Comparing ecology, fire, and human land use across

high-rainfall savannas in Africa and Australia

Sally Archibald

CSIR, Natural Resources and the Environment, University of the Witwatersrand

Maputo Miombo Meeting

July 2012

CSIR our future through science

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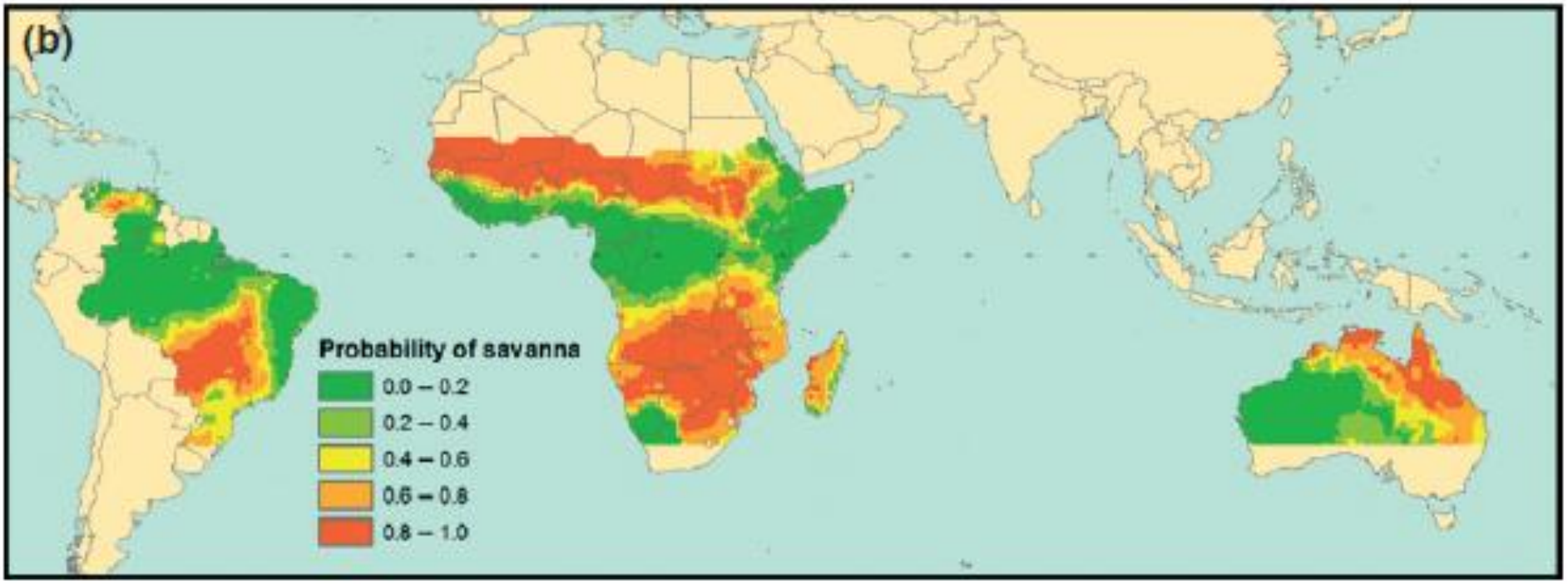
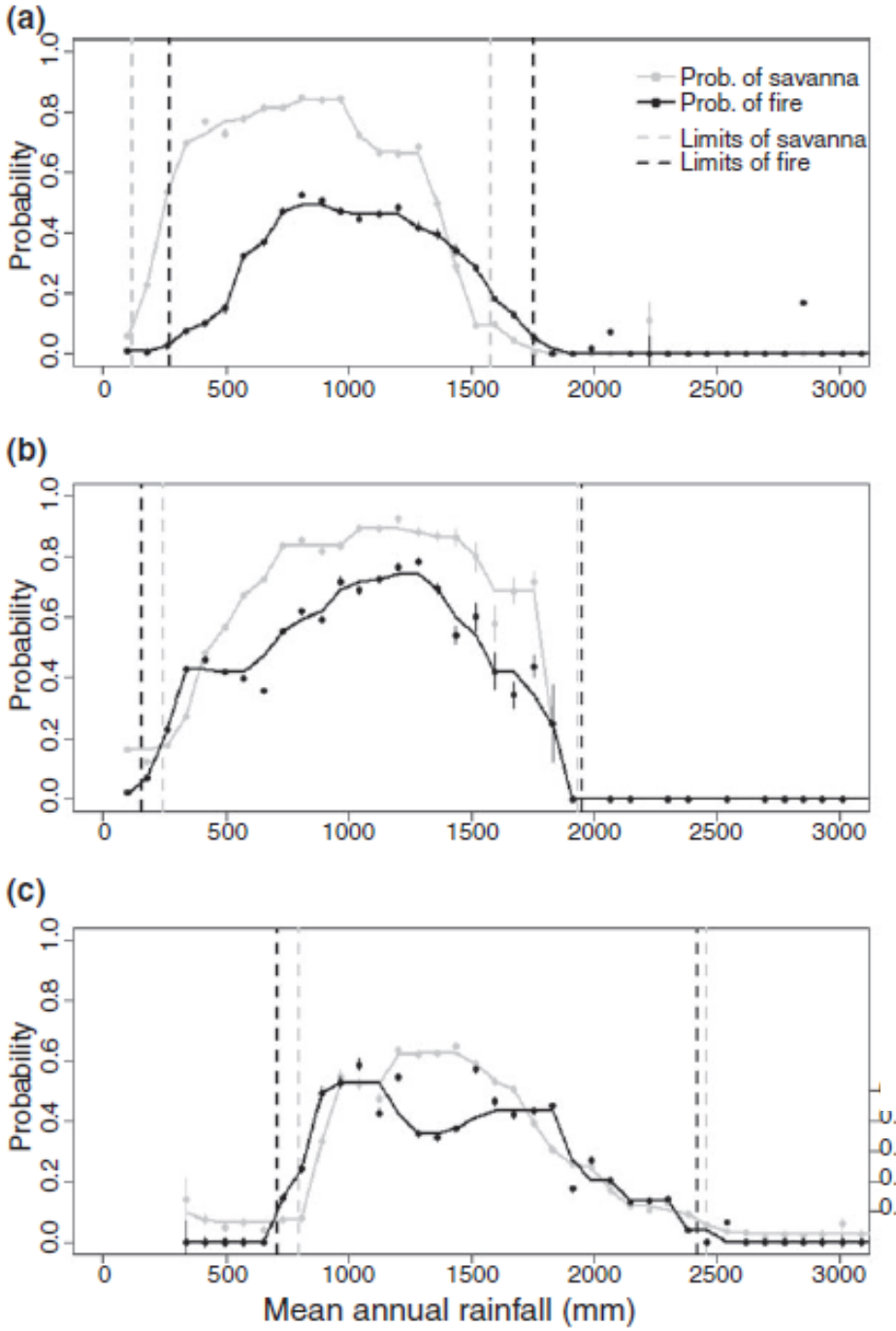
UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

Why compare different savannas?



These ecosystems evolved separately on the different continents
Are treated as one “land cover type” by global models – expected to change in similar ways in the future
Sense that carbon capture schemes are transferable between continents.



Africa

Australia

South America

Rainfall limits of savanna vegetation across three continents

Definitions are important

- Miombo “forests”
  - imply should be managed to maximise tree cover (maintain structure and function)
- Miombo “savannas”
  - imply should be managed to maintain a representative mixture of trees and grass (maintain structure and function)

Definitions are important

- Miombo “forests”
  - imply should be managed to maximise tree cover (maintain structure and function)
- Miombo “savannas”
  - imply should be managed to maintain a representative mixture of trees and grass (maintain structure and function).
  - i.e. expect a certain amount of variability in tree height/cover in space and time

Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2011)

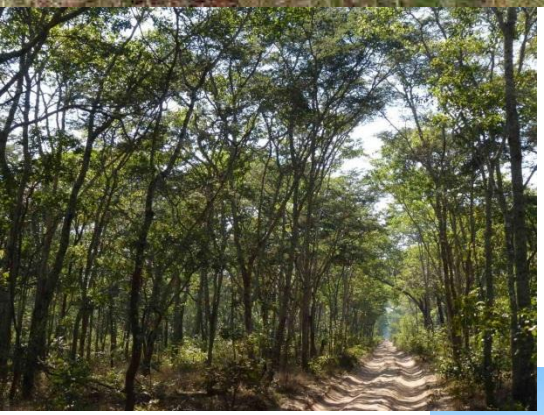
ECOLOGICAL SOUNDING

When is a 'forest' a savanna, and why does it matter?

Jayashree Ratnam[1,2*], William J. Bond[3], Rod J. Fensham[4,5], William A. Hoffmann[6], Sally Archibald[7], Caroline E. R. Lehmann[8], Michael T. Anderson[9], Steven I. Higgins[10] and Mahesh Sankaran[1,11]

A guide to distinguish between true forests, degraded forests and mesic savannas

1. Closed canopy (Forest)
1. Not closed canopy (2)
2. C_4 grass species absent (Not savanna)
2. C_4 species present (3)
3. Dominant tree species able to regenerate in closed canopy forest (Degraded forest)
3. Dominant tree species do not occur in forest (Savanna)
3. Tree habitat uncertain (refer to Table 1)




Tiaburina

Australian Government

Savanna Fire Management:
Mitigation and Sustainable Development Opportunities for Developing Countries

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Are these methodologies transferable?

- do we suffer from the same fire management problems?
- do the ecosystems respond in the same way to fire?
- are there the same human livelihood concerns?

- No reseeder species
- Perennial grass – different patterns of seasonal curing
- Very populated and utilised landscapes: 3 (Angola) to 75 (Malawi) people/km^2

- Fire-sensitive species (*Calytris*): need infrequent/less intense conditions to recruit
- Annual grass – gets flammable very quickly at the end of the dry season
- Depopulated landscapes: less than 0.2 people/km^2

- Aboriginal communities do not graze/cultivate their land
- Do make use of the savannas for hunting, fuel wood, and many other resources

Mean Area Burned: Depends on people:
30-34% protected areas
12-20% inhabited land

Mean Fire Return Interval
2- 3 years

Fire Seasonality:
More evenly spread ~20% of area in each month during the dry season (driest 2 months account for ~40%)

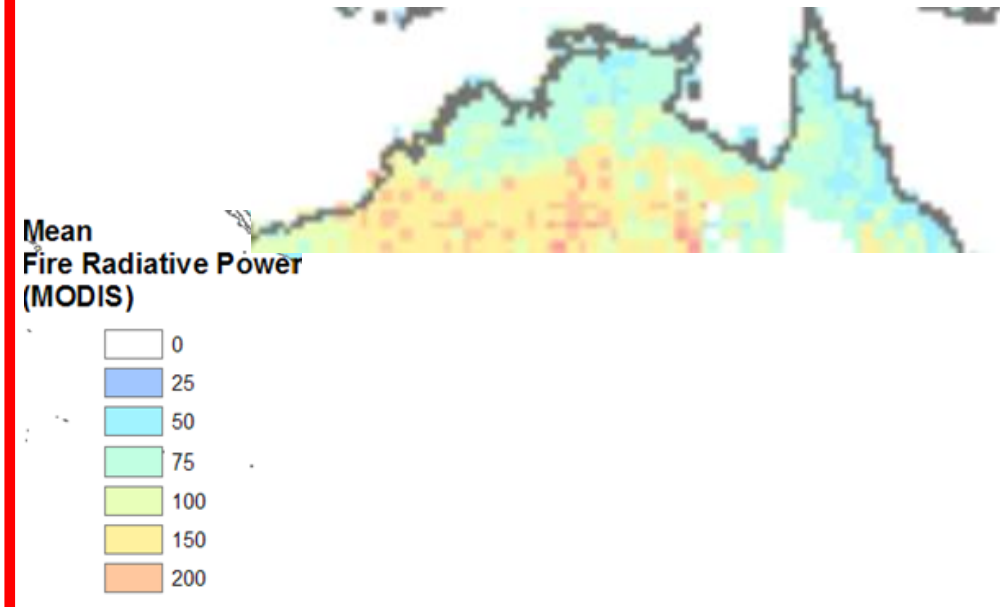
Mean Area Burned:
35% (8-80%)

Mean Fire Return Interval
2-3 years

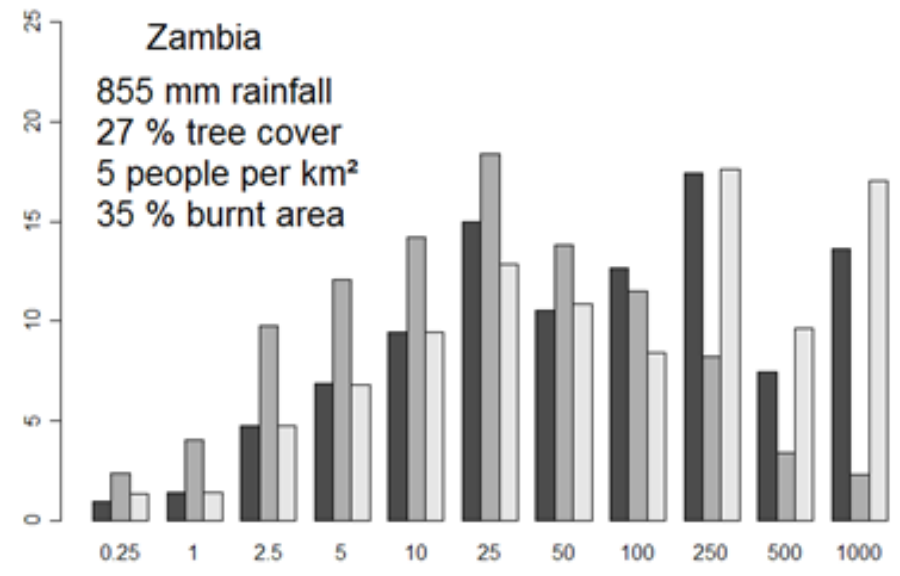
Fire Seasonality:
60% of the fires and 71% of the area burns in late dry season (driest 2 months of the year)

Fire Intensity: 25-50 MW/pixel on average

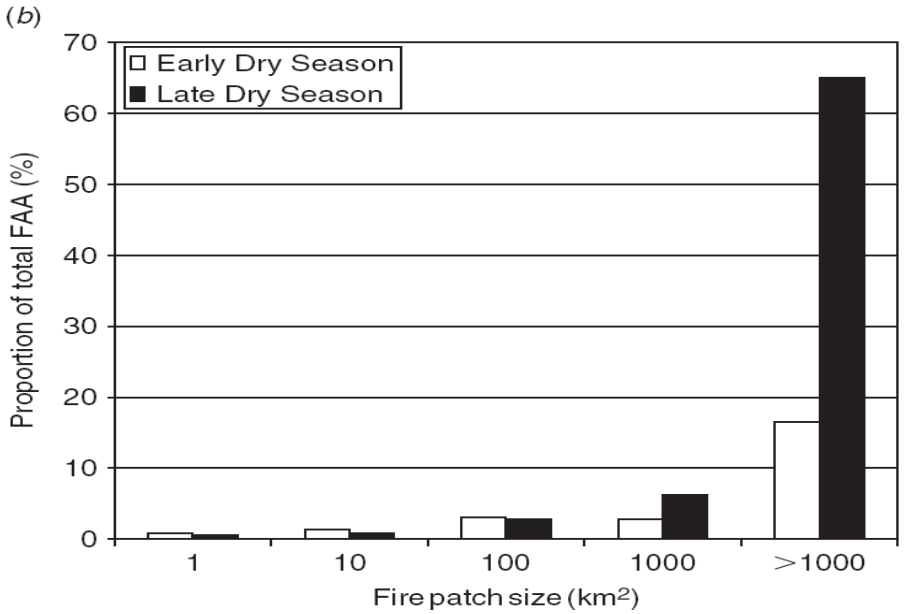
Fire Intensity: 75-100MW/pixel on average

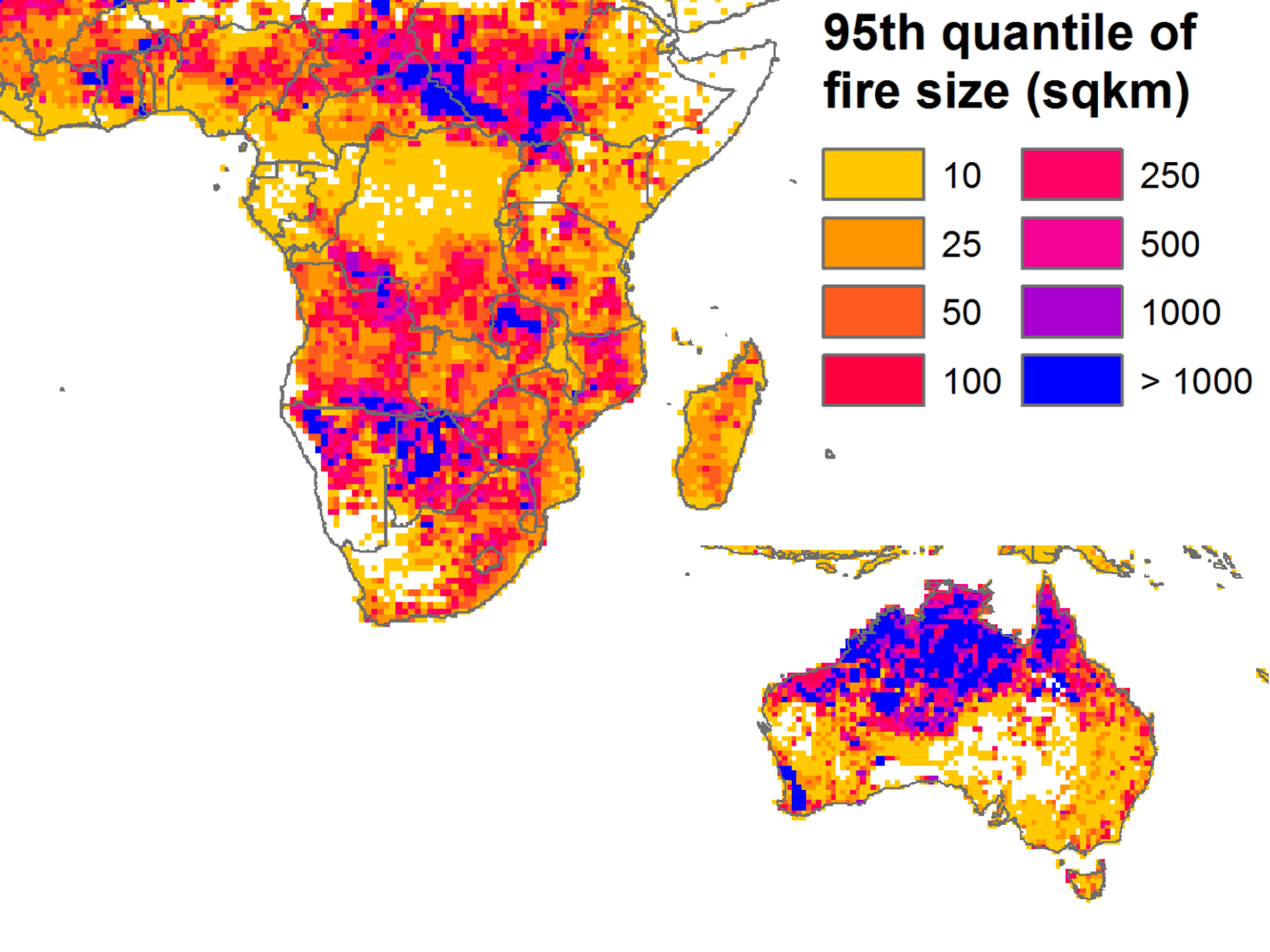


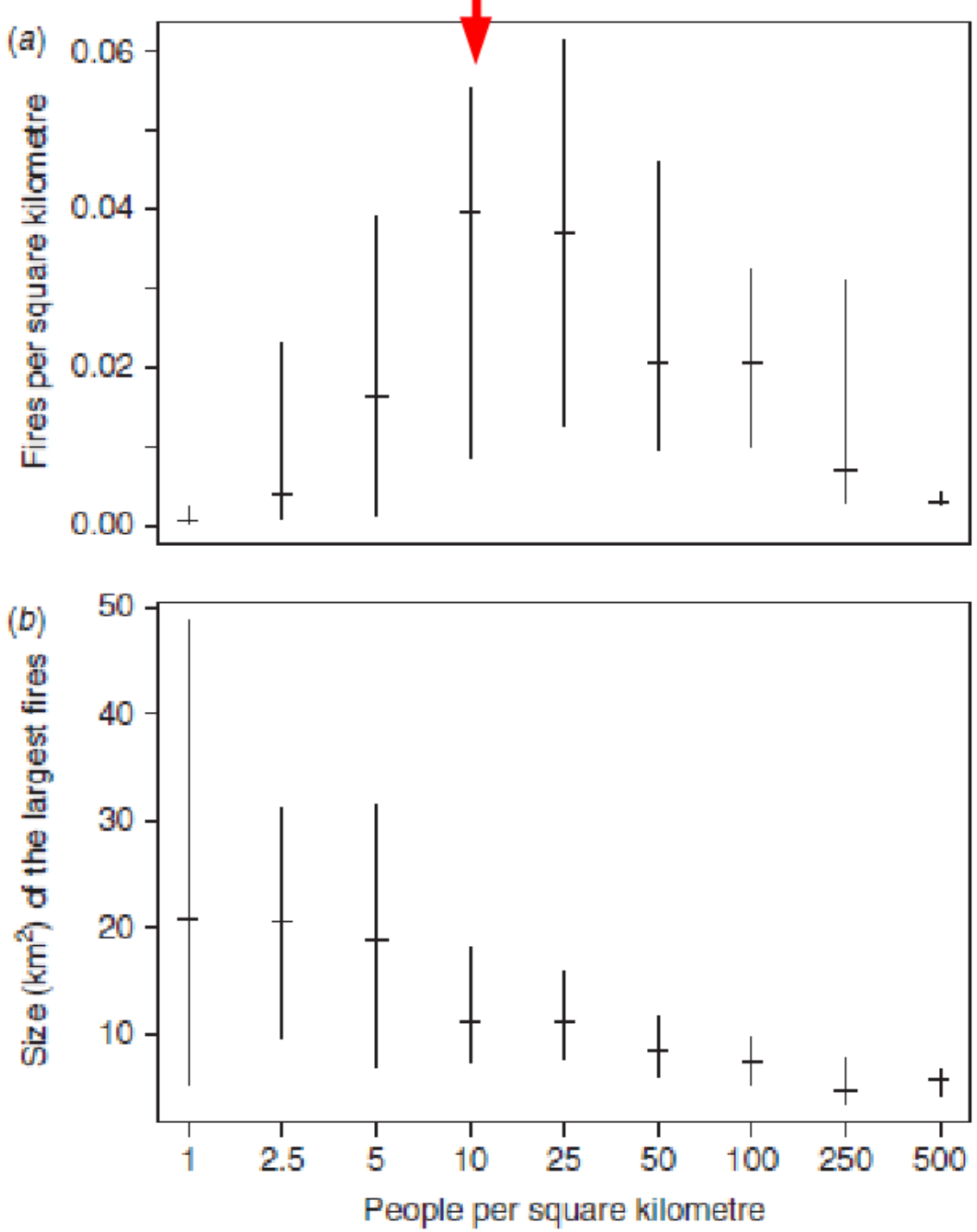
Fire Size



Fire Size:




95th quantile of fire size (sqkm)
10
25
50
100
250
500
1000
> 1000



Impact of people on fire NUMBER and fire SIZE

NUMBER OF FIRES

SIZE OF FIRES

Similarities in terms of ecology and fire patterns

Differences related to human USE of the landscape,
and the extent to which fire is currently MANIPULATED by people

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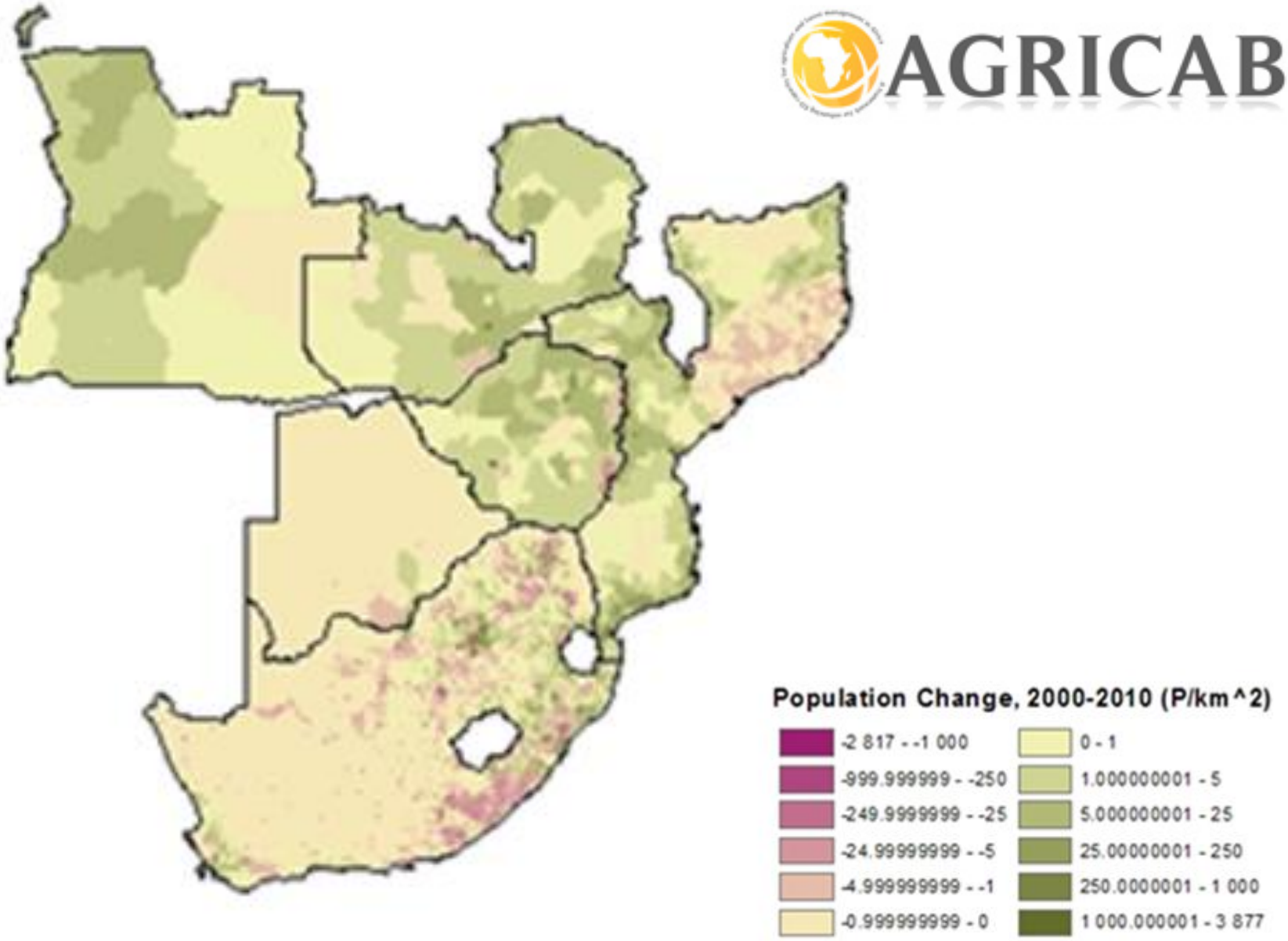
Population Change, 2000-2010 (P/km^2)
-2 817 - -1 000
-999.999999 - -250
-249.9999999 - -25
-24.99999999 - -5
-4.999999999 - -1
-0.999999999 - 0
0 - 1
1.000000001 - 5
5.000000001 - 25
25.00000001 - 250
250.0000001 - 1 000
1 000.000001 - 3 877

sarchibald@csir.co.za

Australian Government

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Mitigation and Sustainable Development Opportunities for Developing Countries

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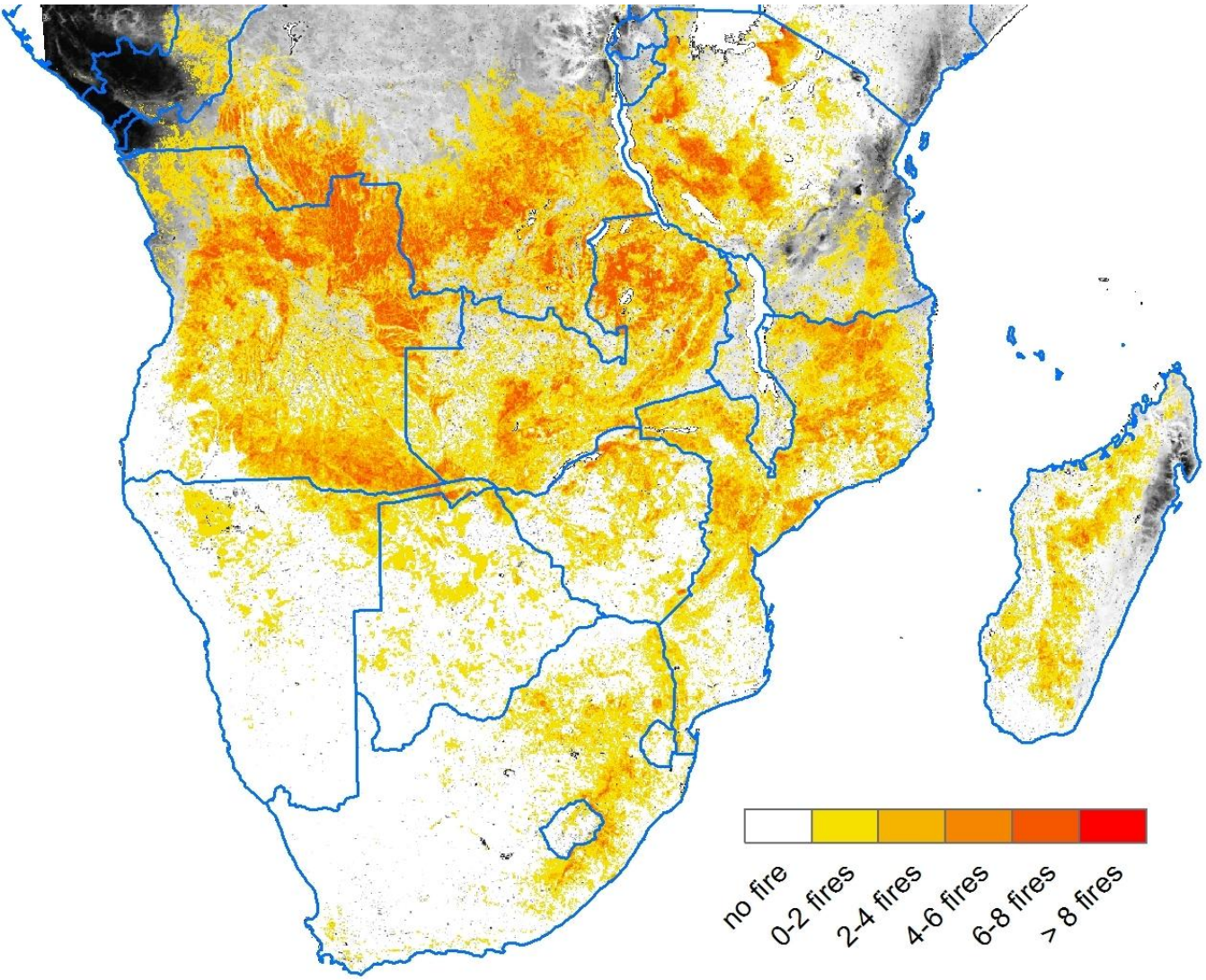
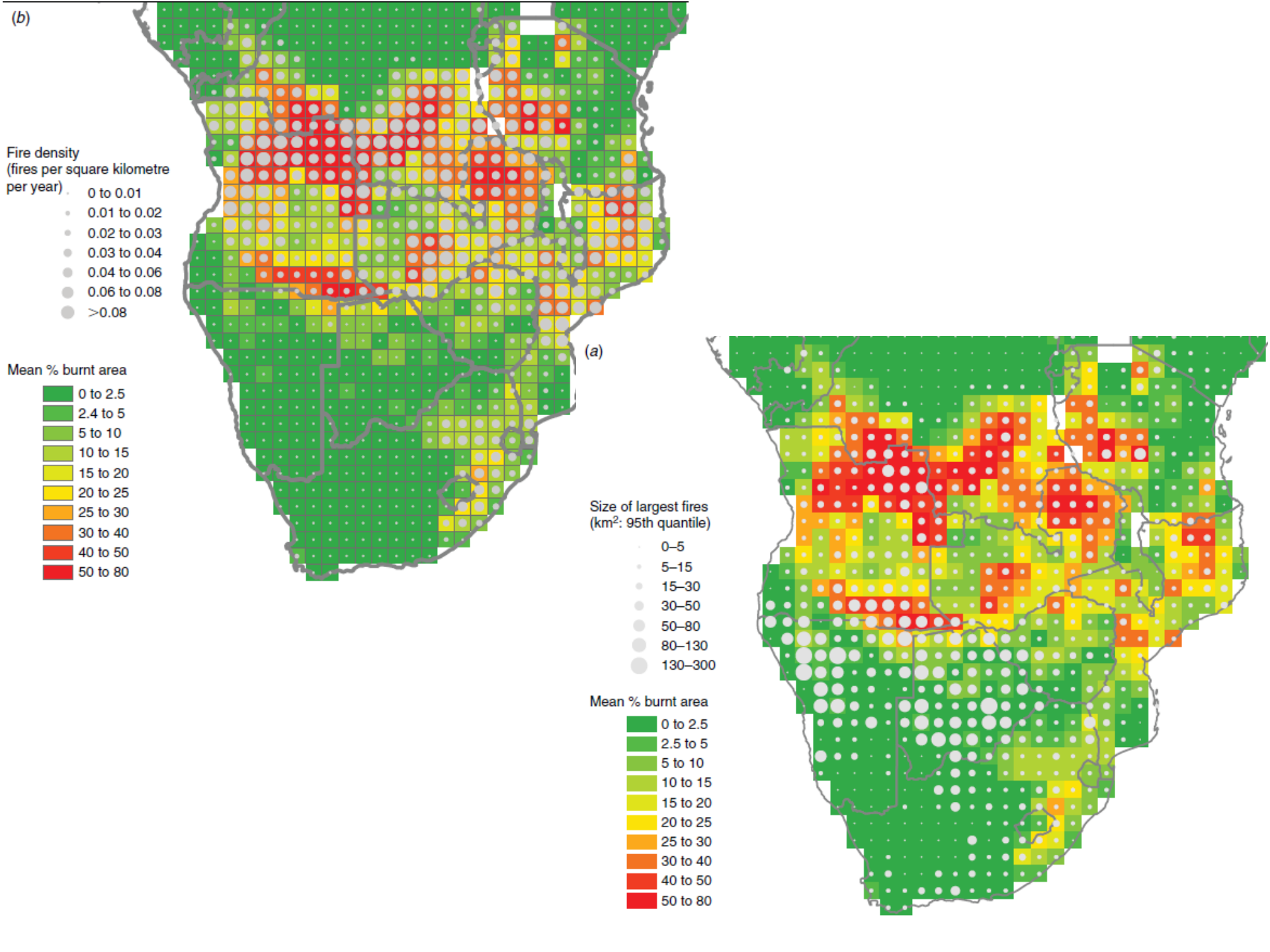
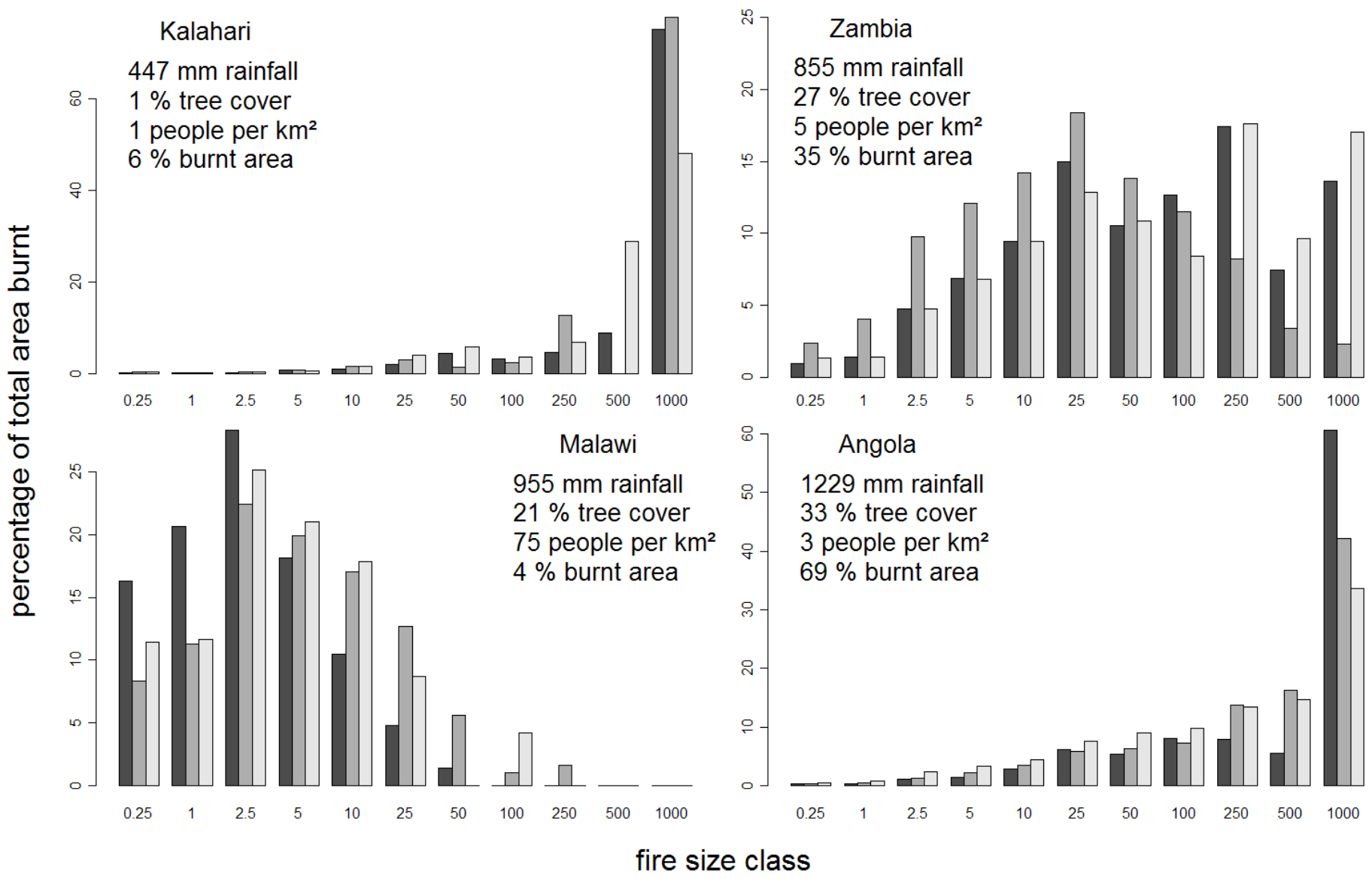
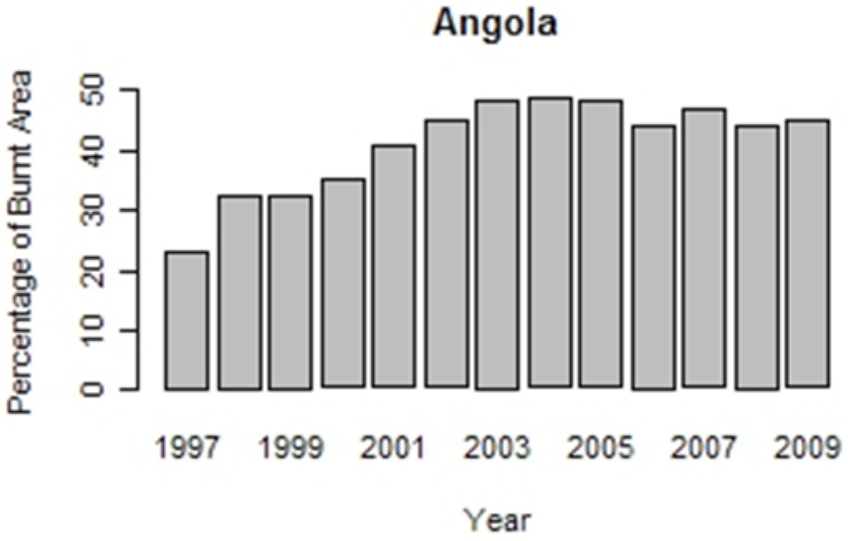
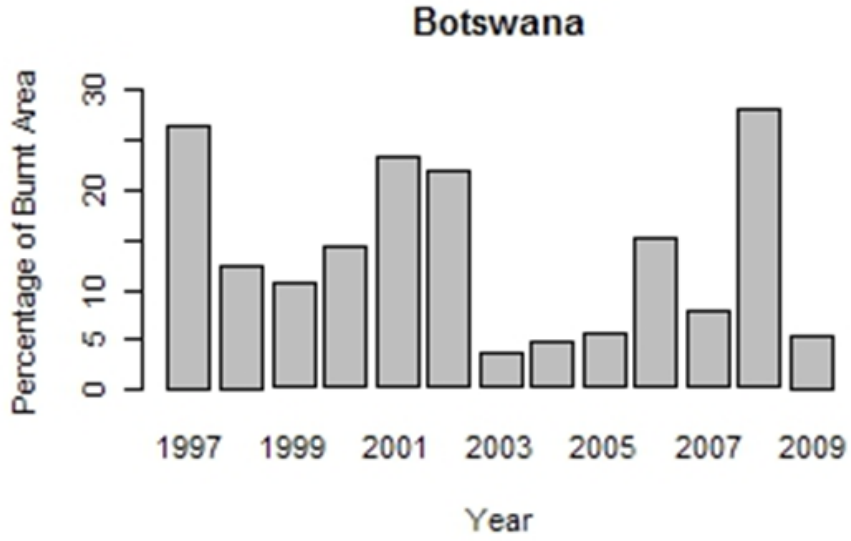

no fire
0-2 fires
2-4 fires
4-6 fires
6-8 fires
> 8 fires

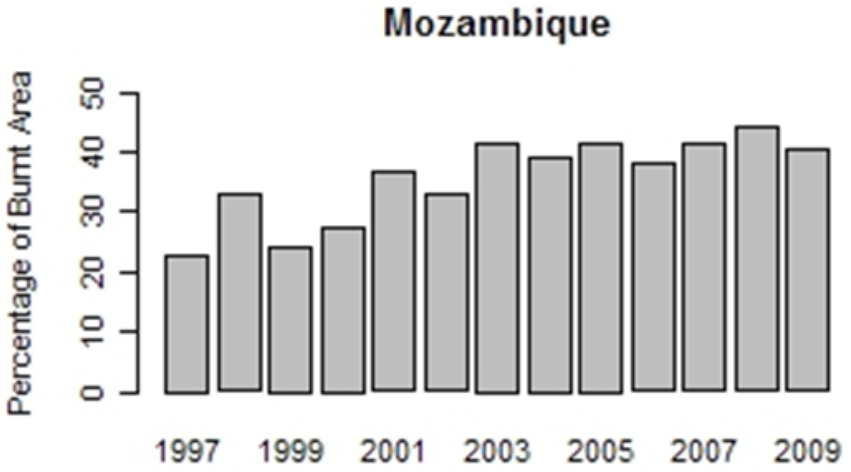
- Miombo – very variable structure – from tall closed-canopies, tall open canopies, short closed canopies (thicket), short open canopies. Transition to forest
- What proportion of each structural type is appropriate? -

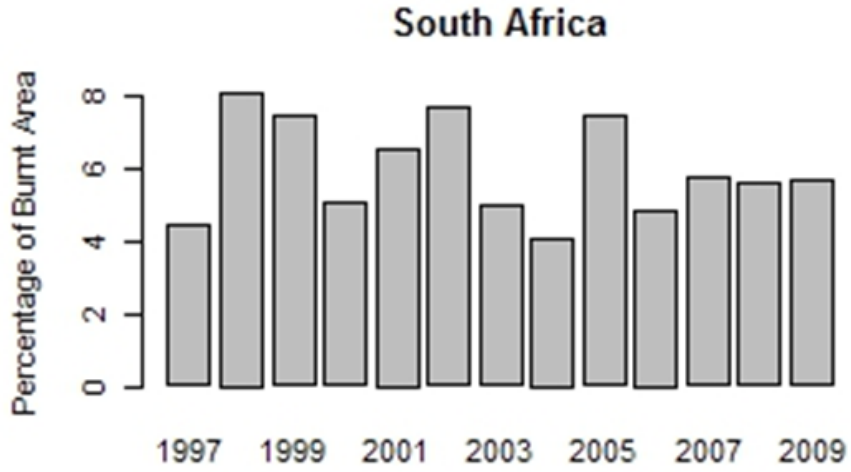

(b)
Fire density
(fires per square kilometre
per year)
0 to 0.01
0.01 to 0.02
0.02 to 0.03
0.03 to 0.04
0.04 to 0.06
0.06 to 0.08
>0.08
Mean % burnt area
0 to 2.5
2.4 to 5
5 to 10
10 to 15
15 to 20
20 to 25
25 to 30
30 to 40
40 to 50
50 to 80
(a)
Size of largest fires
(km2: 95th quantile)
0–5
5–15
15–30
30–50
50–80
80–130
130–300
Mean % burnt area
0 to 2.5
2.5 to 5
5 to 10
10 to 15
15 to 20
20 to 25
25 to 30
30 to 40
40 to 50
50 to 80

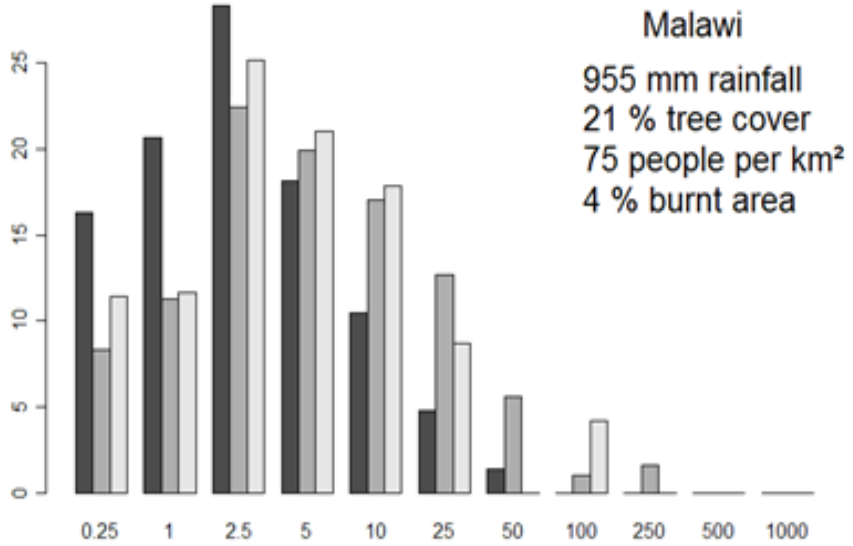

Kalahari
447 mm rainfall
1 % tree cover
1 people per km²
6 % burnt area
Zambia
855 mm rainfall
27 % tree cover
5 people per km²
35 % burnt area
Malawi
955 mm rainfall
21 % tree cover
75 people per km²
4 % burnt area
Angola
1229 mm rainfall
33 % tree cover
3 people per km²
69 % burnt area
percentage of total area burnt
fire size class
0.25
1
2.5
5
10
25
50
100
250
500
1000

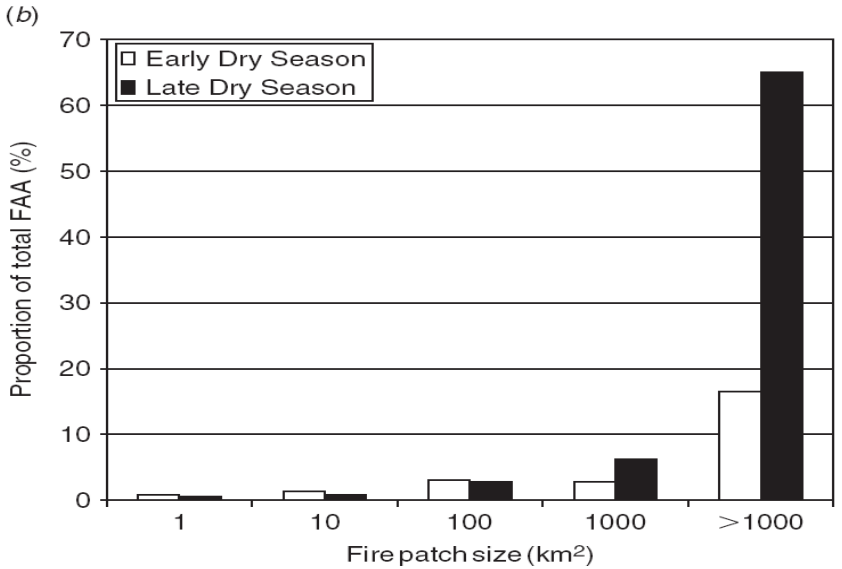

Angola
Percentage of Burnt Area
0 10 20 30 40 50
1997 1999 2001 2003 2005 2007 2009
Year


Botswana
Percentage of Burnt Area
0 5 10 20 30
1997 1999 2001 2003 2005 2007 2009
Year

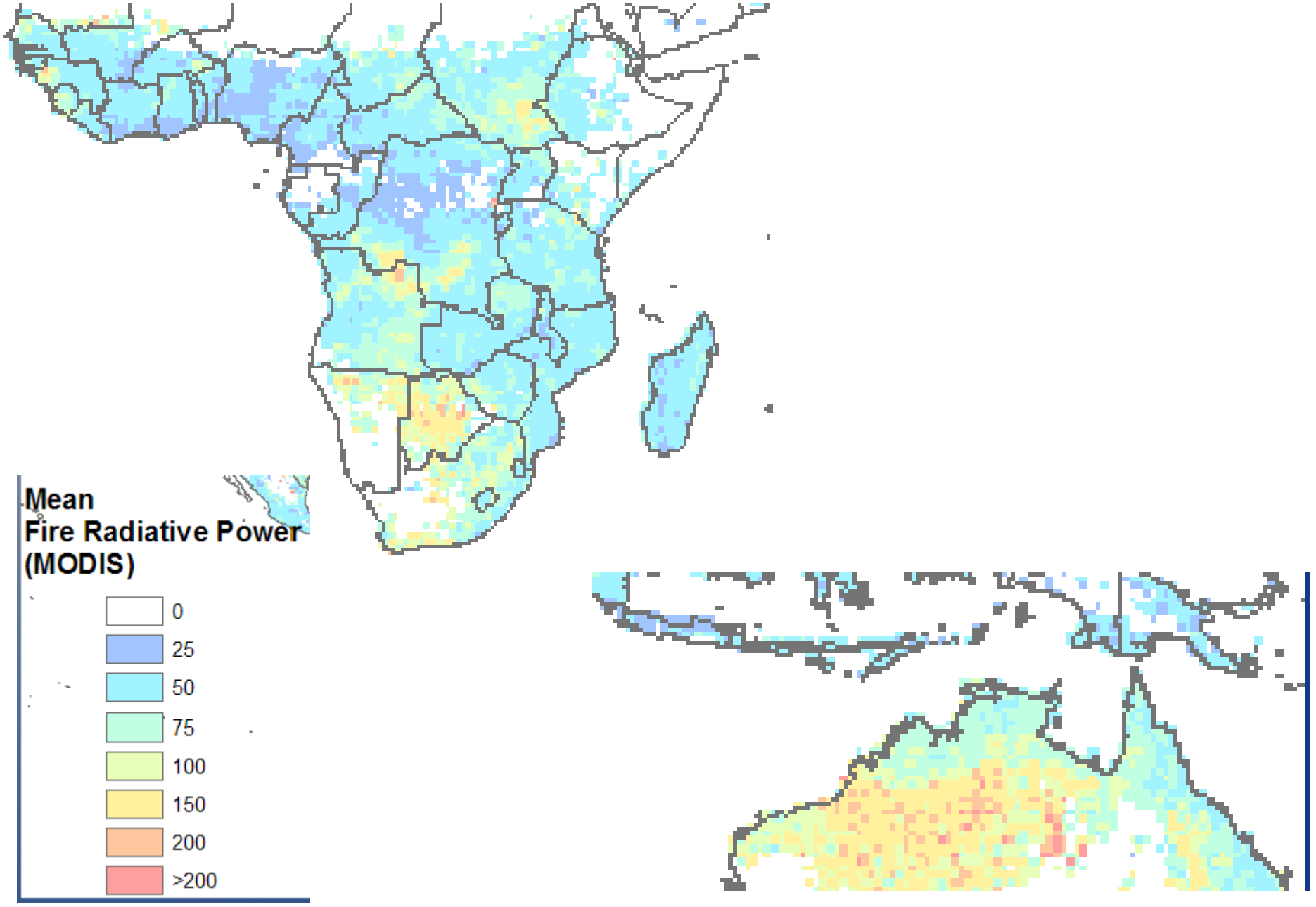

Mozambique
Percentage of Burnt Area
0 10 20 30 40 50
1997 1999 2001 2003 2005 2007 2009

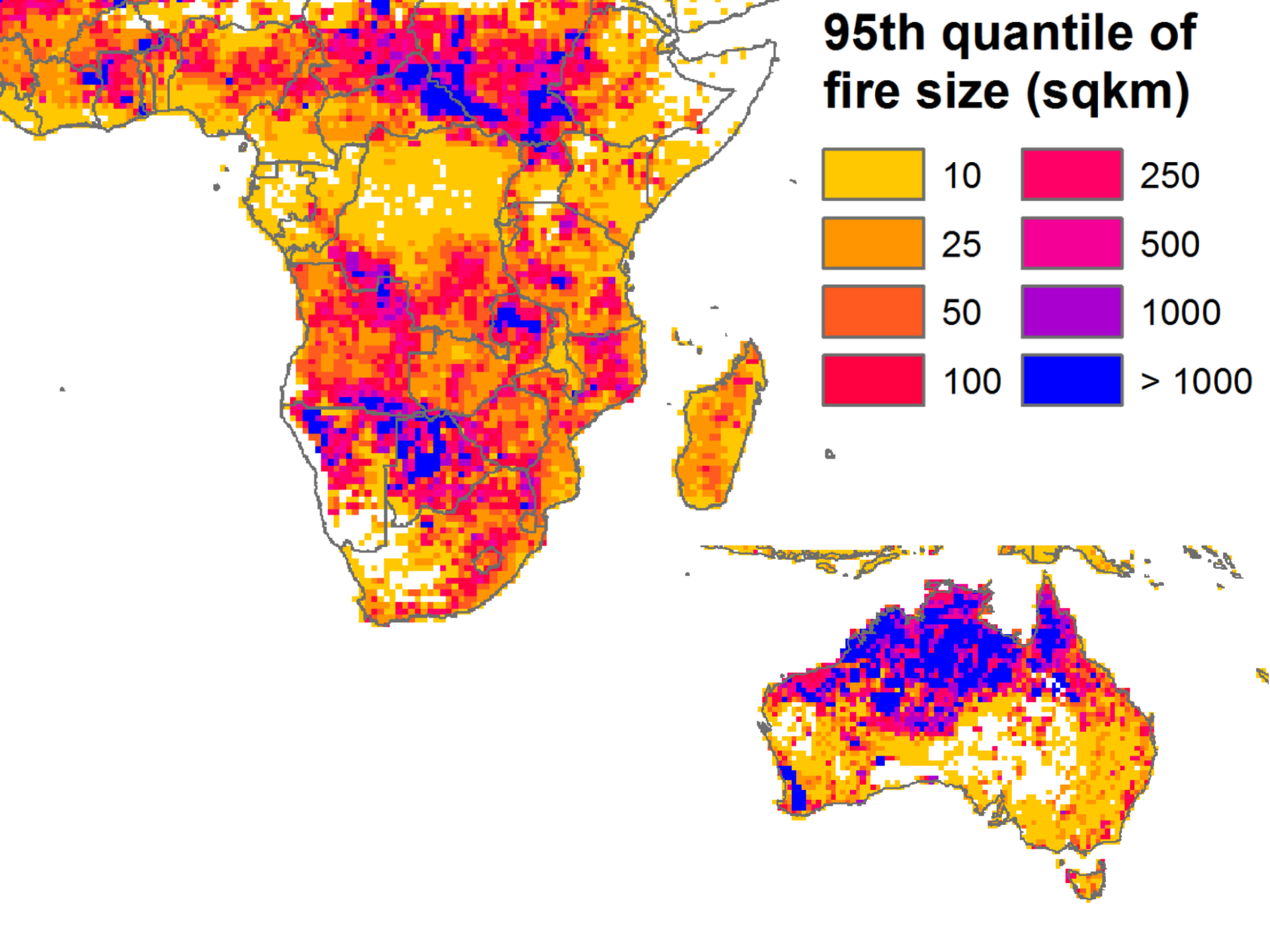

South Africa
Percentage of Burnt Area
0 2 4 6 8
1997 1999 2001 2003 2005 2007 2009





Australia: Yates et al IJWF 2000


Mean
Fire Radiative Power
(MODIS)
0
25
50
75
100
150
200
>200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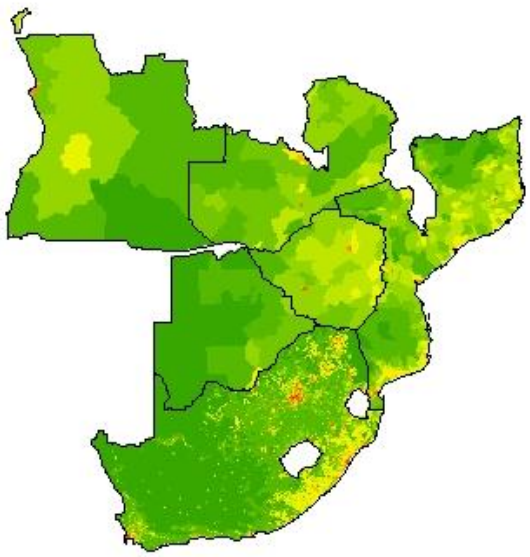

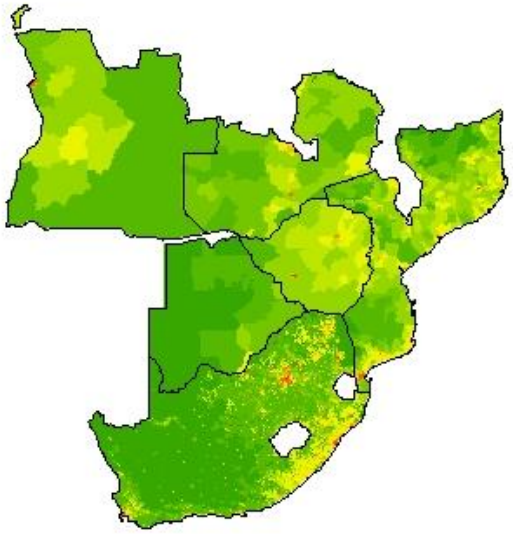

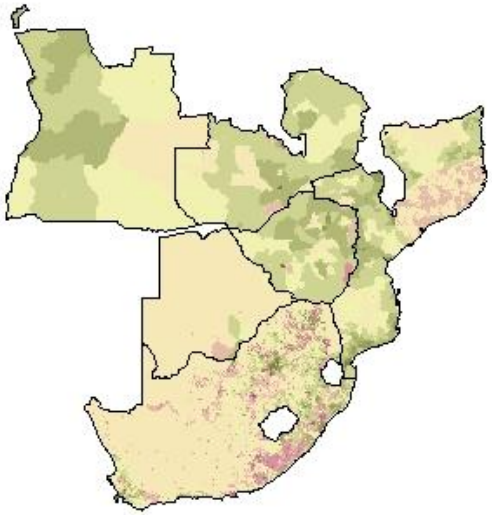

Population density (P/km^2)

0	100.0000001 - 250
0 - 5	250.0000001 - 500
5.000000001 - 10	500.0000001 - 1 000
10.00000001 - 25	1 000.000001 - 5 000
25.00000001 - 50	5 000.000001 - 7 500
50.00000001 - 100	7 500.000001 - 14 287

Population Change, 2000-2010 (P/km^2)

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-999.999999 - -250	1.000000001 - 5
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Jobs √
Foreign currency √
Biodiversity √
Sustainable livelihoods ?

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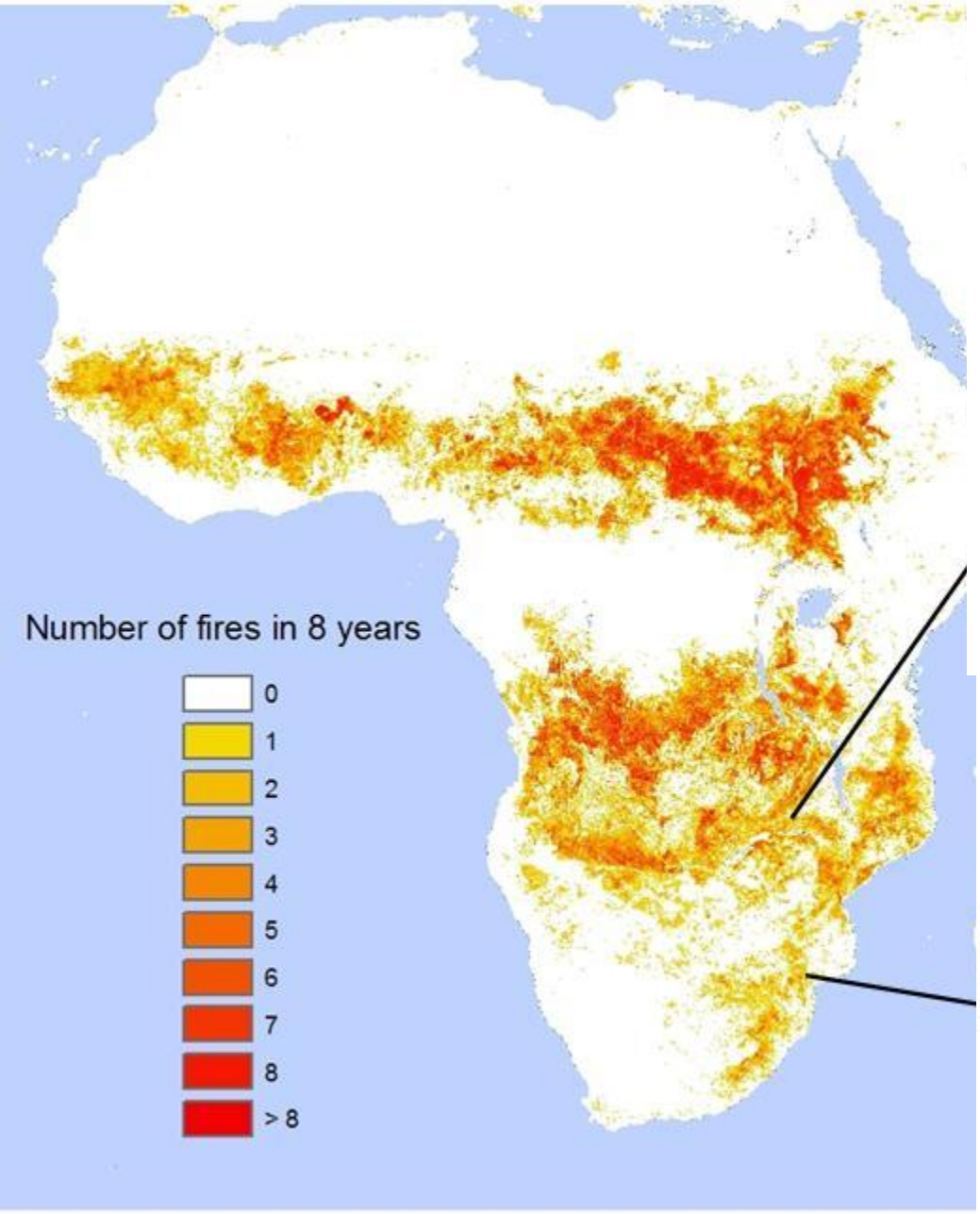
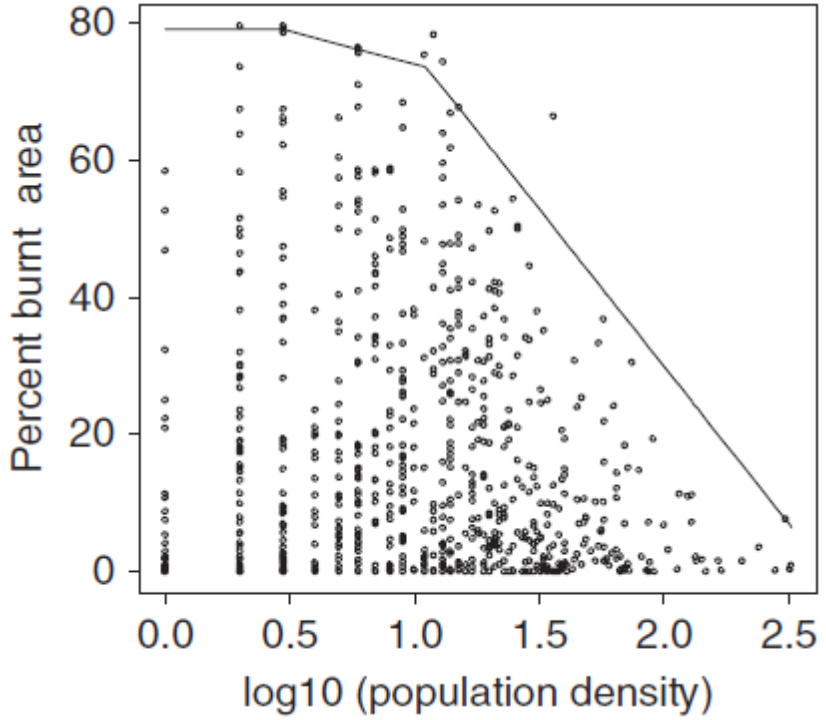
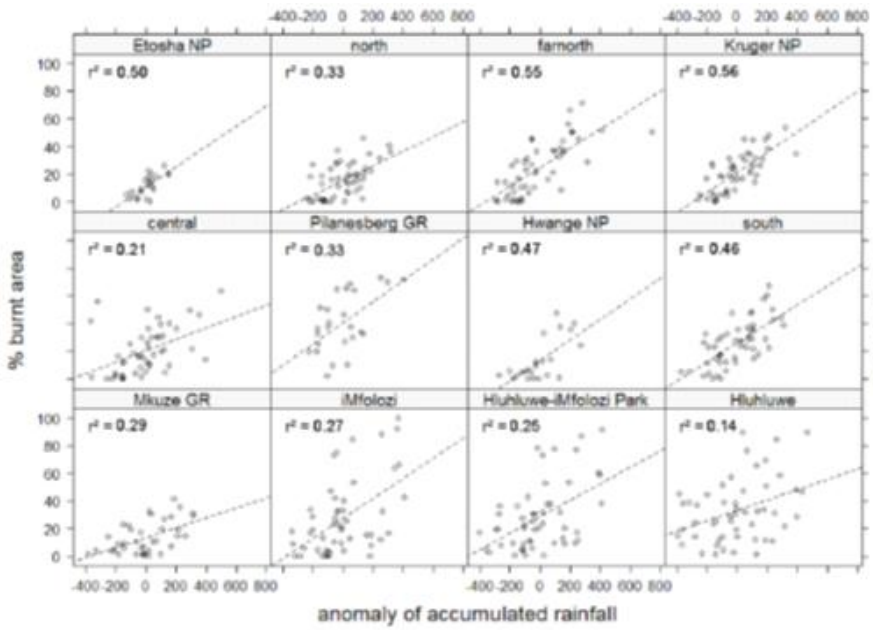

Number of fires in 8 years
0
1
2
3
4
5
6
7
8
> 8


Percent burnt area
80
60
40
20
0
0.0
0.5
1.0
1.5
2.0
2.5
log10 (population density)


Etosha NP
north
farnorth
Kruger NP
central
Pilanesberg GR
Hwange NP
south
Mkuze GR
iMfolozi
Hluhluwe-iMfolozi Park
Hluhluwe
% burnt area
anomaly of accumulated rainfall

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