

Application of GIS and AHP Technique for Land Suitability for Afforestation



Center for development non
formal education



Vienna 08th April 2019



Photography
encouraged



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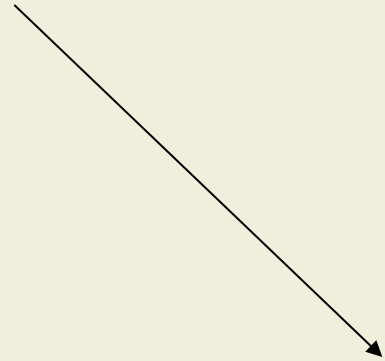


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The aim

- The aim of this research is an algorithm that could support local and regional government in the decision making process in the forestry sector.
- The algorithm gives an answer to the question where making a new forest





Successful Afforestation

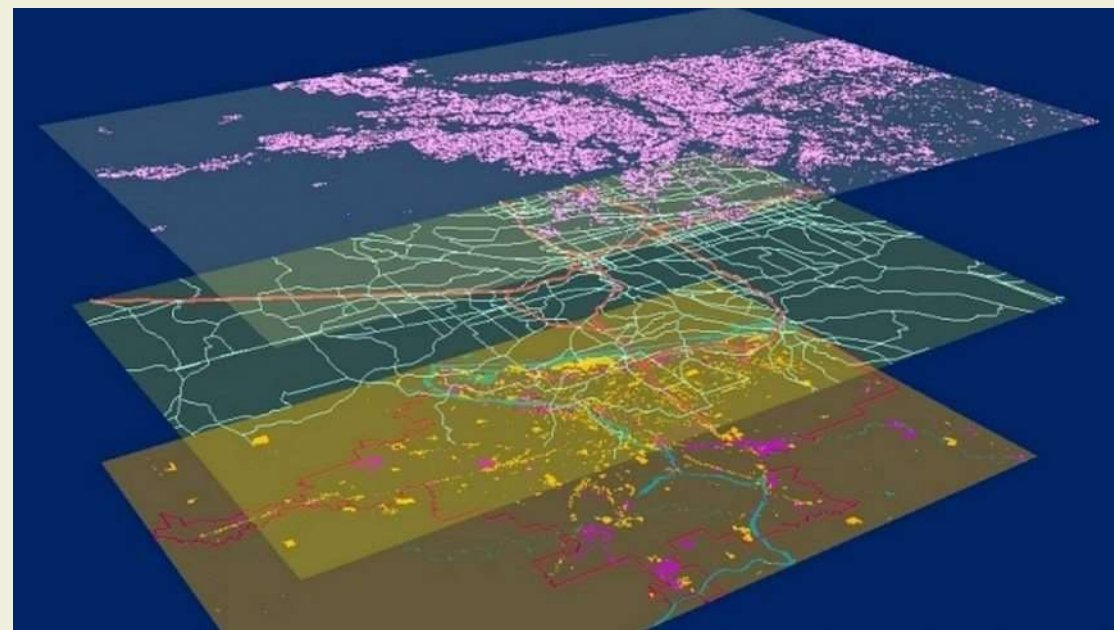
Location

Tree Species

The Analytic Hierarchy Process and Geographic Information System



+



$$A = (0,35 \cdot P + 0,24 \cdot C + 0,16 \cdot G + 0,11 \cdot H + 0,07 \cdot N + 0,04 \cdot S + 0,02 \cdot R) \cdot K \cdot Z$$

A – Suitability for afforestation,

P – Soil conditions,

C – Climate conditions,

G – Topographic conditions,

H – Water accessibility;

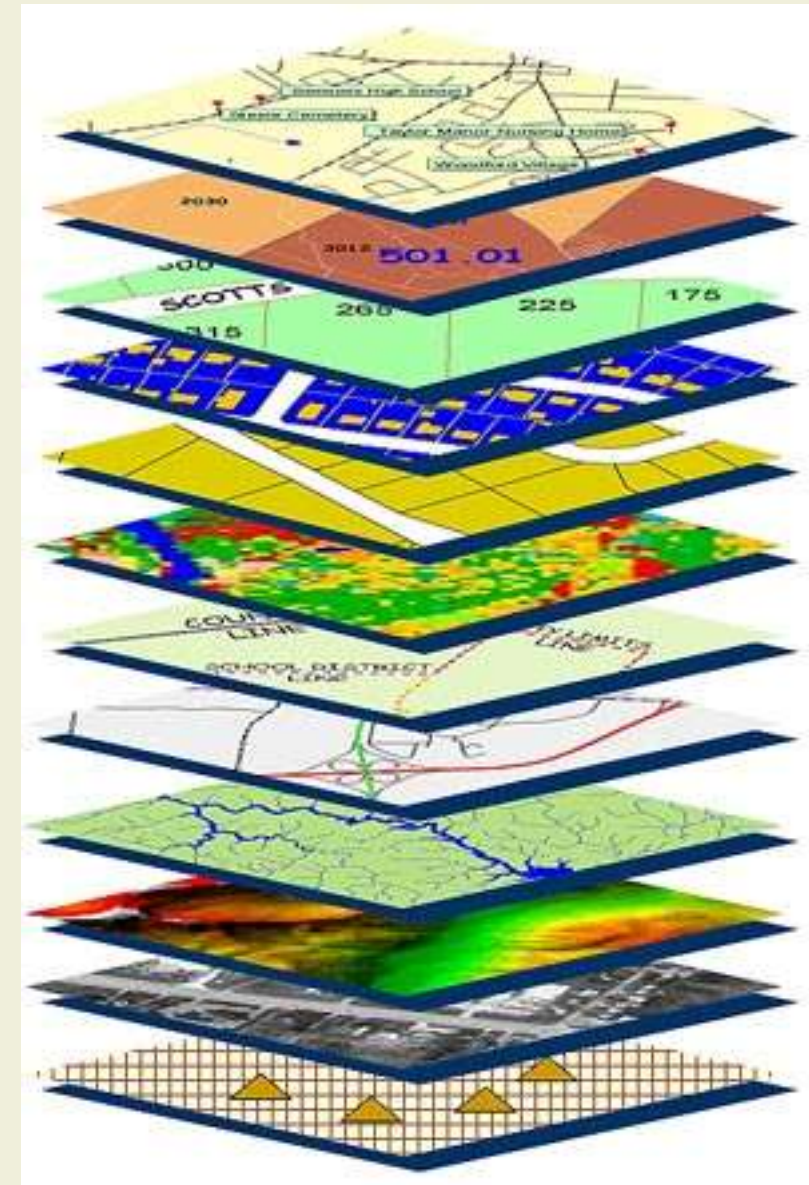
N – Land use,

S – Transport infrastructure,

R – Risks,

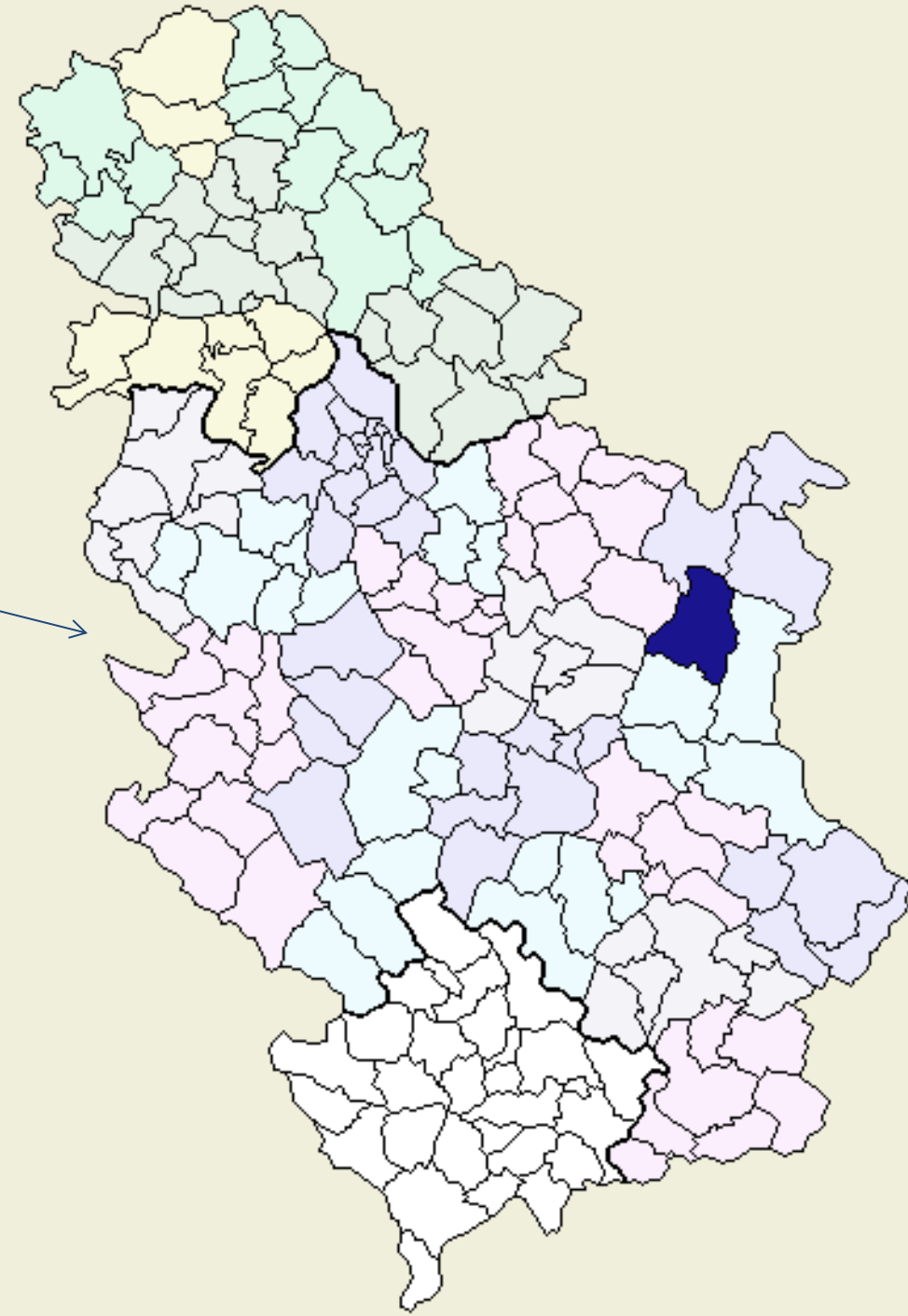
K – Landslides,

Z – Protected Areas





Case study area: Municipality of Bor



Species: *Pinus nigra* – Black pine

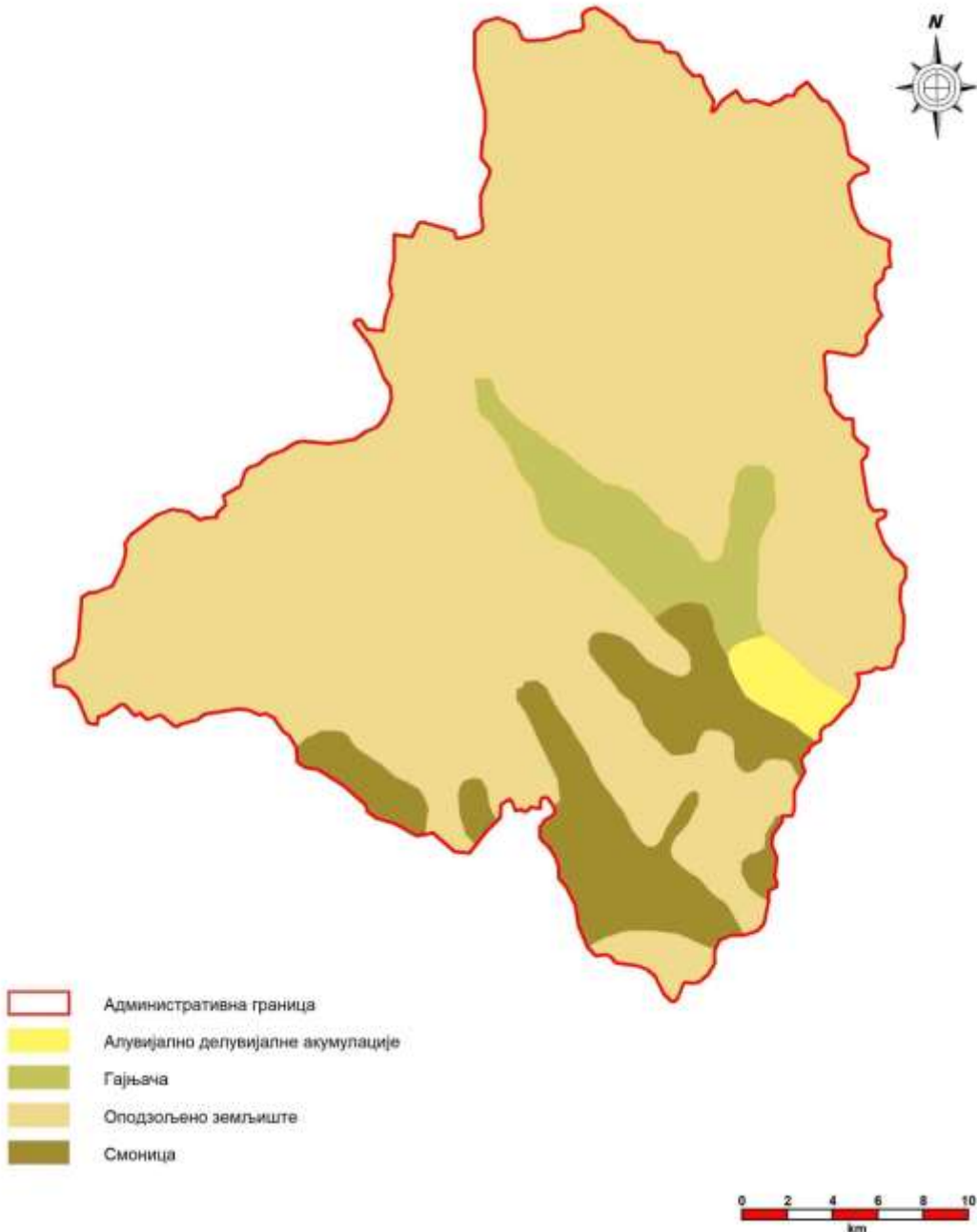


Accpetable conditions for Black Pine:

- 800 to 1500m above sea level
- A variety of soils: from podzolic sands to limestone
- A light-demanding species, but it shows higher shade tolerance than Scots pine (*Pinus sylvestris*)
- Resistant to dorught and wind
- Black pine regenerates with difficulties after a fire event
- Widely use for afforestation and to control soil erosion and landslides

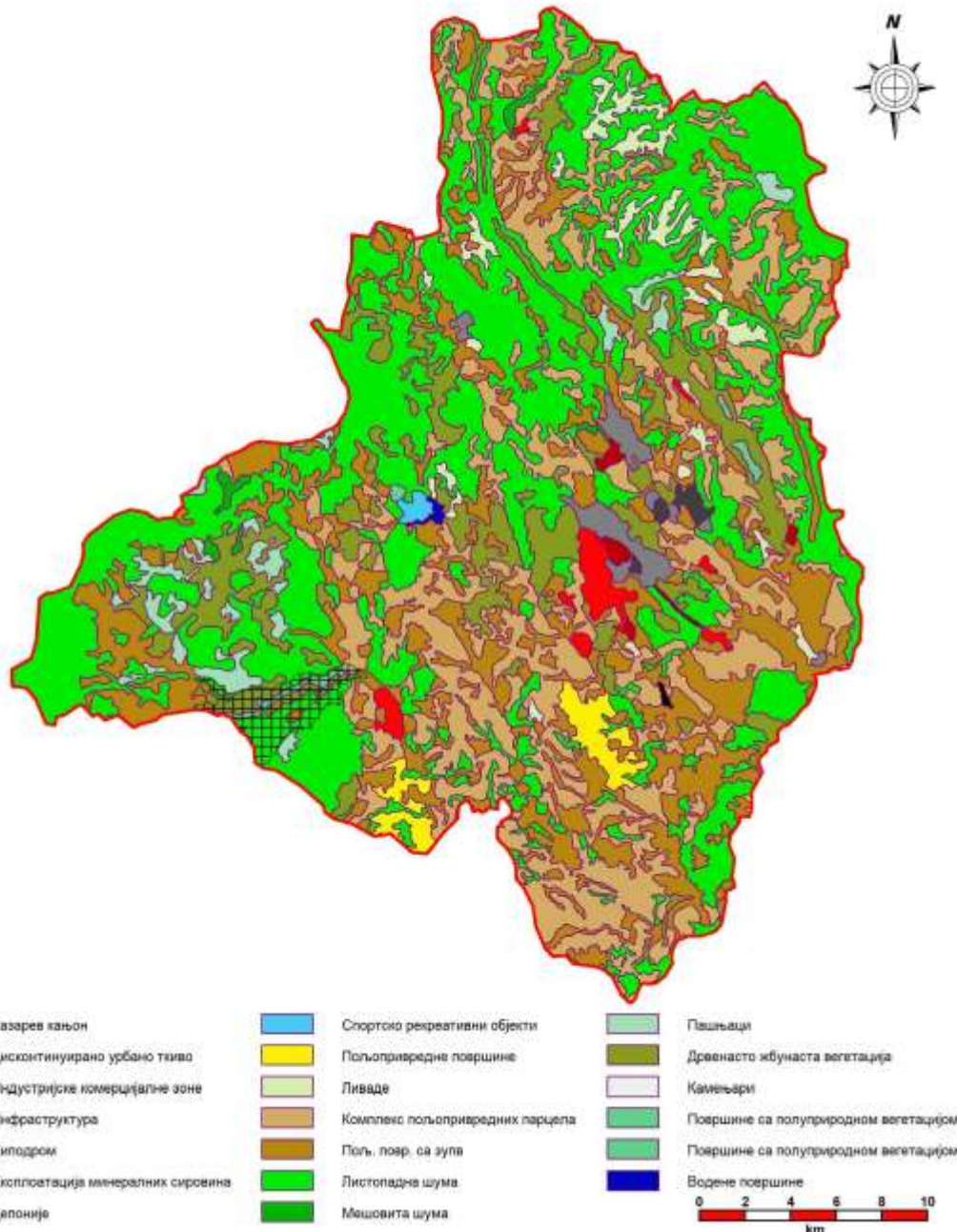


Soil conditions - P



Soil type	Value	Area km2	Percentage %
Aluvial- diluvial	4	12.45	1.44
Podzols	5	712.41	82.49
Cambisol	4	47.54	5.50
Vertisol	5	91.20	10.56
Sum		863.60	100.00

Land Use - N



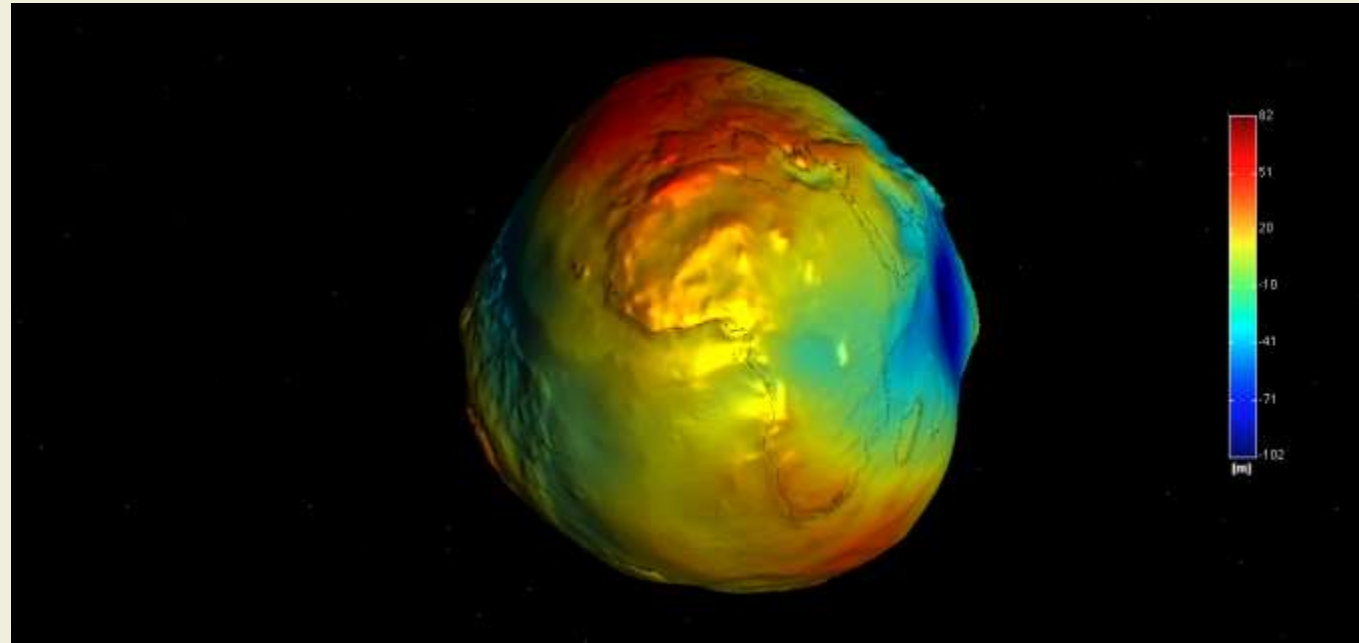
Land use	Values	Area km2	Percentage %
Road and rail networks and associated land	0	0.35	0.04
Airports	0	0.31	0.04
Sport and leisure facilities	0	1.48	0.17
Sclerophyllous vegetation	0	0.1	0.01
Burnt areas	5	3.02	0.35
Water bodies	0	0.67	0.08
Discontinuous urban fabric	0	9.52	1.10
Industrial or commercial units	0	2.5	0.29
Mineral extraction sites	0	11.05	1.28
Dump sites	0	2.39	0.28
Non-irrigated arable land	3	12.67	1.47
Pastures	4	20.54	2.38
Complex cultivation patterns	3	183.53	21.25
Land principally occupied by agriculture, with significant areas of natural vegetation	5	172.94	20.03
Broad-leaved forest	0	330.11	38.23
Mixed forest	0	3.24	0.38
Natural grasslands	4	17.84	2.07
Transitional woodland-shrub	2	91.32	10.57
Sum		863.58	100.00

Topographic conditions - G

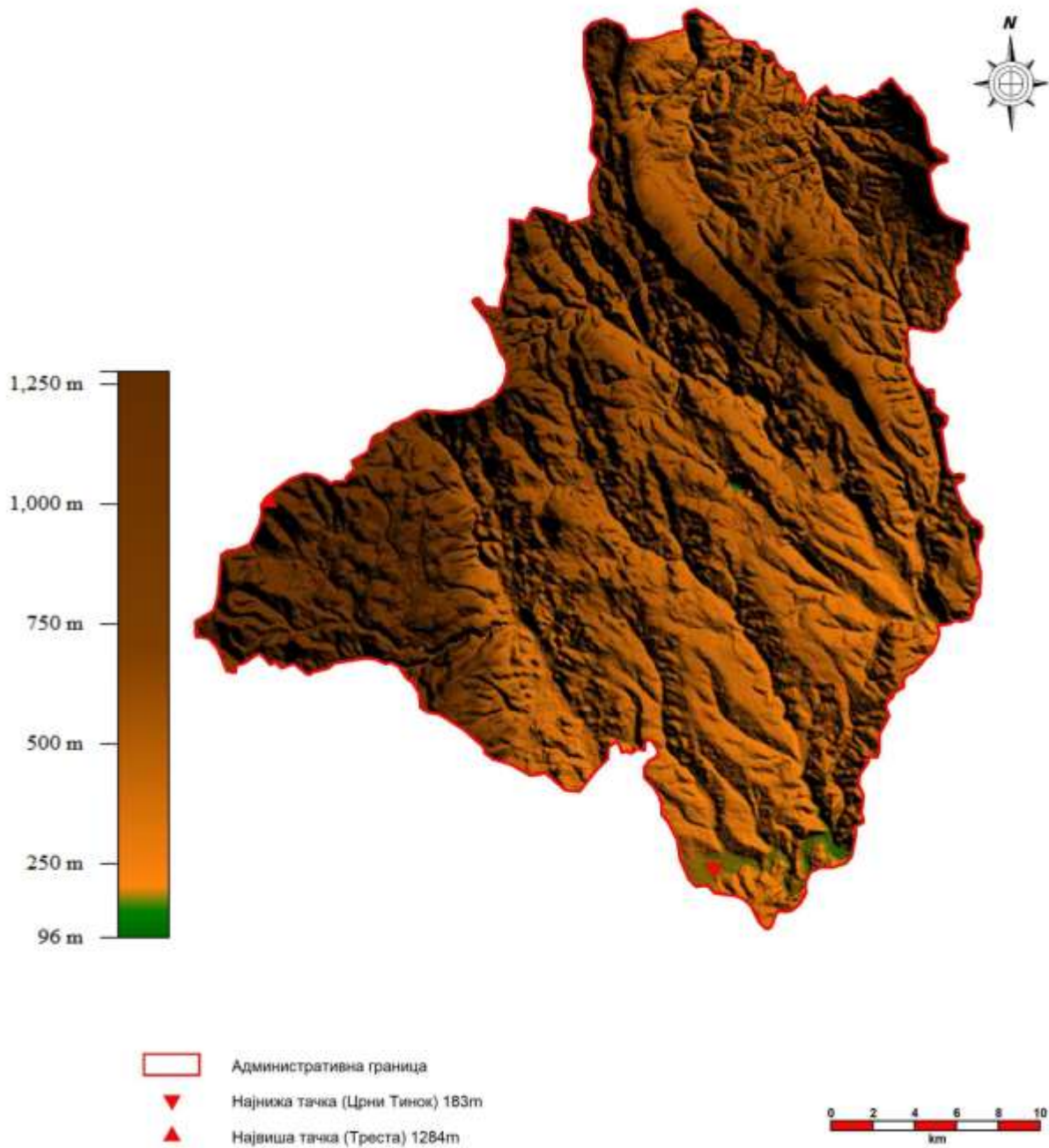
$$G = 0,57 \cdot V_z + 0,27 \cdot E_t + 0,11 \cdot N + 0,05 \cdot E_r$$

V_z- Elevation zones
E_t- Aspect

N- Slope
E_r- Erosion

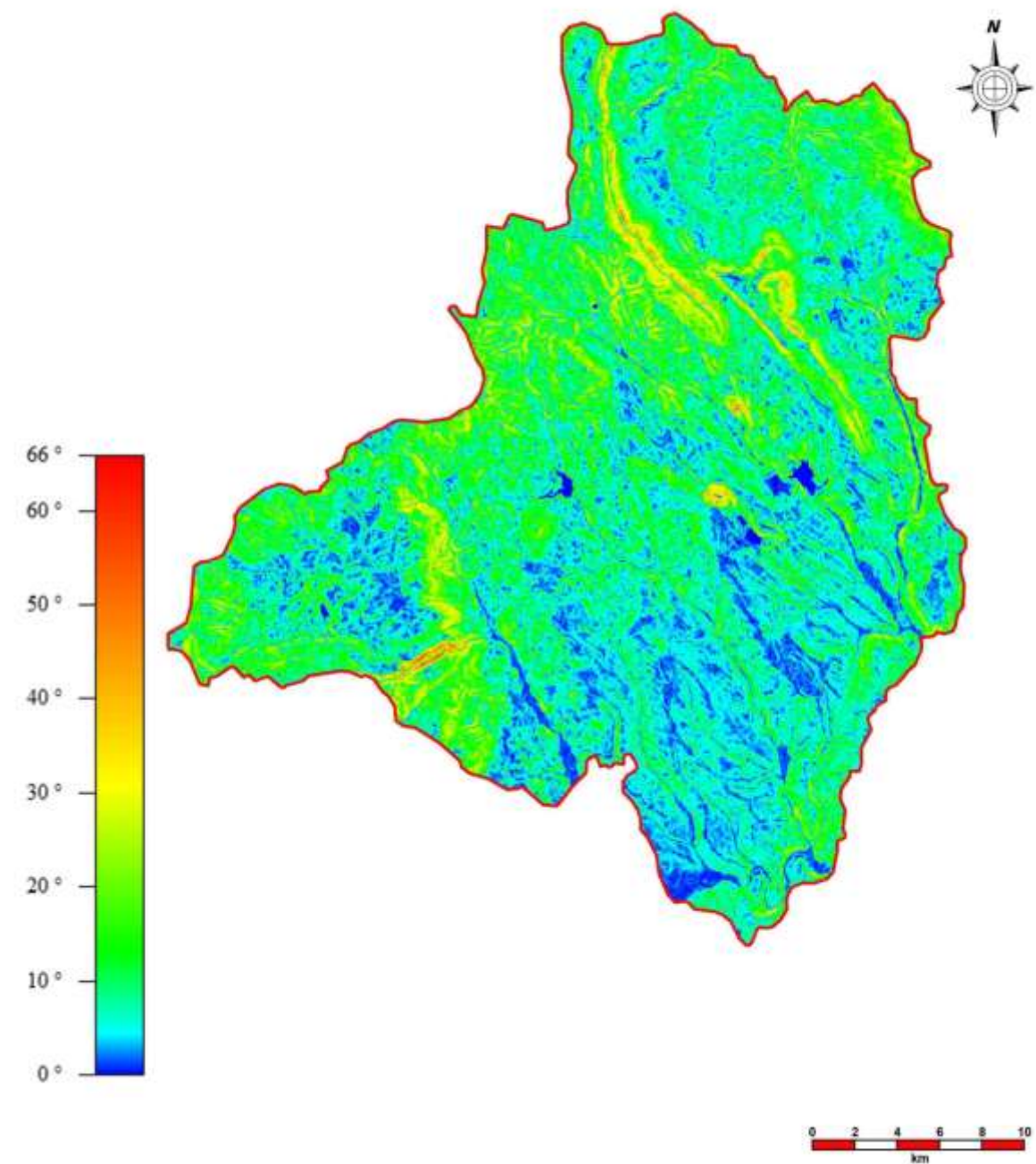


Elevation zones - Vz



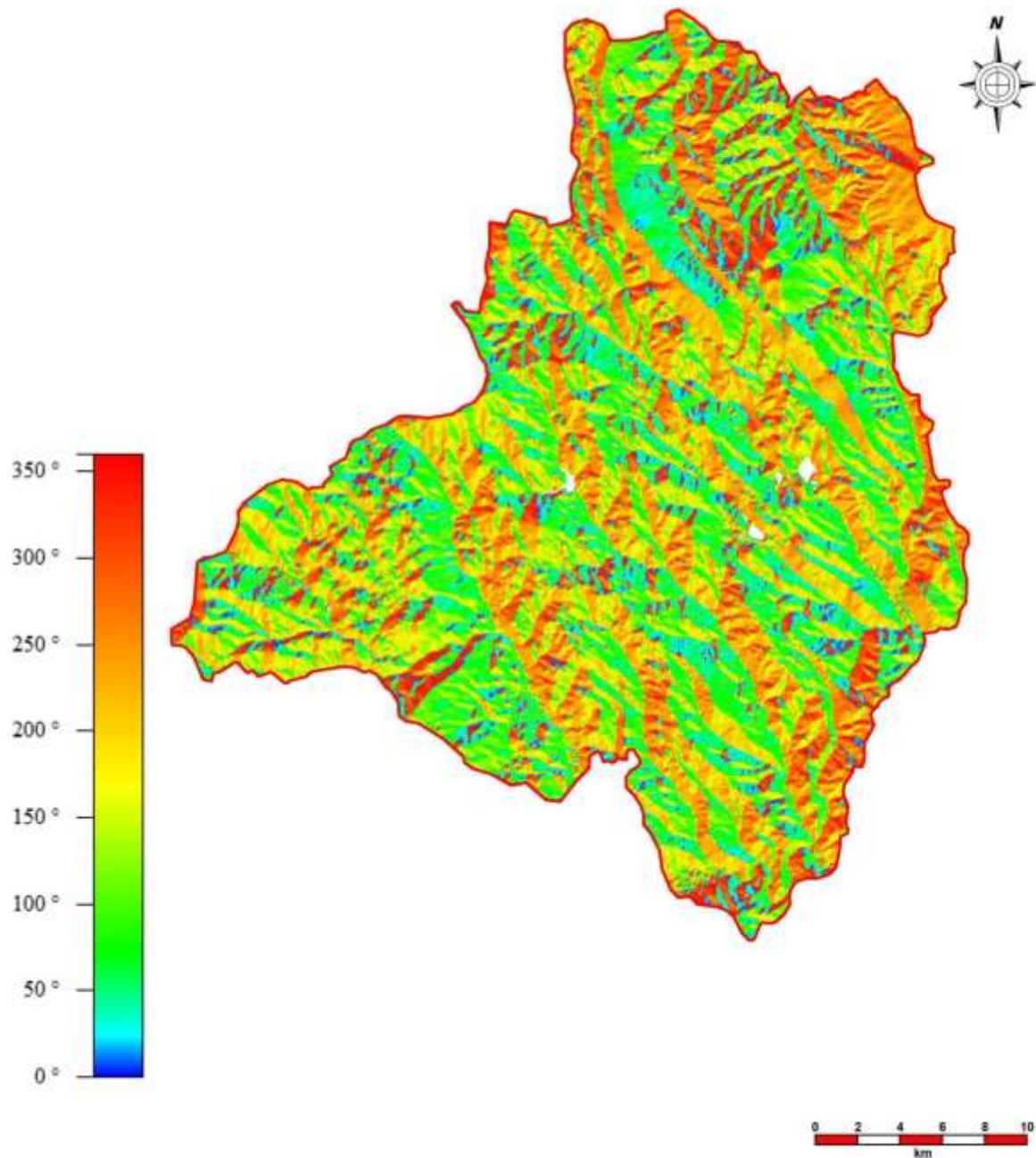
Elevation	Value	Area km2	Percentage %
95-350	1	202.68	23.47
350-500	2	297.00	34.39
500-650	3	156.81	18.16
650-800	4	88.16	10.21
>800	5	118.94	13.77
Sum		863.60	100.00

Slope - N



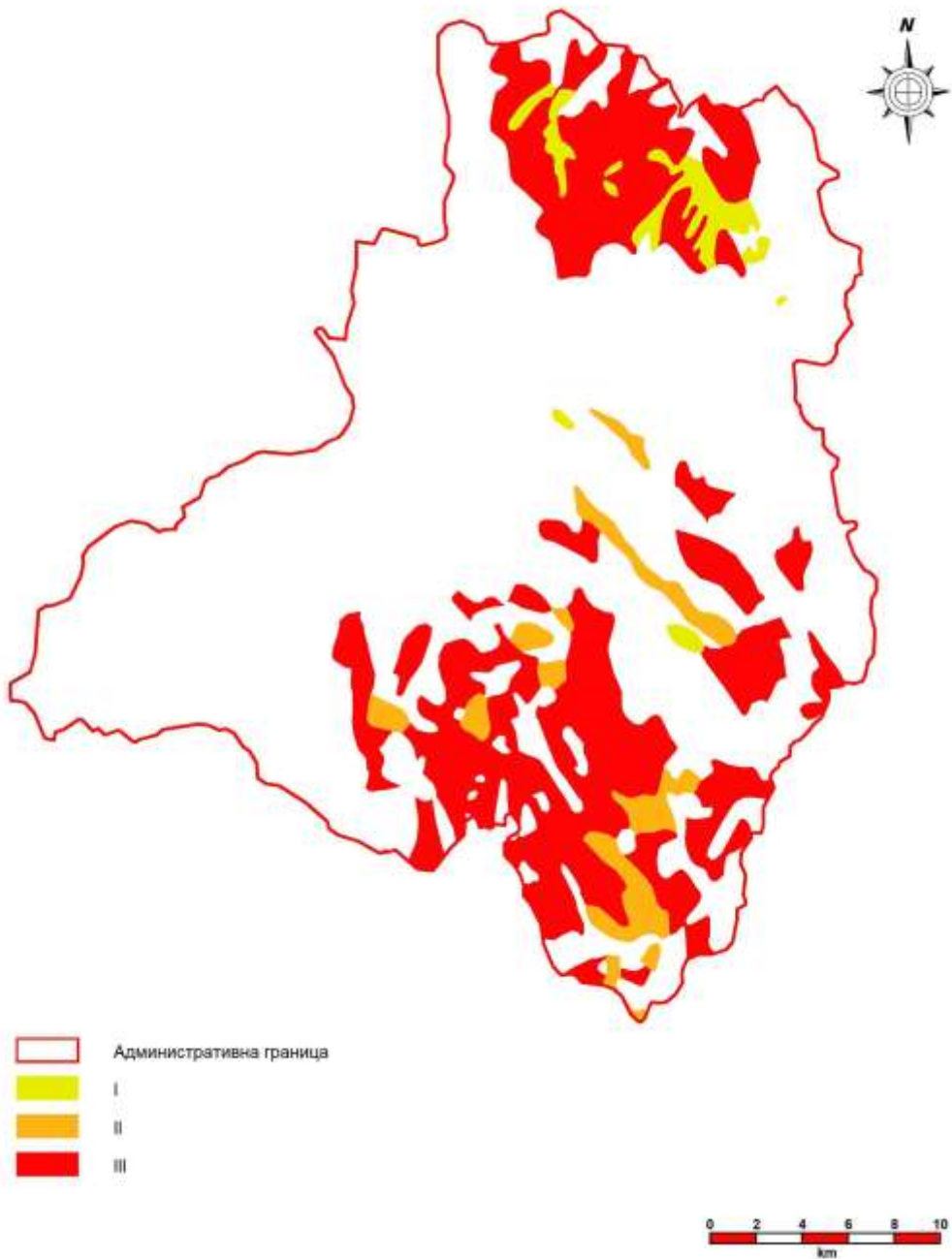
Slope (°)	Value	Area km2	Percentage %
0-12	5	0.48	0.06
12-25	3	22.62	2.62
25-45	2	213.20	24.69
>45	1	627.30	72.64
Sum		863.60	100.00

Aspect - Et



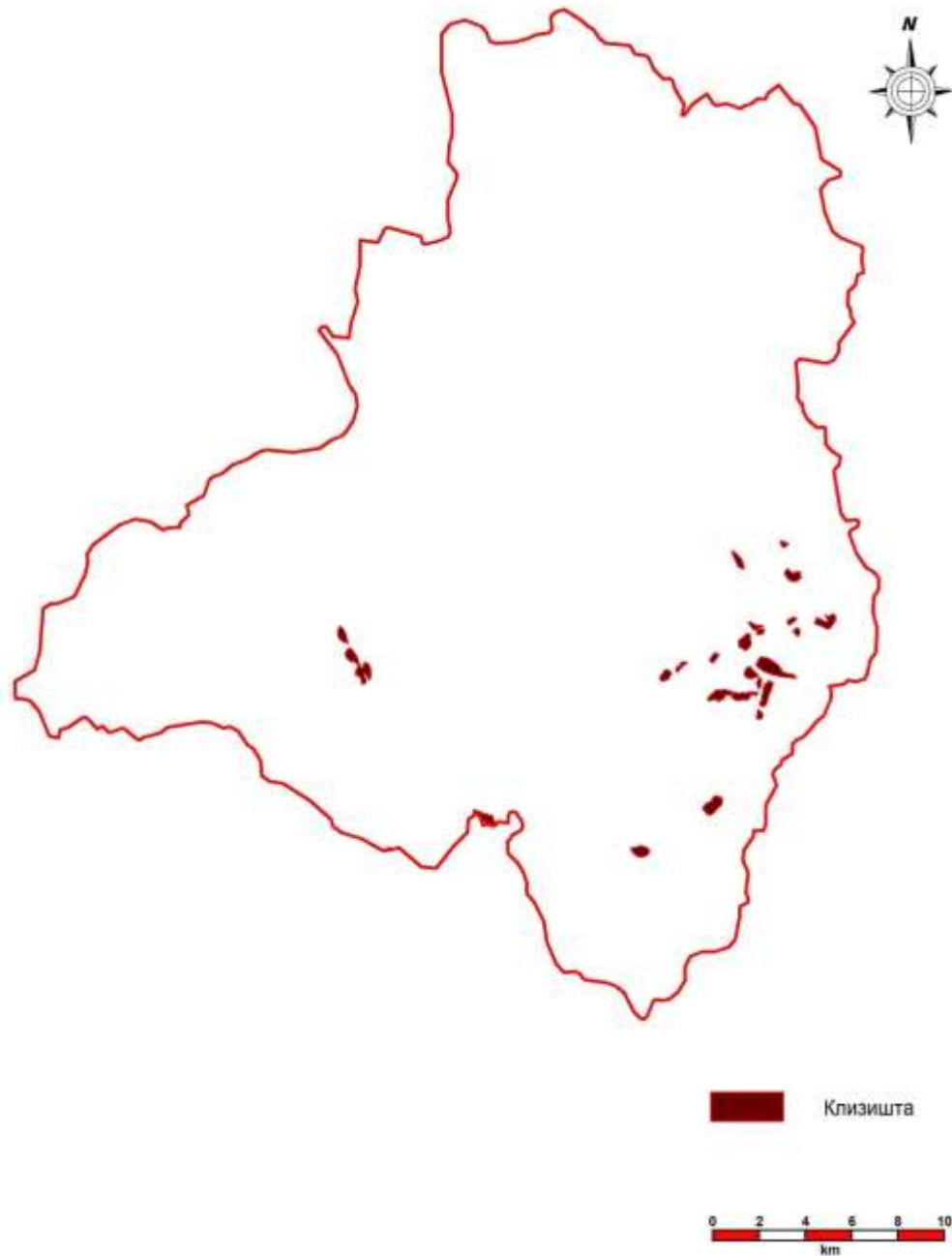
Aspect	Value	Area km2	Percentage %
Non exposed, north	1	67.20	7.78
North-east	2	141.63	16.40
East, southwest, northwest	3	348.52	40.36
Southeast, west	4	196.15	22.71
South	5	110.11	12.75
	Sum	863.60	100.00

Soil erosion - Er



Erosion level	Value	Area km2	Percentage%
Middle	3	194.24	22.49
Strong	4	29.86	3.46
Excessive	5	16.74	1.94
Sum		240.84	

Landslides - K



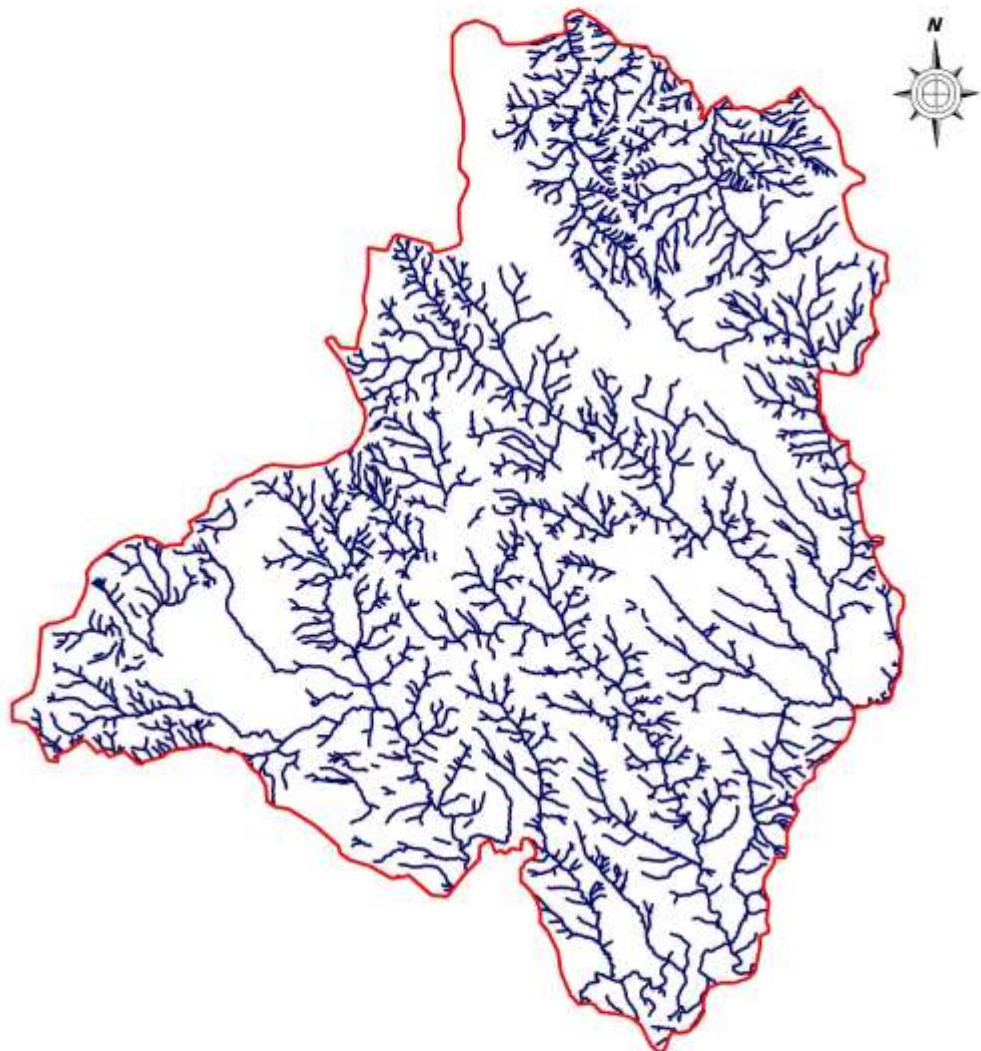
	Area km2	Percentage %
Landslides	5.13	0.59



Water tolerance

Very low		Low		Middle		High		Very high	
Европска буква	<i>Fagus sylvatica</i>	Млеч	<i>Acer platanoides</i>	Клен	<i>Acer campestre</i>	Црна топола	<i>Populus nigra</i>	Бела врба	<i>Salix alba</i>
Европска смрча	<i>Picea abies</i>	Граб	<i>Carpinus betulus</i>	Бели јасен	<i>Fraxinus excelsior</i>	Шљива	<i>Prunus domestica</i>	Црна јова	<i>Alnus glutinosa</i>
Храст медунац	<i>Quercus pubescens</i>	Багрем	<i>Robinia pseudoacacia</i>	Храст лужњак	<i>Quercus robur</i>	Врба ива	<i>Salix caprea</i>	Барска ива	<i>Salix cinera</i>
Европски ариш	<i>Larix decidua</i>	Ситнолисна липа	<i>Tili cordata</i>	Бела топола	<i>Populus alba</i>	Сива јова	<i>Alnus incana</i>	Бадемаста врба	<i>Salix triandra</i>
Клека	<i>Juniperus communis</i>	Бели бор	<i>Pinus sylvestris</i>	Пољски брест	<i>Ulmus minor</i>	Крушина	<i>Frangula alnus</i>	Пепељкаста врба	<i>Salix daphnoides</i>



Water accessibility - H

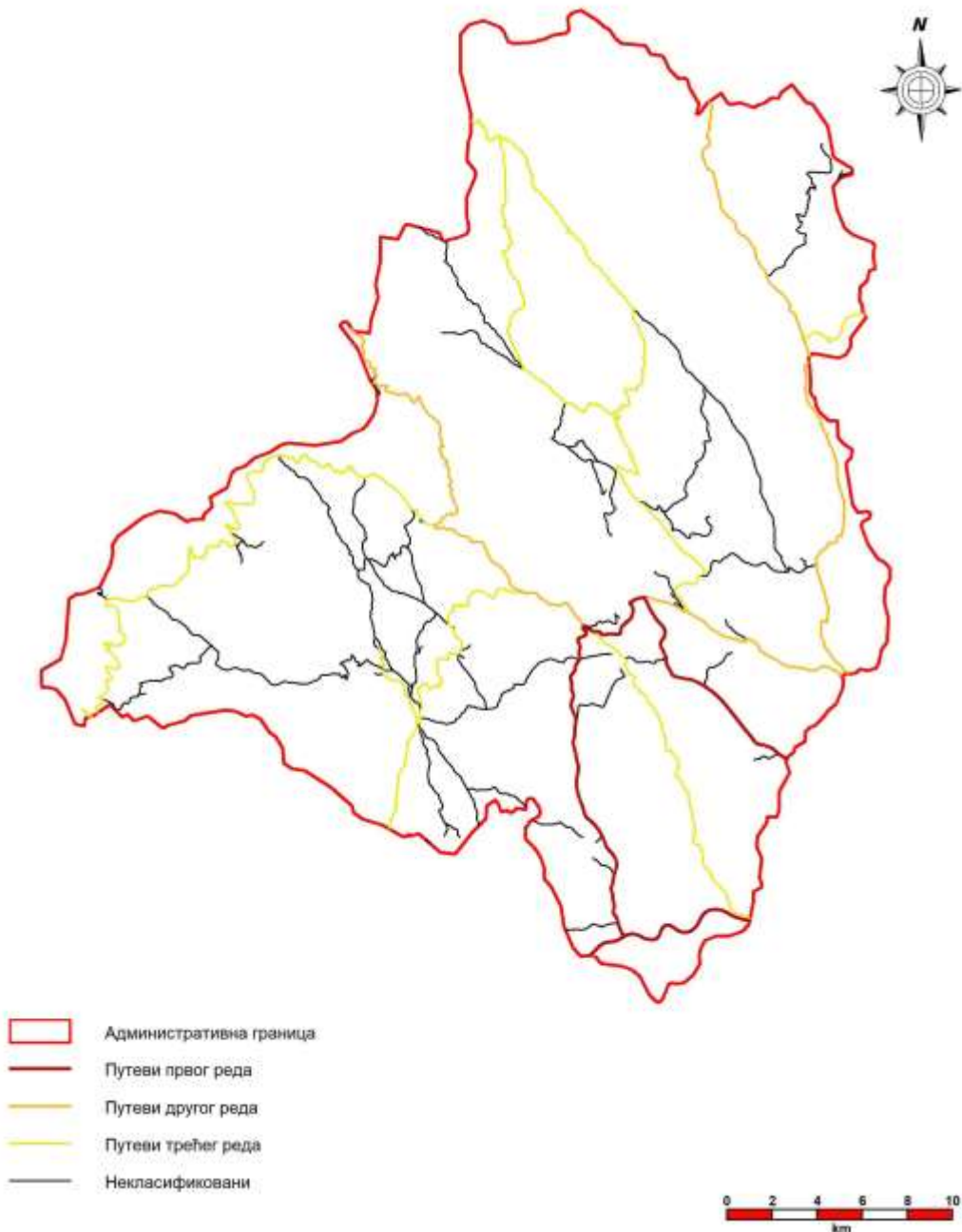


 Административна граница
 Речна мрежа



Bufferr zones around rivers	Values	Area km2	Perentage %
0-40	1	55.05	6.37
40-60	5	54.36	6.29
>60	3	754.19	87.33
	Sum	863.60	100.00

Traffic network - S



Buffer zones around roads	Values	Area km2	Percentage %
0-40	1	16.48	1.91
40-60	5	16.26	1.88
>60	3	830.86	96.21
	Sum	863.60	100.00

Climete conditions - C

$$K = 0,47 \cdot P_g + 0,28 \cdot P_j + 0,16 \cdot T_g + 0,09 \cdot T_j$$

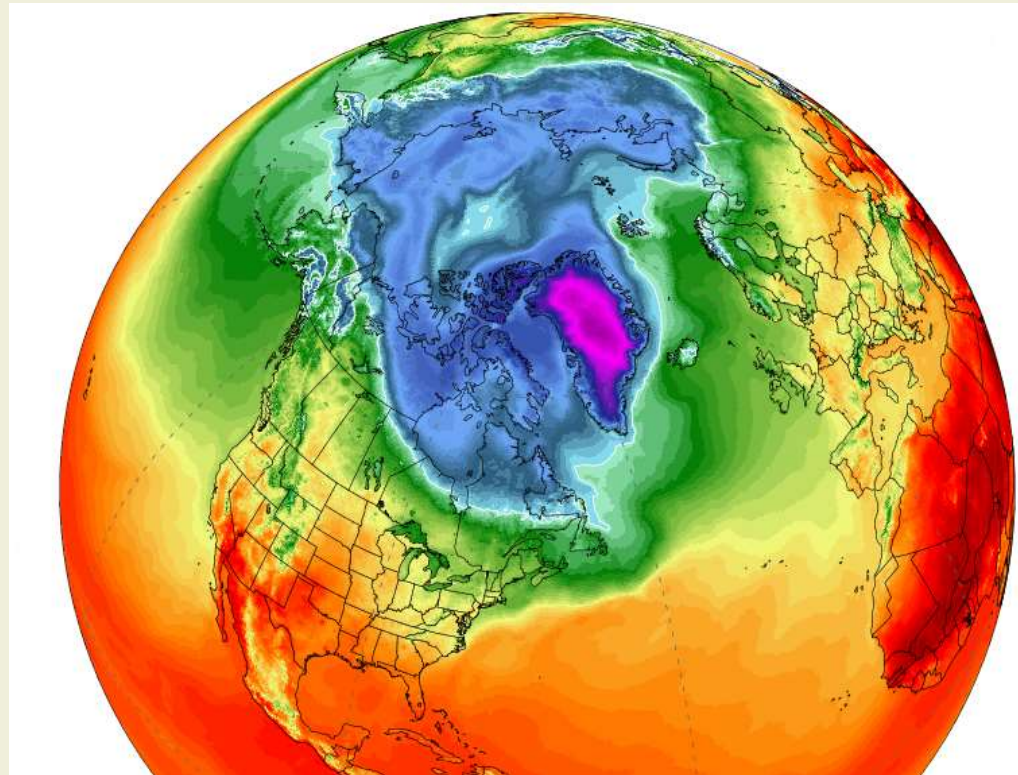
K- Climate condition

P_g- Annual precipitation

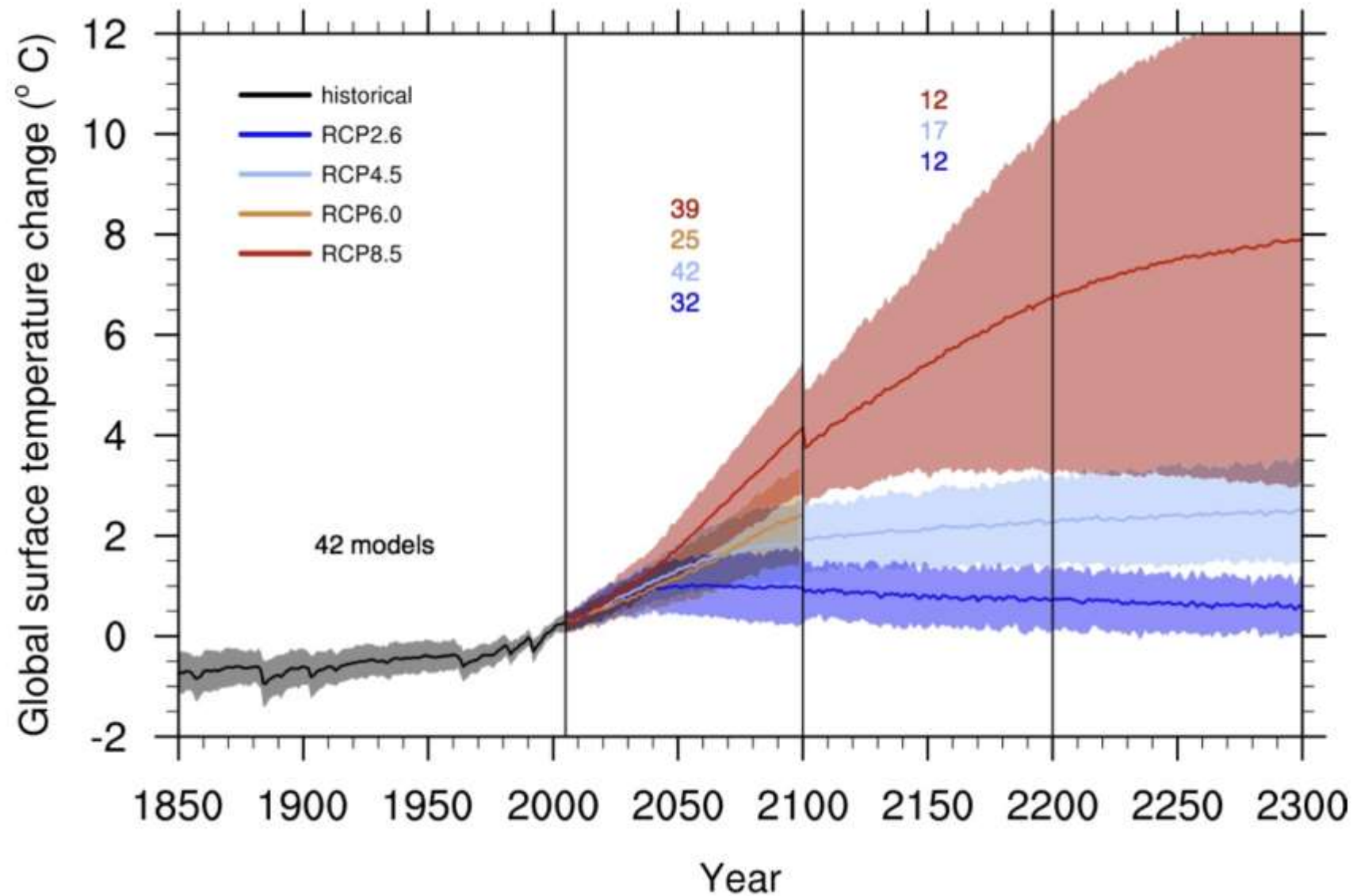
P_j- Precipitation in January

T_g- Average annual temperature

T_j- Average January temperature

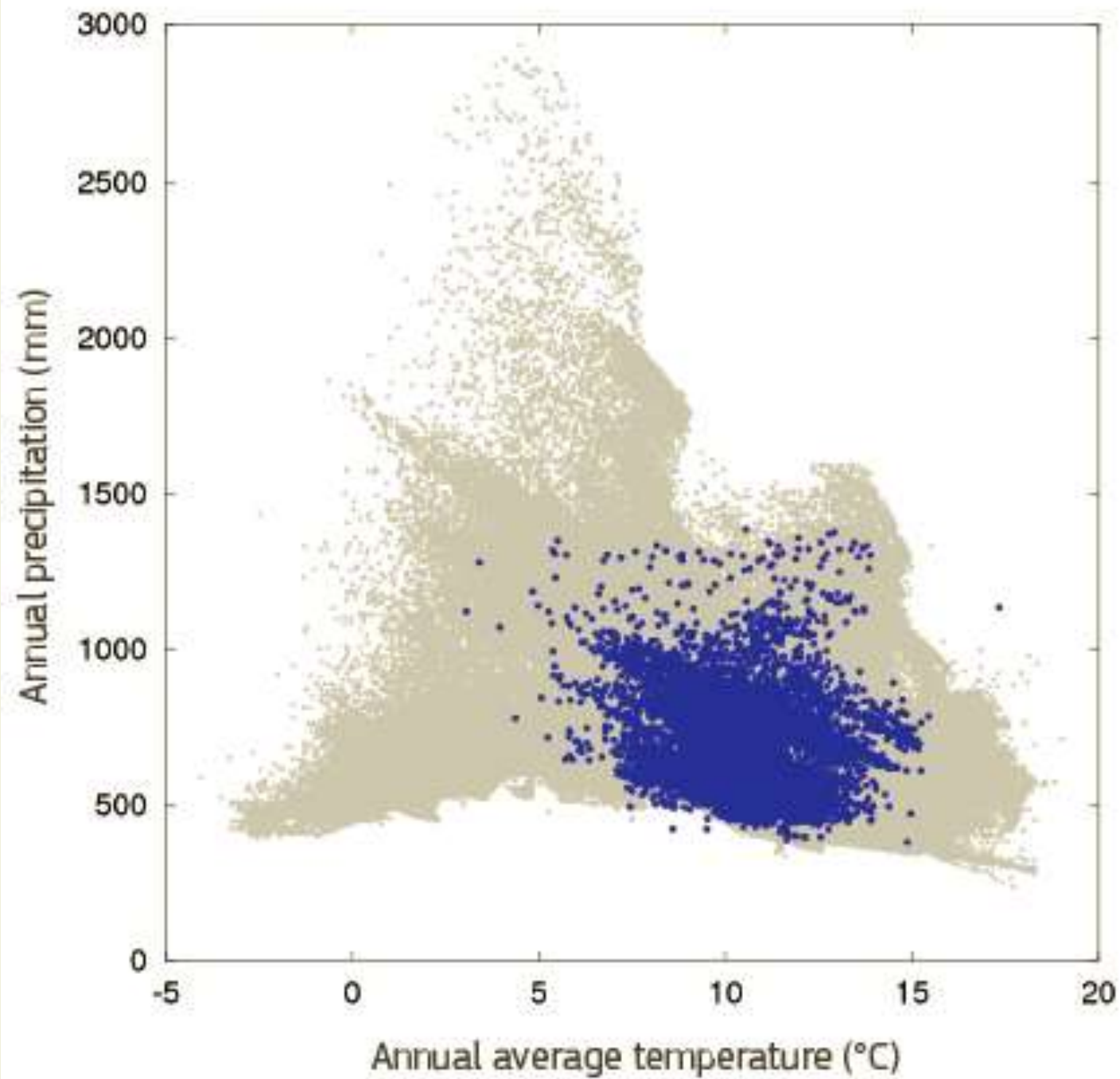


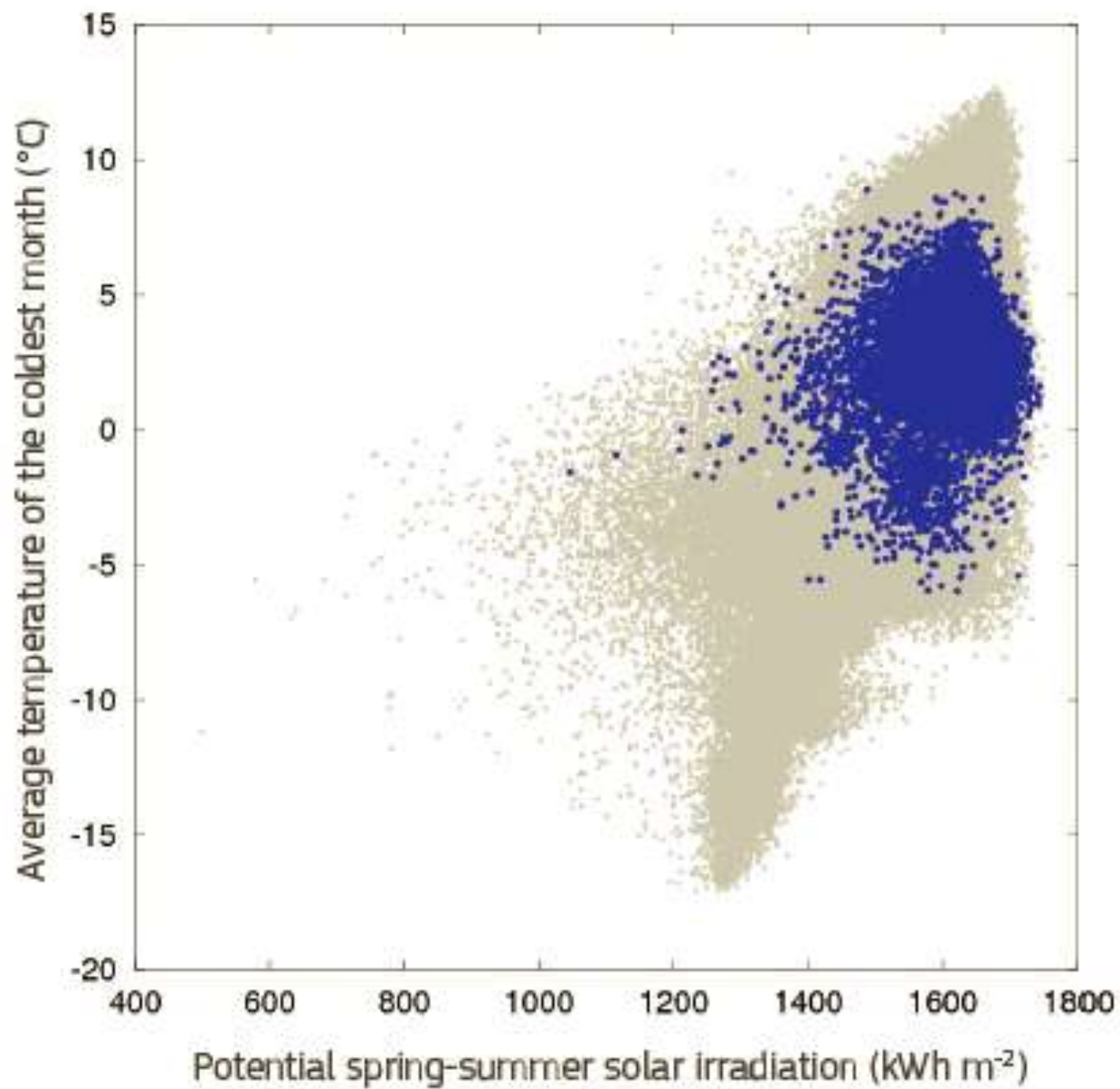
Climate changes

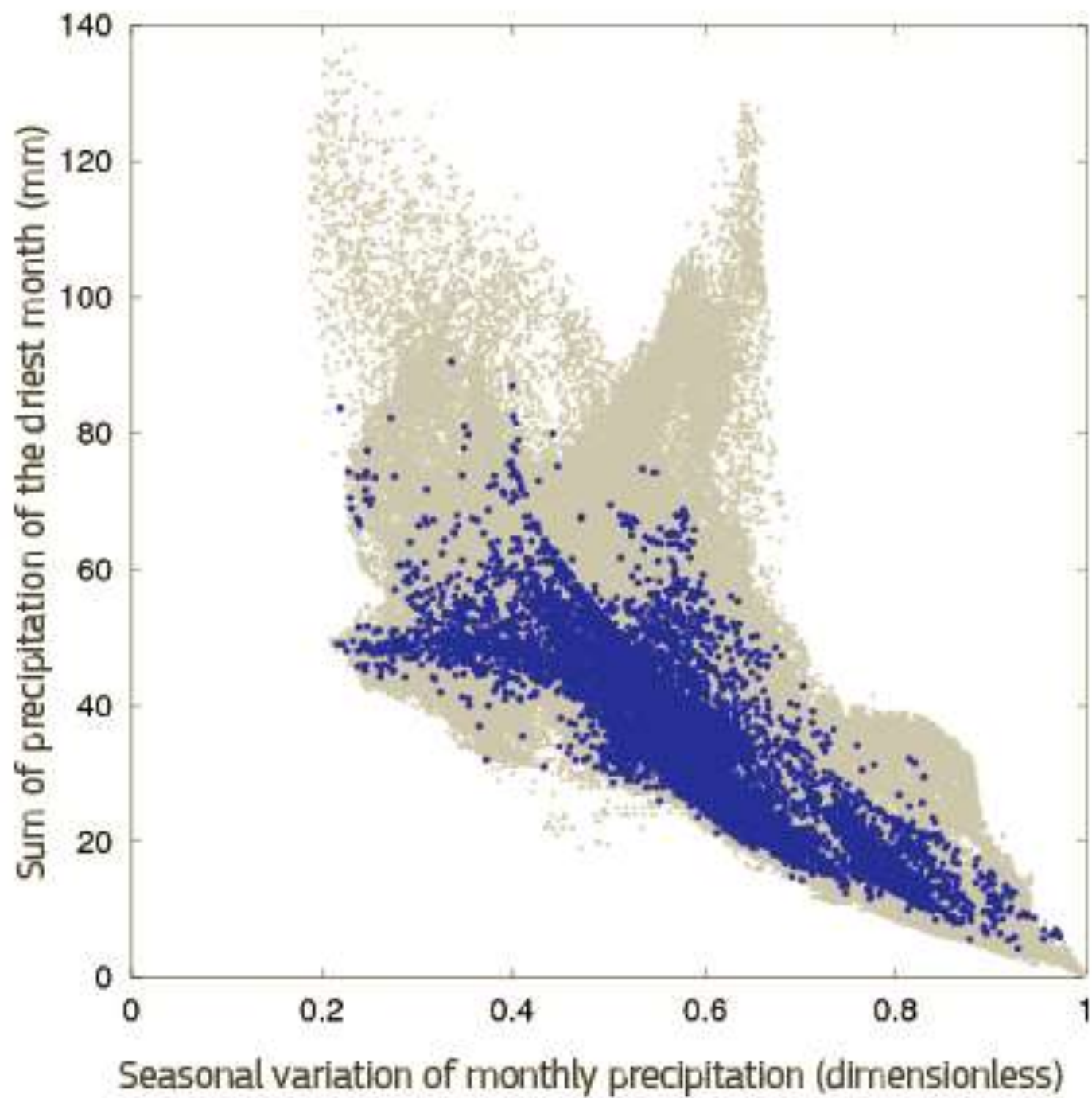




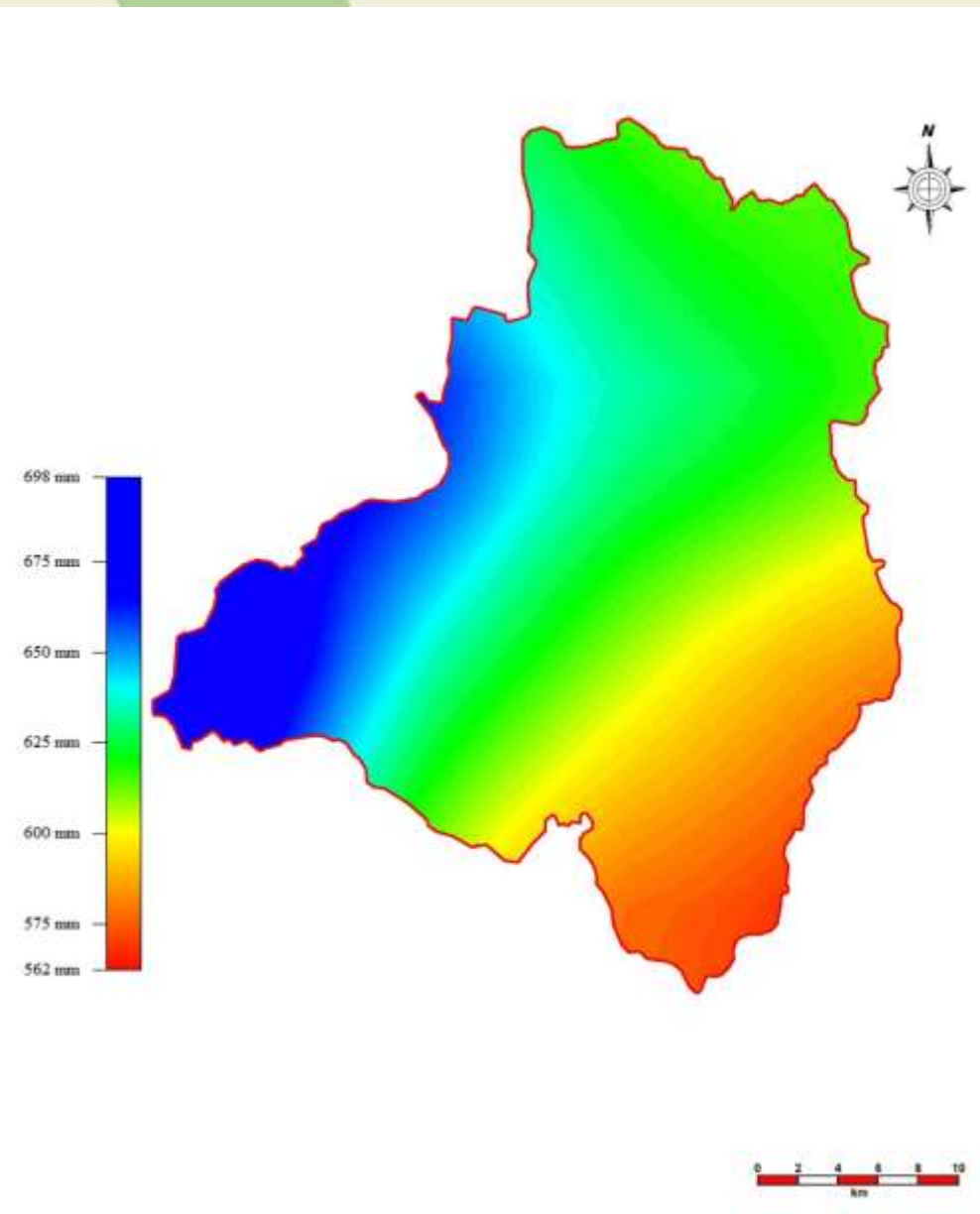
Name of species	Latin names	Average annual temperature (C°)		Average temperature of the coldest month (C°)		Annual precipitation (mm)		Precipitation in the driest month (mm)	
		From	To	From	To	From	To	From	To
Црни бор	<i>Pinus nigra</i>	5	15	-5	7	450	1400	8	70
Граб	<i>Carpinus betulus</i>	6	13	-6	5	480	1100	20	80
Црна то-пола	<i>Populus nigra</i>	7	16	-4	10	350	1000	5	75
Врба ива	<i>Salix caprea</i>	-2	13	-15	8	450	1500	20	80
Багрем	<i>Robinia pseudoacacia</i>	7	14	-5	10	500	1200	20	60
Храст лужњак	<i>Quercus robur</i>	6	15	-7	10	500	1500	20	75
Европска буква	<i>Fagus sylvatica</i>	4	14	-7	7	500	1400	20	100



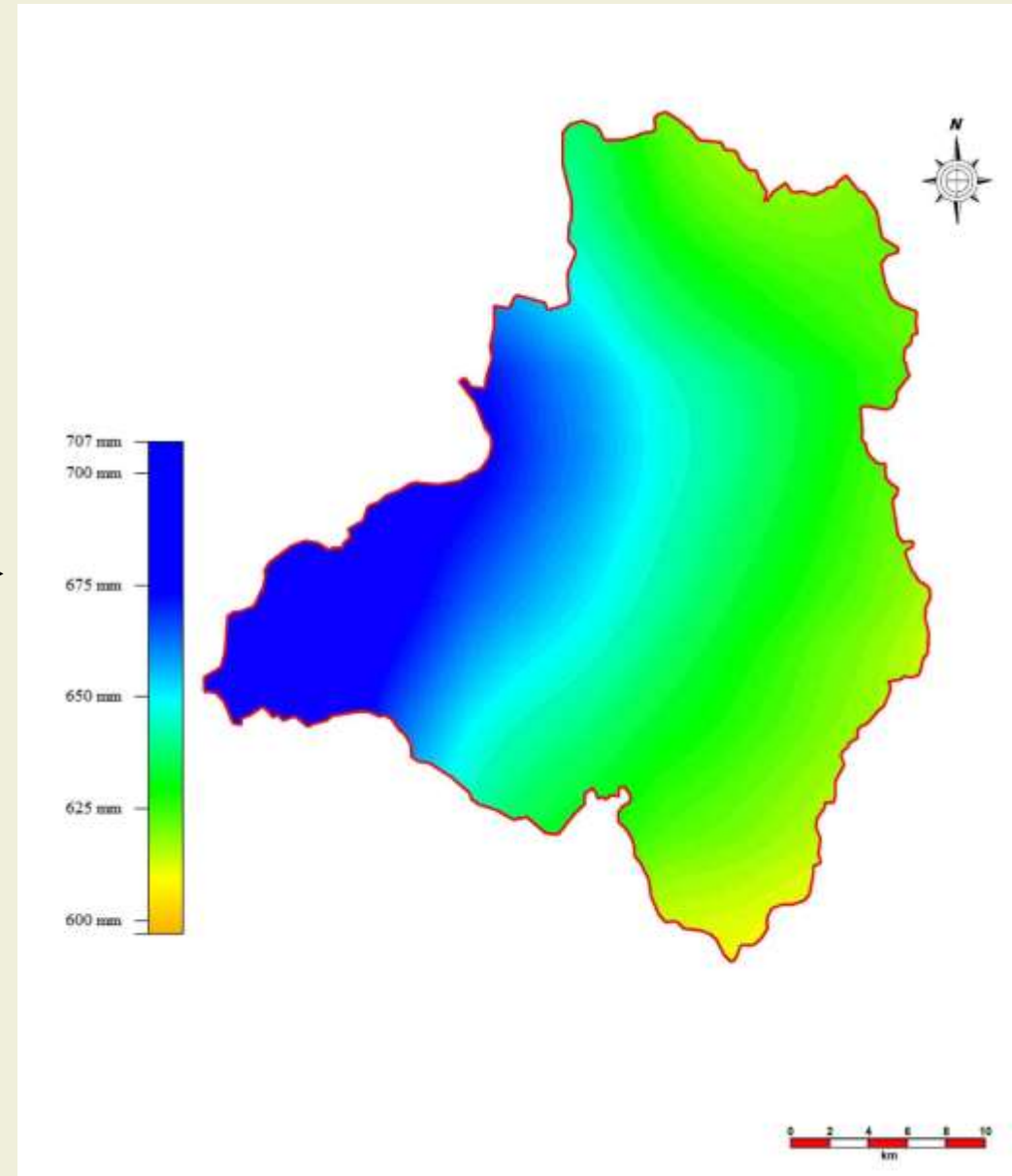




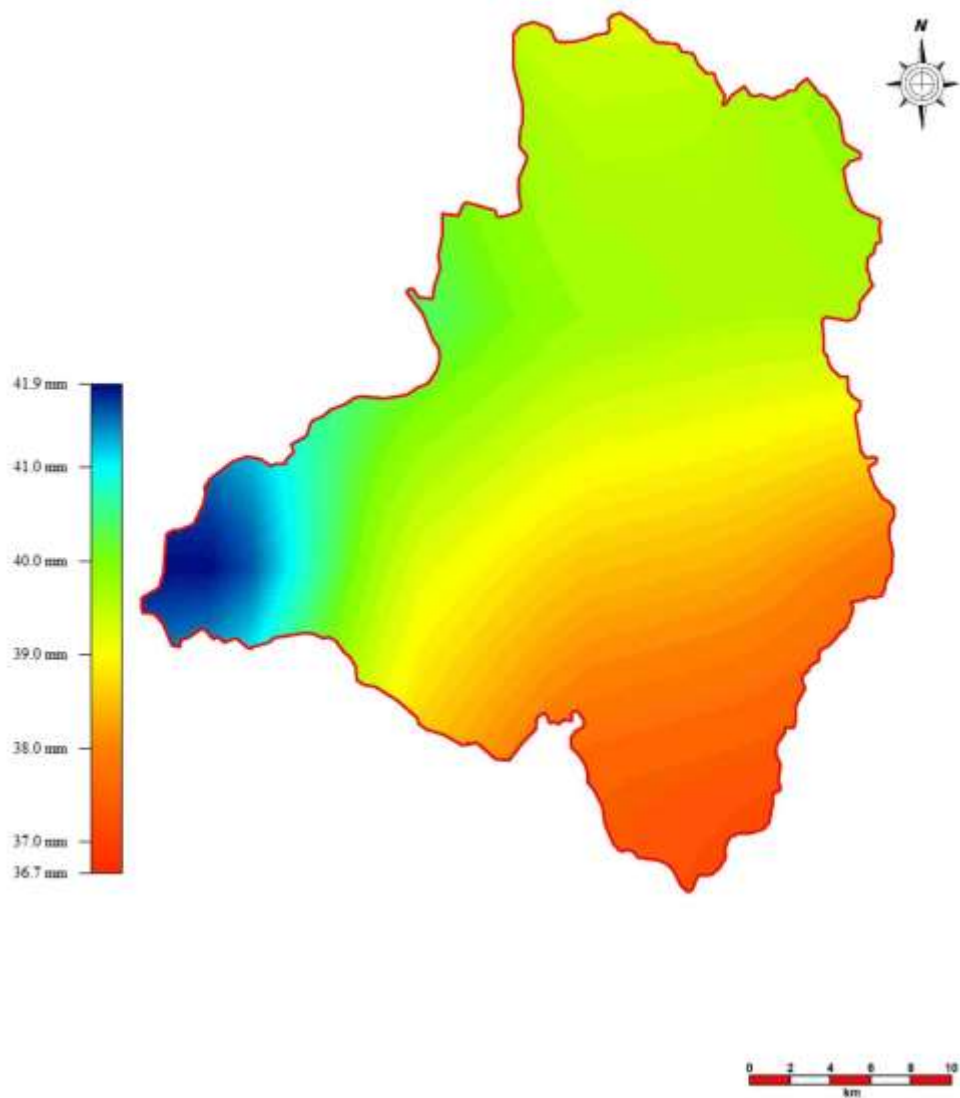
Annual precipitation



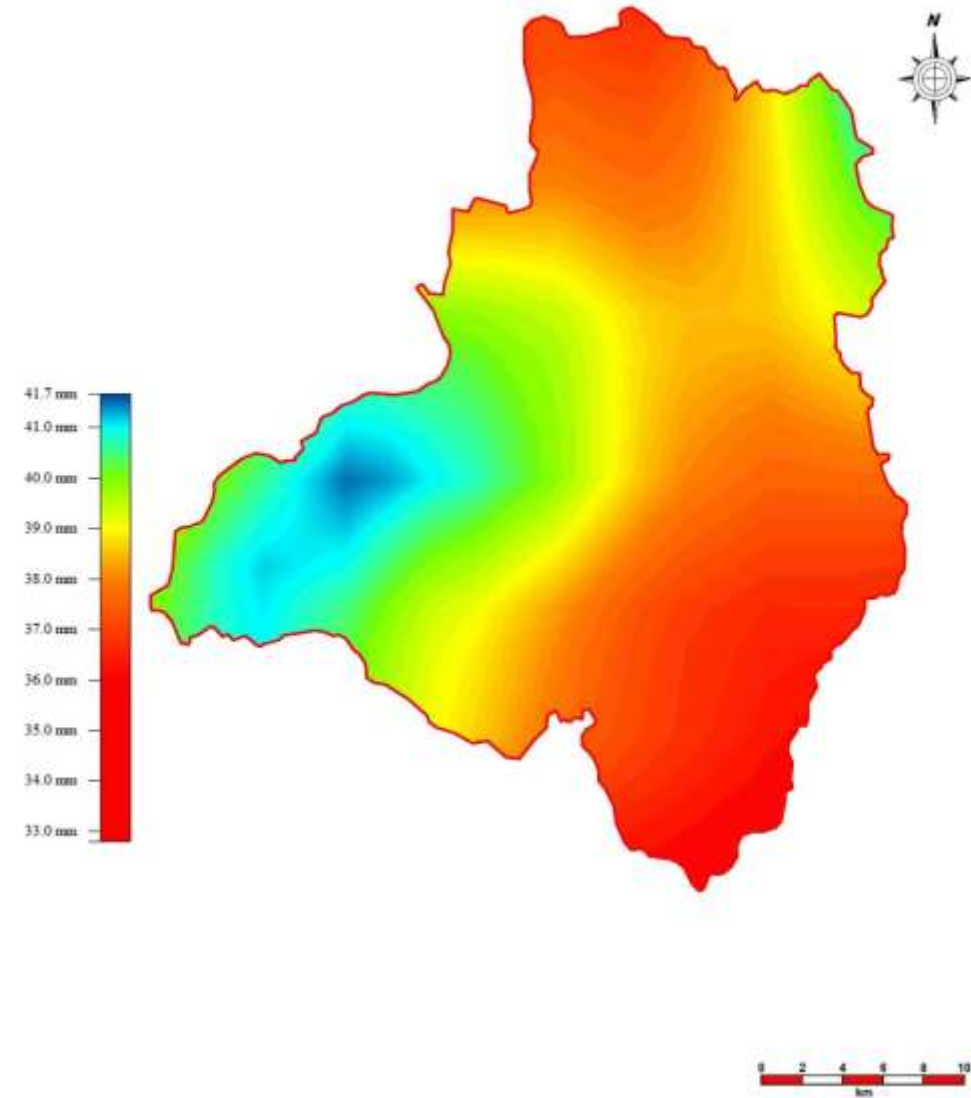
1986-2005 2041-2070



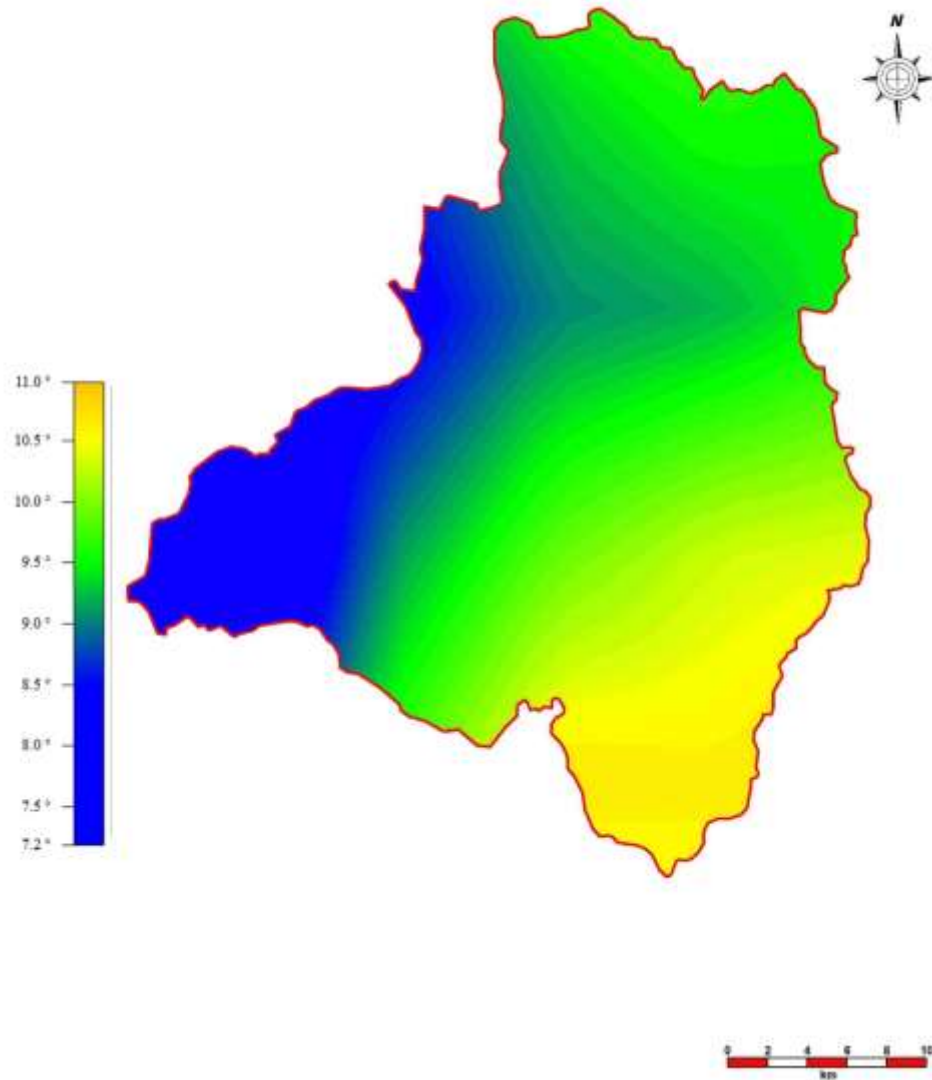
Precipitation in January



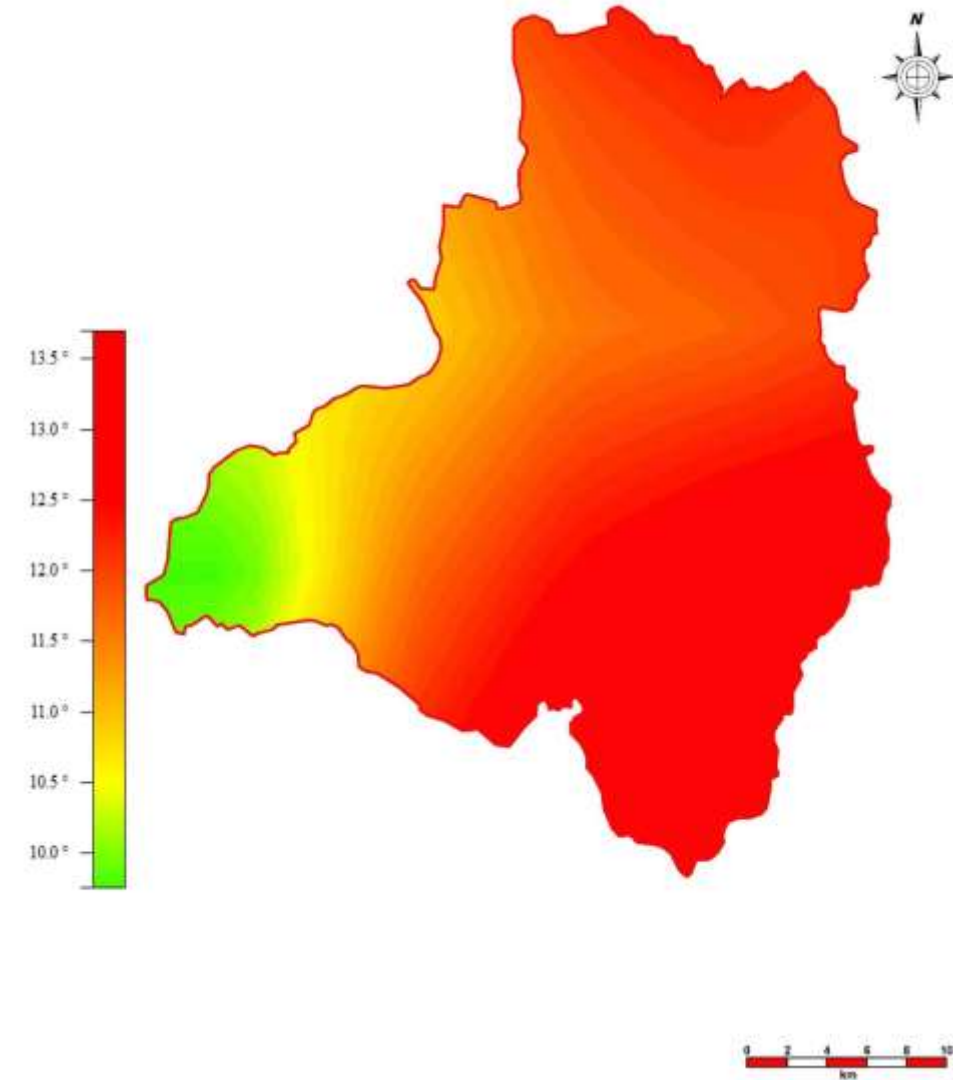
1986-2005 2041-2070



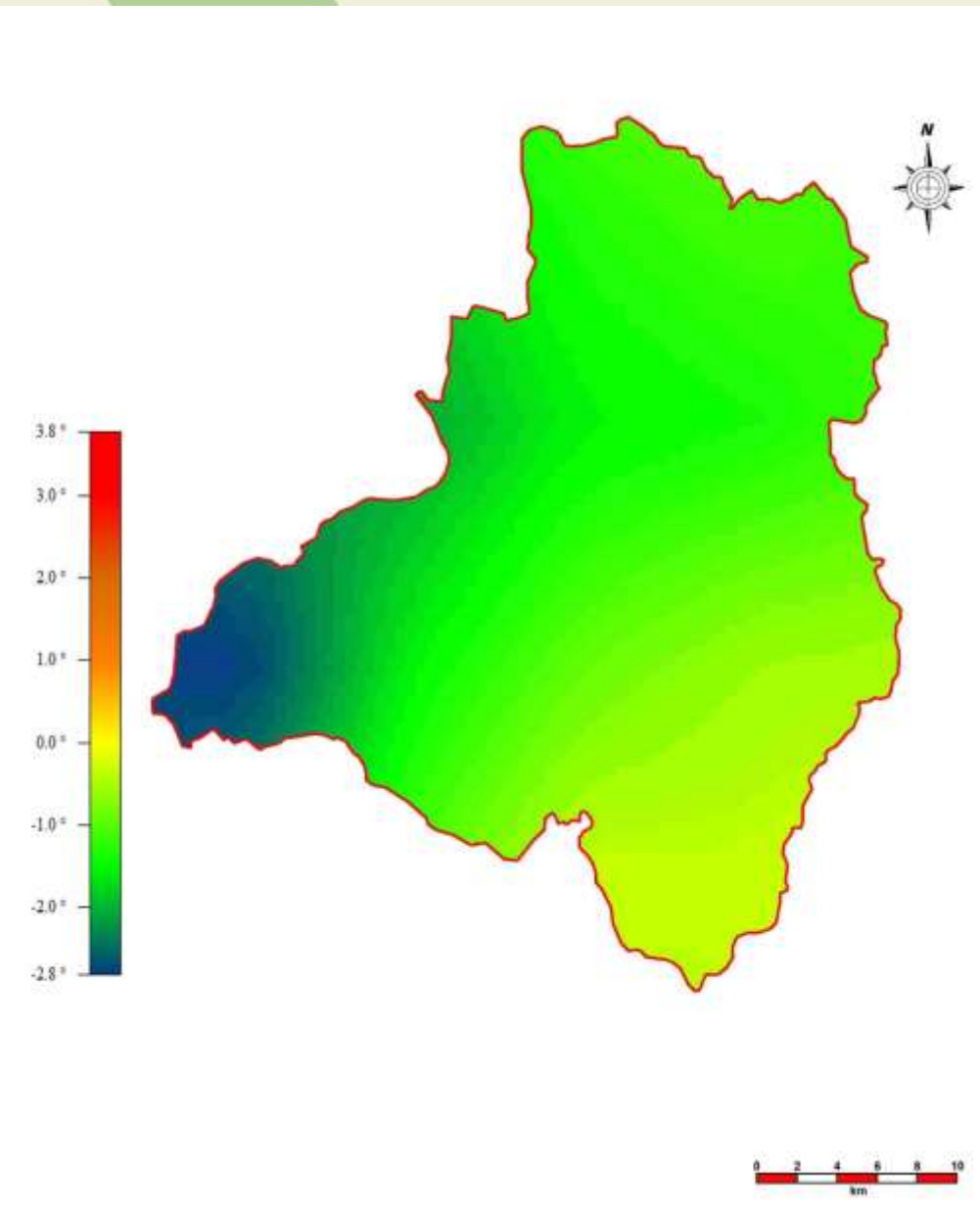
Mean annual temperature



1986-2005 2041-2070

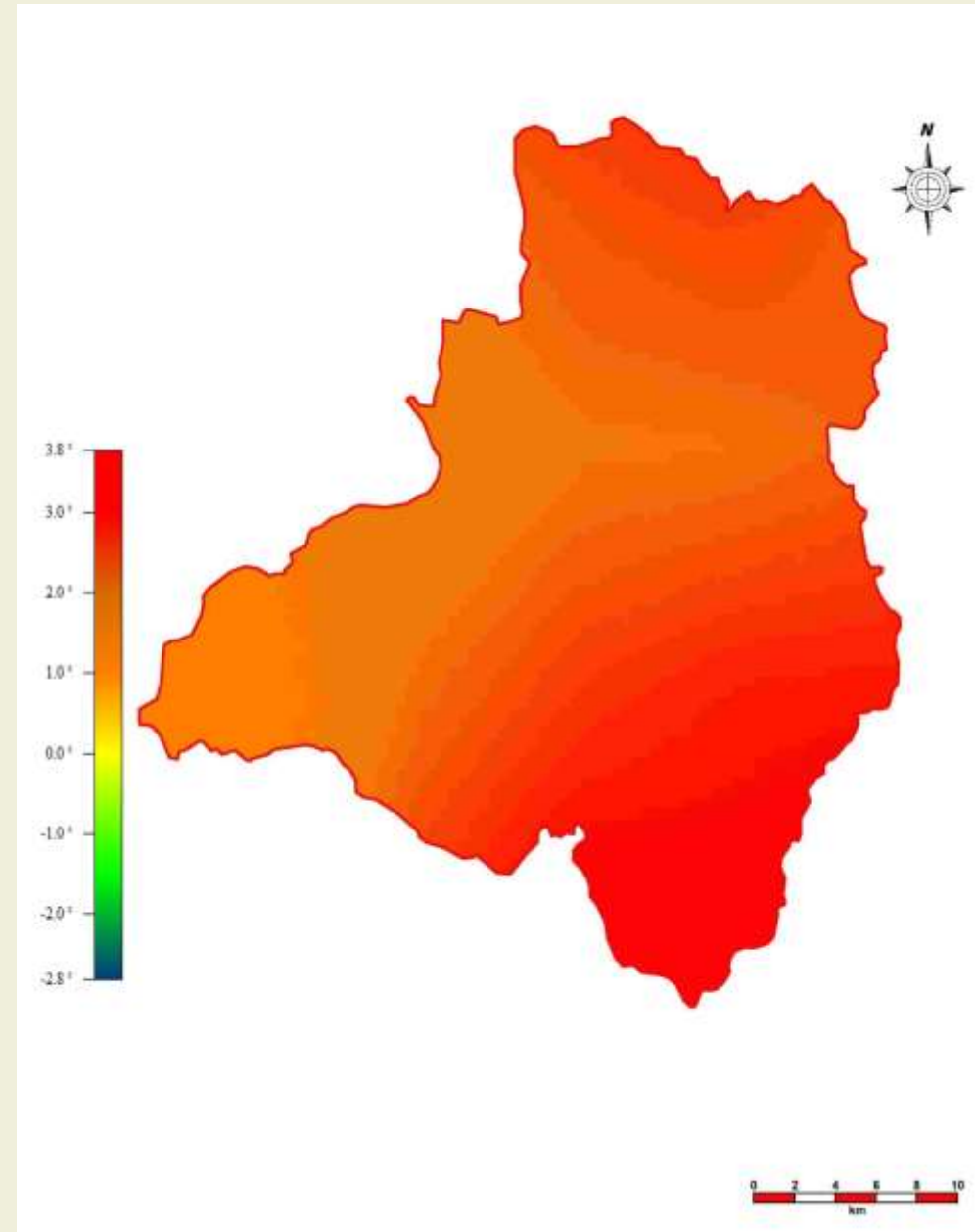


Mean January temperature



1986-2005

2041-2070



Risk – drought - R

- FAI – Forestry aridity index
- TVII – Mean temperature of July
- TVIII – Mean temperature of August
- PV – Rainfall in May
- PVI – Rainfall in June
- PVII – Rainfall in July
- PVIII – Rainfall in August

$$FAI = (100 * ((TVII + TVIII) / 2)) / (PV + PVI + 2 * PVII + PVIII)$$

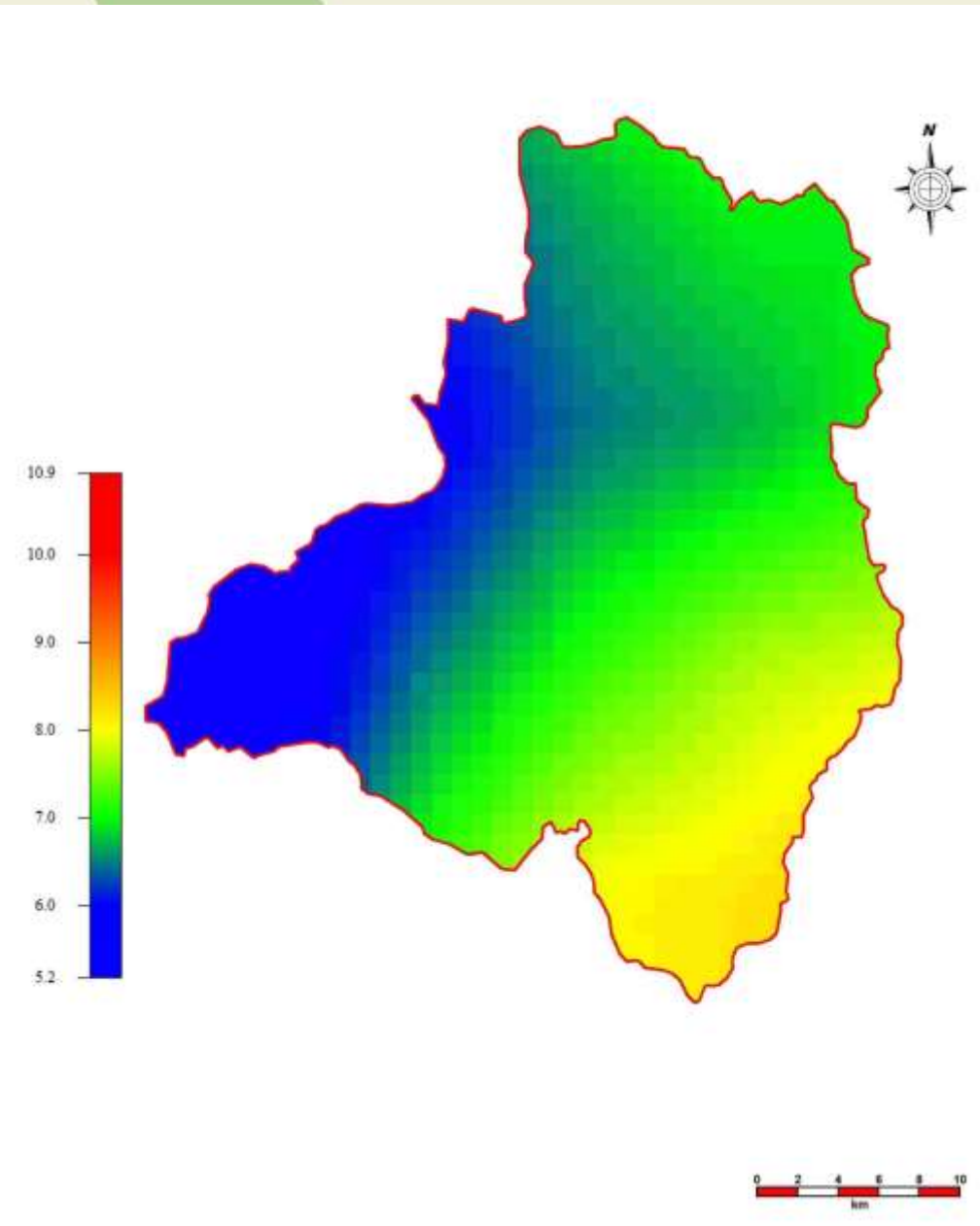


FAI - Serbia

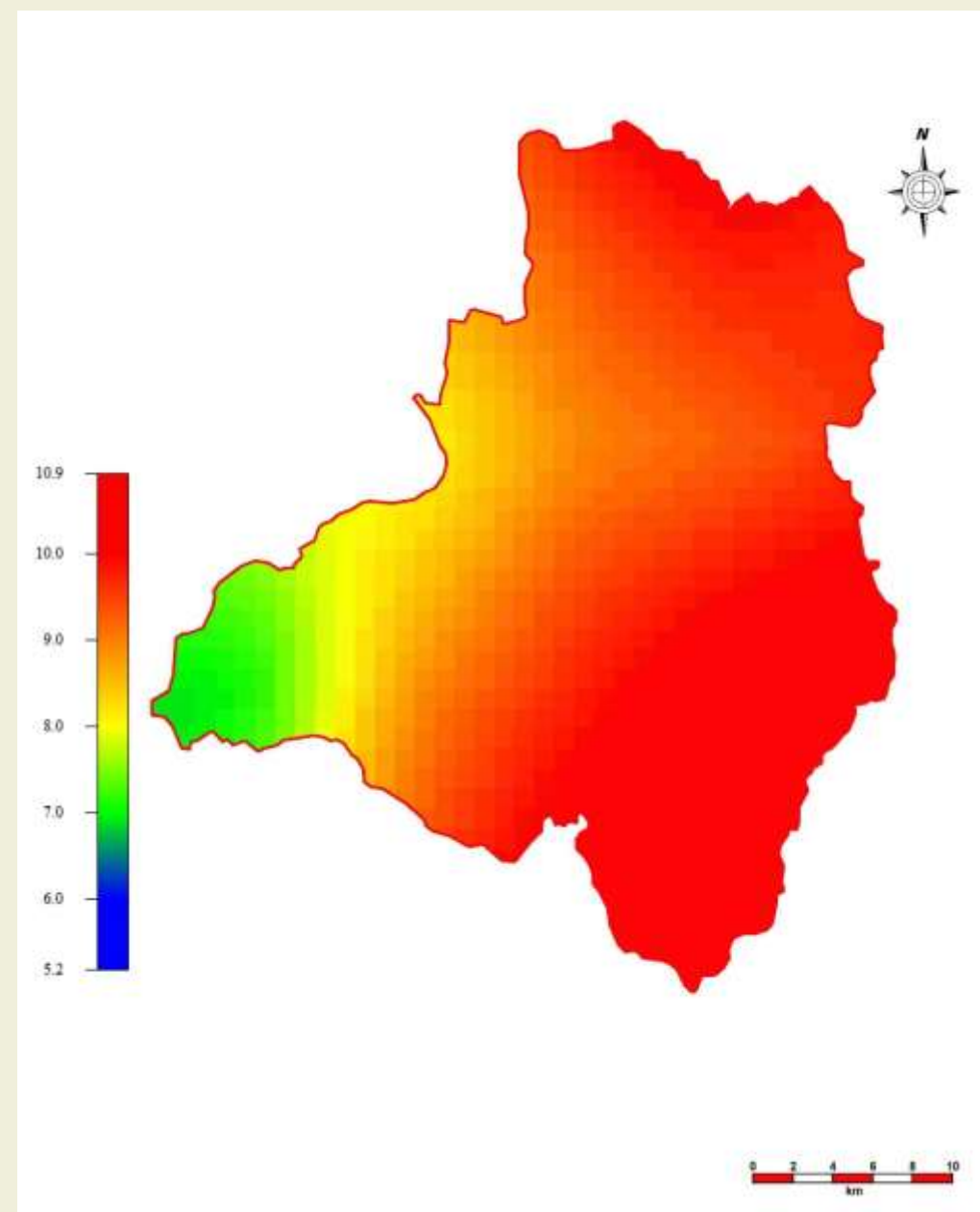
Species	FAI minimal values	FAI maximal values
Quercus robur	4.8	6.9
Quercus cerris	4.3	7
Quercus frainetto	3.6	7.7
Quercus petraea	3.3	7.6
Fagus sylvatica	3.5	7.6
Pinus nigra/Pinus sylvestris	3.1	7.7
Abies alba	2.9	6.1
Picea abies	2.8	7.4



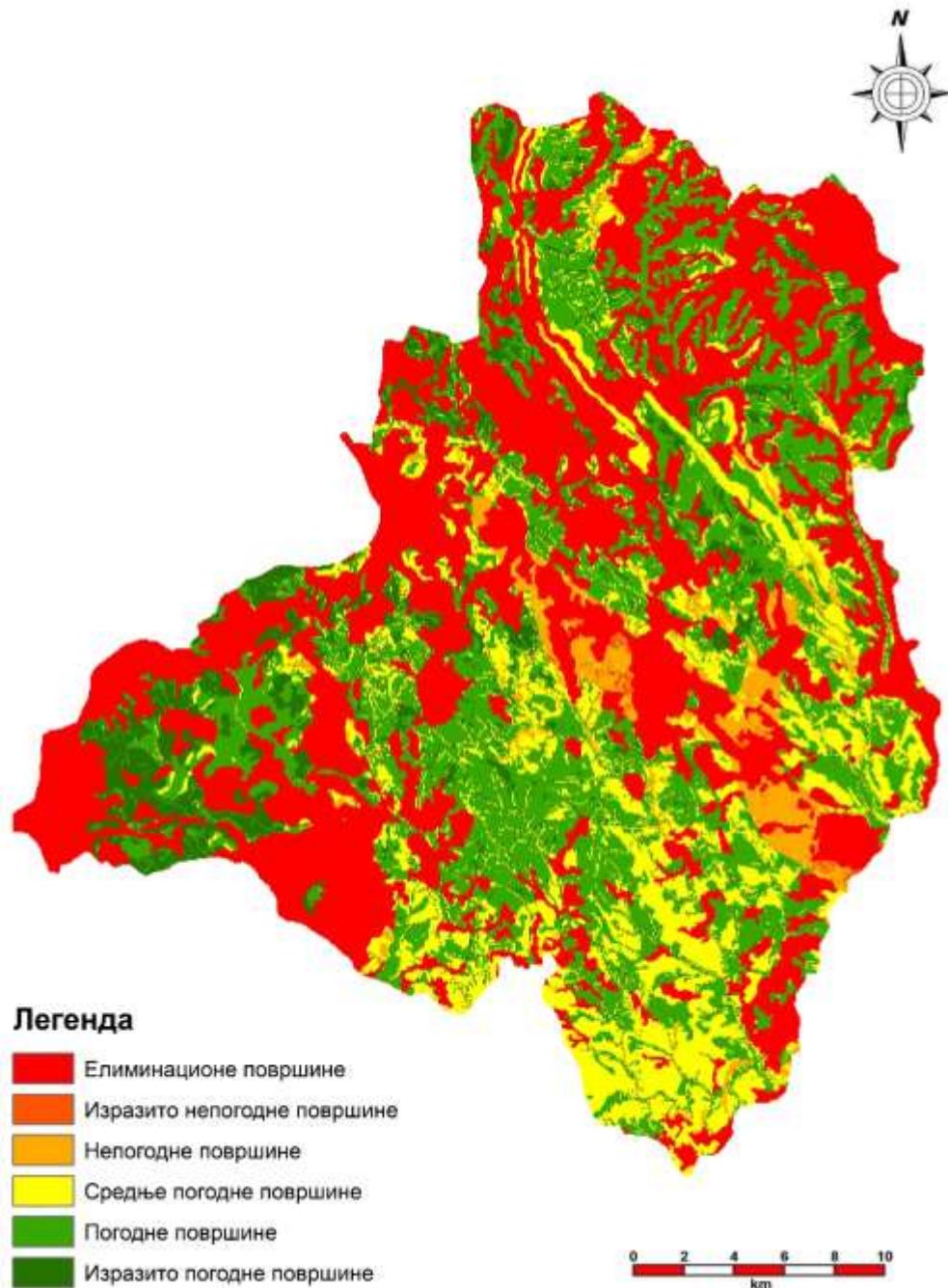
Forest aridity index - FAI



1986-2005 2041-2070

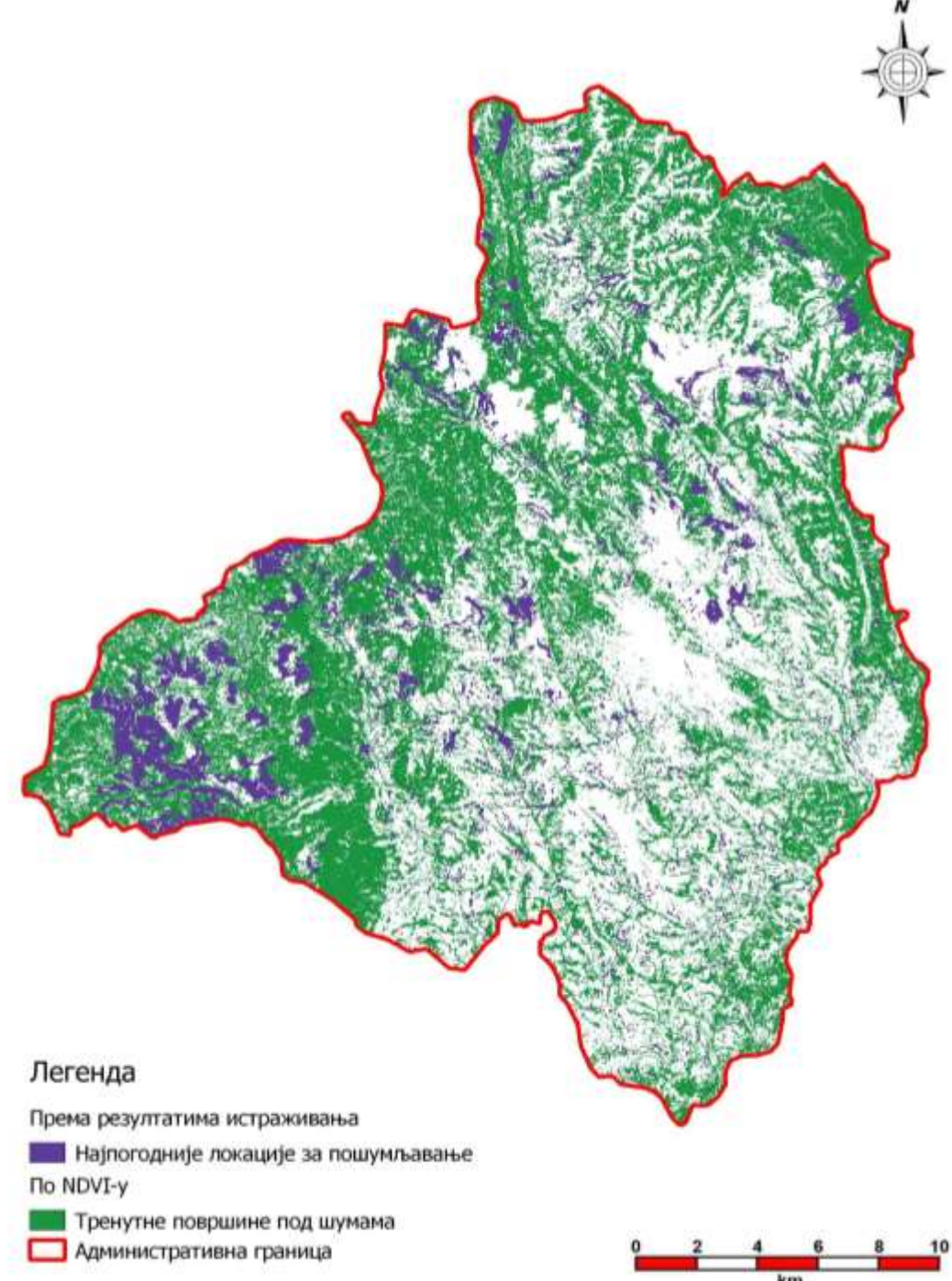


The result

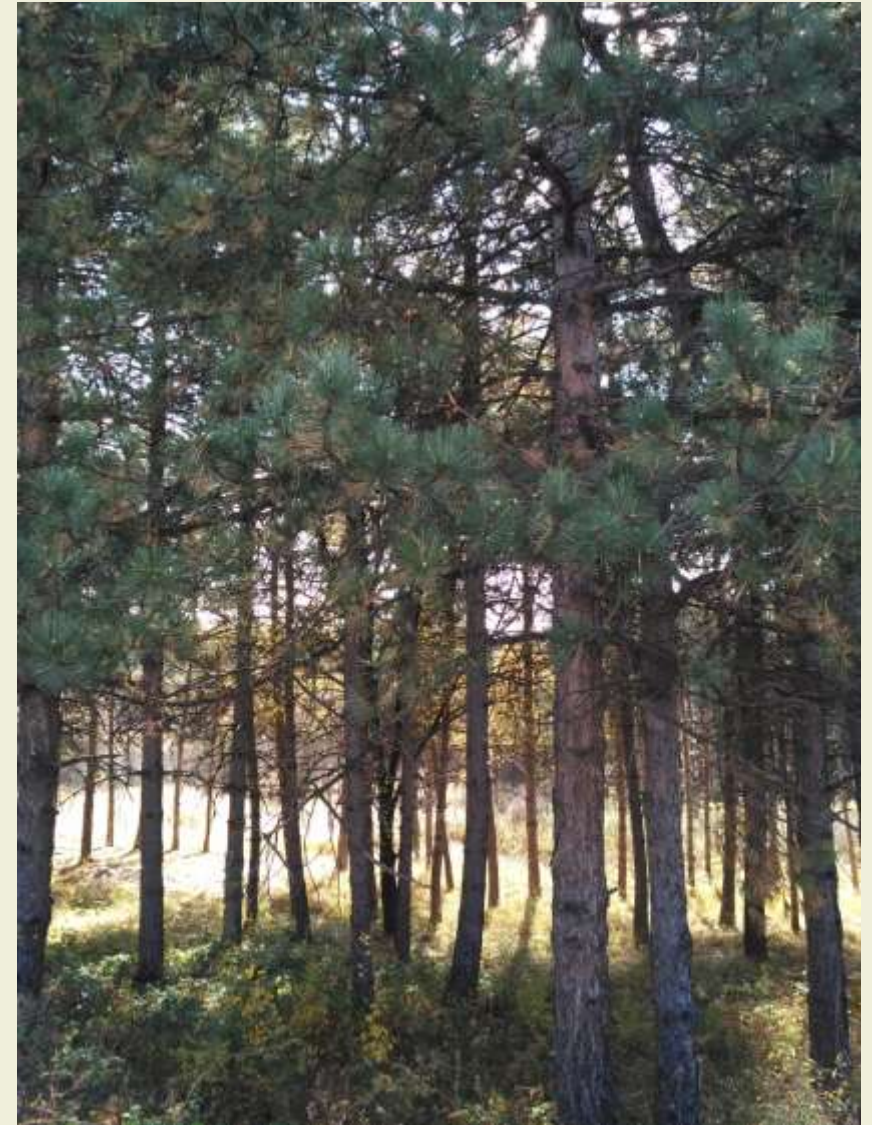


Suitability class	Area (km2)	Participation in whole area of municipality(%)
Eliminated area	369.64	42.80
High unsuitable area	2.23	0.26
Unsuitable area	34.21	3.96
Medium suitable area	147.37	17.06
Suitable area	244.84	28.35
High suitable area	65.31	7.56

Normalized Difference Vegetation Index validationa



Black pine near Bor lake



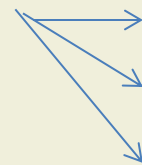
Fieldwork validation



NEXT STPEPS?

1. Further development of the algorithm

Three stages of algorithm



Physical geographic conditons

Social geographic conditions

Risks



2. We are accpted by:
Climate-KIC Accelerator
EU4Tech Progam



Feel free to ask!

Now....

I am here

Later...

tlezaic@gmail.com



Thank you for your attention!

**MAY THE
FOREST
BE WITH
YOU**

