MAPPING AND MODELLING THE DISTRIBUTION OF INVASIVE WEED, BUFFEL GRASS *(CENCHRUS CILIARIS)* USING REMOTE SENSING METHODS

Victoria Marshall

PhD candidate, The University of Adelaide

REPORT ON THE OUTCOMES OF THE NCCARF SUPPORTED COLLABORATIVE TRAVEL 2012

In 2012 I sought and was awarded $3000.00 through the National Climate Change Adaptation Research Facility: Terrestrial Biodiversity Network to part-fund a collaborative visit with US research institutions; The University of Arizona, Northern Arizona University and Trinity University in Texas. My goal at the outset was to form links with US researchers, gain understanding of Buffel grass in the US landscape, and learn new techniques for the remote detection of Buffel grass in arid Australia. My findings, collaboration outcomes, research significance to Australia's terrestrial biodiversity, and future research suggestions are presented below.

Major findings and outcomes of the collaboration

- **Similarities and differences of the Sonoran Desert to Australian arid zone and how that impacts the feasibility of remote sensing Buffel grass in desert scrub.** Remote sensing applications are target-feature and location specific. In this case, our target-feature, Buffel grass, has highly variable morphology; it grows in stands of varying size, vigour and structure depending on the phenotype, as well as competition and resources available at the site. Less than five scientific papers exist on the remote detection of Buffel grass, and these relate to its presence in the Sonoran Desert of the USA and Mexico. A strong understanding of Buffel grass morphology in these landscapes, and what the surrounding vegetation looks like, is important to determining the feasibility of applying these remote sensing approaches in the Australian landscape. From my own experience, in Australia, Buffel grass is most commonly seen on alluvial flats. It's typically at highest density around creek lines, and disturbance pathways and spreads out were conditions are suitable. In the Anangu Pitjantjatjara Yankunytjatjara Lands, where my study is based, it's presence on hill slopes appears to be highly soil dependant. In Tucson, Arizona, Buffel grass does occupy roadsides, and drainage lines, but it also plagues the mountains which surround the city and is often more dominant on the slopes than in the valleys or on the flats. Buffel grass infestations can be seen from the city, as it turns the slopes its own unique colour of yellow or green (depending on the life cycle stage). Furthermore, Buffel grass infestations coincide with a unique Sonoran Desert ecosystem characterised by Giant Saguaro Cacti. It's observed that Brittle Bush *(Encelia farinosa)*, Palo Verde *(Parkinsonia aculeata)* and Saguaro Cacti *(Carnegiea gigantea)* disappear from Buffel grass infested sites.

- **Applications of Remote Sensing to Buffel grass detection in the Sonoran Desert.** I learned about the usefulness of single and multi-date Landsat TM imagery, airborne hyperspectral, and high resolution satellite imagery for Buffel grass detection and monitoring in desertscrub around Tucson during a week spend at Northern Arizona University with Dr. Aaryn Olsson. Dr. Olson found success was linked to the plant phenology, and that October, following the Tucson Monsoon Season was the best time to discriminate the grass. This works because there aren't really any other C4 bunchgrasses with similar phenology in the region. In arid Australia, where my study is based, there is no defined monsoon season, and there are several other grasses which can be misidentified as Buffel grass such as Spinifex and Barley Mitchel grass *(Astrebla pectinata)*. This makes acquiring imagery to correspond with the required phenology difficult. At this stage of investigation I know of no direct equivalent in climate driven phenology or geomorphology that might result in the same level of success using these techniques in Australia.

- **Community involvement in Buffel grass control and eradication.** Unlike in Australia where Buffel grass is an "Outback" problem, in Tucson, most people are aware of Buffel grass and want to eradicate it. There are several Buffel grass removal groups including Southern Arizona Buffel grass Coordination Center, Sonoran Desert Weedwackers and the Buffel grass Weedwackers. These groups conduct weekly weed-removal efforts with dedicated members; typically a section of road, or a creek line will be identified for members to congregate at, and they will work for several hours in the early hours of the day to manually remove tussocks. I attended a Buffel grass removal event, advertised in the local paper; approximately 20 fresh faces showed up. The organisers taught the group how to recognise Buffel grass, how to pull it out and how to dispose of the plant. We focused on a creek line in a popular national park, and removed all the Buffel grass up to about 200 meters down the creek. Keeping the area Buffel grass free depends of locals reporting infestations to authorities, and running successful campaigns to get people involved.

- **Forging research bonds.** The University of Arizona Centre for Arid Lands Remote Sensing hosted me for three months. I worked in a lab of post-graduate students and researchers, all using remote sensing and spatial analysis to solve social and environmental issues. This was a fantastic working and learning environment, which, among other things, further developed my understanding of the computer coding language MatLab; an important for tool for advanced image analysis. This visit was facilitated and supported by Professor Steve Yool, Geography Department, who acted as my point of contact for the duration of my stay, and provided strong guidance. Whilst in Tucson I was able to attend academic group seminars, as well as the Phenology Research and Observations of Southwest Ecosystems Symposium which were beneficial for contextualising. I spent one week at Northern Arizona University, in Flagstaff, Arizona, directly collaborating with Dr Aaryn Olson by sharing our knowledge of Buffel grass at our respective sites. I spent one week at Trinity University in San Antonio, Texas visiting Assoc. Prof. Kelly Lyons, learning about invasive plant ecology. We visited field labs set up to examine the invasiveness of Buffel grass in native vegetation and examined the equipment used to run germination experiments.

Significance to adapting and protecting Australia's terrestrial biodiversity

- **Wildfires and loss of biodiversity caused by Buffel grass minimised through early detection and effective monitoring.** For several reasons, Buffel grass is a critical species to monitor for climate change adaptations for terrestrial biodiversity; it has implications for stakeholders at every level from *national-regional* to *regional-local* and it may be a key-stone for developing win-win policies that are beneficial for both climate change mitigation and biodiversity. Specifically this research addresses Priority issue 2.2 *How will climate change interact with other key stressors such as fire, invasive species, salinity, diseases, changes to water availability, grazing and clearing and integrated implications for ecosystem structure and functioning*. But it may also inform broad scale monitoring, carbon accounting and perhaps even biofeuls research. Here's how: Buffel grass forms dense monocultures at broad scales relatively quickly following rain and fire, it fuels ferocious wildfires that burn hotter and faster than native grasses due to the high volume of dead matter and the high oil content of the leaves. Climatic modelling indicates that greater than 90% of Australia could support its growth, with only temperate climates in the far south-east (incl. Tasmania) safe from invasion. Operating at these scales, Buffel grass can alter aspects of ecosystem structure and function, which can, via the domino effect impact factors of climate change. At more localised scales, Buffel grass is causing significant species loss at a rapid rate. Early detection of emerging infestations and improved long-term monitoring will direct future control efforts and help prevent further spread. Remote sensing may be the most effective means to achieve these goals. Our current research is directed towards improving early detection with high resolution aerial photography. On this collaborative trip, I explored the potential for monitoring large infestations with satellite imagery.

Future research suggestions

- **Compare aerial survey with landsat.** In the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands, where my study is based, the Pipalyatjajara people already notice that they must travel further for hunting and gathering. It is important in these areas not to try to eradicate Buffel grass, because it is too widespread, but to prevent further spread into key assets. In the project so far, I have been able to map Buffel grass at local scales using ultra-high resolution aerial photography (~ 5cm GSD) in a 17 * 12 km area of the APY lands. At this scale we can detect individual grass tussocks. To examine at broader scales, I would like to examine Landsat images over time. However, given challenges identified in the USA, that Buffel grass is not as phenologically unique from its surroundings in Australia, as it is in Arizona, a single-date satellite image with high spatial resolution may be more appropriate. I suggest that an area for further research would be to explore the use of Worldview-2 or Quickbird high resolution satellite imagery for detection of moderate Buffel grass infestations.

- **Landsat and MODIS time trace, in heavly infested areas, and pasture sites.** Though inappropriate for monitoring small infestations, monitoring the broader impact of large infestations may be possible with satellite image time series. I suggest an appropriate trial site, would be similar in climate and vegetation structure to the Sonoran Desert, perhaps in northern Australian desert systems, where Buffel grass is sown over large areas for pasture, and it exists in high volumes. MODIS satellite imagery has a coarse grain size, but its temporal resolution is every 1-2 days, a substantial improvement on Landsat's fortnightly return. In an area first tested using Landsat, I suggest trialling MODIS would be beneficial for documenting "green-up" sequences and potentially for long-term monitoring.