Multi-scale phenology from digital time-lapse camera to Sentinel-2 and MODIS over Australian pastures

Yuxia Liu • PhD candidate
Distinguished Professor Alfredo Huete
Dr Qiaoyun Xie & Dr Ha Nguyen

Ecosystem Dynamics, Health and Resilience • Faculty of Science
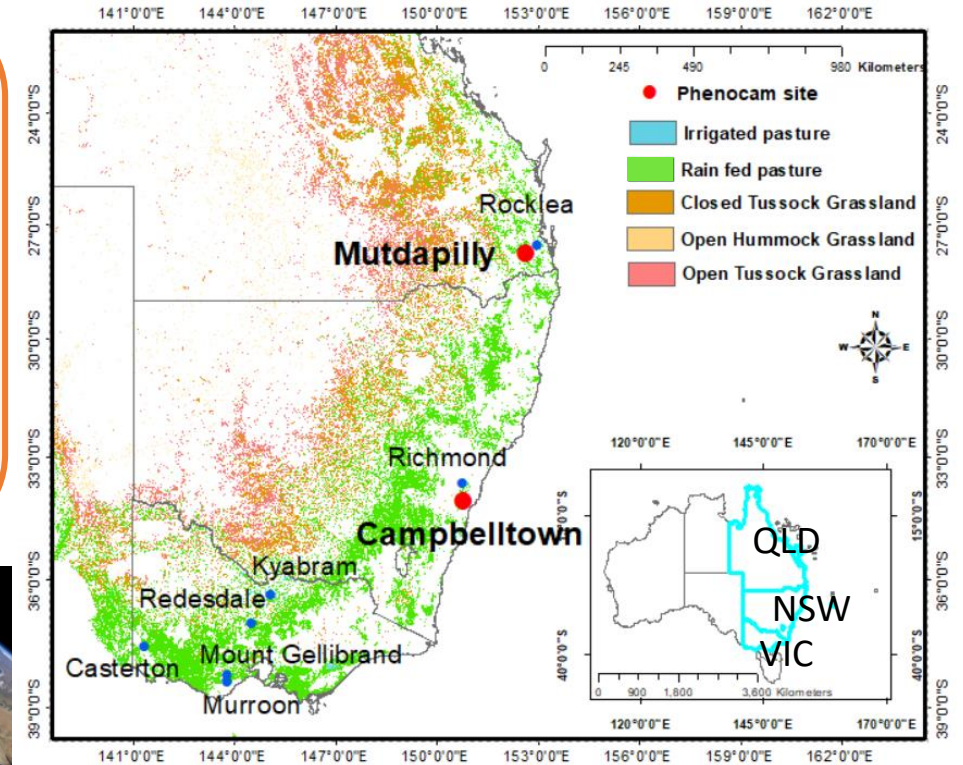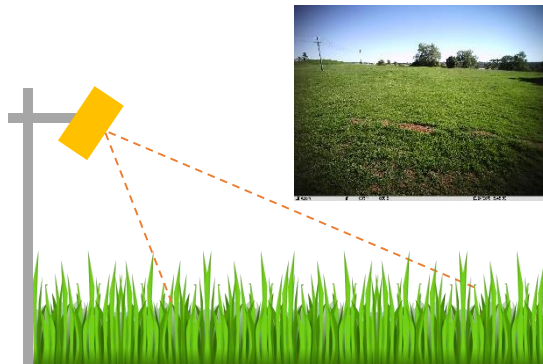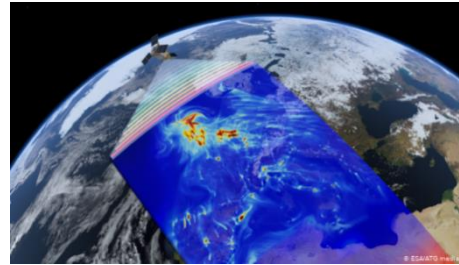University of Technology Sydney (UTS)

Introduction & Research questions

- Grass pollen has significant public health impacts on allergic diseases, globally and in Australia
- Phenocams can aid pollen forecasting by providing information on grass greening and flowering phenology
- Here we aim to explore upscaling and extension of phenocam data to satellites

MODIS (250 m)

Sentinel-2 (10 m)

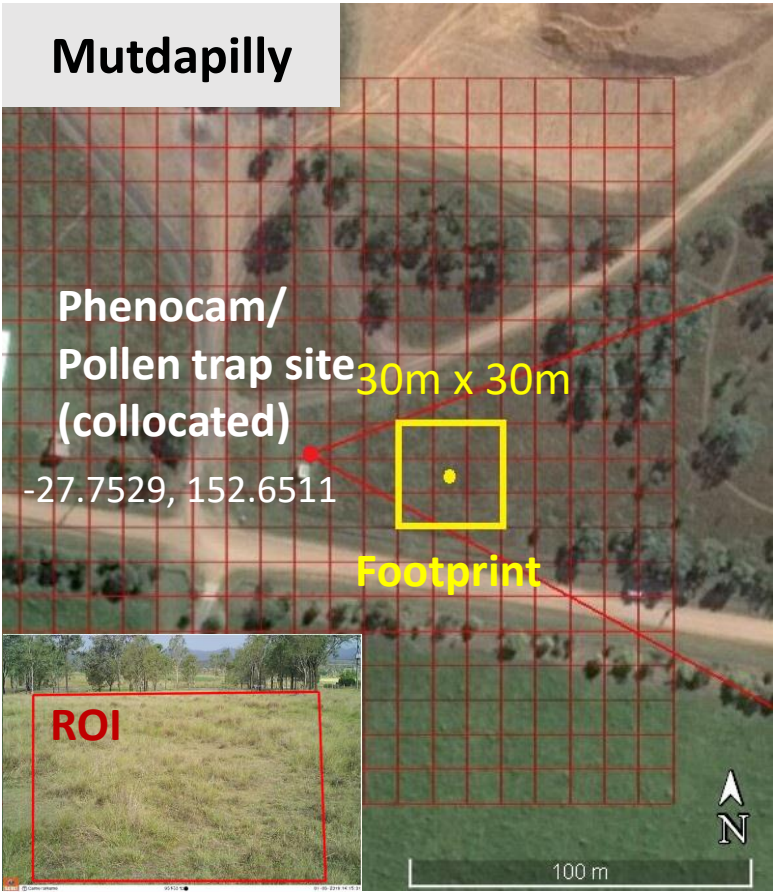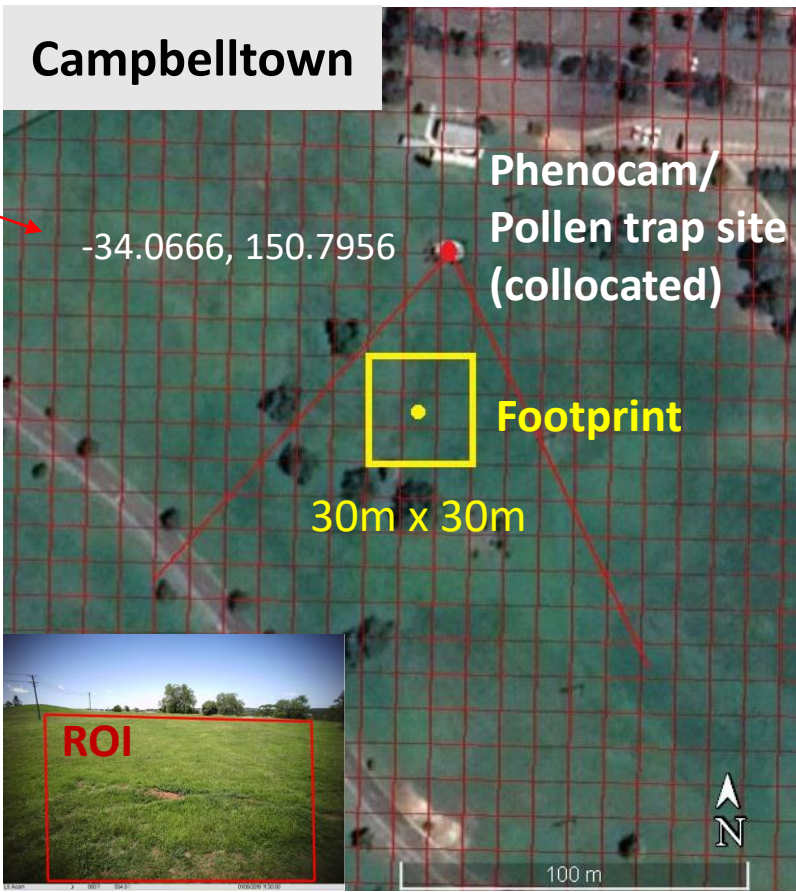**Digital time-lapse camera (phenocam)**

Phenology
Regional to in-situ scales

- **Q 1:** How well can we calibrate Sentinel-2 'greenness' measures to in-situ phenocam 'greenness'?
- **Q 2:** How well does a site phenocam represent surrounding grassland/ pastures?
- **Q 3:** How can we improve greenness upscaling from phenocam to Sentinel-2 and MODIS?

Phenocam site
Irrigated pasture
Rain fed pasture
Closed Tussock Grassland
Open Hummock Grassland
Open Tussock Grassland

Rocklea
Mutdapilly
Richmond
Campbelltown
Kyabram
Redesdale
Mount Gellibrand
Casterton
Murroon
QLD
NSW
VIC

Q 1: How well can we calibrate Sentinel-2 'greenness' measures to in-situ phenocam 'greenness'?

Fishnet
The scale of grid:
10 m x 10 m

⇩

One Sentinel-2 pixel

Campbelltown

-34.0666, 150.7956

**Phenocam/
Pollen trap site
(collocated)**

Footprint

30m x 30m

ROI

100 m

Mutdapilly

**Phenocam/
Pollen trap site
(collocated)**

30m x 30m

-27.7529, 152.6511

Footprint

ROI

100 m

- **3x3 pixels**
- **9x9 pixels**

(Huete et al., 2002)

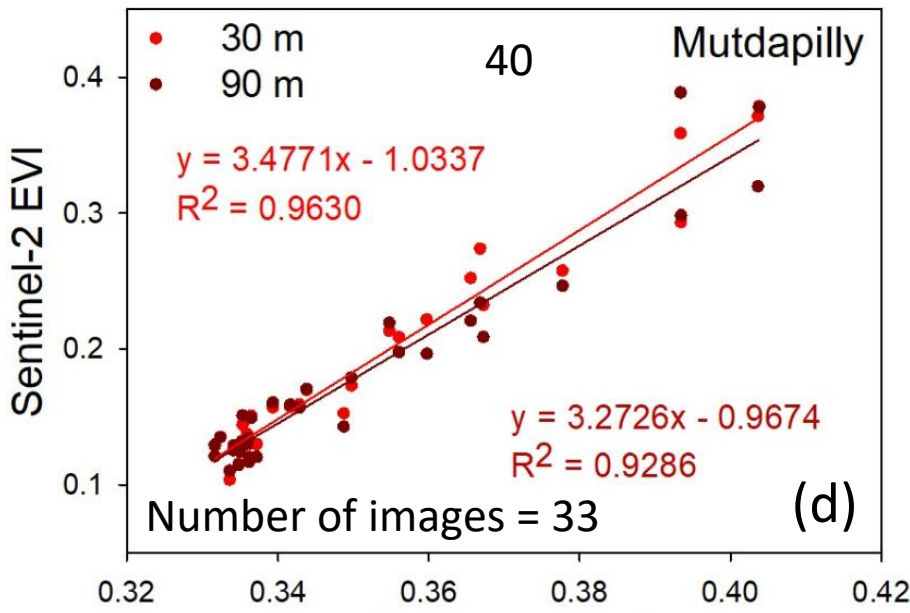$$GCC = \frac{G_{DN}}{R_{DN} + G_{DN} + B_{DN}}$$

Green chromatic coordinates
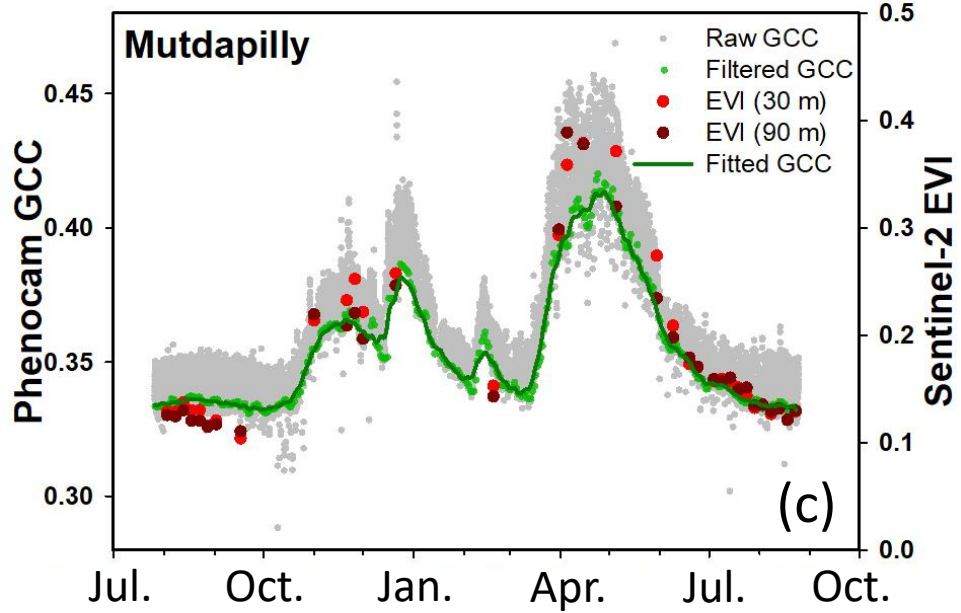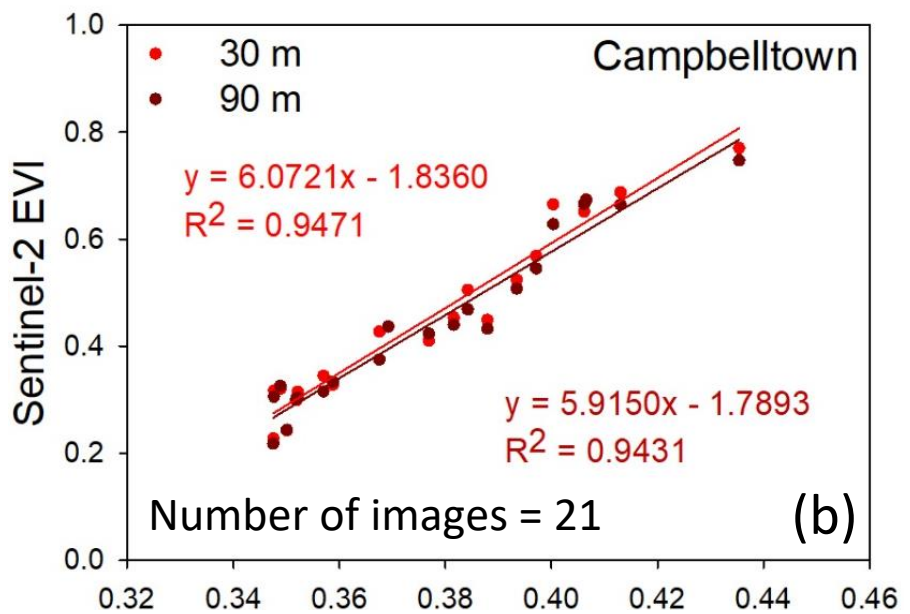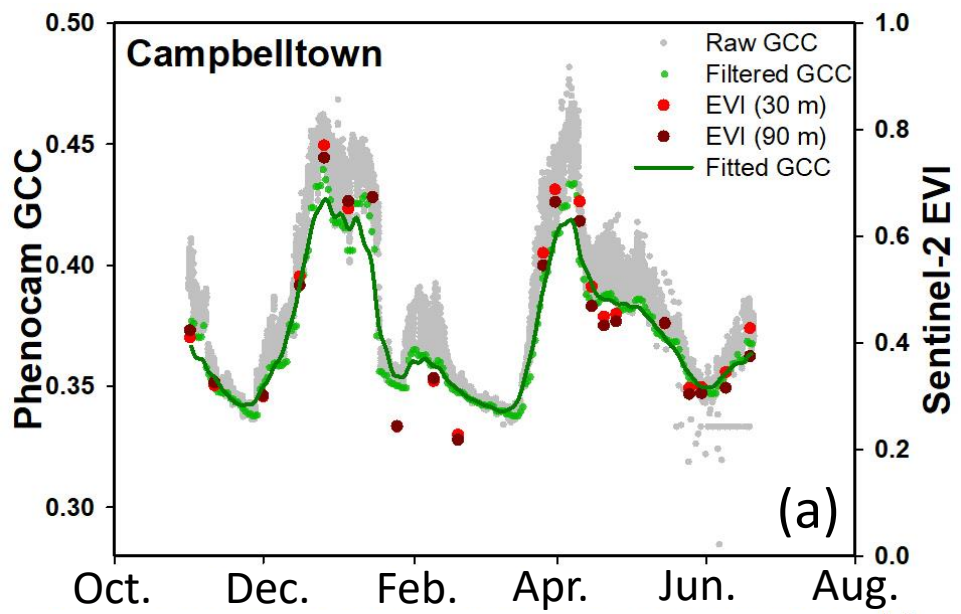
$$EVI = 2.5 \times \frac{(NIR - RED)}{(NIR + 6 \times RED - 7.5 \times Blue + 1)}$$
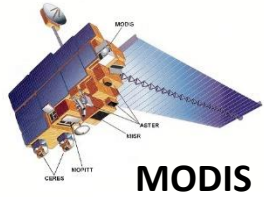
Enhanced vegetation index

Sentinel-2

Q 1: How well can we calibrate Sentinel-2 'greenness' measures to in-situ phenocam 'greenness'?

Temporal trajectories and correlations between phenocam GCC and Sentinel-2 EVI at footprint (30 m) and 90 m scales, Campbelltown (a & b), Mutdapilly (c & d).
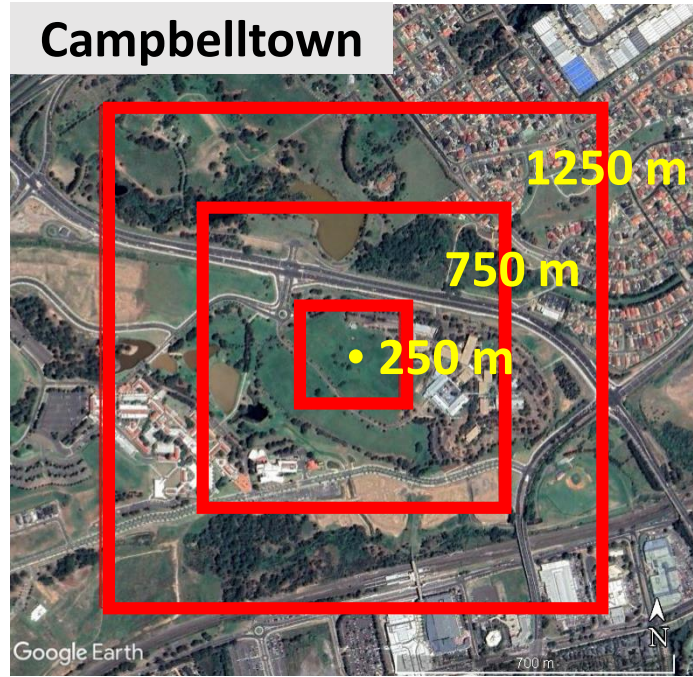
3

Q 2&3: How well does the phenocam represent the surrounding pastures, and can we improve greenness upscaling by grass land cover masks?

MODIS

Dynamic Land Cover Dataset (DLCD)

Campbelltown

DLCD grass mask (250 m)

Sentinel-2 grass mask (10 m)

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Q 2&3: How well does the phenocam represent the surrounding pastures, and can we improve greenness upscaling by grass land cover masks?

MODIS
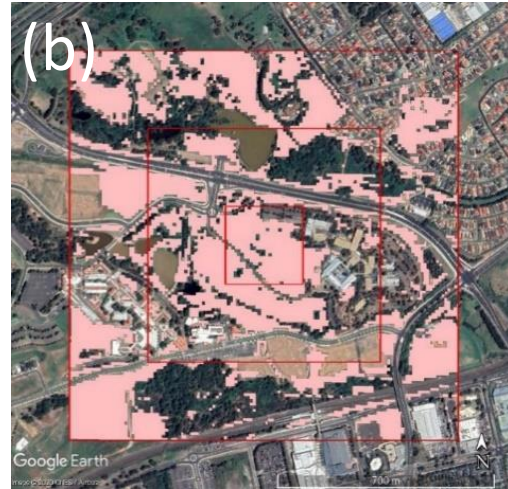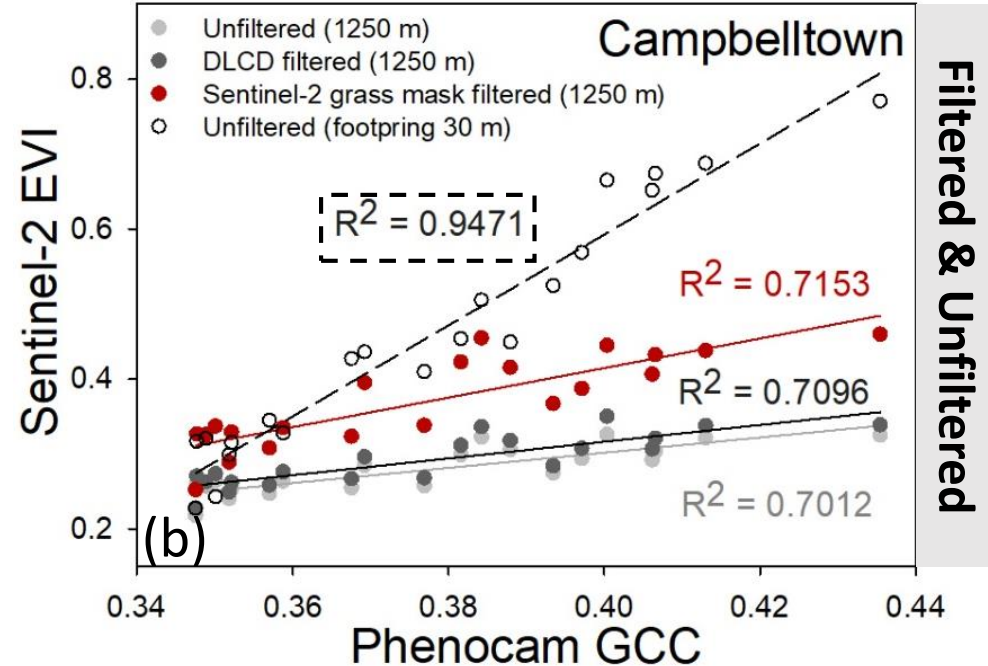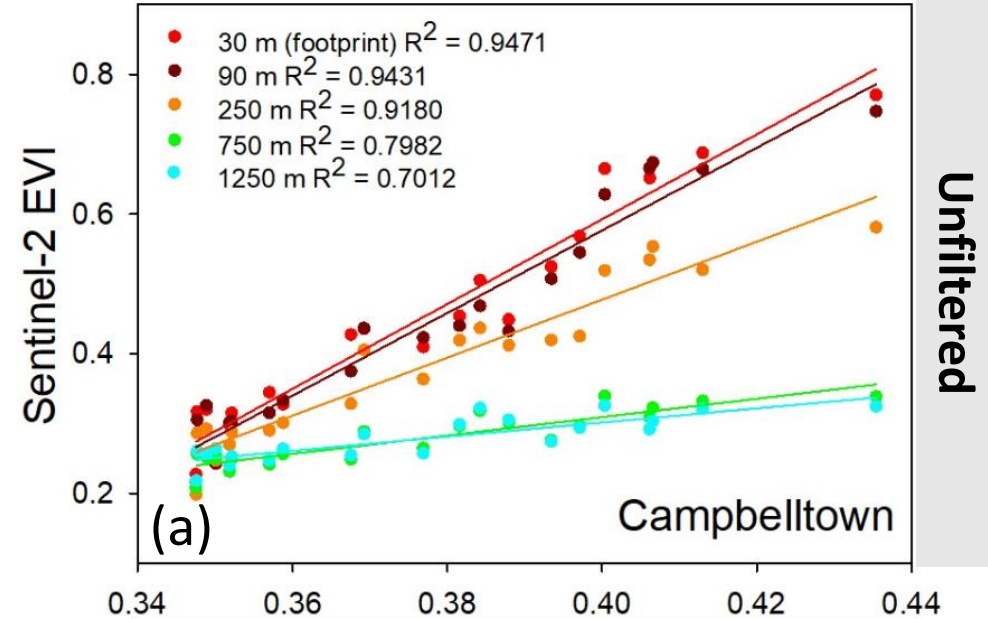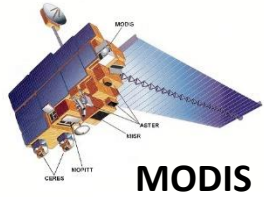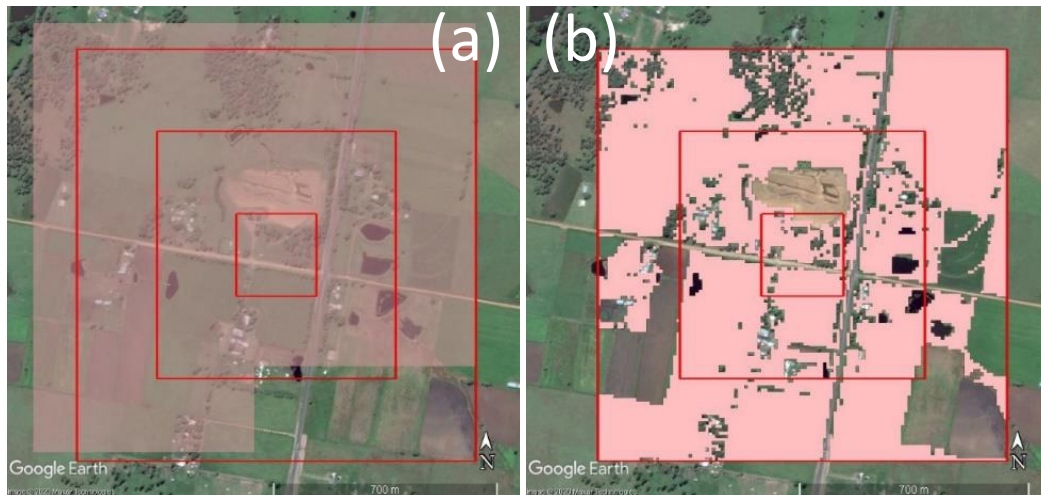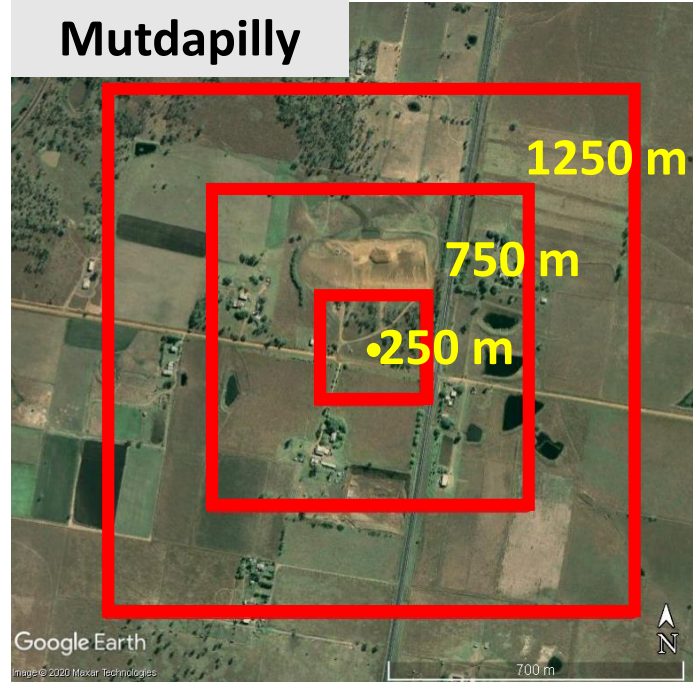
Dynamic Land Cover Dataset (DLCD)

Mutdapilly

1250 m
750 m
250 m

DLCD grass mask (250 m)   Sentinel-2 grass mask (10 m)

(a) Unfiltered:
- 30 m (footprint) $R^2 = 0.9630$
- 90 m $R^2 = 0.9286$
- 250 m $R^2 = 0.8842$
- 750 m $R^2 = 0.8984$
- 1250 m $R^2 = 0.9388$

Sentinel-2 EVI vs Phenocam GCC — Mutdapilly

(b) Filtered & Unfiltered:
- Unfiltered (1250 m)
- DLCD filtered (1250 m)
- Sentinel-2 grass mask filtered (1250 m)
- Unfiltered (footpring 30 m)

$R^2 = 0.9433$
$R^2 = 0.9457$
$R^2 = 0.9388$
$R^2 = 0.9630$

Mutdapilly

Q 3: Can we improve greenness upscaling from phenocam to satellites by grass masks? (Further discussion to Sentinel-2 grass mask)
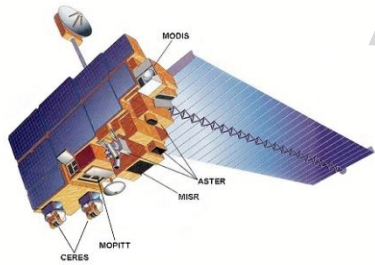

The histogram of pixel numbers from unfiltered and filtered (Sentinel-2) EVI images (1250 m) at greenest day, Campbelltown and Mutdapilly. The red solid line represents the average of EVI values from equivalent image with 30 m scale (phenocam footprint).

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Conclusions

MODIS (250 m)

Sentinel-2 (10 m)

Phenocam

1. **Sentinel-2** with fine spatial resolution can efficiently capture grassland/ pasture information at phenocam **footprint scale**.

2. The in-situ phenocam better represented the surrounding grass pastures at the more homogeneous land cover site (Mutdapilly), than at the Campbelltown phenocam site which was found to not be representative of the neighboring grassland/ pastures.

3. Both sites showed deteriorating relationships with increasing spatial extension (window sizes).

4. Our results demonstrate the potential of Sentinel-2 data as a **land cover filter** to improve greenness upscaling from phenocam to satellites.

Thanks for your attention

Email: yuxia.liu@student.uts.edu.au
yuxia.liu0912@gmail.com