PROCEEDINGS OF THE AUSTRALIAN RANGELAND SOCIETY

19th BIENNIAL CONFERENCE

Official publication of The Australian Rangeland Society

Form of Reference

The reference for this article should be in this general form:

Author family name, initials (year). Title. In: Proceedings of the 19th Australian Rangeland Society Biennial Conference. Pages. (Australian Rangeland Society: Australia).

For example:

Bastin, G., Sparrow, A., Scarth, P., Gill, T., Barnetson, J. and Staben, G. (2015). Are we there yet? Tracking state and change in Australia's rangelands. In: 'Innovation in the Rangelands. Proceedings of the 18th Australian Rangeland Society Biennial Conference, Alice Springs'. (Ed. M.H. Friedel) 5 pages. (Australian Rangeland Society: Parkside, SA).

Disclaimer

The Australian Rangeland Society and Editors cannot be held responsible for errors or any consequences arising from the use of information obtained in this article or in the Proceedings of the Australian Rangeland Society Biennial Conferences. The views and opinions expressed do not necessarily reflect those of the Australian Rangeland Society and Editors, neither does the publication of advertisements constitute any endorsement by the Australian Rangeland Society and Editors of the products.

The Australian Rangeland Society

TERN AusCover: Delivering Imagery and Services to Industry and Landholders in the Rangelands

P Scarth[1,2], R Trevithick[2], G Metternicht[3,], S Phinn[1], A Held[4], B Christensen[5]
[1] Joint Remote Sensing Research Program, School of Earth and Environmental Sciences, The University of Queensland, St Lucia 4072. p.scarth@uq.edu.au
[2] Remote Sensing Centre, Department of Science, Information Technology and Innovation, Ecosciences Precinct, Dutton Park, 4102.
[3] School of Biological, Earth and Environmental Sciences, PANGEA Centre, University of New South Wales, Sydney 2052.
[4] CSIRO Land and Water Flagship, Canberra 2601.
[5] TERN, The University of Queensland, St Lucia 4072.

Keywords
Rangelands, ecosystems, remote sensing, fractional cover, land condition

Abstract

In the Australian rangelands, Terrestrial Ecosystem Research Network (TERN) collaborates with several groups including the NT Department of Land Resource Management (DLRM), the Queensland Department of Science, Information Technology and Innovation (DSITI), the Australian Collaborative Rangelands Information System (ACRIS), the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). These collaborations have led to the development of biophysical products tailored for the Australian Rangelands including MODIS, Landsat and Sentinel-2 fractional cover, fractional ground cover, burnt area mapping and persistent green state and trend products.

These products underpin several rangeland-specific information products, including the Dynamic Reference Cover Method (DRCM) to assess the state and trends in rangeland environments; bare and green cover deciles to report on the current and historical condition of the grazing resource; and custom anomaly products to compare past and current conditions against a known baseline period. As well paddock, property and regional time series plots are used for comparative cover analysis with tools such as VegMachine and the NRM Spatial Hub.

Products are delivered through time series-enabled web mapping and customised web-processing services, enabling full time series over any spatial extent to be retrieved in seconds. The tools allow interrogation and summarization of massive earth observation data sets in an accessible, producer-friendly way, and are being used by graziers monitoring paddock condition, organisations supporting land management initiatives in Great Barrier Reef catchments, and students developing tools to understand land condition and degradation. Internet tools are supporting several other land condition mapping tools and will inform global efforts to combat desertification by reporting on UN Sustainable Development Goal 15 and associated indicator of annual change in degraded or desertified arable land.

Introduction

TERN was created in 2009 by the Department of Innovation, Industry, Science and Research as the National Observatory for Australian ecosystems. The infrastructure is designed to examine Australian ecosystems and their processes at local, regional and continental scale. TERN's key capability areas are climate, land, biodiversity and data. It delivers ecosystem data and programs to collect that data

from surveillance and targeted monitoring programs, provides tools for the research community and provides infrastructure that supports the discovery access and reuse of ecosystem data.

In the Australian rangelands, TERN collaborates with several groups including DLRM, DSITI, ACRIS, CSIRO and ABARES. These collaborations have facilitated the collection of field and satellite data while leveraging significant research expertise in these environments to produce base-level products on land cover and land use across the rangelands. Several of the TERN products have grown from well-established and long running QLD, NSW and NT, satellite image products that are part of legislated mapping and monitoring programs (e.g. Danaher et al., 2010; Karfs et al., 2009). This paper describes the methods applied to derive the remote sensing products most often used in grazing land management applications and discusses potential applications of these imagery in support of decision making for industry and landholders in the Australian rangelands.

Methodology

One of the key products for measuring state and change in the rangelands is fractional vegetation cover, which is delivered by TERN through the AusCover facility. Fractional vegetation cover is an estimate of the percentage of green, non-green and bare cover fractions within each image pixel (Figure 1).

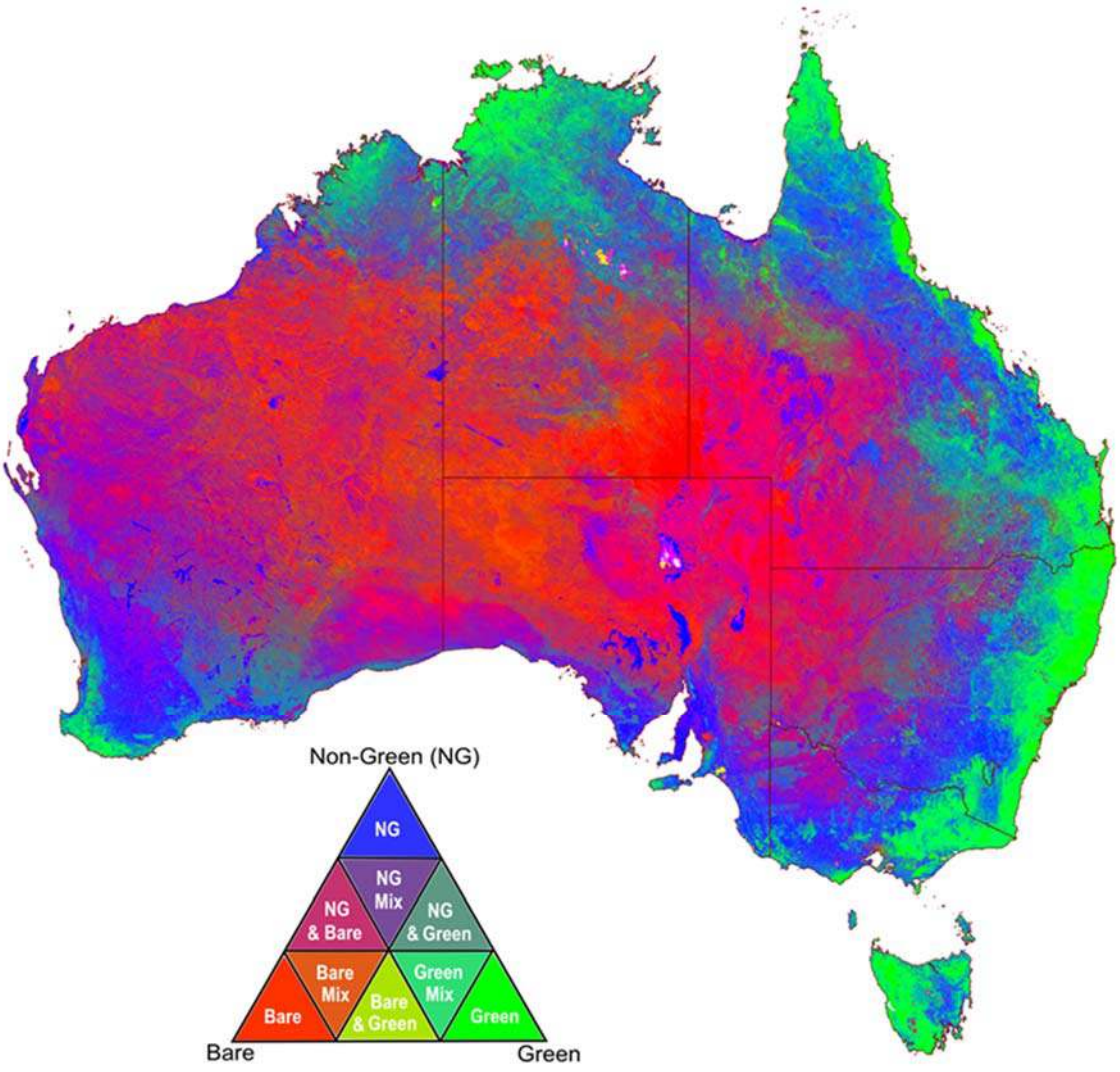

Figure 1 - MODIS fractional cover image of Australia

This is currently calculated using a model referencing a national set of 3000 field star transect cover observations collected primarily by state and territory officers over a 10 year period (Muir et al., 2011), which can be accessed via the portal[1] (figure 2).

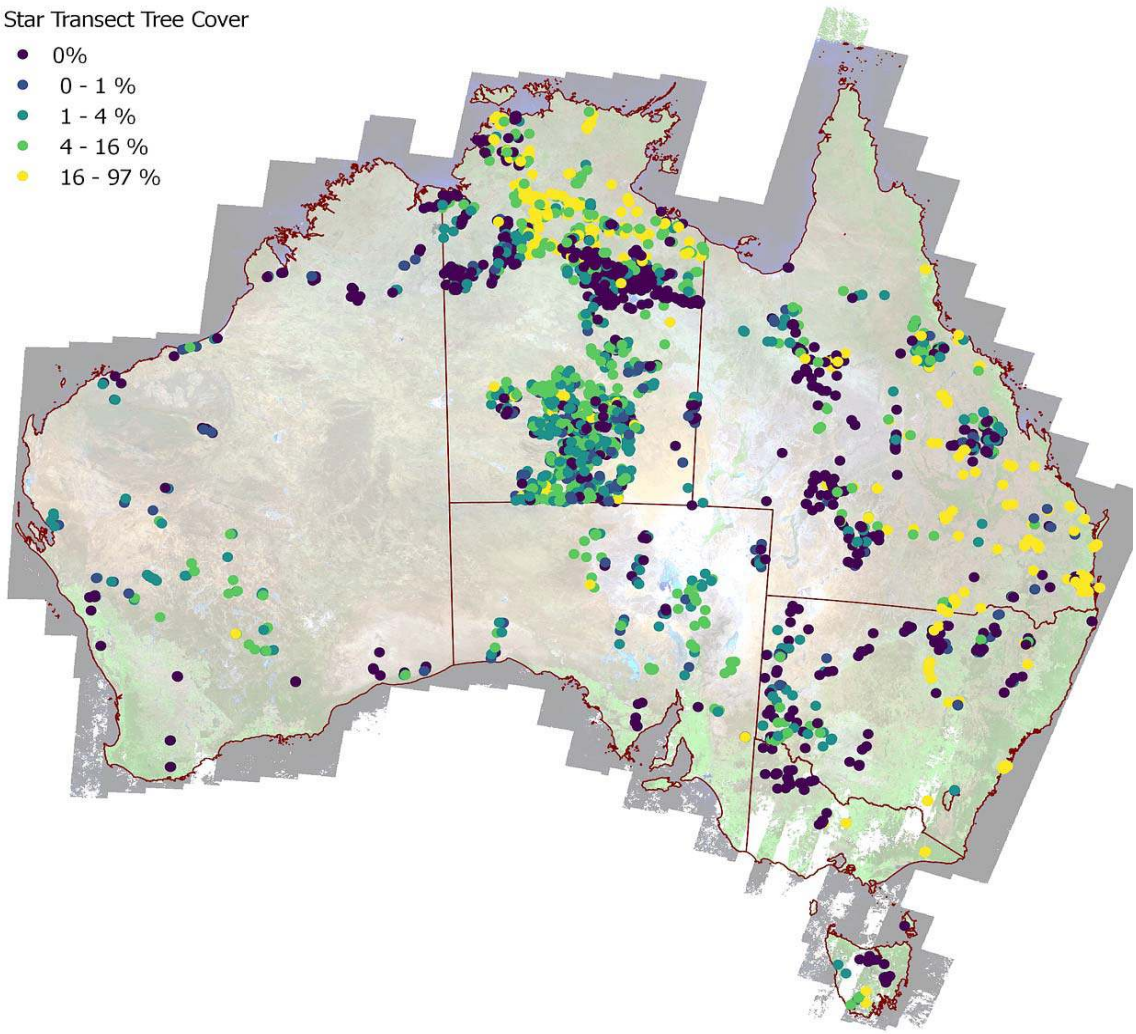

Figure 2 - Location of the 3000 star transect ground and tree cover plots across Australia. Each plot has 300 point intercepts within a 1 ha area and collects attributes about the amount of bare, green and non-green vegetation across the ground, mid story and over story components.

The model requires an estimate of surface reflectance produced from either MODIS, Landsat or Sentinel 2 imagery (Scarth et al., 2010). For any location in Australia, there are now more than 700 dates of Landsat imagery over the 30+ year period. To reduce the data volume and to provide more seamless mosaic products to end-users, these data are composited into representative seasonal images (figure 3). For Landsat and Sentinel data a three-month period (with approximately 10 images per period) is used for the compositing process. The MODIS products, with their more frequent daily revisits, enable the production of a monthly composite product. The benefits of compositing in this manner are the creation of a regular time-series capturing seasonal variability, and the minimisation of missing data and contamination present in single date imagery (Flood, 2013).

[1] http://www.auscover.org.au

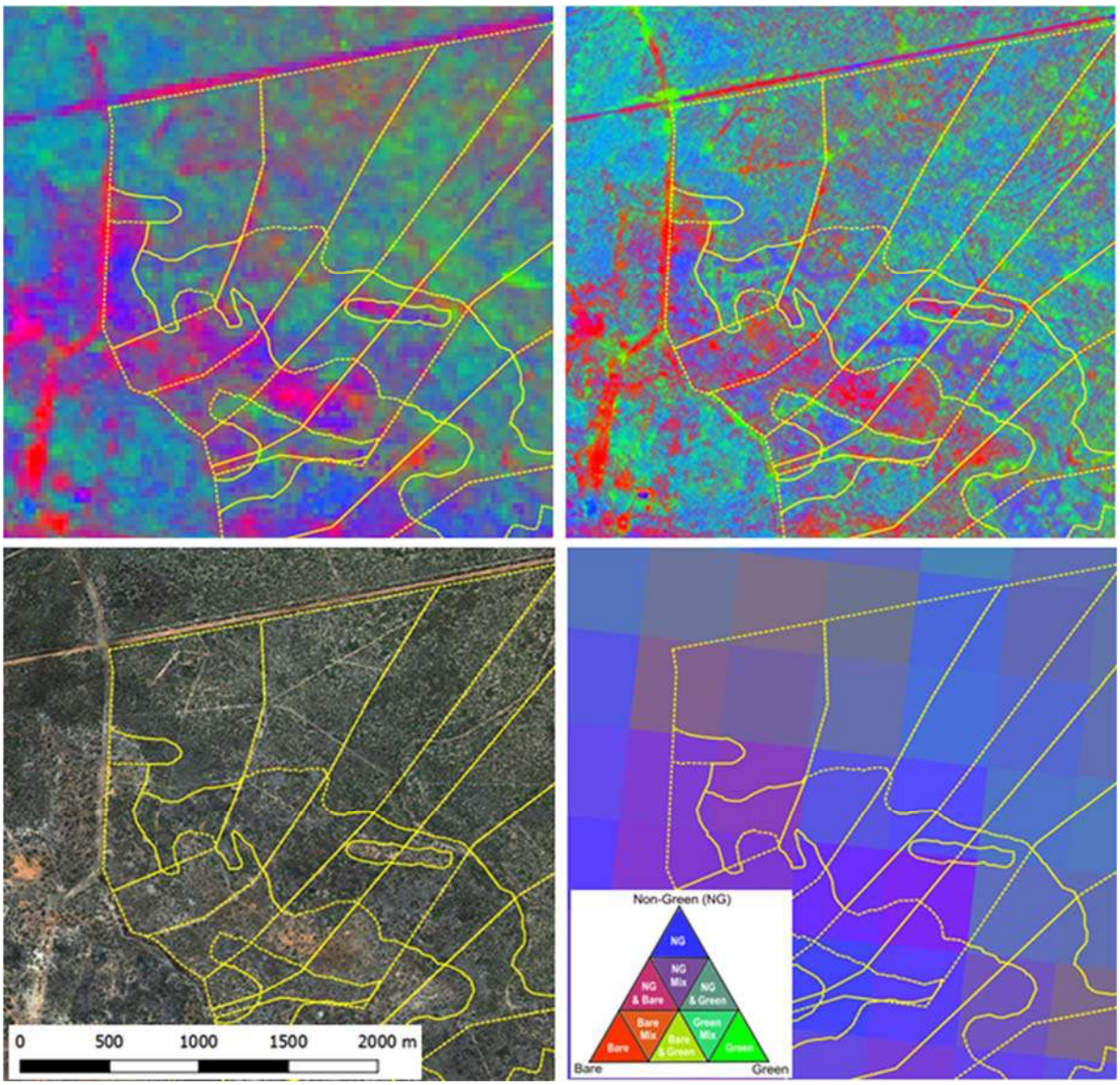

Figure 3 - Examples of seasonal fractional cover products over the Wambiana grazing trial in northern Queensland. Clockwise from bottom left, true colour Worldview 3 image, Landsat 8 fractional cover (30m pixel), Sentinel 2 fractional cover (10m pixel) and MODIS fractional cover (500m pixel).

The fractional cover product does not separate tree and mid-level woody foliage and branch cover from green and dry ground cover. Thus, in areas with even minimal tree cover (>15%), estimates of ground cover become uncertain. Therefore, we use the seasonal time series of fractional cover to estimate the amount of persistent green vegetation for any given pixel, providing an estimate of the woody vegetation. This separation of the 'persistent green' from the fractional cover product allows for the adjustment of the fractional cover image to create a fractional ground cover estimate for each season (figure 4).

Figure 4 - In the first image, both woody vegetation and grass are green. The second image shows the 'persistent green' component. Subtracting this from the first image provides an indication of the ground cover alone.

These seasonally generated products are hosted on the NCRIS infrastructure and are made accessible via FTP, HTTP, Thredds and Geoserver services on the AusCover portal and the TERN portal. This allows users to download all seasonal images from 1986 to the current season.

To make these products more useful for rangeland applications we developed tools to assist in the analysis of large areas, and techniques to separate the differing effects of climate and management to better understand land condition. Several different methods have been used operationally to achieve this aim and these methods have been delivered by groups such as VegMachine[2], FarmMap4d[3], FORAGE[4], Reef reporting[5] and ACRIS (Bastin et al., 2012).

The extraction of timeseries data within a polygon is a recurring theme of many reporting tools so a web site was developed that takes a polygon and a product as input and returns time series summary statistics within that polygon for the selected product. The tool also has the capability of returning the monthly rainfall (figure 5).

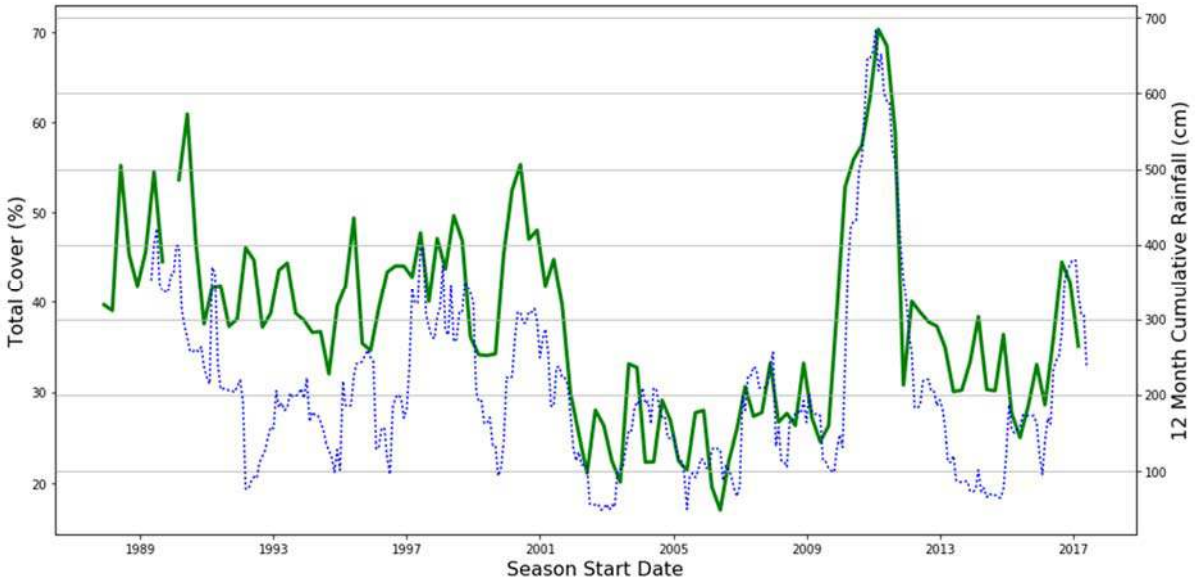

Figure 5 - Example time series plot of total vegetation cover over the Mitchell Grass Downs along with twelve-month cumulative rainfall generated directly from the timeseries internet tool data

[2] http://vegmachine.net/

[3] http://www.farmmap4d.com.au/

[4] https://www.longpaddock.qld.gov.au/forage/

[5] http://www.reefplan.qld.gov.au/measuring-success/methods/catchment-indicators/groundcover/

Timeseries comparisons are used by several reporting tools and these are typically completed by making two requests to the time series tool and comparing the statistics between the two products (figure 6).

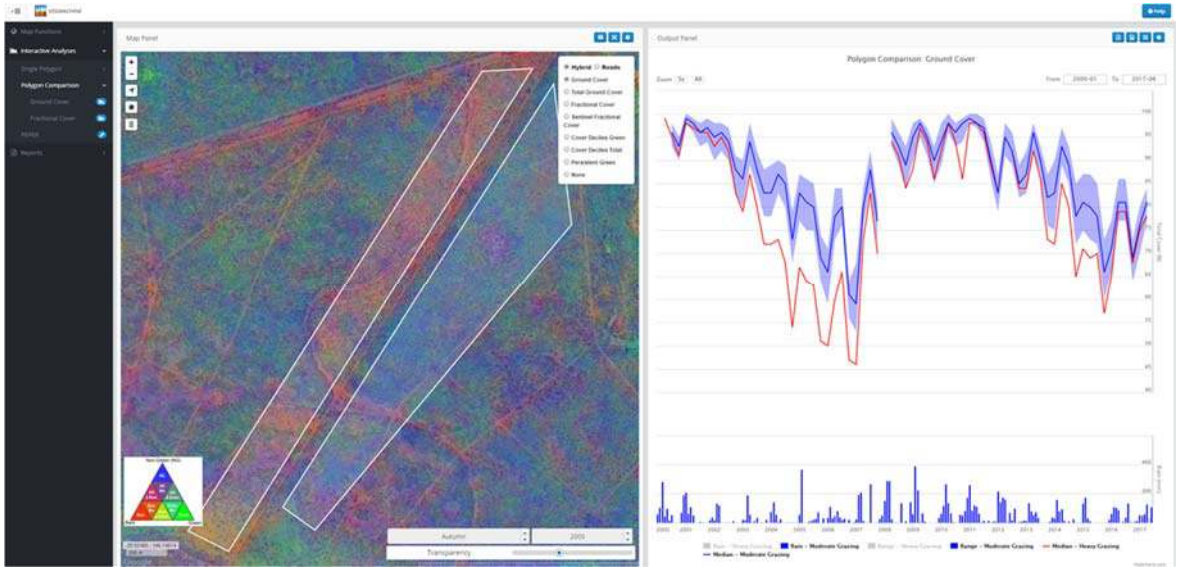

Figure 6 - Example property timeseries comparison calculated using the VegMachine platform. Red line is the median ground cover timeseries for the heavily grazed paddock. Blue line is the median ground cover timeseries for the moderately stocked paddock and the transparent blue area represents the range of values seen in this paddock.

To better understand current and historical grazing pressure on an individual property, tools to integrate many years of satellite imagery were developed to compare seasonal quality and assess long term grazing pressure and utilisation within paddocks and across properties. These have been made available through a tool which takes a property or paddock polygon and start, end and comparison dates and returns images of the selected area (figure 7).

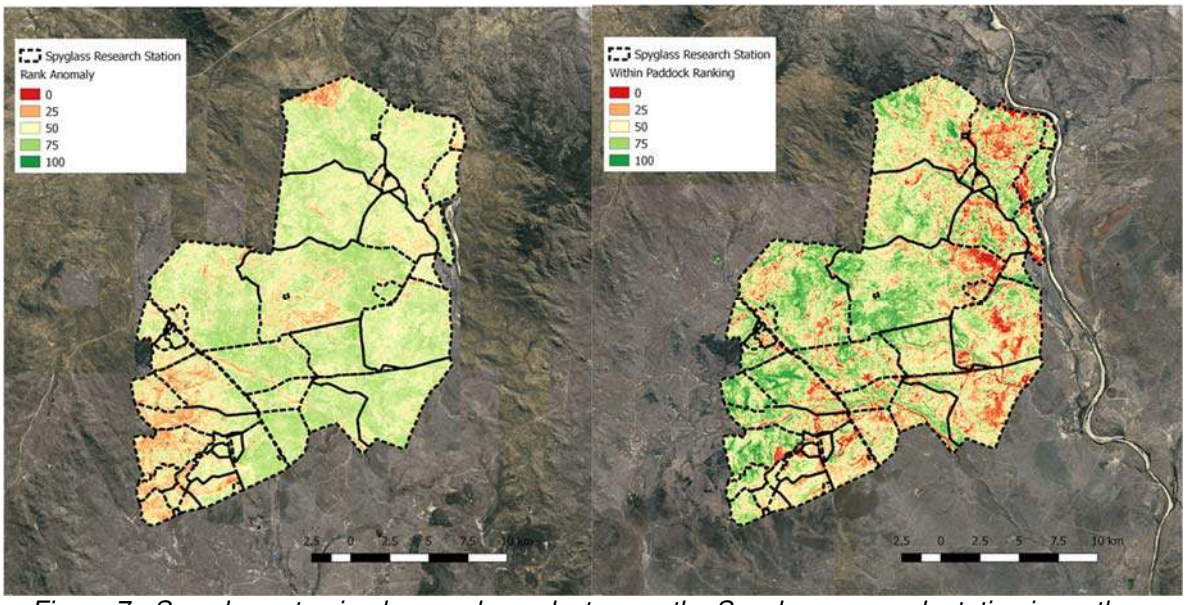

Figure 7 - Sample customised anomaly products over the Spyglass research station in northern Queensland. Left is a seasonal anomaly product, showing the percentile of cover where each pixel in the current season lies in comparison to a user-specified baseline. Green areas show higher than average cover in comparison to the reference seasons. Right is a within paddock long-term cover ranking, showing the areas that are heavily utilised in red and more lightly utilised as green within individual paddocks.

Results and discussion

TERN data is being used operationally by several NGOs to directly service landholders. The spatial and temporal information provided by the remote sensing data and backed up by rigorous field survey is being used to understand the condition, resilience and sustainability of the Australian rangelands. Access figures for the tools are showing usage of about 2000 requests per month from third-party internet applications along with hundreds of thousands of web mapping service (WMS) tiles being delivered to users.

The Environment Protection and Biodiversity Conservation Act 1999 mandates national State of the environment reporting. These TERN products can support the preparation of such reports in rangelands. For instance, the MODIS-derived vegetation fraction cover products informed the 2016 Australian State of Environment Report on land condition. Likewise, vegetation cover fraction, persistent green vegetation time series are fundamental datasets that may be used by Australia in setting reliable targets for the UN Sustainable Development Goals (Metternicht et al., 2017).

Concluding remarks

The TERN AusCover tools allow interrogation and summarization of massive earth observation data sets in an accessible, producer-friendly way, and are being used by graziers monitoring paddock condition, organisations supporting land management initiatives in Great Barrier Reef catchments, and students developing tools to understand land condition and degradation and the underlying data. Web based tools are supporting several land condition mapping tools, and can inform global efforts to combat desertification by reporting on UN Sustainable Development Goal 15 and associated indicator of annual change in degraded or desertified arable land.

References

Bastin, G. and Scarth, P. and Chewings, V. and Sparrow, A. and Denham, R. and Schmidt, M. and O'Reagain, P. and Shepherd, R. and Abbott, B. 2012. Separating grazing and rainfall effects at regional scale using remote sensing imagery: A dynamic reference-cover method. Remote Sensing of Environment, 121 . pp. 443-457.

Danaher, T., Scarth, P., Armston, J., Collet, L., Kitchen, J., and Gillingham, S. (2010). Ecosystem Function in Savannas: Measurement and Modelling at Landscape to Global Scales. Vol. Section 3. Remote sensing of tree-grass systems: The Eastern Australian Woodlands. Taylor and Francis.

Karfs, R.A. and Abbott, B.N. and Scarth, P.F. and Wallace, J.F. (2009) Land condition monitoring information for reef catchments: a new era. Rangeland Journal, 31 (1). pp. 69-86.

Flood, N. (2013) Seasonal Composite Landsat TM/ETM+ Images Using the Medoid (a Multi-dimensional Median). Remote Sens. 2013, 5(12), 6481-6500.

Metternicht, G., A Held, S. Phinn, R. Christensen, F. Kerblat, N. Sims, J. Guershman (2017) Earth Observation for supporting and tracking progress of sustainable development goals: best practice example from the Australian Terrestrial Ecosystem Research Network (TERN). 37th International Symposium on Remote Sensing of Environment, Tshwane, South Africa, May 2017.

Muir, J., Schmidt, M., Tindall, D., Trevithick, R., Scarth, P., Stewart, J., 2011. Guidelines for Field measurement of fractional ground cover: a technical handbook supporting the Australian collaborative land use and management program. Tech. rep., Queensland Department of Environment and Resource Management for the Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

Scarth, P., Röder, A. and Schmidt, M., 2010. Tracking grazing pressure and climate interaction - the role of Landsat fractional cover in time series analysis. In: Proceedings of the 15th Australasian Remote Sensing and Photogrammetry Conference (ARSPC), 13-17 September, Alice Springs, Australia. Alice Springs, NT.