Band Ratios & Remote Sensing Indices For Analyzing Burn Areas in Northern Ontario

Aila Jalo

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Introduction

During the summer of 2021, the province of Ontario recorded a record amount of land burnt by forest fires. Roughly 800,000 hectares of land had been burned, mostly in the northwestern parts of the province, where over 3,000 people had to be evacuated and were displaced as the fires were brought under control (Vis, 2021).

The focus of this project was to look at the burnt land in Quetico Provincial Park, which is located north of the Canada-USA border, 159 km west of Thunder Bay (Figure 1). The burned area can be seen in the true colour composite as a brown patch surrounded by healthier vegetation. This provincial park closed on August 17th due to nine fires burning within the park (CBC, 2021).

The image in Figure 1 was captured by the Landsat 8 satellite on September 22nd, 2021. There are no active fires visible in the image. This image was chosen as it had the largest visible burn scar where the scene was not covered in clouds, smoke and haze from the fires that were still burning late in the summer. An image from the summer was important so that there was still healthy vegetation remaining on the trees in the surrounding areas to be able to see the differences between healthy and unhealthy vegetation.

Band Ratios & RGB Image

Three different band ratios were used for this project. In the red channel, Band 4 was divided by Band 2. In the green channel, Band 5 was divided by Band 4. In the blue channel, Band 2 was divided by Band 4.

Red/Blue (R/B) was chosen to separate water bodies and vegetation from soil. Soil is highly reflective in the red band, and water absorbs most red light, as does healthy vegetation. Water is also more reflective in the blue band. With the R/B ratio, high values will represent brighter soils, and low values will represent water. Areas in the composite image (Figure 2) that have a high reflectance in the red band, will appear as shades of red-orange-yellow as this ratio is displayed in the red channel.

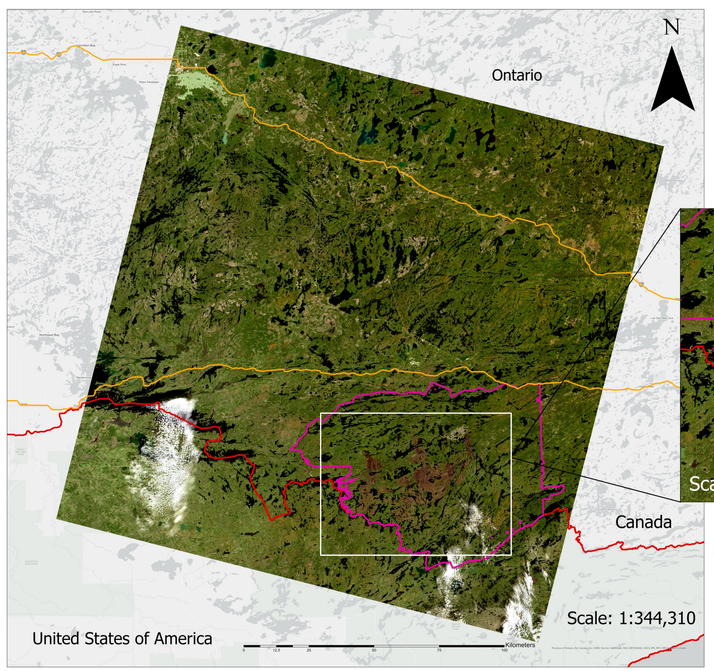


FIGURE 1: Study Area, true colour composite

Band Ratios & RGB Image (continued)

Near-infrared/Red (NIR/R) was chosen to separate healthy vegetation from soil and unhealthy vegetation. Healthy vegetation has high reflectance in the near-infrared and absorbs red light. Soil and unhealthy vegetation reflect more red light. With the NIR/R ratio, high values show healthy vegetation, while low values will show soils and unhealthy vegetation. Green areas in the composite image (Figure 2) represent a high reflectance in the NIR band due to this ratio being displayed in the green channel.

Blue/Red was chosen to for the same reasons as the R/B ratio. Healthy vegetation will not absorb as much blue light, while unhealthy/dry vegetation and water will. Soil is again highly reflective in the red band. With this ratio in the blue channel, blue areas (Figure 2) will be features with high reflectance in the blue band.

RGB is an additive colour model, therefore colours other than red, green and blue will be areas where there are higher values in more than one of the ratios. For example, the dark purple areas (Figure 2) are most likely bare soil in recently burnt areas. The soil and dry vegetation has higher values in the R/B and the B/R. Yellow areas will be places of low-vegetation, as the spectral signatures of the soil and vegetation are combined. The dull greenish-gray (Figure 2) is possibly coniferous stands, as they don't reflect as much NIR as deciduous stands. Orange is mostly red with some green added, therefore orange areas on the map are going to be features of higher reflectance in the red band with some reflectance in the NIR. This could mean that the orange spaces are areas where not all the vegetation was burned, or regrowth is occurring.

Some of the water bodies appear as pink on the map, probably due to suspended sediment, while beaches and sand also appear in shades of pink and red (Figure 2). There are also some clouds visible in the bottom right, which appear as a blue slightly lighter than the water.

Index Image

The normalized burn ratio (NBR) is an index used to assess vegetation after a forest fire. The formula uses both the NIR and the shortwave infrared (SWIR), to separate burnt land from vegetation. Healthy vegetation reflects most NIR light, and does not reflect much in the SWIR, while burnt areas reflect highly in the SWIR and low in the NIR (United Nations). In Figure 3, healthy vegetation appears green as it has high reflectance in the NIR and has the highest values after performing the NBR. The yellow areas have values of around zero, which is going to be un-burnt land and areas with little vegetation. The orange represents burned areas and soil as it has the lowest values after performing the NBR, meaning it reflected highly in the SWIR.

FIGURE 3: Normalized Burn Ratio Index

Band Ratio Image To Enhance Burn Scars

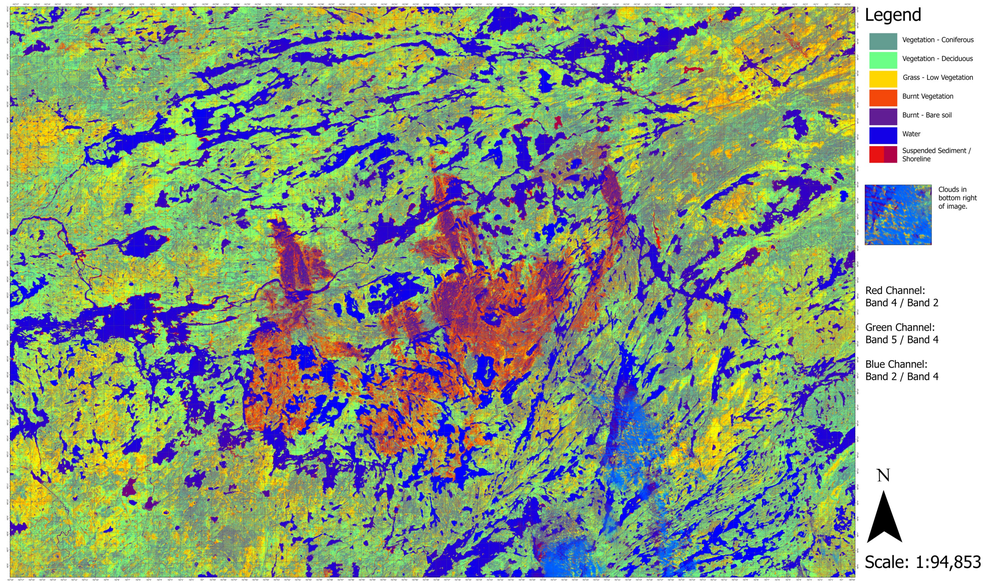
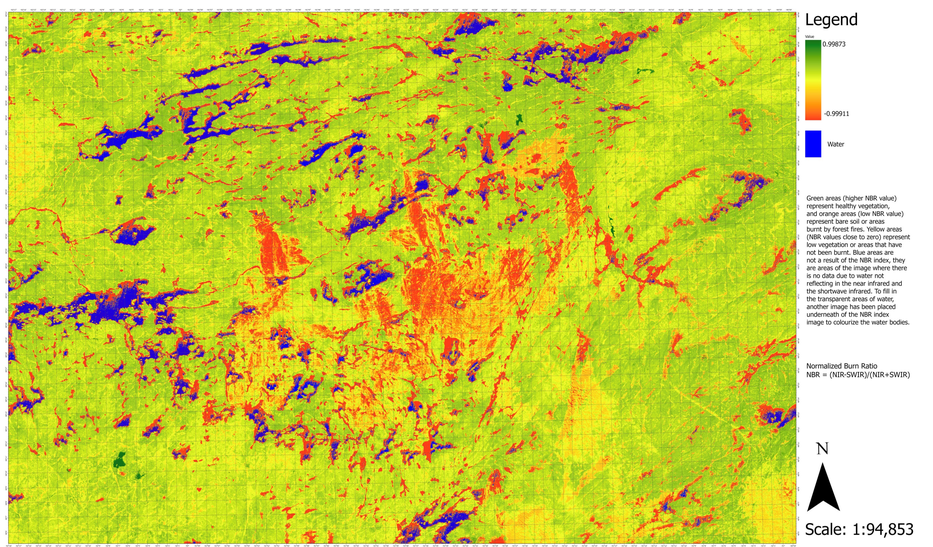


FIGURE 2: Band Ratio RGB Composite

Normalized Burn Ratio Image



Conclusions

To better assess the damage done by a forest fire, a NBR should be done on an image from before a fire, and one after. The differences would be even more pronounced as you would be able to see the changes that occurred to vegetation.

References and Citations

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Index image and Band ratio composite images produced with PCI Geomatics Catalyst. Maps produced with ESRI ArcGIS Pro.

Base Map Source: ESRI Light Grey Canvas, Light Grey Community Map

Projection Source: United States Geological Survey, Department if the Interior.

Projection: Universal Transverse Mercator, Zone 15 North.

Datum: World Geodetic System 1984 (WGS84).

This poster is produced by Aila Jalo as a portion of the requirements for the Remote Sensing program at the Centre of Geographic Sciences, NSCC, Lawrencetown, Nova Scotia.

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