

17. Given Satellite image, Identify the amount of green cover

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Introduction

Green areas are important parts of urban sprawl with environmental and social effects. Trees play important role in cleaning pollution, equilibration of water cycle and climate stability of the environment. Mapping of green cover is a basic condition for effective management and protection.

This project presents a technique to estimate the amount of green cover and urban cover when a satellite image is given.

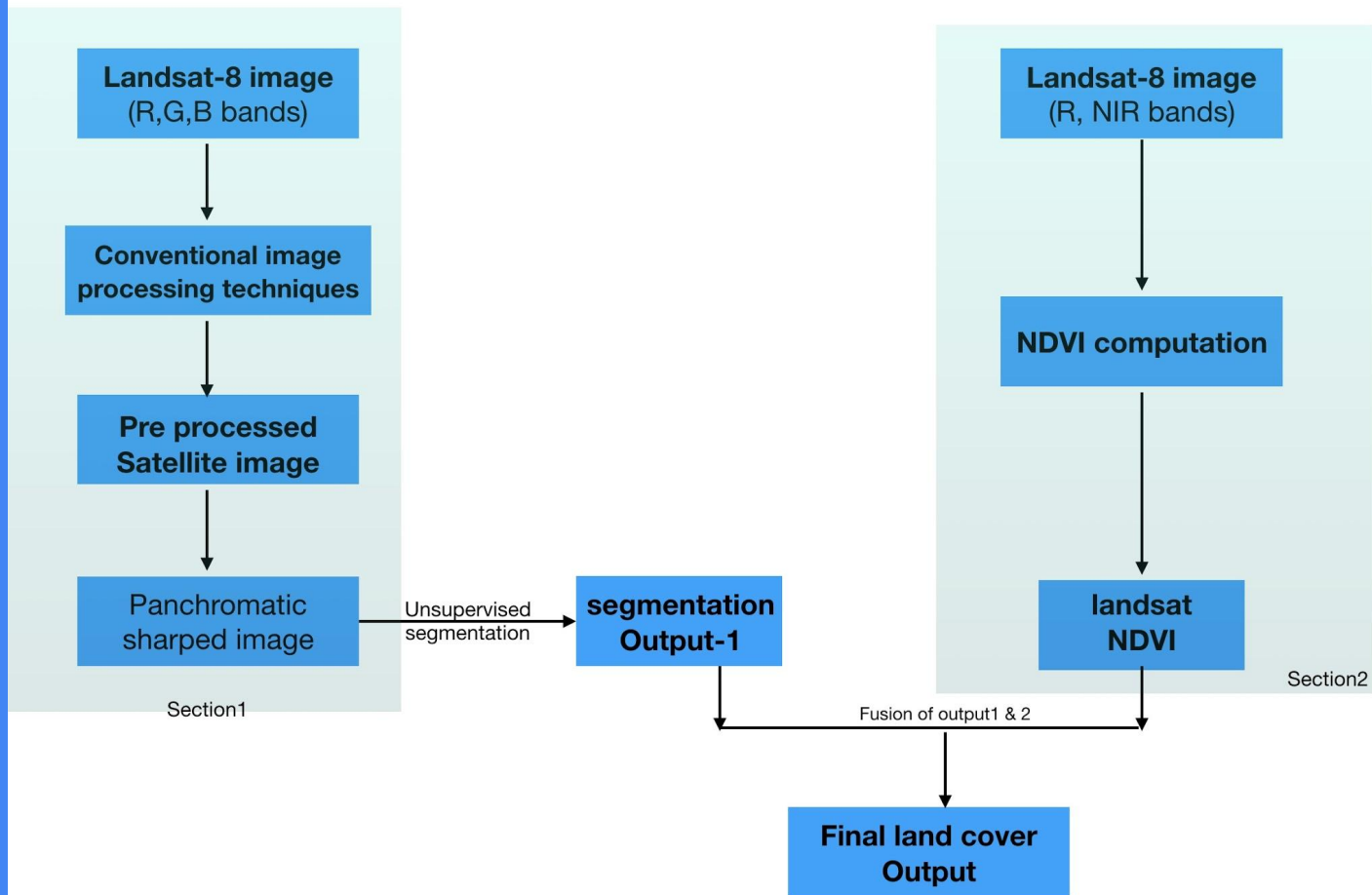
Implementation

Overview

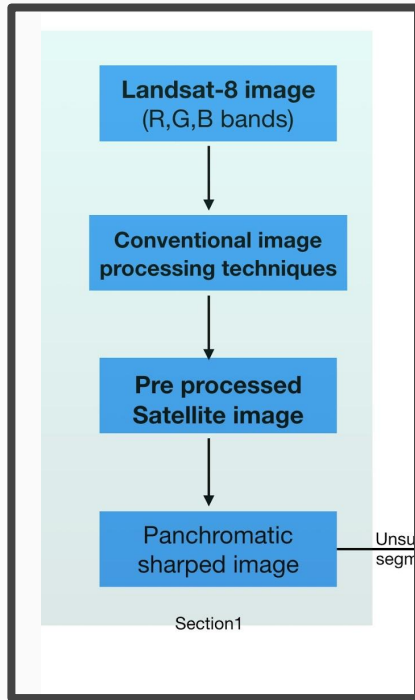
Series of steps

- Separation Landsat dataset with different bands
- Image enhancement
- NDVI computation
- Panchromatic sharpened image
- Unsupervised segmentation
- Final land cover

Workflow

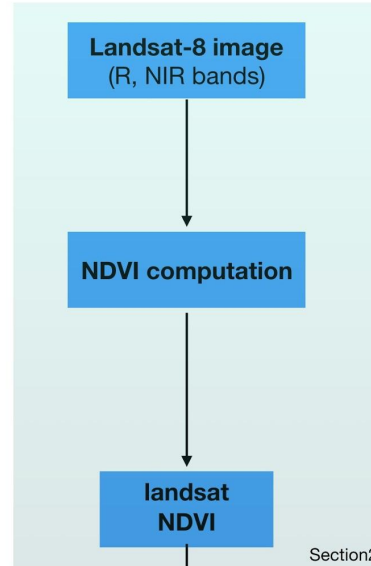


Section 1



Workflow

segmentation
Output-1

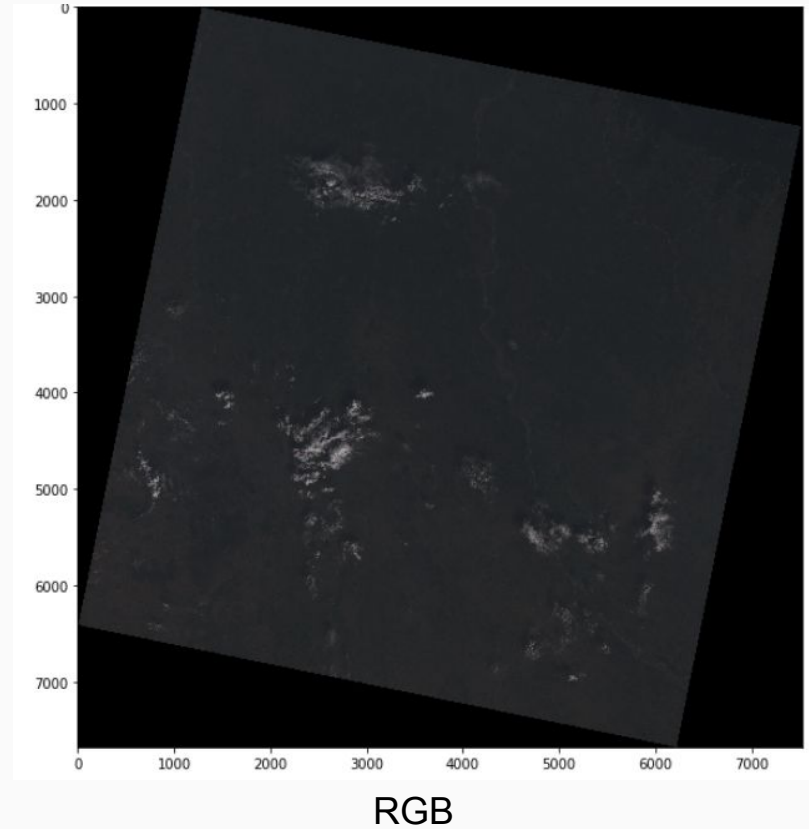


Final land cover
Output

Landsat-8 Satellite image:

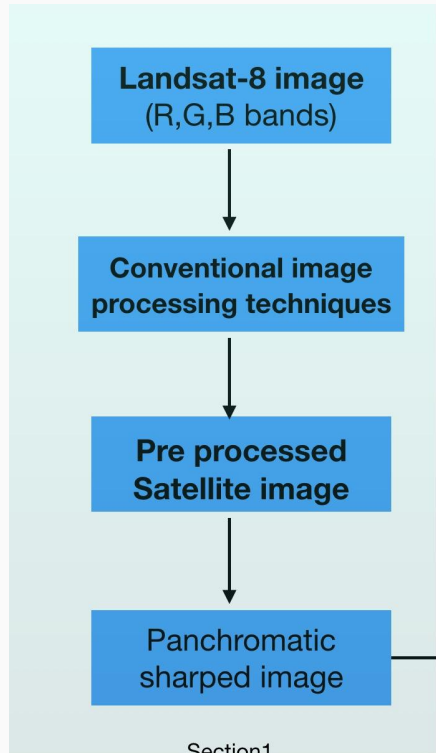
The input landsat image consists of 11 different bands. For the first section of the workflow, The R,G,B channels (band4, band3, band2) are merged to get a color satellite image of the area.

- Average resolution of landsat datasets: **8000 x 8000 pixels**
- Area covered can be from 100-150 km in width.



Band	Wavelength	Useful for mapping
Band 1 – Coastal Aerosol	0.435 - 0.451	Coastal and aerosol studies
Band 2 – Blue	0.452 - 0.512	Bathymetric mapping, distinguishing soil from vegetation, and deciduous from coniferous vegetation
Band 3 - Green	0.533 - 0.590	Emphasizes peak vegetation, which is useful for assessing plant vigor
Band 4 - Red	0.636 - 0.673	Discriminates vegetation slopes
Band 5 - Near Infrared (NIR)	0.851 - 0.879	Emphasizes biomass content and shorelines
Band 6 - Short-wave Infrared (SWIR) 1	1.566 - 1.651	Discriminates moisture content of soil and vegetation; penetrates thin clouds
Band 7 - Short-wave Infrared (SWIR) 2	2.107 - 2.294	Improved moisture content of soil and vegetation and thin cloud penetration
Band 8 - Panchromatic	0.503 - 0.676	15 meter resolution, sharper image definition
Band 9 – Cirrus	1.363 - 1.384	Improved detection of cirrus cloud contamination
Band 10 – TIRS 1	10.60 – 11.19	100 meter resolution, thermal mapping and estimated soil moisture
Band 11 – TIRS 2	11.50 - 12.51	100 meter resolution, Improved thermal mapping and estimated soil moisture

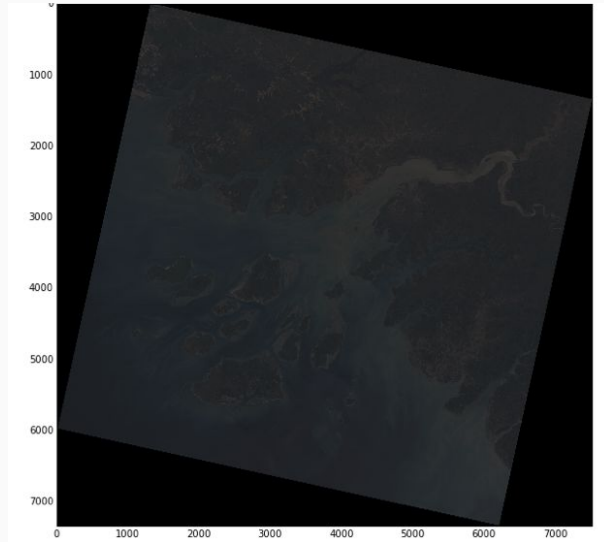
Image Enhancement



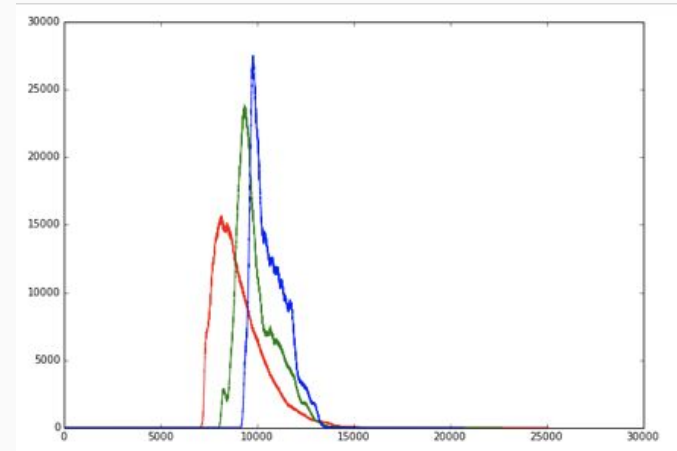
- Histogram equalisation
- Contrast and color balance adjustment
- Panchromatic sharpening

Histogram equalisation

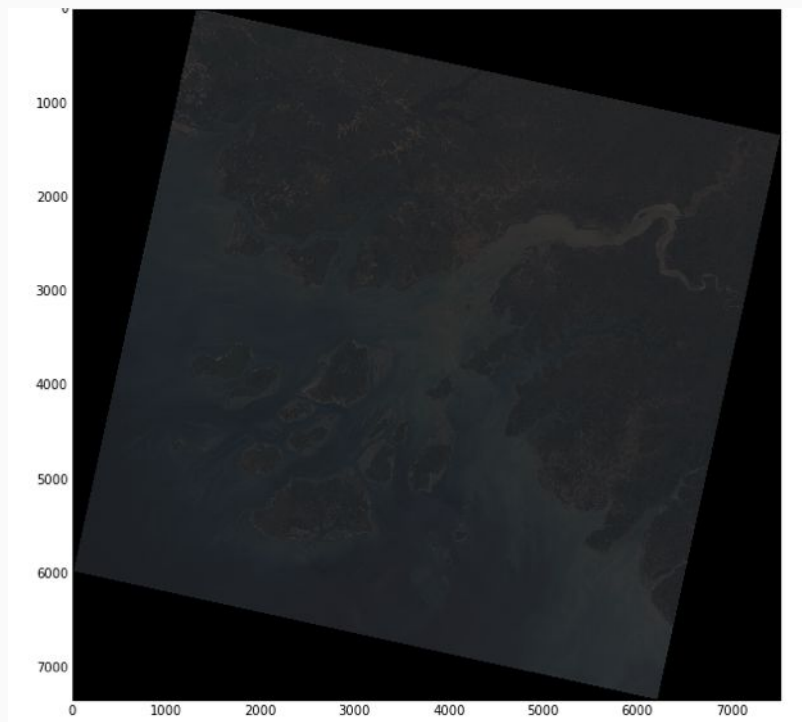
Histograms of RGB colours corresponding to raw data show that the data is not utilising full 16-bit range afforded by the detector. The RGB channels are histogram equalised and this results in apparent brightening of the image .



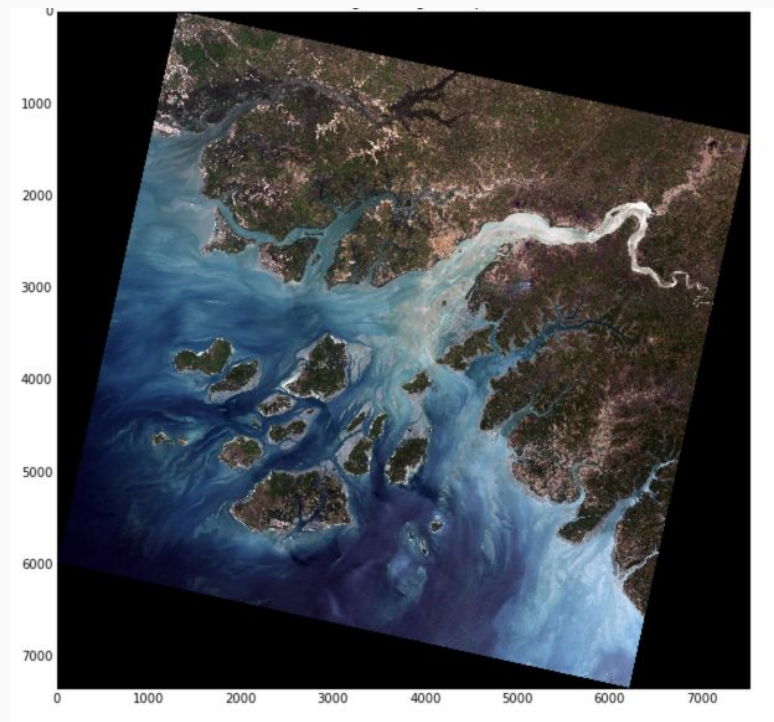
RGB Image



Histogram of RGB image



Before histogram equalisation



histogram equalised

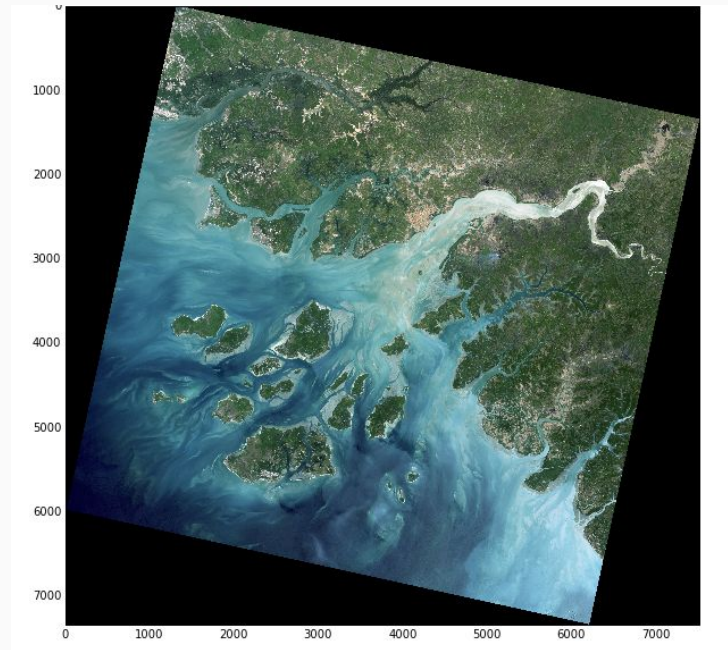
Contrast and Color Balance Adjustment

We will adjust balance of green and blue colours by shifting them to partially "brighter" values using gamma adjustment.

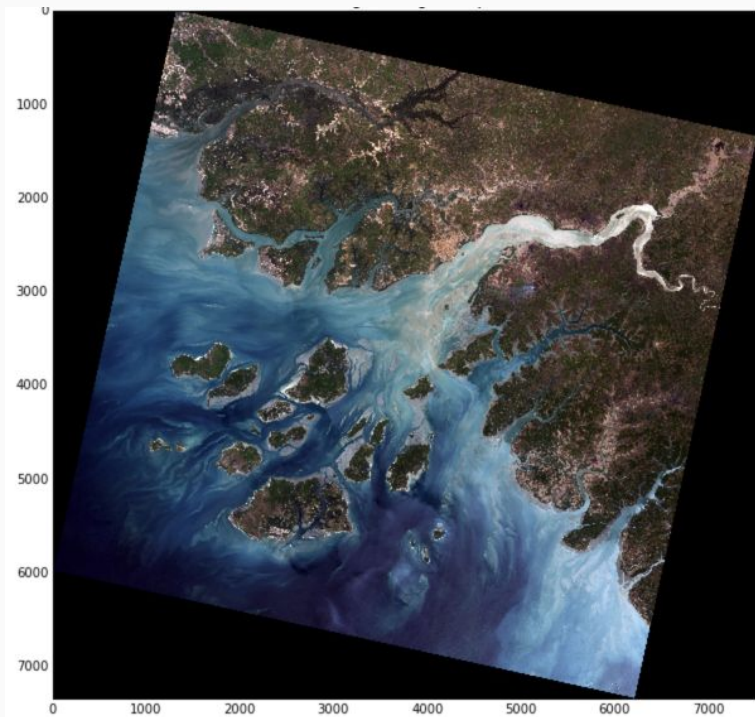
Gamma correction:

$$s = cr^\gamma$$

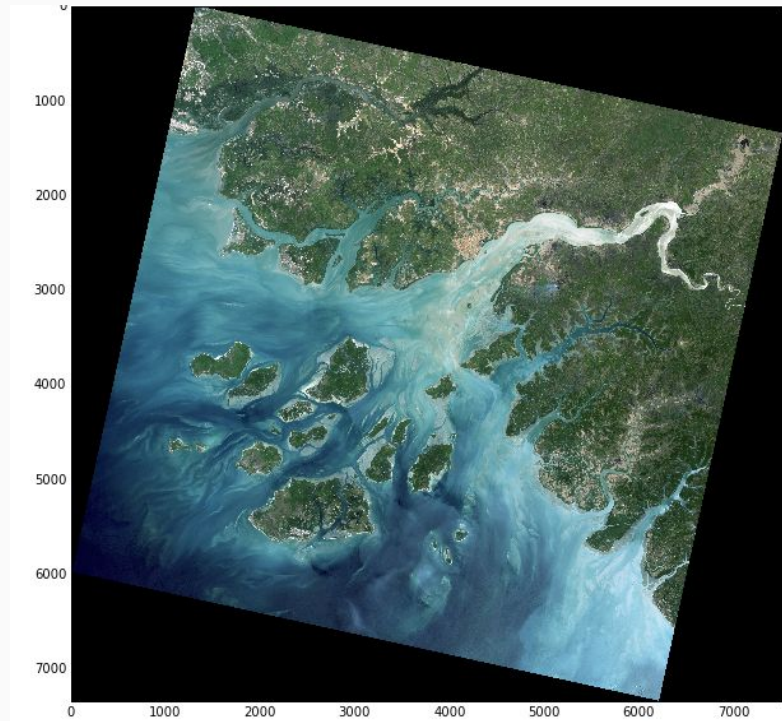
Images that are not corrected properly can look bleached out.



Gamma corrected image



Before gamma correction



After gamma correction

Panchromatic Sharpening

Panchromatic sharpening uses a higher-resolution panchromatic image (table 1 , where band-8 is the panchromatic band) to fuse with a lower-resolution red-green-blue bands.Landsat dataset provides low resolution, multiband images and higher-resolution, panchromatic images of the same scenes. Panchromatic sharpening is used to increase the spatial resolution and provide a better visualization of a multiband image using the high-resolution, single-band image.

Band 8 - Panchromatic	0.503 - 0.676	15 meter resolution, sharper image definition
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Original Color image
(240cm resolution)



panchromatic image
(60 cm resolution)



Pan-sharpened color image
(60 cm resolution)

Segmentation

Segmentation is done on this image by unsupervised learning which uses the K-means algorithm. It groups the pixels depending on their interdependency. It generates a color segmented image in RGB format where the chromatic values of each identified region are directly related to the original chromatic values.

If the number of clusters is not known before (for example, water, snow, green cover, urban area, etc) the mean shift algorithm can be used for segmentation.

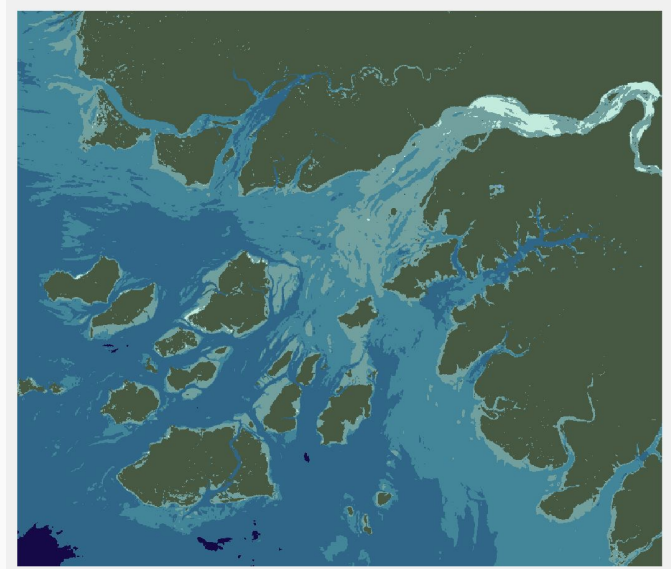
Algorithm:

- Initialise random seed points.
- Define window radius.
- For points which are inside this distance threshold compute new mean.
- Repeat the above step until there is a convergence i.e; the new mean is the same.

Segmentation results



Enhanced image



Segmented output

Segmentation results

Subjective results : visual differences



A



B

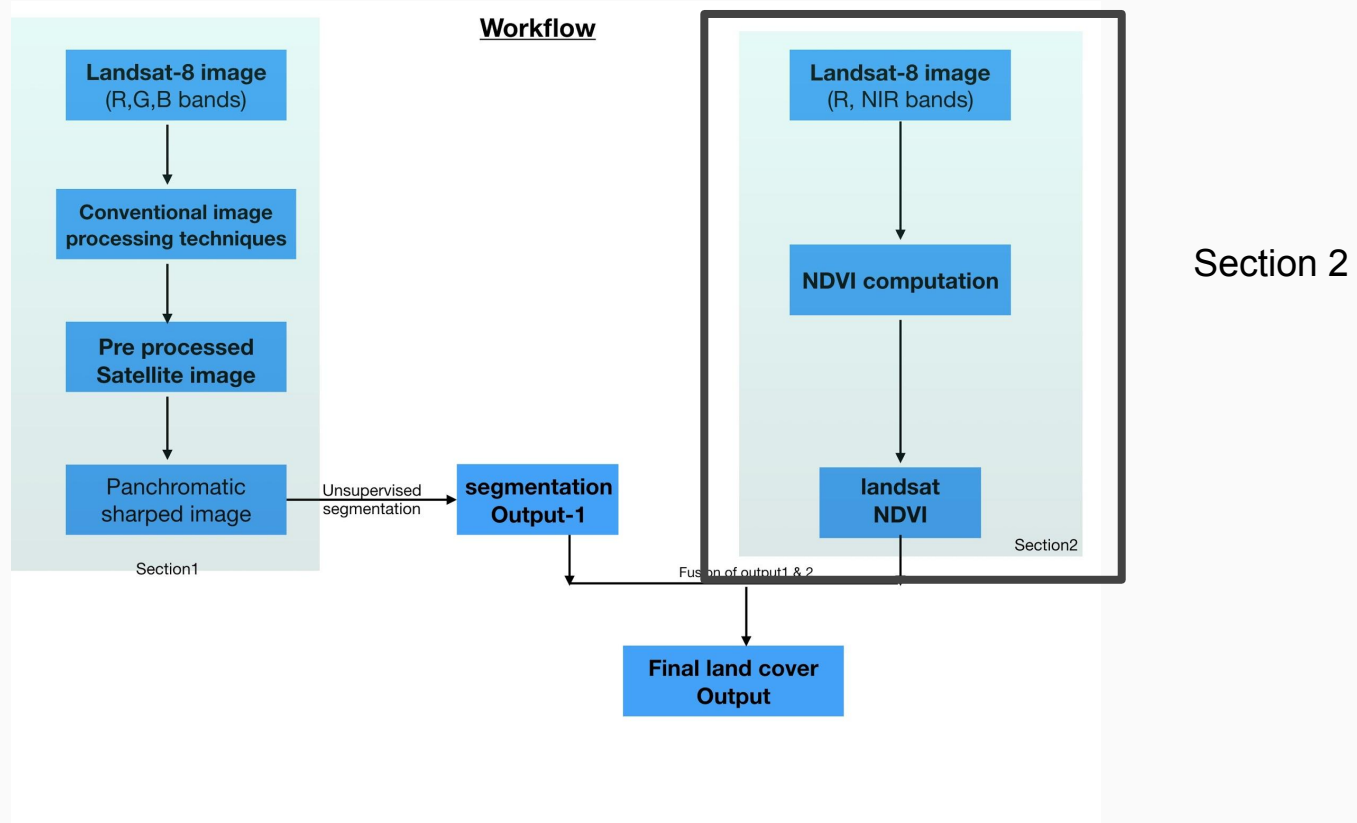


C

Objective results: difference through MSE

Threshold value	Threshold value	MSE
0.2	0.1	40
0.1	0.07	21

Section 2:



NDVI computation

The Normalized Difference Vegetation Index (NDVI) is used to assess the state of vegetation.

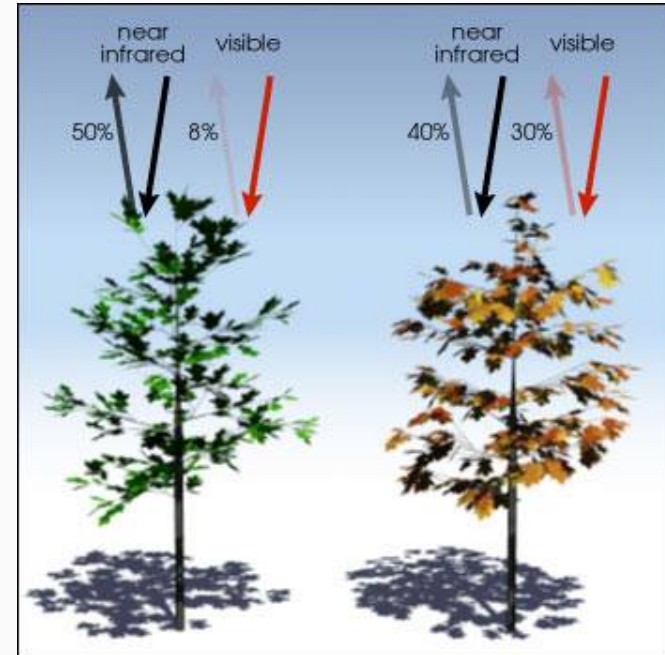
$$\text{NDVI} = (\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red})$$

Where **NIR** is near-infrared band-5

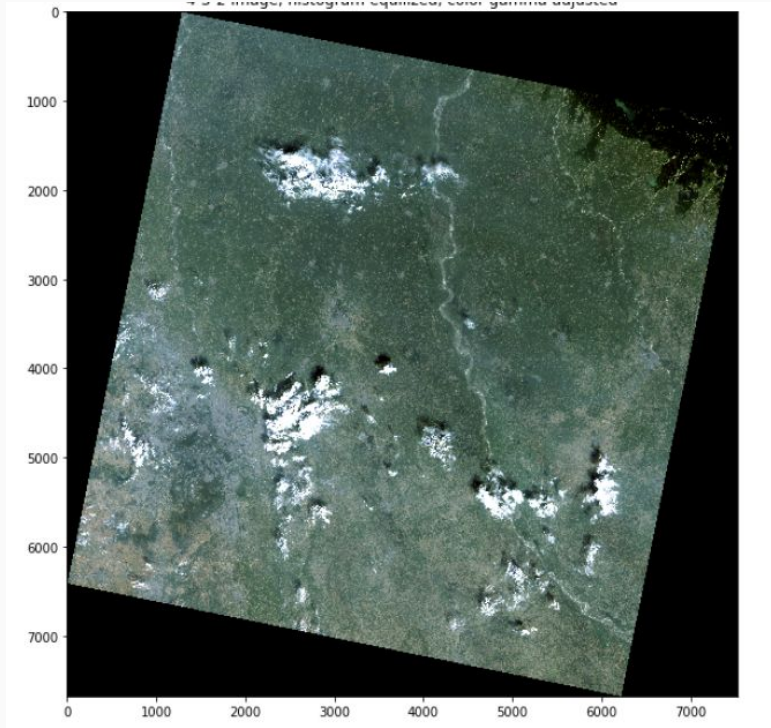
Red is colour red band-4

NDVI of various types of terrains:

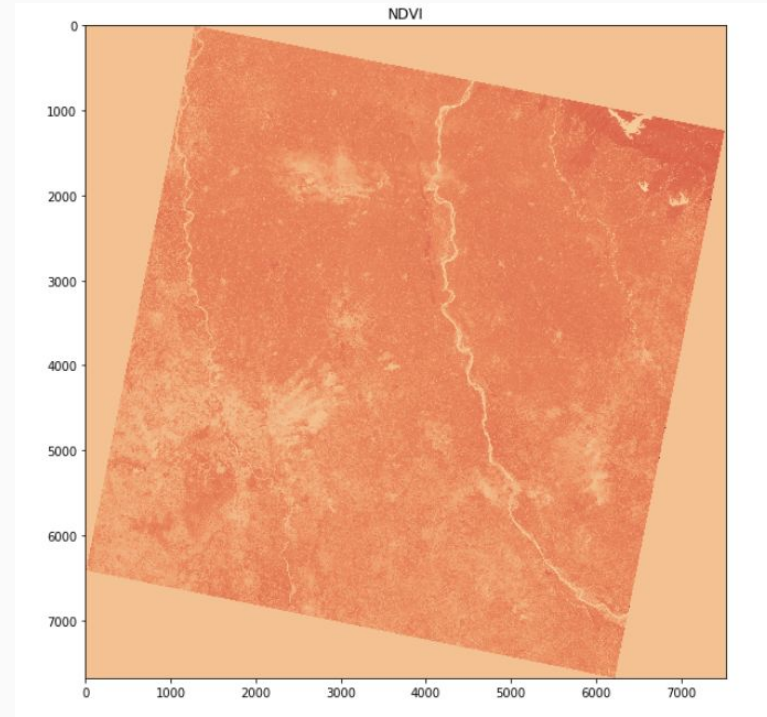
- NDVI ranges from -1 to +1. In practice, an area of an image containing living vegetation will have NDVI in the range 0.3 to 0.8.
- High water content clouds and snow will have negative values of the index. Bodies of water, having low reflectance in both Band 4 and 5, exhibit very low positive or negative index.
- Soil, having slightly higher reflectance in near-infrared than in red, will produce low positive values of the index.



NDVI computation

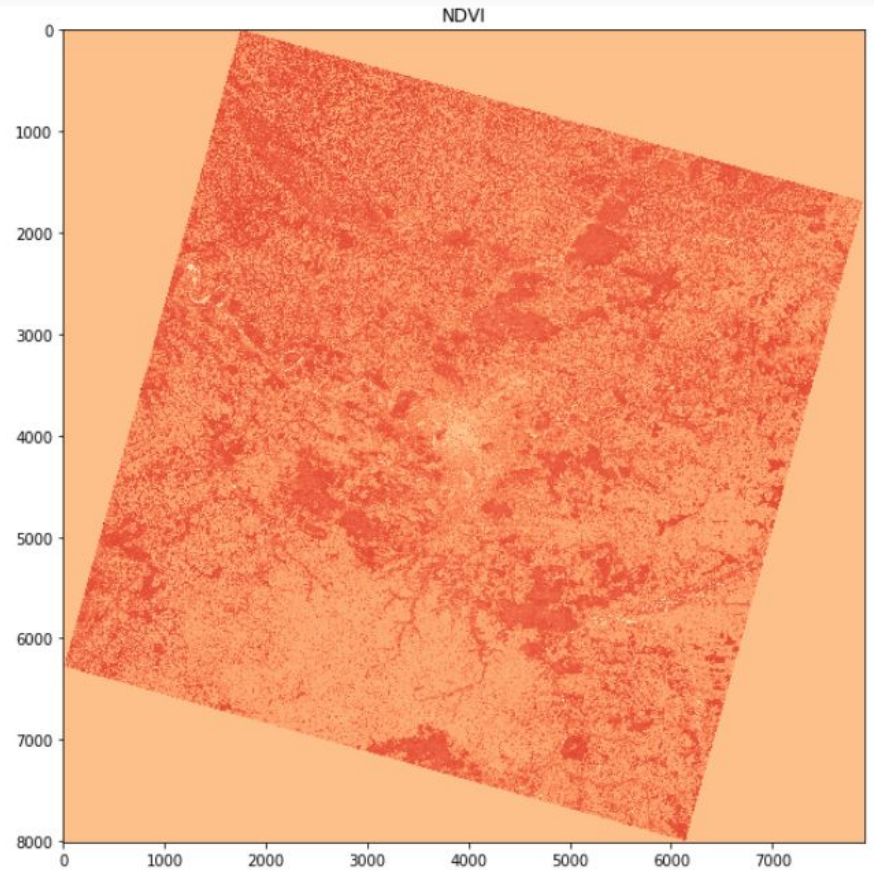
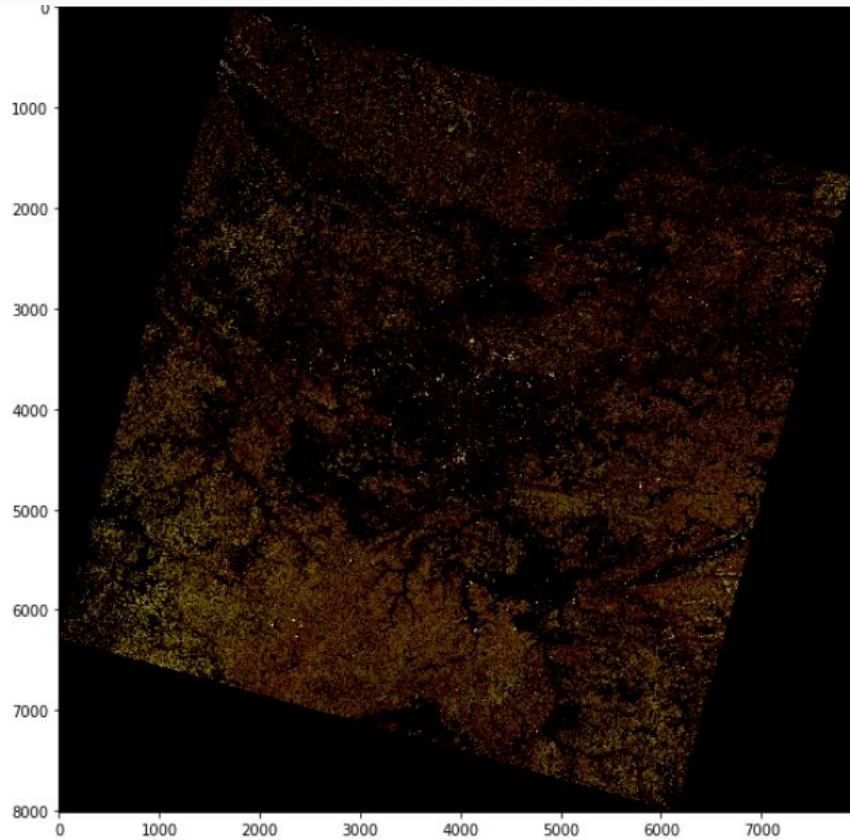


Enhanced image



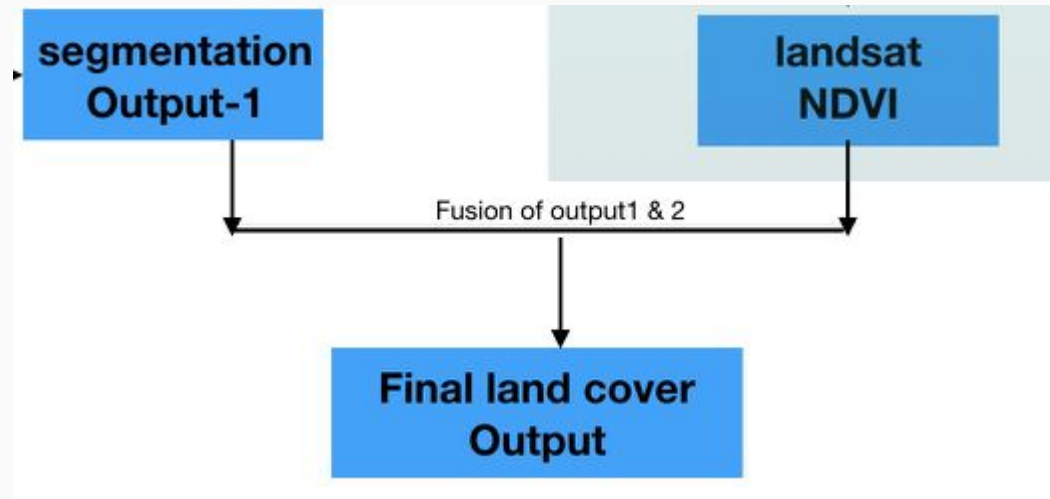
Landsat NDVi

ndvi

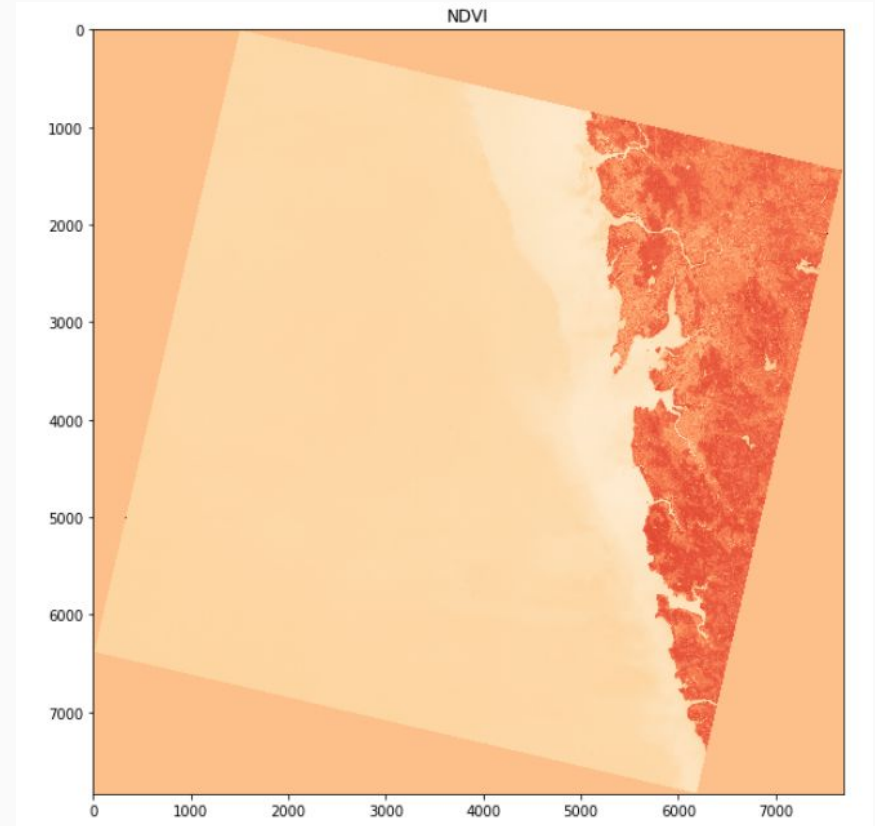
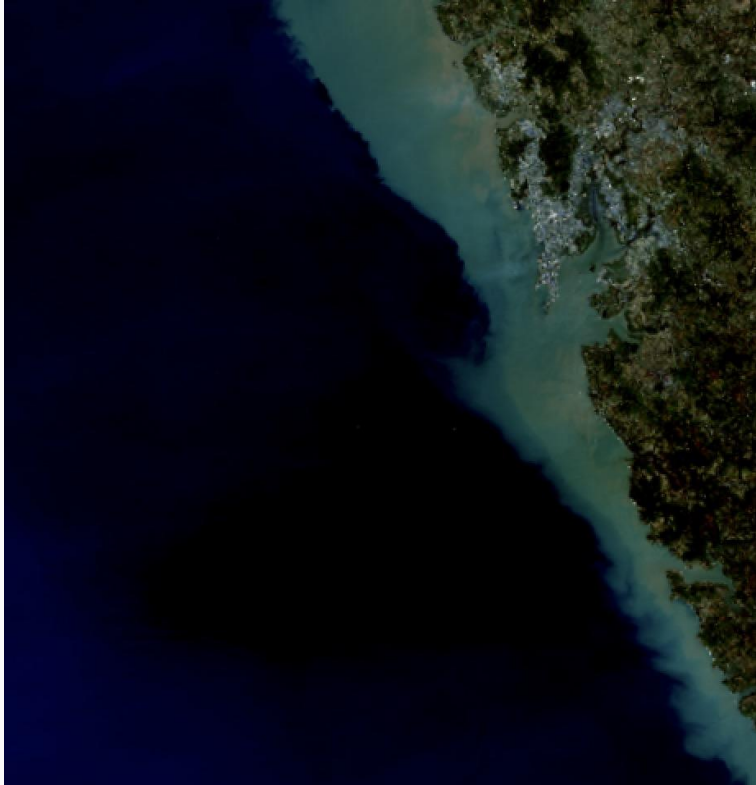


Final Classification

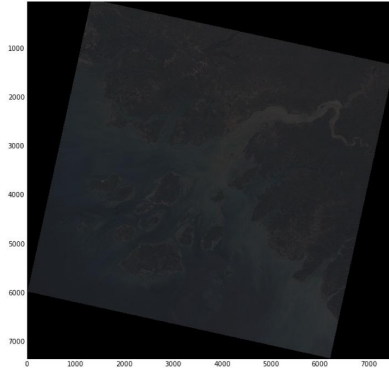
The segmented image is checked with the Landsat NDVI to get an accurate classification.



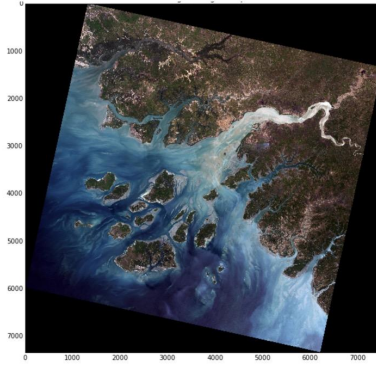
ndvi



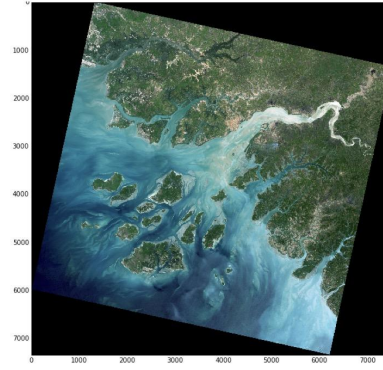
Results



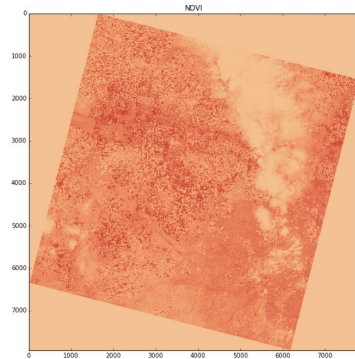
Input



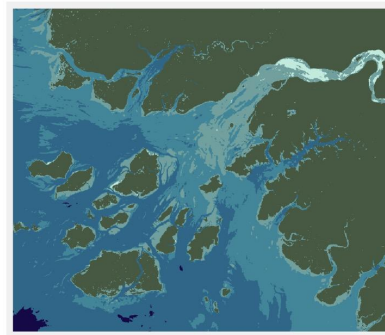
histogram equalised



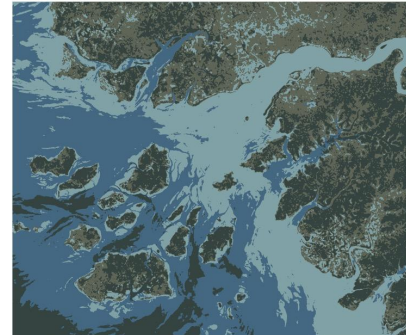
histogram equalised and
colour gamma adjusted



NDVI

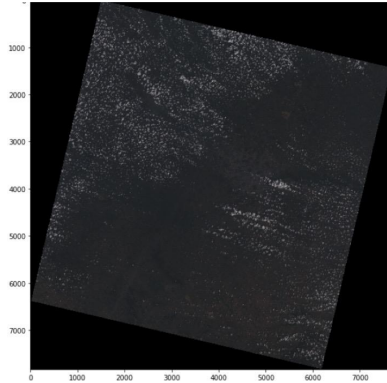


Output from
section 1

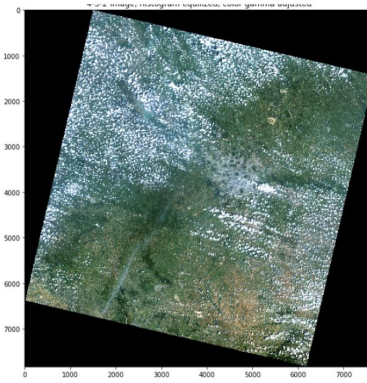


Final output

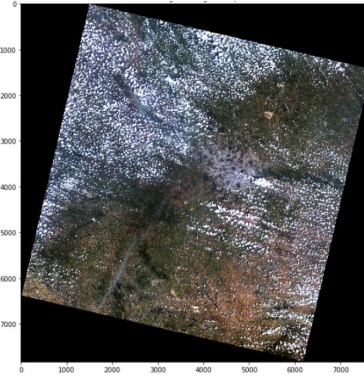
Results



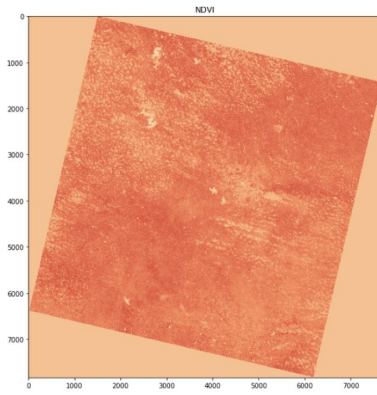
Input



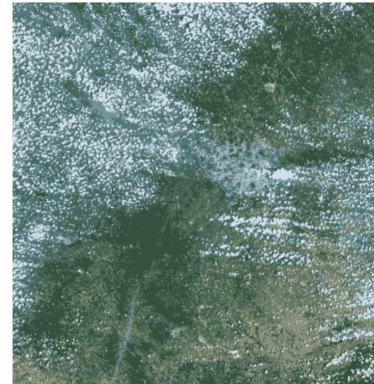
histogram equalised



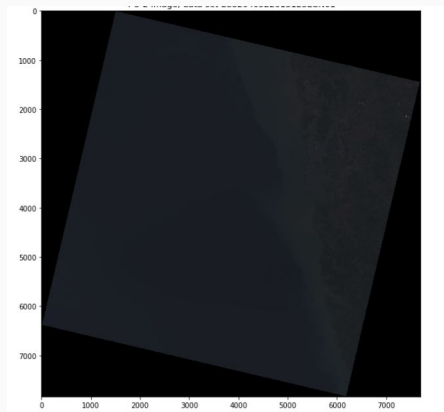
histogram equalised and
colour gamma adjusted



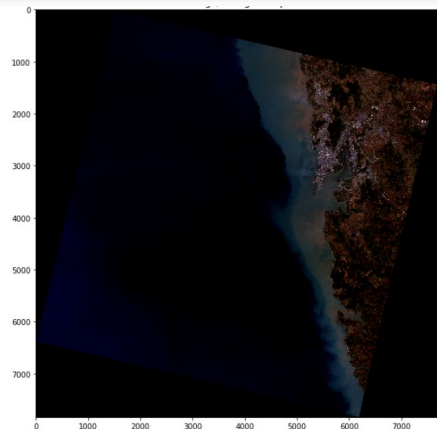
NDVI



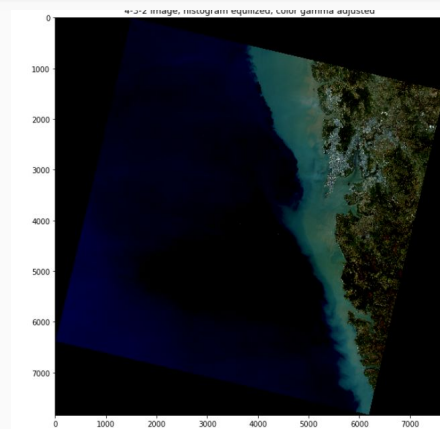
Final output



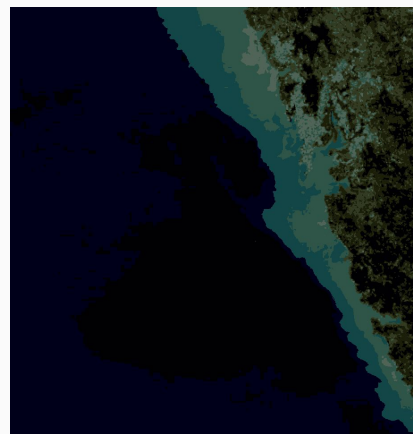
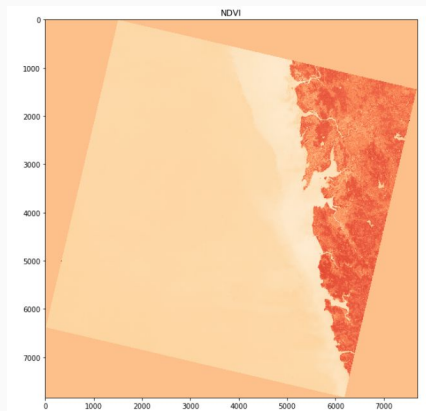
input



Hist equalised

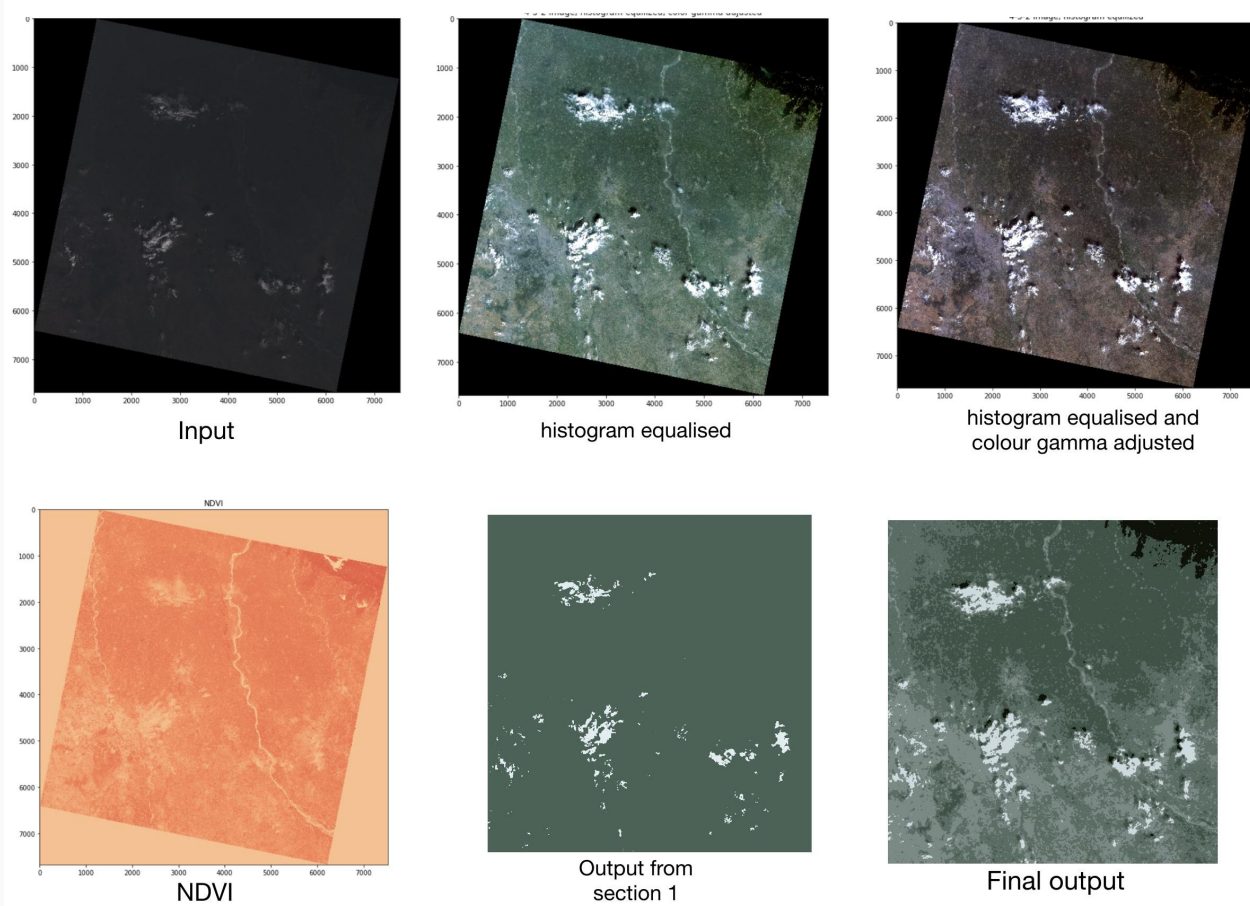


Gamma corrected



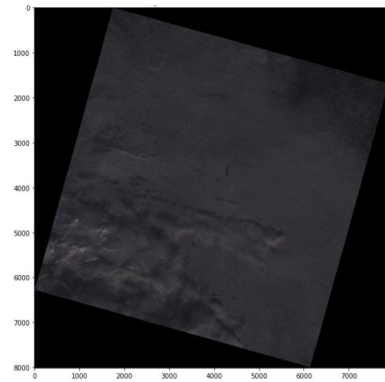
Final output

Results

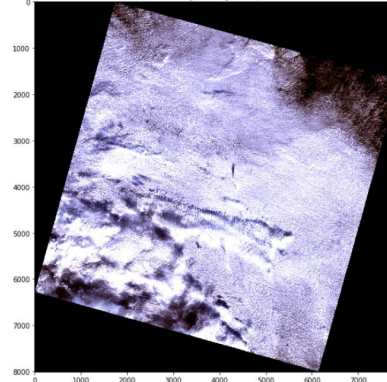


Failure case:

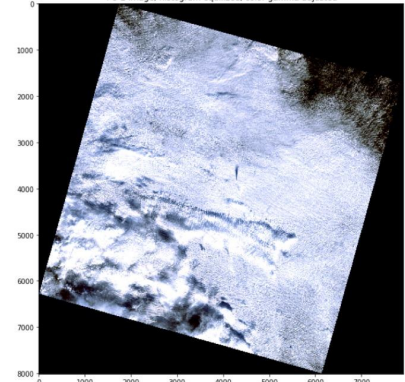
This method fails when there is large extent of cloud cover and the ground is blocked.



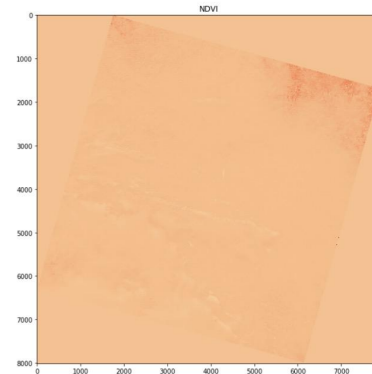
Input



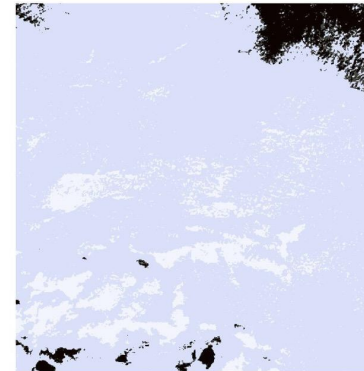
histogram equalised



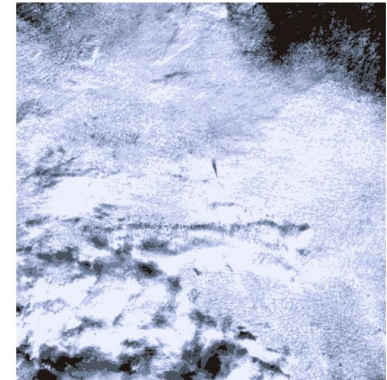
histogram equalised and
colour gamma adjusted



NDVI



Output from
section 1



Final output

Limitations:

- Choosing the right format of the satellite image datasets (landsat, Worldview, Sentinel, IKONOS ,Quikbird etc)
- But only a few of them are publicly available for free with limited content.
- Each Satellite image has a very large resolution and have many bands. These images are very large (approx. 800-900 MB for each image). Working on them is computationally very hard to run image processing algorithms on them.
- Calculation of NDVI
- Atmospheric composition and appropriate modeling influence the calculation
- Sensor effects such as Sun angle not being calculated on per-pixel basis can influence the index estimation.

Thanks!

