INTRODUCTION TO REMOTE SENSING

Lab 3: Image processing: Image enhancements

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ANSWERS OF ALL THE QUESTIONS FROM A TO G

a) *Describe the observed spectral differences between the original image and the filtered images. What factors do you think contribute to these differences?*

Ans:

Spectral Differences Between the Two Images: The Image 1 shows some vegetation, looks like a semi-arid ecosystem and clouds along with the shadows are visible as well. There is a main river noticeable, and some smaller contributive flows derived from it, some relief characteristics can be seen as well, there are a few higher areas that appear to be mountains located within the zone.

On the other hand, image 2 provides a look to the area without the cloud coverage unlike image 1, vegetation is still observable in small scale as well as the river and its smaller flows. This time, even though higher areas are still visible; they are a little less identifiable.

Factors that Contribute to these Differences:

1. Time variation
2. Seasonal Change

b) *Describe the observed geometric differences between the reference (image1) and the source (image2).*

Ans:

Geometrically speaking, Image 1 and Image 2 are different in shape, a piece in between the top left and right corners of image 1 is missing and a piece about the same dimensions is located at the bottom as if extra and Image 2 looks the same but the missing piece appears on the bottom and the extra on the top. On the other hand, Image 1 is a little tilted to the right compared to Image 2 which reflects the horizontal difference in the position of image.

c) *Based on the description of the displacement function that can be found under the 'docs' tab in GEE, describe the parameters maxOffset, patchWidth, stiffness.*

Ans:

MaxOffset:

The maximum offset allowed when attempting to align the input images, in meters. Using a smaller value can reduce computation time significantly, but it must still be large enough to cover the greatest displacement within the entire image region.

PatchWidth:

Patch size for detecting image offsets, in meters. This should be set large enough to capture texture, as well as large enough that ignorable objects are small within the patch. Default is null. Patch size will be determined automatically if not provided.

Stiffness:

Enforces a stiffness constraint on the solution. Valid values are in the range [0,10]. The stiffness is used for outlier rejection when determining displacements at adjacent grid points. Higher values move the solution towards a rigid transformation. Lower values allow more distortion or warping of the image during registration

d) Was the registration successful?

Ans:

Yes. The before registration and after registration images are different because of little shift on the location, this shift pushed the after-registration image a little to the right, which gives a more accurate visualization.

e) What advantages do you see between this type of registration that identifies offset and angle of distortion versus the traditional image-to-image registration seen during lecture?

Ans:

Both registrations share a purpose to match images, premises are the same, and fixing points with an accurate location. But the registration identifying offset, and angle of distortion minimizes the differences between images in a more accurate way than image to image and its overlapping process, this allows having a better representation, precise alignment, correct displacement and less margin of error on the result.

f) After running all filters, describe the differences between the original and each of the filtered images, and specify if the filter is lowpass or highpass.

Ans:

- Original VS Filtered Mean and Median

These filters make the resulting image look a little blurry compared to the original one. Since these are Low pass filters it makes total sense knowing that they generalize pixel values of the image to smooth it and are useful when looking to get rid of noise form the image.

- Original VS Laplacian and Sobel filters

Both of these filters classified as high pass, Laplacian shows a dark image and enhances urban areas and limits between ground and water bodies by edges. Sobel, as well, looks dark and emphasizes edges more profoundly, especially around water bodies. This kind of filter is better used for when one wants to enhance limits where coverage areas change, sometimes abruptly.

g) *Compare the original color composite to the output of both pansharpening methods. What is the advantage of pansharpening?*

Ans:

Pansharpening is a process of merging high-resolution panchromatic and lower resolution multispectral imagery to create a single high-resolution color image.

Pansharpening represents an advantage when merging high with low resolution images. Panchromatic band has a finer spatial resolution (15 meters) than the rest of the Landsat bands we are working with (30 meters), zooming into the image can give a good idea of how the panchromatic band adds resolution to the final image, some attributes that on the original image were not very distinguishable by Multispectral and panchromatic band but the pansharpening images these are more clear. Different land use pattern like settlements, buildings and roads are more visible.

The common advantages are:

- *Higher accuracy: the final image allows for a more detailed representation of the earth's surface, allowing for a more detailed analysis.*
- *Higher compatibility: pansharpened images are often more compatible with aerial and other high-resolution images, which facilitates data fusion.*

Part 1

Link: https://code.earthengine.google.com/bde86fc2ba9353548d89449e91b8a9b9

- **Image 1 and 2 Selected from image collection**



Image 1

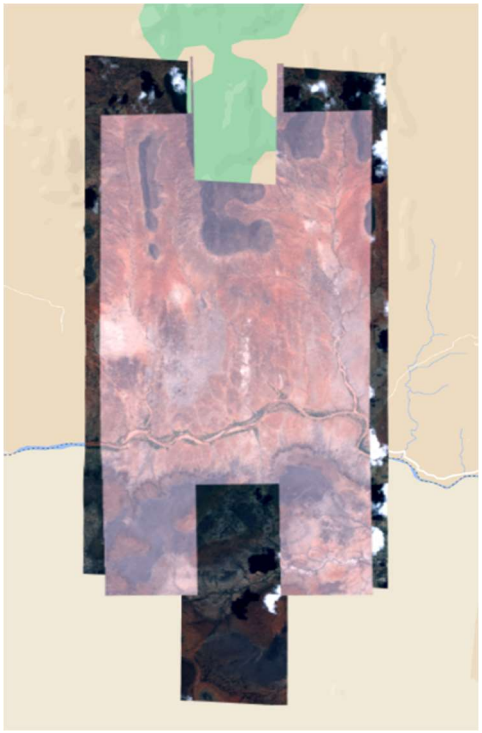


Image 2

- **Image 1 Before and After Registration**



Before



After

- **Image 2 Before and After Registration**



Before

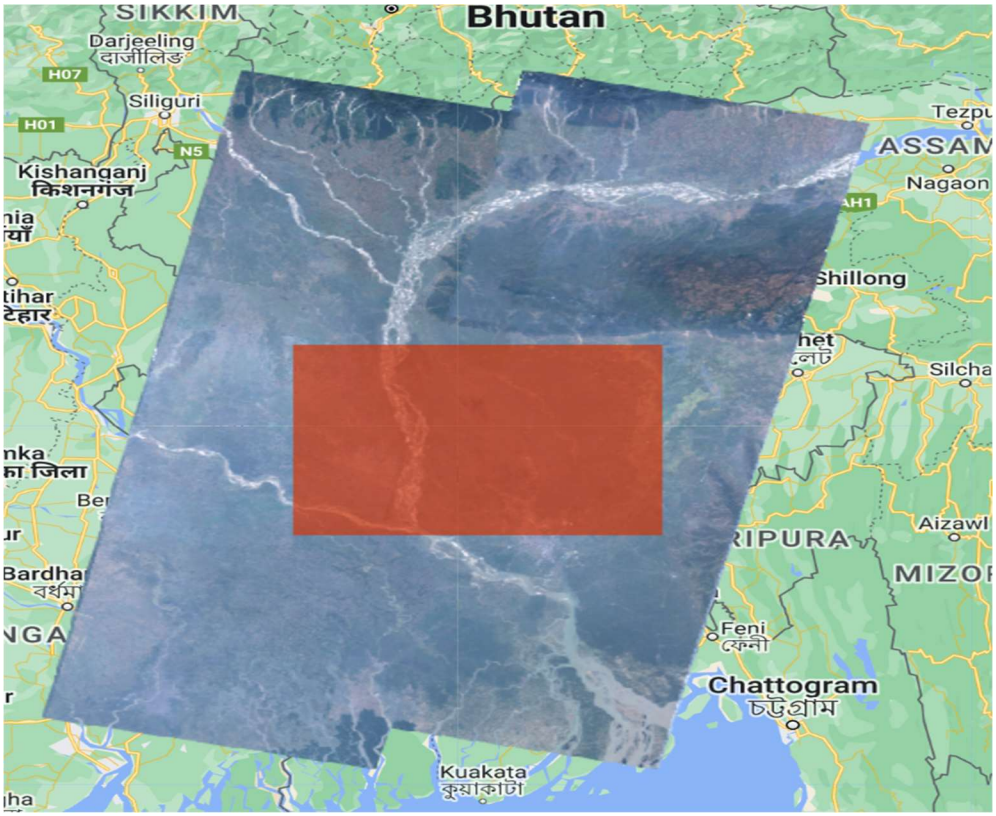


After

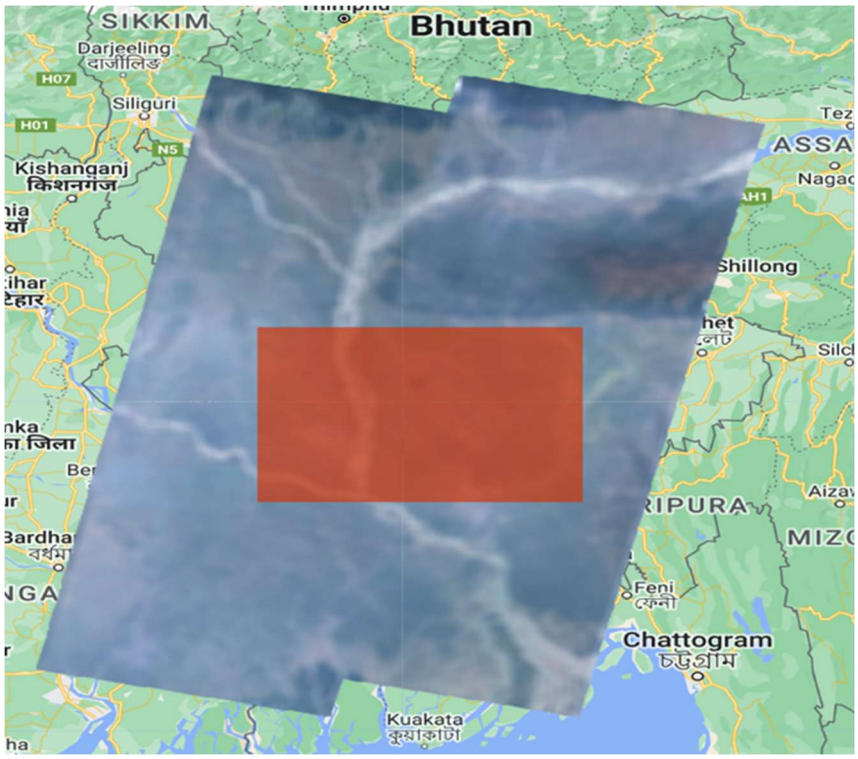
Part -2

Link: https://code.earthengine.google.com/f558e27a159bd09da157e0b6b4823b3d

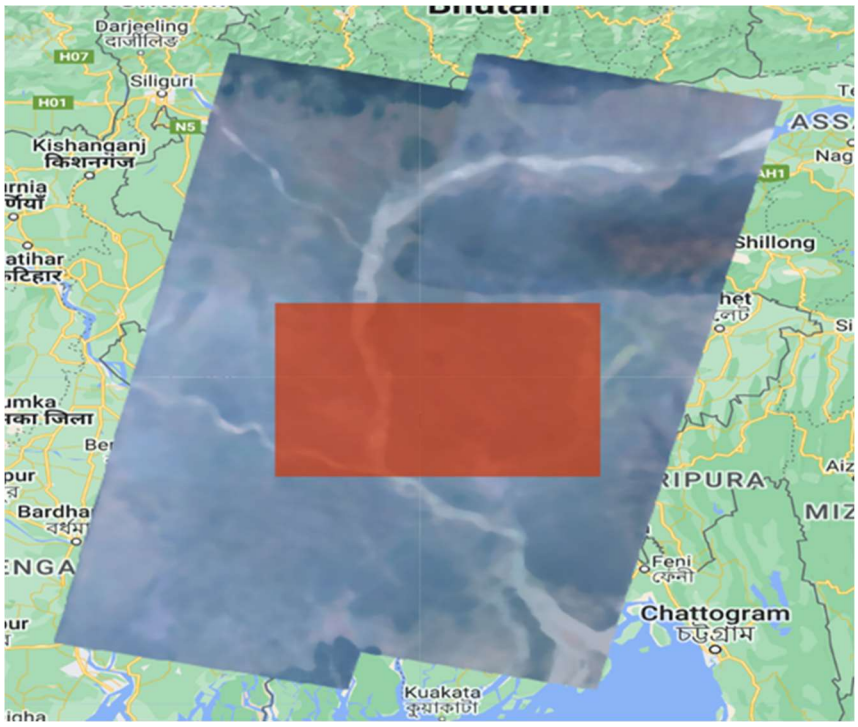
- **Original Image:** Selected image from collection which is filtered by date, geometry and clouds. The median across all images in the section is calculated. It is a true color composite image.



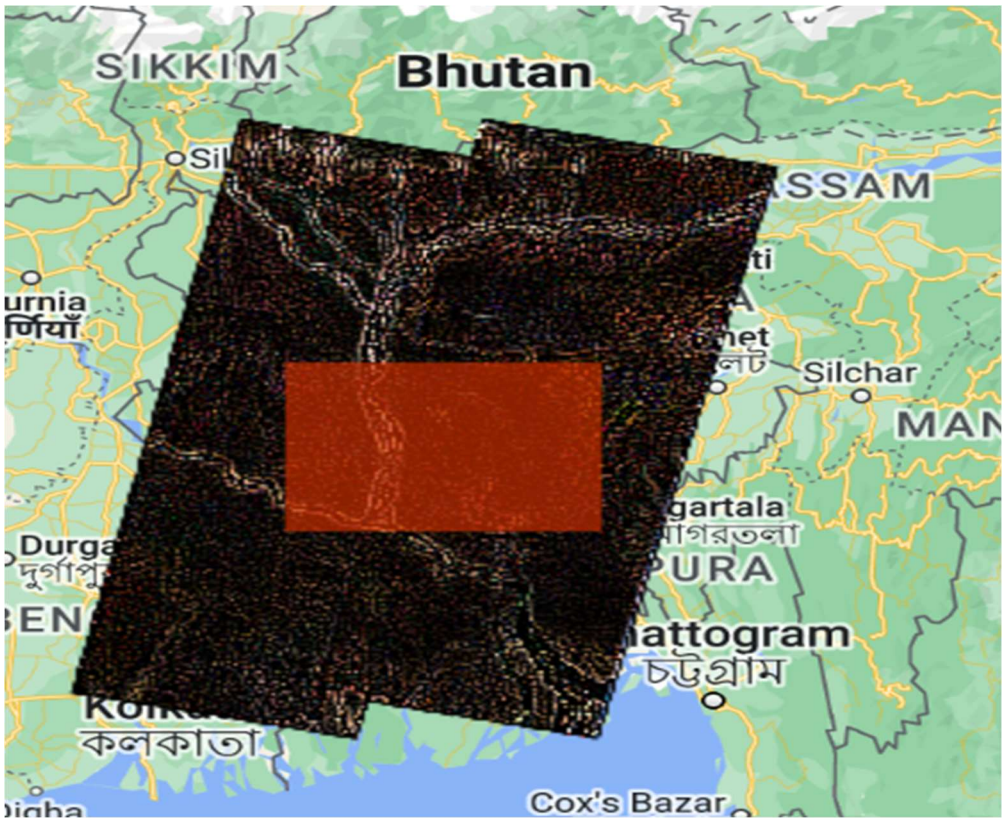
- **Filtered Mean: Low pass filter using 3×3 neighborhood**



- **Filtered Median: Low pass filter using 3×3 neighborhood**



- **Filtered Laplacian: High pass filter using 3×3 neighborhood**



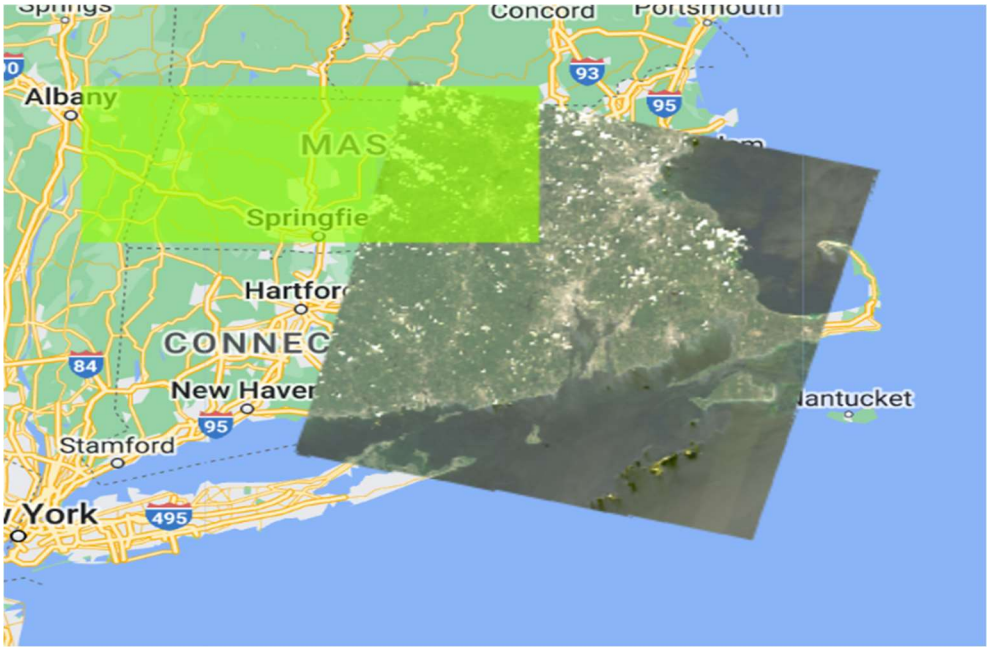
- **Filtered Sobel: High pass filter using 3×3 neighborhood**



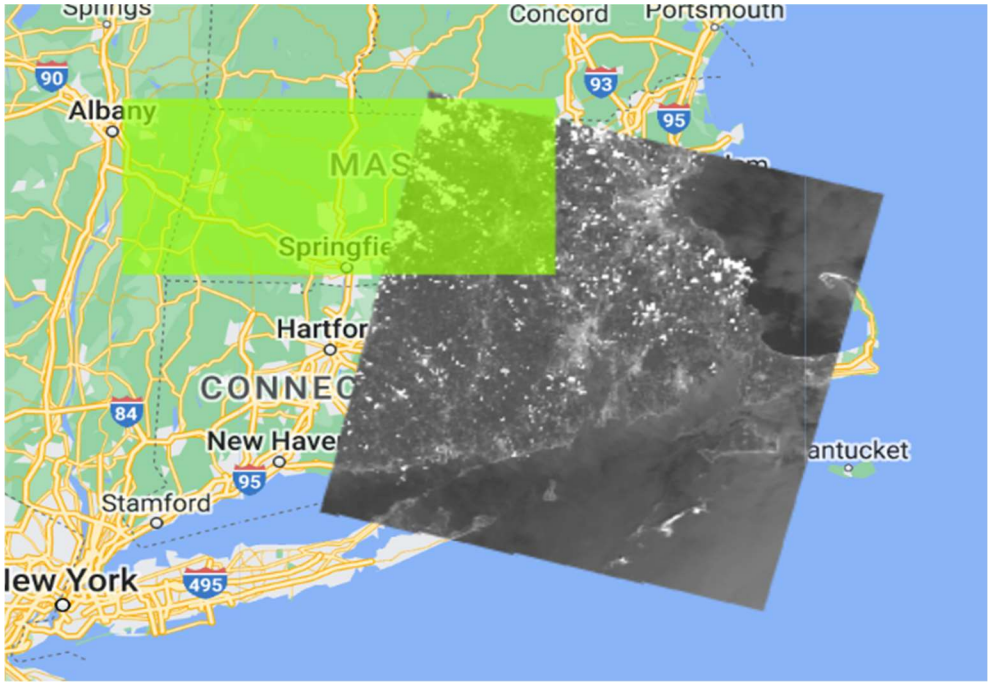
Part-3

Link: https://code.earthengine.google.com/5e6671ff2a5bbda12315d19b47b9dd23

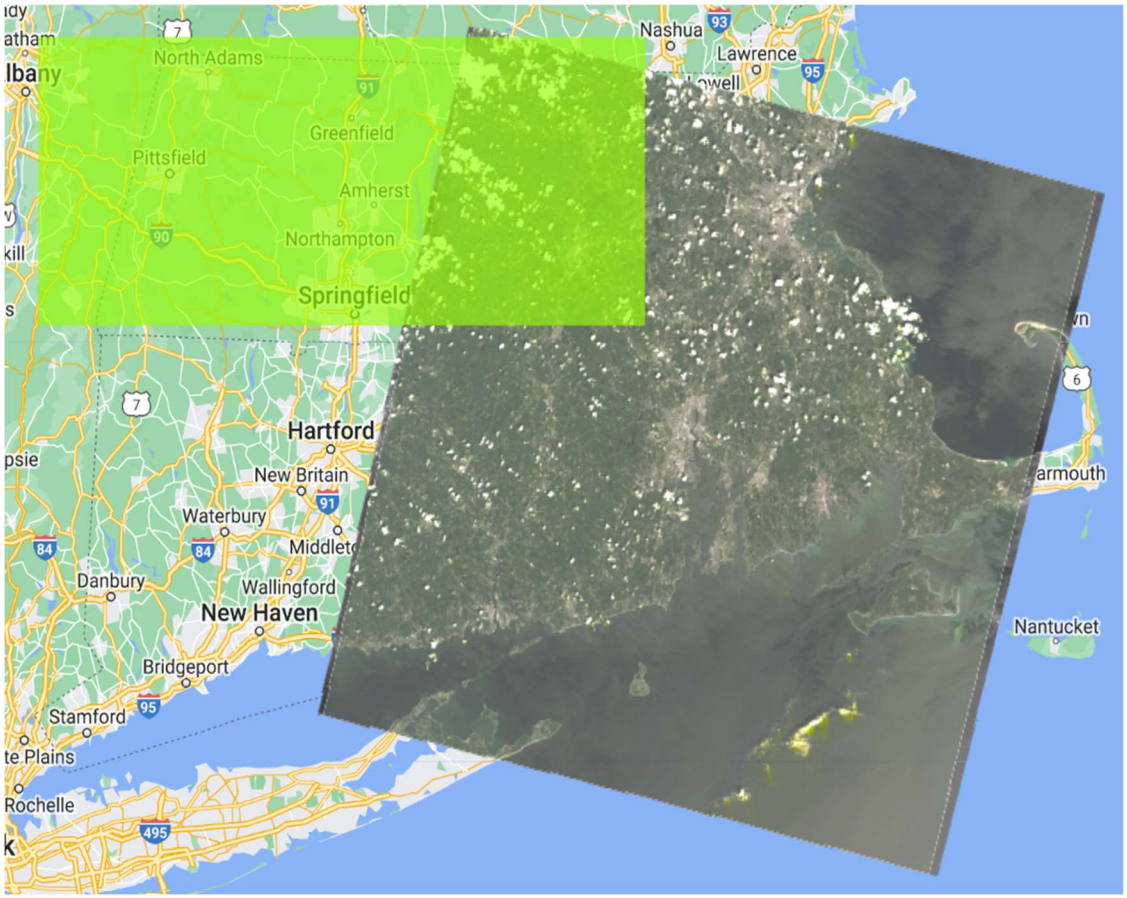
- **Multispectral Image : It is the image of true color composite.**



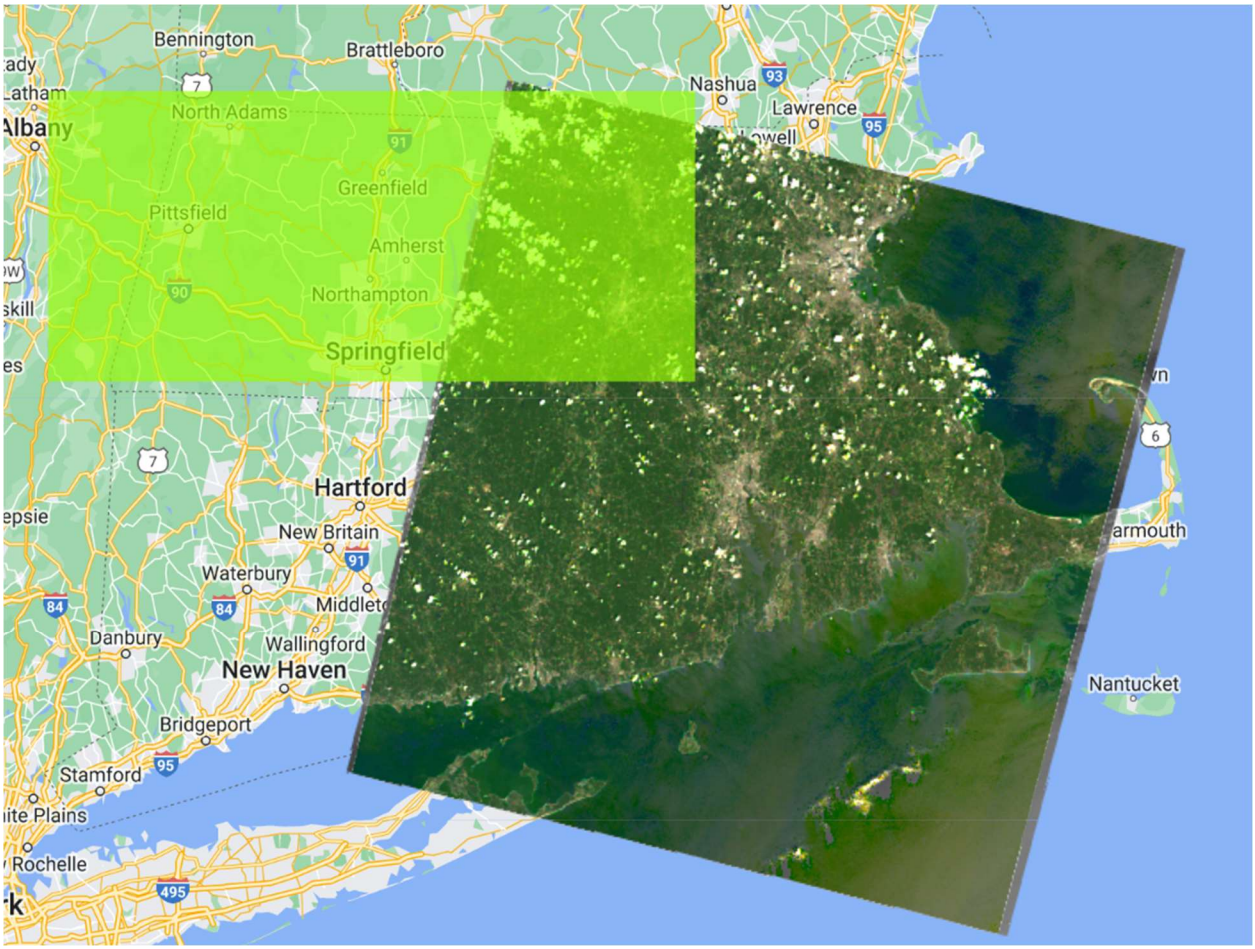
- **Panchromatic Image: Displaying panchromatic band for the selected image in gray scale.**



- **Pansharpen Brovey: This method adds all optical bands and divides by the panchromatic. Display of Pansharpen Brovery composite is a true color composite image.**



- **Pansharpen IHS: Intensity-Hue-Saturation (IHS) pansharpen method assumes that panchromatic band is equivalent to the brightness intensity of the combination of optical bands. The method then transforms the RGB space to an IHS space. Then, the Intensity image is replaced the panachromatic and transformed the space back to RGB. Thereby this image is also a true color composite image.**


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Lawrence
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Pittsfield
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Northampton
Springfield
Hartford
New Britain
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Wallingford
New Haven
Bridgeport
Stamford
Rochelle
Nantucket

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