

Representativeness and comparability of ground-based Leaf Area Index measurements across a number of TERN/AusCover study sites

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- What is LAI? -

Leaf Area Index (LAI) is a fundamental descriptor of vegetation structure and function. It can be defined as the total one-sided leaf area per unit of ground area. LAI is recognised as an Essential Climate Variable (ECV) which supports research, modelling, analysis, and capacity-building activity requirements of the United Nations Framework Convention on Climate Change (UNFCCC).



Figure 1: Visualising a forest with LAI equal to 2

- Instruments -



Figure 2: High resolution Digital Hemispherical Photography (HR DHP)



Figure 3: CI-110 (CID Inc.) (LR DHP)



Figure 4: LAI-2200 (Licor Inc.)



Figure 5: Riegl VZ 400 (ToF TLS)



Figure 6: Trimble CX (Phase TLS)

- Results -

Direct Instrument Comparison - Rushworth

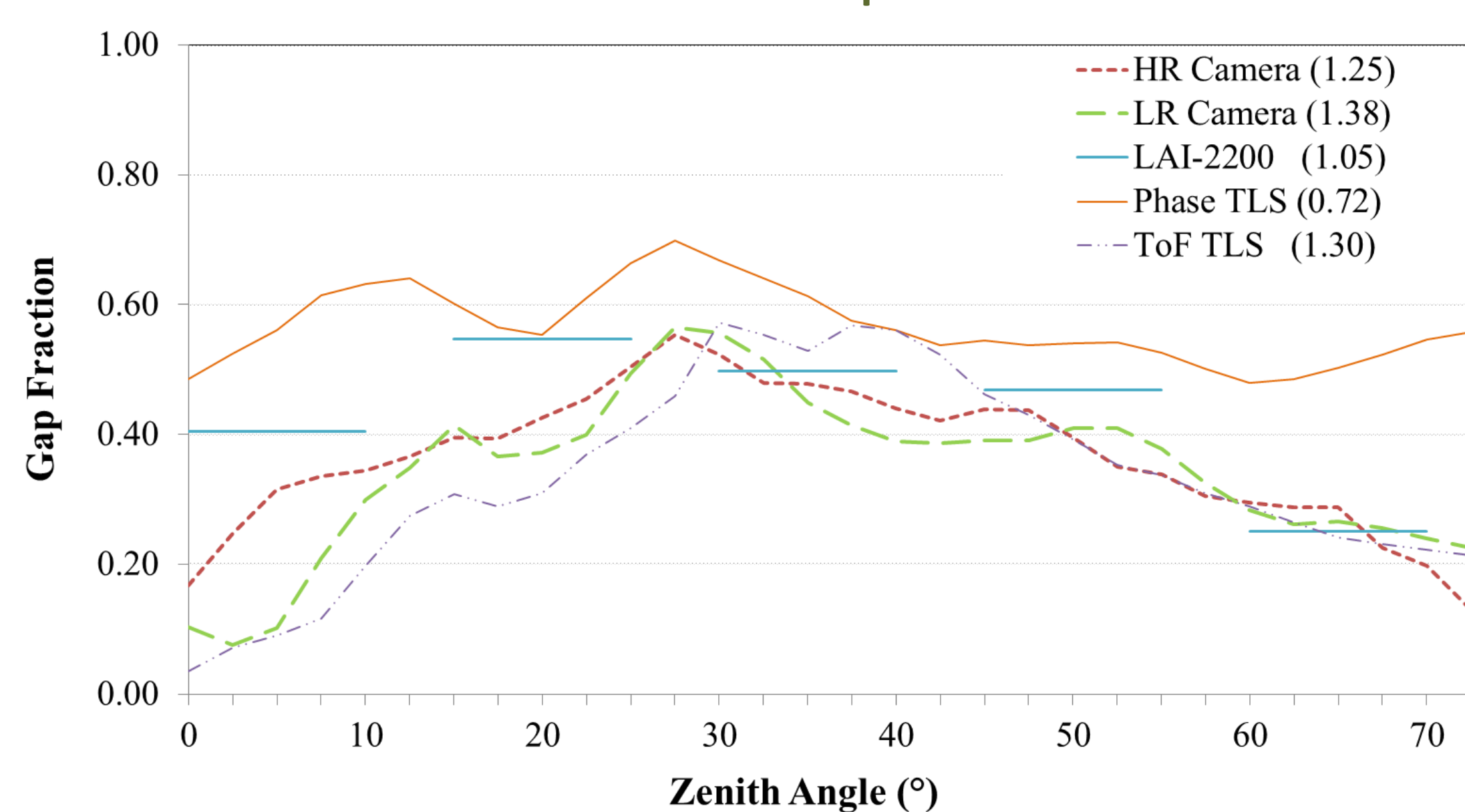


Figure 11 (left): The probability of sky over the range of view zenith angles (0-75°) sensed by each of the five instruments at one location in Rushworth. The resulting LAI value for each instrument is in brackets next to the instrument type in the key.

Direct Instrument Comparison – All Sites

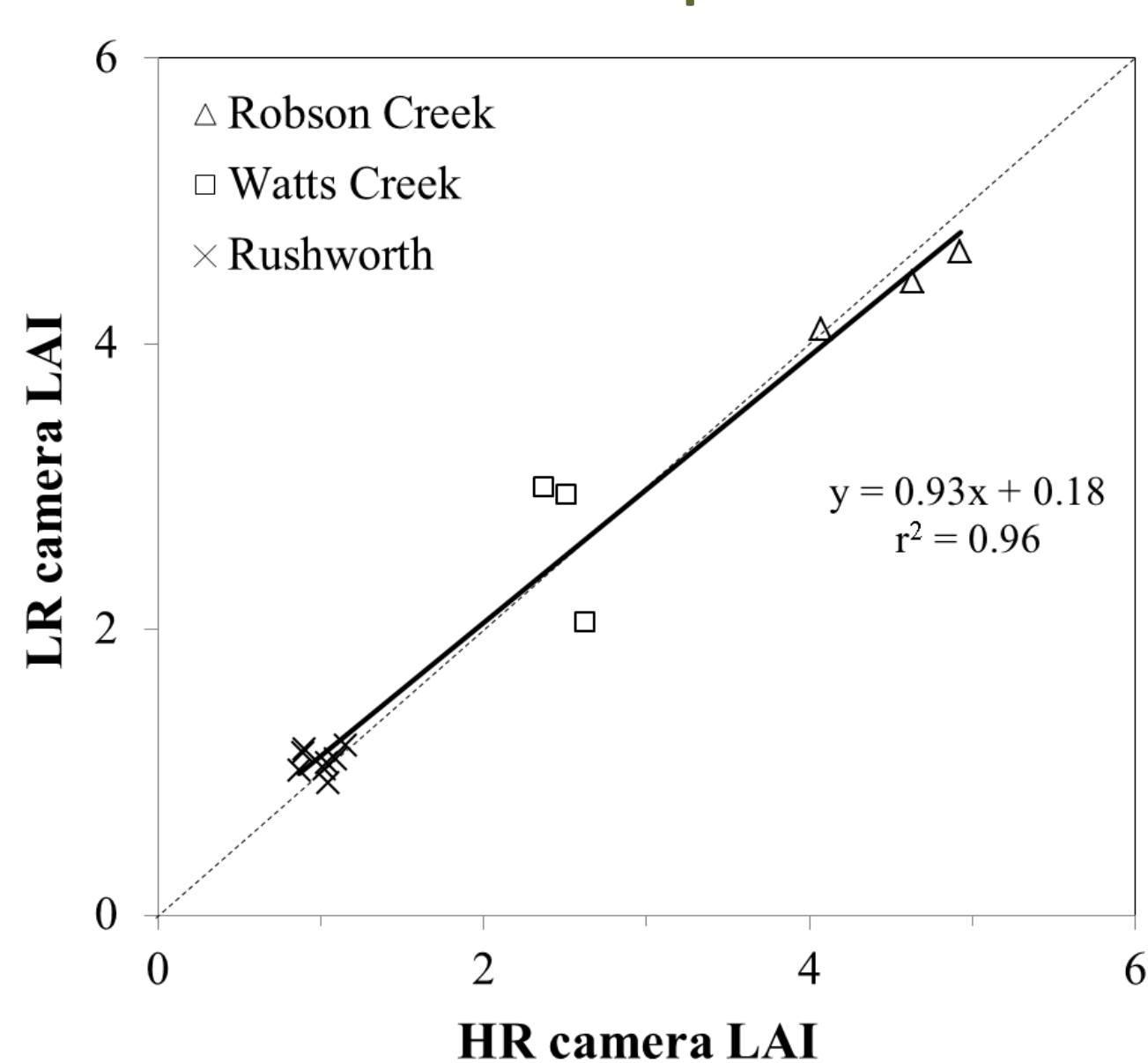
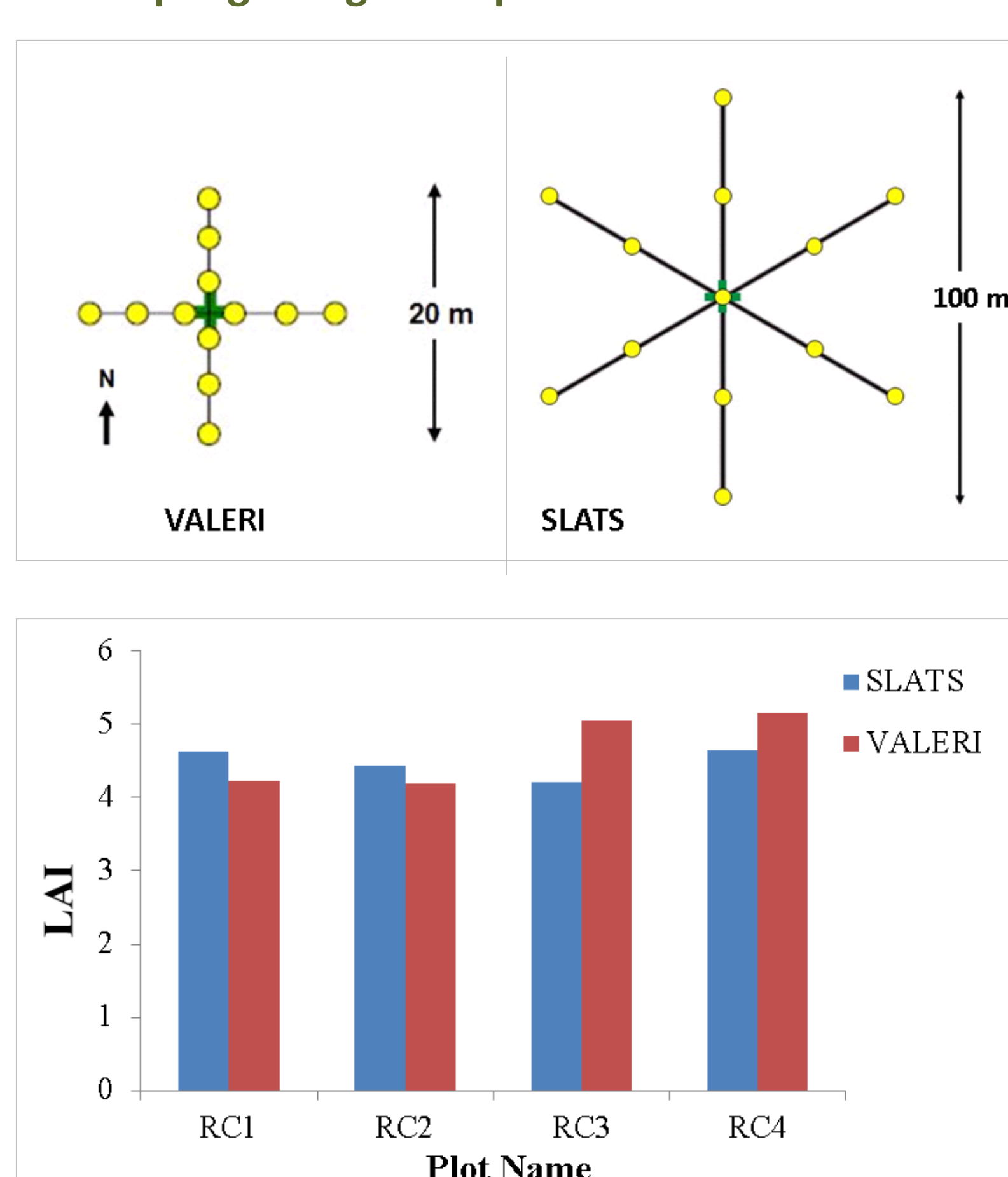


Figure 12 (above): Comparing the performance of the LR DHP and HR DHP across all three study sites

Figure 13 (above right): The VALERI and SLATS sampling designs. Measurement locations are the yellow circles.

Figure 14 (right): Comparing the performance of the SLATS and VALERI plot designs using DHP in four plots within Robson Creek

Sampling Design Comparison – Robson Creek



- Introduction -

Ground-based measurements of Leaf Area Index (LAI) are a priority for TERN/AusCover calibration and validation (cal/val) initiatives of remotely sensed LAI products. A crucial consideration when gathering field measurements is determining a suitable instrument and sampling design, which ensures the collection of representative measurements. A selection of ground-based instruments to derive LAI including the TERN funded LAI-2200 and CI-110 were compared to determine their level of interoperability. Furthermore, the optimal number and configuration of measurements required per plot for cal/val; and variability of the study sites based on the sample plot locations were investigated. These measurements are used to validate the MODIS LAI product in a subset of representative forested environments within Australia.

The benchmark for assessing the comparability of instruments and sampling designs (adapted from a Committee on Earth Observation Satellites (CEOS) recommendation for LAI validation):

± 0.5 or maximum 20% (LAI)

- Study Sites -

Three TERN/AusCover study sites were chosen for this analysis. Each are representative of an important Schlerophyll or Notophyll forest. All three are complimentary and cover a range of LAI values from 1 to 7. The two Victorian sites, Rushworth and Watts Creek, are Box Ironbark and Mountain Ash forests respectively. Rushworth and Watts Creek are classified as Victorian Midlands and Australian Alps/South Eastern Highlands IBRA Bioregions¹ respectively. The third study site, Robson Creek, located in Far North Queensland is a tropical rainforest. Robson Creek is part of the Wet Tropics IBRA bioregion¹ and has one of the highest levels of biomass in the world².

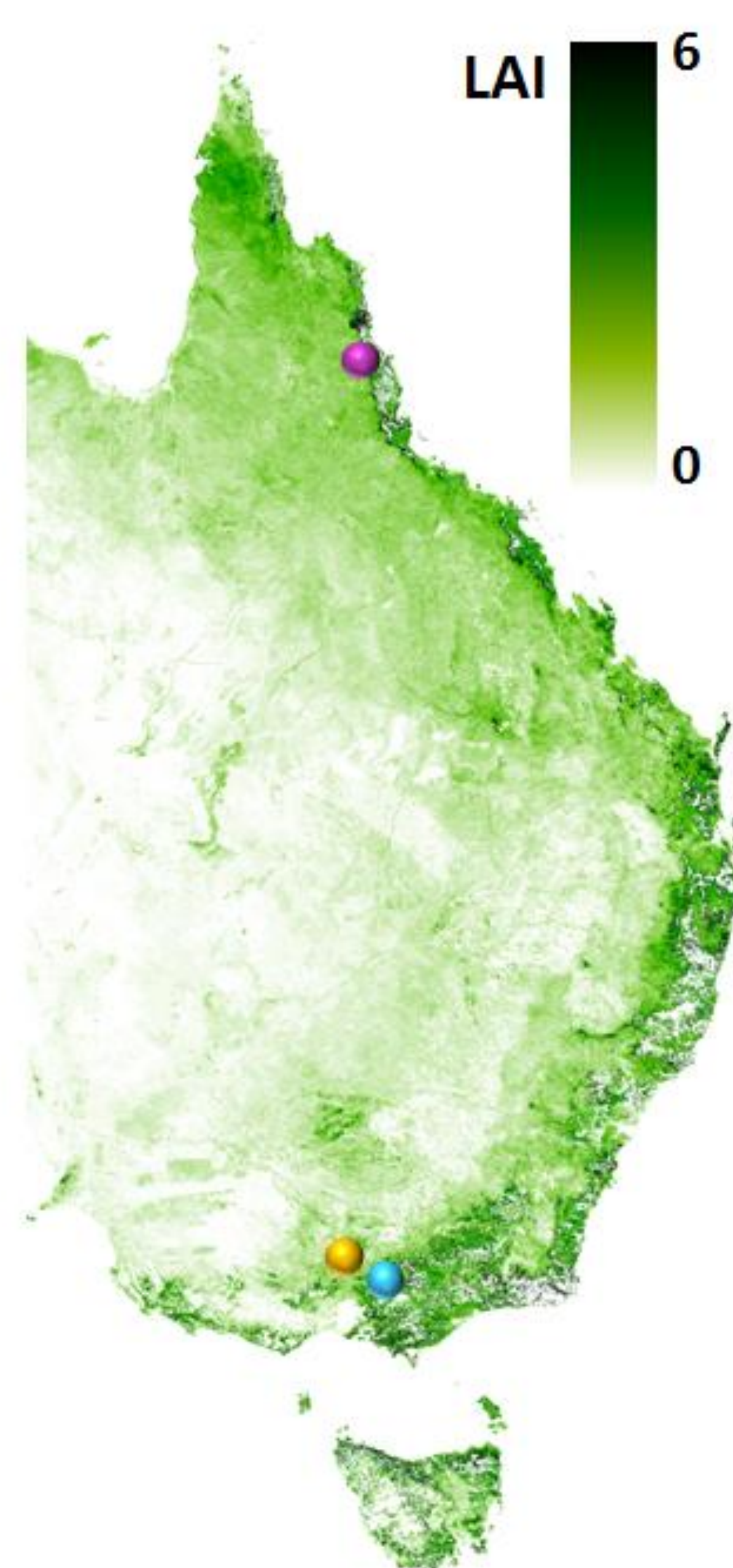


Figure 7: Location of study sites overlaid on the MODIS LAI product (April, 2012)



Figure 8: Rushworth hemi

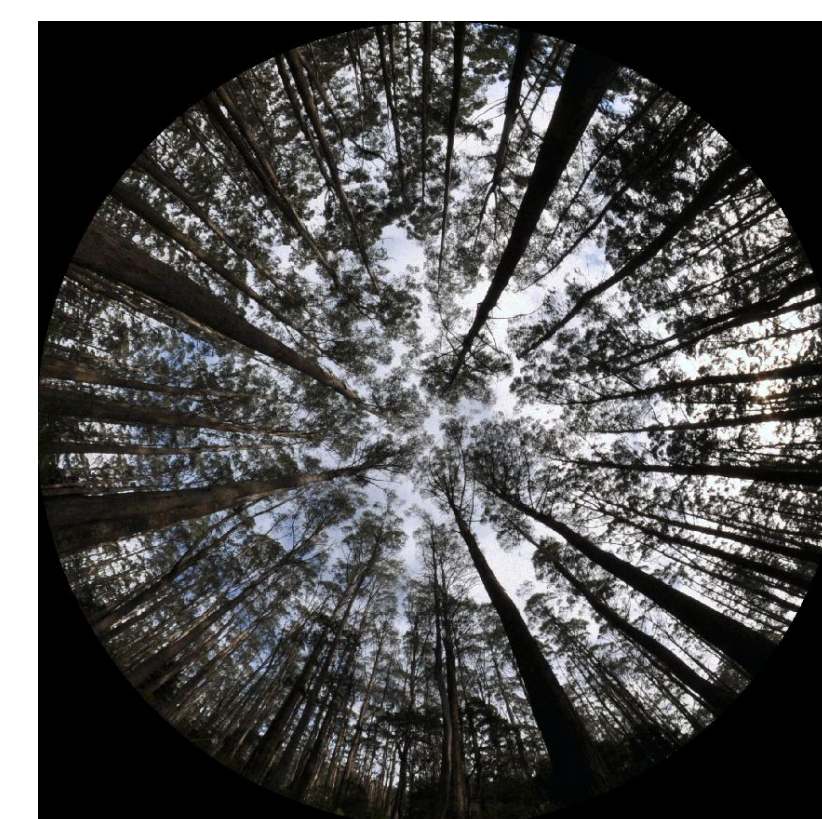


Figure 9: Watts Creek hemi



Figure 10: Robson Creek hemi

- Conclusions -

- Overall the majority of the instruments were highly correlated but not always equal for their ability to measure foliage. The correlation between instruments was mainly consistent for individual plots, but not at the site scale
- For passive sensor comparisons (e.g. LAI 2200, LR and HR DHP) the acquisition conditions (e.g. sky colour and illumination) caused larger discrepancies than the site characteristics (e.g. structure and density)
- The two sampling designs tested in Robson Creek when compared for the DHP instrument are towards the upper end of the CEOS benchmark for LAI (RMSE 0.45)
- There were instances where instruments when compared with one another were not within the CEOS benchmark tolerance levels at the point and plot scale
- It is important to determine which instrument produces results closest to the true LAI value, and if this remains consistent across study sites. This will require further research.

References: 1. Australian Government (2012) IBRA Version 7, <http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html>; 2. Liddell, M., (2012) Quote in TERN Newsletter, Sept. 2012, online at: <http://www.tern.org.au/Newsletter-2012-Sept-ASNRobsonCreek-pg23539.html>