Date:	10/3/2022	File:	622088
To:	Ryan Cook		
From:	James Burn		
Project:	Pelham Urban Area Tree Canopy Evaluation		
Subject:	Processing Memorandum		

TECHNICAL MEMO

Project Background

In May of 2022, The Town of Pelham (the Town) engaged GM BluePlan Engineering Limited (GMBP) to provide an estimate of the total tree canopy coverage within the Town's Urban area boundary. Both satellite and elevation information were combined with Niagara Region and Town information to perform a complex calculation, resulting in the production of two GIS files representing the approximate tree canopy coverage complete with area information in meters squared.

Information

To perform this analysis, two primary information resources are required. The first is an overall aerial view of the subject areas and the second is elevation information to determine ground level vs. non-ground elements such as trees and buildings.

As the Region of Niagara's aerial data is generally collected after leaf fall, this was deemed as in-adequate for the purposes of determining tree locations and leaf canopy. To accomplish this, satellite data was acquired using the SkyWatch system. Two areas were defined for acquisition – one for the Fonthill urban area and one for the Fenwick urban area. For both areas, capture from the Palisades satellite at 0.5m resolution with 0% cloud cover was acquired. In addition to standard red, green and blue colour bands, this information also included the near-Infra-red band.

For elevation data, both digital **surface** and digital **terrain** model data was acquired from Ontario's open source GeoHub site. A digital surface model (DSM) represents the 3-dimensional surface of an area inclusive of elements such as buildings, trees and other structures. A digital terrain model (DTM) is similar but has been processed to remove structural elements which are deemed to be taller than ground level.

Other data used for this project include the Region of Niagara Open Data for Building Footprints and Urban Areas.

Processing Steps

Using the above data, the following process was completed to create a resulting ESRI shp file, delineating the tree canopy area. Assumptions are also documented.

Creation of a Normalized Difference Vegetation Index (NDVI)

An NDVI is a tool that may be used to display vegetation vs. non-vegetative areas. This is done using the near infra-red information and the following equation: (nIR – Red) / (nIR + Red). The result of this is shown below (Fonthill Town Hall area) with vegetative areas being displayed in yellow to red, and non-vegetative areas (roads, buildings) being displayed in blues. This provides a good indication of where "green vegetation" is located.

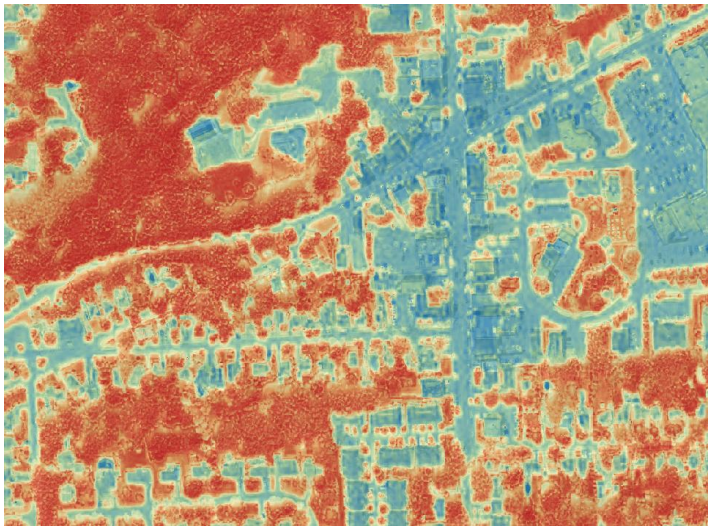
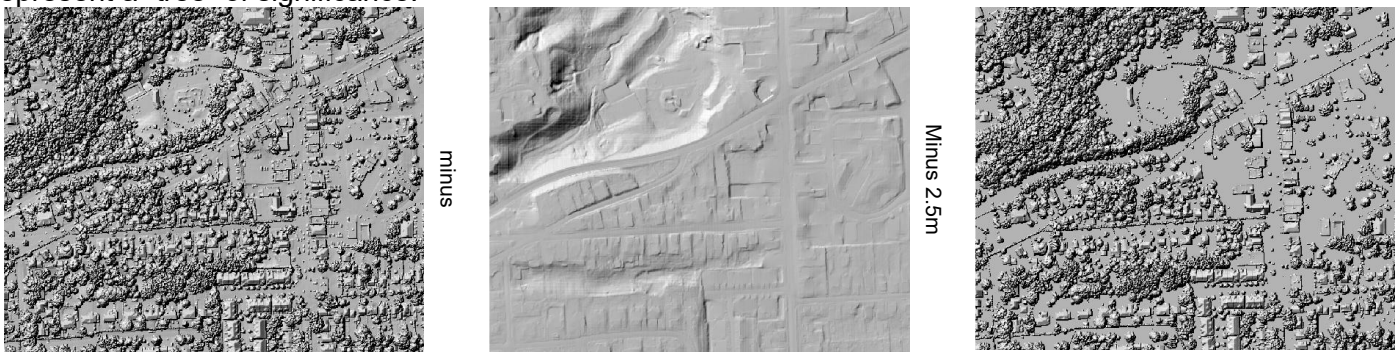


Figure 1 - NDVI

Initial Tree Location Determination

The next step involved a review of elevation information. The while the DSM was used to determine the ground elevation, the difference between this and the DTM results in the height, above ground, of structures. After this difference was calculated, an assumption was made that any structures less than 2.5m in height did not represent a "tree" of significance.



The resulting dataset now provides an accurate assessment of elements that are greater than 2.5m in height which also allows for ground vegetation (i.e. grass) from being included as a tree. Merging this result with the NDVI result in Figure 1 begins to show a better picture of tree locations as shown in Figure 2.

Figure 2 - NDVI merged with Elevation Difference

As one can see, trees become much more easily visible. Spatial indexing allows for the determination that index values of less than 2 are most likely buildings or structures, while those greater than 2 are trees as shown in Figure 3:

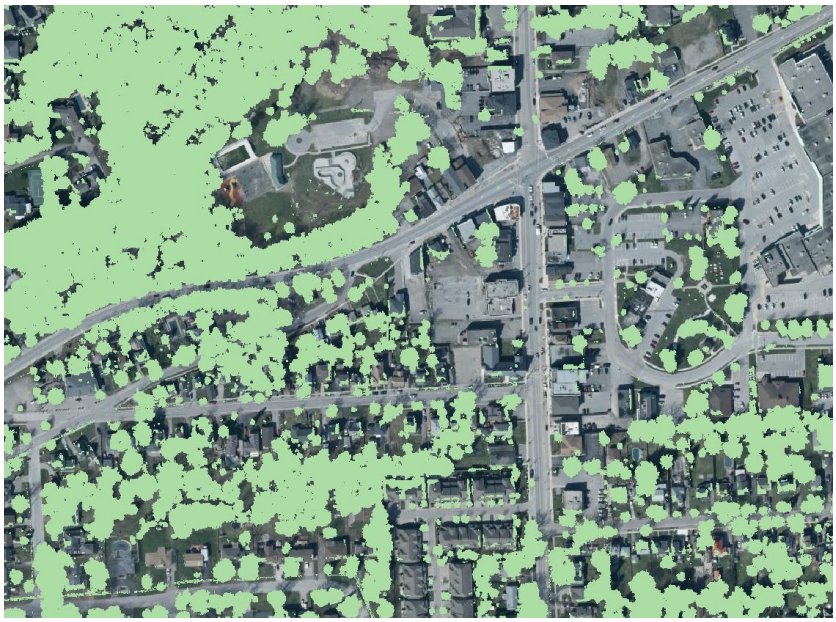


Figure 3 - Tree Canopy Indexing

VECTORIZATION

The results from the Tree Canopy Indexing were then automatically vectorized and compared with the Region's current building footprint file. An overlap analysis was run to calculate any locations that were more than 50% contained within a building envelope. These were clipped to the envelope to provide a final layer. This allows for anomalies to be removed while still allowing for tree canopy results that overhand a building as shown in Figure 4.

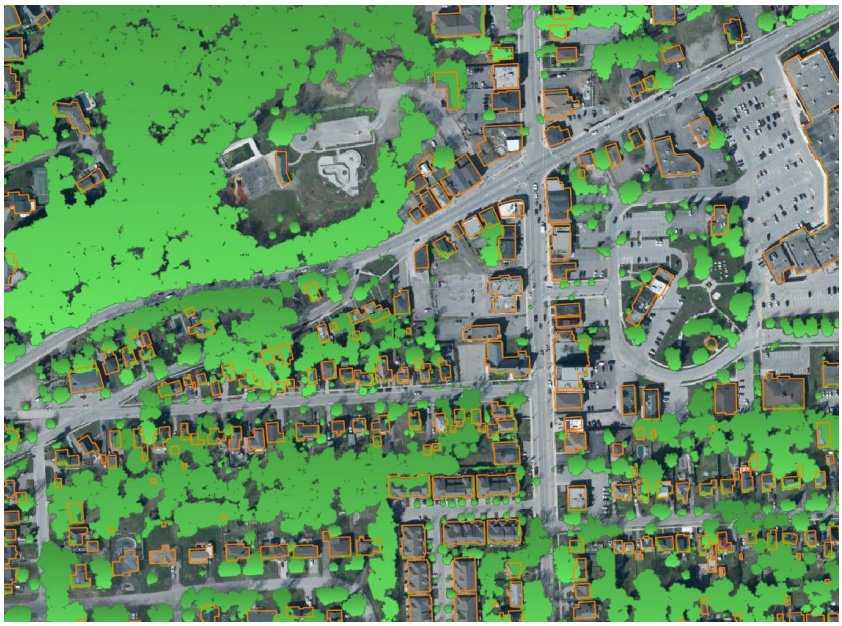


Figure 4 - Final Tree Canopy Layer

Results

As the results are digital GIS files, they by default include calculated area information. Combining these together, the following calculated tree canopy areas were determined:

- Fonthill: **2,461,000 m²**
- Fenwick: **885,000 m²**

The final digital deliverables include the following:

- Fenwick
  - Imagery
    - NDVI grid
    - NDVI merged elevation data grid
    - Resulting grid indexed greater than 2
  - Map of Fenwick showing tree canopy area
  - ESRI shp file of tree canopy area for Fenwick
- Fonthill
  - Imagery
    - NDVI grid
    - NDVI merged elevation data grid
    - Resulting grid indexed greater than 2
  - Map of Fonthill showing tree canopy area
  - ESRI shp file of tree canopy area for Fonthill
- Satellite Acquisition
  - Raw Imagery acquired from SkyWatch system
  - Urban Area boundaries for Fonthill and Fenwick

Conclusion

We feel that this analysis will provide the Town with an actionable estimate of the Town's tree canopy area within the Urban Area boundary. Any questions may be sent to James Burn (james.burn@gmblueplan.ca).