DRAFT VERSION – December 2023

CEOS Ecosystem Extent Task Team Demonstrator

The Great Western Woodlands, Australia

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Introduction

The Great Western Woodlands (GWW) in southwest Australia represent the largest remaining area of temperate woodlands on Earth, covering 160,000 km^2. The GWW consists of a mosaic of largely intact semi-arid eucalypt woodlands, mallee, shrublands, and salt lakes – supporting significant biodiversity and cultural values, as well as storing carbon. These woodlands are unique globally as they are dominated by obligate seeding trees that can reach 20 m in height and 1 m in stem diameter, despite receiving only 200 – 400 mm of rainfall per year. The broader region is considered one of the world's biodiversity hotspots and is home to more than 3000 species of flowering plants.

Motivation

The GWW and the biodiversity they support are under growing pressure from climate change and land-use intensification. South-western Australia has been identified as one of the fastest drying regions of the world, with aridity increasingly sharply since the early 2000s (IPCC 2021). It is estimated at ~30% of the woodland area has burned at least once since 1970, and drier and warmer conditions in coming years will likely lead to increases in burn extent and frequency. The dominant obligate-seeder eucalypt species have low resilience to fire, so even low-intensity surface fires cause stand-replacing tree death. There is therefore a pressing need for conservation, restoration and adaptation strategies designed to ensure the long-term persistence and resilience of the GWW. Central to this is the provision of high-quality maps of ecosystem extent, capturing the key vegetation types in the region, as well as their predicted ages.

The core goal of this demonstrator project is to improve the spatial delineation of vegetation types and stand ages in the GWW region.

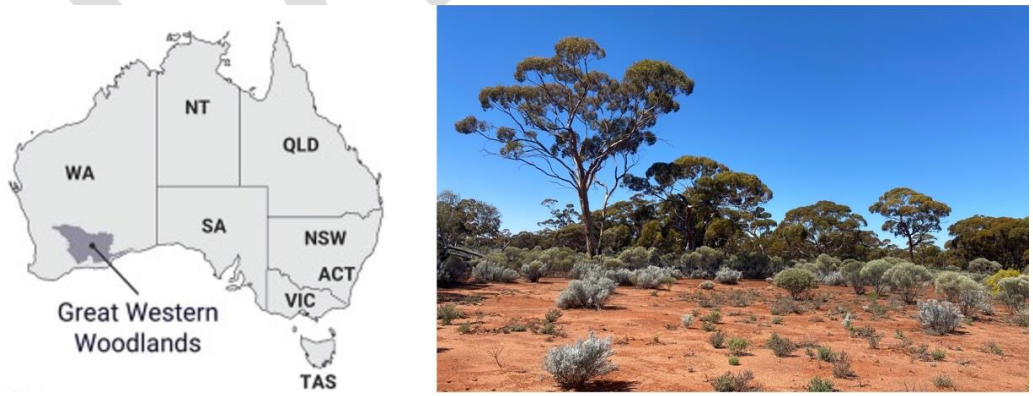

Figure 1 - Location of the Great Western Woodlands in south-western Australia. Iconic tall salmon gums in the arid landscape.

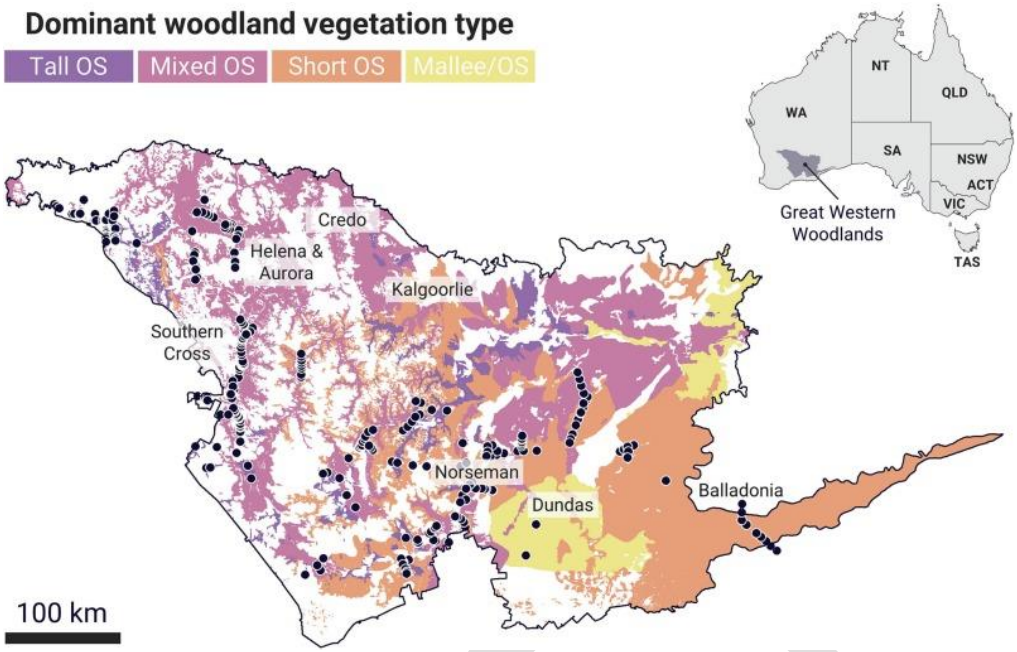

Figure 2 - Overview of vegetation structural classes in the GWW region. OS = over-story. Image courtesy of Jucker et al. 2023.

Approach

The research goal of mapping vegetation types and stand ages will be addressed through the integration of earth observation data and field records in a data cube environment. CSIRO's implementation of the Open Data Cube (EASI Hub) will be used as the core analytical infrastructure, and the Jupyter Notebooks developed here will be cross-compatible with other ODC instances.

Stage 1: Populate the study region datacube with Digital Earth Australia Landsat products for the region of interest from 1988 to 2022. These include the geomedians and geomedian absolute deviation (GeoMAD) for each calendar year, annual tassel-cap percentiles (10^{th}, 50^{th}, 90^{th}), and fractional cover percentiles (10^{th}, 50^{th}, 90^{th}). Derive key spectral indices from the geomedians (e.g. kNDVI, NDWI, NDMI, NBR).
Stage 2: Ingestion/preparation of canopy structural data – including available GEDI L2 data, airborne LiDAR datasets, and ALOS-2/Sentinel-1 SAR backscatter. Consider inclusion of more recent Sentinel-2 time-series and red-edge indices.
Stage 3: Ingestion of field data with information on vegetation community composition, soil type and estimated stand age (based on structural attributes).
Stage 4: Develop machine learning model for predicting vegetation type and stand age from multi-spectral imagery.
Stage 5: Ingestion of experimental hyperspectral products over subsets of the region to test the improvement of adding higher-dimensionality data. This stage will mostly likely include EMIT as a first pass, with potential of EnMAP inclusion.

Partners and Roles

CEOS: Spaceborne data access and provision? (most are open but JAXA L-band would be useful, so might higher resolution X-band from DLR).
CSIRO: Data cube implementation and analytics**,** ecological expertise, field data provision (Shaun Levick, Matt Paget, Suzanne Prober, Alison O'Donnell, Leo Lymburner, new post-doc hire)
DBCA: Ecological expertise, airborne LiDAR data provision, field data provision (Katherine Zdunic, Gerald Page)

University of Bristol: Ecological expertise, statistical modelling (Tommaso Jucker)

Challenges

Ingestion of hyperspectral data in the ODC is still experimental. Some good progress thus far but will take time to troubleshoot various issues.

Working environment access for non-CSIRO staff – how can other members of the EETT get involved and contribute?

Schedule

Stage 1: September - January 2023
Stage 2 and 3: Feb - April 2024
Stage 4: May - July 2024
Stage 5: January – September 2024

Presentation of results and demo of Jupyter Notebook at Plenary 2024.