Универзитет у Београду
Шумарски факултет

EWWF
The England & Wales Wildfire Forum
WILDFIRE CONFERENCE
CARDIFF 2019

Forest fire probability mapping in Serbia using logistic regression

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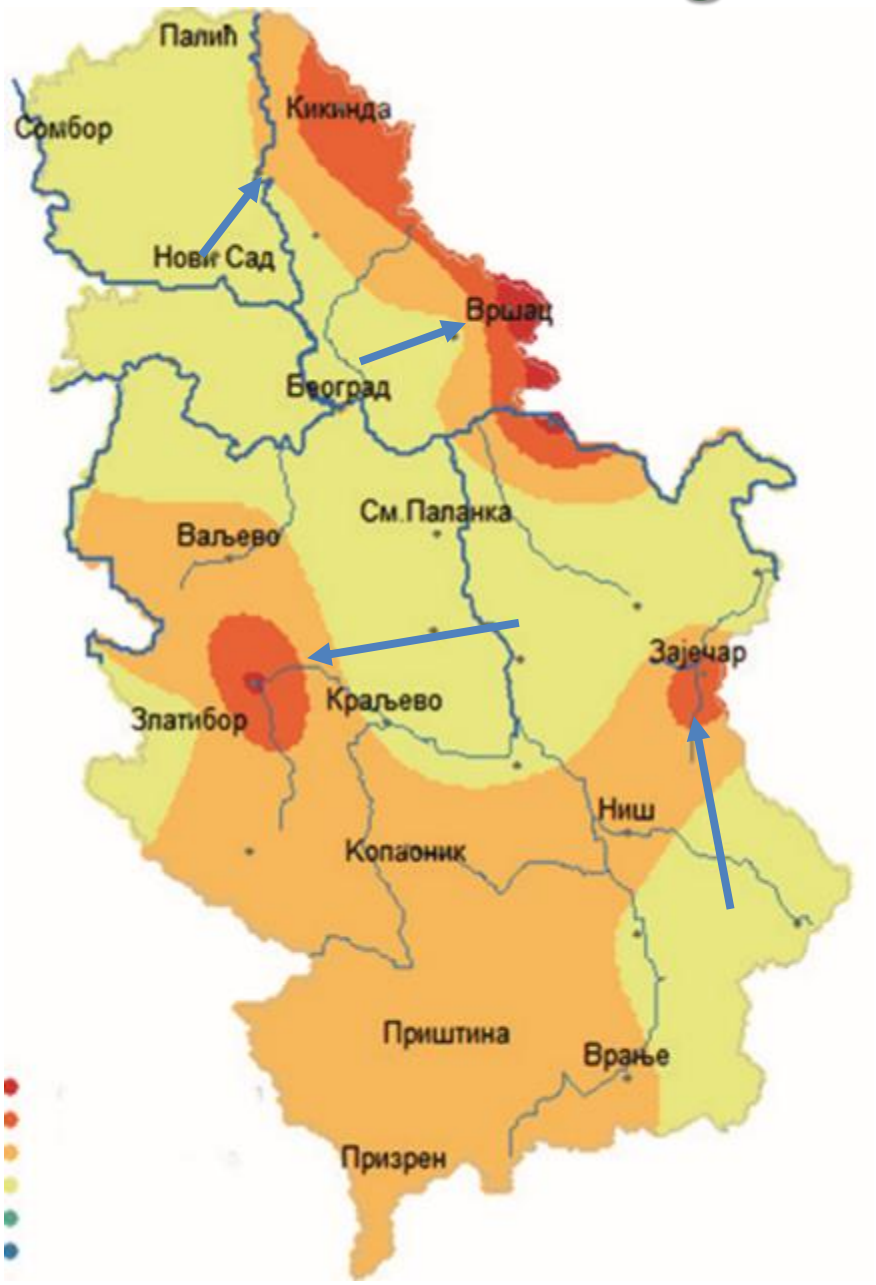
Forest protection system against fire in Serbia needs:

- Forest fire danger rating system
- Early detection of forest fire
- Rapid response
- Restoration of the burned area

Forest danger rating system–**Why?**



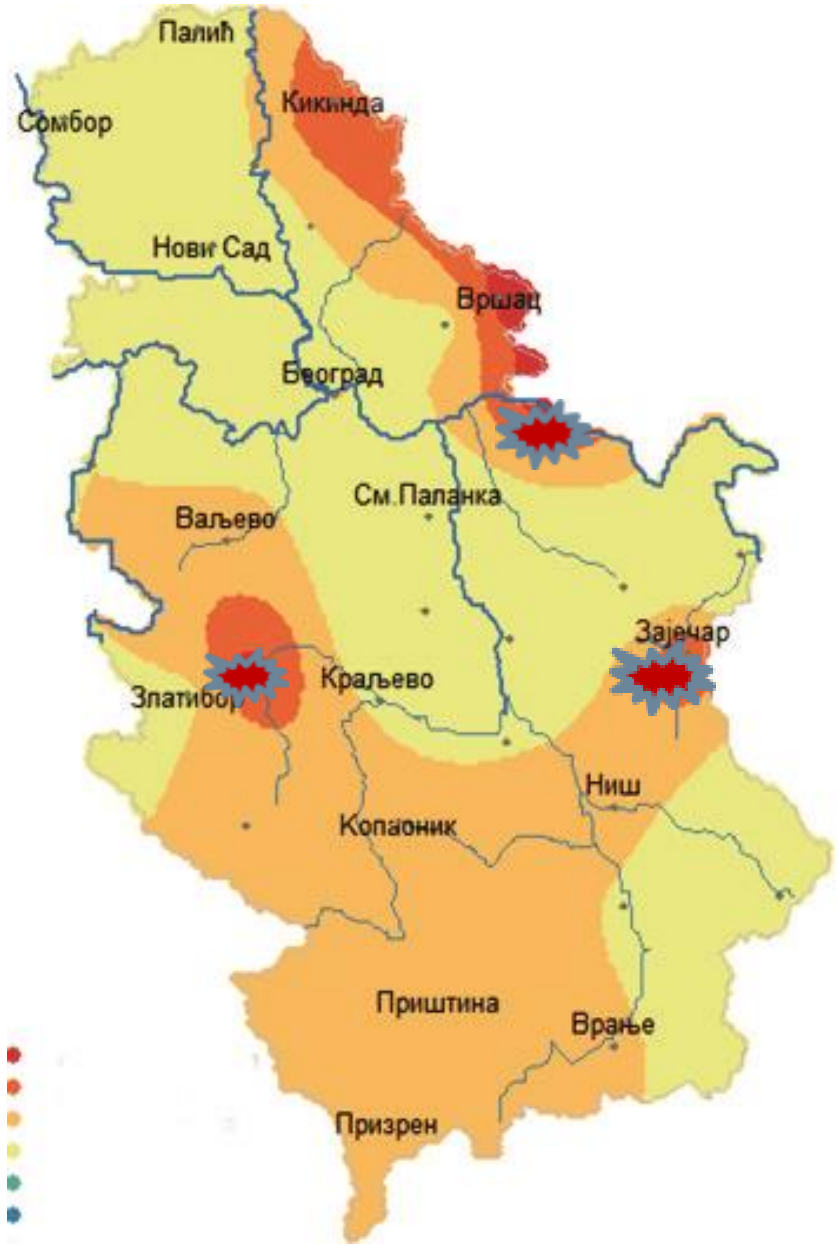
Allocation of resources

Intense observation

Early detection

Reduction in burned area

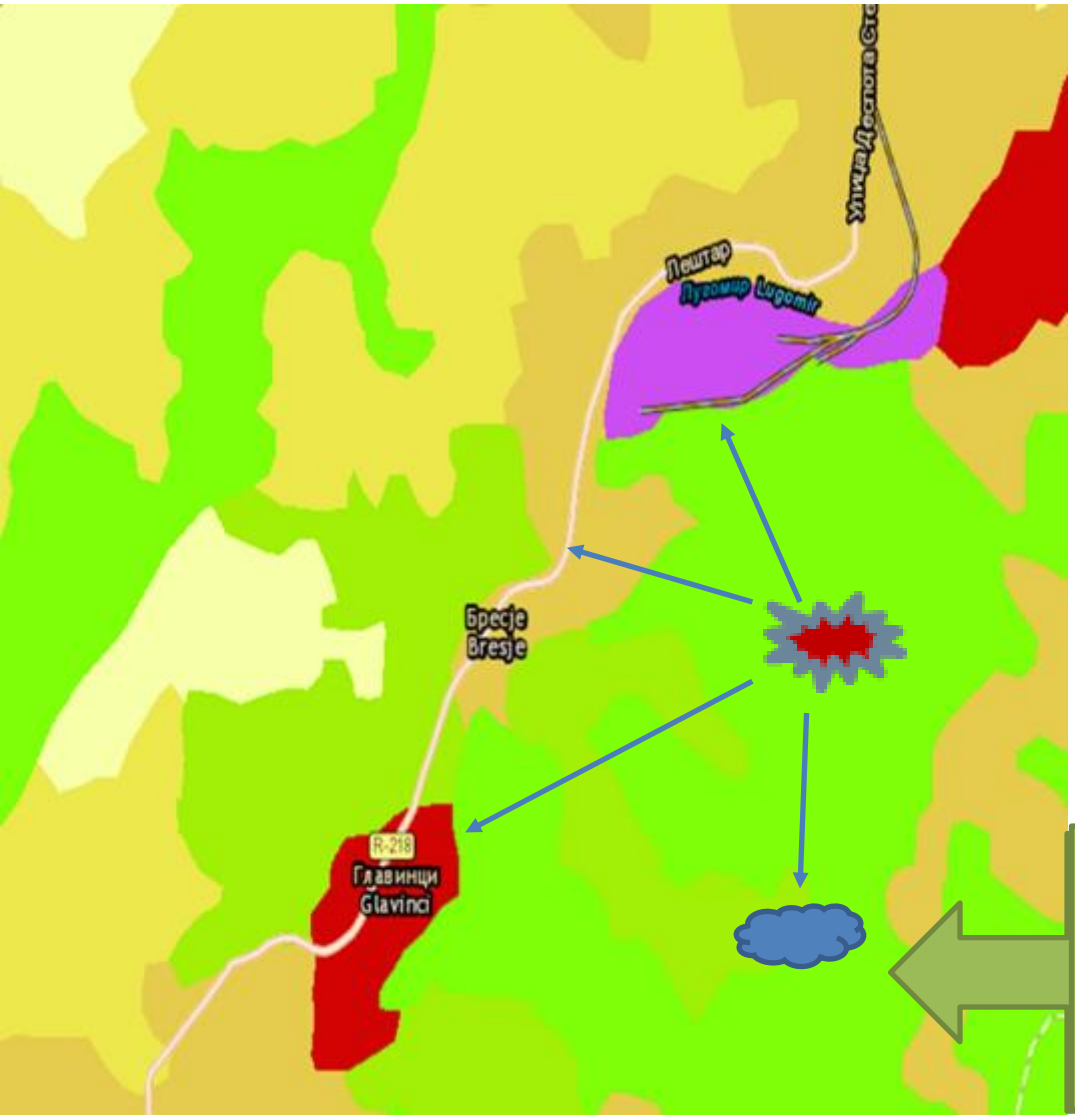
Early detection of forest fire -**Why?**



Rapid response

Reduction in burned area

Rapid response-**Why?**



- distance to the settlement
- distance to industrial facilities
- distance to roads
- distance to water intake

Information system

Restoration of the burned area- **Why?**

Multi risks!

Forest fire

Insect outbreaks

Deforestation

Torrent

Floods

Literature survey

Chapter 11

Wildland Fire Danger Rating and Early Warning Systems

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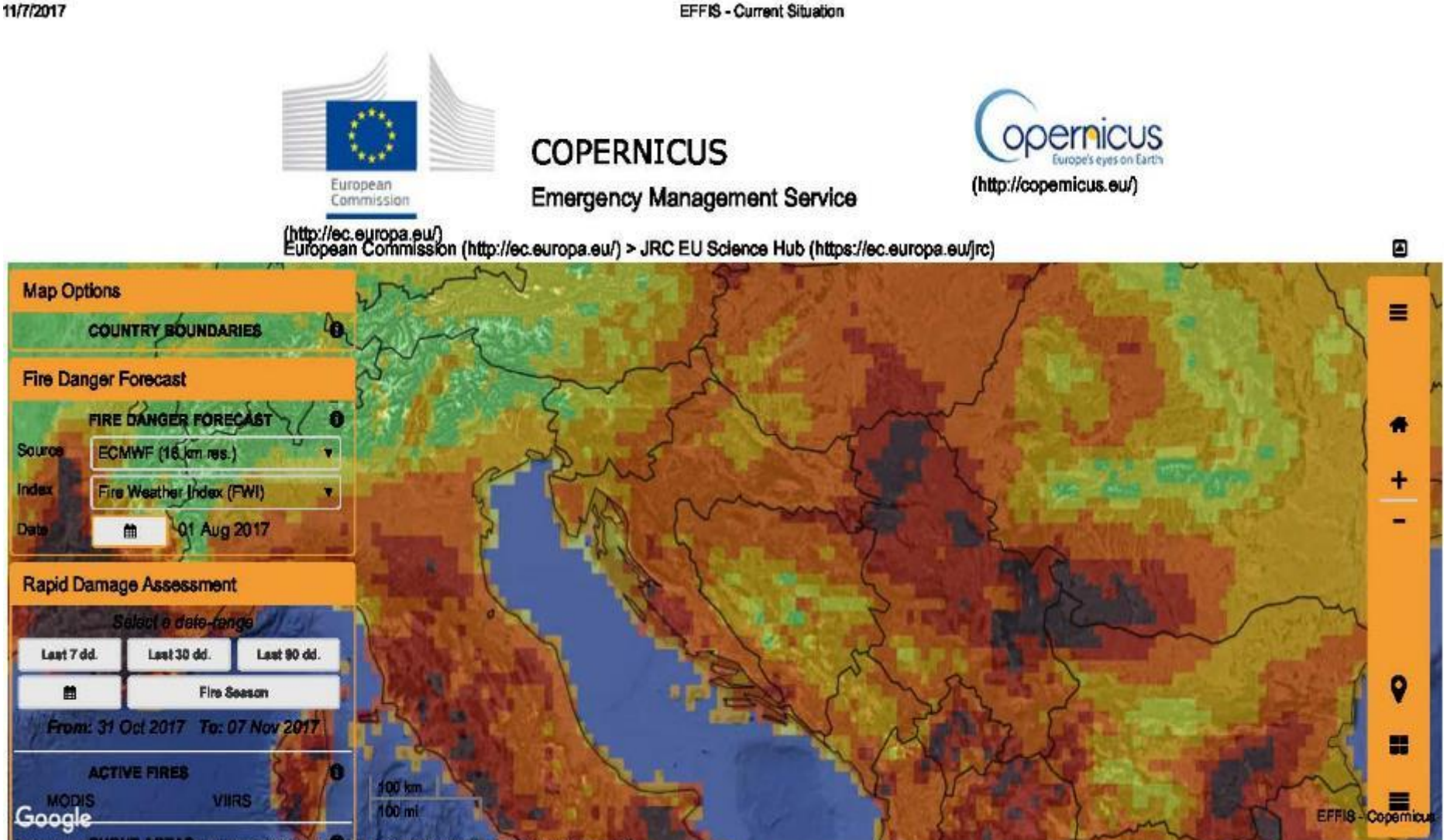
Faculty of Forestry, University of Toronto, Toronto, ON, Canada

Michael D. Flannigan
Dept. of Renewable Resources, University of Alberta, Edmonton, AB, Canada

TABLE 11.1 Characteristics of Common Weather-Based Fire Danger Rating Systems and Indexes[a]

Fire Danger System or Index	Characteristics	Primary Input Parameters	Application Locations	References
Angström Index	Daily index	Temperature, relative humidity	Sweden, Scandinavia, Germany	Chandler et al. (1983) Holsten et al. (2013)
Baumgartner Index	Cumulative (5-day) index	Precipitation, potential evapotranspiration	Germany, Slovakia	Holsten et al. (2013)
Canadian Forest Fire Weather Index System	Cumulative daily fuel moisture codes; daily fire behavior indices	Temperature, rainfall amount, relative humidity, wind speed	Argentina, Canada, China, Chile, Fiji, Indonesia, Malaysia, Mexico, New Zealand, Portugal, South Africa, Spain, Sweden, Thailand, United Kingdom, United States (Alaska, Florida, north and eastern states), Venezuela; Europe and North Africa, Eurasia, global, Southeast Asia, Southern Africa	Van Wagner (1987) Taylor and Alexander (2006) Wotton (2009)
Fire Danger	Daily index	Temperature, relative humidity, precipitation	Brazil, South America	Setzer and Sismanoglu (2012)

Why **FWI!?**


11/7/2017
EFFIS - Current Situation
European Commission
(http://ec.europa.eu/)
COPERNICUS
Emergency Management Service
Copernicus
Europe's eyes on Earth
(http://copernicus.eu/)
European Commission (http://ec.europa.eu/) > JRC EU Science Hub (https://ec.europa.eu/jrc)
Map Options
COUNTRY BOUNDARIES
Fire Danger Forecast
FIRE DANGER FORECAST
Source
ECMWF (16 km res.)
Index
Fire Weather Index (FWI)
Date
01 Aug 2017
Rapid Damage Assessment
Select a date-range
Last 7 dd.
Last 30 dd.
Last 90 dd.
Fire Season
From: 31 Oct 2017 To: 07 Nov 2017
ACTIVE FIRES
MODIS
VIIRS
100 km
100 mi
Google
EFFIS - Copernicus

Republic Hydrometeorological Service of Serbia
(established 1888, WMO member since 1947)

Fire Weather Index

Numerical Weather Prediction
+381 11 3050 923
numerika@hidmet.gov.rs

Republic of Serbia

Ћирилица Latinica

- Alarm homepage
- Meteoalarm
- Hydroalarm
- FWI
- FWI - forecast
- UV index forecast
- Heat / cold wave
- Feedback
- Documentation
- Meteoalarm EU

Fire Weather Index: TUESDAY 07.11.2017.

Station	Temperature (°C)	Humidity (%)	Wind speed (m/s)	Precipitation quantity in the past 24 hours (mm)	FFMC	DMC	DC	ISI	BUI	FWI	FIRE DANGER
Palić	15.2	53	4	0.0	85	16	442	5	29	9	Low
Sombor	15.3	50	8	0.0	86	17	382	11	31	18	Moderate
Novi Sad	14.5	62	8	0.0	84	13	403	9	24	14	Moderate
Zrenjanin	15.1	56	8	0.0	85	20	608	10	36	18	Moderate
Kikinda	15.7	50	5	0.0	86	23	518	7	41	14	Moderate
Loznica	16.8	50	2	0.1	86	15	178	4	25	7	Low
S. Mitrovica	16.2	60	7	0.0	84	14	396	7	25	12	Low
Valjevo	14.9	63	3	0.0	84	12	220	3	21	5	Low
Beograd	14.5	62	4	0.0	85	12	432	5	23	8	Low
Kragujevac	14.6	63	2	0.0	84	13	287	3	23	5	Low
S. Palanka	14.3	58	4	0.0	84	10	344	4	18	6	Low
Crni Vrh	2.3	100	7	0.9	33	1	142	0	1	0	Very Low
Negotin	8.7	97	1	0.0	75	14	356	1	26	1	Very Low
Zlatibor	9.8	70	3	0.1	81	4	9	2	4	1	Very Low
Sjenica	9.7	79	7	0.0	83	8	243	6	15	8	Low
Požega	10.1	82	0	0.0	61	6	213	0	11	0	Very Low
Kraljevo	15.4	58	5	0.0	82	6	197	4	12	5	Low
Kopaonik	4.5	87	7	0.0	75	2	3	3	1	1	Very Low
Kruševac	16.2	54	4	0.0	86	11	296	5	21	8	Low
Niš	16.7	52	2	0.0	85	12	375	3	22	5	Low
Leskovac	17.2	53	1	0.0	85	16	276	3	27	5	Low
Zaječar	9.0	86	3	0.0	69	15	360	1	27	1	Very Low
Dimitrovgrad	14.7	50	6	0.0	87	15	297	9	27	15	Moderate
Vranje	14.8	60	3	0.0	85	12	350	4	22	7	Low

Data updated: 13:35 07.11.2017
FFMC - Fine Fuel Moisture Code
DMC - Duff Moisture Code
DC - Drought Code
ISI - Initial Spread Index
BUI - Buildup Index
FWI - Fire Weather Index

More information.

Republic Hydrometeorological Service of Serbia
(established 1888, WMO member since 1947)

Fire Weather Index

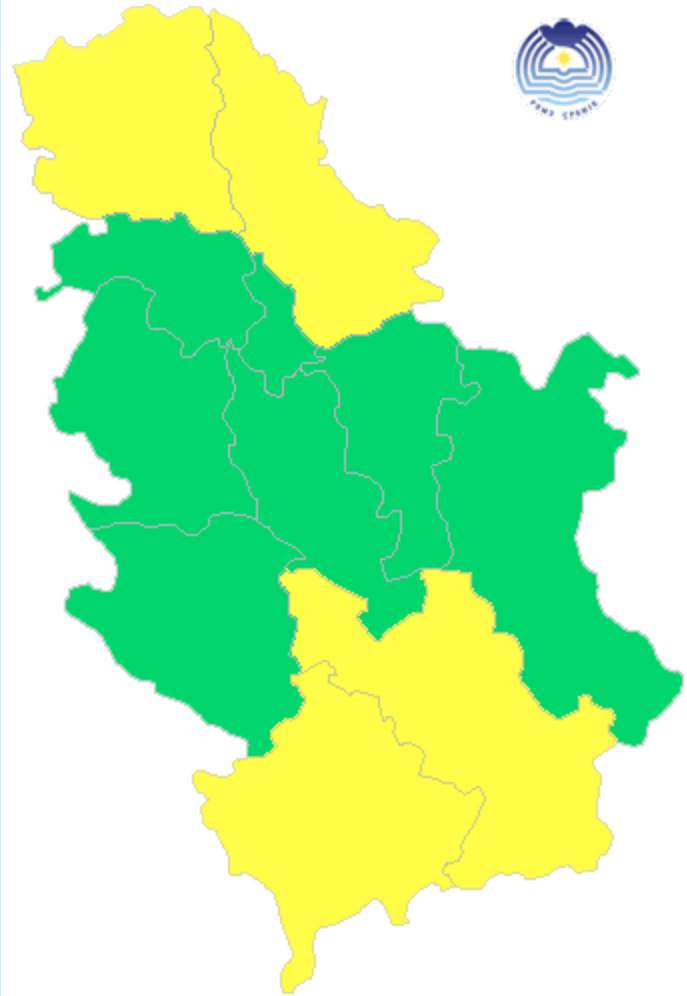
Numerical Weather Prediction
+381 11 3050 923
numerika@hidmet.gov.rs

Republic of

Ћирилица Latinica

Alarm homepage
Meteoalarm
Hydroalarm
FWI
FWI - forecast
UV index forecast
Heat / cold wave
Feedback
Documentation
Meteoalarm EU

Fire Weather Index: TUESDAY 07.11.2017.



Bačka:		Moderate
Banat:		Moderate
Srem:		Low
Beograd:		Low
Zapadna Srbija:		Low
Šumadija:		Low
Pomoravlje:		Low
Istočna Srbija:		Very Low
Jugoistočna Srbija:		Moderate
Jugozapadna Srbija:		Low
Kosovo and Metohija:		Moderate

Click here for more information.

- Very Low and Low.

- Moderate.

Retrospective analysis of forest fire in Serbia

Historical data (Location & Dates)

Calculation of all FWI components for 25 weather station)

Creation of maps for each FWI component and each fire day

Collection of interpolated data about each fire event from the maps

Generating of topographic data for each fire event

1. aspect
2. altitude
3. inclination

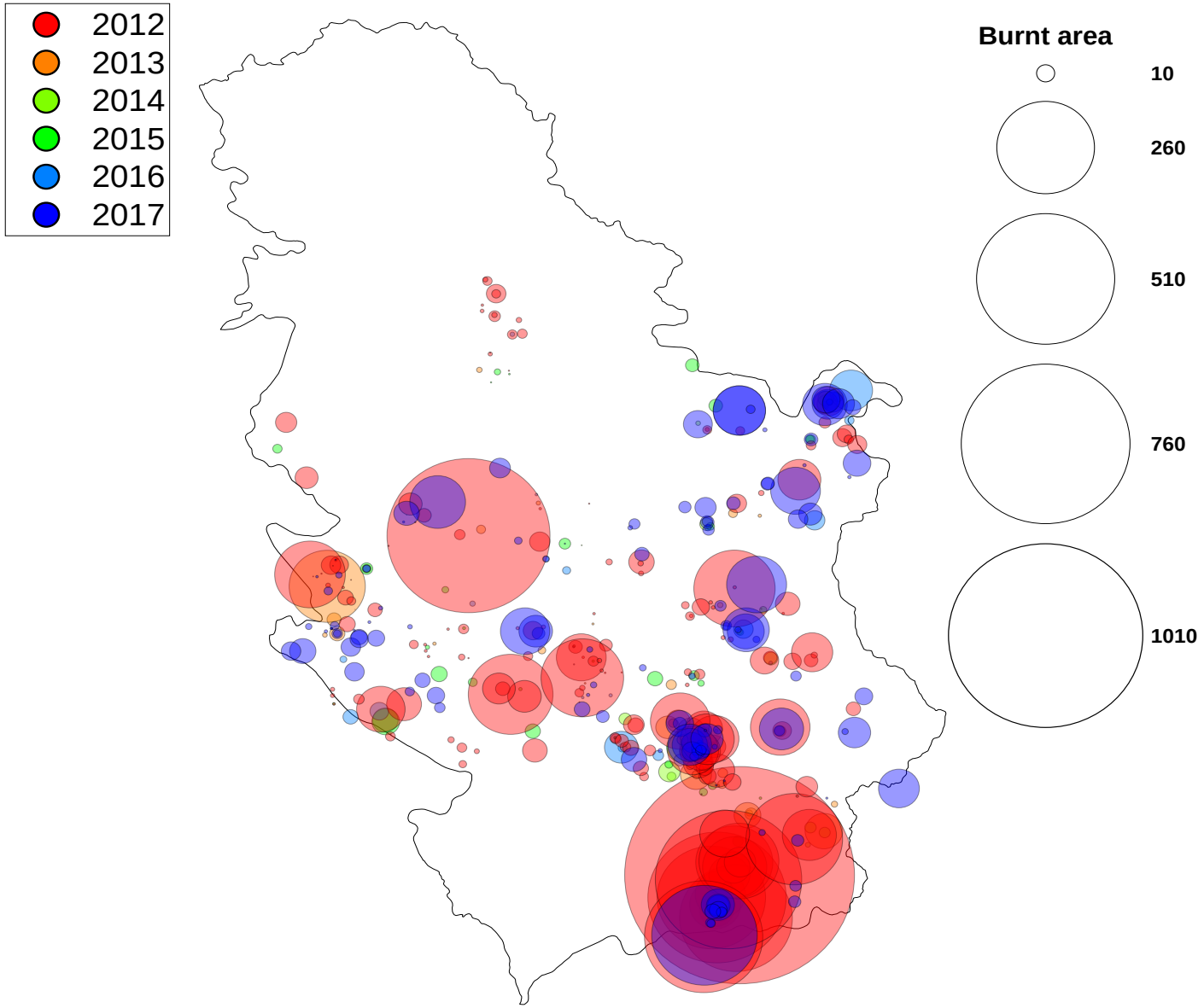
Generating of data vegetation type

1. Broad-leaved
2. confers
3. mixed
4. shrubs
5. Pastures,. etc

Generating of data about the anthropogenic effect

1. Distance to road
2. Distance to settlement
3. Population density
4. Distance to arable land, etc

Database about the forest fire

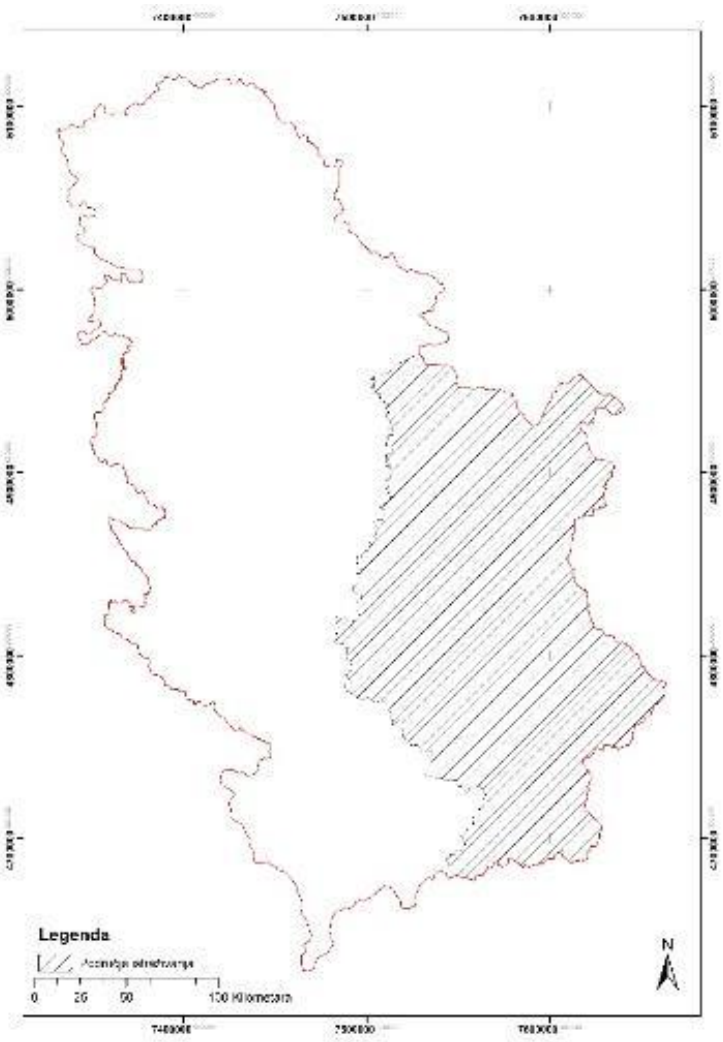

2012
2013
2014
2015
2016
2017
Burnt area
10
260
510
760
1010

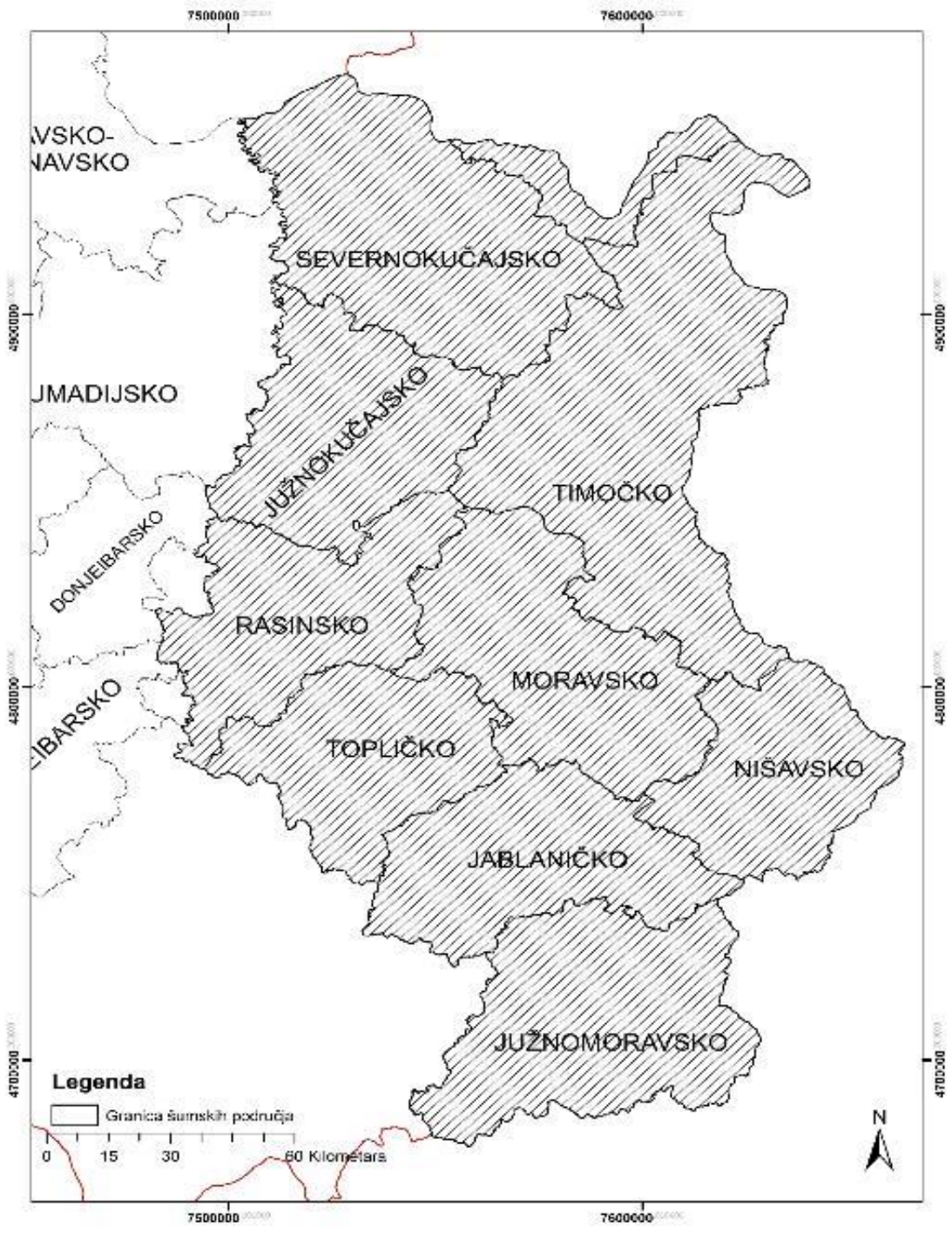
Regional statistics

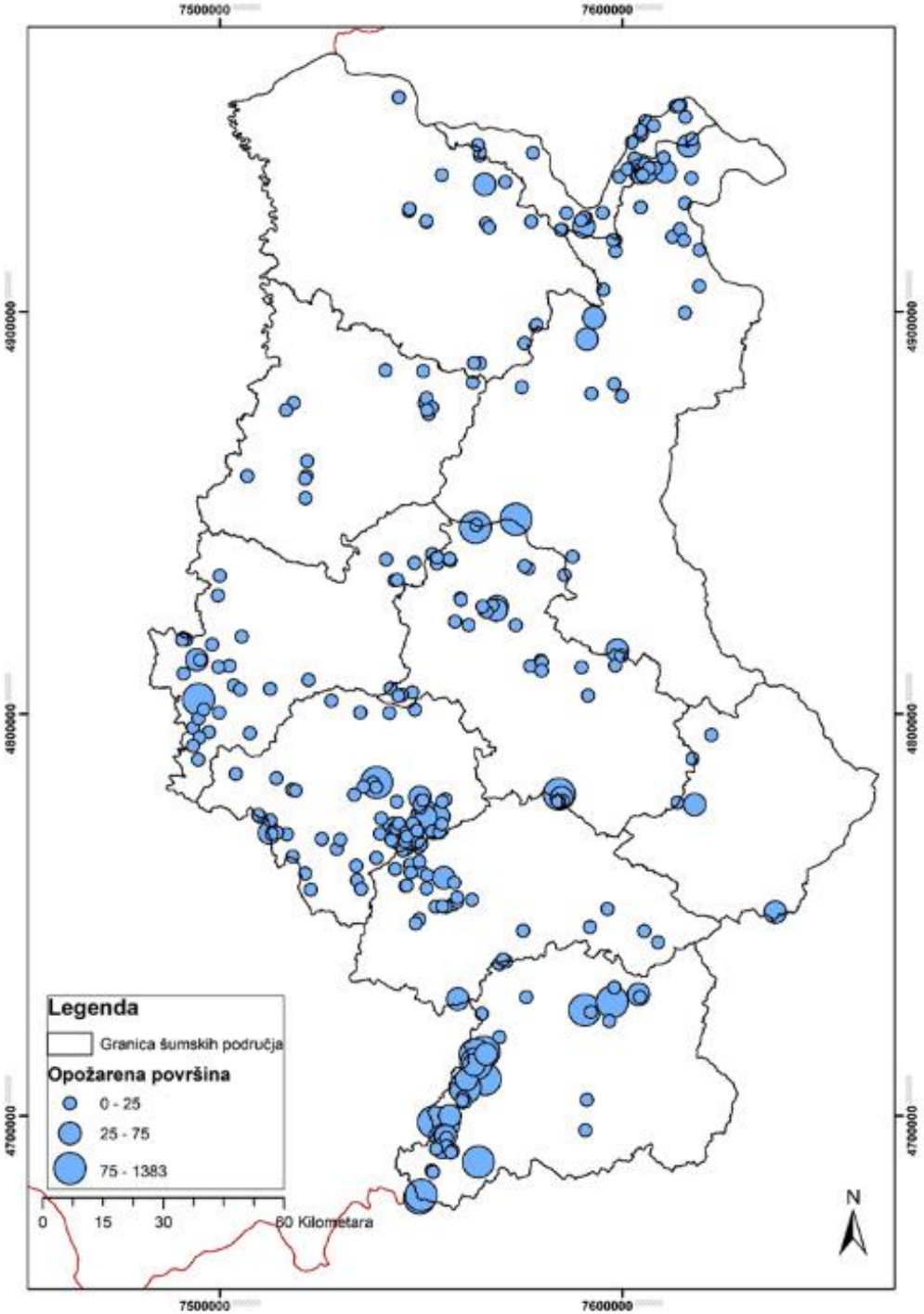
	Belgrade	Šumadija and western Serbia	Southern and Eastern Serbia
Forest fire event 2012-2016	**19**	**98**	**199**
Average burnt area	1.57	16.54	**32.29**
cause (% men)	73.7	39.8 (45.9)	**52.8 (46.2)**
Type of forest fire			
ground (%)	100	77.6	76.4
crown (%)	-	5.1	4.0
combine (%)	-	17.3	14.1
Type of vegetation			
Conifer forest(%)	10.5	**58.2**	25.1
Broadleaved forest(%)	89.5	28.6	**50.8**
Mixed forest(%)	-	5.1	-
Pastures and meadows (%)	-	5.1	11.6
Shrubs and (%)	-	3.1	12.6

Regional statistics

	Belgrade	Šumadija and Western Serbia	Southern and Eastern Serbia
Aspekt			
N	42.1	30.6	24.6
E	31.6	14.3	23.1
S	15.8	36.7	32.7
W	10.5	18.4	19.6
Average altitude	116.74	**844.38**	612.75
Average distance to settlement (m)	1394.81	**3879.42**	**3575.70**
Average distance to road (m)	420.42	**1487.81**	**1648.40**
Average distance to water (m)	1463.00	4903.26	**5671.28**
Average FWI indices during the fire			
FWI	20.38	26.45	**30.62**
FFMC	88.95	88.83	**91.62**
ISI	9.02	9.12	**10.95**
DMC	46.33	81.89	**96.17**
DC	235.95	332.32	**381.77**
BUI	60.62	99.73	**115.16**


Legenda
0 25 50 100 Kilometara
N


7500000
7600000
4900000
4800000
4700000
VSKO-
NAVSKO
SEVERNOKUČAJSKO
JMADIJSKO
JUŽNOKUČAJSKO
TIMOČKO
DONJEBARSKO
RASINSKO
MORAVSKO
TOPLIČKO
NIŠAVSKO
JABLANIČKO
JUŽNOMORAVSKO
Legenda
Granica šumskih područja
0 15 30 60 Kilometars
N


7500000
7600000
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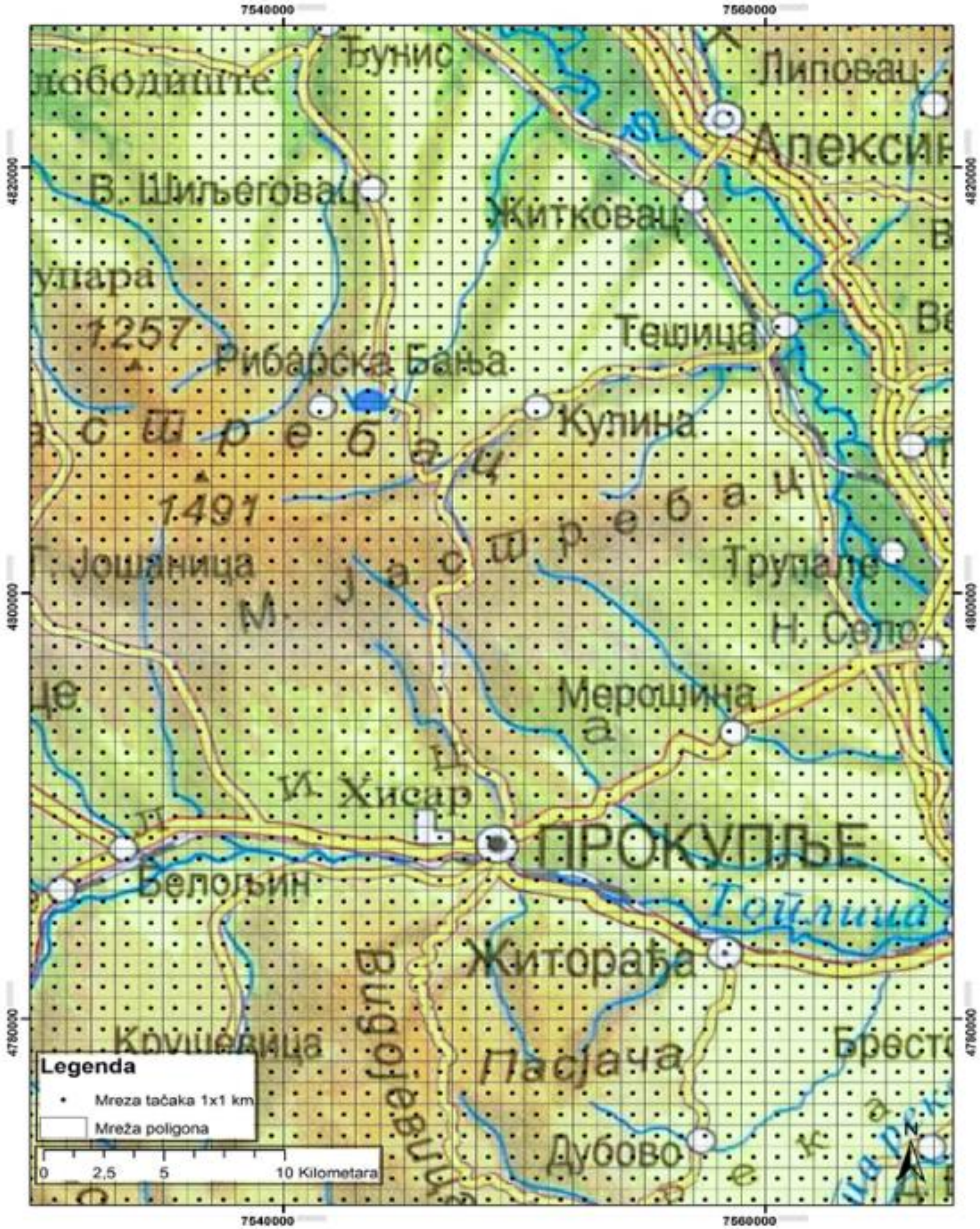
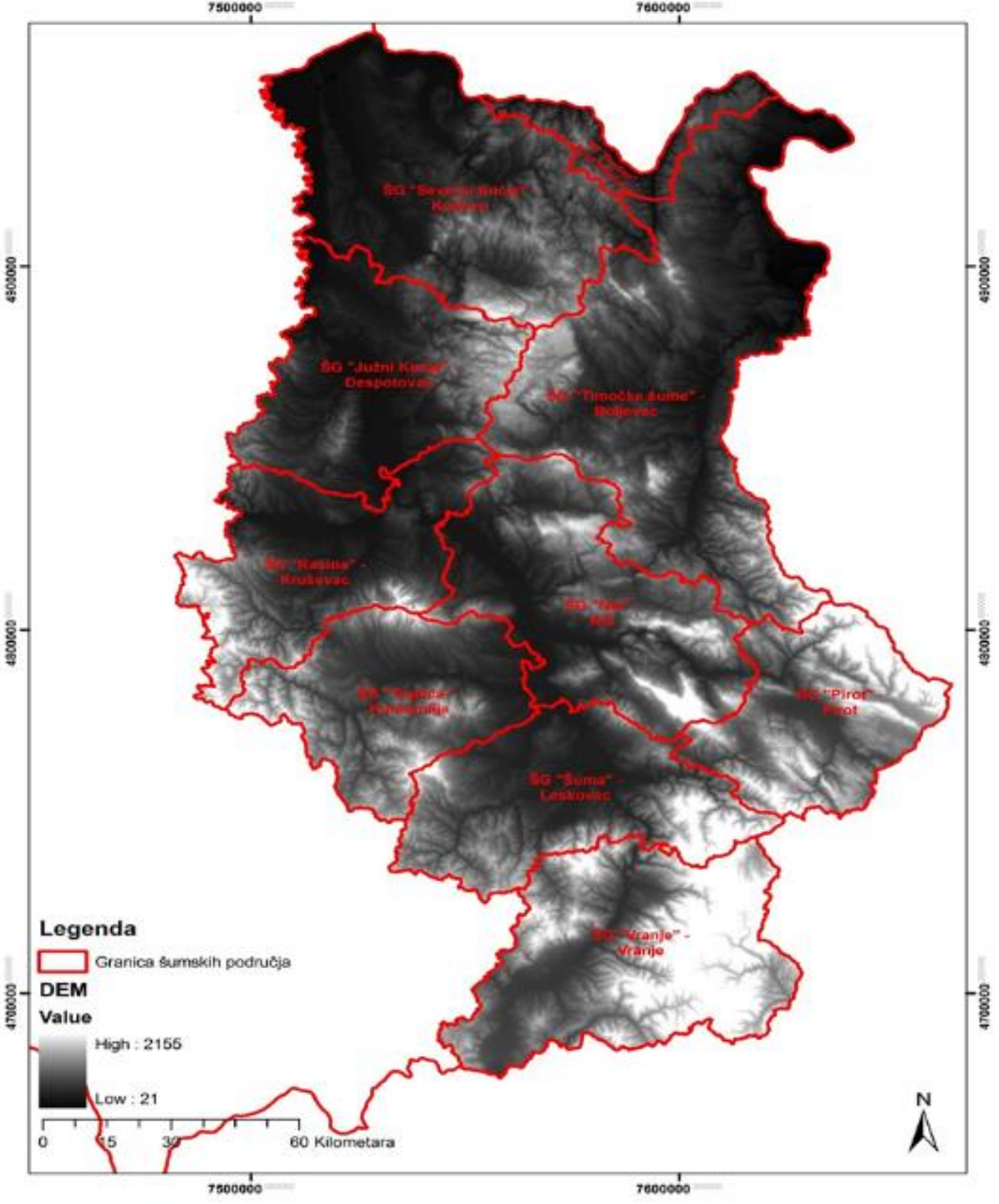
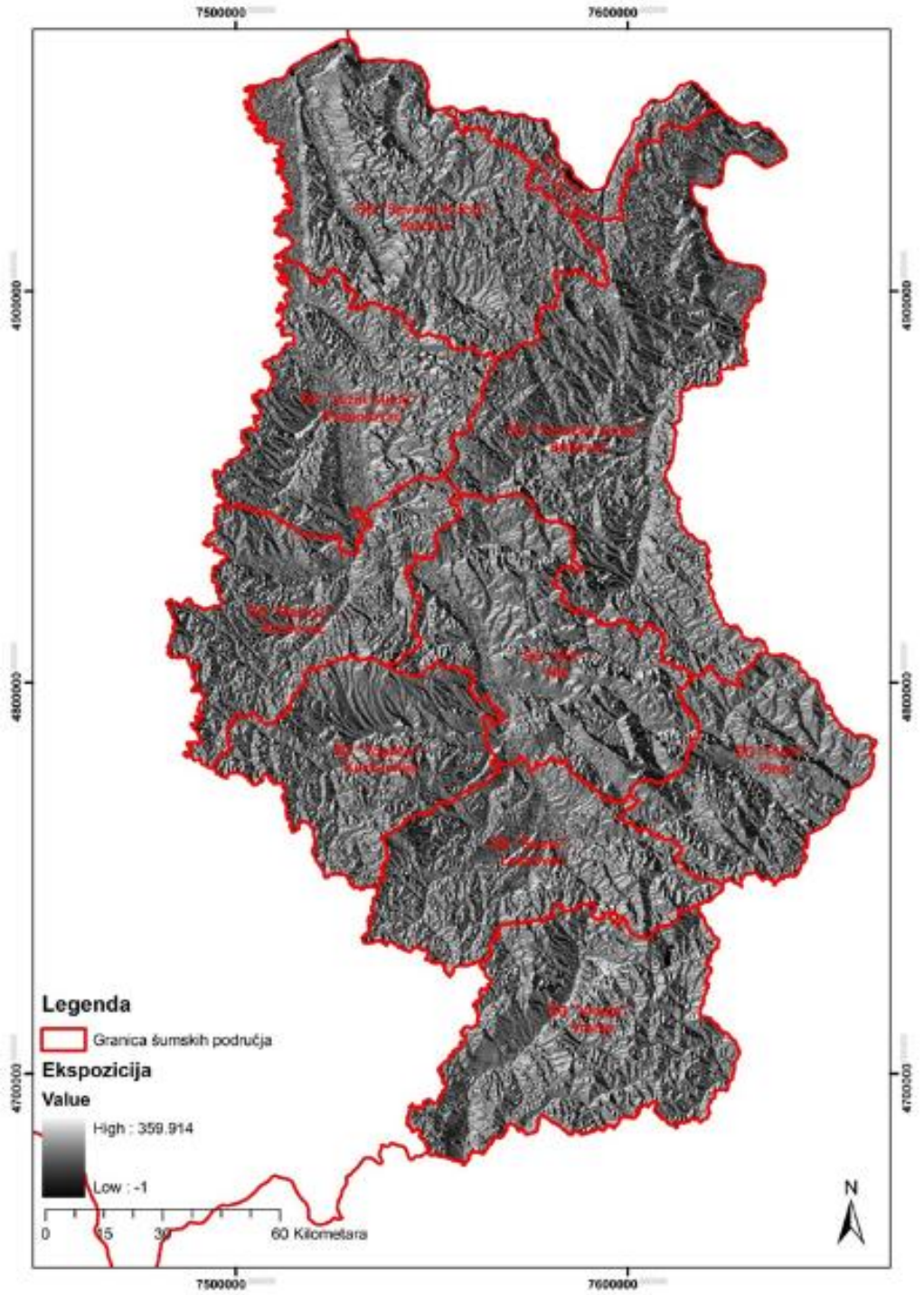
4800000
4700000
Legenda
Granica šumskih područja
Opožarena površina
0 - 25
25 - 75
75 - 1383
0
15
30
60 Kilometara
N

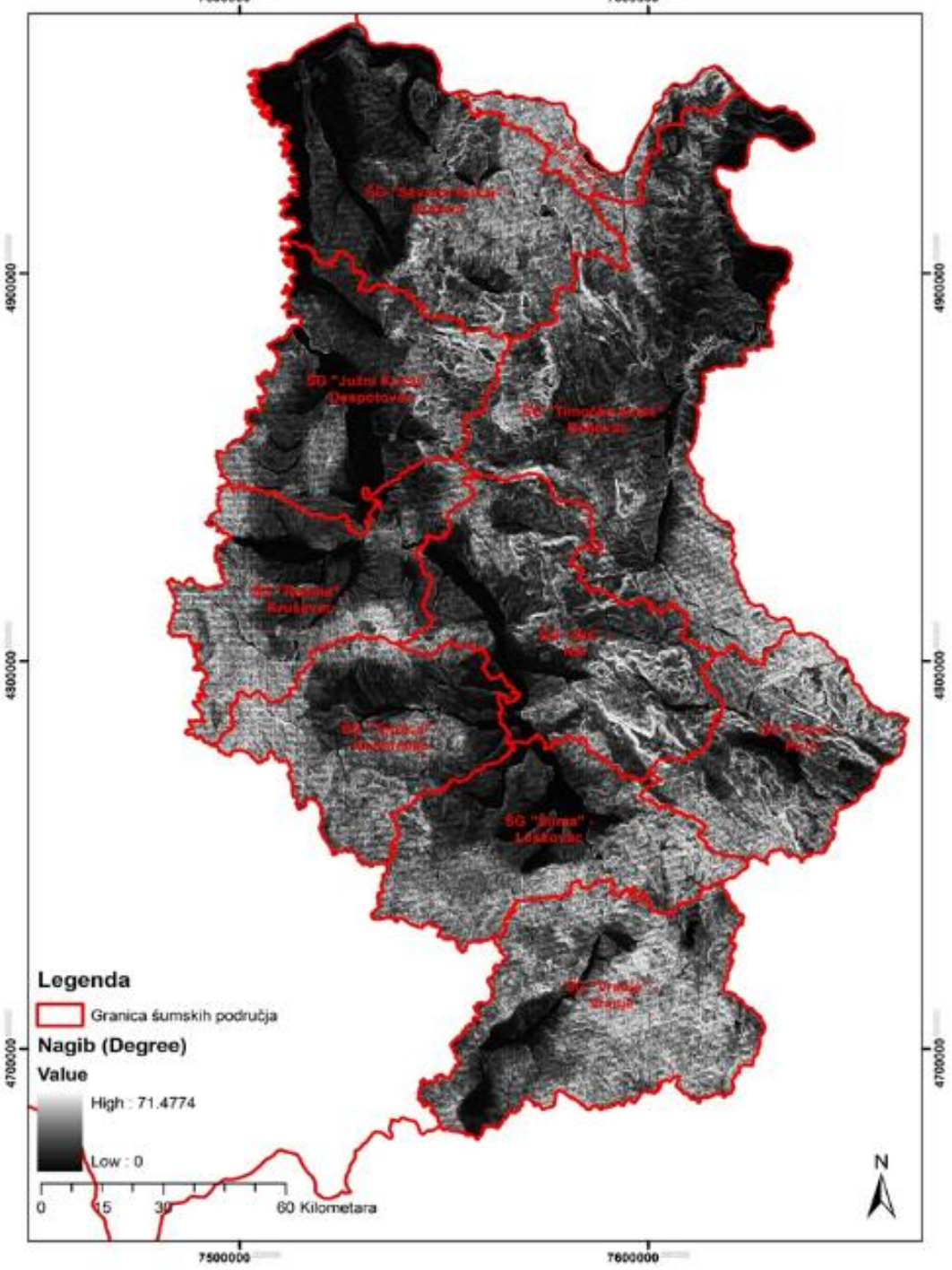

7540000
7560000
4820000
4800000
4780000
Ђунис
Липовац
Алексин
В. Шиљеговац
Житковац
1257
Рибарска Бања
Тешица
Кулина
1491
Трупале
Н. Село
Мерошина
Хисар
ПРОКУПЉЕ
Белољин
Топлица
Житорађа
Крушевица
Пасјача
Дубово
Legenda
Mreza tačaka 1x1 km
Mreža poligona
0 2,5 5 10 Kilometara
N



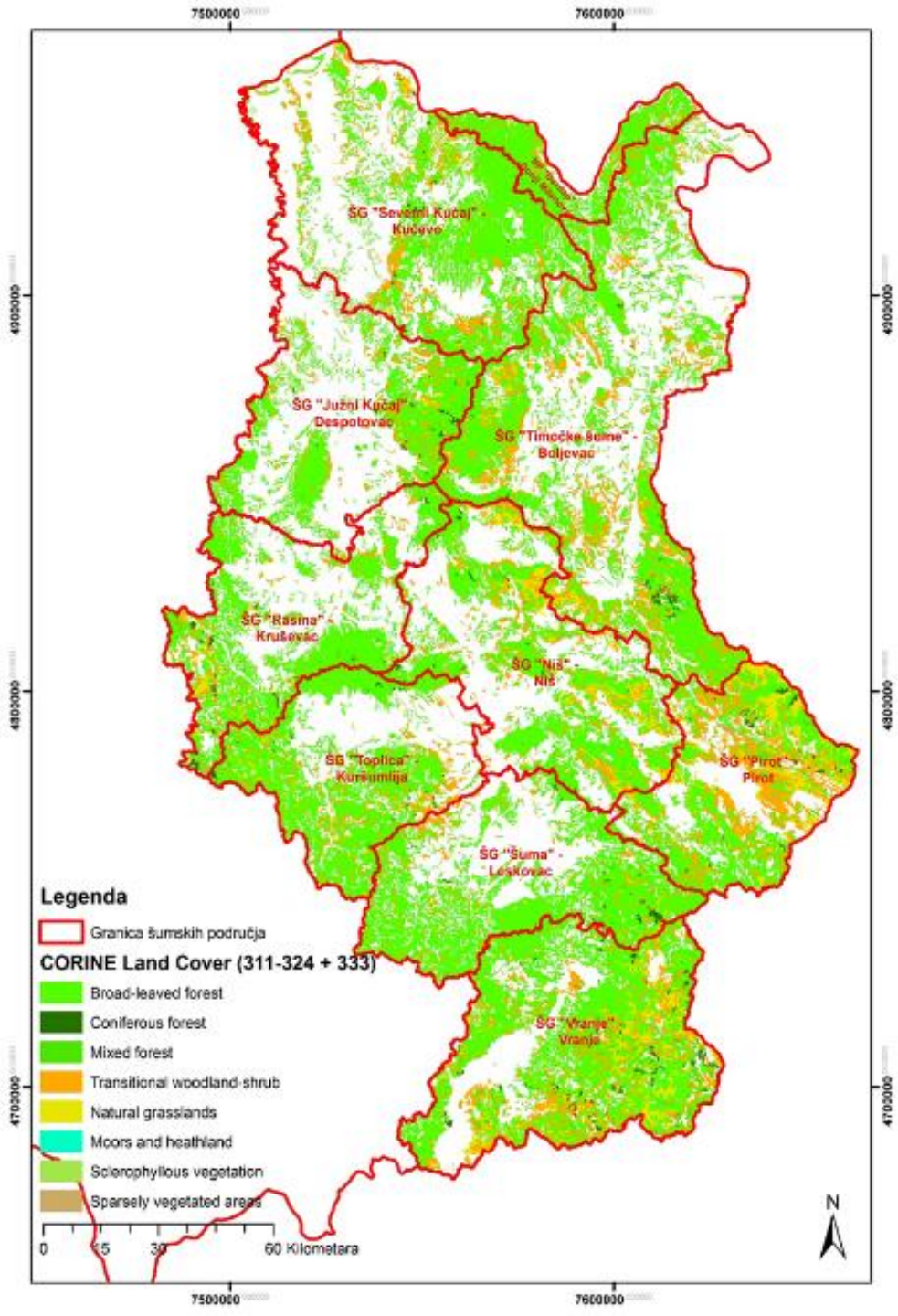
Digital elevation model with a resolution of 3 ArcSEC

Raster of aspects





Raster of inclination


7500000
7600000
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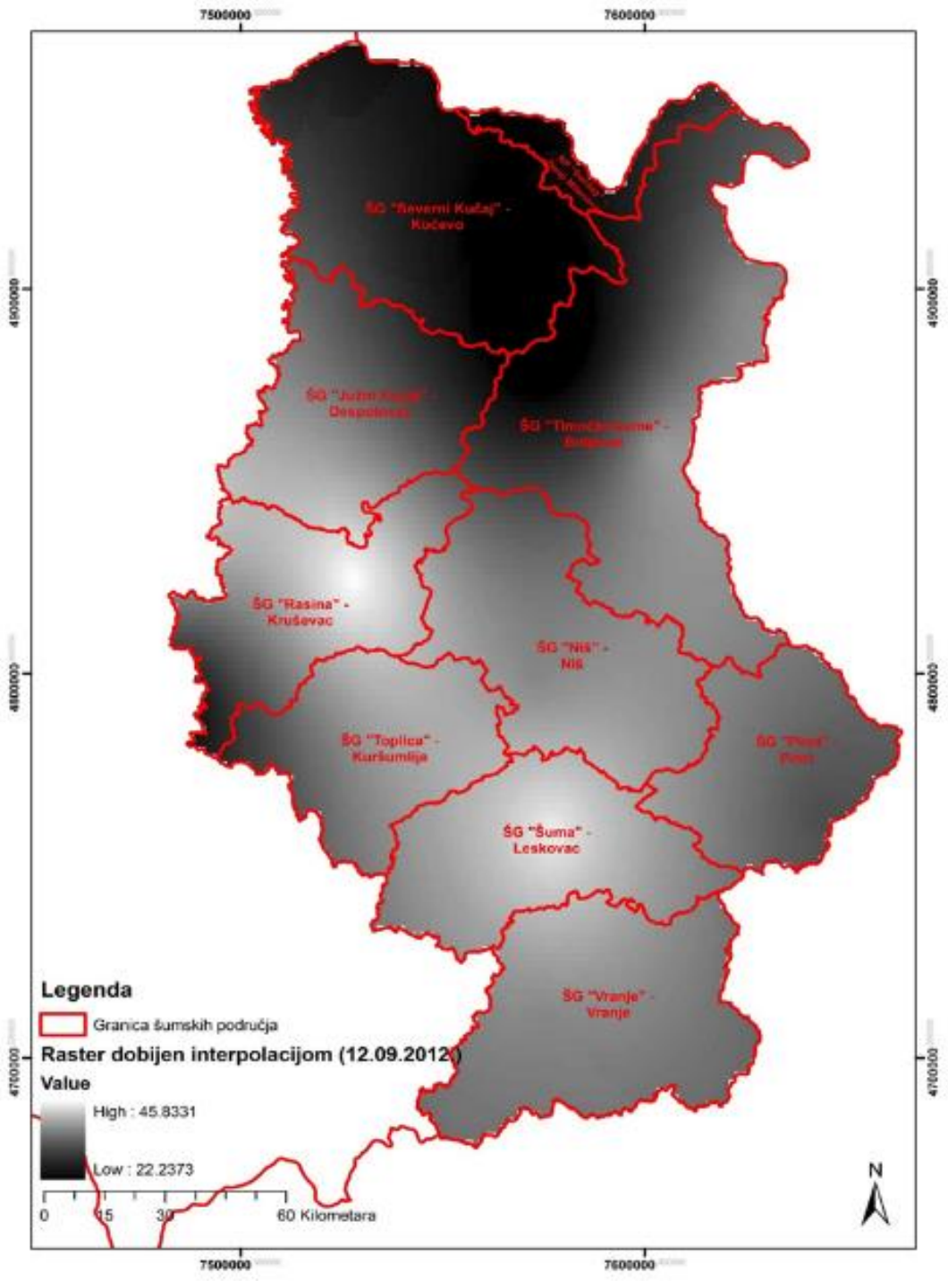
4805000
4705000
ŠG "Severni Kučaj" - Kučevo
ŠG "Južni Kučaj" - Despotovac
ŠG "Timočke šume" - Boljevac
ŠG "Rasina" - Kruševac
ŠG "Niš" - Niš
ŠG "Toplica" - Kuršumlija
ŠG "Pirot" - Pirot
ŠG "Šuma" - Leskovac
ŠG "Vranje" - Vranje
Legenda
Granica šumskih područja
CORINE Land Cover (311-324 + 333)
Broad-leaved forest
Coniferous forest
Mixed forest
Transitional woodland-shrub
Natural grasslands
Moors and heathland
Sclerophyllous vegetation
Sparsely vegetated areas
0
15
30
60 Kilometara
N



FWI raster of interpolated data using method of Kriging

Prediction model

Matching criteria:

1. 5 years average FWI

Matching method: Propensity score matching

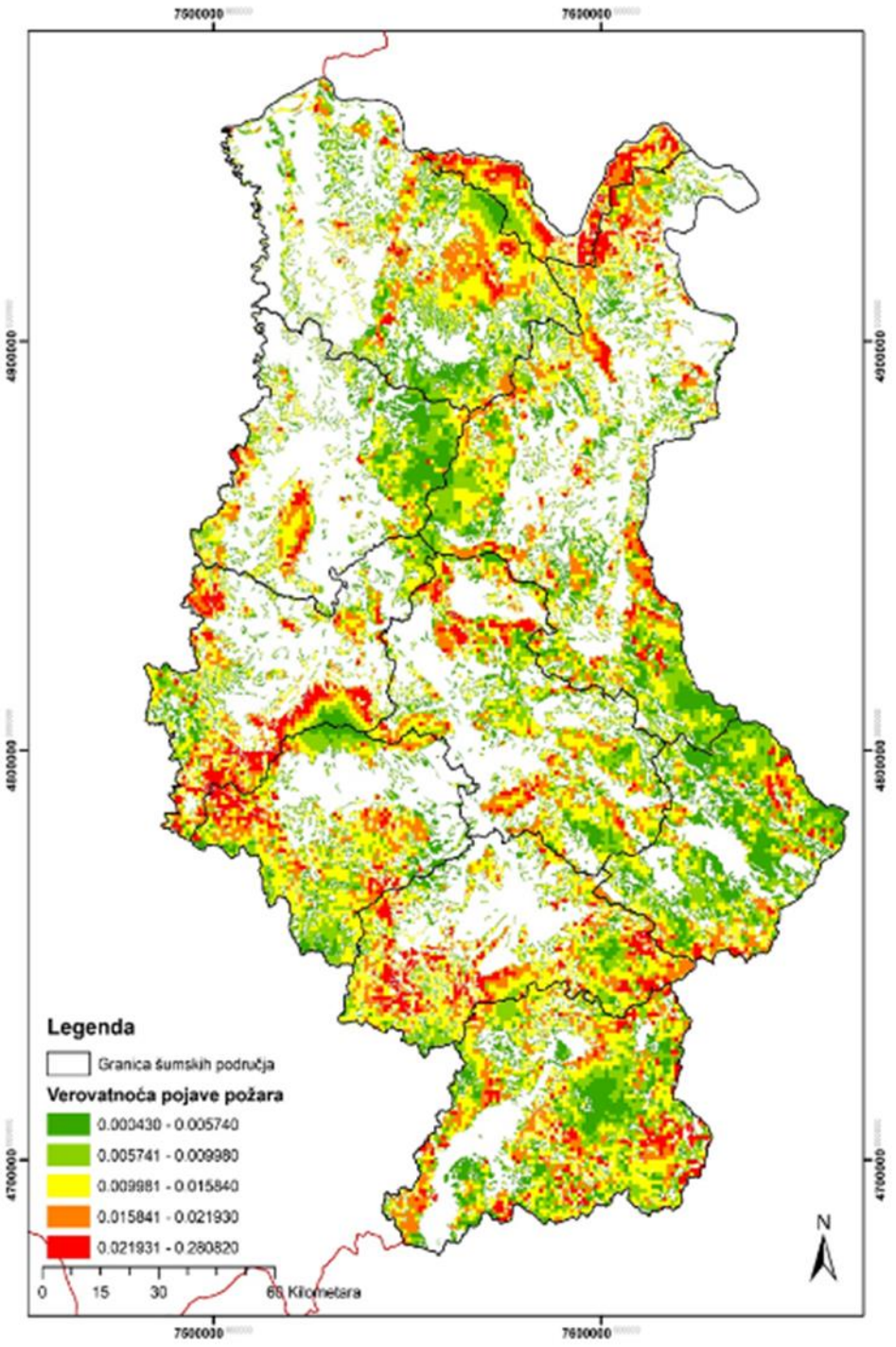
Tested variables that contribute to the fire occurrence:

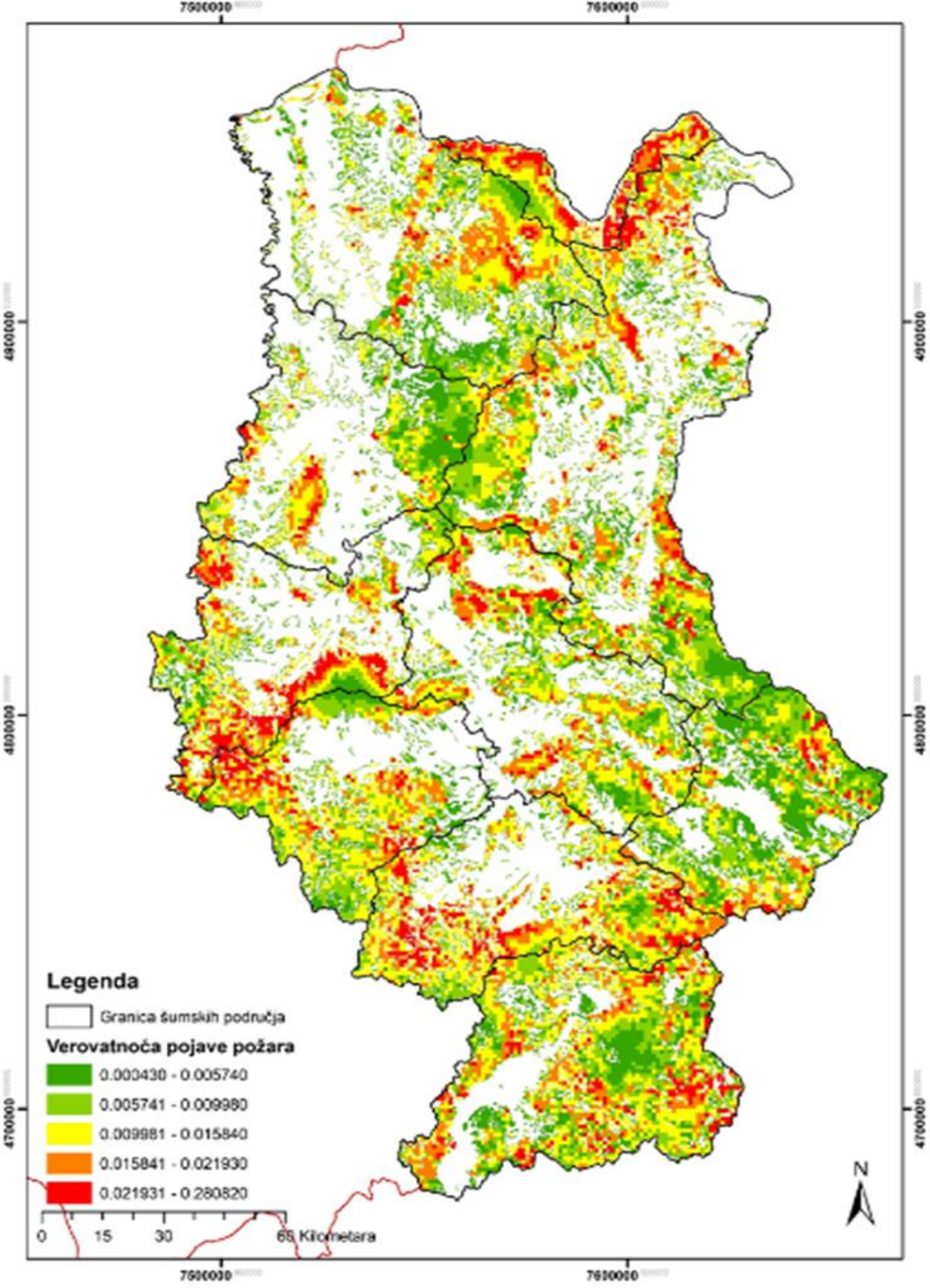
1. Distance to road
2. Population density
3. Distance to settlement
4. Aspect (exposition)
5. Average altitude

Prediction accuracy

75.0%

Forest fire occurrence probability map

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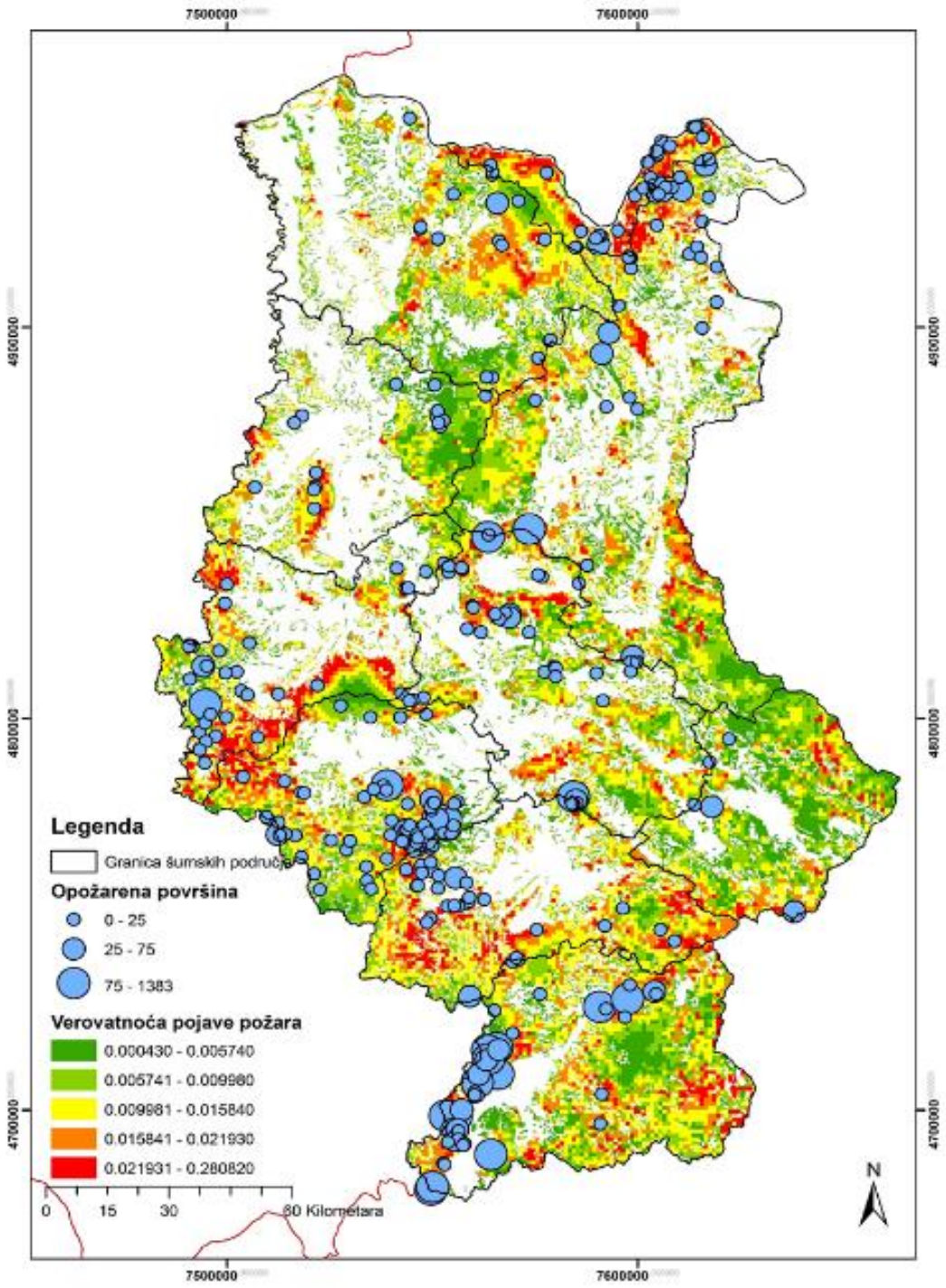
Legenda
Granica šumskih područja
Verovatnoća pojave požara
0.000430 - 0.005740
0.005741 - 0.009980
0.009981 - 0.015840
0.015841 - 0.021930
0.021931 - 0.280820
0
15
30
60 Kilometara
N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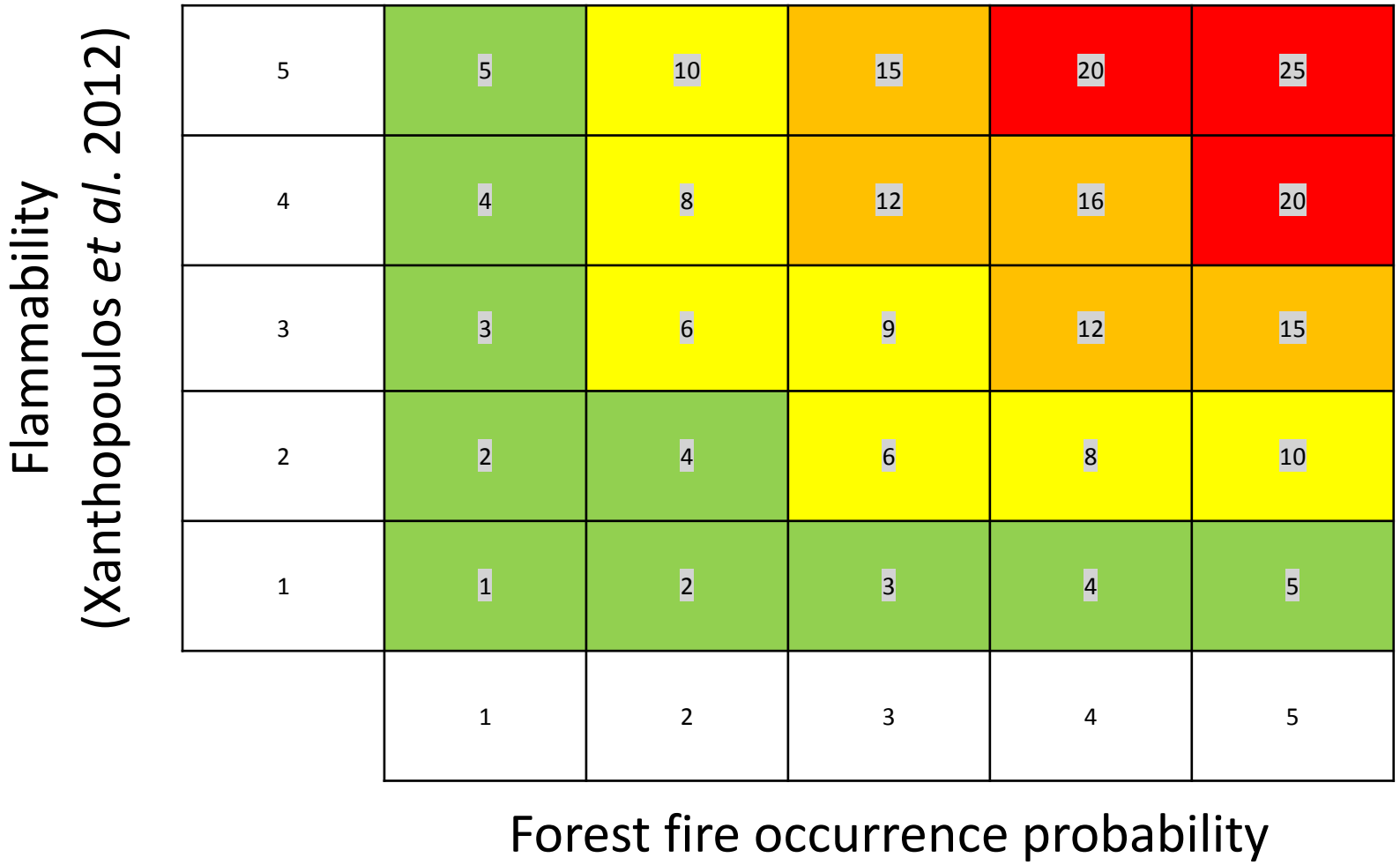
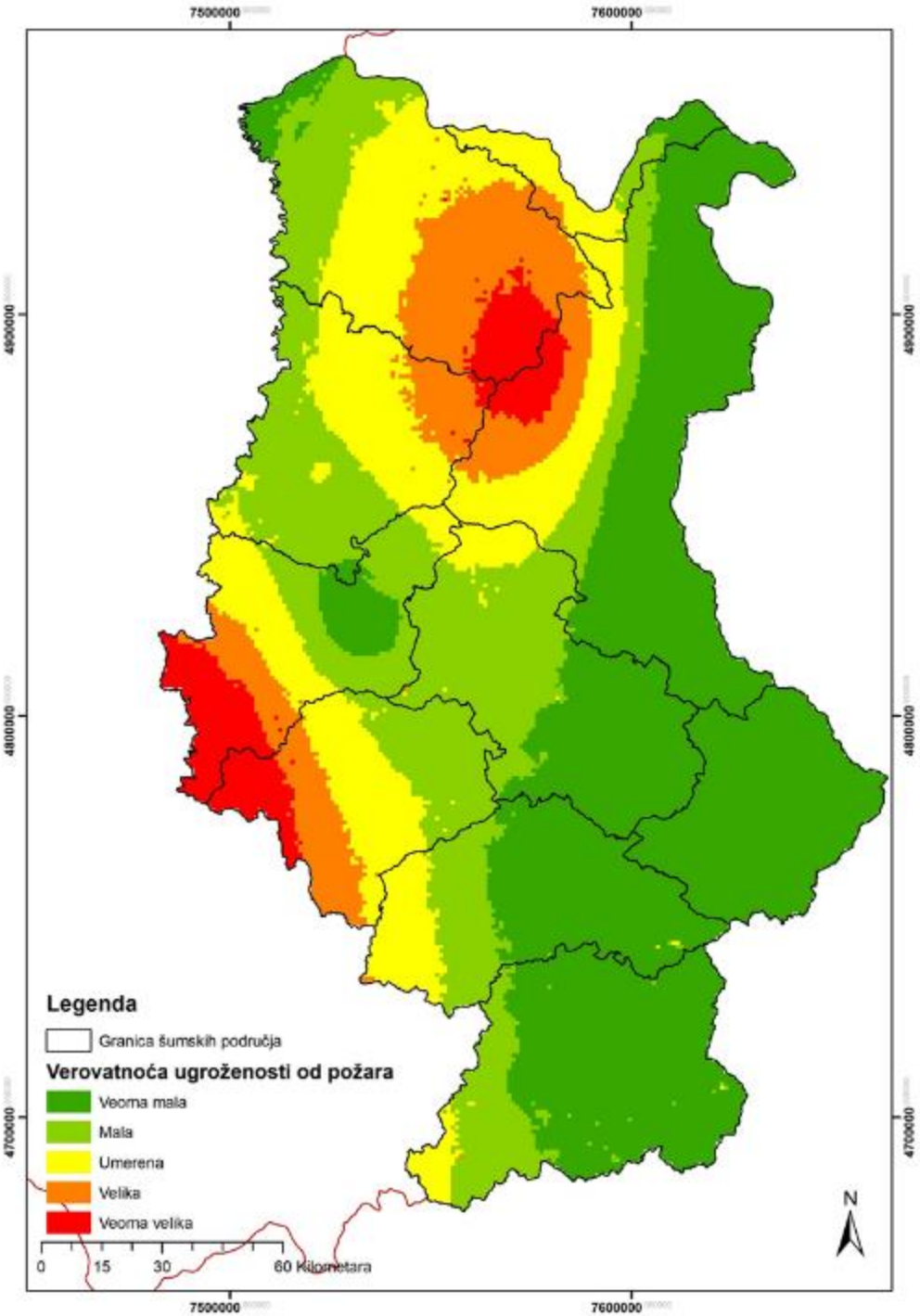
Legenda
Granica šumskih područja
Opožarena površina
0 - 25
25 - 75
75 - 1383
Verovatnoća pojave požara
0.000430 - 0.005740
0.005741 - 0.009980
0.009981 - 0.015840
0.015841 - 0.021930
0.021931 - 0.280820
0
15
30
60 Kilometara
N

Thank you for your attention!



low	moderate	high	ekstreme
1-5	6-10	12-16	20-25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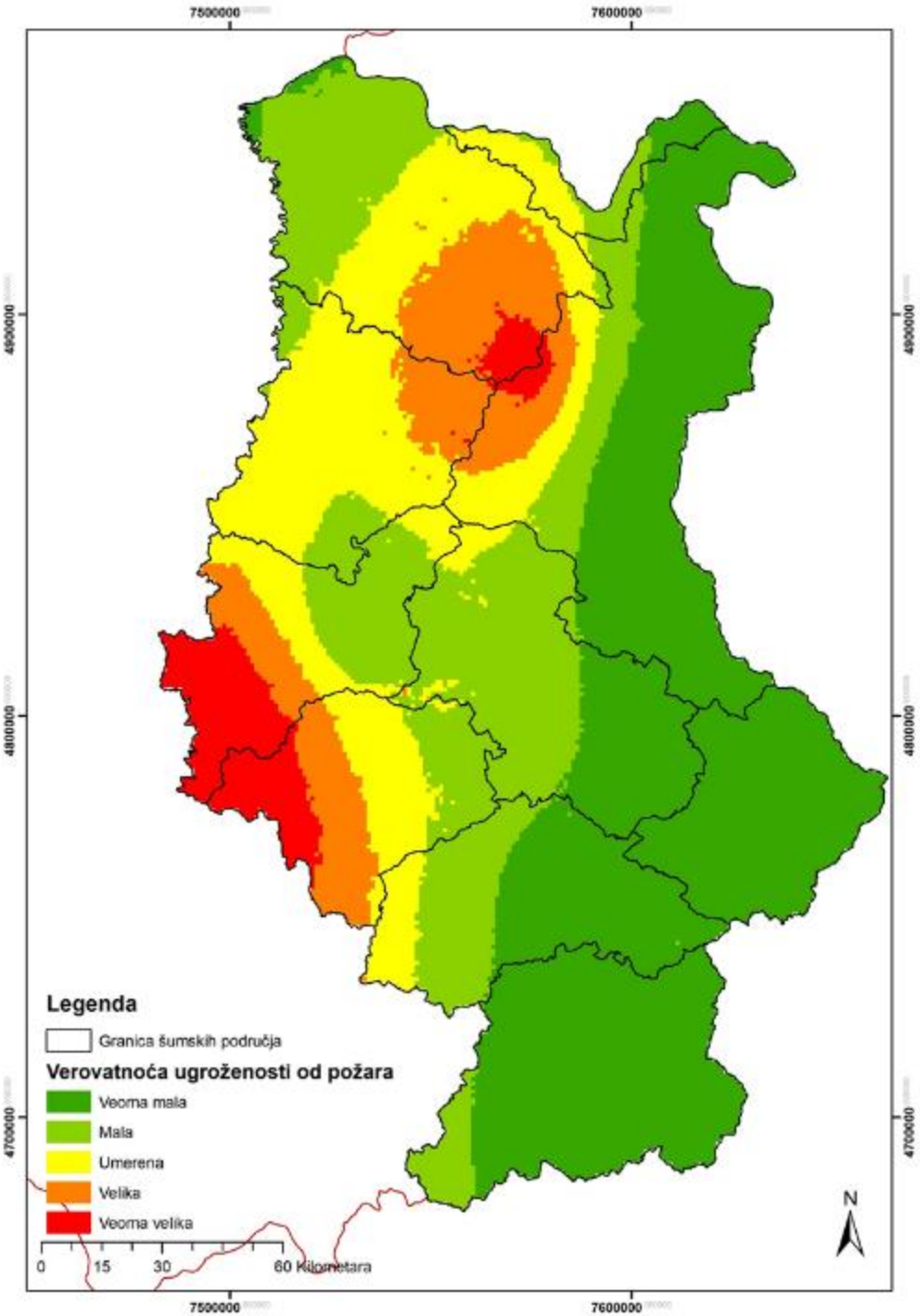
Legenda
Granica šumskih područja
Verovatnoća ugroženosti od požara
Veoma mala
Mala
Umerena
Velika
Veoma velika
0
15
30
60 Kilometara
N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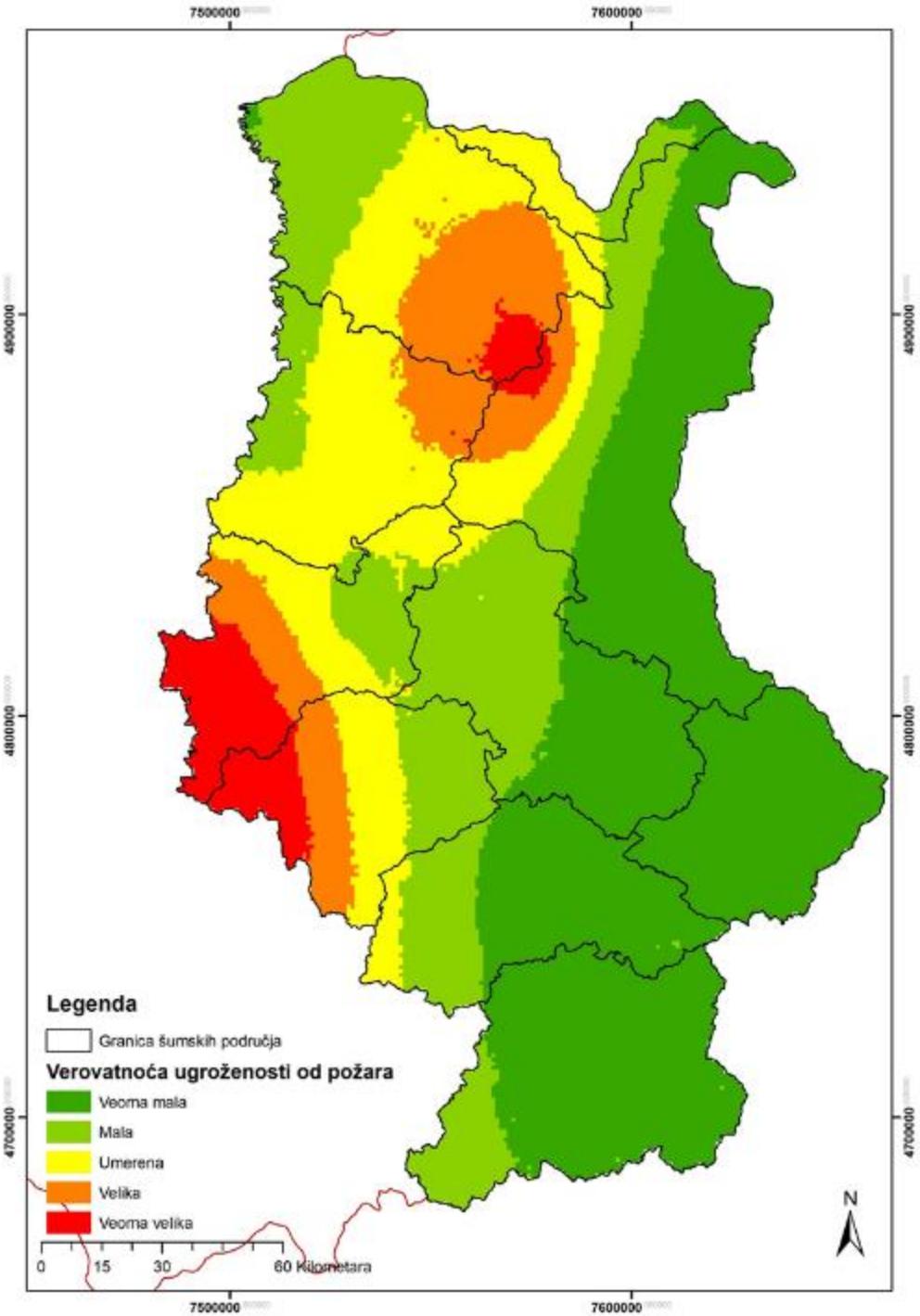
Legenda
Granica šumskih područja
Verovatnoća ugroženosti od požara
Veoma mala
Mala
Umerena
Velika
Veoma velika
0
15
30
60 Kilometara
N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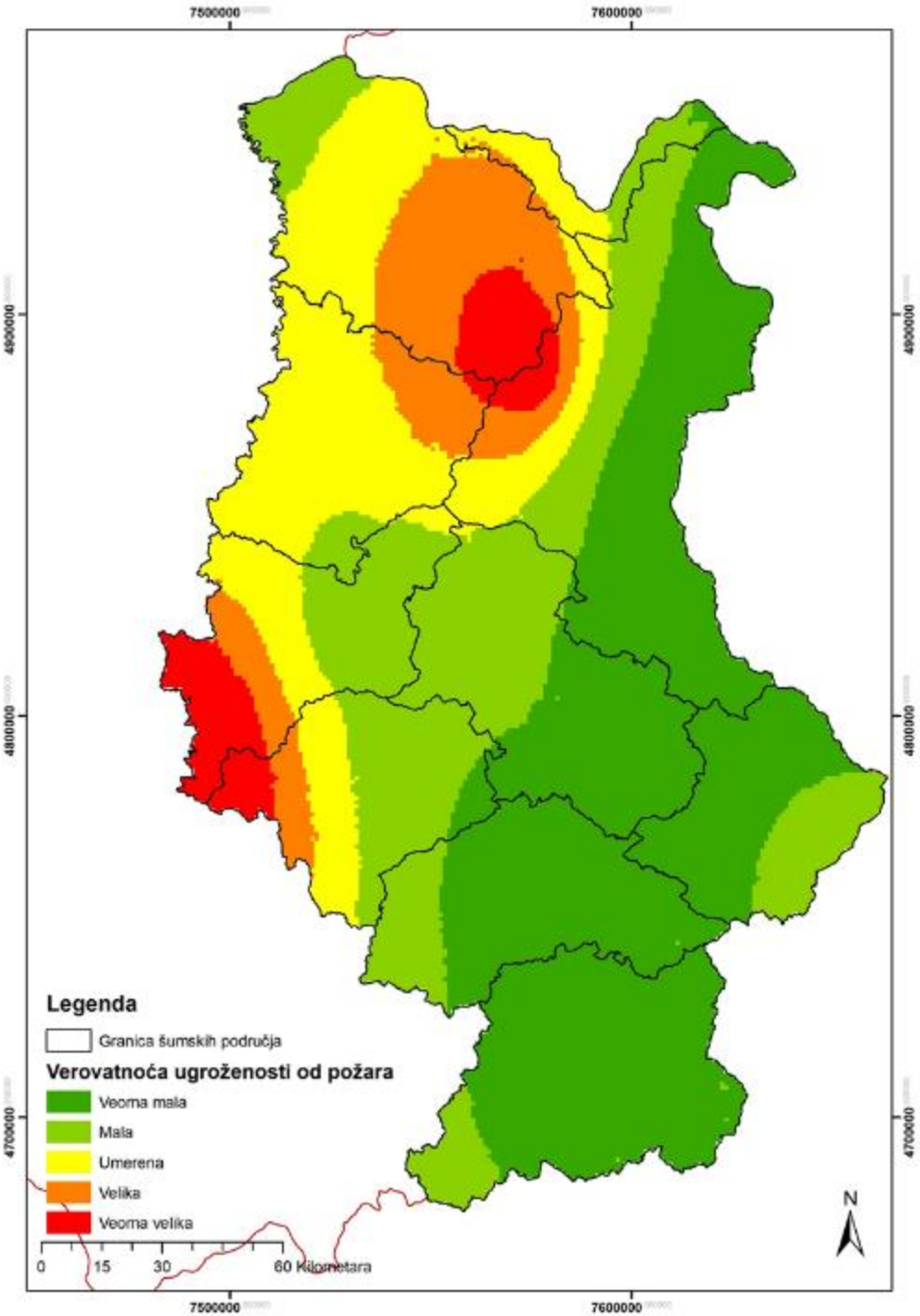
Legenda
Granica šumskih područja
Verovatnoća ugroženosti od požara
Veoma mala
Mala
Umerena
Velika
Veoma velika
0
15
30
60 Kilometara
N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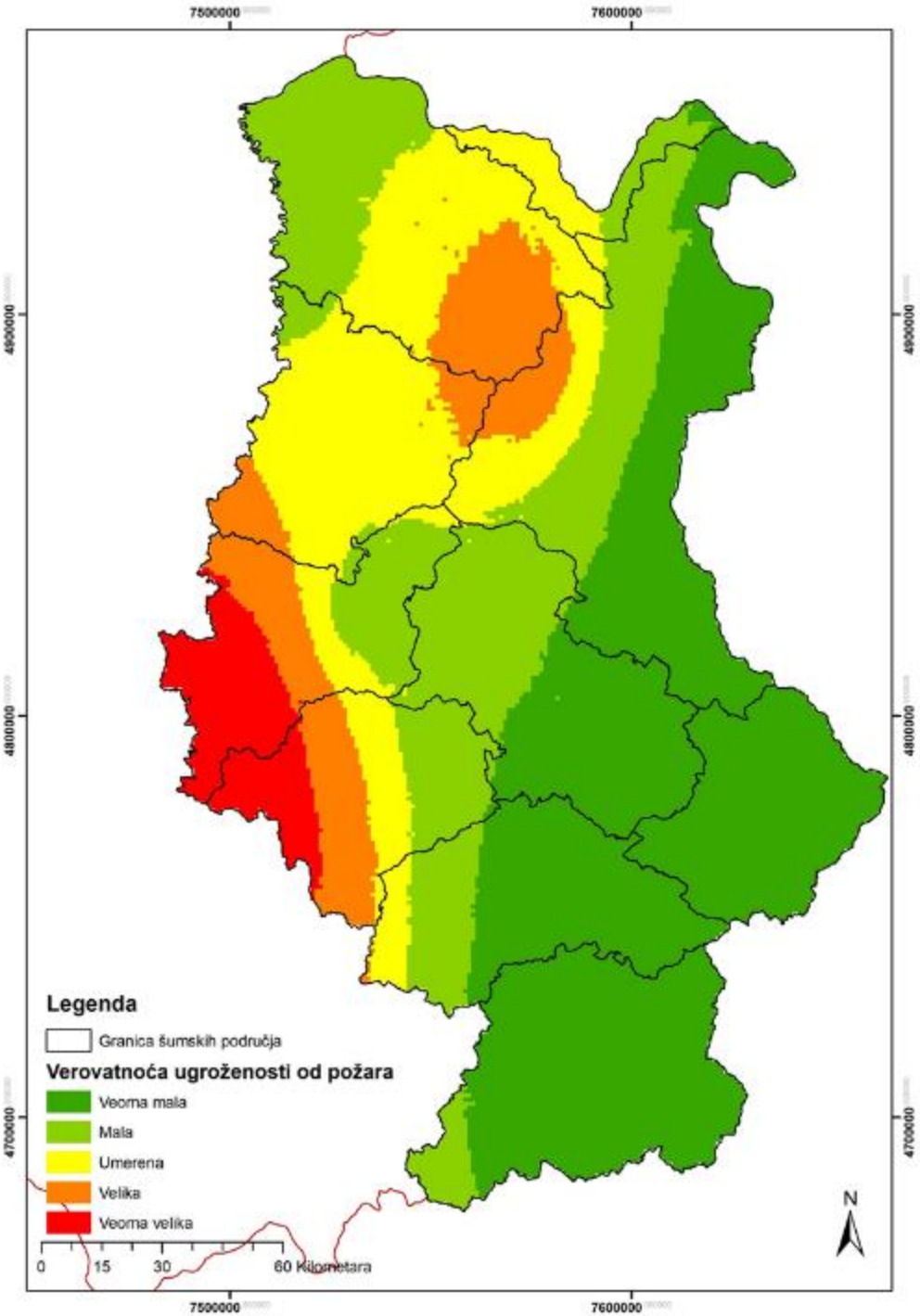
Legenda
Granica šumskih područja
Verovatnoća ugroženosti od požara
Veoma mala
Mala
Umerena
Velika
Veoma velika
0
15
30
60 Kilometara
N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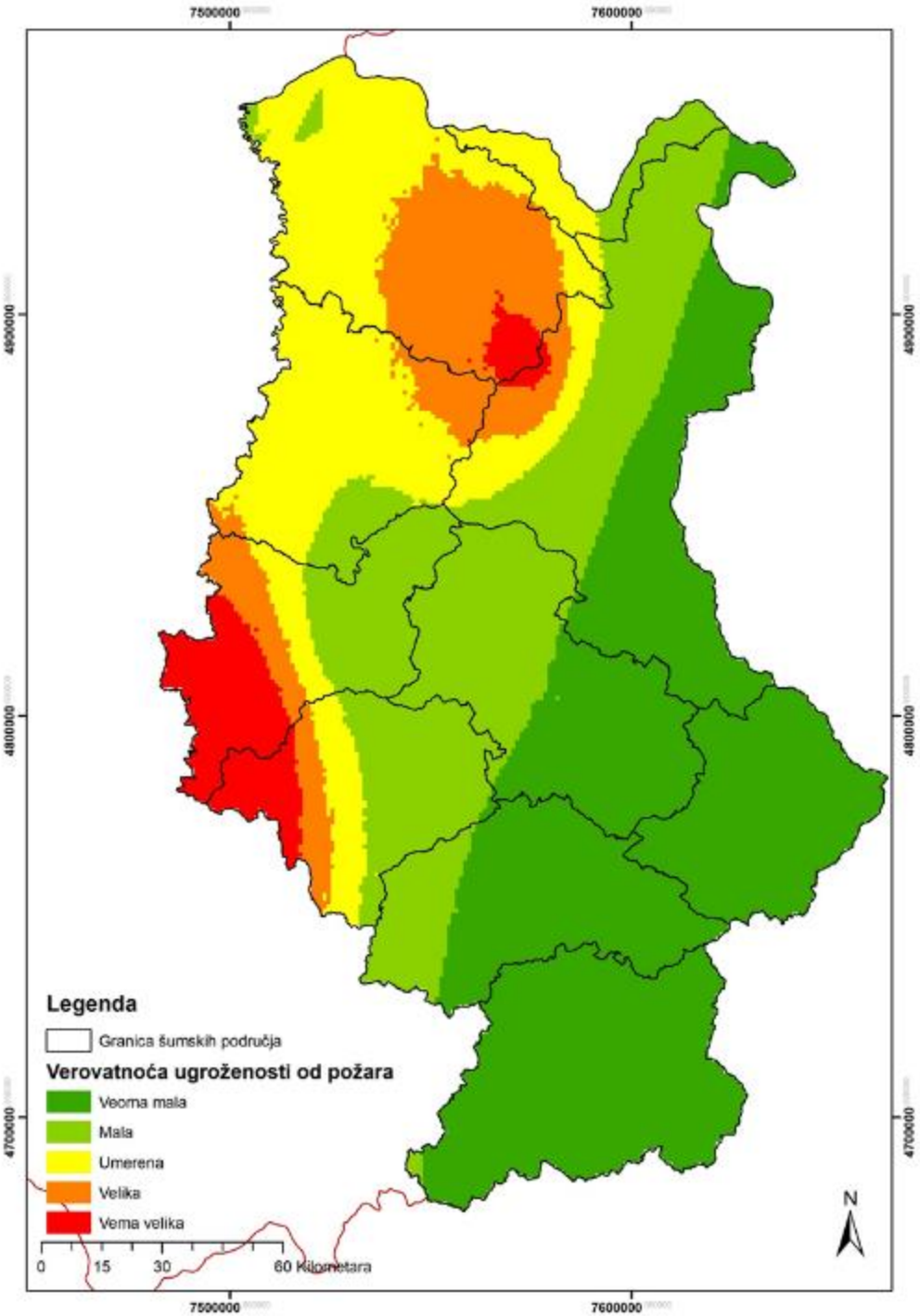
Legenda
Granica šumskih područja
Verovatnoća ugroženosti od požara
Veoma mala
Mala
Umerena
Velika
Veoma velika
0
15
30
60 Kilometara
N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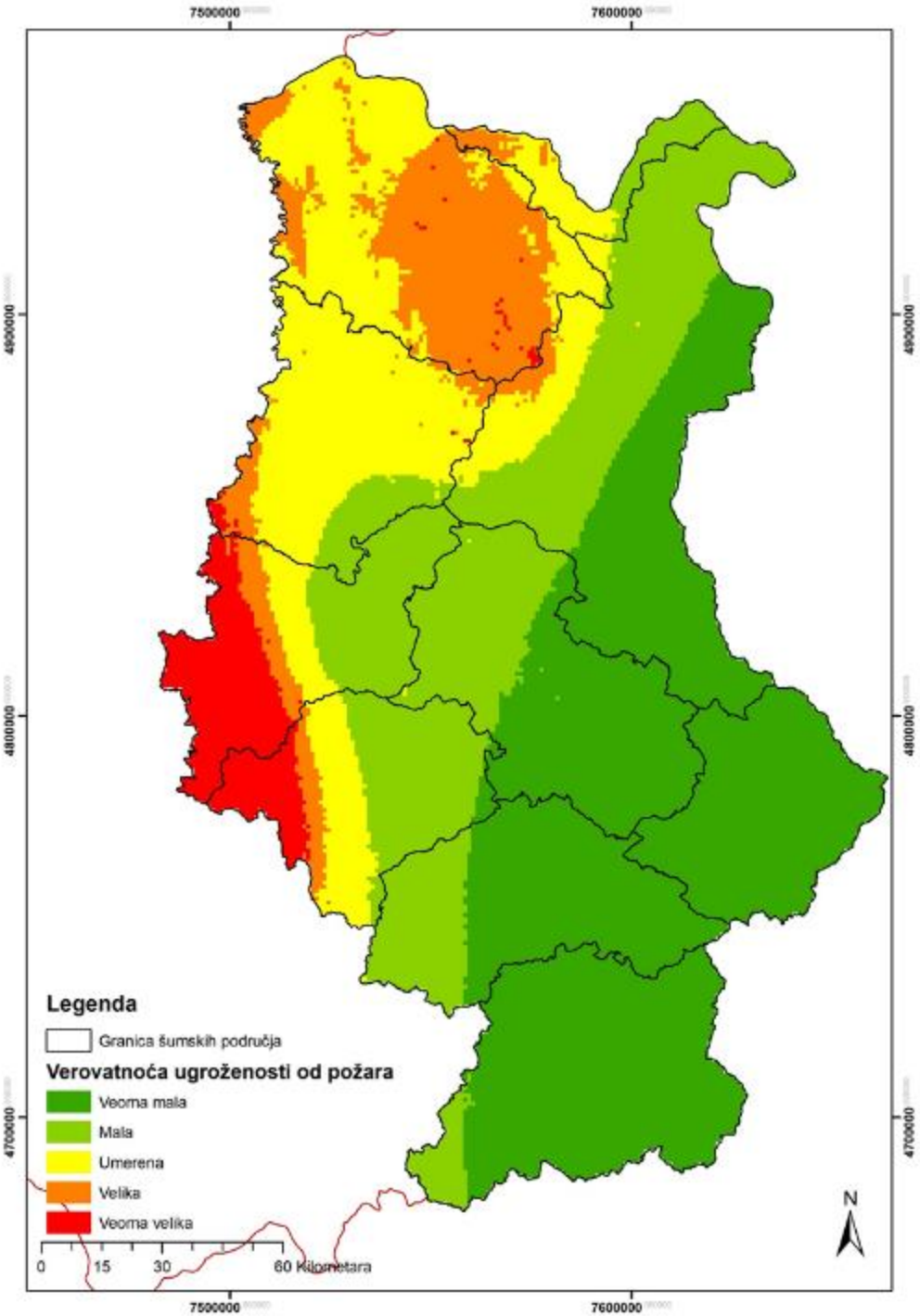
Legenda
Granica šumskih područja
Verovatnoća ugroženosti od požara
Veoma mala
Mala
Umerena
Velika
Vema velika
0
15
30
60 Kilometara
N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7600000
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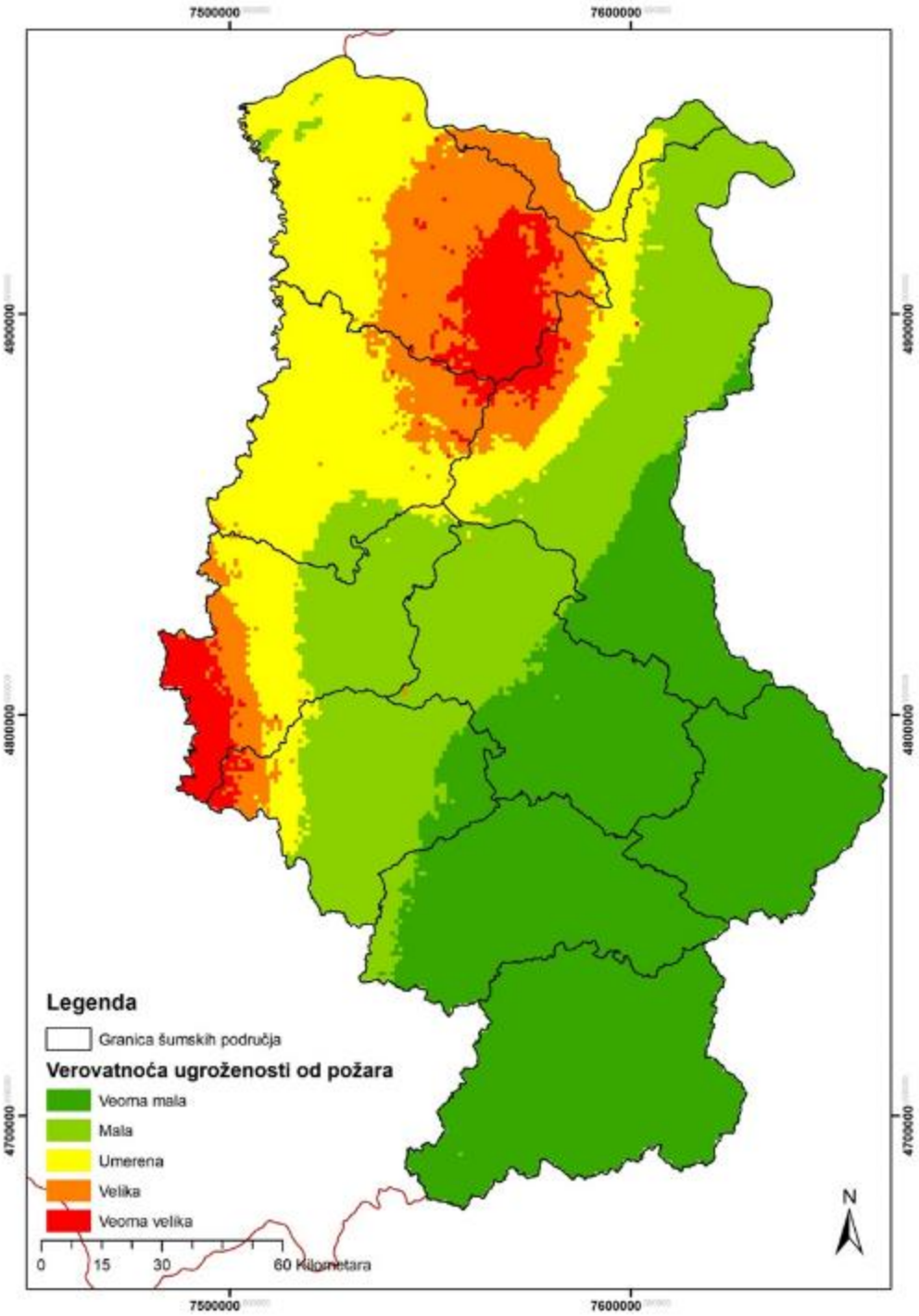
4700000
Legenda
Granica šumskih područja
Verovatnoća ugroženosti od požara
Veoma mala
Mala
Umerena
Velika
Veoma velika
0
15
30
60 Kilometara
N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7600000
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4700000
Legenda
Granica šumskih područja
Verovatnoća ugroženosti od požara
Veoma mala
Mala
Umerena
Velika
Veoma velika
0
15
30
60 Kilometara
N

Calibration and risk assessment in other countries

http://dx.doi.org/10.14195/978-989-26-0884-6_114 Chapter 4 - Fire Risk Assessment and Climate Change

A new calibration for Fire Weather Index in Spain (AEMET)

Romero, R., Mestre, A., Botey, R.

Agencia Estatal de Meteorología (Aemet), Spain, rromerof@aemet.es, amestreb@aemet.es, mboteyf@aemet.es

Forest Ecology and Management 381 (2016) 360–369

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Modeling fire size of wildfires in Castellon (Spain), using spatiotemporal marked point processes

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Nat. Hazards Earth Syst. Sci., 16, 1217–1237, 2016
www.nat-hazards-earth-syst-sci.net/16/1217/2016/
doi:10.5194/nhess-16-1217-2016

Natural Hazards and Earth System Sciences

Calibration and evaluation of the Canadian Forest Fire Weather Index (FWI) System for improved wildland fire danger rating in the United Kingdom

Mark C. de Jong[1], Martin J. Wooster[1,2], Karl Kitchen[3], Cathy Manley[4], Rob Gazzard[5], and Frank F. McCull[4]

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[2]National Centre for Earth Observation (NCEO), UK
[3]Met Office, Exeter, UK
[4]Forestry Commission England, 620 Bristol Business Park, Coldharbour Lane, Frenchay, Bristol, BS16 1EJ, UK
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METEOROLOGICAL APPLICATIONS
Meteorol. Appl. 18: 83–93 (2011)
Published online 27 July 2010 in Wiley Online Library
(wileyonlinelibrary.com) DOI: 10.1002/met.214

RMetS Royal Meteorological Society

Evaluation of the Canadian fire weather index system in an eastern Mediterranean environment

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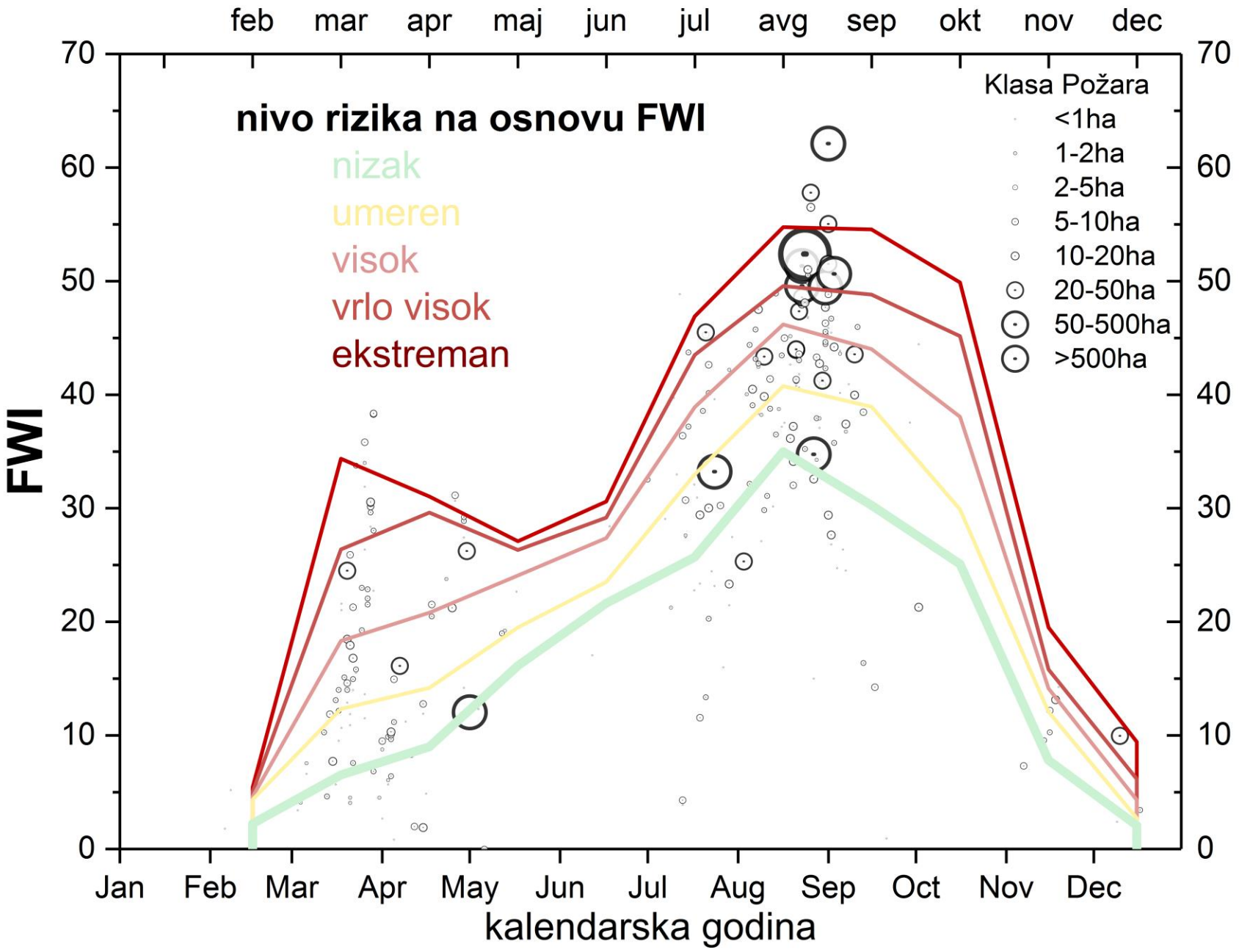
[b] Mediterranean Agronomic Institute, P. O. Box 85, 73100 Chania, Greece

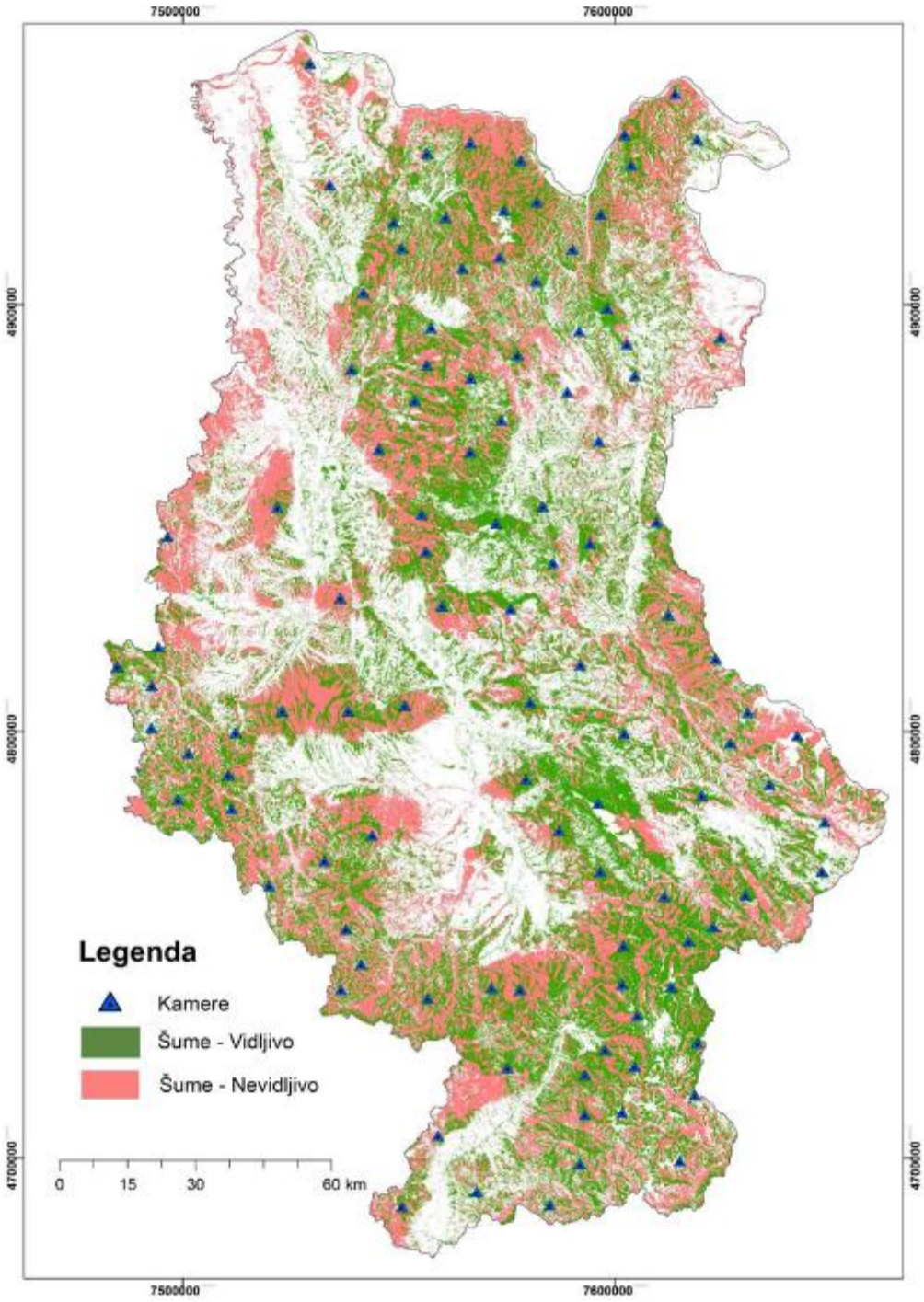
PeerJ

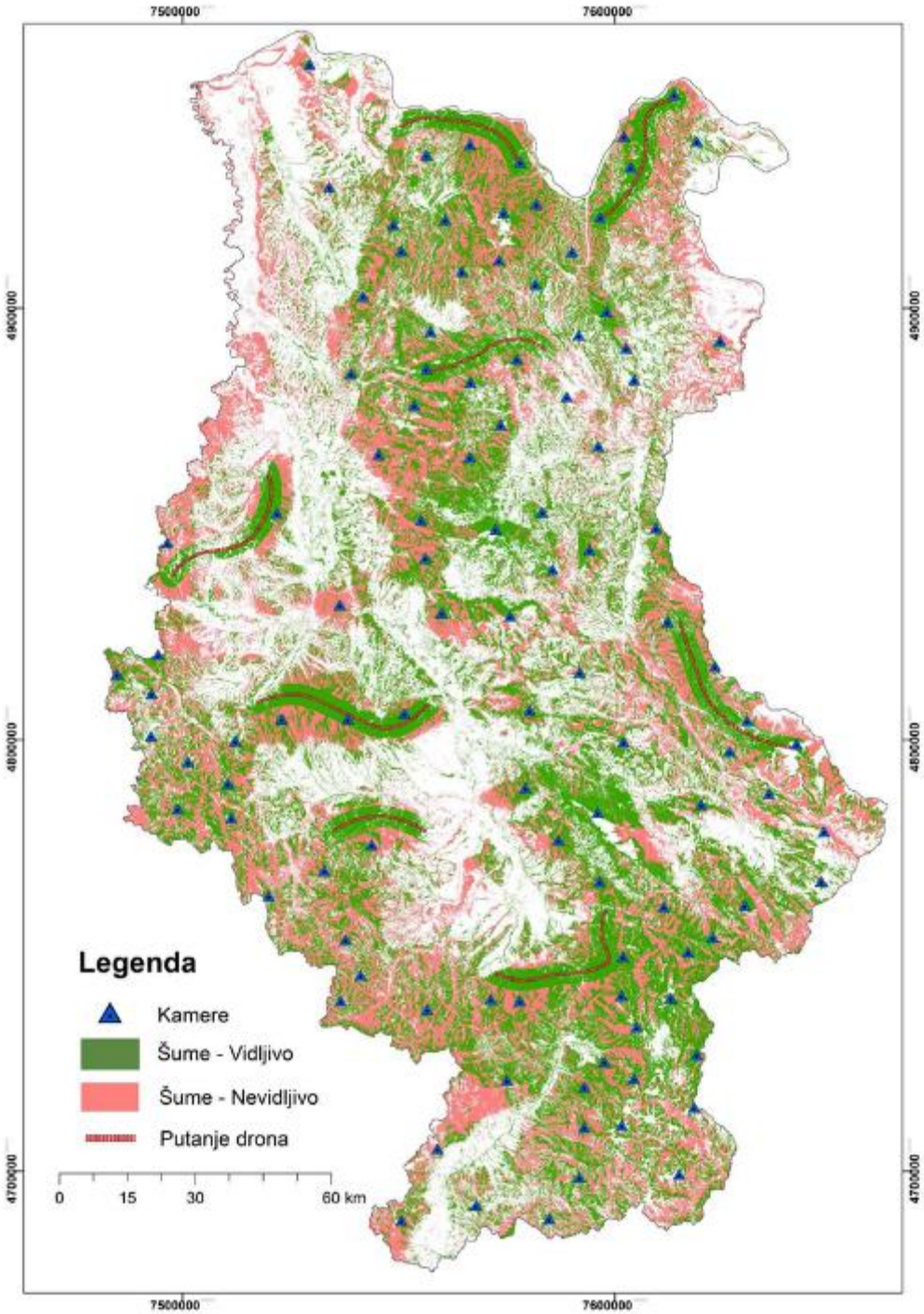
Regional variation in fire weather controls the reported occurrence of Scottish wildfires

G. Matt Davies[1] and Colin J. Legg[2]

[1]School of Environment and Natural Resources, The Ohio State University, Columbus, OH, United States of America
[2]School of GeoSciences, The University of Edinburgh, Edinburgh, Scotland, United Kingdom


feb mar apr maj jun jul avg sep okt nov dec
nivo rizika na osnovu FWI
nizak
umeren
visok
vrlo visok
ekstreman
Klasa Požara
<1ha
1-2ha
2-5ha
5-10ha
10-20ha
20-50ha
50-500ha
>500ha
FWI
0
10
20
30
40
50
60
70
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
kalendarska godina


7500000
7600000
4900000
4800000
4700000
Legenda
Kamere
Šume - Vidljivo
Šume - Nevidljivo
0
15
30
60 km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7600000
4900000
4800000
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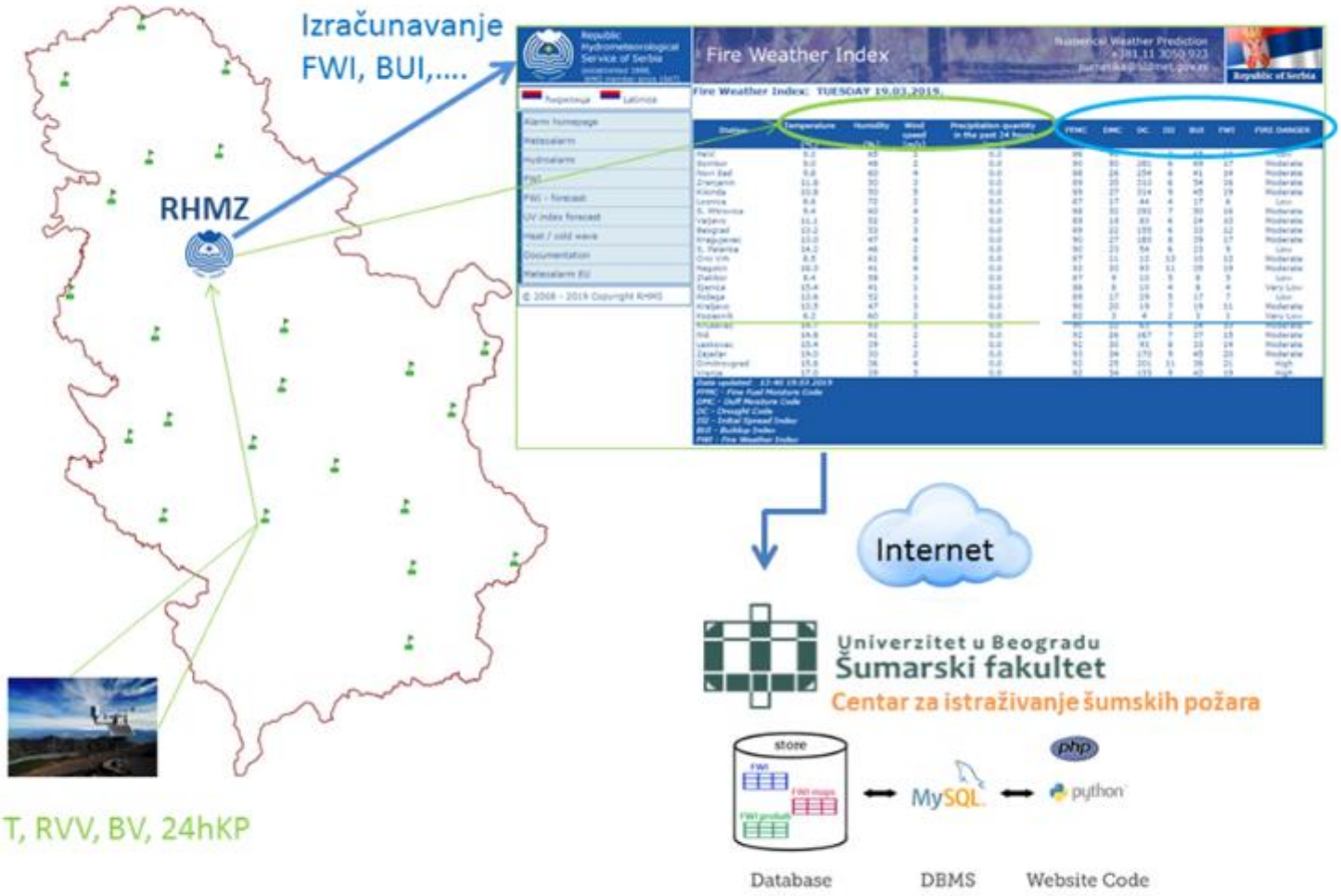
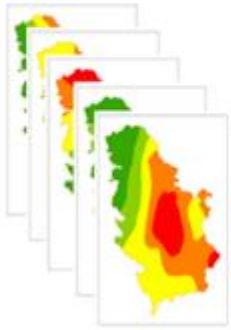
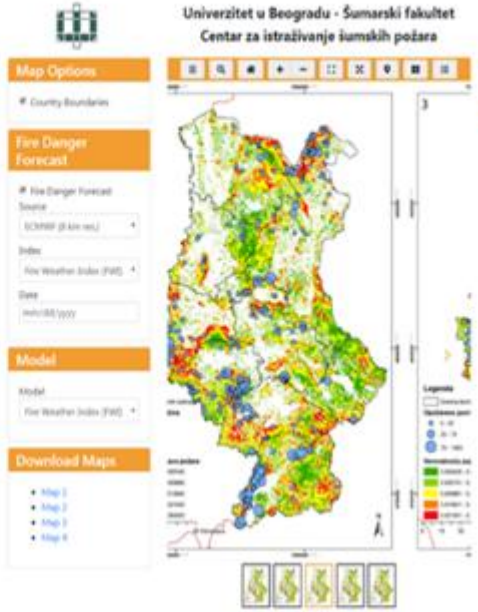
Legenda
Kamere
Šume - Vidljivo
Šume - Nevidljivo
Putanje drona
0
15
30
60 km



Koncepteptulana šema prikupljanja i dobrade podataka o vremenskim uslovima i FWI sa komponentama

Interpolacija





Modeli / Kalkulacije

Database DBMS Website Code