

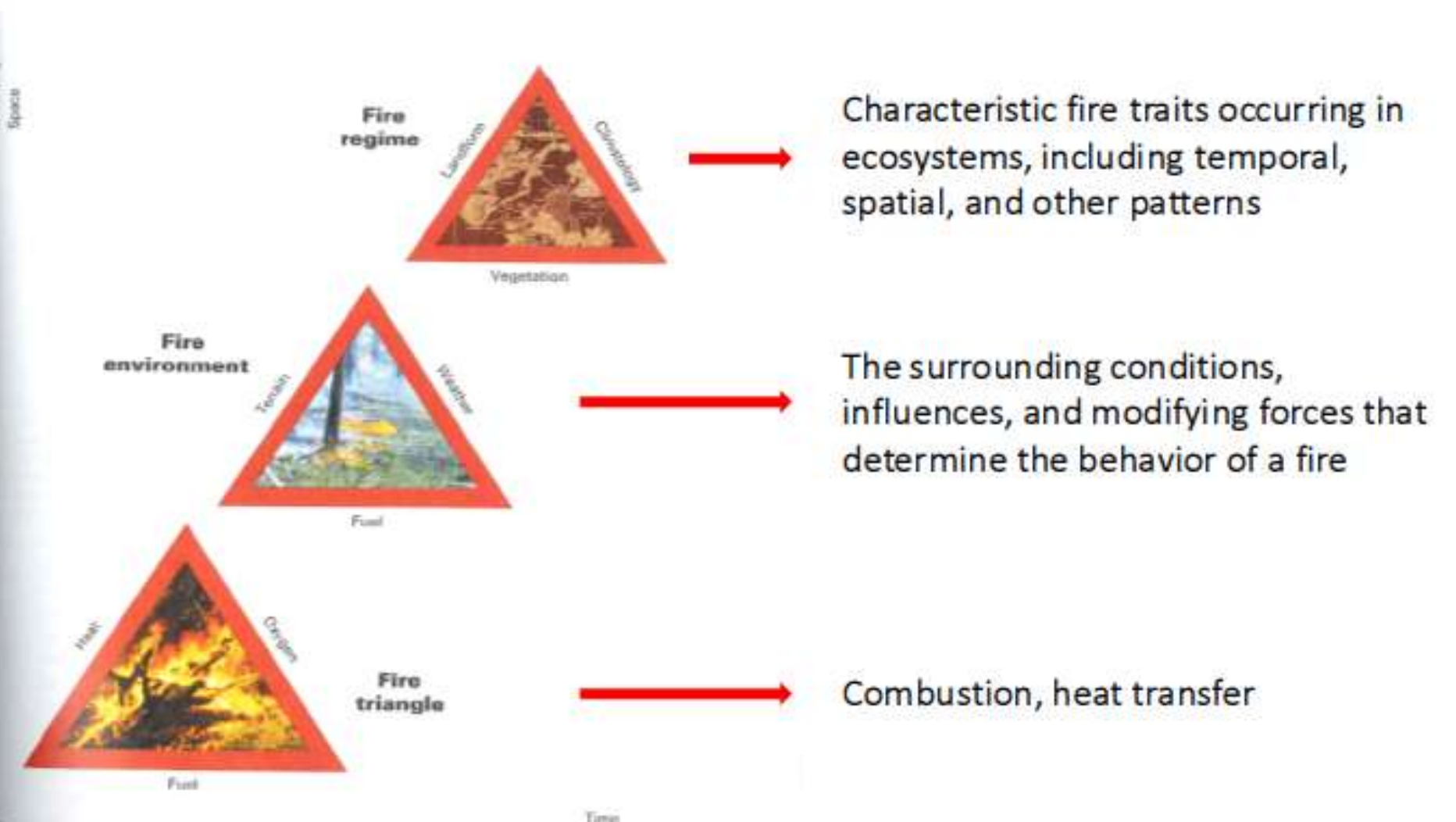
# The role of fires in the Tropical Andes

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# Overview

- Introduction:
  - The fire triangle across change and time
  - Fire-type ecosystems
- The Fire Project in the Tropical Andes
  - Fire dynamics in the Tropical Andes
  - Effects of fire on Tropical Montane Cloud Forests (TMCFs) dynamics
  - Effects of fire on puna grasslands
  - Combustion properties of soils

# The fire triangle across space and time



# Fire – type ecosystems

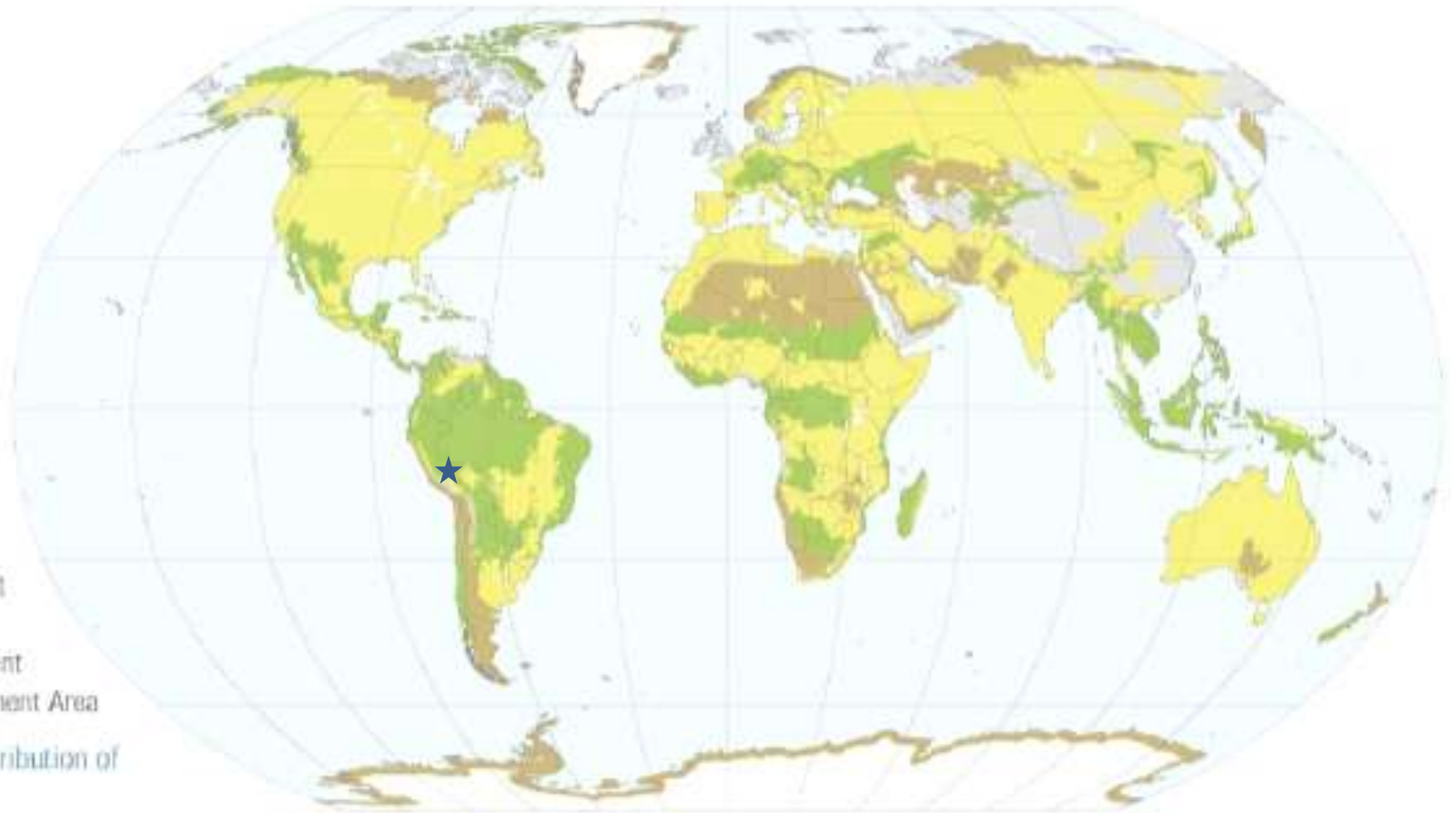


Figure 2. Global distribution of fire regime types.

**Fire  
regime**

*Landform*

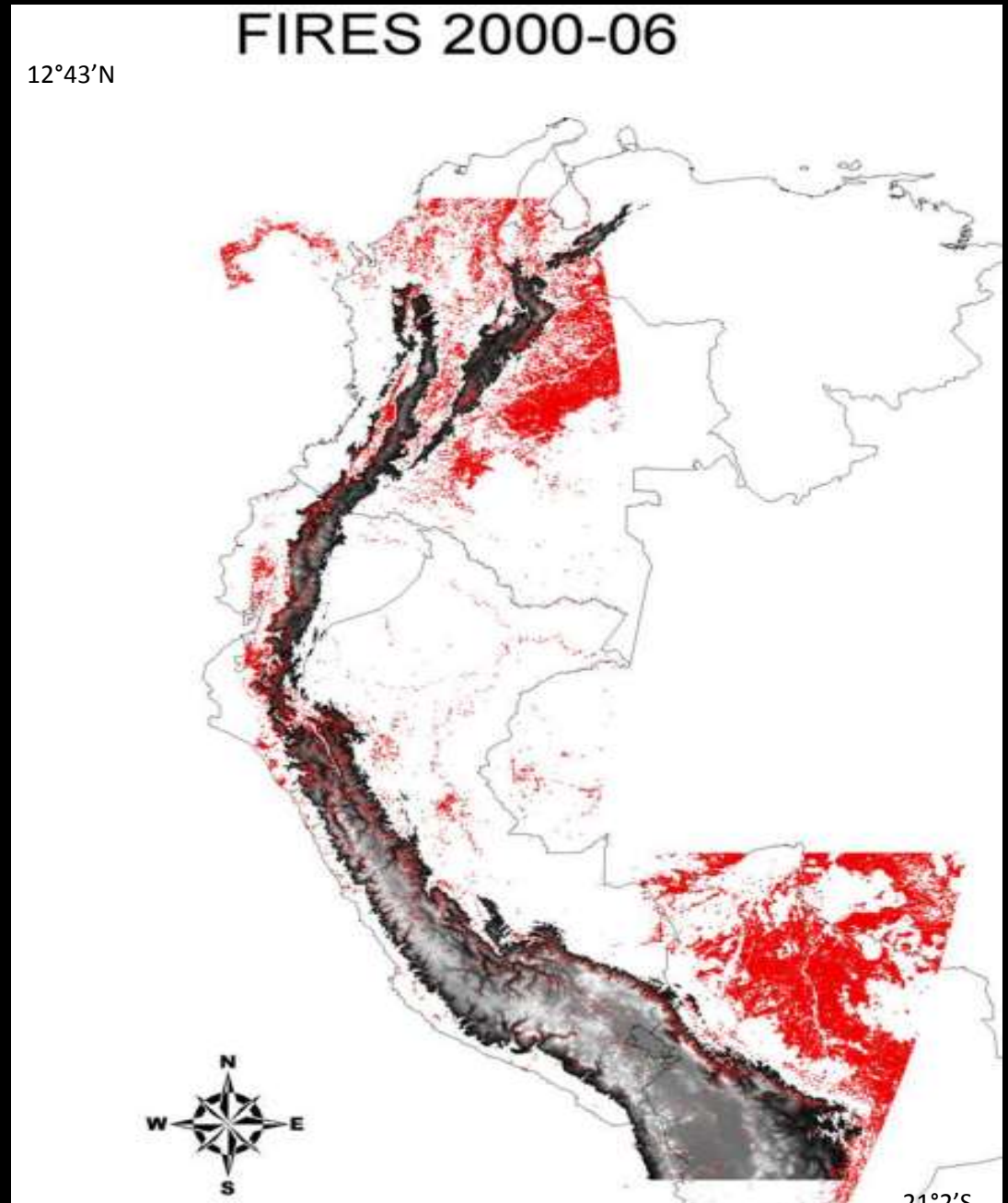
*Climatology*



**Vegetation**

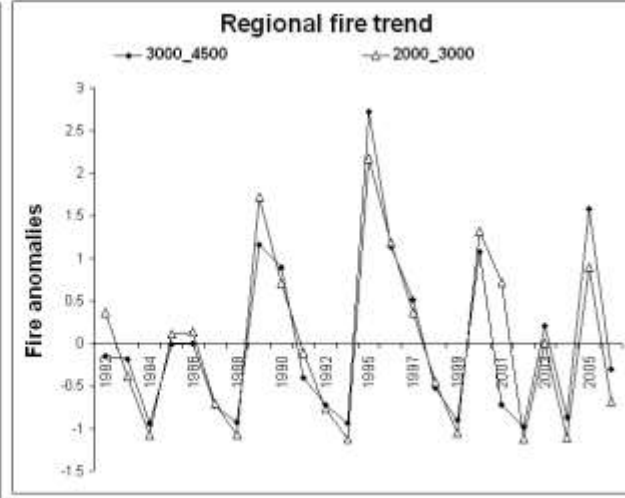
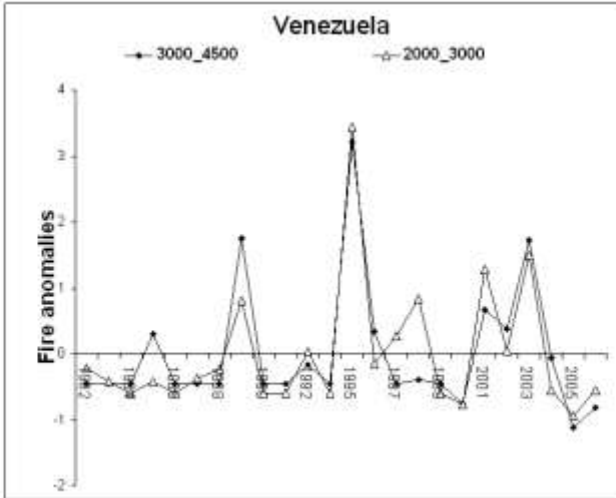
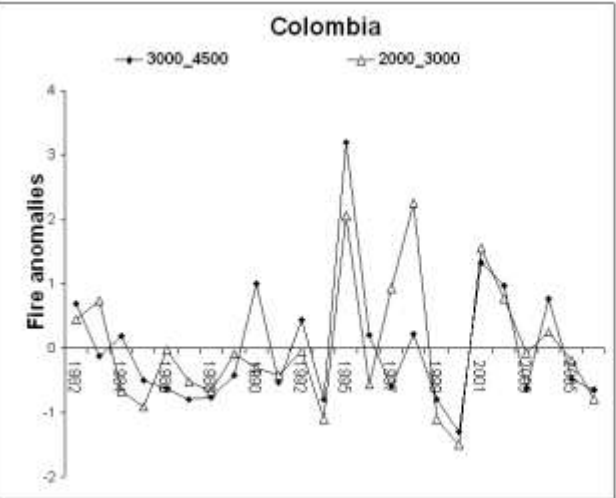
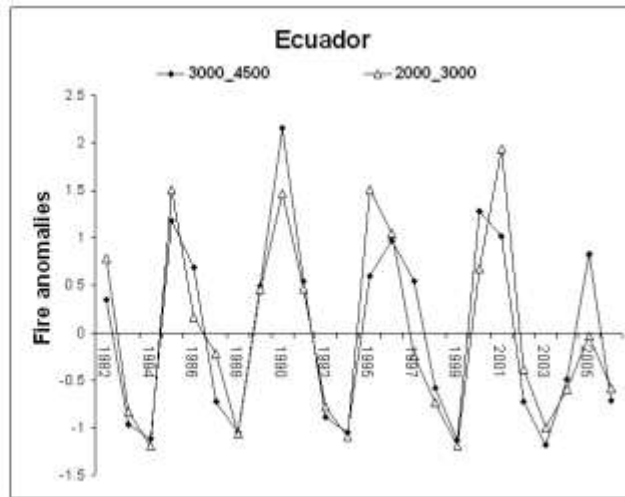
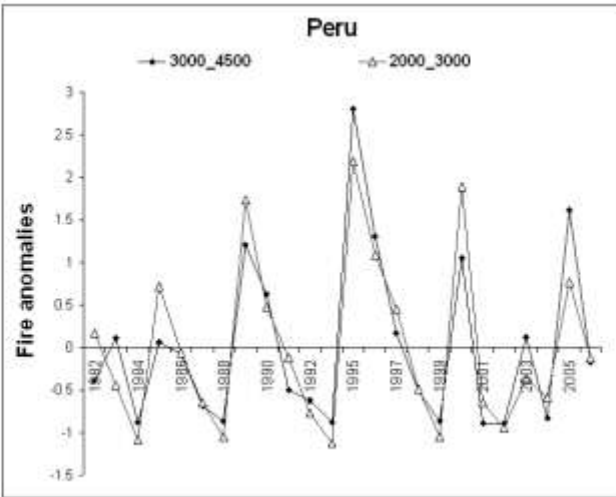
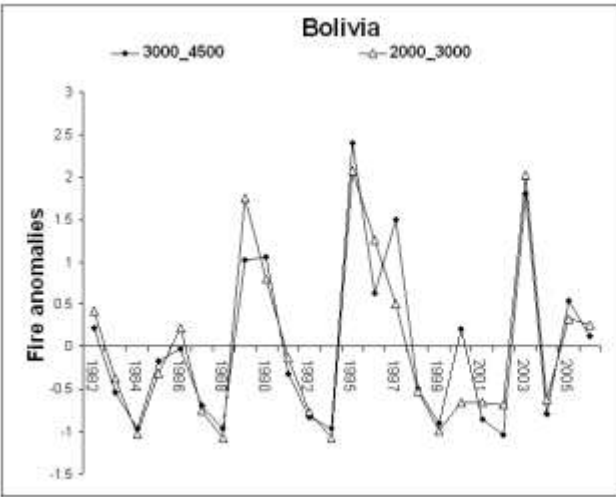
# Fires in the Tropical Andes

- The Tropical Andes
- Remote sensing products are not good fire predictors (lots of omissions)
- However, at present is the most reliable tool we have for the area...
  
- Developing a map combining different remote sensing products and on-ground observations

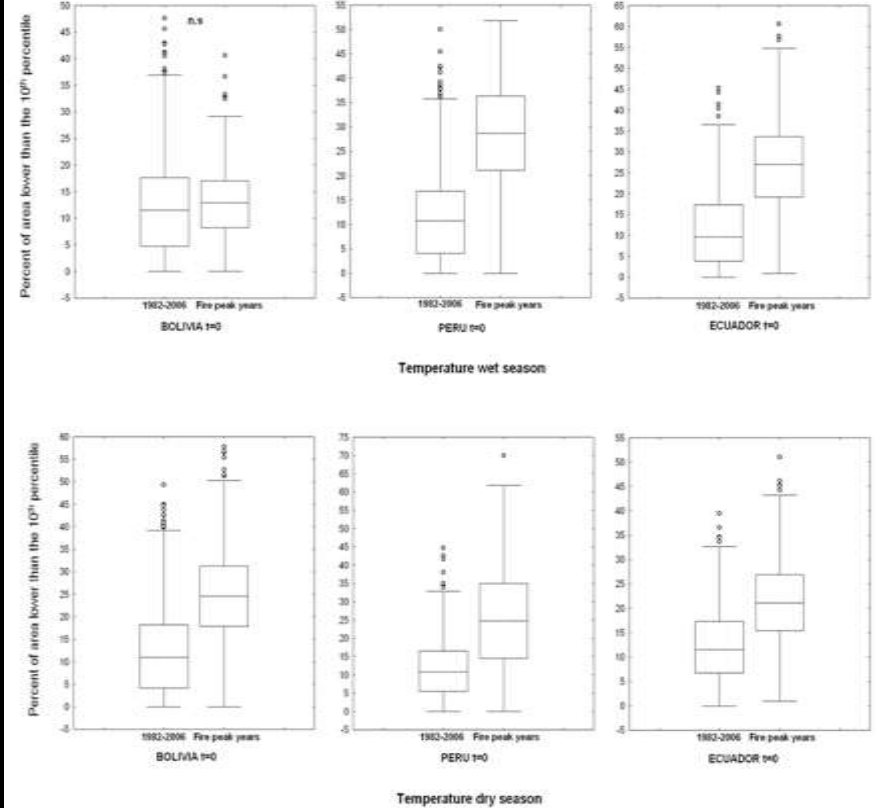
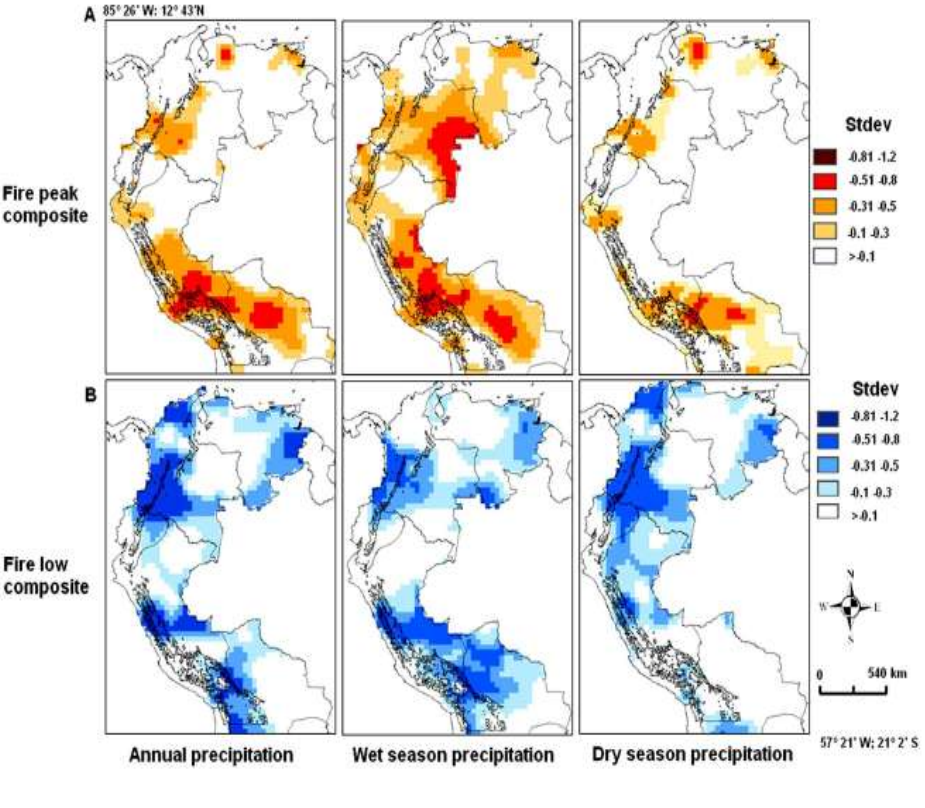


# Fire Anomalies in the Tropical Andes

## Synchronous cyclicality



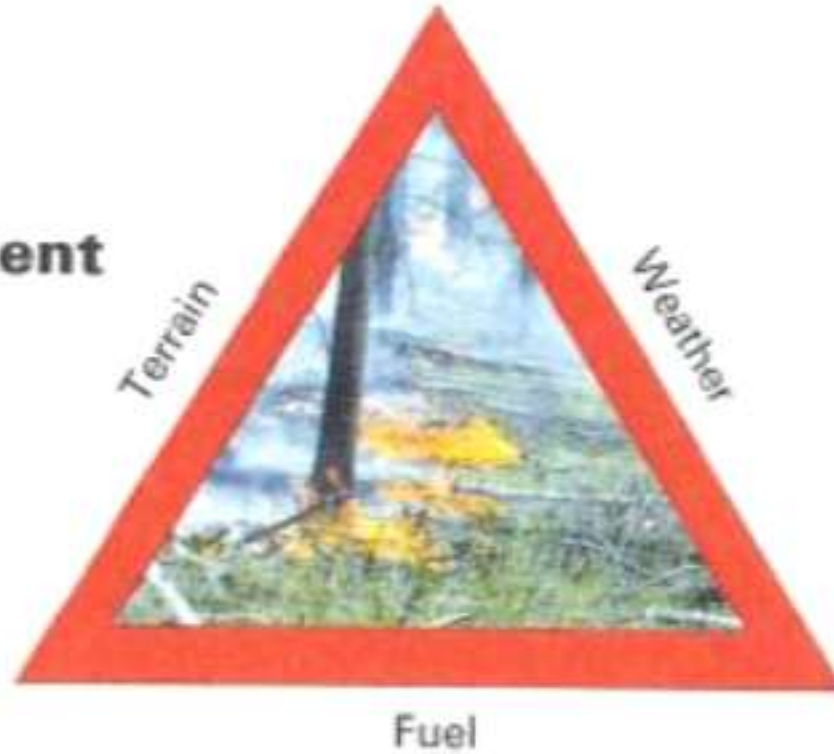
# Climate driven cycles



Decreased precipitation during a fire peak year  
 Increased precipitation during a low fire year

Decreased temperatures on a fire peak year

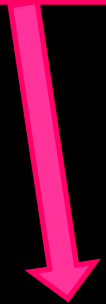
**Fire  
environment**



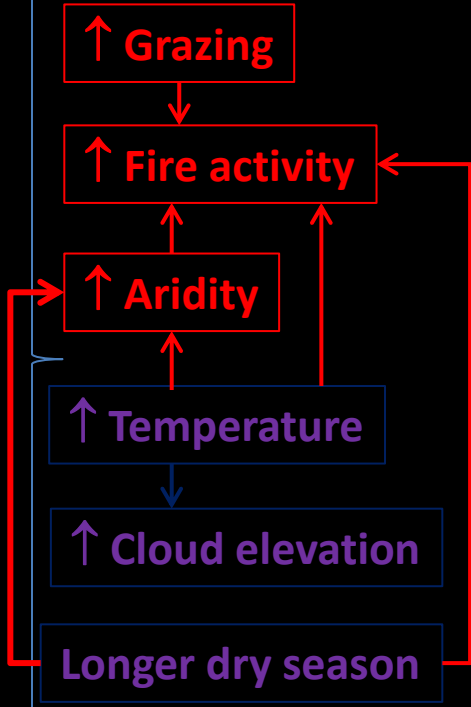
# Fires in the Tropical Andes: Sunchubamba fire September 2010



**Human disturbance  
VS  
Climate Change**



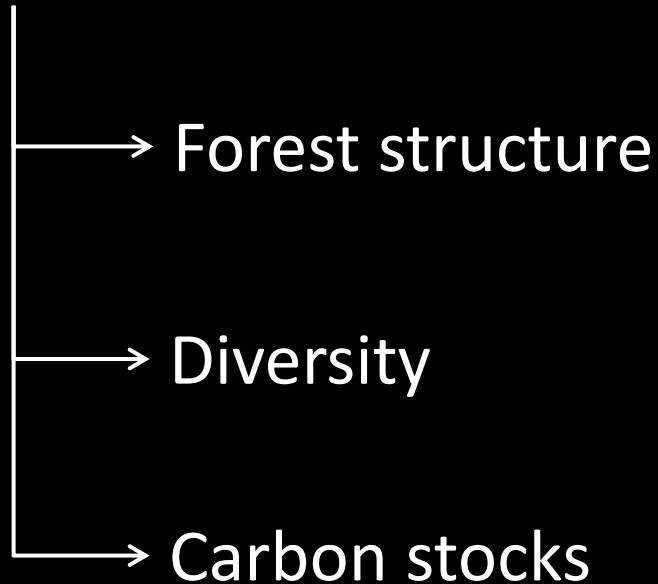
**ECOLOGICAL  
TENSION**



*e.g. Young and Leon 2007 (Roy. Phil. Trans. B); Vuille et al., 2008; Bush et al 2010 (GCB); Keeley and Silman 2010 (a:J. Biogeog., b:GCB); Malhi et al. 2010 (GCB)*

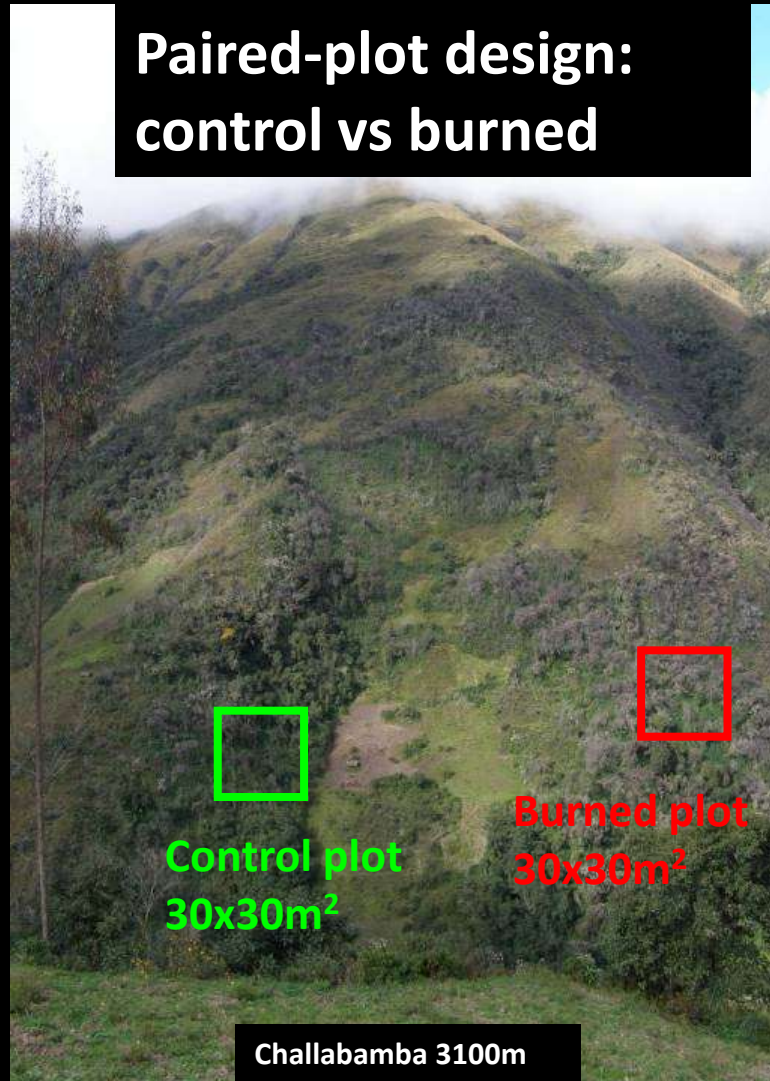
# Fire effects on TMCFs

- Field evaluation of burned forests:





# Methods



## a) Above – ground biomass

- Standing live + dead trees (DBH > 2.5 cm)
- Shrubs and grasses
- Woody debris (coarse + fine)
- Litterfall
- Bark thickness (2011)

## b) Below-ground biomass

- Soil organic and humic layers
- Soil profile depth
- Fine roots
- Coarse roots (2011)

## Control plots

- Elevation: 2200-3555 m a.s.l.
- Slope: 25-75%



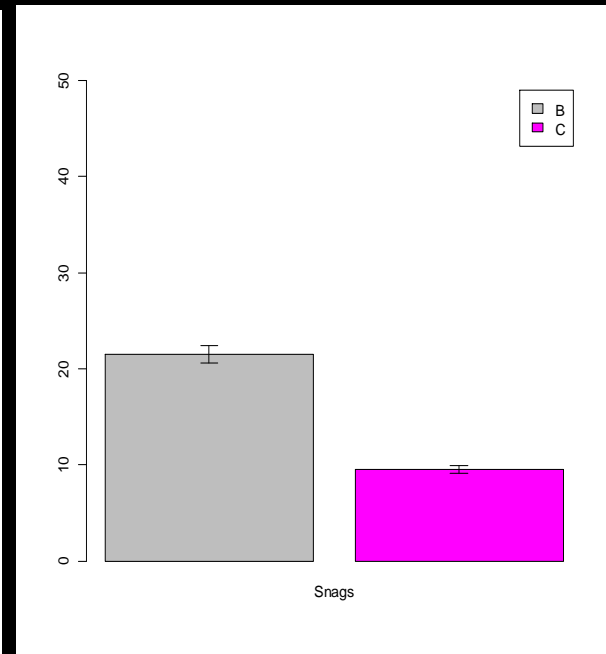
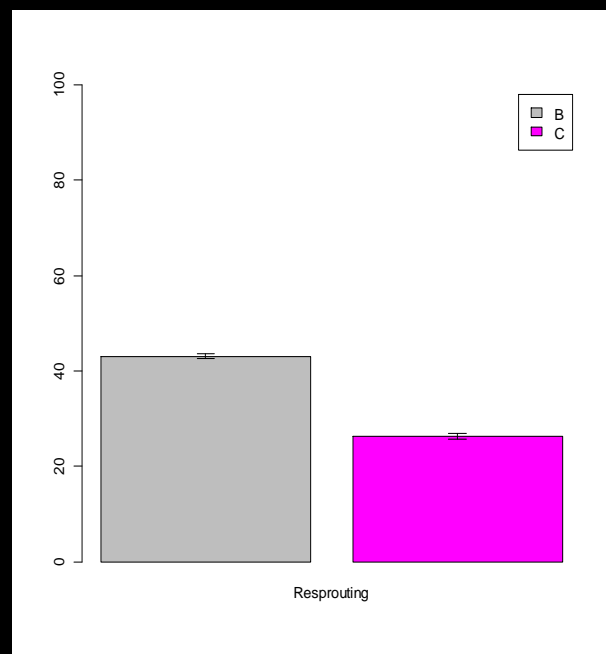
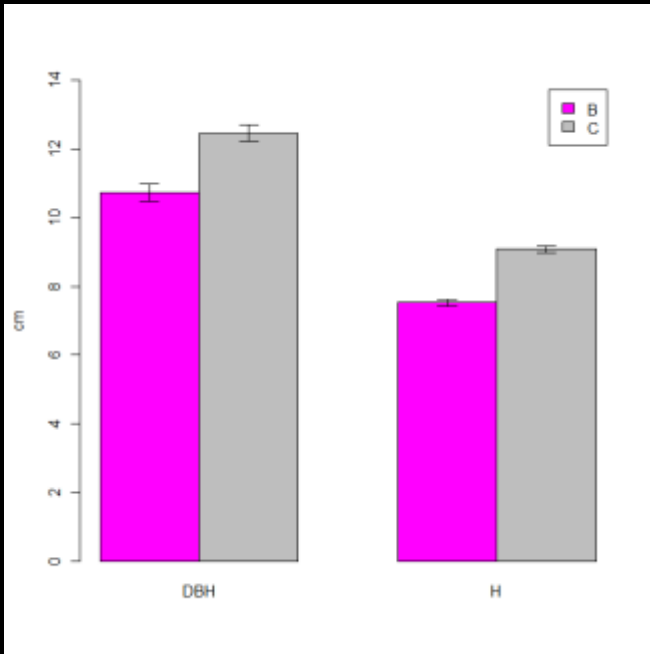
*\*No visible fire scars*

## Burned plots

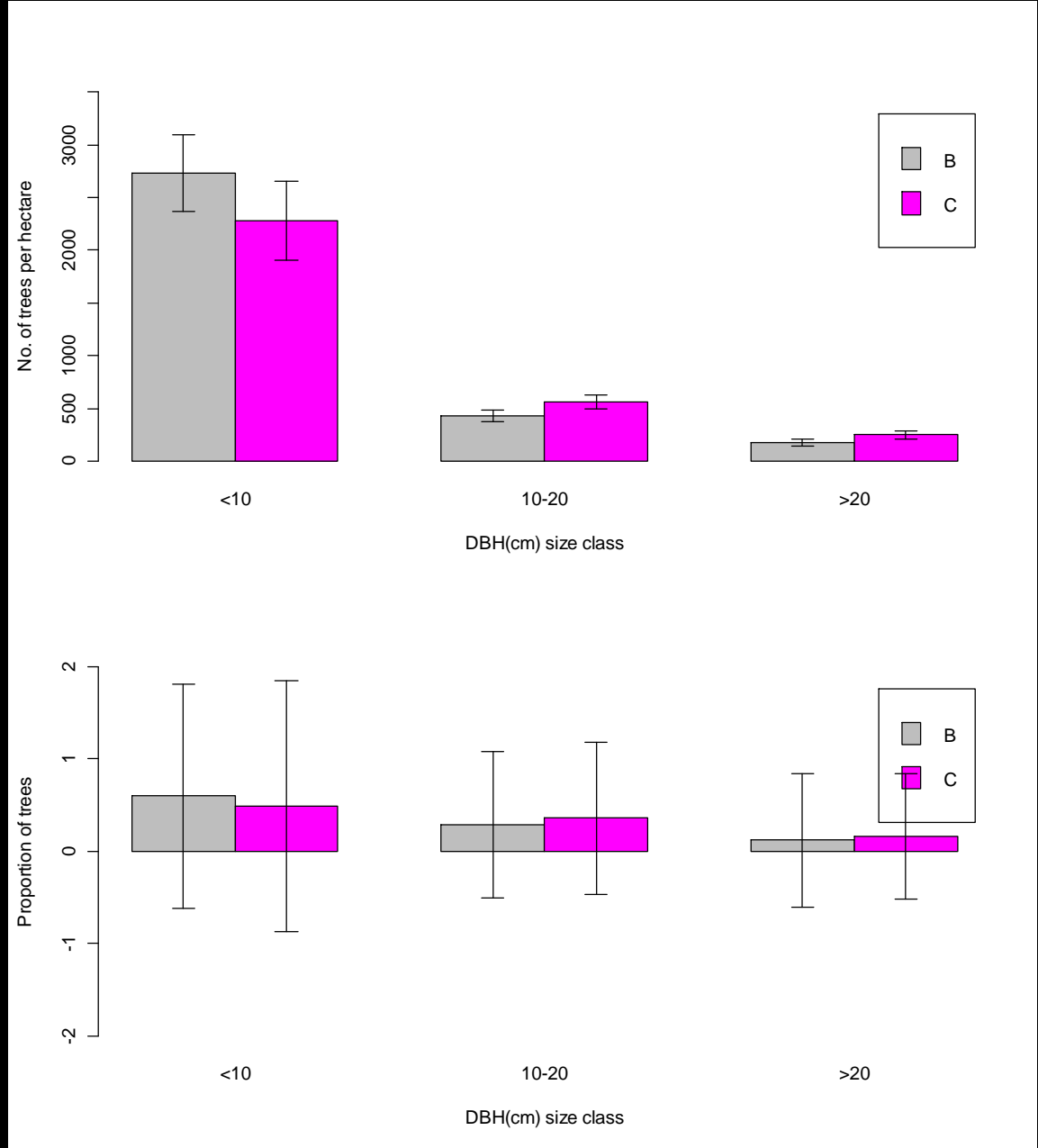
- Elevation: 2180 – 3540 m a.s.l.
- Slope: 30 – 80%
- Time since last fire: 1-15 years



# Fire effects on forest structure



# Fire effects on forest structure



# Fire effects on forest composition

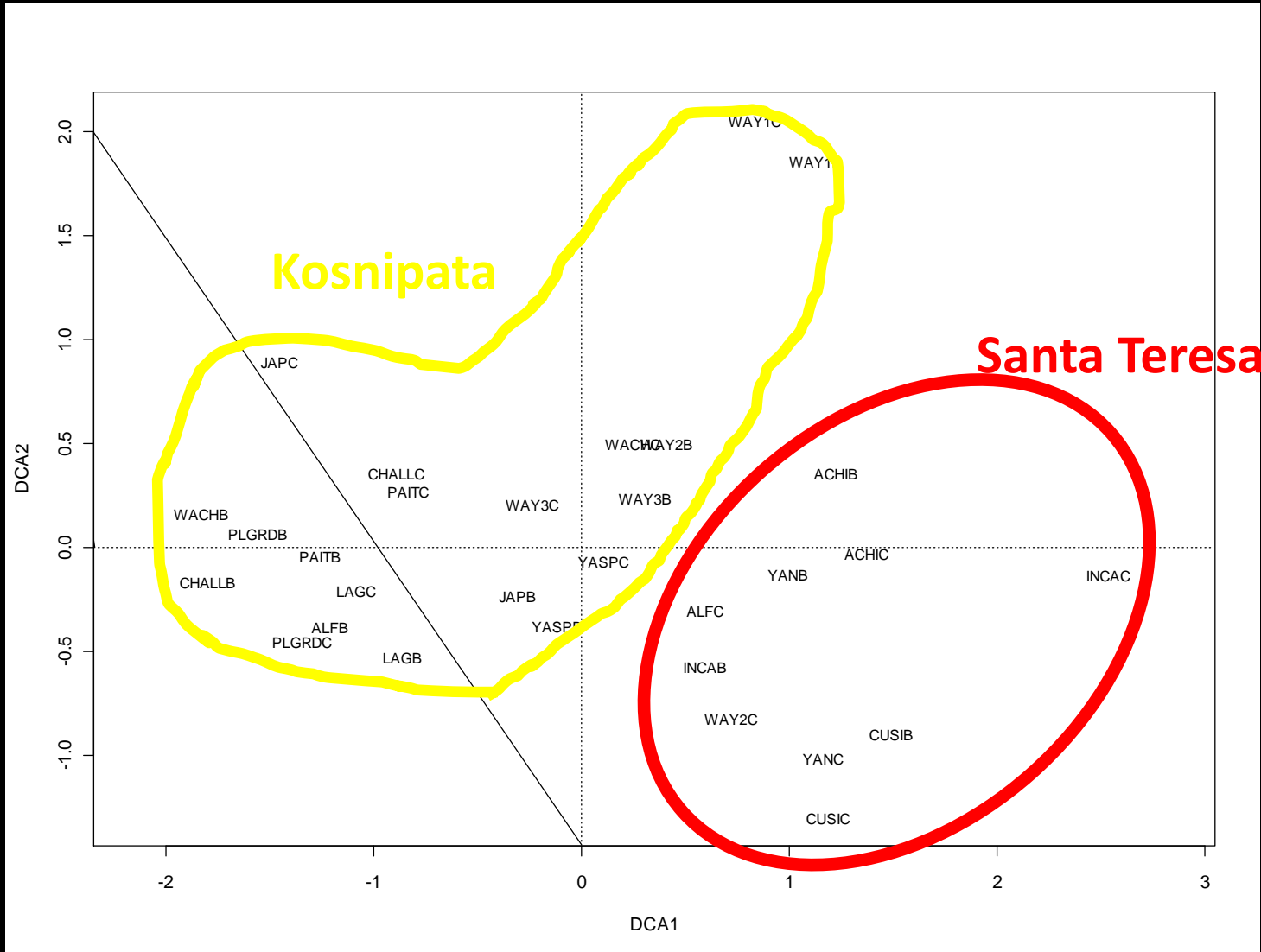
- 125 different genera
- 100 in burnt plots
- 97 in control plots
- High (and same) dissimilarity index (Jaccard) within plots (Control: 0.871; Burnt: 0.871)
- Dissimilarity index correlated with elevation and location, not fire

Gradient	Corr.
FIRE	0.012822
FC	0.23548
EL	<b>0.367333***</b>
OR	0.166053
SL	0.152427
X	0.078234
Y	<b>0.312358***</b>

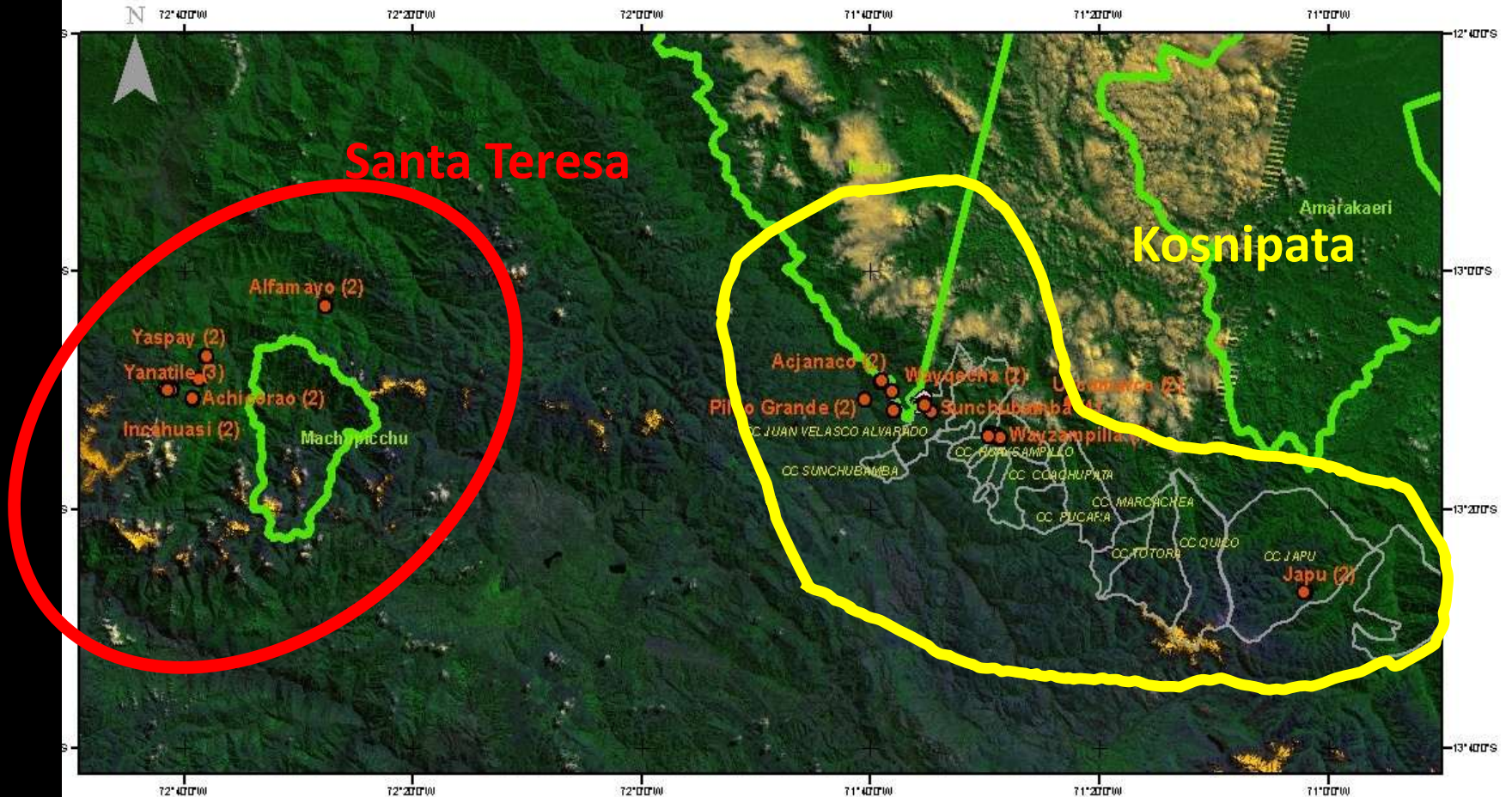
## 19 different genera most contribute to total basal area of plot

Site	Genus	Prop tot BA
ACHI-B	Turpinia	0.30
ACHI-C	Myrcianthes	0.25
ALF-B	Clusia	0.41
ALF-C	Myrsine	0.18
CHALL-B	Polylepys	0.43
CHALL-C	Myrica	0.20
CUSI-B	Hieronyma	0.15
CUSI-C	Weinmannia	0.19
<b>INCA-B</b>	<b>Ocotea</b>	0.45
<b>INCA-C</b>	<b>Ocotea</b>	0.43
JAP-B	Polylepys	0.21
JAP-C	Gynoxys	0.22
<b>LAG-B</b>	<b>Clusia</b>	<b>0.46</b>
<b>LAG-C</b>	<b>Symplocos</b>	<b>0.27</b>
<b>PAIT-B</b>	<b>Clusia</b>	<b>0.37</b>
<b>PAIT-C</b>	<b>Begonia</b>	<b>0.12</b>
<b>PLGRD-B</b>	<b>Polylepys</b>	<b>0.42</b>
<b>PLGRD-C</b>	<b>Polylepys</b>	<b>0.50</b>
USC-B	Prunus	0.53
USC-C	Alnus	0.34
<b>WACH-B</b>	<b>Clusia</b>	<b>0.28</b>
<b>WACH-C</b>	<b>Schefflera</b>	<b>0.22</b>
WAY1-B	Freziera	0.40
WAY1-C	Alnus	0.19
<b>WAY2-B</b>	Alnus	0.17
<b>WAY2-C</b>	Alnus	0.26
WAY3-B	Prunus	0.41
WAY3-C	Freziera	0.51
YAN-B	Endlicheria	0.27
YAN-C	Ficus	0.21
YASP-B	Clusia	0.23
YASP-C	Brunellia	0.17

# Fire effects on forest composition



# FIRE PAIRED PLOTS 2010



WGS84 LAT/LONG

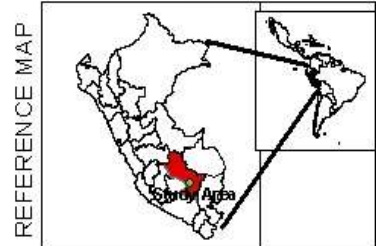
MADE: LAN DSATMOSAIC 03069 - 04069 JULY 2007

SOURCE: SERANAP, ACC A, GLO VIE  
DATE: 3 NOV 2010  
AUTHOR: L O Iruas

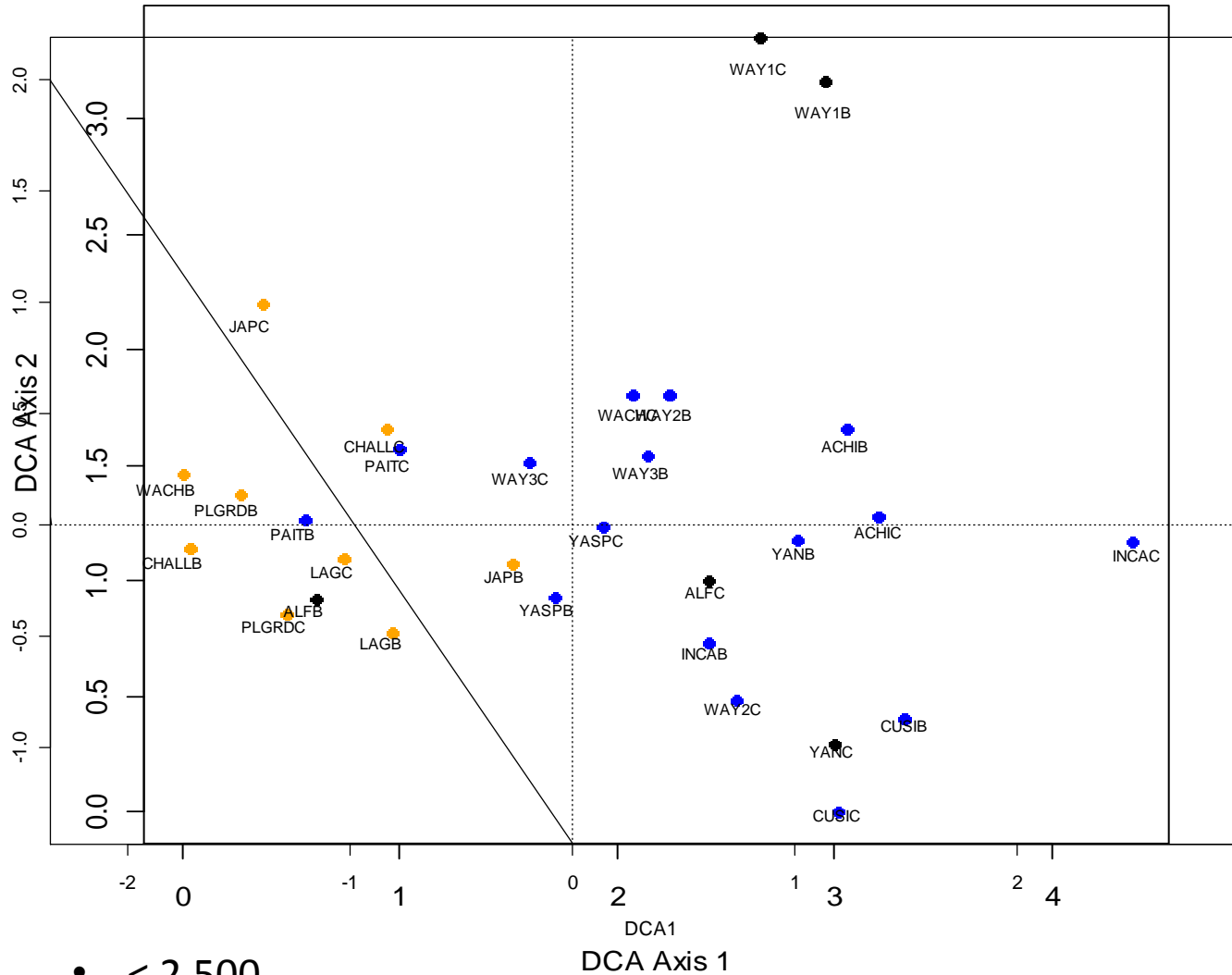


**Legend**

- Fire Plots
- Estación\_biológica\_Wayquechua
- Natural Protected Areas
- Local communities



## Sample Scores, by Elevation



	DCA1	DCA2	r2	Pr(>r)
FIRE	-0.99312	-0.11714	0.0280	0.654
FC	0.40892	-0.91257	0.0302	0.660
EL	-0.95913	-0.28298	0.4290	<b>0.001 ***</b>
SL	-0.67167	0.74085	0.2304	0.022 *
X	0.22002	-0.97550	0.1339	0.137
Y	-0.60127	0.79904	0.5364	<b>0.001 ***</b>
OR	0.95811	-0.28639	0.3256	0.007 **
MOR	-0.90541	-0.42454	0.2415	0.030 *

# Fire effects on TMCF carbon stocks

Carbon stocks for above and belowground compartments. Values represent mean  $\pm$ SE, max and min for each variable.  $n = 5$  for the control plots and  $n = 4$  for the burned plots. n.a. indicates non-available data to display variability.

		Control			Burnt			Difference from control (MgC ha <sup>-1</sup> )
		Mean	Max	Min	Mean	Max	Min	Absolute difference (% of difference)
Standing	Live	69.2 $\pm$ 13.4	97.7	32.9	45.5 $\pm$ 17.4	83.5	13.4	-23.7 $\pm$ 22 (-34%)
	Dead	16.4 $\pm$ 4.4	24.2	4.3	45.2 $\pm$ 9.4	71.5	30.4	+28.8 $\pm$ 10.4 (+276%)
Fallen dead wood		6.7 $\pm$ 3.2	15.8	1.5	11.2 $\pm$ 5.0	26.2	4.4	+4.5 $\pm$ 6 (+167%)
CWD		23.1 $\pm$ 5.4	37.2	7.5	56.4 $\pm$ 10.6	97.7	35.9	+33.3 $\pm$ 11.9 (+244%)
Standing dead + fallen dead								
Percent of fallen dead in CWD		29%			19.9%			-9.1 (-31%)
Soil organic layer		54.1 $\pm$ 22.3	108	10.7	5.8 $\pm$ 5.3	21.7	0	-48.3 $\pm$ 22.9 (-89%)
Roots (<2 mm)		14.8 $\pm$ 0.8	n.a.	n.a.	n.a. $\pm$ n.a.	n.a.	n.a.	-14.8 $\pm$ 0.8 (-100%)

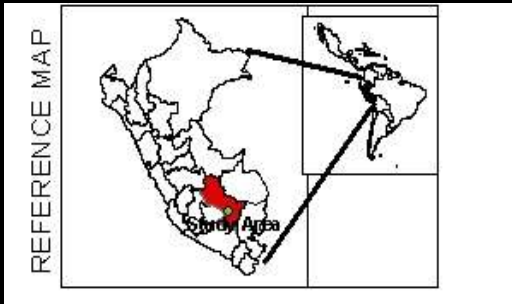
Roman-Cuesta et al. (2011) FORECO

# Fire effects on puna

- Puna productivity experiments – fire and grazing effects



# Study area



2 SITES: ACJANACO & WAYQECHA

Transects:  
BURNT/UNBURNT (8)  
GRAZING/NO GRAZING (4)

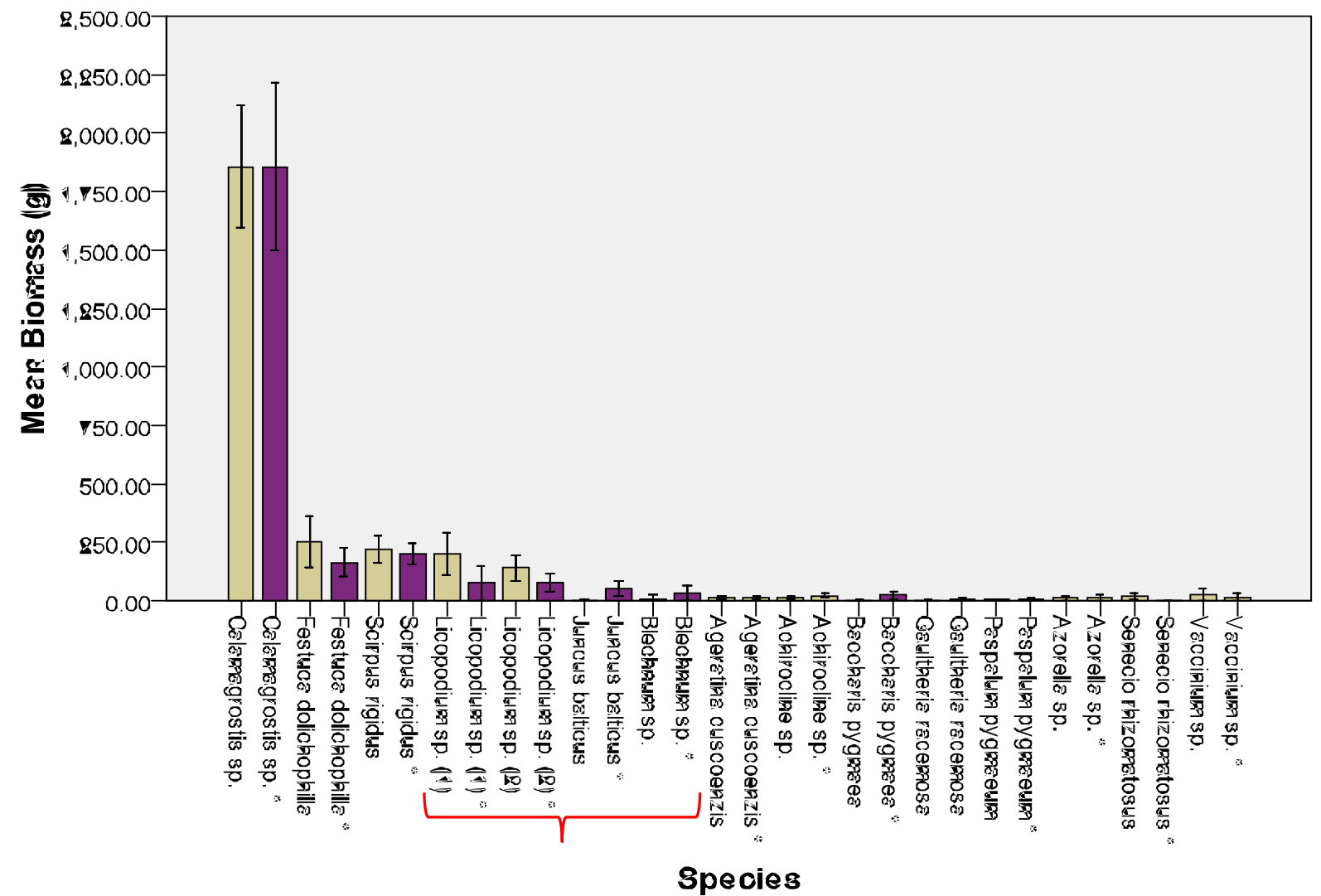
AGB: species identification, measures for allometric equations, cuts every 2 months



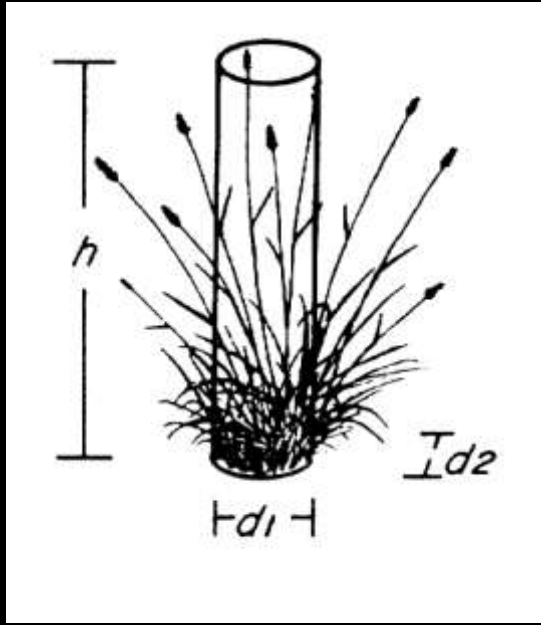
# BGB: ingrowth cores, fine roots, respiration



# Fire effects on puna species composition



# Allometric equations



**Variables:** basal diameter, field height, maximum height, crown diameter

Species specific (*Calamagrostis sp*, *Scirpus rigidus*, *Festuca dolichophylla*, *Juncus balticus*)

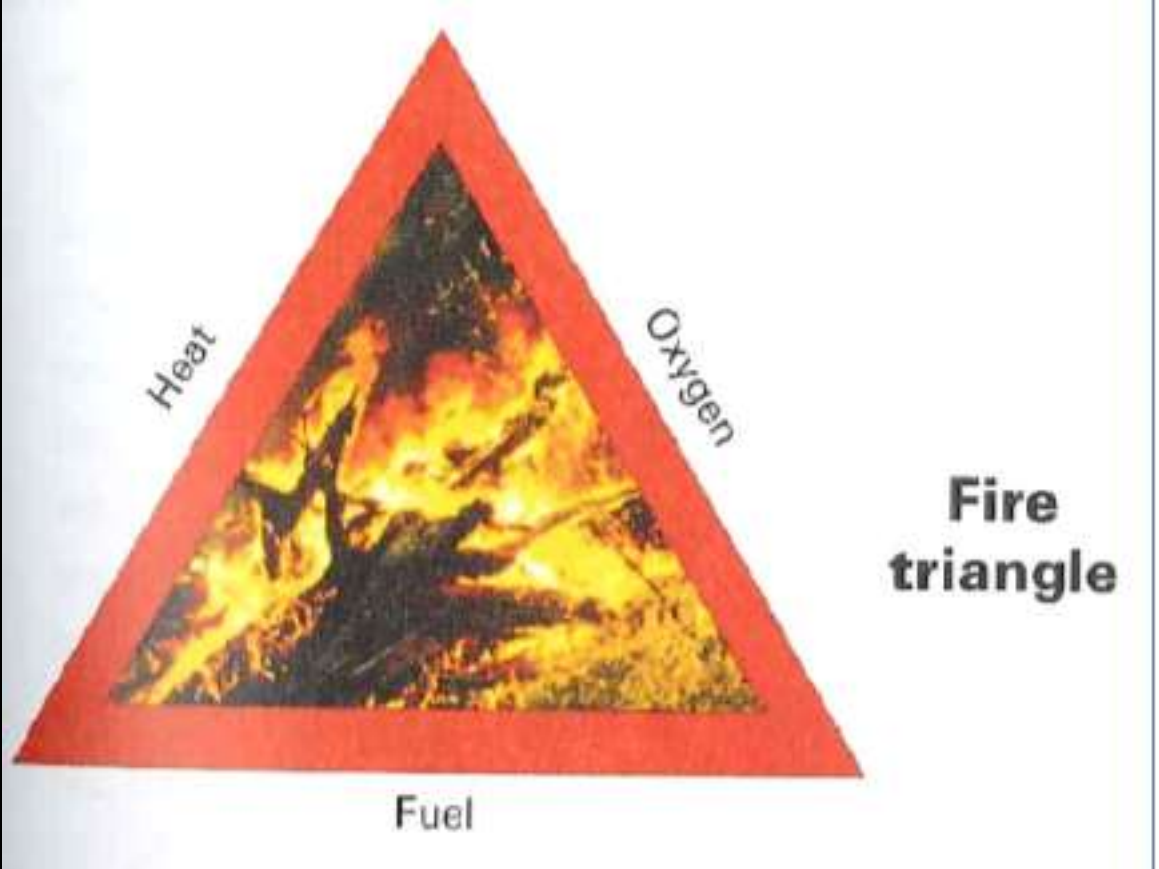
Multispecies (4 species together)

Best predictors:

- Volume (as Johnson et al., 1998)
- Maximum height

No significant effects of fire

Multispecies more powerful equations than species specific



# Combustion soil properties

## Questions:

- What are the moisture thresholds that enable combustion?
- Is fire self-sustained at any point? If so, what are the fire behaviour characteristics (temperature, rate of spread, heat and carbon emissions)?

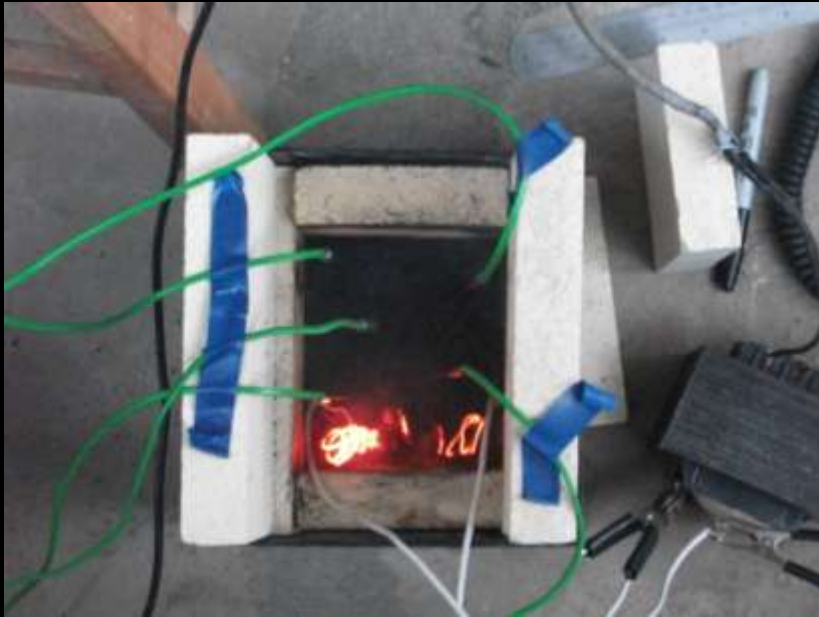


## Field experiment

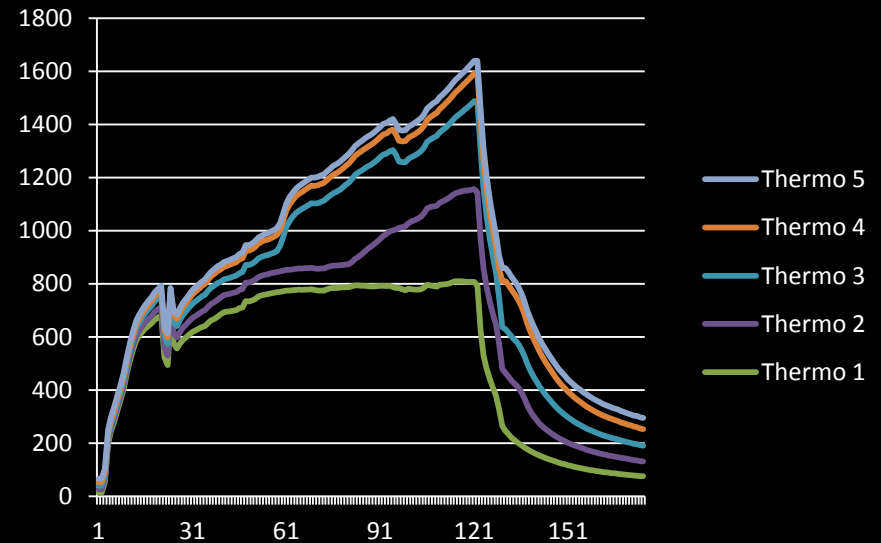


- Metal plates installed on June 2010
- Covered with plastic
- Moisture and soil temperature recorded every 2 weeks
- Ignition tested after 1 month from the installation of the metal plates
- No success:
  - Energy supply
  - Soil moisture

# Lab experiment



- 15 x 15 cm box
- Samples from puna, shrub, forest
- Different moisture contents
- Analyses of ashes (mineral content) and SOC



# Combustion experiments

*No results yet....*



*....And still thinking about how to  
get successful experiments!*

**THANK YOU!!!**

