

Histogram Equalization

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Learning Outcomes

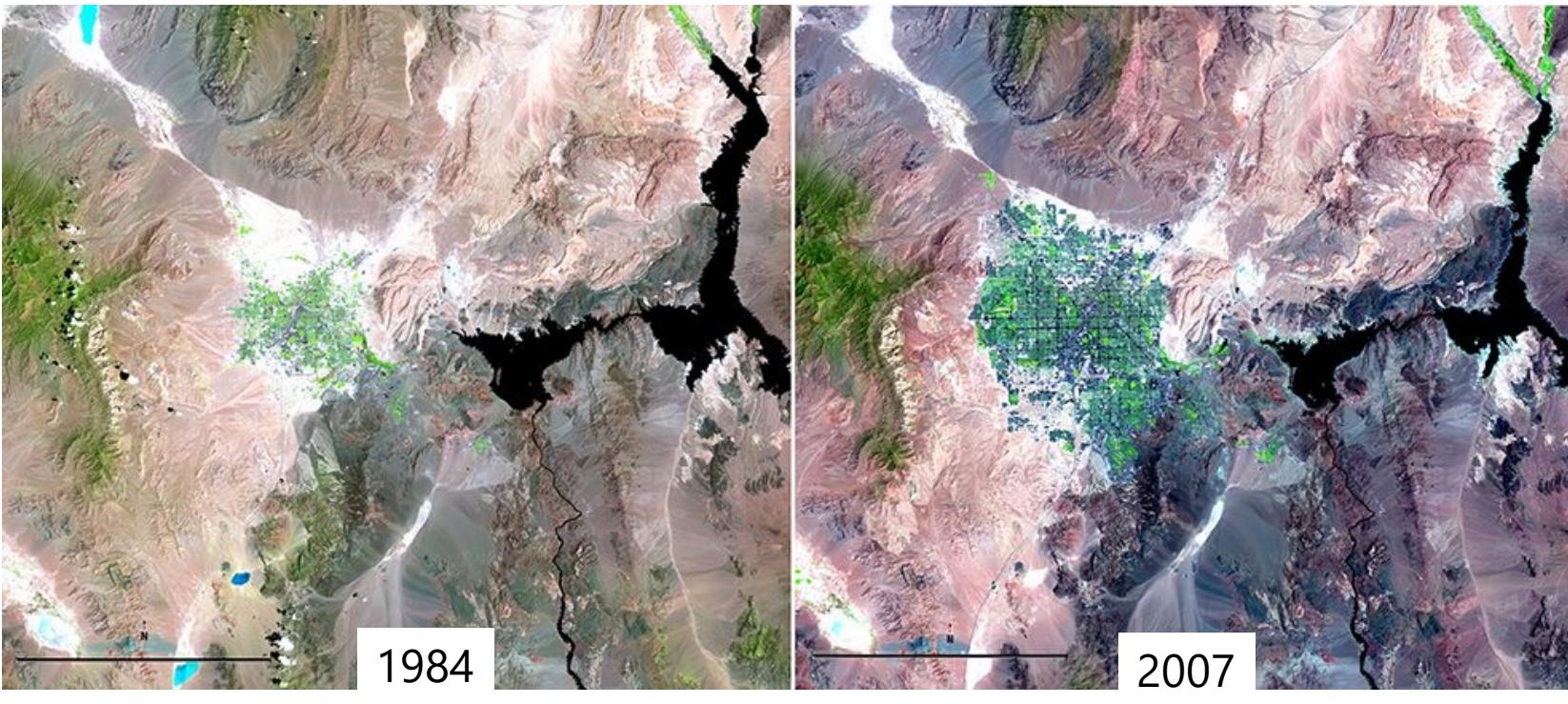
- Students will be able to compare histograms for earth science images.
- Students will be able to discuss the shapes of image histograms and how they relate to image quality.
- Students will be able to discuss the value of histogram equalization.

Outline

- Images in earth science
- What is an image histogram?
- Shapes of histograms
- Issues with image contrast
- Histogram equalization

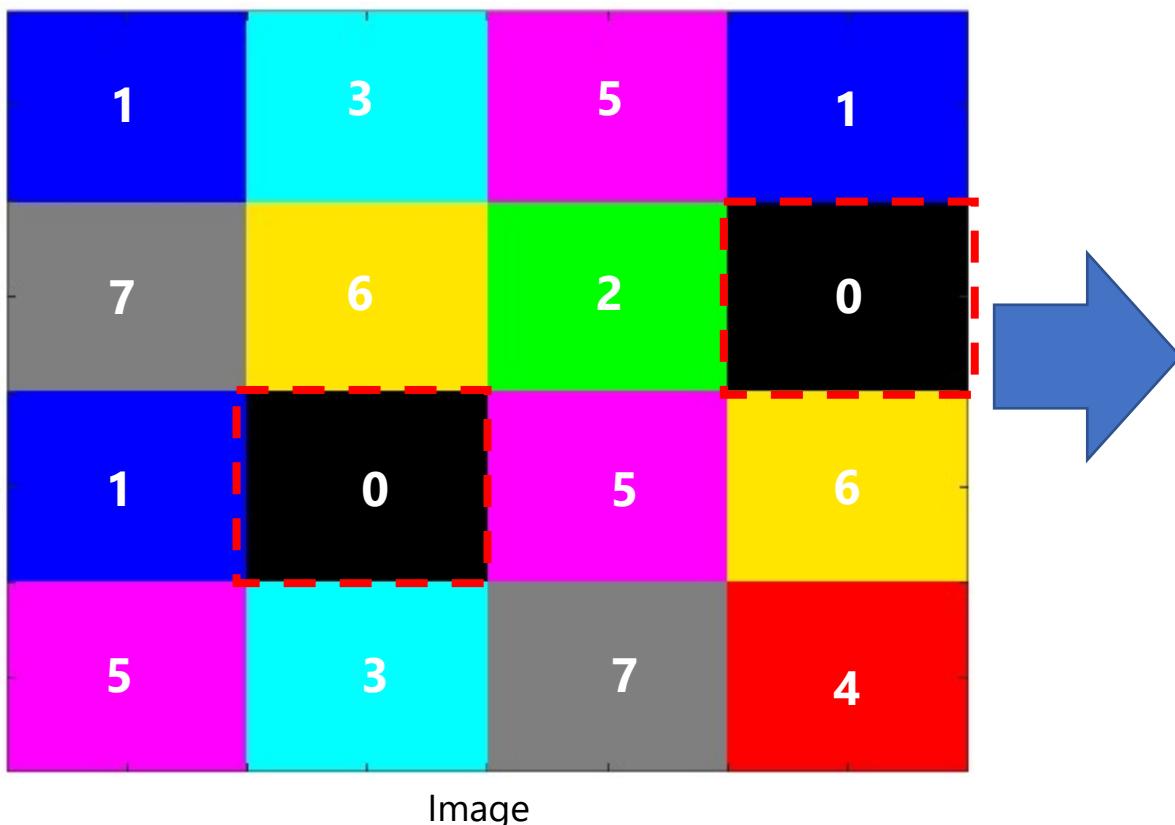
Images in Earth Science

- Images play an important role in earth science
- Many sources

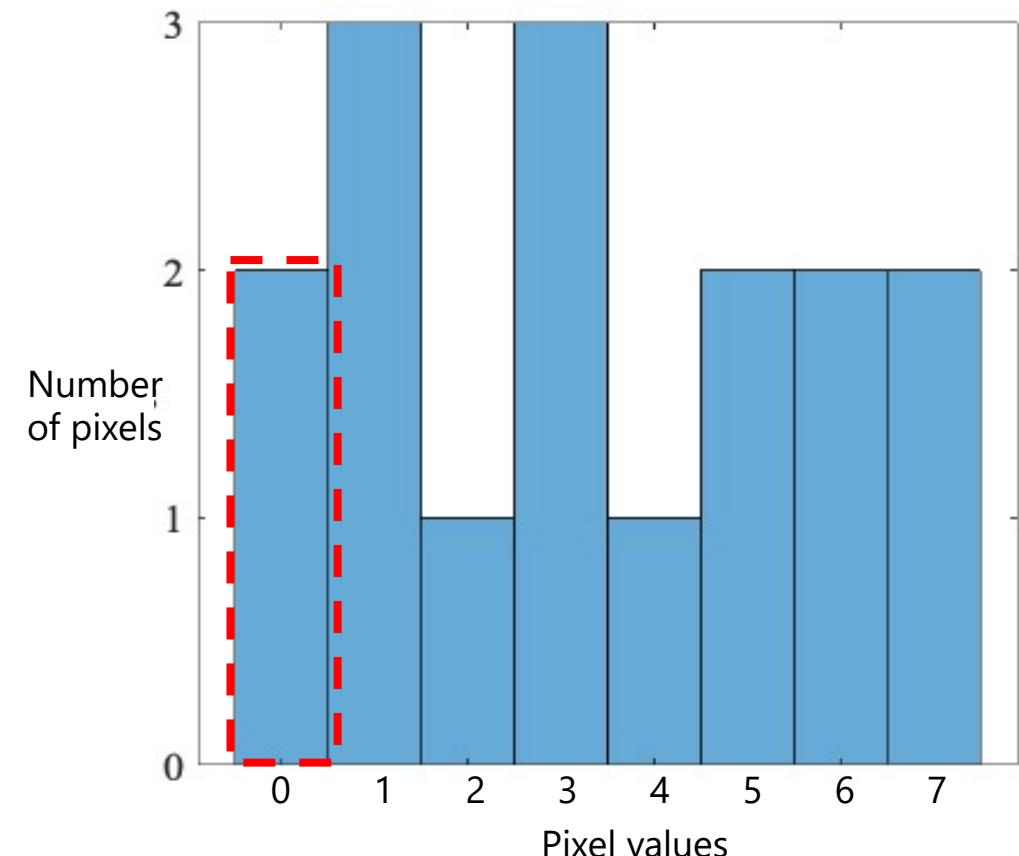


What is a Histogram?

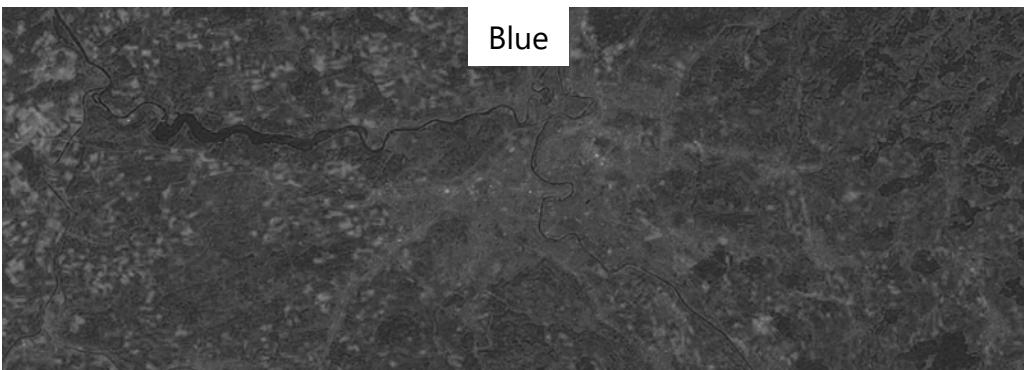
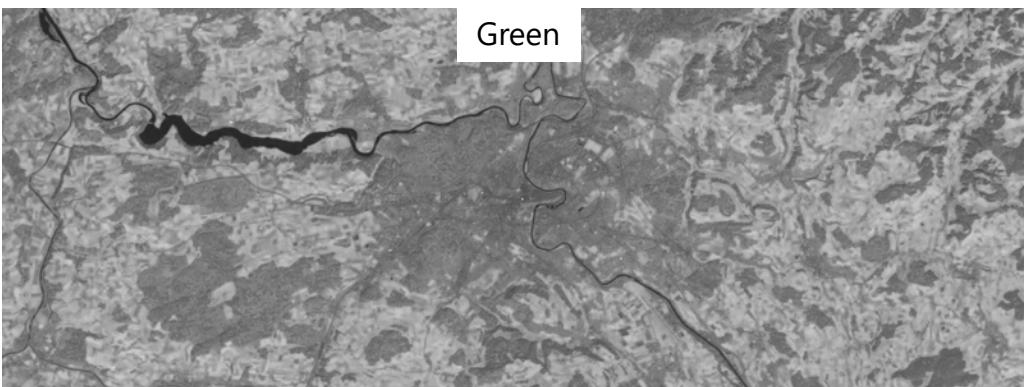
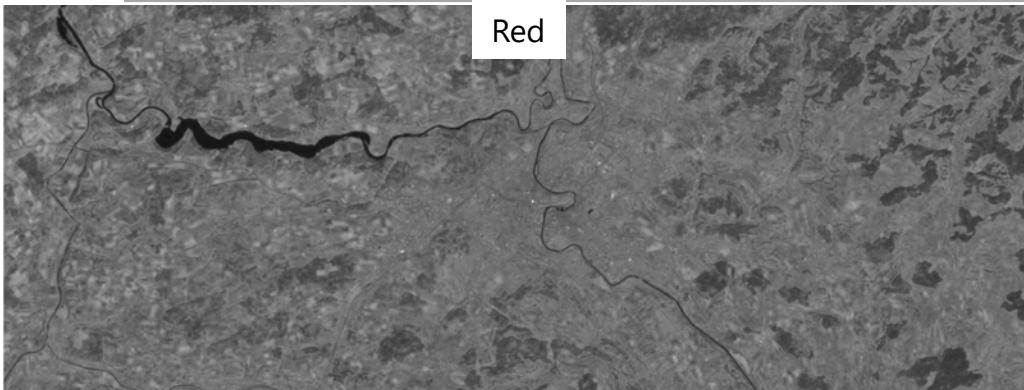
- A function that maps pixel values in an image to their frequencies



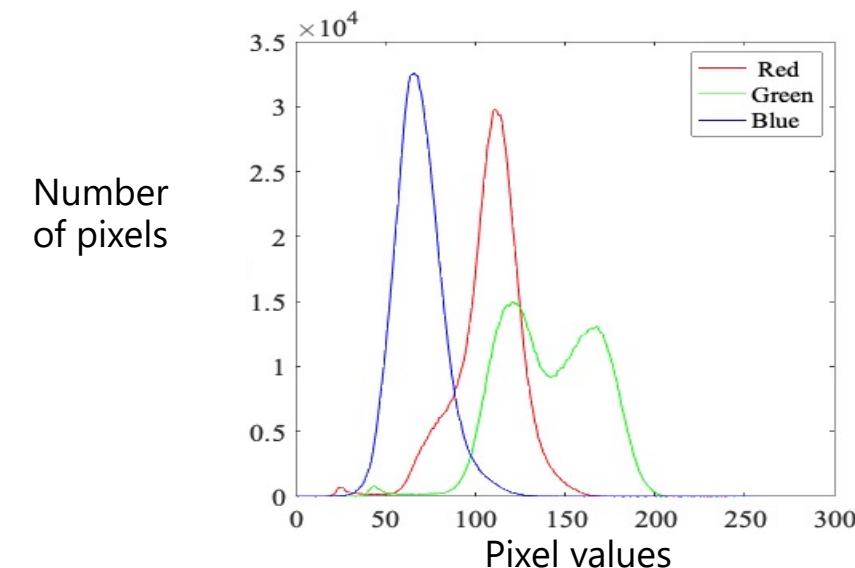
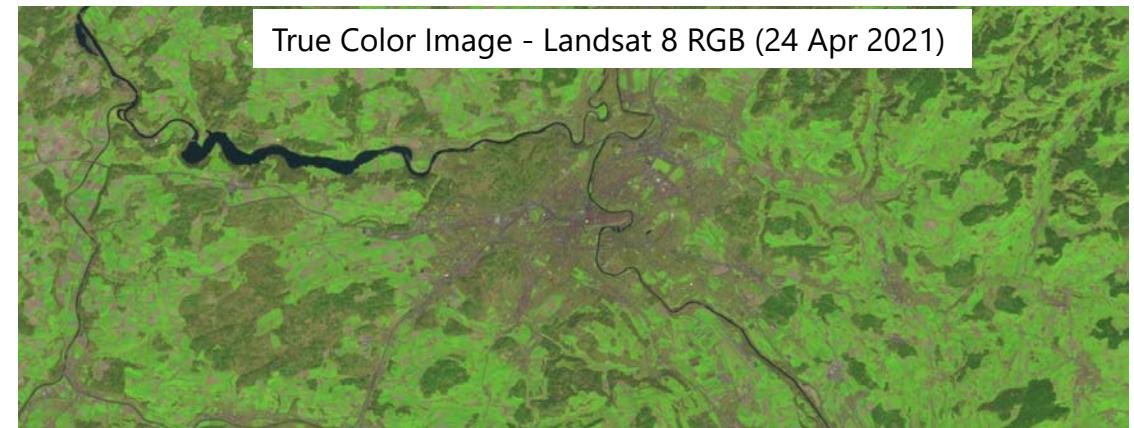
Number of pixels with value 0 is 2



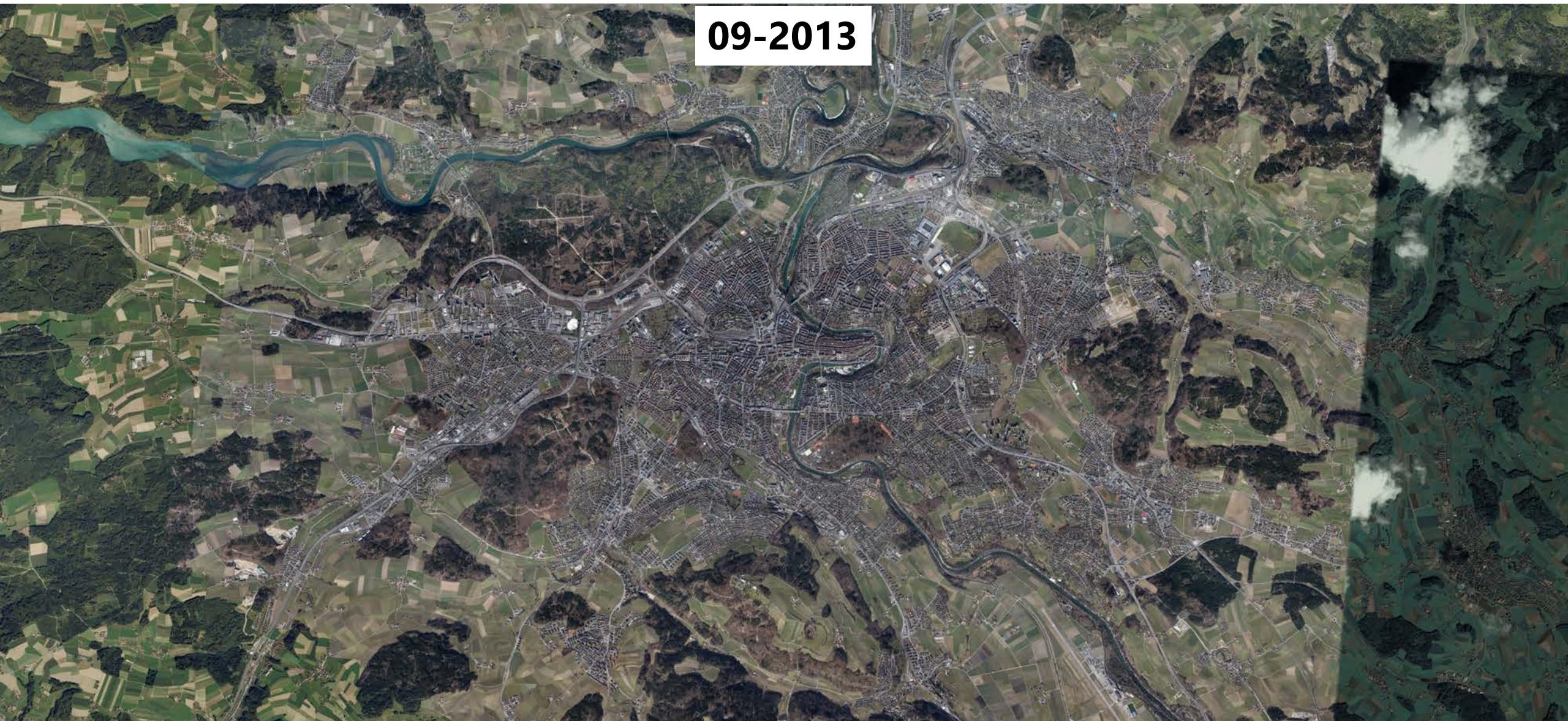
Shapes of Histograms



Contrast is the difference in visual properties that makes an object distinguishable from other objects and the background.

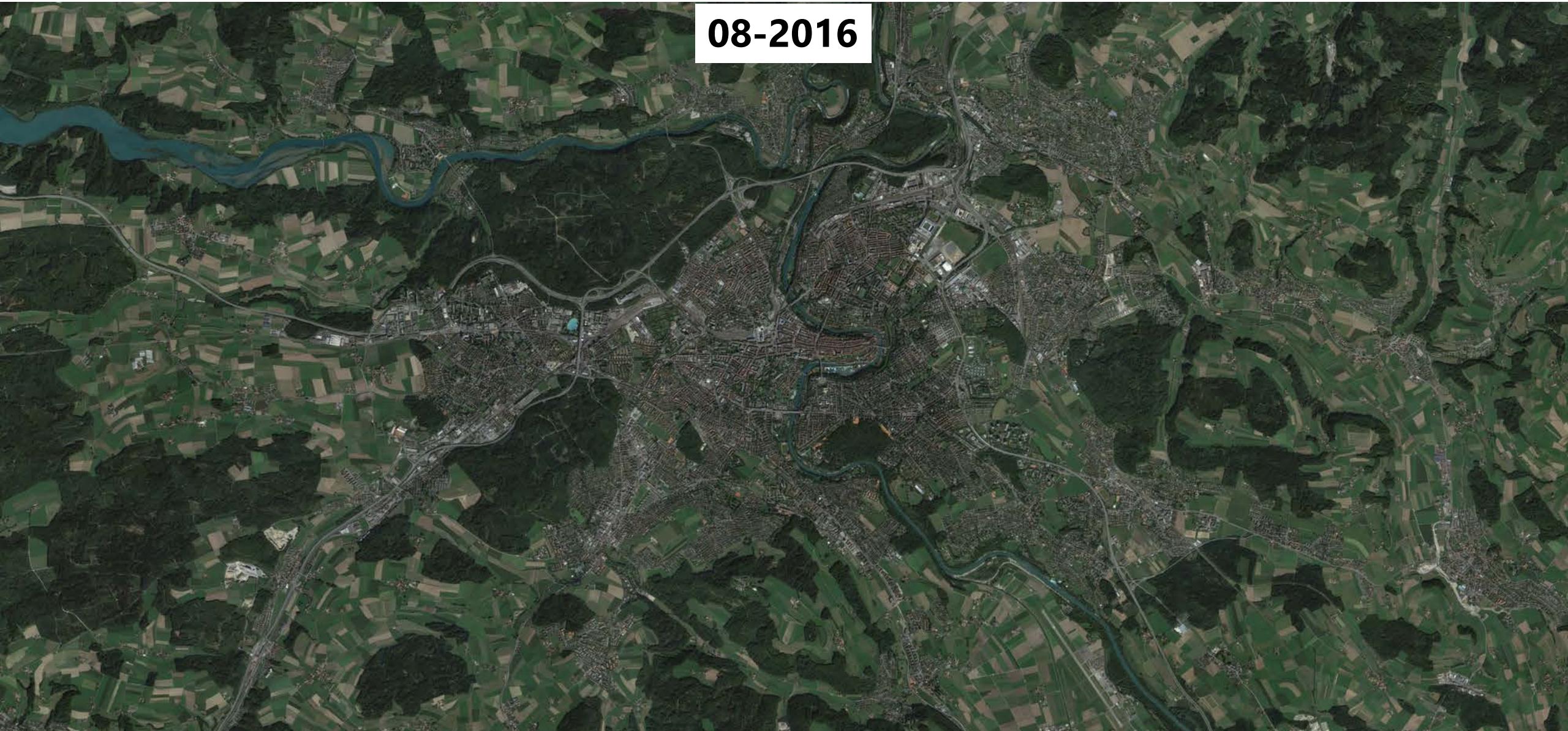


Contrast Issues with Images



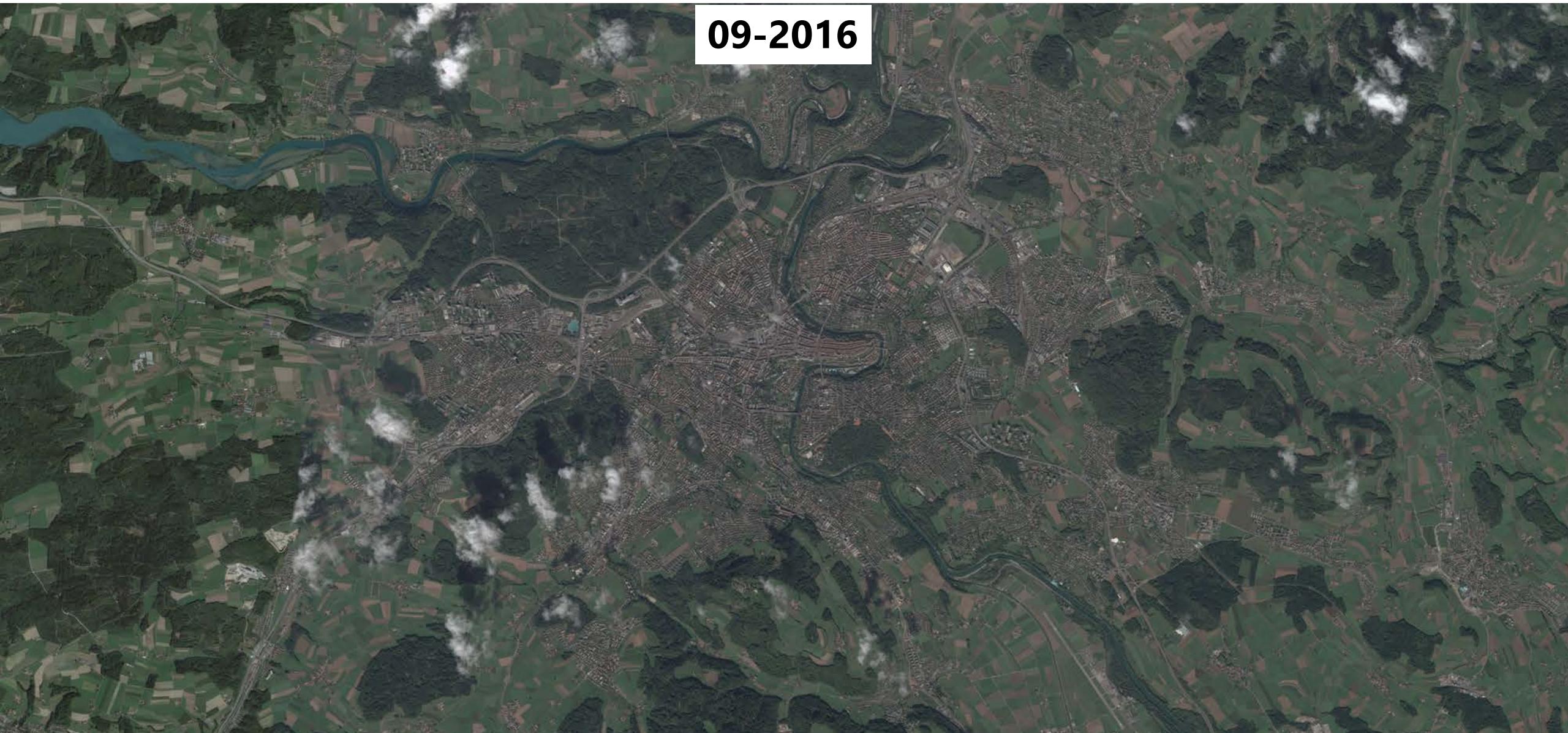
Contrast Issues with Images

08-2016



Contrast Issues with Images

09-2016

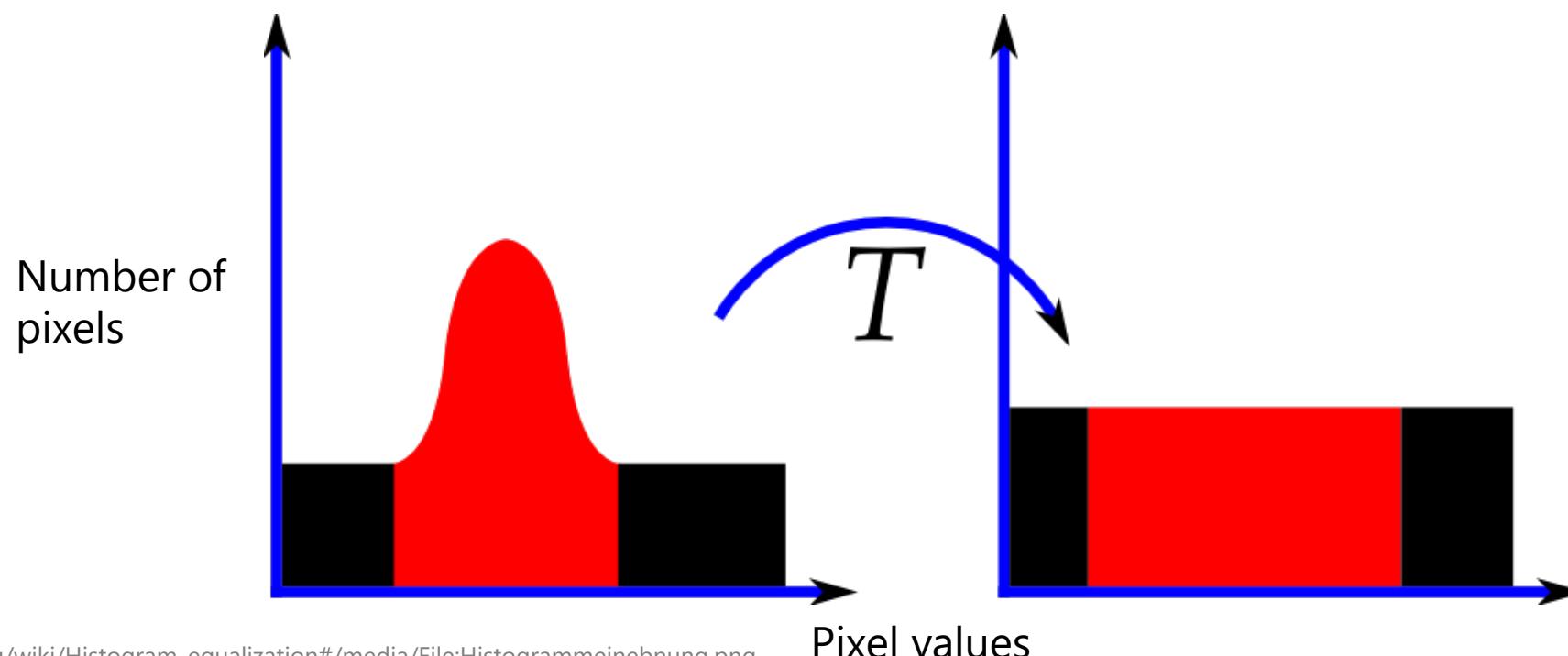


Causes of Contrast Changes

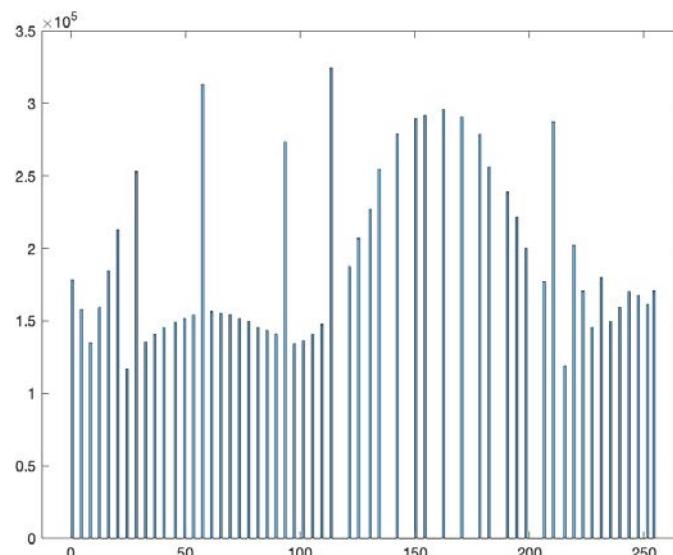
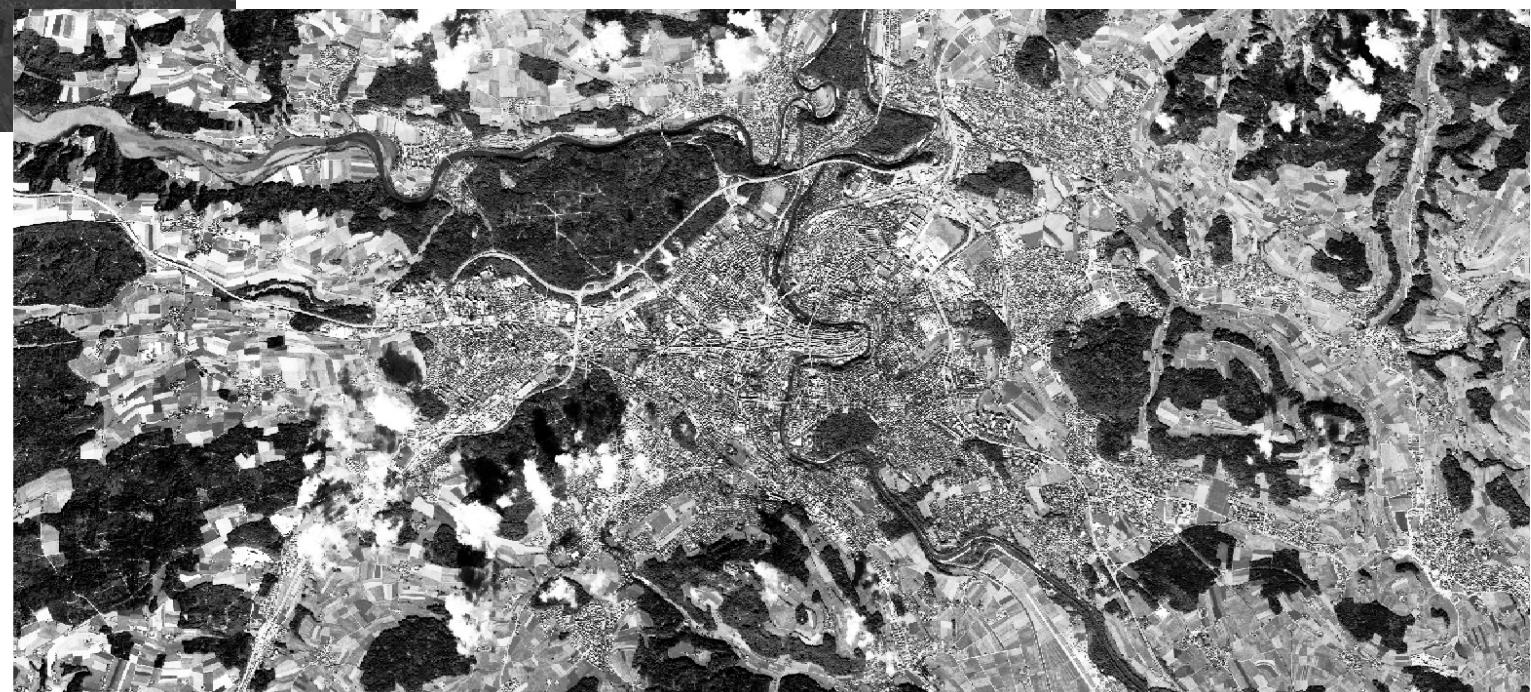
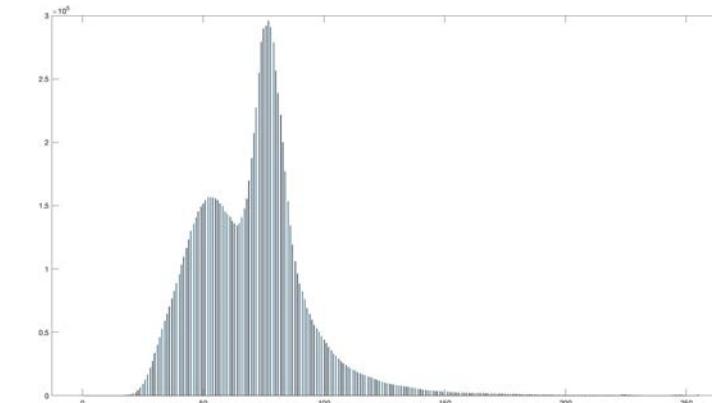
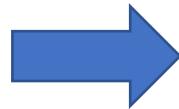
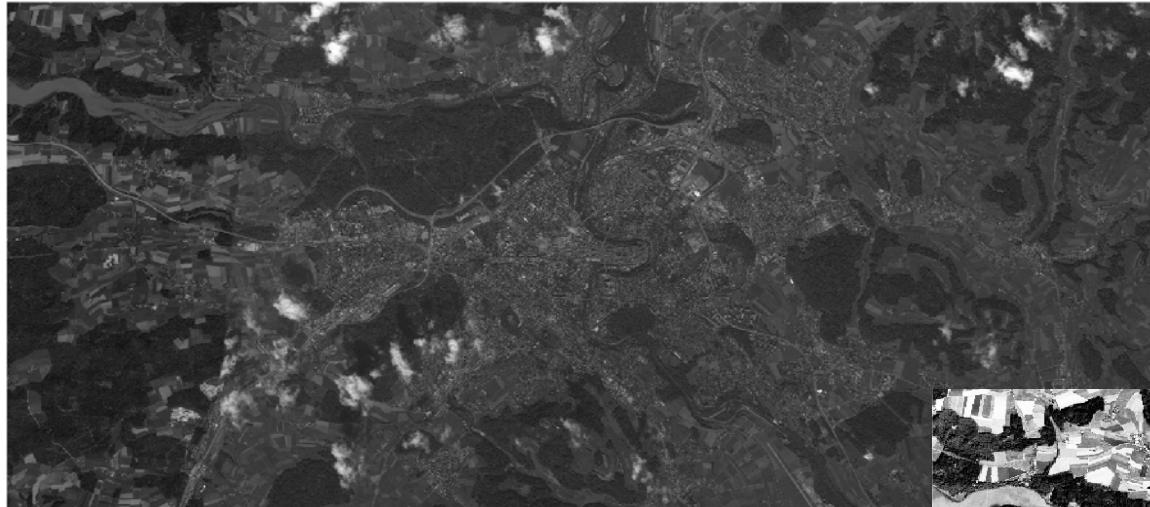
- Issues with the sensor
- Different sensors
- Different collection times
- Different collection angles
- Image infilling due to clouds

Histogram Equalization

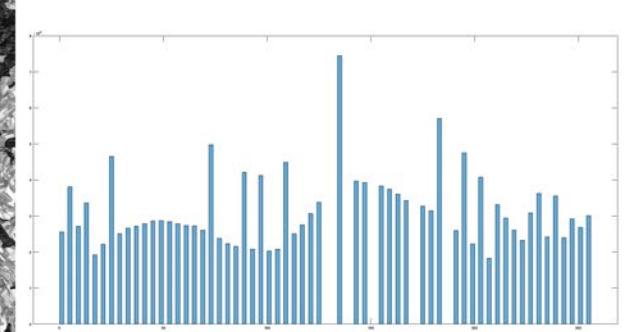
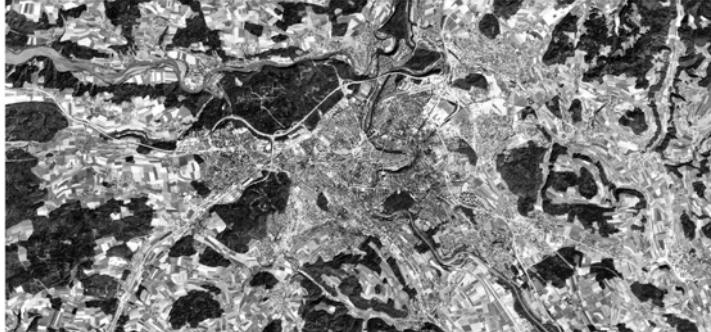
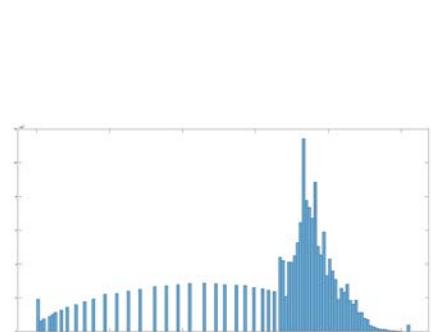
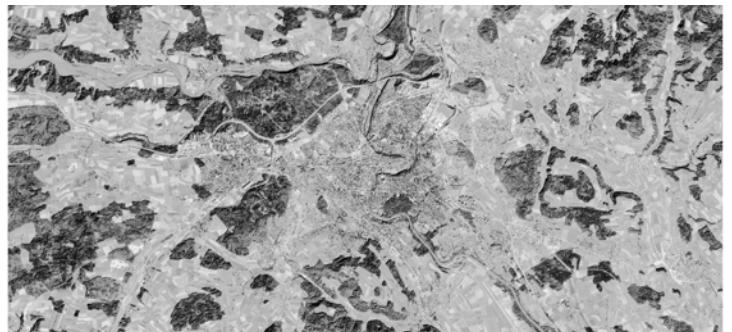
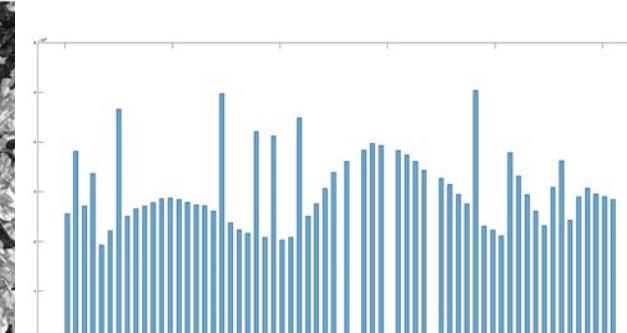
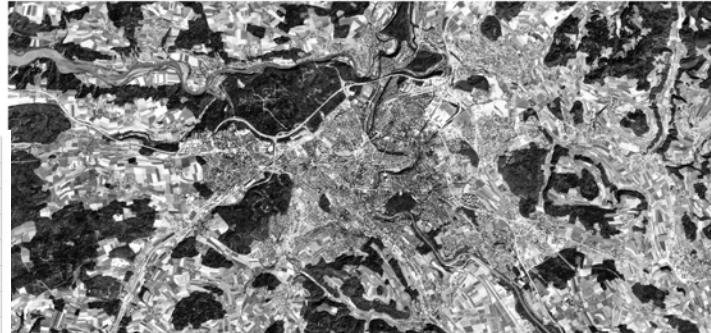
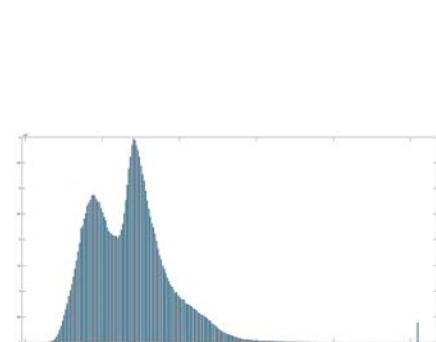
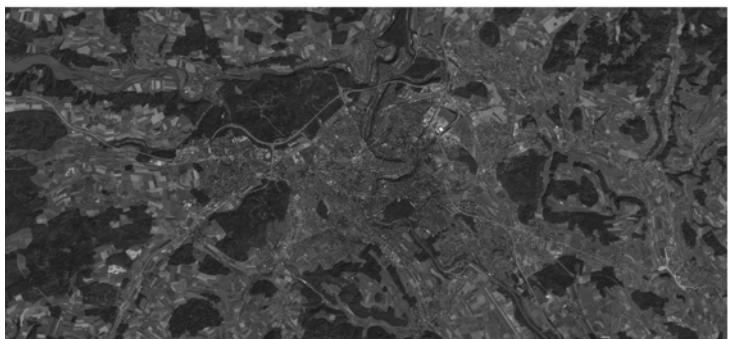
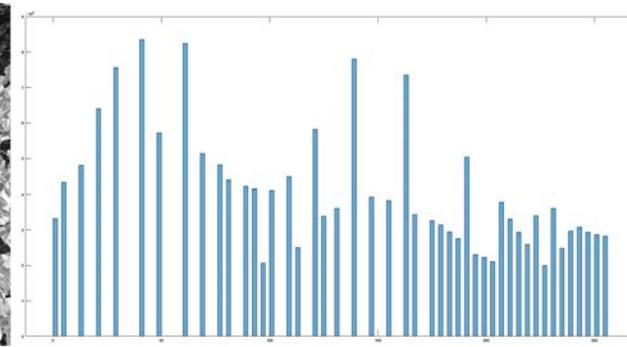
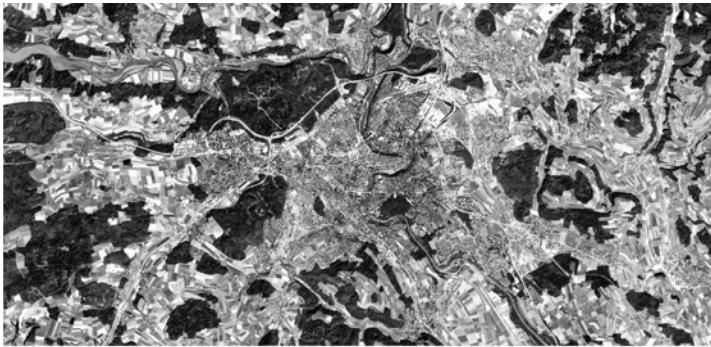
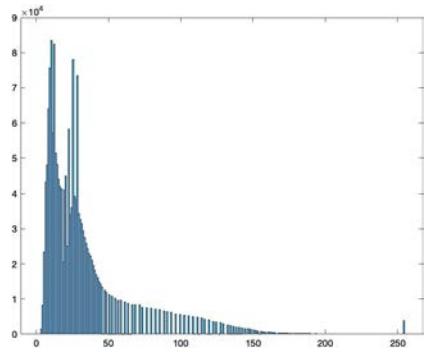
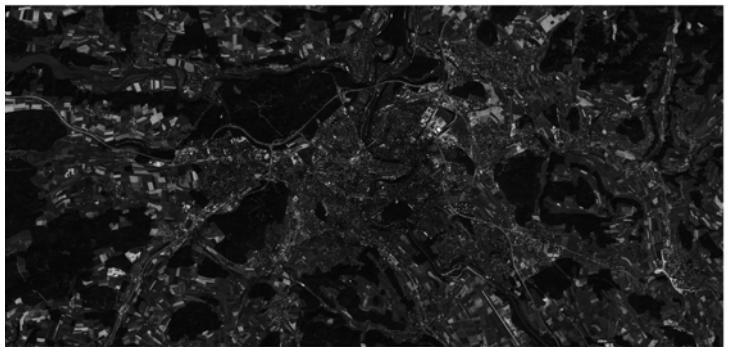
- A form of contrast enhancement.
- Spreads out the most frequent pixel intensity values or stretches out.



Histogram Equalization Examples



Histogram Equalization Examples



Summary

- Histograms provide important information about the quality of an image.
- We can apply histogram equalization to correct poor image contrast.
- Can be done automatically, and at scale.

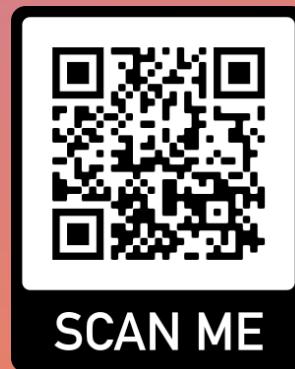
Thank you

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Histogram Equalization – Tutorial

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Histogram Equalization

Welcome, and thank you for being interesting in this learning module. Today we'll delve very briefly in to histogram equalization, we'll understand what it is and why it is importance in earth sciences. This module will present information at a very high level, and will not get into any technical aspects of the process of histogram equalization. For readers that would like a bit more depth into the process of histogram equalization, see below for a few references.

Learning Outcomes

- Students will be able to compare histograms for earth science images.
- Students will be able to discuss the shapes of image histograms and how they relate to image quality.
- Students will be able to discuss the value of histogram equalization.

NOTE: Additional code

- Some additional code is included in this notebook. The can be found between the "%%" symbols
- You do not need these blocks of code, there are only provided for advanced users who want some additional flexibility with understanding histograms and the histogram equalization process.

There is some advanced code in this notebook that can be found

Images in Earth Science

- Images play an important role in earth science
- Many sources (e.g., satellites, drones)

Creating and displaying a sample image

In MATLAB, a digital image is represented as an array of pixel values. Let's first start by creating a sample image in MATLAB and displaying it. Our sample image will have a bit depth of 3, which means that each pixel in this image can be assigned to one of eight unique values (i.e., 2 raised to the power of 3). Most digital images have a bit depth of 8, meaning that each pixel can be assigned to one of 128 unique pixel values (i.e., 2 raised to the power of 8). In our case, we'll keep it simple for now.

```
% Clears the Command Window and removes all variables from the Workspace
% Window.
clear;clc

% Create a sample digital image as an array of pixels. The pixels used here
% are arbitrarily chosen.
A = [1 3 5 1;
      7 6 2 0;
      1 0 5 6;
      3 3 7 4];

% Display smallest and largest pixel values
smallest = min(min(A)); % Smallest value
largest = max(max(A)); % Largest value
fprintf('The smallest pixel value is %d and the largest pixel value is %d',smallest, largest)

% Define a color palette to display pixel values in color
mycolorpalette = [0 0 0;           % Black color for pixels with value 0
                  0 0 1];         % Blue color for pixels with value 1
```

