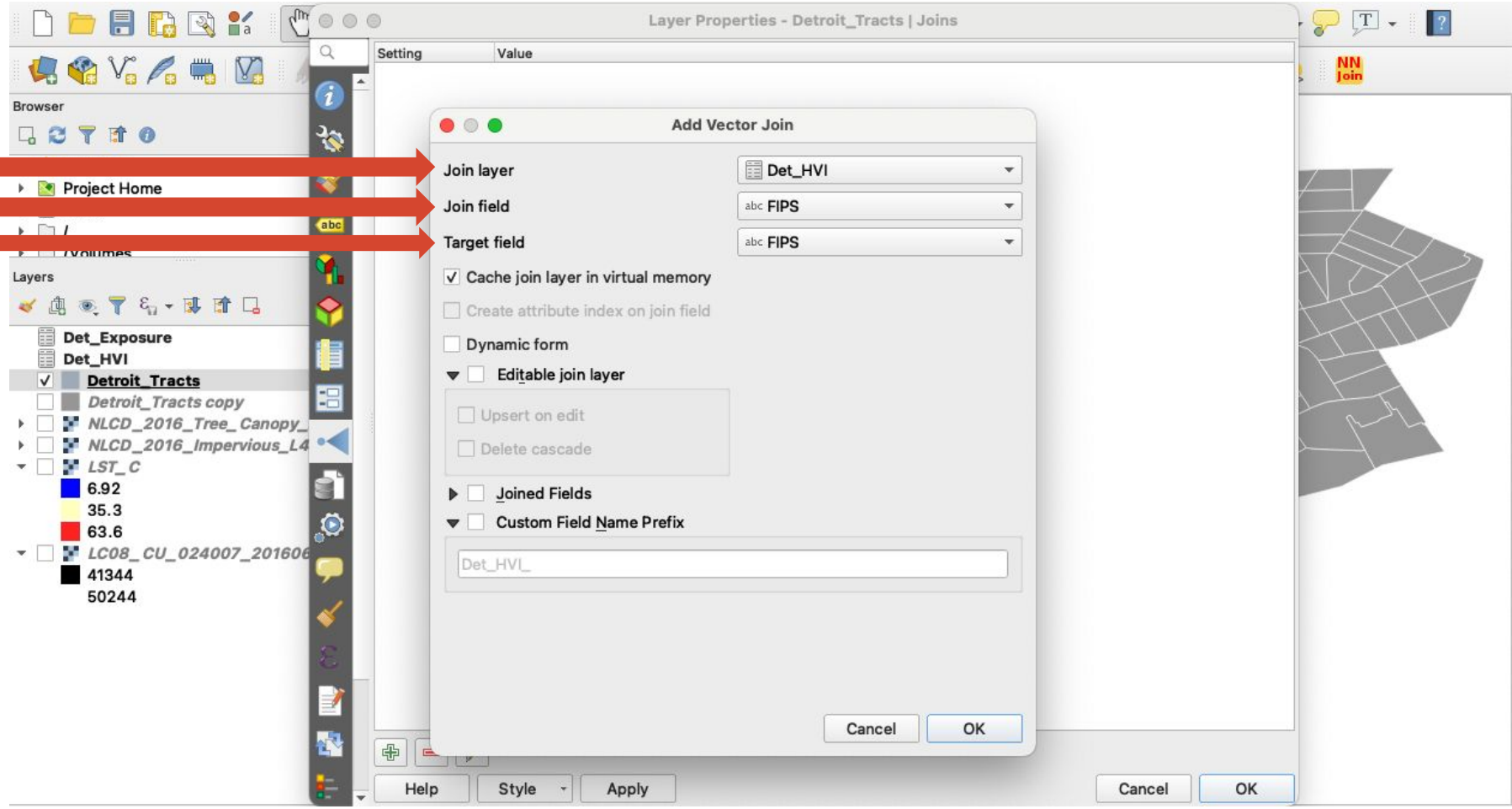
Mapping the Heat Vulnerability Index

Joining Your Data for Mapping

Processed HVI table as CSV

Key field in HVI table

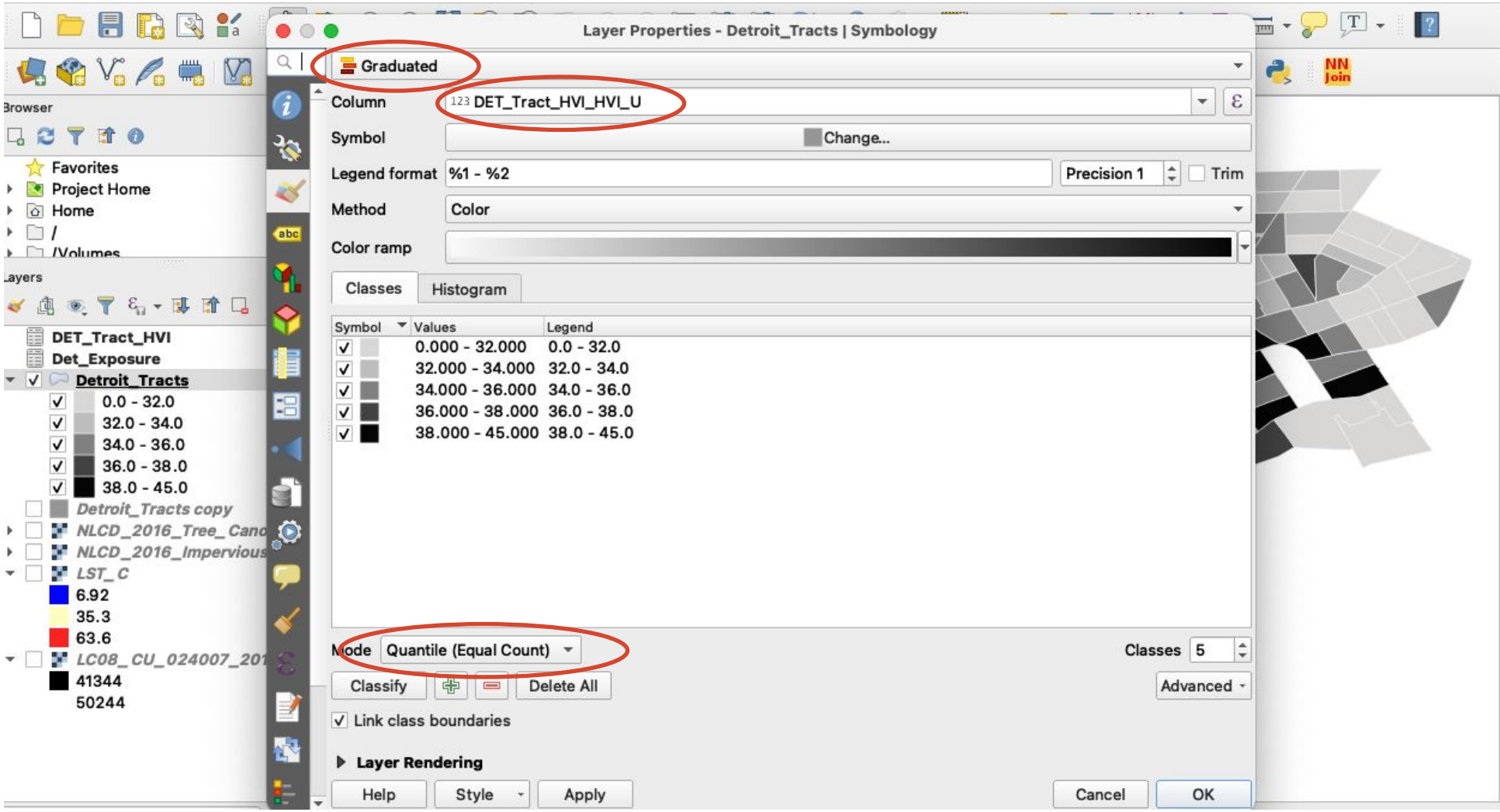
Key field in shapefile table



Joining Your Data for Mapping

Design your map using the **Symbology** tab in **Layer Properties**.

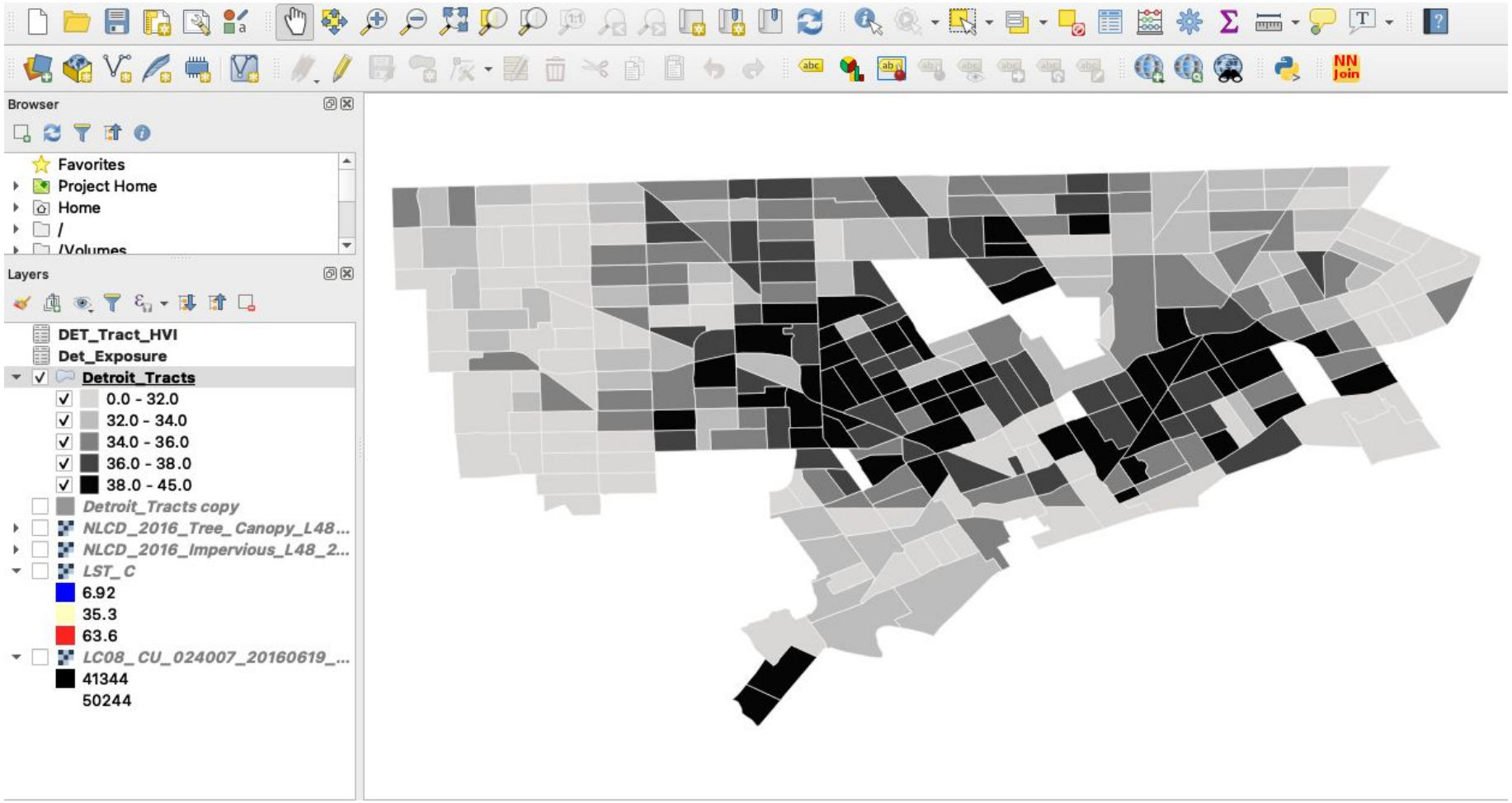
We recommend "Quantile" mode to indicate areas of highest relative priority.

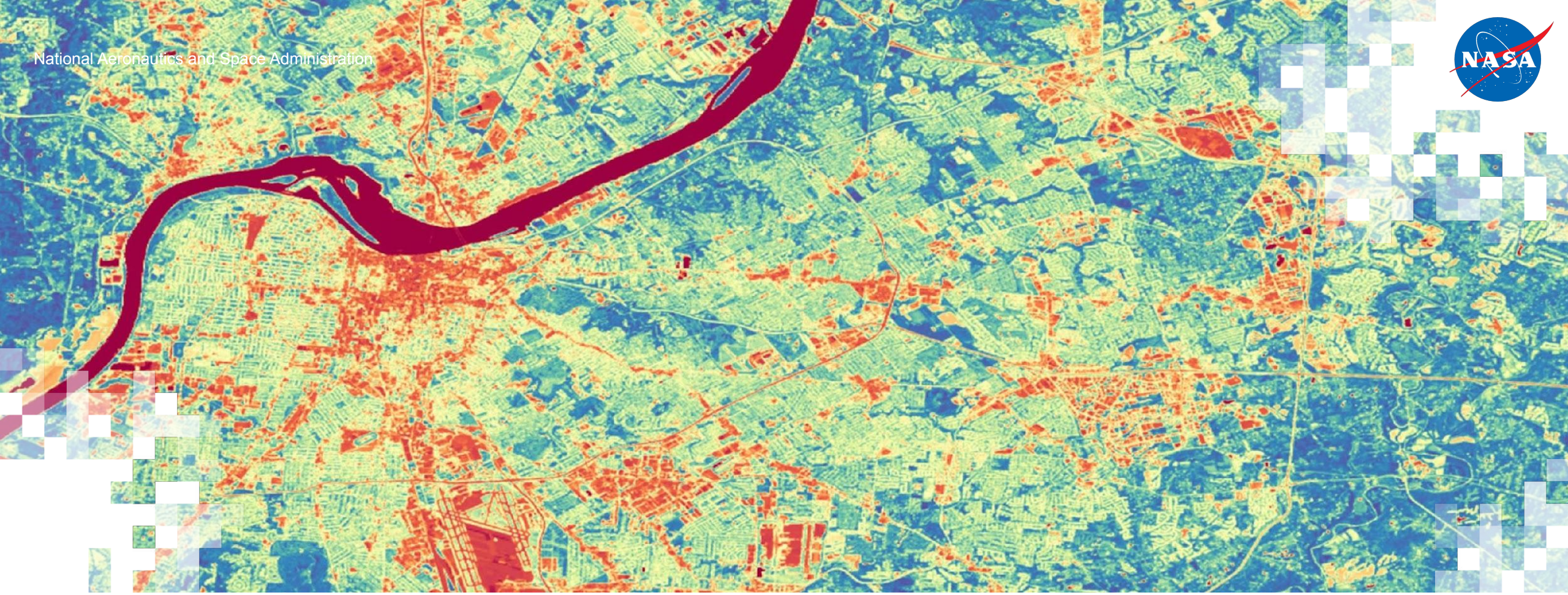


Your HVI Map

Your map is complete!

Now how will you use it?





Time to Practice!

Homework Materials

1. Provided dataset of heat vulnerability characteristics for Detroit, MI USA
    1. Demographic data
    2. Land use data
    3. Temperature data
2. Slide deck with step-by-step guidance

Note: Dataset is organized such that variables confer vulnerability

Homework Questions

1. What is your intervention?
2. Which indicators will you use?
3. How will you weight your indicators?
4. Map of HVI
5. Based on your HVI results, where will you deploy your intervention?

Works Cited

- Conlon KC, Mallen E, Gronlund CJ, Berrocal VJ, Larsen L, O'Neill MS. Mapping human vulnerability to extreme heat: a critical assessment of heat vulnerability indices created using principal components analysis. Environmental Health Perspectives. 2020 Sep 2;128(9):097001.
- McHarg, I. L., & American Museum of Natural History. (1969). *Design with nature*. Garden City, N.Y: Published for the American Museum of Natural History [by] the Natural History Press.
- Reid, C., O'Neill, M., Gronlund, C., Brines, S., Brown, D., Diez-Roux, A., Schwartz, J. (2009). Mapping community determinants of heat vulnerability. Environmental Health Perspectives, 117(11), 1730–1736. http://doi.org/10.1289/ehp.0900683

Questions?

- Please enter your questions in the Q&A box. We will answer them in the order they were received.
- We will post the Q&A to the training website following the conclusion of the webinar.

Credit: NASA

Contacts

- Trainers
  - Kathryn Conlon, PhD, MPH: kcconlon@ucdavis.edu
  - Evan Mallen, PhD, MUP: emallen3@gatech.edu

- Training Webpage:
  - https://appliedsciences.nasa.gov/join-mission/training/english/arset-satellite-remote-sensing-measuring-urban-heat-islands-cold

- ARSET Website:
  - https://appliedsciences.nasa.gov/what-we-do/capacity-building/arset


APPLIED REMOTE SENSING TRAINING PROGRAM
TRAIN - EMPOWER - ADVANCE

Thank You!