University of Zagreb

ANTHROPOGENIC DRIVERS OF FIRE OCCURRENCE IN THE EASTERN ADRIATIC

K. Pavlek, P. Moharić, F. Bišćević, V. Gugić, P. Furčić, A. Grđan, N. Malešić, V. Vragović, Marin Cvitanović, Borna Fuerst – Bjeliš

XI. INTERNATIONAL SEMINAR: OVERARCHING ISSUES OF THE EUROPEAN AREA
FLUP, MAY 27-28 2016, Porto

Wildfires in the Eastern Adriatic

- Mediterranean – one of the most vulnerable areas to wildfires in the world

  - 45 000 wildfires in Mediterranean Europe/year
  - Up to 1,7% loss of forest cover
  - EU FUME project in European Mediterranean countries (2014): trend of growth:
    - Burnt area
    - Number of fires

Wildfires in the Eastern Adriatic

- Environmental conditions
  - Warm and arid mediterranean climate
  - Prevalence of flammable (coniferous) vegetation
  - Karst - porous limestone

Wildfires in the Eastern Adriatic

- Societal conditions
  - In the course of the last century: two processes
  - 1. depopulation and population ageing
    - Land abandonment
    - Cattle herding abandonment

→ change in the landscape

: change in the vegetation

: natural succession ↓

maquis- lots of burning fuel

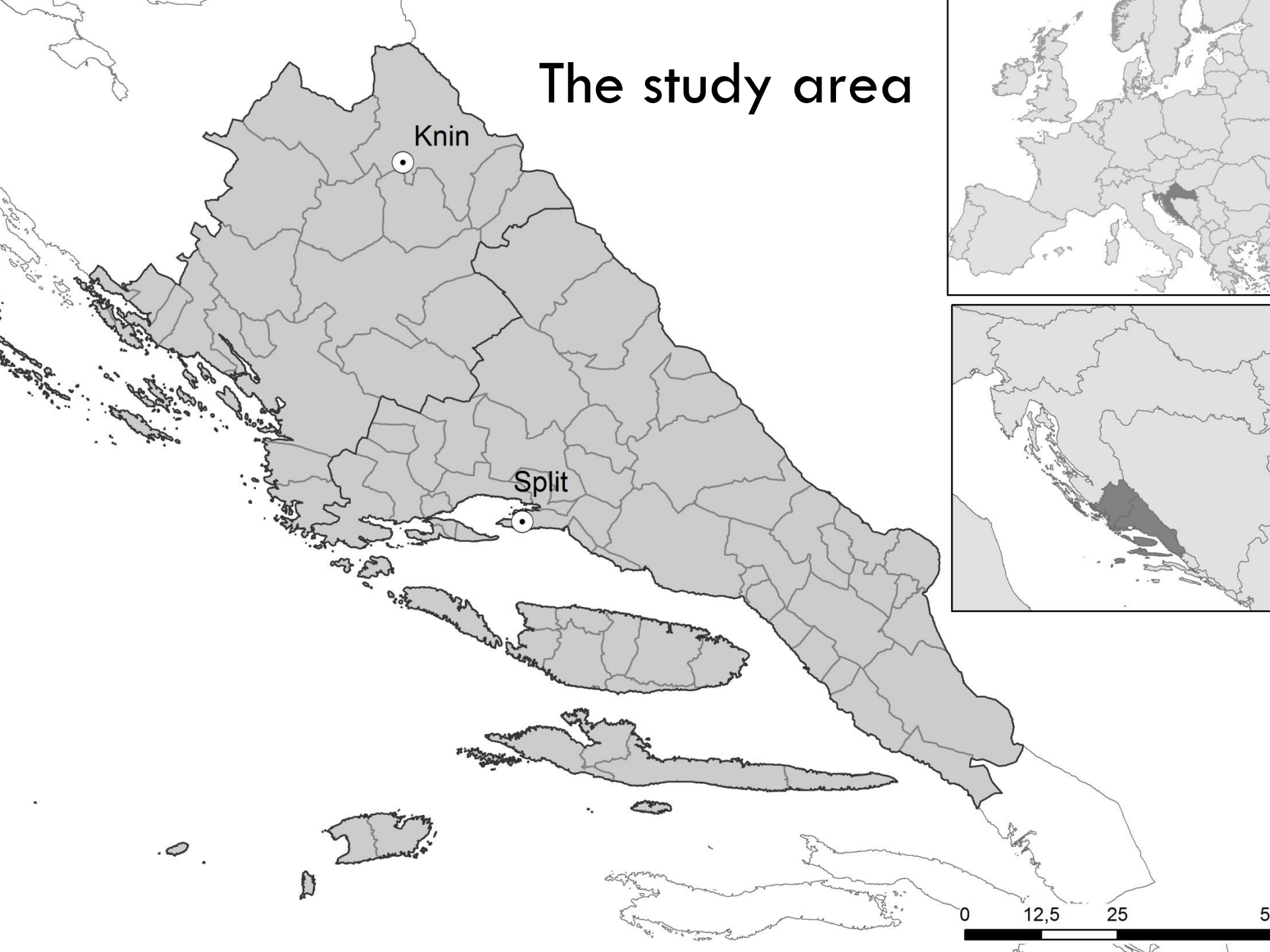
Wildfires in the Eastern Adriatic

- Societal conditions
  - 2. Littoralization and population increase
    - Wildland – urban interface (WUI)
      - Urban growth
      - Spread of recreational activities and tourism

Wildfires in the Eastern Adriatic

- Research questions and aims
  - Spatial distribution of the most endangered zones of fire occurence in the central eastern Adriatic
  - Defining the key drivers of fire occurence: environmental and societal
  - The significance assessment of the anthropogenic (societal and economic)drivers of fire occurence

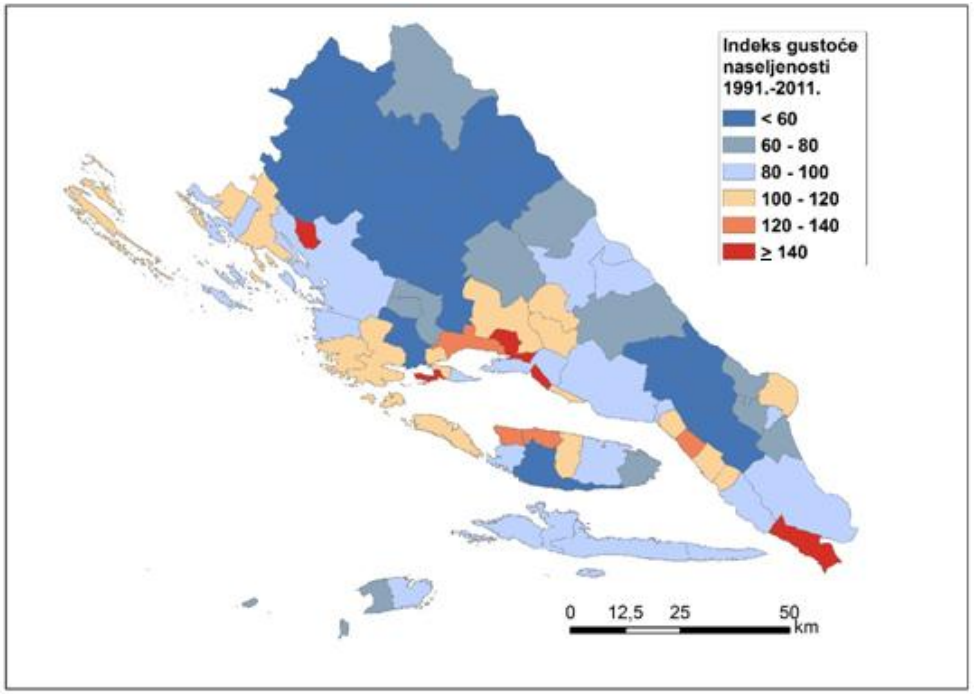
The study area



Wildfires in the Eastern Adriatic

- Karst area
- Mediterranean climate (Cfa & Csa)
- Rural exodus inland
  Population ageing
  Deagrarization
- Tourism – environmental pressure in the littoral

Population density index1961-2011



Wildfires in the Eastern Adriatic

Tab.1. Number of fires and burnt area in Croatia and Dalmatian counties 1998.-2012.

	Number of fires	Burnt area (ha)
Croatia	130.465	766.368
Dalmatian counties	39.632	280.105
Share of Dalmatian counties in total (%)	**30,37**	**36,54**

Source: Statistički pregled temeljnih sigurnosnih pokazatelja i rezultata rada u 2012. godini, MUP, Zagreb, 2013.; Statistički pregled temeljnih sigurnosnih pokazatelja i rezultata rada u 2010. godini, MUP, Zagreb, 2011

Wildfires in the Eastern Adriatic

- National level – agricultural land

- Eastern Adriatic – forest fires
  - 76% forest fires
  - 93% burnt forest areas

Wildfires in the Eastern Adriatic

Study area	7 534 km2
Population	564.617
Number of fires 2013.	771
Burnt area 2013. (ha)	3.027 (0,4%)

Source: Statistički ljetopis 2014., DZS, Zagreb
DUZS, 2014.

Up to 2%

Data

- A: Data on fires
- B: Environmental data
  - B1: Meteorological data
  - B2: Altitude
  - B3:Vegetation cover
- C: Socio-economic and demographic data

Fire data

- 2013: 771 fires
  275 > 0,3 ha → 98% of total burnt area

- Source: National protection and rescue directorate:
  - Date, time, location of fire, vegetation, burnt area size
- Georeferencing of fires - via arcGIS 10.1.
  - 1:25 000 Topographic map from the State Geodetic Administration and the Habitat map from the DZZP-a

- Methodology: Global & Local Moran's Index
  - Spatial clustering: existence and location

Environmental data

- Weekly mean temperature and precipitation
  - Source: Croatian Hydrometeorological Service
  - Methodology: Linear regression
- Altitude
  - Source: ASTER GDEM
  - ArcGIS 10.1 – every fire (point data) was given it's altitude – *extract values to point*
  - % burnt area surface and number of fires in altitude categories: 0-200m, 200-500m, 500-1000m, >1000m

Environmental data

- Vegetation cover
  - Source: DZZP – Habitat map 2004
  - 7 types of vegetation – coniferous forest, deciduous forest, mixed forest, shrubland (maquis), grasslands, olive groves, other agricultural land
  - % burnt areas and number of fires per hectare for each vegetation category separately

Socio-economic and demographic data

- Source: Population census 1961, 1991 and 2011.
  - Population in 2011
  - Population density in 2011
  - Population index 1961 – 2011
  - Ageing index 1991 – 2011
  - Changes in number of people employed in the agricultural sector 1991-2011
  - Tourist arrivals
  - Agricultural population density
  - 74 units (municipalities)
  - Methodology: OLS regression

Results

1. Fire occurence

Municipality	No of fires
Šibenik	36
Omiš	21
Drniš	17
Knin	17
Promina	16
Kistanje	15

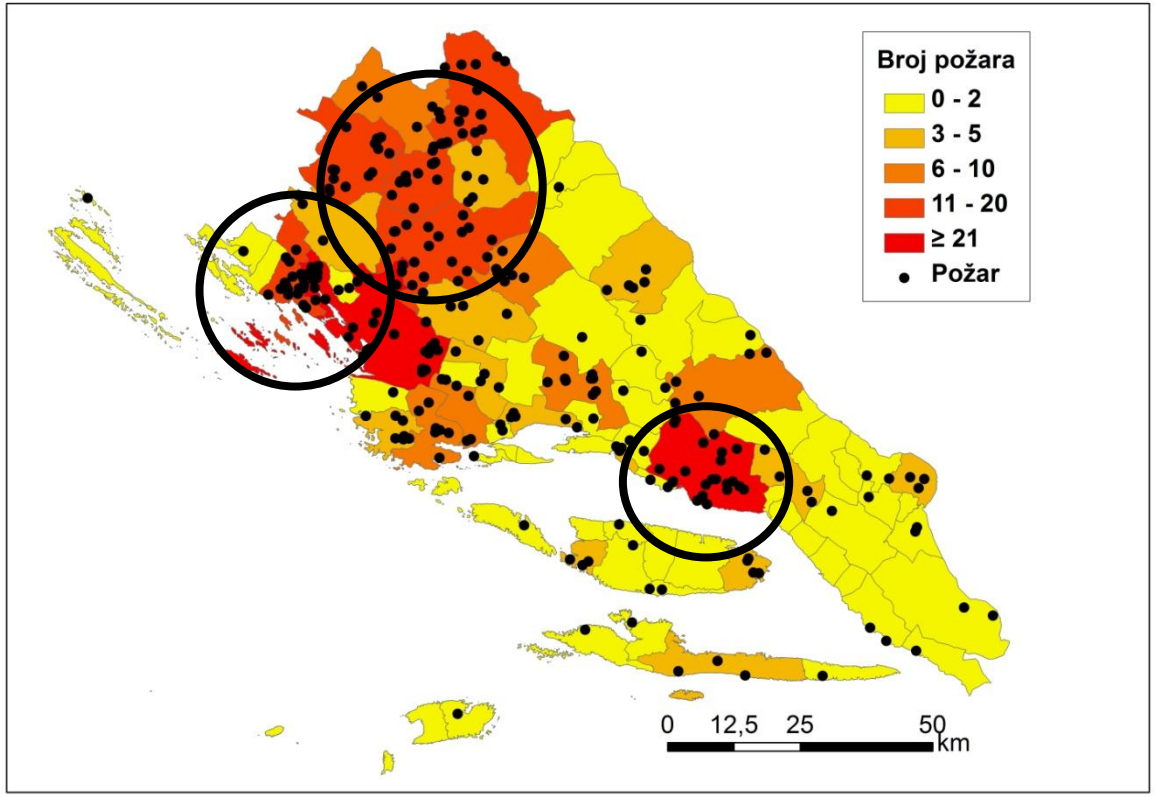


Fig.2. Distribution of fires in the study region 2013.

Source: Digitalni atlas Rep.
Hrvatske, GISdata, Zagreb, 2005., DUZS, 2014.

Cluster analysis

- Anselin Local Moran's I – **Location;** clusters in the coastline and northern hinterland

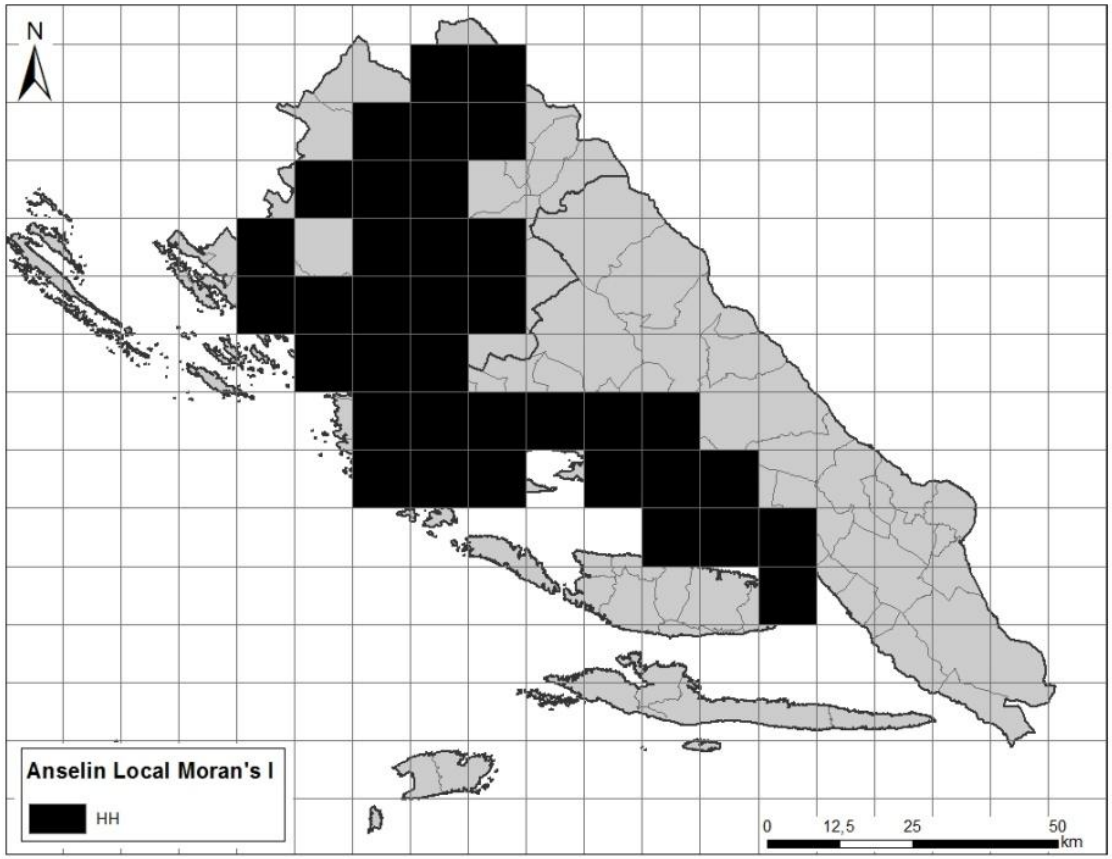
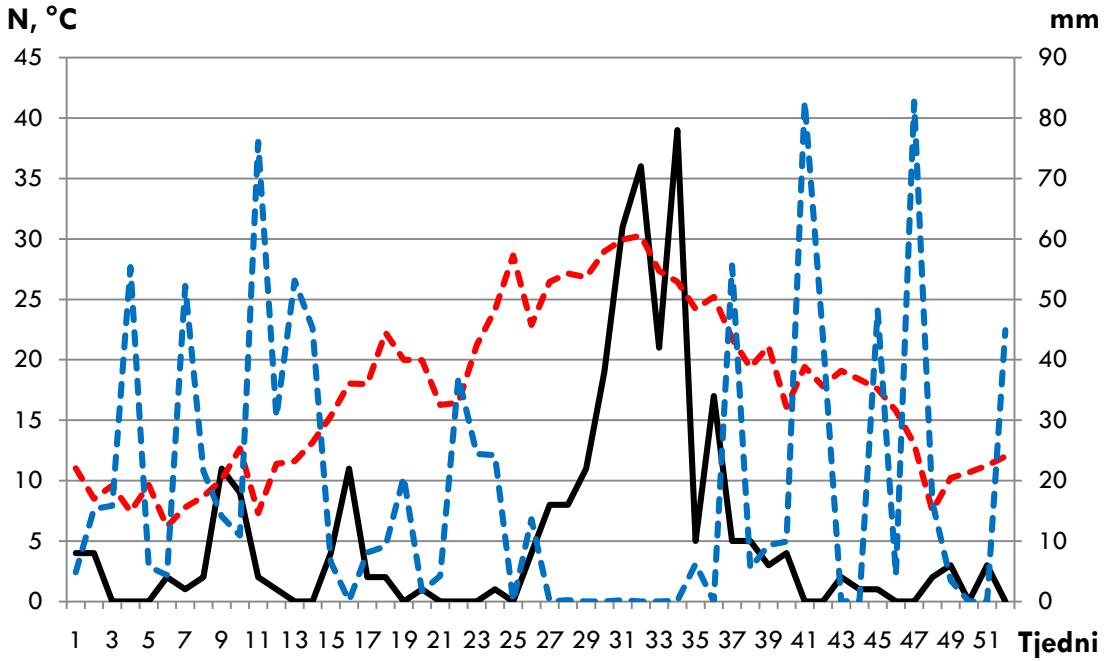


Fig.3. Spatial clustering of fires;
Anselin Local Moran's I

2. Temperature and precipitation

Split



Knin

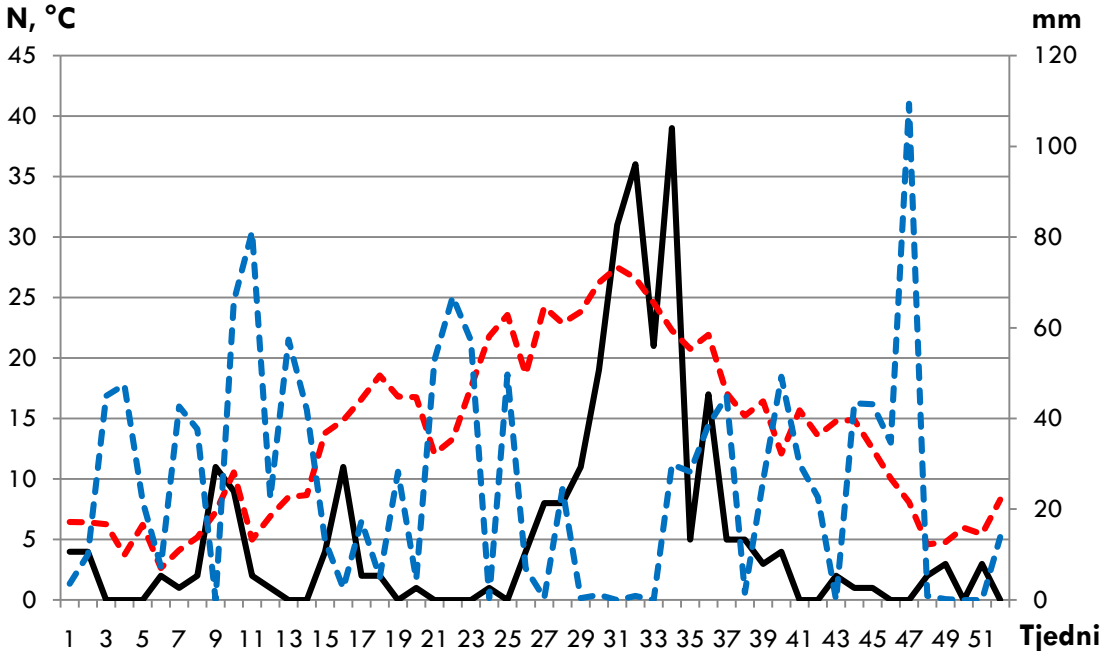


Fig.4. Mean temperature and precipitation, compared to the number of fires (weekly)

Source: DHMZ, 2015., DUZS, 2015.

Correlation with temperature and precipitation (multiple linear regression)

Knin	Unstandardized Coefficients		Standardized Coefficients	t	Sig
	B	Std Error	Beta		
(Constant)	-2.391	2.685		-0.89	0.378
Temperatures	0.676	0.145	0.547	4.66	0.000*
Precipitation	-0.056	0.042	-0.156	-1.33	0.189
Split					
(Constant)	-4.258	3.323		-1.281	0.206
Temperatures	0.641	0.157	0.501	4.074	0.000*
Precipitation	-0.075	0.047	-0.195	-1.583	0.120

3. Altitude

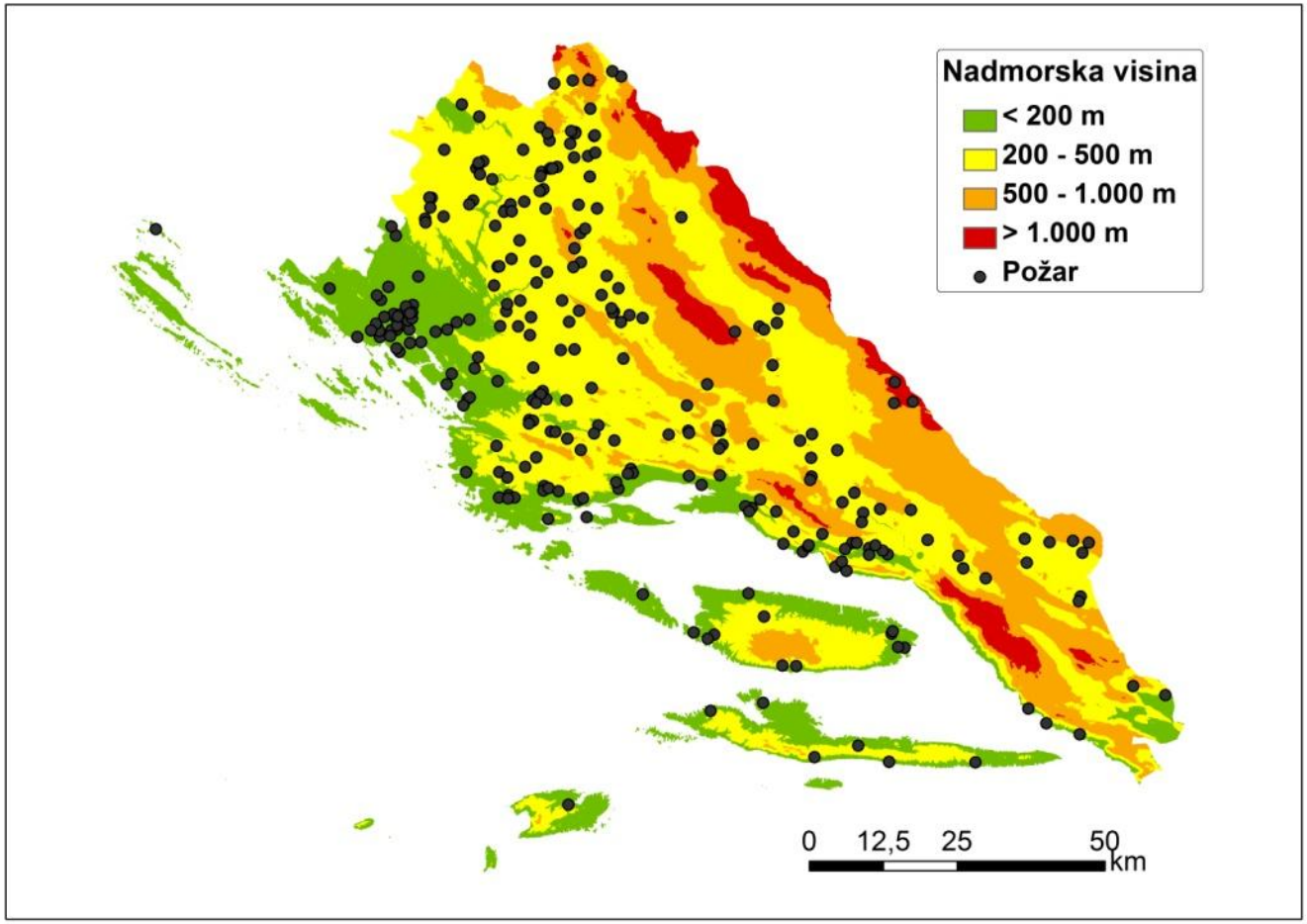
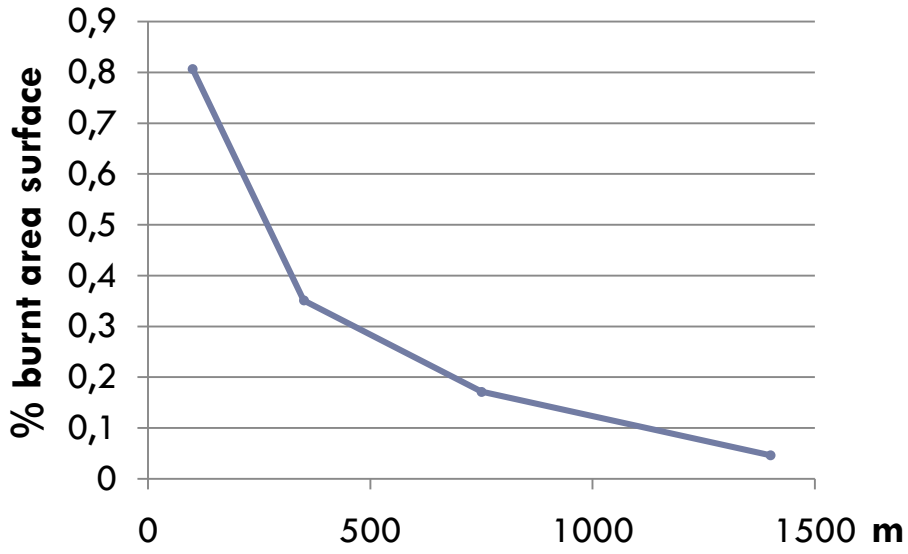
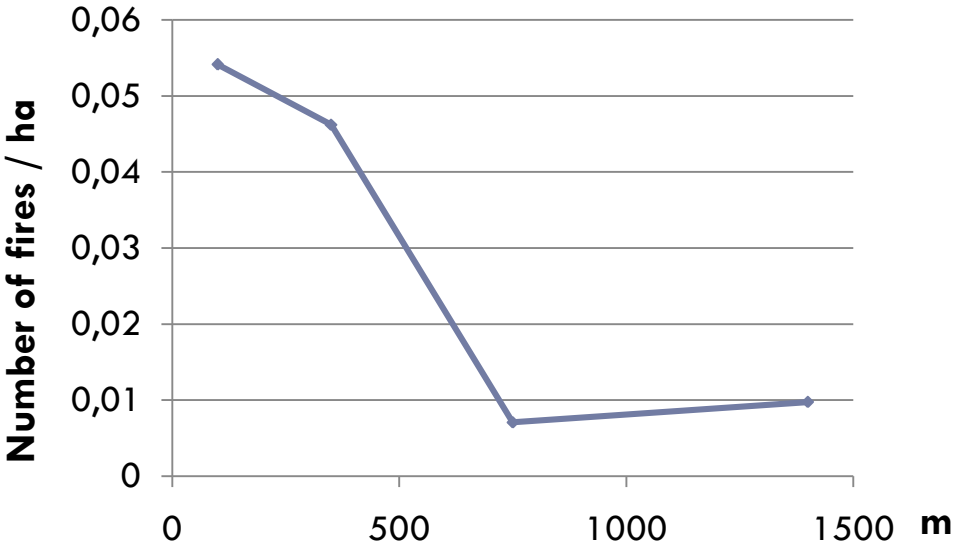


Fig.5. Forest fires depending on the altitude

Source: ASTER GDEM, 2015., DUZS, 2014.

3. Altitude





Increase in altitude:
→decrease in both burnt area surface and number of fires

→ decrease in temperature
→ increase in precipitation
→ vegetation change (deciduous)
→ decrease in population density

Fig .6. Correlation between altitude and number of fires
Izvor: ASTER GDEM, 2015., DUZS, 2014.

4. Vegetation cover

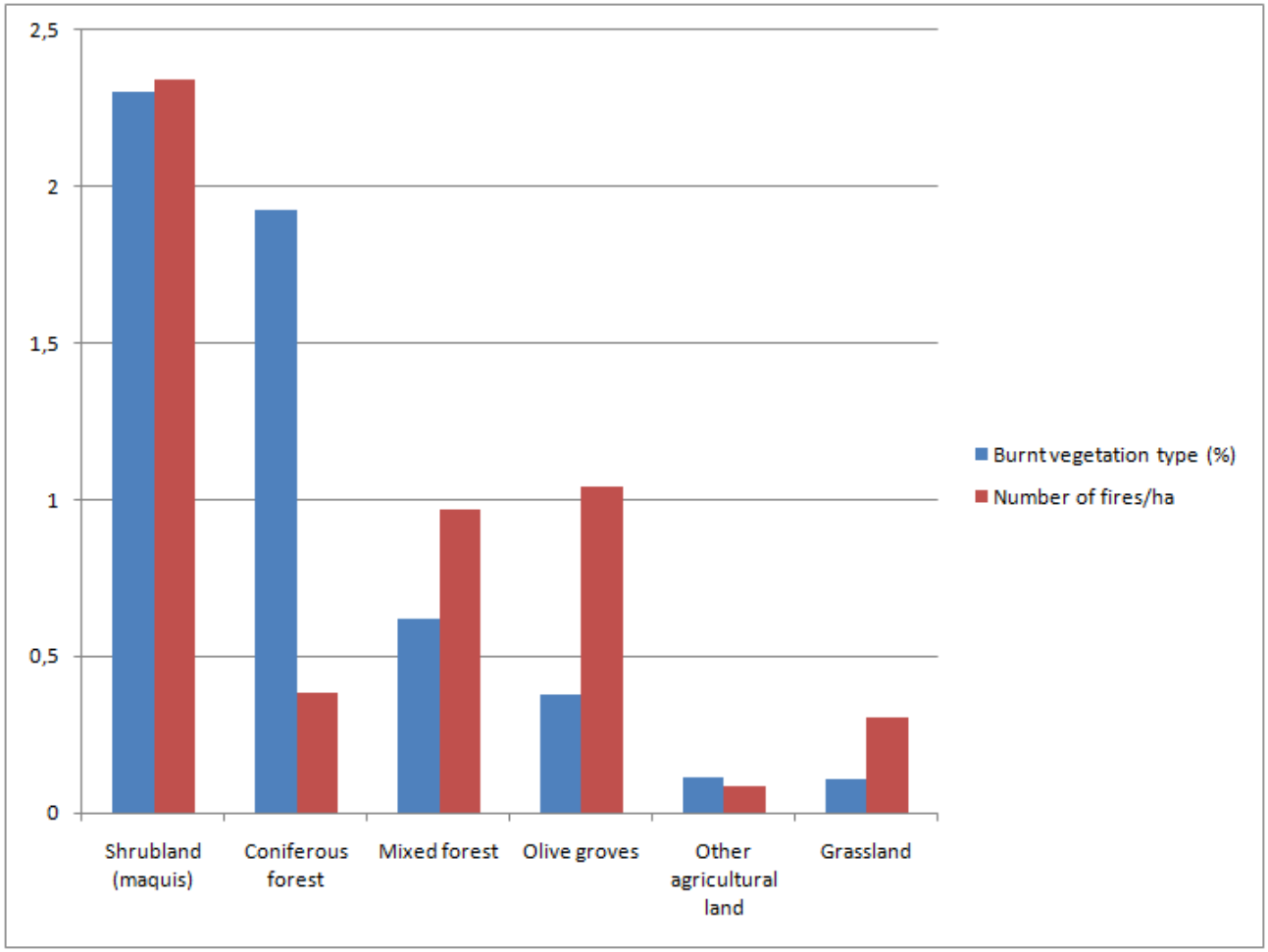


Fig 7. Fire occurence according to the vegetation type

Izvor: DZZP, 2004., DZUS, 2014.

4. Vegetation cover

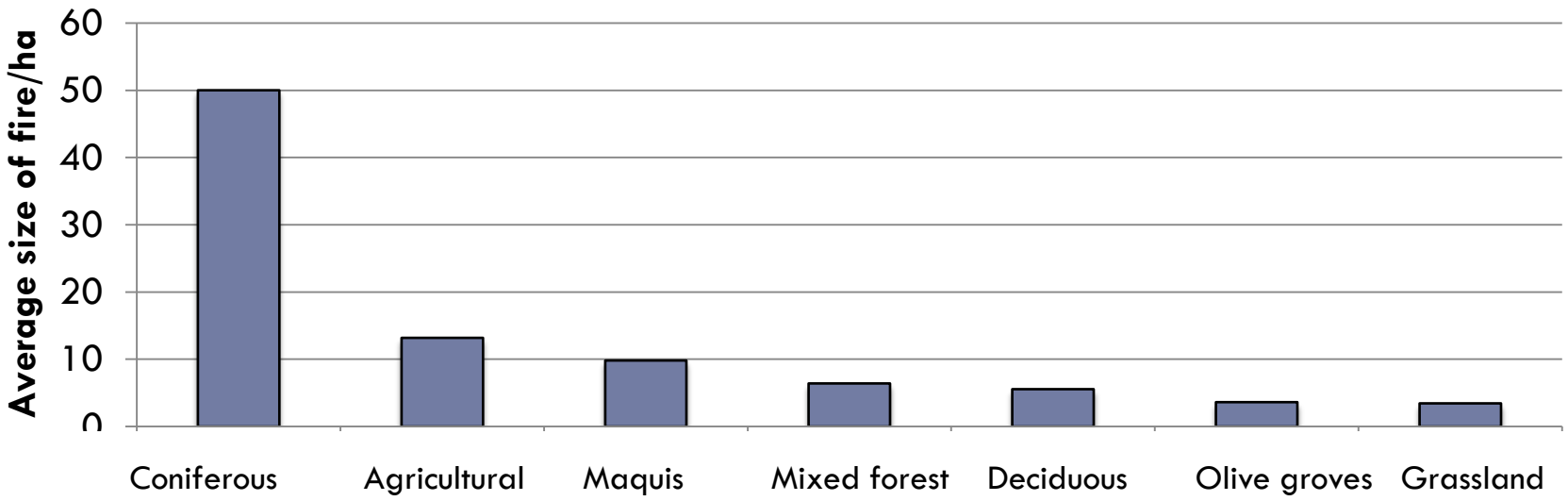


Fig.8. Vegetation cover and the average size of fire (ha)

5. Socio-economic and demographic data

- Linear regression (OLS)
- n = 74

Variable	Coefficient	Std Error	t-Statistic	Probability	VIF
POP_CHAN61 1961-2011	0.000198	0.00004	4.6772	0.000016*	1,3985
USED_LAND	- 0.000087	0.00031	- 0.2847	0.7767	1.2385
UNUSED_LAND	- 0.002585	0.00471	- 0.5484	0.5853	3.7544
ABAND_ARABLE	0.000385	0.00208	0.1856	0.8533	3.8477
AGRI_POP11	- 0.000472	0.00098	- 0.4812	0.6319	3.1679
CHAN_AGRI_POP	0.000077	0.00056	1.3841	0.1711	2.3182
AGRI_DENSITY	0.000116	0.00024	0.4788	0.6337	1.8111
TOURIST_ARRIV	0.000000	0.00000	0.1524	0.8793	1.2834

5. Socio-economic and demographic data

- Population increase in the littoral positively correlated with fire occurence

  - Hot spots: two urban littoral municipalities
  - Wildland –urban interface areas (WUI)
    - Urban growth
    - Spread of recreational activities and tourism in recreational areas ⟶ >90% fires of anthrop. origine
    - Urban surroundings – growth of maquis shrubland - fuel

Conclusion

- Environmental and demographic drivers of primary importance – explain the majority of fires
  - Climatic (mostly temperature) drivers : 33% of variance explained
    - Most significant variable positively correlated with the fire density in Dalmatia
  - Population change (increase) 25% variance explained

Conclusion

Anthropogenic drivers - much wider significance

Landscape structure: creating fire-prone environment

Maquis shrubland – not solely physical driver

- most fire-prone vegetation type
- indicator of socio-economic restructuring

Thank you for your attention!

CRORURIS 2030
mcvitan@geog.pmf.hr

This work has been supported by the Croatian Science Foundation under the project number 4513. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of Croatian Science Foundation.

Obrigada pela
vossa atenção