TERN

TERN: Australian Ecological Data & More

Bernardo Blanco-Martín

ecoEd Champions Training, Canberra, December 2018

NCRIS National Research Infrastructure for Australia An Australian Government Initiative

ecoEd

PRESENTATION OVERVIEW

- Introduction to TERN
- TERN's Data
  - Types
  - Applications
  - How to Obtain TERN's Data
- What else can TERN offer you?

TERN

PRESENTATION OVERVIEW

- Introduction to TERN
- TERN's Data
  - Types
  - Applications
  - How to Obtain TERN's Data
- What else can TERN offer you?

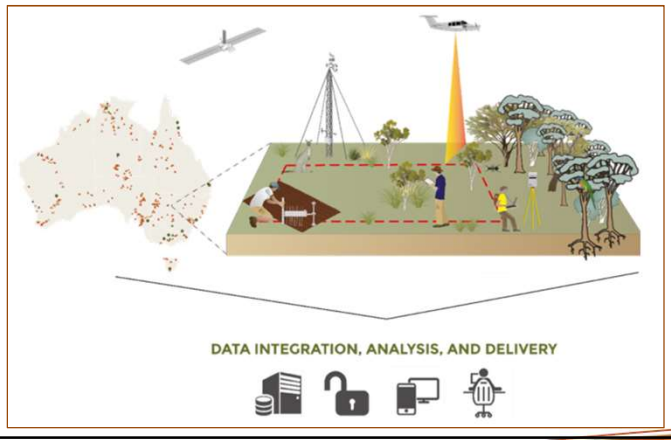
Main focus

TERN

TERN: What is it?

TERN = Terrestrial Ecosystem Research Network

TERN is Australia's land ecosystem observatory



TERN

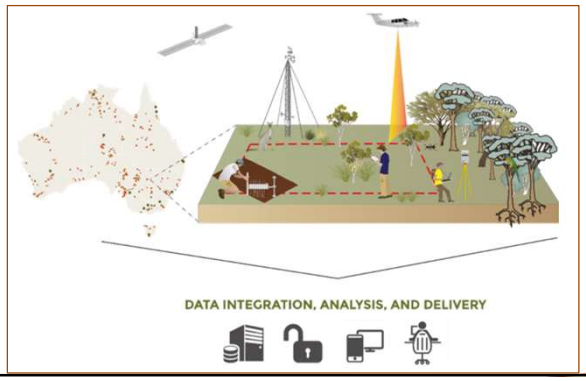
TERN: What is it?

TERN observes, measure and records critical terrestrial ecosystem parameters and conditions for Australia:

- *Spatial scale*: From continental scale to field sites at 100s of representative locations.
- *Temporal Scale*: Repeatedly over time. From continuous to > 1 yr

Information is standardised, integrated and transformed into model-ready data.

TERN



TERN: History, Funding, &Partners

- Established in 2009.
- Australia's first Commonwealth Government NCRIS grant-funded research infrastructure to deliver a national terrestrial ecosystem observatory "providing standardised and integrated measures of changes in Australia's land-based ecosystem biodiversity".

Supported by

NCRIS National Research Infrastructure for Australia
An Australian Government Initiative

Hosted by

The University Of Queensland AUSTRALIA

In partnership with

CSIRO · The University of Adelaide · James Cook University Australia · Australian National University · The University of Sydney

TERN: Funding

Released in 2017.

Nine focus areas:

- **Digital Data and eResearch Platforms✓**
- Platforms for Humanities, Arts and Social Sciences
- Characterisation
- Advanced Fabrication and Manufacturing
- Advanced Fabrication and Manufacturing
- Advanced Physics and Astronomy
- **Earth and Environmental Systems✓**
- Biosecurity
- Complex Biology
- Therapeutic Development

TERN

TERN: Funding

Table 3: Priority Areas for National Research Infrastructure - Digital Data and eResearch Platforms

Elements	National Research Infrastructure response
Tier 1 HPC	Enhance existing national HPC – NCI and Pawsey. Explore governance integration of these Tier 1 HPC facilities.
Create Australian Research Data Cloud	Enhance existing capability through the integration of existing capability – ANDS, NeCTAR and RDS to establish an integrated data-intensive infrastructure system, incorporating physical infrastructure, policies, data, software, tools and support for researchers.
Research networks	Enhance the capability and capacity of the AREN.
Access and authentication	Enhance capability and international relationships in access, authentication and authorisation services.

TERN

TERN: Funding

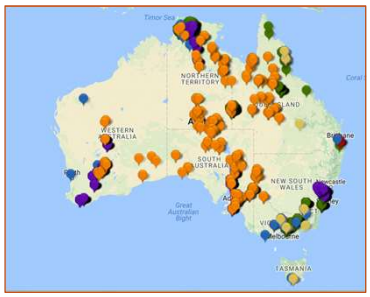
Table 8: Priority Areas for National Research Infrastructure – Earth and Environmental Systems

Elements	National Research Infrastructure response
Earth observations	Enhance capability in remotely sensed data infrastructure, including sensors and sensor networks, and calibration sites across Australia. Enhance capability to provide a wide range of new and innovative remotely sensed products and high quality field data to the research community, business, government and industry in near real time.
Environmental prediction system	Enhance capability for new infrastructure integrated with eResearch to enable existing and new data with new technologies and modelling to build an Environmental Prediction System for Australia. Enhance capability to re-engineer weather and climate modelling (ACCESS) systems. Explore integration to build new infrastructure to automate the upload of data. Maintain priority for new biodiversity data streams to be integrated with existing environmental data platforms such as ALA.
Agricultural integrated networks	Explore integration of networked agricultural platforms based on next generation sensor data for a national approach to integration and modelling likely production across diverse geographical locations and under a range of climatic scenarios.

TERN

TERN: Purpose[1]

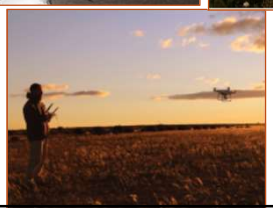
- Collecting, collating, storing and sharing Australia's terrestrial ecosystem data sets and knowledge.
- Facilitate open access to terrestrial ecosystem research data.



TERN

TERN: Purpose[2]

- National **infrastructure** for **collecting** Australia's terrestrial ecosystems data.
- Build and manage **data infrastructure** to provide public **access** to terrestrial ecosystem data.



TERN

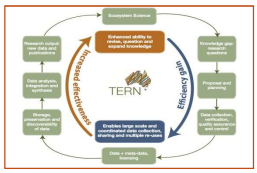
TERN: Delivers

- **Infrastructure**: To support collection, collation, storing, discovery, access, and re-use of TERN data….and other ecosystem data.
- **Data**: A lot more to come on this!
- **Tools** for the research community, including:
  - Nationally consistent field methods
  - Vegetation and Soil Samples
  - Data Collection App.
  - Data Publishing Tools.
  - Analytic Tools.
  - …and the Data Skills Development Program (DSDP)!

TERN

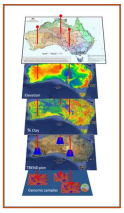
TERN: Infrastructure & Activities

Collection Methods

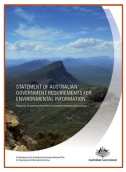


Data Storage

Data Sharing



Modelling



Policy + Management

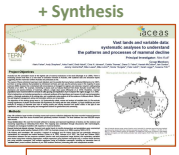
Instruments + Sensors

Processing + Analysis

Data Curation + Publishing

Data Searching

Analysis + Synthesis

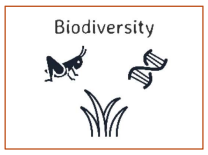


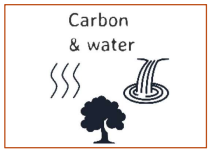
CoESRA

TERN

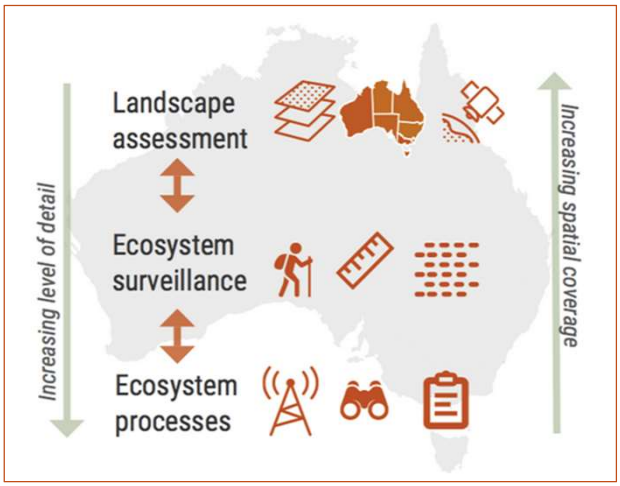
TERN: Monitoring Themes & Scales

Key Themes





Key Scales of Observation



TERN

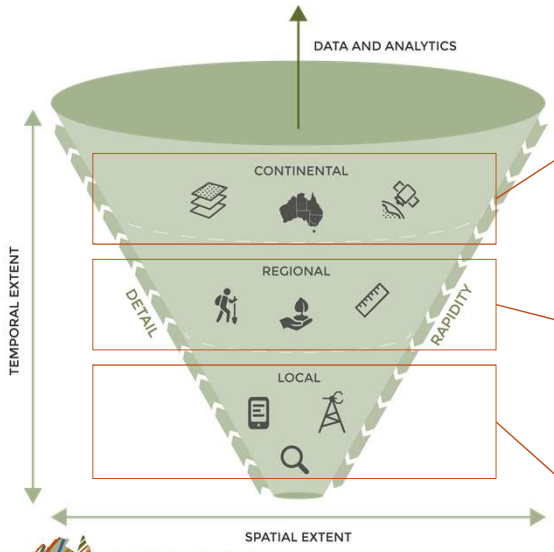
TERN: 3 Key Monitoring Scales

From the beginning, the TERN ecosystem field observatory was structured around three key scales of observation:

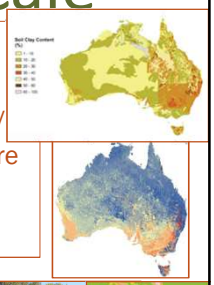
- **Landscape assessment monitoring** mostly through remote sensing techniques based on satellite data, with the use of airborne data from autonomous vehicles (UAVs). We also undertake modelling and synthesis activities to extrapolate and interpolate from observational data to produce modelled data products.
- **Ecosystem surveillance monitoring**, which enables us to monitor and detect biodiversity change across a wider spatial extent of environments. TERN uses an extensive network of monitoring plots distributed strategically through the country.
- **Targeted ecosystem process monitoring**, which gives a high level of detail at a small number of sites. This is done through intensive field stations or 'SuperSites' which combine instrumented or sensor measurements.

TERN

TERN: Data Examples per Obs. Scale

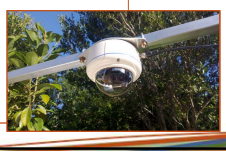


- Satellite remote sensing products
- Land cover dynamics and phenology
- Vegetation composition and structure
- Fire dynamics and impacts
- Continental Soil & Landscape data



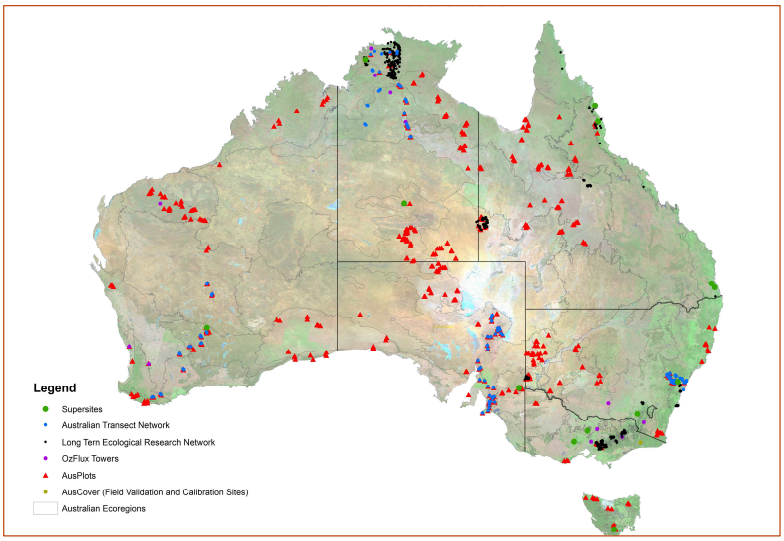
- Plot-based surveillance monitoring
- Soil sample, leaf tissue samples, LAI, Basal area

- Carbon, energy, water fluxes
- Phenocams
- Acoustic sensors
- Flora population



TERN

TERN: Monitoring Scales Infrastructure



TERN

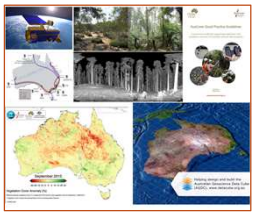
TERN: Monitoring Scales Infrastructure

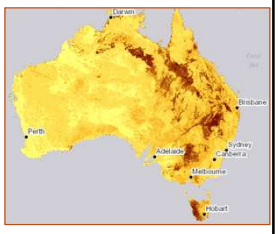
Video displaying TERN Monitoring Infrastructure
Click on underlined link to view

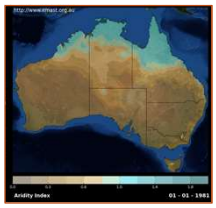
TERN

TERN: Data Publication Hightlights[1]

- Over 40 continental scale remote sensing data products
  - Land cover dynamics and phenology
  - Vegetation composition and structure
  - Fire dynamics ad impacts
  - Airborne data products
- Over 30 continental scale soil and landscape attributes data products
- Continental scale data on climate variables at 1 km spatial resolution
- Coastal ecosystem datasets
  - National seagrass
  - Beach observation from 40 sites
  - Water quality



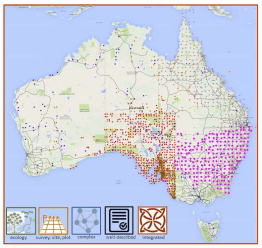


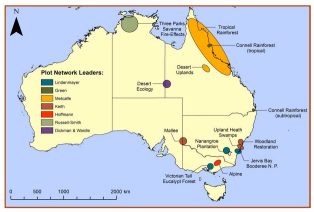


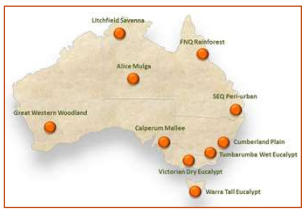
TERN

TERN: Data Publication Hightlights[2]

- Publication data from over 98,000 ecological sites
  - 12 ecosystem observatories
  - 600 surveillance plot networks
  - State government survey plot networks
  - 12 long term research networks
- Half-hourly time-series flux data across Australia
  - 30 towers from Australia and NZ

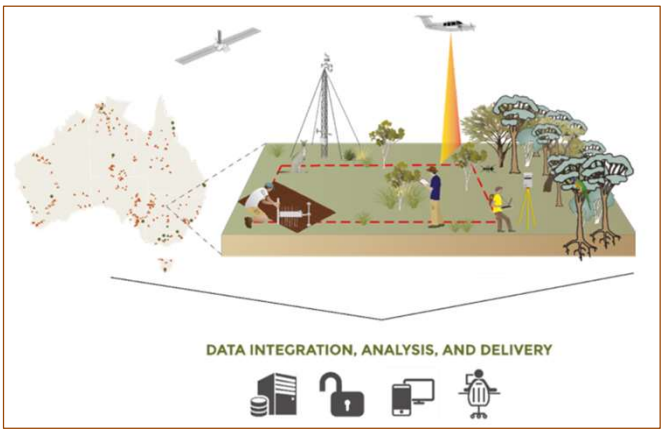






TERN

TERN: Some Stats



more than **600** ecosystem observing sites

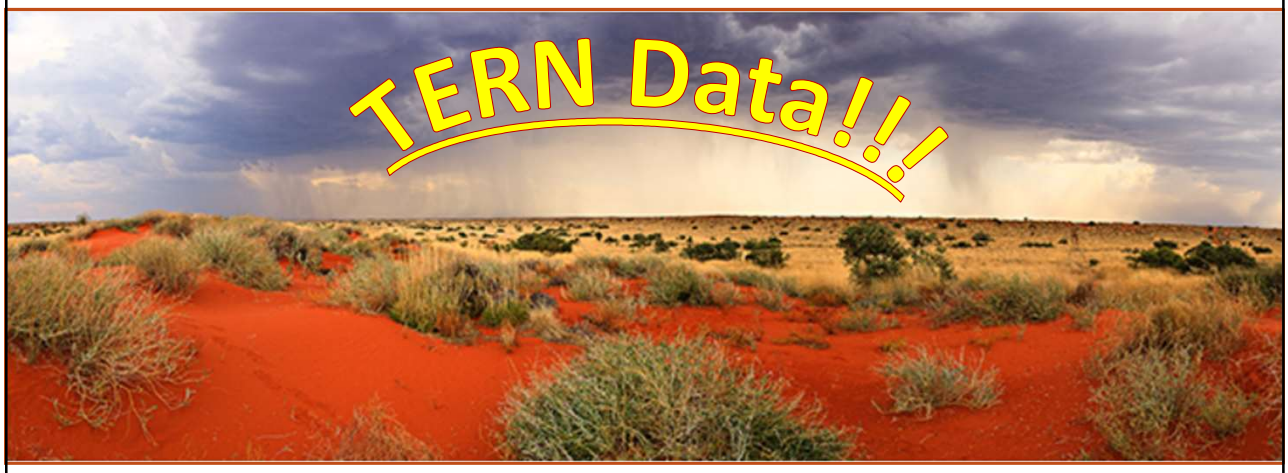
more than **2500** open datasets

more than **50** national and international partners

more than **90** year continuity for datasets

more than **1000** peer-reviewed papers using TERN data

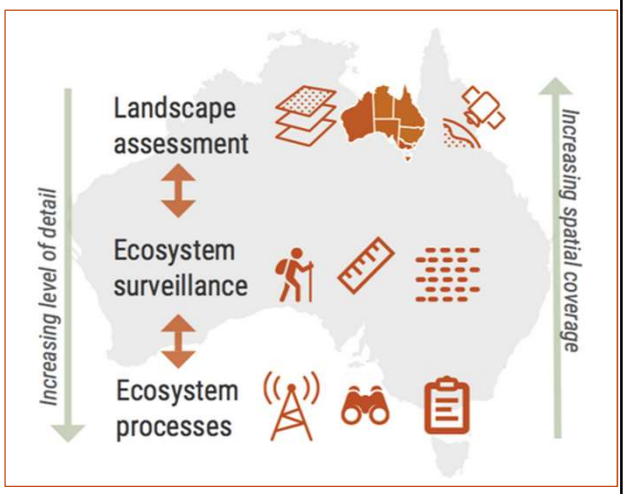
TERN



TERN

TERN: Data Streams

- Landscape Assessment (LA)
  - Remote Sensing
  - Soil and Landscape Grid
- Ecosystem Surveillance (ES)
  - Rangeland
  - Forest
- Ecosystem Processes (EP)
- Other (often related to above)
  - BioAcoustic & BioImages
  - Australian Transect Network
  - Contributed



TERN

TERN: LA – Remote Sensing

Over 40 Data Product Types in 8 Data Themes

TERN

TERN: LA, Remote Sensing

Over 40 Data Product Types in 8 Data Themes

Very detailed overview and descriptions
included in the provided Supporting Materials:

- Data Themes and Product Types Description (pdf)
- Datasets ('GIS') Description (spreadsheet)

TERN

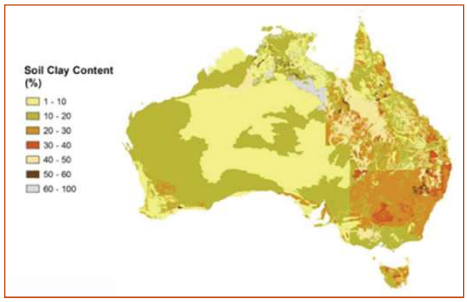
TERN: LA, Soil & Landscape Grid of Aus.

- 30 different products
  - *Resolution*: 90 m
  - *Depth*: 6 soil depths to a maximum of 2 m
  - *Attributes* recorded:
    - *Landscape*: 17 attributes
    - *Soils*: 14 attributes
- Overview and descriptions Supporting Materials:
  TERN_LanscapeAssess_SoilLandscape.pdf

TERN

TERN: LA, Soil & Landscape Grid of Aus.

Soil and landscape data infrastructure for the whole of Australia at the finest resolution ever to support research, management and policy.



TERN's Soil and Landscape Grid provides easily-accessible, consistent, comprehensive and freely-available soil attribute and landscape information at a range of spatial scales from continental down to individual farms.

Accessibility via Google Earth Engine enables users to quickly complete large parallel image processing tasks and use Google imagery together with Grid data.

The Grid can also be integrated with a wide range of other databases and computer modelling programs to support agriculture, climate and ecosystem models.

Soil attributes

- Bulk Density
- Organic Carbon
- Clay
- Silt
- Sand
- pH (water)
- pH (CaCl2)
- Available Water Capacity
- Total Nitrogen
- Total Phosphorus
- Effective Cation Exchange Capacity
- Depth of Regolith
- Depth of Soil
- Coarse Fragments

Landscape attributes

- Slope
- Aspect
- Relief
- Topographic Wetness Index
- Topographic Position Index
- Partial Contributing Area
- Multi-resolution Valley Bottom Flatness (MrVBF)
- Plan Curvature
- Profile Curvature
- Prescott Index
- Solar Radiation (SRAD)

TERN: LA, Soil & Landscape Grid of Aus.

Period : 22/11/2014 to 3/5/2016 (~ 18 months)

Data downloads count = 10214 (20Tb of data)

Web site

Visits = 22,083 (average = 200 per week)

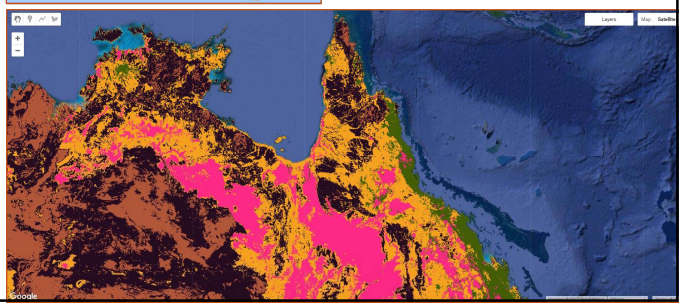
Total number of countries viewing = 122

Map Views

Views = 300,962 (average = 4,180 / week)

Most Viewed : Terrain attributes, Clay, Sand, Bulk Density, Available Water Capacity

TERN



TERN: Other Soil Data at TERN

Ecosystem Surveillance (AusPlots)

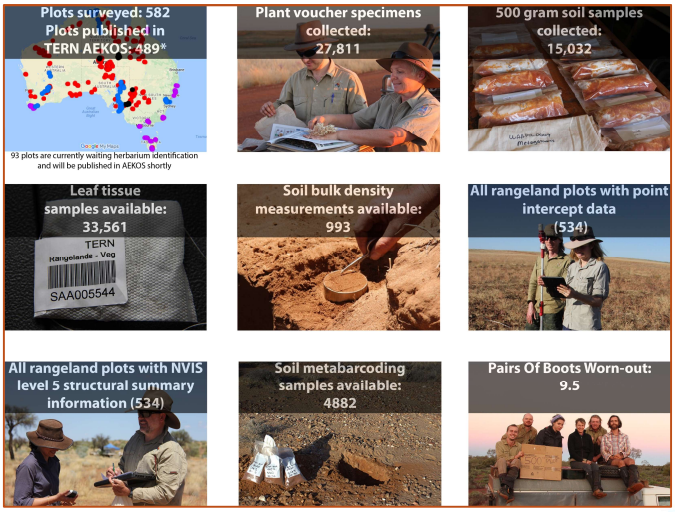
TERN collects and makes openly available, data on key soil attributes across the majority of Australia's biomes and vegetation groups including:

- Soil characterization
- Soil bulk density
- Soil temperature
- Soil moisture
- Soil chemistry
- Soil microbial diversity

TERN

TERN: Ecosystem Surveillance (AusPlots)

Plot-based surveillance monitoring program, undertaking consistent and ongoing ecological assessment of Australian ecosystems.



TERN

TERN: Ecosystem Surveillance (AusPlots)

Plot-based surveillance monitoring program, undertaking consistent and ongoing ecological assessment of Australian ecosystems.

Supplementary Materials: TERN_AusPlots_Desc.pdf

- **Rangelands**: Baseline surveys of vegetation and soils in Australian rangelands bioregions at 1ha permanent plots using consistent standardised methodology. Data collected include measurements, samples, and photopoints.
- **Forest**: Repeated measurements taken in a continental-scale monitoring network of plots in tall eucalypt forests ecosystems. The attributes measured allow the tracking of tree growth, forest productivity, and carbon dynamics.

TERN

TERN: Ecosystem Surveillance (AusPlots)

Plot-based surveillance monitoring program, undertaking consistent and ongoing ecological assessment of Australian ecosystems.

Supplementary Materials: TERN_AusPlots_Desc.pdf

2nd Talk & Tutorial

- **Rangelands**: Baseline surveys of vegetation and soils in Australian rangelands bioregions at 1ha permanent plots using consistent standardised methodology. Data collected include measurements, samples, and photopoints.
- **Forest**: Repeated measurements taken in a continental-scale monitoring network of plots in tall eucalypt forests ecosystems. The attributes measured allow the tracking of tree growth, forest productivity, and carbon dynamics.

TERN

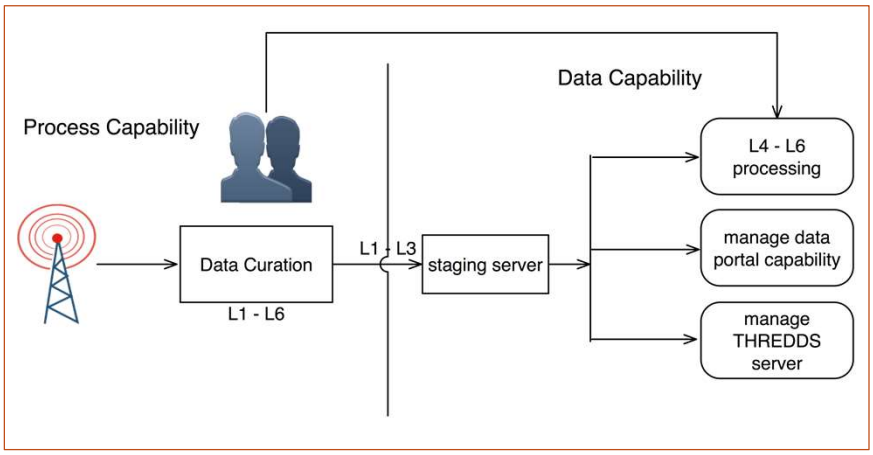
TERN: Ecosystem Processes (OzFlux)

- ~ 30 towers across Australia
- Time-series flux data measuring:
  - Solar radiation
  - Albedo
  - Longwave radiation
  - Soil heat flux
  - Soil temp
  - Air temp
  - Relative humidity
  - Precipitation
  - Wind speed & direction
  - Concentration of CO_2 & H_2O
- Trans disciplinary applications
- National & International interest

TERN

TERN: Ecosystem Processes (OzFlux)

- Ability to automate large part of data processing, quality control and publication routine.



TERN

TERN: BioAcoustic & BioImages

Collected at Australian SuperSite Network (co-located with OzFlux)

BioAcoustics:

- Captured using acoustic sensors.
- Large temporal scale.

TERN

TERN: BioAcoustic & BioImages

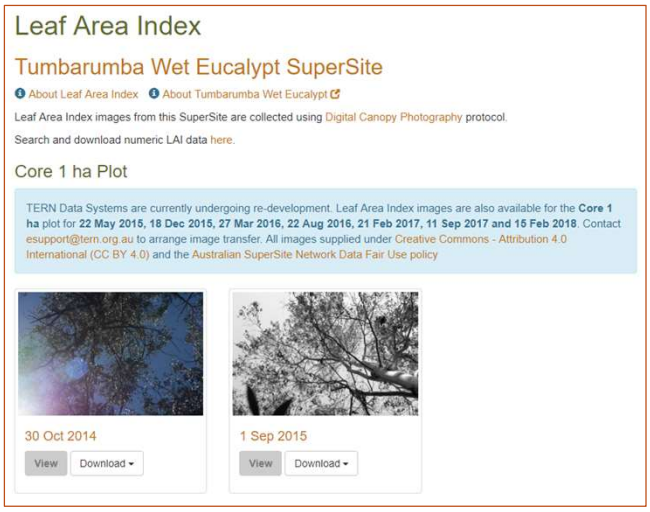
BioImages:

- Visual records of state and changes over time.
- Collected at across 1ha vegetation plots.
- Three types:
  - Leaf Area Index (LAI) images
  - Phenocam images
  - Photopoint images

TERN

TERN: BioAcoustic & BioImages

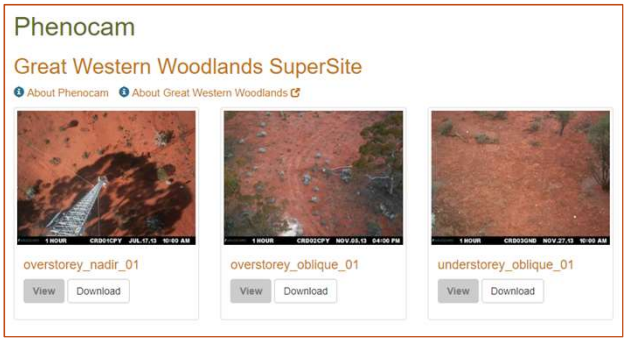
BioImages - Leaf Area Index (LAI) images: Canopy images used to calculate LAIs. Preferred measure of cover for vegetation. Relates to: Total 1-sided Area of Leaf Tissue / Unit Area of Ground.

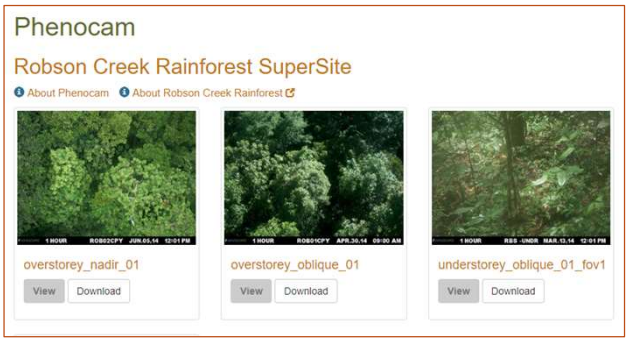


TERN

TERN: BioAcoustic & BioImages

BioImages - Phenocam images: Time-lapse photographs taken by fixed digital cameras. They enable cost-effective long-term record of vegetation structure and condition. Thus, they allow the tracking of seasonal and unseasonal changes in vegetation and ground cover.





TERN

TERN: BioAcoustic & BioImages

BioImages - Photopoint images: High quality digital photos taken from five set points to create reference images. Photos are taken annually to record natural phenomena and how sites changes over time.

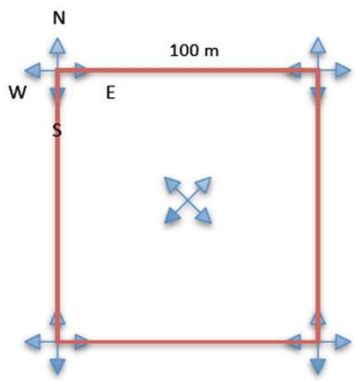


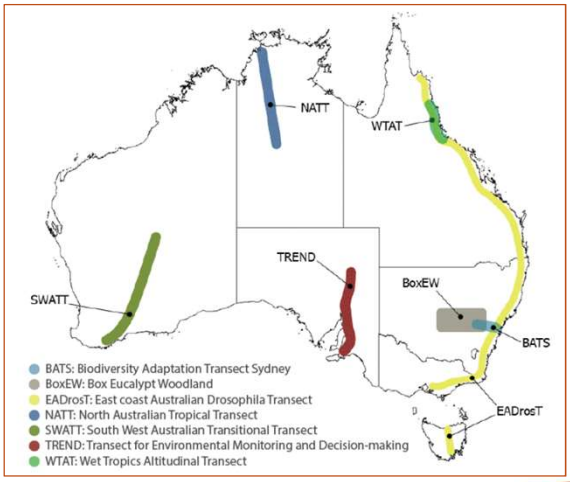
Figure 1: Photopoints for SuperSites core 1 ha vegetation plot.

More info in Supplementary Materials:
BioAcoustc_BioImages.pdf

TERN

TERN: Australian Transect Network (ATN)

- Network of large-scale transects
- Facilitates the study of ecological structure and processes over major biophysical gradients
- Focused primarily on field observations, monitoring of natural and semi-natural terrestrial ecosystems



Infrastructure overlap
E.g. TERN facilities on the BATS:
- AusPlots
- OzFlux,
- Supersites
- Long Term Ecological Research Network (LTERN)

TERN

TERN: Australian Transect Network (ATN)

- Strive to record same measures across transects:
  - *Soil and Vegetation* consistent data for BATS, NATT, SWATT and TREND
  - *Ant Communities*: NATT, TREND, WTAT
  - *Plant Traits*: BATS, TREND
  - *Soil Microbial Communities*: BATS, NATT, SWATT, TREND

ATN Core Attributes	COMPOSITION										STRUCTURE						FUNCTION						LANDSCAPE									
	Plant ID	Plant Genetic Samples	Plant Genetic Analysis	Ant ID	Ant Genetic Analysis	Soil Samples	Soil Texture	Soil Chemistry	Soil Metagenomic Samples	Soil Metagenomic Analysis	Cover (Intercept/Estimate)	Leaf Area Index	Height	Plant Growth Form	Soil Horizon	Substrate	Basal Area	DBH	Above Ground Carbon	Soil Bulk Density	Plant Functional Traits	Carbon Isotope Analysis	Fire Impact (basic)	Fire Regime	Grazing Presence	Weed Presence	Slope & Aspect	Homogeneity	Surface/Sub-surface Geology	Landform (Pattern/Element)	Site Photo	On-plot Climate
TREND	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●		●	●		●	●	●	●	●	●	●	
SWATT	●	●				●	●	●	●	●	●	●	●	●	●	●	●			●			●		●	●	●	●	●	●	●	
NATT	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	
BATS	●	●	●			●	●	●	●	●	●	●	●	●	●	●	●			●	●		●		●	●	●	●	●	●	●	●

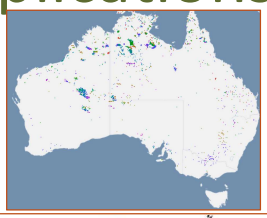
The ATN's coverage of a range of ecological attributes is tailored and responsive to the needs of the research community. The above table features attribute coverage of the network's *core* transects and will in the future include the network's *affiliate* transects, including WTAT, BoxEW and EADrosT.

TERN

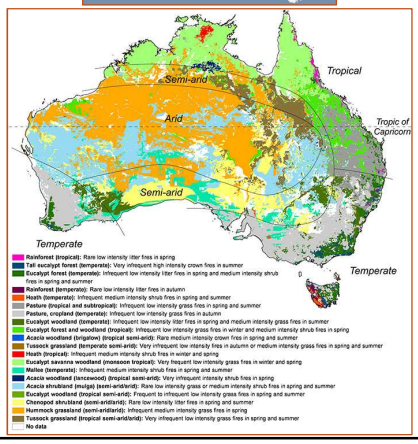
TERN

TERN: Applications – Fire Management

Pre-processed MODIS fire burnt area satellite imagery

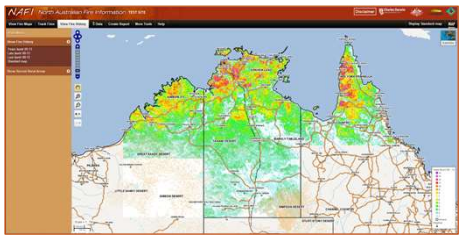


+



Vegetation Map and Expert elicitation

=

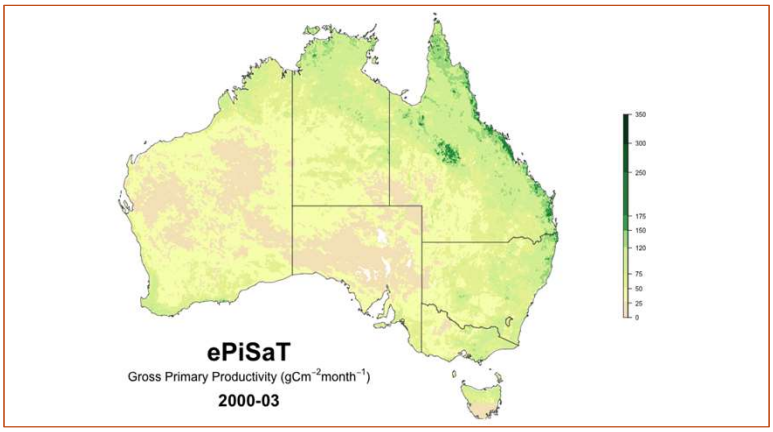


Fire regimes of Australia: a pyrogeographic model system

Brett P. Murphy[1,2*], Ross A. Bradstock[3], Matthias M. Boer[4], John Carter[5], Geoffrey J. Cary[6], Mark A. Cochrane[1], Roderick J. Fensham[7,8], Jeremy Russell-Smith[9], Grant J. Williamson[10] and David M. J. S. Bowman[10]

TERN

TERN: Apps. – Gross Primary Productivity

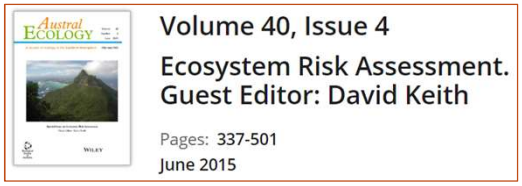


The **ecosystem Production in Space and Time (ePiSaT) project** was supported by the Australian National Data Service (ANDS). ANDS is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy Program and the Education Investment Fund (EIF) Super Science Initiative.

TERN

TERN: Apps. – IUCN Red List of Ecosystems

How to apply the International Union for Conservation of Nature (IUCN) Red List of Ecosystems in the Oceania region?



http://onlinelibrary.wiley.com/doi/10.1111/aec.2015.40.issue-4/issuetoc

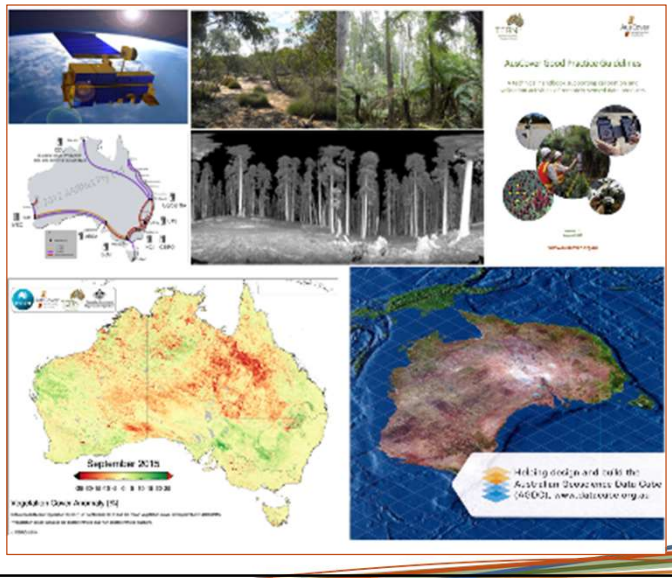
TERN

TERN: Apps. – Agricultural Management

Bringing it all together for Agricultural Management – Remote Sensing

Over 40 continental scale Remote Sensing data products

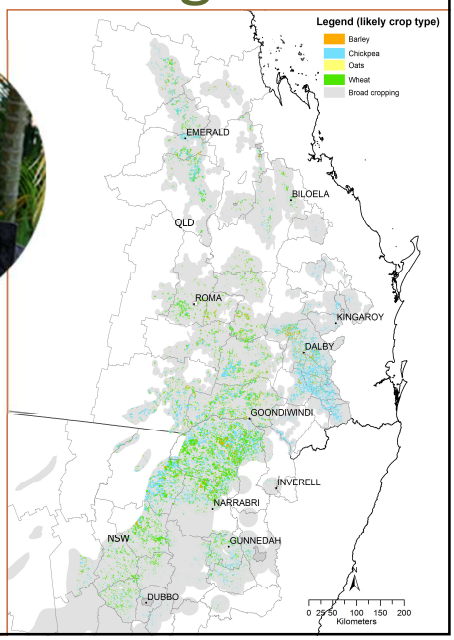
- Land cover dynamics including phenology and fractional cover (measures of vegetation greenness)
- Vegetation composition and structure
- Fire dynamics ad impacts
- Airborne data products



TERN

TERN: Apps. – Agricultural Management

- TERN's near real-time satellite data products enable early and accurate crop forecasts
- Reduced risk and improved economic viability for industry and business
- Improved decision making for government



TERN

TERN: Apps. – Agricultural Management

Bringing it all together for Agricultural Management – Ecosystem Surveillance

TERN samples from 'phosphorus-efficient' native plants are being used to develop novel approaches that reduce agriculture's reliance on phosphorus fertiliser and save agricultural industries millions of dollars every year.

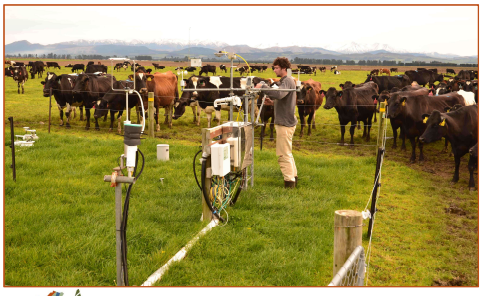
TERN's national open access soil and plant sample library

TERN

TERN: Apps. – Agricultural Management

Bringing it all together for Agricultural Management – Ecosystem Processes

- Measuring exchanges of carbon, energy and water across a range of ecosystems and meteorological conditions
- Automated sensors
- Drought experiments



TERN

TERN

TERN: Data Access

TERN Data Discover Portal

- Enables to discover data across all TERN portals in a single platform.
- Browse by: species, ecosystem, location/bioregion,…..
- URL: https://portal.tern.org.au

TERN

TERN: But there is more…

Some other Bits & Pieces to finish:

- Data Visualisation: TERN-ANU Landscape Data Visualiser
- Analytic Tools: ecocloud & CoESRA (R-Studio, Q-GIS, Jupyter notebooks)
- Data Skills Development Program (DSDP)

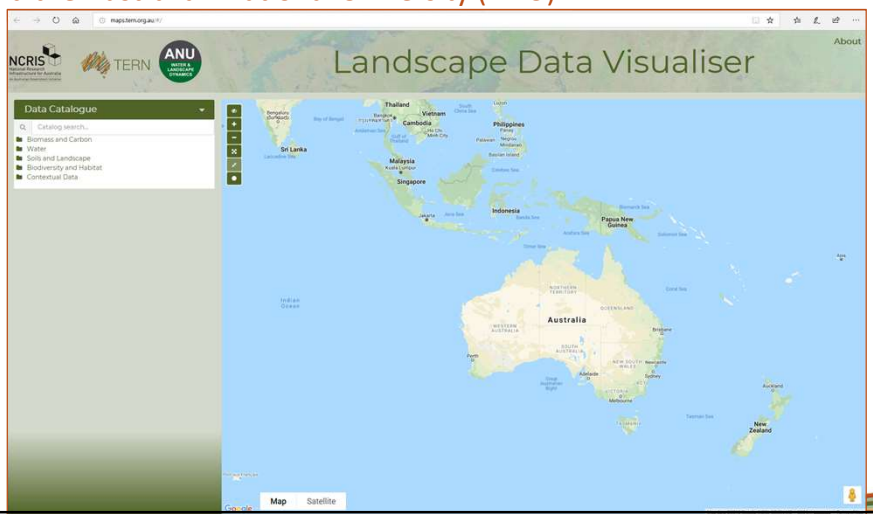
TERN

TERN: Data Visualisation

TERN-ANU Landscape Data Visualiser

Discover, map and analyse the extensive range of landscape-scale ecosystem datasets provided by TERN Australia and the Australian National University (ANU).

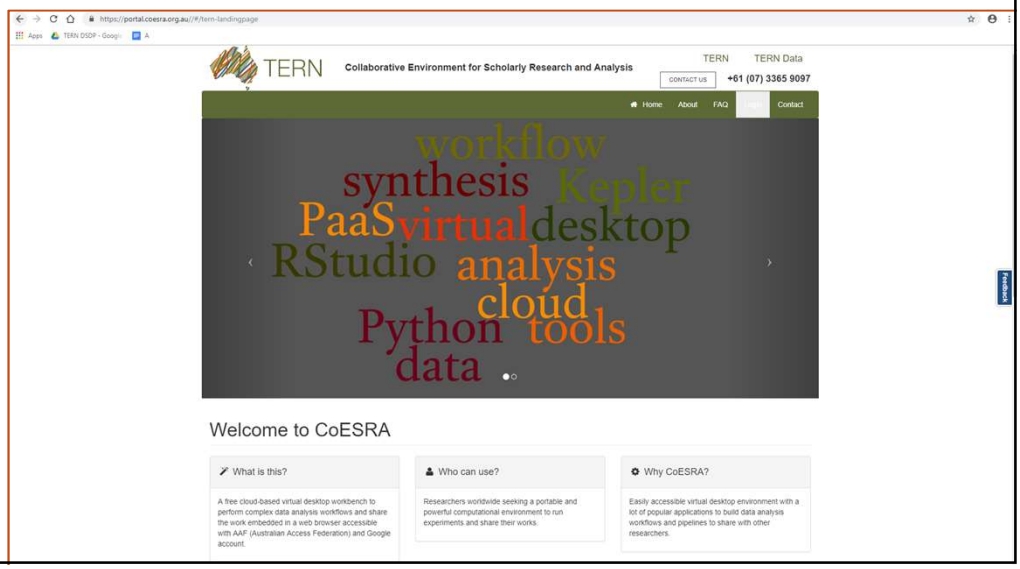
maps.tern.org.au



TERN

TERN: Analytic Tools - CoESRA

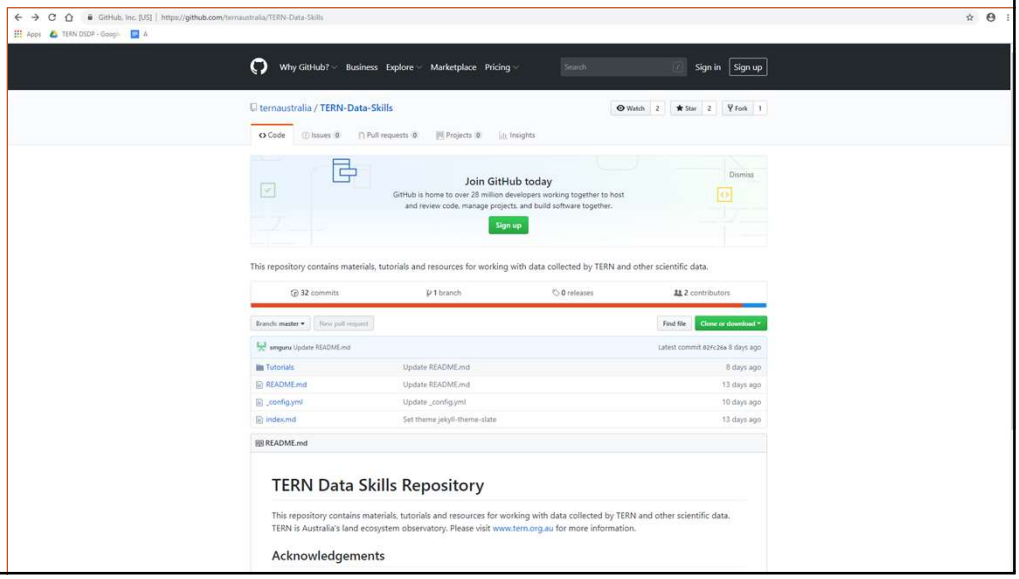
portal.coesra.org.au



TERN

TERN: Data Skills Development Program

github.com/ternaustralia/TERN-Data-Skills



TERN

TERN: More information

- TERN website: www.tern.org.au
- TERN Data: www.portal.tern.org.au

Bernardo Blanco-Martin
b.blancomartin@uq.edu.au

Thank you to Siddeswara Guru

CC BY

Citation: Bernardo Blanco-Martín, TERN, "TERN: Australian Ecological Data & More", ecoEd Champions Training, Canberra, December 2018. https://github.com/ternaustralia/TERN-Data-Skills/ecoEdChamps18/Presentation1_TERN

TERN