Opportunities in SPACE for South Australian Professionals

Spatial Information Day - 2019

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UniSA, Flinders Uni and International Space Uni.
AUSTRALIA RE-ENTERS THE “SPACE RACE”

1967 - WRE SAT - 45kg payload launched from Woomera and completes 642 near polar, Low Earth orbits in 42 days

2002 - FED SAT – 58kg payload launched from Tanegashima and completes approx. 20,000 near polar, Low Earth orbits in 4 years

Sept 2017 – IAC Adelaide

2018 – Australian Space Agency formed; based in Adelaide; several M$100’s of investment
Opportunities?

SPACE

SPATIAL

TWO EXAMPLES
Opportunities?

EARLY FIRE DETECTION

Global application - a sensor resolution issue

FOREST STATE MAPPING

Continental application - a computing issue
High Temporal
Medium Spectral
Medium-low Spatial

Medium Temporal
Medium Spectral
Medium-Low Spatial

Medium Temporal
Medium Spectral
Medium-Low Spatial

Medium-Low Temporal
High Spectral
Medium-Low Spatial

The Resolution Gap

Spectral Resolution

Temporal Resolution

SENSOR RESOLUTIONS:
Spectral (X) v Temporal (Y) plus Spatial (Bubble Size)
Example 1: Early Forest Fire Detection

- **15 mins warning** of commencement of fire – **high temporal resolution**.
- Need a sensor and platform which will detect fire at medium (~10m) spatial resolution.
- Current solutions use Middle IR (Hot fires) or Thermal IR (Cool fires) - **MODIS (1000m pixels)**; **VIIRS (375m pixels)** **low spatial resolution**
- **ToPeCAI** (Tropical Peatland Combustion Algorithm) - Parwati Sofan and David Bruce (UniSA) detects cool fires using Landsat 8 imagery (30m pixels), but **low temporal resolution**.

S = Smouldering; FS = Flaming & Smouldering; F = Flaming
Sofan, Bruce, Jones and Marsden (2019)
Sensor / Platform solutions

HAPS

LEO Sensors

GEO Sensor

CO₂

CH₄

CO

K

H₂O
Australian and New Zealand forestry managers require monthly updates of forest state (new plantings, growth state and harvesting)

- Australia’s total commercial plantation area - 1,955,100 ha 2016–17 (ABARES, 2018)
- Total area of softwood plantations - 1,036,900 Ha (2016-2017)
- Approx. area to be mapped (red polygons) 65,000,000 ha
Forest State Mapping

- **Monthly satellite imagery** - all forest areas in ANZ. **Cloud cover** is a confounding issue for optical imagery.
- E.G. Sentinel 2 (optical) satellite availability for 4 sites in Australia over 1 year (May 2017 to April 2018)

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Satellite **Radar imagery** to augment Optical imagery.
- Radar imagery **penetrates cloud**.
- Available night and day

**Mt Crawford forest area**

Sentinel 2 – 27 Jan 2017
Bands 8,4,2 – R,G,B

Sentinel 1 – 27 Jan 2017
Polarisations:
   VV, HV, VV – R,G,B

ALOS PALSAR 2– 24 Jan 2017
Polarisations:
   HH, HV, HH PHASE – R,G,B
Mt Crawford – enlargement
Classification of S2

Forest State Mapping

PR Stand. Vol. > zero (end 2016)
Forest State Mapping

- Use satellite L Band Radar imagery to augment Optical imagery.
- Radar imagery penetrates cloud and available day or night.
- Tests site results (Std RS classification) for Adelaide Hills (Mt Crawford), using Forestry SA forest GIS data as control.

![Results Table](image)

Use of AI – machine learning shows increase in accuracy of ~5%
Forest State Mapping

For Australia:

- Sentinel 2 (S2) image size is 290 x 290km delivered in 100 x 100 km tiles. Imagery is free for non-commercial purposes and lost cost otherwise.

- Approx. **65 tiles** required to map softwood plantations **per month**.

- Data for S2 is **325 Gb per month** (4 Tb per year)

- Processing space required **1 Tb per month**.

- **ALOS PALSAR** (JAXA) is **expensive** (~A$3200 per image) So mapping forests is not viable with this satellite sensor. However, a free source of L and S Band radar will become available in late 2021 with the launch of **NISAR**
  
  [https://directory.eoportal.org/web/eoportal/satellite-missions/n/nisar](https://directory.eoportal.org/web/eoportal/satellite-missions/n/nisar)

- Processing of Radar requires more time and space than for optical.
### Professional Expertise Requirements

<table>
<thead>
<tr>
<th>EARLY FIRE DETECTION</th>
<th>FOREST MAPPING</th>
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<tbody>
<tr>
<td>Spatial (RS) scientists</td>
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<td>Spatial (GIS) scientists</td>
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<td>Sensor developers</td>
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<td>Web portal managers</td>
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CONCLUSIONS

• Opportunities exist for professionals to collaborate, innovate and be part of Australia in Space 2.0.

• It is not the launch of the satellite – it is the application of space technology to solve problems hither to either not solved or solved by less efficient means.

• Spatial Science has a role to play.

• Space collaboration and grants - through:
  • The SMARTSAT CRC - https://smartsatcrc.com/
Resources, references and acknowledgements:

Slide 4: Greece Fires: Contains modified Copernicus Sentinel data (2017), processed by ESA, CC BY-SA 3.0 IGO http://www.esa.int/spaceinimages/Images/2017/08/Kalamos_fires
Global Forest Watch https://www.globalforestwatch.org/
Slide 5:
Slide 6:
Slide 17: Himawari image of Earth – NOAA / JMA:

Acknowledgements:
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THANK YOU FOR LISTENING