



Integration of Remote Sensing for improved Biosecurity

Prof. Andrew Robson

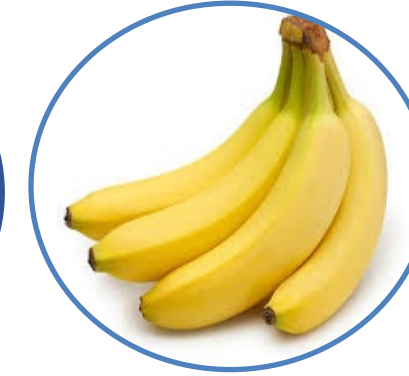
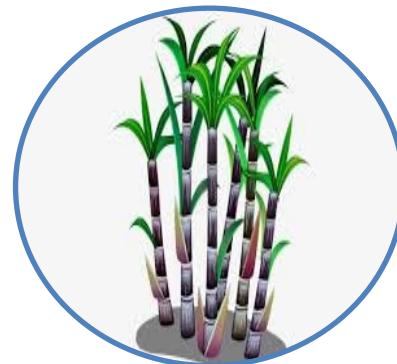
Director of University of New England's
Applied Agricultural Remote Sensing Centre (AARSC)

 @une_aarsc

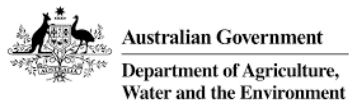
 www.une.edu.au/aarsc



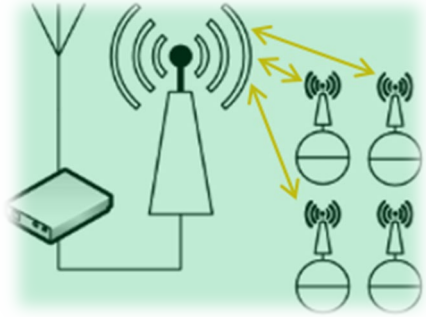
We develop Remote Sensing Applications for many industries



We don't do it alone



There are a lot of Ag technologies



Sensor Networks



Mobile Apps



Satellite



Animal tracking



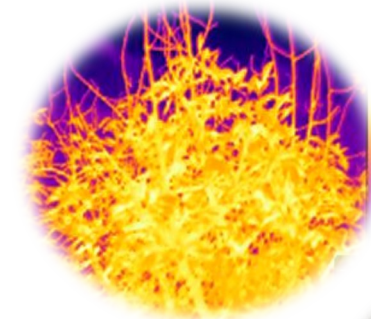
Lidar



Proximal Sensing



NIR



thermal



Machine vision



UAV



Airborne



Robotics



Spore trapping



However.....IT IS NOT JUST ABOUT THE TECH

- Need a fundamental understanding of how the technologies work, as well as their integration with core science related to the pests and diseases;
- Need to know the '**when**' and the '**where**' to deploy them and the '**what**' we are trying to measure;
- Need to be accessible, practical and affordable;
- We have developed **4 strategies** over the last two decades, for the appropriate implementation of these technologies for improved pest and disease management.



Strategies for integrating mapping/ remote sensing into biosecurity



Preparedness:

- Identifying the location of all crops
- Have an established response network of expertise (industry, academic and commercial)



Risk:

- *Know your diseases/ pests:* Model likely mode of movement based on historic examples.
- include crop distribution, climate, human movement, watercourses, surrounding land cover types etc.
- identify the 'where' and 'when' to look



Detection:

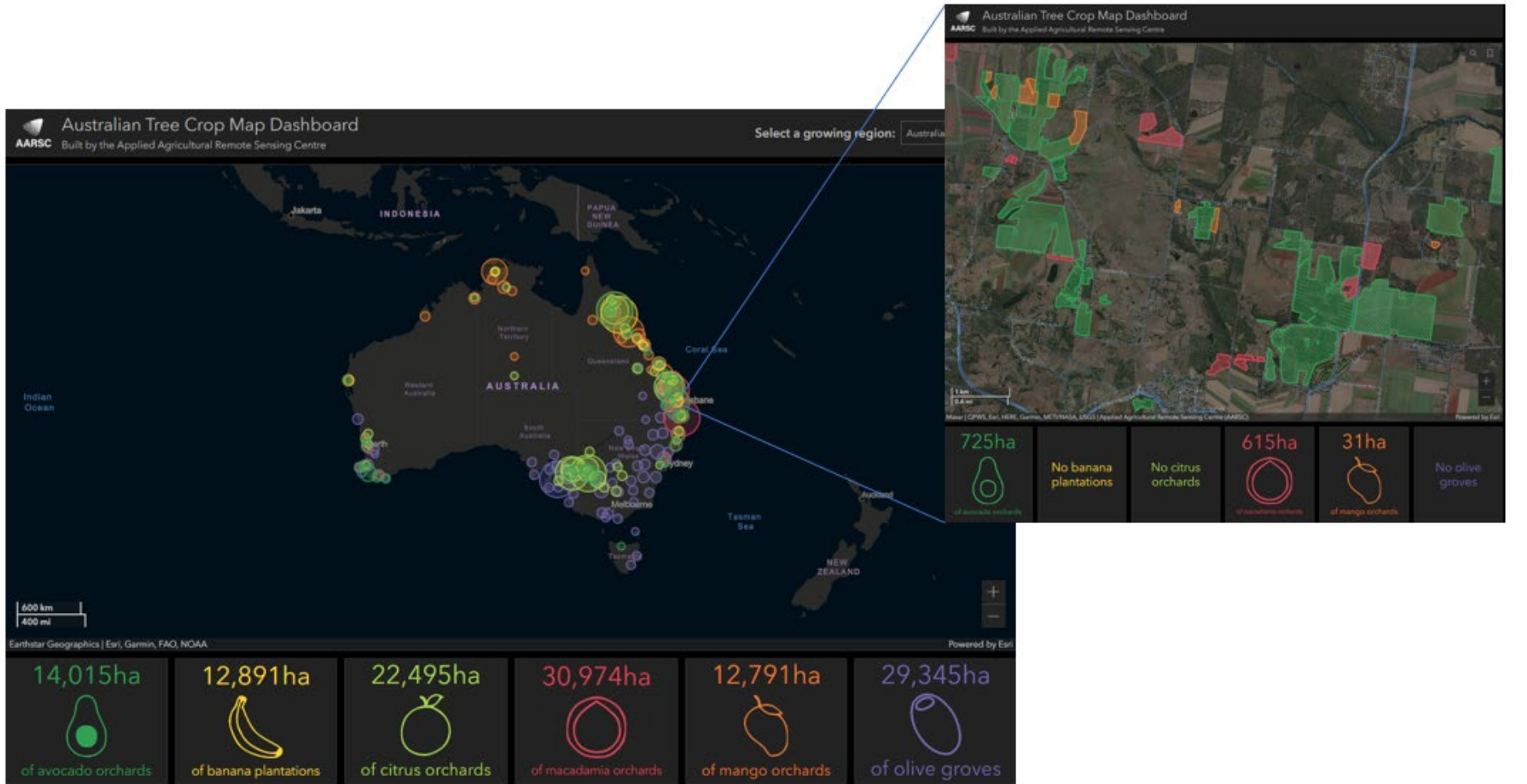
- Identify optimum non-invasive detection technologies based on the specific pest/ disease.
- MobileApps that assist within field detection.
- Positioning of spore/ vector trapping, PCR testing etc.



Response:

- More swift establishment of exclusion zones, the 'where' and 'when' to deploy detection technologies
- quantifying impact

Preparedness: Know where the crops are

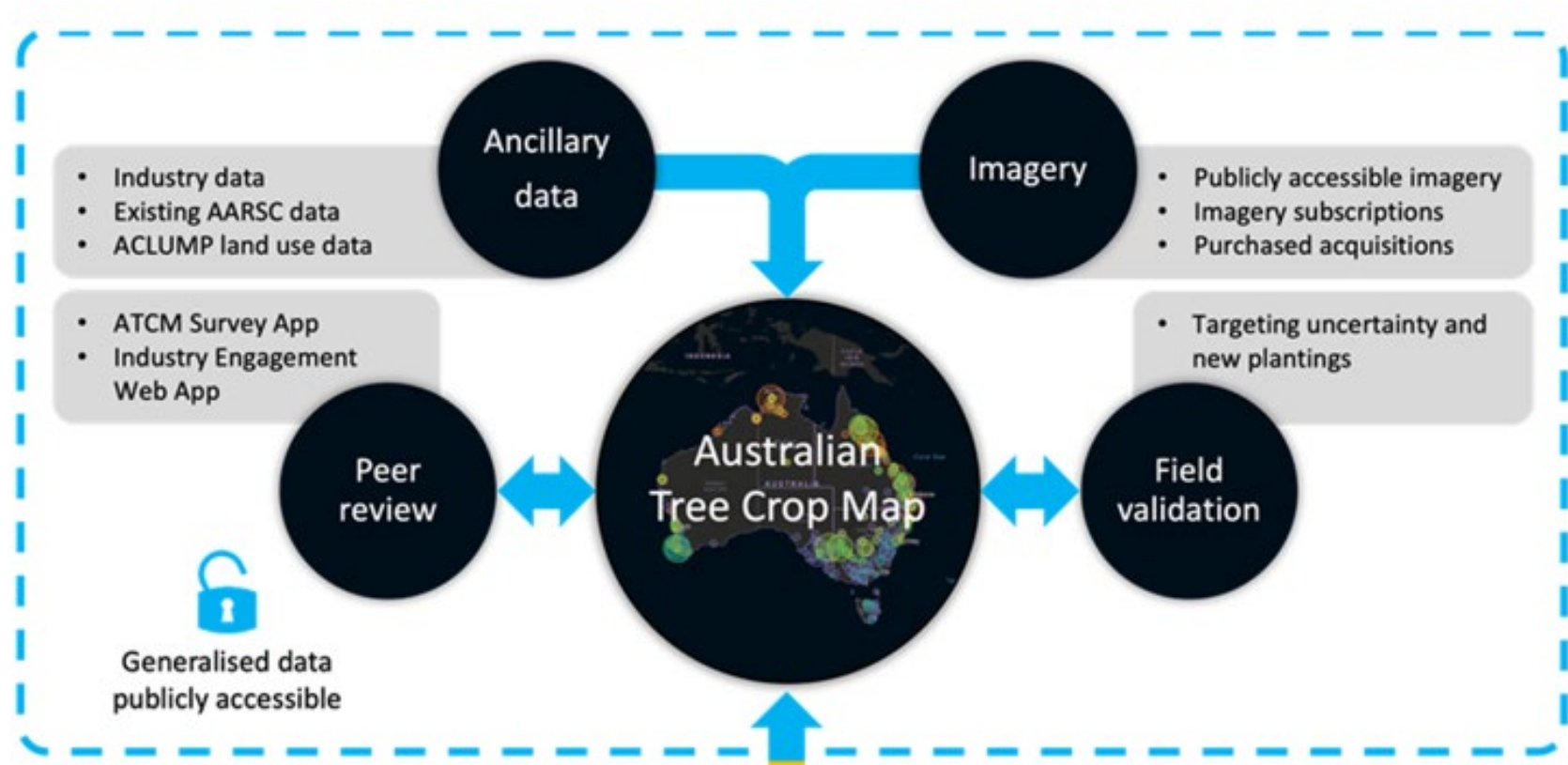


Identifying the location of all commercial crops annually is ESSENTIAL to guide surveillance, derivation of exclusion zones, placement of insect/ spore trapping

Preparedness: Developing the maps

This has to be done right:

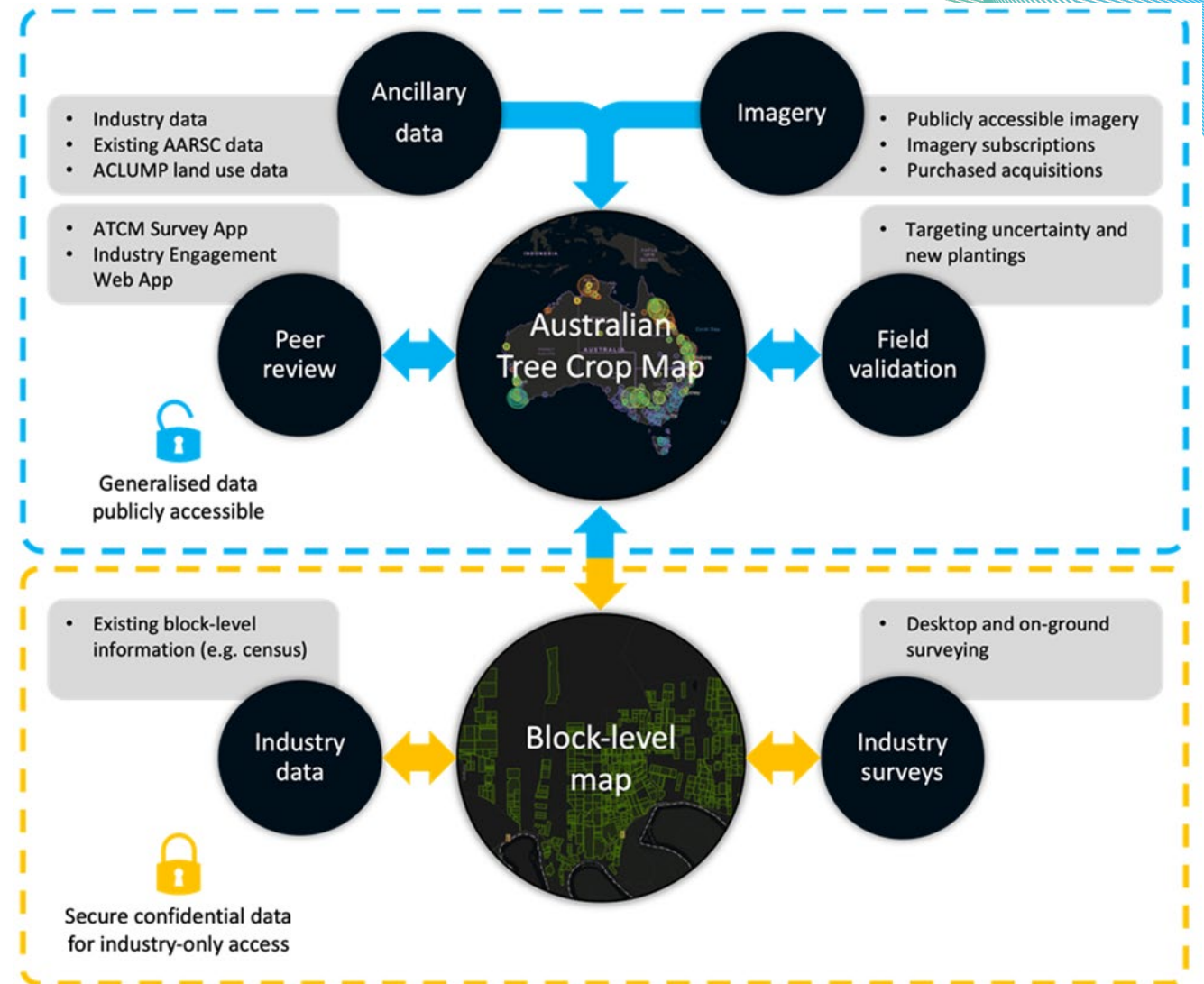
- Built from 4 information streams
- mapped to Australian mapping standards, interoperable with other software's, updated annually)
- Needs to be accessible when required
- Needs to be developed with industry (not seen as 'Big Brother')
- Needs to respect grower privacy



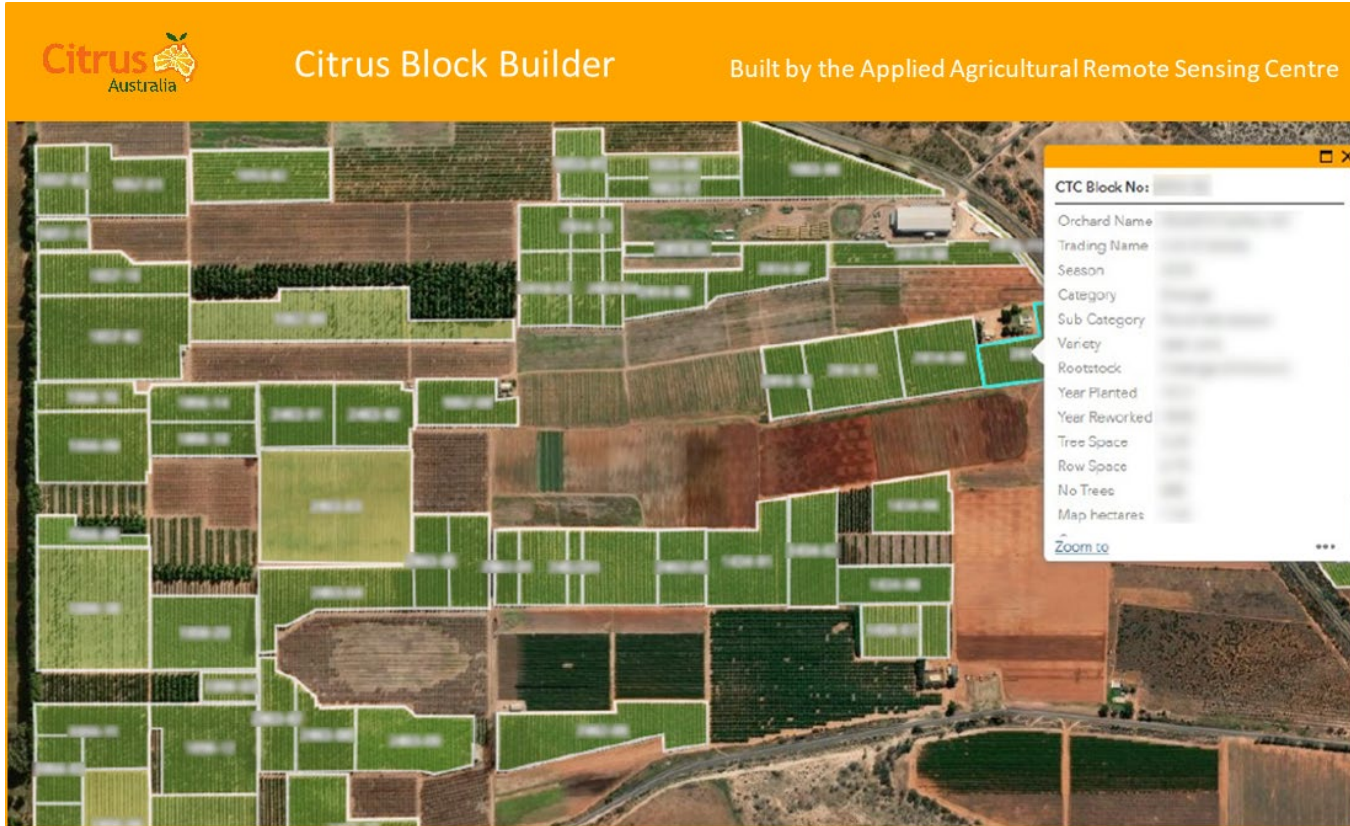
Preparedness: Citrus Aus taking it to the next level

Citrus Australia are building an **industry only** map with AARSC, which value adds information at block level, variety, age, management.

- Citrus Australia own and manage the data
- All data is secured, not publicly accessible



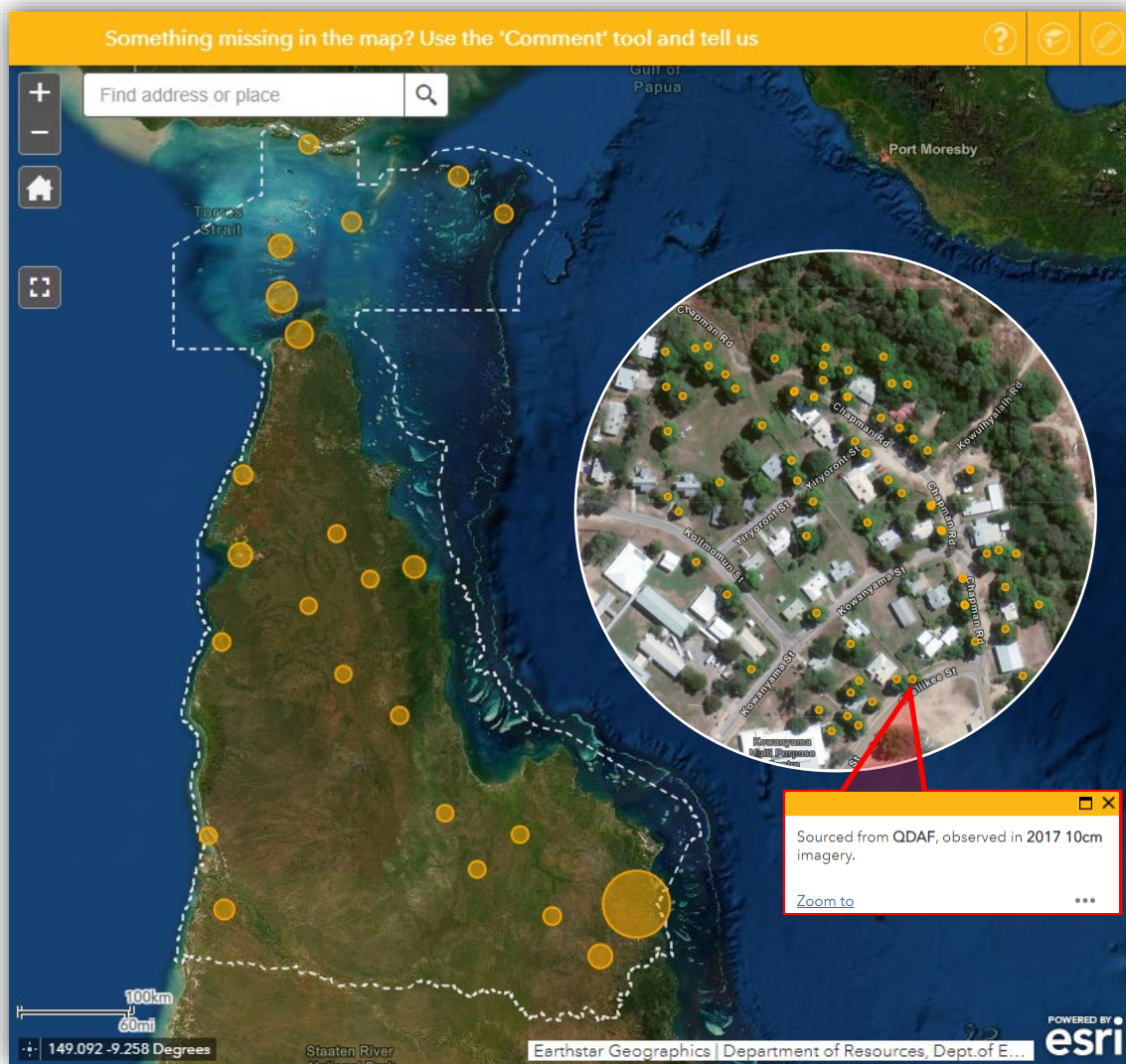
Preparedness: Citrus Aus taking it to the next level



Currently developing a Future Food Systems CRC project to do this for :



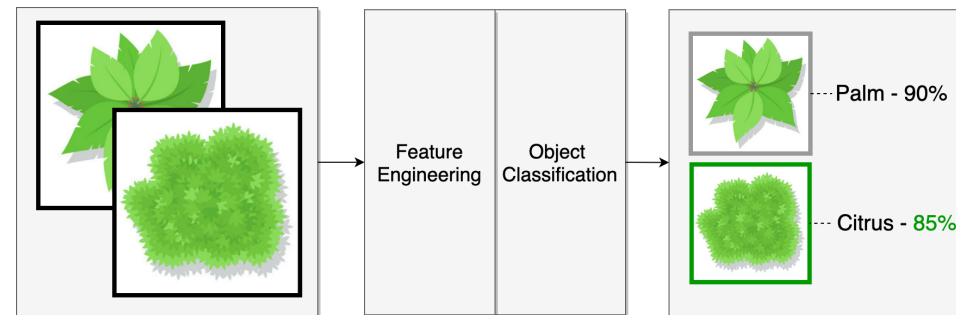
Preparedness: Cape 'non-commercial' Mango mapping



- geocoded existing data (QDAF + NAQS)
- Cape York + TSI NRM regions
- Map currently shows 8,969 non-commercial mango trees
- Draft map published and shared with key stakeholders
- Supports ongoing field validation and peer review—web map.

Cape Mango 'non-commercial' map

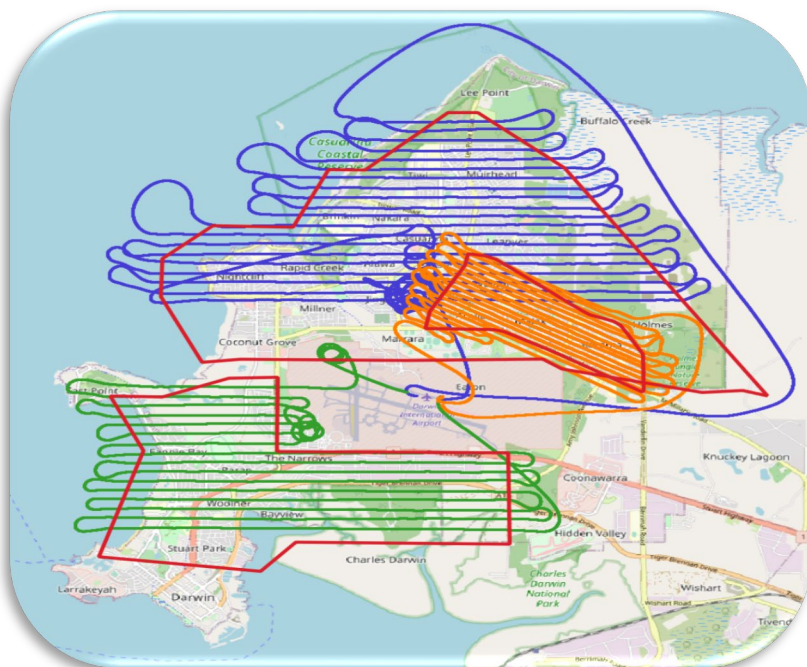
Preparedness: Mapping Backyard Citrus Trees (Canker response)



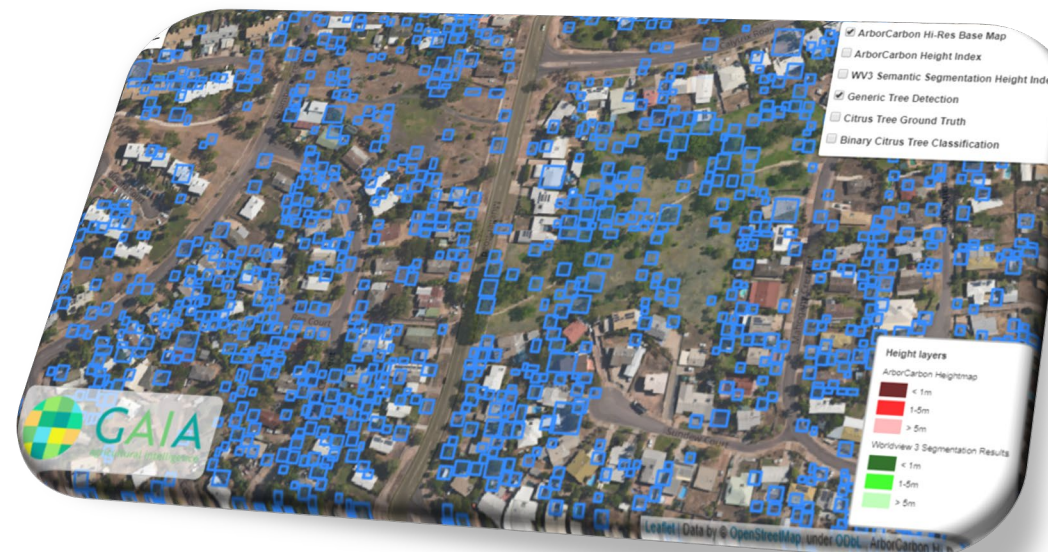
Bounding Box Images

Example *object classification* pipeline.

Category Labels



Flight paths over Darwin



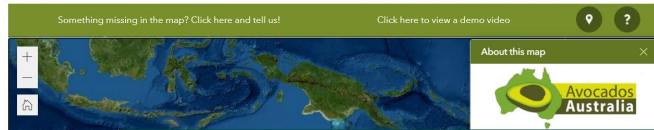
tree detection using aerial RGB imagery.

Preparedness: Border interception (Hitchhiker Pests)

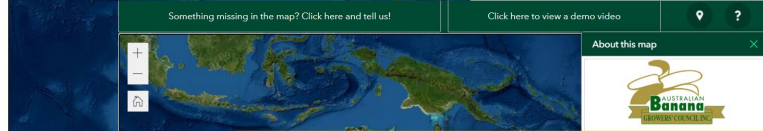


Computer vision classification of shipping containers around the Port of Brisbane and Lytton training area. Areas of red indicate a high probability of shipping containers and areas of green a low probability.

Industries are adopting this 😊



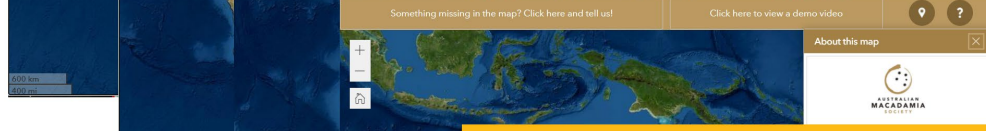
Avocado: [Embed](#)



Banana: [URL](#)



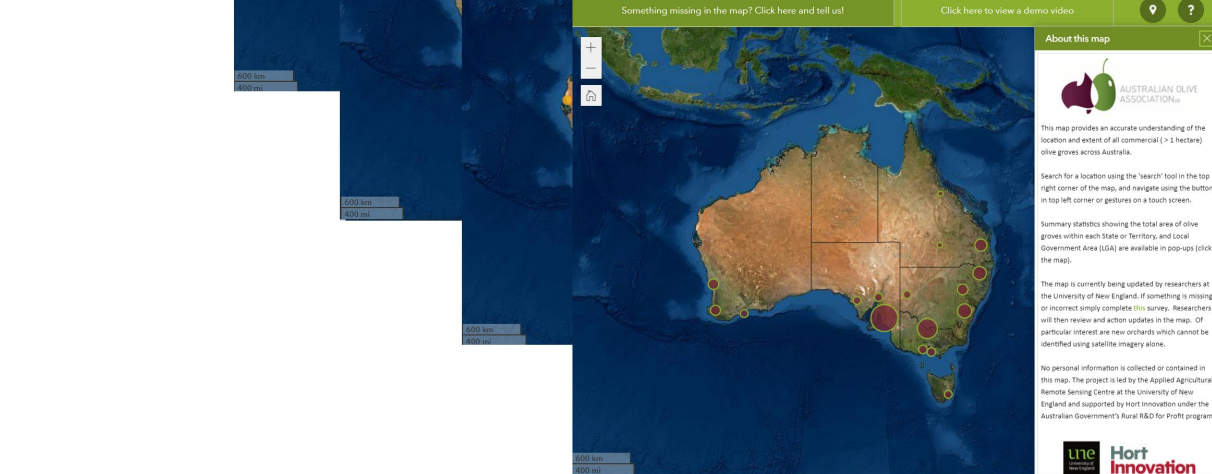
Citrus: [URL](#)



Macadamia: [Embed](#)



Mango: [Embed](#)



Olive: [Embed](#)

- Also currently being mapped:
- Protected Cropping Structures
 - Truffles
 - Rice
 - Soybeans (Qld)

Remains an Essential NEED to map all crops

Current status to map all Australian crops

3 workshops conducted in 2020:

- The developers of mapping products
- The users of mapping products
- A strategy to get this done

Now being championed by:



NCLUMI

National Committee for Land Use and Management Information



Crop Class Mapping in Australia: Workshop Report

Session 1: Wednesday, 14 October 2020, 13:00 - 14:35 AEST

Australian crop mapping: capabilities, challenges and cooperation

Session 2: Thursday, 15 October 2020, 13:00 - 14:35 AEST

How are crop classification products used by government, industry, science and NGOs

Session 3: Friday, 16 October 2020, 13:00 - 15:00 AEST

Moving Forwards Effectively - Linking Producers and Users of crop classification products and services

Linking National capabilities, end user needs, and government for establishing a unified approach to Australian Agricultural crops



The recordings of each workshop are available through this link :

https://www.youtube.com/channel/UC2q2vJZb9y0hbteY3Ob_iLQ



Existing systems are becoming more automated

“Future updates on ABS’ Agricultural Statistics Program

*The ABS is moving towards a modernised approach to producing official agricultural statistics which aims to reduce reliance on large scale surveys. **In this modernised approach, agricultural statistics will be produced using existing public and private sector data sources (for example, levy payer data and earth observations derived crop mapping).**”*

Sarah Kiely

Co-Director Agricultural Statistics Program | Physical Environment Accounts and Statistics Branch | Australian Bureau of Statistics

*“**Crop mapping through use of satellite data is a fundamental dataset to support accurate statistics not just about location of crops but also production, value, number of businesses and water use**”.*

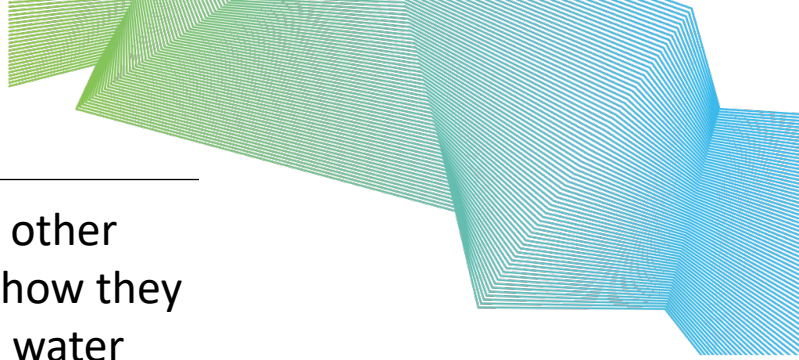
Rob Walter

Co - Director

Agriculture Statistics Program | Australian Bureau of Statistics



Risk: Understanding the threat

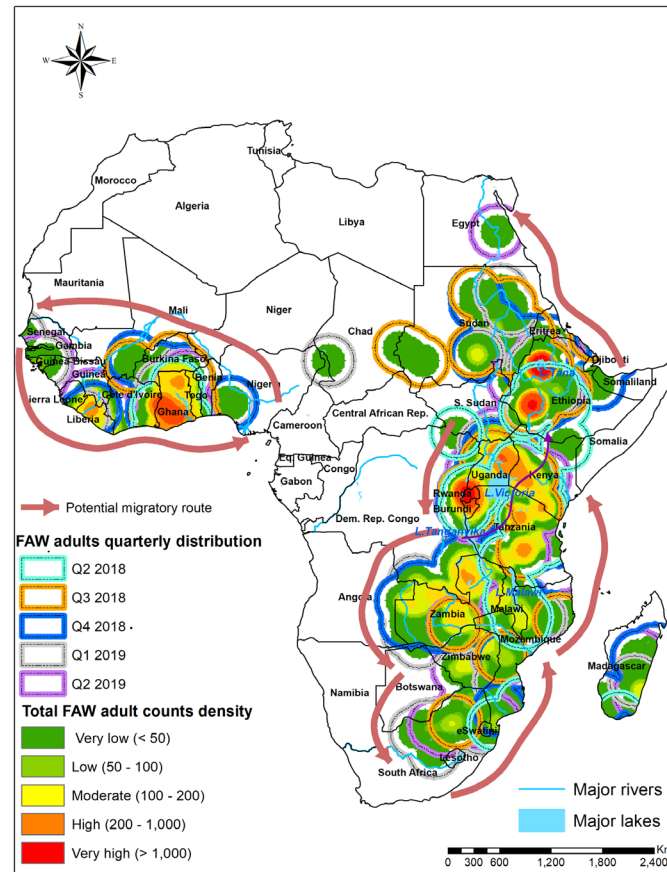


Identify the high risk pest/
disease. Behaviour, breeding
cycles, habitats (entomologists/
pathologists)

Identify past experiences domestically/ other
countries on when these occurred and how they
spread e.g. climate, human movement, water
movement etc (spatial modellers, climatologists)

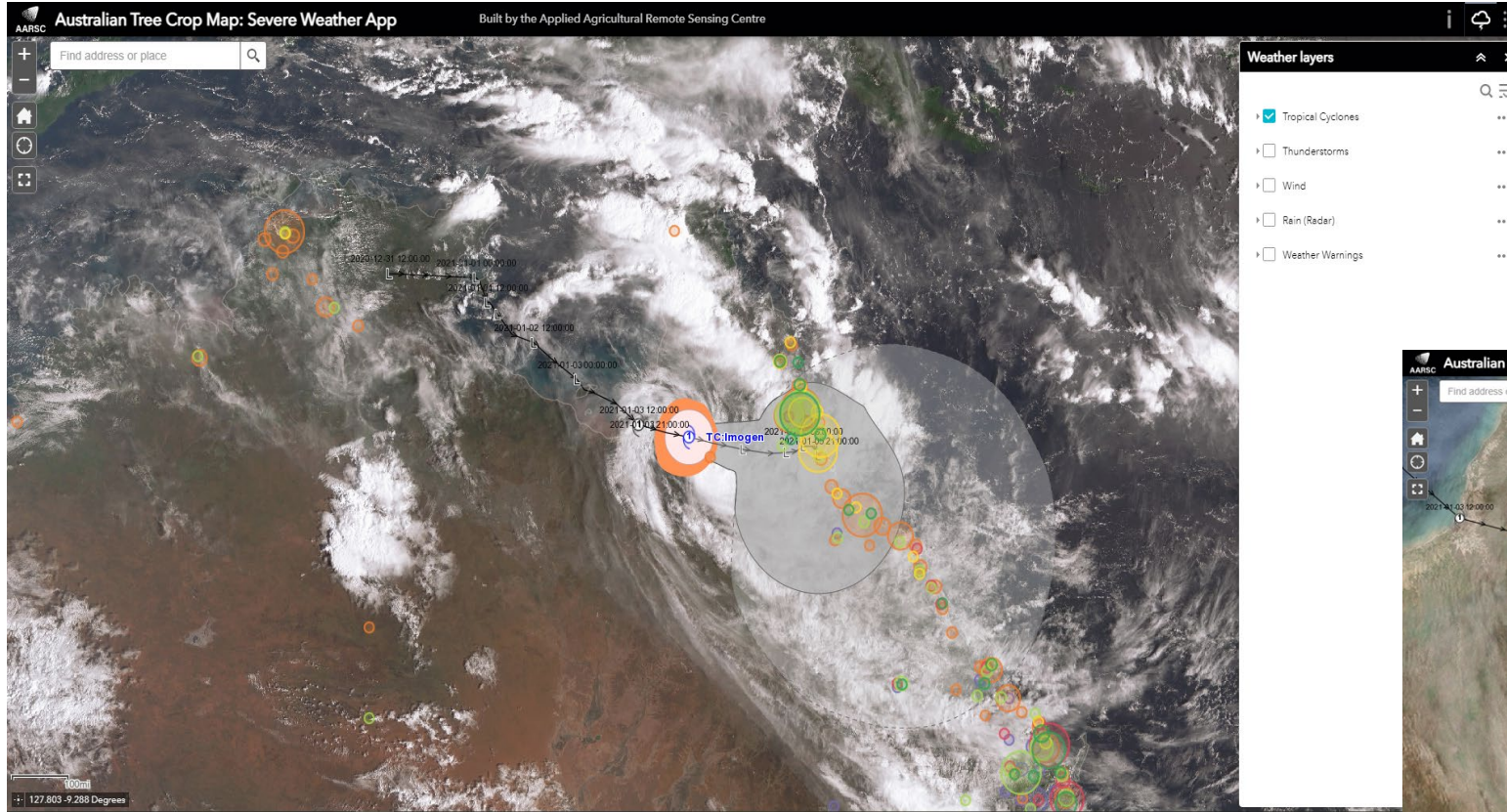


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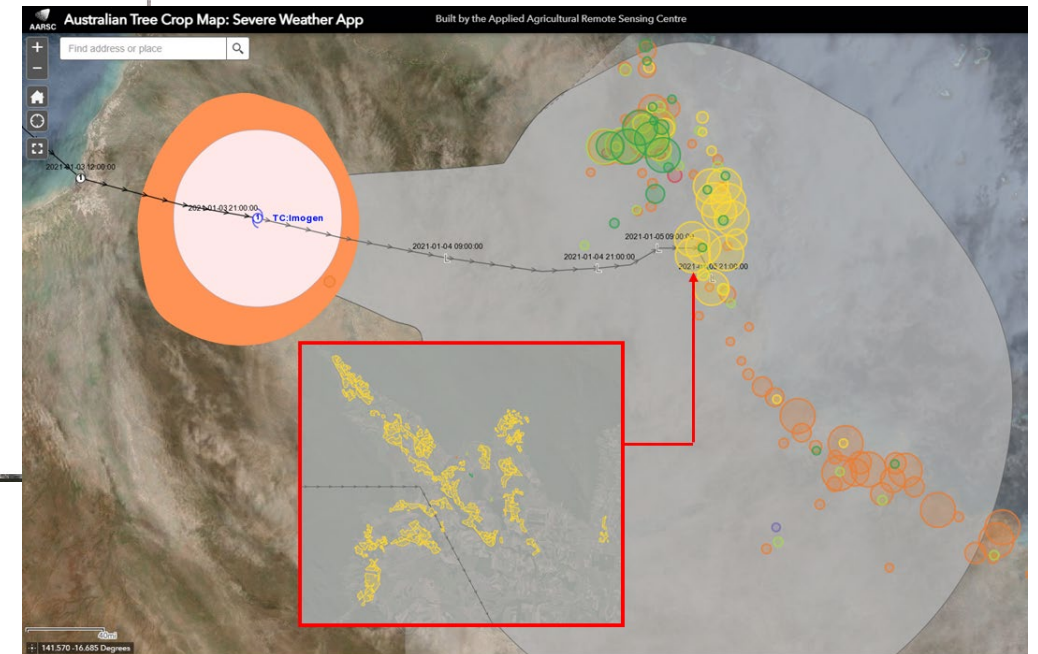


This will help identify the
What to look for, **Where** and
When to look and what
technologies may be best
suited.

Risk: weather potential movers of pests



One theory: 2011 low pressure system, may have transported leaf hoppers carrying phytoplasma to Aus.



The addition of BOM weather information (severe weather warnings, cyclone paths etc) to the 'Australian Tree Crop Map'

<https://une-2351.maps.arcgis.com/apps/webappviewer/index.html?id=d65a6a5fdf5e459e95fa73ad7cb516c9>



Australian Government
Bureau of Meteorology



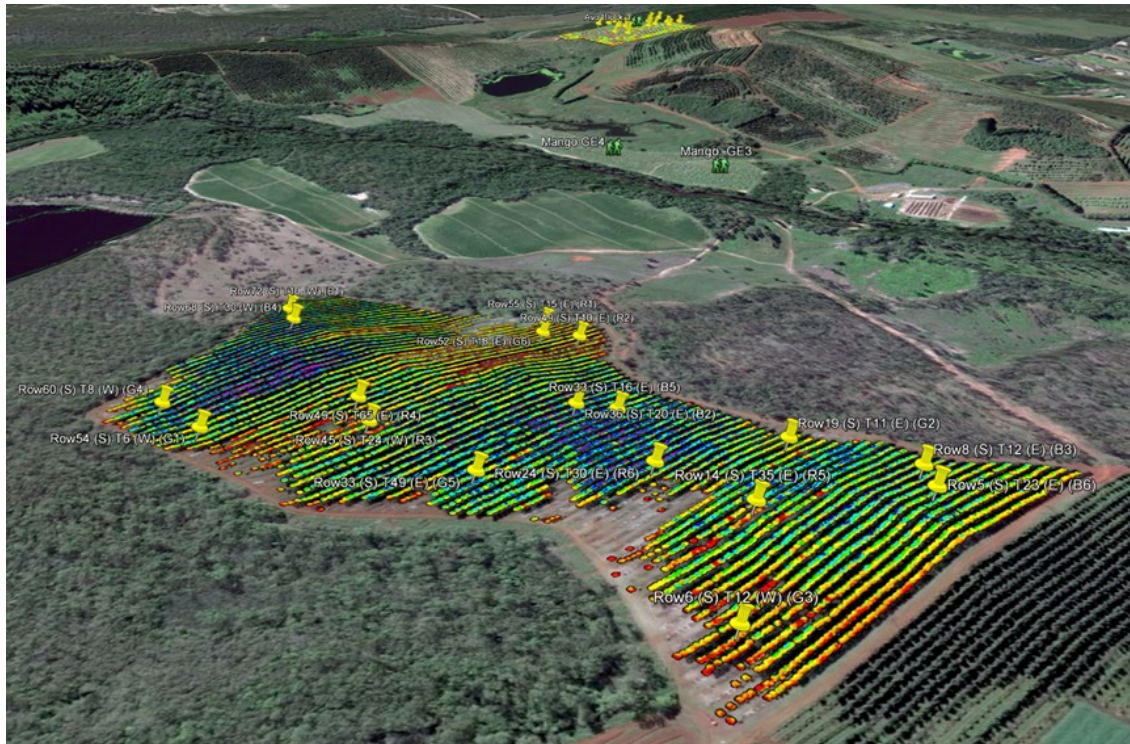
Australian Government
Department of Agriculture
and Water Resources

Hort
Innovation



AARSC
Applied Agricultural
Remote Sensing Centre

Detection: Remote Sensing



Easy bit is to create a colourful picture, but what does it mean?

- **When** do you obtain imagery
- **Where** do you obtain imagery
- **What** Resolution (spatial, spectral, temporal) is needed
- **What** is driving variation
- **How** is variation changing spatially and temporally

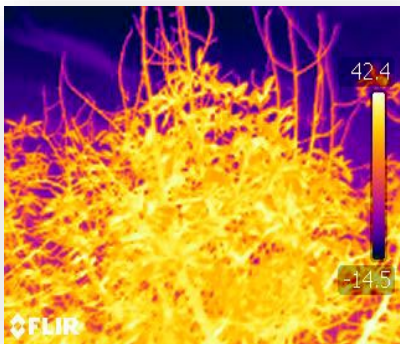
YOU cannot fly a UAV, plane, very high res. satellite over all crops, all of the time, looking for a change that may or may not be a high risk threat

Detection: Remote Sensing

Remote sensing is good at identifying variability in plant health



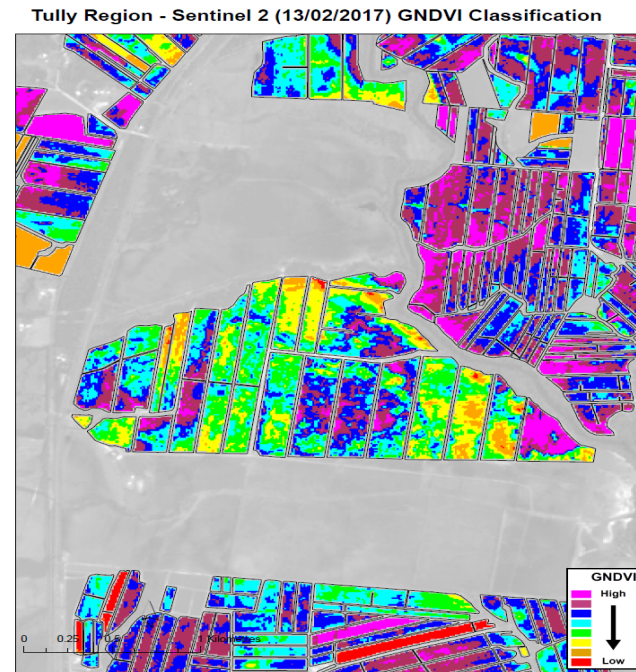
leaf level



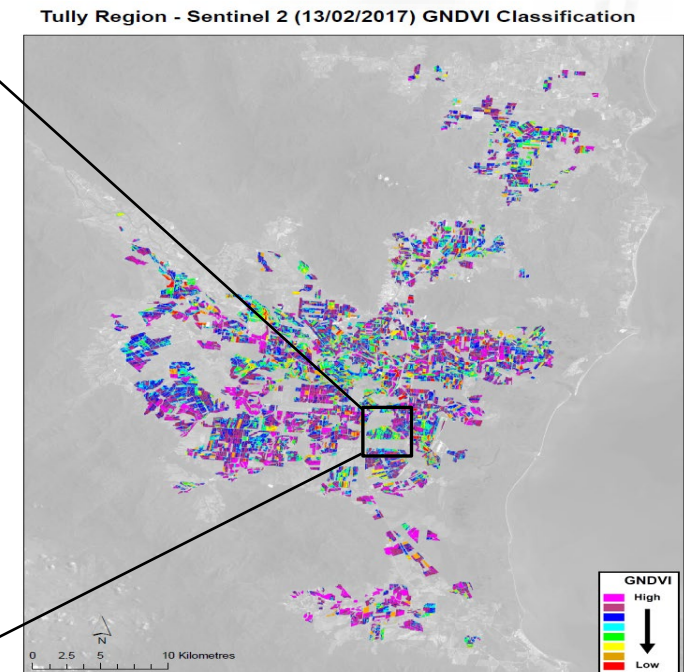
Tree level



Block level



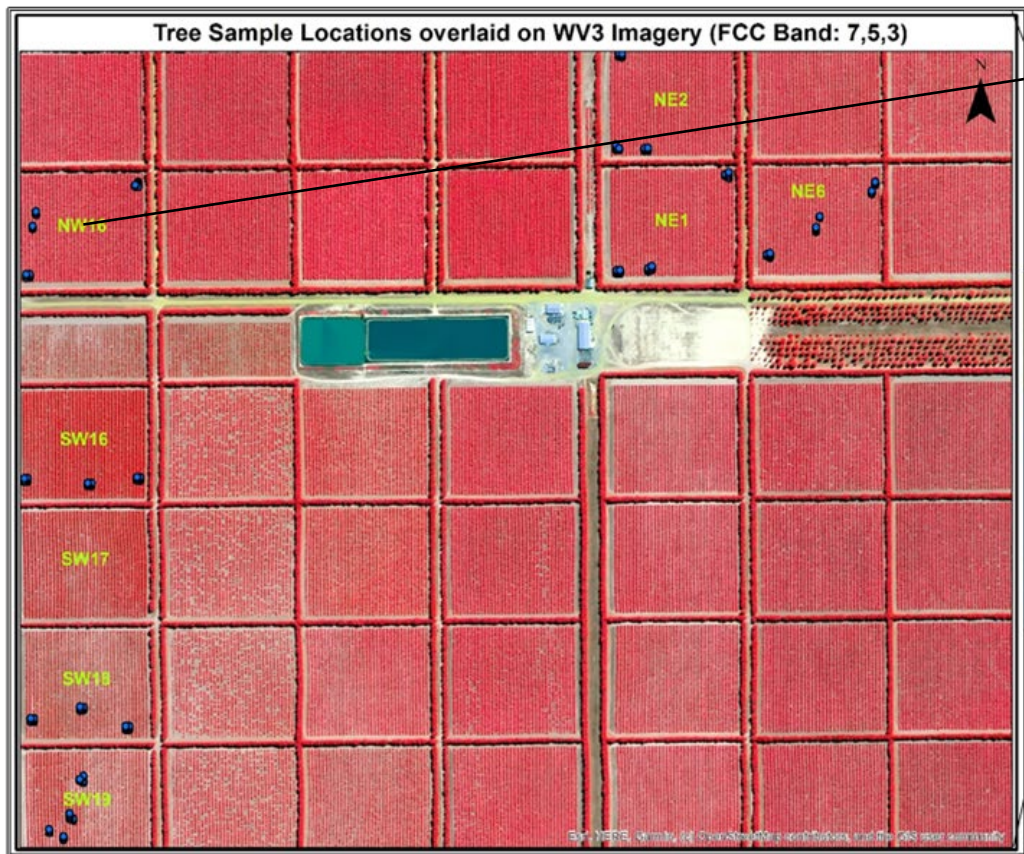
Farm level



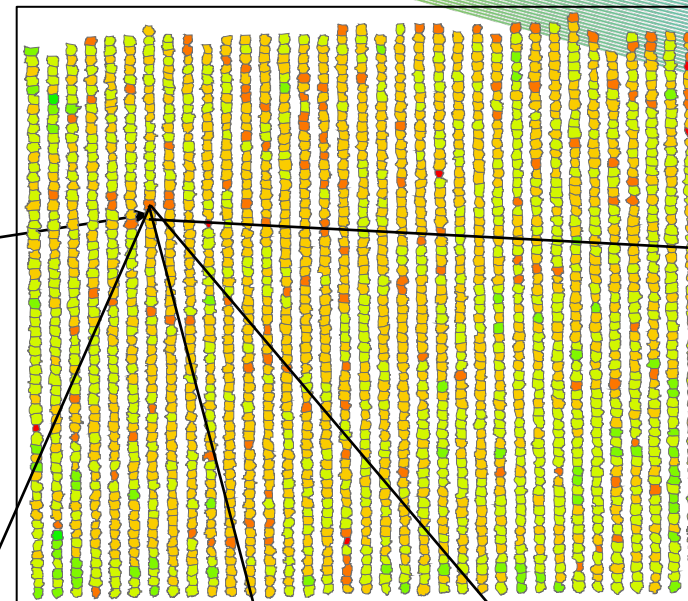
Regional level



Detection: Remote Sensing: At the very least will support targeted surveillance



WV3 satellite image of Citrus



Visual inspection



PCR barcoding



Spore trapping



Disease or pest App
Eg. Tumaini banana

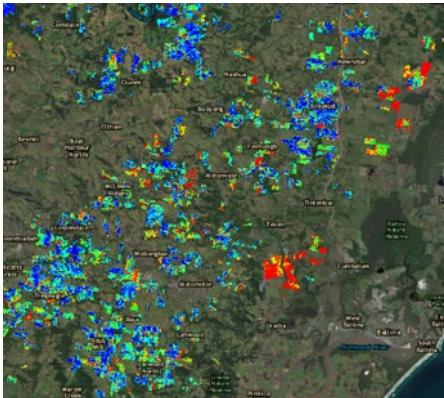
Detection: Remote Sensing: Benchmarking behaviour



Tree

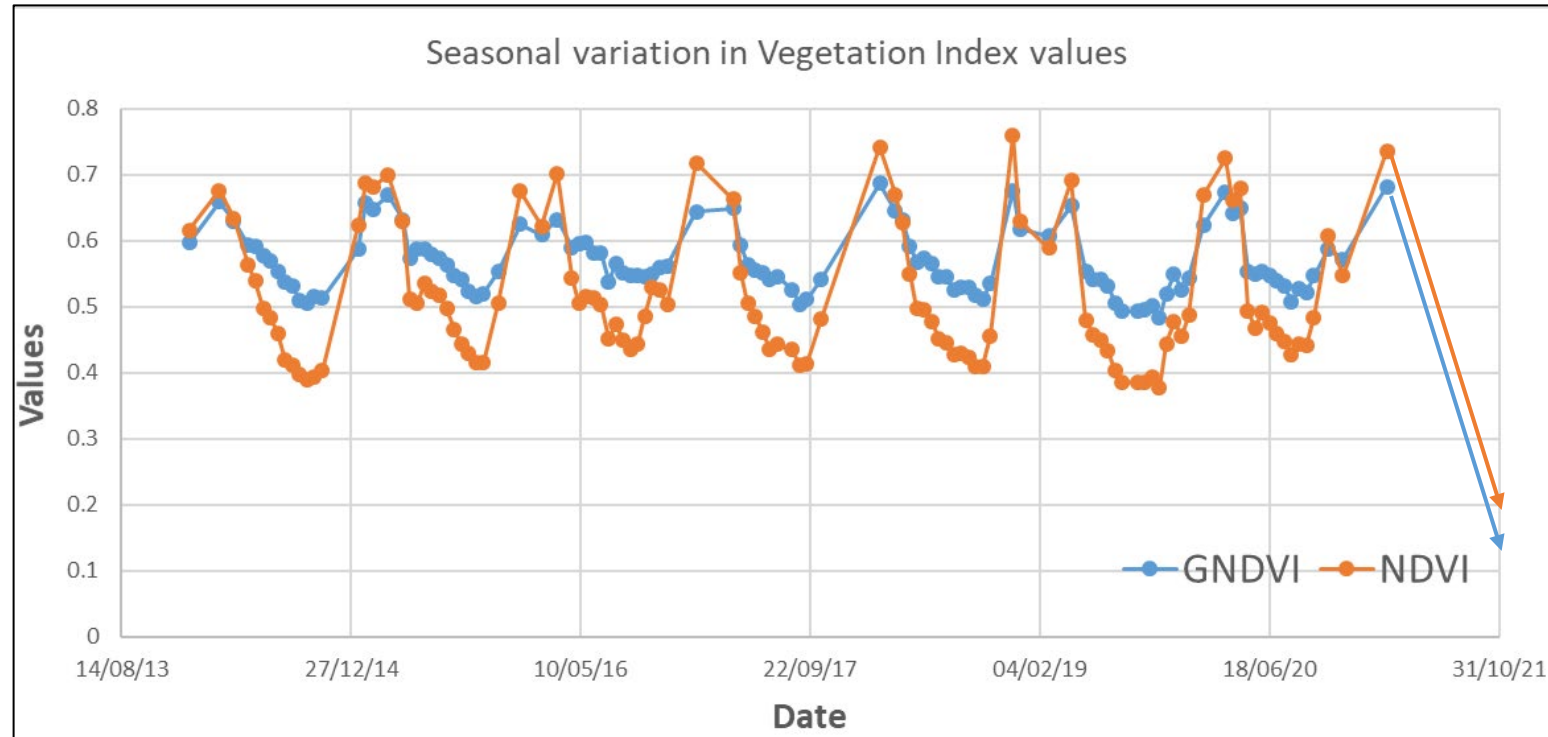


Crop



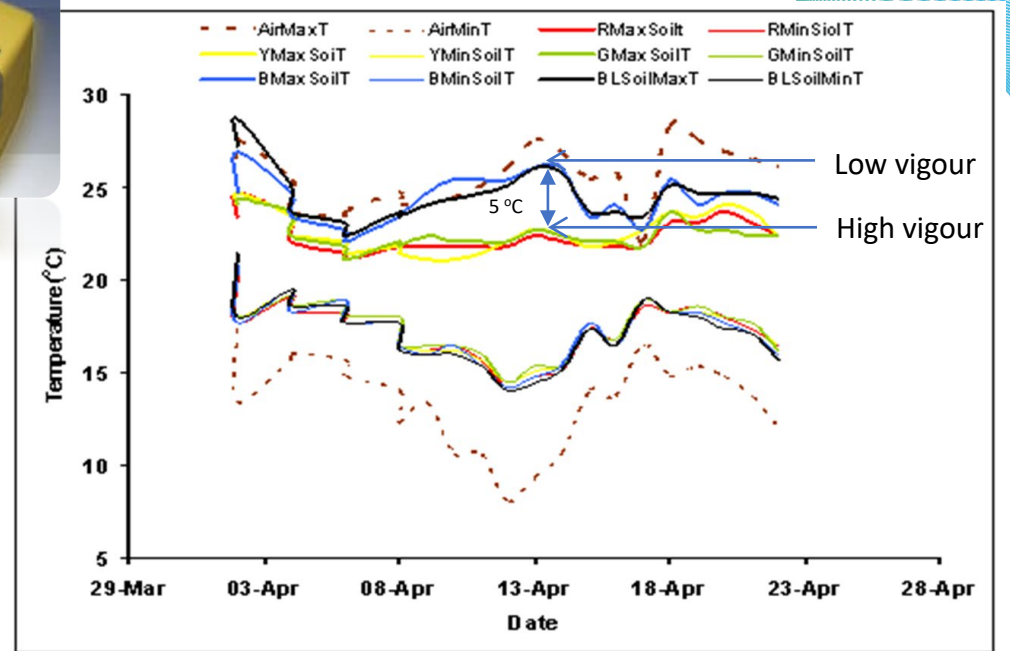
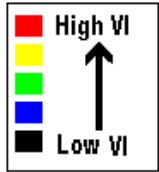
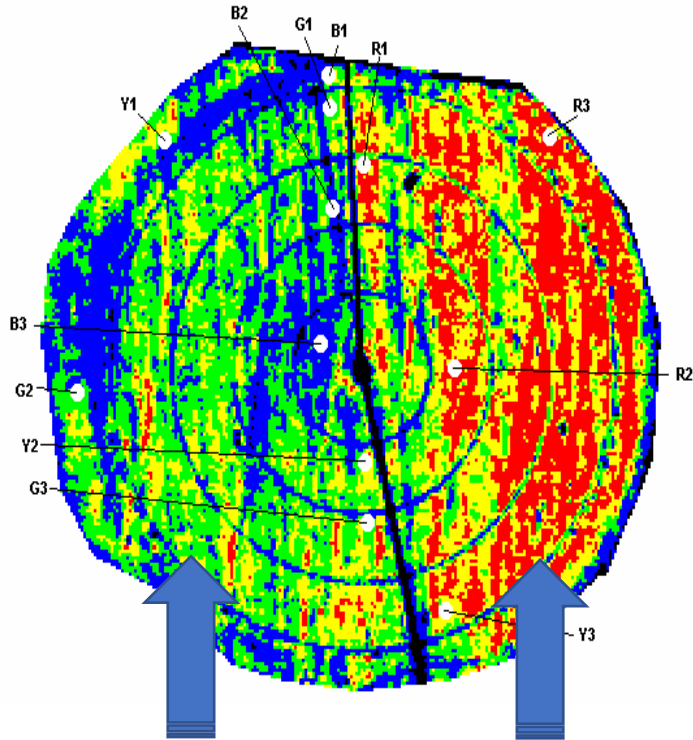
Region

Temporal trends (measured over time) can be used a varied spatial scales to establish a 'normal' or benchmarked seasonal growth profile of crops. Any deviation can indicate the incidence of pest/ disease.



Combining Tech and Core science: aflatoxin example

NDVI of Peanut crop (under centre pivot)



Soil temperatures measured at strategic locations



Crop classified as Blue

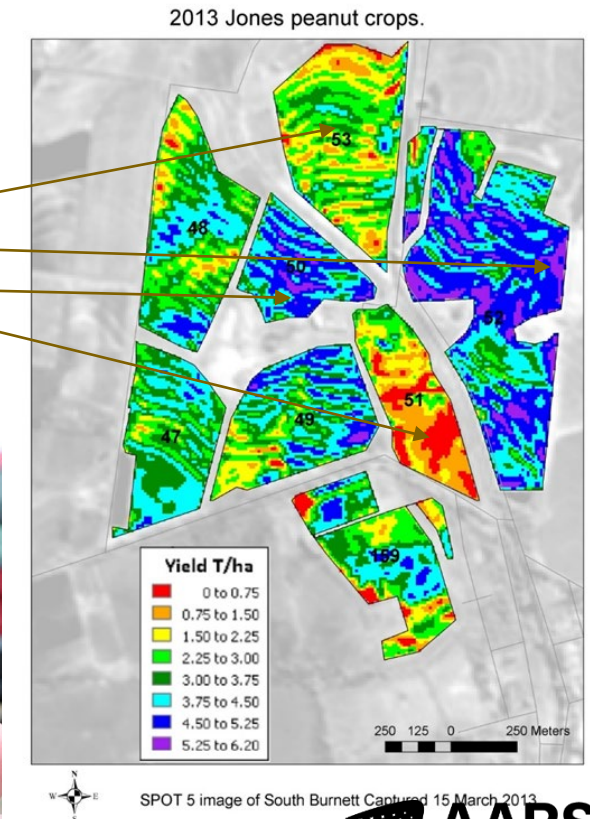
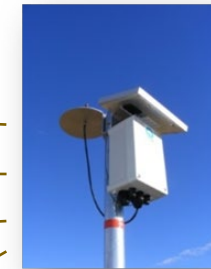
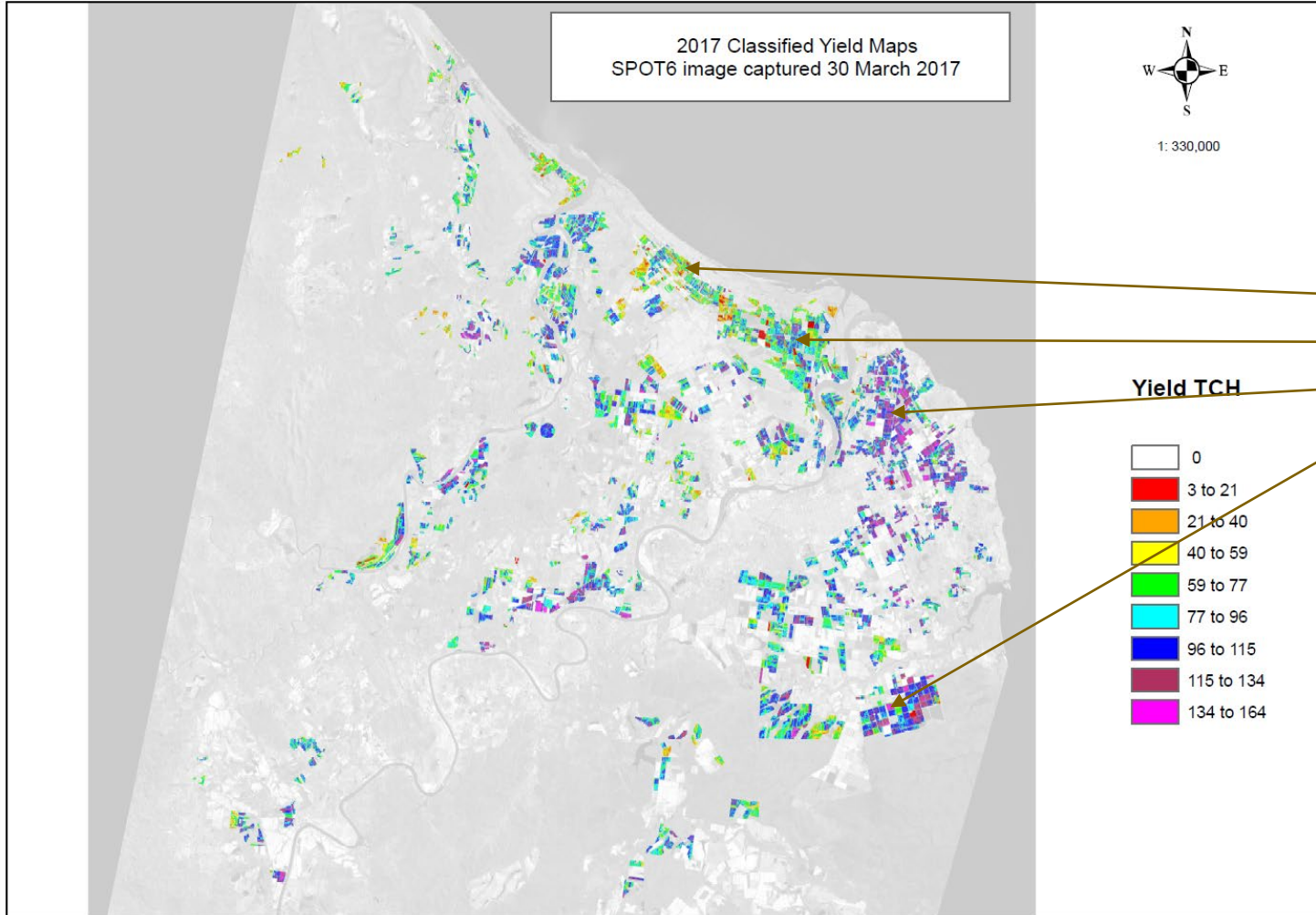


Crop classified as Red

KNOW YOUR THREAT: Aflatoxin risk is high when soil temperatures reach 25°C to 32°C and low soil moisture

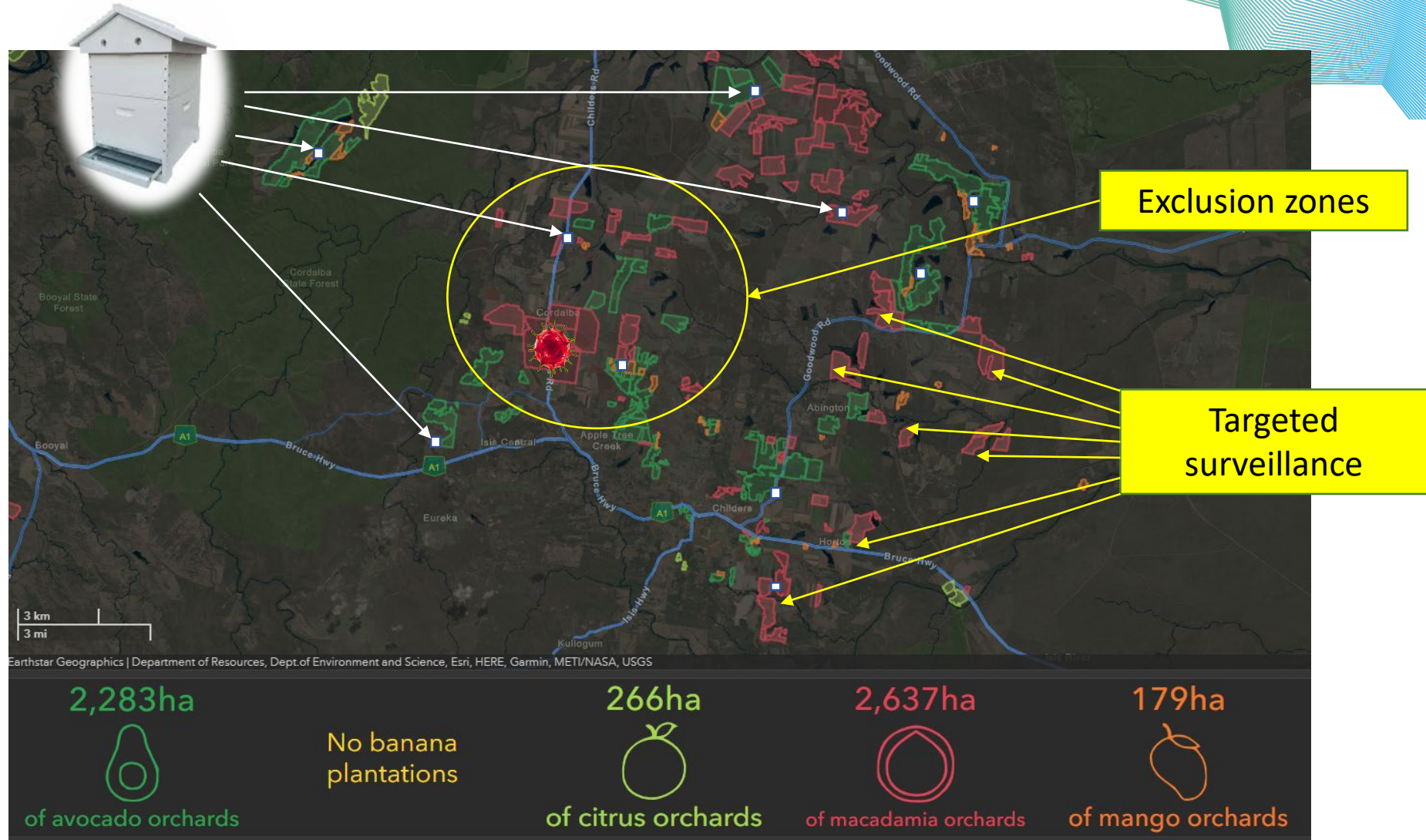
cont. aflatoxin example:

Aflatoxin warning system: Strategically located sensors (within farm and across regions) linked with an App that can alert growers of high risk conditions conducive with aflatoxin. In response growers can irrigate (if possible) or harvest if mature or harvest segregate at a later time to maximise quality and reduce penalty



Response: Establishing exclusion zones and targeted surveillance

- Native vegetation
- Surrounding crops
- Vehicle routes
- Topography
- Watercourses
- Stock routes
- Walking tracks
- Drainage lines



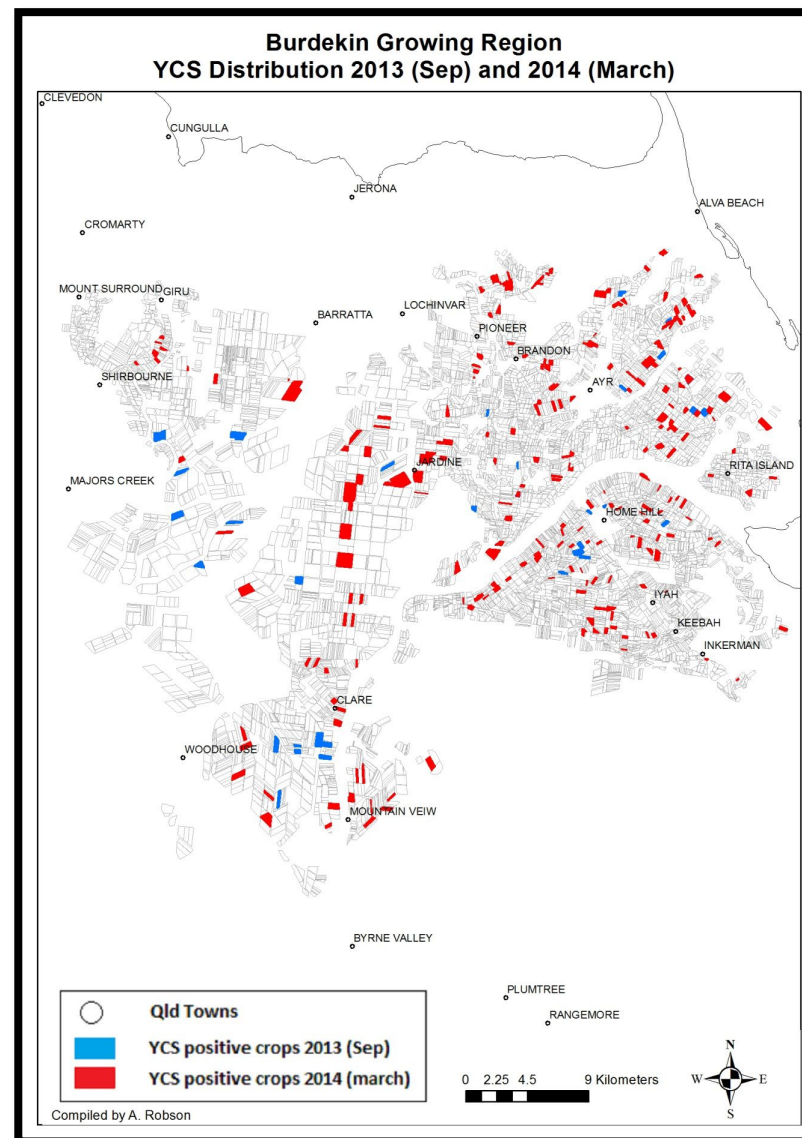
quantifying impact: Yellow Canopy Syndrome: Sugar cane



Mapping the distribution of YCS blocks identified by field assessments of the Burdekin during the early 2014 season (September 2013) (blue polygons) and March 2014 (red polygons).

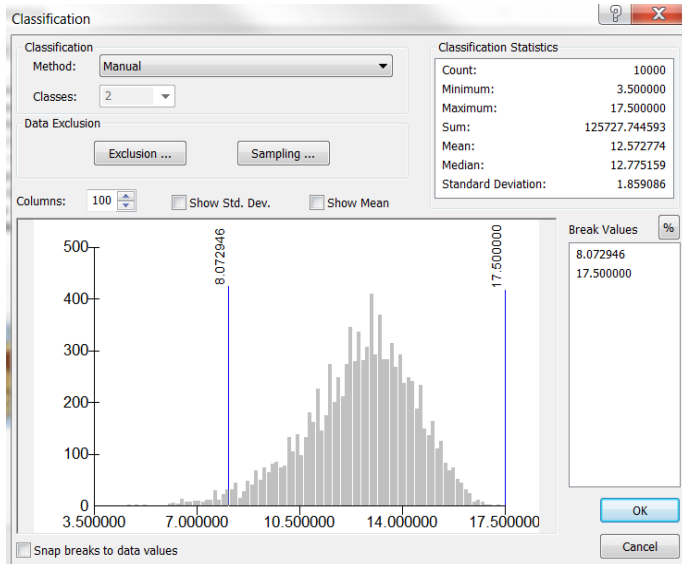


Assist with mapping spread:
predict future Spread

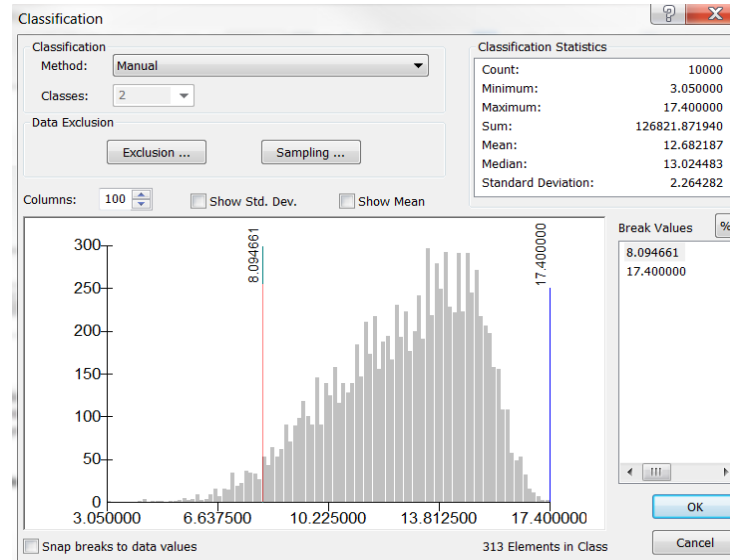


Cont. Example YCS: Sugar cane

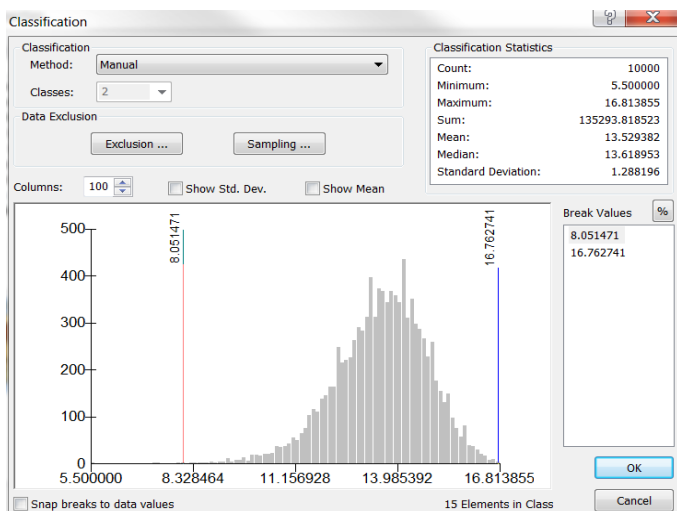
2010



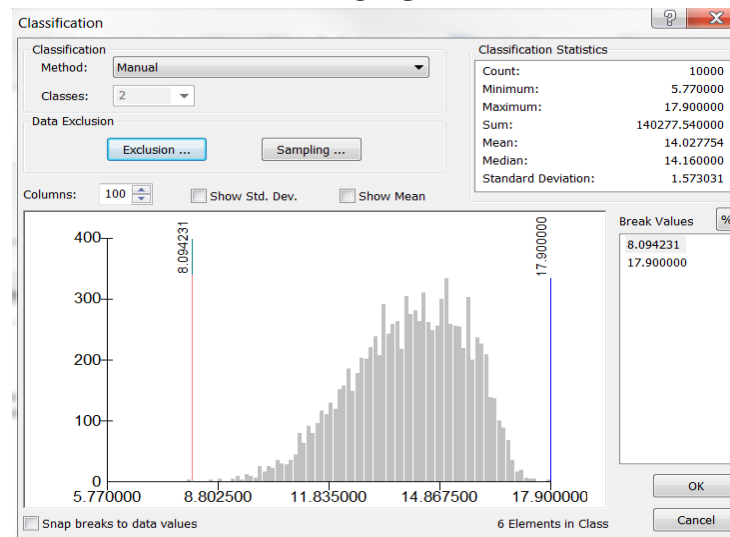
2011



2012



2013



Supports Spatial statistics:

Mapping the distribution and frequency of crop level CCS in the Herbert Region from 2010- 2013.

10,000 crops analysed using actual data (not modelled)

Full report: 'Preliminary investigating into the effectiveness of remote sensing and GIS for identifying Yellow Canopy Syndrome (YCS) in Sugarcane'.

<https://pdfs.semanticscholar.org/86aa/4f4a2fed8472afca62adfd2c0fbb41aabff.pdf>

In Conclusion:

- **Remote sensing** is a perfect tool for assisting in the **What, Where, When,** and the **Why** biosecurity threats are likely to occur
- Essential tool to support biosecurity and IPM strategies, requires the appropriate **integration of technologies with core sciences** for improved:




- **We need the most fundamental base layer (National map of all crops) developed and available ASAP.**
- **This layer will underpin a spatial structure to support:**
 - biosecurity (\$25 billion p.a.)
 - natural disaster response (1.59 billion p.a.),
 - improved traceability (1 billion p.a.),
 - carbon modelling(6.58 billion p.a.) etc.

Thank you and Questions?

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 www.une.edu.au/aarsc