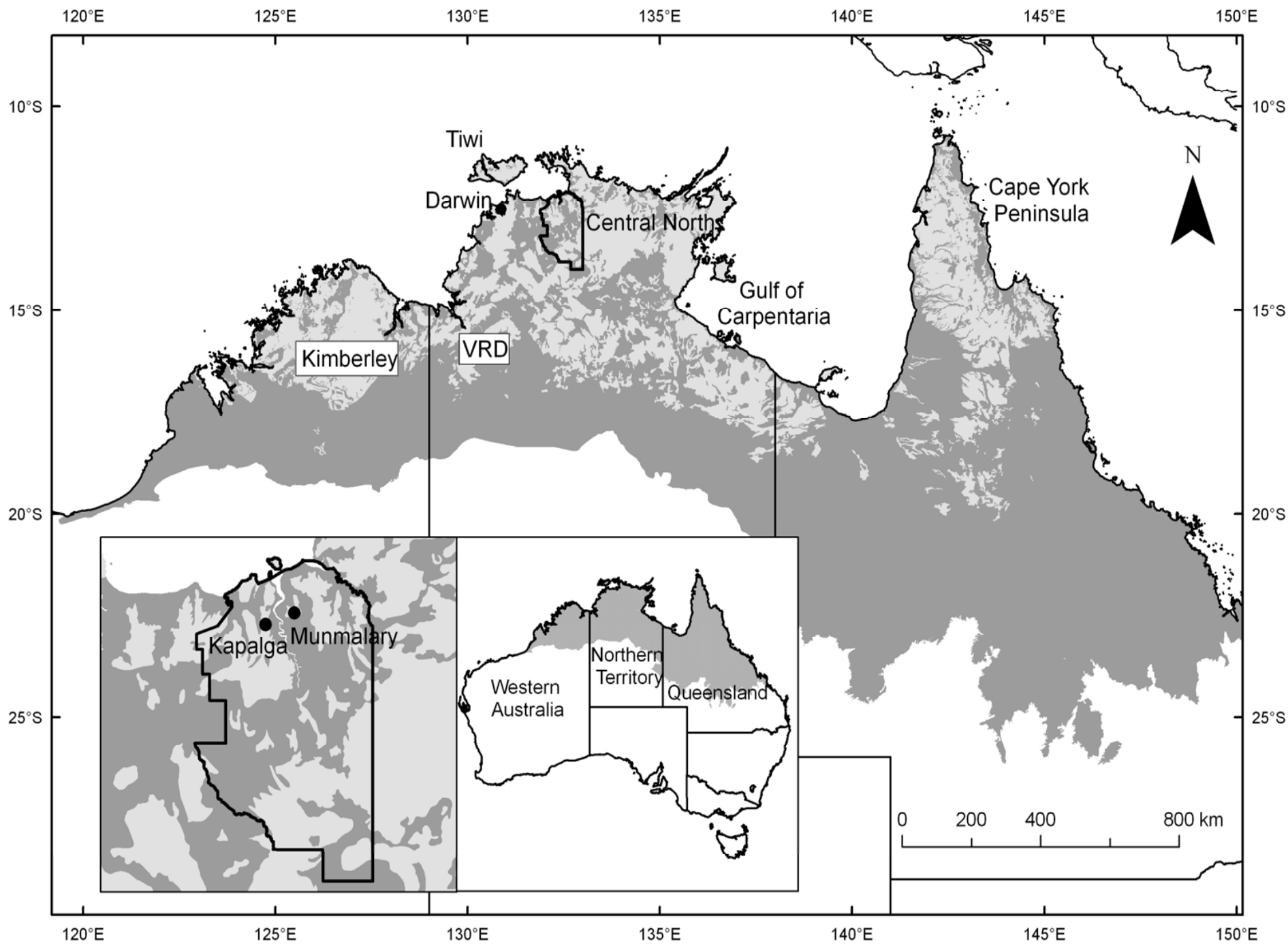


Savanna vegetation dynamics in tropical north Australia

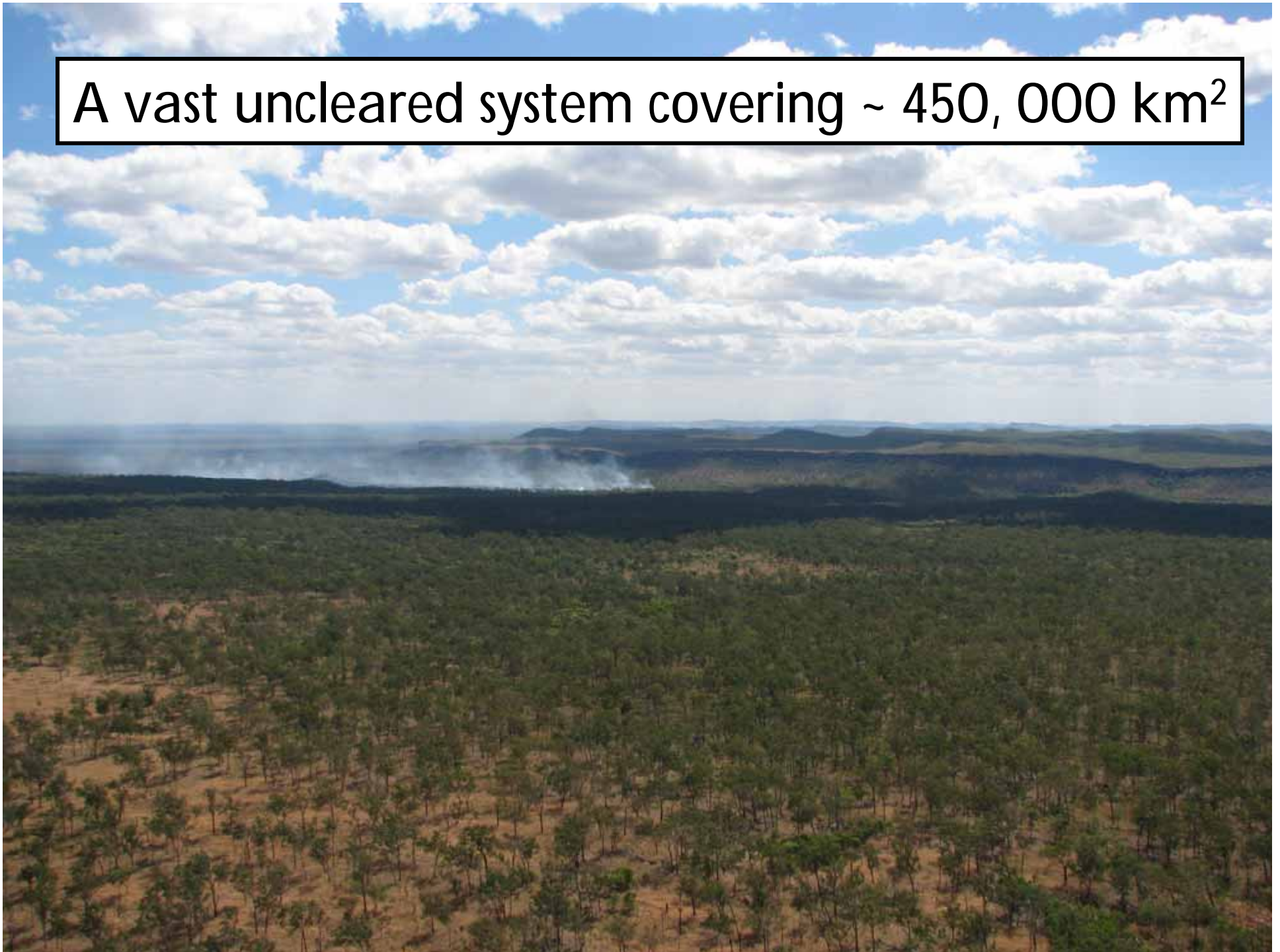


Lehmann, Prior, Williams and Bowman





A vast uncleared system covering ~ 450, 000 km²

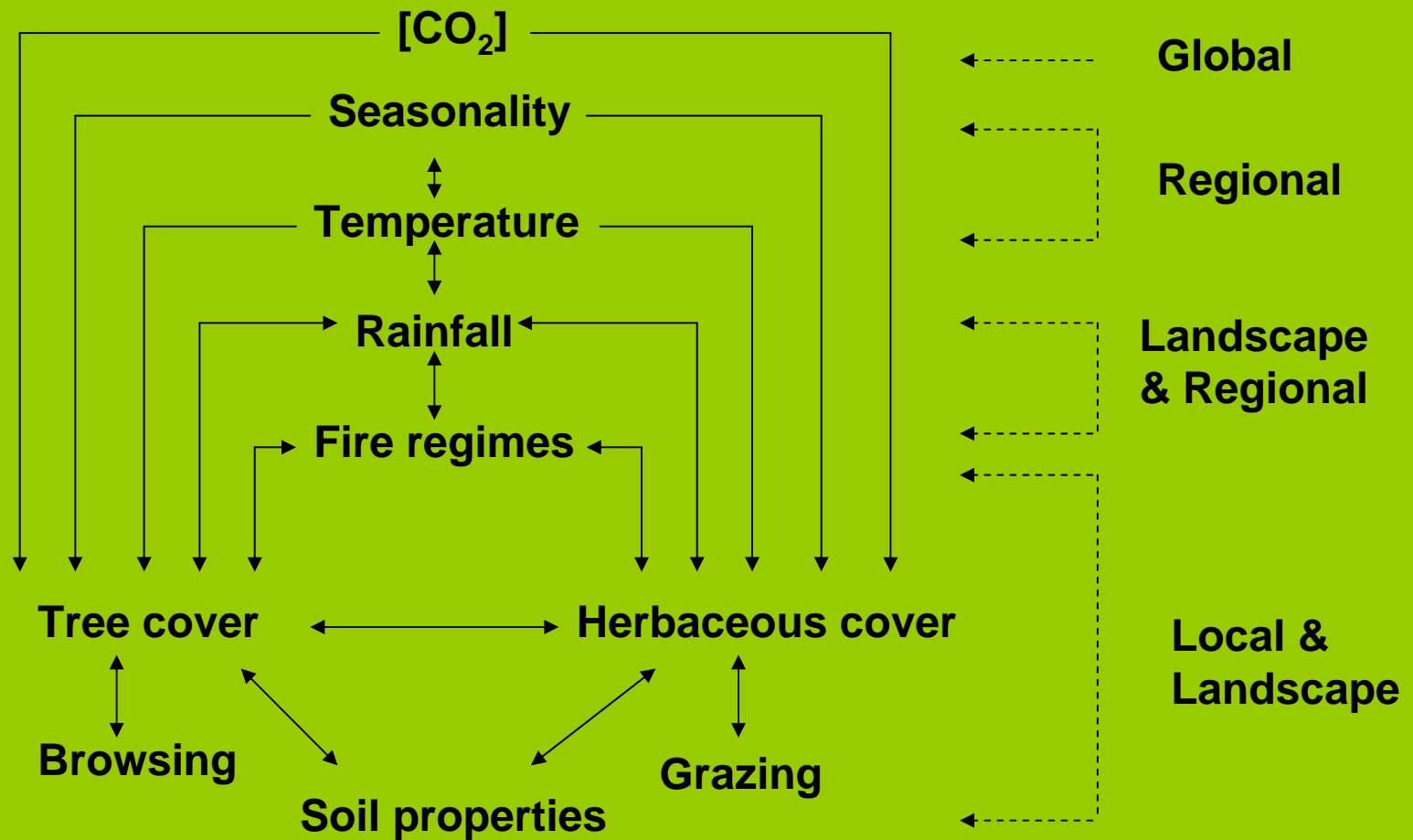




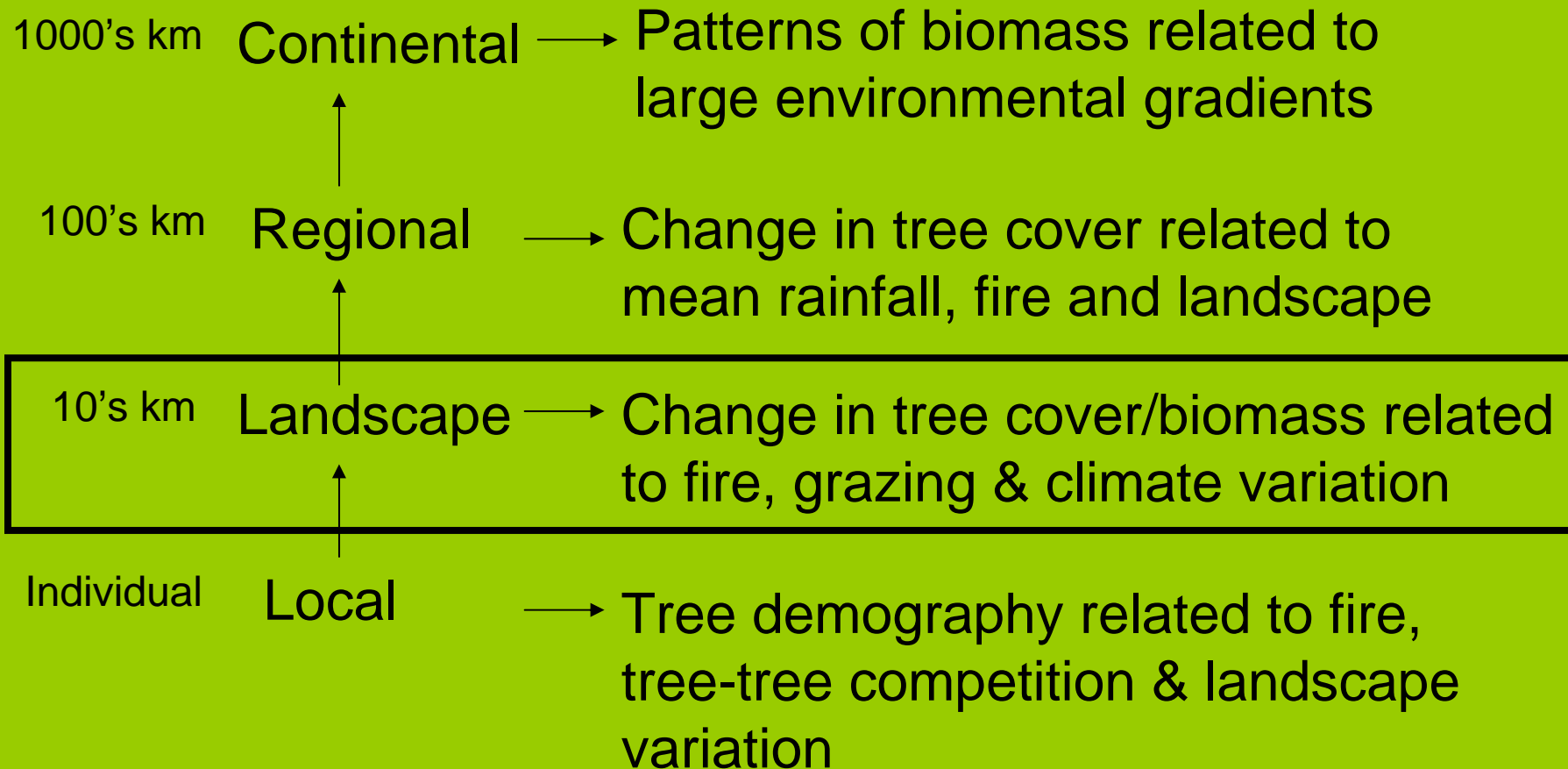
Eucalyptus tetradonta dominated savannas



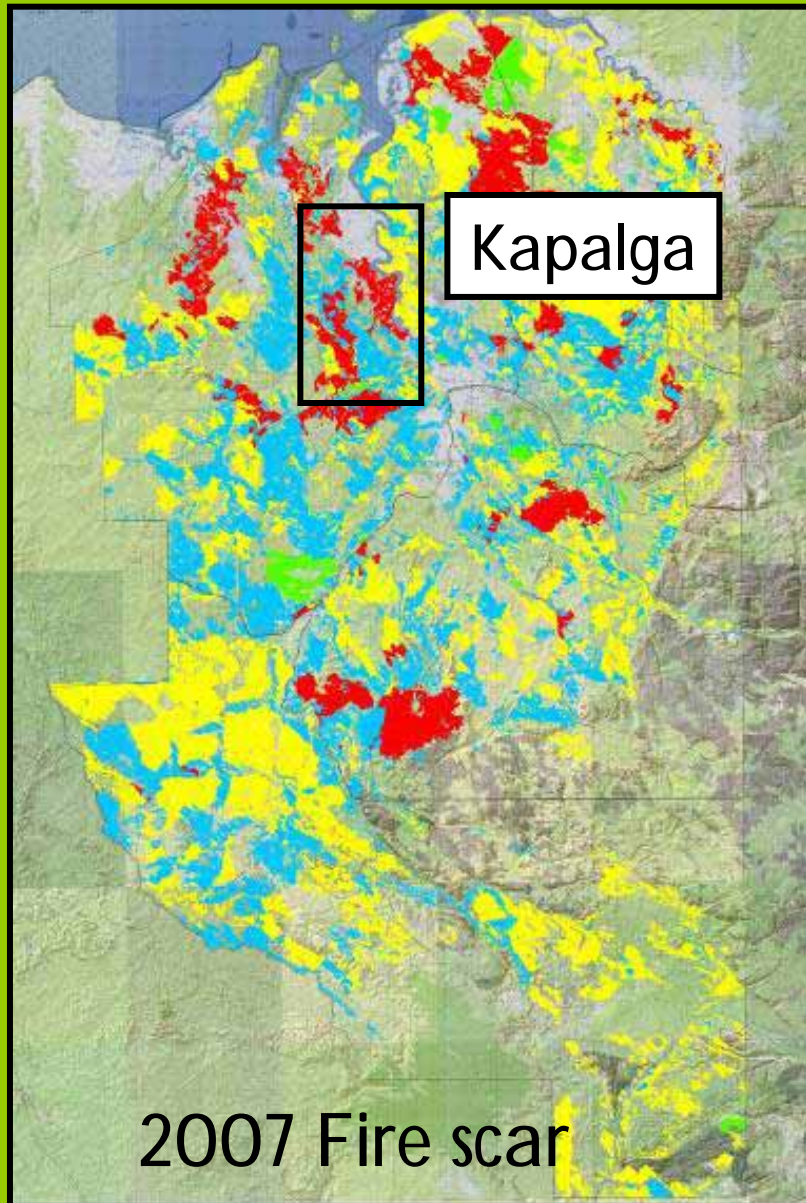
Multi-scale feedbacks in savannas



What drives spatio-temporal trends in biomass?



Fire is highly prevalent

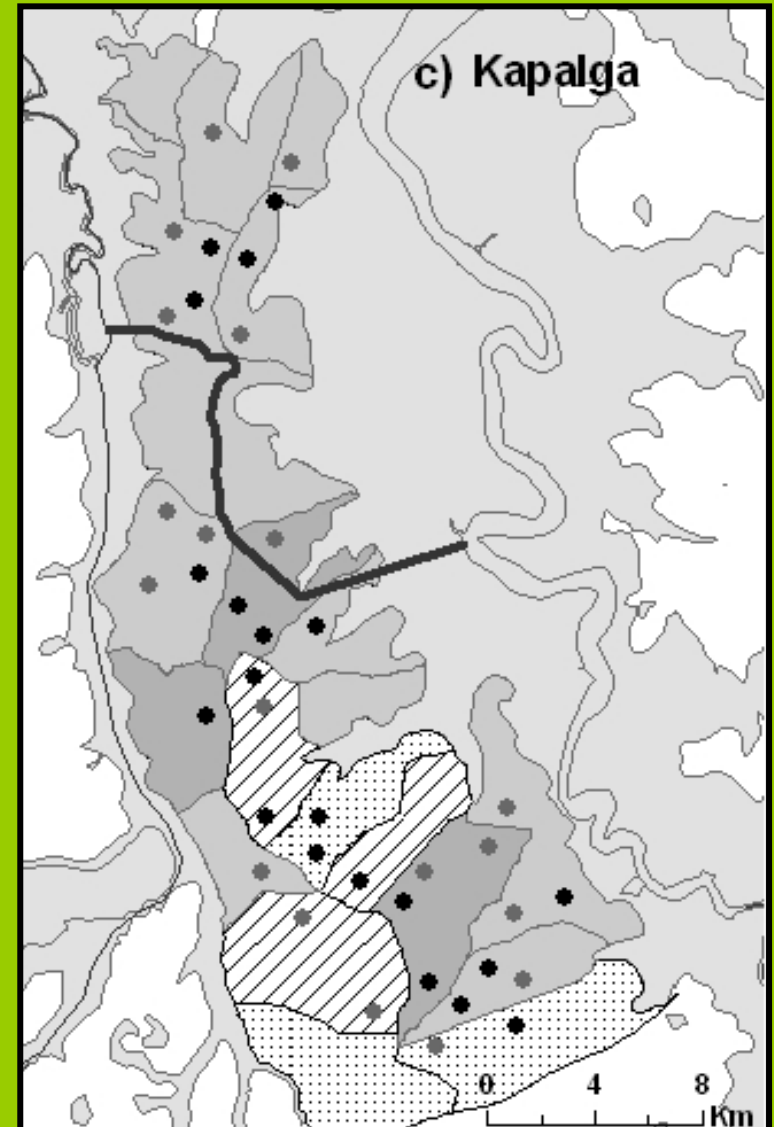


- Kakadu = 20, 000 km²
- 50% of Kakadu burns annually
- Fire in north Australia is strongly influenced by human intervention

Red = Late dry season

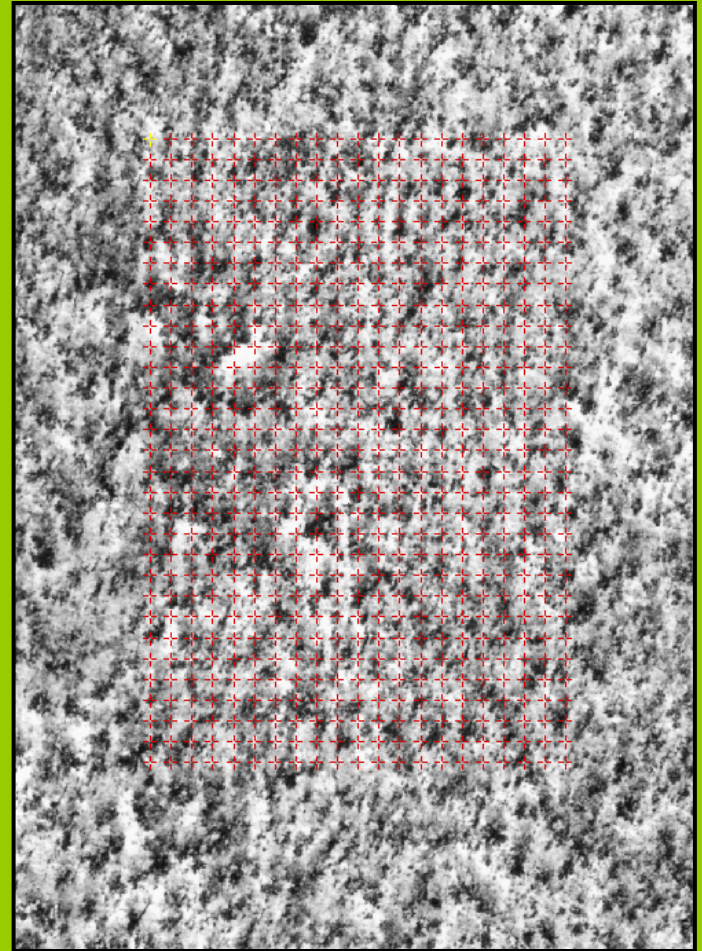
Kapalga: an experimental landscape

- Kapalga – landscape fire & grazing experiment covering 760 km² during the 80's + 90's
- Fire exclusion, early dry season, and late dry season treatments
- Buffalo presence/absence



Remote sensing of tree cover

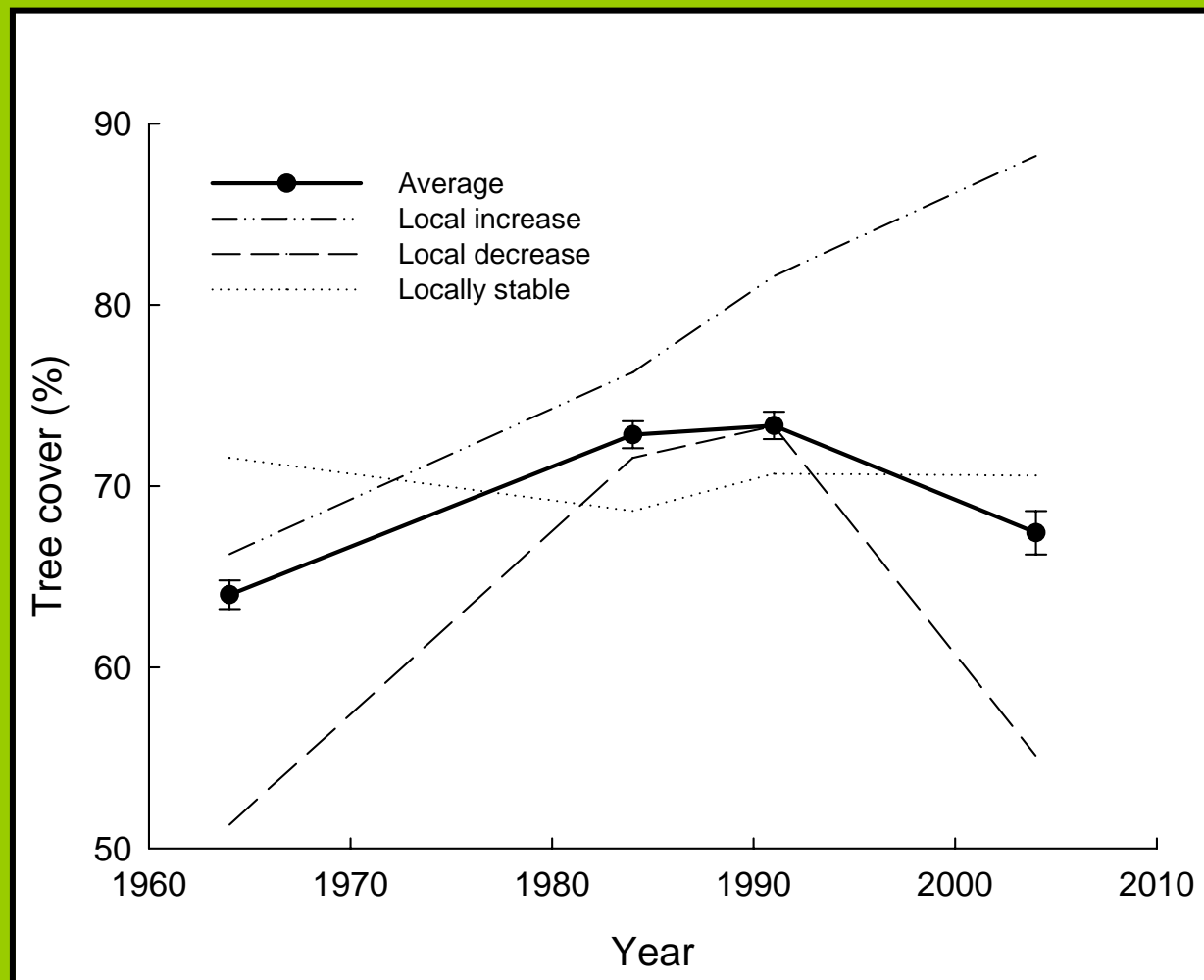
- Data on woody cover from stratified 40 sites using aerial photography over 40 years: 1964, 1984, 1991 & 2004
- Three time periods and 120 site-time period combinations



1964

Tree cover is variable

Tree cover varied between 5 – 30 % across sites and between three time periods across 760 km²



Relative role of fire vs grazing?



Time period	Avg. annual cover change	Avg. Early fire	Avg. Late fire	Buffalo	Rainfall
1964 - 1984	0.44%	0.17	0.07	present	1434
1984 - 1991	0.06%	0.25	0.10	present at 11 sites	1286
1991 - 2004	-0.47%	0.40	0.23	absent	1465

1. Grazing alters fire

- Buffalo presence explained 18% deviance in the data
- However, the model including buffalo had little support

Annual change in tree cover				
Model	ΔAIC_c	w_i	%DE	
EF + LF + IC + INT	0.00	0.442	45.20	
EF + LF + IC	1.22	0.196	42.38	
EF + LF + IC + B + INT	1.63	0.146	45.26	
INT	41.06	<0.001	23.50	
IC	45.87	<0.001	20.32	
B	50.02	<0.001	18.44	
LF	51.19	<0.001	17.21	
EF	70.65	<0.001	8.39	
<i>Null</i>	88.55	<0.001	n.a.	

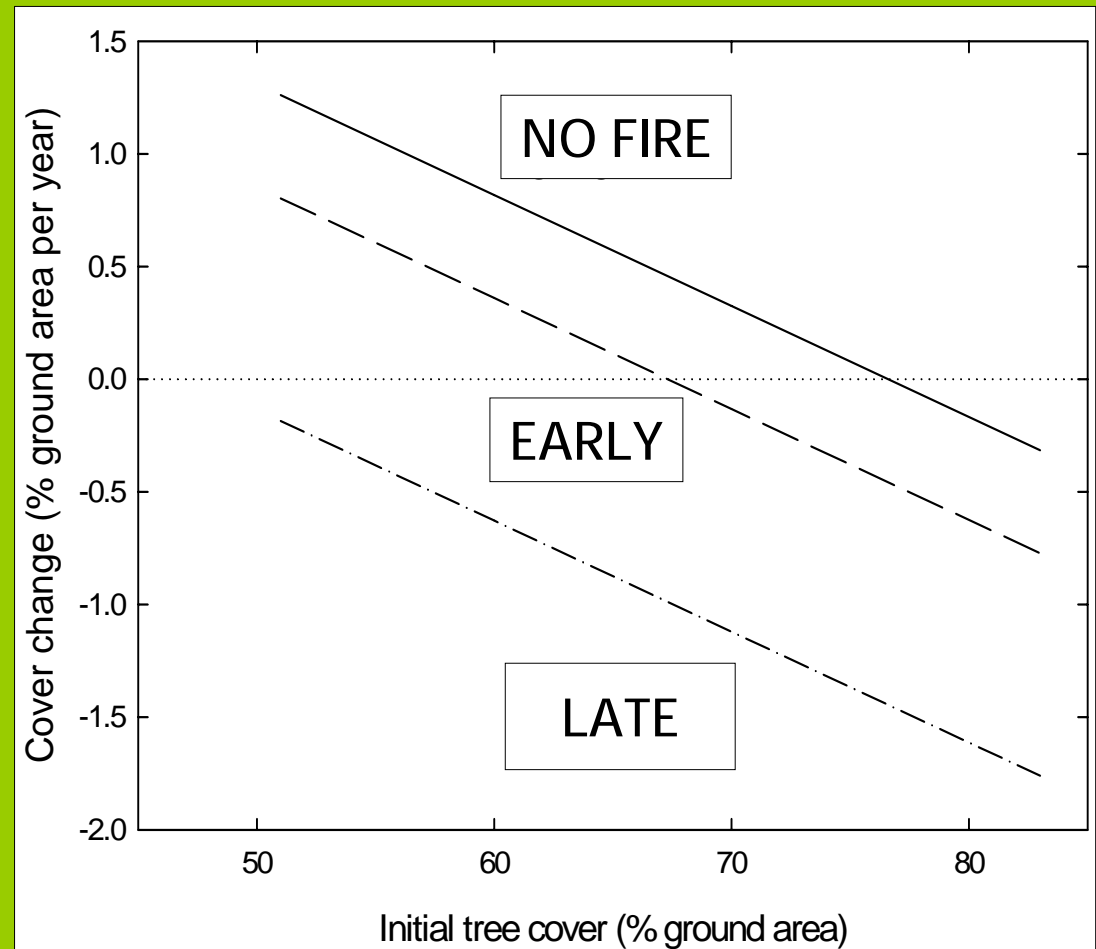
Buffalo presence &
fire appear
inter-related

EF = Early fire
LF = Late fire
IC = Initial cover
INT = Interval
B = Buffalo presence

2. Fire season & frequency

Modelled relationships between annual change in woody cover and initial cover

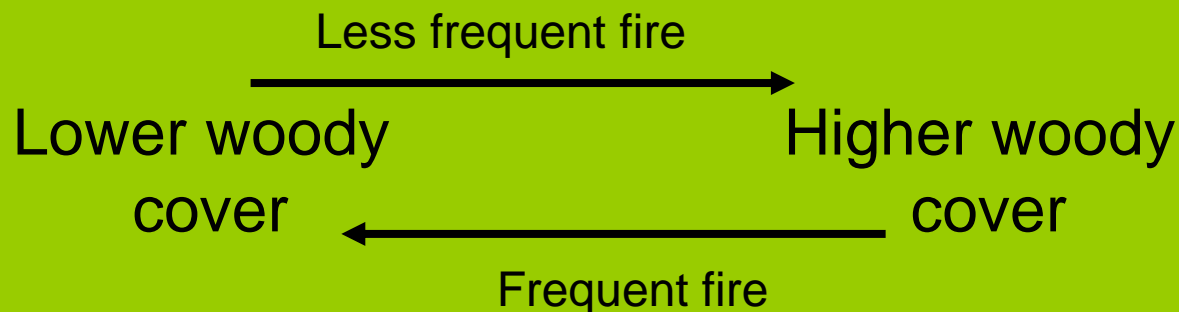
The effect of buffalo (+0.01) would be imperceptible at this scale



3. Historical contingencies of a site

- Strong relationship between initial cover & the trajectory of cover change (20% deviance)
- Areas of high woody cover are vulnerable to cover loss as they are near a maximum stocking rate

An inherently cyclical system responding to frequent landscape variation in disturbance?



4. Inter-annual variability

- Annual change in woody cover differed between intervals (23% deviance)
- Change in rainfall & management over 40 years
- Biologically sound mechanisms increased MAP negatively affect woody cover/tree growth
 - Increased grass production
 - Increased fire (because of increased grass production)
 - Reduced solar radiation
 - Transient water-logging of large trees

Validation against ground data

- Landscape data related well to ground data!
- Validate using tree basal area data from Williams *et al.* (2003)
- Time-series demographic data from Werner *et al.* (2005) and Prior *et al.* (2006) examining growth rates and recruitment validated results

Conclusions:

Spatio-temporal variation in woody cover

- Stochastic processes influence woody cover trajectories
- Absence of fire promotes increases in large tree cover
- Contrasting effects of grazing and fire
- A mosaic of “patches” responding to landscape variation in disturbance (& physical properties)

Thank you...

