TUTORIAL 3 | RASTER DATA

Goals

- Import and style raster data of urban heat.
- Overlay redline vector layer.
- Examine urban heat in comparison to other variables.

Introduction

In this tutorial, you will import and analyze urban heat data collected for a project called “Heat Watch” by NOAA’s National Integrated Heat Health Information System in collaboration with volunteer cities. Luckily for us, all three of our focus cities have participated in this campaign to collect temperature data. In each case, during a single summer day, a team biked around the city and collected point data during three times: morning, afternoon, and evening. This data gives us a useful snapshot of where heat collects and lingers in these cities. However, note that the data only cover a single day, and so they can’t be assumed to represent every day or every time of the year. Nonetheless, we can see interesting patterns in the heat differences between neighborhoods.

For this tutorial, you will be using map data layers from tutorials 1 and 2, though you will create a new file. This will give you other variables to compare with the new heat data, like natural features, roads, and topography. You will also import the redline data layer to compare with the city’s hot spots.

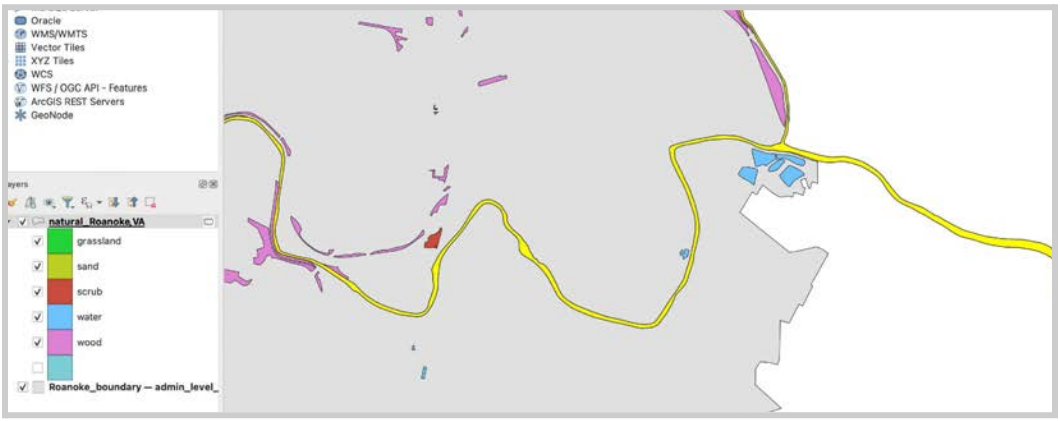
Step 1: Create new QGIS file and import relevant layers.

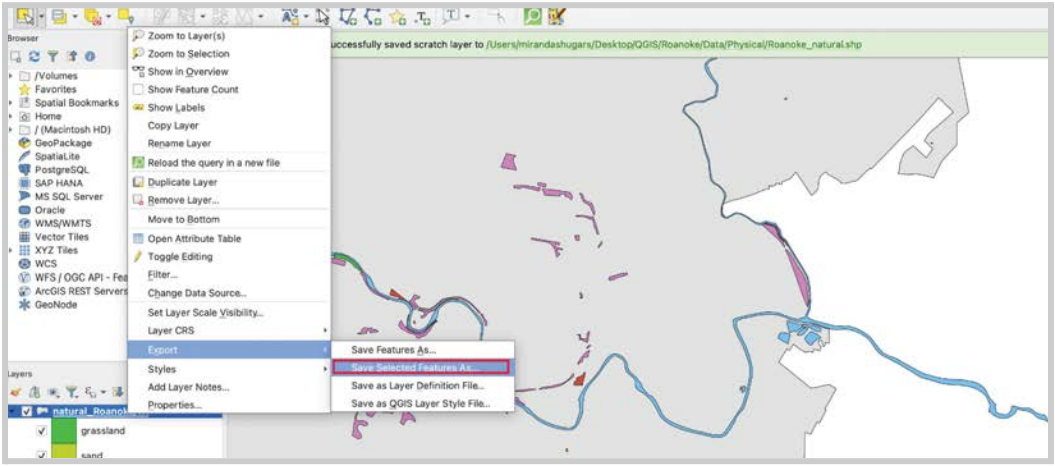
1a Set the **CRS** for your new map to the local UTM 17.

1b Import layers from your previous files using Layers > Add Layer > Add Vector Layer…. Navigate to your Data folder and choose a few relevant layers. I chose to import the **road, railway, and river layers, and the boundary layer**.

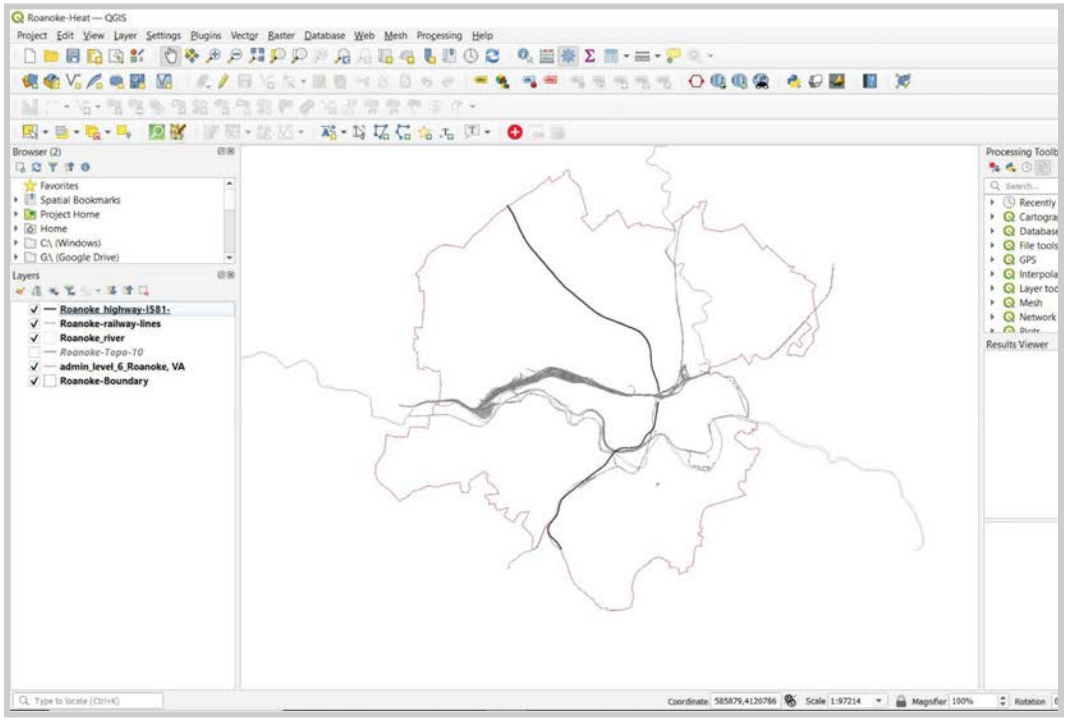
NOTE: There are a few ways to separate only the River from the Natural Features layer. The easiest is to use the OSM plugin to download **"key" = "water" and "value" = "river"**. If you see an incomplete river, try also downloading **"key" = "water" and "value" = "reservoir"**, since parts of these rivers feed into reservoirs and are designated that way in OSM.

The second way is to import the Natural Features layer and then use the "**select**" tool from the upper toolbar (white arrow on yellow square) to select the river on your map. You'll need to have your natural features layer selected (gray highlight). You should see it become highlighted. Then, right click on the Natural Features layer and go to "Export" and then "**Save SELECTED Features As…"**





1c I also included a separate layer of an important road in Roanoke which I know relates to a major high-building urban renewal project – Interstate 581. I downloaded this road from the OSM plugin by entering the key “name” and value “I-581”. Another technique to download only the major roads to compare with heat would be to enter the key “highway” and value “motorway” (highways) or “primary” (large local roads).

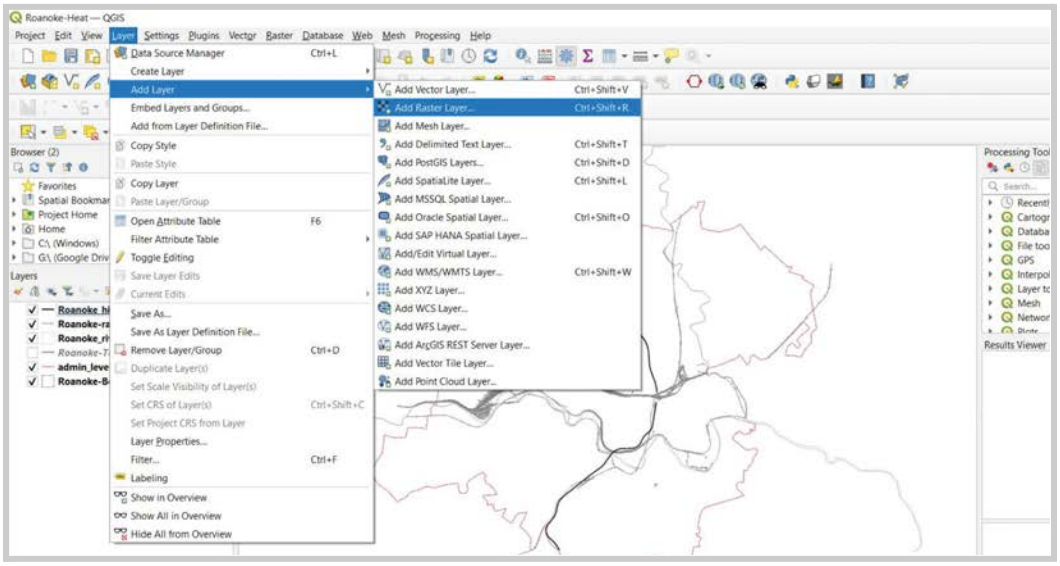


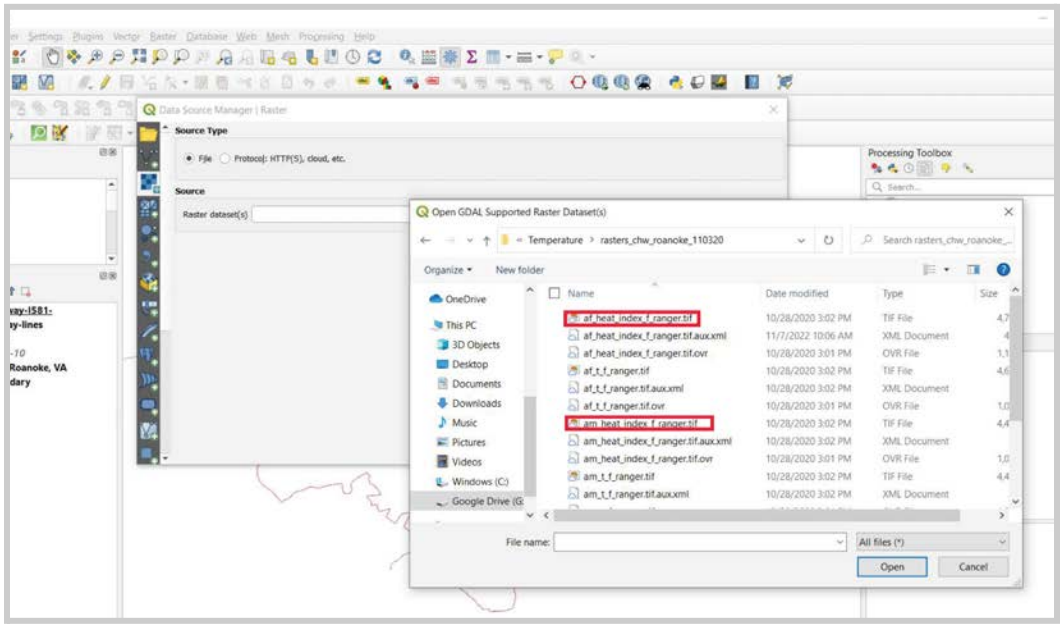
Step 2: Download and import heat raster data.

2a From the Data folder, download the "**Heat**" folder for your city. Put the downloaded folder into you "Data" folder. These heat data files were downloaded from the Heat Watch website: https://www.heat.gov/pages/nihhis-urban-heat-island-mapping-campaign-cities

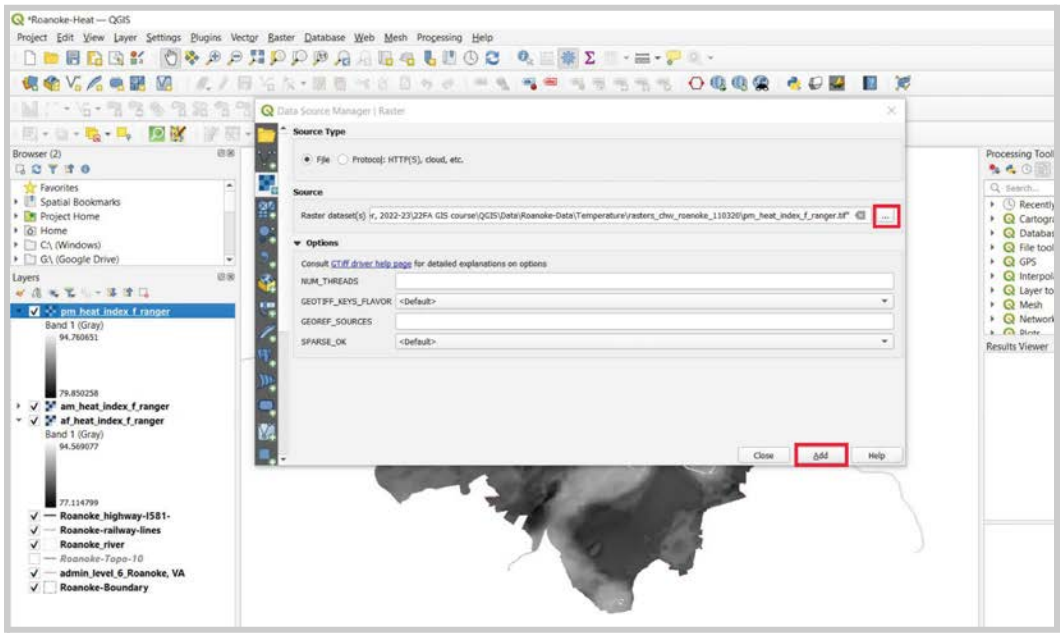
2b In your QGIS file, go to Layer > Add Layer > **Add Raster Laye**r… Select ONLY the **".tif"** files. You'll notice that there are six of these. You can control+select the individual tif files, or add them one at a time.

Once imported, delete the files that show lines and keep only the **three** with full coverage of the city. You'll see the file names contain **af, am, and pm**. This refers to afternoon, morning, and evening measurement times.





2c Check that all three layers have been added to your map. They should show up in black and white as default.

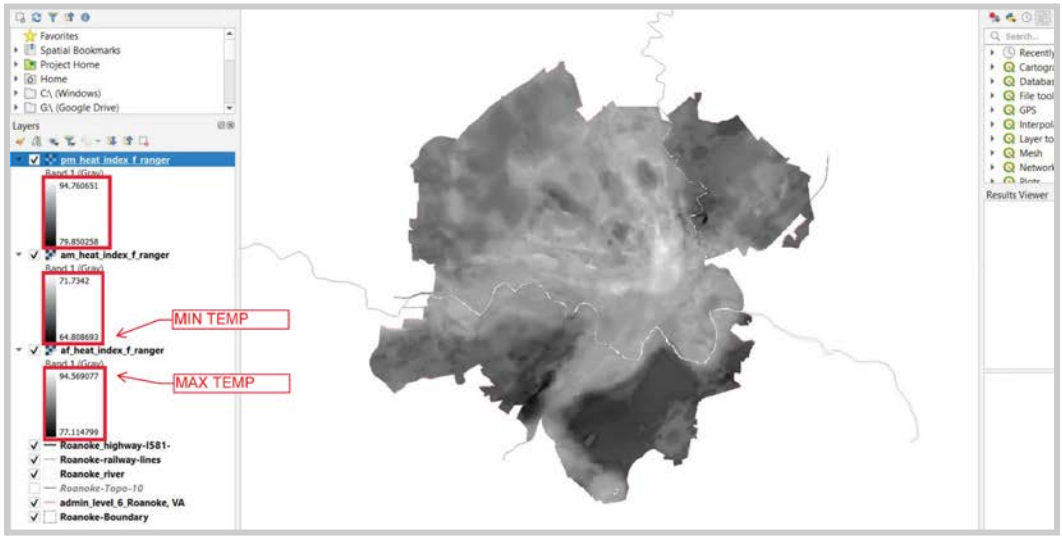

*Roanoke-Heat — QGIS
Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh Processing Help
Data Source Manager | Raster
Source Type
File Protocol: HTTP(S), cloud, etc.
Source
Raster dataset(s)
Options
Consult GTiff driver help page for detailed explanations on options
NUM_THREADS
GEOTIFF_KEYS_FLAVOR
GEOREF_SOURCES
SPARSE_OK
<Default>
Close
Add
Help
Browser (2)
Favorites
Spatial Bookmarks
Project Home
Home
C:\ (Windows)
G:\ (Google Drive)
Layers
pm_heat_index_f_ranger
Band 1 (Gray)
94.760651
79.850258
am_heat_index_f_ranger
af_heat_index_f_ranger
Band 1 (Gray)
94.569077
77.114799
Roanoke_highway-I581-
Roanoke-railway-lines
Roanoke_river
Roanoke-Topo-10
admin_level_6_Roanoke, VA
Roanoke-Boundary
Processing Tool
Results Viewer

Step 3: Style heat raster data.

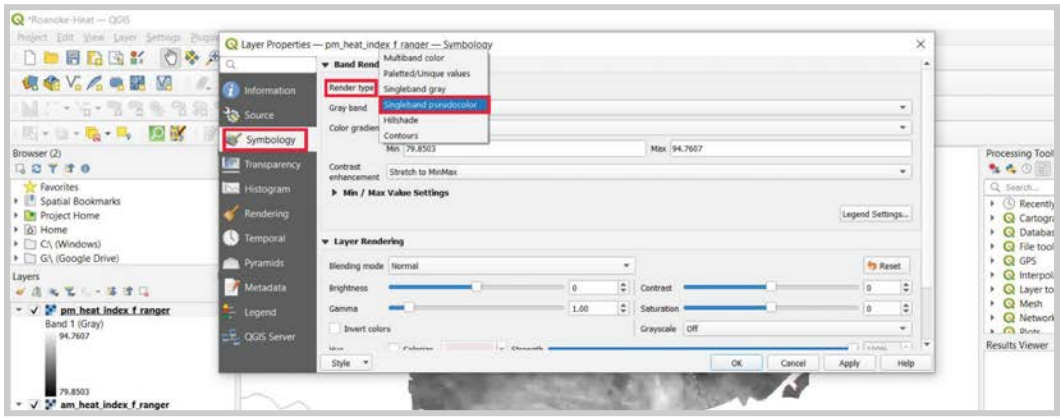
3a Double click on the first of your heat layers, and go to the “Symbology” tab. You’ll notice the Raster Symbology looks different from the Vector layer ones you’ve seen before. Here, we have something called “Band Rendering”, which refers to how QGIS colors the pixels imported.

Unlike the Vector layers, raster layers don’t have Attribute Tables. Instead, they store variables in their color data. We saw this in the DEMs used in the topography tutorial. There, the variable stored was elevation. In this case, it’s temperature. However, we won’t be extracting vector data from this raster like we did with the topography lines. Instead, we’re going to color the data on a gradient which represents its temperature.

3b Close the “Layer Properties” window and click the small arrow beside each of your raster temperature layers to expand their legend. For each, you’ll see a range of temperatures represented by a black and white gradient. Make a note of the **maximum and minimum temperatures** recorded across ALL layers. For instance, if your morning range is 64-75, your afternoon range is 75-95, and your evening range is 70-85, then your **overall minimum** would be 64, and your **overall maximum** would be 95.

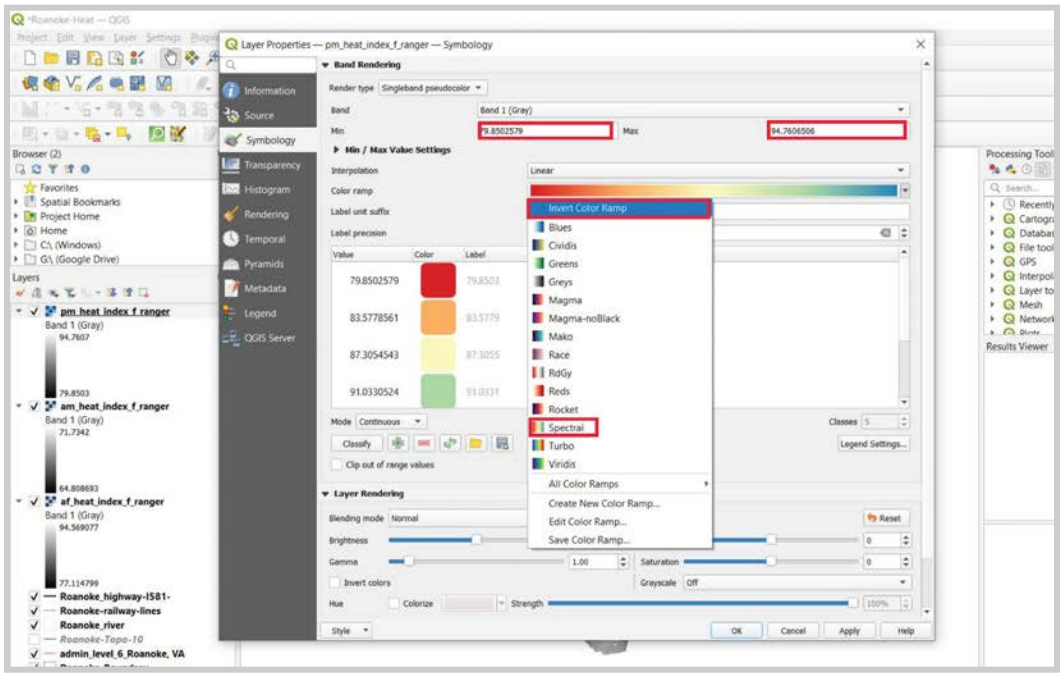


3c Open up your “Layer Properties” again for one of the temperature layers. Under “Band Rendering”, change the Render type to **“Singleband pseudocolor”.** This means that your raster only has one band (in this case, black to white), and you’ll be artificially coloring it. Sometimes data is stored across multiple color bands (red, green, blue), in which case you’d use Multiband color.



Keep the “Band” set to “Gray”, and add in your **Min and Max temperatures** that you noted before (in my case, 64 and 95). We’re going to use a single color gradient across all three raster layers in order to compare them, rather than styling them across their separate ranges. This way, orange will mean the same temperature across all three, as will blue, green, and so on.

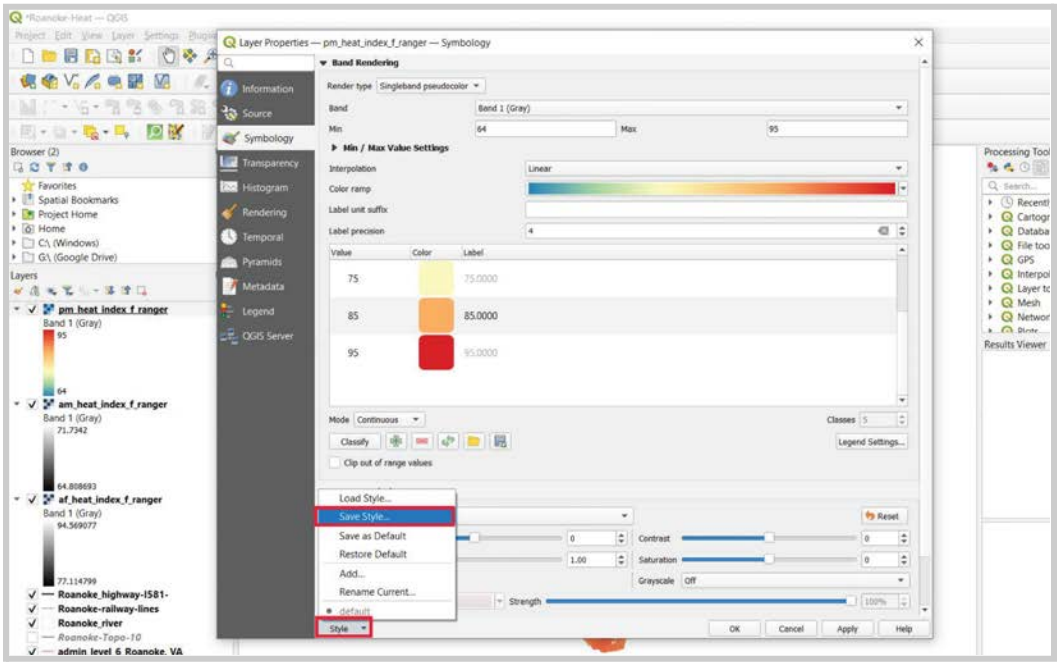
Lastly, set the “Color ramp” to “**Spectral**” (blue-green-yellow-orange-red). Select “Invert Color Ramp” at the top of the drop-down color ramp menu to set blue as the lowest and red as the highest value.



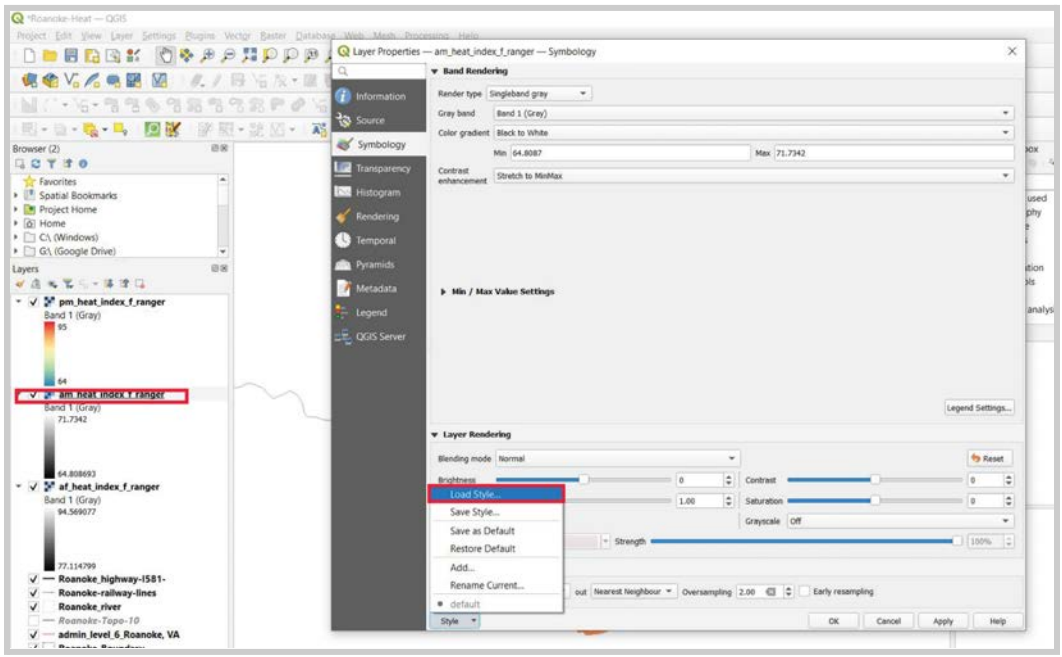
Make sure your “Mode” is set to “**Equal Interval**” and click “**Classify**”. I opted for 8 classes to create more or a gradient, but you can choose to leave it at 5. You should see your minimum set as blue and maximum as red, with equally spaced intervals matched to colors in between. Click “Apply”, and then “Ok”.

3d Check that the layer you just styled looks correct – you should see some part of the color gradient represented. If everything looks alright, then you can go ahead styling the other two layers. For this, you’ll want to use the exact same Symbology Style with the same range. You can either go into each layer and manually set the min/max like you did before, or you can save the Style you used for the first layer and import it for the other two.

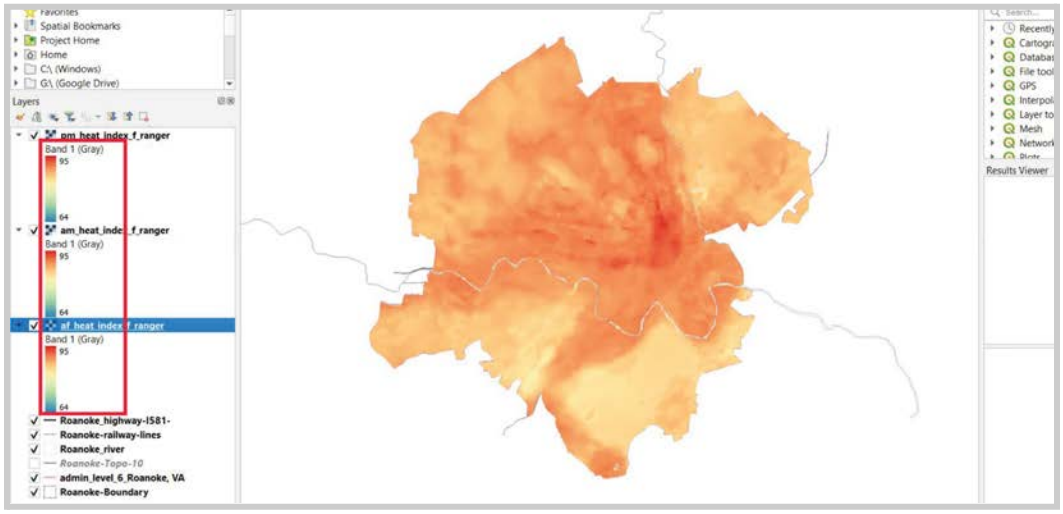
To do this, open the Symbology again for the layer you’ve already styled. At the bottom of the window, click the “Style” button, and select “**Save Style…**”. Save the Style in your Data folder as something like “Heat-Style”.



Then, open up your next raster layer. Click “Style” again, and this time select **“Load Style…”.** Navigate to your saved style and select it. Click “Apply”, and “Ok”. Do the same for your third raster layer.



You’ll see that all three layers now have the same gradient and temperature range in their legends.



3e Remember to **Save** your file frequently.

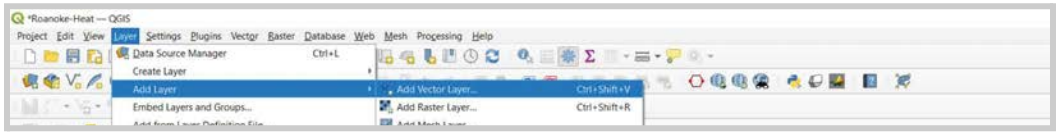
3f Now that you've visualized the temperature change throughout the day, try turning on and off your three raster layers to see how the city heats up and cools down unevenly over a summer day.

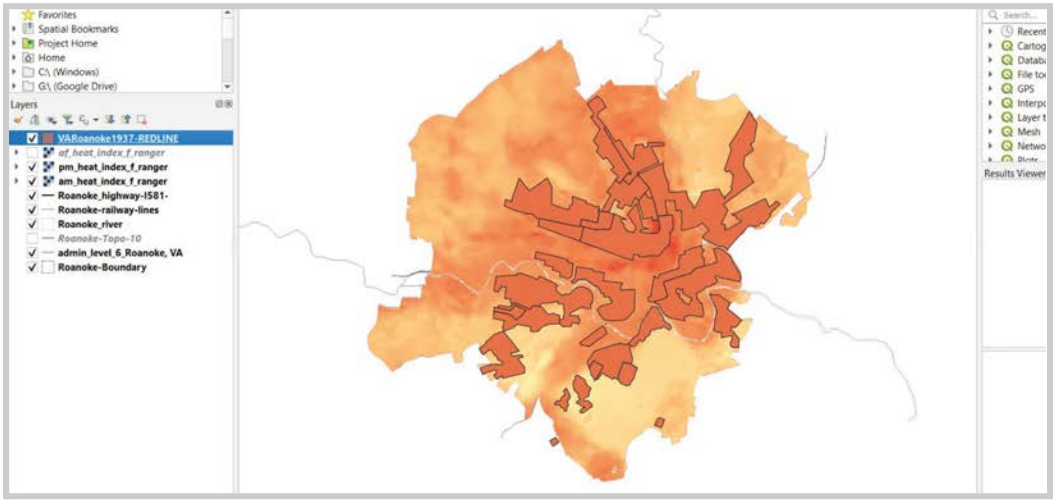
Step 4: Download, import, and style redlining vector data.

Now that we've started to see temperature patterns, we're going to add in one more data layer: redlined areas. This will allow us to compare historical lending practices with temperature outcomes today. You will typically see a positive correlation between these two variables for many reasons. Firstly, redlining often occurred in denser areas which tend to retain more heat. Secondly, it often occurred near industrial areas which are also hotter. Thirdly, redlined areas were often subject to urban renewal projects which involved tearing down "blighted" neighborhoods to build large roads or commercial spaces with expansive parking lots, both of which retain heat. Fourth, redlined areas which prevented homeownership also prevented dedicated investment by homeowners in their physical environments, so things like gardens, mature trees, and parks tend to be rarer in these neighborhoods. All of this contributes to heat today, which has negative health outcomes.

4a From the Data folder, download the **"Redline"** file for your city. Put the file into your "Data" folder. These redlining vector files were downloaded from the University of Richmond's **"Mapping Inequality"** project: https://dsl.richmond.edu/panorama/redlining/#loc=5/39.1/-94.58&text=downloads

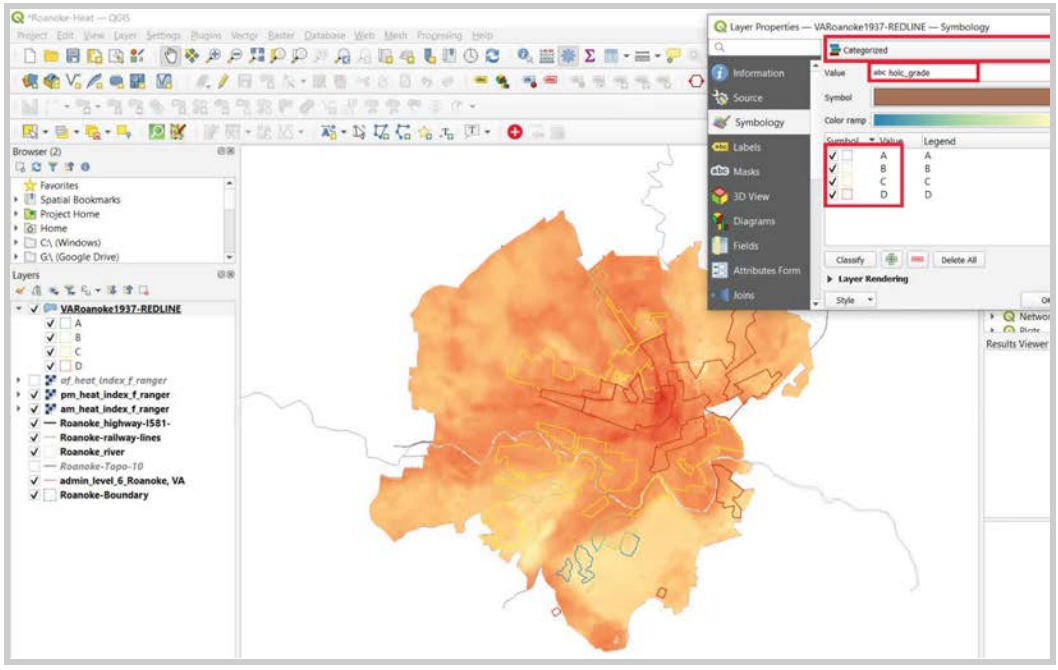
4b Add the redlining layer to your QGIS project (**Layer > Add > Vector**).



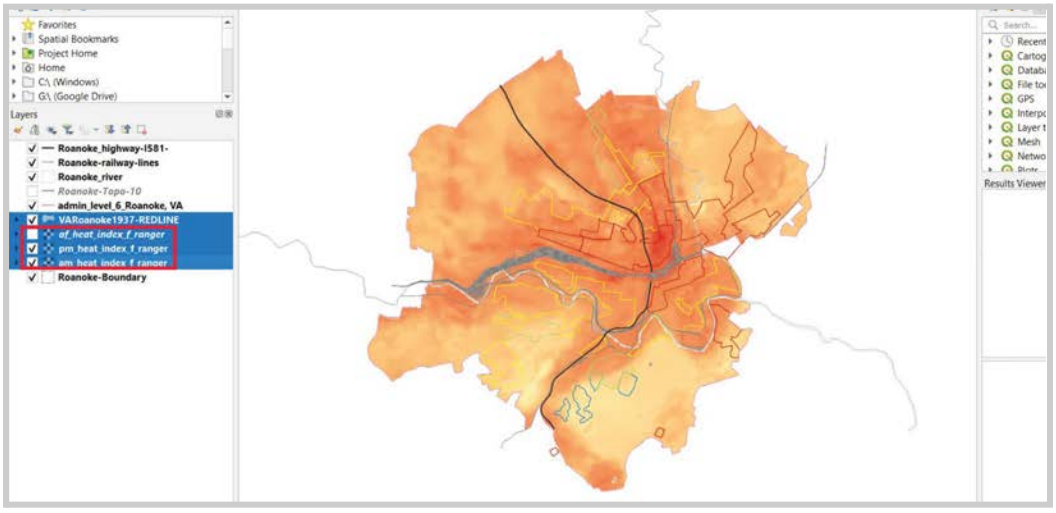


You'll style this layer by its HOLC (Home Owners Loan Corporation, the company responsible for the redlining maps) grade. These were A (best), B (still desirable), C (definitely declining), and D (hazardous), represented respectively by green, blue, yellow, and red zones on maps.

Select **"Categorized"** from the drop down menu, and for the Value select **"holc_grade"**. You should see four values when you classify the data: A, B, C, and D. Color A as green, B as blue, C as yellow, and D as red. For this map, I chose to make the symbols outlines only to clearly show the raster data below. You could also choose to add a texture fill, like a hatch, to make the areas more legible. To make the symbol an outline only, apply the color to the **"Stroke color"** of each and turn the opacity to 0 for the "Fill color".



4c Check that all of your layers are **visible**. The order they appear in your Layers window (right) also control their display order. Your heat layers, which are opaque, should be moved to the bottom on your layer list so that the roads, river, redlining, and other line data can be seen. Select the three raster layers and **drag** them to the bottom of your list.



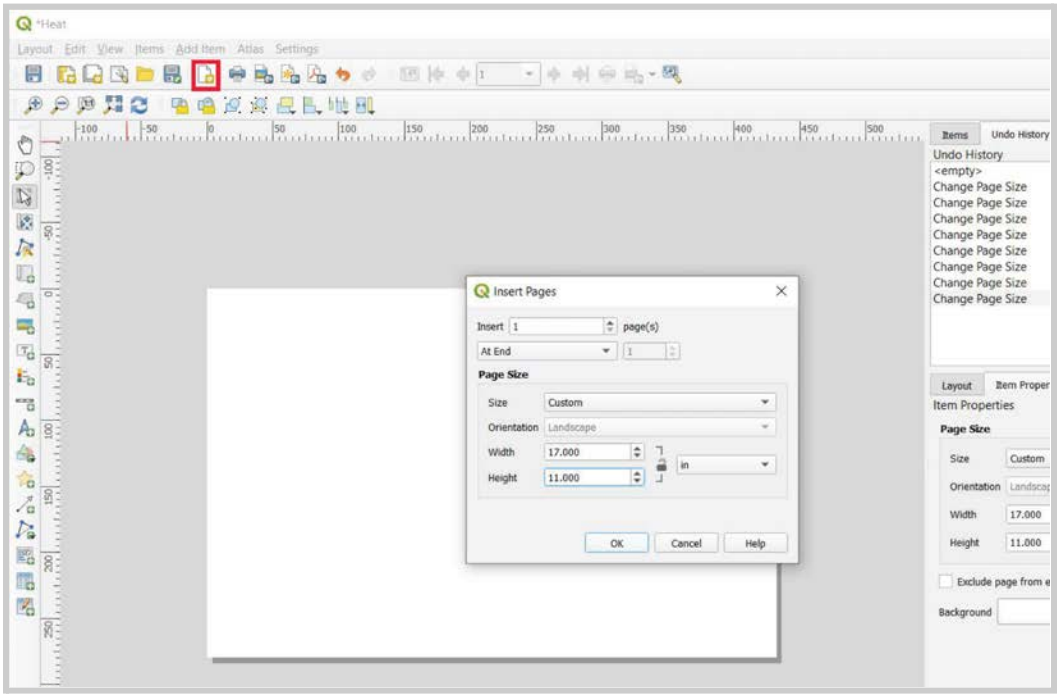
Step 5: Create print layouts.

For this tutorial, you'll create two print layouts: for the first one, you'll compare the three heat data layers to the physical geography (roads, rivers). For the second, you'll compare the heat data to the redlining layer.

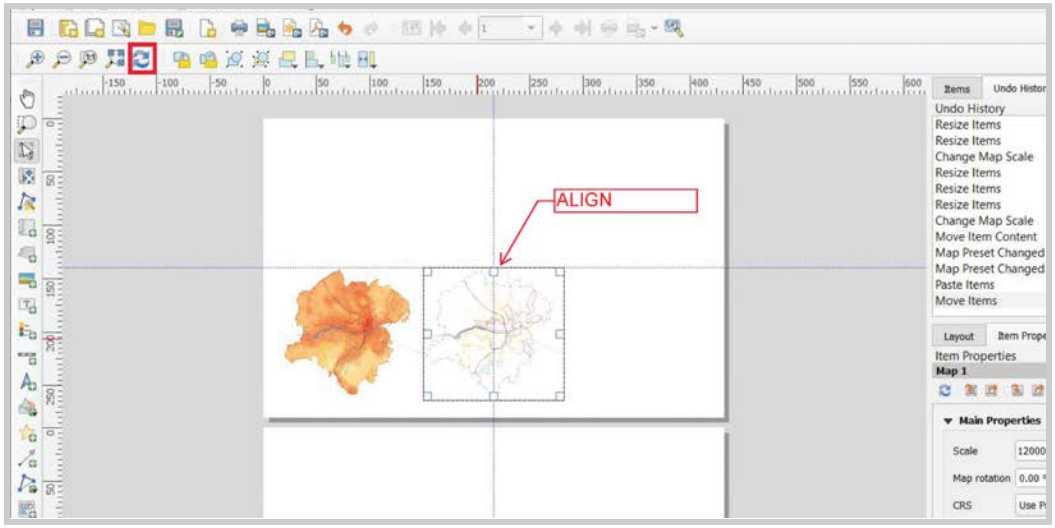
5a Click **Project > New print layout**, or use the New Print Layout icon (upper right toolbar, beside the save button) to create a new print layout. Name it something like "Heat" and say "Ok".

5b Resize your print layout to Custom > 11"x17" in the page Item Properties box (right click page > Item Properties).

5c Add a second page for your second map. Click "Insert new Page", the symbol just right of the Save symbol in the upper toolbar. Set the size to Custom > 11x17.



5d Add three maps to your first page. Create the first map roughly ¼ of the page width. NOTE: your temperature layer may disappear if you zoom out too far in the print layout. To fix this, try clicking the "refresh" button on the top menu. Set the scale to show all of your city, and then copy / paste the map twice. Copy / paste all three maps to the second page in your layout, making sure to align them with the maps above.

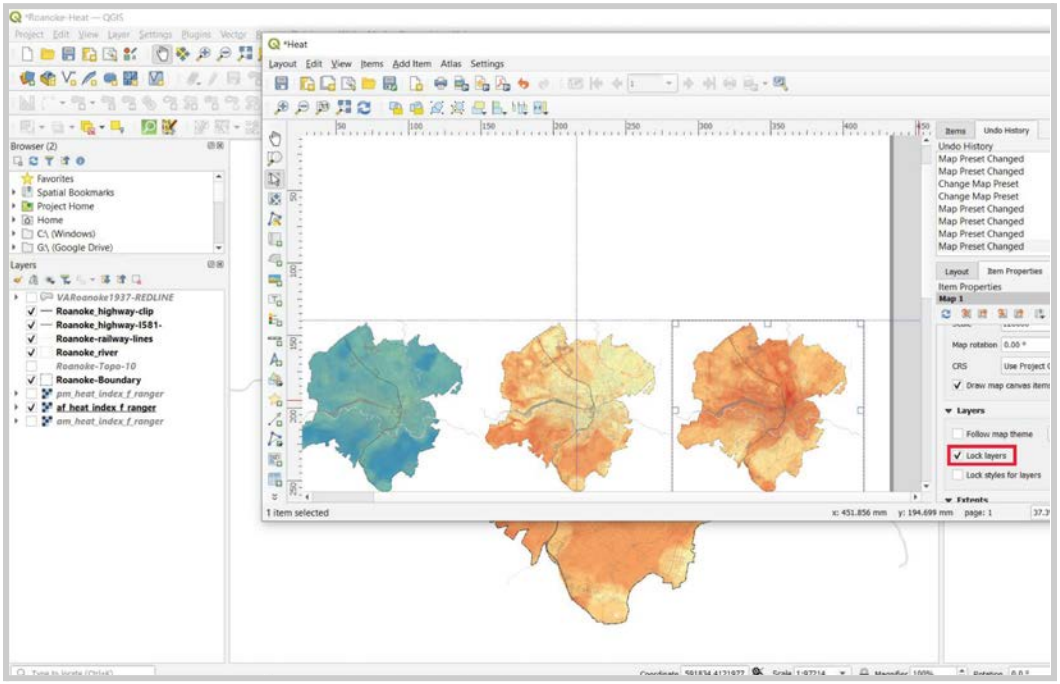

ALIGN
Undo History
Resize Items
Resize Items
Change Map Scale
Resize Items
Resize Items
Resize Items
Change Map Scale
Move Item Content
Map Preset Changed
Map Preset Changed
Paste Items
Move Items
Item Properties
Map 1
Main Properties
Scale
Map rotation
CRS


Undo History
Resize Items
Resize Items
Resize Items
Change Map Scale
Move Item Content
Map Preset Changed
Map Preset Changed
Paste Items
Move Items
Paste Items
Move Items
Move Items
Item Properties
Map 1
Main Properties
Scale
Map rotation
CRS


ALIGN
Undo History
Resize Items
Change Map Scale
Move Item Content
Map Preset Changed
Map Preset Changed
Paste Items
Move Items
Paste Items
Move Items
Move Items
Paste Items
Move Items
Item Properties
Map 1
Main Properties
Scale
Map rotation
CRS
Draw map canvas
Layers
Follow map theme
Lock layers
Extents
X min

5e First, set up your first three maps. Turn off your redlined layer, and keep on your physical geography layers. For the left-most map, turn off your af and pm temperature layers and keep on your am (morning) layer. Reload the left-most map in your print layout and then click **"Lock Layers"** in the Item Properties window on the right.

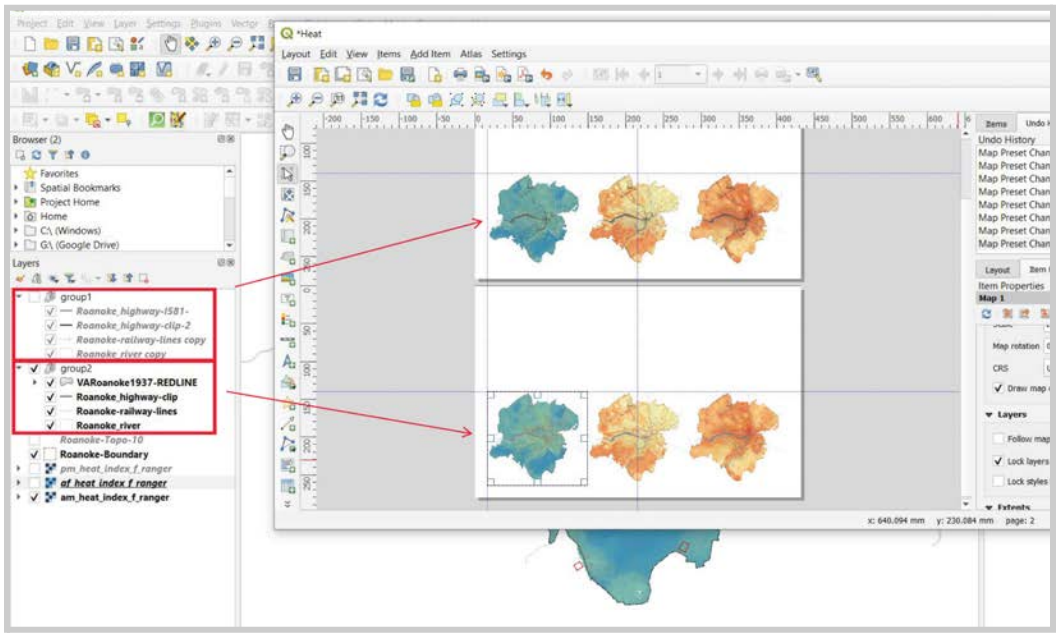
Do the same with your next two maps, afternoon in the middle and evening on the right. Make sure to lock the layers of all three maps.



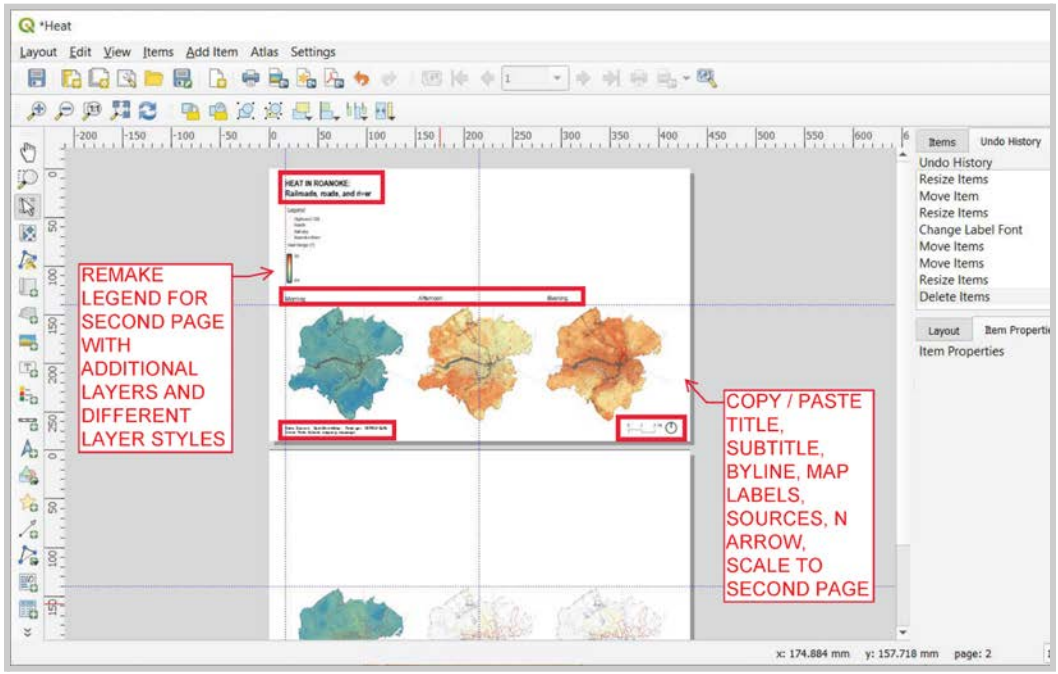
5f Next, set up the three maps on your second page. Turn on your redlined layer. As with the previous page, set each map to your am, af, and pm raster layers. These should now show the respective temperatures below the railroad, river, and redlining.

You may need to re-style your roads, river, and railroads to not overpower the redlining layer. You can either 1) change the style in each layer and select "Lock styles for layers" for each map. However, this may make it difficult to go back and forth between your two pages if you want to tweak the style for the previous page. *A cleaner way to change the style* is to, 2) **copy** your physical geography layers and style the new layers separately. This way, you can simply turn off the style of road, river, etc. that you don't want and turn on the ones you do, and "Lock layers" of each map. You can also then tweak the styles between the two pages of maps easily in their separate layers.

To make this even easier, you can separately **group** the layers for each of your pages of maps. This way, you can easily turn on and off the groups as you adjust your maps.



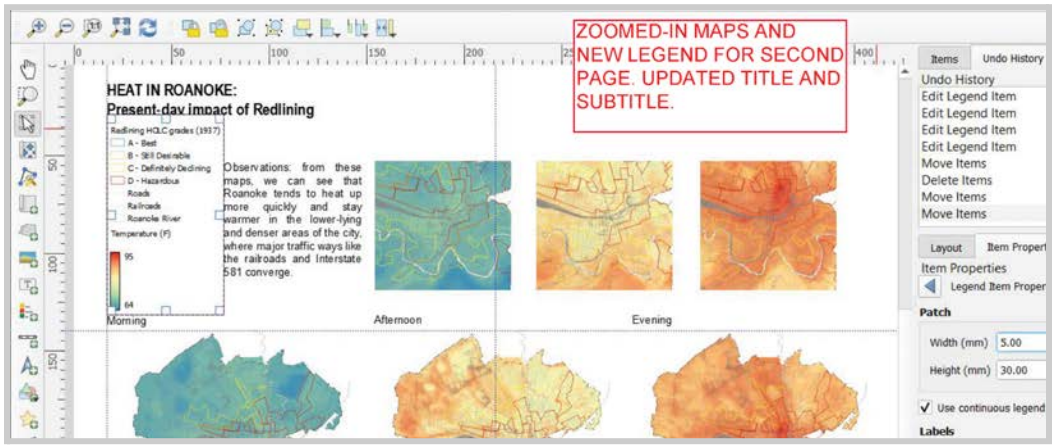
5g Add labels to each map. Add a map title, byline, and sources. Add a north arrow and scales. Add a legend to each page which includes only the data shown on that page (for instance, your first page legend should not include redlining).

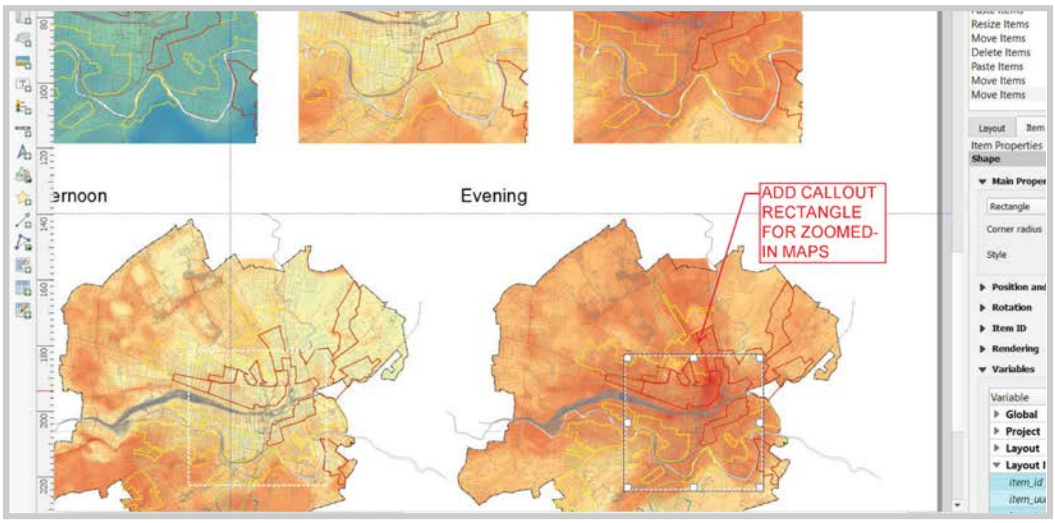


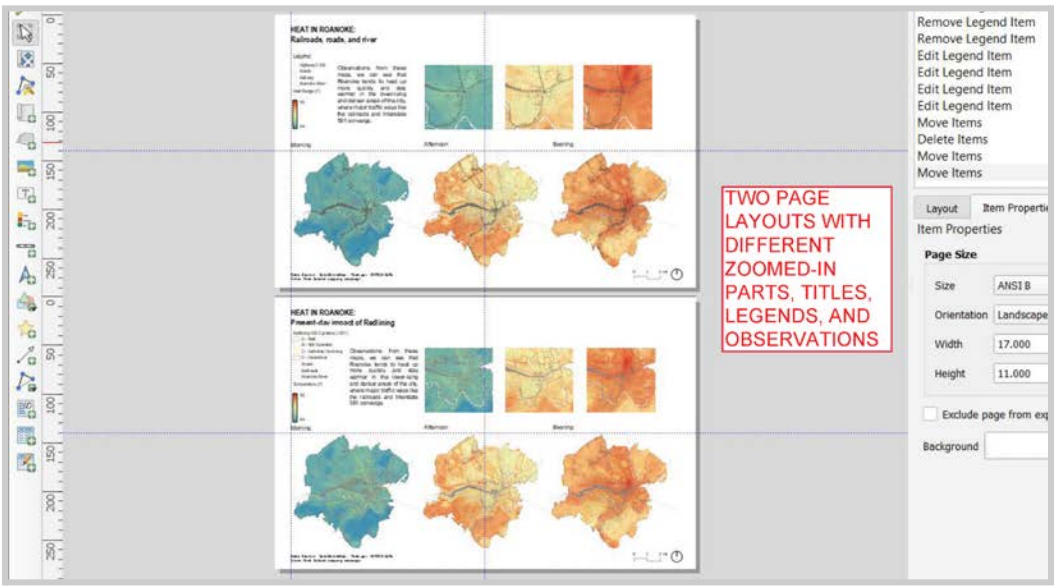
5h Finally, add a short explanation of the patterns that you see in your maps. What correlations can you spot? What might this tell you about the city? What questions does it raise?

To complement your observations, add **additional zoomed-in maps** for each time of day and part of the city. You can do this by copying one of your maps, Zooming in to the desired area, and then copy/pasting this map and setting the

three times of day again. Make sure to add a **"callout" rectangle** to your zoomed-out map indicating where the zoomed-in map is taken from.







– Bonus –

Step 6: Add another data layer to your map that might help explain the temperature pattern you see. This could be your topography layer, natural features, or anything else you want to add.

Step 7: Create a third page in your layout. Add three new maps with your new variable. Again, label everything and write a short explanation of the patterns you see and how this might help explain the temperature changes in different parts of the city.