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Lethal Yellowing Disease in Coconuts: A Diagnostic Tool, and the Potential of Satellite-Based Surveillance

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Bogia Coconut Syndrome/lethal yellowing

- Phytoplasma disease
- Present in the Americas, Africa, Asia and Oceania
- Not only in coconut but in other palms

Monitoring: Surveillance & Confirmation

- Monitoring is essential to control and eradicate the disease

- Surveillance will identify suspicious trees
- Confirmation will confirm/deny disease

Surveillance

- What are we looking for?
  - Sick looking trees
- How do we look for it?
  - From below
  - With our eyes

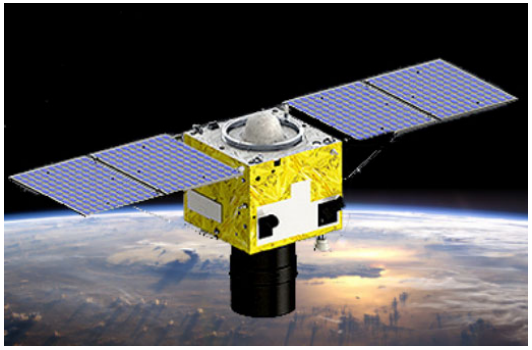
Surveillance

- We can also look from above

- We can use different sets of eyes

Surveillance from above

- Satellites
  - Low resolution: over 60m/pixel
  - Medium resolution: 10 – 30m/pixel
  - High to very high resolution: 30cm – 5m/pixel
- Unmanned aerial vehicles (drones)

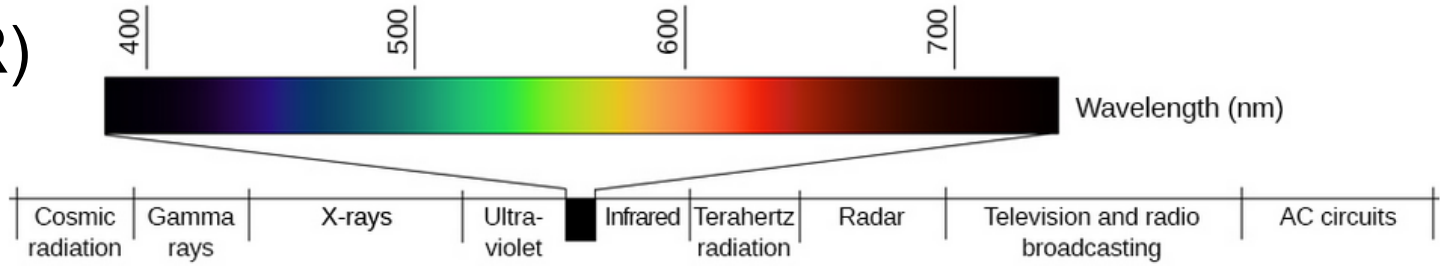


Superview-1 0.5m/pxl

Sentera Double 4K Multispectral NDVI/NDRE Sensor Upgrade for DJI Phantom 4 Series

There is a lot we cannot see with our eyes

- Visible
- Near Infrared (NIR)
- Fluorescence
- Thermal
- Synthetic Aperture Radar
- Light Detection and Ranging (Lidar) systems



Surveillance: Lethal yellowing symptoms

- Fruits drop
- Trees show yellowing of canopy
- Phytoplasma diseases restrict phloem movement
- Plant is stressed
- Lower photosynthesis

Surveillance Essential Requisite

Find a spectral signature for diseased trees

How can we recognise a diseased tree?

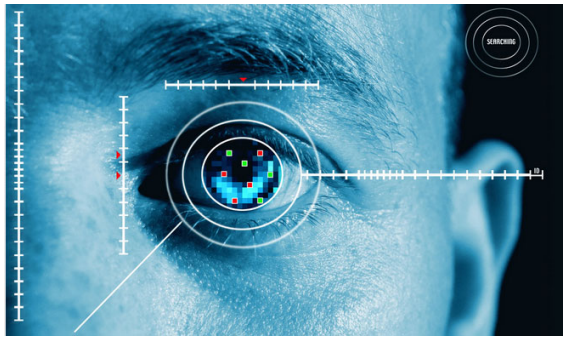
How early can we find it?

Does it changes with disease progression?

Can we use Artificial Intelligence/Machine Learning to recognise symptoms?

Surveillance

1. Image acquisition



2. Image analysis

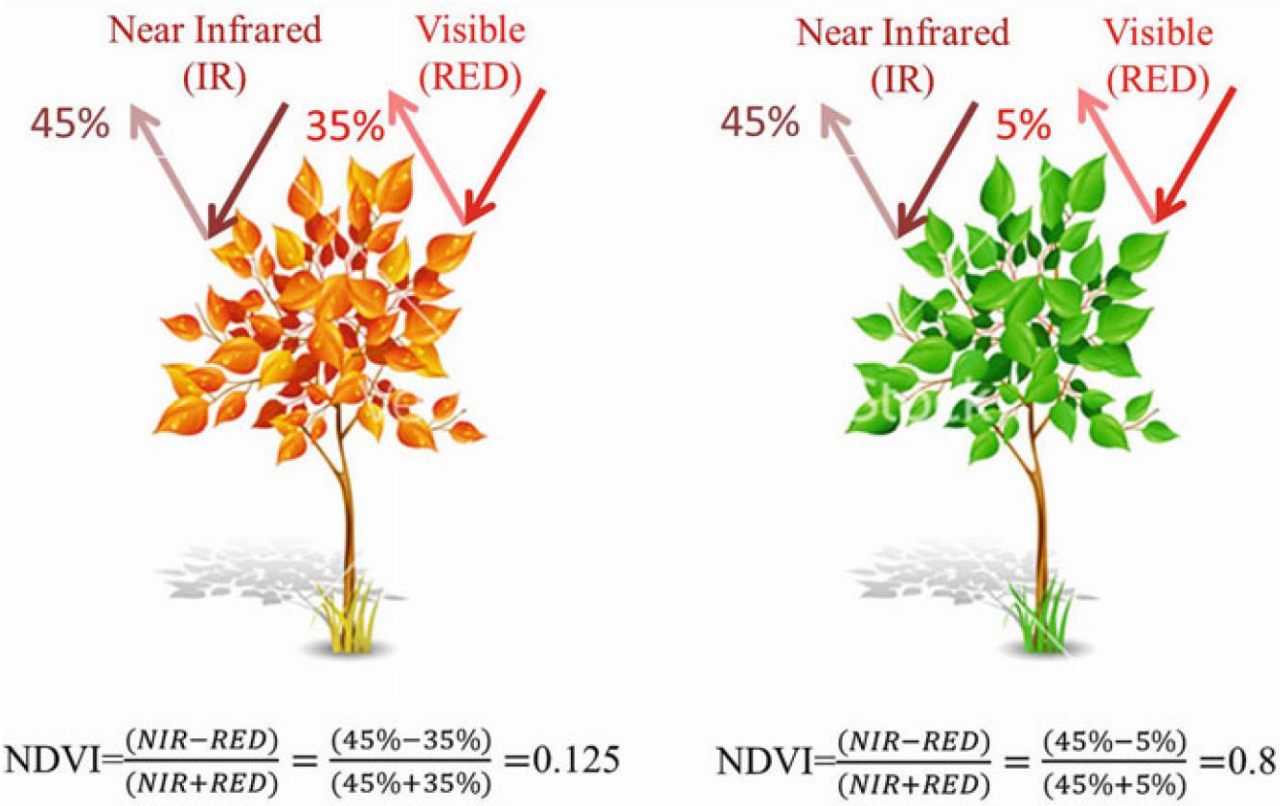
Surveillance: Image acquisition

- Drones are good local surveillance
  - Small scale
  - High resolution
  - Fast
  - Cheap
- Satellites are good for large/national programs
  - Large scale
  - Lower resolution
  - More expensive

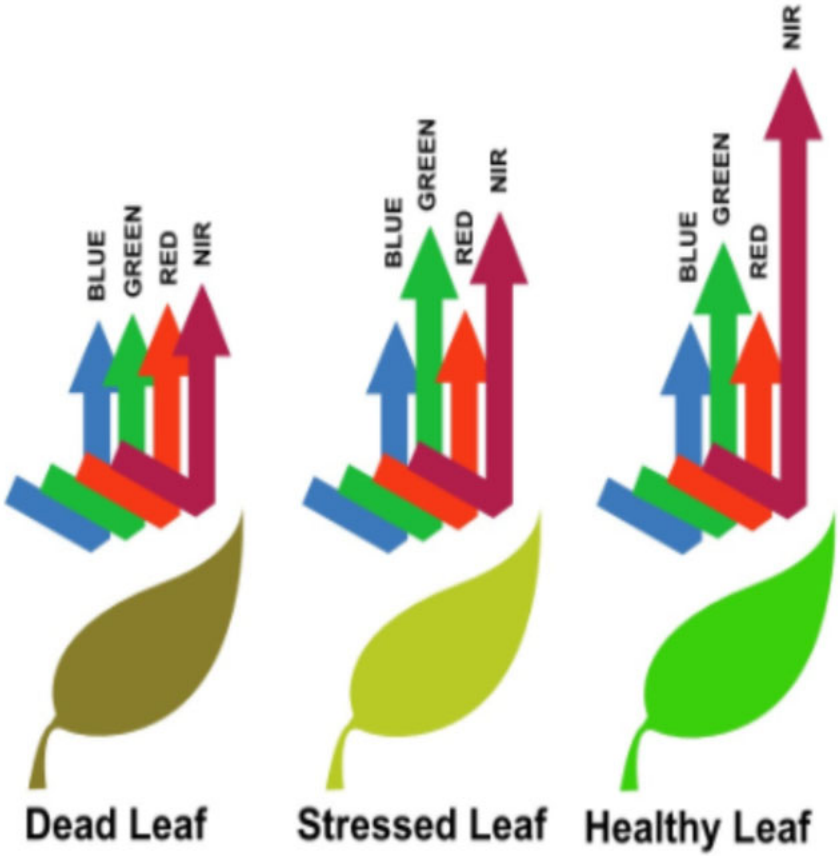
Surveillance: Image analysis

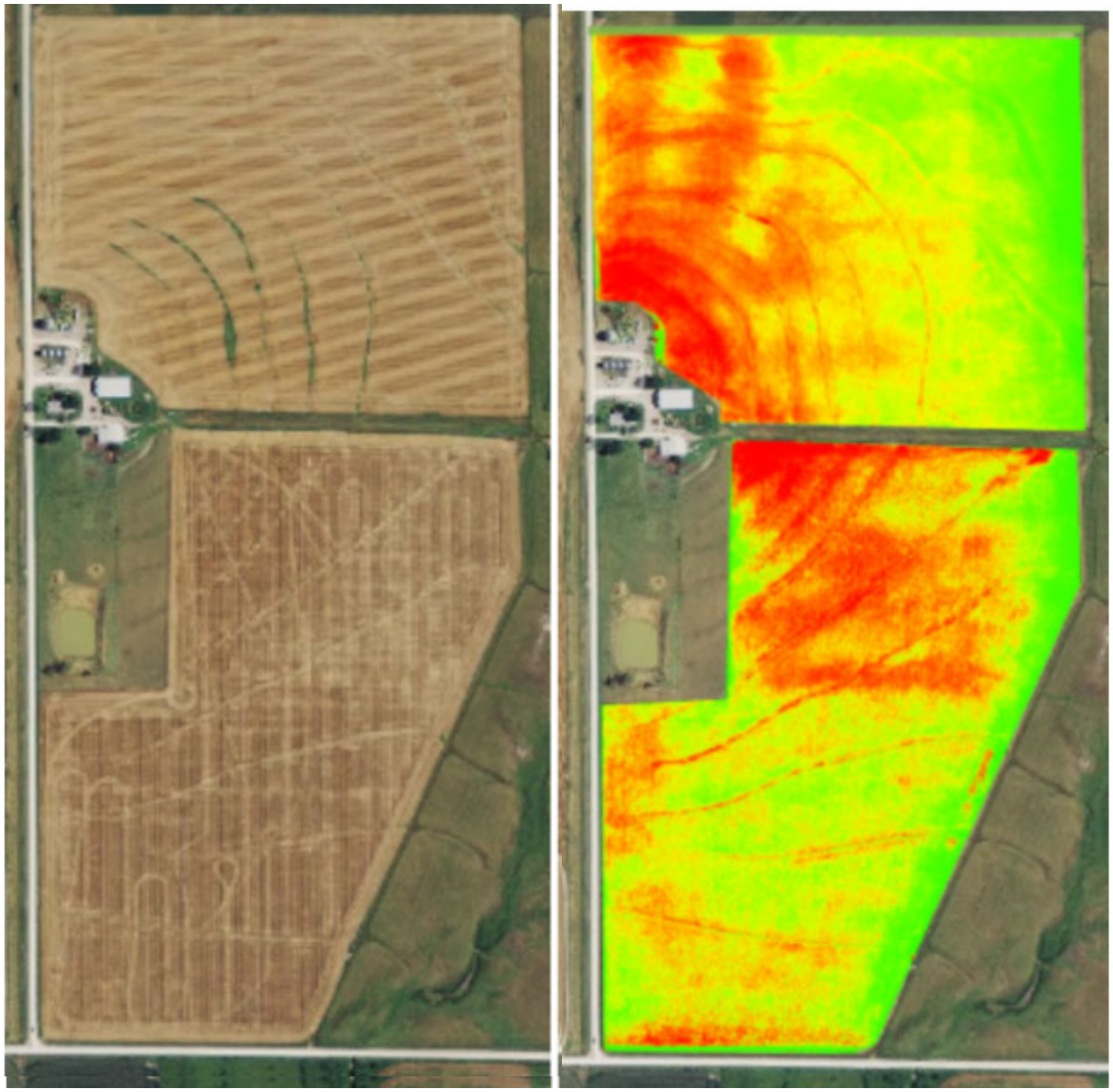
Is not only what you detect, it is how you analyze it

- Normalized Difference Vegetation Index (NDVI)
- NDVI = $\frac{(NIR - VIS)}{(NIR + VIS)}$

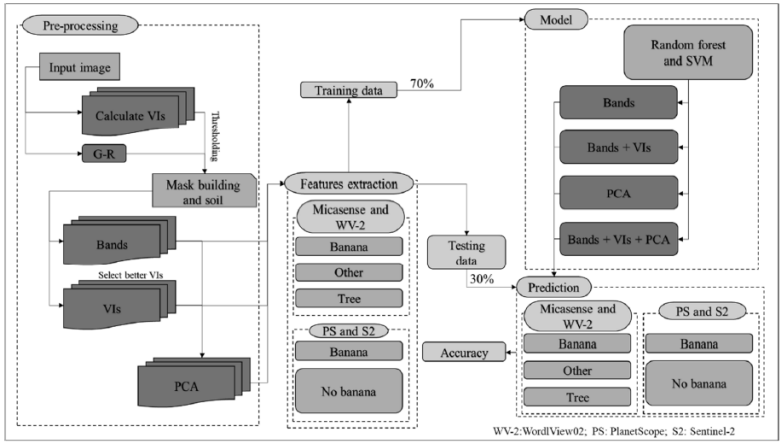


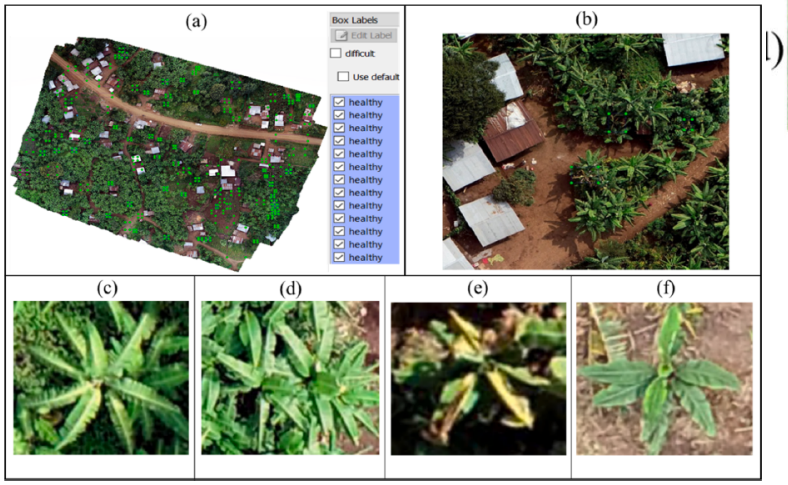
NDVI

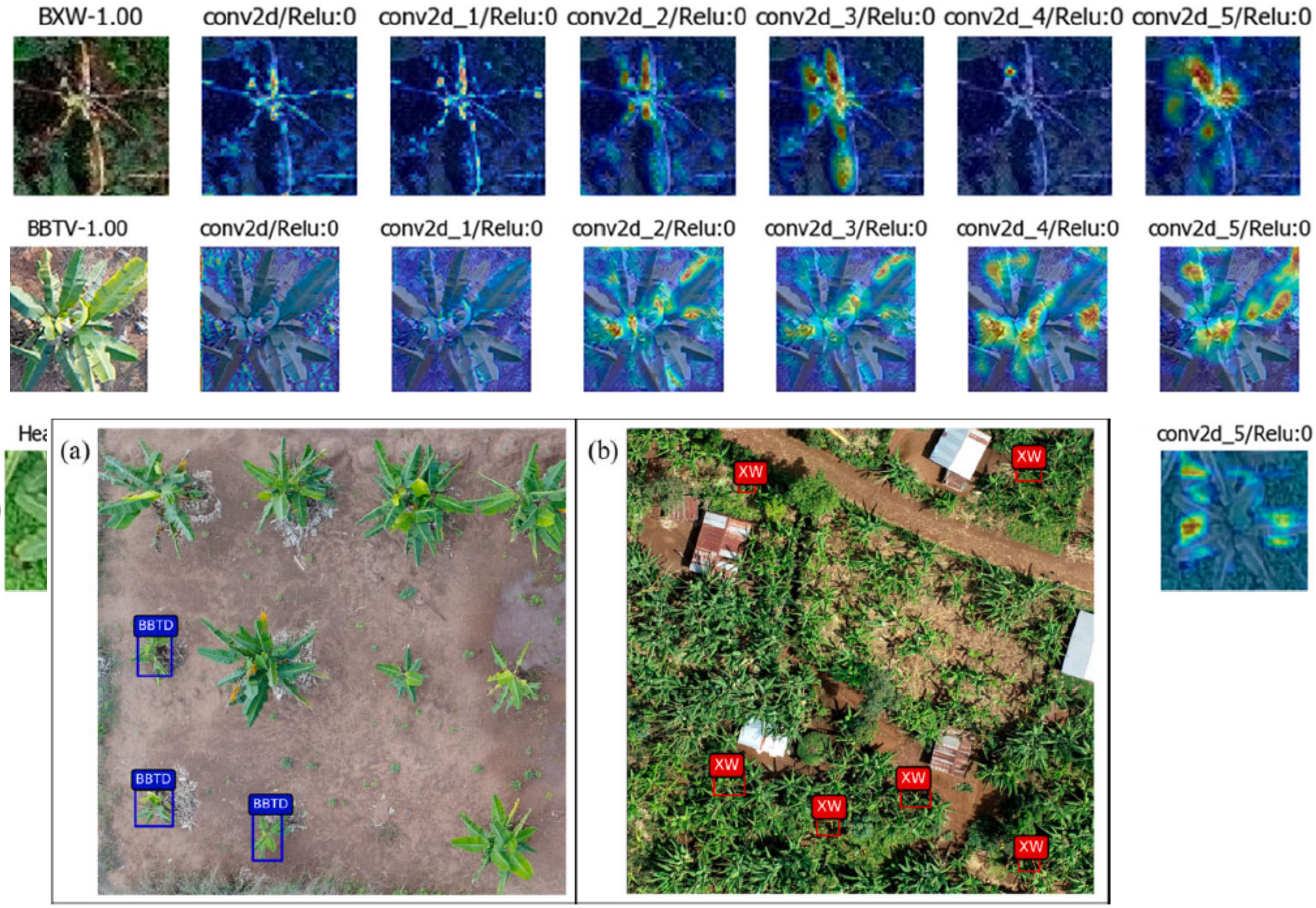




Surveillance: Image analysis/machine learning







Gomez Selvaraj et al. (2020) ISPRS Journal of Photogrammetry and Remote Sensing 169:110-164

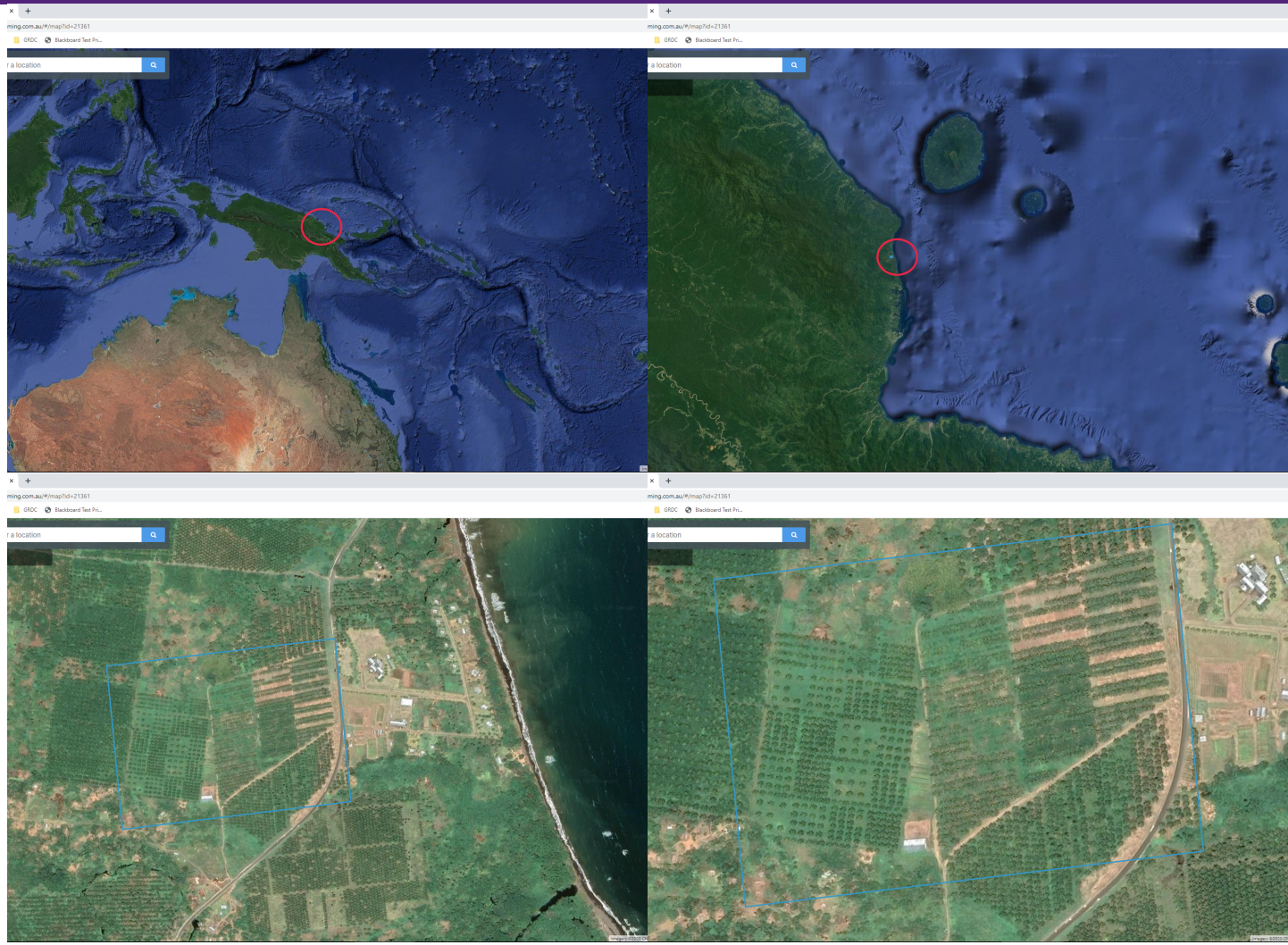
A road map for research

1. Locate trees at different stages of disease
2. Collect image/spectral data with drone
3. Collect satellite images/spectral data
4. Mathematical analysis of data
   - NDVI, thermal, RGB, visible/image analysis
5. Use machine learning/artificial intelligence
6. Create surveillance method for local systems (UAVs)
7. Create surveillance method for wide area systems (satellites)

Madang Stewart Research Station

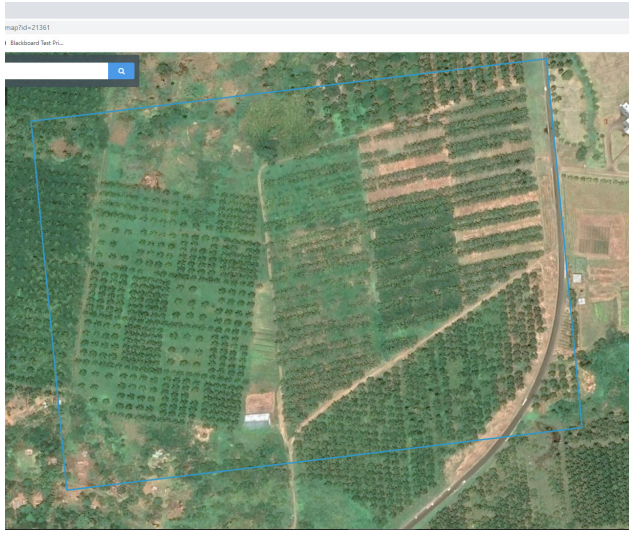
Airbus Worldview imagery showing station

Below is example of 0.5m NDVI image

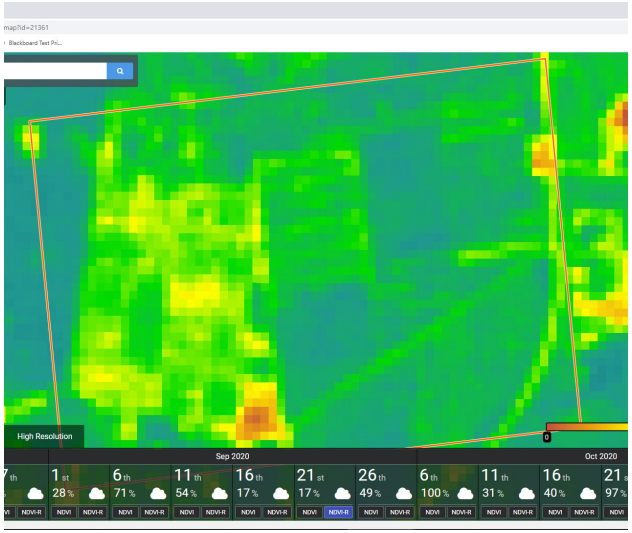


Madang Stewart Research Station

2019?
Google reference satellite image
RGB @ 0.5m



21 Sep 2020
Sentinel-2
NDVI @ 10m resolution



7 Oct 2020
Airbus Worldview
NDVI @ 0.5m resolution

Madang Stewart Research Station

2019?

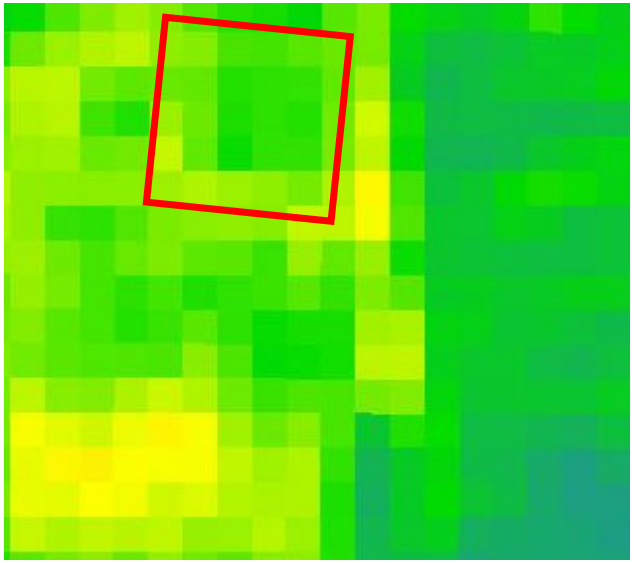
Google reference satellite image

RGB @ 0.5m

21 Sep 2020

Sentinel-2

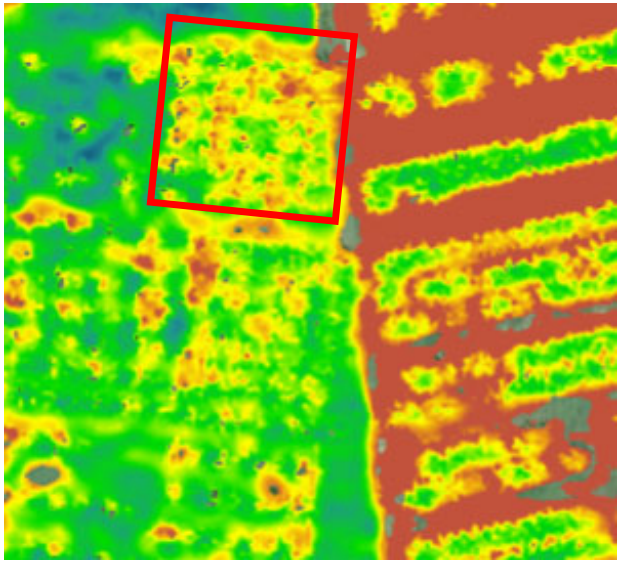
NDVI @ 10m resolution



7 Oct 2020

Airbus Worldview

NDVI @ 0.5m resolution



Reference square ~ 50m x 50m

Monitoring: Confirmation

- After suspicious trees are identified we need to confirm the disease
- Field ready system developed for BCS in PNG
- Awaiting deployment (delayed because of COVID)
  - Transfer of kits
  - Training of personnel

Monitoring: Confirmation