Lake Eerie Image Enhancements Using Focus

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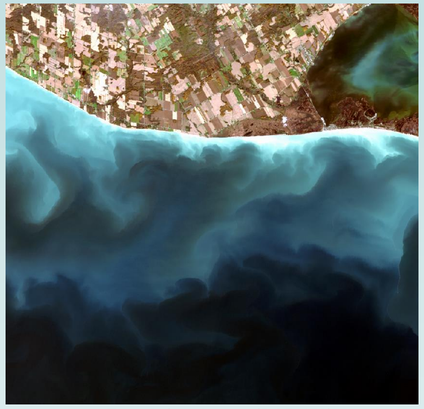
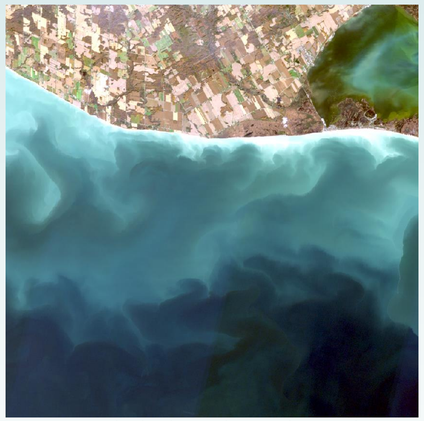
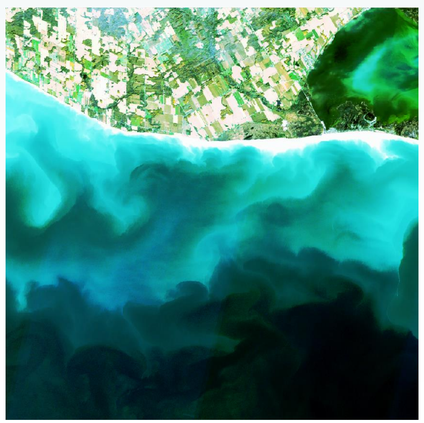


True Colour Image (RGB 432)



Standard Enhanced Image (RGB 431)



Custom Enhanced Image (RGB 431)

Introduction

The purpose of this project is to perform image enhancements to Landsat imagery depicting Lake Eerie in an effort to strengthen the interpretation of sediment load in the lake water. The results will be compared between a true colour non-enhanced image, a standard enhanced image using default enhancement tools within Focus, and a custom enhanced image created using lookup tables within Focus.

The study area of this project is a 30 kilometer squared area of the north shore of Lake Eerie located in Norfolk County, Ontario, Canada (Figure 1). Lake Eerie is one of the five Great Lakes, being the shallowest and smallest by volume. It is also home to a third of the total Great Lakes Basin population. It's small volume along with effects from urban and agricultural runoff, has exposed the lake to immense sediment loading.

Methodology

The collection 2 level 1 Landsat 8 data set used was acquired from USGS Earth Explorer and loaded into Catalyst's Focus window.

Atmospheric correction was applied to the raster file using ATCOR ground reflectance workflow to remove atmospheric effects in the satellite imagery before enhancement is applied. Digital number values are now presentative of ground reflectance values as opposed to at-sensor radiance.

The image was then clipped to a 30 km2 area. For the true colour image, no enhancements were made and a 432 band combination was used. For both the standard and custom enhanced images, the image was spectrally filtered to only utilize bands 4 (Red), 3 (Green), and 1 (Coastal Aerosol). This band combination is useful for estimating suspended sediment in water.

The standard image enhancement was created by taking the resulting image and applying a standard root contrast stretch to enhance the lower portion of the DN histogram to emphasize features within the water. Contrast and brightness was also adjusted.

The first step to producing the custom enhanced image was creating a bitmap covering the lake portion of the image. The bitmap was applied to each band's lookup table as a type of piece-wise stretch to explore subtle differences in the area of interest. This restricted the enhancements to a specific range of DNs for better radiometric detail. The goal behind this enhancement is to create an image similar to true colour, but to enhance variability within the green and blue (coastal aerosol) bands. Because of the use of a bitmap, instead of enhancing the lower portion the histogram, we can now enhance variation within the entire histogram using an equalization stretch. This stretch was applied to both the green and blue band. Because of its inherent ability to identify sediment, it was important for the blue band to be as intensified as possible. Due to the prominent double peaks in its histogram (Figure 2), a closer look at the differences within the green band was preferable. For the red band, a linear stretch was applied to slightly enhance the band, but keep the focus on green and blue.

Results

Comparing the 3 images of Lake Eerie, the custom enhanced image gave the best results in terms of interpretive detail of sediment load. By use of the equalization contrast stretch, variation within the most frequently occurring digital numbers were intensified. This brought out subtle differences in the green and coastal aerosol bands which is evident in the stronger colour gradients and dramatized wave patterns. In the original true colour image, sediment is evident, but the detail is mostly contained to those areas close in proximity to the shore, whereas the new custom enhanced image has increased the area of detail southward.

Using the coastal aerosol band instead of blue also made for better sediment interpretation. This band's main use is imaging shallow water and tracking fine particles, which suits the area of interest excellently. Although technically not in our area of interest, the effects of this enhancement are also seen in the amplified algal blooms in the harbour located in the top right of the image.

Between the use of the coastal aerosol bands combined with the use of a bitmap and equalization stretch, the blue and green tones in the image were greatly enhanced and patterns were delineated.

The standard enhanced image brought out some detail not otherwise evident in the original image. It seemed to have stretched out the colours in the water with lighter blue colours spanning more area, but in the process decreased variation of colour within water. Therefore, this process brought out more sediment presence in the water but decreased the differentiation between the sediment loads. With the custom enhancements, the image was successfully stretched to show more sediment, but was also able to retain the details in differentiation.

Figure 1: Context map of area of interest

Discussion

Custom enhancements yield better results for visual analysis of specific features of a study area. Standard enhancements are better in terms of efficiency and overall enhancement of entire image. Standard enhancements may be helpful as a starting point to enhance features in imagery that the analyst may not initially detect. Using the results of this standard enhancement, the analyst may then want to further investigate those features and possibly create custom look up tables to further enhance those features .

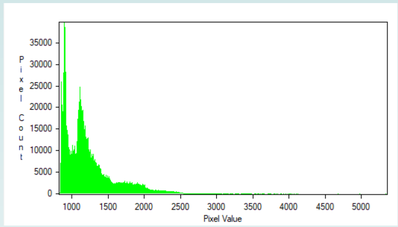


Figure 2: Digital number histogram of green band (before enhancement)

Acknowledgements

Landsat Imagery Source: USGS Earth Explorer
Universal Web Mercator Zone 17 Northern Hemisphere
World Geodetic System 1984
Landsat 8, collection 2, level 1, path 018, row 30, acquired November 10 2021

References:

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