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Remote sensing & machine learning applications for urban forest biosecurity surveillance

Progress Report (APBSF030/CONT20/625)

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1. Executive Summary

Early detection of forest biosecurity threats relies on reliable surveillance methodologies. Forest biosecurity surveillance programs utilise insect traps with pheromone of kairomone lures and host-tree surveillance. Because very few local councils have georeferenced street tree databases, mapping of target tree species for host-tree surveillance relies on resource-intensive and time-consuming ground surveys. A more efficient method is needed — if it is accurate. Remote sensing technologies, coupled with machine learning algorithms, are a promising method.

High resolution (from 12 cm) 10-band multispectral imagery was captured using the ArborCam camera system mounted in a fixed-wing aircraft over Bayside Local Council, encompassing Port Botany and Sydney International Airport, an area identified as high risk for entry of exotic forest pests and where forest biosecurity surveillance is carried out by NSW DPI. Locations of individual trees were validated and mapped on the imagery, including more than 450 *Platanus* and 600 *Pinus* trees. These genera have been selected because they are hosts of High Priority Pests identified by the forest industry, Top 42 National Pests, the environmental pest list, and are among the most planted amenity trees in Sydney.

Data analysis and classification is currently underway.

2. Introduction

Several reviews have highlighted a need for improved biosecurity surveillance at first points-of-entry, commonly called high risk site surveillance (HRSS), such as at major ports and approved arrangement facilities (Mohammed et al. 2011; Carnegie et al. 2017; Carnegie et al. 2018; Tovar et al. 2017). Government- and industry-funded surveillance programs utilize insect traps and host-tree surveillance. Currently in most jurisdictions, host trees are identified and mapped via ground surveillance (i.e. driving the streets), supplemented by examining GoogleMaps. This is very inefficient, and as such has only be conducted for a relatively small area of high-risk sites. Very few local councils have geodatabases of their street and park trees (http://opentrees.org/#pos=4.93/-32/134.8).

During an emergency response to a forest pest detection, tree-host mapping is required for surveillance to delimit the spread and determine feasibility of eradication. Without accurate host-tree location data, this process is time-consuming and resource-intensive, possibly delaying a timely response to an exotic incursion.

Remote sensing technologies combined with machine learning applications show promise in being able to locate and identify individual trees in urban areas (e.g. citrus canker response in Darwin). There have been many advances in remote sensing in recent years, with examples of amenity trees species mapping from various studies (Jombo et al. 2020; Faschnett et al. 2016; Shahtahmassebi et al. 2021). Some local councils already capture such data (e.g. to map greenspace), thus allowing biosecurity agencies to piggy-back on data acquisition to assist in high risk site and emergency response surveillance of forest, amenity, and environmental pests.

3. Aim

1. Assess the feasibility of remote sensing technologies and machine learning applications for detection and mapping of urban trees to assist in forest biosecurity surveillance.

2. Liaise with local councils to develop a collaborative agreement to improve urban tree biosecurity surveillance, linking in the NSW DPI/Local Land Services Peri-Urban Biosecurity Program

4. Methods/Process

Analyse existing remote sensing data captured over urban areas by ArborCarbon and tree-location data captured by NSW DPI to investigate likely sensors and resolution for further acquisition.

Acquisition of aerial imagery over Bayside Local Council (Port Botany); image processing; machine learning application; generation of derived products.

Utilise tree location data already captured by NSW DPI and supplement with higher resolution ground capture (i.e. differential GPS) to feed into machine learning process; includes tree location and species identification.

Utilise existing relationships with local councils to establish collaborative agreement(s).

5. Achievements

Aerial data acquisition

Aerial acquisition over Bayside Local Council completed in November 2020. Products produced by ArborCarbon (Figure 1): Seamless RGB orthomosaic (12cm GSD), False Colour Composite orthomosaic (36cm GSD), Vegetation Condition Index orthomosaic (36cm GSD), Height-stratified vegetation cover layer as a single band categorical raster (36cm GSD), Radiometrically corrected greyscale thermal orthomosaic with values equal to land surface temperature (150cm GSD).

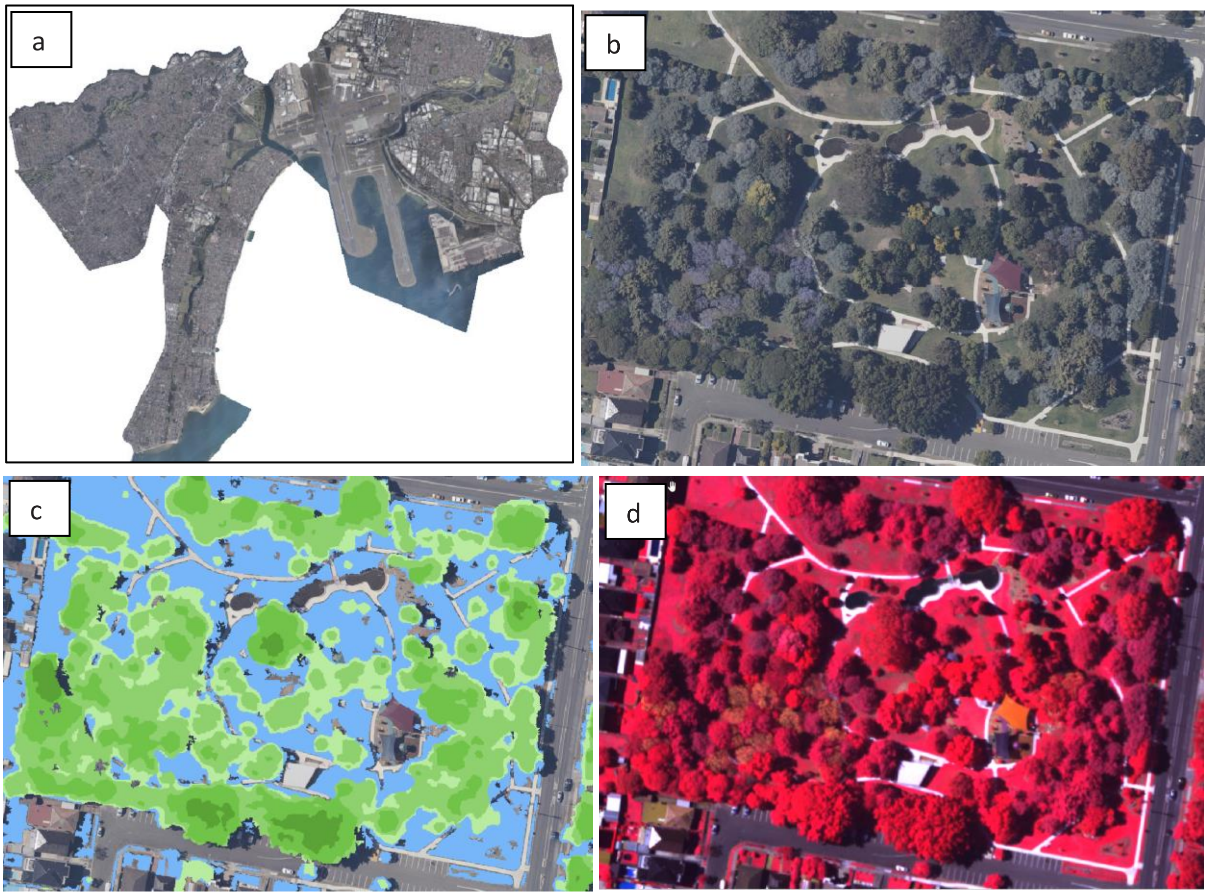

Figure 1. Imagery and data provided by ArborCarbon. (a) RBG orthomosaic, (b) close-view of RBG orthomosaic, (c) Height-stratified vegetation cover layer, (d) False Colour Composite orthomosaic.

Field data collection

Accurate location and mapping of trees hosts completed by DPI in April 2021, including more than 450 *Platanus* and more than 600 *Pinus* (Figure 2). This is the calibration (validation) reference data that will used for training the model to semi-automatically detect and map *Pinus* and *Platanus*.

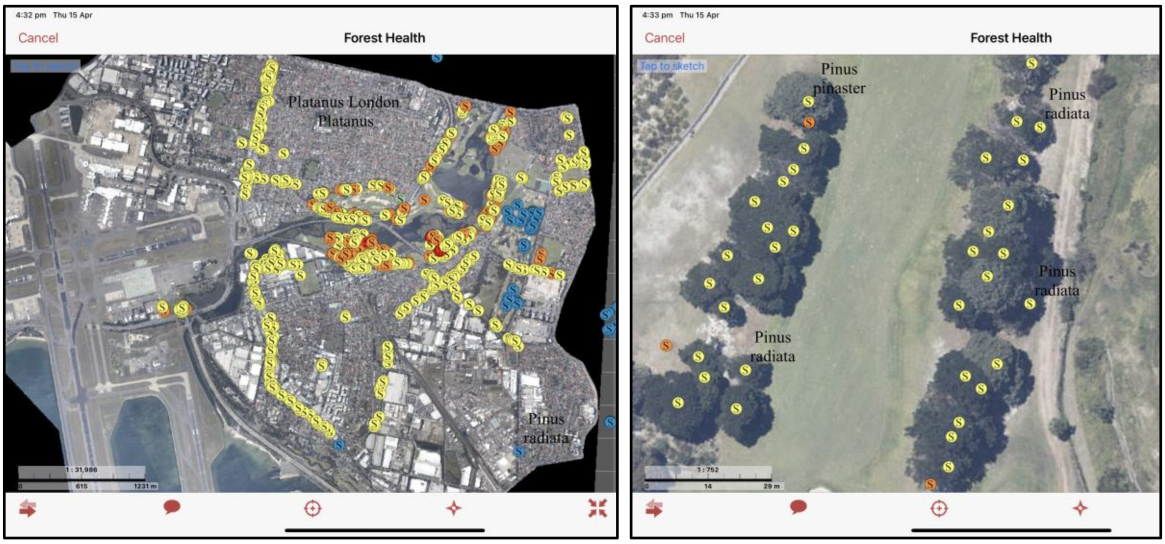

Figure 2. Ground mapping of trees using FCMapApp (Forestry Corporation of NSW) and imagery supplied by ArborCarbon.

Data analysis and classification

Data analysis and classification is currently underway.

9. References

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