Remote Sensing Analysis Reports

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Assignment 1: Analysis of Landsat Thermal Imagery

Introduction

This report presents an analysis of a Landsat thermal image captured on May 25, 2023. The primary focus is on the surface temperature variations across different land use/land cover types, as well as the interpretation of thermal data obtained from the imagery. The Landsat 8 satellite's thermal infrared data is particularly useful for understanding surface temperature distribution, which can be influenced by factors such as time of day, thermal capacity, and thermal inertia of various materials.

Landsat Thermal Band Analysis

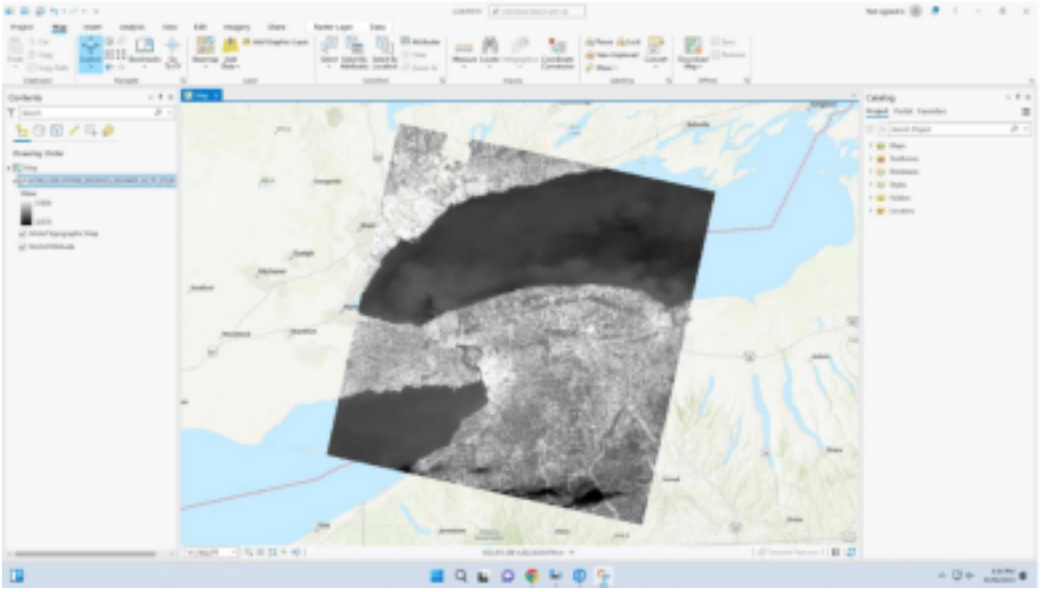
The thermal band used for this analysis was extracted from the file named LC09 L2SP 017030 20230525 20230601 02 T1 ST B10.TIF. This file repre sents the thermal data captured by the Landsat 8 satellite. To convert the pixel values in this thermal band to Celsius, the following equation was used:

$$\text{Temperature (Celsius)} = \text{BandName} \times X + Y - Z$$

Where the constants X, Y , and Z are:

- $X = 0.00341802$
- $Y = 149$
- $Z = 273.15$

These constants were derived from the metadata accompanying the image file, which provided the necessary calibration parameters.



LC09 L2SP 017030 20230525 20230601 02 T1 ST B10.TIF

Image Timing and Orbit Characteristics

The image was captured at 15:57:05.5146919Z, which translates to 10:57 AM local time in Mississauga. Landsat 8 follows a sun-synchronous orbit, ensuring that it crosses the equator at approximately 10:00 AM local time each day. This orbit allows for consistent daytime imagery across the globe, which is crucial for maintaining uniformity in the thermal data captured.

Surface Temperature Statistics

The statistical analysis of the image revealed the following surface tempera ture values:

- Minimum Temperature: -12.725°C
- Maximum Temperature: 53.368°C
- Mean Temperature: 15.81°C
- Standard Deviation: 6.926

The location of the image corresponds to Mississauga, and the data is consistent with the expected temperature range for this region and time of year.

Land Cover Type Analysis

Surface temperature values were recorded for six land use/land cover types: water, forest, urban, suburban, agriculture with crops, and fallow agriculture. The median pixel values for each type were as follows:

- Water: 11.4806°C
- Forest: 13.3786°C

- Urban: 35.2304°C
- Suburban: 27.2136°C
- Agriculture with Crops: 18.4168°C
- Fallow Agriculture: 26.5264°C

These values align with the expected thermal characteristics of these land cover types. For example, water bodies, due to their high thermal capacity and inertia, exhibit relatively stable temperatures, while urban areas, char acterized by low thermal inertia, show higher temperatures.

Thermal Capacity and Inertia

Thermal capacity refers to the amount of heat an object can hold, while thermal inertia describes how quickly an object changes temperature. In this study, water bodies displayed high thermal inertia, leading to stable temperatures throughout the day, whereas urban areas, with low thermal inertia, exhibited significant temperature fluctuations.

Expected Nighttime Temperature Changes

If another image were taken 12 hours later at 10:57 PM, it is anticipated that urban areas would cool down significantly due to their low thermal capacity and inertia. Conversely, water bodies would retain more heat, resulting in a more gradual temperature decrease.

Thermal Infrared Bands and Other Sensors

Landsat 8's thermal infrared data is collected using two bands that operate within the 10.6-12.51 μm range, optimizing the capture of thermal radia tion. Other remote sensors such as ASTER and MODIS also collect thermal infrared data, with different wavelength regions and spatial resolutions.

Source of Thermal Radiation

The thermal radiation detected by Landsat 8 originates from the Earth's surface, which emits long-wavelength radiation due to its temperature. This data is crucial for understanding surface temperature distribution and its implications for various land cover types.

Spatial Resolution Considerations

The lower spatial resolution of Landsat 8's thermal bands (100m) compared to other bands (30m) is due to the lower energy emitted by the Earth's sur face. Larger pixel sizes are necessary to capture enough radiation, resulting in reduced spatial resolution.

Map Export and Spatial Distribution

The final thermal map of Mississauga, exported as a JPEG, highlights the spatial distribution

of surface temperatures. Urban and industrial zones are identified as the hottest areas, while water bodies, such as Lake Ontario, are the coolest.