bnhcrc.com.au

bushfire&natural HAZARDSCRC

SAVANNA FIRE MANAGEMENT AND SCENARIO PLANNING FOR NORTHERN AUSTRALIA

Annual project report 2014-2015

Jeremy Russell-Smith and Andrew Edwards

Charles Darwin University
Bushfire and Natural Hazards CRC

Version	Release history	Date
1.0	Initial release of document	30/11/2015

Australian Government
Department of Industry and Science

Business
Cooperative Research
Centres Programme

Publisher:
Bushfire and Natural Hazards CRC

November 2015

Citation: Russell-Smith, J. and A. Edwards. (2015) Savanna fire management and scenario planning for northern Australia: Annual project report 2014-15, Bushfire and Natural Hazards CRC

Cover: A fire near the Adelaide River wetlands.
Photo credit: Nathan Maddock, Bushfire and Natural Hazards CRC

TABLE OF CONTENTS

EXECUTIVE SUMMARY **3**

ELEVATOR PITCH **4**

END USER STATEMENT **5**

PROJECT BACKGROUND **5**

WHAT THE PROJECT HAS BEEN UP TO **7**

Savanna Burning 8

North Australia fire regimes 11

Gulf fire management 7

Significant all of hub workshop 10

PUBLICATIONS LIST **12**

CURRENT TEAM MEMBERS **13**

REFERENCES **14**

EXECUTIVE SUMMARY

The '*Savanna fire management and BNH scenario planning for northern Australia'* project is part of a larger suite of BNH CRC 'northern hub' projects being undertaken through Charles Darwin University. Collectively, these projects aim to promote enhanced understanding of the special circumstances concerning resilience issues in remote Indigenous communities, and identify culturally appropriate governance arrangements and enterprise opportunities that can contribute to enhancing community development and resilience.

We report here on the past year's activities undertaken through two of the three sub-projects. The third sub-project '***management of high biomass weeds***' will commence activities in July 2015. The '***Gulf fire management***', project, now more appropriately replacing the '*spinifex and mulga landscapes*' project, commenced in January 2015, building on the substantial effort made by Indigenous ranger groups, it will assist to develop culturally appropriate landscape fire management programs that will also offer economic opportunities through existing and future market-based savanna burning greenhouse emissions abatement, carbon sequestration and other Payment for Ecosystem Services markets. Although in its infancy, to date this project has:

1. Appointed a CRC funded PhD student, Kate van Wezel, to assist develop the capacity and engagement of women rangers in a project entitled "Towards culturally appropriate fire management in the Waanyi and Garawa lands: impediments, opportunities, and key challenges.

2. Undertaken a week long field trip to this very remote region and visited the Indigenous communities of Borroloola and Robinson River, to familiarize staff with the region and to discuss the proposed research program with key local community members.

The '***savanna burning***' project commenced late in 2013. It builds upon satellite derived modeling of fire severity mapping, these data, combined with fire history mapping have been applied to assess the risk of fire to biodiversity, emissions and ecosystem services in general. In the past year this sub-project has:

1. developed and refined the fire severity mapping algorithm;

2. developed finer scale analyses of the fire mapping and ancillary spatial data for two remote indigenous regions around Kunbalanja and Ngukurr;

3. undertaken informal workshops with indigenous ranger groups to ascertain the use and utility of the mapping products, and;

4. co-edited a substantial book outlining the north Australian 600 to 1,000 mm mean seasonal rainfall region methodology for calculating greenhouse gas emissions abatement and the potential for carbon sequestration from trees and coarse woody debris.

To date the projects and their sub-components are being managed correctly, with all milestones completed.

ELEVATOR PITCH

What is the Problem?

Australia's tropical savannas constitute the most fire-prone landscapes of a fire-prone continent—where ~20% of the 1.9 km^2 savanna region (a quarter of the Australian land mass) is currently burnt each year. Annual fire incidence is particularly frequent across higher rainfall (>1000 mm) far northern regions, where over half the landscape is burnt each year, mostly under relatively severe late dry season fire-weather conditions.

Why is it important?

The current patterning of late dry season fires impacts on a broad range issues, including community safety and health, production (e.g. pastoral enterprise) and environmental (e.g. soil erosion, stream health, biodiversity, greenhouse gas emissions) values.

How are we going to solve it?

As part of a suite of complementary projects being undertaken by the 'Northern Hub' of the BNH CRC, this project focuses on a number of issues broadly relating to identifying the extent and magnitude of risks to community, production and environmental values. The project currently has three sub-project components (with a fourth component, dealing with scenario planning, due to commence 2017):

- Describing environmental risks across the north and providing mapping tools for remote community planning purposes in trial locations
- Quantifying the risks posed by large flammable exotic grasses (e,g, gamba and mission grasses)
- Exploring fire management risks and challenges in the NT / QLD Gulf region

A second suite of Northern Hub projects explores related issues pertaining to remote community resilience and governance, and the potential for environmental services projects to provide enhanced economic and community resilience. A major report addressing all above matters is due to be completed in 2017.

END USER STATEMENT

Naomi Stephens, Office of Environment and Heritage, NSW.

This project is now meeting its milestones. It has delivered research outputs, has undertaken significant stakeholder engagement which is leading to meaningful discussions regarding utilisation. The project is now progressing well.

PROJECT BACKGROUND

This project has four sub-projects: Savanna burning; Management of high biomass weeds; Spinifex and mulga landscapes and; Major disaster scenarios planning.

- The Savanna Burning project builds on the substantial work previously undertaken within the Bushfire CRC's North Australian Fire Mapping project. The sub-project continues with this work by undertaking more detailed field and mapping assessments of fire metrics including fire severity in regions defined as being at greatest risk. This includes working with the other Northern Hub projects, especially ARPNet and NAILSMA, to develop a network of indigenous people to assess the utility of mapping products and incorporating the fire severity mapping into carbon accounting methodologies.

- Managing flammable high biomass grassy weeds: A range of invasive grasses have spread rapidly in tropical Australia over the past two decades, substantially altering the savanna, riparian and wetland ecosystems. The ecological, economic and social consequences of these grasses are so significant that many are now declared at the Territory and State level, have been listed as Weeds of National Significance, and listed as a Key Threatening Process under the EPBC Act.

- the former 'spinifex and Mulga landscapes' project has been shifted geographically to focus on developing fire management capacity in the NT / QLD Gulf region. In the absence of any realistic possibility (in the short term at least) of undertaking a successful project in central Australian mulga and spinifex rangelands, the shift in is warranted on the bases that within the past six months a revised market-based savanna burning greenhouse gas emissions abatement project opportunity has become available to landholders in fire-prone northern lower rainfall (600-1000 mm isohyet) savannas (http://www.comlaw.gov.au/Details/F2015L00344), including the Gulf region. To date, substantial efforts have been made by Indigenous ranger groups operating in the Gulf, the Waanyi Garawa Rangers in the NT and Carpentaria Rangers in QLD, to develop landscape fire management programs mostly with ad hoc Indigenous funding (e.g. Working on Country, Indigenous Protected Area, programs). Therefore there is significant potential to develop more sustainable payment for environment services (PES) enterprises based on emerging carbon market arrangements

- Major disaster scenarios planning: Major disasters either from man-made or natural hazards can completely devastate a community. In centres such as Darwin whose footprint covers most of the NT and a considerable portion of north Australia, the development of major disaster scenario planning is mandatory. This sub-project will commence activities in 2016-17.

WHAT THE PROJECT HAS BEEN UP TO

Until the recent inclusion of the 'Gulf Fire Management' sub-project in early 2015, only components relating to the 'Savanna Burning' sub-project were being undertaken in this project. In this past year this has entailed the continued development of the fire severity map product to improve it adequately for inclusion into a savanna burning methodology; and the continued collation of finer scaled spatial layers for the two project areas in Arnhem Land relating to the calculation of the effects of fire on key carbon, biodiversity and topographic elements, previously undertaken at a savanna wide scale.

Significantly in this past year, we finalized the publication of an expansive carbon accounting text through CSIRO publishing (Murphy et al. 2015). This book, Figure 1, outlines all the components of the methodology for the lower rainfall region, as these components need to published in the peer reviewed literature to be accepted through the process into Commonwealth Law.

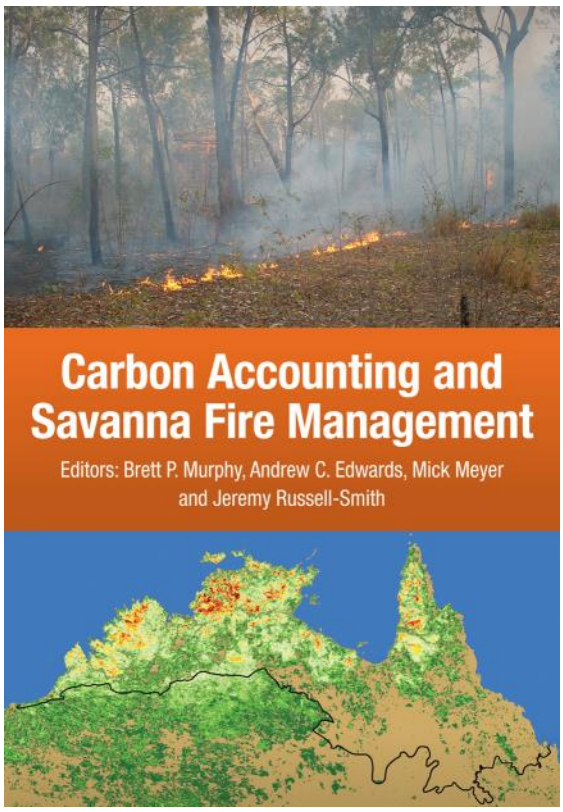

FIGURE 1. THE COVER OF THE BOOK OUTLINING THE COMPONENTS OF THE SAVANNA BURNING FOR CARBON METHODOLGY IN THE LOWER RAINFALL REGION OF NORTH AUSTRALIA.

Finally, there was the incorporation and utilization of the outputs of other Northern hub projects. The NAILSMA members of the "Scoping remote north Australian community resilience and developing governance models through action research" project team undertook a desktop mapping exercise, for two key Indigenous remote communities, Kunbalanja and Ngukurr, describing their capacity and relisience, and highly, pertinent to this project, they strongly indicated the lack of appropriate "two-way" communications, where instead governments, most notably, had dealt with indigenous people most often using a Top-Down approach. We were able to incorporate this information into the recent

manuscript published in the AFAC 2015 conference proceedings (Edwards et al. 2015b), to provide a social context to the communication of the development of the mapping products.

SAVANNA BURNING

Outlined here we provide detail of the components of the Savanna Burning sub-project, namely: the continued calibration and validation of the fire severity mapping; the consultation and network development with indigenous rangers and the consultation process through ARPNet with the, thus far, key remote indigenous communites of Kunbalanja and Ngukurr; an overall assessment of the fire season in north Austraia for 2014; and

Fire Severity Mapping

The 2014 fire season was above average, with fire affecting 41% and 27% of the higher and lower rainfall regions of the tropical savannas, respectively. The fire season was dominated by early dry season fires, in terms of fire severity, 65% of fires were not-severe whilst 35% were severe, that is, affected the upper canopy. The seasonal occurrence of severe fires was 23% in the early dry season and 40% in the late dry season. This result is consistent with other published results describing the seasonal occurrence of severe fires for long term monitoring sites in the top end (Russell-Smith and Edwards 2006)..

Methods

Methods for mapping and discriminating the level of fire effect, known as the fire severity, on savanna vegetation are provided in detail in (Edwards et al. 2013, Edwards et al. 2015a). In summary, a time series of MODIS satellite images is acquired every 5 to 10 days, the optimal acquisition difference being 7 days (Edwards 2011). The pre and post difference in the reflectance of light from a fire affected area between two consecutive dates is calculated and compiled for each month, This layer is masked by the MODIS-derived burnt area mapping from North Australia Fire Information (NAFI – www.firenorth.org.au) for that month. The total mapping covers the area north of 20° S in Western Australia (WA), the Northern Territory (NT) and Queensland (QL), approximately 1.9 million km^2.

Calibration

Aerial validation flights are undertaken throughout the fire season across the breadth of the north Australian tropical savannas. These data are collected in conjunction with validation data for the NAFI burnt area mapping and many other projects, such as vegetation mapping, wherever and whenever the opportunity to collect these data is possible. The methods for collection of the aerial validation data are robust and systematic (Edwards et al. 2013). Although the validation data from any given year can be applied to calculate the accuracy of the mapping for that year, it can then be used to calibrate future years of mapping to improve the class thresholds that pertain to various levels of fire severity. The calibration dataset has been compiled since 2010, it is annually applied to determine the thresholds in the proportional change in the pre versus post-fire change in reflectance values pertinent to the fire severity classification.

Validation

In 2014, validation data were collected from helicopter along transects for a total of 1,750 km^2 and a total of 4,369 waypoints, however only 15% of that number pertain to fire severity assessments, as the data are only collected over burnt areas, and very specifically in homogeneous patches for accuracy.

Results

Classification

The calibration data collected in previous years indicate a threshold proportional reflectance change value of ~20% for a binary classification differentiating severe from not-severe savanna fires, where a severe fire has affected the upper canopy. This value was applied to the collated time series image, to produce a fire severity map for 2014, Figure 2.

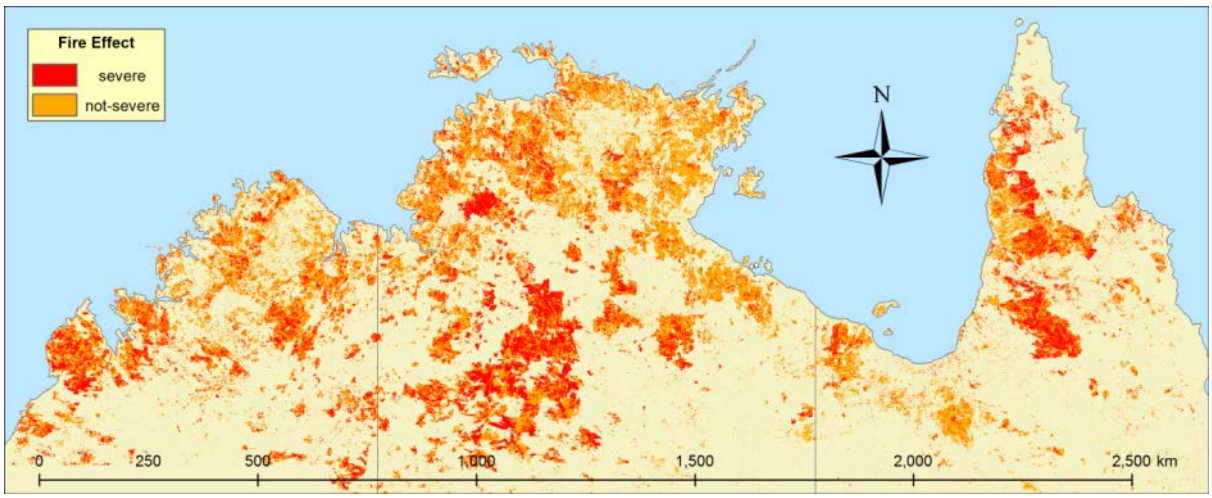

Figure 2. Fire severity mapping for 2014. The methodology uses differencing of a MODIS satellite image time series and an extensive calibration dataset for classification.

Validation

The results of the validation for each survey are given in Table 1. The burnt area mapping has accuracies $\geq$ 85%, the fire severity mapping has overall accuracies ranging from 70 to 74%, with relatively similar accuracies for each area across the seasons.

Table 1. Description of burnt area and fire severity mapping aerial surveys and classification accuracy in 2014.

Survey	Date	Waypoints	Overall Burnt Area Accuracy	Overall Fire Severity Accuracy
Nitmiluk NP	8th May 2014	999	85%	74 %
Cape York	5th August 2014	1508	89%	70 %
Kimberley	3rd October 2014	758	88%	72 %
Nitmiluk NP	5th November 2014	1104	87%	70 %

Analyses

Fire severity mapping for northern Australia is illustrated in Figure 2. Analyses, summarised in Table 2, were undertaken for the higher and lower rainfall regions, > 1,000 mm and 600 to 1,000 mm mean seasonal rainfall, respectively, within the 3 jurisdictions: WA, NT, QL.

For the whole higher and lower rainfall savanna regions, 65% of fires were not-severe and 35% were severe. The difference between the 2 rainfall regions is very small, only 2%, however the difference between jurisdictions is marked, with 80% not-severe fires in the areas burnt in WA compared to 59% and 64% in the NT and QL respectively, with again very little difference in the rainfall regions for each jurisdiction.

Table 2. Proportion of severe and not-severe fire affected area as a percentage of the total area burnt for the higher and lower rainfall regions in the 3 jurisdictions (WA, NT and QL) and for the whole north Australian savannas.

Region/ Jurisdiction	Season	Not-severe	Severe	Region/ Jurisdiction	Season	Not-severe	Severe
Higher Rainfall				**Lower Rainfall**			
WA	EDS	84%	16%	WA	EDS	93%	7%
	LDS	73%	27%		LDS	68%	32%
NT	EDS	60%	40%	NT	EDS	82%	18%
	LDS	61%	39%		LDS	53%	47%
QL	EDS	84%	16%	QL	EDS	61%	39%
	LDS	63%	37%		LDS	94%	6%
Total		*66%*	*34%*	Total		*64%*	*36%*
Both regions	EDS	77%	23%		LDS	60%	40%
	All year	65%	35%				

NORTH AUSTRALIA FIRE REGIMES

In summary the 2014 fire season in northern Australia was above average, with fire affecting 41% of the higher rainfall region and 27% of the lower rainfall region, Figure 3. These proportions of fire affected area are ranked the highest and 10th highest in 15 years for the higher and lower rainfall regions respectively. However in the higher rainfall region, 2014 produced the greatest early dry season fire affected area ever mapped. Metrics describing fire management effect indicate a significant improvement in both WA and the NT, however no such improvement is indicated in the Queensland northern savannas which have remained constant.

Methods

Analyses were undertaken across the two rainfall regions, Figure 4, and separately for the three northern jurisdictions (WA, NT QL), for the 15 years from 2000 to 2014. This period coincides with the extent of the

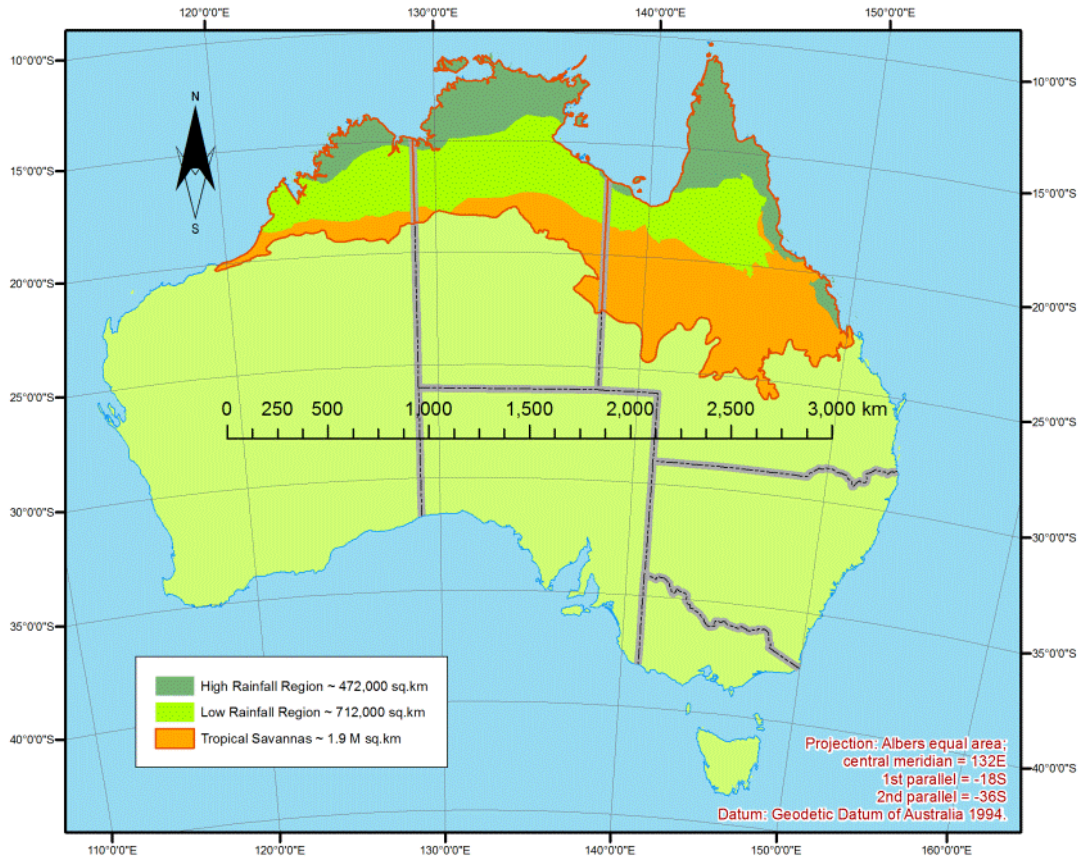

Figure 3. The Mean Seasonal Rainfall regions within the tropical savannas of northern Australia. The tropical savannas are outlined in orange. The darker green to the north is the Higher rainfall region, > 1,000 mm mean seasonal, the bright green is the Lower rainfall region, 600 to 1,000 mm mean seasonal rainfall, and the orange is the remaining tropical savannas with < 600 mm mean seasonal rainfall.

database of burnt area mapping derived from the MODIS satellite data, as provided on the North Australia Fire Information (NAFI) web site (www.firenorth.org.au).

The total amount of fire that occurs in a given fire season is affected predominantly by climatological factors, such as antecedent rainfall (duration of the wet season and amount of rain), prevailing winds (affect timing and degree of curing, affect the effective period for prescribed burning, propagate wildfires), and the preceding fire seasons (fuel production and accumulation).

We present and compare the seasonal proportion of fire, as it provides an **absolute** indication of the fire affected landscape, however we also present the early versus late dry season ratio of the proportion of burnt area as it indicates the **relative** level and therefore the potential effectiveness of fire management.

Lastly, to characterise the longer term effects of fire, particularly on biodiversity components beyond simple analyses of annual effects, we have calculated and assessed the proportion of longer unburnt area. The proportion of area greater than five years unaffected by fire has potential beneficial effects on flora and fauna.

Results

North Australia burnt area

In 2014, the total area burnt in the higher rainfall region was 213,000 km^2, compared to the 15 year average of 192,000 km^2, and in the lower rainfall region this was 46,000 km^2 compared to the average of 47,000 km^2. The proportion of the higher rainfall region burnt in the early dry season was 21%, and 24% in the late dry season, compared to the 15 year average of 16% and 25%, Figure 2. This indicates more early burning was undertaken across the whole of the north than the average, with only a slight, 1%, increase in late dry season proportion burnt. The time series also indicates an increase in early dry season burning through time in both WA and the NT. The ratio of early to late dry season fires in 2014 is also greater than the 15 year mean, 0.87 compared to 0.67, however there was almost a doubling of this ratio from 2010 onwards, with a mean of 0.53 from 2000 to 2009 and 0.94 from 2010 to 2014. Our 2014 ratio of 0.87 is within 1 standard deviation (±0.12) of the 2010 to 2014 mean.

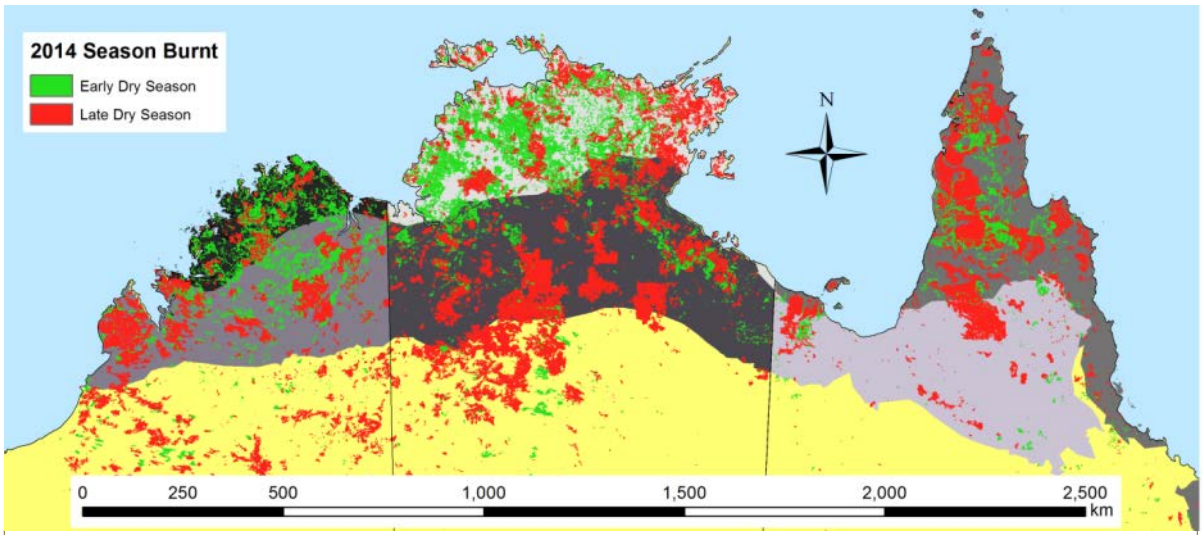

Figure 4. Burnt area mapping 2014, north Australia, indicating the 6 sub-regions.

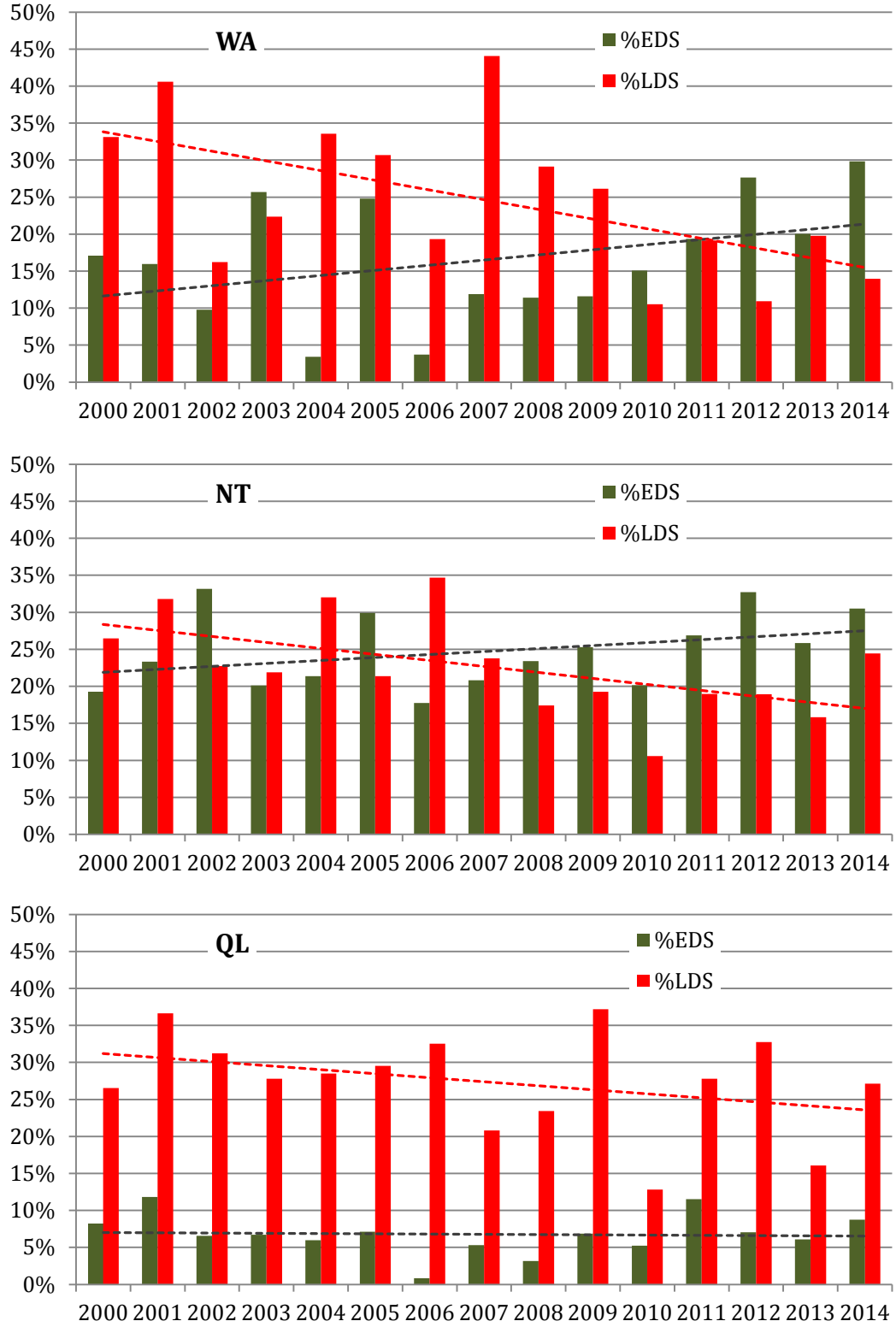

Figure 5. The proportion of the whole area burnt in the early (EDS) and late (LDS) dry seasons in the 3 jurisdictions of the higher rainfall region for the period 2000 to 2014. Note the trend of EDS area burnt is increasing in WA and NT, whilst LDS area burnt is decreasing across all jurisdictions.

Burnt areas in the Jurisdictions and rainfall regions

As illustrated in Figure 4, there are 3 jurisdictions (WA, NT, QL) within both the high and low rainfall regions, all together 6 sub-regions. Provided in detail in Appendix 1, and illustrated in Figure 5, we have calculated the area burnt seasonally and in total for each year, 2000 to 2014. 48%, 41% and 34% of WA, NT and QL were fire affected in total, however the EDS/LDS ratio is 0.87 for WA, 1.19 for the NT, but only 0.26 in QL. Regression analysis of all the years of data for the high rainfall region in the 3 jurisdictions is illustrated in Figure 6. There are significant relationships indicating that the ratios are improving through time in both the NT and WA, an obvious and positive effect of management since 2010. However no such relationship exists in QL, although the data indicate a steady relationship between early and late dry season fires through time.

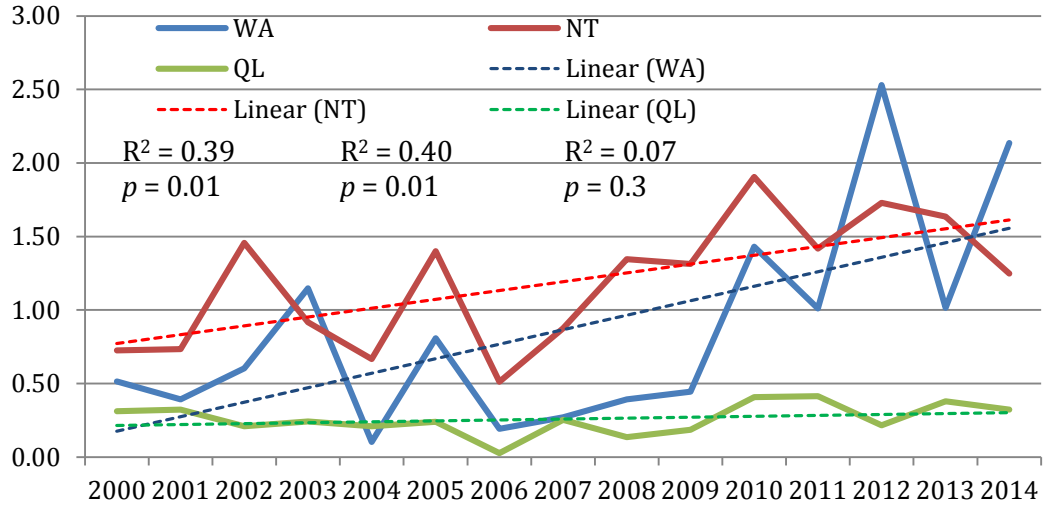

Figure 6. The change in the ratio of Early to Late dry season fires for the 3 High rainfall (> 1,000 mm mean seasonal rainfall) jurisdictions.

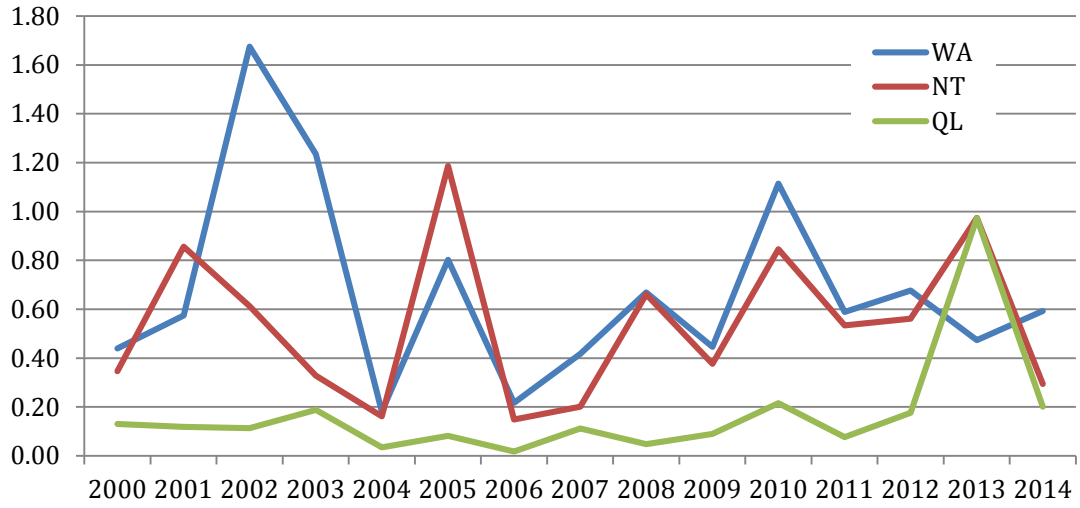

Figure 7. The change in the ratio of Early to Late dry season fires for the 3 Lower rainfall (600 to 1,000 mm mean seasonal rainfall) jurisdictions.

For the lower rainfall region the EDS/LDS ratio is very different in WA and the NT, Figure 7. The variance, forward through time, is high, especially compared to QL, with values ranging from 0.02 in 2006 to 0.22 in 2010, the only large variance in QL being 0.97 in 2013. The ratios are about 4 times higher but still only 0.55 and 0.43 on average in WA and NT respectively, compared to 0.12 in QL.

Longer unburnt areas

In the higher rainfall region the proportion of longer unburnt area remains fairly stable (21 ± 2%) for the 2001 to 2014 period, however it was relatively much higher in the starting year 2000 (27%). In the higher rainfall region the mean area of longer unburnt is 32% in QL compared to only 13% and 11% in the NT and WA respectively. In the lower rainfall region there has been a significant increase in longer unburnt area since 2001, Figure 8. However this same level of significance occurs only in the NT fire history, not in WA nor QL, where the mean longer unburnt area is less than half (14% and 15% respectively) compared to the mean for the NT (34%). Overall, in QL there was a mean of 40% longer unburnt area compared to 18% and 15% in the NT and WA respectively.

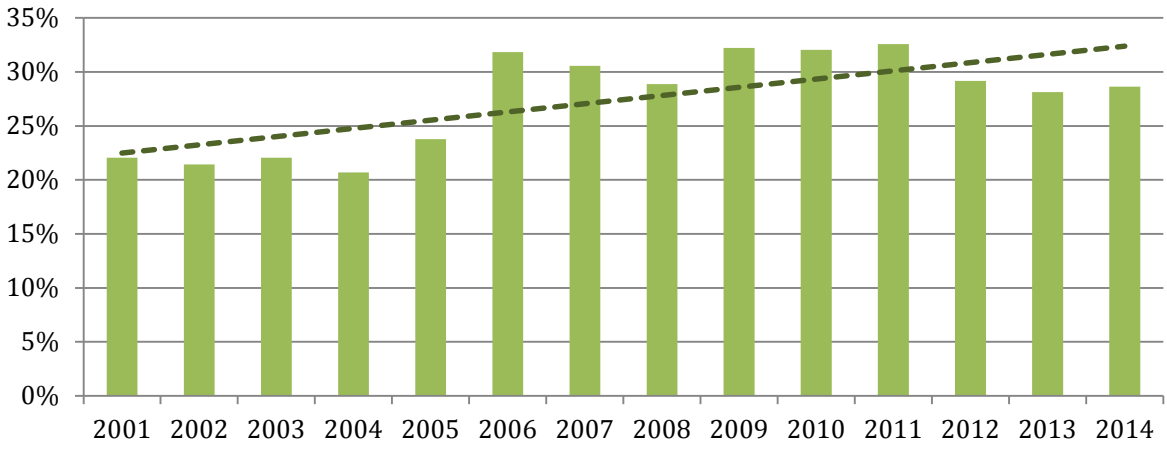

Figure 8. The change in the area of longer unburnt area for the combined 3 Lower rainfall (600 to 1,000 mm mean seasonal rainfall) jurisdictions. The linear trend described by the dark dashed line is significant. The NT has the only significant trend.

Conclusion

There is a notable change in the EDS/LDS ratio in both the Kimberley and the Top End of the Northern Territory since 2010, potentially indicating a change in fire management practices that coincides with activities undertaken by some of the larger indigenous estates in the Kimberley (Balangarra, Dambimangari, Wilinggin and Wunambal Gaambera – totalling approximately 40,000 km^2) and in the Top End of the NT (Western and Central Arnhem Land –approximately 55,000 km^2). In these two jurisdictions there has been an increase in the proportion of the landscape affected by early dry season fires and a decrease in the proportion of late dry season fires, but notably, there has been a decline in the proportion of the landscape affected by fire overall. These changes have affected the overall trends for the two rainfall regions, Figure 9.

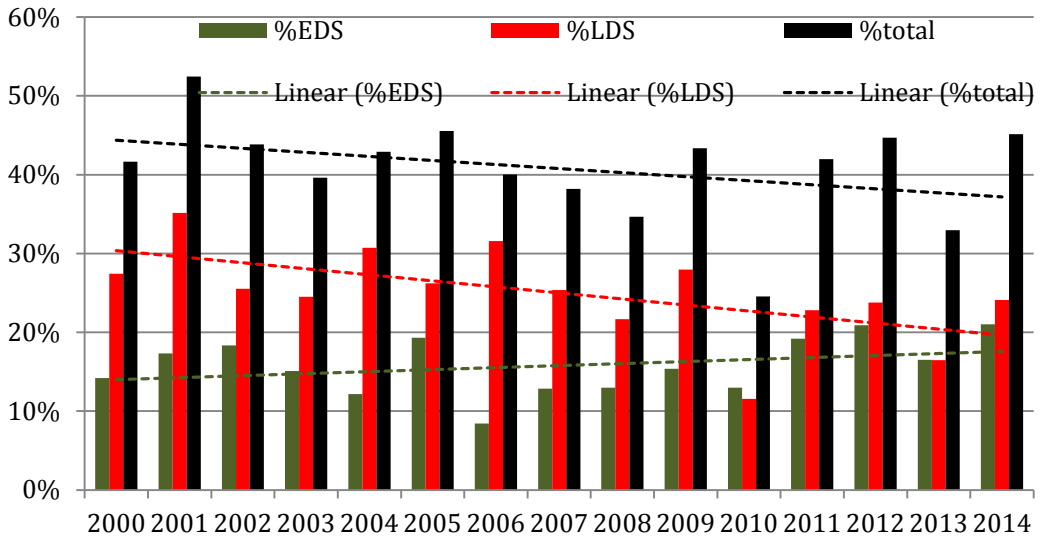

Figure 9. The proportion of area burnt through time, 2000 to 2014, in the combined higher and lower rainfall regions, in the early dry season (EDS), late dry season (LDS) and for the whole year (Total).

GULF FIRE MANAGEMENT

Original 'mulga landscapes' project proposal

It was documented in the original project, that its overarching objective was to explore the extension of carbon market-based fire management initiatives under development in north Australian savannas "...*to provide an economic and employment foundation for remote central Australian communities to develop land management enterprises / undertakings...So as to provide a sustainable basis for developing stronger and more resilient communities*".

The original proposal was submitted on the caveat, stated in the introduction, *"Note: this Project Plan document is provided at this time simply to inform the BNH CRC that this project may be developed over the course of 2014, subject to the outcomes of (a) preliminary investigations currently being undertaken and (b) subsequent sourcing of substantial external funding, for potential start-up in January 2015".*

With funding from the Commonwealth's Indigenous Carbon Farming Fund (ICFF) and Indigenous Land Corporation (ILC) to the North Australian Indigenous Land & Sea Management Alliance (NAILSMA) and partners, those preliminary investigations are now complete, and a preliminary report has been prepared (not for public circulation at this time) by Dr Neil Burrows (WA Dept Parks and Wildlife), *Potential for Indigenous fire management in central Australia to reduce greenhouse gas emissions and increase biosequestration*. That report finds that while there is potential for the development of appropriate accounting methodologies, the logistical and economic realities of undertaking sufficient prescribed burning to be effective in reducing the extent of central Australian wildfires (and thereby emissions) is currently prohibitive.

At the time of writing, project partners have agreed that next steps should involve consultations with relevant stakeholders to develop a broader framework for delivering effective and economic fire management based on an expanded set of ecosystem services, biodiversity and cultural benefits. As such it is our considered view that the BNHCRC strategic funding allocated to this component would be better allocated to an allied, more prospective project endeavour—and one more clearly aligned to the broader savanna focus of other 'northern hub' projects.

Revised focus on a 'Gulf savanna burning' project

We consider there are a number of compelling reasons to focus on the Gulf region:

- Market-based savanna burning greenhouse gas emissions abatement project opportunities have been available to landholders in fire-prone northern higher rainfall (>1000 mm isohyet) savannas since the announcement, in 2012, of the first formal Carbon Farming Initiative (CFI) savanna burning accounting methodology. As at early 2015 there were 34 registered CFI projects in the higher rainfall zone—conspicuously on mostly indigenously owned / managed lands.

- Earlier this year a revised methodology extends that opportunity to the 600 mm isohyet (http://www.comlaw.gov.au/Details/F2015L00344), including the Gulf region. To date, substantial efforts have been made by Indigenous ranger groups operating in the Gulf, the Waanyi Garawa Rangers in the NT and Carpentaria Rangers in QLD, to develop landscape fire management programs mostly with ad hoc Indigenous funding (e.g. Working on Country, Indigenous Protected Area, programs). There is significant potential to develop more sustainable payment for environment services (PES) enterprises based on emerging carbon market arrangements. (Refer forthcoming book chapter: Russell-Smith J, Yates CP, Evans J, Meyer CP, Edwards AC (2015) Application of a lower rainfall savanna burning

emissions abatement methodology. In: Carbon accounting and savanna fire management. Murphy BP, Edwards AC, Meyer CP, Russell-Smith J (eds), CSIRO Publishing, Melbourne).

- The BNHCRC has recently provided PhD funding support to Kate van Wezel for her just-commenced project, *Towards culturally appropriate fire management in the Waanyi and Garawa lands: impediments, opportunities, and key challenges.* A key focus of her project is to assist develop the capacity and engagement of women rangers in these programs.

- Significant related initiatives are under development in the same Gulf region, focusing especially on building the governance and business capacities of regional Indigenous land & sea management organisations. Such initiatives align closely with other BNHCRC 'northern hub' projects, specifically the suite of projects under the BNHCRC – CDU contractual arrangement, *Scoping remote north Australian community resilience and developing governance models through action research*.

Project milestone implications

The original 'mulga landscapes' project was provided $50K p.a. for four years, commencing Jan 2015, for the purposes "that the BNH CRC contribution would assist with PhD / post-graduate study operational funding, and / or targeted operational investments (e.g. workshops, travel support)." (refer Scope, in Attachment A). We consider that these same arrangements can apply directly to the geographically refocused project. It was always the intent that such funding would be used to leverage other funding for an expanded project as required.

There are no Milestone reporting requirements which relate specifically to the 'mulga landscapes' project—refer Schedule 2 in the above-cited head contract agreement. Subject to advice from the BNHCRC and endusers, we propose that Milestone reporting for a refocused PartA)iii project should simply involve:

- Development of an agreed set of quarterly reporting criteria for the current life of the project. To that end it is proposed to undertake discussions with key regional stakeholders (Northern Land Council, Carpentaria Land Council, associated Ranger groups and Indigenous community members, NAILSMA, key 'northern hub' project members—including from the allied 'scoping resilience' suite of projects) as part of a planned road trip in the latter part of June 2015.

- Report against these criteria as part of scheduled quarterly milestone reporting for the Savanna fire management and BNH scenario planning for northern Australia project.

Activity

The key activity for the Q was the undertaking of a week-long field trip to the Gulf region, 20-25 June, to visit the remote, predominantly Indigenous communities of Borroloola and Robinson River in the NT Gulf region. The notes below provide a short summary of details relating to this fieldtrip.

The main purposes of the Gulf fieldtrip were to:

a) familiarize project research staff with Gulf regional / local community development issues and aspirations, especially in connection with PES land management opportunities
b) undertake discussions with key local community members concerning the proposed research program, and especially how that program could be of benefit to local / regional interests

c) and on basis of above, consider opportunities for using the Gulf region as an action research case study.

For the Gulf fieldtrip, the research team included:

1) Prof Jeremy Russell-Smith (Project leader, CDU)
2) Dr Kamal Sangha (PES project post-doc researcher, CDU)
3) Ms Kate van Wezel (BNHCRC PhD student, CDU and ANU)
4) Prof Bob Costanza (PES project key researcher, ANU)
5) Dr Ida Kubizewski (PES project key researcher, ANU)
6) Dr Sean Kerins (associate research collaborator, ANU)

Key meetings were as follows:

a) *Borroloola 22 June*: with Northern Land Council and Waanyi-Garawa Ranger staff, including senior Indigenous community representatives Mr Jack Green, Mr Donald Shadforth, and Mr Jimmy Morrison.
b) *Robinson River 23 and 24 June*: with community members and Waanyi-Garawa Ranger staff, Jimmy Morrison, Robert O'Keefe, and Karen Noble.

Key outcomes included:

a) general interest on the part of community members for involving PES research as part of ongoing regional planning and development initiatives
b) PES project team to explore ongoing opportunities, including the application of formal scenario planning approaches, with other potential interested parties including NAILSMA, Bush Heritage, The Nature Conservancy and possibly the new 'Northern Development CRC'
c) While no formal future meeting arrangements were set, it was agreed that ongoing discussions would occur over the next few months through the undertaking of Kate van Wezel's developing PhD research program.

SIGNIFICANT ALL-OF-HUB WORKSHOP

In early June a workshop was held at the remote indigenous community of Ngukurr. The primary reason for the workshop was to meet the Aboriginal researchers, to hear presentations of the results of the surveys, to discuss results and specifically to meet the Ngukurr community members of ARPNet and other key community personnel in situ.

Attendees:

ARPNet (Carlisa Roberts, Cherry Daniels, Christine Brown, David Thomas, Grace Daniels, Howard Turner, Kasley Daniels, Otto Campion, Patrina Thomas, Anthony Daniels, Cherryanne Daniels, Deborah Daniels, Geraldine Daniels, Guy Andrews (child), Joseph Andrews (child), Marjorie Daniels, Tammy Daniels, Thomas Rami, Trivena Rami (child), Dean Yibarbuk, Serina Namarnyilk, Bev Sithole, Hmalan Hunter-Xenie); **CDU** (Jackie Gould, Kate Van Wezel, Jeremy Russell-Smith, Steve Sutton, Kamal Sangha, Andrew Edwards); Other (Phil (UNE)); **NAILSMA** (Ricky Archer, Glenn James); **NAILSMA Support** Donna Bush, John Bush, Jessica Lew Fatt;

On the first day we were welcomed to country by the senior elder Cherry Daniels and all introduced ourselves. We were then introduced to the Billabong on which we camped "Yarriowada" which was mis-pronounced by the Missionaries and mis-named "Yellow Water".

The key concept from the talk by Cherry Daniels was that she believed that the work they were doing was key to helping people, all people. She said she does this because she loves her people, she loves all people and she loves her country, and she loves Australia and she wants to help all Australians. She is a strikingly marvellous individual.

ARPNet Survey: Ngukurr

The ARPNet survey in Ngukurr was undertaken by a 14 person team with two support crew (Dr Bev Sithole and Hmalan Xenie-Hunter). 115 Ngukurr residents were interviewed.

In summary, about 50% of Ngukurr residents felt safe from the impact of floods and cyclones. The main reason given for this was people felt that the housing situation was not safe. When questioned further most respondents were not aware of shelters, nor the evacuation plan (which we were told was held by the local police), only 1 of the local ARPNet members knew about the plan. People suggested that there should be a lot more consultation about the emergency plans.

The main fear was the incursion of snakes and crocodiles during floods. With respect to fire, too few people had access to a computer to monitor the Bushfires on NAFI, and not knowing the location and movement of bushfires worried people. Most people felt that the fire breaks around the town were inadequate. People suggested they wanted to be more involved in the emergency plans for the town. Most of the work force involved in the evacuation and post-event clean up were brought in from outside. Local people's skills are ignored. It was suggested that a register of local people's skills should be introduced and that they should have first chance to undertake any tasks required.

There are 25 different clan groups represented in Kunbalanja. 100 residents were surveyed, only 17% of people felt safe. Floods are nearly annual and cause waters to rise such that crocodiles are often found in town. Not only do many people come into the town during the wet season but many more so during any natural flooding or cyclone related disasters. The stores are not elevated such that much of the food becomes water damaged during a period when the town is cut off by the floods.

People surveyed in both communities stated that there was a very big issue regarding a loss of knowledge of the location of, and proper care, for sacred sites. The sacred sites affect the weather

therefore mis-management of them leads to adverse weather conditions such as cyclone. This feeling seemed to induce long term stress.

Men's talk

An aside meeting was held separately amongst the indigenous men of the ARPNet group. This proved to provide significant detailed information to the CDU researchers. The major points stated were:

- There is a lot of stress on people due to the high density living arrangements. Homelands have become predominantly dry season camps; they were better supported prior to the intervention due to CDEP, people were healthier and subsequently so was the country; there are now no schools in the outstations; people have a fear of the town schools as they are not on their own land.
- Leaders from clans are chosen within that family/clan unit through ceremony; when people have moved to bigger communities the leaders of the migrating clans defer power to the local leader/s; over time the power of the migrating leaders is diluted or even completed removed; this causes a lot of confusion amongst the migrating groups and therefore a lot of disruption in the community as a whole;
- There are too many "middle men", usually "balanda" (white fellas) that are in the positions that pay the best; this is unfair and reduces the amount of money that can be paid to local people and the number of people that can work;
- However there are issues of jealousy, an example was given for ceremony grounds in Maningrida; There would appear to be a negative correlation between employment and the western training that goes with it and the amount of time spent on country (undertaking ceremonial duties);
- Leadership in clans was strong up until the 70's but has lessened since that time.
- There is a lot of personal conflict between ceremonial obligations (which includes caring for country) and leave from western employment. CDEP included non-specific land management activities including ceremonial duties.
- Ceremony is also part of a monitoring program, when people are out on country the information they acquire is reported back to the clans, the clan leaders then get together in ceremonial ways to discuss the results of ceremony and the monitoring, they then confer and the results of their discussion go back through the clans to individuals attending ceremony and caring for country.

Recommendations from the workshop

1. Develop BNH "Skills Register" for communities;
2. Physically raise the level of the stores in Gunbalanja;
3. Plan for contract for charters during emergencies, subsidise flight costs to places with no road access.
4. The Emergency Plan should be copied as a sticker or small book and placed in each house.
5. Should have siren for flood or cyclone at Gunbalanja and Ramingining
6. People should be informed about the siren and what it means.
7. Fund ongoing performance of ceremony on country, also we need to teach leadership and have ceremony together - if they are separated the strength of the training is not as good. This should include resources like troop carriers.
8. Emergency planning needs to have the involvement of clan leaders. This should include Dalian, Mingnydingki and Jungayai;

Traditional owners, through ARPnet, should be involved in identifying who should be on the emergency leadership board/group.

PUBLICATIONS LIST

Accepted/Published Papers

Kamal Sangha, Jeremy Russell-Smith, Andrew Edwards, Cameron Yates, Jackie Gould, Christine Michael, Glenn James and ARPNet. (2015) ***Developing enterprise opportunities in remote North Australian Communities***. A paper submitted for AFAC 2015.

Andrew Edwards, Jeremy Russell-Smith, Kamal Sangha and Cameron Yates. (2015) ***Culturally appropriate mapping tools for informing two-way fire management planning in remote indigenous north Australian communities***. A paper submitted for AFAC 2015.

Edwards, A., J. Russell-Smith and M. Meyer (2015) ***Contemporary fire regime risks to key ecological assets and processes in north Australian savannas***. International Journal of Wildland Fire. DOI: http://dx.doi.org/10.1071/WF14197

Published Books

Carbon Accounting and Savanna Fire Management (2015) Editors: Brett Murphy, Andrew Edwards, Mick Meyer and Jeremy Russell-Smith. CSIRO Publishing, Melbourne.

CURRENT TEAM MEMBERS

Professor Jeremy Russell-Smith (Project Leader)

- Adjunct Professor, Darwin Centre for Bushfire Research, Research Institute of Environment and Livelihoods, Charles Darwin University, Australia
- Adjunct Professor University of the Sunshince Coast, Australia
- North Australian Indigenous Land and Sea Management Alliance, Darwin, Australia

Dr Samantha Setterfield (Researcher)

- Associate Professor, Research Institute of Environment and Livelihoods, Charles Darwin University, Australia

Dr Natalie Rossiter-Rachor (Researcher)

- Research Fellow, Research Institute of Environment and Livelihoods, Charles Darwin University, Australia

Dr Andrew Edwards (Researcher)

- Research Fellow Bushfires, Darwin Centre for Bushfire Research, Research Institute of Environment and Livelihoods, Charles Darwin University, Australia

Cameron Yates (Coordinator)

- Program Coordinator, Darwin Centre for Bushfire Research, Research Institute of Environment and Livelihoods, Charles Darwin University, Australia

Kate Van Wezel (Student)

- PhD candidate, Darwin Centre for Bushfire Research, Research Institute of Environment and Livelihoods, Charles Darwin University, Australia

REFERENCES

Edwards, A., J. Russell-Smith and S. W. Maier (2015a). *Measuring and Mapping Fire Severity in the Tropical Savannas*. In **Carbon Accounting and Savanna Fire Management**. (Ed's: B. Murphy, A. Edwards, M. Meyer and J. Russell-Smith). Melbourne, CSIRO Publishing**:** 169-181.

Edwards, A., J. Russell-Smith, K. Sangha and C. Yates (2015b). Culturally appropriate mapping tools for informing two-way fire management planning in remote indigenous north Australian communities. AFAC15: New Directions in Emergency Management, Adelaide Convention Centre, Adelaide SA.

Edwards, A. C. (2011). I spy with my little eye something beginning with...fire. PhD Thesis, Charles Darwin University.

Edwards, A. C., S. W. Maier, L. B. Hutley, R. J. Williams and J. Russell-Smith (2013). "Spectral analysis of fire severity in north Australian tropical savannas." *Remote Sensing of Environment* **136**(0): 56-65.

Murphy, B., A. Edwards, C. Meyer and J. Russell-Smith (2015). *Carbon Accounting and Savanna Fire Management*. Melbourne, CSIRO publishing.

Russell-Smith, J. and A. C. Edwards (2006). "Seasonality and fire severity in savanna landscapes of monsoonal northern Australia." *International Journal of Wildland Fire* **15**(4): 541-550.