Mapping fire severity from satellite imagery for greenhouse gas emissions calculations, conservation management and operational use.

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bushfire CRC

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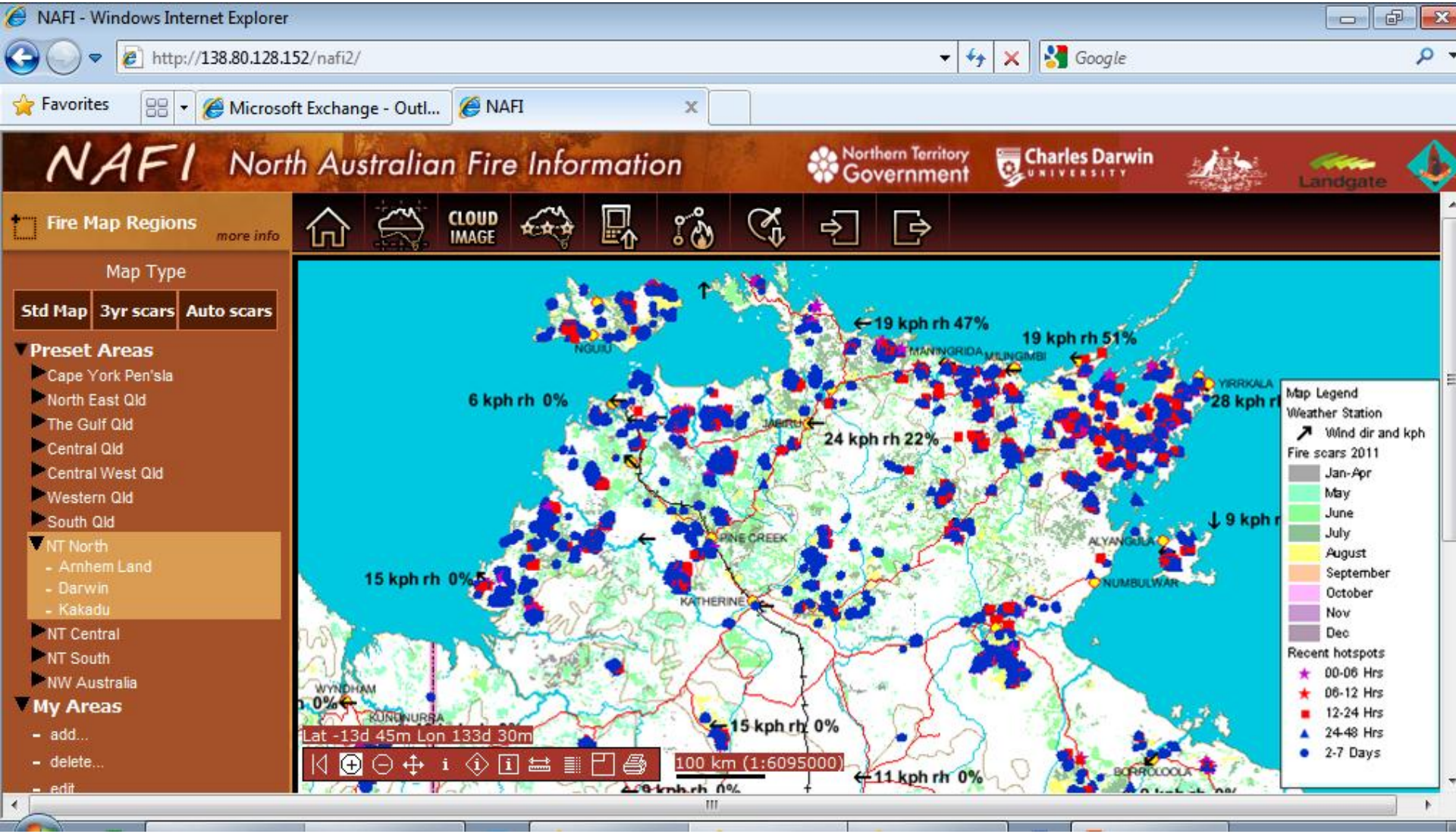
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CLOUD IMAGE
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6 kph rh 0%
24 kph rh 22%
15 kph rh 0%
15 kph rh 0%
11 kph rh 0%
NGUIU
MANINGRIDA
MILINGIMBI
YIRRKALA
PINE CREEK
KATHERINE
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2-7 Days

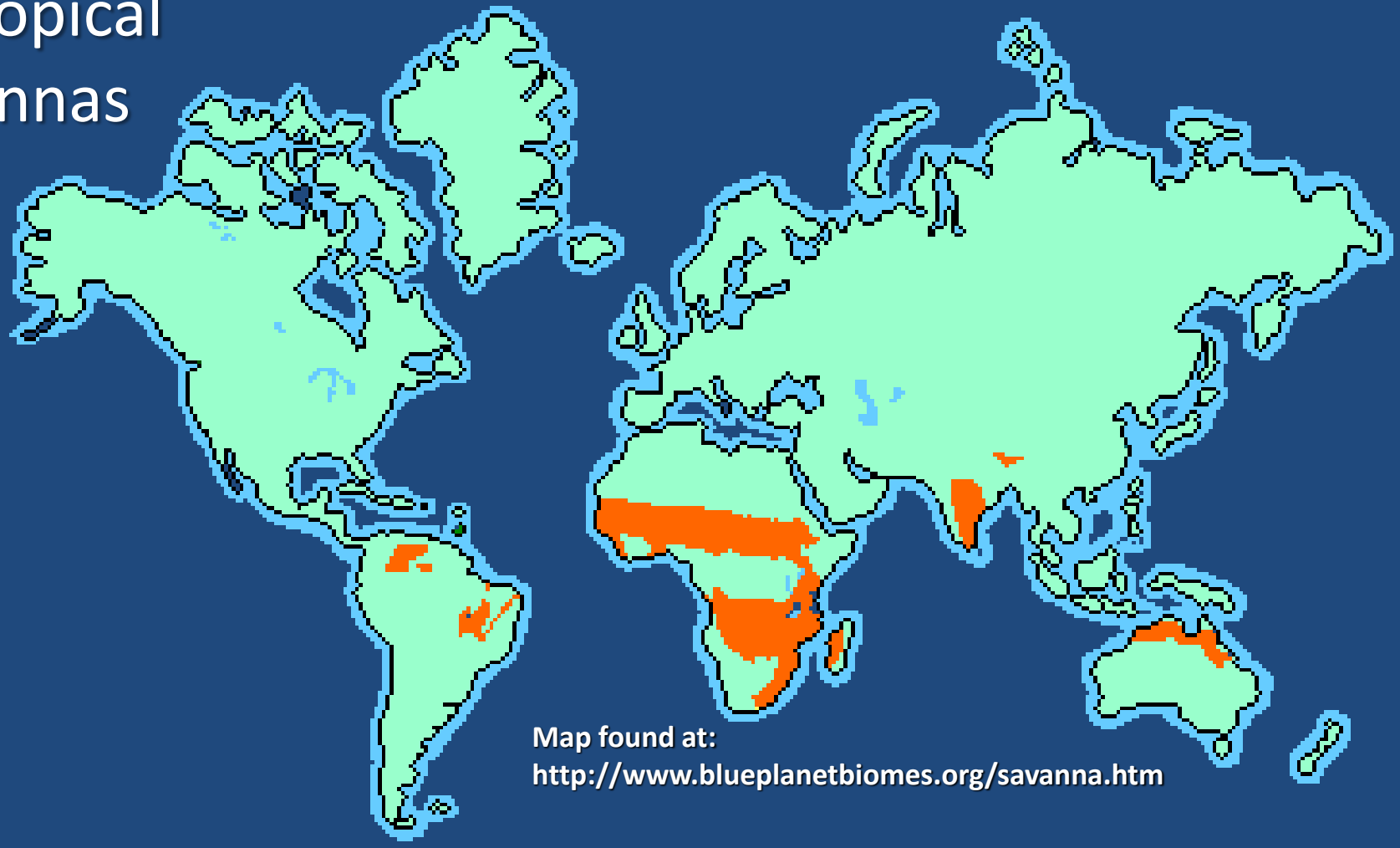
Outline of this talk:

1. PhD thesis

2. Calibration/Validation of an operational product

3. Example of a wildfire from **last week**

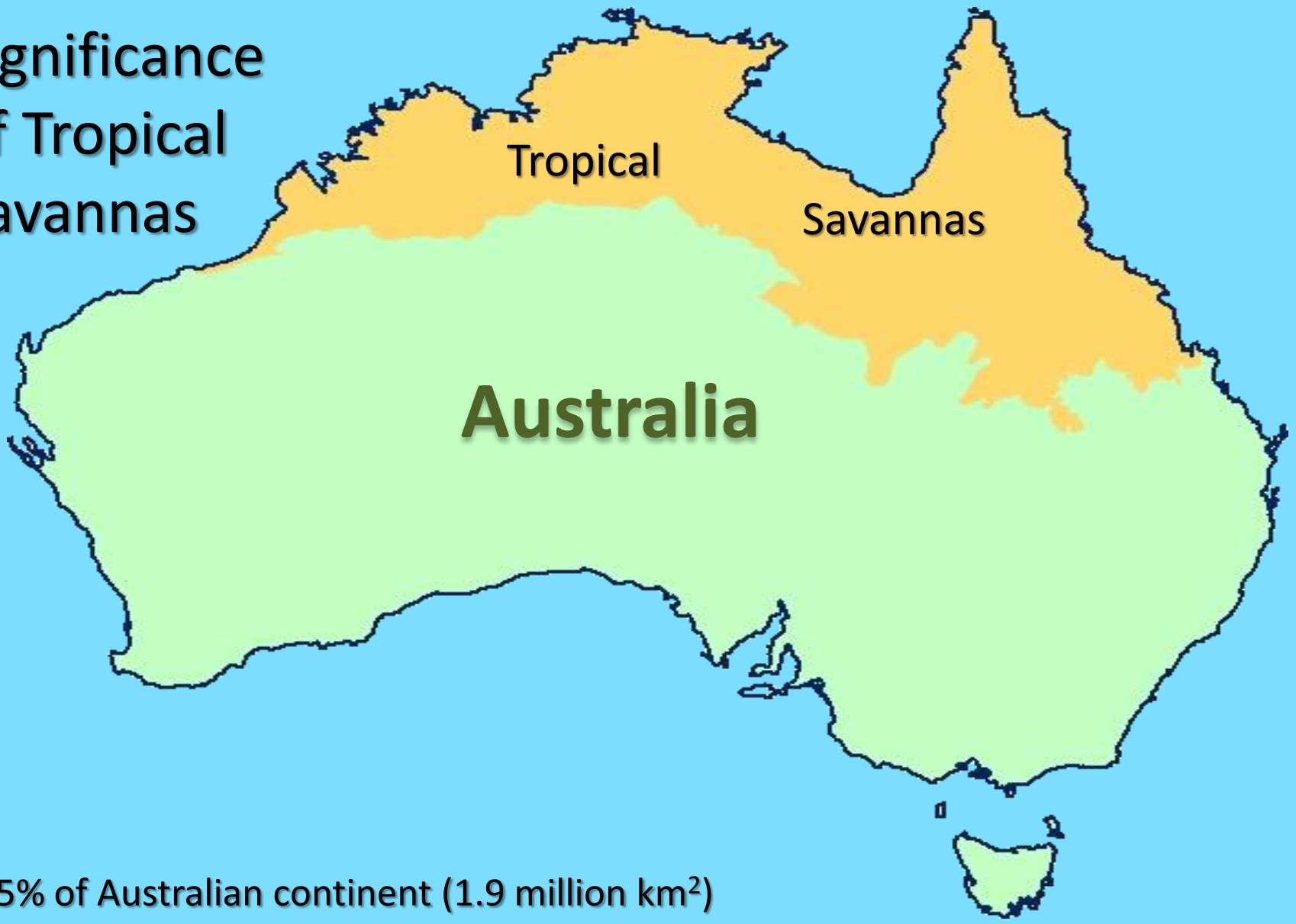
Significance of Tropical Savannas



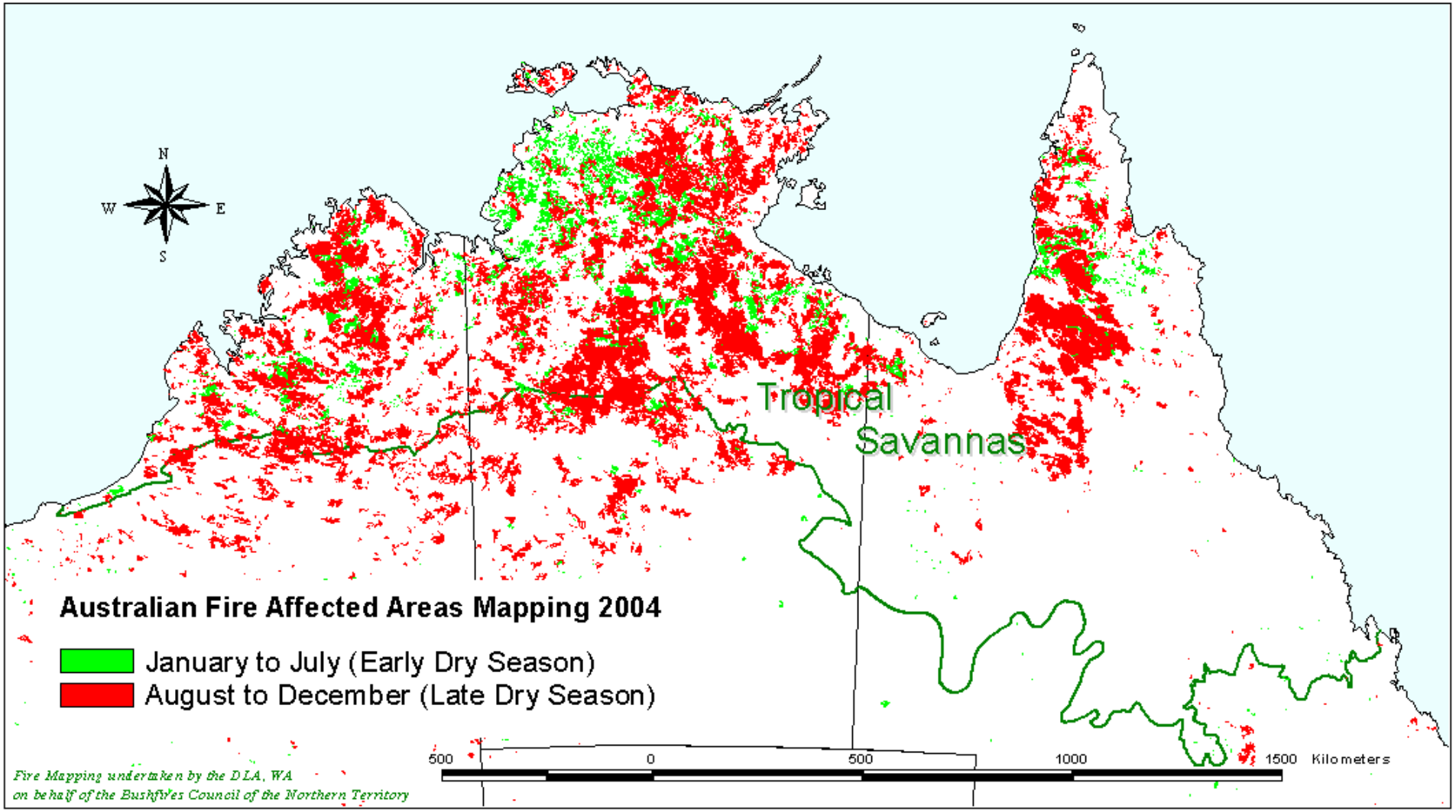
Map found at:
http://www.blueplanetbiomes.org/savanna.htm

- 12% of World landmass
- Globally, it is the most heavily grazed
- Most frequently burnt biome

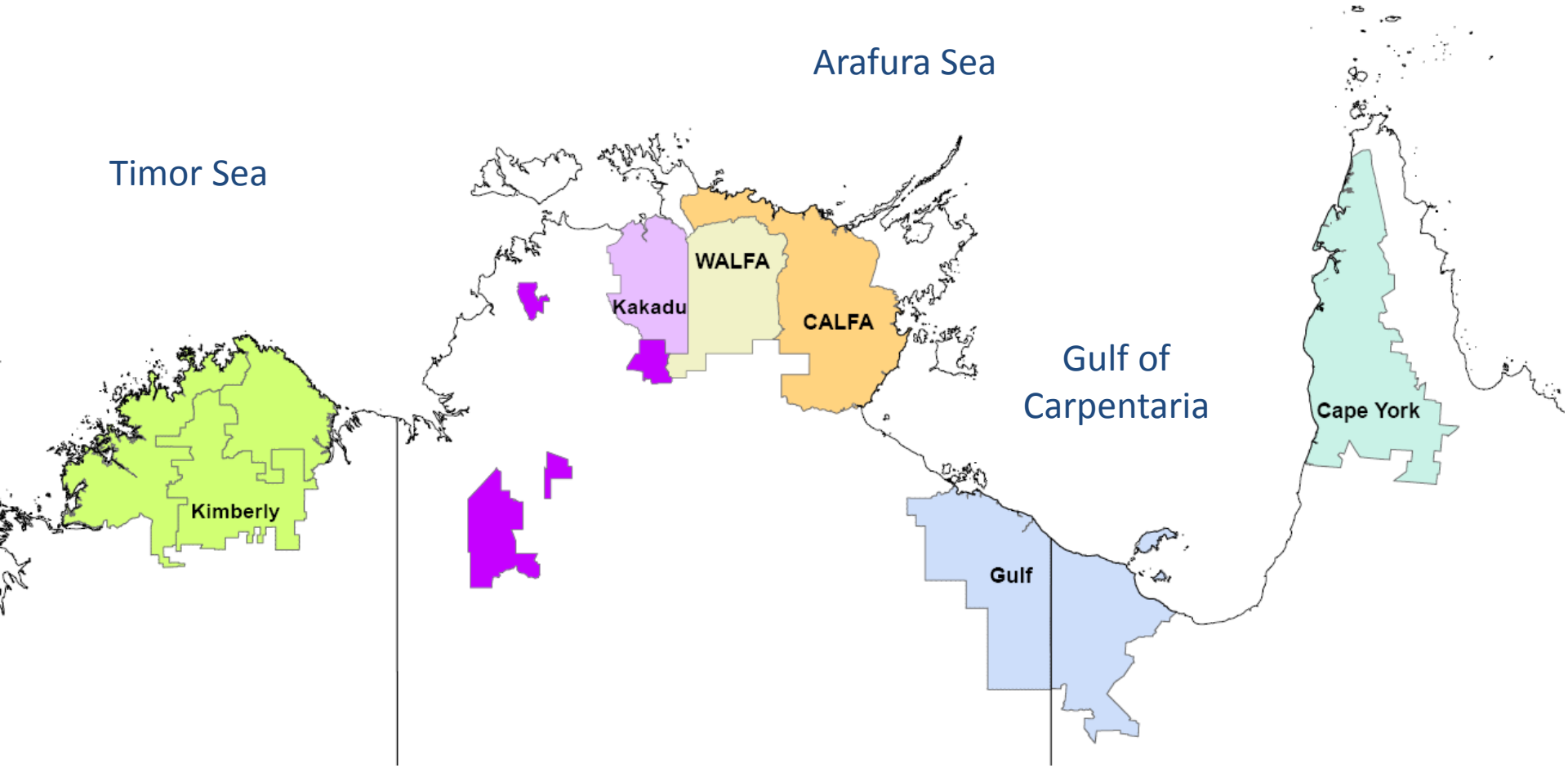
Significance of Tropical Savannas



- 25% of Australian continent (1.9 million km^2)
- On average, it constitutes 95% of the annual area burnt in Australia
- 2% of Australia's annual Greenhouse Gas emissions are from Savanna Burning


N
W
E
S
Tropical
Savannas
Australian Fire Affected Areas Mapping 2004
January to July (Early Dry Season)
August to December (Late Dry Season)
500
0
500
1000
1500 Kilometers
Fire Mapping undertaken by the DLA, WA
on behalf of the Bushfires Council of the Northern Territory

Proposed CFI project areas in North Australia



Terminology

FIRE SEVERITY:

a measure or description of the affect of fire on the vegetation,

has both a horizontal component - patchiness,

and a vertical component - scorch height.

Simplified Fire Severity Categories

Patchy

Low

Moderate

High

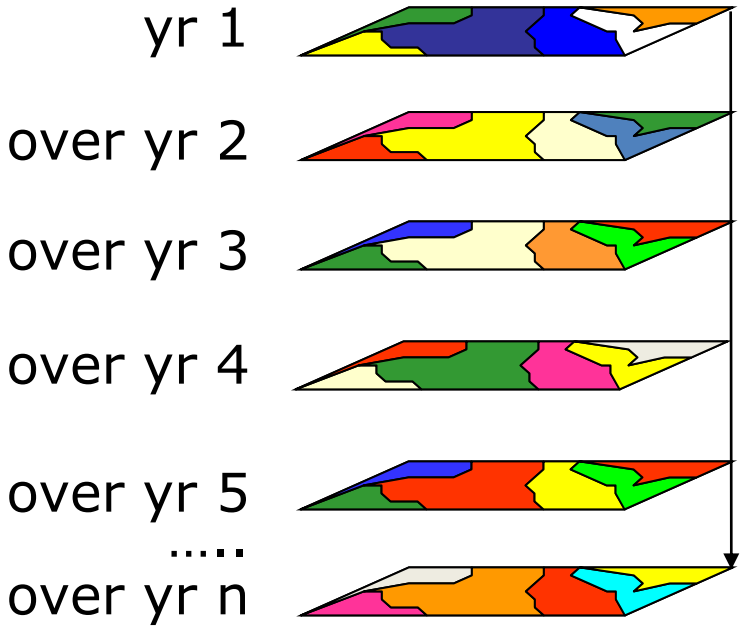
Extreme

GHG emissions calculations

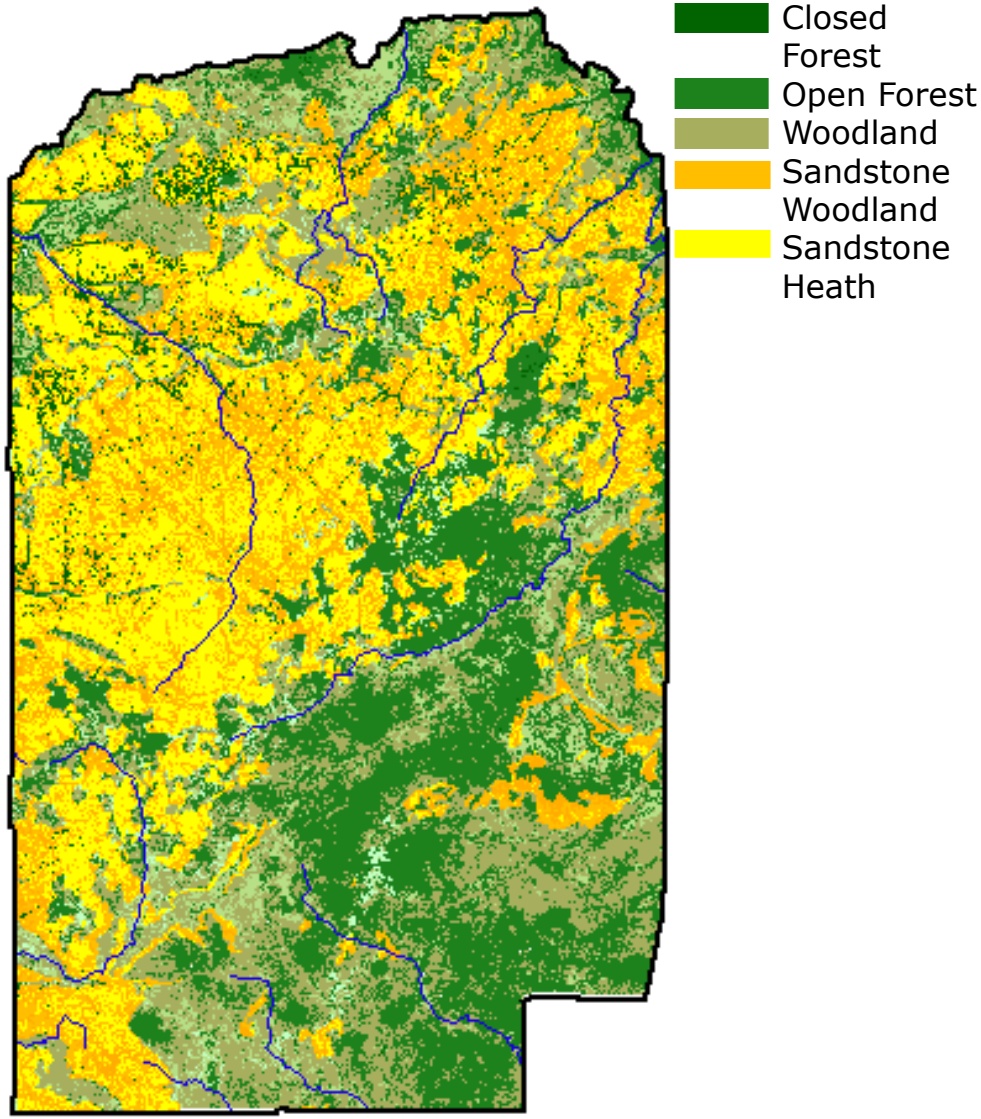
Spatial

Fire mapping

Years since last burnt



Vegetation/Structure Mapping



GHG emissions calculations

Spatial

Point data

Fuel types:
Grass/Herbs etc,
Fine (≤5 mm),
Coarse (5 mm to 5 cm),
Heavy (> 5 cm),
Shrubs (allometric),
Trees (allometric).

➔ Habitat related Fuel Accumulation (years).

GHG emissions calculations

Aspatial

Burning Efficiency → Patchiness x Combustion Completeness

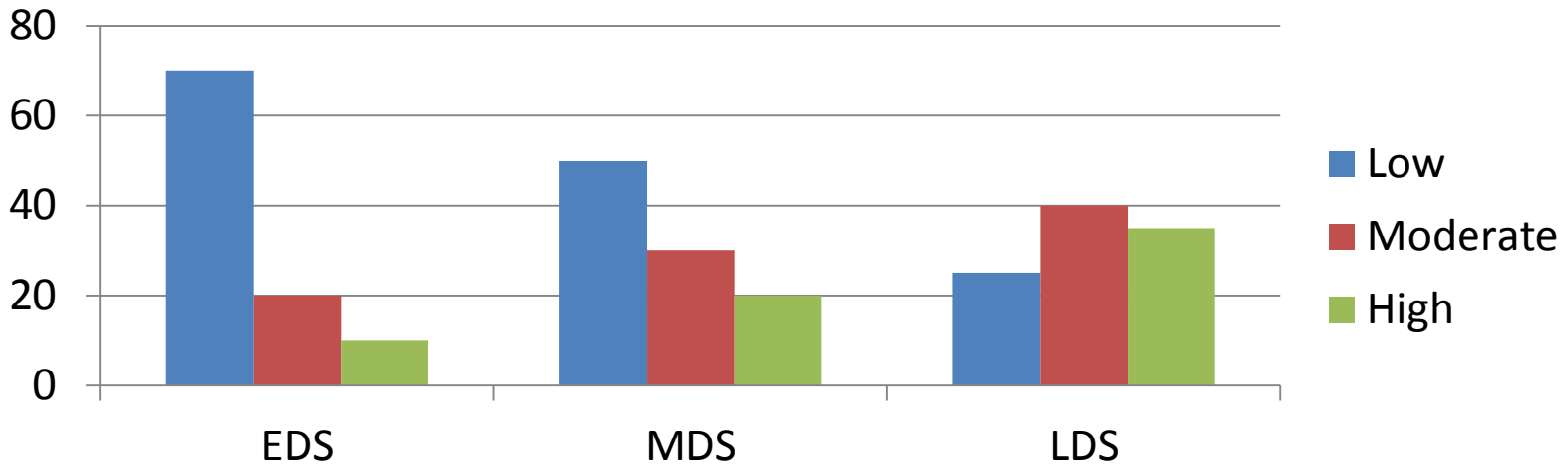
These parameters are derived from the literature and are related to the fire seasonality.

	Season	Fine	Coarse	Heavy	Shrubs
Patchiness	Early Dry Season (April/May/June)	0.71	0.71	0.71	0.71
	Mid Dry Season (July/August)	0.71	0.71	0.71	0.71
	Late Dry Season (Sept/Oct/Nov/Dec)	0.89	0.89	0.89	0.89
Combustion Completeness	Early Dry Season (April/May/June)	0.66	0.13	0.15	0.26
	Mid Dry Season (July/August)	0.66	0.13	0.13	0.26
	Late Dry Season (Sept/Oct/Nov/Dec)	0.76	0.32	0.27	0.35

GHG emissions calculations

Probabilities of types of fires (fire severity)

have been previously determined:



Accuracy of occurrence of Patchiness and Combustion Efficiency

can be improved by replacing the aspatial fire seasonality

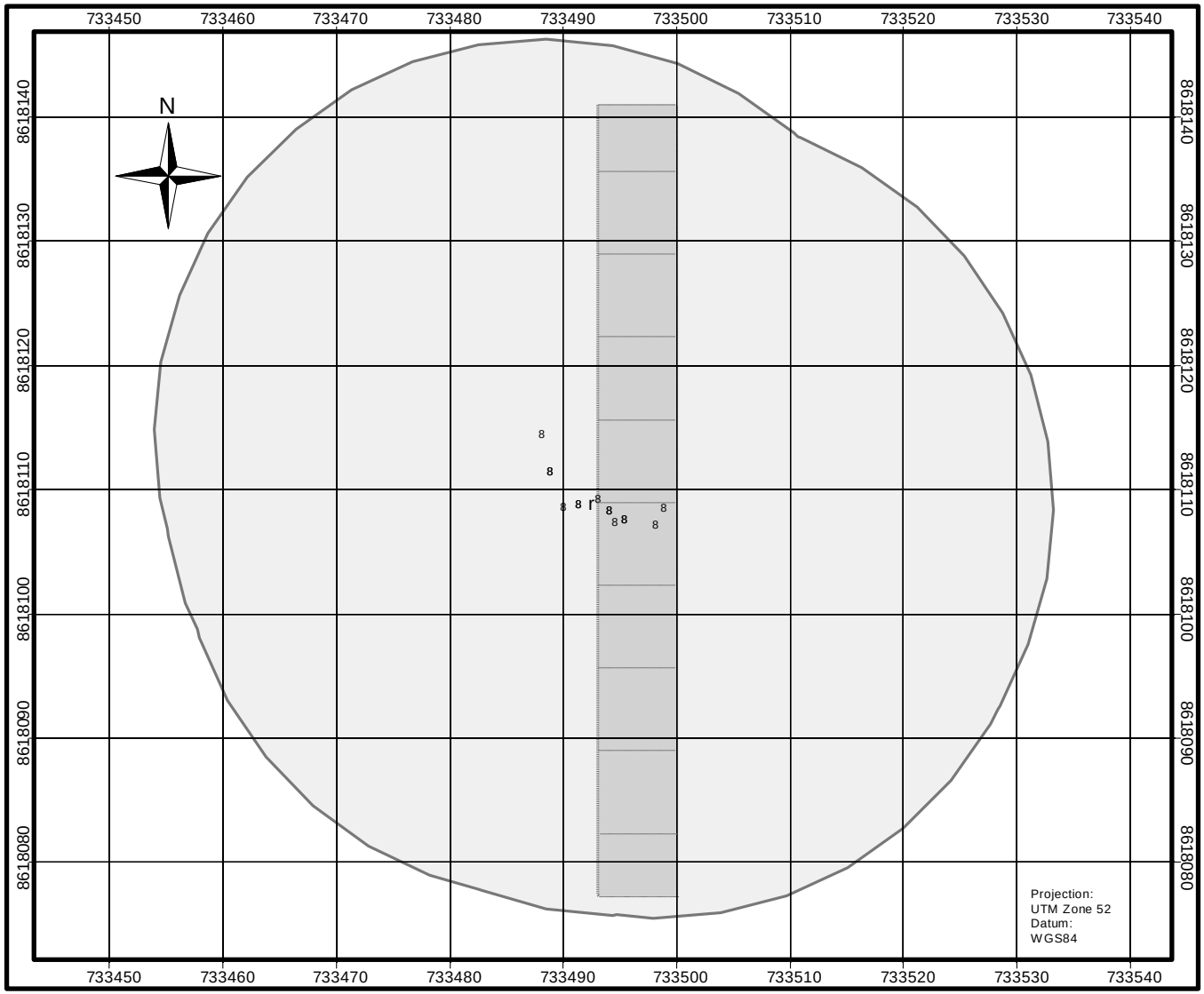
with fire severity mapping.

Field Methods

Collecting Spectra

Site 2: 12th May 2008

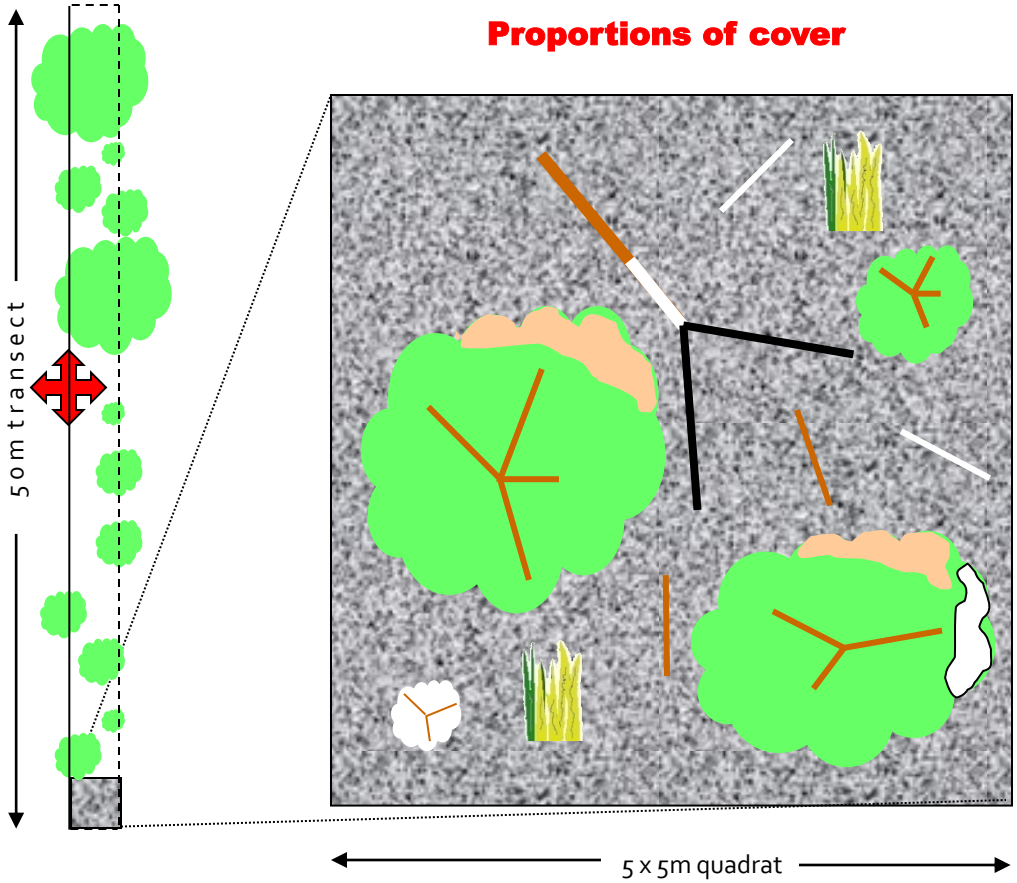
Illustrates the position of the 10 GPS points,
the average waypoint at the centre of the sampled area
within the pixeloid sampled by the spectrometer.



Field Methods

Ground data

Transect



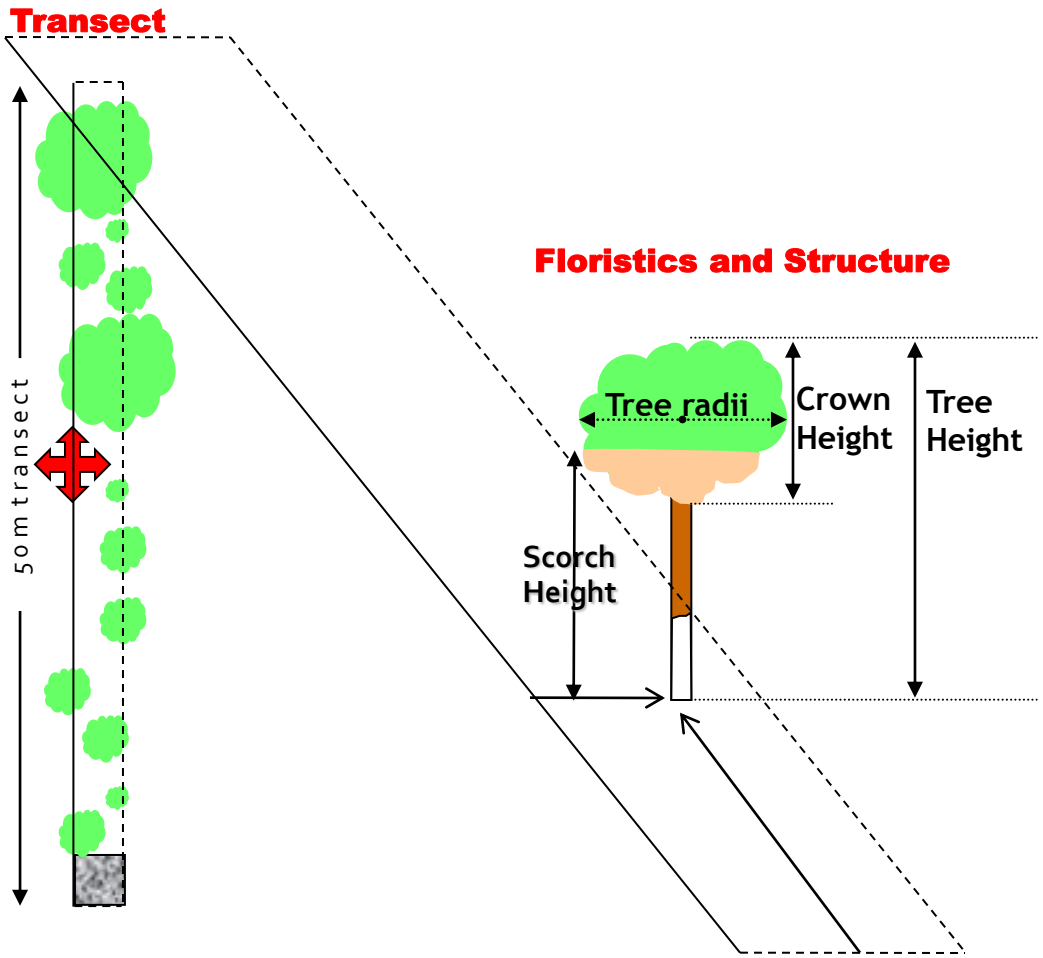
GROUND MEASUREMENTS

Collected at the same GPS point

Describing
- stand structure
- proportions of cover of the various fire affected or unaffected phenomena

Field Methods

Ground data



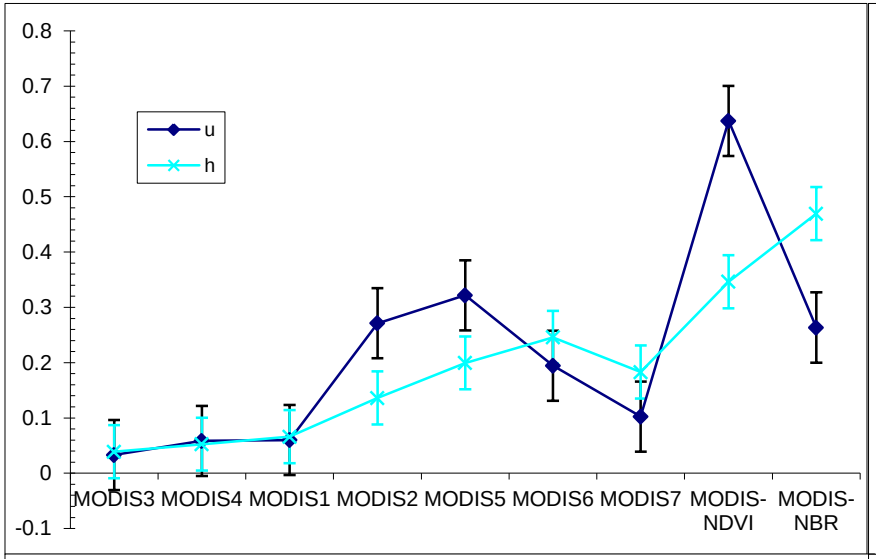
GROUND MEASUREMENTS

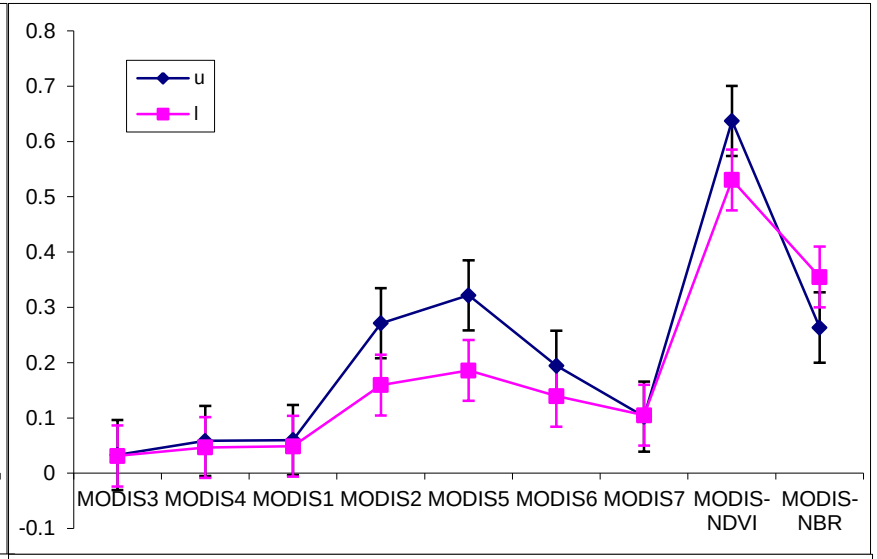
Collected at the same GPS point

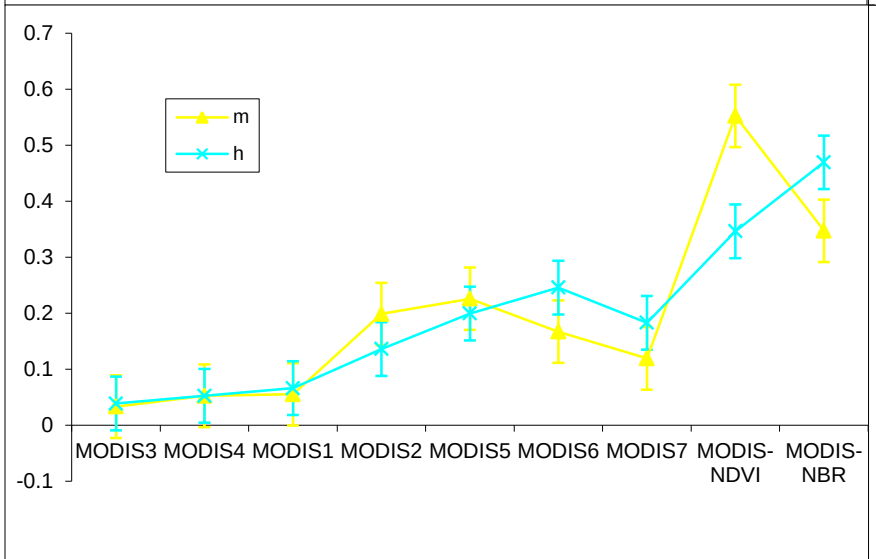
Describing
- stand structure
- proportions of cover of the various fire affected or unaffected phenomena

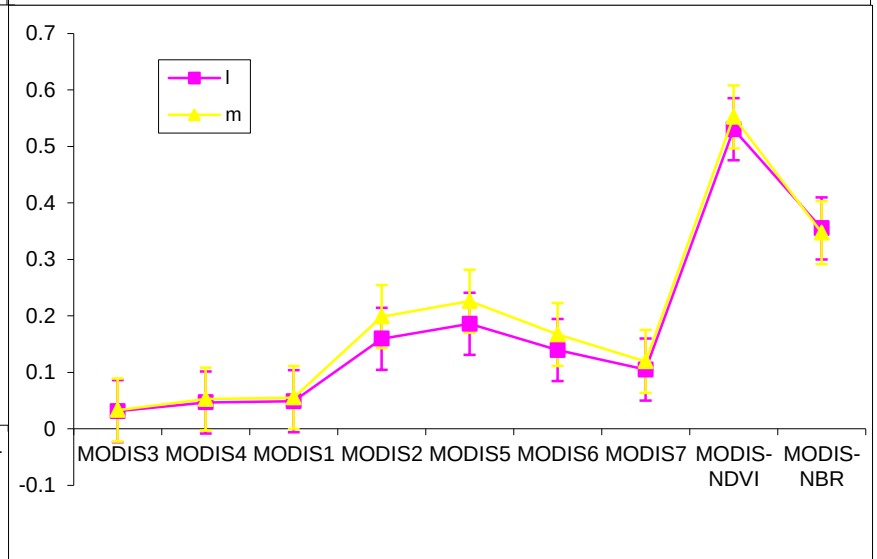
Analysis

The focus of the study is to develop an operational product.
It must cover the whole region, it must be regularly updated.
Therefore an algorithm using MODIS 250 and 500 m channels was chosen.

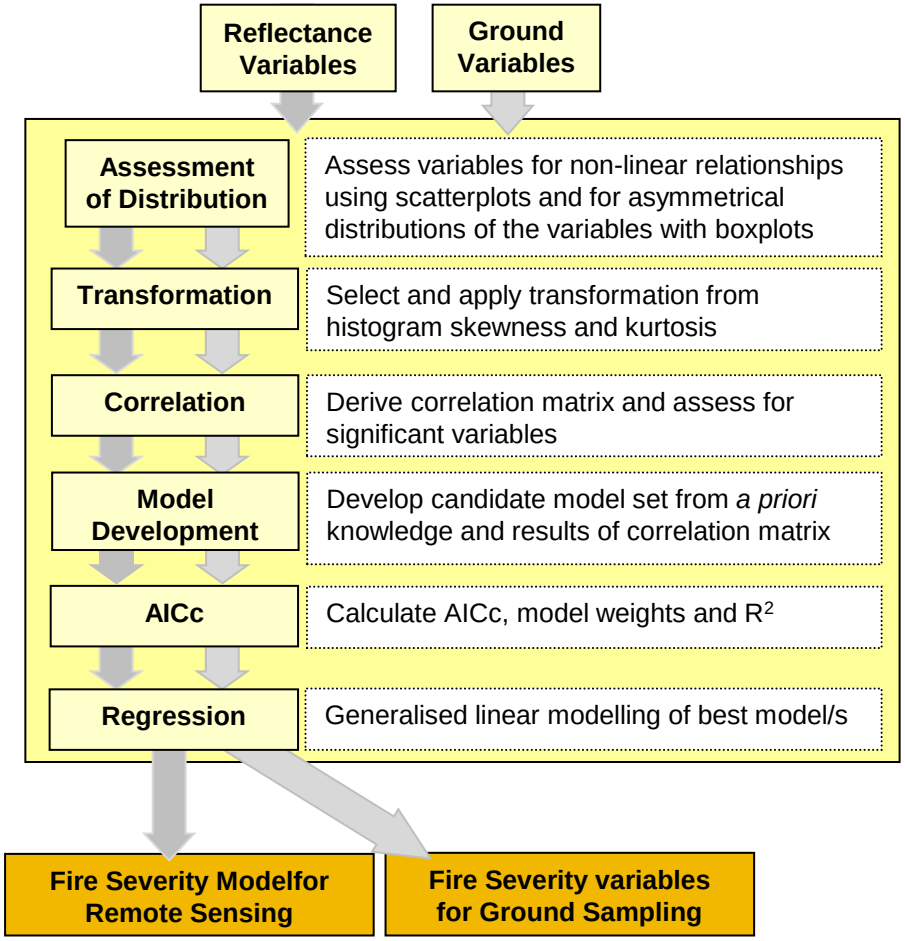






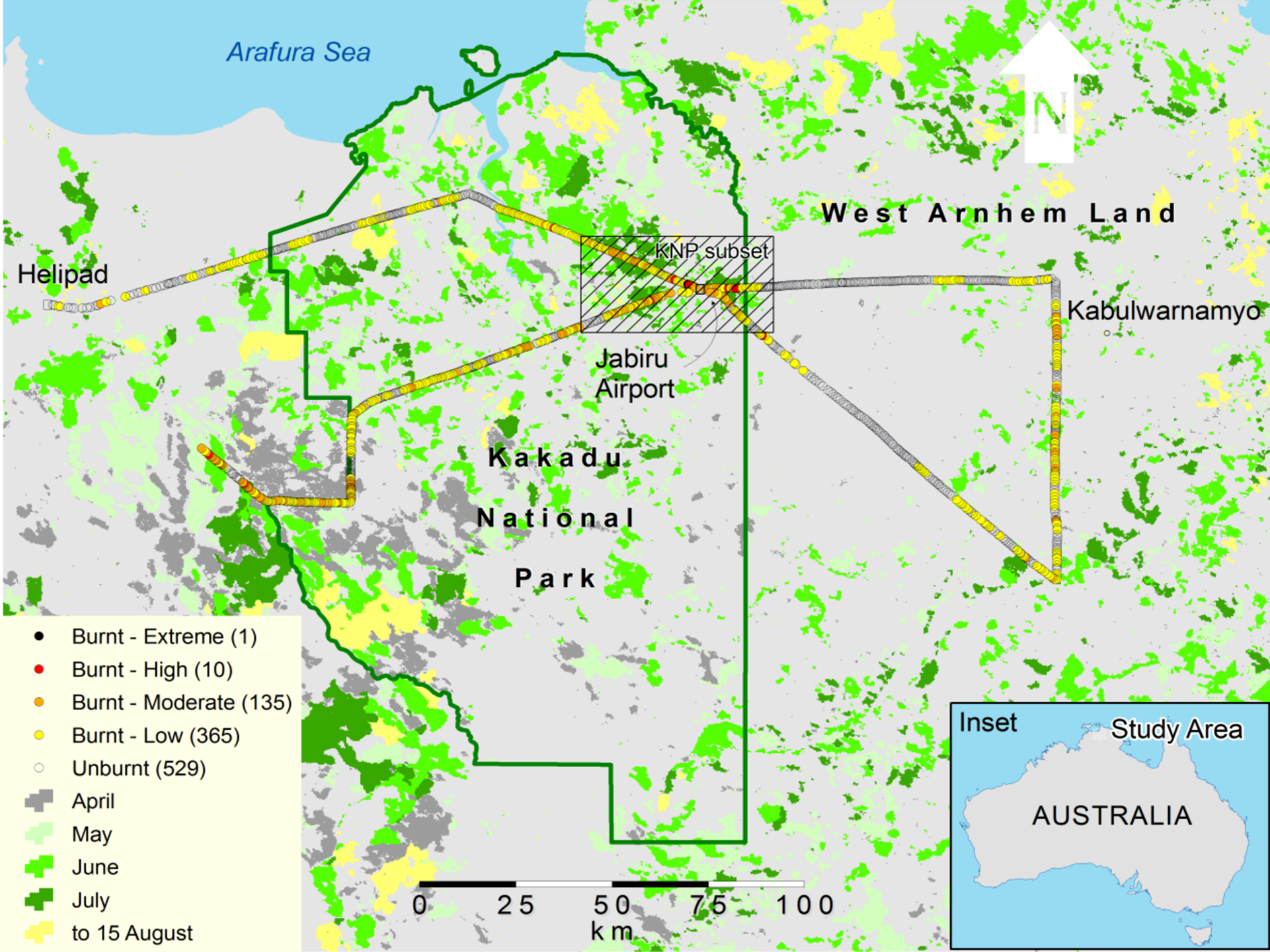


Analysis


Reflectance Variables
Ground Variables
Assessment of Distribution
Assess variables for non-linear relationships using scatterplots and for asymmetrical distributions of the variables with boxplots
Transformation
Select and apply transformation from histogram skewness and kurtosis
Correlation
Derive correlation matrix and assess for significant variables
Model Development
Develop candidate model set from *a priori* knowledge and results of correlation matrix
AICc
Calculate AICc, model weights and R^2
Regression
Generalised linear modelling of best model/s
Fire Severity Modelfor Remote Sensing
Fire Severity variables for Ground Sampling

Preliminary Results

DOES NOT indicate Fire Severity	**DOES indicate Fire severity**
The amount of Charred material (blackened)	The amount of Ashened material (whitened)
The amount of Green material (photosynthetic vegetation)	The amount of non-Green plant material (non-photosynthetic vegetation)

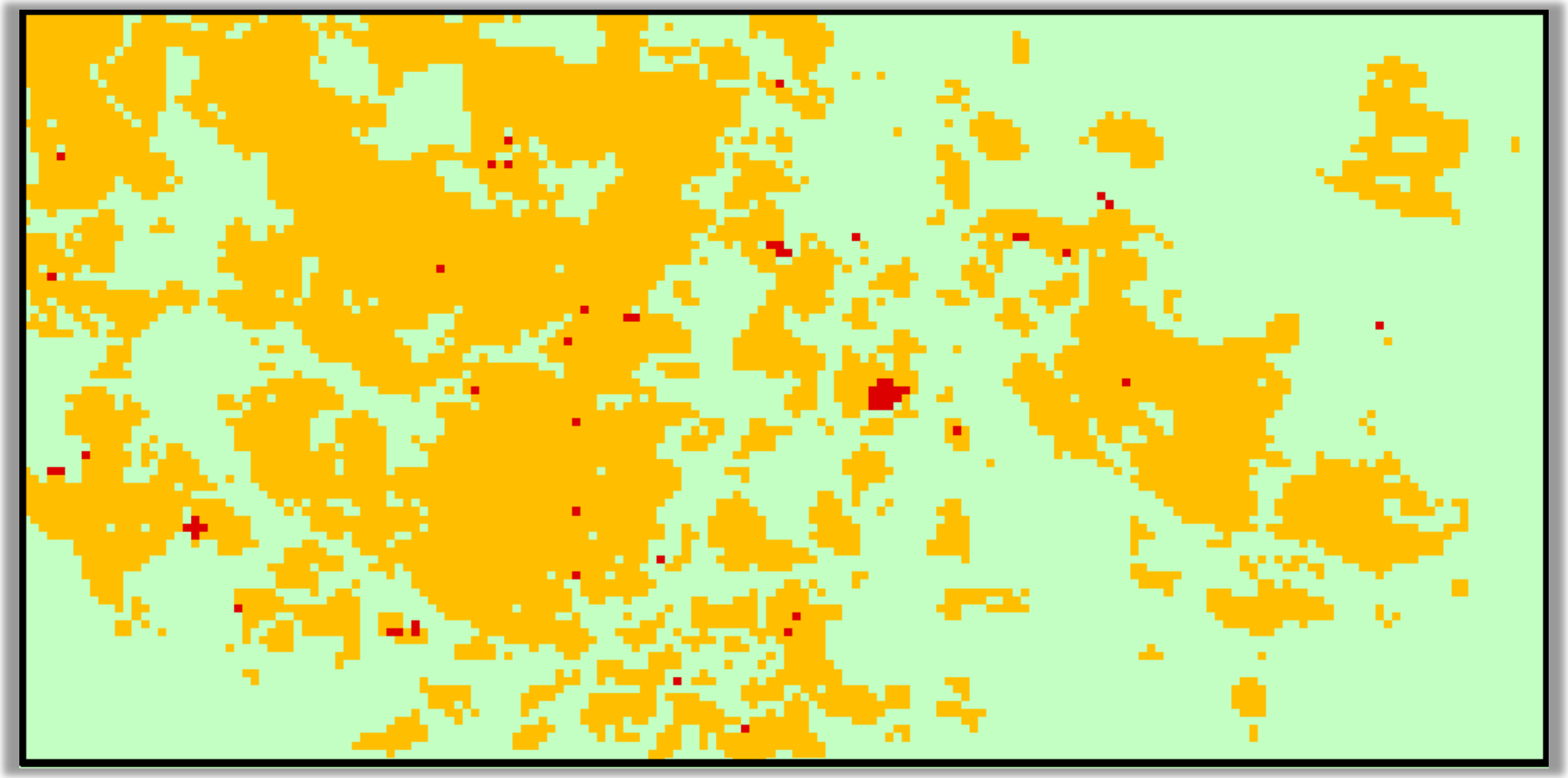

Arafura Sea
N
West Arnhem Land
KNP subset
Helipad
Kabulwarnamyo
Jabiru
Airport
Kakadu
National
Park
Burnt - Extreme (1)
Burnt - High (10)
Burnt - Moderate (135)
Burnt - Low (365)
Unburnt (529)
April
May
June
July
to 15 August
0
25
50
75
100
km
Inset
Study Area
AUSTRALIA

Results

INDEX	Fire Severity
Normalised Burn Ratio	Distinguishes well between Severe (Low & Moderate) and not-Severe (High & Extreme) fires
Short Wave Infra-Red (MODIS band 6)	Distinguishes between Low and Moderate Severity Fires, however the difference appears to vary through the fire season

Results

INDEX	Fire Severity
Normalised Burn Ratio	Severe v not-Severe Overall accuracy = 94% KHAT statistic = 0.63



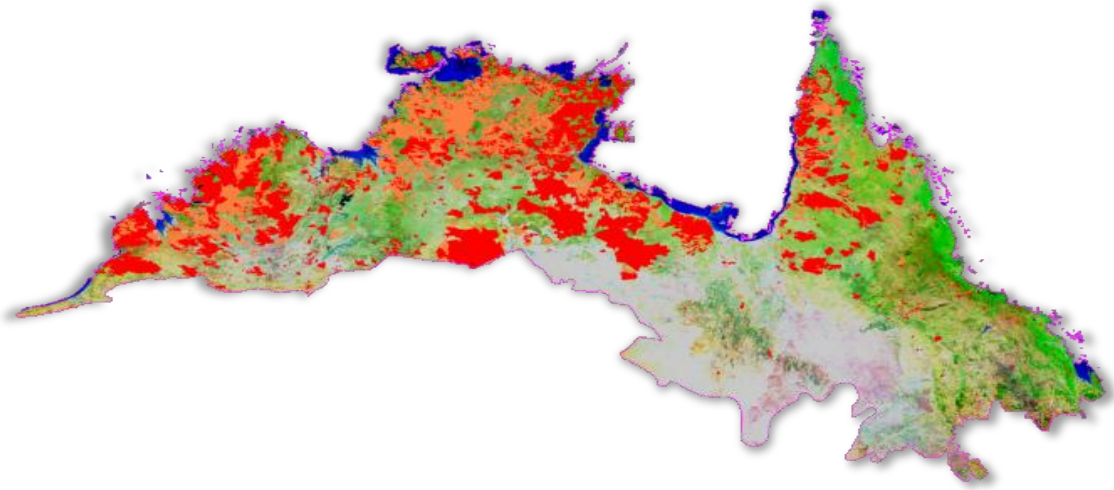
Results

INDEX	Fire Severity
Short Wave Infra-Red (MODIS band 6)	Low v Moderate Severity Overall accuracy = 48% KHAT statistic = 0.10
MODIS 2 * MODIS 5 * MODIS 7	Low v Moderate Severity Overall accuracy = 60% KHAT statistic = 0.19

Obviously, much work required to improve accuracy in these lower classes.

Improved ground data would also make a significant difference.

Discussion



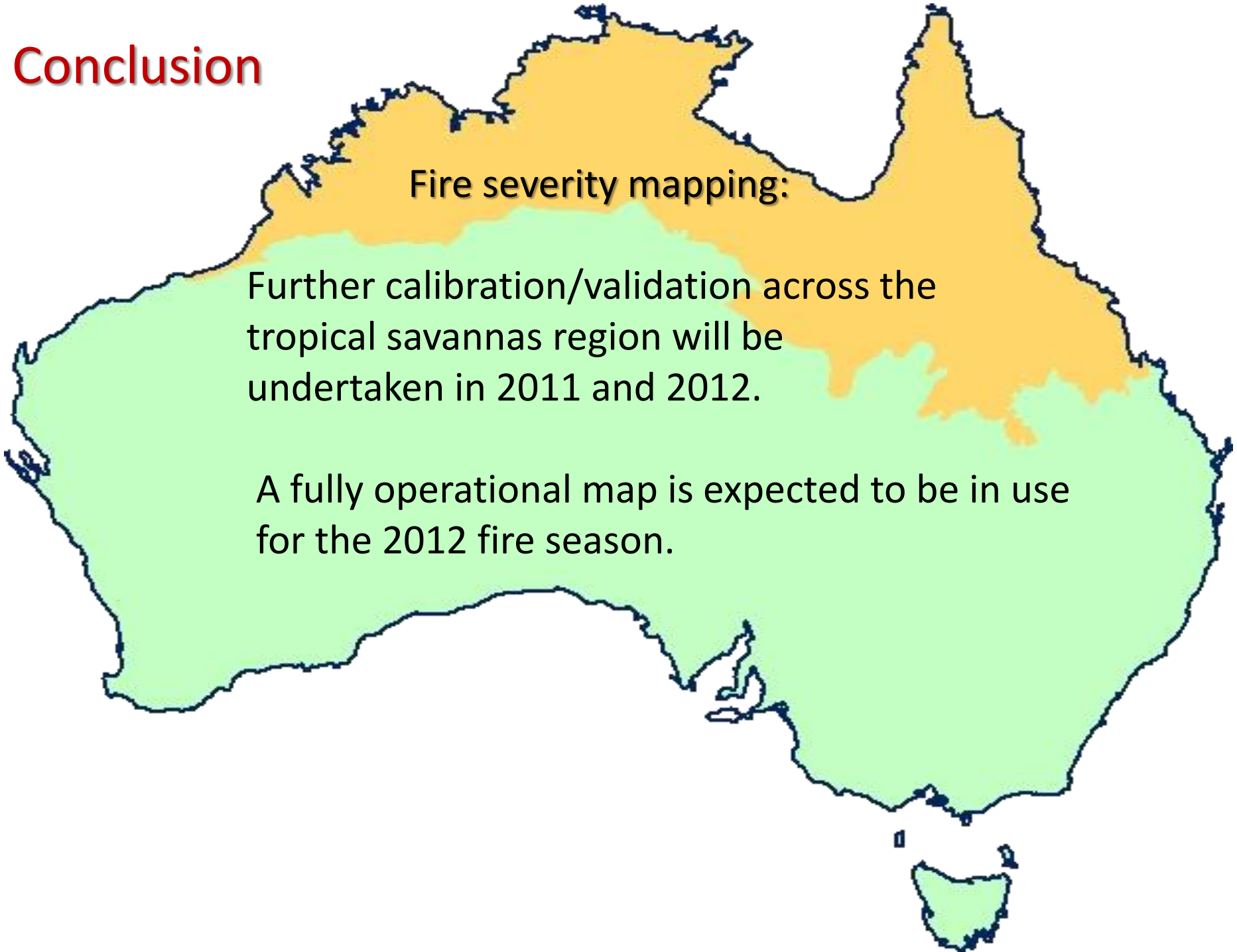
Fire severity mapping:

will improve the accuracy of our Greenhouse Gas emissions calculations,

will provide an iterative intra-seasonal spatial assessment of fire affects to direct fuel reduction/strategic burning activities,

will improve the description of fire mapping history of habitats for conservation management, monitoring and planning.

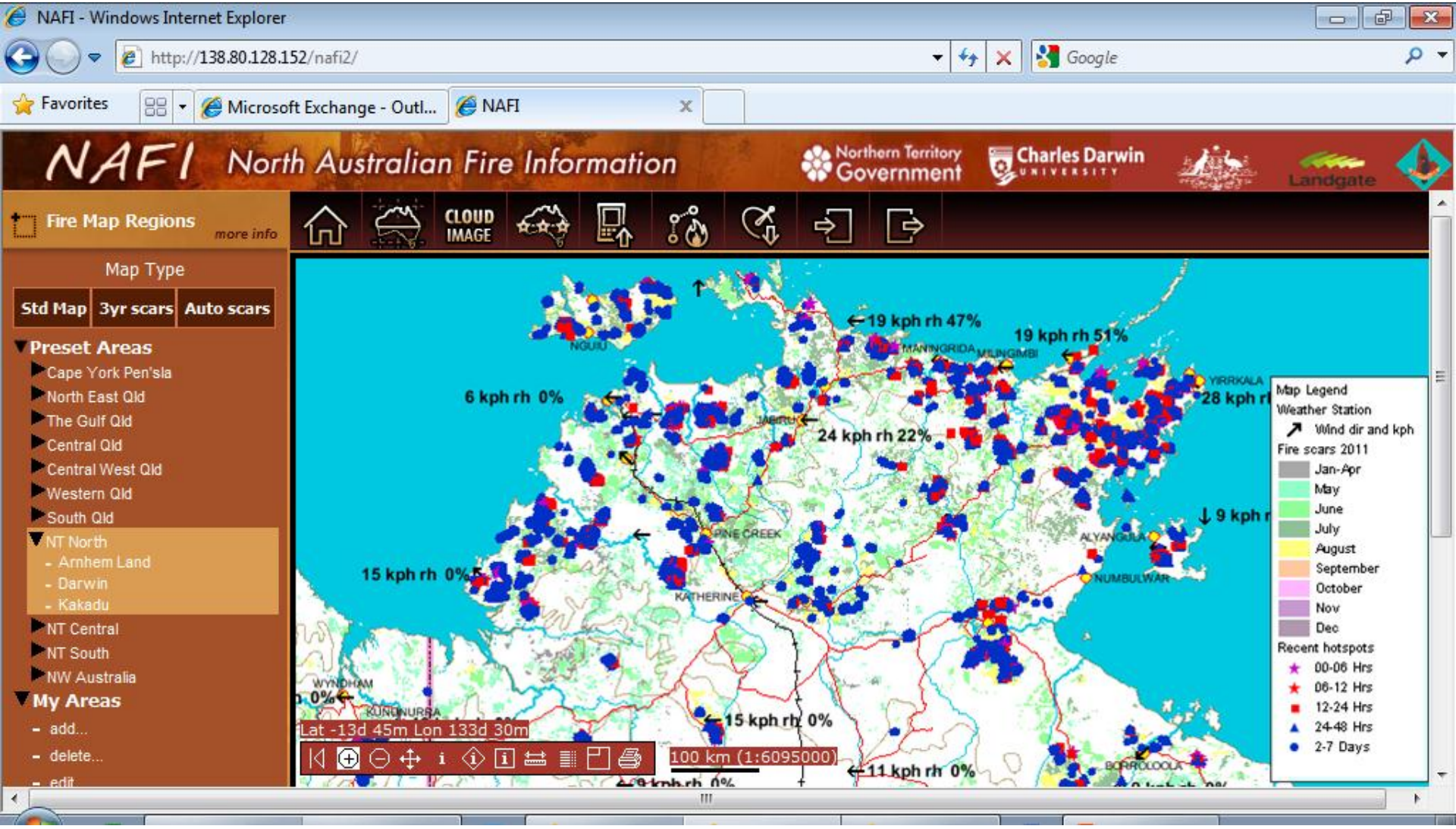
Conclusion



Fire severity mapping:

Further calibration/validation across the tropical savannas region will be undertaken in 2011 and 2012.

A fully operational map is expected to be in use for the 2012 fire season.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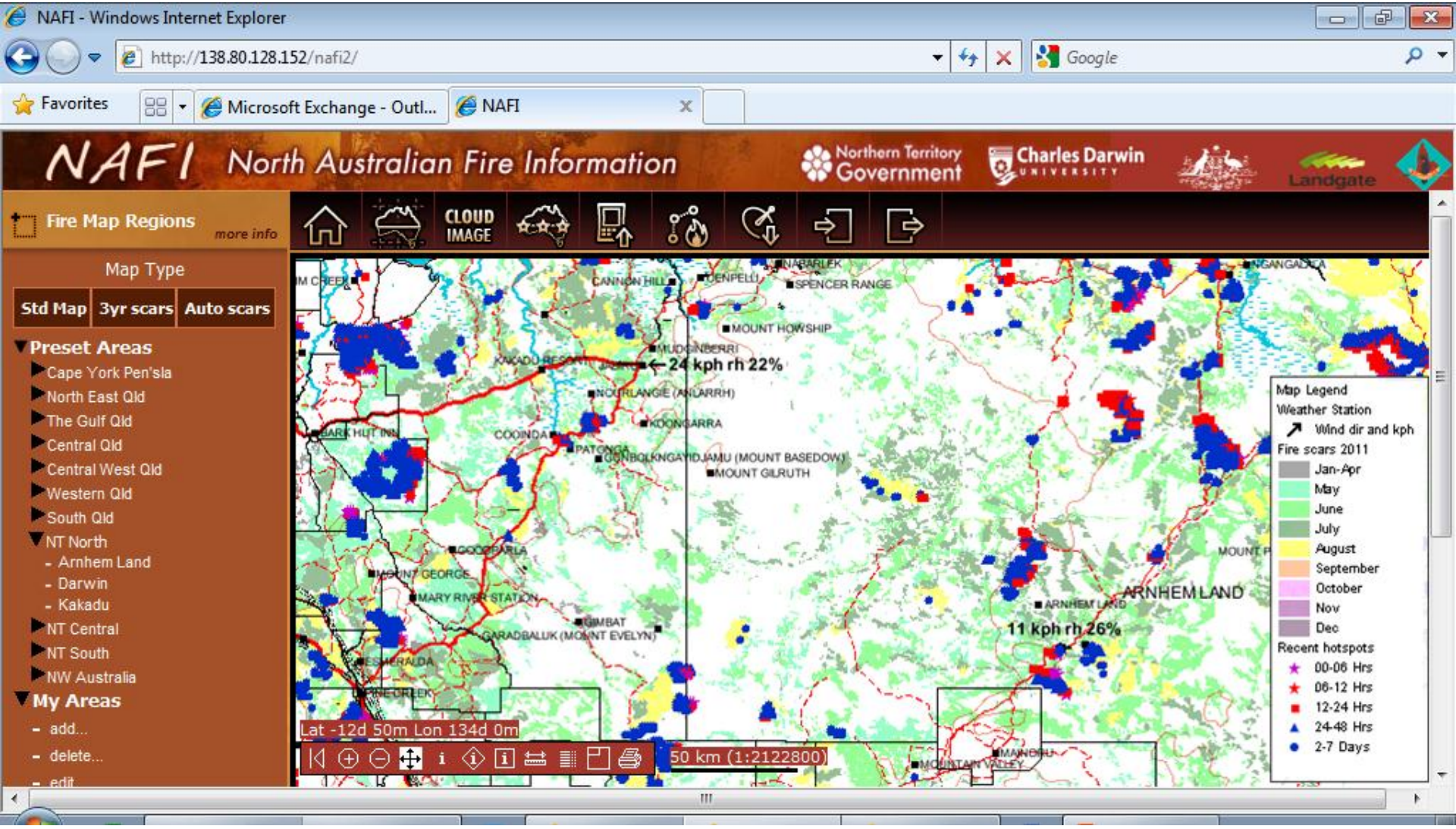
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SPENCER RANGE
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MUDGINBERRI
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KOONGARRA
COOINDA
PATONGA
GUNBOLKNGAYIDJAMU (MOUNT BASEDOW)
MOUNT GILRUTH
GOODPARLA
MOUNT GEORGE
MARY RIVER STATION
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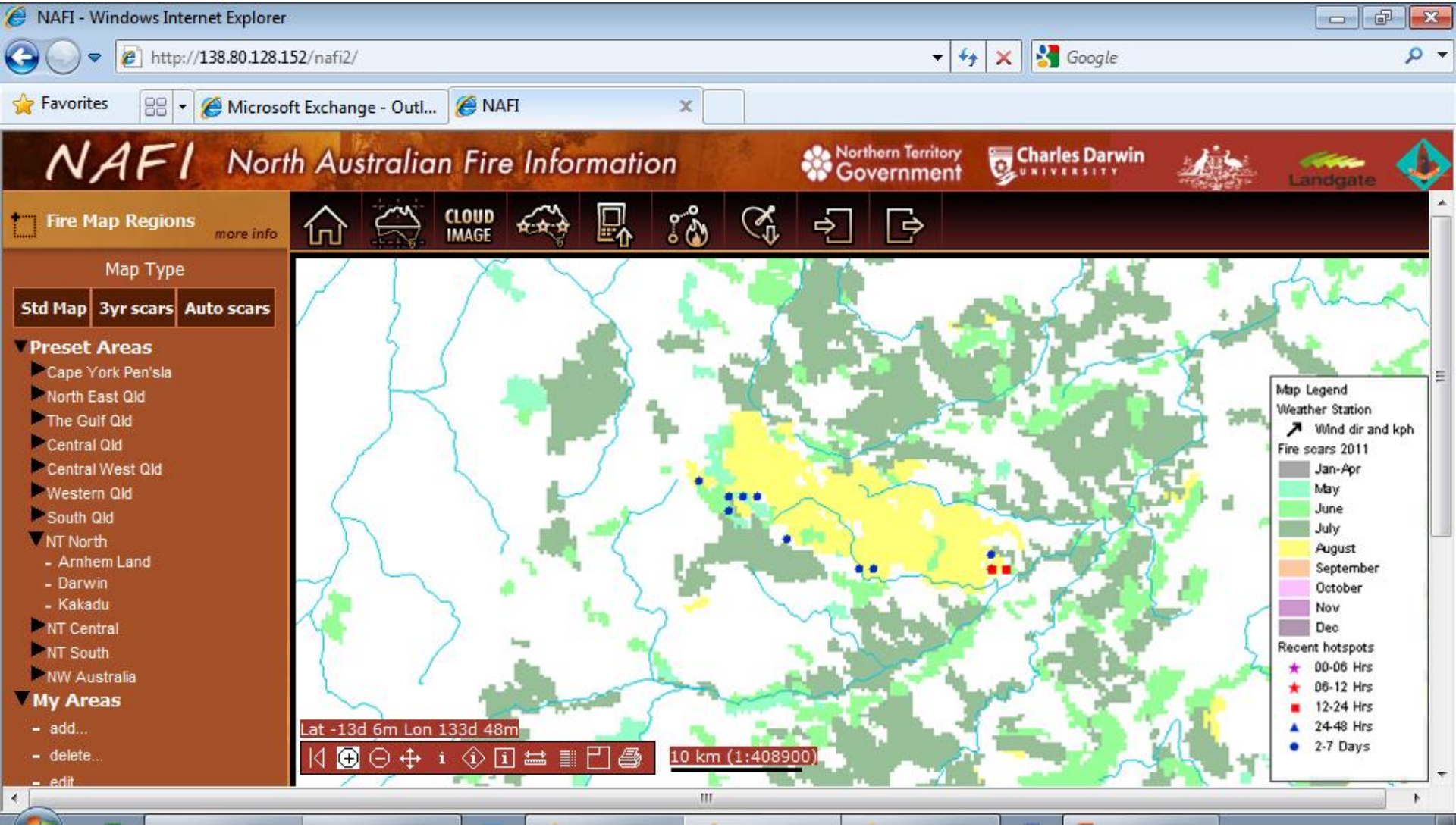
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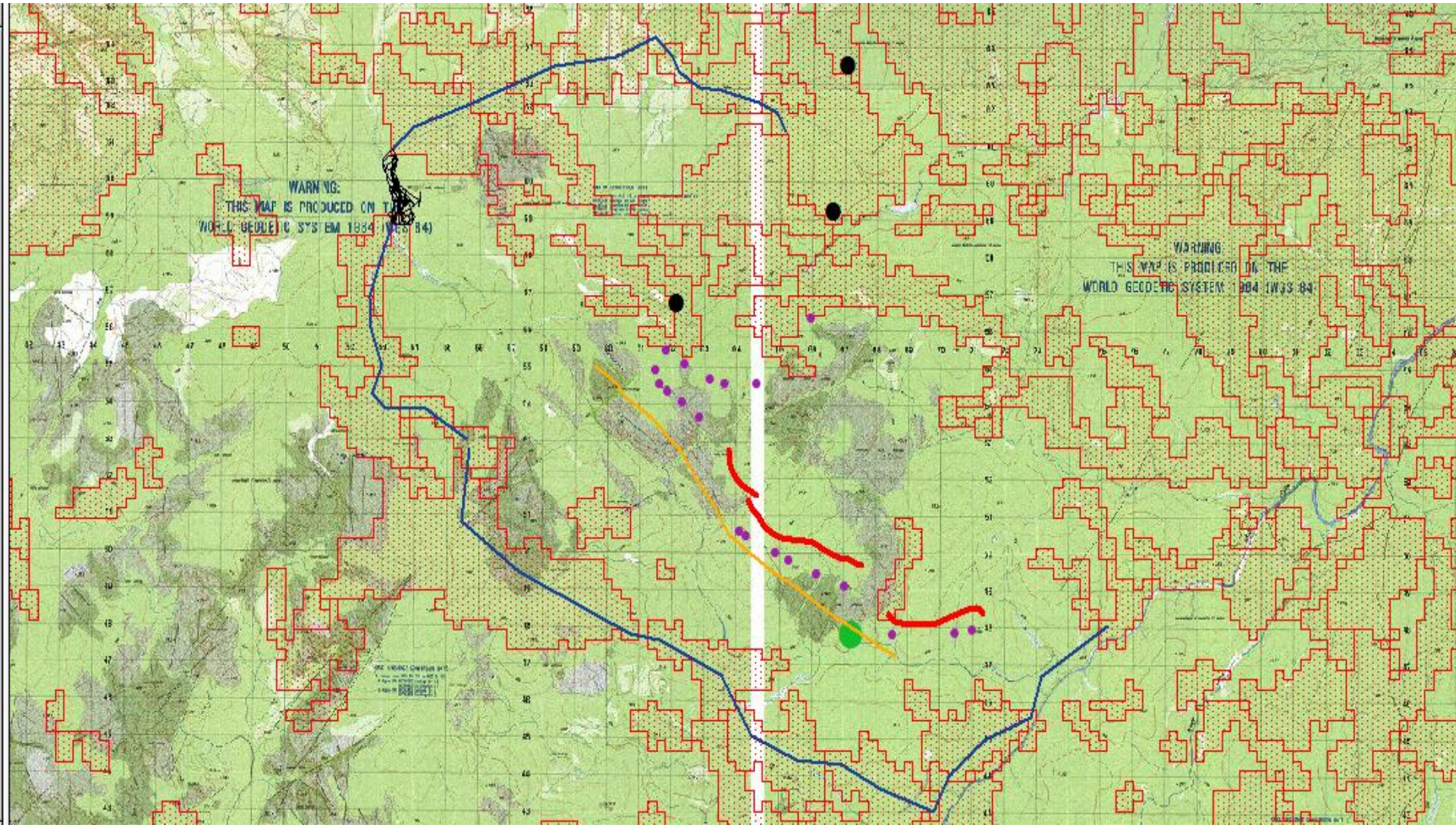
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Amaland