



# Rehabilitation Monitoring Using Drones and Remote Sensing

Case Studies, Field Validation and Lessons Learnt

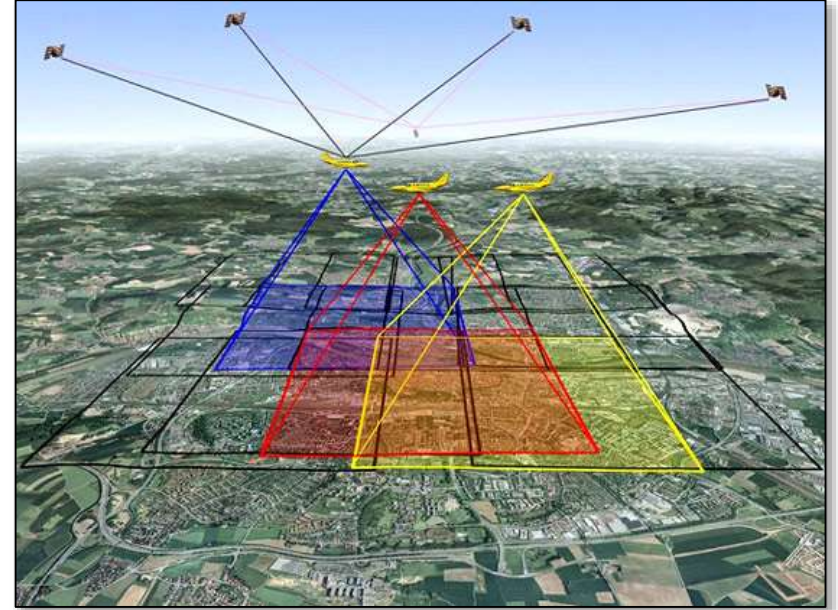
Sam Atkinson

September 2018

# Presentation Outline

1. Background
2. Use cases
  - Construction and earthworks
  - Routine compliance monitoring
  - Investigations and problem identification
3. Field validation results
4. Lessons learnt

# Enabling Technologies



```
def __init__(self, fnr):
    self.fnr = fnr
    self.fnr_file = fnr.split('/')[-1]

    r_ds = gdal.Open(fnr)
    if r_ds==None: self.fnr=None;return

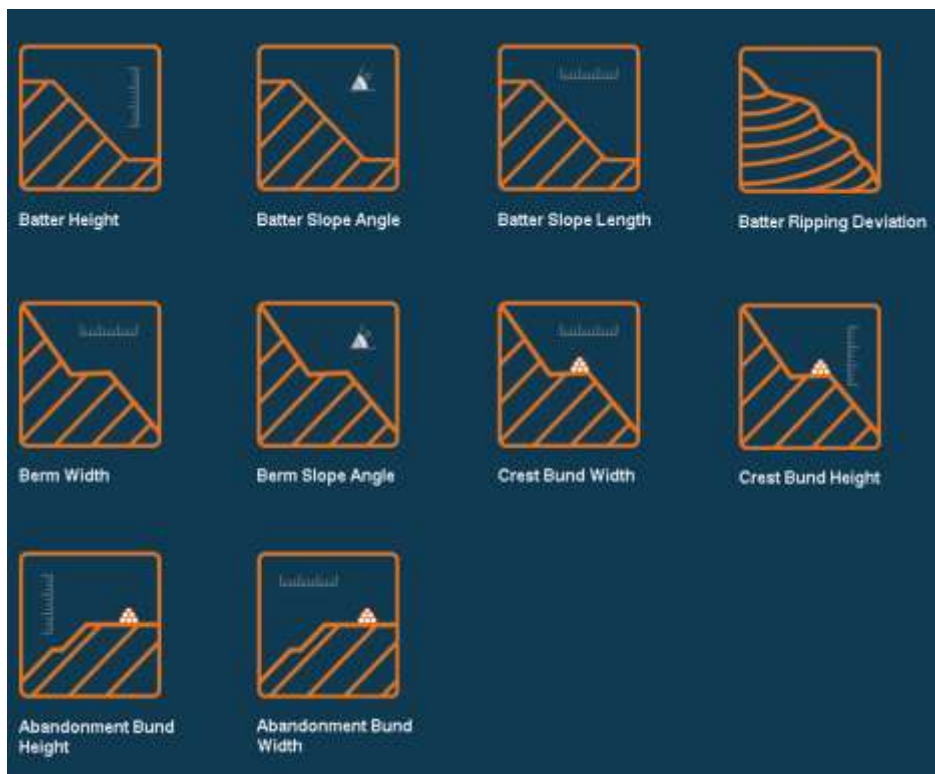
    self.geo_t = r_ds.GetGeoTransform()
    if self.geo_t==None: self.fnr=None;return
    self.proj = r_ds.GetProjection()
    self.dim_x, self.dim_y = r_ds.RasterXSize, r_ds.RasterYSize
    self.b_ct = r_ds.RasterCount
    self.b_nodata = []
    for lp in range(self.b_ct): self.b_nodata.append(r_ds.GetRasterBand(lp).NoDataValue)
    self.pxr_x, self.pxr_y = self.geo_t[1], self.geo_t[5]
    self.geo_x, self.geo_y = self.geo_t[0], self.geo_t[3]
    self.dtype = gdal.GetDataTypeName(r_ds.GetRasterBand(1).DataType)
```



# Rehabilitation Performance Metrics

A suite of metrics to manage and assess rehabilitation performance

## Landform Geometry



## Landform Stability



## Vegetation



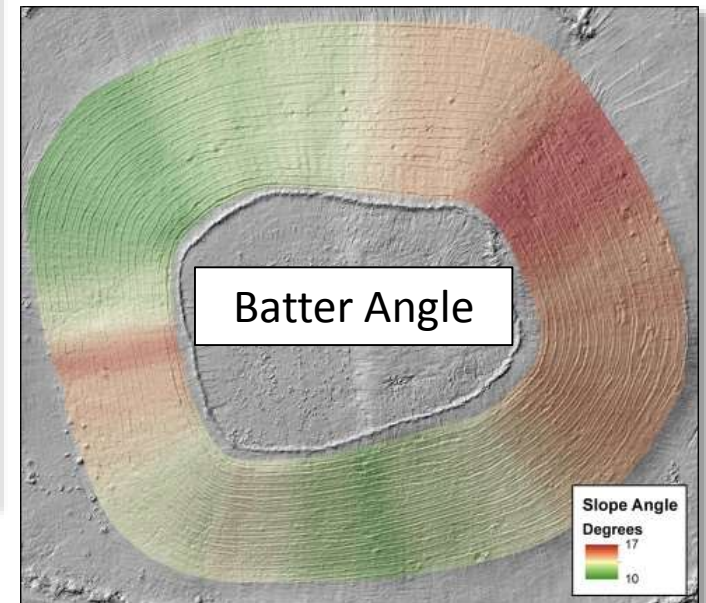
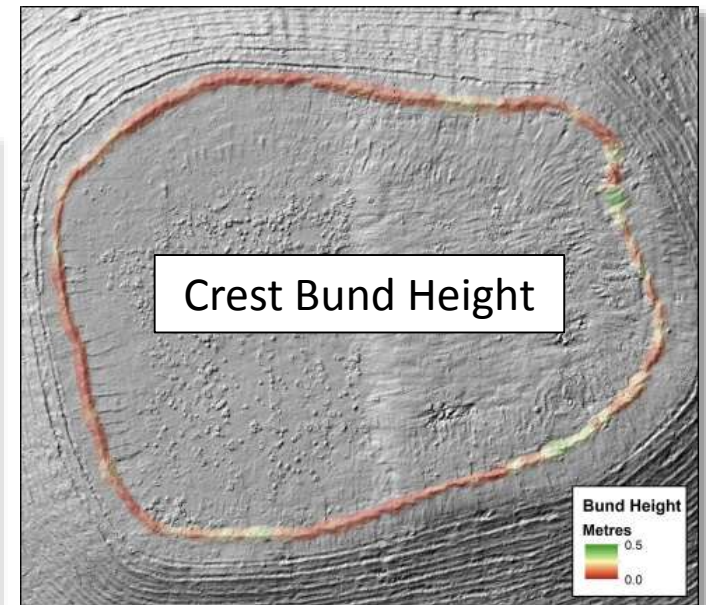
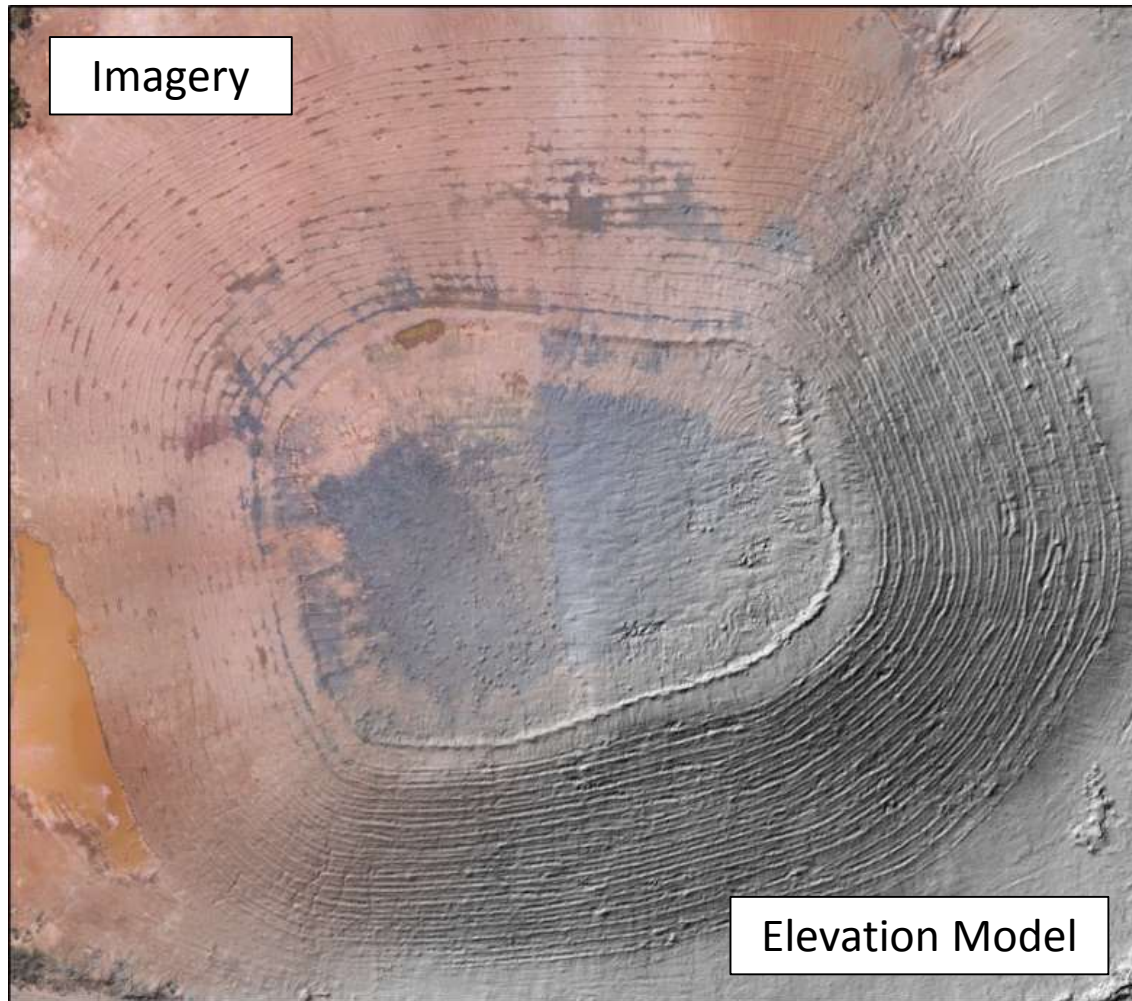


# Rehabilitation Performance Metrics



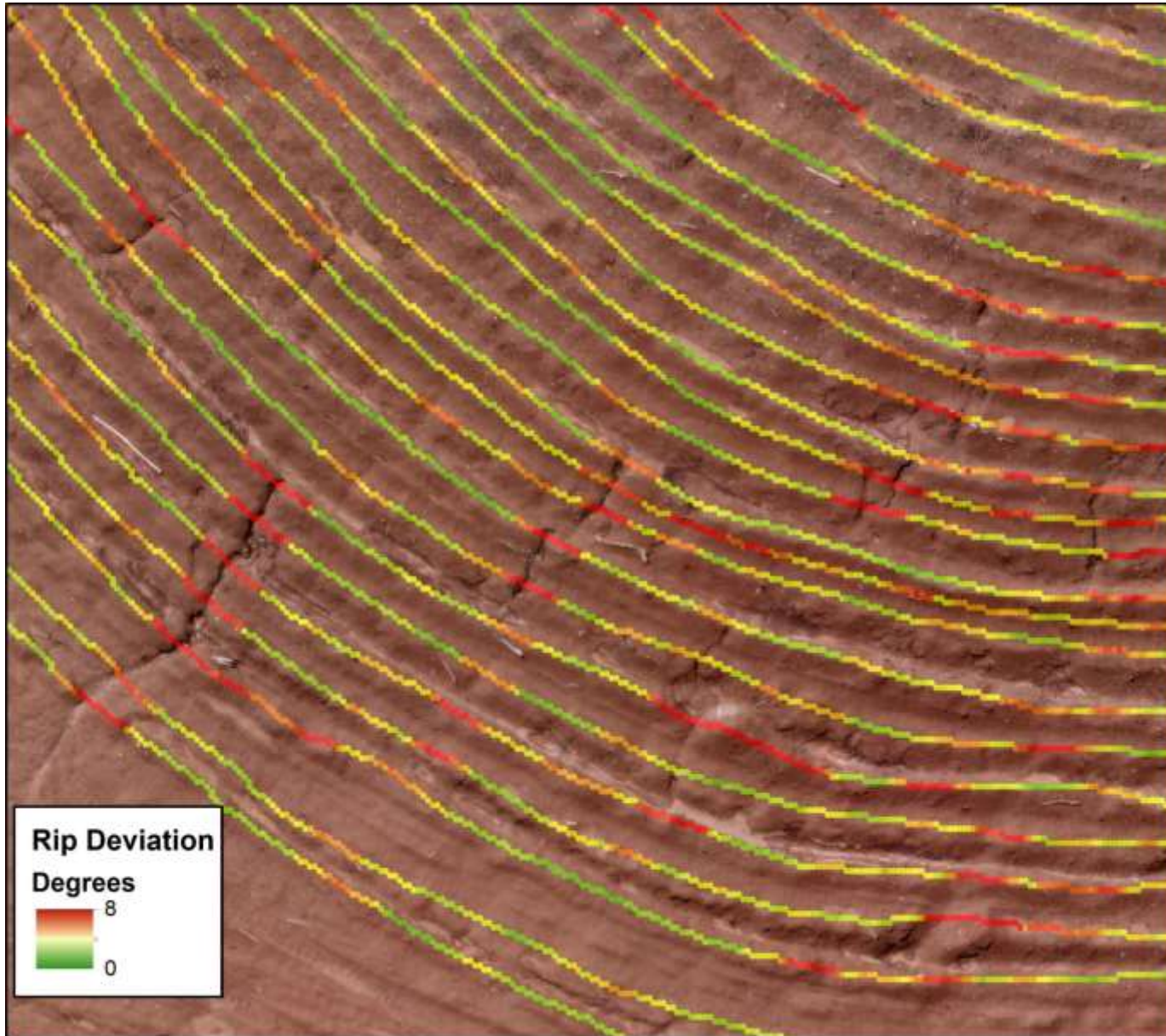


# In Use – Landform Construction

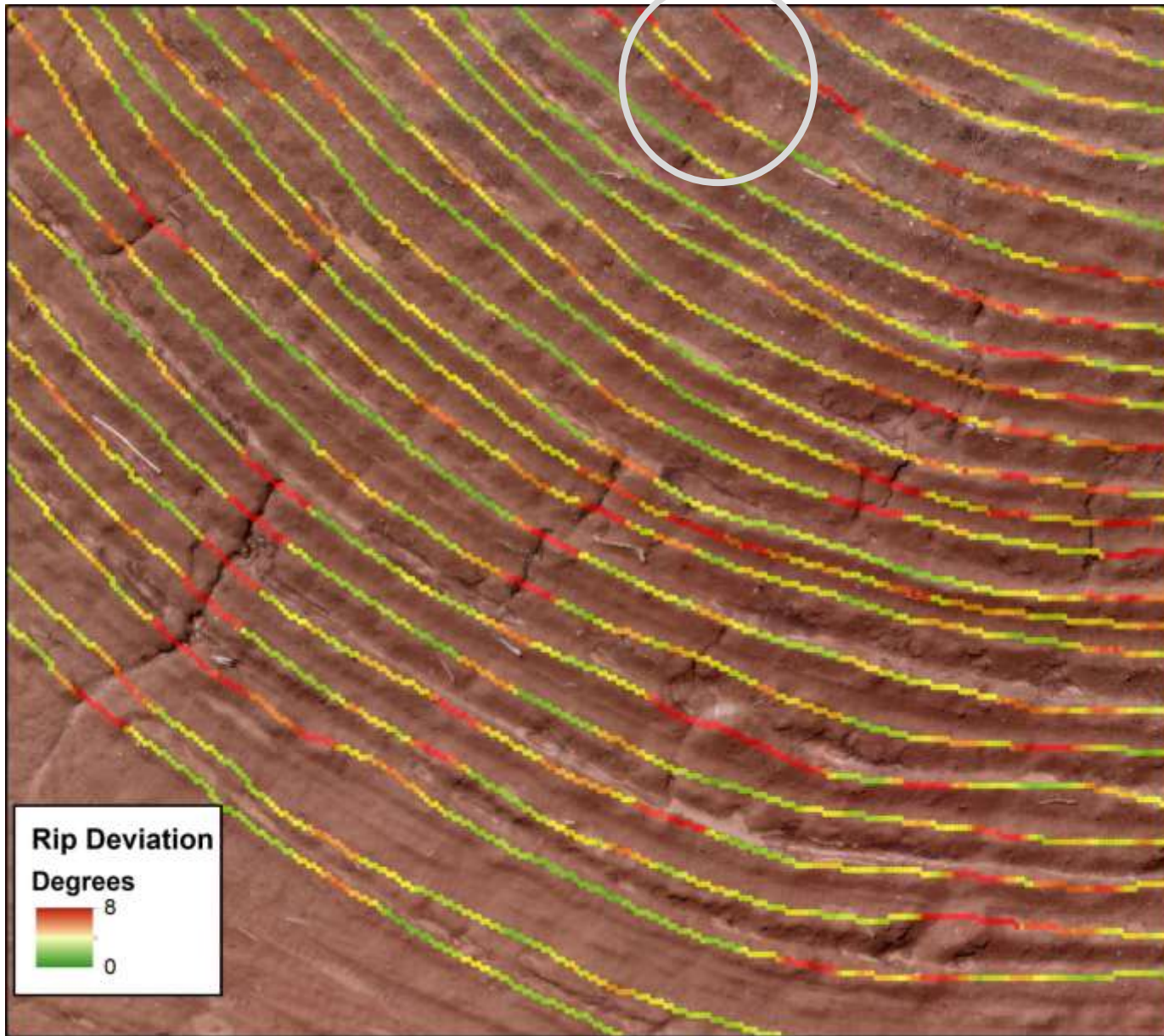




# In Use – Landform Construction

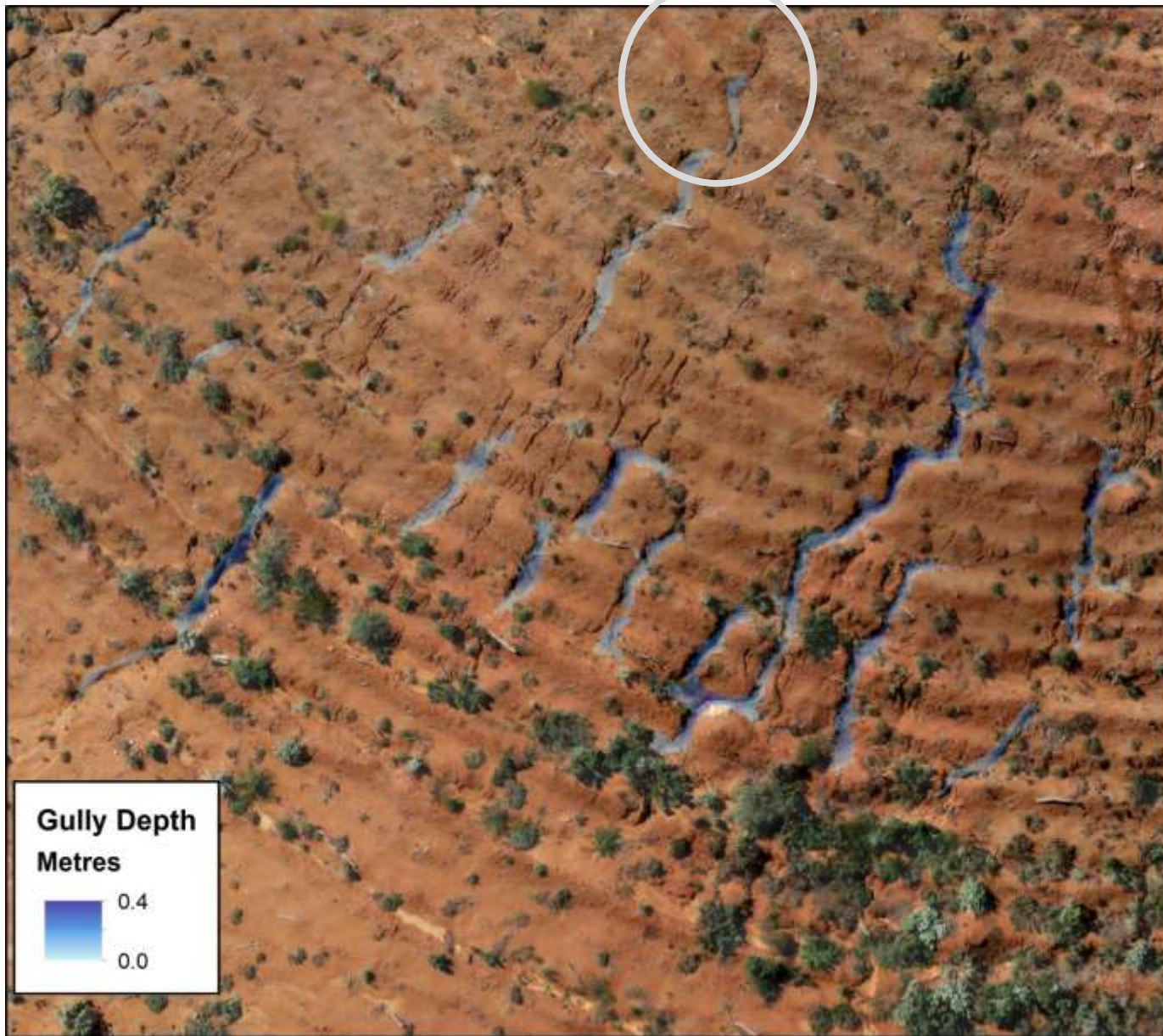


# In Use – Landform Construction





# In Use – Landform Construction



# In Use – Routine Monitoring



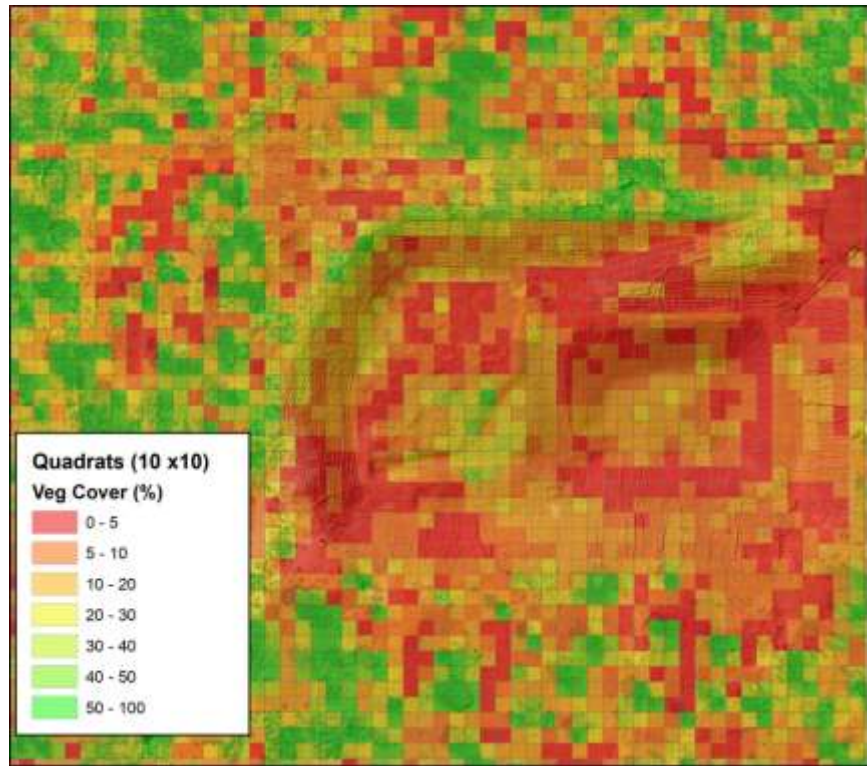
9 ha waste rock dump



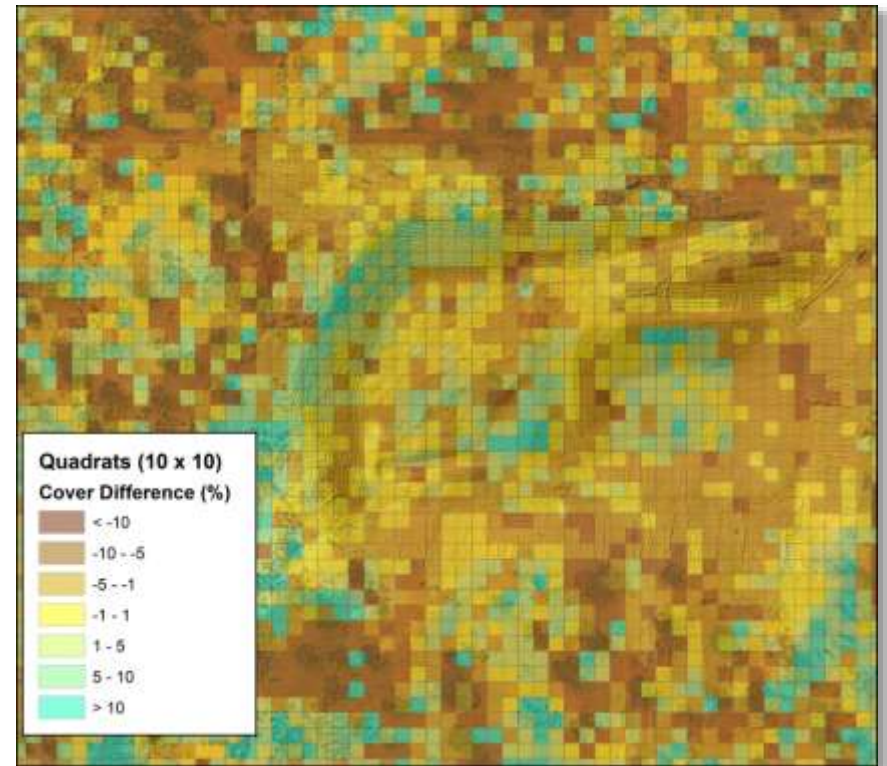
Isolate vegetation



# In Use – Routine Monitoring

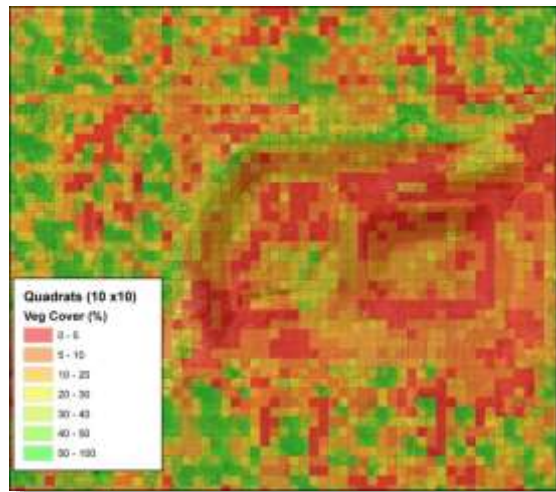


**2016**

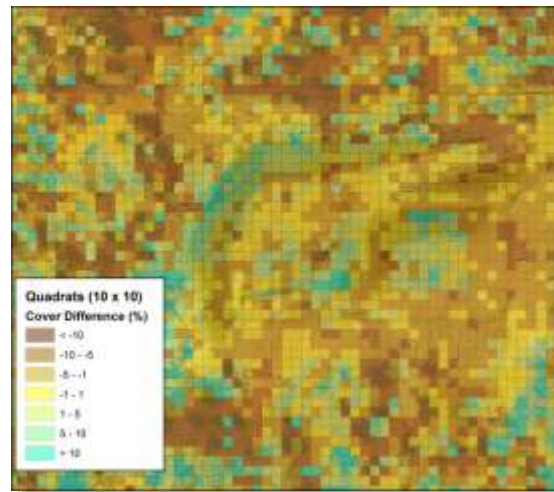


**Change 2016 to 2018**

# In Use – Routine Monitoring

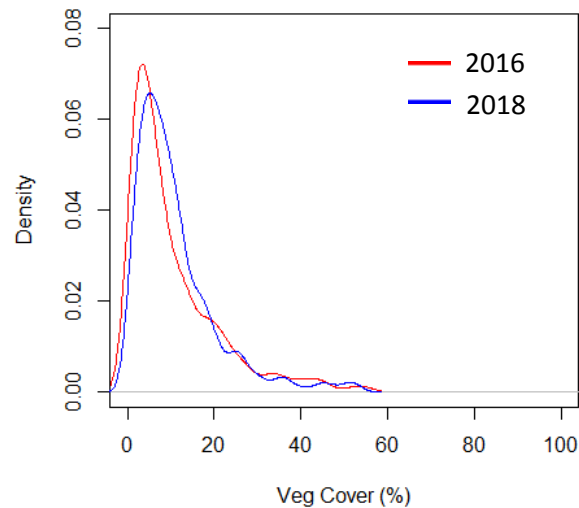


**2016**

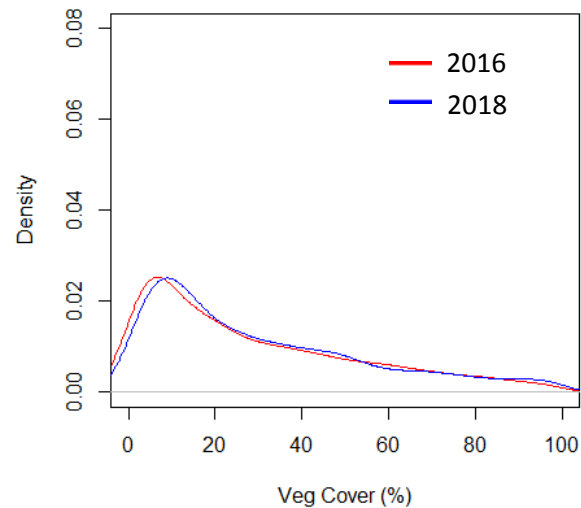


**Change 2016 to 2018**

**Wasterock Vegetation**

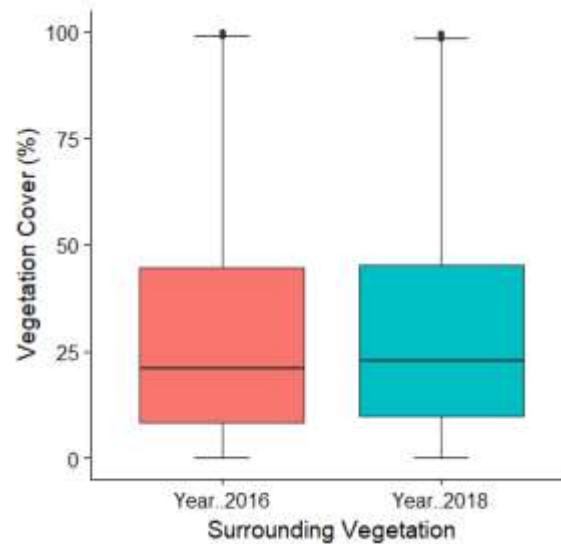
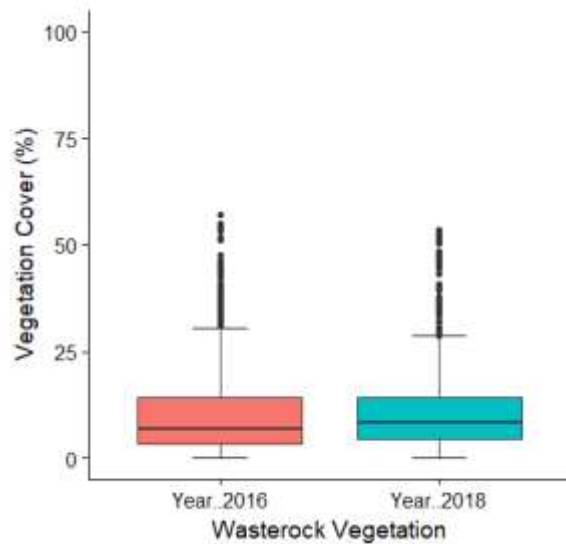


**Surrounding Vegetation**



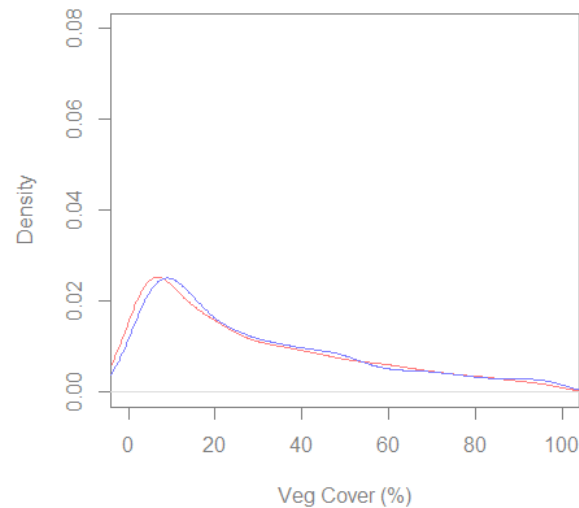
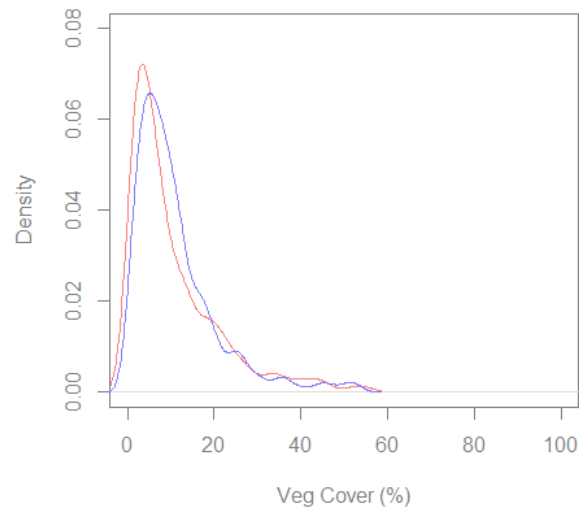


# In Use – Routine Monitoring

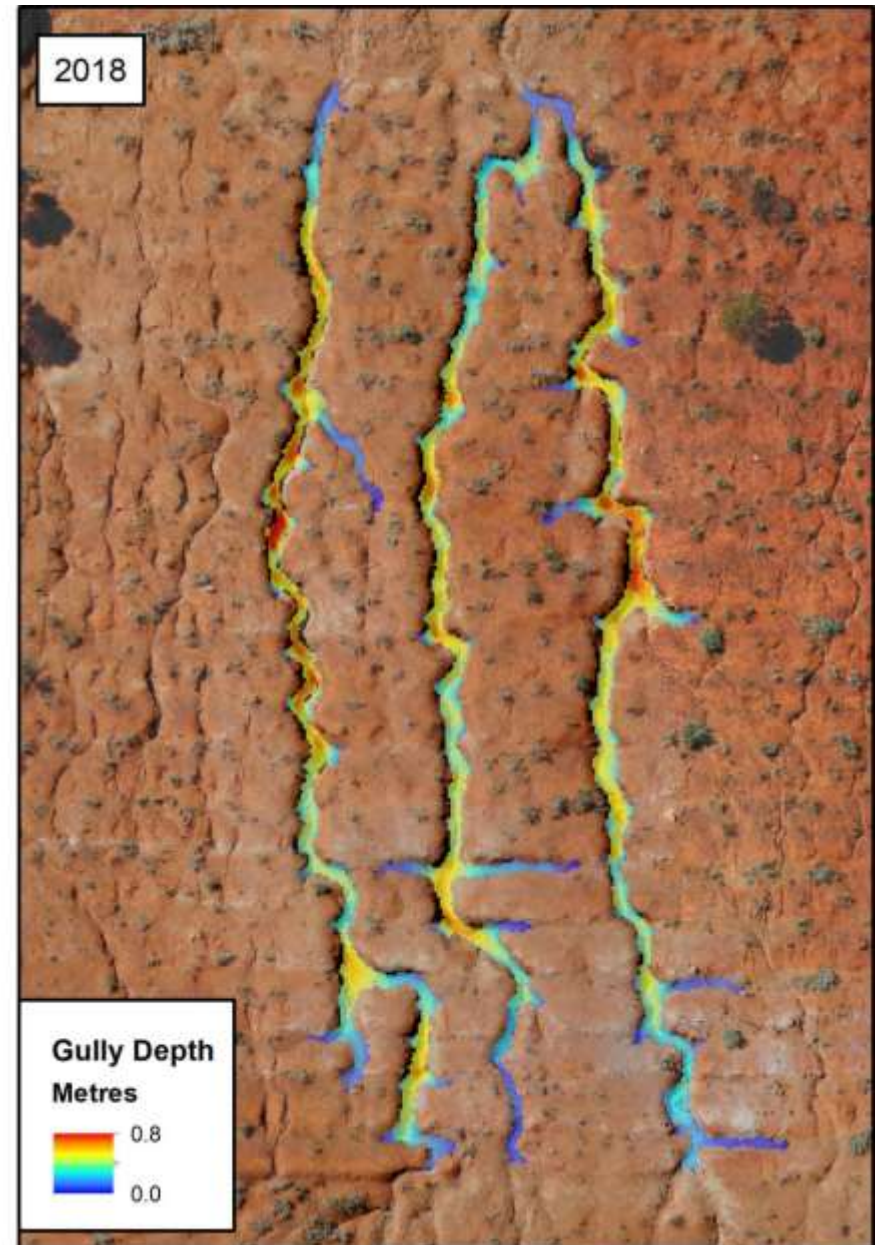
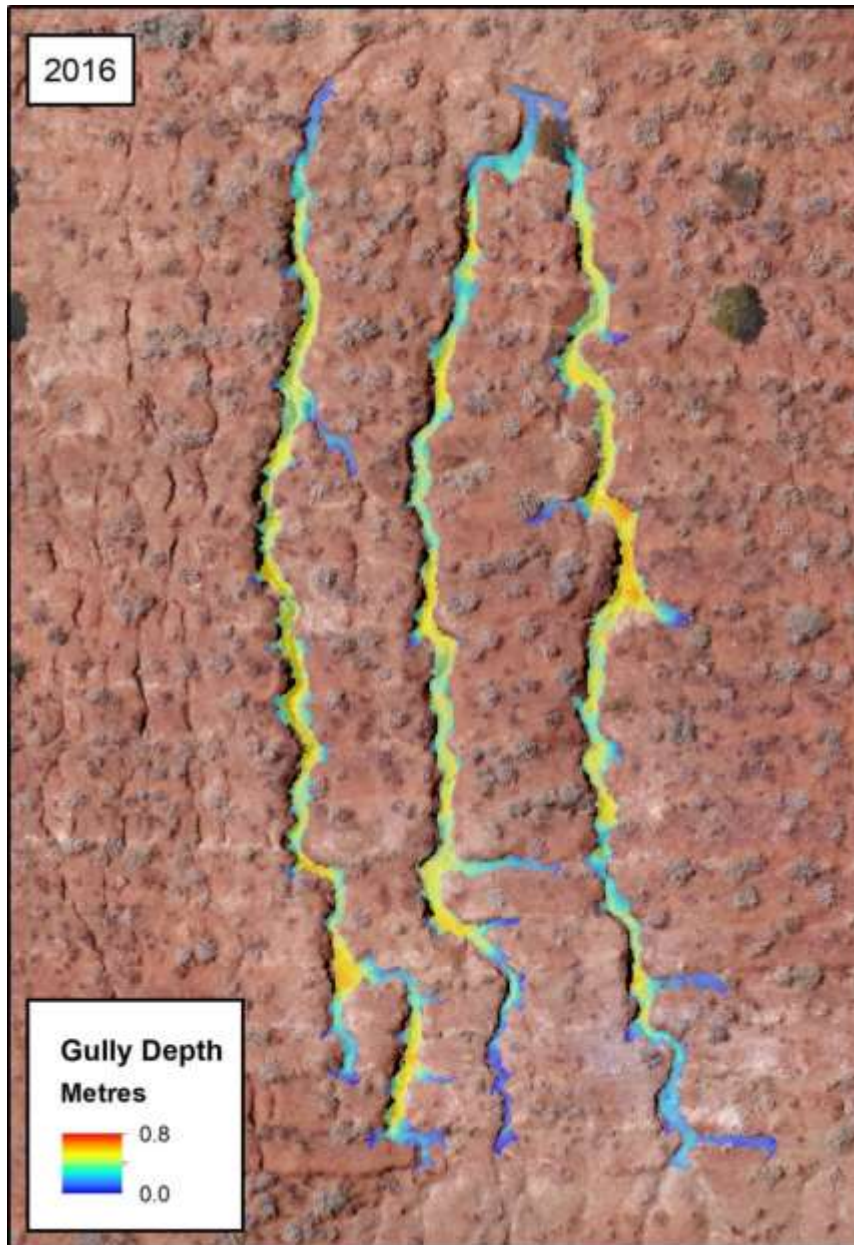


Wasterock Vegetation

Surrounding Vegetation



# In Use – Routine Monitoring





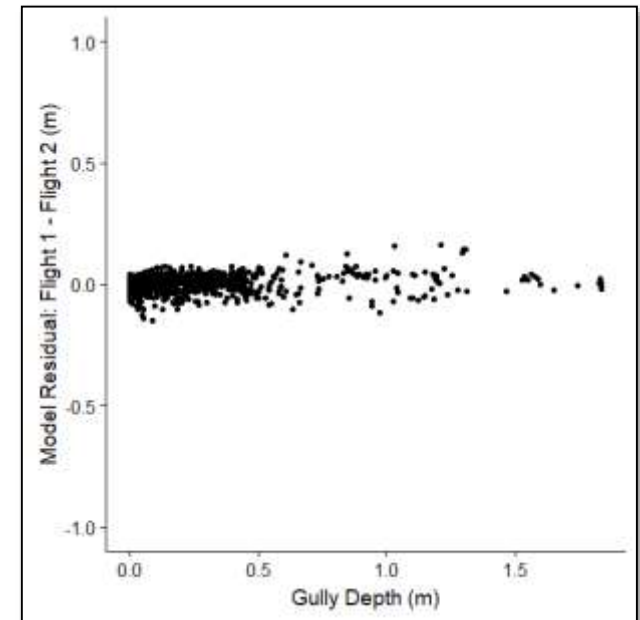
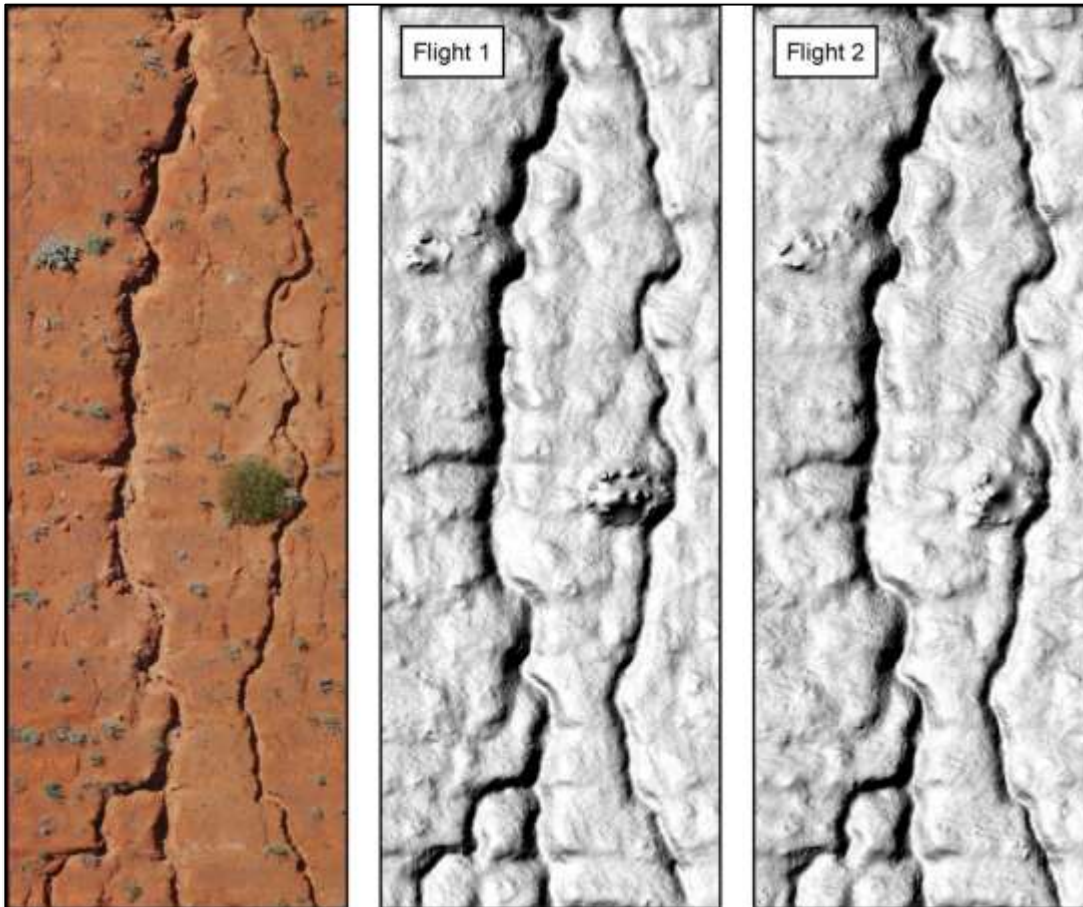
# In Use – Problem ID and Investigation



**Providing multiple information sources for expert interpretation**

# Validation Testing – Drone surveys

Aerial surveys using drones are repeatable and accurate



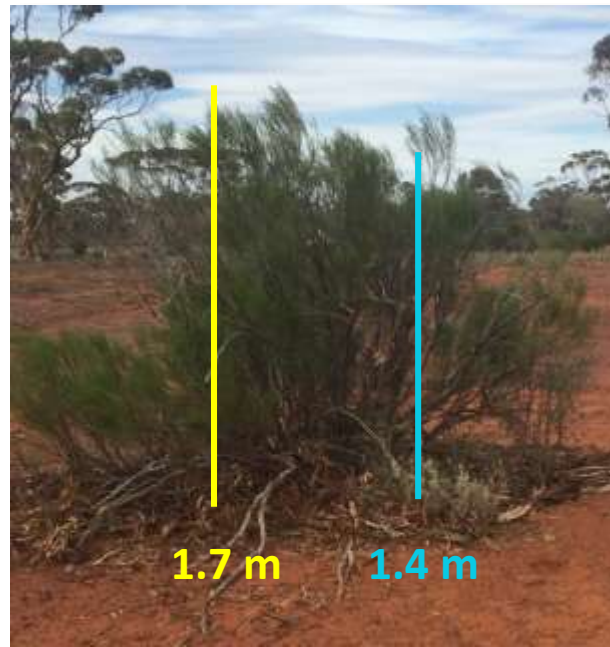
RMSE: 0.03 m



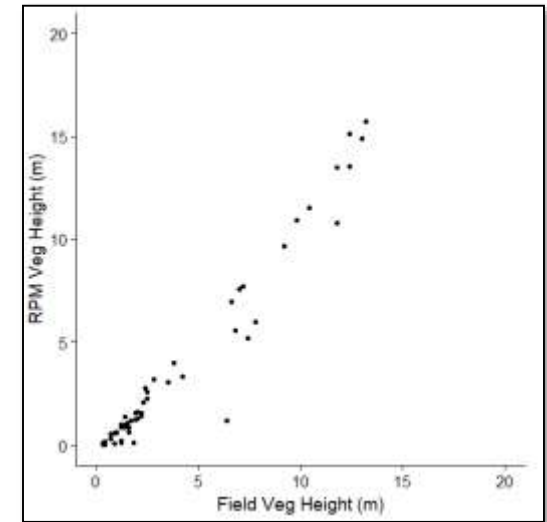
# Validation Testing - Vegetation Height



RMSE (Above 5m): 0.89 m

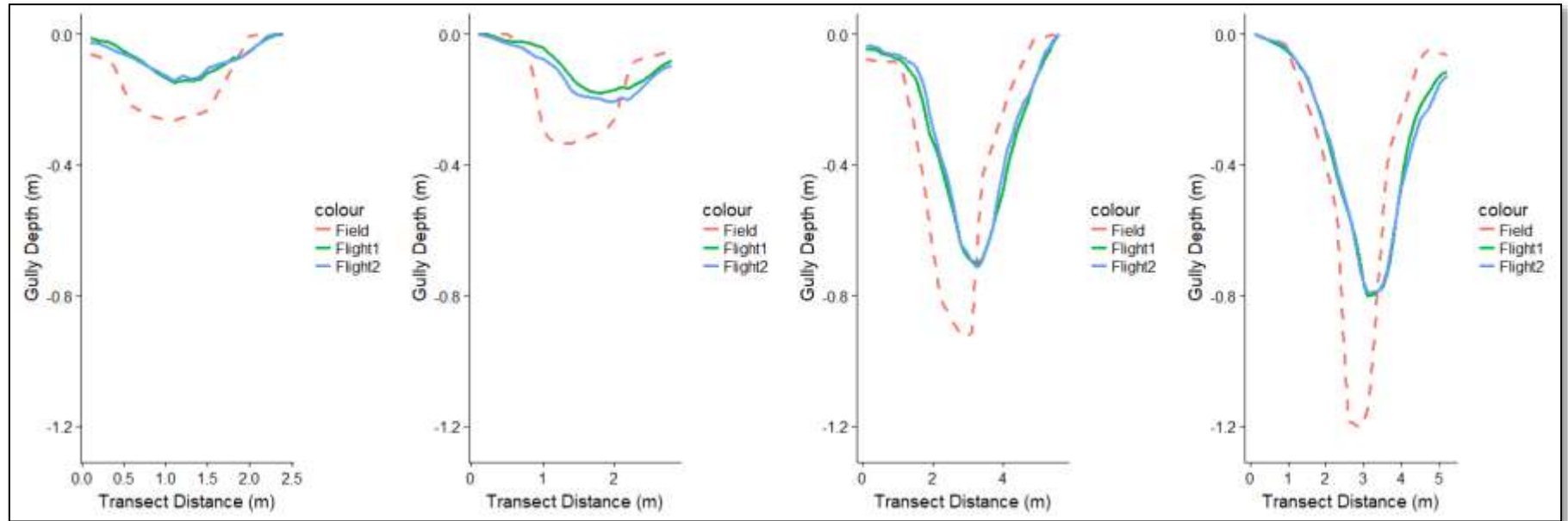


RMSE (Below 5m): 0.35 m



RMSE (Overall): 0.87 m

# Validation Testing – Gully Depth

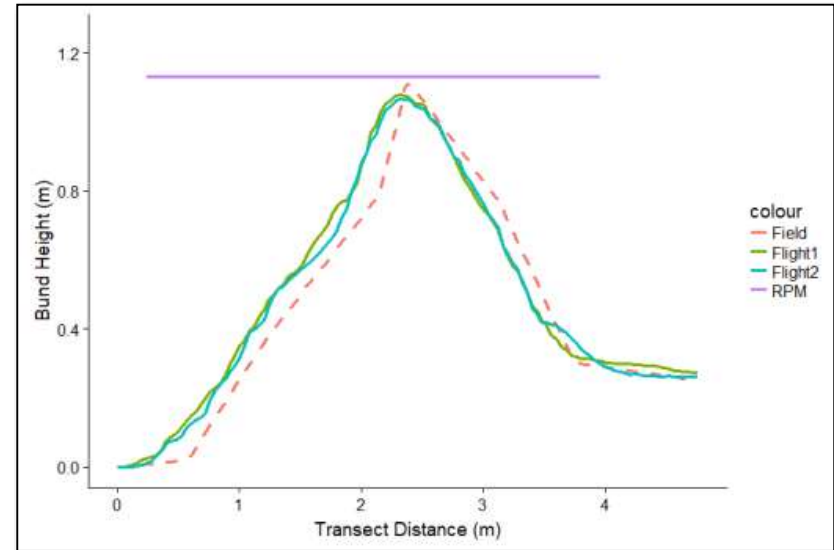
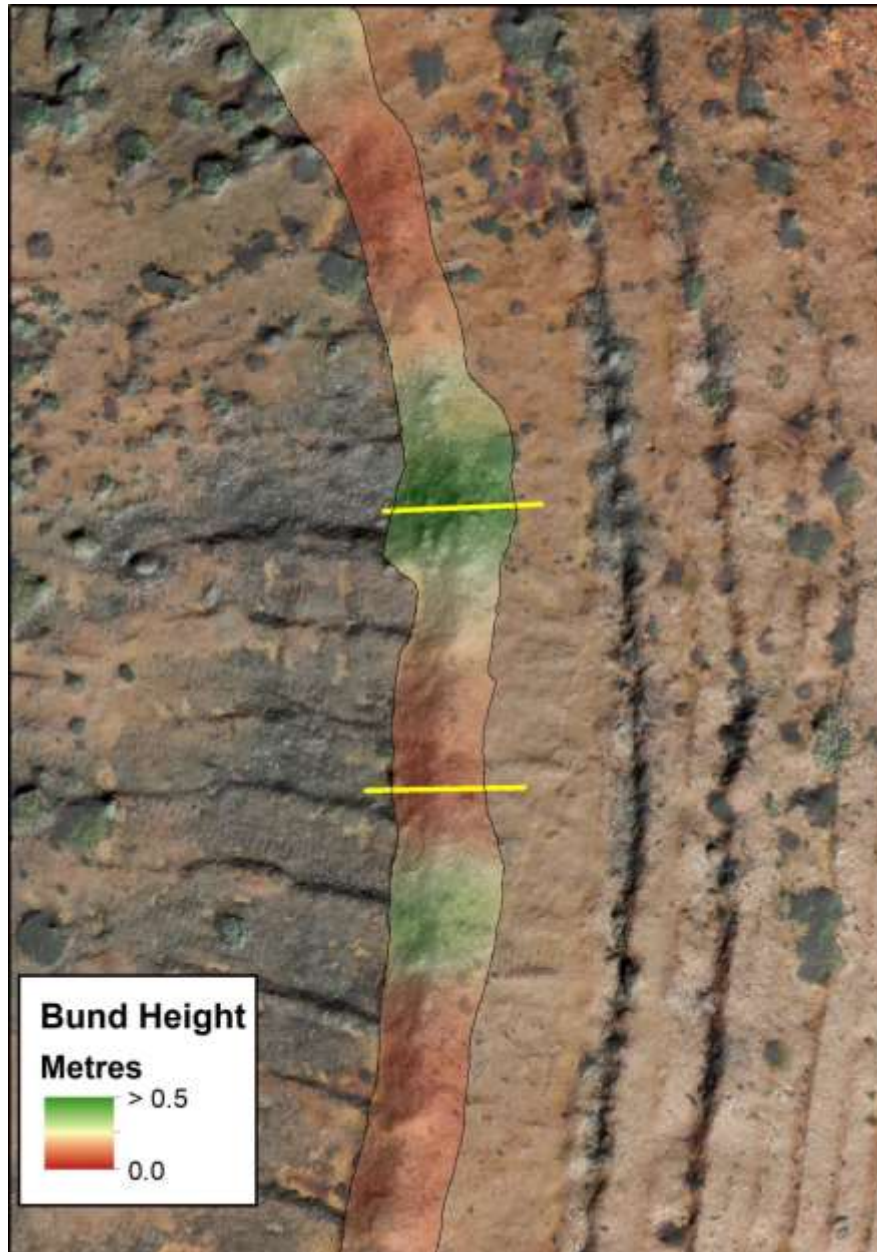


RMSE (Overall) : 0.16 m

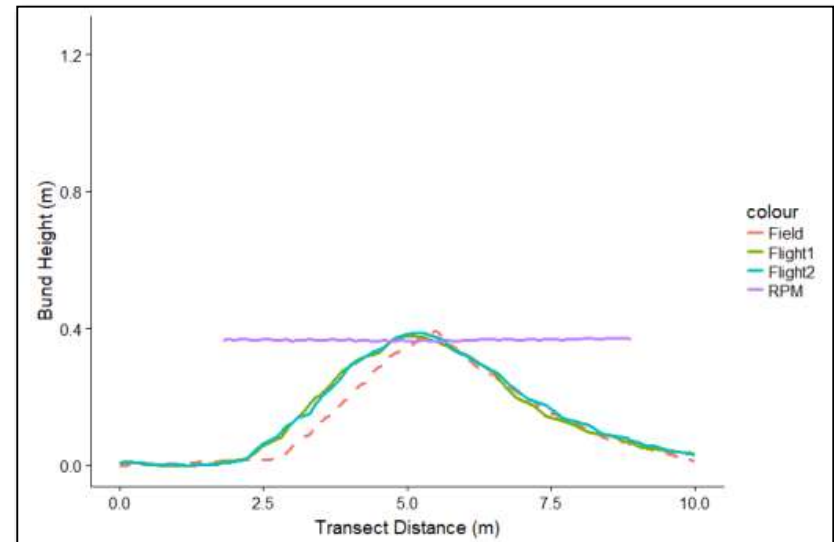
RMSE (0.0 – 0.25 m)	: 0.06 m
RMSE (0.25 – 0.5 m)	: 0.12 m
RMSE (0.5 – 1.0 m)	: 0.20 m
RMSE (1.0m +)	: 0.26 m



# Validation Testing - Bunds



RMSE: 0.09 m



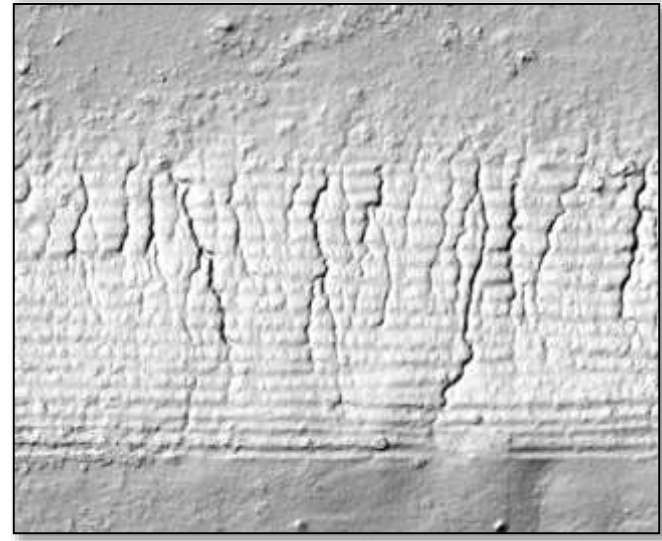
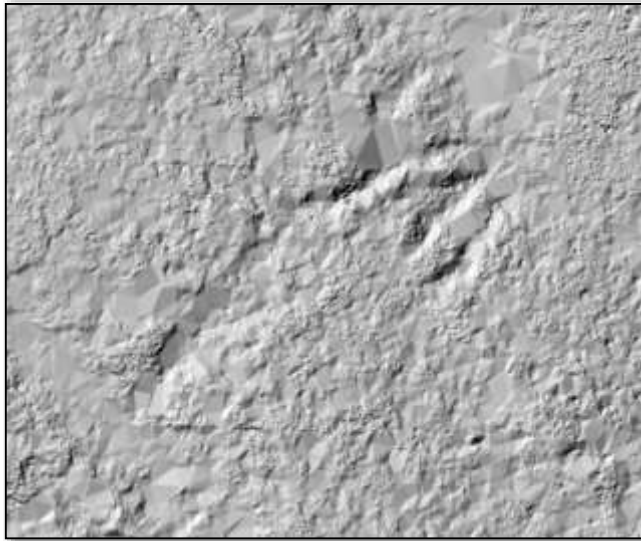
# Lessons Learnt

The *quality* of input data is critical



Two datasets, same specs

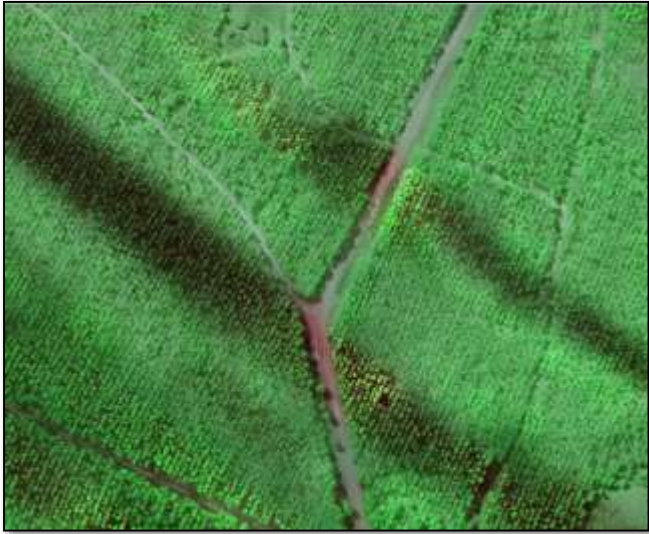
- Resolution = 3 cm
- Accuracy +/- 5 cm
- Same data types



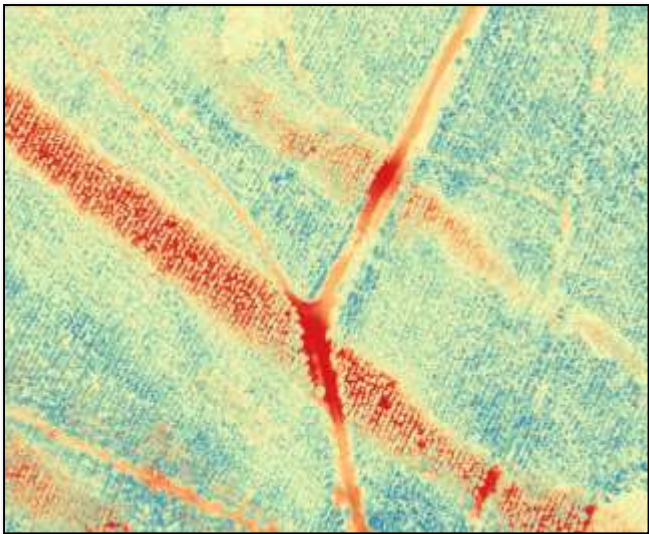


# Lessons Learnt

It's hard to reliably get good results from drones



- Equipment failures
- Part cloudy
- Too windy
- Sun angles
- Regulation
- Processing parameters





# Lessons Learnt

The best ideas for innovation are had by practitioners

