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High resolution mapping of buffelgrass using dense time series of imagery and open source data

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Abstract: Buffel grass (*Cenchrus ciliaris*) is an introduced pastoral grass that poses a significant risk to biodiversity and ecosystems worldwide. Its ability to rapidly colonise new areas, outcompete native plants, invade a wide range of habitats and increase the intensity and frequency of fire make it a disaster for native biodiversity, infrastructure and remote communities. It was implicated in the fires that devastated Lahaina, Hawai‘i in 2023, and in Australia is one of the most significant environmental threats to arid rangelands. Management and control buffel grass requires detailed knowledge of its current spatial distribution, information currently lacking for most of arid Australia. Given the widespread distribution over vast and sparsely populated areas, there is an obvious role for using satellite imagery for large area mapping efforts, but detecting buffel grass through established spectral analysis methods is problematic. Here we present a time series approach using matrix decomposition to model and classify stacks of imagery based on the phenological signals at the pixel level.

Buffel, like many perennial grasses, goes through several distinct spectral signatures over a period of a few weeks or months in its phenological cycle. Central Australian ecosystems typically alternate between long periods of dormancy during prolonged droughts of several months to several years, punctuated by shorter active periods of non-arid conditions from pulses of multiple discrete rain events. Regional biodynamics are correspondingly driven by irregular rainfall with pulses of plant growth and reproduction during these relatively brief periods. During the dormant phase grasses are desiccated or burnt, and their spectral signatures are indistinguishable from other grasses in that state. During the active phase their spectral signatures of various grasses are distinct, but progress through several stages, each with its own spectral signature, in a period of weeks. Interpretation of spectral signatures from individual images are dependent on how much time has passed since the last significant rain. In the arid zone, high levels of spatial and temporal variability in rainfall make this difficult to determine, and much more difficult to estimate than other regions with predictable seasonal cycles.

When imagery is examined in a dense time series, phenological signatures as measured through vegetation indices, can be reliably associated with vegetation types, often at the species level. We apply a matrix decomposition technique to a stacks of images through time, creating implicit models of temporal variability which is inherently robust to irregular seasonal cycles, and create models at the pixel level of this variability which allow these signatures to be subject to a variety of classification techniques. Previous application of this method has been used to identify and map groundwater dependent vegetation (Brim Box et al, 2022). We have found that buffel grass can also be reliably identified and mapped by this technique, using publicly available, analysis-ready data from Geoscience Australia’s Open Data Cube (ODC).

We present an overview and application of this technique to map buffel grass distribution at two sites in central Australia from Sentinel-2 satellite imagery. Our study areas were much larger (~8,000 km^2) and finer scale (at the native resolution of the imagery; 10m for Sentinel and 30m for Landsat) than previous attempts to map buffel grass in both Australia and overseas, and our model accuracies (>80%) were either comparable or higher than previous efforts. There was a strong positive correlation between the mapped buffel probabilities and buffel ground cover, suggesting the maps can be used to draw inference on where buffel ground cover is greatest and where management efforts could minimize fuel loads and fire risk. The buffel grass maps can aid resource managers and practitioners in their control and monitoring efforts, and given our method uses free, open-source software, it is more cost effective than methods using drones and/or aerial surveys.

REFERENCES

Brim Box, J., I. Lieper, C. Nano, D. Stokeld, P. Jobson, A. Tomlinson, D. Cobban, T. Bond, D. Randall and P. Box. 2022. Mapping terrestrial groundwater-dependent ecosystems in arid Australia using Landsat-8 time-series and singular value decomposition. Remote Sensing in Ecology and Conservation 1-13.

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