

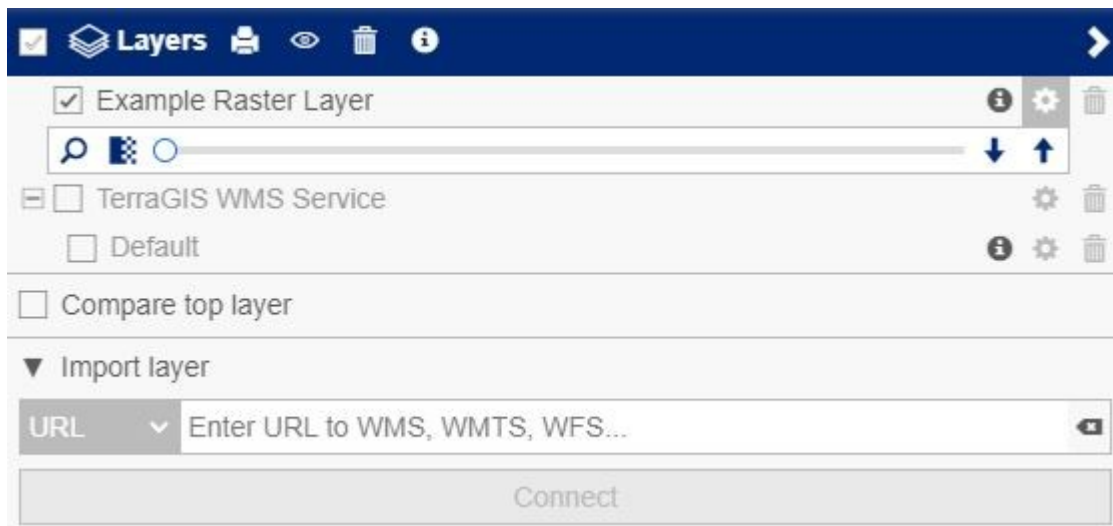
Appendix: New Raster Layer Management Subsystem of the MRI Instrument

The new 2022 Layer Management Subsystem of the MRI Instrument enables the users to:

- Import external WMS, WMTS, or WFS layers into the map.
- Show, hide, and delete layers.
- Reorder layers
- Adjust layer transparency
- Zoom to a layer
- Compare two layers

Online demo link: <http://midway.cs.fiu.edu/TerraGISWeb/>

Below is a screenshot of the layer management subsystem:



Feature: Import external layers

This feature allows users to add any external WMS, WMTS, or WFS layers to the map. Once the URL to an external map service is entered, the map will connect to the external service, retrieve all the available layers, and add them to the layer management tool.

Feature: Show, hide, and delete layers

Users can uncheck any layer to hide it temporarily from the map. Only the checked layers will be shown on the map. If any layer is no longer needed, it can be deleted by clicking the trash bin icon.

Feature: Reorder layers

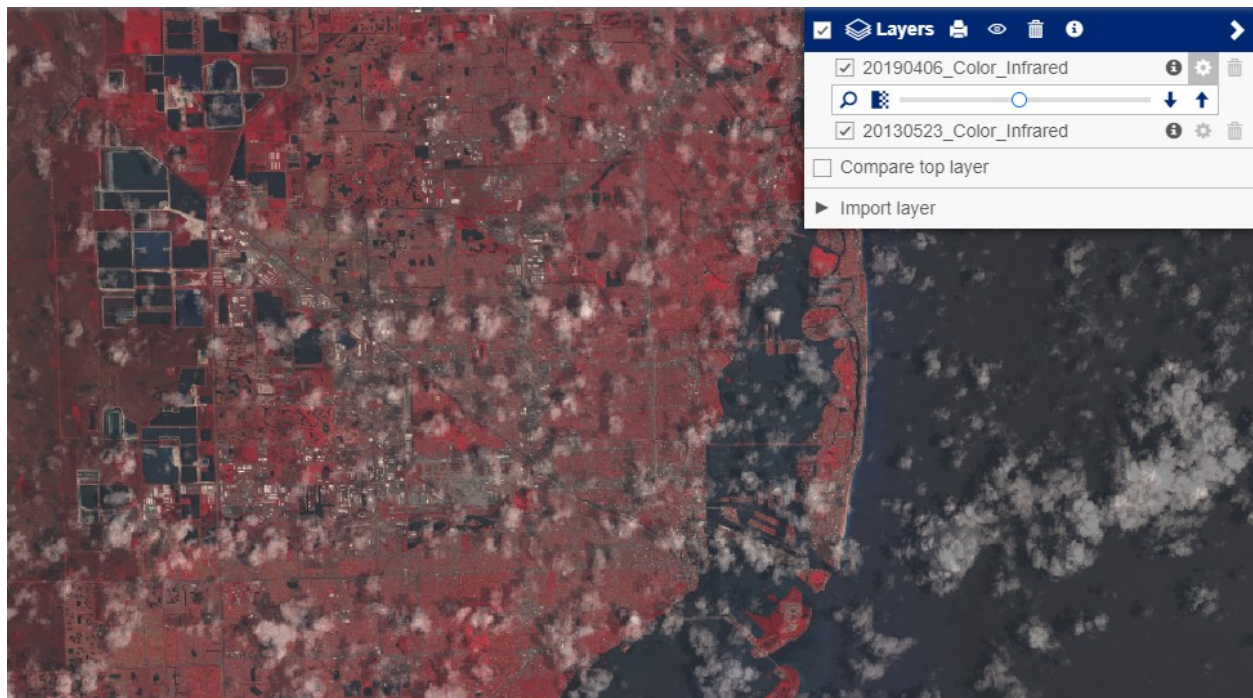
Multiple layers can be shown on the map at the same time. If they overlap one another, the layer order as appears in the Layer Management Tool will determine the stacking order of the layers. Users can click the up/down arrows to adjust the layer stacking order.

Feature: Adjust layer transparency

Users can utilize the transparency slider to adjust any layer's transparency settings from opaque (slide to the left end of the bar) to fully transparent (the right end of the bar).

This feature is implemented on the client side (the browser); thus, the rendering is done in real-time. Users can move the slider back and forth and see the changes immediately.

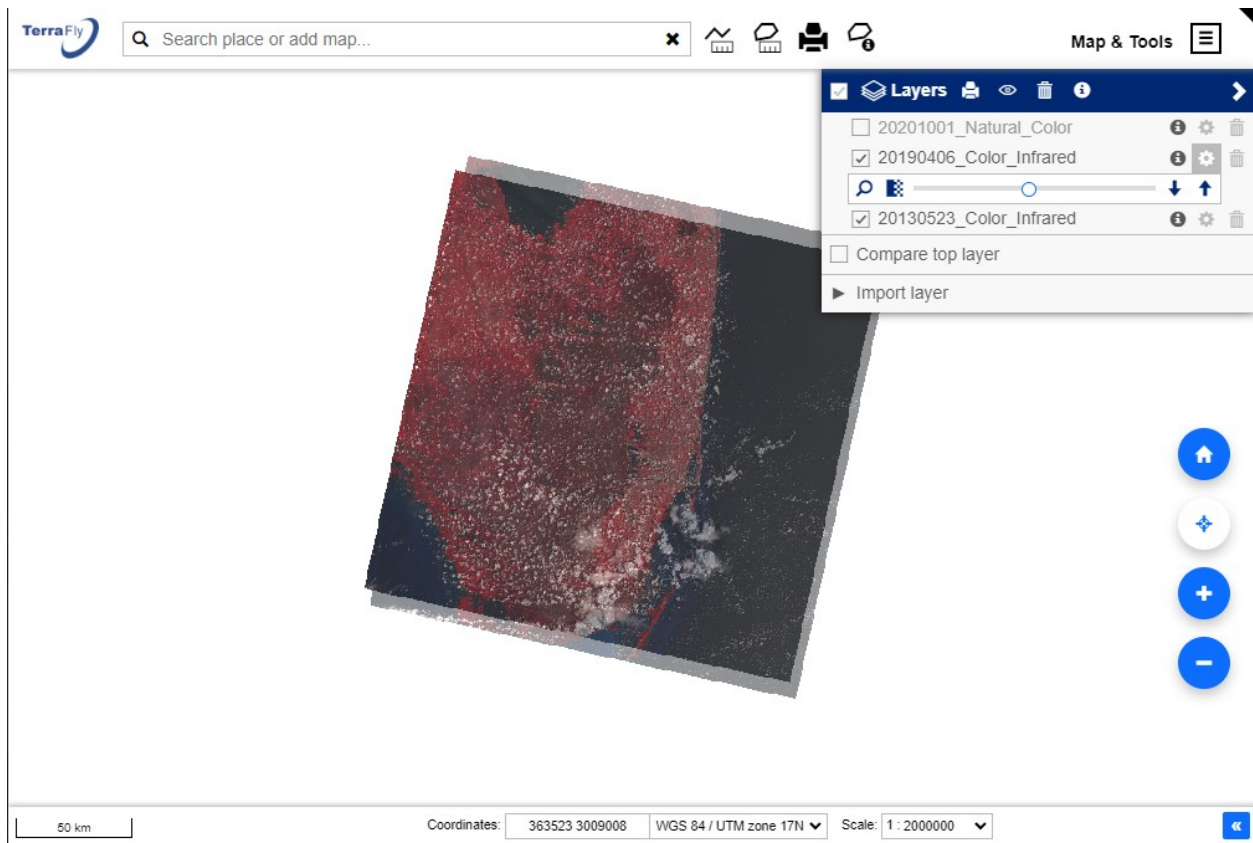
The screenshot below demonstrates two layers from 2013 and 2019, respectively, with the 2019 layer rendered above the 2013 layer with a transparency of 50%.



Feature: Zoom to a layer

Users can click the magnifier icon of any layer to jump to the layer's location. The map will also automatically zoom to the appropriate scale at which the entire layer is shown.

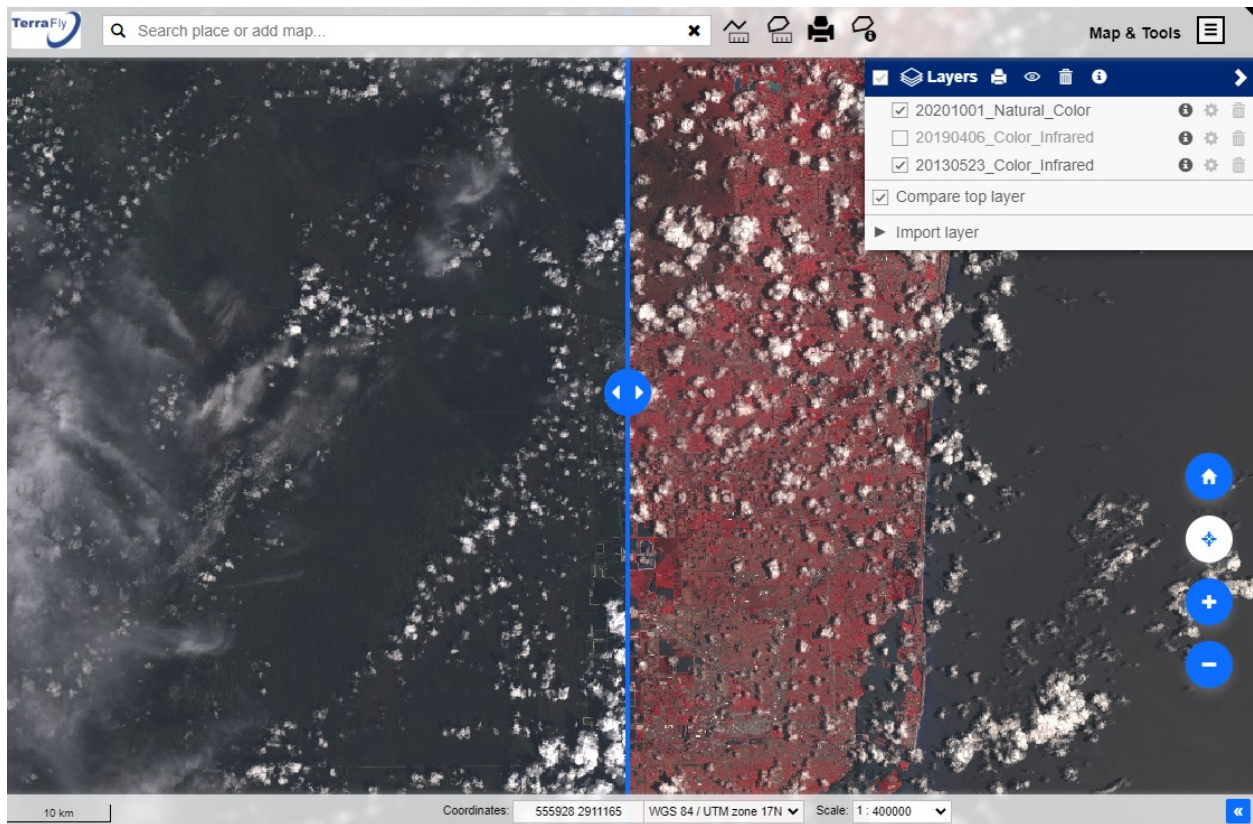
The screenshot below shows how the map after clicking the zoom button.



Feature: Compare two layers

This tool enables a vertical slider on the map. The first layer will be rendered to the left of the slider, and the second layer will be rendered to the right. To use this feature, users need to choose two layers to compare; the user should make sure the “Compare top layer” is checked.

Once the vertical slider appears, users can then move the slider to the left or right to compare the two selected layers conveniently.



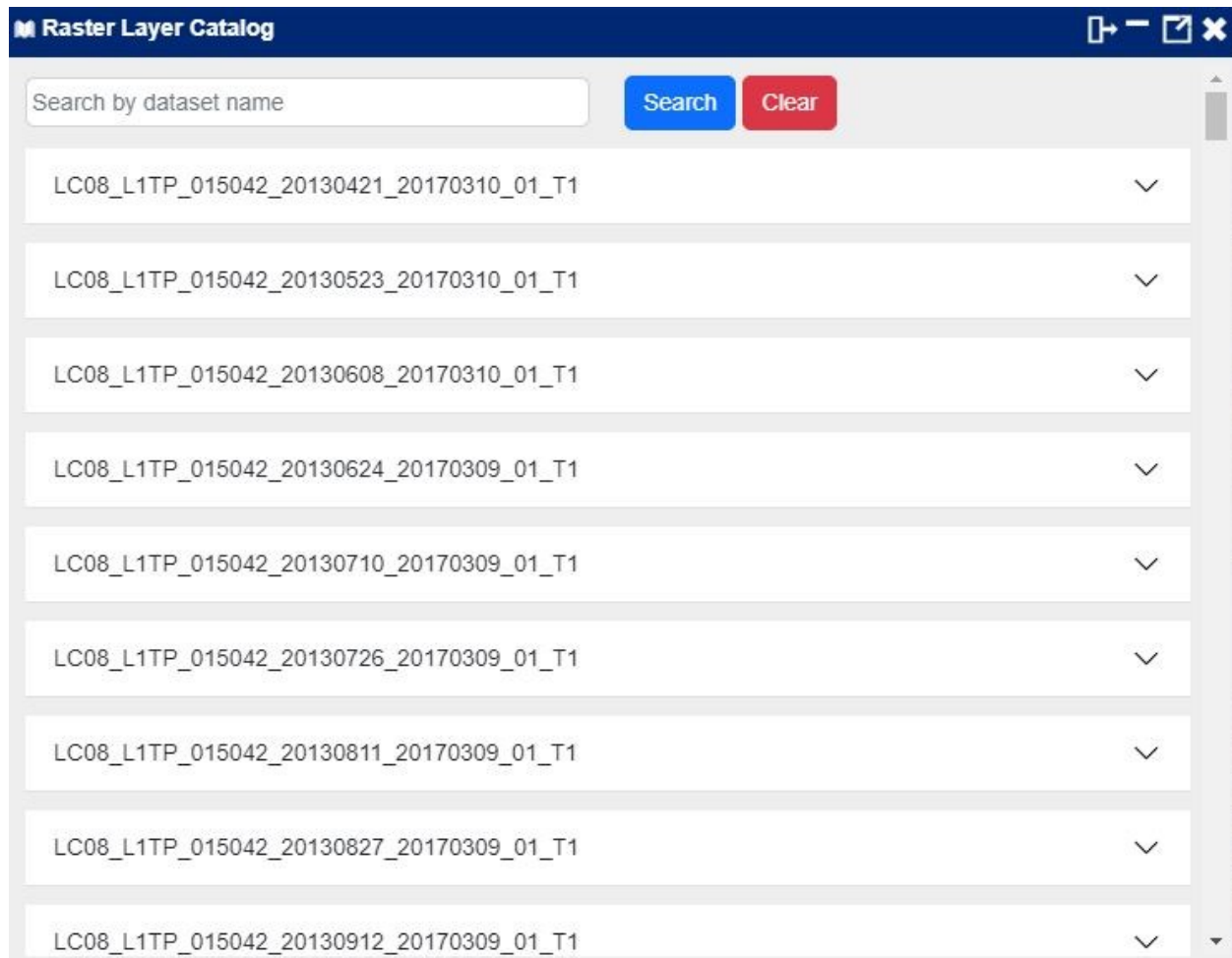
Raster Layer Catalog

Users can choose to add any of the pre-loaded layers to the map. The system has pre-processed and loaded more than 5000 layers from the Landsat Satellite Image Collection over the entire South Florida area. These datasets range from the Year 1984 to the Year 2020.

See below a screenshot of the Raster Layer Catalog Tool. The naming of the layers follows the Landsat file naming convention. Users can easily search and add any layer to the map using this tool.

Online demo link: <http://midway.cs.fiu.edu/TerraGISWeb/>

Click "Map & Tools," then click "Raster Layer Catalog" to bring up the tool.



Dynamic Spectral Band Combination

The original data of the Landsat satellite imagery come with multiple spectral bands (for example, Landsat 8 has 11 spectral bands) corresponding to different wavelengths collected by the satellite's sensors.

All these spectral bands are extremely useful data, and different band combinations are used for different research purposes. Below is a list of some commonly used band combinations (displayed as red, green, and blue):

- Natural Color: 4 3 2
- False Color (urban): 7 6 4
- Color Infrared (vegetation): 5 4 3
- Agriculture: 6 5 2
- Atmospheric Penetration: 7 6 5
- Healthy Vegetation: 5 6 2

- Land/Water: 5 6 4
- Natural With Atmospheric Removal: 7 5 3
- Shortwave Infrared: 7 5 4
- Vegetation Analysis: 6 5 4

Since there are over a thousand ways to combine the bands, it is impossible to pre-process the images with a fixed list of band combinations to satisfy all researchers' needs. Thus, a new feature called Dynamic Spectral Band Combination is implemented to enable researchers to choose any combination of bands and render them on-the-fly.

The screenshot below shows how the feature works. After selecting a layer from the Raster Layer Catalog tool, users can adjust the band combination settings before adding the layer to the map. The example shows a Natural Color setting, which renders Band 4 as red, Band 3 as green, and Band 2 as blue. After setting the band combination, the user can then give the layer a name and add it to the map. The layer will then show up in the Layer Management Tool, and all the functionalities in the tool can be applied to this layer as well.

Screenshot: User Interface for the Dynamic Spectral Band Combination feature

The screenshot shows a web application window titled "Raster Layer Catalog". It features a list of layers at the top, with "LC08_L1TP_015042_20130827_20170309_01_T1" selected and highlighted in blue. Below the list, there are several configuration fields for the selected layer:

- Channel:Red**: Band 4
- Channel:Green**: Band 3
- Channel:Blue**: Band 2
- Pixel Mapping:Red**: 0:0,40000:254,65535:255
- Pixel Mapping:Green**: 0:0,40000:254,65535:255
- Pixel Mapping:Blue**: 0:0,40000:254,65535:255
- Layer Friendly Name**: Natural Color Layer 1

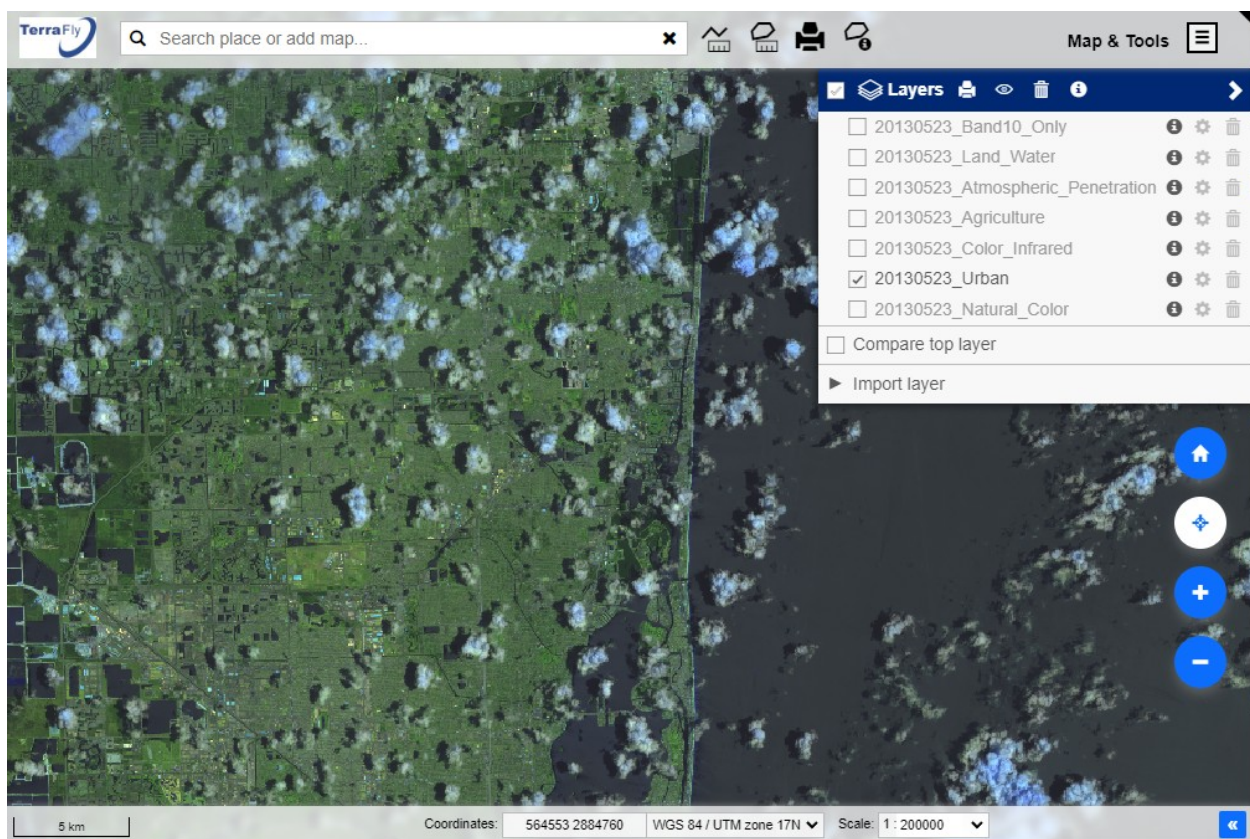
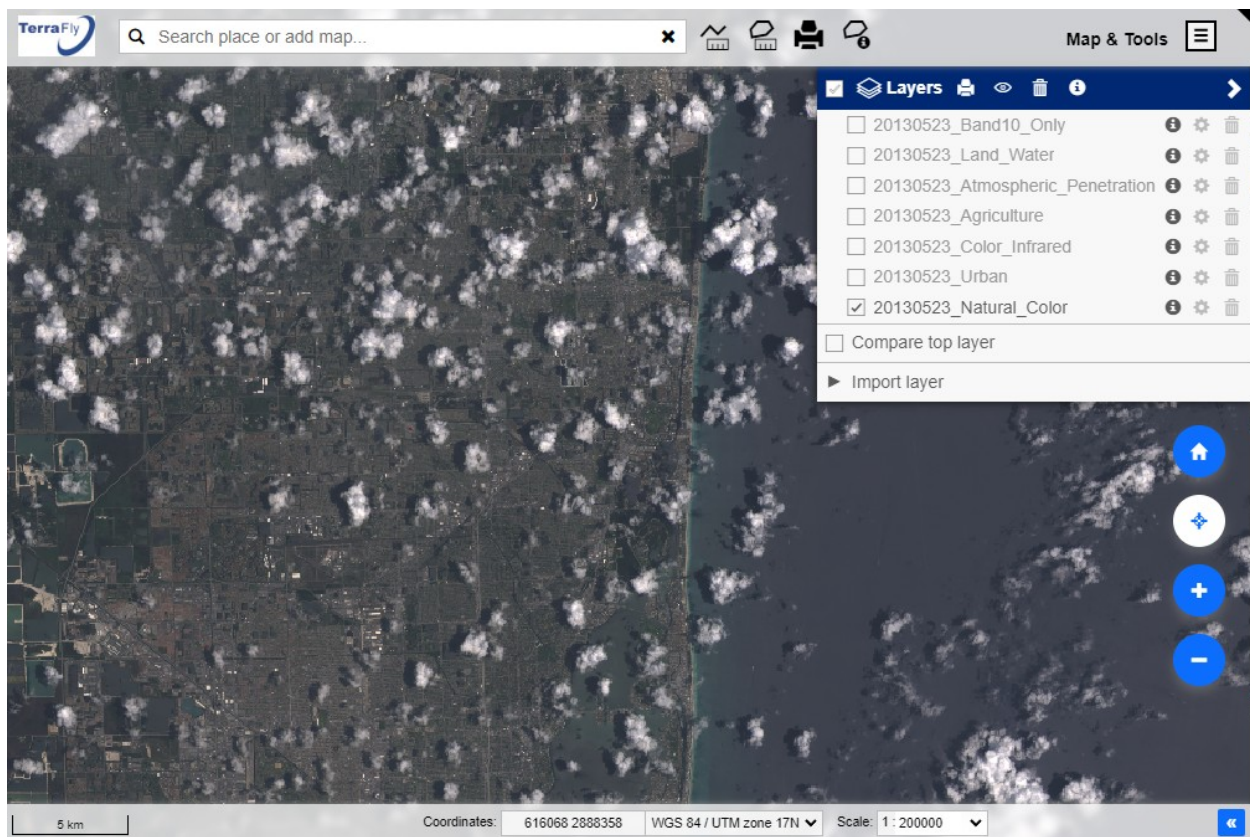
At the bottom of the configuration section is a blue button labeled "Add layer to map". The interface includes standard window controls (minimize, maximize, close) in the top right corner and a vertical scrollbar on the right side.

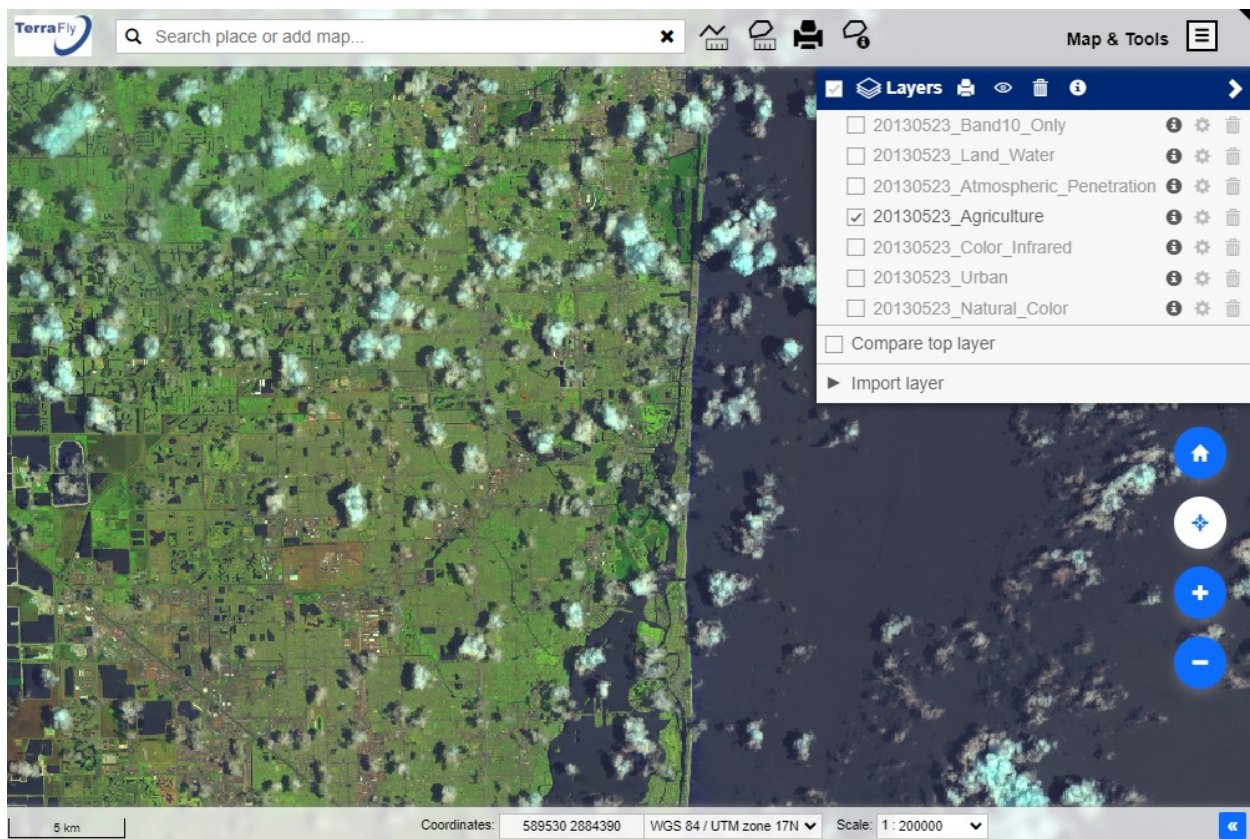
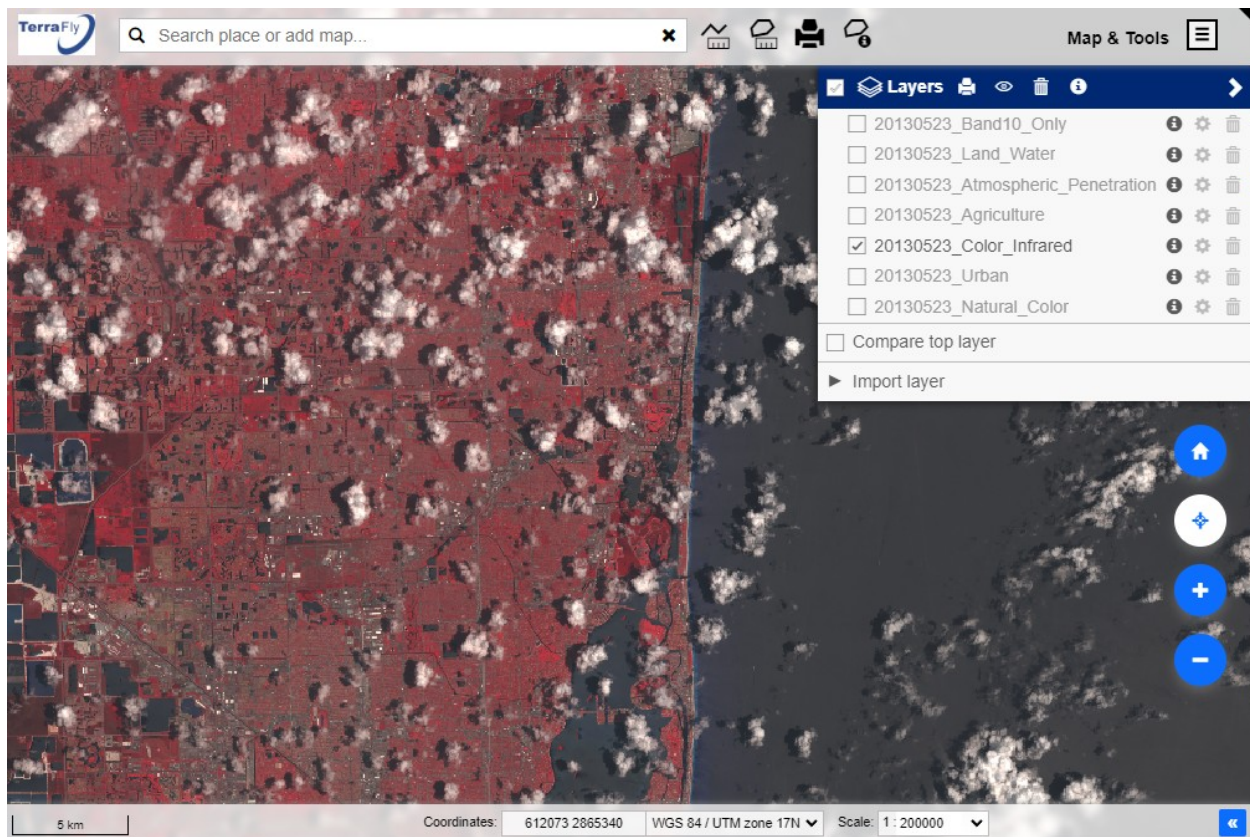
Screenshots: Examples of the Dynamic Spectral Band Combination

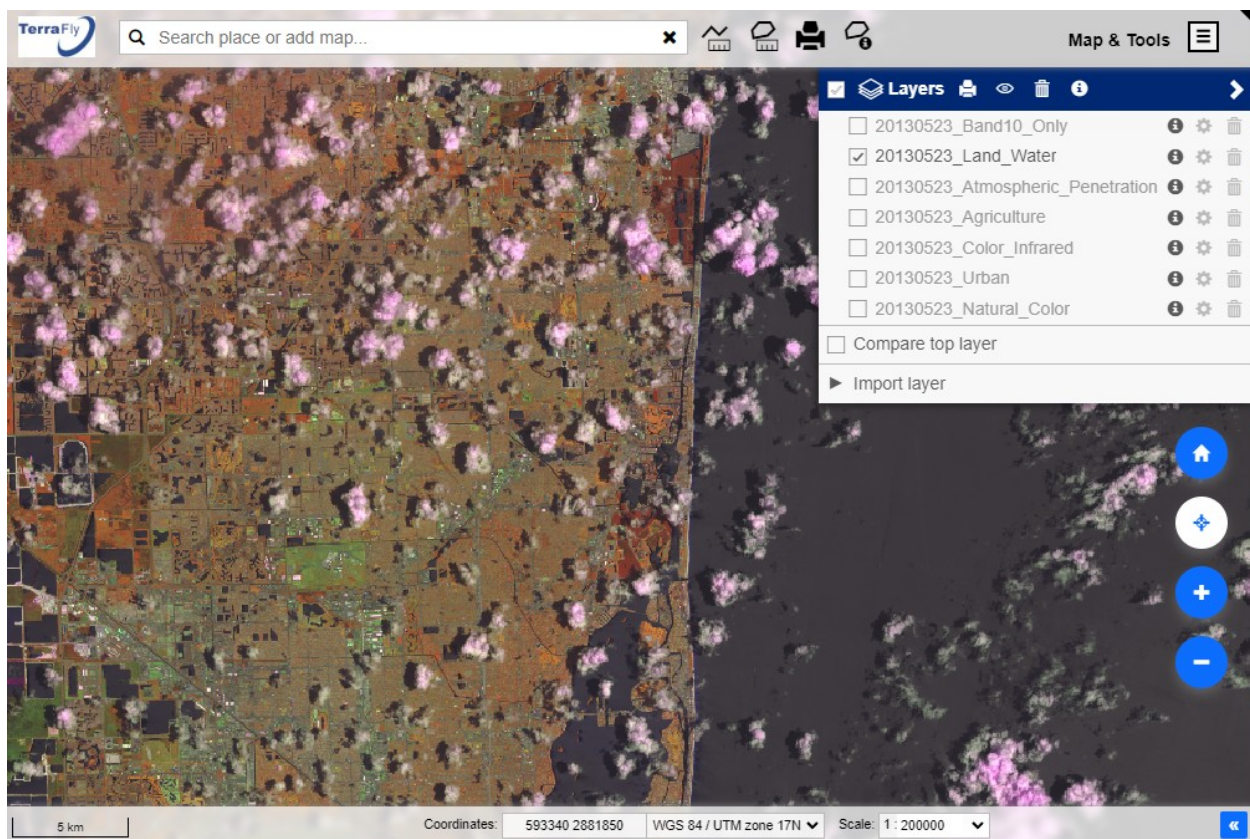
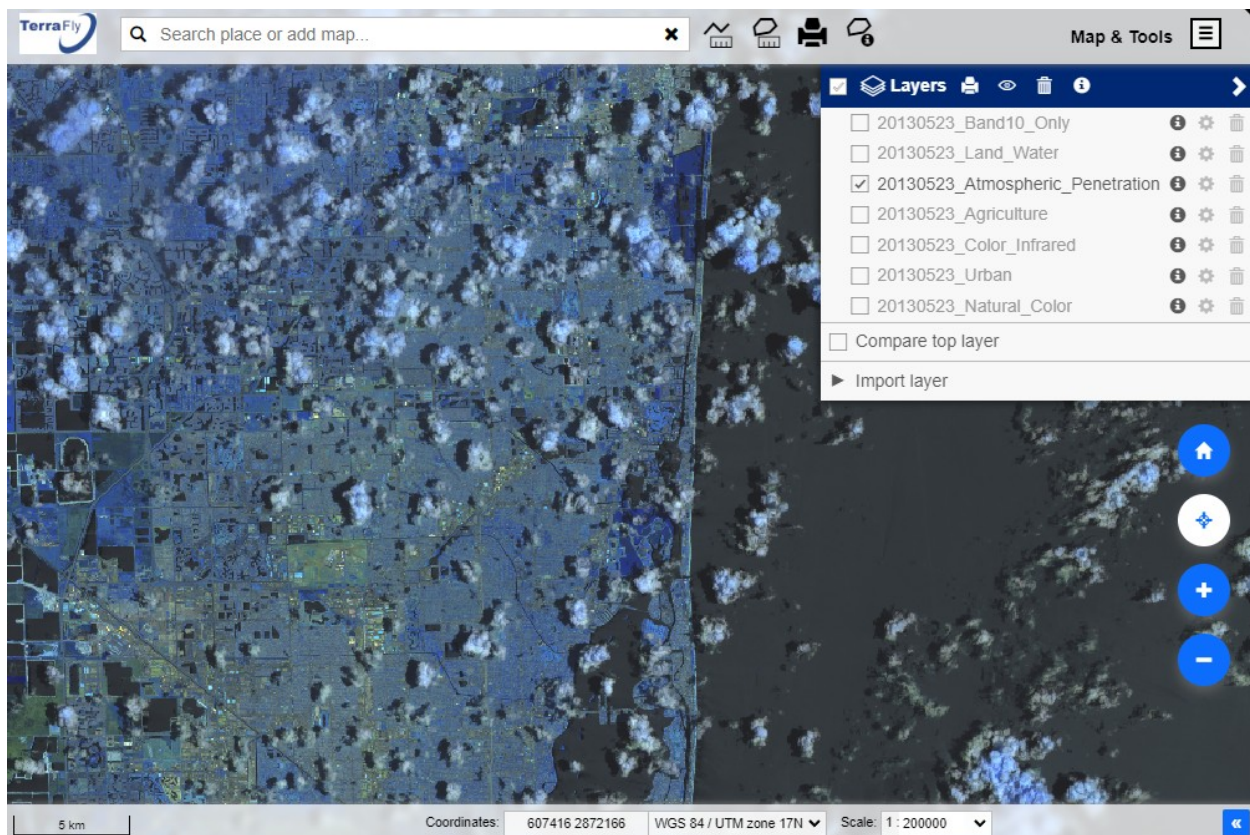
The screenshots below are examples of how to use the Dynamic Spectral Band Combination tool to generate layers from various useful band combinations like Natural Color, Urban, Color Infrared, Agriculture, Atmospheric Penetration and Land/Water.

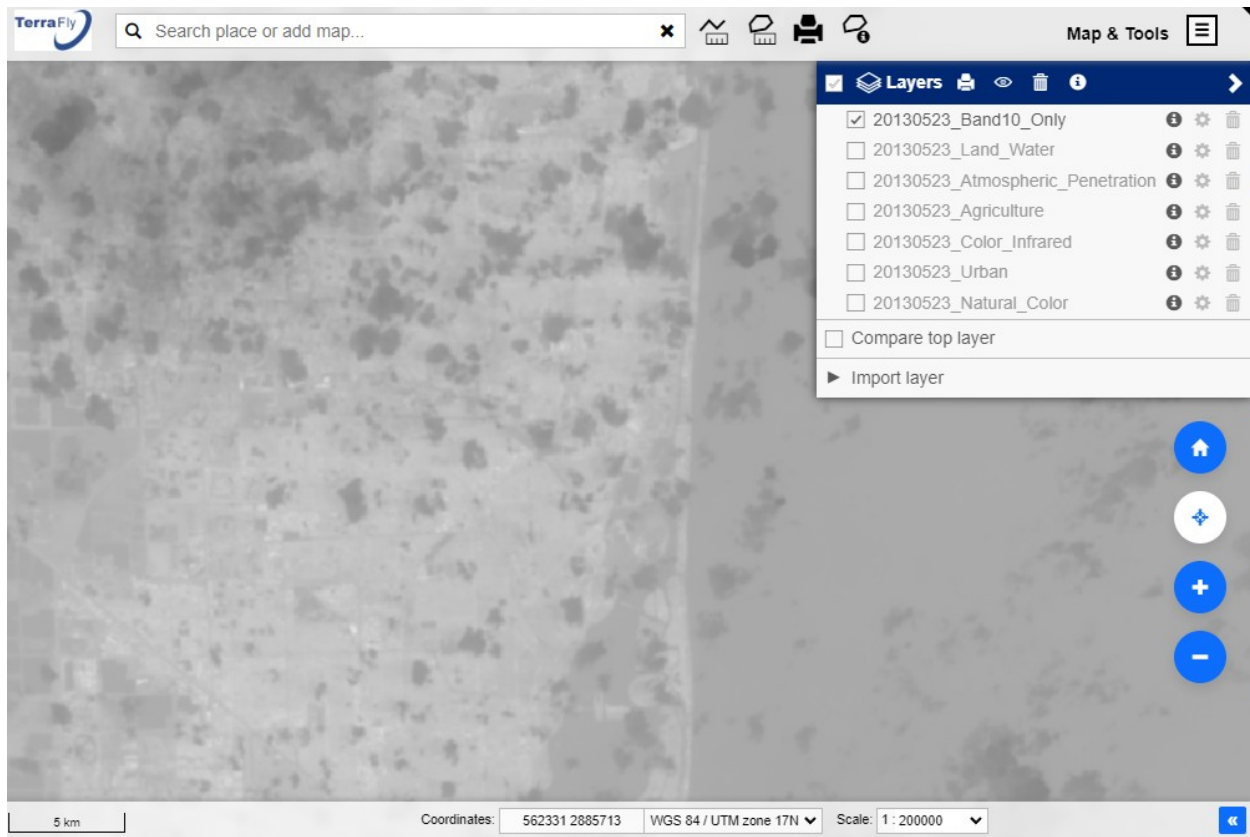
It's worth mentioning that single band layers can be generated as well. Users can achieve the goal by setting red/green/blue to use the same band.

Online demo link: <http://midway.cs.fiu.edu/TerraGISWeb/>









Custom Pixel Mapping

In the Landsat imagery dataset, pixel values are called digital numbers (DN), which are integers representing the amount of energy detected by the satellite. This is very different from the definition of the RGB color values, which represent the intensity of the corresponding color.

Thus, when rendering DN values to RGB values, the mapping cannot be simply described by a linear relationship. In order to solve this issue, we have introduced into the system a novel feature called Custom Pixel Mapping, which allows users to define what mapping relationship to be used in the rendering process.

The tool accepts a list of comma-separated value pairs, with each pair defining what DN should be mapped to what color value. For example, 0:0,40000:254,65535:255 means 3 value pairs with DN=0 maps to Color=0, DN=40000 maps to Color=254 (linear scaling is used for DN values between 0 and 40000), DN=65535 maps to Color=255. The range of DN for this layer is 0 to 65535 since it's a Landsat 8 image.

The screenshot below demonstrates how the rendered results would change using two different mappings:

Default Mapping = 0:0,40000:254,65535:255

Alternative Mapping = 0:0,20000:254,65535:255

Pixel Mapping:Red	0:0,40000:254,65535:255
Pixel Mapping:Green	0:0,40000:254,65535:255
Pixel Mapping:Blue	0:0,40000:254,65535:255
Layer Friendly Name	Required. This name will be displayed in the layer tree.
<button>Add layer to map</button>	

