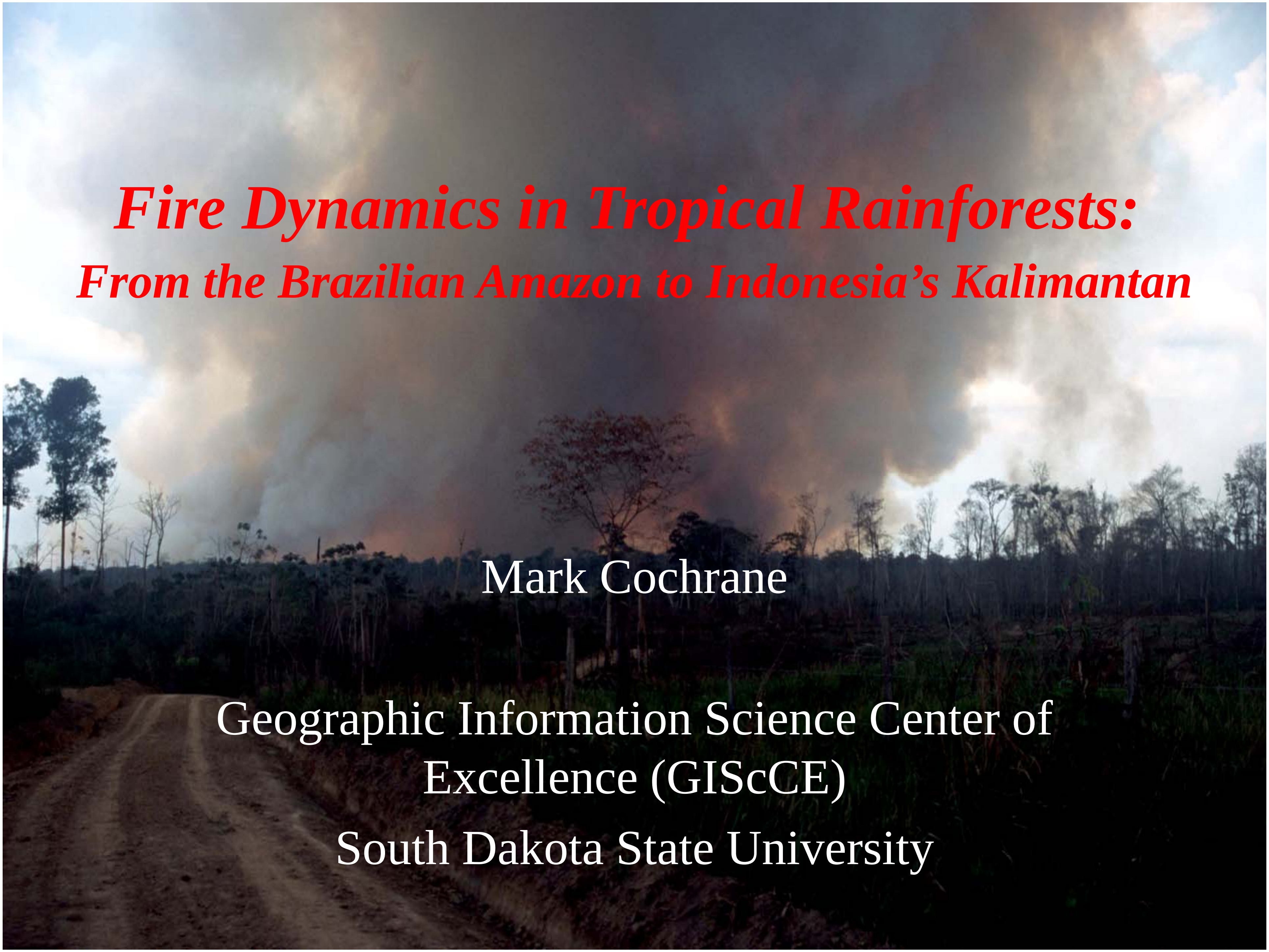

Fire Dynamics in Tropical Rainforests:
From the Brazilian Amazon to Indonesia’s Kalimantan

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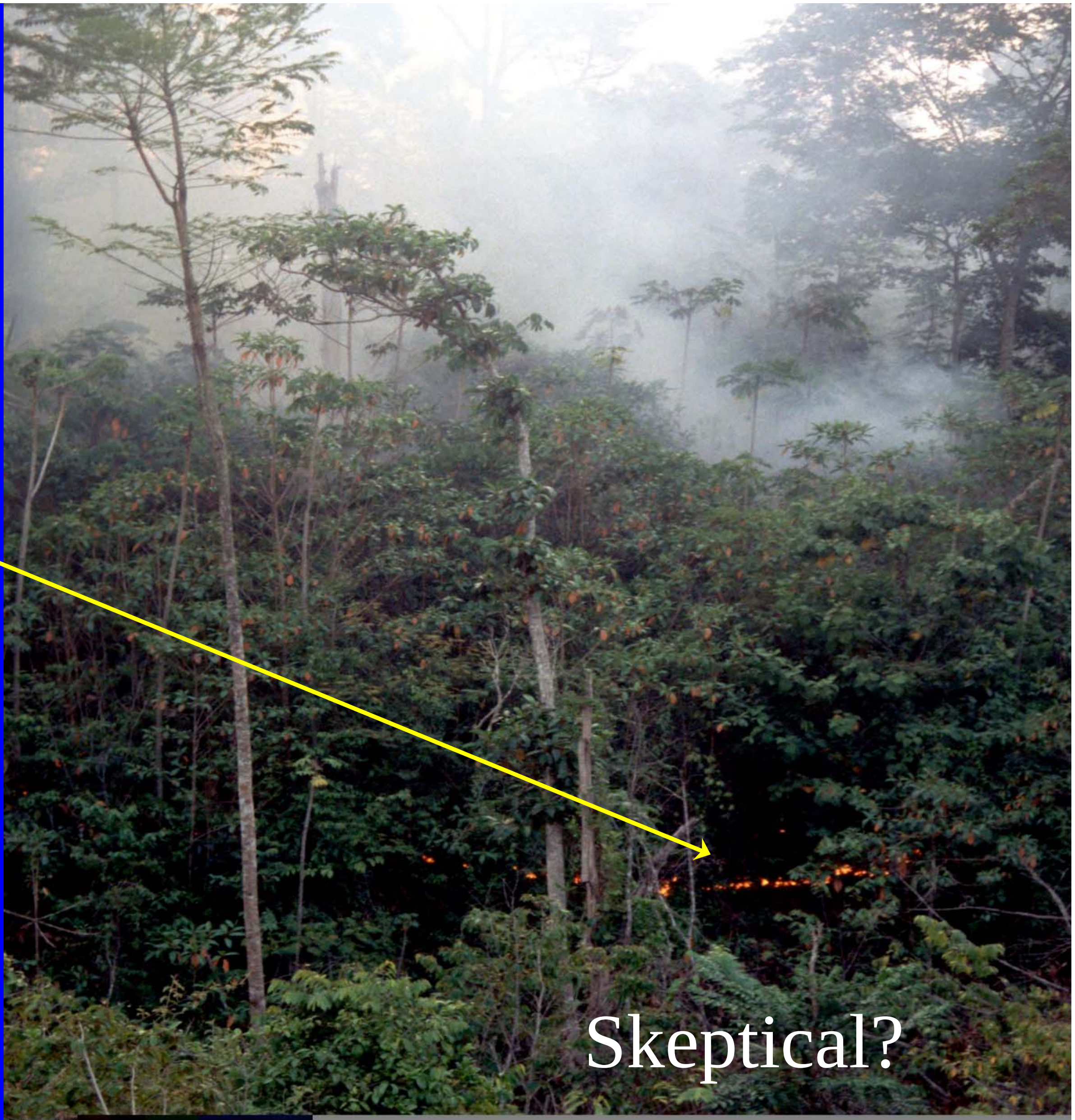
What is a Rainforest Fire?

- Previously uncommon event
- Surface fire that burns through dry leaf litter
- Causes high levels of plant mortality due to poor evolutionary adaptation of the plants

BUT -- Is it really a severe disturbance?


This is what is normally considered severe

But this is what I consider to be a truly severe disturbance



My Research

- Forest fire
  - Why do rainforests burn?
  - How do fuel structure, composition and moisture affect fire behavior?
  - How do fire dynamics affect ecosystem responses?

- Interaction and Synergy
  - How do land use and land cover changes modify the fire environment?
  - How does fire occurrence modify land cover and land use choices?

My Research (continued)

- Development and Conservation
  - Can fires and fuels be managed effectively on a landscape scale?
  - How might continued development affect future fire-driven land cover change?
  - What do regional fire dynamics imply for conservation strategies?

- Sustainable Landscapes
  - Are they achievable?
  - What role will wildfire play?


ATLANTIC OCEAN
TRINIDAD AND TOBAGO
PANAMA
VENEZUELA
COLOMBIA
ECUADOR
GUYANA
SURINAME
FRENCH GUIANA
AMAPÁ
RORAIMA
AMAZONAS
BRAZIL
PARÁ
MARANHÃO
ACRE
RONDÔNIA
MATO GROSSO
TOCANTINS
GOIÁS
PERU
BOLIVIA
Upper Canopy
Lower Canopy

The Brazilian Amazon

- Brazil's Legal Amazon is 80% of total Amazon (equal to 55% of entire US)
- Size = 5,000,000 km^2 = 19 x Colorado
- Naturally Forested = 4,000,000 km^2
- Deforested to date = 600,000 km^2
- Until 2005, deforested at a rate of 20,000 km^2/yr
  - 1 Colorado sized area every 13 years

Deforestation rates have improved

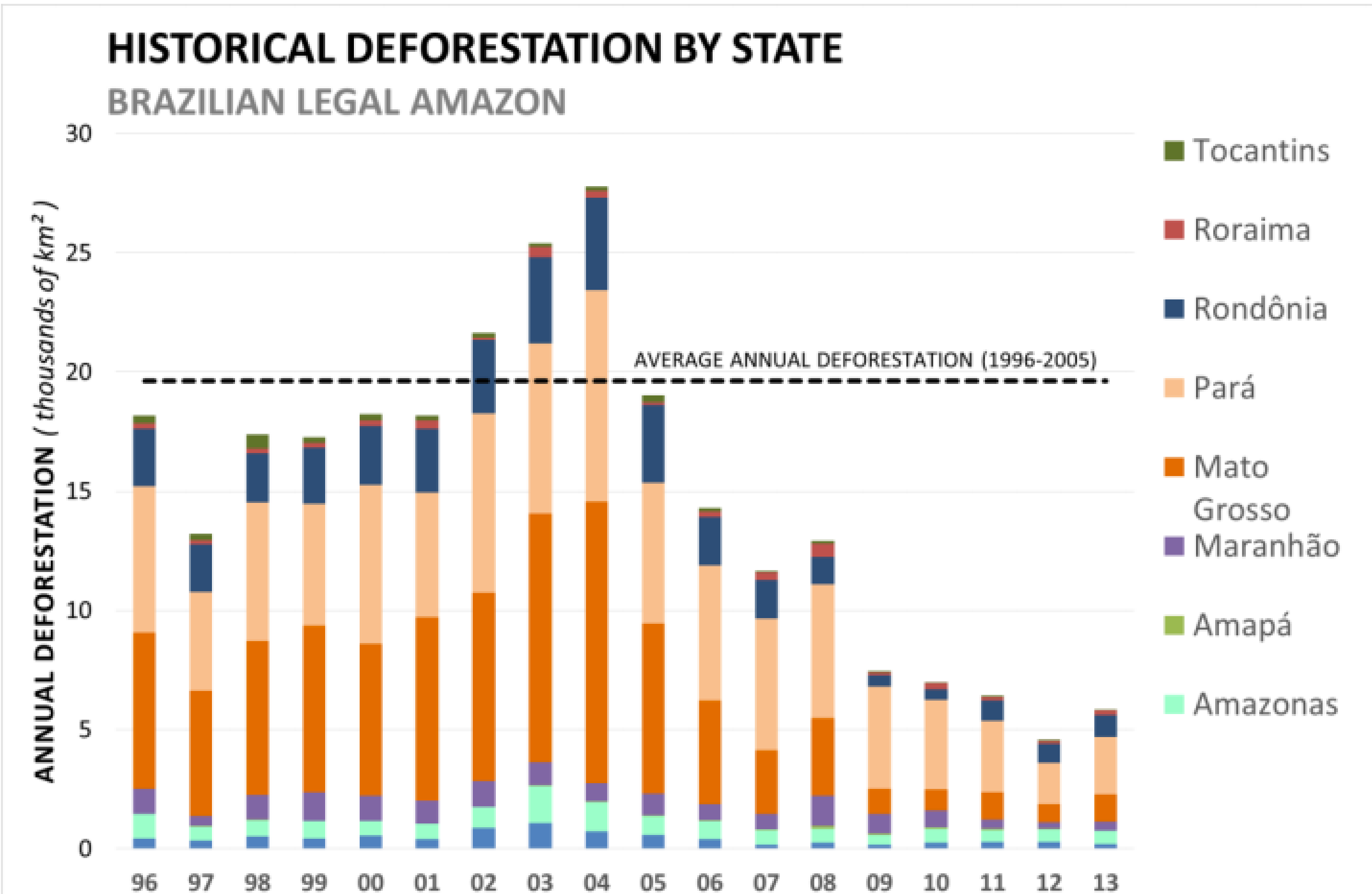


Fig. S3.

Annual deforestation by state in the Brazilian Amazon (96-2013), relative to the average annual deforestation rate between 1996 and 2005. Annual deforestation from INPE 2013 (*26*).

Biodiversity and Carbon

Meteorologically Important

Salient Points of Land Cover and Land Use Change in the Amazon

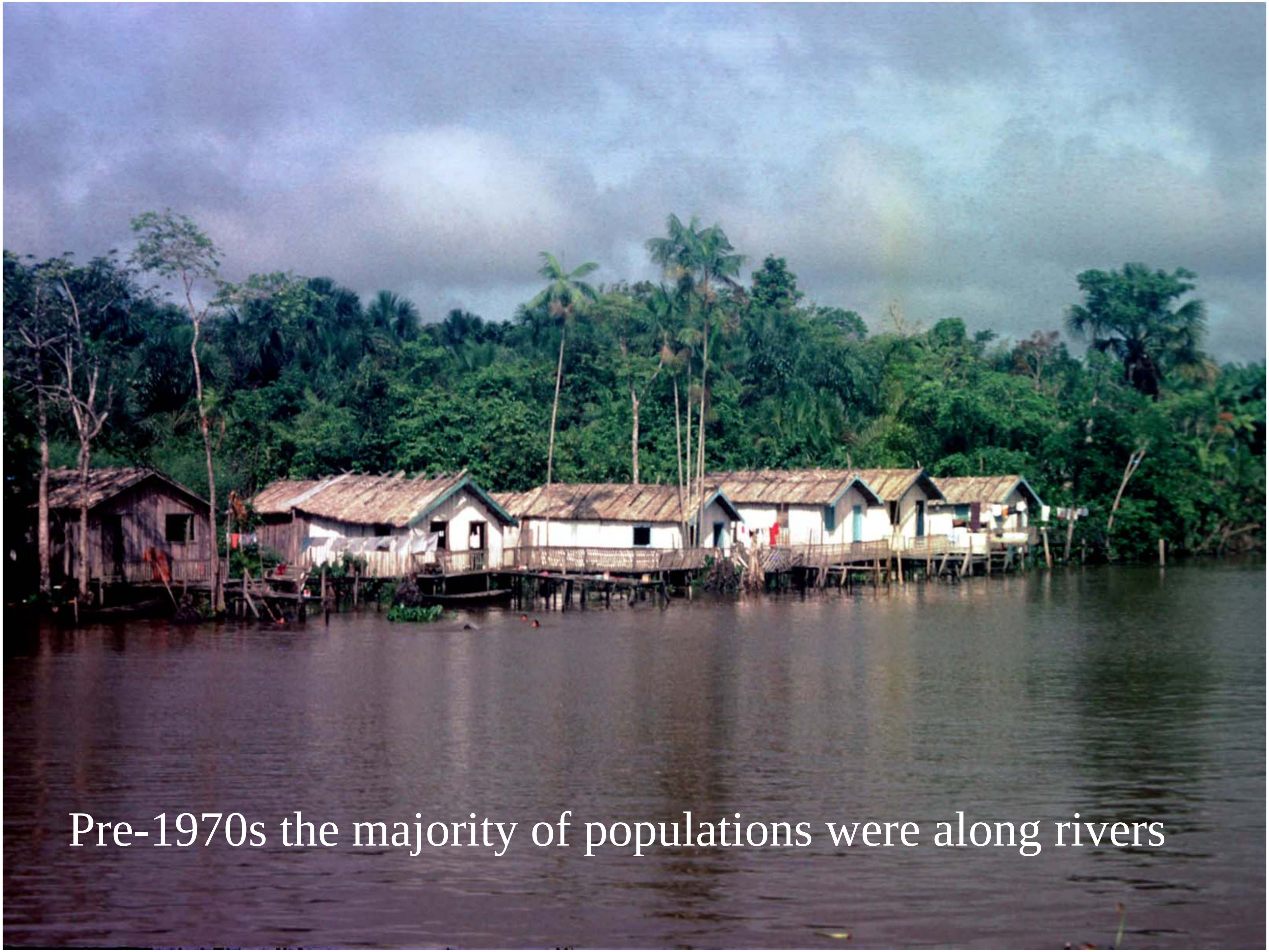
- Deforestation
  - Land use driven (agriculture, ranching, mining)
  - Clusters along transportation corridors
- Forest Fragmentation
  - Function of deforestation
- Selective Logging
  - Activity of growing extent and economic importance
  - Very concentrated regionally
- Forest Fire
  - Previously rare event, becoming more common
  - Dynamically links land use and land cover change

Short History of Deforestation

- Indigenous peoples practicing slash-and –burn deforestation for up to 10,000 years
- Western peoples (Portuguese) deforesting for over 300 years
- Major deforestation begun in the 1960s-70s
- Geopolitical decision to ‘secure’ land and ‘help’ people. People without land for land without people.

Current situation

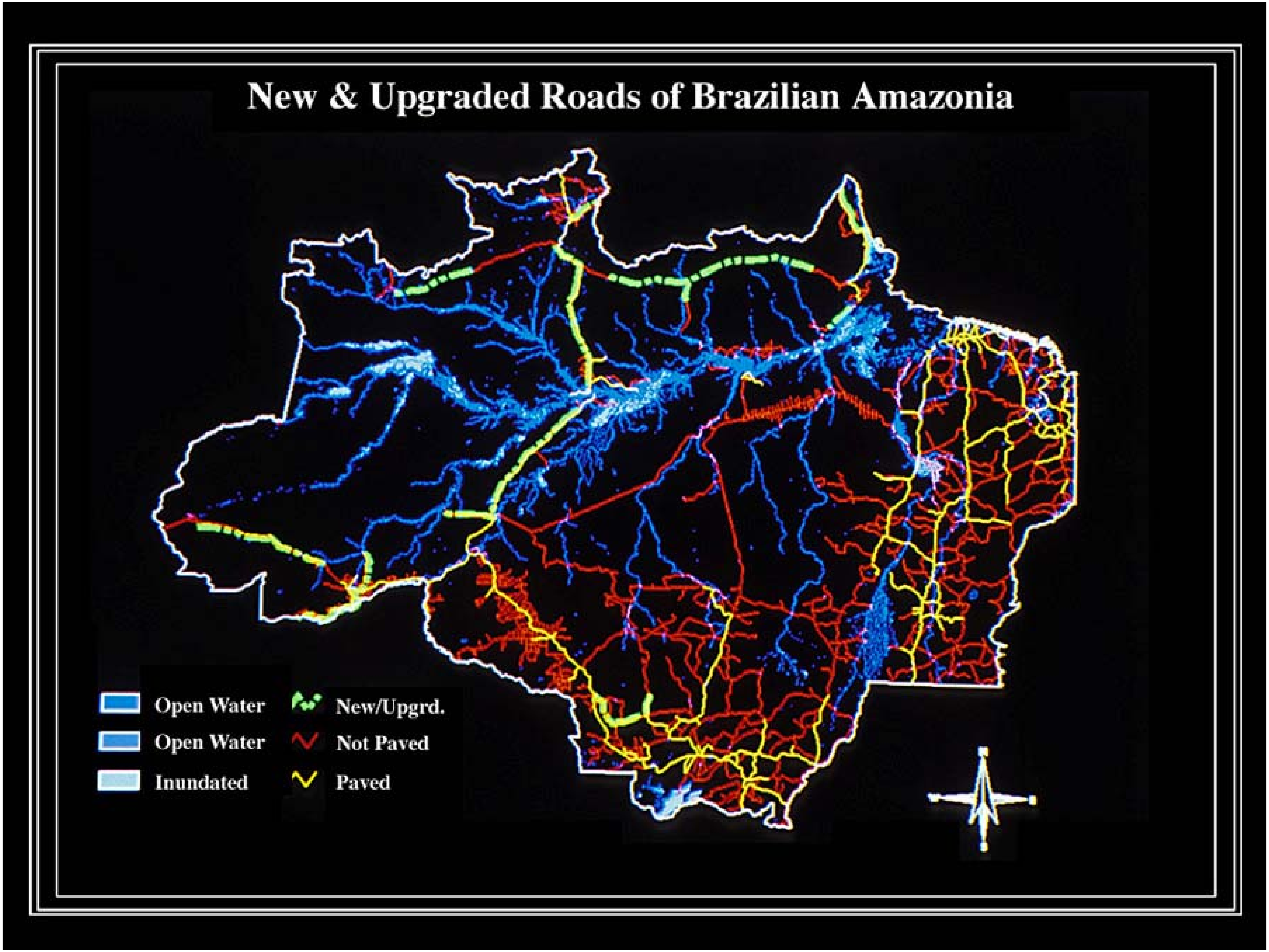
- Population has increased to 20 million people
- Many are clustered in large cities (e.g. Belém, Manaus)
- Combination of subsistence agriculture, ranching, and large scale agriculture
- Millions of rural poor still need to deforest areas in order to survive



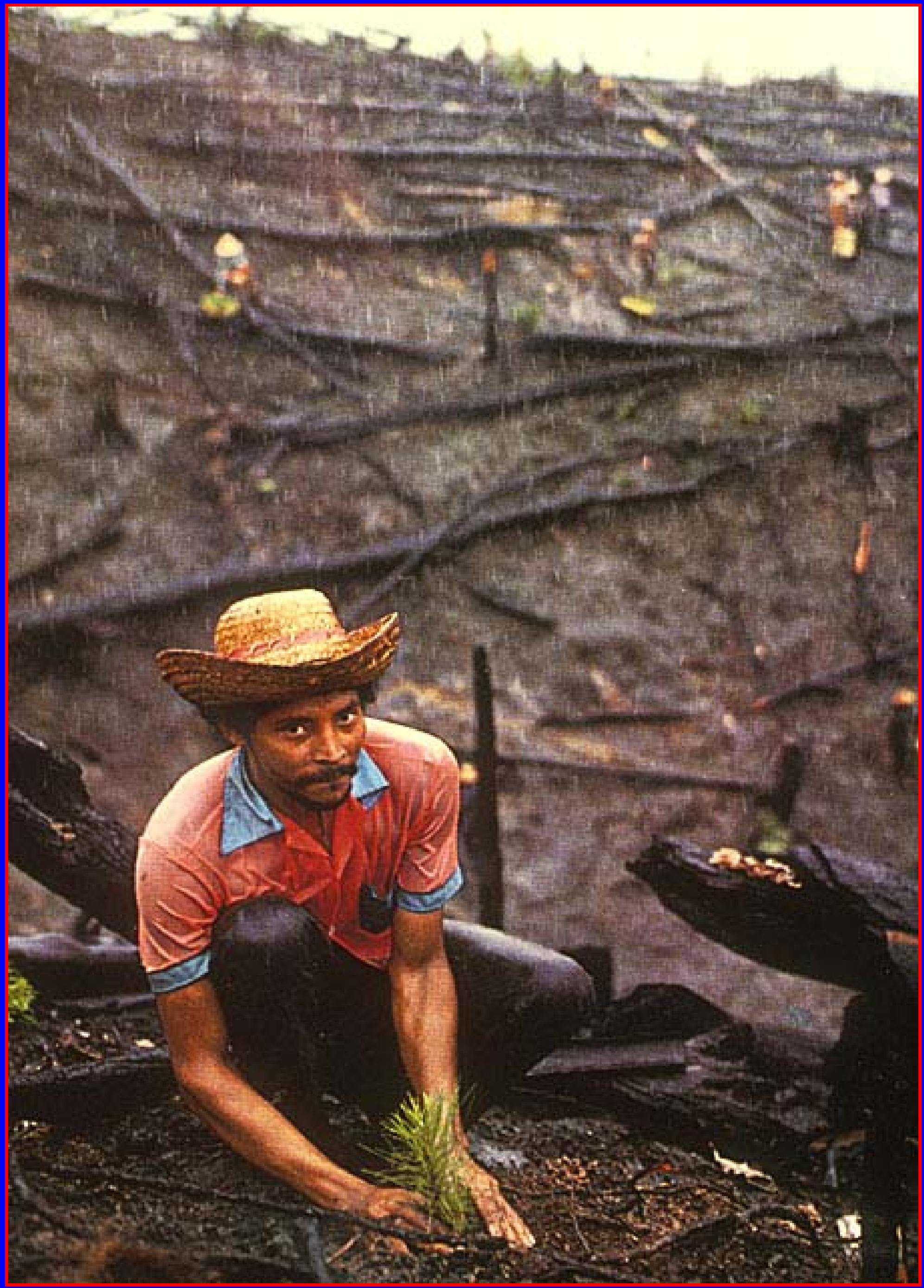
Pre-1970s the majority of populations were along rivers


These were the major transportation corridors

With Road Construction Have Come New Land Use Patterns

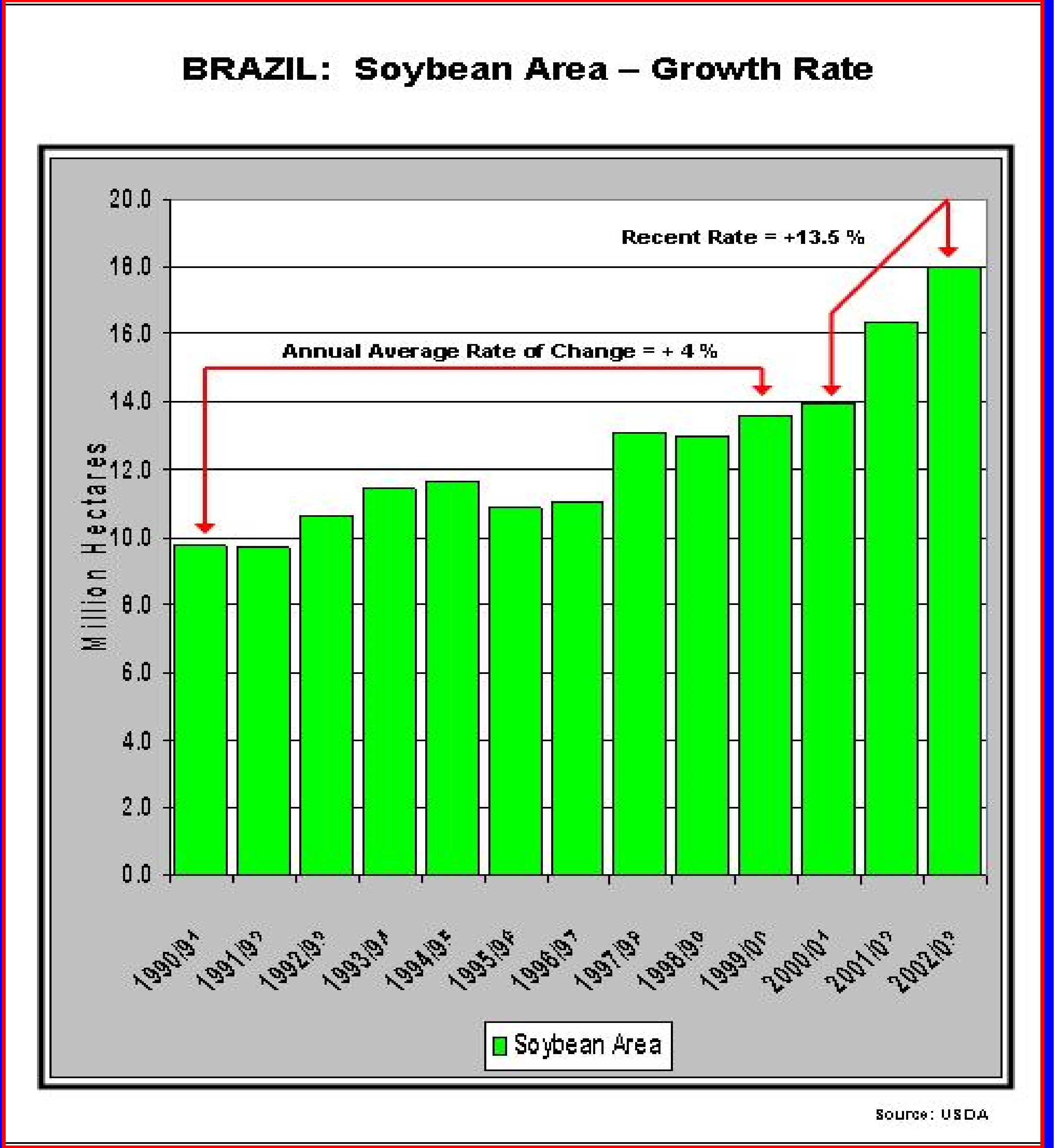

New & Upgraded Roads of Brazilian Amazonia
Open Water
Open Water
Inundated
New/Upgrd.
Not Paved
Paved

Slash & burn farming



Large-scale ranching

Industrial soybean farming



All Of These Land Uses Are Fire Dependent

The Amazon is the frontier of the modern era

There are cowboys

There are Indians

And even gringos!

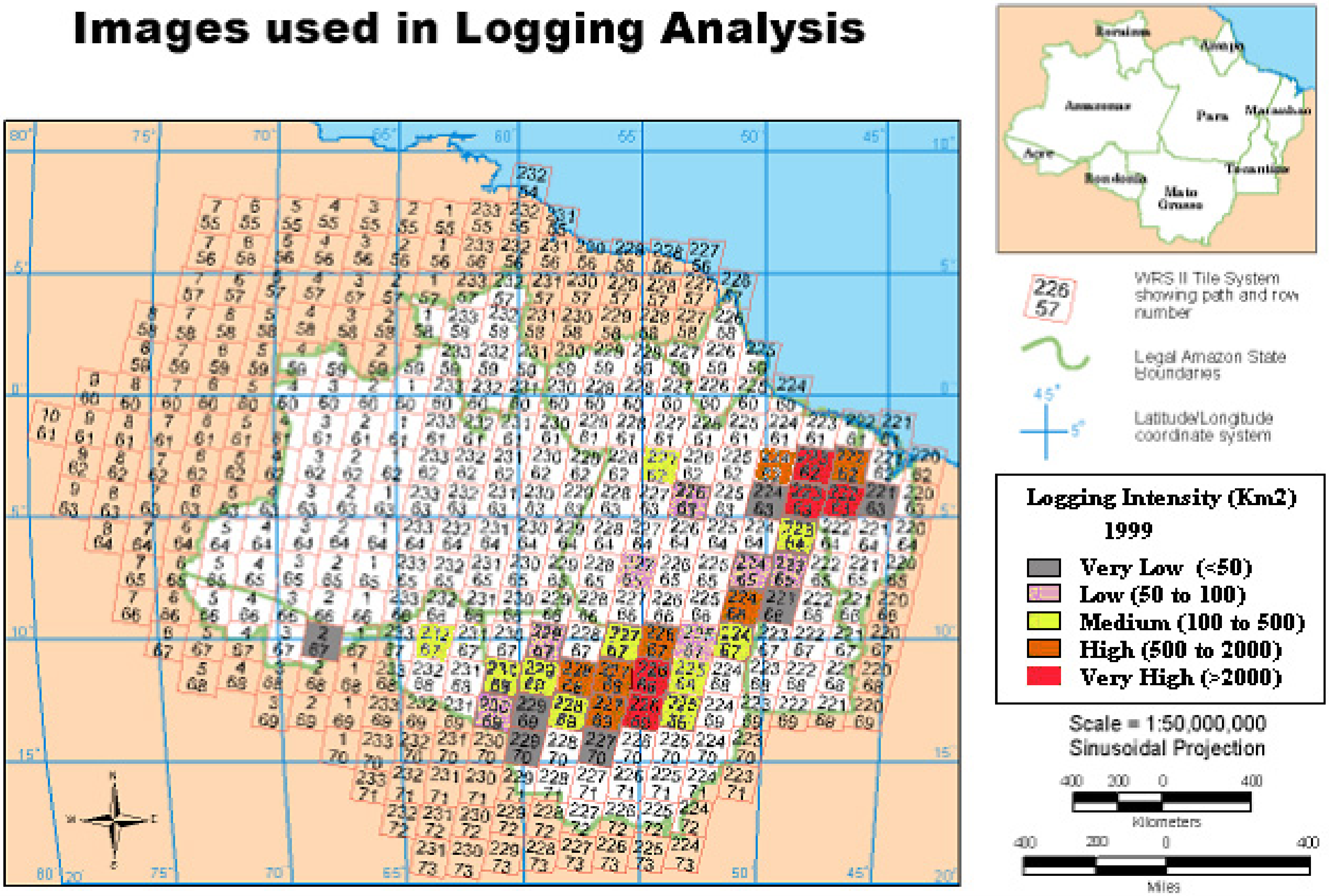
What is Selective Logging?

- Lots of trees
- Lots of species
- Few economically valuable species
- Low density stocking levels
- High grading dominates

Where does the Logging Happen?

- Logging requires access to lands – roads, rivers
- Logging requires power – utilities
- Logging requires markets – near cities and major transportation networks

Images used in Logging Analysis



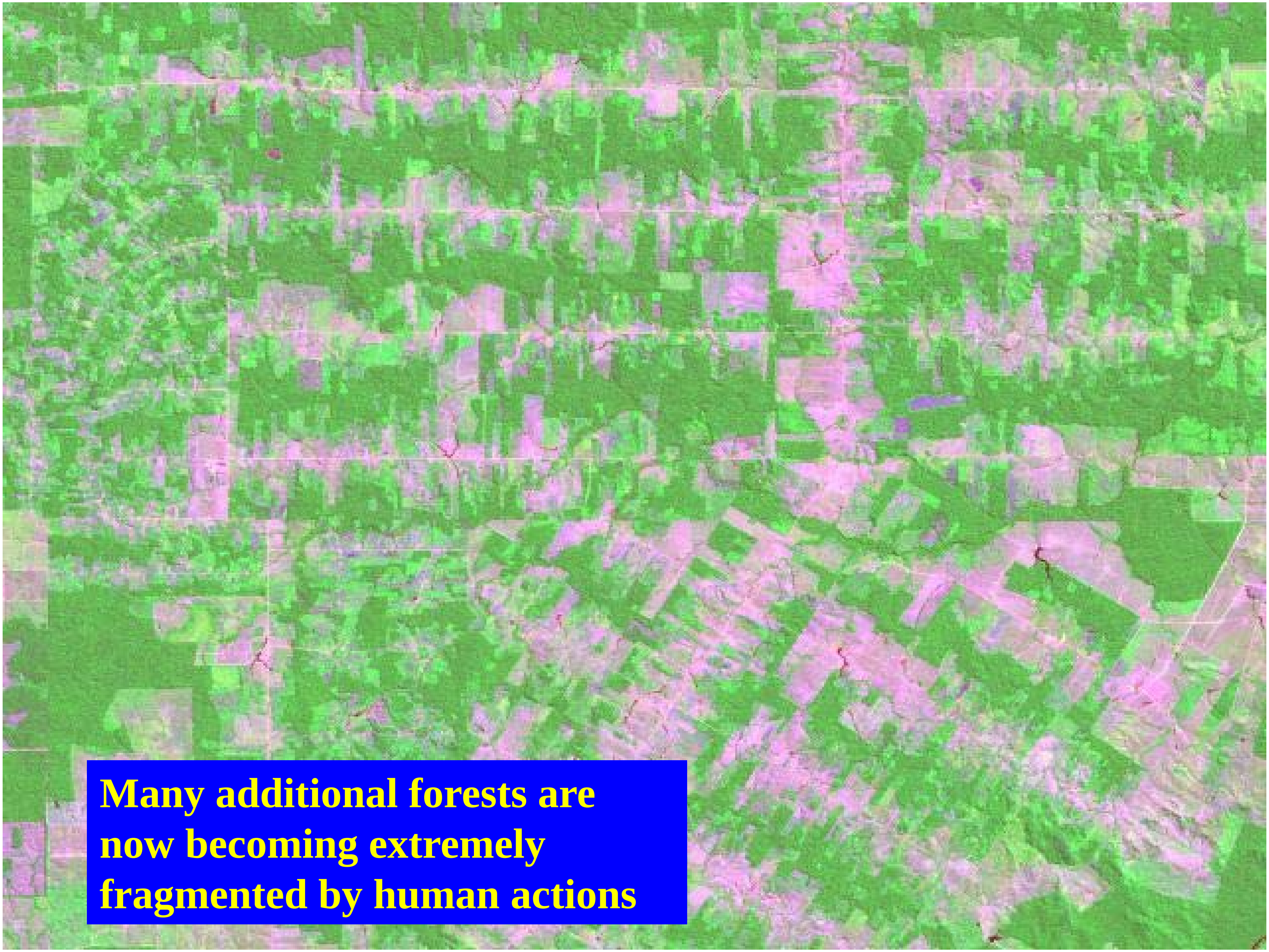
(Matricardi 2003)

What are the Effects of Selective Logging?

- Increased fire susceptibility
- Damage to nearby trees and soils
- Increased risk of local species extirpation
- Emissions of carbon
- Many forests are revisited several times
  - These forests become very degraded and may have 40 – 50% of the canopy cover removed during these logging operations

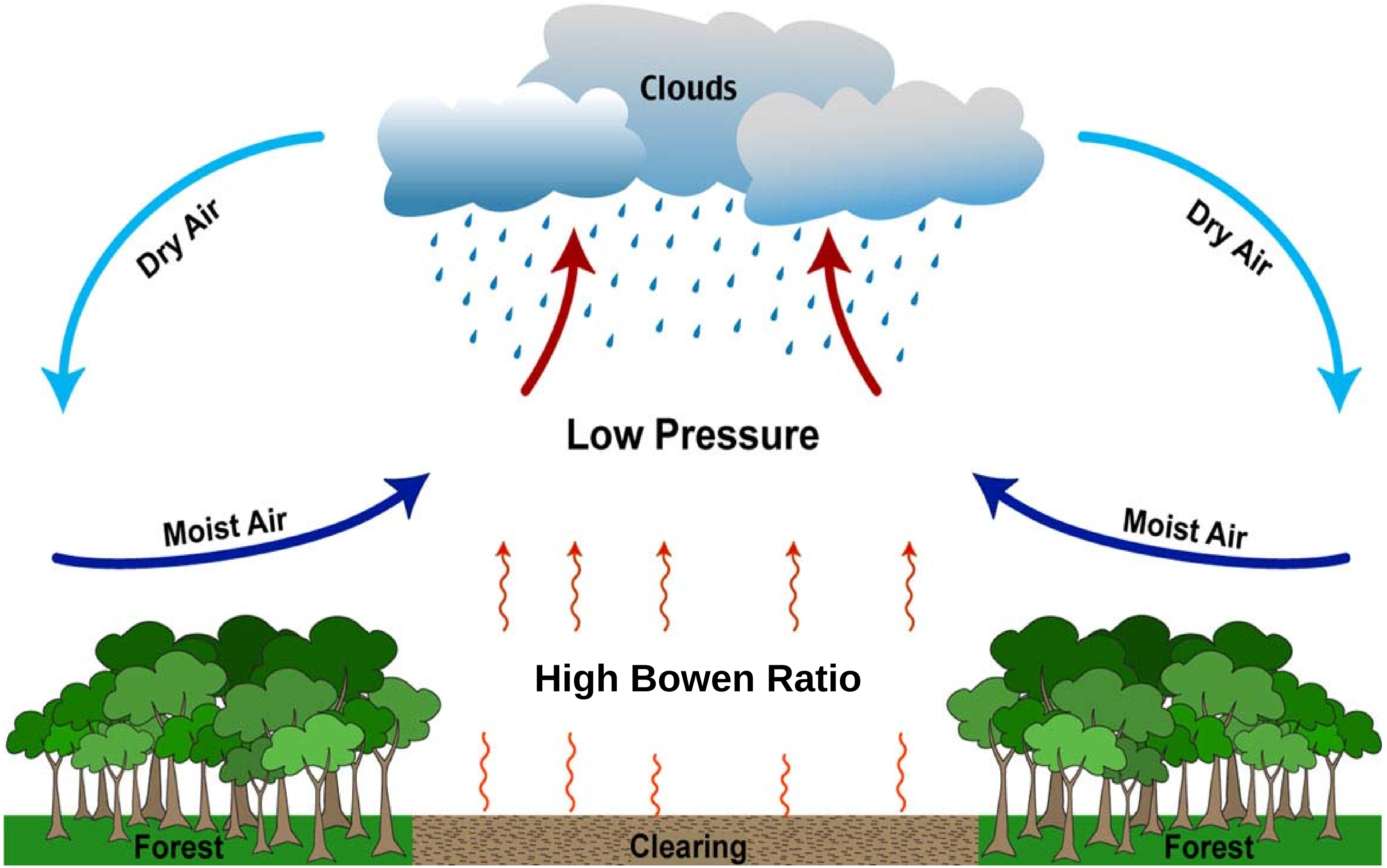
What is Forest Fragmentation?

- Creation of forest edges by deforestation
- Causes microclimate changes near edges
- Degrades habitat for many species
- Leads to ‘biomass collapse’ near edges


Many additional forests are now becoming extremely fragmented by human actions

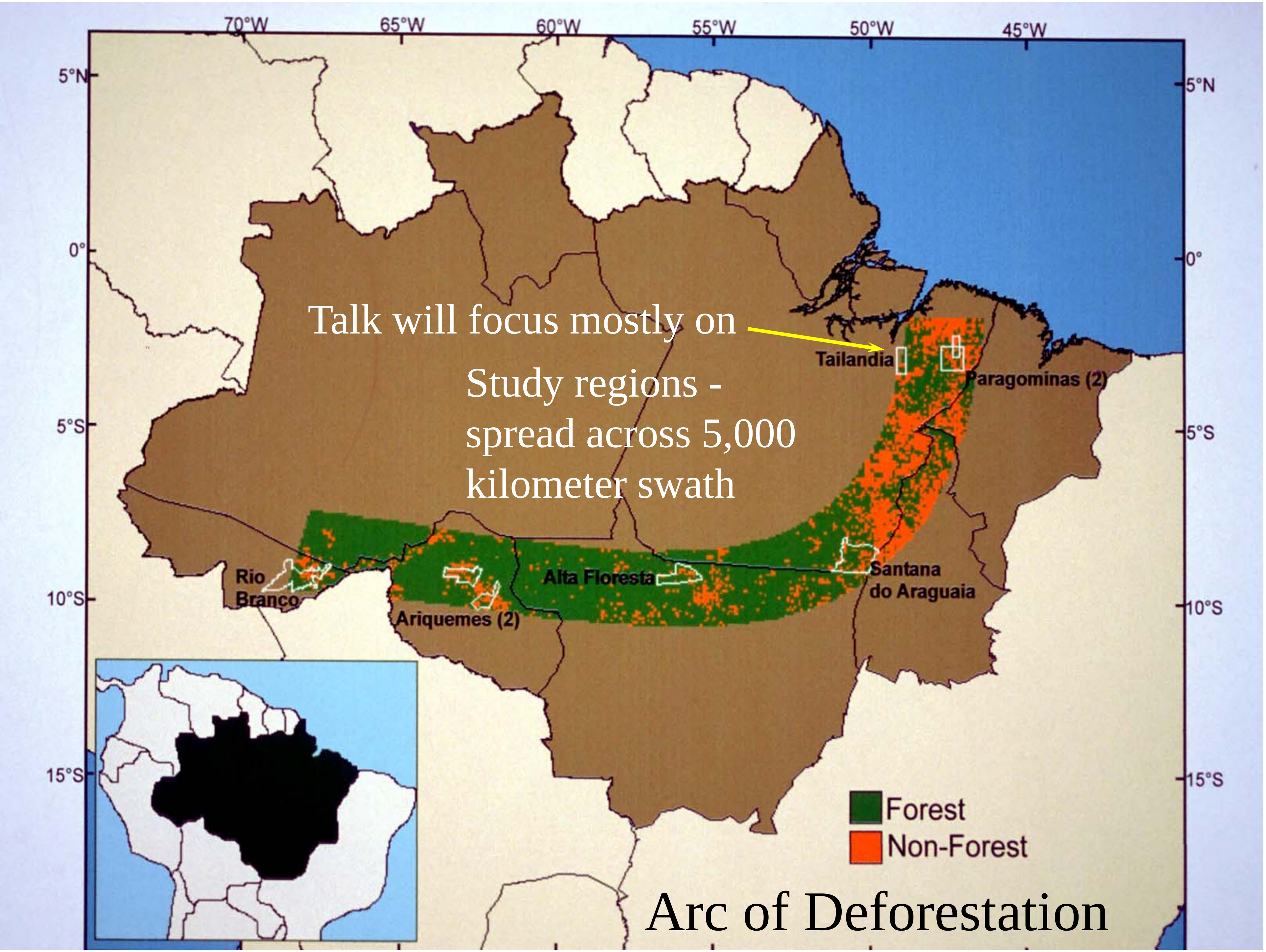
Deforestation induced fragmentation creates forest edges where they previously did not exist

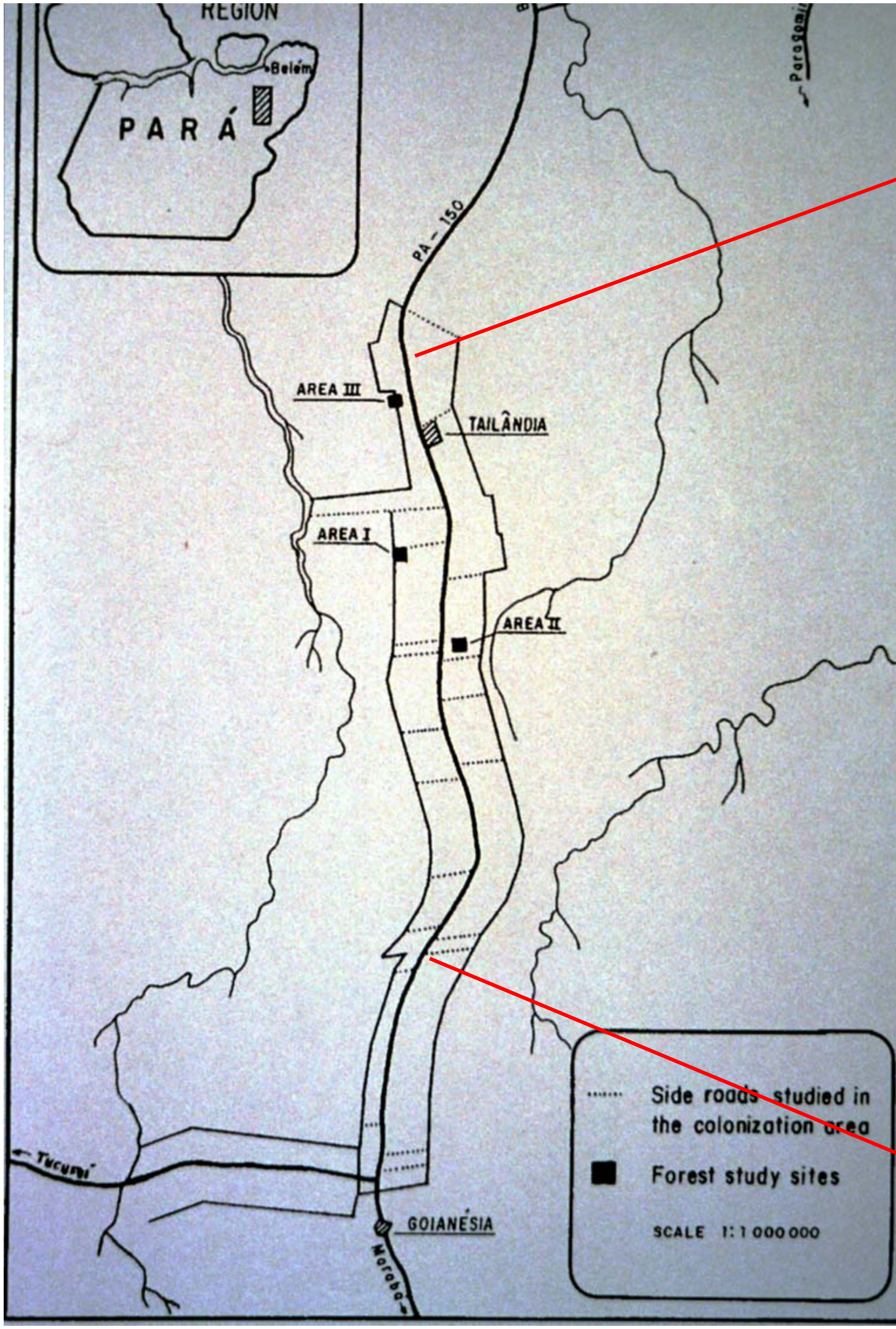
The Vegetation Breeze



Edge-related Changes in Forest Fuels

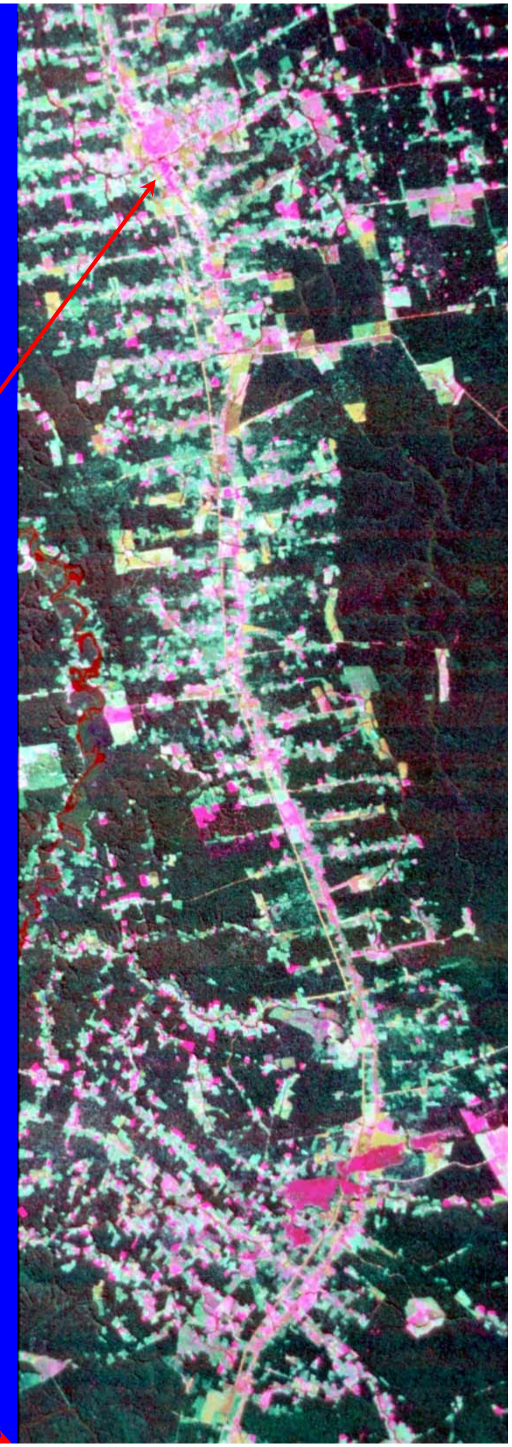
- Increased wood debris and litter
- Greater insolation, temperatures and wind
- Increased desiccation within 60-200 m of edges


70°W
65°W
60°W
55°W
50°W
45°W
5°N
0°
5°S
10°S
15°S
Talk will focus mostly on
Study regions -
spread across 5,000
kilometer swath
Tailandia
Paragominas (2)
Rio
Branco
Alta Floresta
Santana
do Araguaia
Ariquemes (2)
Forest
Non-Forest
Arc of Deforestation



Multitemporal study region of Tailandia Main town of 5,000 people

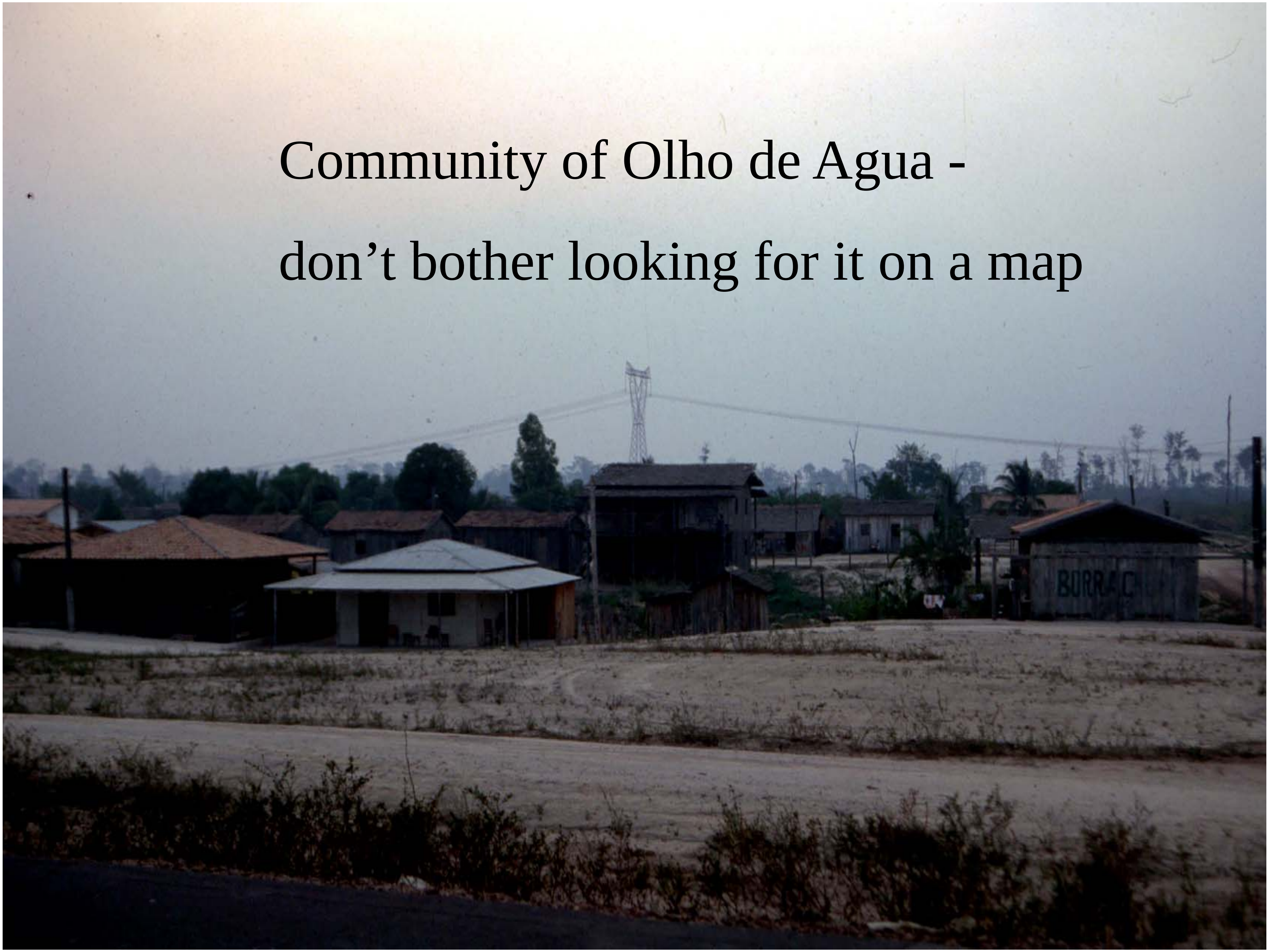
The study region was 25 km x 100 km (250,000 ha)



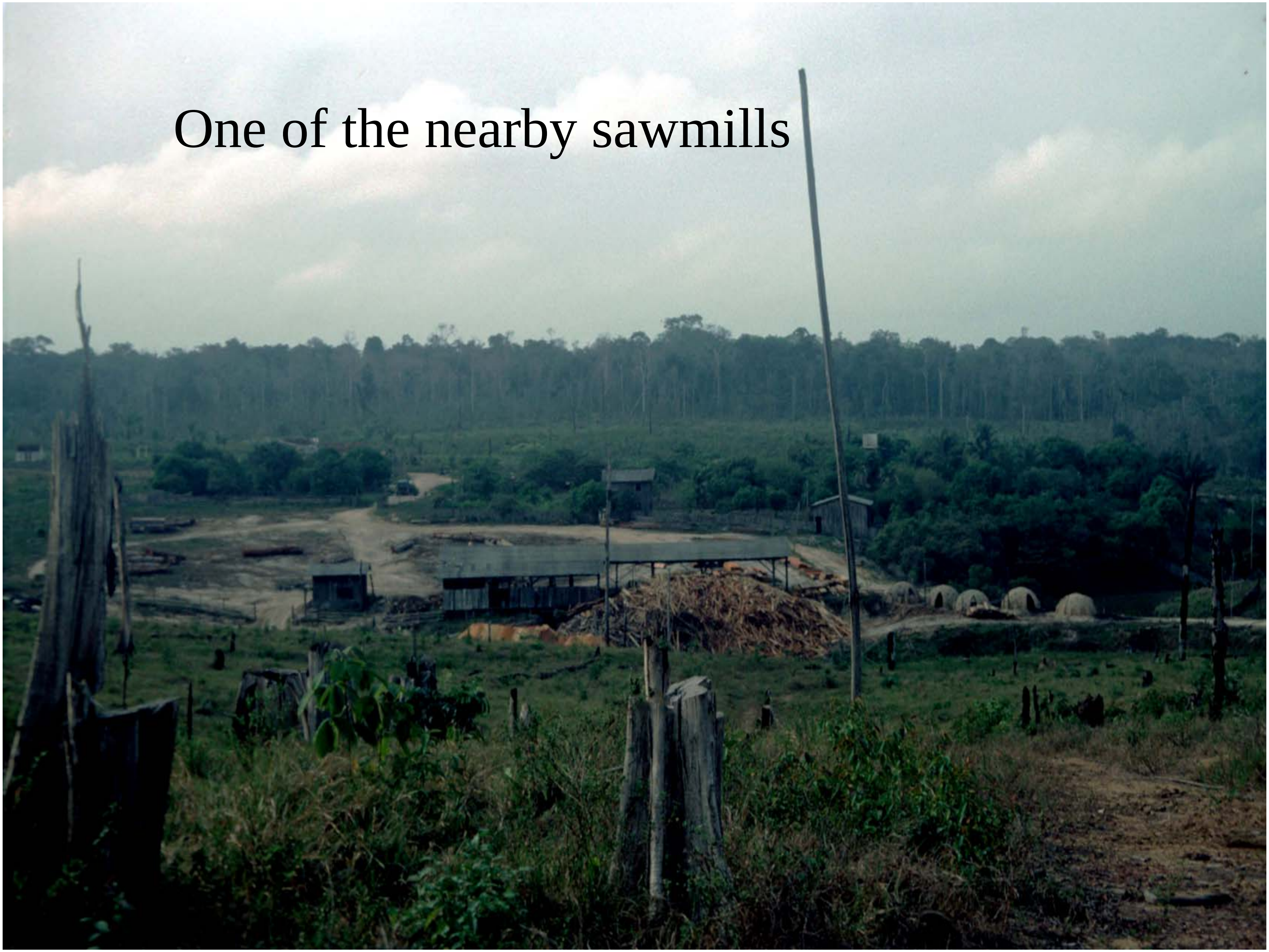

Highway PA-150

Community of Olho de Agua -

don’t bother looking for it on a map




Most of the community is
associated with logging.


One of the nearby sawmills


Smoke from small deforestation fire


Convection Plume -
Large-scale
deforestation fire


The end result of deforestation

It is necessary to burn every 2-3 years to keep the weeds (trees!) from taking over


Forest regeneration, killed by fire

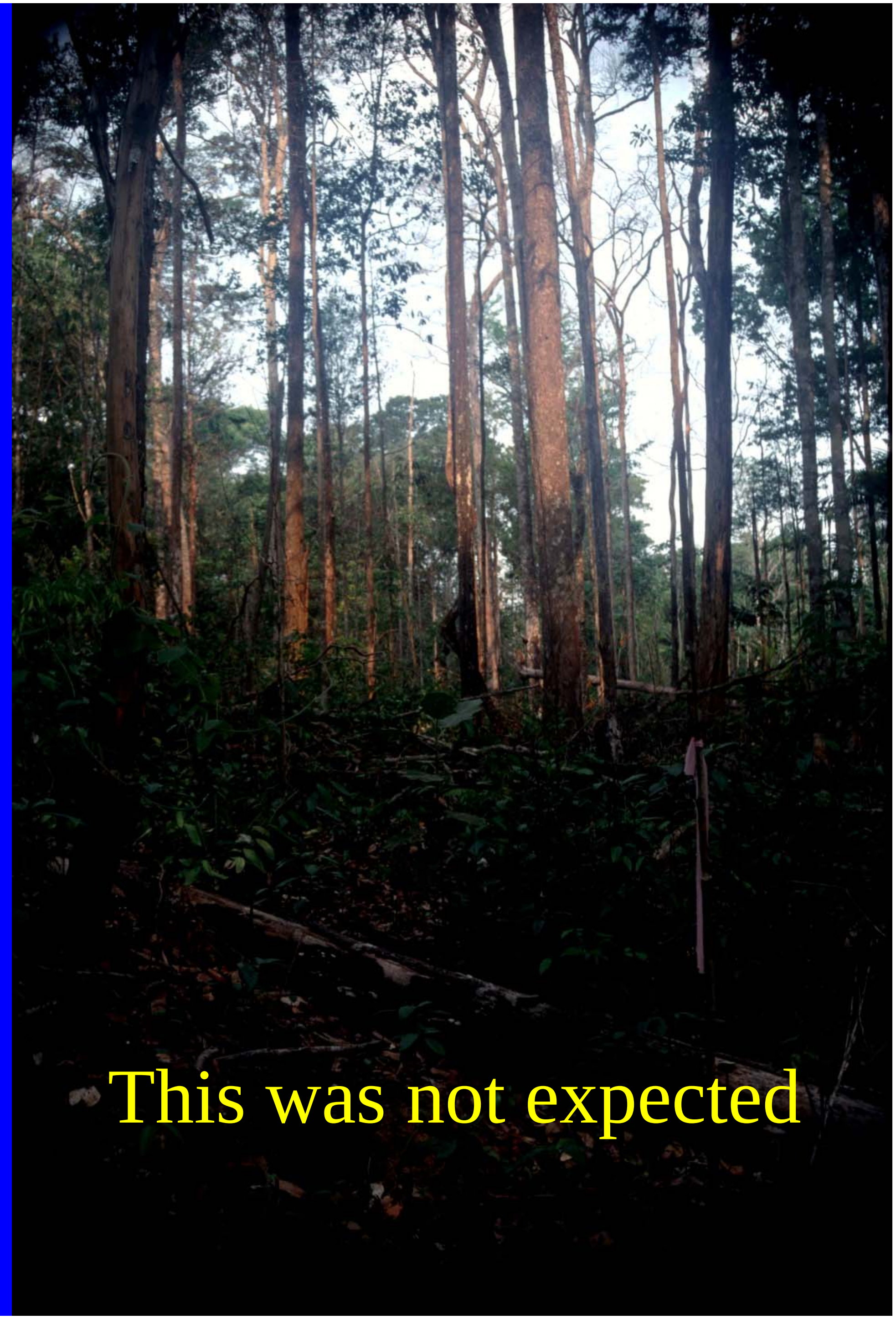

Desired result - good pasture


Accidental result -
Escaped fire into forest

This is what the forest should look like

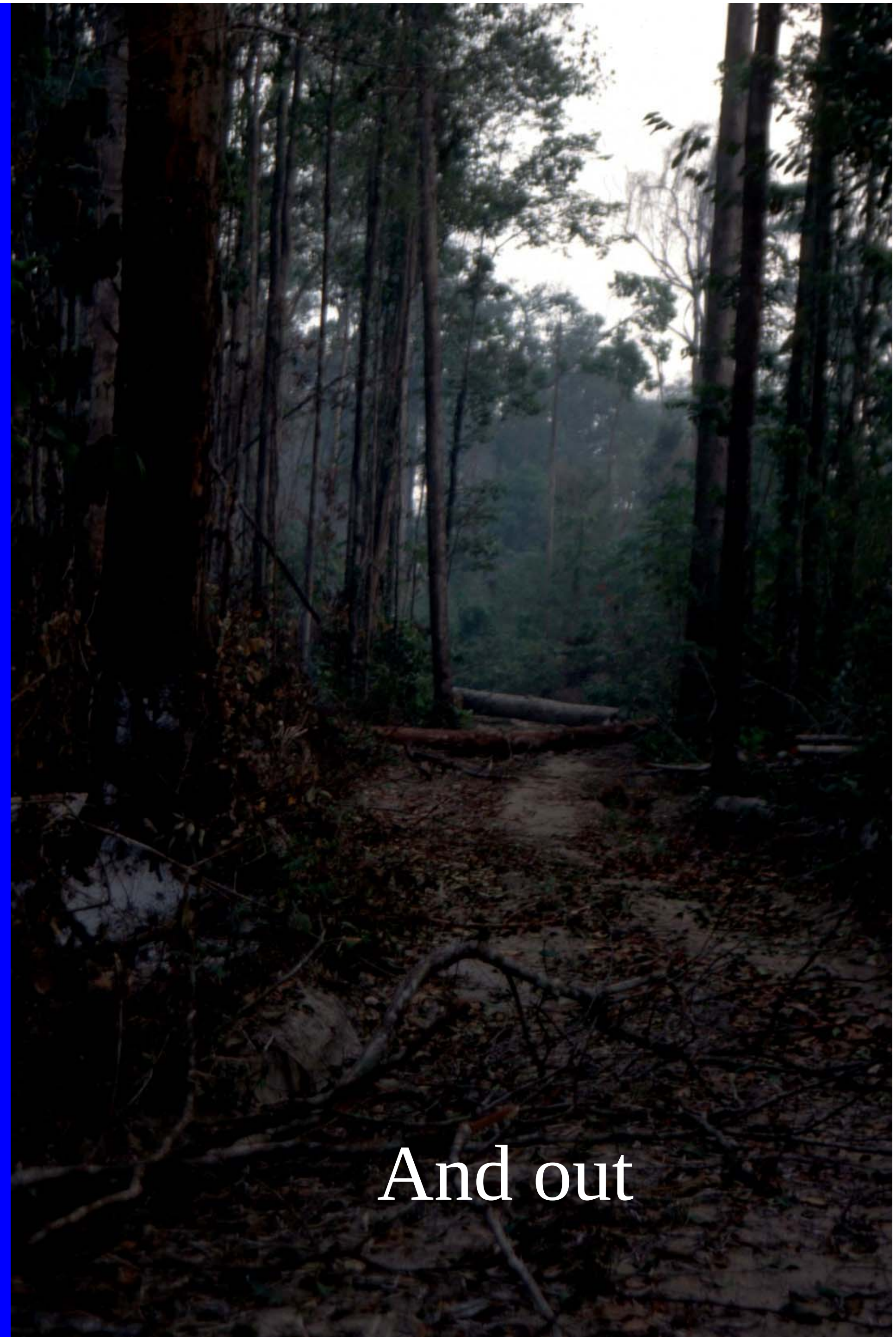

Travel can be tedious!


Forest that had
burned 1yr previous


Don’t forget to pack a chainsaw!

This was not expected


What is going on here?


Cut our way in


And out


Something is not right!

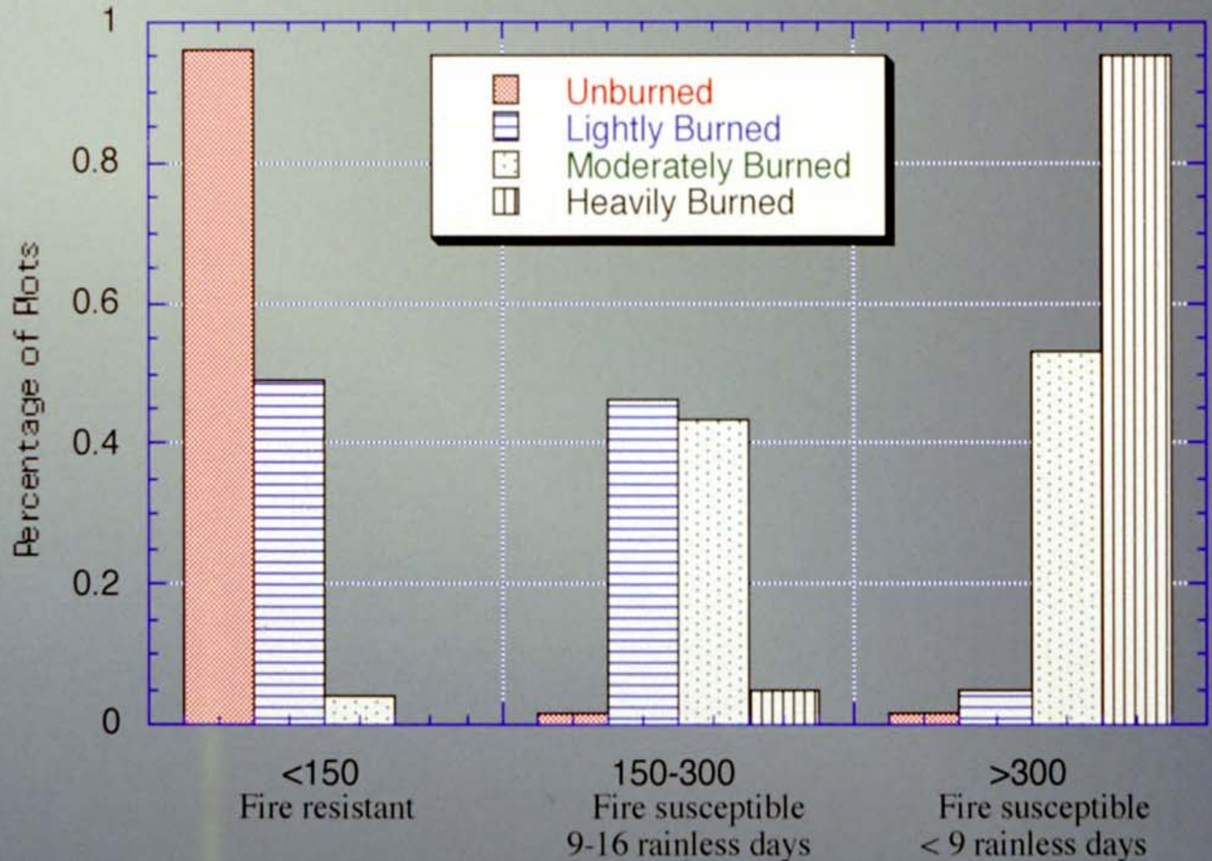
Deforestation can lead to severe erosion here too

The chainsaw didn't help!

This is not a pasture!

Trees were never cut - but live density was only 18 per hectare

Fire susceptibility of forest types

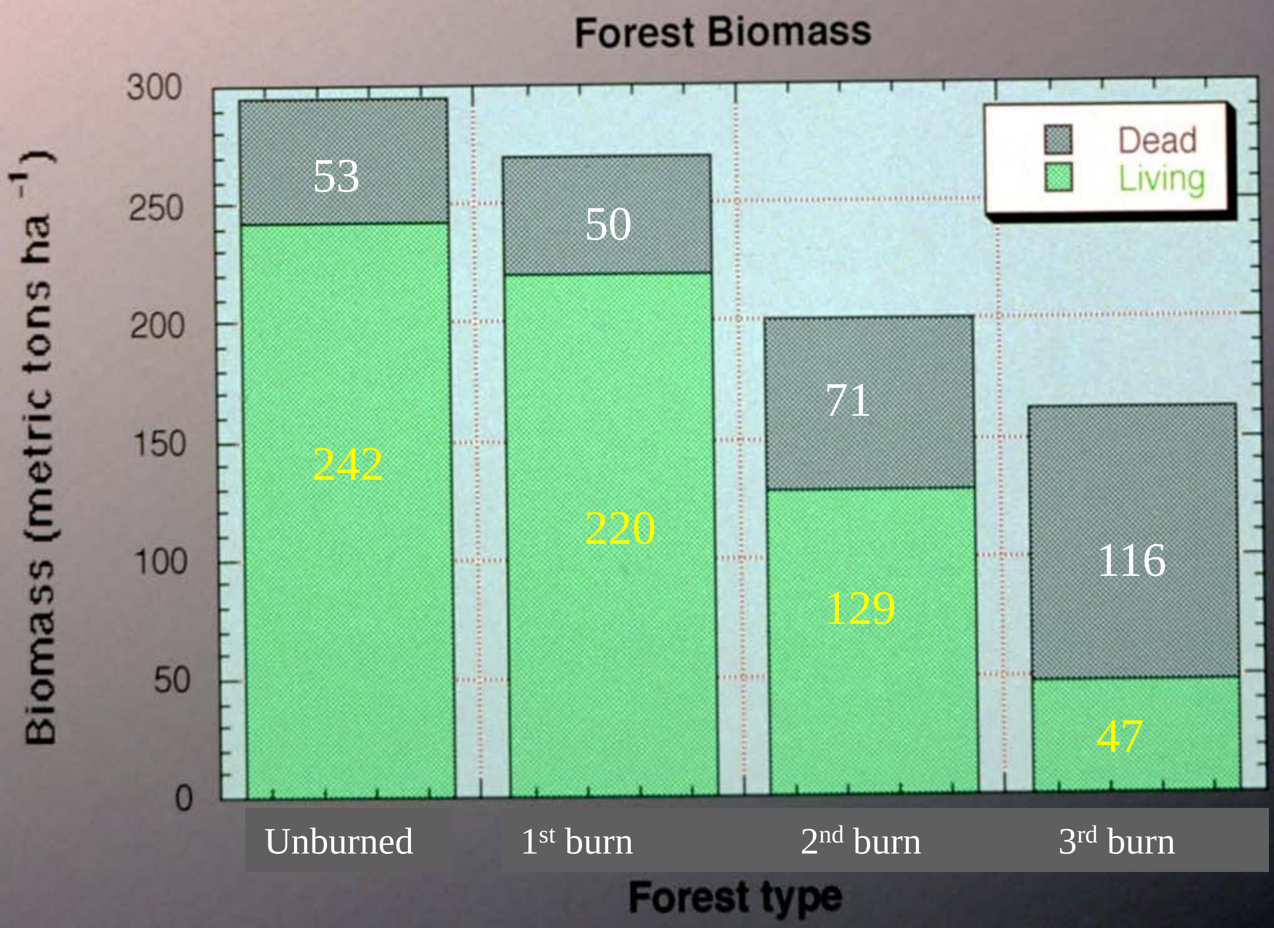


Rate of direct photon flux density (PFD in minutes of mol•m^{-2}•d^{-1}). Bar height relates the percentage of plots in each forest type to three separate ranges of PFD values. The three PFD ranges correspond to different fire susceptibilities (c.f. Holdsworth and Uhl 1997).

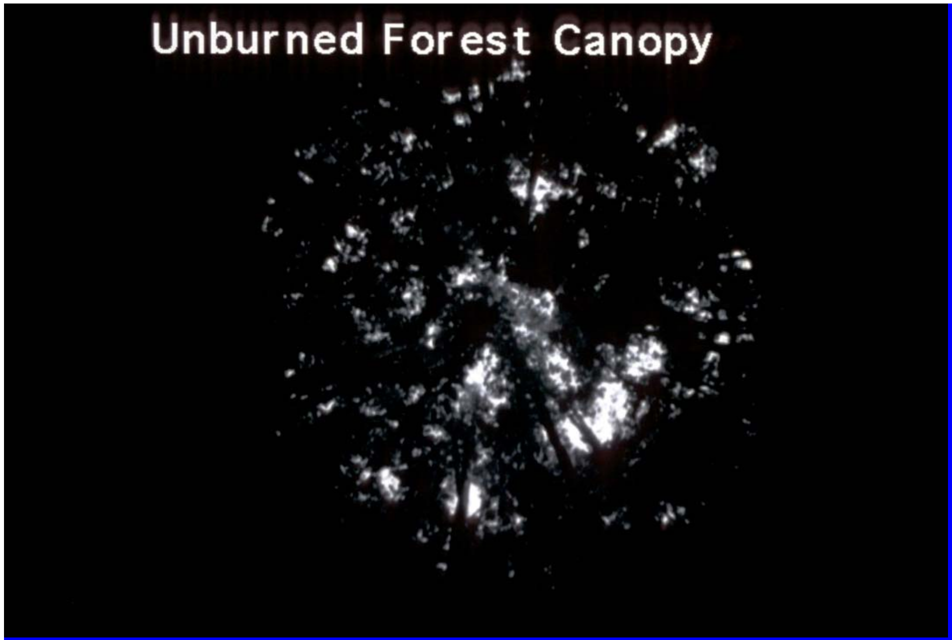
Cochrane and Schulze 1999

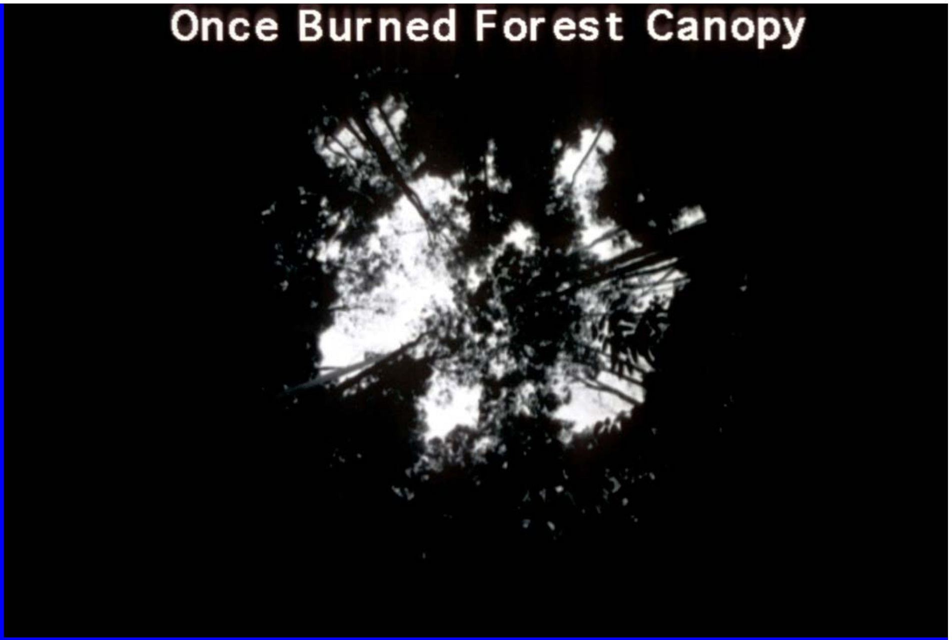

Burned
Unburned

Standing Biomass changes



Cochrane and Schulze 1999





Canopy degradation after successive fires

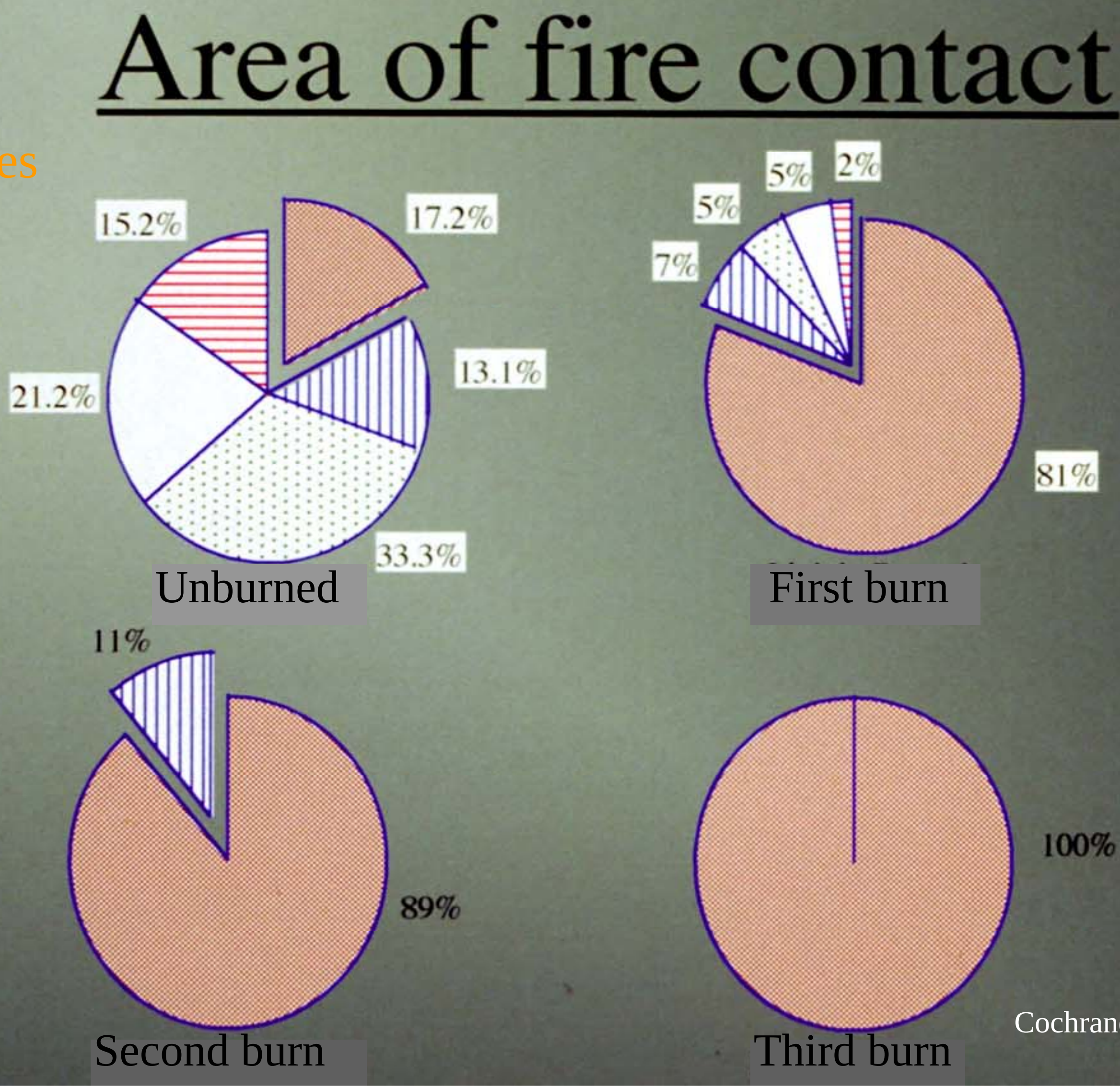
Average Canopy Cover by Forest Type

Cochrane and Schulze 1999

Fire contact roughly 80% of surface each event - remaining patches get fewer and smaller

Orange = no live vines

Other classes are 25. 50, 75 and 100 m^2 patches



Cochrane and Schulze 1999

In 1997 -- I had the misfortune of standing in my control plots when they burned

When handed lemons - make lemonade

We took the opportunity to collect primary data on the fire behavior

The fires didn't seem to impressive

Flame lengths were generally less than 10 cm

Spread rates were only 25cm/min


It didn’t take much to put them out


But, soon, there were a lot of fires


Everywhere we looked


For days on end

Time series of fire progression

These photos spanned approximately 8-12 minutes

Note the foreground: this same section of forest had burned a week or so previously!

The dense canopy holds the smoke in and prevents winds

This is analogous to a very stable atmosphere - canopy induced inversion

This makes the fires very uniform - well behaved fires!

Initial Forest Fires

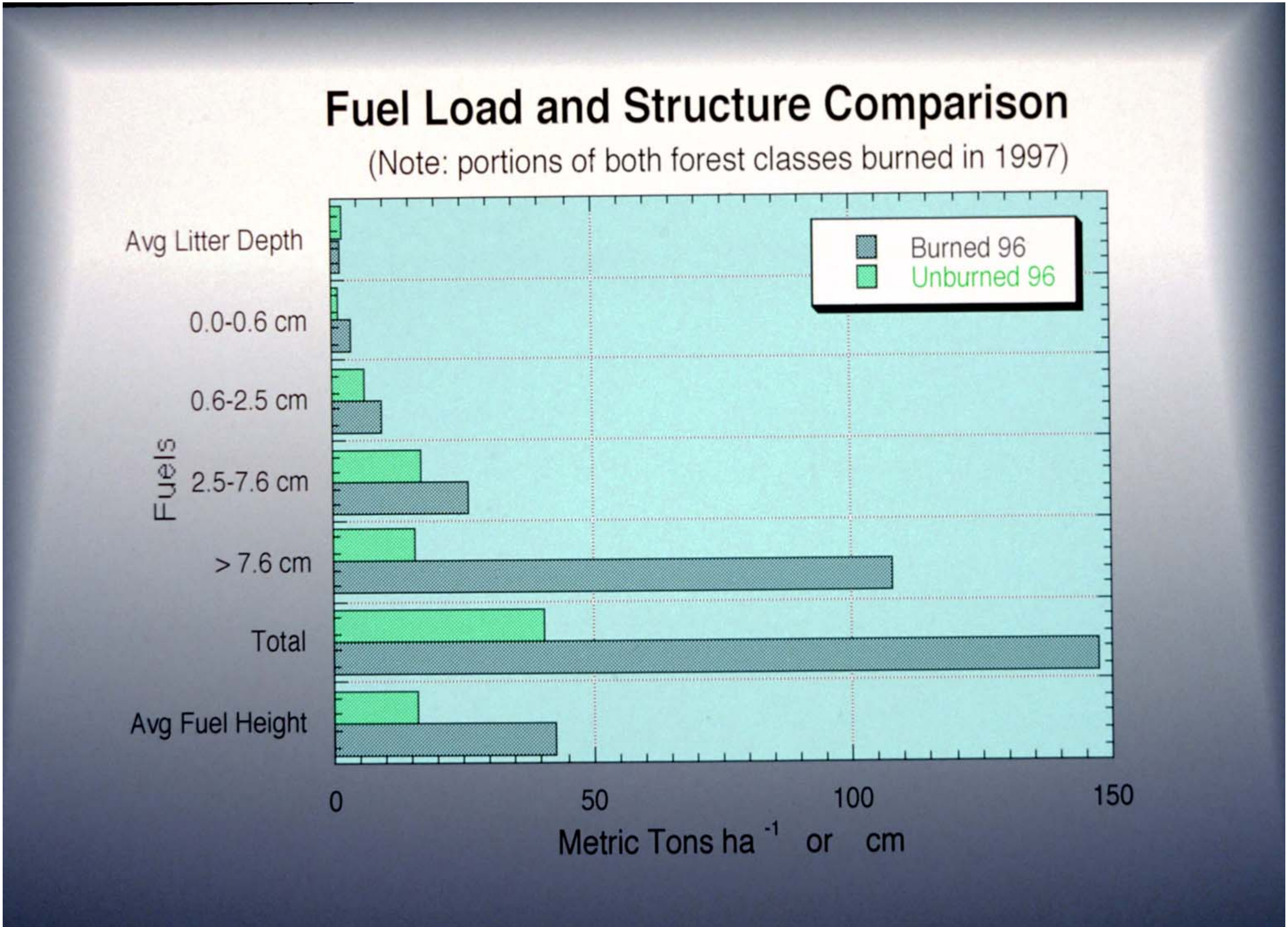
- Usually low intensity
- Spread slowly
- Unlikely detection using ‘Hot spots’
- Kill mostly trees <30 cm DBH
- Counter-intuitively increase fuel loads

Before and After Fire

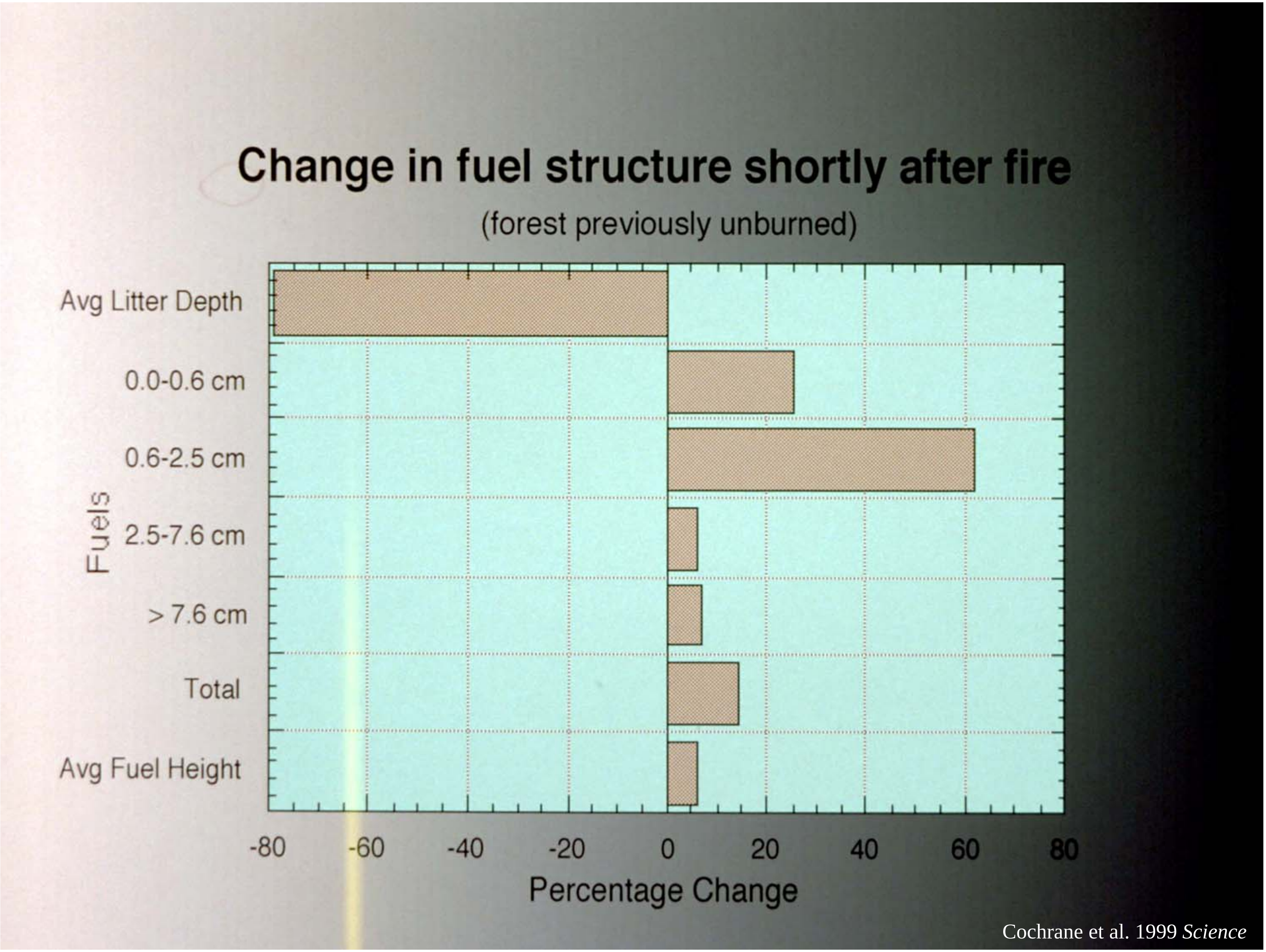
Fires spread in a daily cycle

Spreading fires self-extinguish each night as the litter layer reaches the moisture of extinction.

Fires hold over in smoldering 1000-hr fuels – start burning again the next morning once the RH drops and litter layers dry



Cochrane et al. 1999 *Science*


Change in fuel structure shortly after fire
(forest previously unburned)
Avg Litter Depth
0.0-0.6 cm
0.6-2.5 cm
2.5-7.6 cm
> 7.6 cm
Total
Avg Fuel Height
Fuels
-80
-60
-40
-20
0
20
40
60
80
Percentage Change
Cochrane et al. 1999 *Science*


The fires spread slowly but some animals don't escape

With such low intensity fires, minor scarring is expected


Long residence times can also cause charring


But, extensive burn
through of buttresses
and heavy charring
cannot be caused by
the observed fires

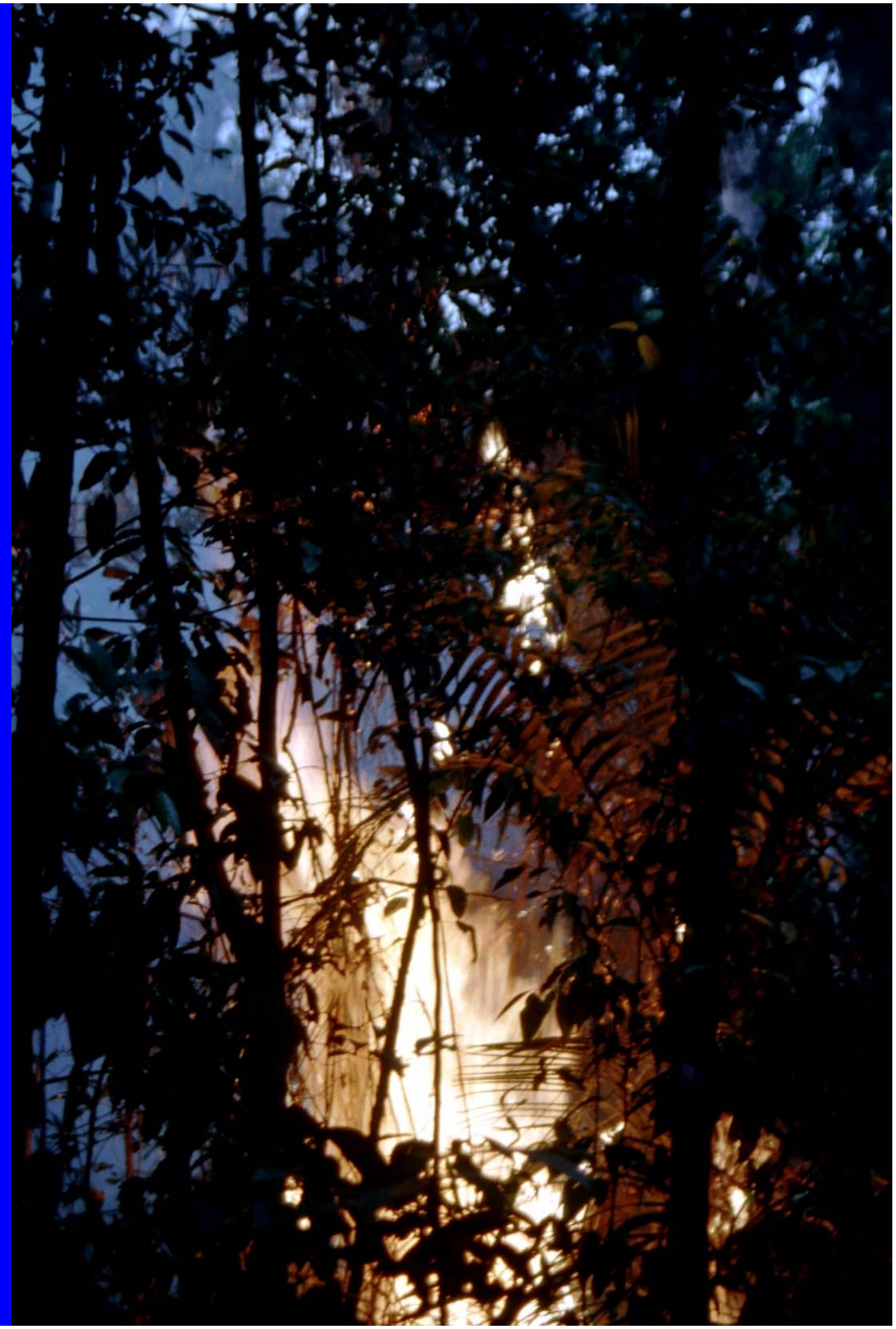
2-3+ meter fire scars!


Complete burns of large -- and small tree boles


Circular burnouts of many trees all the way to the bare mineral soil (blowing holes in the canopy)


AB





Re-ignition of fire – smoldering logs hold the fire overnight and re-ignite once the relative humidity levels drop sufficiently

Fires typically burn downed woody debris but green fuel involvement and periodic passive crowning can occur

This series of images depicts the burning of a massive (2m diameter) Sumauma tree

During the fire, firebrands were continually lofted above the canopy, starting spot fires up to at least 100m away as well as in 2 nearby tree crowns

All Fires Are Not Created Equal

- Recurrent fires and fires in logged forests are much more severe
- Probability of fire increases
- Intensity increases
- Mortality increases (kills even large trees)
- Fuel loads increase

Positive Feedbacks in Fuel Loading -- Fires Create Fuels

Fuel Class	*Unburned Forest*	*Once Burned Forest*	*Twice Burned Forest*
1-hr ($Mg \bullet ha^{-1}$)	1.3	3.3	6.6
10-hr ($Mg \bullet ha^{-1}$)	5.2	11.8	16.9
100-hr ($Mg \bullet ha^{-1}$)	16.8	36.8	40.1
1000-hr ($Mg \bullet ha^{-1}$)	15.5	124.9	106.1
Fuel height (cm)	15.8	47.8	60.2

Cochrane et al. 1999 *Science*

Positive Feedback in Fire Occurrence – each fire makes the next more likely

Distribution of 1997 fire	*Unburned Forest*	*Once Burned Forest*	*Twice Burned Forest*	*Thrice Burned Forest*
Area Burned (ha)	30,964	33,441	3196	30
Percentage of existing forest type that burned	22.7%	39.2%	47.8%	68.8%

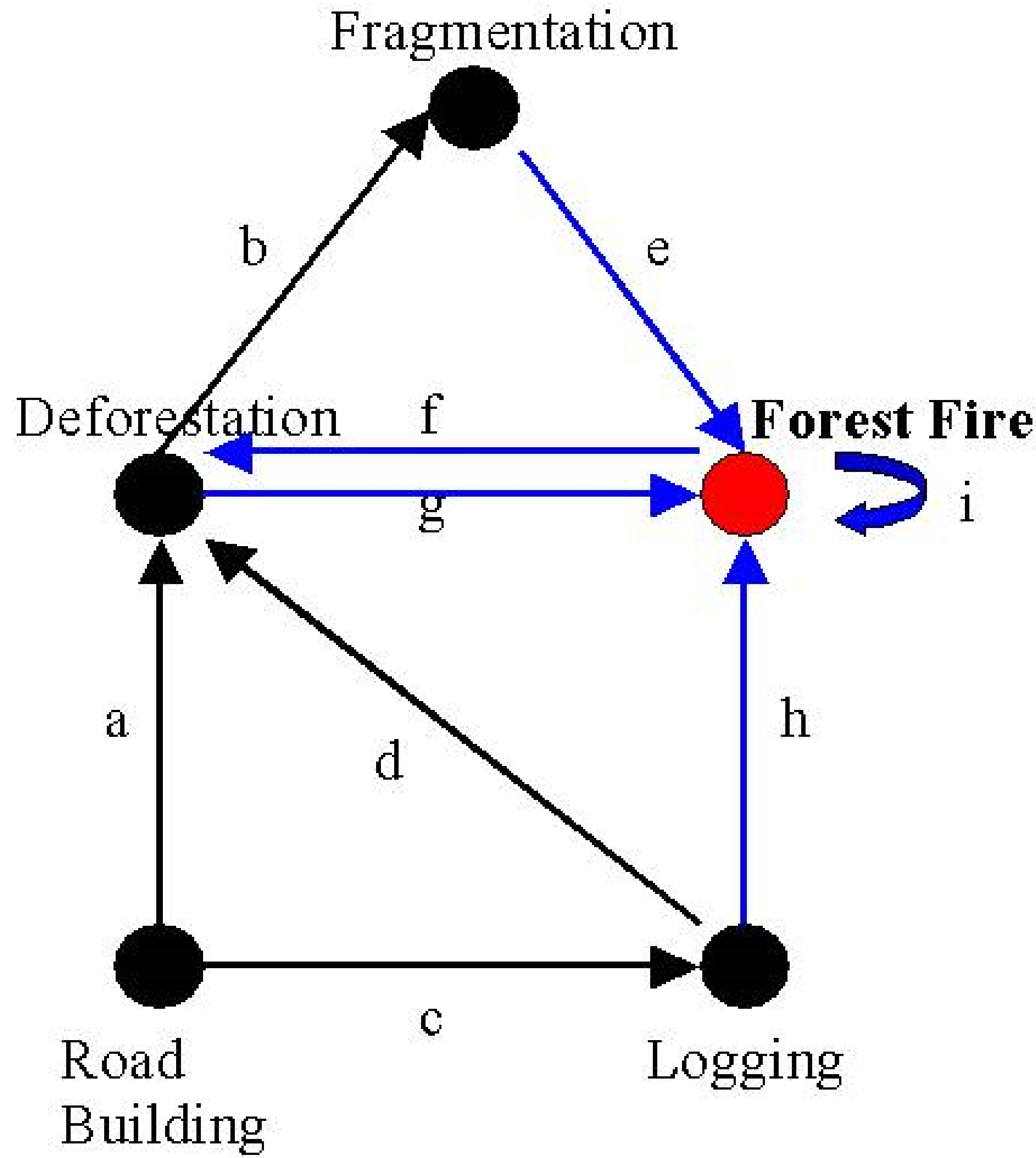
Cochrane et al. 1999 *Science*

Positive Feedbacks in Fire Behavior

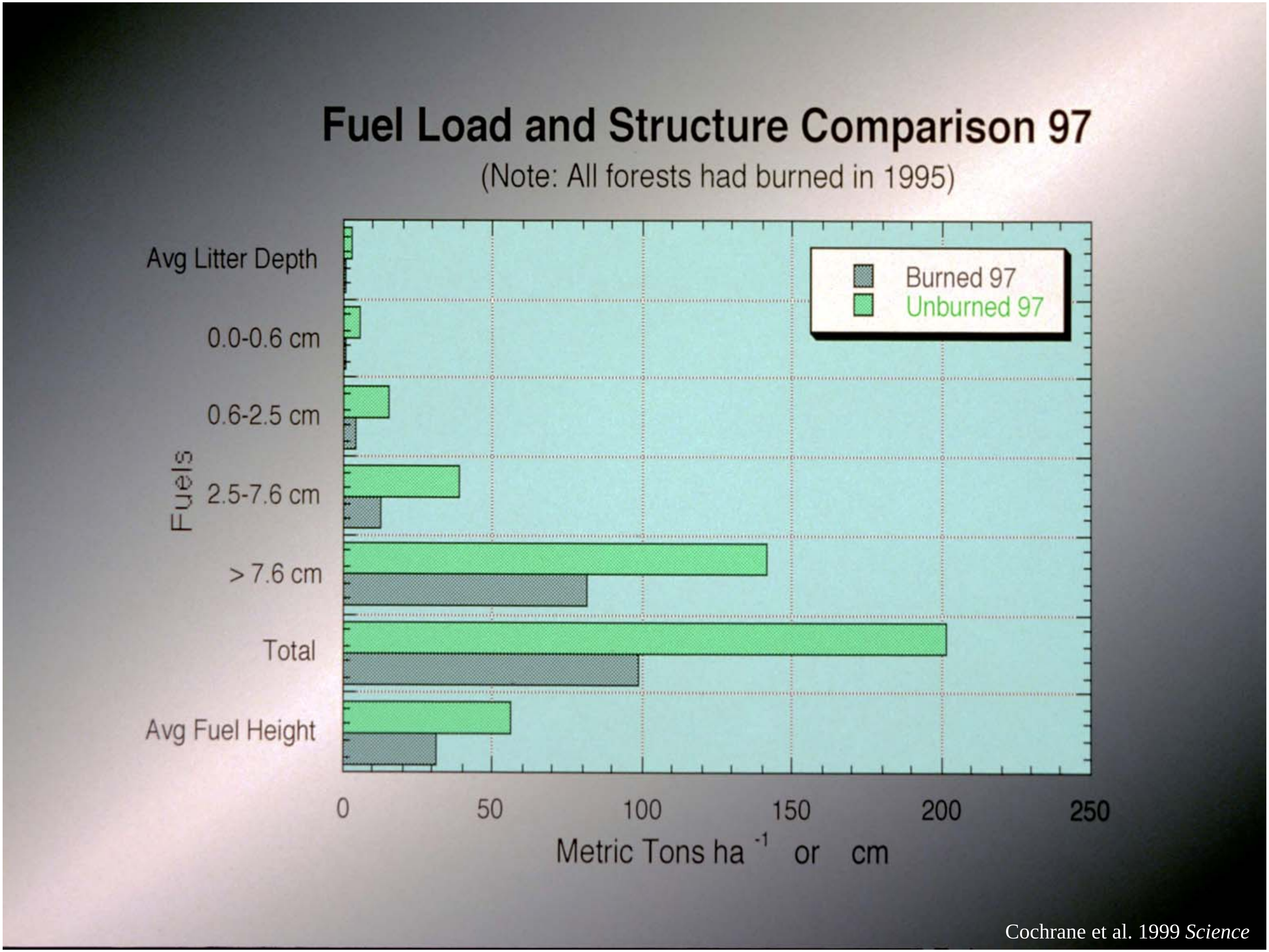
Fire Characteristics	*Once Burned Forest*	*Twice Burned Forest*	*Thrice Burned Forest*
Flame heights (m)	0.13-0.46	0.32-0.88	0.46-1.33
Flame depths (m)	0.08-0.2	0.18-0.49	0.29-0.99
Rate of spread ($m \bullet min^{-1}$)	0.25	0.33	0.52
Residence time (min)	0.32-0.80	0.49-1.39	0.66-2.27
Fireline intensity ($kW \bullet m^{-1}$)	4.4-55.0	82.5-412.2	94.2-728.3
Height of crown scorch (m)	0.3-1.9	2.4-8.2	4.6-17.2

Cochrane et al. 1999 *Science*

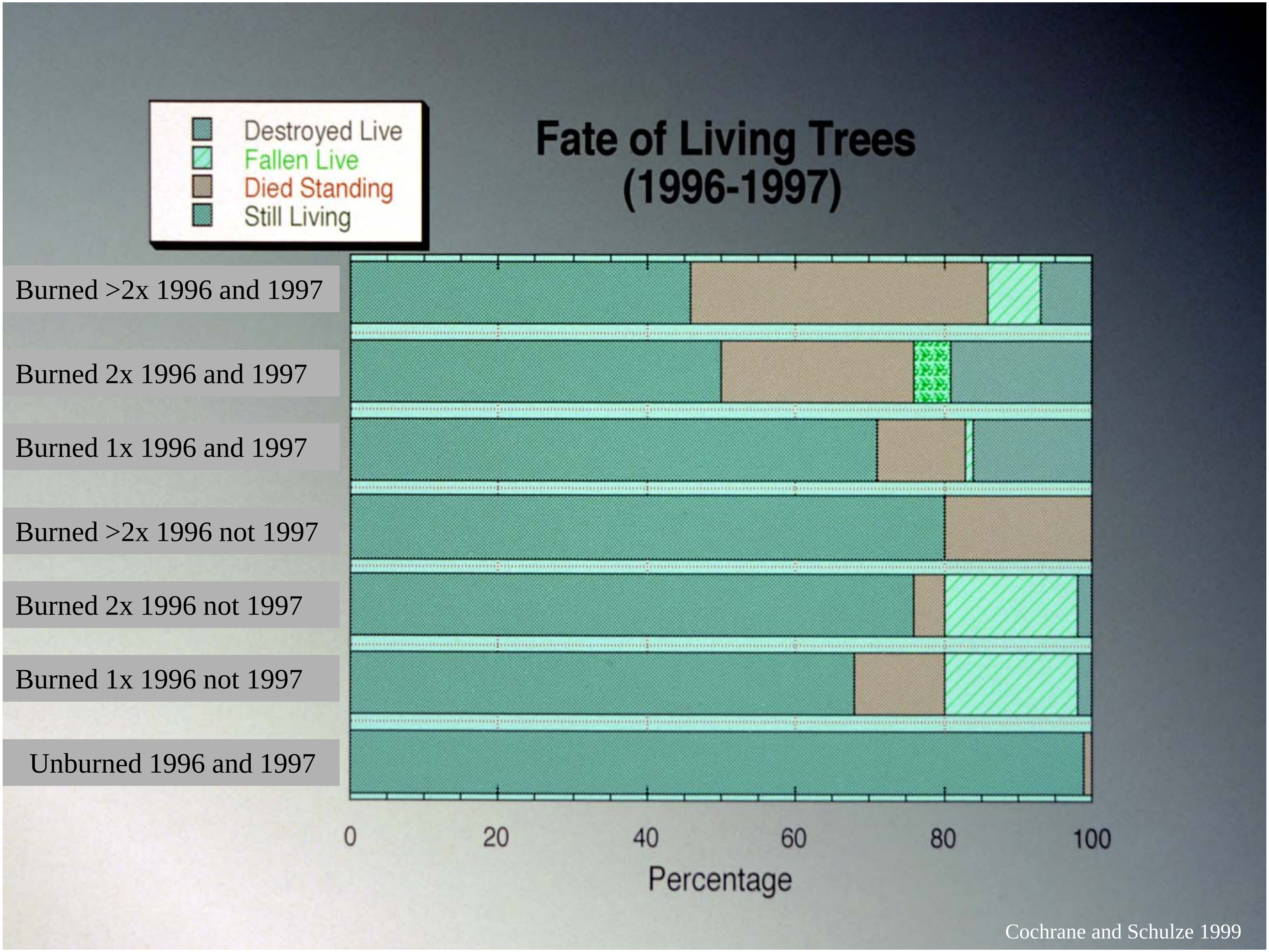
Feedbacks between land use, landscape characteristics and fire occurrence

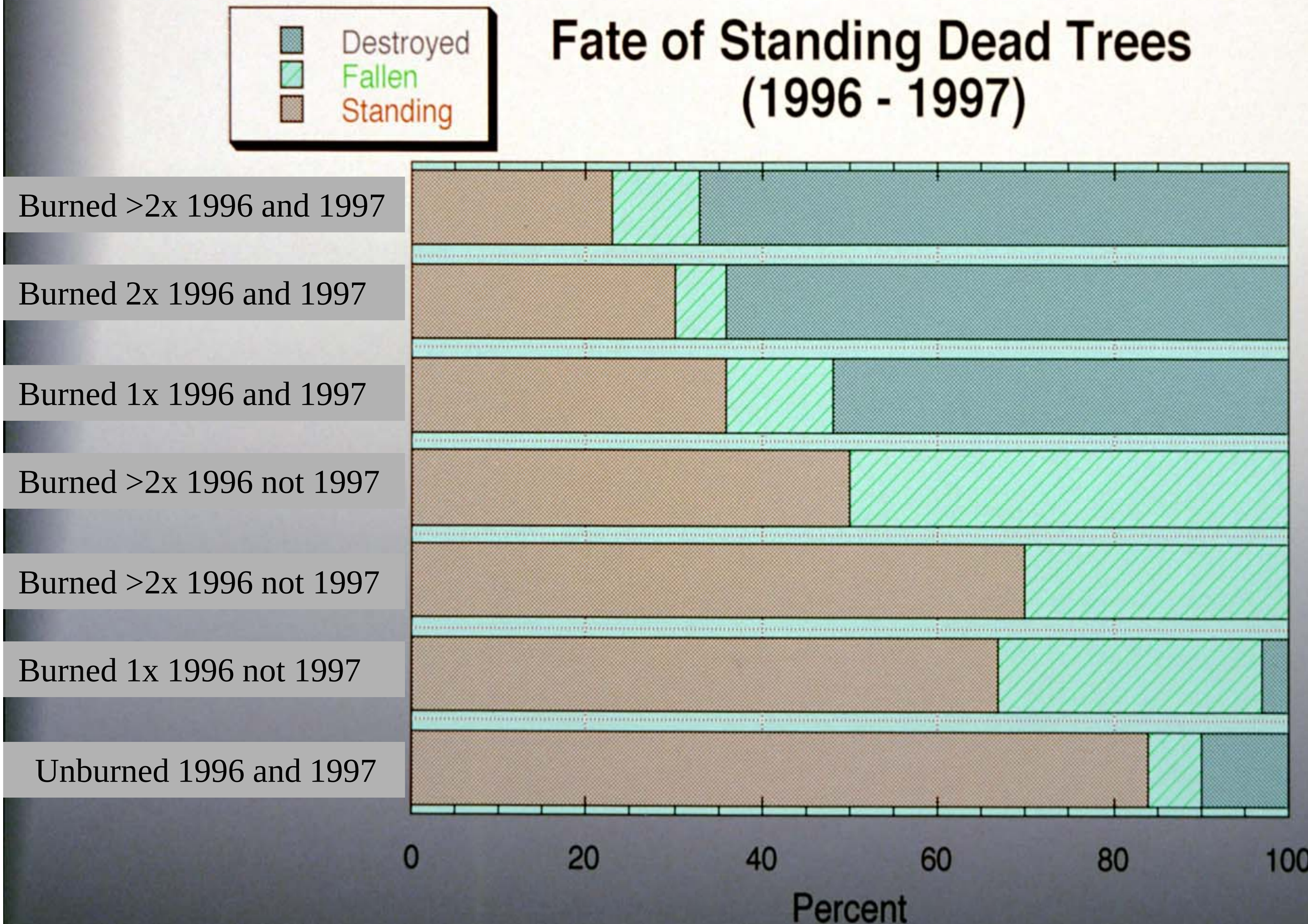


Cochrane 2003 *Nature*



Cochrane et al. 1999 *Science*


Fate of Living Trees
(1996-1997)
Destroyed Live
Fallen Live
Died Standing
Still Living
Burned >2x 1996 and 1997
Burned 2x 1996 and 1997
Burned 1x 1996 and 1997
Burned >2x 1996 not 1997
Burned 2x 1996 not 1997
Burned 1x 1996 not 1997
Unburned 1996 and 1997
0
20
40
60
80
100
Percentage
Cochrane and Schulze 1999

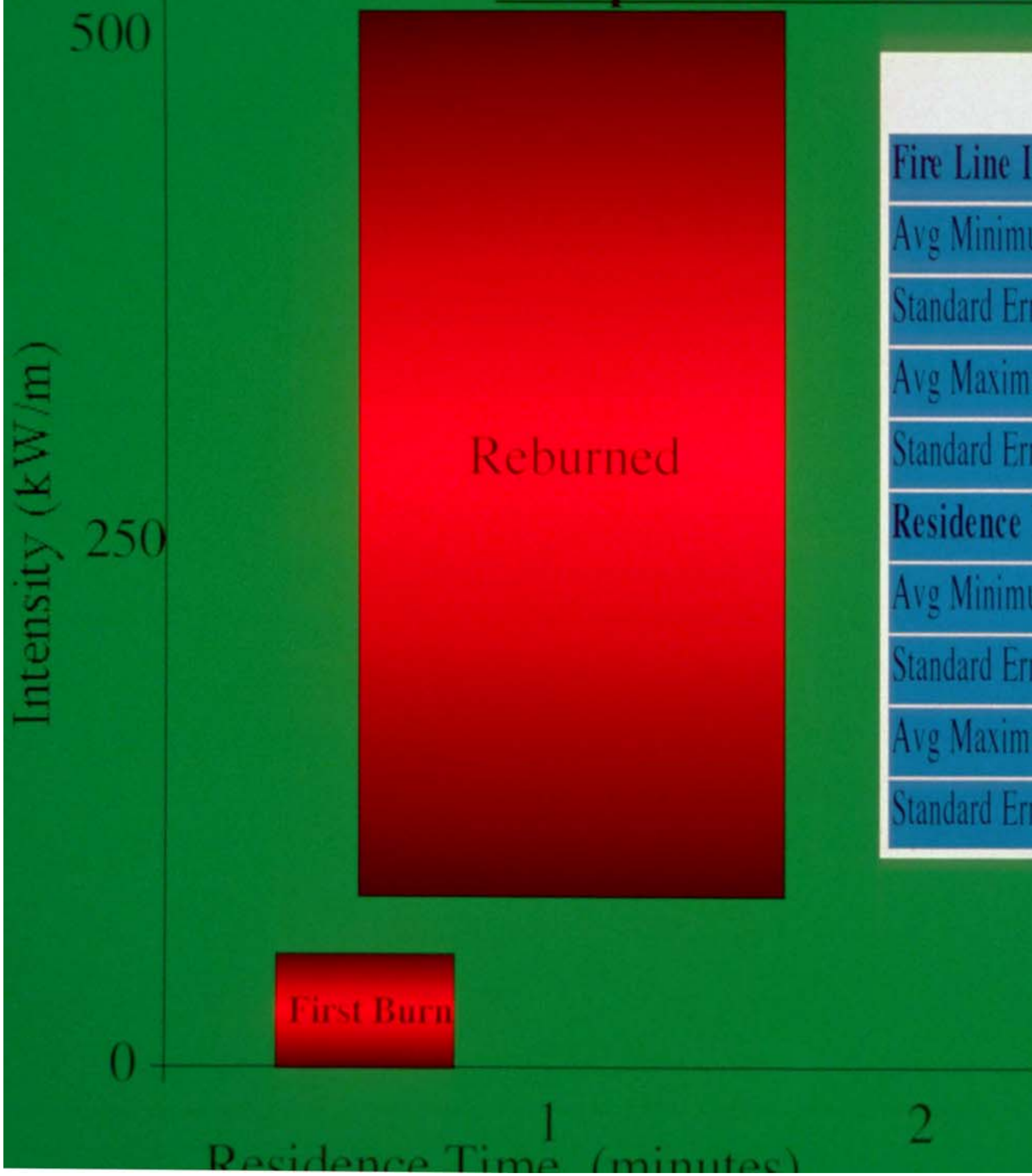


Cochrane and Schulze 1999

Percentage of observed fires by fire class and burn type

Fire Class	Fireline Intensity (kW/m)	Flame Height (meters)	First Burn	Flare	Reburn	Flare	Description
1	0 - 172	0 - 0.85	95 %	14 %	55 %	5 %	Most prescribed burns
2	172 - 344	0.85 - 1.15	5 %		14 %	14 %	Limit of control for manual attack methods
3	344 - 1720	1.15 - 2.36		9 %	23 %	23 %	Fires too intense for direct attack
4	1720 - 2408	2.36 - 2.9					Heat load on people within 30 ft dangerous
5	2408 - 3440	2.9 - 3.27			8 %		Above this intensity, spotting, firewhirls and crowning expected
6	>3440	>3.27				18 %	Severe fire behavior expected

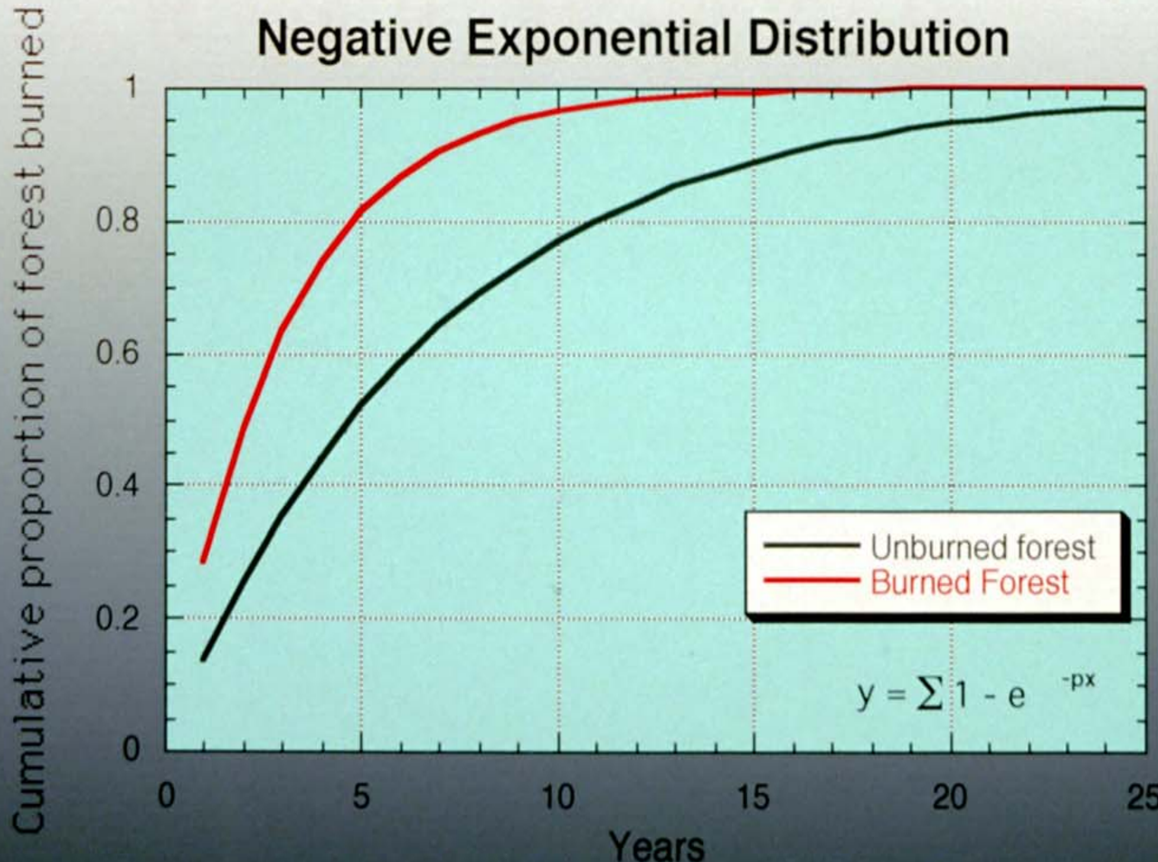
Comparison of Fire Characteristics



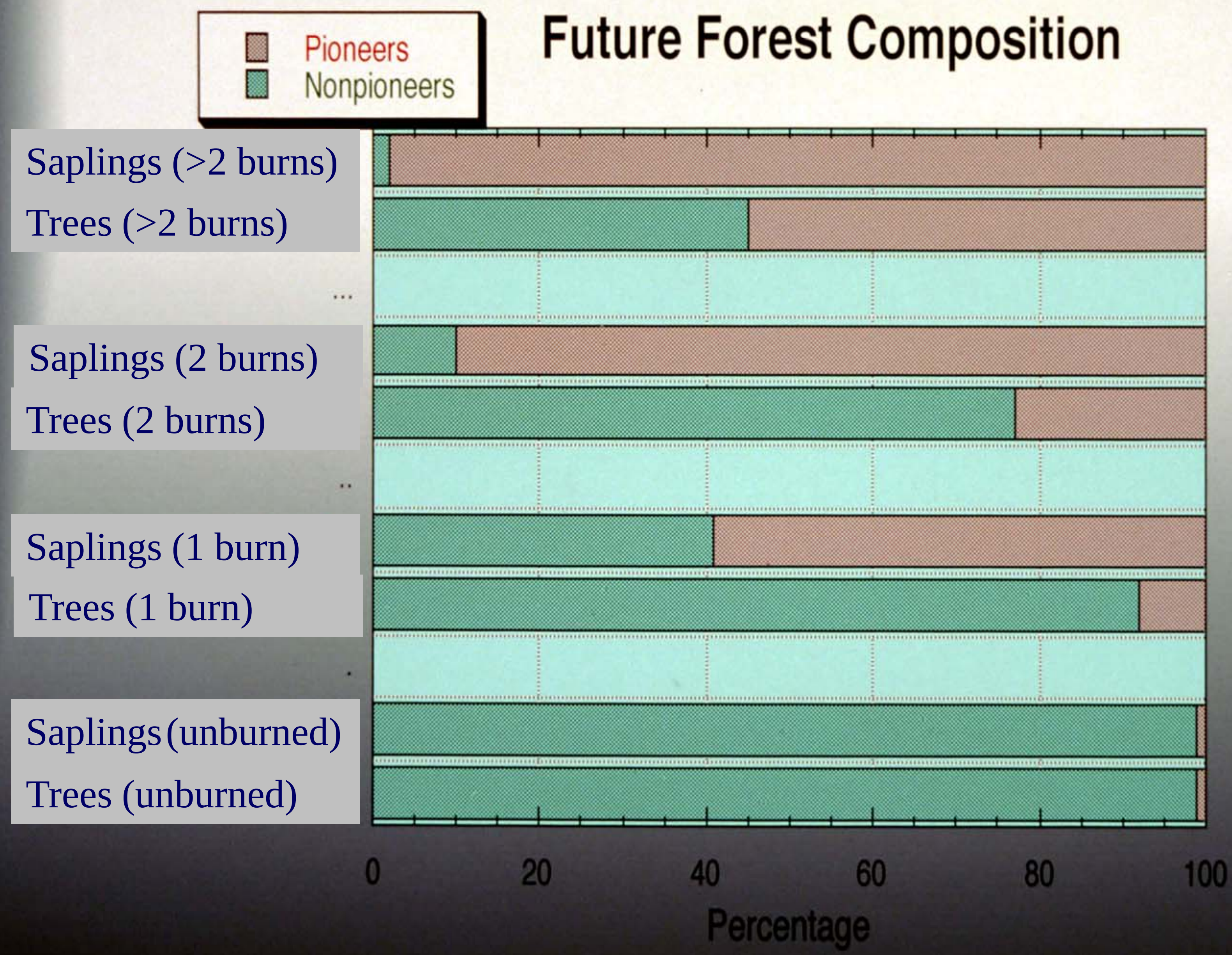
	First Burn	Reburned
Fire Line Intensity		
Avg Minimum*	4	87
Standard Error	1.5	34.1
Avg Maximum*	55	527
Standard Error	10.4	182.9
Residence Time		
Avg Minimum*	0.32	0.55
Standard Error	0.03	0.09
Avg Maximum**	0.80	1.71
Standard Error	0.04	0.27

* $p < 0.05$ ** $p < 0.005$

Time until a forest stand burns



Future of a hypothetical forest under the observed fire regime



Cochrane and Schulze 1998

Is Fire a Significant Disturbance in Tropical Forests?

To be significant, fire disturbance must :

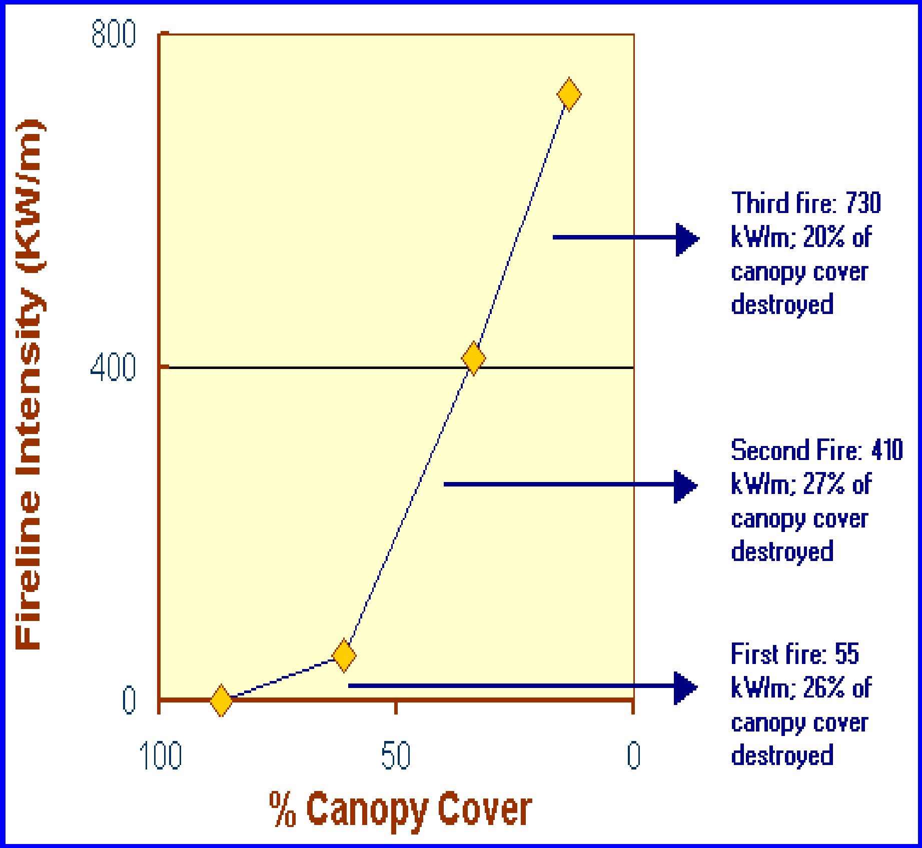
1. Substantially damage or modify forest structure and/or composition

2. Affect a reasonably large area

3. Be frequent enough to be more than a curiosity

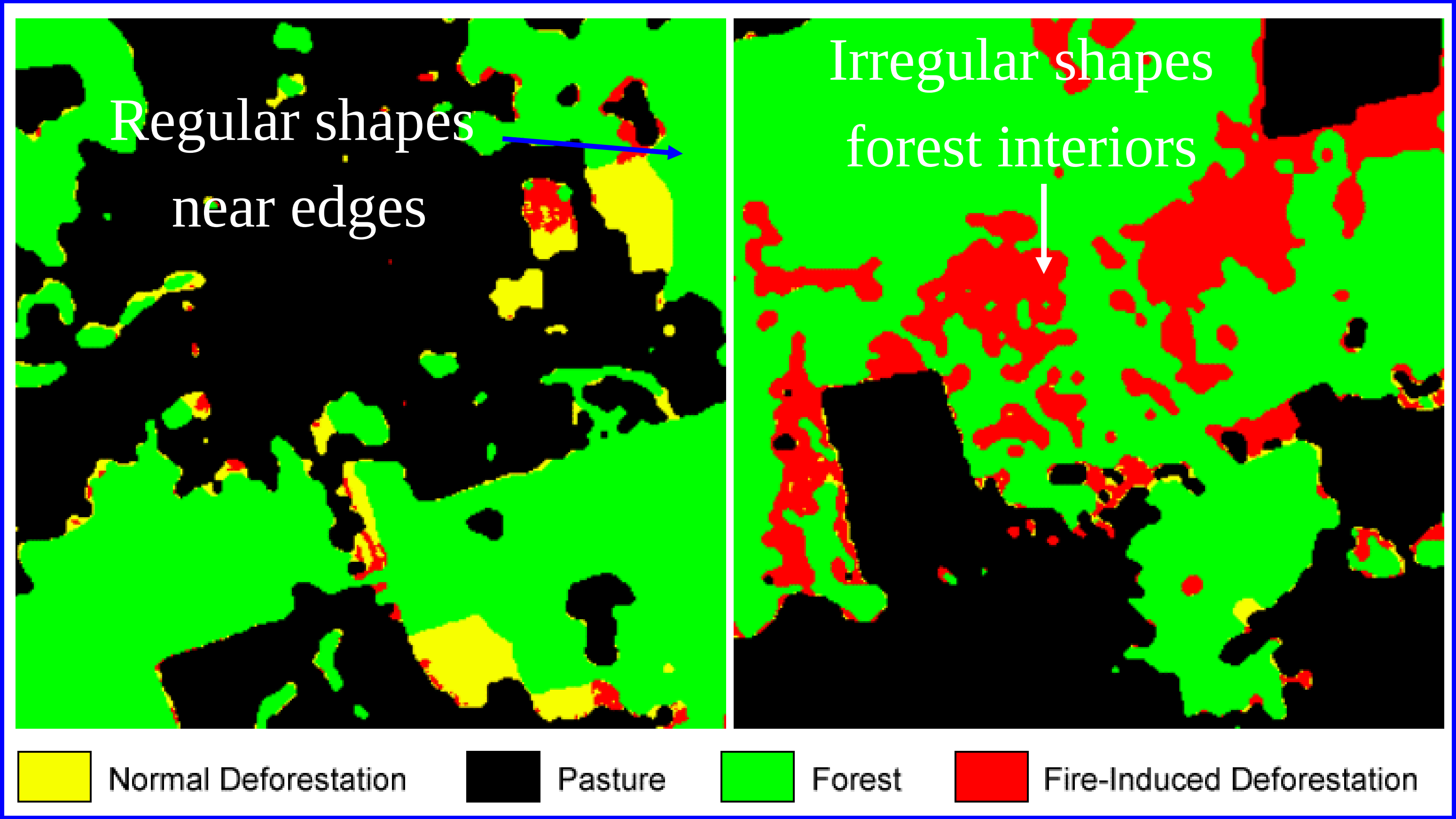
Fire and Forest Integrity

- Even low-intensity fires drastically reduce canopy cover.
- Increased canopy openess means more rapid drying.
- The first fire can kill 40% of the trees >10cm DBH but only 10% of the biomass.
- The second fire can kill another 40% of the trees but this time corresponding to 40% of the biomass
- A positive feedback of increasing susceptibility and fire severity can deforest a region



Cochrane 2001

Fire-induced Deforestation

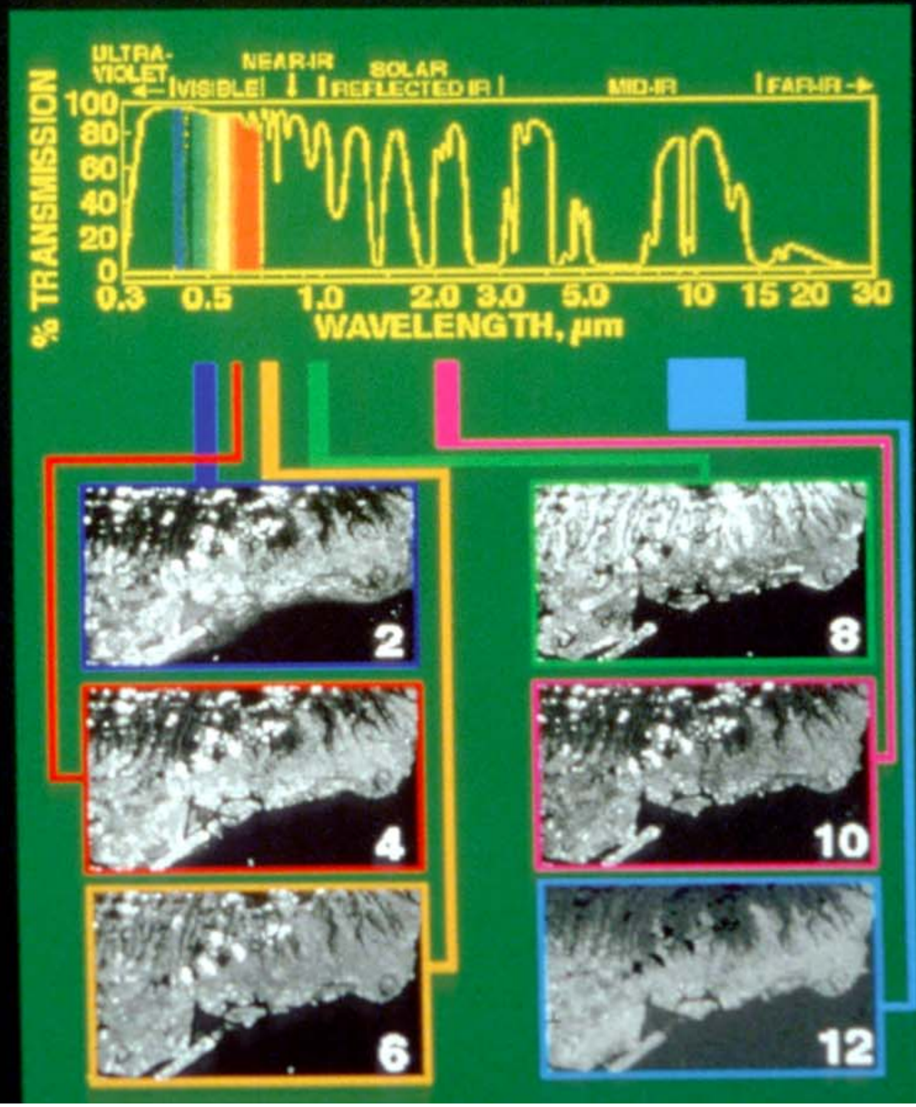


Cochrane et al. 1999 *Science*

The Problem

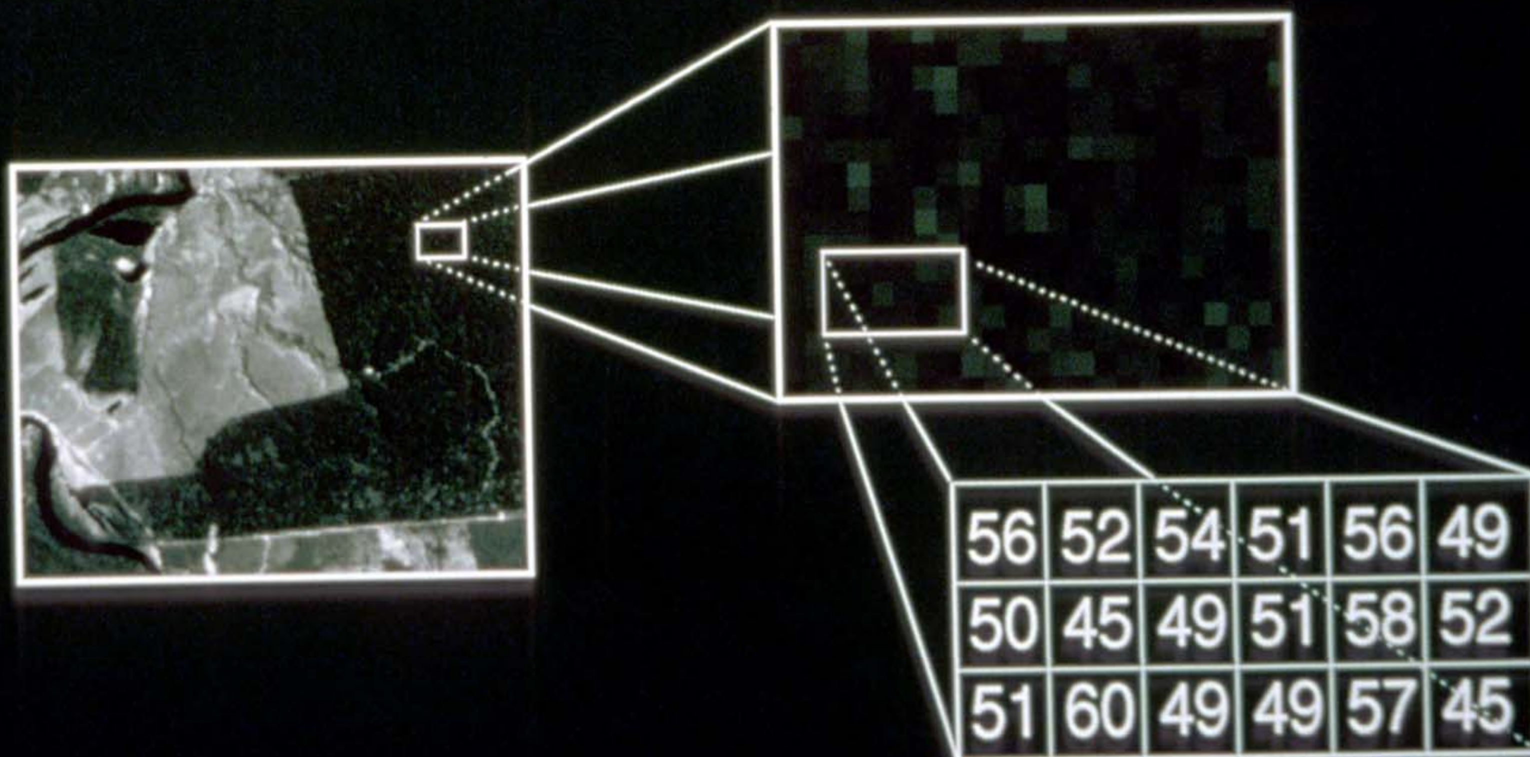
- We have a disturbance we want to quantify
- BUT, the fires are very small, under the dense canopy and ephemeral
- The fires cause definite structural and compositional changes to the forest
- BUT, the forest is still VERY green!
- And the canopy changes are generally smaller than the resolution of Landsat
- **How can we ‘see’ something that is smaller than the smallest thing (pixel) in the image?**

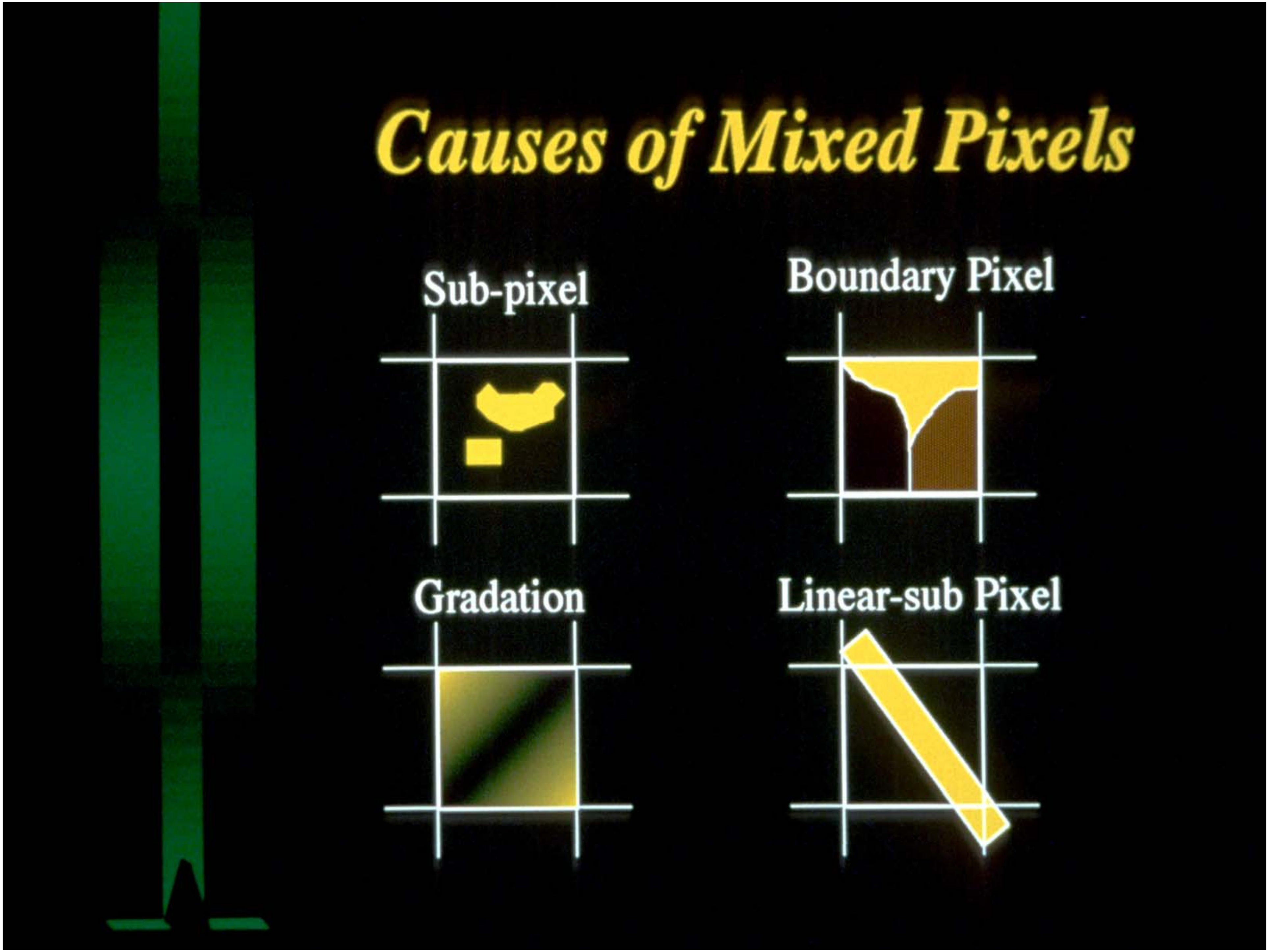
Remote Sensing Concepts



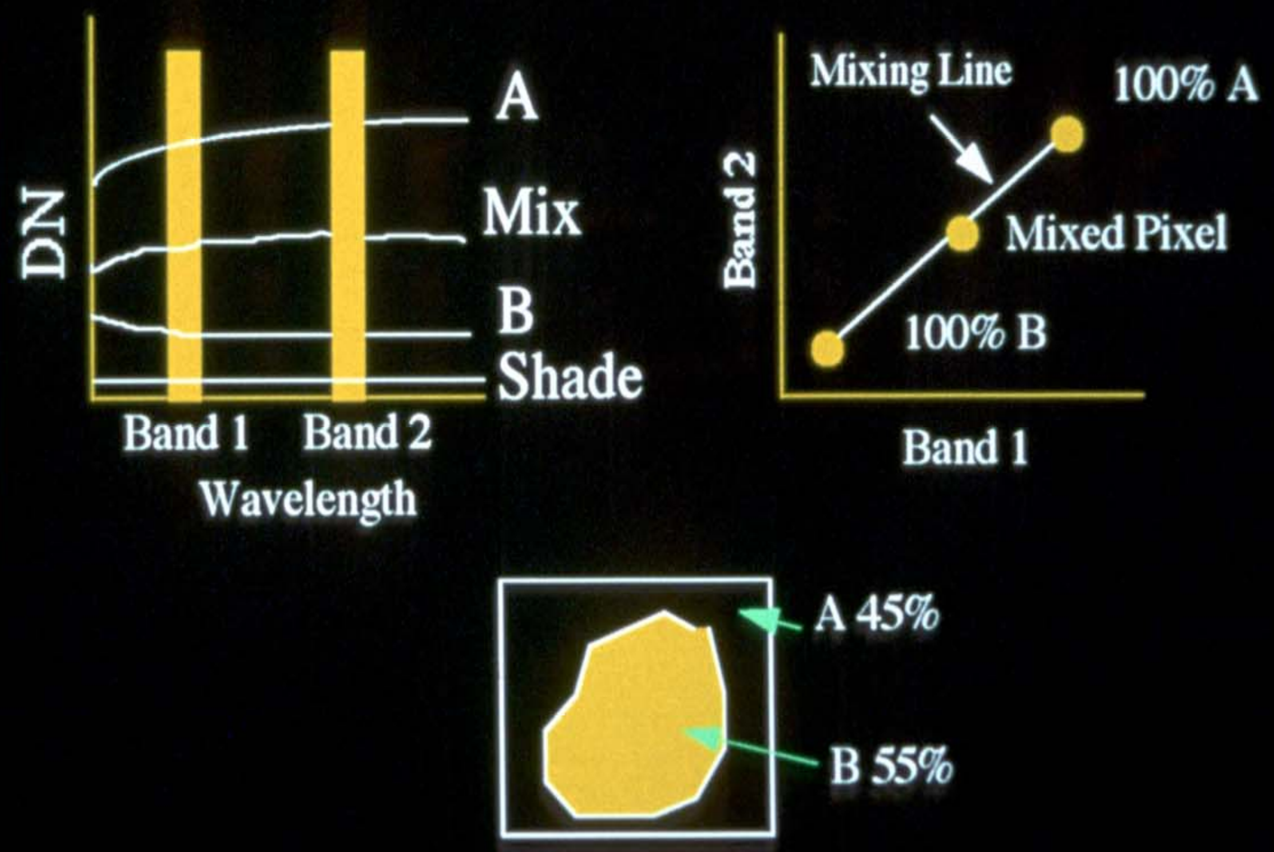
Remote Sensing Concepts

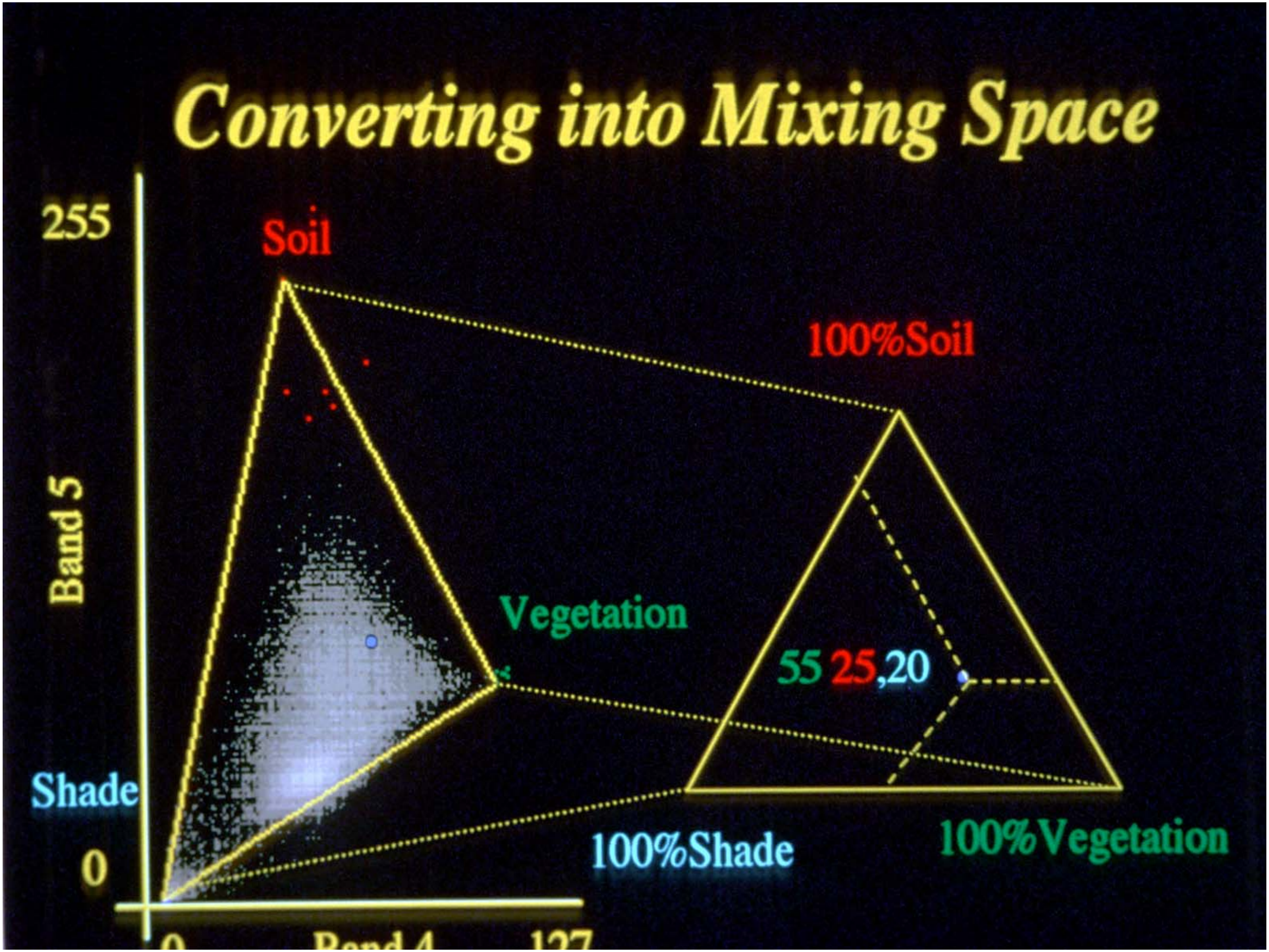
- Pixel, Digital Number and Resolution:



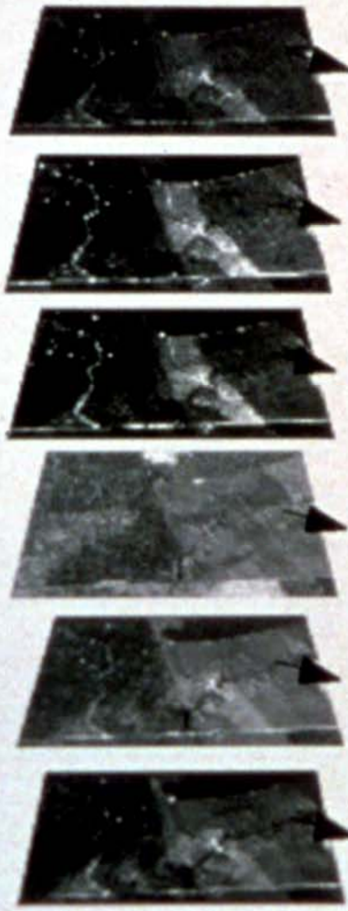

Causes of Mixed Pixels
Sub-pixel
Boundary Pixel
Gradation
Linear-sub Pixel

Mixing Assumption




Converting into Mixing Space
255
Soil
Band 5
Vegetation
Shade
0
0
Band 4
127
100%Soil
55 25,20
100%Shade
100%Vegetation

Linear Mixing Model



Band 1 — $DN_{1n} = Fveg*Veg + Fsoil*Soil + Fshade*Shade + error$

Band 2 — $DN_{2n} = Fveg*Veg + Fsoil*Soil + Fshade*Shade + error$

Band 3 — $DN_{3n} = Fveg*Veg + Fsoil*Soil + Fshade*Shade + error$

Band 4 — $DN_{4n} = Fveg*Veg + Fsoil*Soil + Fshade*Shade + error$

Band 5 — $DN_{5n} = Fveg*Veg + Fsoil*Soil + Fshade*Shade + error$

Band 7 — $DN_{7n} = Fveg*Veg + Fsoil*Soil + Fshade*Shade + error$

$$\boxed{Fveg + Fsoil + Fshade = 1}$$

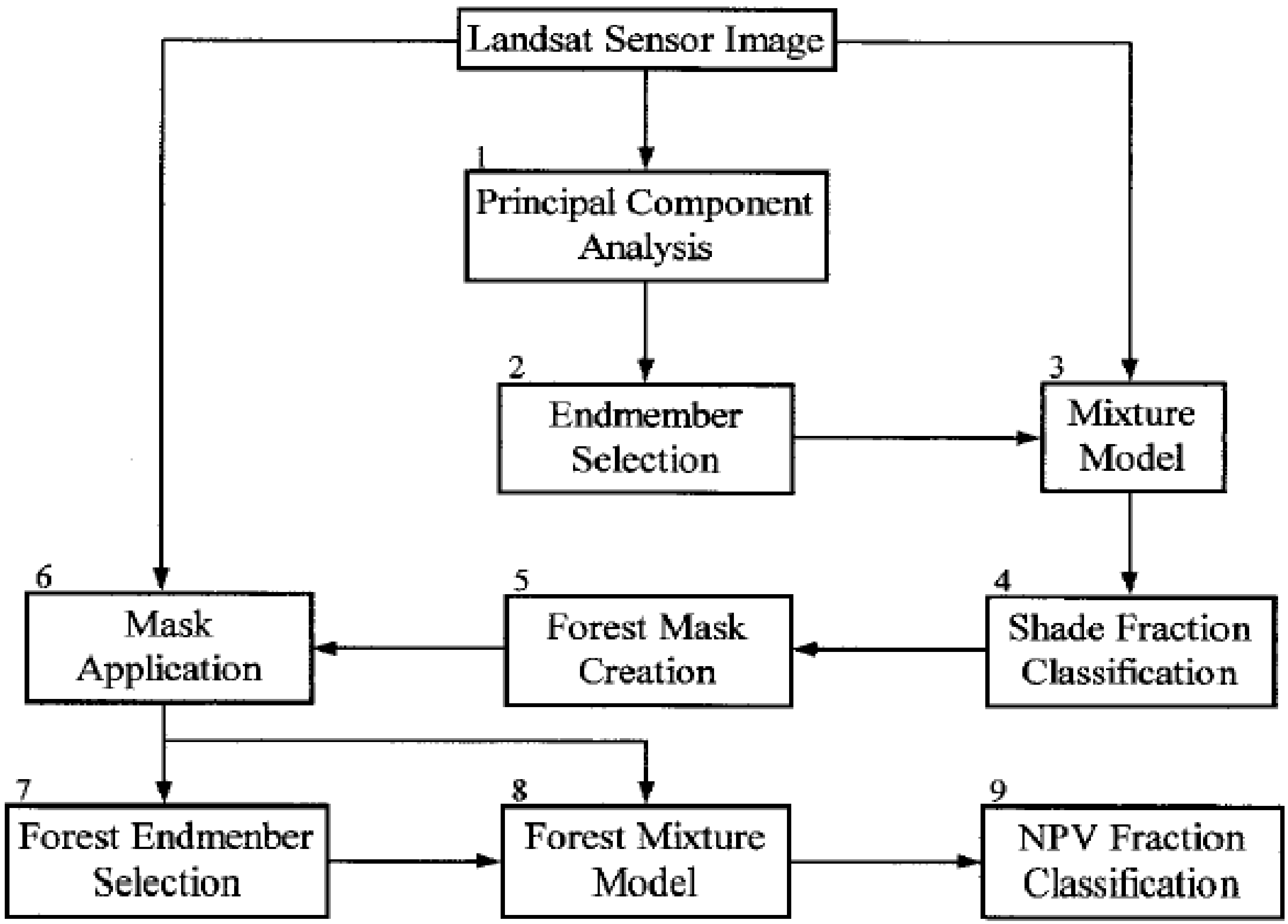
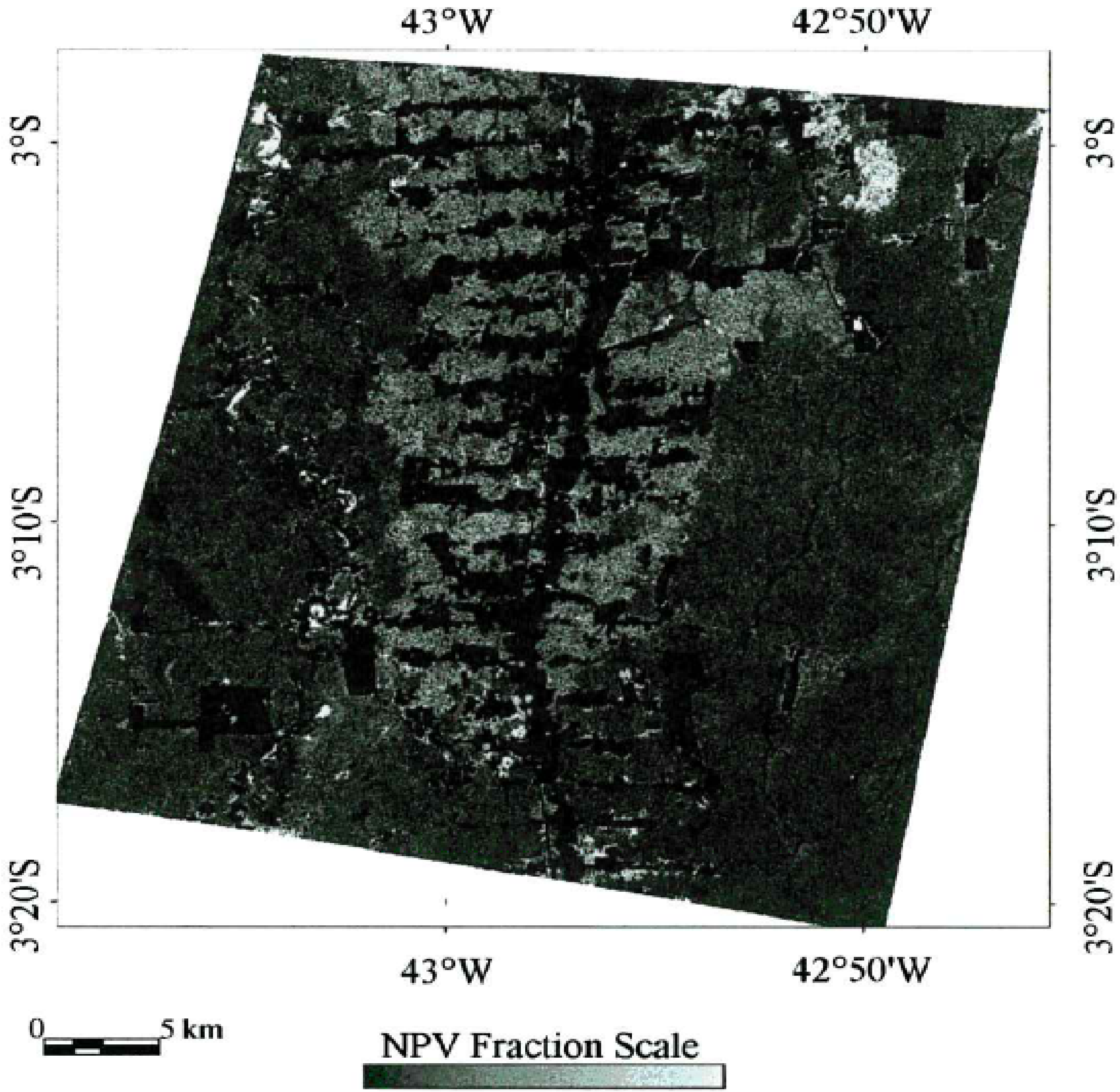


Figure 1. Flow chart of the image processing methodology.

Cochrane and Souza 1998

Fractional image of a 1280 km^2 section of forest in the vicinity of Tailândia, Pará, in the Brazilian Amazon.

NPV is non-photosynthetic vegetation (i.e. dead vegetation)



Cochrane and Souza 1998

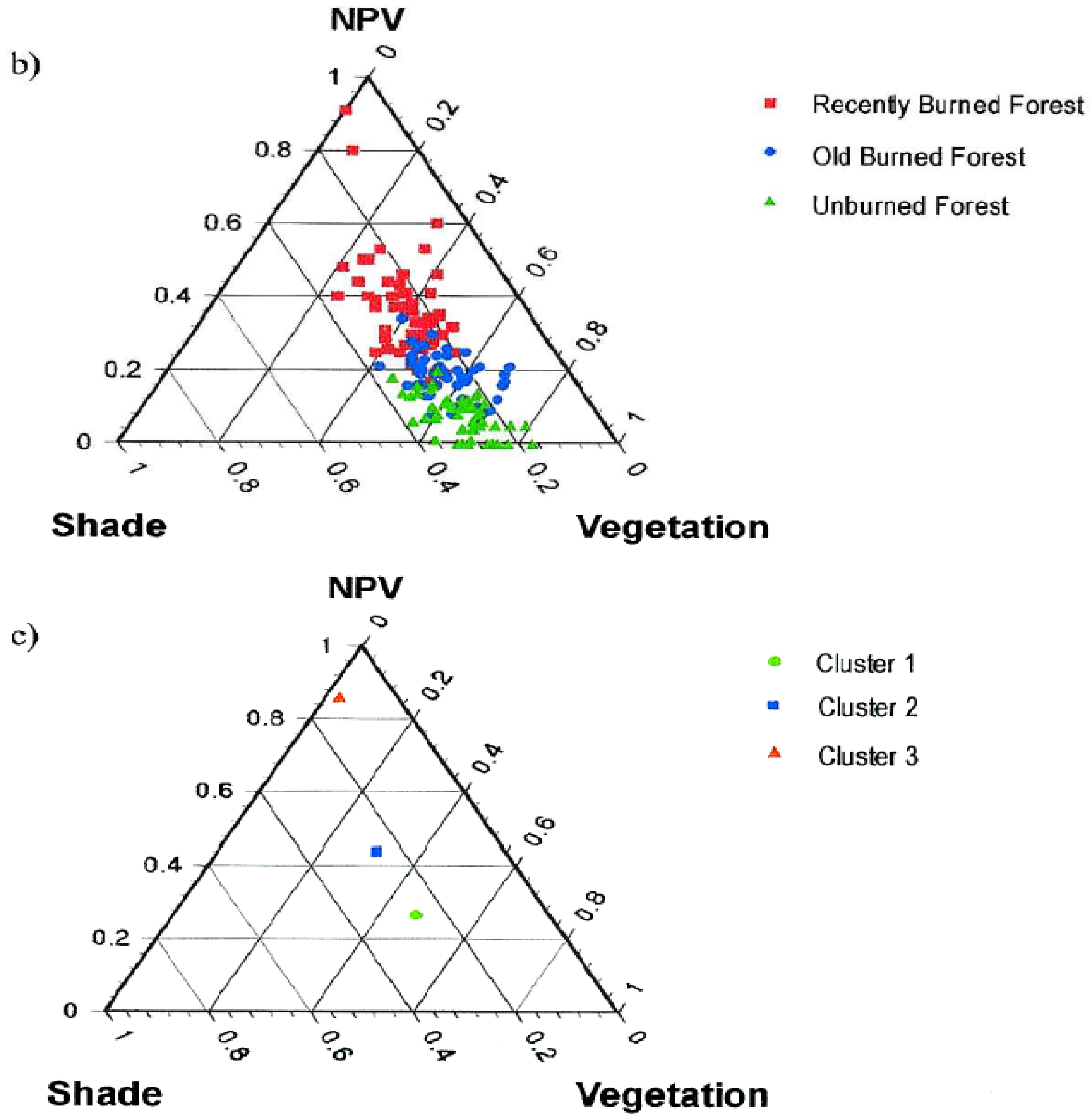
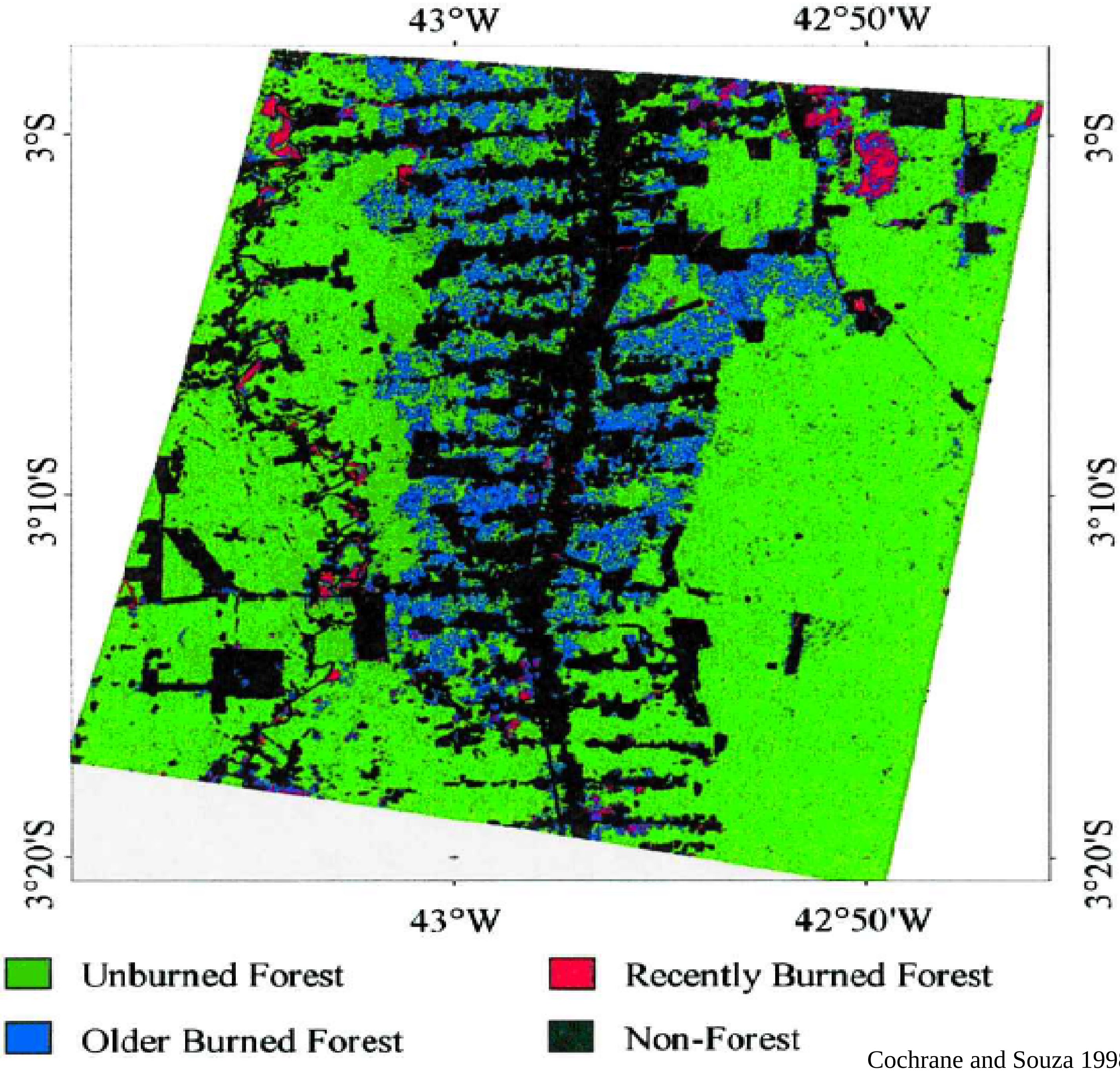


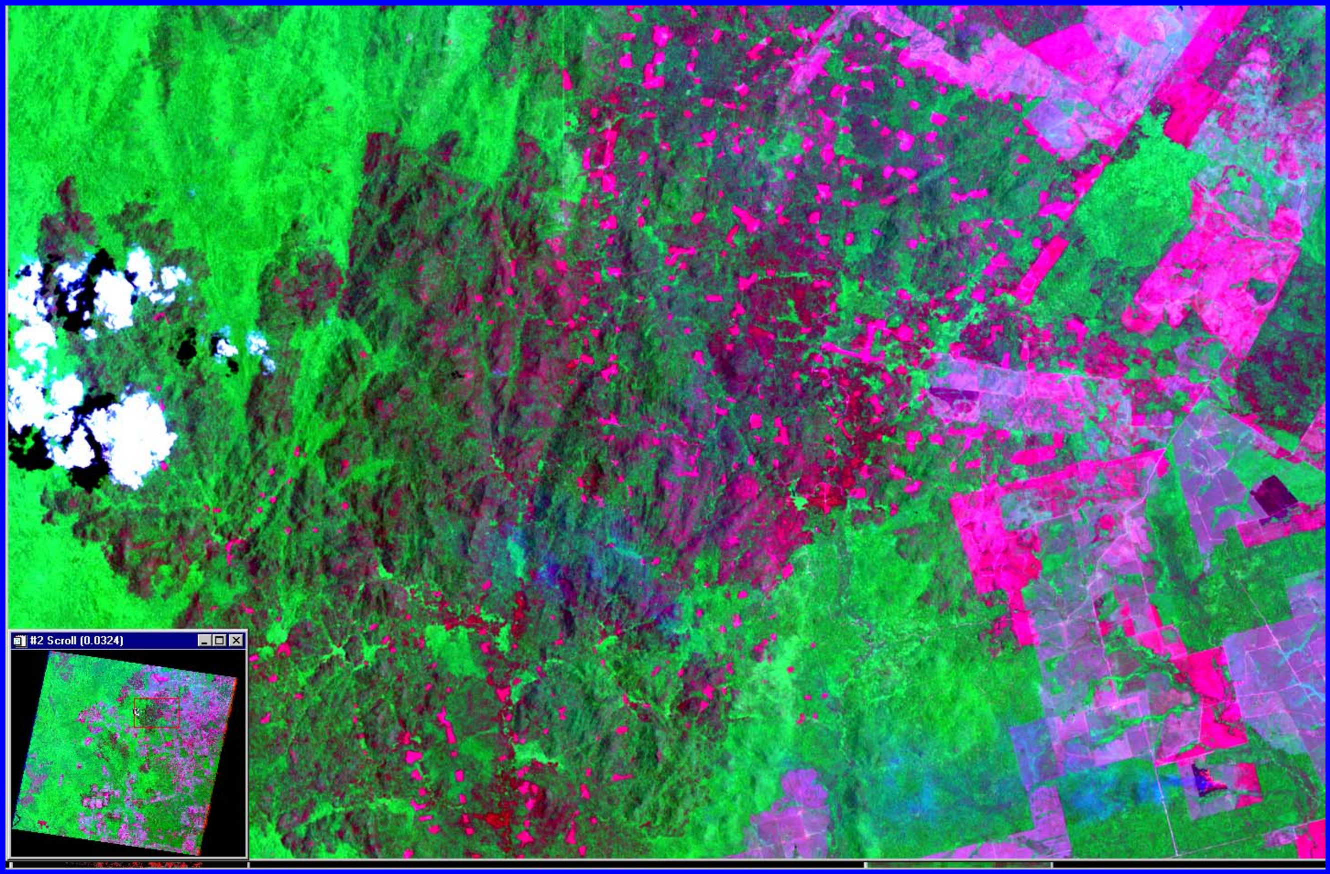
Figure 3. NPV-vegetation-shade mixing space diagram showing the distribution of forest classes; (*a*) Recently Burned Forest and Unburned Forest, (*b*) includes Older Burned Forest, and (*c*) cluster centroid location of recently burned forest classes.

The same image after it has been classified based on the fractional representation of NPV and groundtruth data.

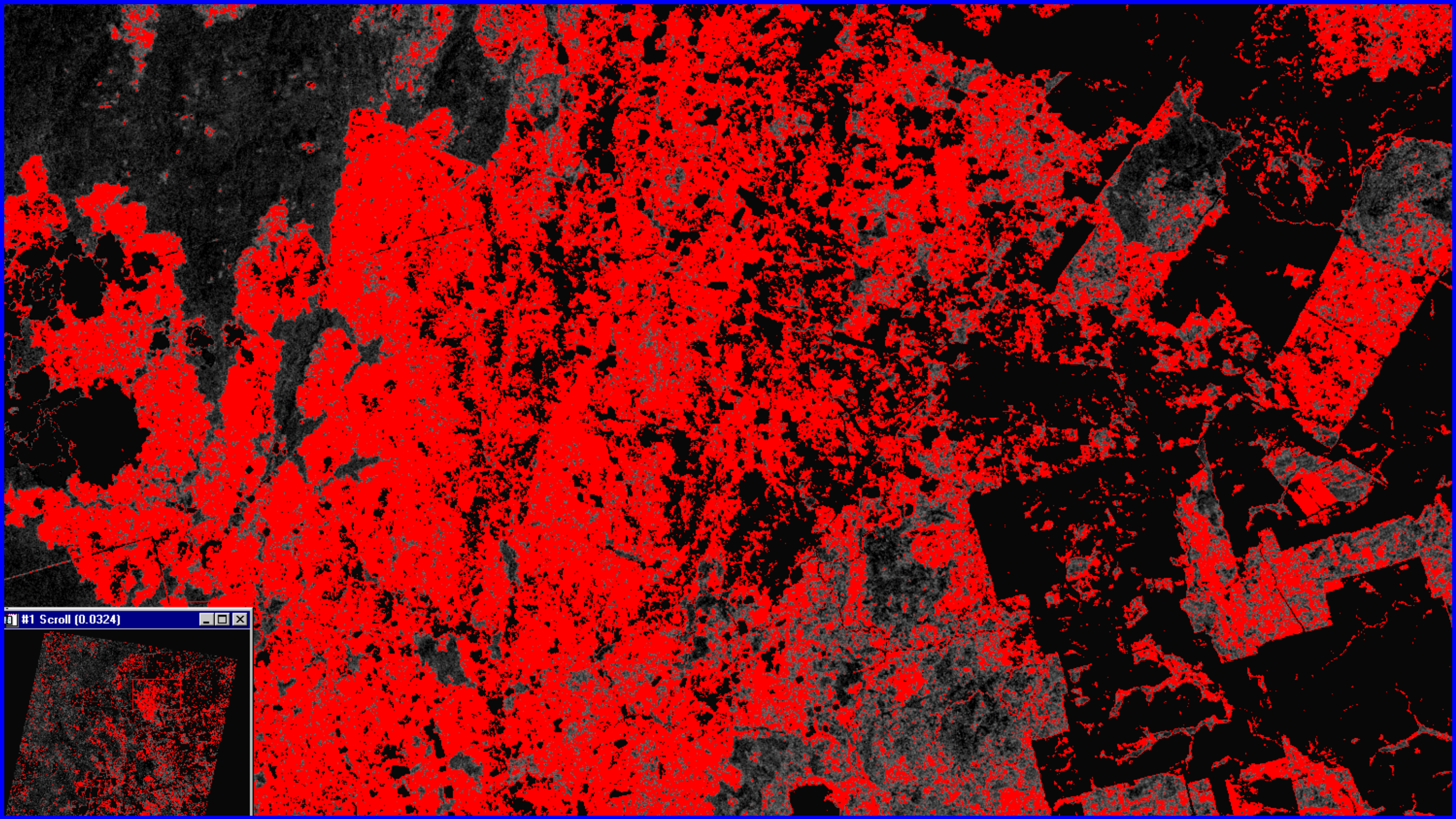


Cochrane and Souza 1998

Visual Fire in Southern Para 1999 (obviously burned)



Degraded Forests by NPV Fraction (model agrees well)



Visually Detected Fires in 1999, Mato Grosso

Disturbed Forests Apparent in NPV Fraction Image

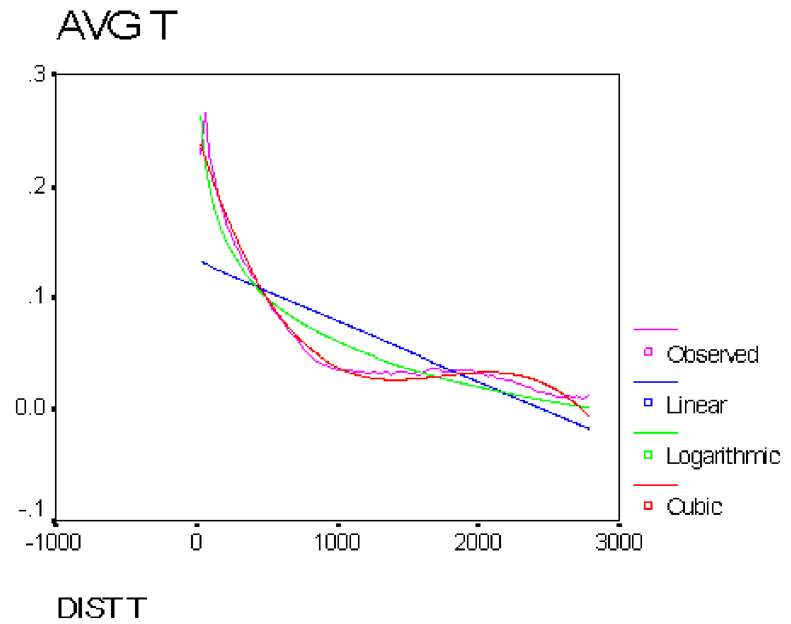
The Fire-Fragmentation Dynamic

- Edge-related changes in forest fuels and flammability
- Alterations in local and regional climate
- Increased ignition sources

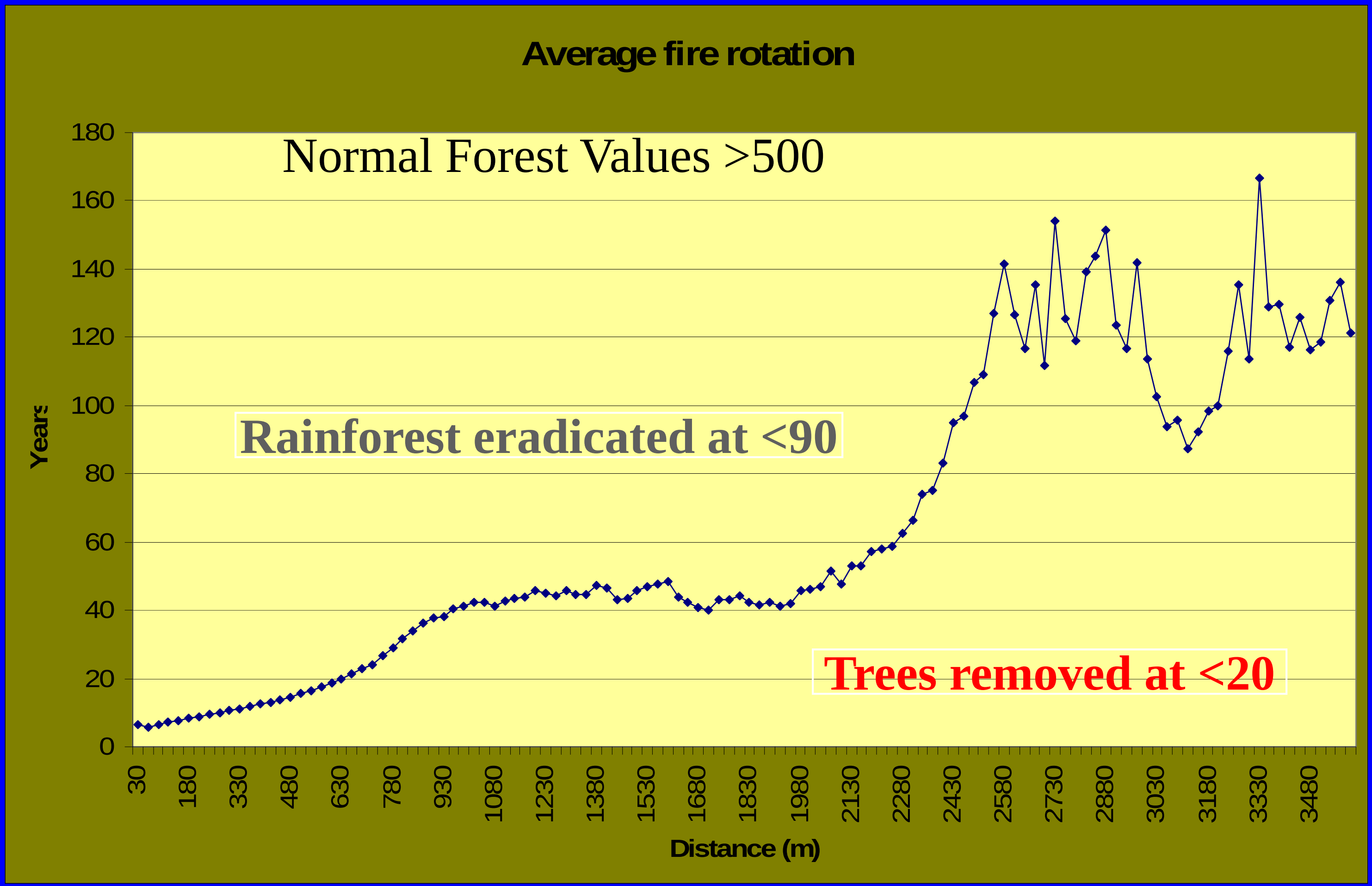
How Much Does Distance Tell Us About Fire Occurrence?

- Use GIS to compare existing forests and observe burns as a function of distance from deforestation
- Perform regressions on relation between burning and edges
- Fires are highly related to edges with up to 98% of variation explainable within 3 km of edge

Dependent	Mth	Rsq	d.f.	F	Sigf	b0	b1	b
V19	LIN	.628	91	153.33	.000	.1337	-5.E-05	
V19	LOG	.927	91	1147.77	.000	.4599	-.0578	
V19	CUB	.982	89	1639.50	.000	.2494	-.0004	2.4E-0

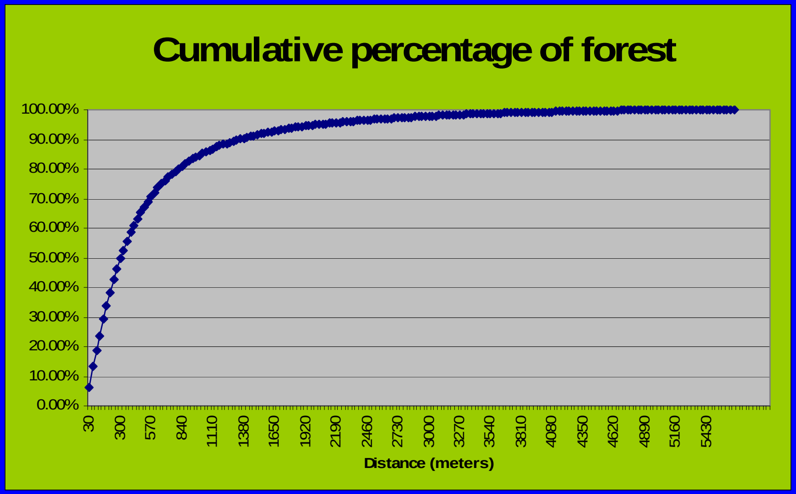


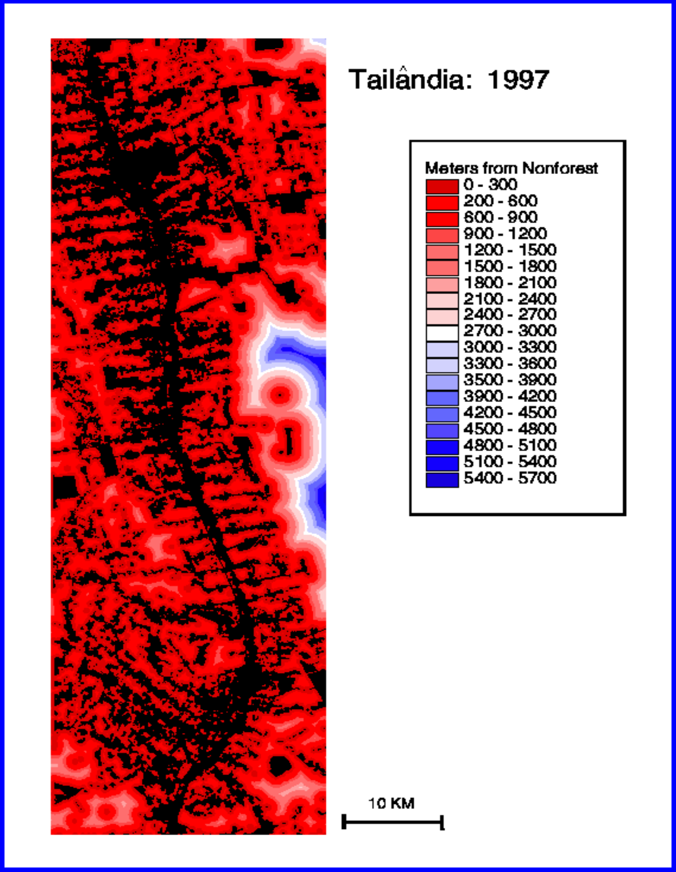
Fire-return Intervals and Ecological Effects (Tailandia)



Cochrane 2001

Fire, Fragmentation and the Future of the Forest





2,500 km^2 of land

>95% of forest has

Fire–return intervals of <90

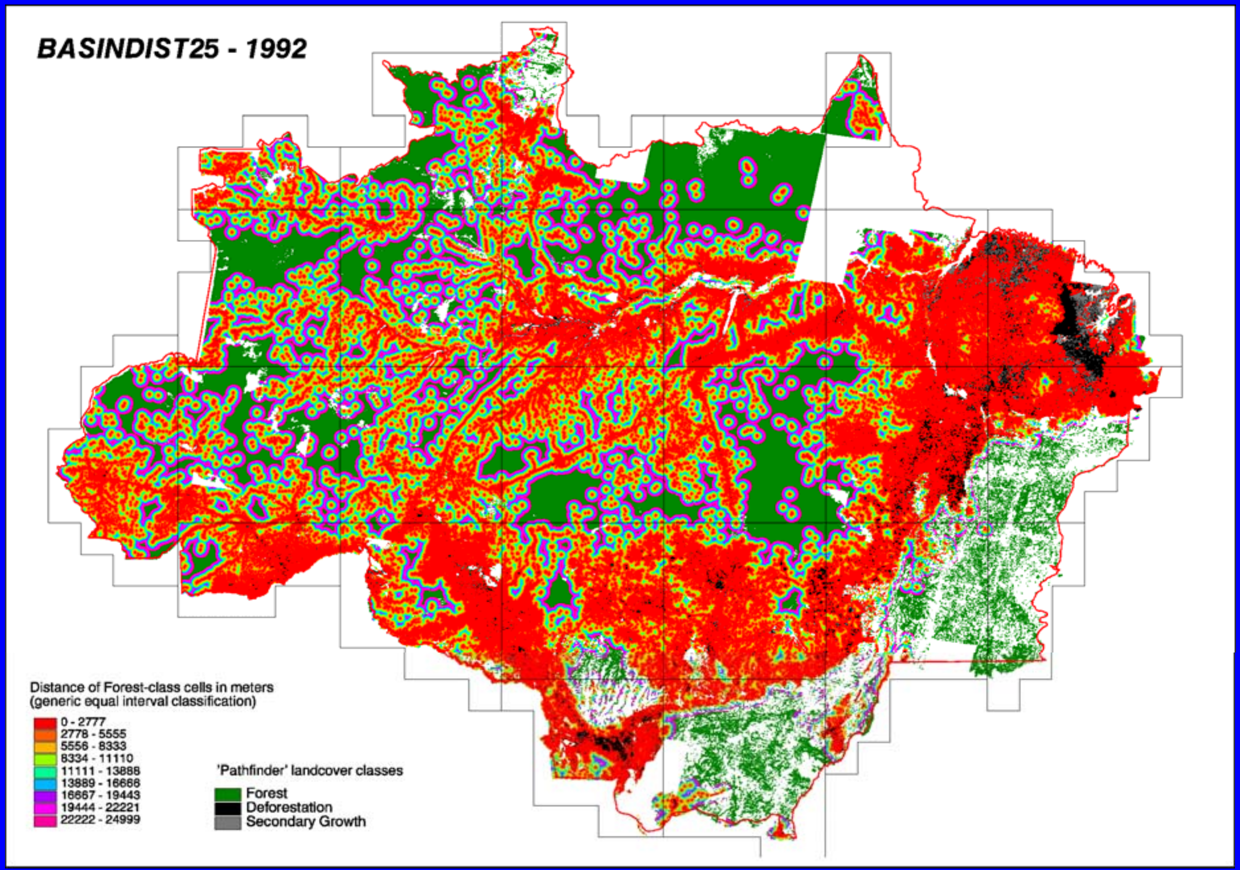
>70% with intervals <20

Cochrane 2003 *Nature*

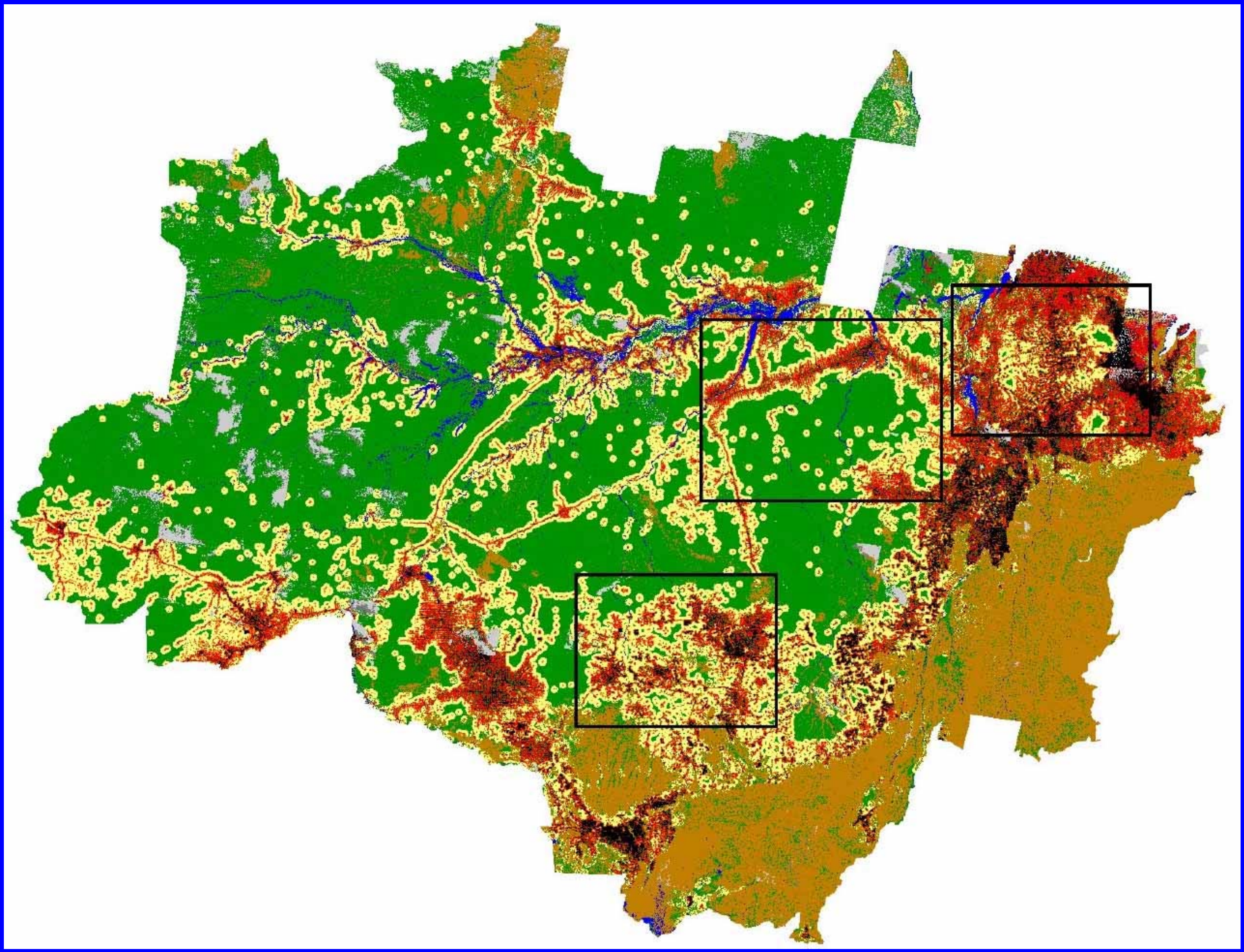
Fragmentation/edge effects:
Forests within 100 meters

	Forest Edge Area (Km^2)	
State	1992	1999
Acre	3,854	5,046
Amapá	95	*
Amazonas	11,772	12,109
Maranhão	16,377	21,974
Mato Grosso	18,052	26,953
Pará	41,069	51,930
Rondônia	13,762	15,385
Roraima	824	1,634
Tocantins	2,800	3,542
Totals	108,606	138,666

Large-scale Edge Effects, How Bad Could They Be?

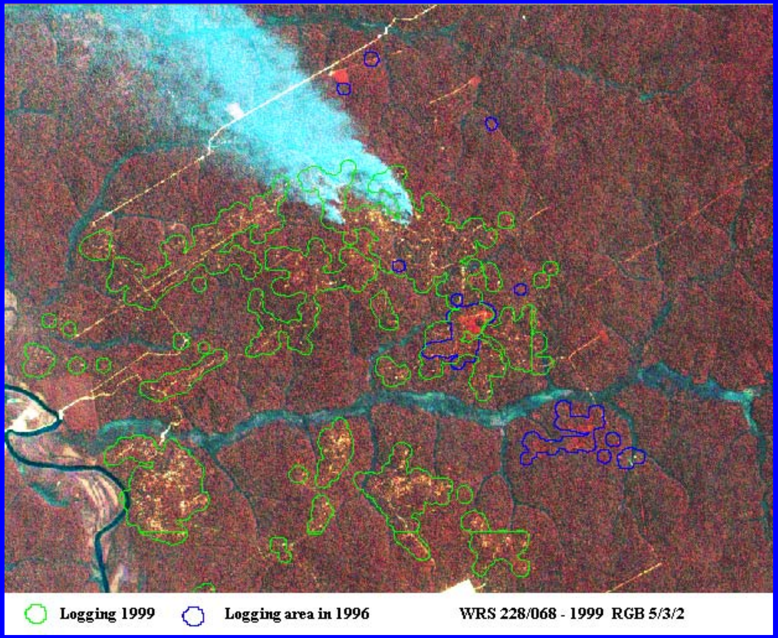


More realistically……

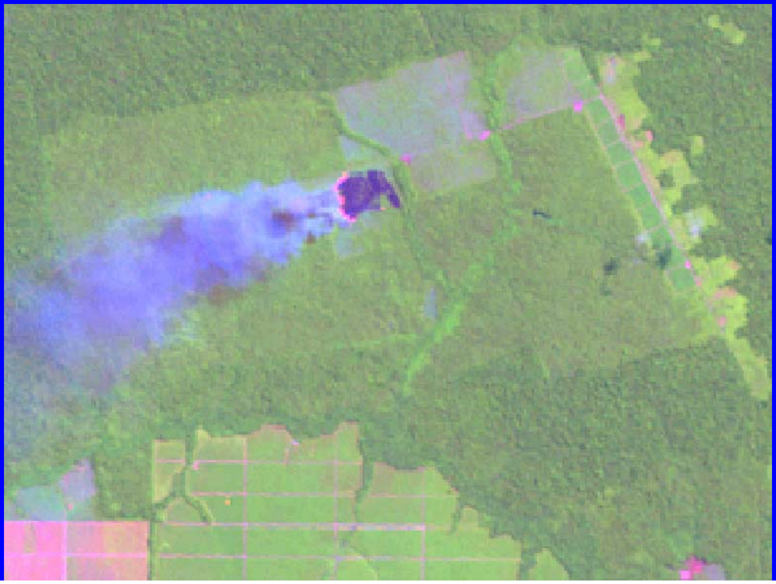


Is there Actual Interaction between Selective Logging and Fire?

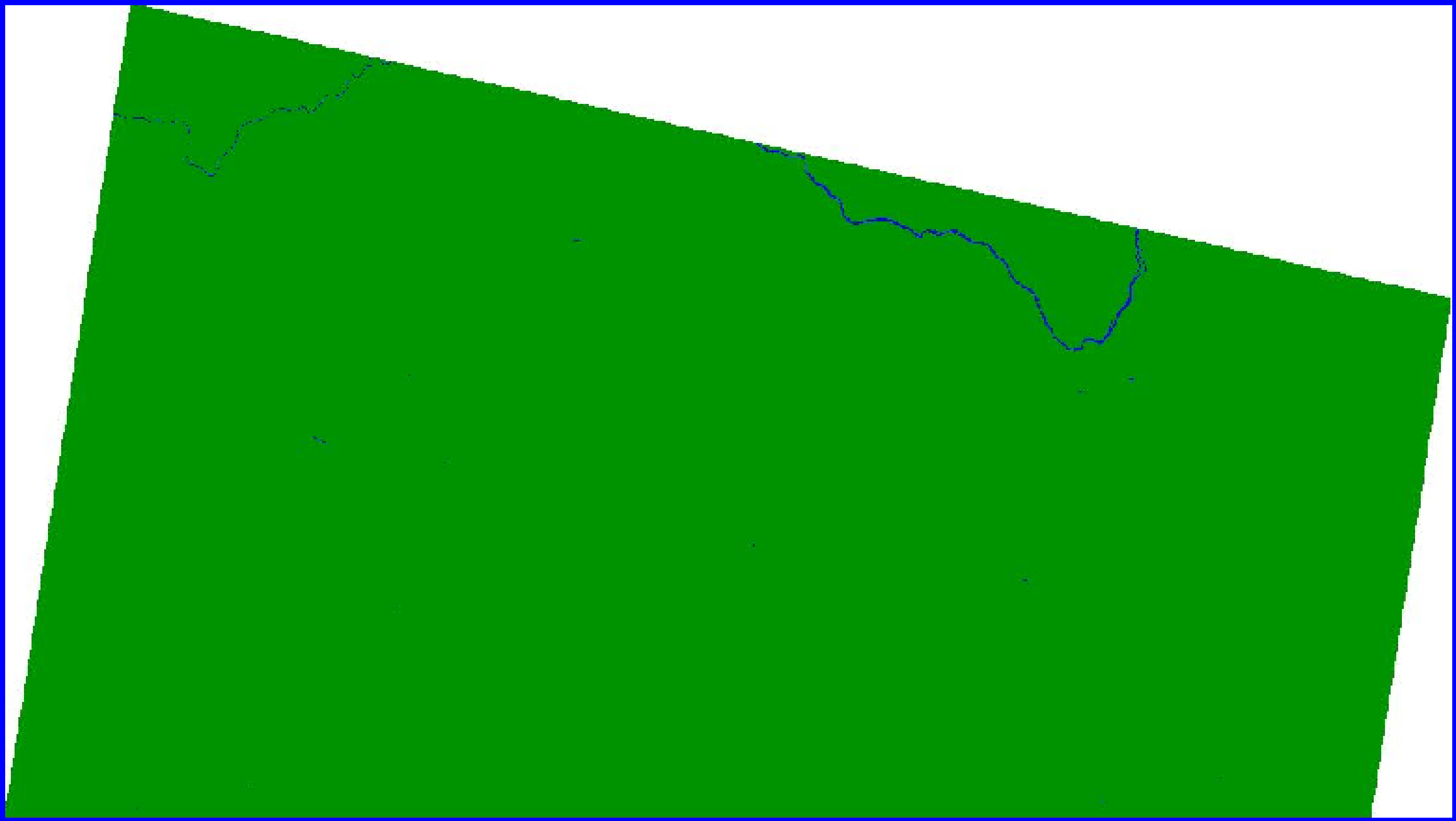
Logging increases forest fire susceptibility



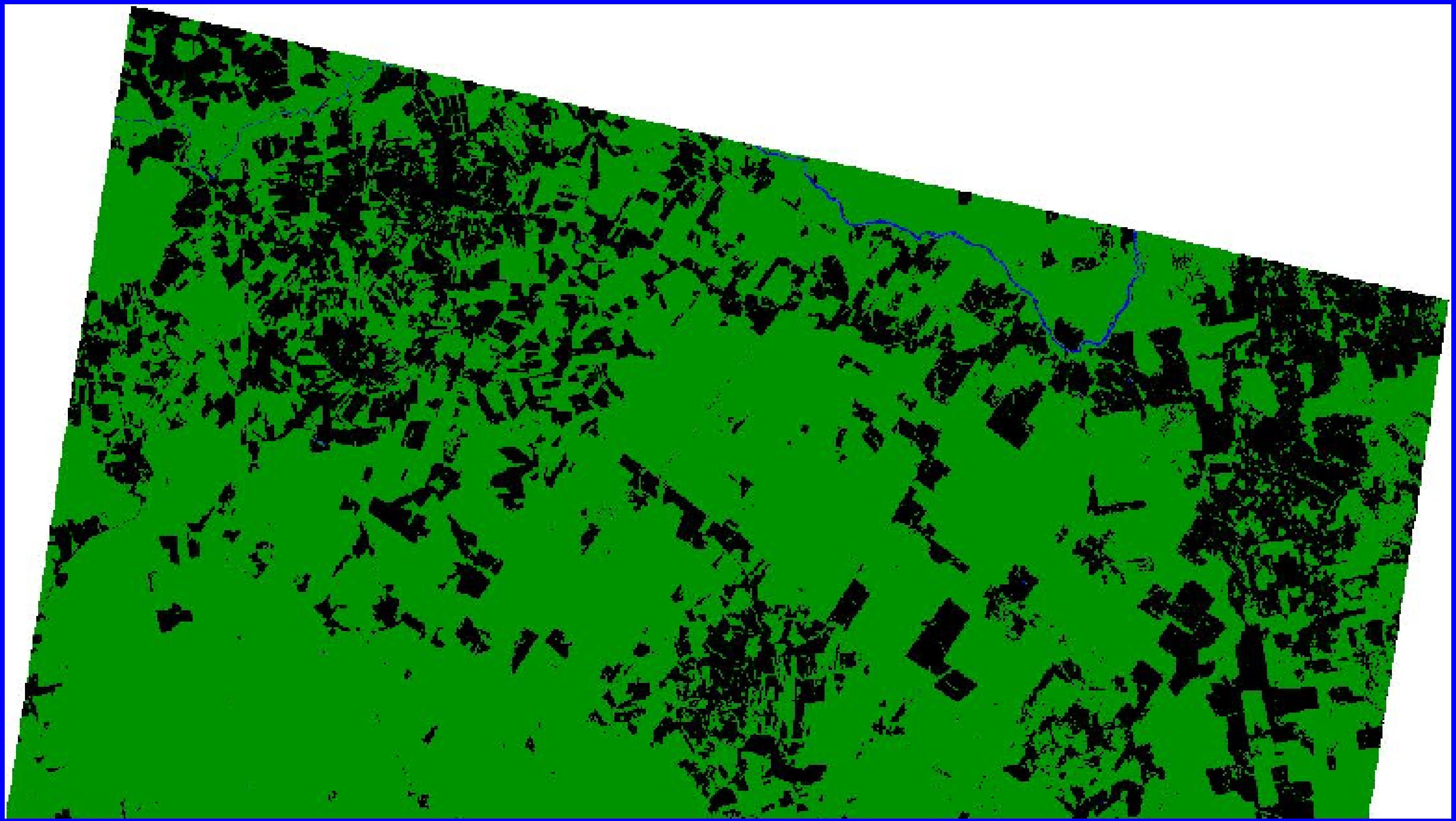
Logging increases access, deforestation and fire occurrence



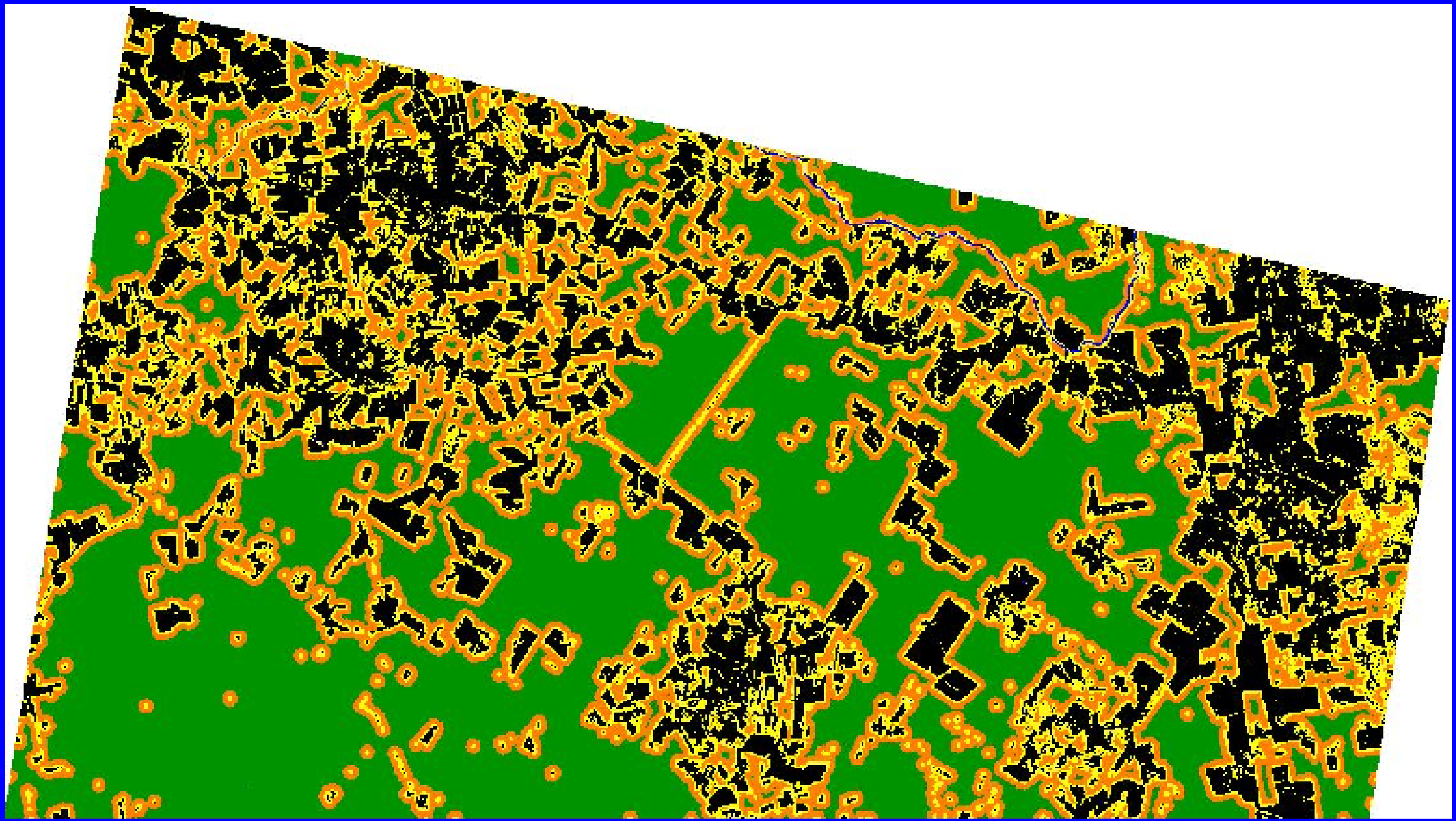
In the Begining



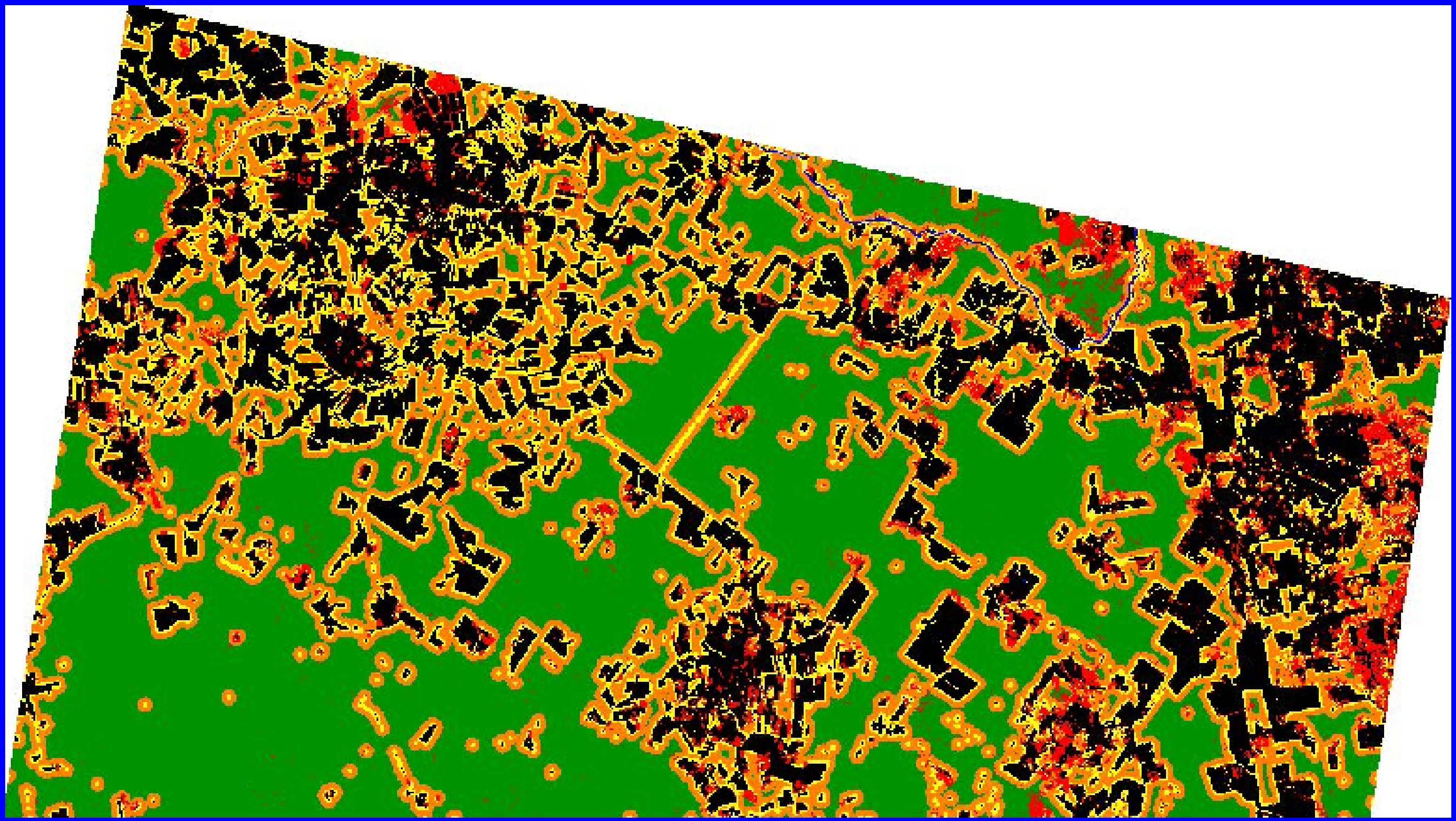
Deforestation by 1999



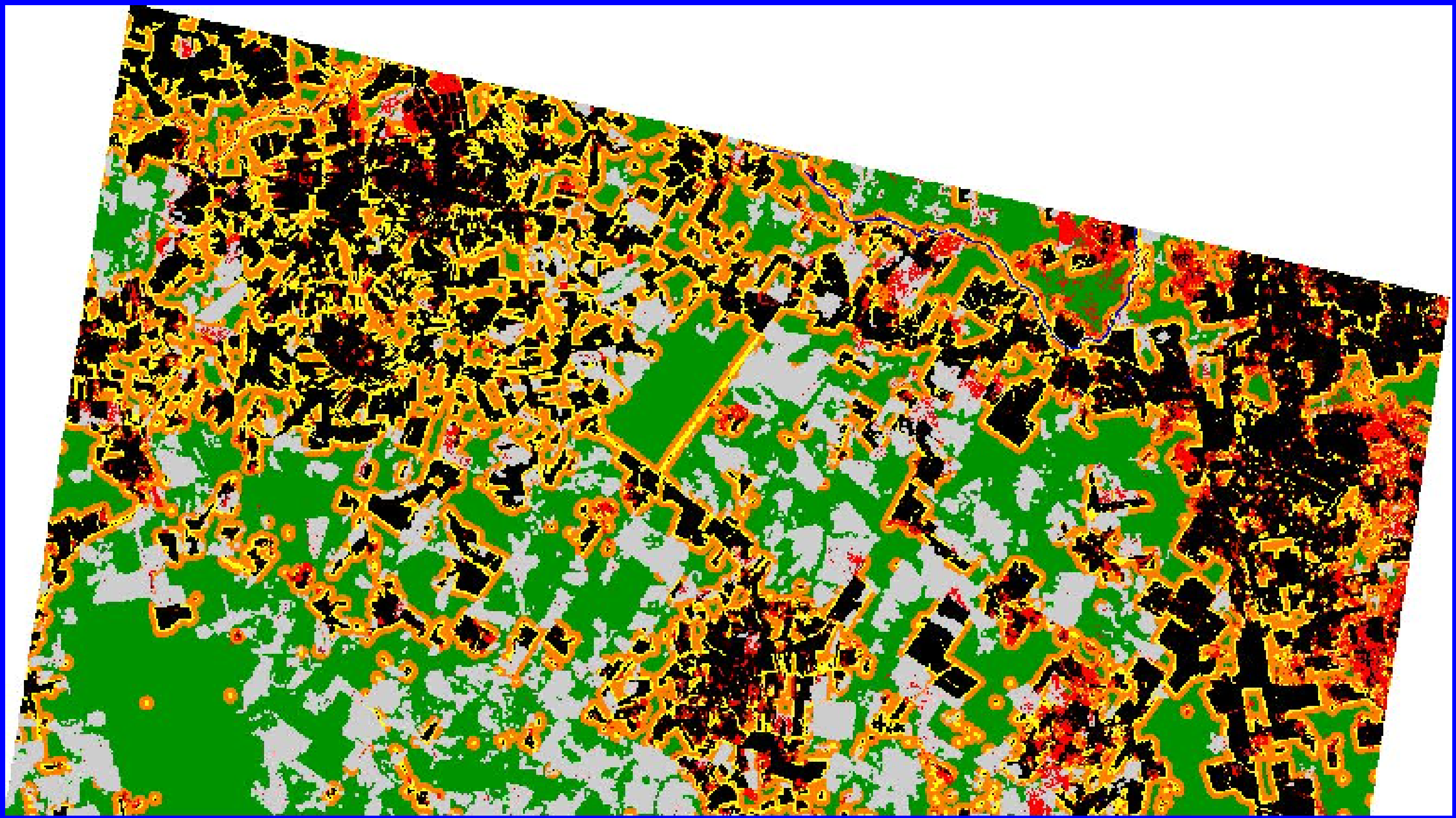
Fragmentation and Edge Effects

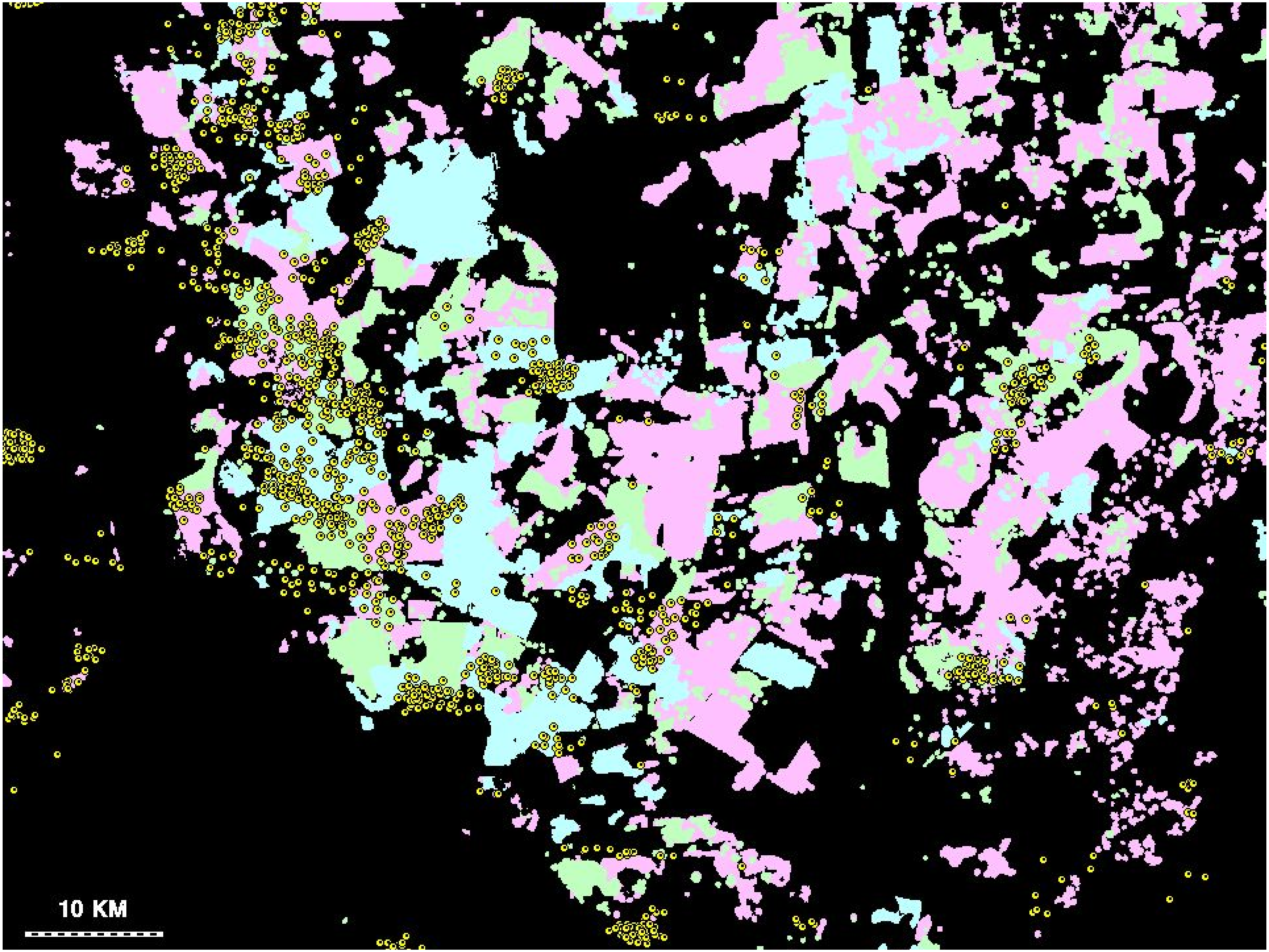


Fires in 1999

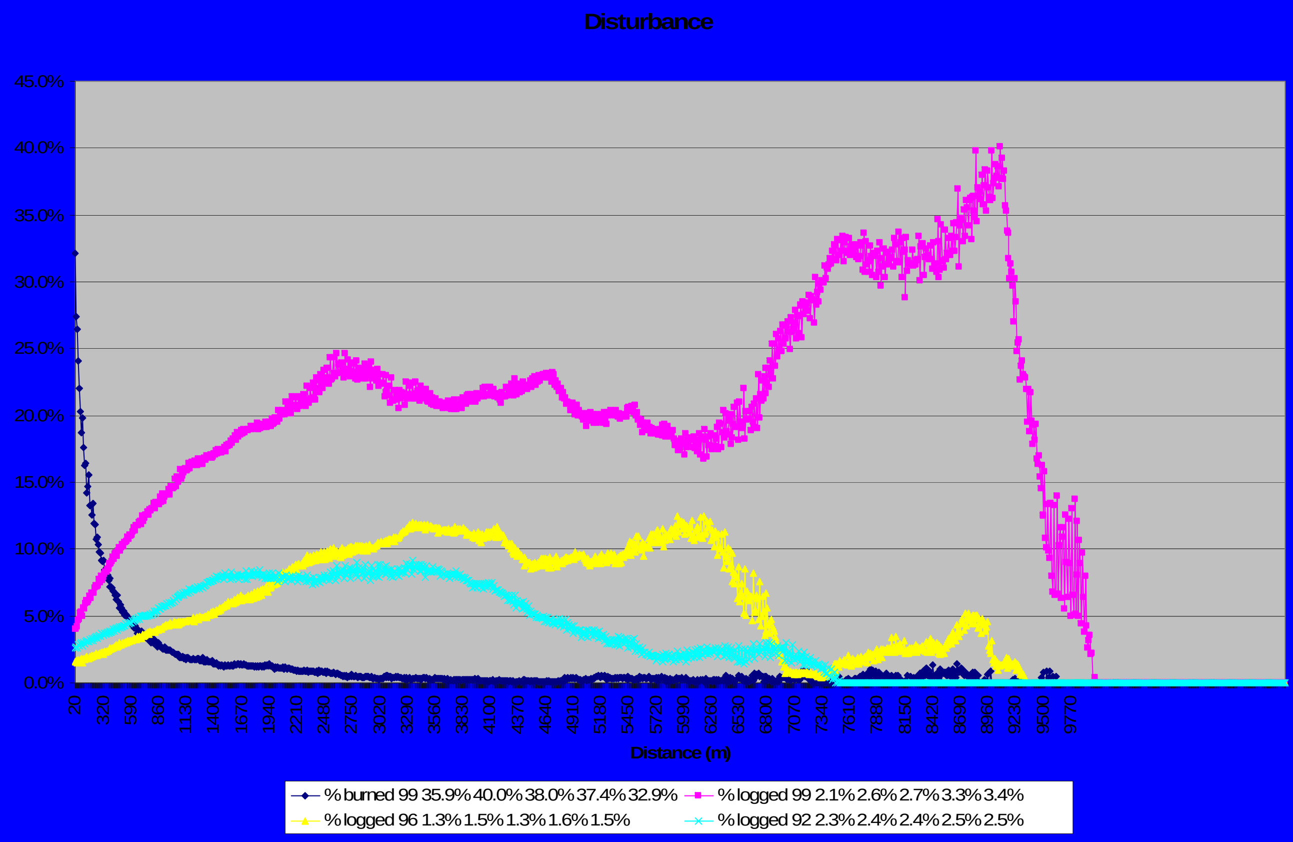


Logging 1992-1999

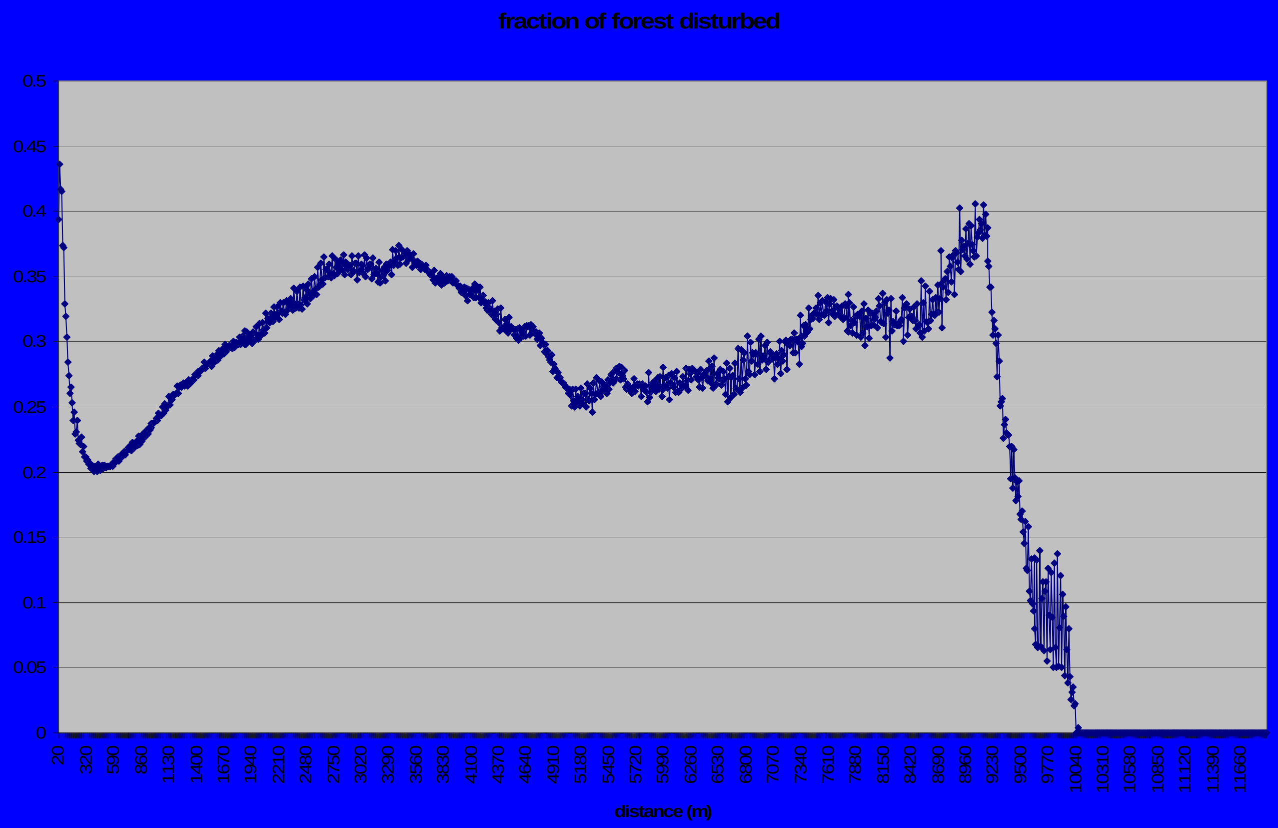



10 KM

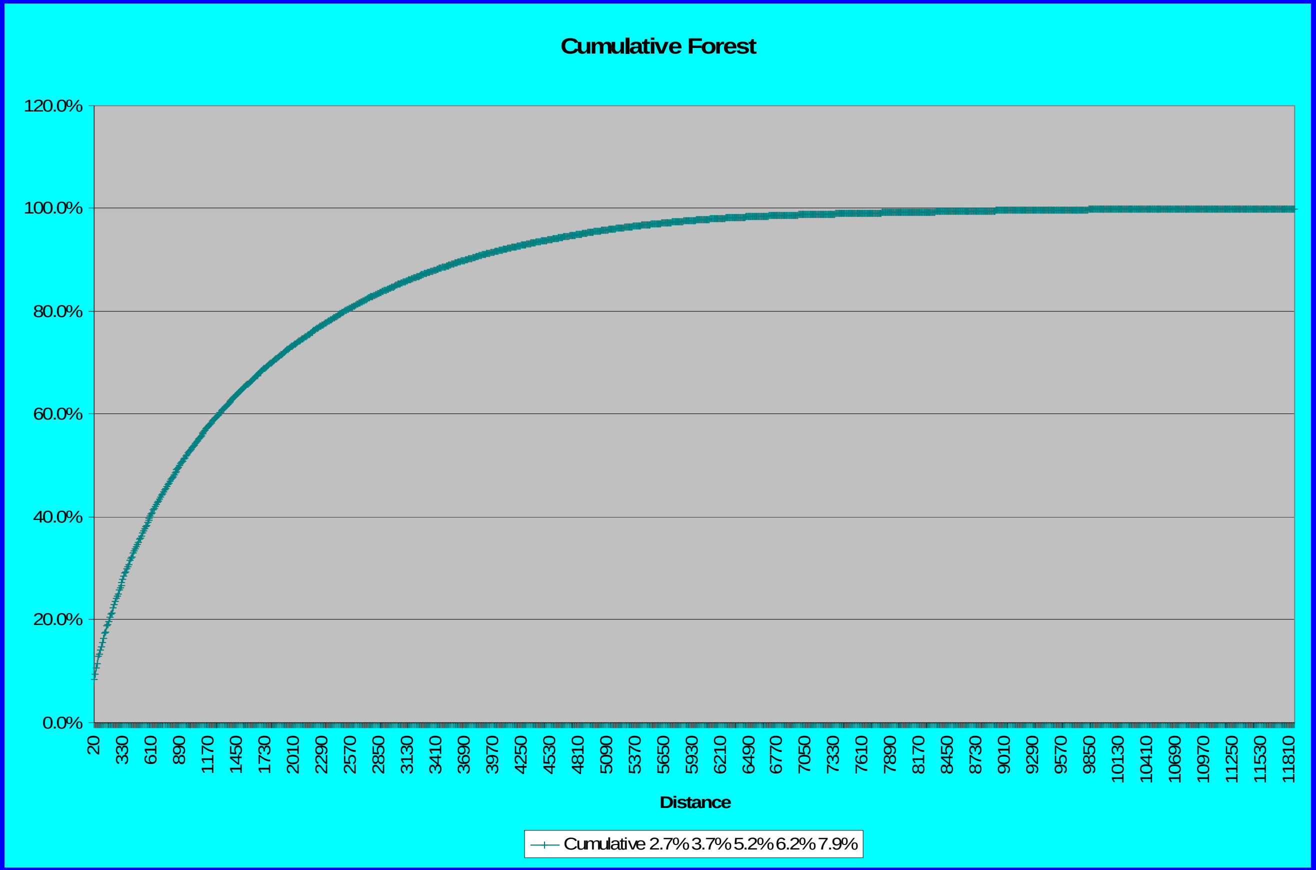
Logging and Fire by Year and Location



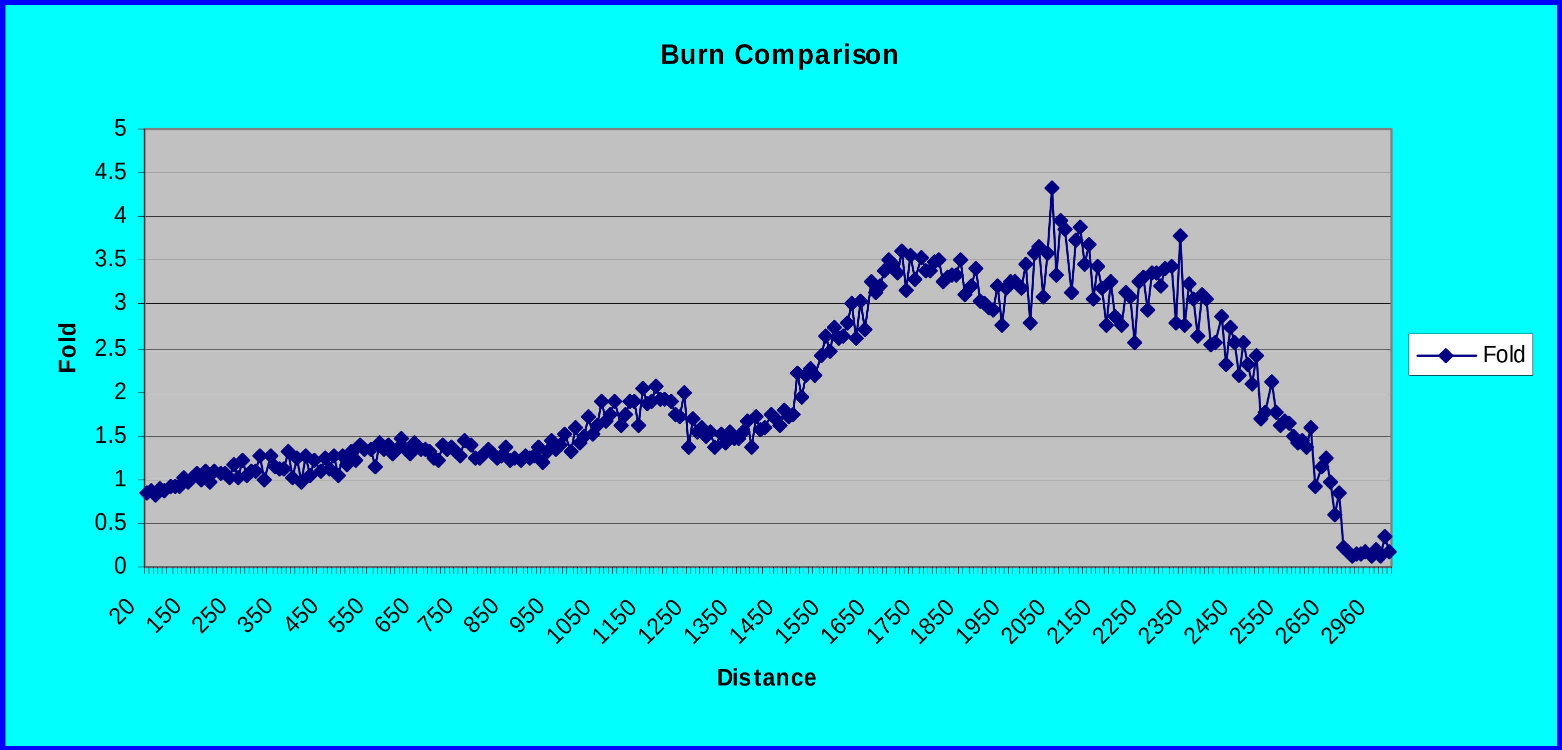
Combined Effect of Fire and Logging



Forest Distribution



1999 Fire Risk for Forests Selectively Logged in 1992



Cochrane et al. (in press)

Fun Facts Regarding Land Cover

	Area (km2)		%
Total Area	16,819		
Total Deforested by 1999	4,547		27%
Total Forested 1999	12,271		
Total Logged by 1999	2,599		21%
Total Burned in 1999	958		8%
Total within 300 m	1,992		16%
Total within 1km	4,728		39%
Total likely disturbance	8,161		66%
Altered Landcover	12,708		76%

Elements of Forest Degradation

- Deforestation
  - 1.9 million hectares/yr (1995-1999) – 100%
- Selective Logging
  - >2.3 million hectares (1999) – 100%
- Forest Fragmentation
  - > 13.8 million hectares (1999) – 100%
- Forest Fire
  - 1.6 million hectares (1997) – 6% sample

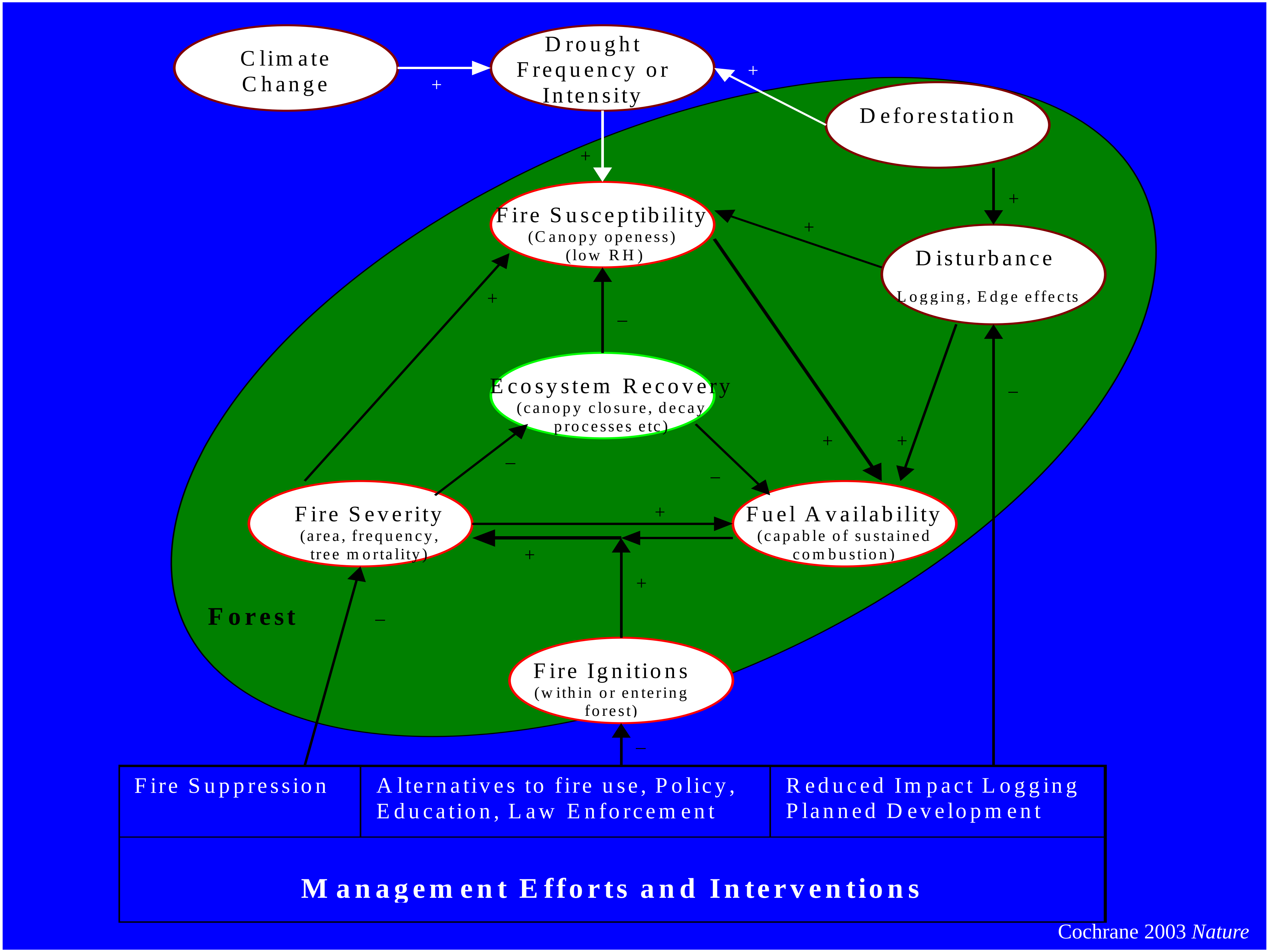
Issues in Fire-driven Land Change

- Fire-driven land change is a spatial problem where land cover and land use interact (positive, negative and synergetic)

- Human use of the land will be a function of the <u>perceived</u> risk of fire occurrence and severity

Fire Management

- What are the issues?
  - Good fire versus bad fires
  - Prediction – early warning and risk assessment
  - Human resources – and their preparedness
  - Infrastructure and equipment
- What can be done?
  - Prevention – of what? How?
  - What can be done ‘before’ a fire?
  - What can be done ‘during’ a fire?
  - What can be done ‘after’ a fire?


Climate Change
Drought Frequency or Intensity
Deforestation
Fire Susceptibility
(Canopy openess)
(low RH)
Disturbance
Logging, Edge effects
Ecosystem Recovery
(canopy closure, decay processes etc)
Fire Severity
(area, frequency, tree mortality)
Fuel Availability
(capable of sustained combustion)
Forest
Fire Ignitions
(within or entering forest)
Fire Suppression
Alternatives to fire use, Policy, Education, Law Enforcement
Reduced Impact Logging
Planned Development
Management Efforts and Interventions
Cochrane 2003 Nature

Introduction to Peat Fire Ecology and Distinction between Peat Fires and Fires in Peatlands

Dr. Mark A. Cochrane
South Dakota State University

Fire in Peatlands

- Globally, Indonesia is ranked 4th in CO_2 emissions over the last 50 years.
- This ranking largely results from unintended carbon emissions from drained peatlands.
- Fire is used in to clear forests and manage peatlands for numerous land uses.
- However, all fires are not the same.

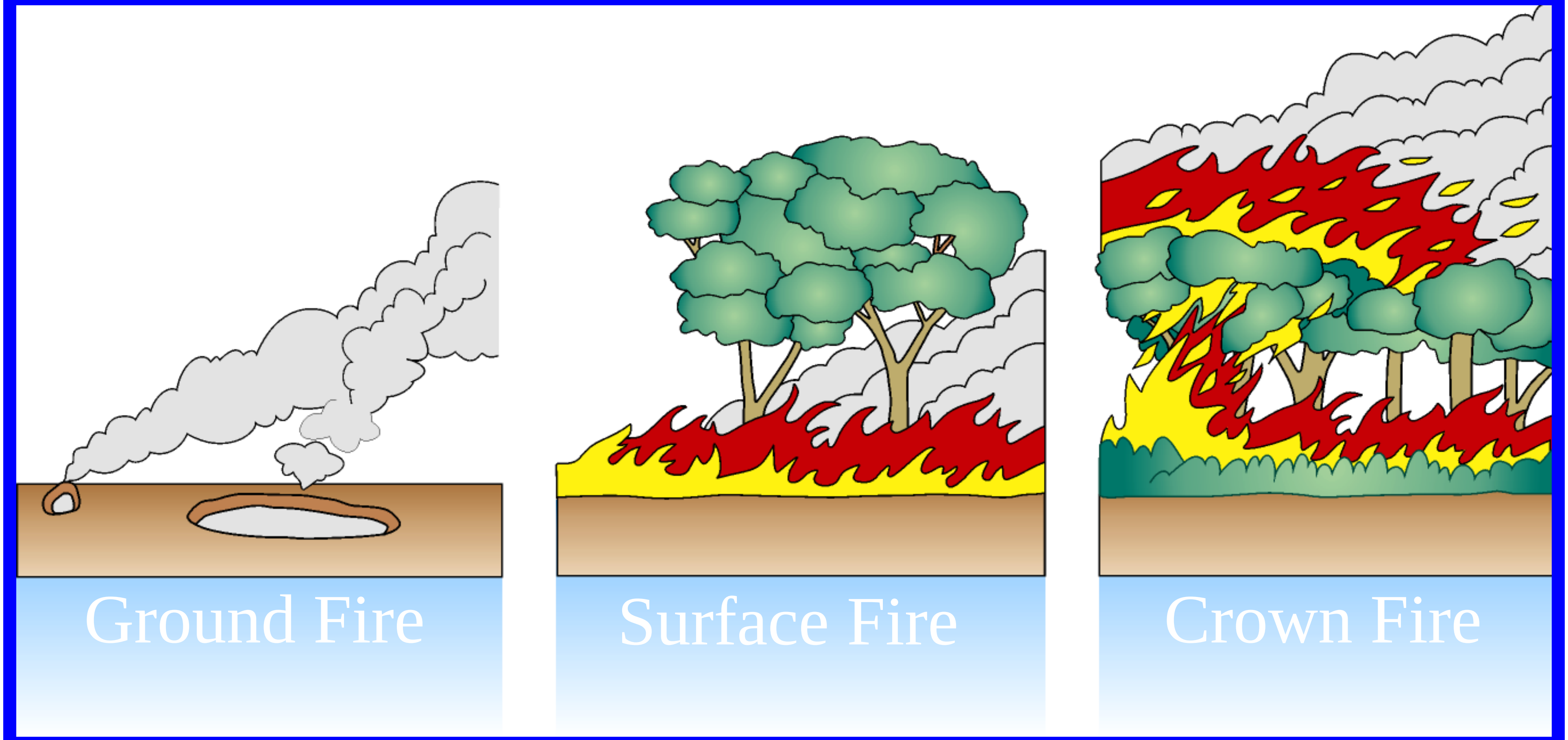
Concept:
Peatland Fire vs. Peat Fire

1. Peatland Fire = Surface Fires on peat dominated sites
2. Peat Fire = Ground Fires burning into Peat Soils

Surface fires on peatlands can sometimes result in peat fires that enter the ground surface but only <u>when peat soils are dry</u>.

Smoke Column Sept 20th 2012 near SP1

Terms:
Types of Fire:



Most emissions Most fires Most intense

e.g., Surface Fuels Flaming

Herbaceous Fuels (ferns), EMRP

Biomass vs. Fuels

- **Surface Fires**
  - **burn quickly**
  - **spread rapidly**
  - **consume little**

less smoke

e.g., Light Surface Fire in Shrub-Dominated Peatland
- peat soil was too wet to burn, shrub stems still standing

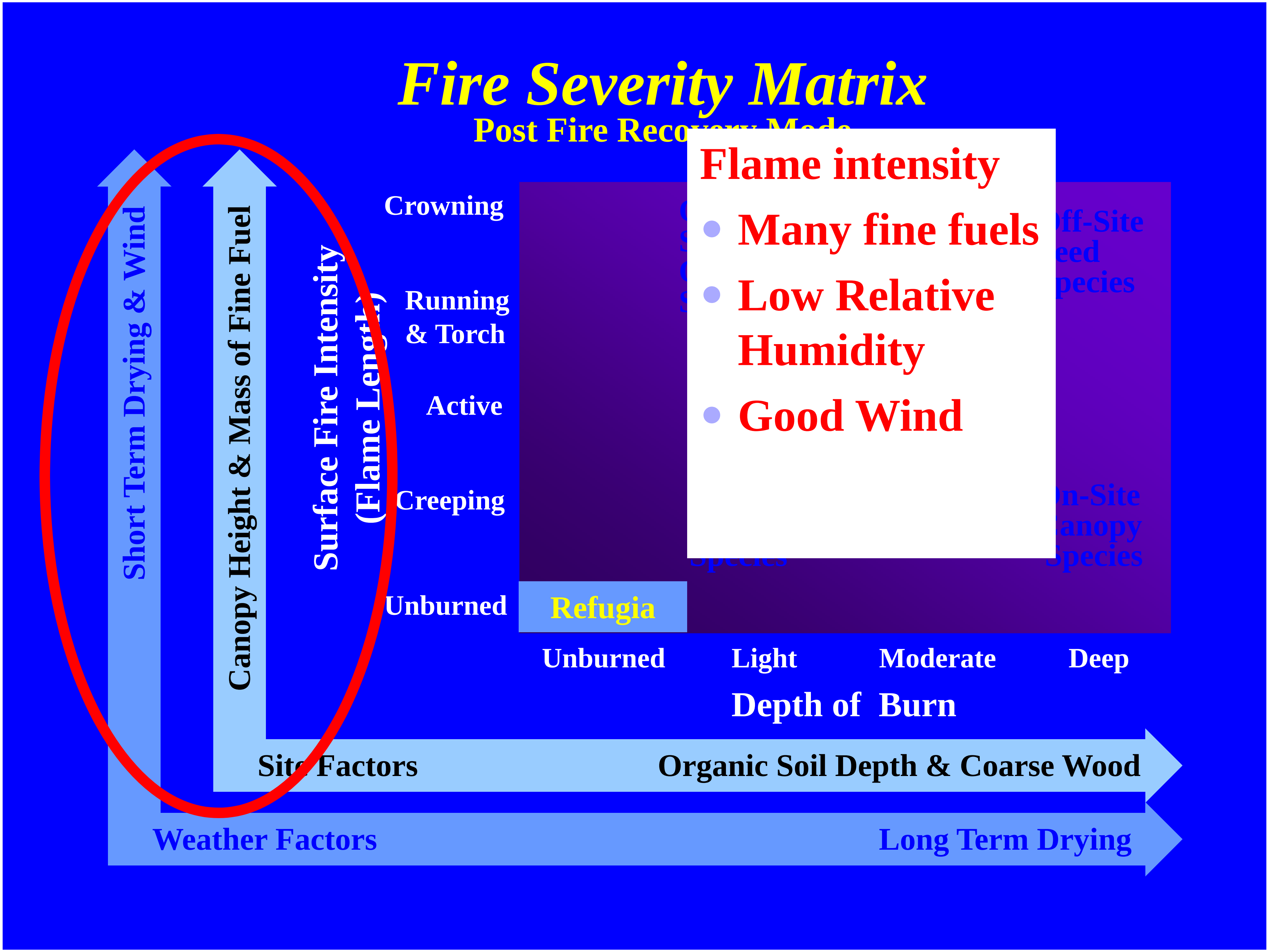
Light Depth of Burn

Surface Fire

burns fine & coarse fuels < 2 meters tall:

- Flaming Combustion + Smoldering
- Area Burned - Dominant Factor
- Rate of Spread, Intensity & Consumption Vary with Fire Environment –
  - ✓ **Fine Fuels – mass & type**
  - ✓ **% Relative Humidity (*Air*)**
  - ✓ **Wind Speed**

Fire Assessment Goal: Develop better data on Fire Environment and depth of burning


Fire Severity Matrix
Post Fire Reco
Flame intensity
Many fine fuels
Low Relative Humidity
Good Wind
Short Term Drying & Wind
Canopy Height & Mass of Fine Fuel
Surface Fire Intensity
(Flame Length)
Crowning
Running & Torch
Active
Creeping
Unburned
Refugia
Unburned
Light
Moderate
Deep
Depth of Burn
Site Factors
Organic Soil Depth & Coarse Wood
Weather Factors
Long Term Drying

Burning peat = less flame **but more smoke**

Ground Fuels (Peat) Smoldering

Ground fire burning beneath a “shelf” of unburned peat

Biomass vs. Fuels

Peat Fires:
- **Burn slowly**
- **Spread slowly**
- **Consume soils**
- **Alter terrain**
- **Yield heavy smoke**

e.g., Ground Fire in Shrub-Dominated Peatland, pockets of peat were dry enough to burn

Deep Depth of Burn

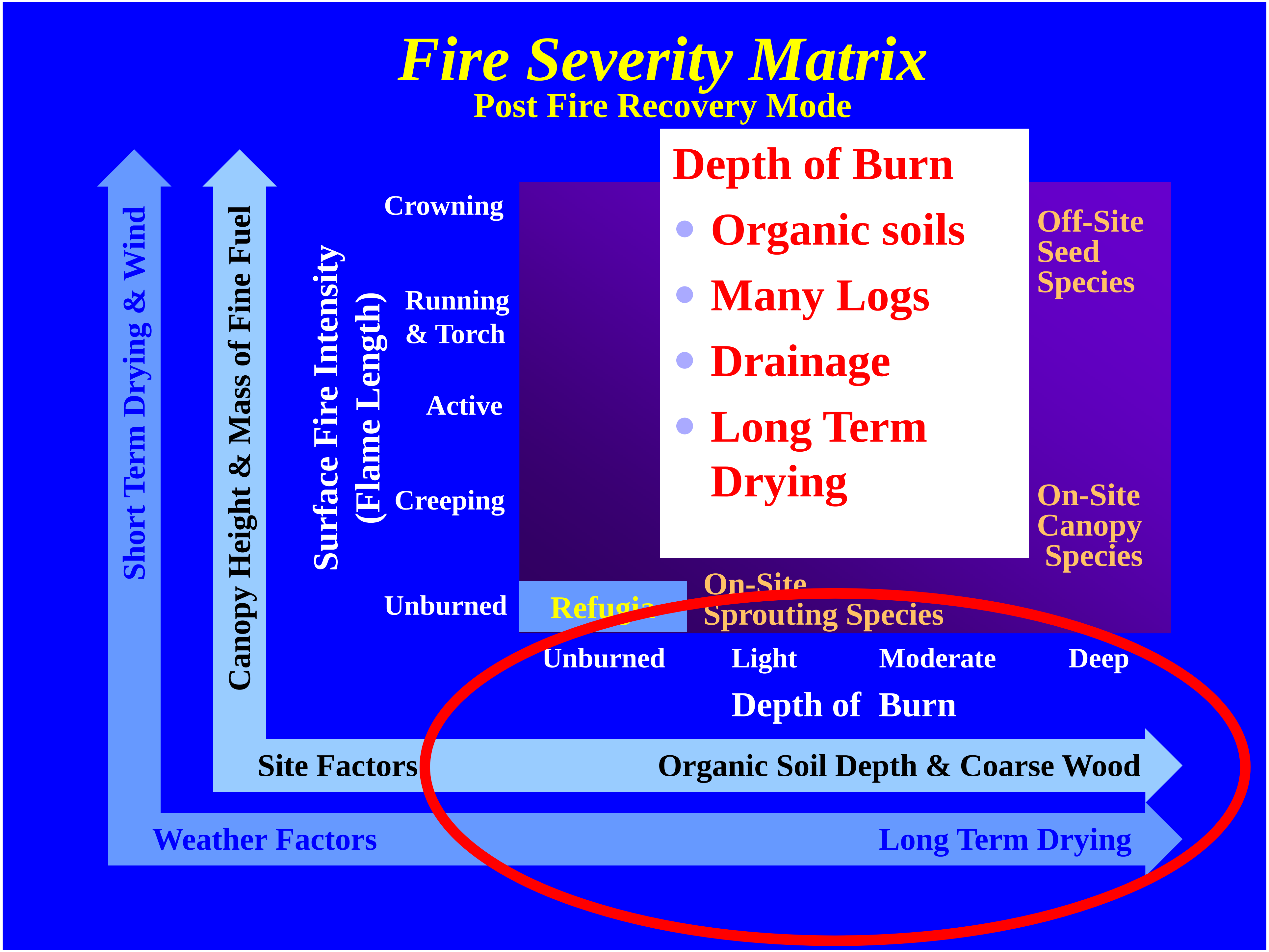
Ground Fire – burns organic soil:

- Smoldering Combustion
- Major Contributor GHG Emissions
- Peat fires spread slowly (~ 3-5 cm/hr)
- Peat Consumption – varies with **Fire Environment** –

✓ **Peat Properties (fibric, sapric, hemic)**
✓ **Moisture Content (within Peat *Soil*)**
✓ **Water Table Depth (moisture profile above water table)**
✓ **Heavy Fuel Loading (mass/area)**

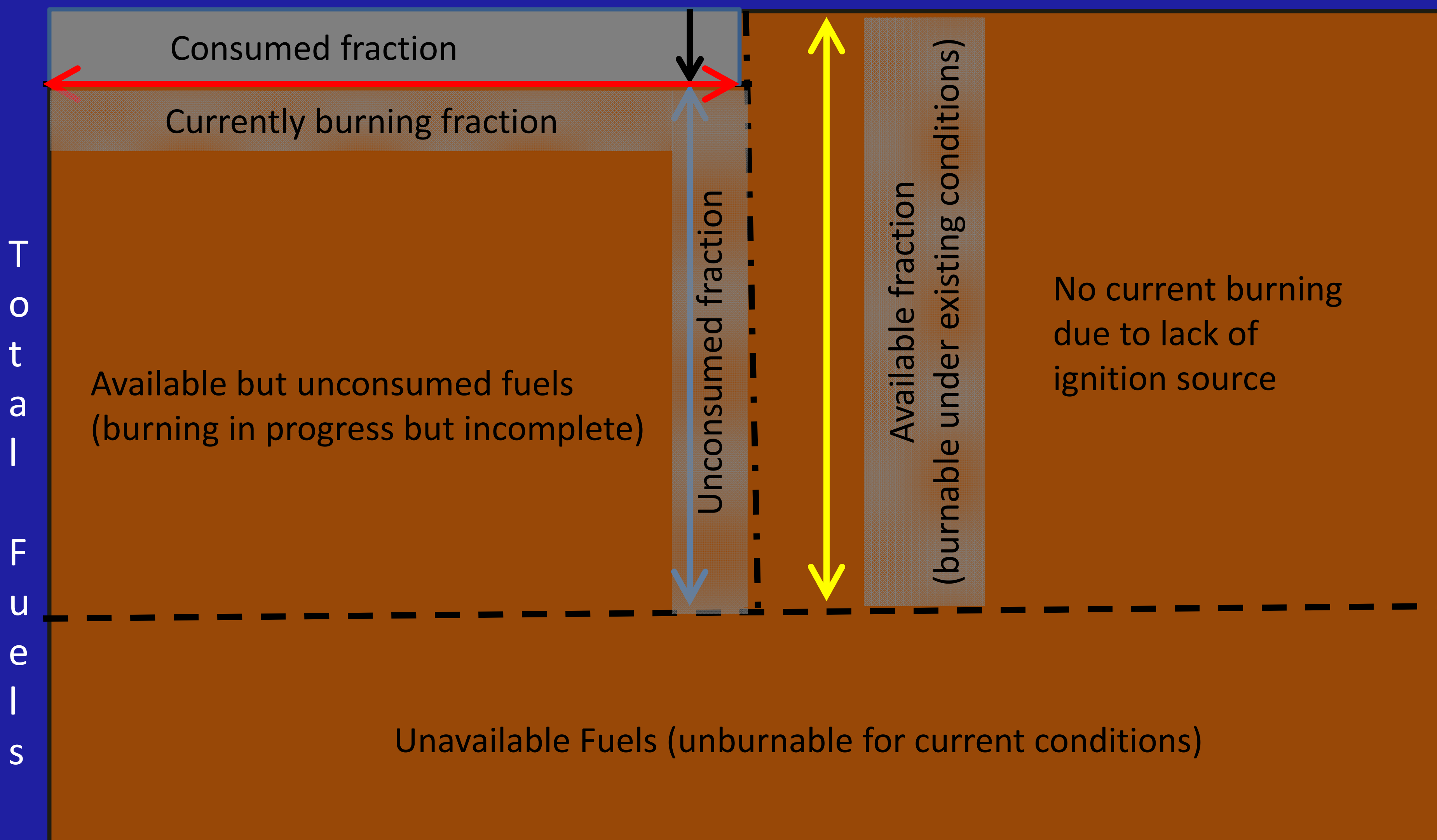
Fire Assessment Goal:

Develop better data on Fire Environment


Fire Severity Matrix
Post Fire Recovery Mode
Depth of Burn
Organic soils
Many Logs
Drainage
Long Term Drying
Crowning
Running & Torch
Active
Creeping
Unburned
Surface Fire Intensity (Flame Length)
Canopy Height & Mass of Fine Fuel
Short Term Drying & Wind
Off-Site Seed Species
On-Site Canopy Species
Refugia
On-Site Sprouting Species
Unburned
Light
Moderate
Deep
Depth of Burn
Site Factors
Organic Soil Depth & Coarse Wood
Weather Factors
Long Term Drying

Depth to the water table is a prime determinant of the peat that can burn

Schematic of biophysical fire dynamic



Main objectives of the project

To improve upon the data sets and methods for MRV that will be use to calculate carbon emisions, particularly for peatland fires in Central Kalimantan, for INCAS and for the international community.

To strengthen and facilitate accurate assessment of conservation and rehabilitation activities on tropical peatlands, that are currently being carried out by BOS-Mawas, KPHL and others, such as:

-Blocking tatas

-Monitoring and patroling for illegal activities

- reforestation activities

-Community development and education activities

In order that we can estimate reductions in greenhouse gas emissions, essential in the development of accurate, internationally-accepted MRV methodology and data-sets


The End?