

# CE671A Lab 3

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## 1 Introduction

The tasks provided involves processing and analyzing multispectral imagery using two different software platforms. In QGIS, the focus is on importing and visualizing the imagery, specifically by displaying individual bands in grayscale and adjusting their contrast using linear stretching. The exercise also involves analyzing the digital numbers (DN) of the original and stretched images at specific pixel locations to understand the effect of stretching on pixel intensity. In MATLAB, the tasks revolve around creating a color composite from three individual bands, identifying and cropping a region of interest (the IIT Kanpur campus), and applying a mask to highlight or isolate specific areas. Both sections aim to develop a deeper understanding of how image processing techniques can be applied to multispectral data to extract meaningful information, compare different image representations, and understand the potential sources of error in measurements derived from such imagery.

## 2 Methodology

### 2.1 Procedure-

Using QGIS

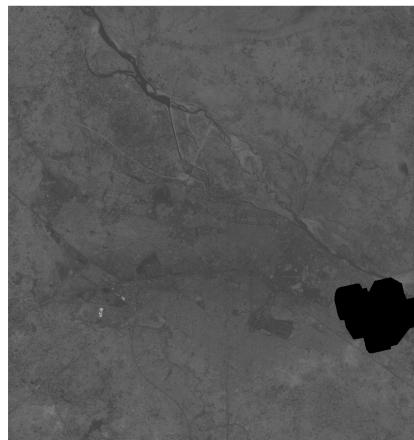
- Import the Multispectral Imagery in QGIS
- In the Layers panel, right-click on the imported imagery layer and select "Properties". Go to the "Symbology" tab.
- Choose the "Render type" as "Singleband gray."
- Ensure that "No Contrast Enhancement" is selected under the Contrast enhancement dropdown.
- Within the same layer properties window, go to the "Histogram" tab.
- Select each band to display its histogram. Observe the distribution of pixel values.
- Stay in the "Symbology" tab and select Band 3.
- Apply linear stretching by setting the minimum value to 100 and the maximum value to 150.
- Import the saved stretched image into QGIS.
- Perform linear stretching on other bands by choosing different minimum and maximum values.
- Import both the original and stretched images into QGIS as separate layers.
- Select both layers, right-click, and choose “Identify Features.”
- Click on different pixel locations and compare the DN values of the original image and the stretched band.

### Using MATLAB

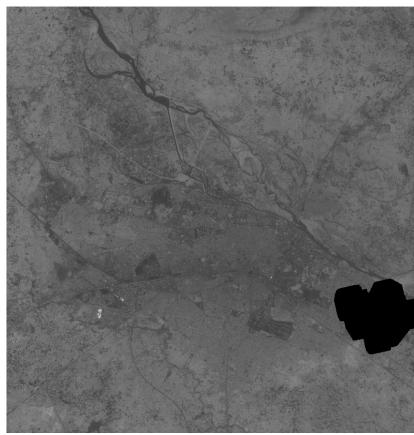
- Import the three images (Im1, Im2, Im3) in the L4\_tiff folder using `imread`.
- Create a color composite image:
- Visually inspect the color composite to identify the IIT Kanpur campus area.
- Crop the campus area using `imcrop`:
- Use `roipoly` to create a mask:
- Convert the logical mask to match the image data type if necessary:
- Remove everything except the IIT Kanpur campus area:
- Use `imtool` to Explore the Image\*\*
- Explore tools such as zoom, pan, pixel information, and measurement tools available in the menu bar.
- Identify the airstrip in the image.
- Measure its length using MATLAB's measurement tools or pixel information.

### 2.2 Results-

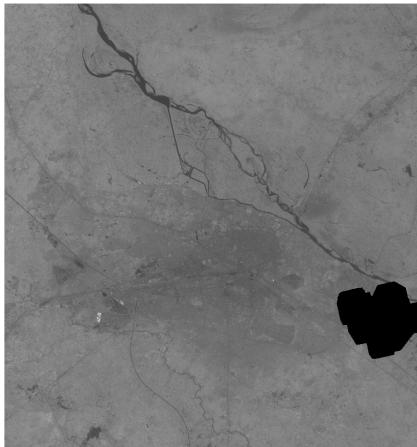
1. b)



Original ‘singleband gray’ BAND 1; No  
Contrast Enhancement

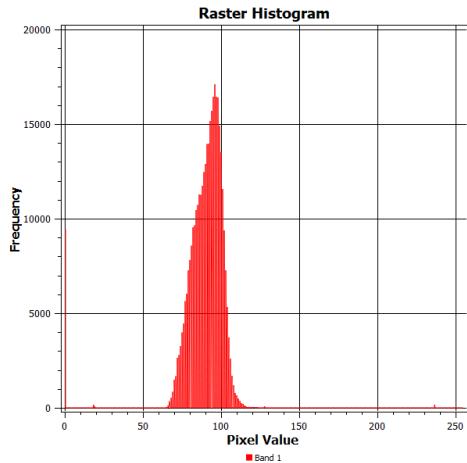


Original ‘singleband gray’ BAND 2; No  
Contrast Enhancement

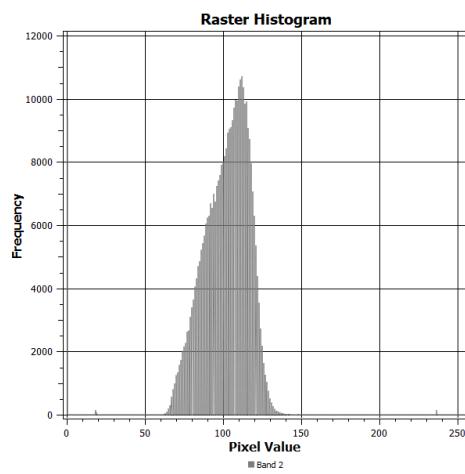


Original ‘singleband gray’ BAND 3; No  
Contrast Enhancement

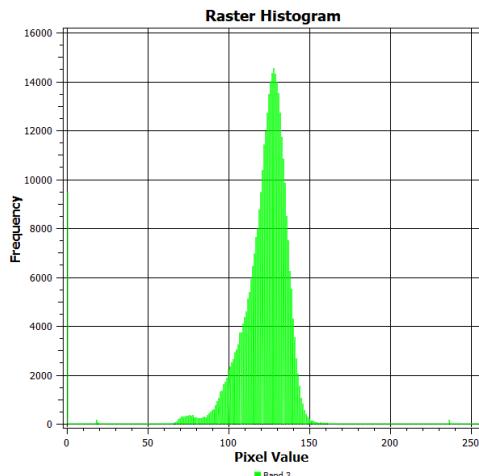
c)



Histogram BAND 1;

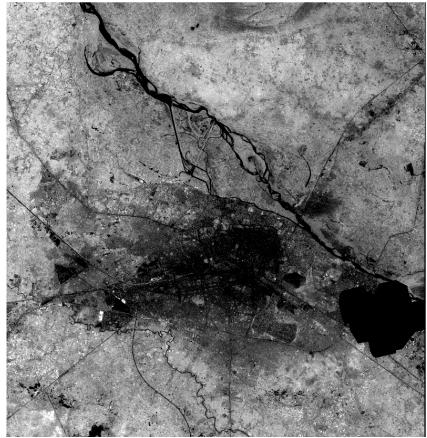


Histogram BAND 2;



Histogram BAND 3;

d)



Linear stretching to band 3 by giving minimum and maximum values of 100 and 150.

e)

This saved image has more than one band:

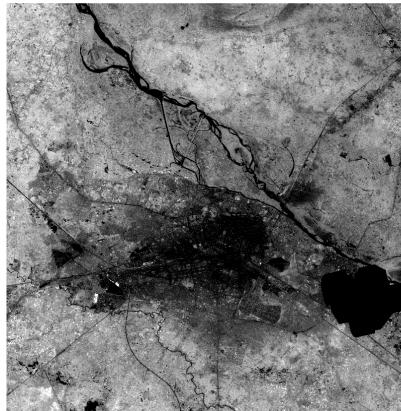
**Original Multi-Band Structure:** Since a part of a multispectral dataset (with multiple bands), the software might preserve the multi-band structure even after applying the stretching to just one band. This means that when you save the stretched image, the software includes all the bands present in the original file, even though the stretching was only applied to Band 3.

**Export Settings:** Depending on the export settings in QGIS, the software might save the entire image with all bands, not just the stretched band.

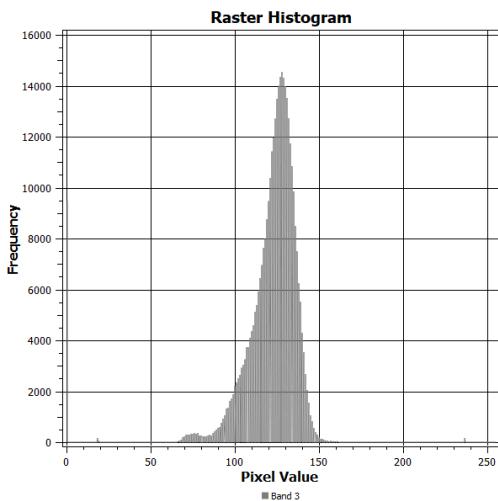
The saved image may still have more than one band because the software retains the multi-band structure even after processing just one band.

The pixel values in Band 3 have been altered due to the stretching, while the other bands (if included in the saved image) retain their original values.

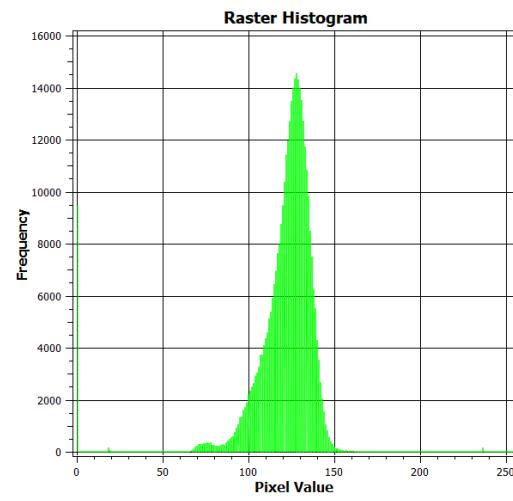
f) Stretched Band 3



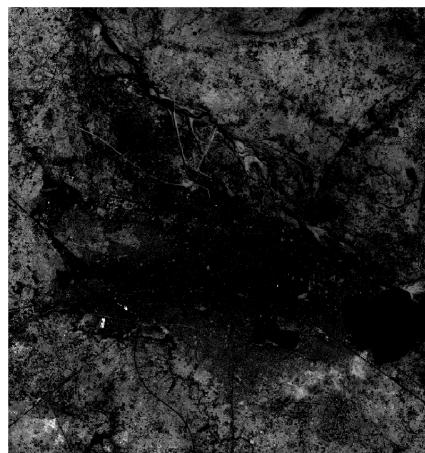
Histogram Stretched Band 3



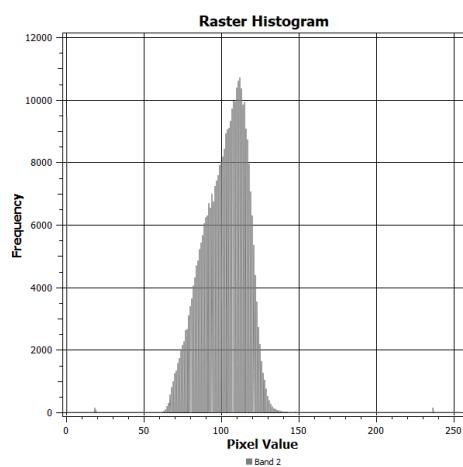
Histogram Original Band 3



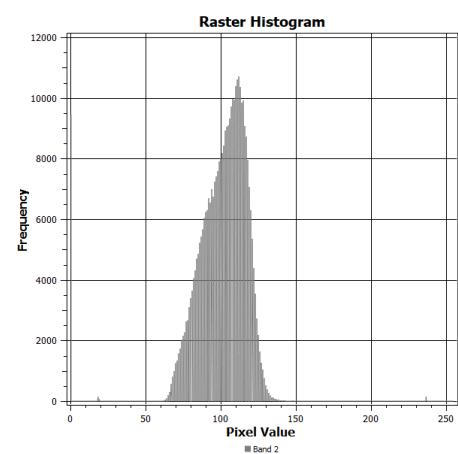
Stretched Band 2



Histogram Stretched Band 2



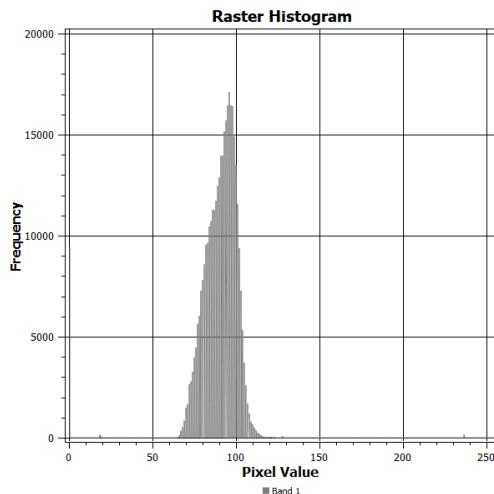
Histogram Original Band 2



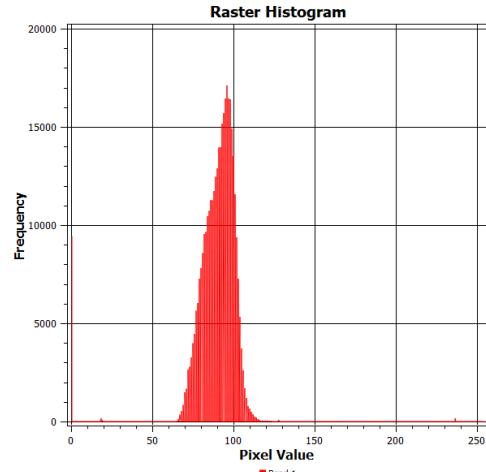
### Stretched Band 1



Histogram Stretched Band 1



Histogram Original Band 1



#### POSSIBLE REASONS BEHIND HISTOGRAM-

- If the original image has pixel values concentrated within a very narrow range, applying a linear stretch may not significantly alter the distribution. The stretched values may still fall within a similar range, leading to similar histograms.
- There could be an issue in how the stretching was applied. Ensure that the minimum and maximum values were correctly set and that the changes were properly applied to the image.

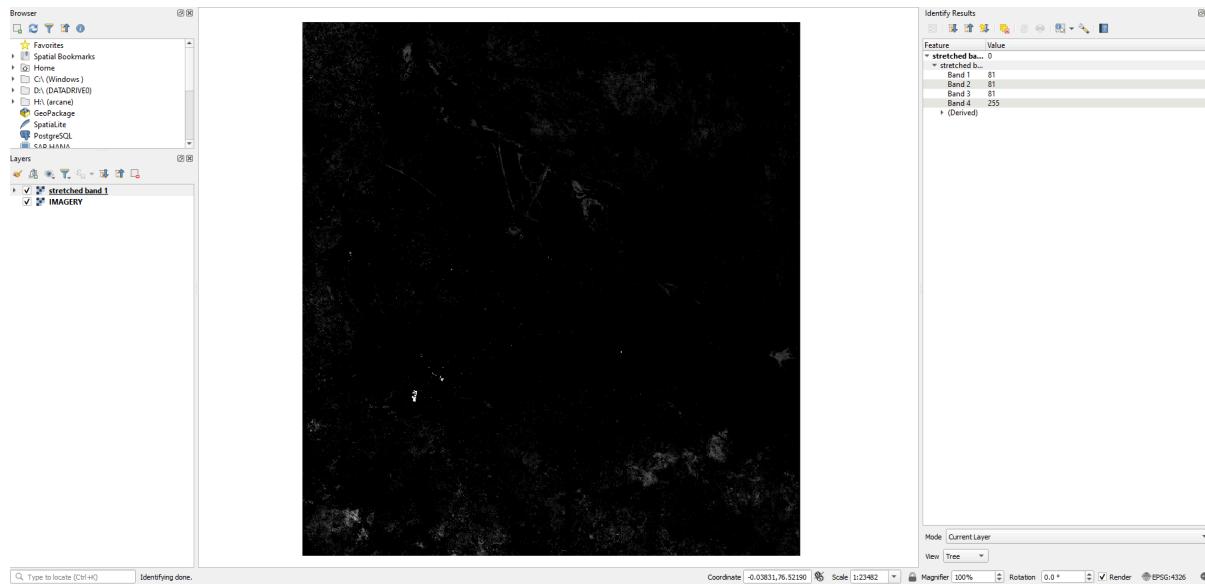
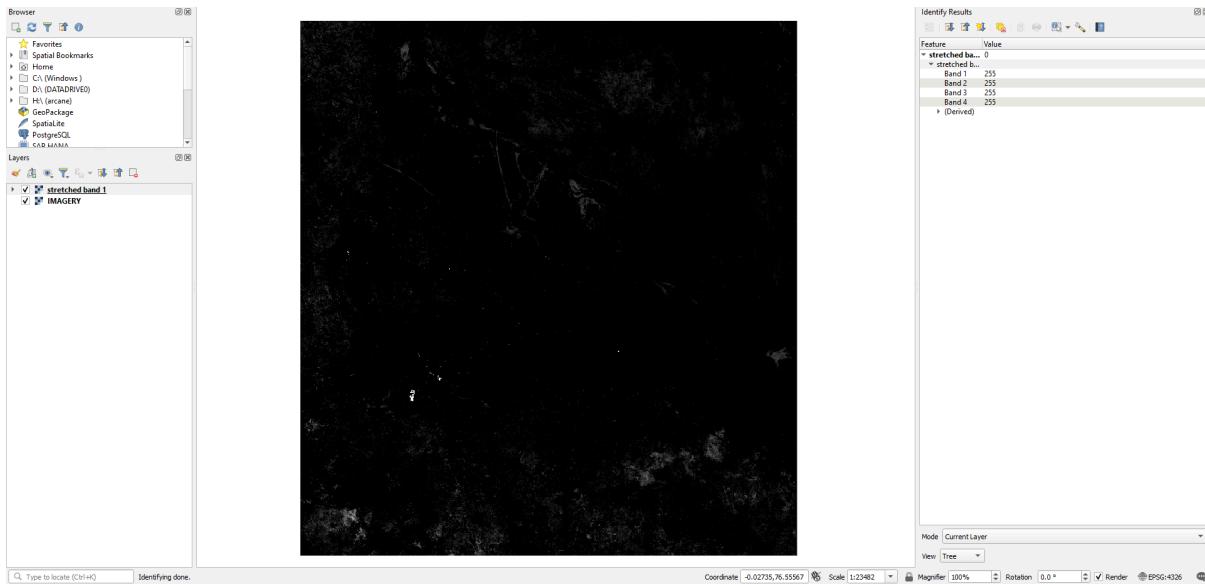
g)

Linear stretching is the simplest transform and usually (though not always) a very bad one. If the data histogram is relatively uniform (*e.g.*, like a velocity map) then a linear stretch where the display values are linearly spaced in data values between some minimum and maximum works well.

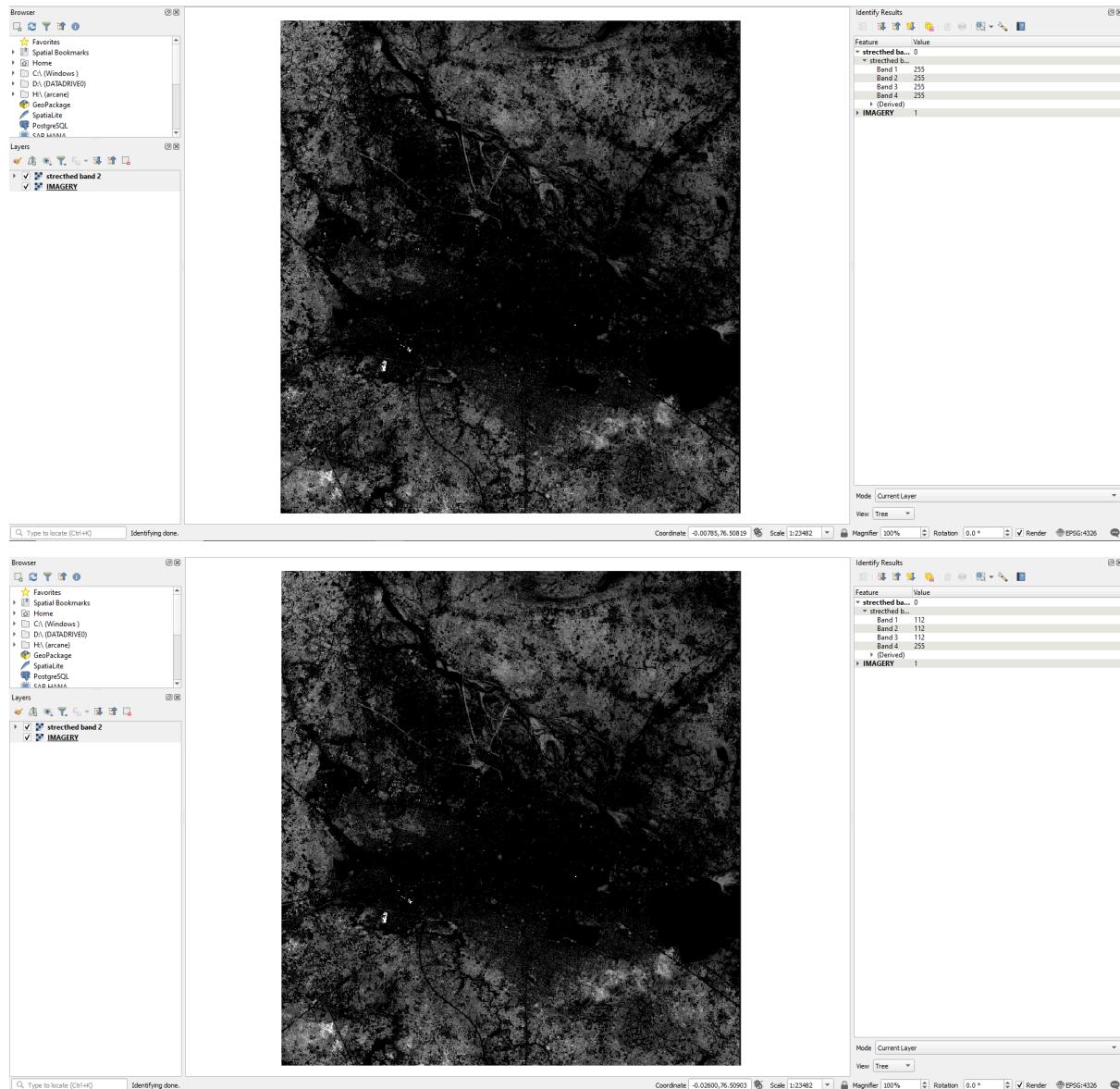
The process of linear stretching is straightforward and ensures that the relative differences between pixel intensities are preserved across the entire image. This technique is particularly useful in remote sensing and medical imaging, where it enhances the visibility of critical features, such as vegetation

patterns in satellite images or structures in medical scans. While linear stretching is effective for many applications, its simplicity means that it may not always account for outliers or non-linear distributions of pixel values, potentially requiring more sophisticated techniques in such cases. Nonetheless, linear stretching remains a widely used method for quick and effective contrast enhancement.

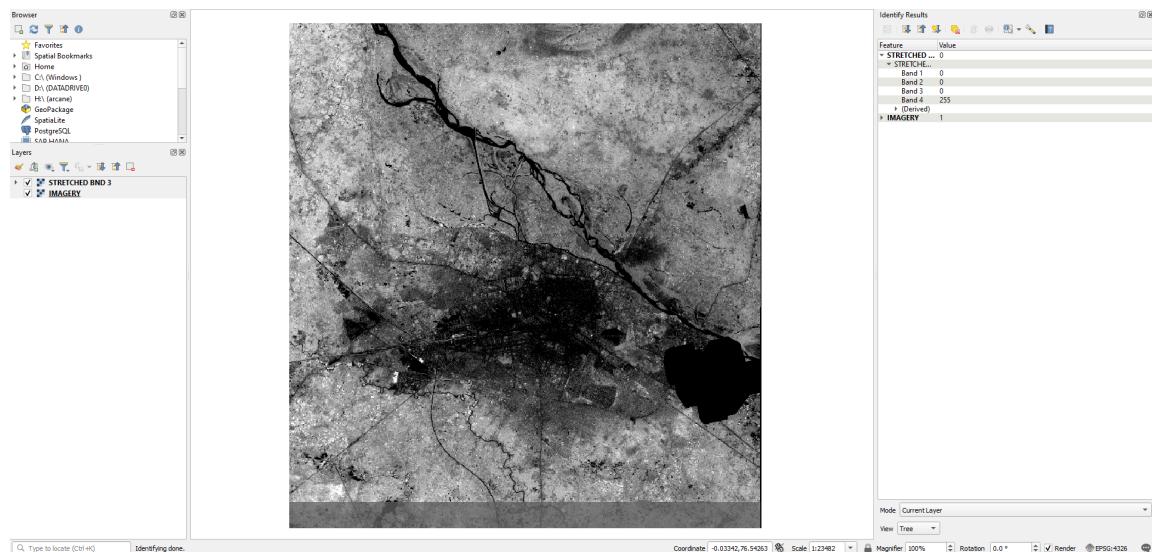
### h) Band 1 with digital number (DN)

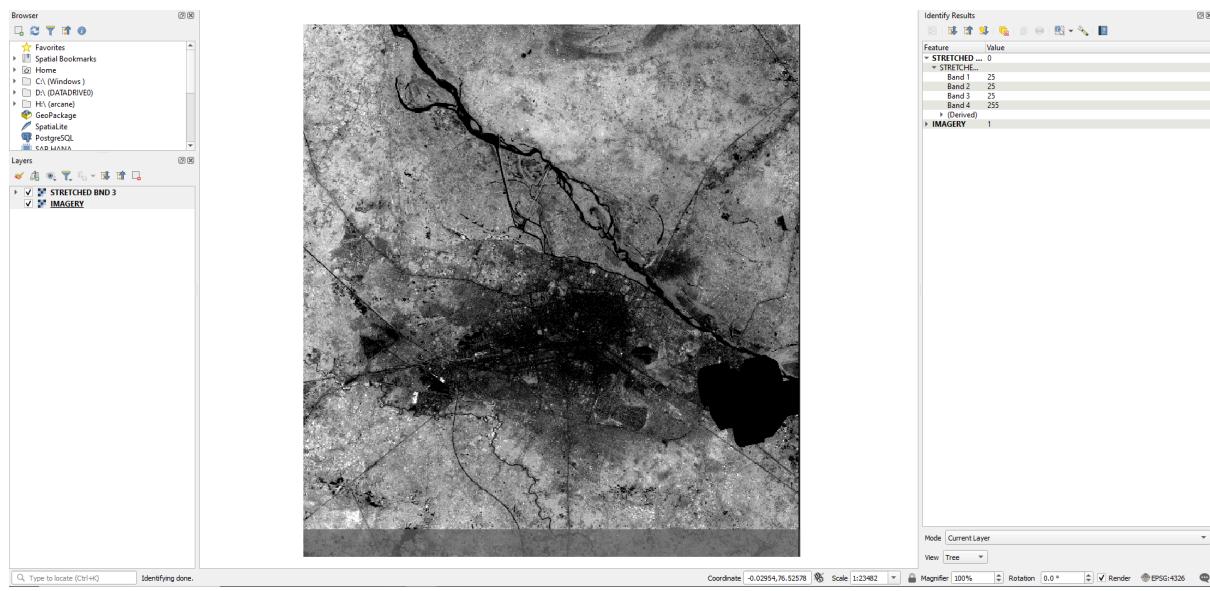


## Band 2 with digital number (DN)

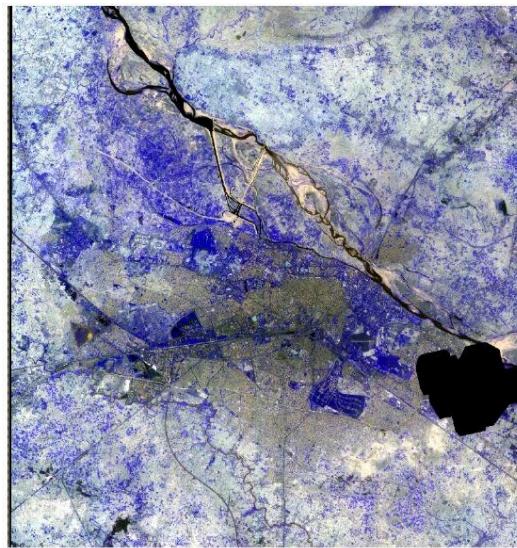


## Band 3 with digital number (DN)



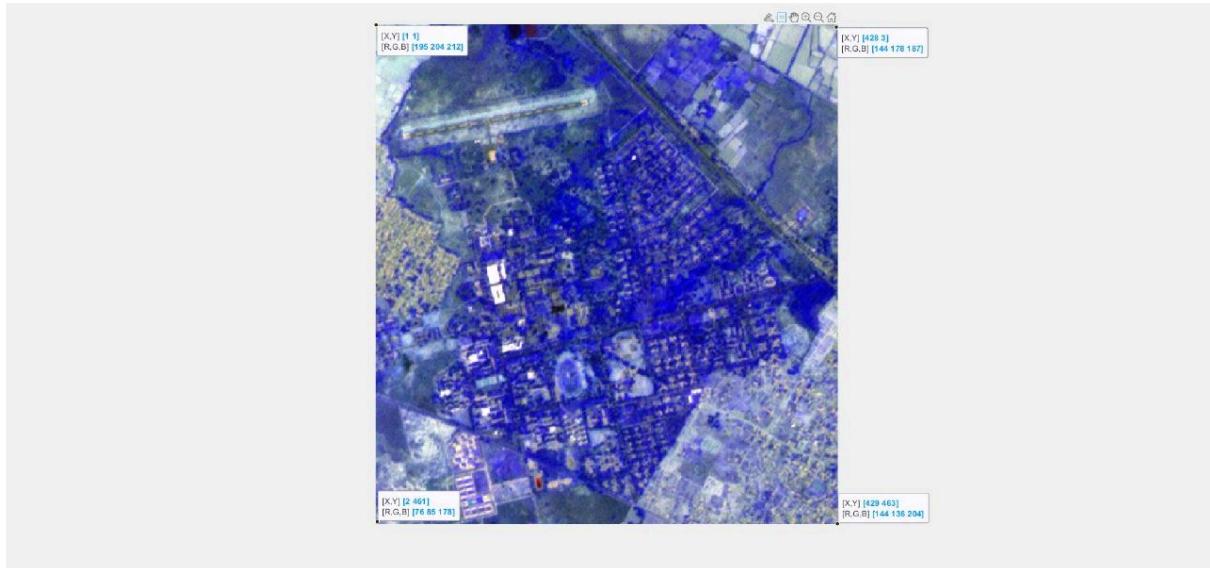


2)a) Color Composite Image



b) Cropped Image





## Interactive Interface

- You use the imcrop function with an interactive interface to select the region you want to crop visually.

## Specifying Pixel Coordinates

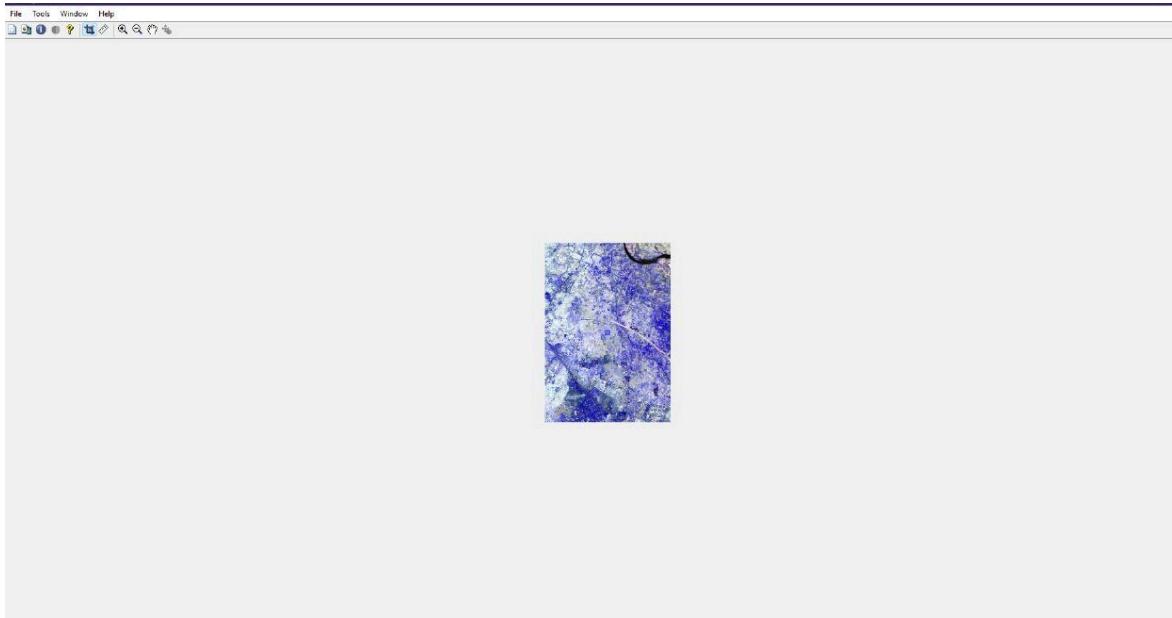
- You specify the coordinates of the bounding box directly using pixel values to crop the image.

d) IIT Kanpur Highlighted Area

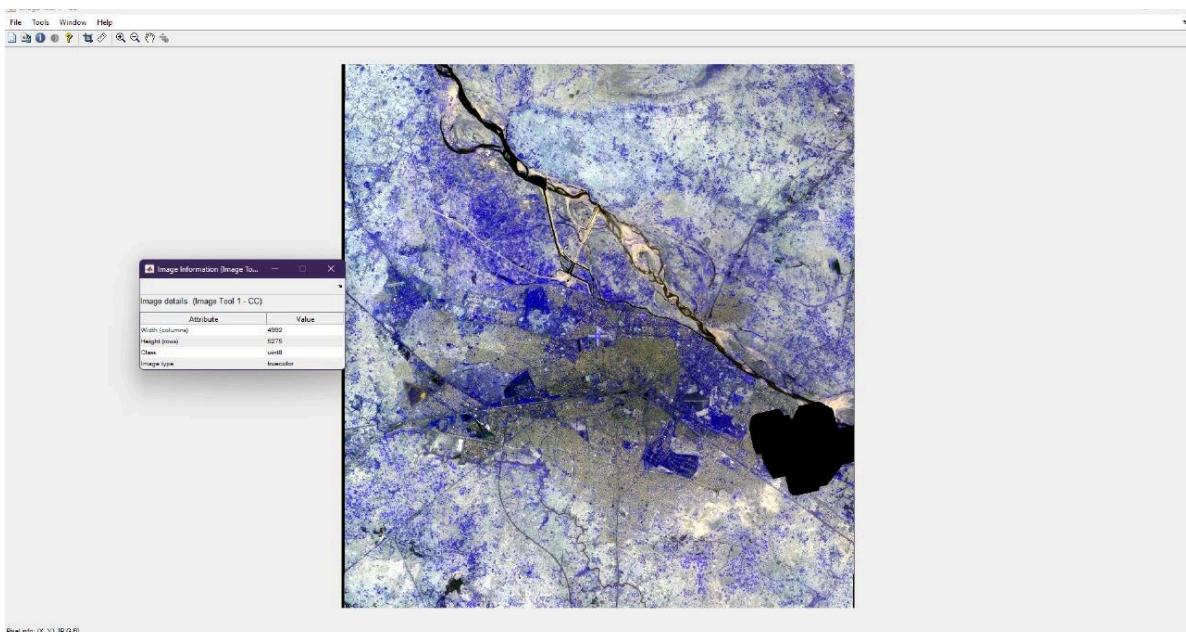


e) imtool menu bar

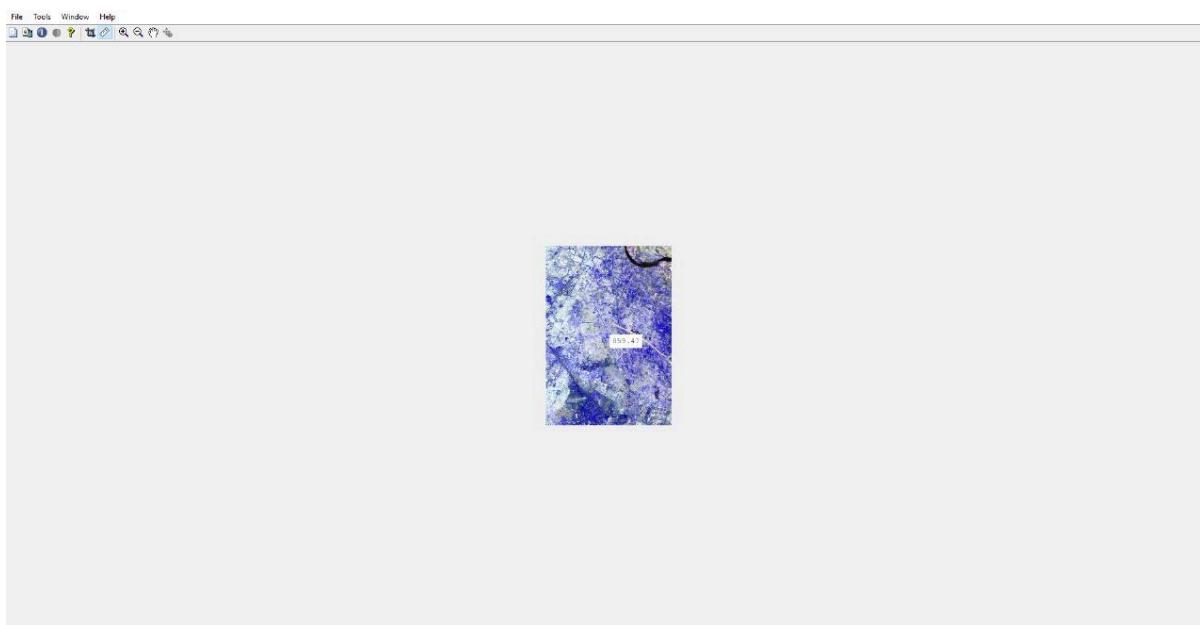
## Bounding box



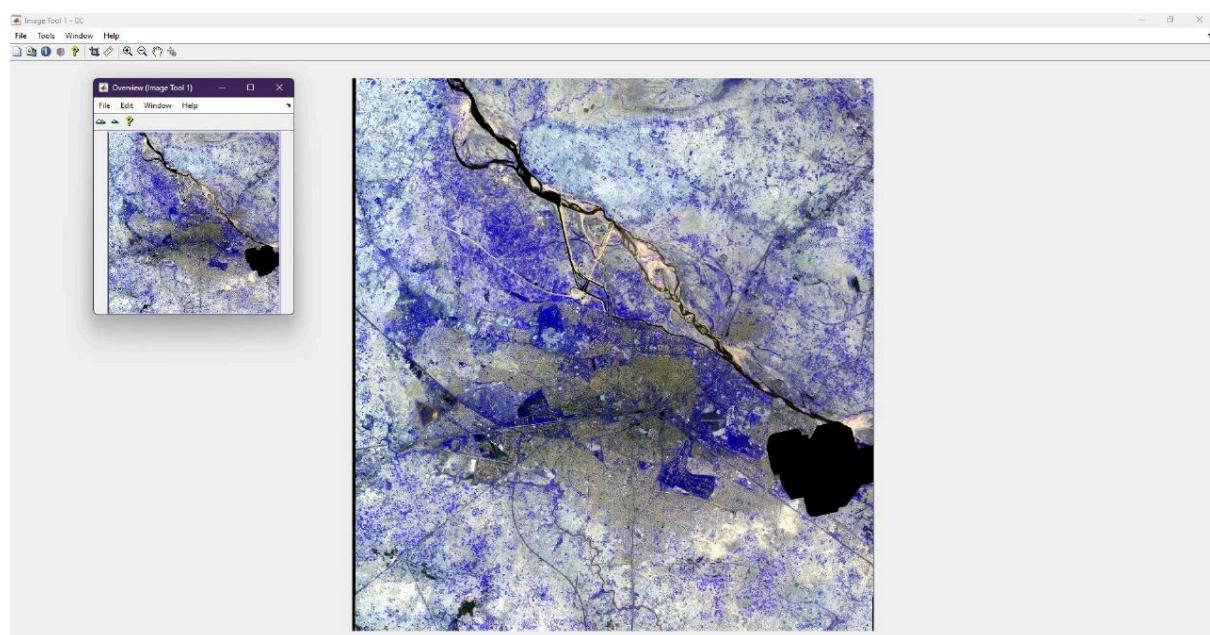
## Image info



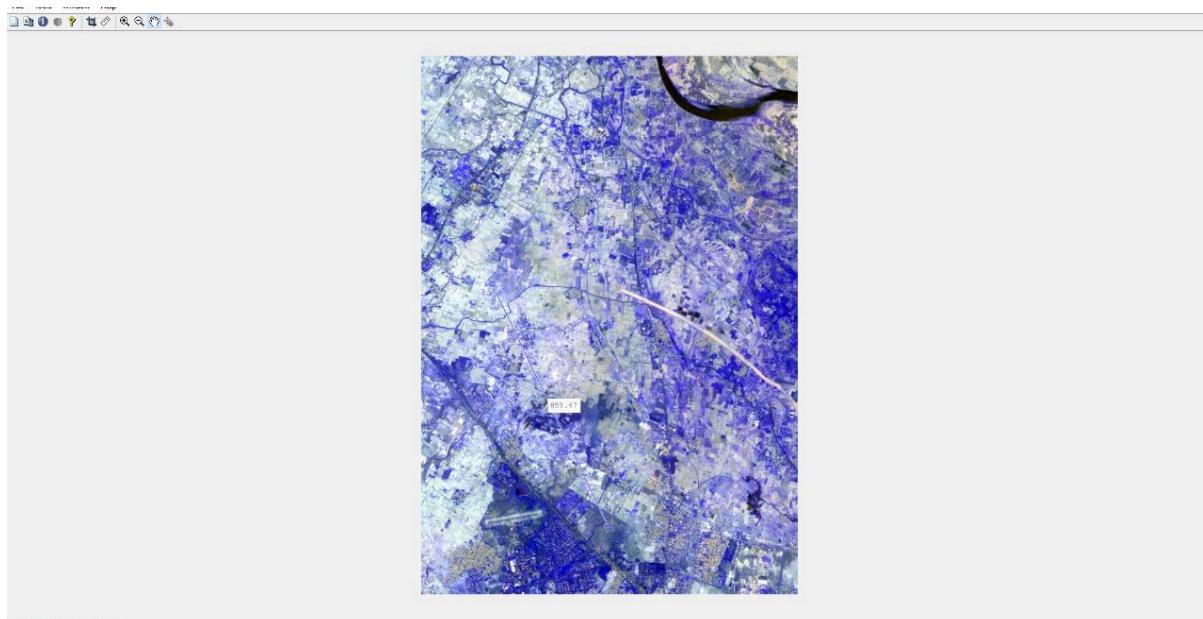
## Measure



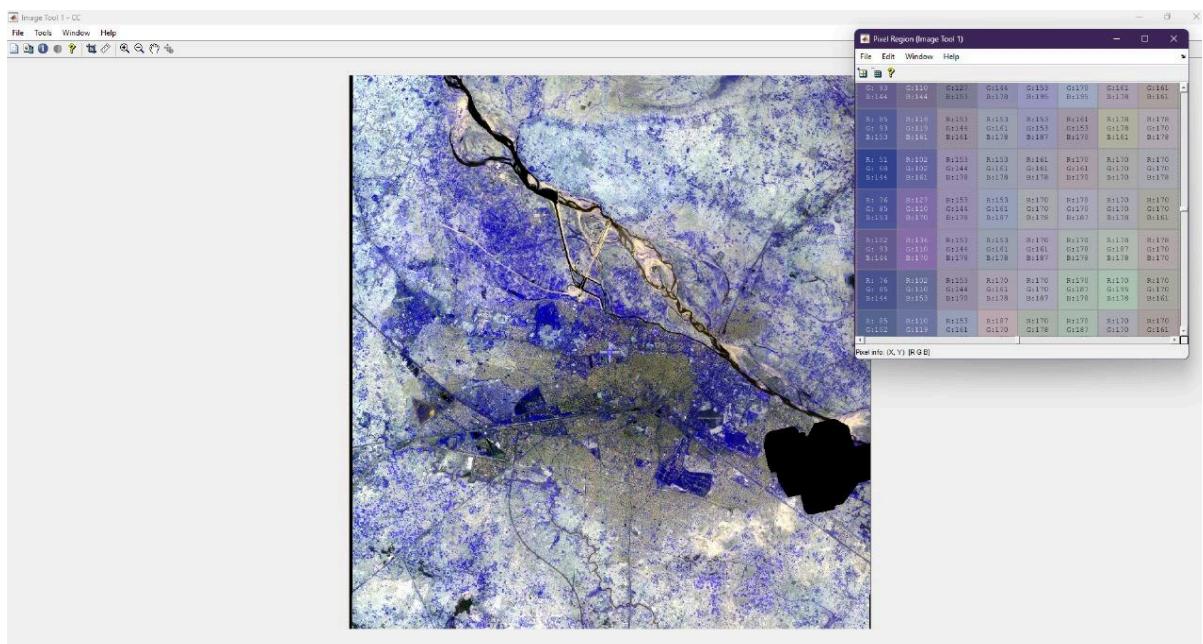
## Overview



## Pan



## Pixel Info



## ZOOM



## f) Airstrip length-



Pixels- 170.42

Length of Airstrip-  $170.42 \times 5.8$  metres = 988.436 metres

ERRORS-

**Image Distortion:** Lens distortions, perspective effects, or other distortions in the image can affect the measurement. Make sure the image is as distortion-free as possible.

**Cropping Errors:** If the cropping is not precise or includes extraneous areas, it can impact the measurement of the airstrip length.

**Image Quality:** Low-resolution images or poor quality can affect measurement accuracy, especially if the airstrip's boundaries are not clearly defined.

### 3 Discussion

In this assignment, we utilized multispectral imagery to enhance and examine satellite images using QGIS and MATLAB. By applying contrast stretching in QGIS, we improved the visibility of features in band3, as evidenced by the more spread histogram, which reflected a broader range of pixel values and enhanced detail. In MATLAB, we created a color composite by combining three image bands, then cropped and masked the IIT Kanpur Campus area for focused analysis. Measuring the airstrip length based on the image resolution revealed the importance of accurate calibration and potential sources of error such as image distortions and conversion inaccuracies. Overall, these methods demonstrated effective techniques for visualizing and analyzing satellite data, contributing to detailed and accurate insights.

### 4 Conclusion

Challenges:

- Accurate cropping and masking of the IIT Kanpur Campus area.
- Adjusting image contrast effectively.
- Converting pixel measurements to real-world units with precision.

Results:

- Linear stretching in QGIS improved image contrast, making features more distinguishable.
- MATLAB enabled precise cropping and masking of the campus area.
- Measurement of the airstrip length highlighted potential errors from resolution inaccuracies and image distortions.

### 5 References

<http://montage.ipac.caltech.edu/docs/Stretches/#:~:text=Linear%20Stretch&text=Linear%20stretching%20is%20the%20simplest,minimum%20and%20maximum%20works%20well.>

<https://in.mathworks.com/help/images/create-image-histogram.html>