Fire-size dependent factors to describe occurrence in Mediterranean Forests

Marina Peris-Llopis, José Ramón González-Olabarria, Blas Mola-Yudego

marinp@uef.fi

UEF // University of Eastern Finland

Forest fires in Mediterranean Europe

430 000 ha, 57 000 fires

Damages to forest structure and functions

Economic and ecologic losses, human casualties

Forecast: increase in frequency and burnt area, extreme events

Aim: address the potential differences in fire occurrence related to the dimension of the final burnt area

Study area: Eastern Spain

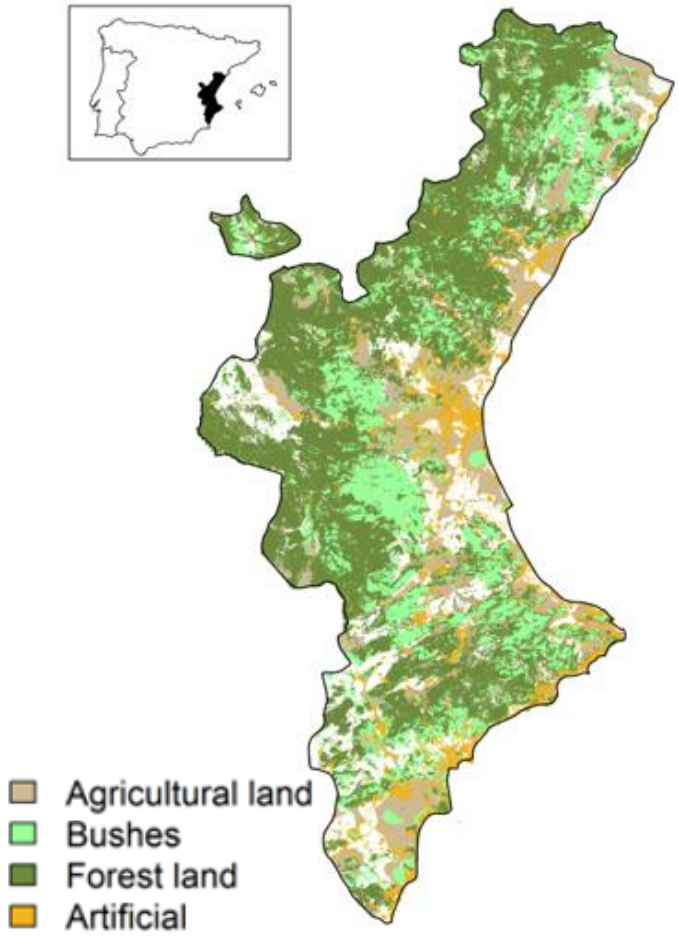
Comunitat Valenciana

5 million inhabitants in 23 255 km²

1.3 million ha of forest land (56%)

Pinus halepensis dominated stands

3rd region with more large fires and 2nd in relative burnt forest area by large fires (87%)



Data sources

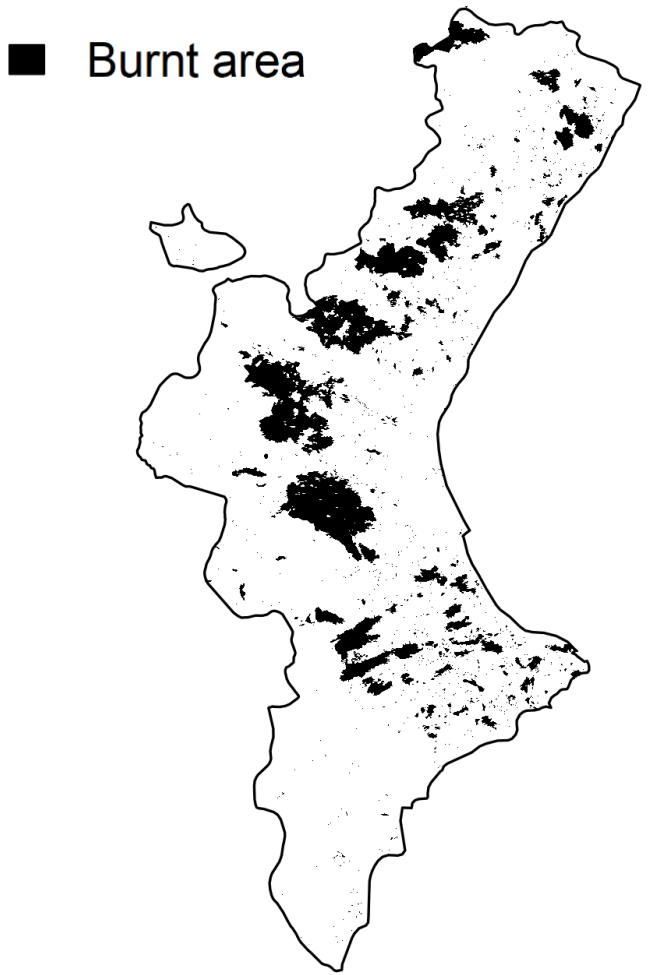
- **Forest fires data** (1993-2015)

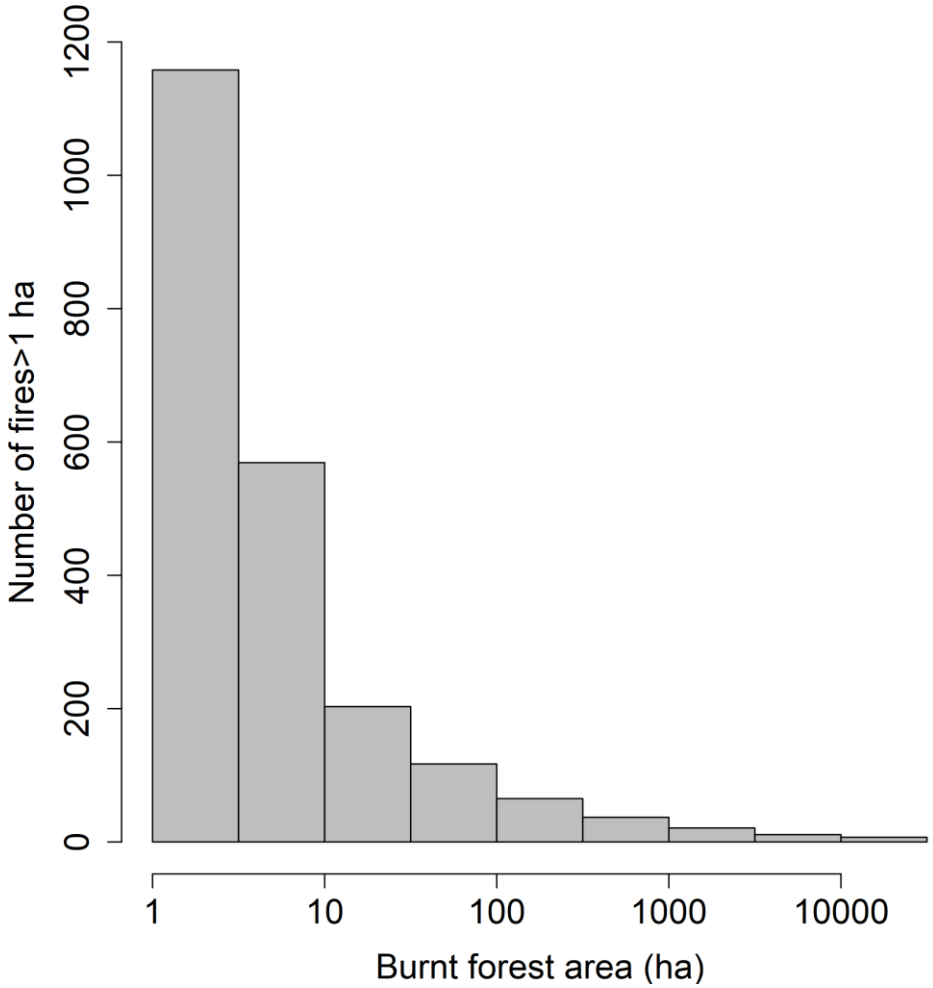
  Forest fires prevention service

- **Spanish Forest Map** (1:50 000)

- **DMT200** (1997-2006)

- **Population and roads maps**





10 722 fires

301 483 ha burnt

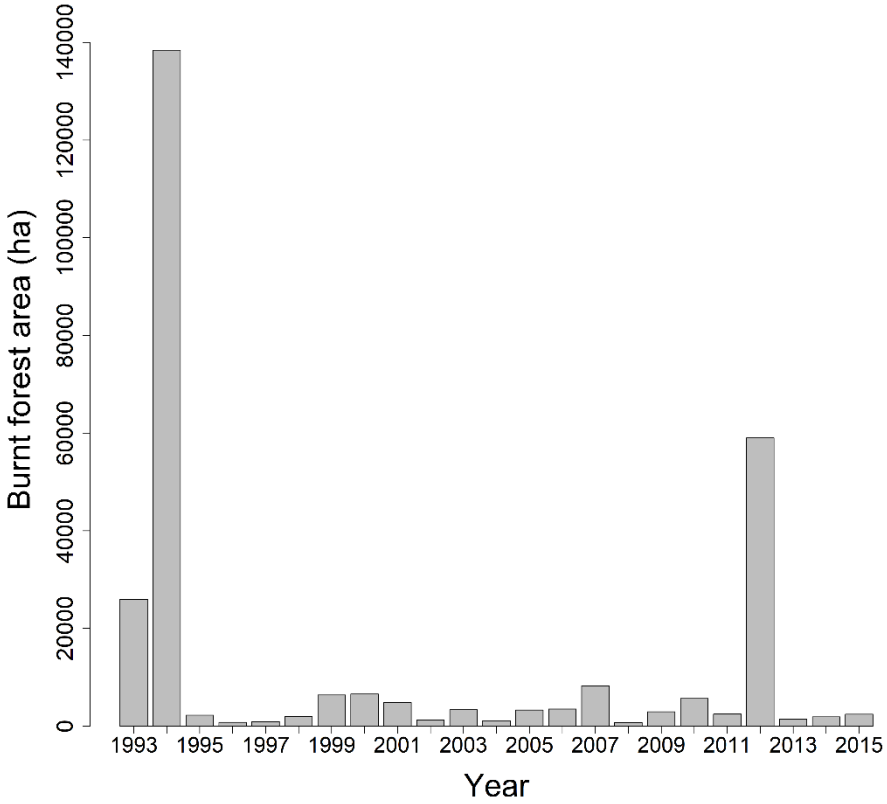
285 024 ha of forest burnt

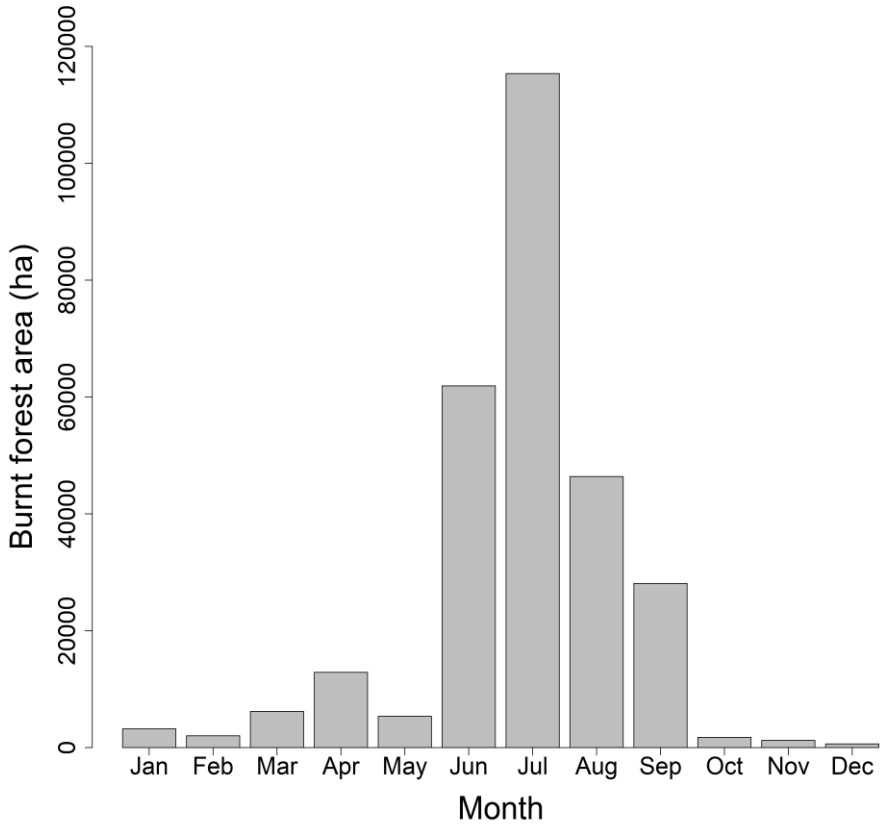
22% of the forest land

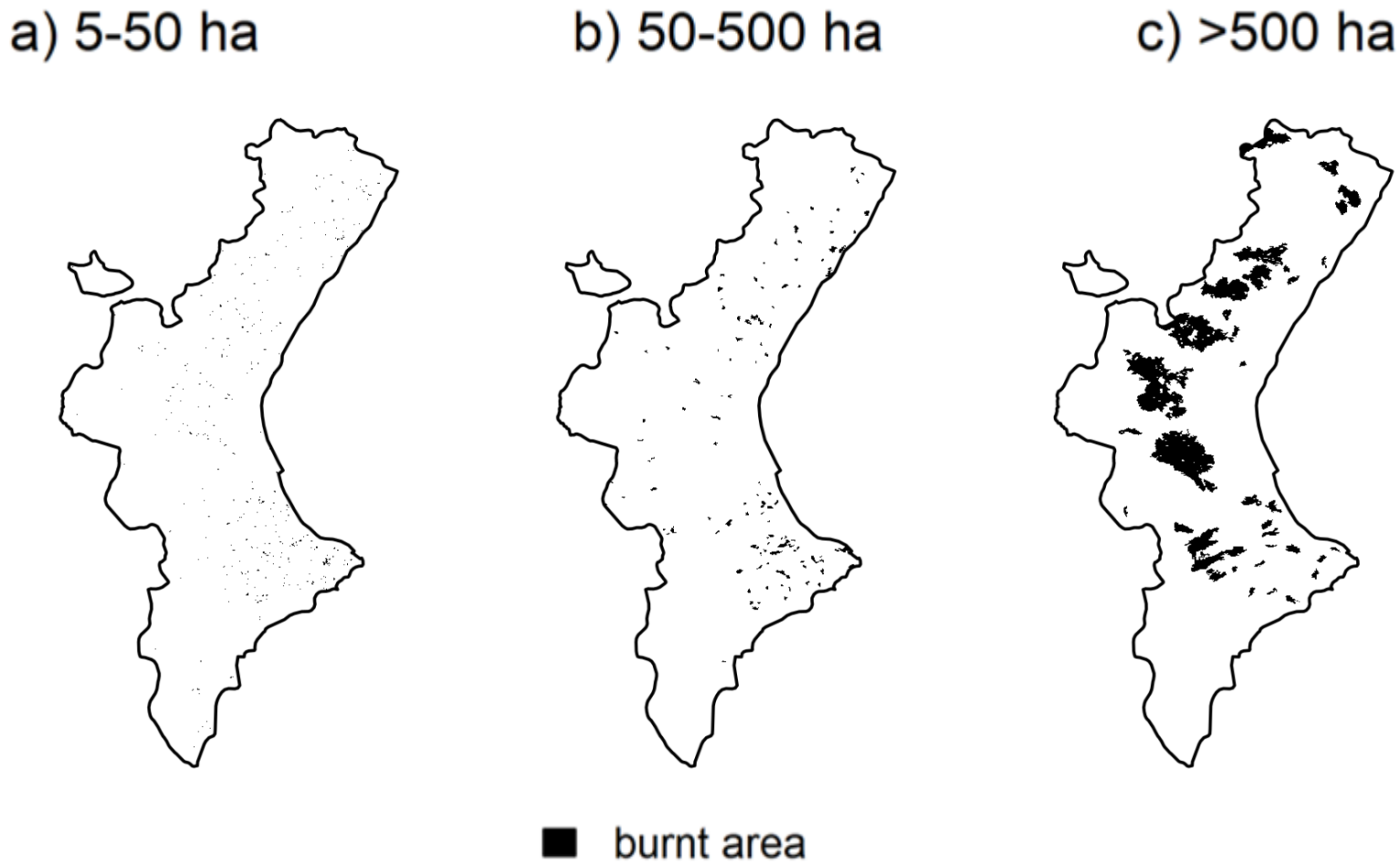
Negligence and accidental fires

54% of burnt forest

Natural fires 24%


Burnt forest area (ha)
0
20000
40000
60000
80000
100000
120000
140000
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
Year


Burnt forest area (ha)
0
20000
40000
60000
80000
100000
120000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


a) 5-50 ha
b) 50-500 ha
c) >500 ha
burnt area

Fire size (ha)	5-50	50-500	>500
N	585 5.4%	146 1.3%	59 0.5%
Burnt forest surface (ha)	7968 2.7%	23 247 8%	248 653 87%
Mean burnt surface (ha)	13.6	159	4214.4
Forest formation	*P. halepensis*	*P. halepensis*	*P. halepensis*
Fuel type	Low vegetation cover	Bushes/small trees	Bushes/small trees
Mean relative humidity (%)	41	40	34
Mean max temperature (°C)	15	16.5	21
Altitude (m)	414.6	471	617
Slope (%)	17	20.3	16.8
Population density (hab km^{-2})	37.4	20.7	9.2

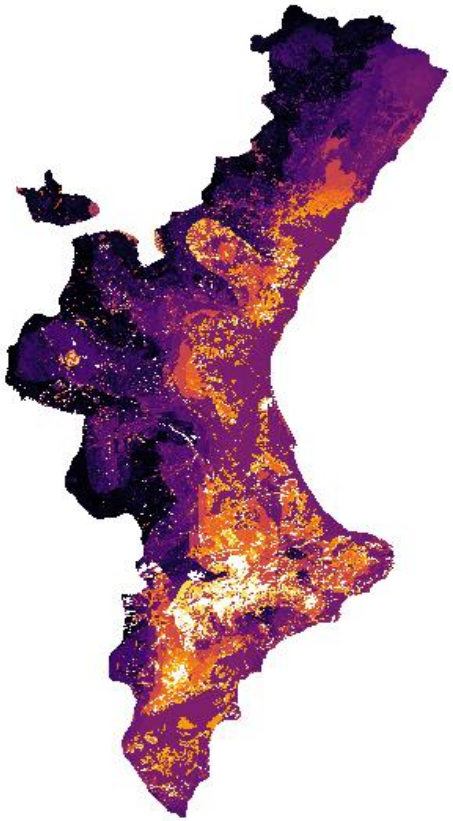
Forest classification

Variables	Classes
Altitude (N=5)	0-200 m, 200-600 m, 600-1000 m, 1000-1400 m, 1400-2100 m
Slope (N=5)	<3%, 3-12%, 12-20%, 20-35%, >35%
Aspect (N=4)	315-45º (North), 45-135º (East), 135-225º (South), 225-315º (West)
Fuel (N=5)	Vegetation cover <20%, Pasture, Bushes and small trees (height < 8-10 m), Medium trees (height > 8-10 m and diameter < 20 cm), Mature trees (diameter > 20 cm)
Species (N=5)	Tree coverage <20%, Pine, Oak, Pine and Oak mixture, Other species
Population (N=3)	Population density < 25 hab km^{-2}, 25-100 hab km^{-2}, > 100 hab km^{-2}
Road density (N=5)	0-50 km km^{-2}, 50-100km km^{-2}, 100-150km km^{-2}, 150-200km km^{-2}, > 200 km km^{-2}

Forest classification

- Altitude
- Slope
- Species
- Fuel
- Population
- Roads

Proportion of burnt and non-burnt strata



Statistical modelling

- Weighted Generalized Linear Models

$$y_i \equiv \ln\left(\frac{p_i}{1-p_i}\right) \equiv X_i^t \beta + \varepsilon_i$$

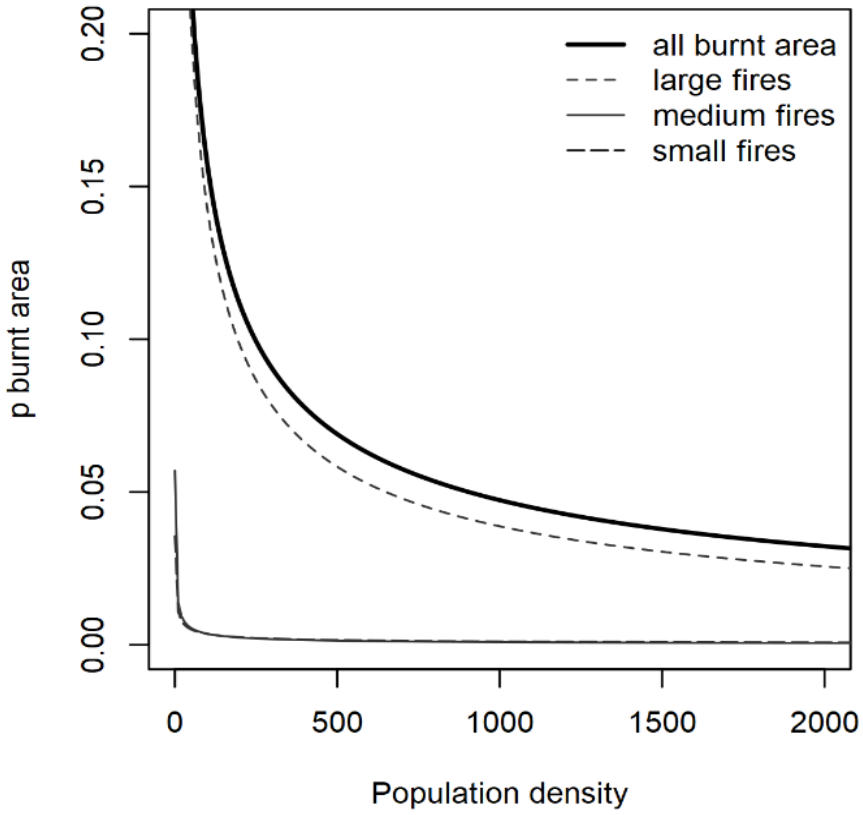
4 Models → Small, Medium, Large, All

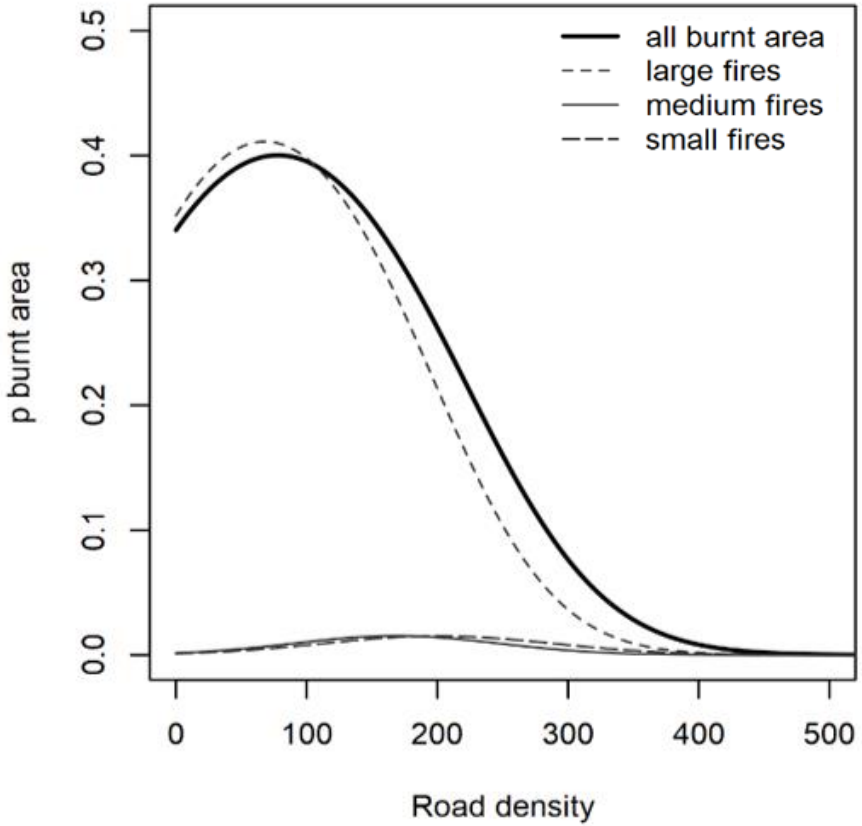
- Pseudo-R^2

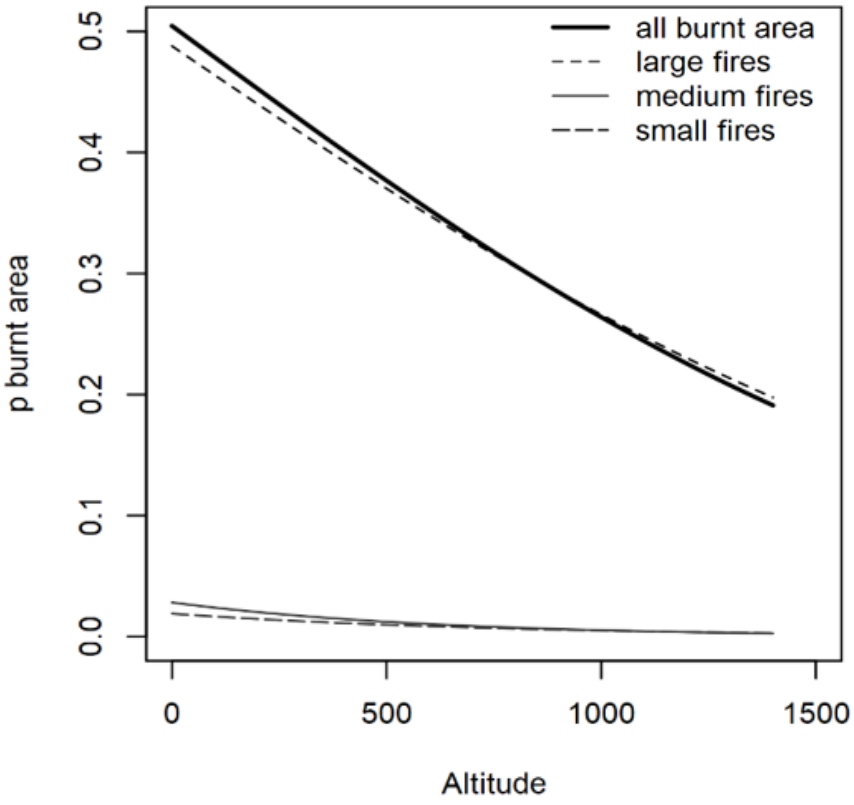
Results

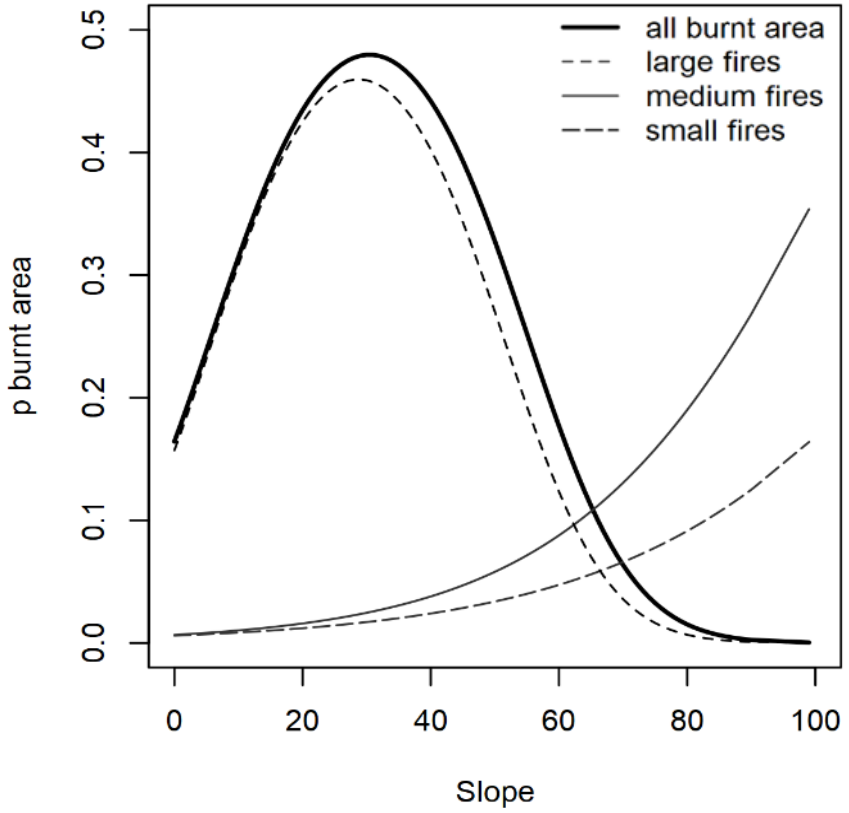
Species	Fuel	Topography	Accessibility
Pine as a fire-prone species, positively related to large fires Pine-Oak mixture was positive for large fires Oak not significant	Presence of bushes with small trees was positively related to all fire sizes The dominance of medium and mature trees was negatively related to all fire sizes occurrence Pasture positive for small fires	Where there are steeper slopes, there is less area burnt Altitude negatively related to large fires East aspect was the only significant	The higher road and population density, the lower the proportion of burnt area Small fires occurred in populated and accessible areas (early detection) Large fires in isolated areas

pseudo R^2 : Small 0.14, Medium 0.22, Large 0.55, All 0.57


all burnt area
large fires
medium fires
small fires
p burnt area
0.00
0.05
0.10
0.15
0.20
0
500
1000
1500
2000
Population density


all burnt area
large fires
medium fires
small fires
p burnt area
0.0
0.1
0.2
0.3
0.4
0.5
0
100
200
300
400
500
Road density


all burnt area
large fires
medium fires
small fires
p burnt area
0.0
0.1
0.2
0.3
0.4
0.5
0
500
1000
1500
Altitude


all burnt area
large fires
medium fires
small fires
p burnt area
0.0
0.1
0.2
0.3
0.4
0.5
0
20
40
60
80
100
Slope

Conclusions

- There are differentiated effects of these variables between small and large fires
  - Small fires: accessibility
  - Large fires: species and fuel composition

Allocation of prevention efforts depending on the occurrence of small, medium and large fires

- Some of these variables can be influenced through forest management

→ **Need to integrate fire risk into forest planning**

Marina Peris Llopis
marinp@uef.fi

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