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CULTURALLY APPROPRIATE MAPPING TOOLS FOR INFORMING TWO-WAY FIRE MANAGEMENT PLANNING IN REMOTE INDIGENOUS NORTH AUSTRALIAN COMMUNITIES

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Cover: A fire burns in savannah country near the Adelaide River wetlands in the Northern Territory.

Photo by Nathan Maddock, Bushfire and Natural Hazards CRC.

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ABSTRACT

Remote northern indigenous communities are prone to annual flood, cyclonic events, and severe fire danger periods lasting weeks, that frequently result in environmentally destructive wildfires. Although effective responses to such events are typically hindered by inadequate infrastructural resources, of equal concern is the paucity of culturally appropriate 'two-way' planning aids which can help inform both non-indigenous and indigenous governance institutions, and build local community resilience. Based on extensive savanna fire management research describing fire impacts on a variety of ecosystem services and values, here we describe the development and testing of mapping tools to assist community-based fire management planning in two remote Arnhem Land communities.

INTRODUCTION

This project aims to build upon the suite of map-based tools describing the effects of fire on the environment, and develop their utility in a collaborative approach with remote indigenous communities in north Australia. Current map tools, available through the North Australia Fire Information (NAFI) web portal, are used in day-to-day, annual and long-term fire management and planning activities across north Australia. NAFI was developed by Bushfires NT (Research) with the Tropical Savannas CRC in response to and, most importantly, **with** land managers. The intent in this project is to develop a slightly more sophisticated suite of maps incorporating modelling of key ecological attributes from empirical models. An important lesson from the development of NAFI is collaboration with land managers [1]. A strong user-participation framework has been key to the development of NAFI and is seen as an essential component of this project.

Simple analyses of fire mapping histories clearly identify that fire management in remote indigenous lands can benefit from access to the information available from satellite mapping. These satellite derived data provide the basis through exisitng and future payment for ecosystem services opportunities, such as the Australian Government's Carbon Farming Initiative (CFI): Savanna Burning, Greenhouse Gas Emissions Abatement program (http://www.environment.gov.au/climate-change/emissions-reduction-fund/cfi/methodologies/determinations/savanna-burning). These remote communities with large tracts of relatively intact landscapes, although subjected to high intensity fire regimes [2] and declines in biodiversity [3], need to be in a position to benefit from their land management activities [4, 5].

RESILIENCE

Cultural resilience is dependent upon mental and emotional well-being [6]. Social vulnerability, the inverse of resilience, is the exposure of social communities to stress as a result of change [7]. A recent report by colleagues in the Northern Hub [8] defines resilience and vulnerability as two contrasting perspectives of the same issue, but that the concept of resilience is seen as more empowering. This Northern Hub group of research projects is attempting to scope Indigenous community resilience and governance, and to develop opportunities for building more resilient remote Indigenous communities in northern Australia. NAILSMA [8] report that there is a growing body of literature relating to indigenous livelihoods which supports the importance of diversified and local economies in aiding resilience [9].

The expected life span of Aboriginal Australians is much less than non-Aboriginals, "the gap" in health is recognised by the Australian Government as an issue of national significance [10]. Studies demostrate a positive correlation describing the connectivity between land management involvement and the health of remote aboriginal people [11], particularly through the outstation movement [12] and the formation of indigenous ranger groups [13]. It is also suggesed that any level of involvement in land management is important in addressing some factors affecting aboriginal health and therefore their vulnerability/resilience [14].

The main hazard for indigenous communities is their dependence on welfare which has been subject to a top-down approach in government policy. For example the impact of the NT Emergency Response Intervention, humiliated and demoralised indigenous communities, undermined the existing functional governance structures, instantly, and without warning nor consultation, a large suite of employment activities were removed through the cessation of the CDEP program [15]. The "intervention", by name and by nature, demonstrates a one-way, non-collaborative, government approach. Fundamentally Australian Aboriginal people, like many

other indigenous people around the world [16], require a far greater level of independence to improve their community resilience.

CONTEXT

The NT Police, Fire and Emergency Services (NTPFES) have developed communications and support services in those communities where they have a presence; hence there are many hundreds of small communities and outstations with no direct emergency management support. However, with respect to fire management and planning, the Northern Land Council have been developing Indigenous ranger programs (http://www.nlc.org.au/articles/info/ranger-programs). The rangers have been actively working with traditional land owners, living on country or in towns, to develop over-arching fire management plans; they then coordinate and often undertake prescribed burning.

The literature review undertaken by NAILSMA [8] describes national, Territory and State emergency management with respect to Indigenous communities. They provide specific examples published in the peer reviewed literature demonstrating the paucity of infrastructure, training and, importantly, lack of communication and understanding of community knowledge. A noted example is given by [17] and also described at http://www.em.gov.au/ under Remote Indigenous communities.

The "Keeping Our Mob Safe: A National Emergency Management Strategy for Remote Indigenous Communities" report [18] undertook a community consultation approach to determine Indigenous community needs. The report emphasises the need for collaboration between agencies and communities as a means of self-empowerment and to provide a strategic direction for emergency management. These policies stem from the original COAG review of natural disasters in Australia [19] that highlighted special consideration for remote indigenous communities in the areas of capacity building, as well as relief, and emphasised community participation for effective delivery of disaster management outcomes. In another COAG report [20] from the EMA web site, an additional recommendation is to focus on actions that build economic and social self-reliance.

To this end, this project will provide information to, and in consultation with, Indigenous land managers that will assist in wildfire mitigation planning, thus reducing the area affected by fire generally and late dry season fires particularly. The improved fire management, already demonstrated on the west Arnhem Land plateau [3], offers opportunities to develop payment for ecosystem services projects and provide a level of economic independence.

METHODS

STUDY AREA

Two regions, **Kunbalanja** (*Goon-bar-larn-ya*, aka Oenpelli) and **Ngukurr** (*Ngoo-koo-rr*, with rolling rr's) managed in part by indigenous ranger groups, the **Adjumarllal** (*Ar-jew-marl-larl*) **and Yugul Mangi** (*Yoo-gool Marn-ji*) respectively, have been initially selected to co-develop the mapping due to our contacts through the Aboriginal Research Practitioners Network (ARPNet), Figure 1.

ARPNet have been active in these areas, they have established trust with the communities, many of the researchers are from these communities. Their unique survey techniques involve participatory and other research tools. ARPNet have demonstrated a clear advantage in collecting valuable information from remote Indigenous people [21, 22] that is not accessible through standard assessments. End-user, the NT Fire and Rescue Service Director, Steve Rothwell has shown a keen interest in using the ARPNet to promote remote indigenous community aspirations.

The NAILSMA "Assett Mapping" document [23] provides details of the location, history, geography, climate, natural and cultural assetts, infrastructure, governance and a history of the effects of floods, cyclones and bushfires to the two communities. In summary, both communities are within the Arnhem Land Aboriginal Land Trust, an area of aprroximately 95,000 km^2. Cyclones are periodic, floods quasi-annual and bushfires are certainly annual, occurring throughout the late dry season. Approximately 45% of Arnhem Land has experienced greater than biennial wildfires in the 15 years since 2000.

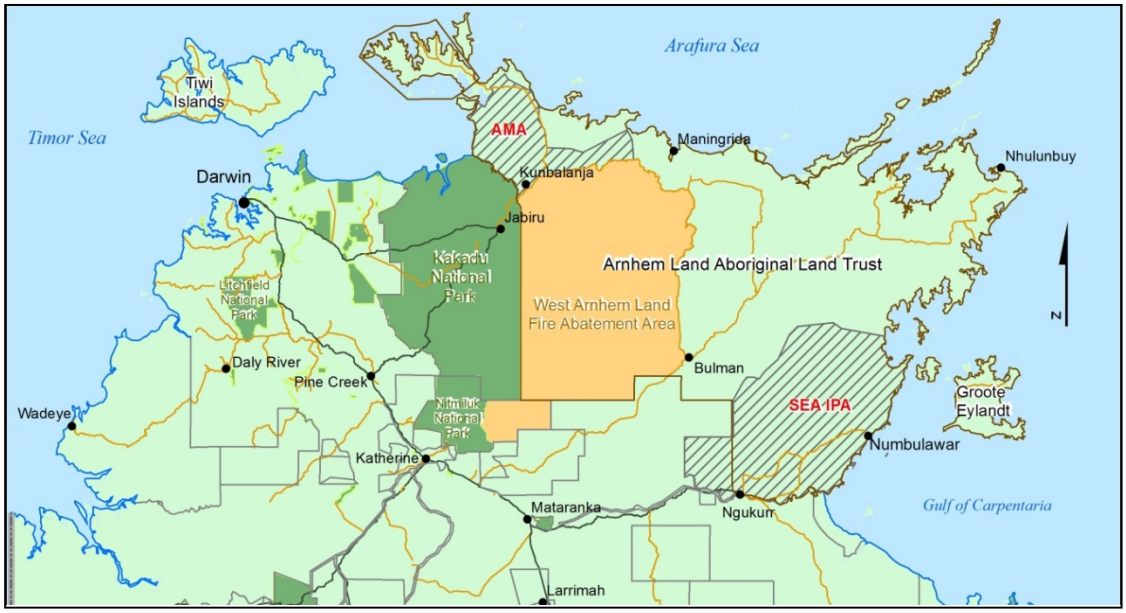

FIGURE1. THE LOCATION OF THE TWO STUDY AREAS (CROSS HATCHED) IN THE TOP END OF THE NORTHERN TERRITORY. AMA = THE "ADJMARLAL MANAGEMENT AREA; SEA IPA = THE SOUTH EAST ARNHEM LAND INDIGENOUS PROTECTED AREA

MODELLING

In these analyses empirically derived ecological models applying fire effect metrics were sourced from the literature quantifying fuel accumulation, greenhouse gas emissions [24, 25], carbon sequestration [26, 27], fire effects on soil erosion and transport, and water quality [28, 29], and counts of key biodiversity elements such as adult stems of the long lived obligate seeder native

conifer *Callitris intratropica* (R.T. Baker and H.G. Smith) and long maturing obligate seeder shrub taxa [30, 31].

SPATIAL DATA

The primary dataset for derivation of spatially explicit fire metrics was the mapping of fire affected (burnt) areas. Mapping used difference-image techniques of red and near infrared bands from 30m pixel Landsat imagery, following mapping methods outlined in [32]. Spatially explicit and multi-temporal datasets describing annual fire frequency, and frequency of early dry season (EDS—before 1 August) and late dry season (LDS—post 31 July) fires, and time since last fire affected (in years since last fire) were derived from the database.

Fire severity mapping was derived from Landsat 30 m pixel imagery by calibrating a model derived from the proportional pre- to post- fire change in reflectance in the near infrared [33]. Three mapped fire severity classes are applied here: *low, moderate and high severity*. These three classes accord generally with fire severity and fire intensity classes as described by Russell-Smith and Edwards [34], based on regional long-term monitoring plot observations.

Vegetation fuel classes follow the classification used by Australia's National Greenhouse Gas Inventory (NGGI) given in DCCEE [24], based essentially on dominant overstorey genera, vegetation structure and grass form [35]. Four broad eligible classes are distinguished: (1) eucalypt open-forest (EOF) with 30-70% upper canopy foliage cover (FC; *sensu* Specht 1981[36][36][36]); (2) eucalypt woodland (EW) with 10-30% FC; (3) sandstone woodland (SW) with 10-30% FC; (4) sandstone heath (SH) with <10-30% shrub FC.

A global digital elevation model (3" pixels) derived from the Shuttle Radar Topography Mission (SRTM) (http://www2.jpl.nasa.gov/srtm/) was clipped for the regions. Slope was calculated in degrees of rise (0-90^{o}) in a 3 x 3 pixel window, and a topographic index (TI; *[37]*), derived for surface roughness.
Spatial analyses were undertaken with raster layers using the Spatial Analyst extension of ESRI® Arcmap TM 10.0 [38]. Spatial data were transformed into the Australian Albers equal area projection [EPSG: 3577] (central meridian: 132^{o}, 1st standard parallel: -18^{o}, 2nd standard parallel: -36^{o}, false easting: 0.0, false northing: 0.0, latitude of origin: 0.0, linear unit: metre, datum: GDA94) with 30 m pixels being the maximum pixel size of all non-categorical data.

ASSESSMENTS

The assessment of the utility of the maps to fire management planning comes from three sources: 1. Feedback from the ARPNet survey. This required a re-interpretation of a simple set of survey questions posed by the Practitioners to the different cohorts in the community. The cohorts represent the spectrum of the community many of whom are not involved in land management or land management decisions; 2. Workshops with various ranger groups; 3. Consultation by fire managers with traditional land owners.

RESULTS

MAPPING TOOLS

This project has developed a set of satellite image derived mapping tools with simple yet sophisticated interpretations of the fire mapping from NAFI representing spatially explicit fire effects on processes representing land management and improvements to land management. Ecosystem functions such as fuel accumulation have been interpreted through empirical modelling into greenhouse gas emissions and bio-carbon sequestration that provide accounting of fire effects for the income from land management in current internationally accepted carbon accounting terms. Other models illustrate fire effects on key biodiversity elements distributed across the landscape; and water quality at appropriate catchment scales. The utility of these maps has been and will continue to be tested using social surveys, workshops and a consultation process involving traditional owners.

SURVEYS

To date, two workshops with indigenous ranger groups servicing remote areas have been undertaken. The indigenous rangers use the NAFI (North Australia Fire Information) fire mapping web site to undertake their planned burns. The NAFI data are served through WMS onto Google Earth providing. Layers illustrating areas burnt in the current fire season and older fuels (> 2 years since last burnt) are overlaid with tenure boundaries and topographic information, with areas depicting sacred sites and the overall strategy developed at the planning meetings and subsequently after consultation with traditional owners. Rangers saw the benefit of inclusion of the biodiversity, emissions and sequestration information in the strategic planning of prescribed burning. It was suggested to provide these map data to the broader regional strategic planning meetings.

The ARPNet researchers reported the preliminary results to the Northern Hub research group at a workshop in Ngukurr in May 2015. Less than half of both communities feel “safe” with respect to flood and cyclone. Most cohorts outside of the ranger groups were not aware of, and might only have had limited access to, any of the on-line mapping including NAFI. People involved in land management responded positively to the benefits of the on-line mapping and suggested that more maps would be beneficial. However they stated that further explanation of their derivation and application is required.

DISCUSSION

The potential for payment for ecosystem services has already been realised through Savanna Burning. In January 2015 the West Arnhem Land Fire Abatement (WALFA) projects were credited with 600,000 Australian Carbon Credit Units (ACCUs) - worth around $A10,000,000 - for GHG emissions abatement in 2011-2013. This project is only one of many undertaken on Indigenous owned land. As of February 2015 there were 34 approved projects with a combined 1.33 million ACCUs, the equivalent of approximately $A24, million. The new Methodology about to become Commonwealth law has found an increase of approximately 1 ACCU for every tonne of emissions abated, and covers an extra 715,000 km^2 of northern Australia. Other Savanna Burning methodologies for bio-carbon sequestration will be available in the next few years, with an expected five-fold increase in annual ACCUs over greenhouse gas emissions methodologies [39].

The potential for many of the fire maps and other derived map products to be used to guide wildfire mitigation has been realized across many sectors of the north Australian community. The added potential of financial biodiversity benefits, although not yet a reality methodologically, can be assessed through our mapped models and traditional knowledge through a two-way consultation process benefited markedly by the ARPNet.

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