



# Remote Sensing for Rehabilitation Monitoring and Weed Survey

21 September 2016

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# Outline

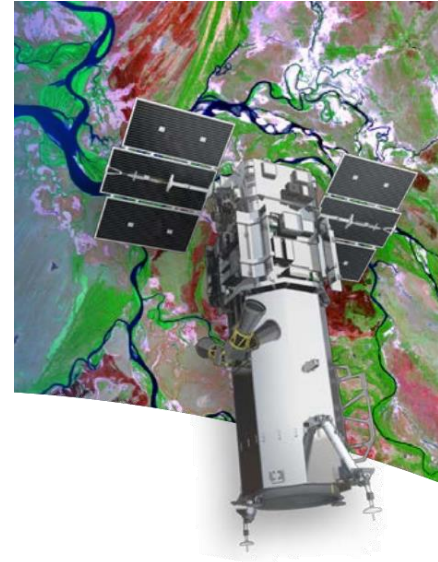
1. Introduction to remote sensing
2. Rehabilitation monitoring
3. Weed detection

# 1. Remote Sensing

Remote sensing is...

...the acquisition of information about an object or phenomenon without making physical contact with the object and thus in contrast to on-site observation (Wikipedia)

# Remote Sensing



 **astron**

# Spatial Resolution

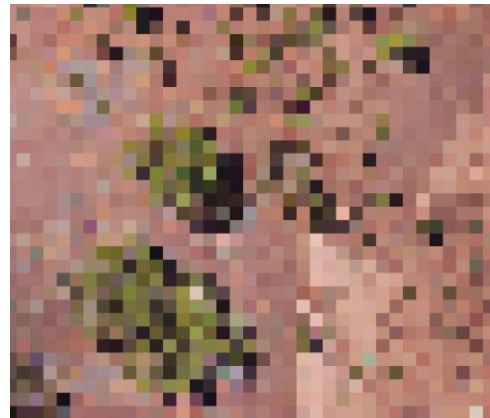
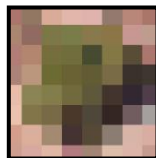
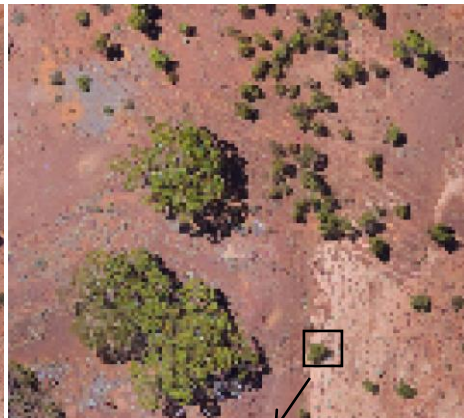
Fine	<< -- >>	Coarse
Dollars / ha	<b>Cost</b>	Free
GBs	<b>Size</b>	MBs
Km <sup>2</sup>	<b>Extent</b>	Globe

0.02 m (UAV)

0.5 m (aerial)

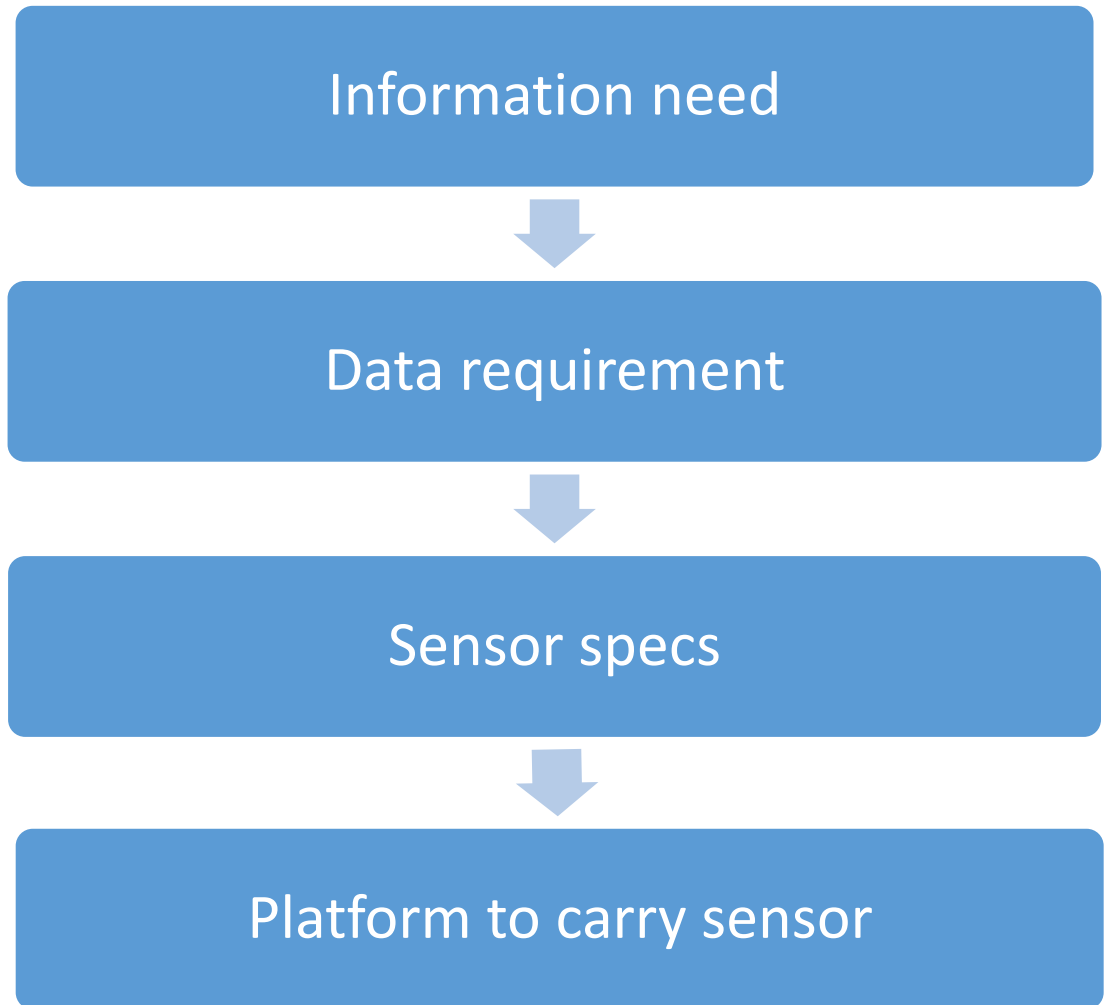
2 m (Worldview 3)

30 m (Landsat 8)



# Platform Choice

Choose the platform  
last!



## 2. Rehabilitation Monitoring

- Landscape scale monitoring → understand your whole site
- Cost effective for:
  - large areas
  - sites with multiple disturbance areas
  - progressive rehabilitation that requires monitoring of multiple areas
- Reduces access constraints

# Census vs Sub-Sample

- Ground-based methodologies using quadrats or transects only monitor a sub-sample of the area. This introduces issues due to:
  - sample bias due to placement of sites
  - observer bias
  - number of sites required for data to be representative
  - can miss important features such as erosion gullies
- Remote sensing is a census of a site rather than a sub-sample

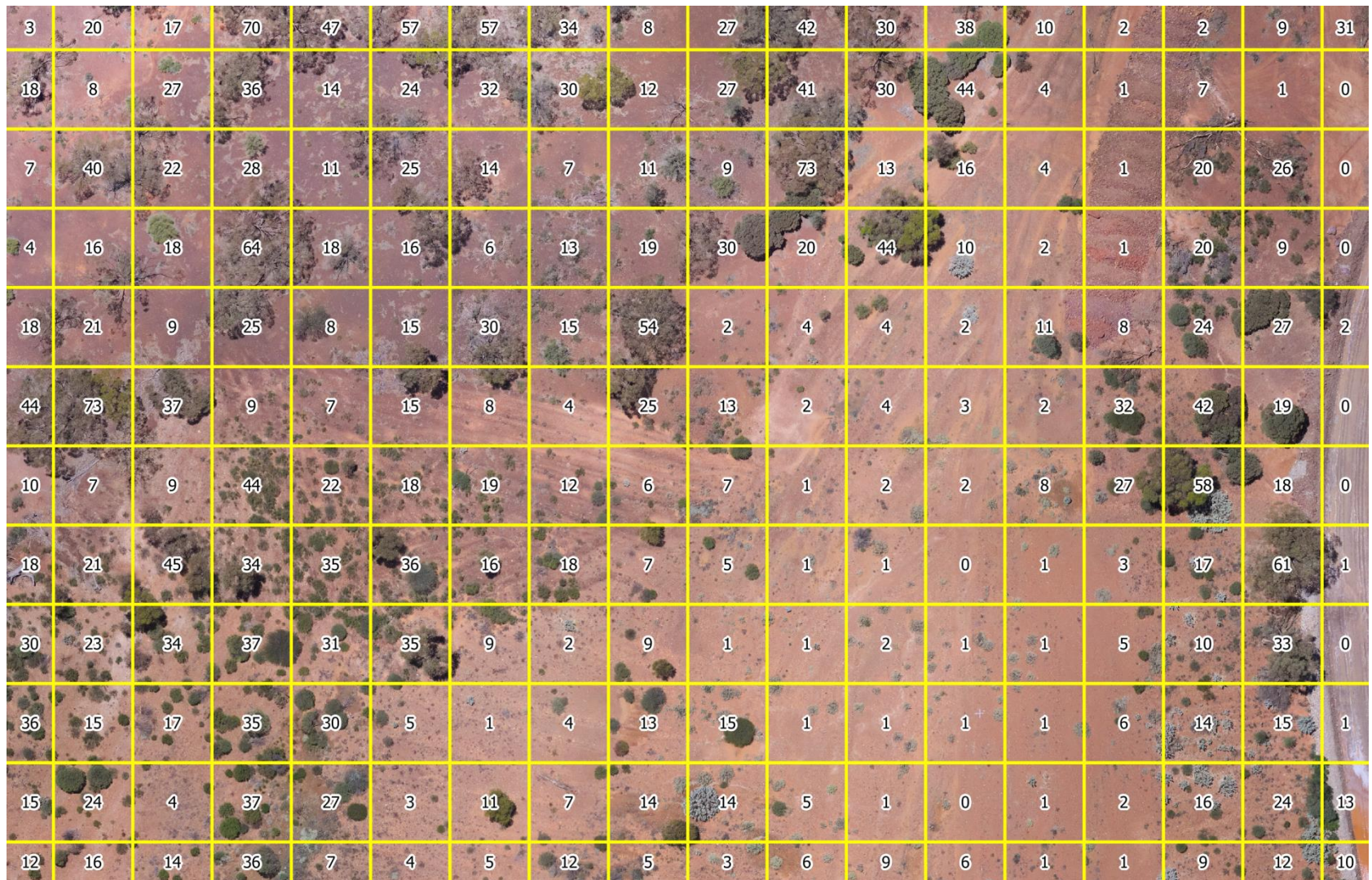


# Census vs Sub-Sample





# Census vs Sub-Sample



Vegetation cover in 10 x 10 m quadrats. 0 to 73% recorded.

# Development of Rehabilitation Performance Metrics

- We have been working with the mining industry to:
  - develop metrics for assessment of rehabilitation performance at the landscape scale
  - use a web mapping system to present spatially enabled data in an intuitive way so it can be easily seen if a site is meeting rehabilitation objectives or completion criteria



# Development of Rehabilitation Performance Metrics

- Focussed on developing metrics which can be used to assess progress towards meeting completion criteria and for guiding management measures in three key areas:
  - landform geometry
  - landform stability
  - vegetation



# Landform Geometry Metrics

- Can be applied at all stages throughout the landform construction process
- Metrics include:
  - batter height
  - batter angle
  - berm width
  - berm slope
  - crest bund height
  - crest bund width
  - landform height and footprint
  - identification of areas where ripping has occurred
  - angle of ripping

# Landform Geometry Metrics

Data can be used to:

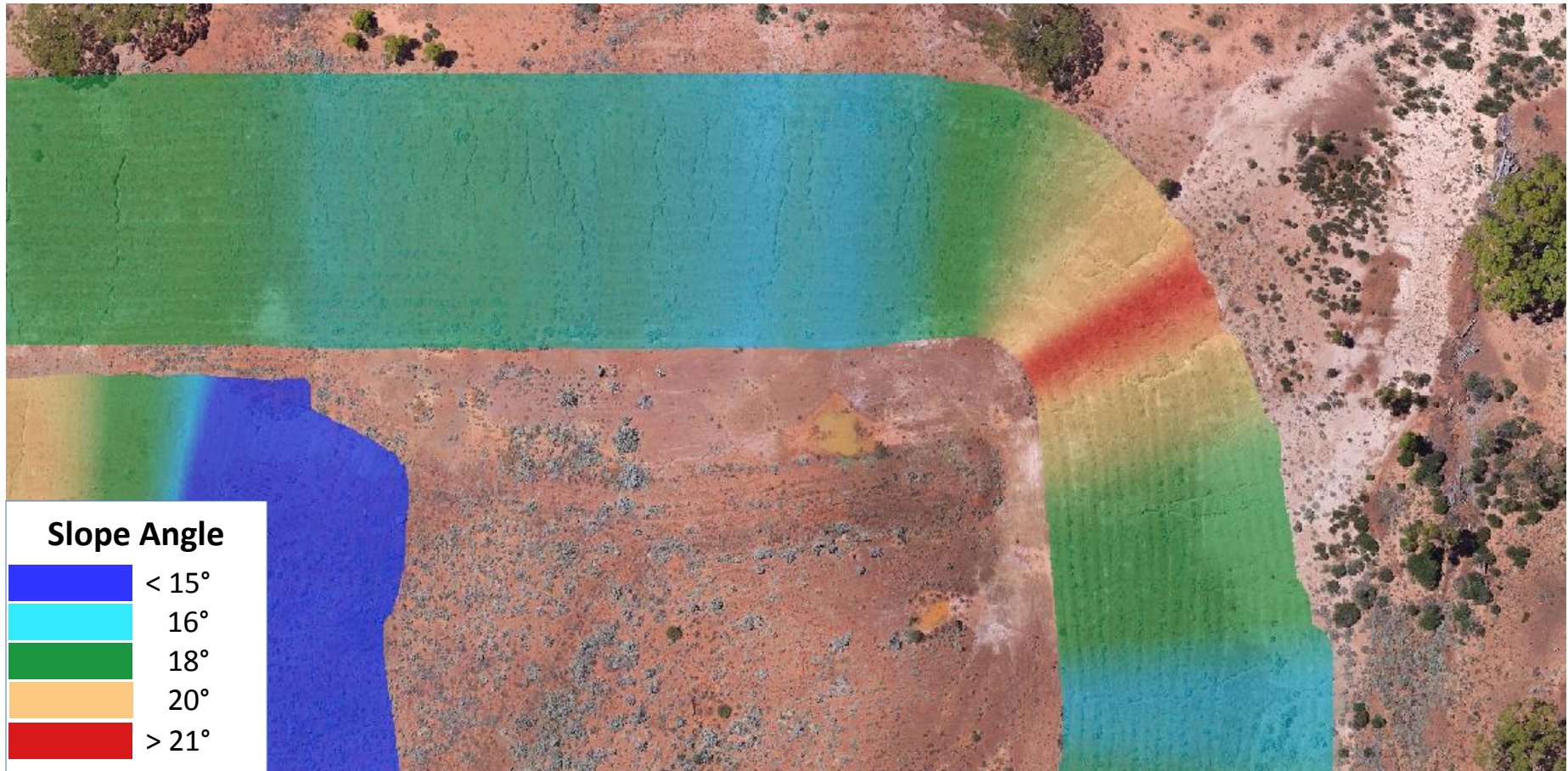
- assess compliance with approved designs
- identify areas of high erosion risk early in the process so they can be fixed at the lowest cost

Modelling can identify risk areas such as:

- areas where ponding will occur
- low points in bunds or berms
- areas of flow concentration
- convex areas on slopes

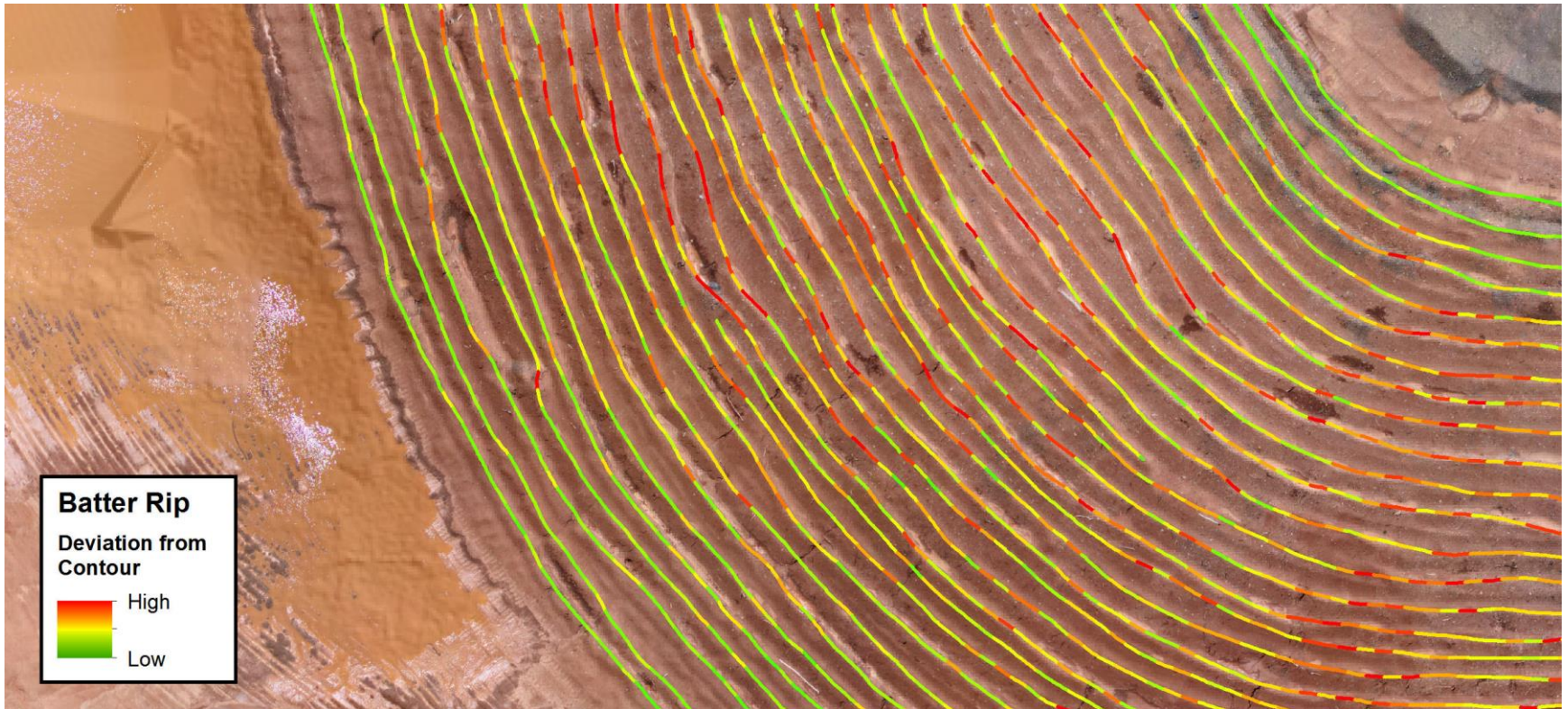


# Landform Geometry – Batter Angle





# Landform Geometry – Ripping Angle





# Landform Stability

Conventional point based monitoring not well suited for landform stability monitoring as it is easy for erosion or gullies to be missed by quadrats or transects.

Metrics include:

- gully location
- gully depth
- gully width
- gully volume
- gully spacing
- total erosion cover

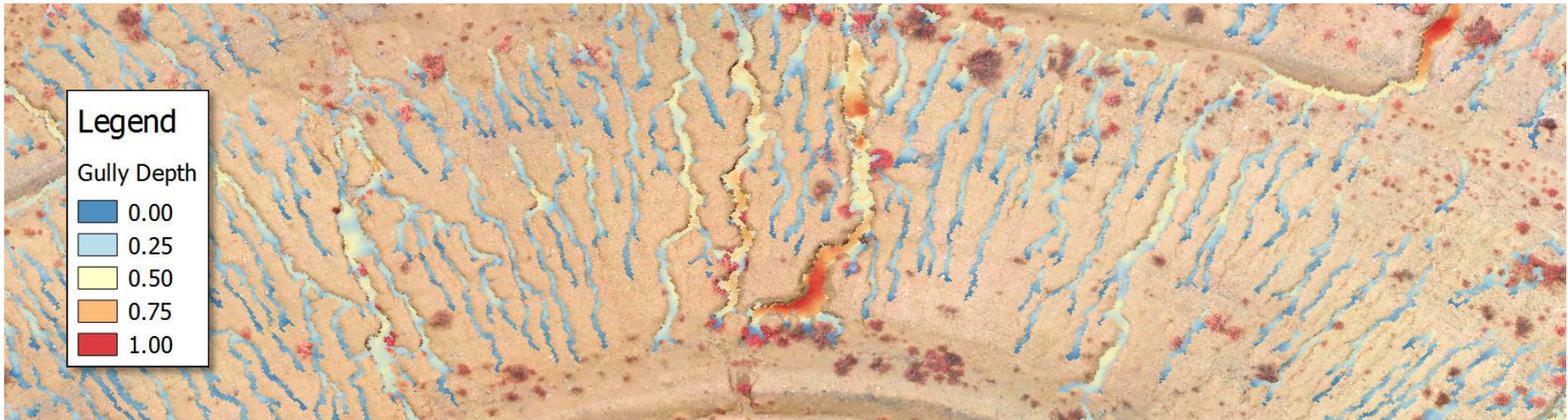
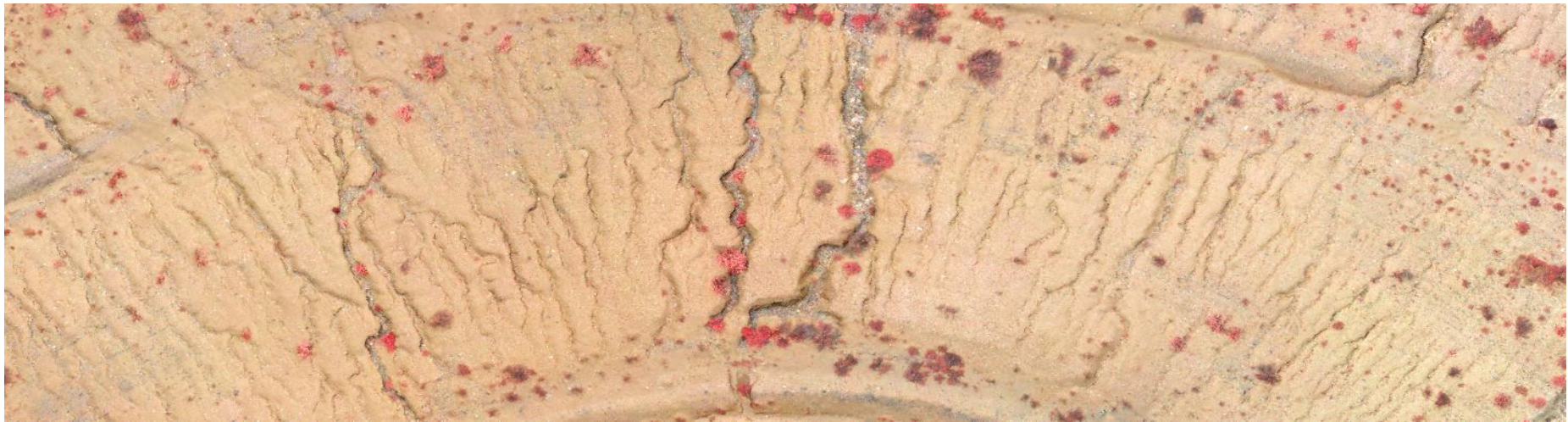


# Landform Stability

- With an elevation model resolution of 2 cm gullies with a width of 8 cm can be reliably detected
- Data can be used to assess performance against completion criteria related to parameters such as gully depth or spacing
- Temporal data can be analysed to determine:
  - if gullies are active or stable
  - if sedimentation is occurring and if it is affecting surrounding vegetation



# Landform Stability – Gully Depth





# Vegetation Metrics

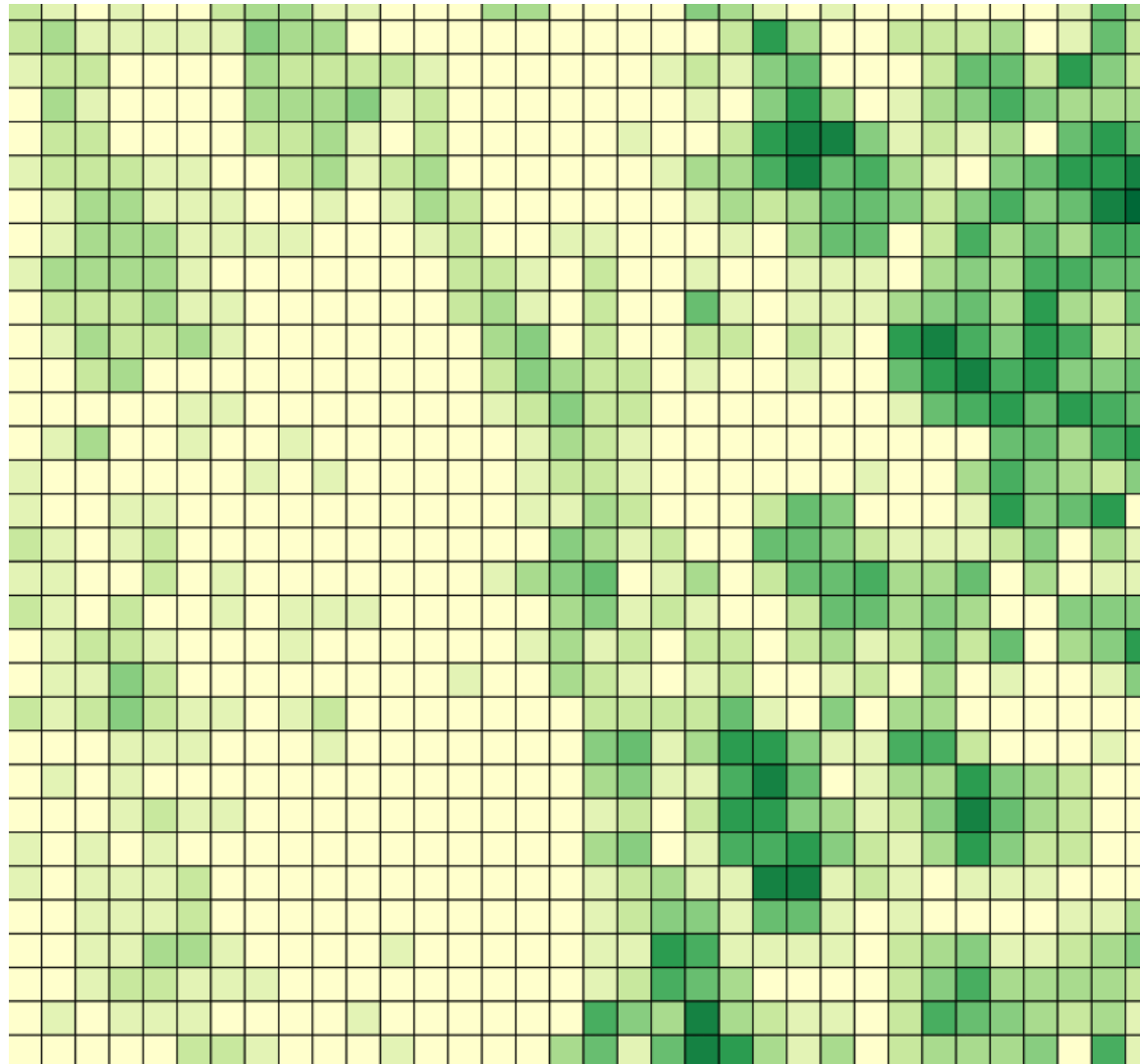
- Metrics include:
  - vegetation cover
  - vegetation cover in height classes
  - vegetation health
  - identification of individual species



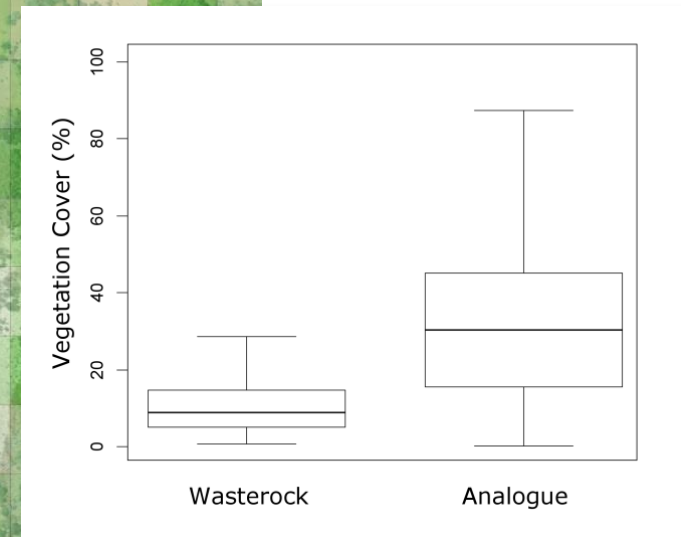
# Vegetation Metrics

- Data can be used for:
  - setting completion criteria
  - assessing performance against completion criteria relating to cover
  - quantifying changes in vegetation health
  - determining if patchiness in rehabilitation is similar to that in the surrounding vegetation
  - identifying areas of poor vegetation health that may be caused by external factors such as acidic drainage.

# Vegetation - Cover



# Vegetation Metrics - Cover



# Data Delivery

- Data can be delivered as GIS layers or on a web-based platform
- Presented in an intuitive and accessible way to easily see if a site is meeting rehabilitation objectives or completion criteria
- Can incorporate point based data (including historic data) with remote sensing data
- Can drill down to the level of detail you are interested in and produce automated reports summarising rehabilitation performance using a range of figures and descriptive statistics



SITE

☐ Wattle Bird

☐ Deep Valley

☒ Devondale

☐ Tailings Storage Facility

☐ Waste Rock Dump

☐ Warringa

REHABILITATION PERFORMANCE METRICS

☐ Landform Geometry

☐ Landform Stability

☒ Vegetation

☐ Cover

☐ Health Index

☐ Height Classes





## Site Overview - Devondale



	Landform Geometry			Landform Stability			Vegetation		
Domain	Batter Angle	Berm Width	Bund Height	Erosion Volume	Gully Width	Gully Spacing	Follar Cover	Health Index	Height Classes
Tailing Storage Facility	19.5	10	0.7	0.7 ↓	1.2 ↓	2 ↔	3.2 ↑	20 ↑	10 ↑
Waste Dump Rock	18	7.5	0.2	0.2 ↔	1 ↔	0.8 ↑	2.8 ↑	26 ↓	15 ↔
Completion Criteria	20	10	0.5	0.5	1	1	3	25	12

## Site Description

Site Commencement  
2008

Current Disturbance Footprint  
198ha

Active Domains  
Tailings Storage Facility - 96ha  
Waste Rock Dump - 102ha

Rehabilitation Liability Category  
Category B

Current Area under Rehabilitation  
102ha

## Site Photos

2015 ▾

2014 ▾

2013 ▲

January  
**February**  
March  
April  
May

2012 ▾

February 2013



## Relevant Documents

Devondale Mine Closure Plan

Rehabilitation Monitoring Report 2014

Rehabilitation Monitoring Report 2013

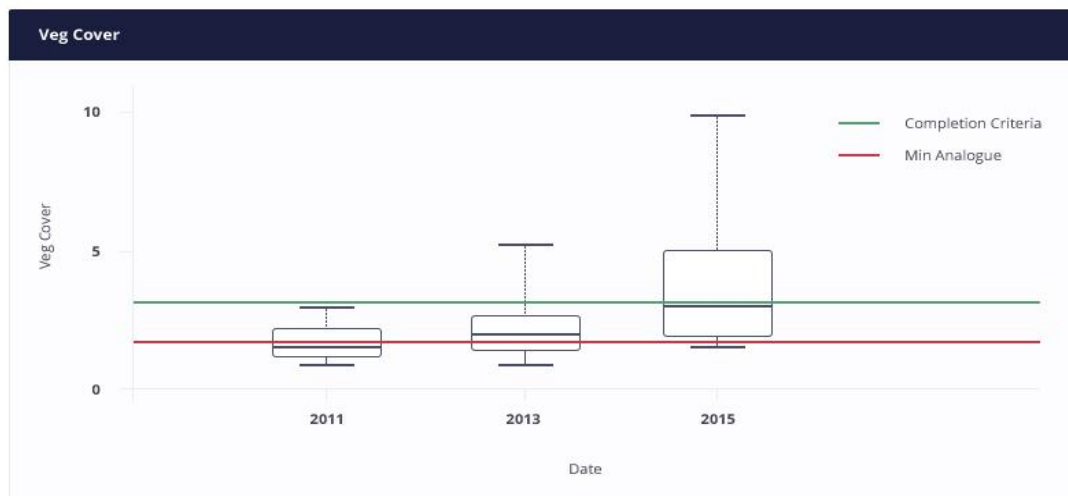
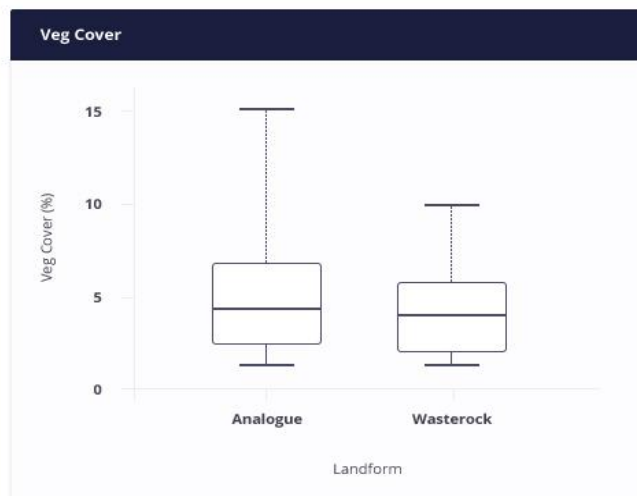
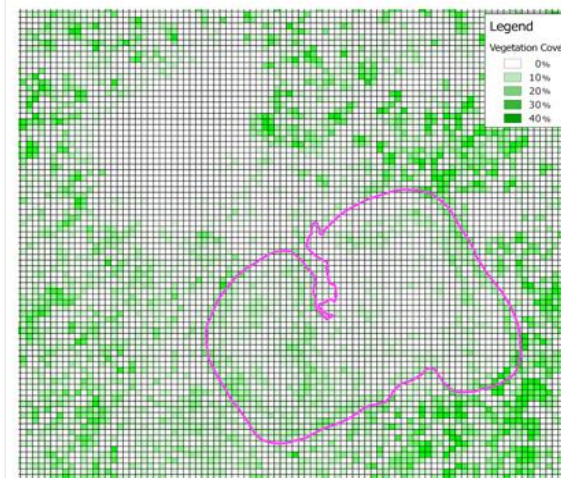
## Detailed Report

Site Devondale

Domain Waste Rock Dump

Metric Vegetation - Cover

Veg Cover (%)	Wasterock (%)	Analogue (%)
0 - 10	93.95	78.94
10 - 20	5.5	10.51
20 - 30	0.51	4.8
30 - 40	0.04	2.54
40 - 50	0	1.63
50 - 60	0	0.91
60 - 70	0	0.47
70 - 80	0	0.17
80 - 90	0	0.02
90 - 100	0	0.01



# 3. Weed Detection - Parkinsonia

## *Parkinsonia aculeata*

- Weed of National Significance
- Declared Pest in WA
- Invasive to rangelands and wetlands



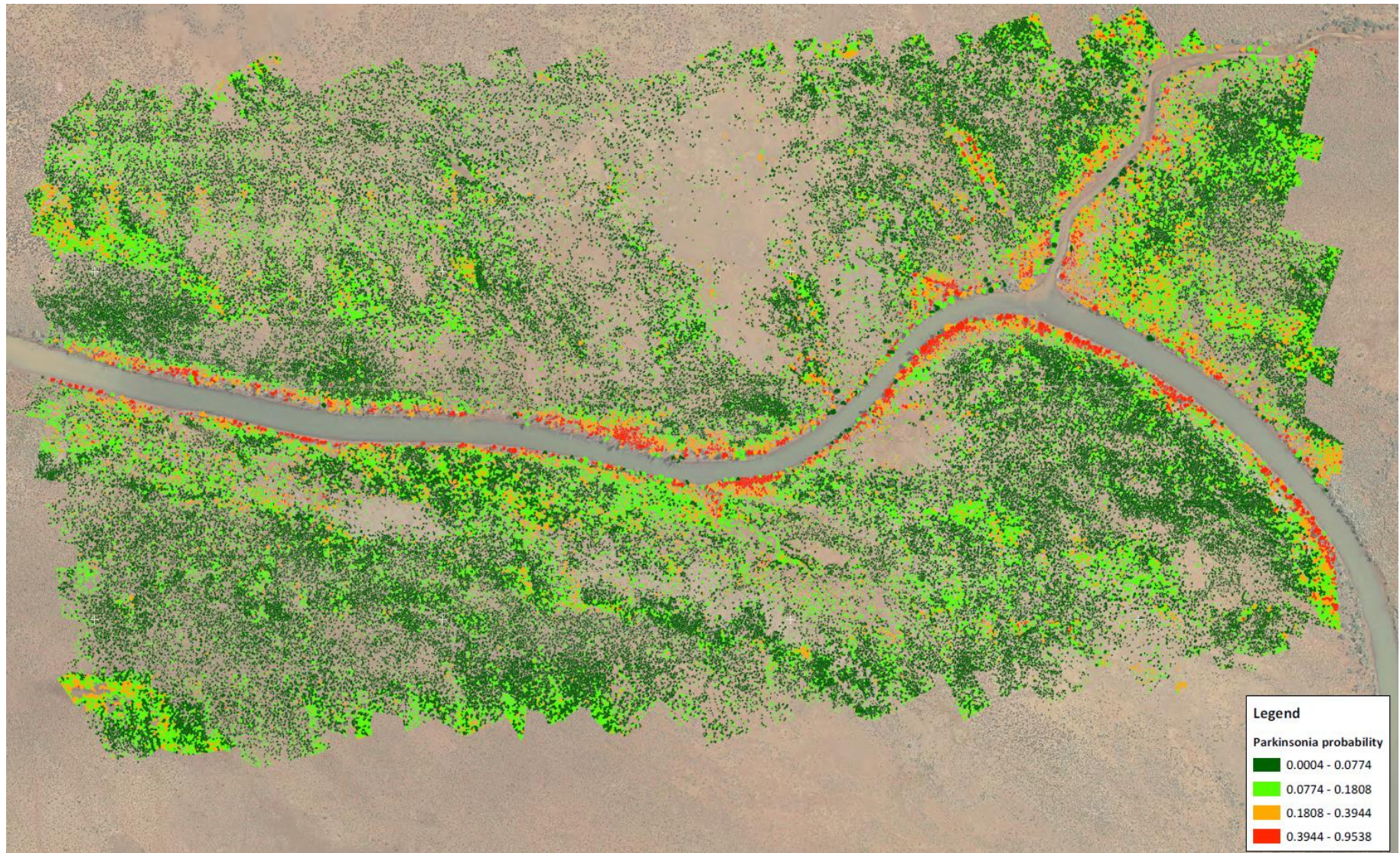


# Weed Detection - Purpose

- Improve the efficiency and effectiveness of the Parkinsonia control program
  - Identify Parkinsonia locations without ground surveys
  - More effective and efficient control activities
  - Precisely monitor control effectiveness



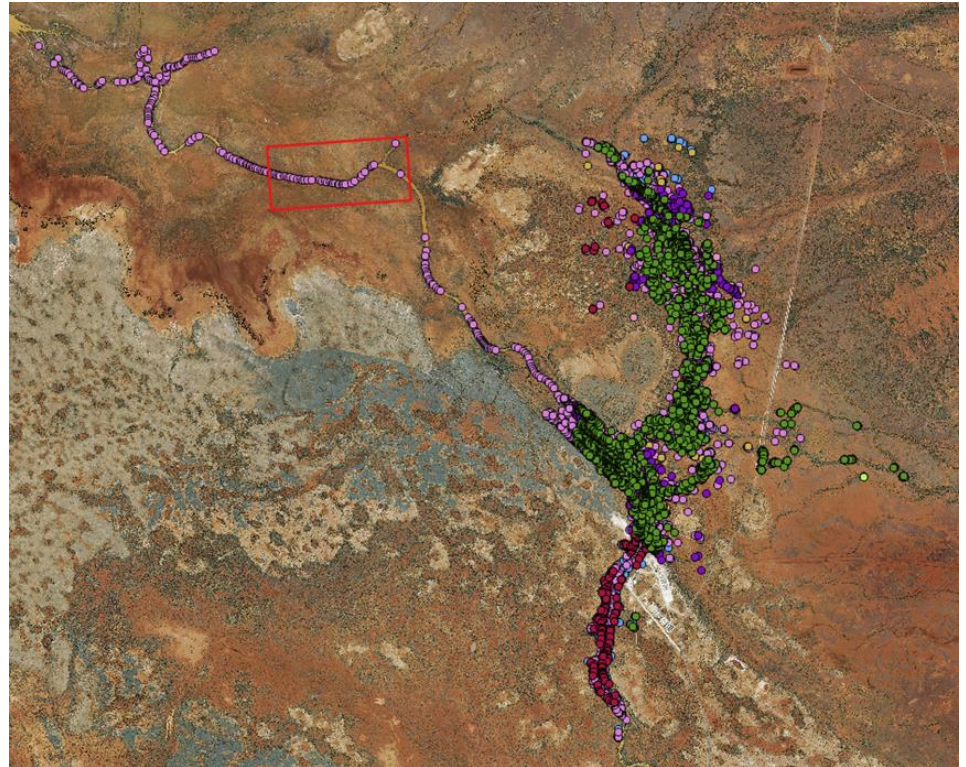
# Weed Detection - Results





# Weed Detection – Operational Use

Fly a planned weed control area



# Weed Detection – Operational Use

Fly a planned weed control or survey area



Apply classification





# Weed Detection – Operational Use

Fly a planned weed control or survey area



Apply classification



Use to direct control



# Weed Detection – Operational Use

Fly a planned weed control or survey area



Apply classification



Use to direct control



Fly again. Measure change in health.



# Questions?