A COLLABORATIVE FRAMEWORK FOR VEGETATED SYSTEMS RESEARCH: A PERSPECTIVE FROM VICTORIA, AUSTRALIA

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ABSTRACT

Collaborative ventures in research infrastructure can allow multiple stakeholders to benefit from outcomes that may otherwise be cost prohibitive. In this study, we discuss how the investment in research infrastructure by various sectors of the academic, scientific, and land management community is promoting high end forest ecosystem research in Australia. Three 25km^2 woodland and open canopy forests that are representative of Victoria's 8 million hectares of public forests were incorporated into the Terrestrial Ecosystem Research Network's calibration/validation campaign. The sites are being used to develop algorithms that will assist land management agencies across various states to characterize fundamental forest attributes at a landscape level. Wireless technology (VegNet) is also being trialed at these sites to investigate forest condition over time. This study provides an example of how the establishment and co-investment in research infrastructure amongst different sectors of the scientific community promote data sharing and ultimately expand our understanding of forest ecosystems, which can in turn be used for monitoring and to inform policy and land management decision making.

Index Terms— Calibration/Validation, research infrastructure, Victoria, Terrestrial Ecosystem Research Network

1. INTRODUCTION

Earth Observation (EO) data provides an invaluable tool for monitoring and researching forest ecosystems. The availability of satellite imagery at free to low costs has never been greater given the open access policy granted to some satellite products (e.g., open access data policy for the U.S. Geological Survey's 40 year Landsat archive, [1]) and organizations that promote the coordination and exchange of satellite imagery, such as the Committee for Earth Observation Satellites or CEOS. The usefulness of such data, however, is closely linked to the level of calibration and validation (cal/val), which determines and potentially improves the accuracy of EO data and their derived satellite products.

In Australia, EO data is crucial to a number of research and environmental programs. Until recently, the collation of EO data and accompanying cal/val activities was fragmented and limited. The Terrestrial Research Ecosystem Network (TERN), funded by the Australian Federal Government's National Collaborative Research Infrastructure Strategy (NCRIS), provides a national framework for the planning and coordination of ecosystem research. Accordingly, one of its key foci is to provide open source access to quality EO data that supports terrestrial research needs at a national level. To achieve this, TERN collates, calibrates and validates previously existing datasets; provides the needed infrastructure to expand ecosystem research across Australia; and manages, stores, and allows access to ecosystem data. Through a series of facilities, TERN facilitates ecosystem science research and promotes collaborative research.

The AusCover facility within TERN seeks to provide a nationally consistent approach for the collection, validation, and distribution of biophysical products derived from time series EO systems in support of ecosystem management and research. It runs a calibration and validation (CALVAL) program to calibrate and validate a range of land surface products (e.g., MODIS Fractional Cover, time series Foliage Projective Cover, Burnt Area, LAI). As part of this CALVAL program, AusCover coordinates and conducts an extensive large area validation campaign over 1000 field sites across multiple forest ecosystems (e.g., sclerophyll forests, savanna woodlands, grasslands and tropical forests) that are intensively characterized using data collected at multiple spatial scales (ground based, airborne, and satellite). In Victoria, three 25km^2 reference sites were incorporated into the AusCover CALVAL site network.

This paper highlights how the network of infrastructure created by TERN has created a favorable environment for high level analysis of forest ecosystems at a local/state level in Victoria throughout the science-policy-management continuum. It details the challenges and benefits of such a collaborative approach into ecosystem research by drawing on the experiences gained at three research sites in Victoria that were incorporated into the TERN AusCover Calibration and Validation (CALVAL) site network.

2. STUDY SITES

Three 25km^2 instrumented research sites of sclerophyll woodland and open canopy forests that are representative of Victoria's 8 million hectares of public forests were incorporated into the national AusCover CALVAL sites through a joint partnership between TERN, the Cooperative Research Centre (CRC), and the Department of Sustainability and Environment (DSE). These include a Box Iron-bark forest, a Mountain Ash forest, and a Mixed Species foothills forest (Figure 1). The co-investment in research infrastructure across these sites has been a catalyst for forest ecosystem research across various stakeholders.

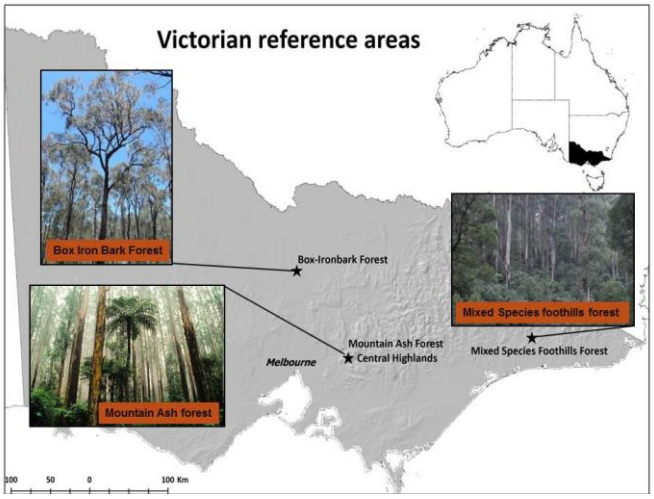

Figure 1. Three reference areas incorporated into the AusCover Calibration and Validation network that are also being used for different research purposes across land management agencies, universities, and research institutions.

3. COOPERATIVE RESEARCH

3.1. CALVAL Activities

As with other sites that are intensively characterized for CALVAL activities, data was collected across several spatial scales: ground, airborne, and satellite (Figure 2). Airborne hyperspectral and full waveform LIDAR data were collected throughout each 25km^2 site by Airborne Research Australia (Figure 2). Field activities were coordinated by AusCover, DSE, and RMIT and involved participants from the state to international level across academic and government agency sectors (e.g., Curtin University, CSIRO, Queensland University, University of Sydney, DSE, RMIT). Ground activities were carried out to estimate leaf area index (LAI), fractional cover, and canopy characteristics. To ensure consistency, standard protocols and methodology were employed. For instance, the State wide Land cover and Trees Survey (SLATS) star transect method [3] was applied to estimate woody vegetation cover or fractional projective cover (FPC).

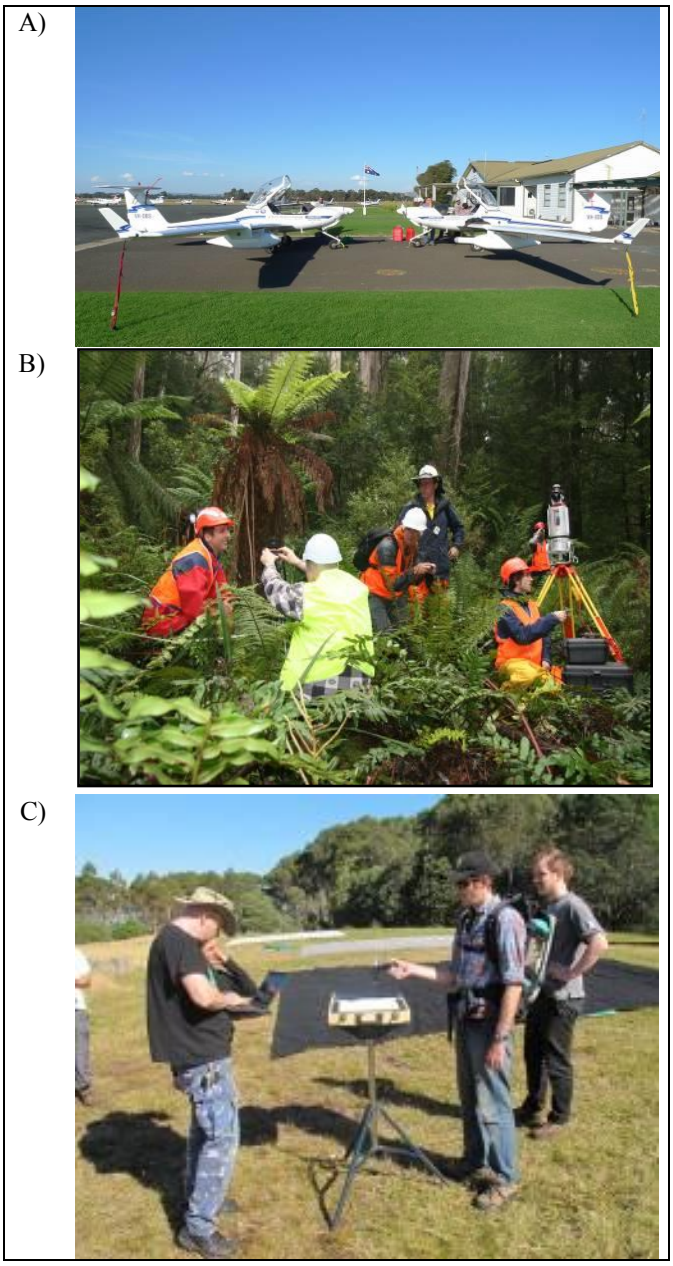

Figure 2. CALVAL associated activities. A) aircraft used to collect high resolution hyperspectral and LIDAR data; B) AusCover CALVAL activities in the Mountain Ash site with participants from RMIT, CSIRO, DSE; C) Ground targets used to calibrate high resolution hyperspectral imagery.

3.1. Ongoing research

The Victorian reference sites are being used to investigate and develop algorithms that will assist land management agencies (represented by Victoria, New South Wales, Queensland, and Western Australia) to characterise forests through Project CRCSI 2.07 (http://www.crcsi.com.au/Research/2-Feature-Extraction/2-07-Woody-Vegetation). This has allowed academic research through the appointment of several doctoral and one post doctoral position at RMIT University, all of whom collaborated in AusCover CALVAL activities during April 2012 along with DSE and CSIRO staff. Besides applying the protocols commonly used by AusCover during data collection, they collected structural and functional measurements of vegetation using traditional forest mensuration transects and plots, terrestrial lidar scanning and high temporal resolution in-situ autonomous laser (VegNet) scanners and dendrometers (Figure 3).

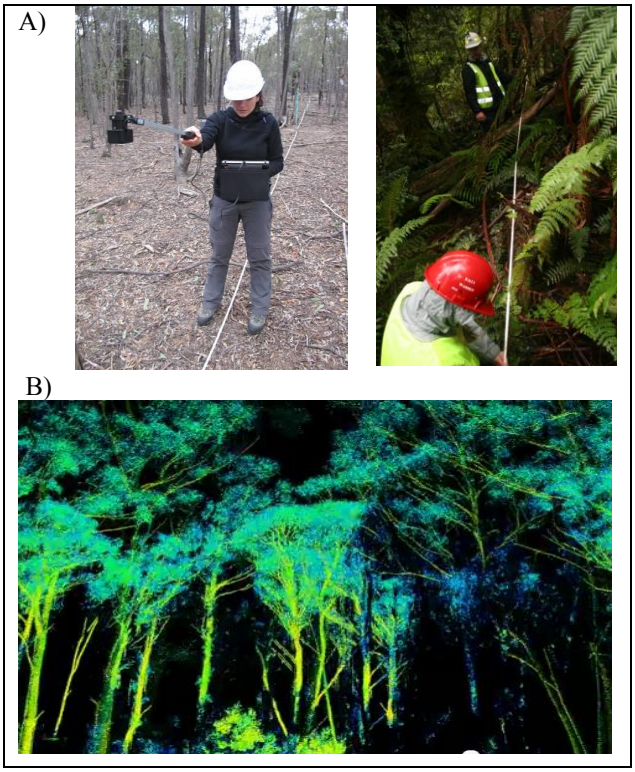

Figure 2. Examples of activities associated with field gathered observations. A) Collection of LAI across a SLATS transect; B) Establishment of transect across a small radius to collect several overstorey and understory attributes (e.g., DBH, tree height, coarse woody debris) C) Terrestrial Laser Scan coloured by intensity using a Riegel Vz400 (courtesy of Kim Calders).

The Victorian reference sites are also being used by the Joint Remote Sensing Research Program (JRSRP) to perform CALVAL of large area vegetation information products using airborne lidar and terrestrial laser scanning. The JRSRP is a

collaborative program amongst the government land management agencies in Victoria, Queensland and New South Wales, that aims to facilitate needed land management research amongst these agencies.

In addition, CSIRO is using these sites to trial VegNet scanners, which are being used to map and monitor forest condition [n]. The VEGNET trial is aimed at validating new in-situ monitoring lidar (IML) instruments as a means of monitoring overstorey and understorey vegetation dynamics (Figure 4).

Figure 4. VegNet scanner at the Box Iron Bark forest

The VEGNET IML instruments are mounted in fixed positions on the ground and perform a daily 360 degree azimuth scan at a fixed zenith angle of 57 degrees. Approximately 900 distance measurements are recorded per full azimuth scan at centimetre resolution. Data are integrated at a monthly timescale to produce vertical profiles of vegetation structure. This is represented as both cumulative LAI and Plant Area Volume Density (PAVD) as a function of height. Validation is occurring relative to monthly hemispherical photographs and litter-fall traps. Data analysis has shown that use of concurrent weather station data improves the reliability of LAI and PAVD estimates by identifying scans affected by high wind or rain at the time of data acquisition. VEGNET scanners are solar powered and have a maximum effective range of 60m. A longer-range version is being developed for use at the Mountain Ash site.

4. CONCLUSION

A key goal of TERN is to provide the necessary infrastructure that promotes and improves communication and data sharing within and between the ecosystem science communities in Australia. This case study shows how the establishment of research infrastructure and co-investment in airborne remote sensing and ground gathered data across various sectors has promoted scientific research that may otherwise be cost prohibitive. In addition, it has encouraged the adoption of widely used data collection standards (e.g., metadata, field methodology employed) and open access policy that allows the data to be available to the wider scientific community. Besides assisting the national CALVAL of biophysical products derived from EO data, it is also facilitating research that ultimately enhances our understanding of forest ecosystems and informs policy and land management decision making.

5. REFERENCES

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