ENHANCED FIRE BEHAVIOUR PREDICTION IN SPINIFEX GRASSLANDS OF ARID AUSTRALIA USING UAS AND LANDSAT IMAGERY

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Scope

• Examine the utility of UAS to:
  – Enhance spinifex fire behaviour models
  – Relate UAS field measures to satellite imagery

• Focus
  – UAS to assess spinifex cover
  – Landsat 8 OLI imagery to provide a desktop assessment of spinifex cover
Spinifex Grasslands

- Perennial hummock grass of genus Triodia
- Physical structure of grass and extreme weather influence flammability
- Previous fire regime of Aboriginal management and lightning
- Effect on biodiversity of unmanaged fire
Fire Management

• Objectives
  – Mitigate wildfire threat to assets
  – Habitat management
  – Pasture/forage management

• Strategies
  – Prescribed burning
  – Limited suppression capability

Spinifex grasslands are the dominant vegetation / fuel type in Australia, occupying about 27% of the continent
Prescribed burning utilises fire behaviour model developed for spinifex grasslands (Burrows et al 2006)

- Model inputs are
  - Fuel quantity (dry weight) / fuel cover and height
  - Fuel moisture
  - Wind
- Models predict whether a fire will spread and subsequently the rate of spread
- In planning locations to prescribe burn information on fuel states is lacking
- Resource waste when a planned location can not be burnt (too much or too little fuel, too wet or dry)
Field Data

- Range of field trips
- Field dates 2016 captured with XIRO
- 2017, 2018 with Phantom 4
- Field transects also captured
- In total 62 field sites + GVD 20 validation field sites
Transect field data collection

- Spinifex fuel sampling is collected along 2 x 50m lines
- Intercepts of along the continuous measure of the tape
  - Spinifex measures: top height of spinifex clumps; clump shape; clump density; live spinifex; dead spinifex
  - Other cover categories: bare ground; surface litter; annual herbs; soft grasses; woody shrubs and herbs <=1.5m; other vegetation >1.5m
- Vegetation height
Transect field data collection

- At 10m intervals 1mx1m fuel load sample of all fuel up to 4-6mm diameter
  - Green field weight
  - Oven dry weight estimated by sub-sampling moisture content

- Measures are summarised to:
  - bare ground; live spinifex; and others
UAS field data collection

Previous UAS model: XIRO - XPLORER V UG3300
- RGB images, can be cropped & classified to extract cover %
- No GPS and distortion at image edges significant
- Proved the utility of UAS with this device
UAS field data collection

Current UAS model: DJI Phantom 4 Pro
- RGB image capture, can be classified to extract cover %
- GPS capture, possible to create image mosaics with Agisoft Photoscan software
- Higher quality images and more reliable outputs
- Now able to create point clouds to assess volume using LAStools software
UAS cover classification
Landsat Satellite Imagery

• To enable desktop assessments of spinifex cover investigated relationship with satellite imagery
• Landsat 8 Operational Land Imager chosen due to cost, coverage and radiometric correction
• Landsat 8 OLI characteristics
  – 30m pixel
  – 8 spectral bands available at 30m, 6 utilised
  – 16 day revisit

<table>
<thead>
<tr>
<th>Band</th>
<th>Description</th>
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<tbody>
<tr>
<td>Band 1</td>
<td>Ultra Blue (coastal/aerosol)</td>
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<tr>
<td>Band 2</td>
<td>Blue</td>
</tr>
<tr>
<td>Band 3</td>
<td>Green</td>
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<tr>
<td>Band 4</td>
<td>Red</td>
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<tr>
<td>Band 5</td>
<td>Near Infraed (NIR)</td>
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<td>Band 6</td>
<td>Shortwave Infraed (SWIR) 1</td>
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<tr>
<td>Band 7</td>
<td>Shortwave Infraed (SWIR) 2</td>
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<tr>
<td>Band 9</td>
<td>Cirrus</td>
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Landsat | UAS | Transect
Landsat cover index

• An index is a combination of spectral bands that show the relative abundance of a landscape attribute of interest e.g. NDVI
• Field data of spinifex cover was used to derive spinifex indices using discriminant analysis
• Also tested established vegetation indices
• Red band / Green band index derived during UAS classification had the strongest relationship
Landsat cover index and field data

For UAS RGBcover:

\[ y = -63.14x + 137.32 \]
\[ R^2 = 0.6484 \]

For Landsat OLI Red Band / Green Band:

\[ y = -47.784x + 121.21 \]
\[ R^2 = 0.3348 \]
Landsat cover index application

- Derived regression can be applied to corrected Landsat 8 OLI imagery
- Only applicable in spinifex dominated grasslands
Validation

- 20 field sites in the Great Victoria Desert captured 27-30 April 2018
- Differences between UAS Cover and Landsat Cover less than 10%
Development of other spinifex characteristics

- Spinifex clump shape, height and distribution in the landscape are other important aspects that influence fire behaviour
- Point cloud analysis of UAS field data reveals clump shape, height and volumes can be determined
- The continuity of the spinifex cover can also be quantified
Fuel Modelling Spinifex
Future work

• More field trips to fill in gaps in geographic location and rainfall variation
• Examine the utility of point cloud information
• Moisture index development
• Use of time lapse capture of burn activities
• Scale to whole of state and operationalise
  – Use of other satellite imagery such as Sentinel-2
Summary

• UAS provide more comprehensive evaluation in the field of spinifex cover and volume and distribution
• UAS derived cover can be scaled to satellite imagery
• Field capture times using UAS are much quicker than transect methods, however moisture samples are still required
• Fire behaviour models can be improved by the use of field data captured by UAS – including imagery and video capture
• Impact on operations will be in saved time and resources in being able to better plan prescribed burning field trips
Thanks

- Errol Thoomes
- Jane Chapman