Mapping Emerald Ash Borer (EAB) Infested Trees using Multispectral UAV Technology

Siddharth Mishra (CGCS Intern, siddharth.mishra@mail.utoronto.ca), Justin Murfitt (CGCS Intern, justin.murfitt@mail.utoronto.ca), Yuhong He (Associate Professor, yuhong.he@utoronto.ca)
Department of Geography, University of Toronto Mississauga

Introduction

Background:
The Emerald Ash Borer (EAB) is native to Asia and was introduced to North America in 2002. It causes massive destruction to ash species in North America; ash trees have a nearly 100% mortality after infestation.

Infestation starts when the EAB lays eggs in the bark of ash trees at the beginning of the summer; these eggs hatch after two weeks. Symptoms include tree crown thinning, D shaped exit holes, twig dieback, and bark peelings. As of 2007, the EAB has caused upwards of $7.6 billion in damages.

Objectives:
1. Use high spatial resolution images to delineate ash trees
2. Evaluate individual ash tree health through the collection of field data
3. Map infestation to identify areas of concern

Methodology

Study Site: Koffler Scientific Reserve

Data:
- Field data collection conducted from June to August 2015
- An Unmanned Aerial Vehicle (UAV) was used to obtain high spatial resolution images of the Koffler study site
- Ash tree health score was assessed using several metrics including twig dieback, crown condition, general tree health, and transparency
- Leaf samples were used to obtain chlorophyll concentration and reflectance measurements

Methods:
- Images were segmented using a multiband watershed segmentation method
- Linear regression analysis was performed between NDVI and the ash health index to predict tree health
- The model was applied on a pixel-by-pixel basis to the images and Map Accuracy was calculated

\[ \text{NDVI} = \frac{(NIR - \text{Blue})}{(NIR + \text{Blue})} \]

\[ \text{Map Accuracy} = \left(1 - \frac{\text{RMSE}}{\text{max.\,dn.}}\right) \times 100.00 \]

Results

Discussion

- Segmentation of multispectral UAV images was possible using a multiband watershed method
- EAB infestation was successfully identified using ground based observations
- The EAB infestation was successfully mapped using a combination of multispectral and field data with a map accuracy of 70%

Future Work

- Classifying ash trees from multispectral image
- Obtaining and analyzing hyperspectral data at Koffler
- Expanding study to more sites and a greater number of ash trees

Acknowledgements

I would like to thank CGCS for this opportunity, the members of Prof. Yuhong He’s Remote Sensing Lab for their guidance and support, Prof. Hugh Liu’s team for UAV image collection and our colleagues in Koffler for logistic support.

References


Figure 1. A) Photo of Emerald Ash Borer; B) D-shaped exit holes; C) Infested ash tree

Figure 2. Location of Koffler Scientific Reserve and studied ash trees

Figure 3. A) Acquiring hemispherical transparency photos on site; B) Canopy transparency photo; C) and (D) Chlorophyll extraction process; E) UAV drone flight; F) Acquiring leaf reflectance with ASD

Figure 4. A) UAV Image of Koffler Study Site; B) Site 1 Segmentation; C) Site 2 Segmentation

Figure 5. Relationship between chlorophyll and NDVI at Leaf Level

Figure 6. Relationship between Ash Health Score and NDVI at Canopy Level

Figure 7. Map of Ash Health at Koffler Scientific Reserve, Map Accuracy = 70%