Interreg
Danube Transnational Programme
DriDanube

Analysis of rainless periods within the DriDanube project

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Training course on drought risk assessment, at OMSZ – Hungarian Meteorological Service
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DriDanube – Drought Risk in the Danube Region
Project co-funded by European Union funds (ERDF, IPA)

Outline

Analysis of extreme rainless periods (droughts, or implicitly indicators of droughts) as an approach to drought risk representation based on **ZT method** (after Zelenhasic and Todorovic)

Mapping rainless periods for different return periods over the DriDanube countries

Creating input to the drought risk web portal as a constituent of Drought User Service (DUS) platform

MATH DESCRIPTION

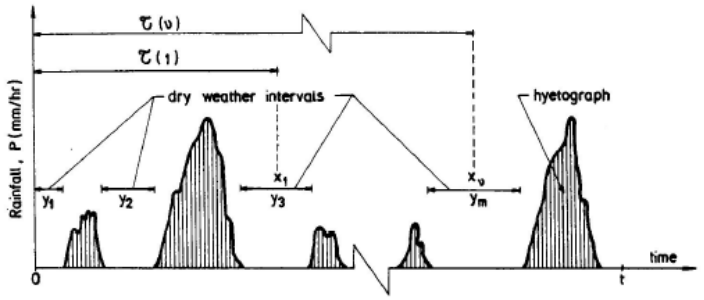


Fig. 1. Sequence of hyetographs observed in some interval of time [0,*t*] at a given meteorological station.

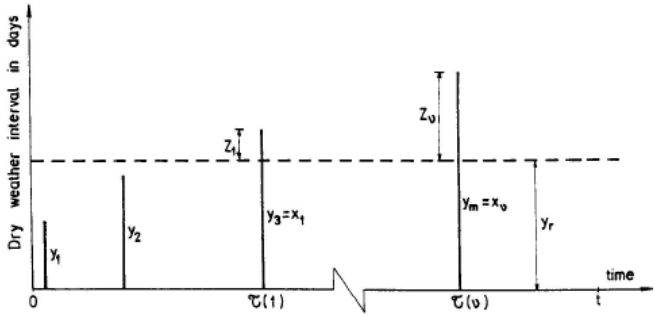


Fig. 2. A realization of the stochastic (discrete, nonnegative) process of dry weather intervals in an interval of time [0,*t*] at a given precipitation station.

Each drought event is composed of the following defining descriptive parameters:

(1) drought duration, X_ν;
(2) time of the beginning of a drought, $\tau_b(\nu)$;
(3) time of the end of a drought, $\tau_e(\nu)$;
(4) time of a drought occurrence, $\tau(\nu)$, defined here as

$$\tau(\nu) = \frac{1}{2}[\tau_b(\nu) + \tau_e(\nu)];$$

(5) order number of a drought, ν, for a given time interval [0,*t*], for a particular growing season, where $\nu = 1, 2, \ldots$.

Considering the entire process of droughts, three additional magnitudes enter the analysis:

(6) total number of droughts, k, within the time interval [0,*t*], where $k = 0, 1, 2, \ldots$;
(7) the longest (largest) drought within a time interval [0,*t*]

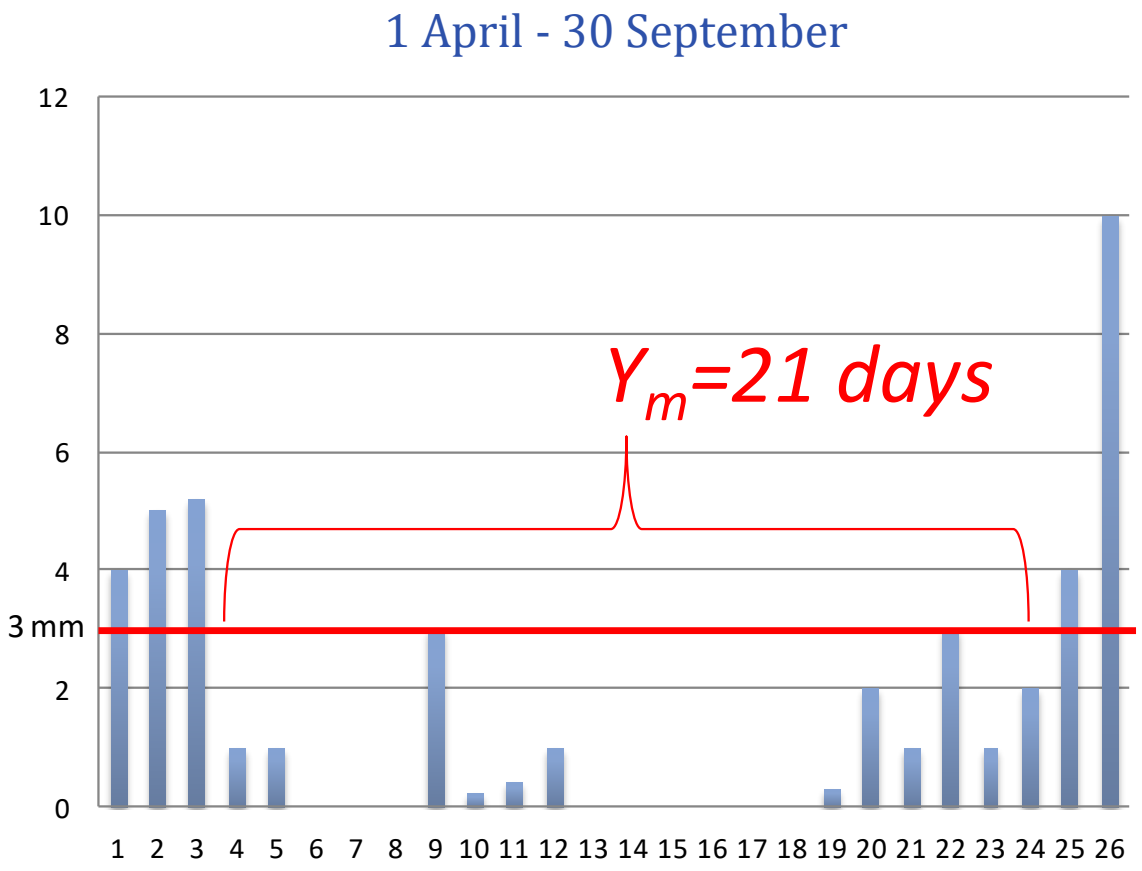
$$X(t) = \sup X_\nu \quad \text{and} \quad \tau(\nu) \leqslant t \tag{5}$$

(8) time of occurrence, $T(t)$, of the longest (largest) drought, within time interval [0,*t*].

According to the nature of drought phenomena, the number of droughts in a time interval [0,*t*], as well as their durations, are random variables. Since the number of droughts in [0,*t*] is random, the times when these droughts occur are random variables, too.

HERE:
DROUGHT EVENT
IS
RAINLESS PERIOD

Rainless periods as extreme events – definition and identification



Y_m - number of consecutive days with less than 3mm of daily rainfall

Searching for periods more than 20 days long, with less than 3 mm of daily rainfall <=> **extreme rainless period**, or **drought.**

DROUGHT EVENTS as a discrete stochastic process of extremes

Rainfall station Sombor in Vojvodina Province (Serbia)

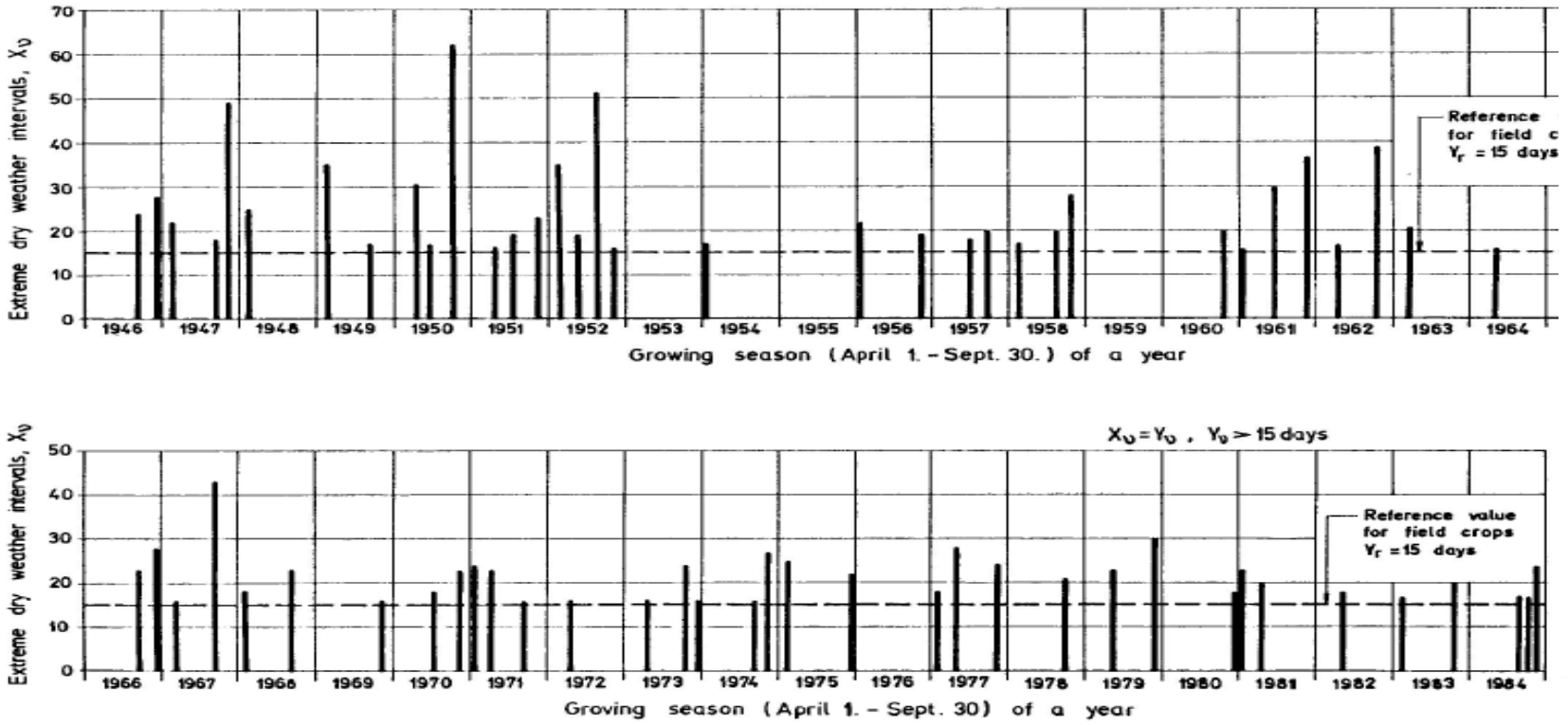
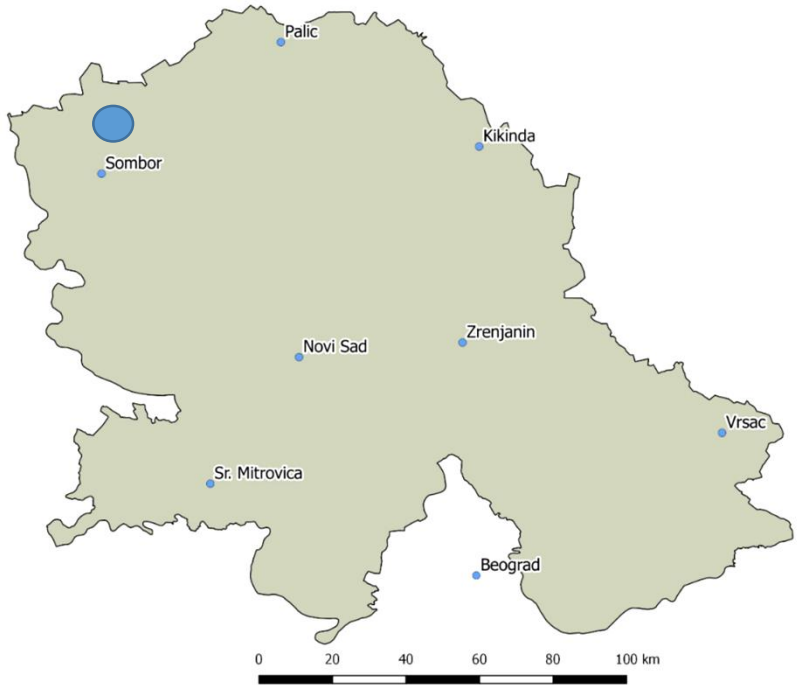
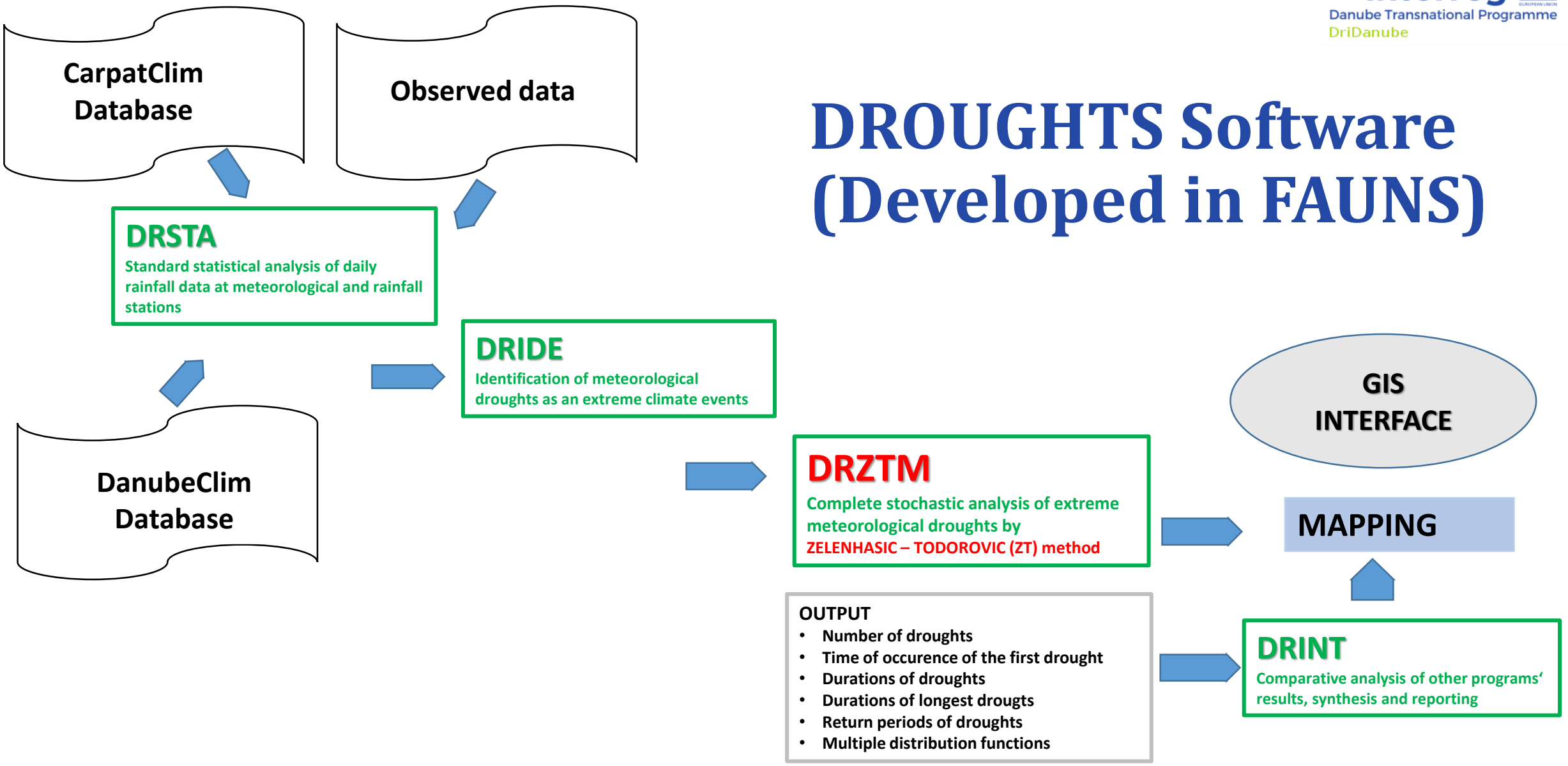


Fig. 4. Observed extreme dry weather intervals at Sombor during the growing season 1 April – 30 September (Y_r = 15 days; 1946–1984)



DROUGHTS Software (Developed in FAUNS)



DROUGHT SOFTWARE

Developped and installed computer programs:

DRSTA	Standard statistical analysis of daily rainfall data at meteorological and rainfall stations
DRIDE	Identification of rainless periods as an extreme meteorological events (droughts)
DRZTM	Complete stochastic analysis of long rainless periods by the ZT method
DRINT	Comparative analysis of other programs‘ results, synthesis and reporting

DRZTM … Main features

- it is a general stochastic model of extreme rainless events (droughts) at certain location;
- drought is defined as at least 20 consecutive days long period with less than 3 mm of daily rainfall;
- droughts are independent events, represented by identically distributed random variables that follow the Poisson probability law;
- method considers all important components of the process – drought duration, time of the occurrence, number of droughts in a given time interval [0,t], and the duration of the longest drought in a given time interval [0,t];
- method provides return periods of the longest droughts, i.e. probability of longest drought occurrence;

DRZTM

INPUT

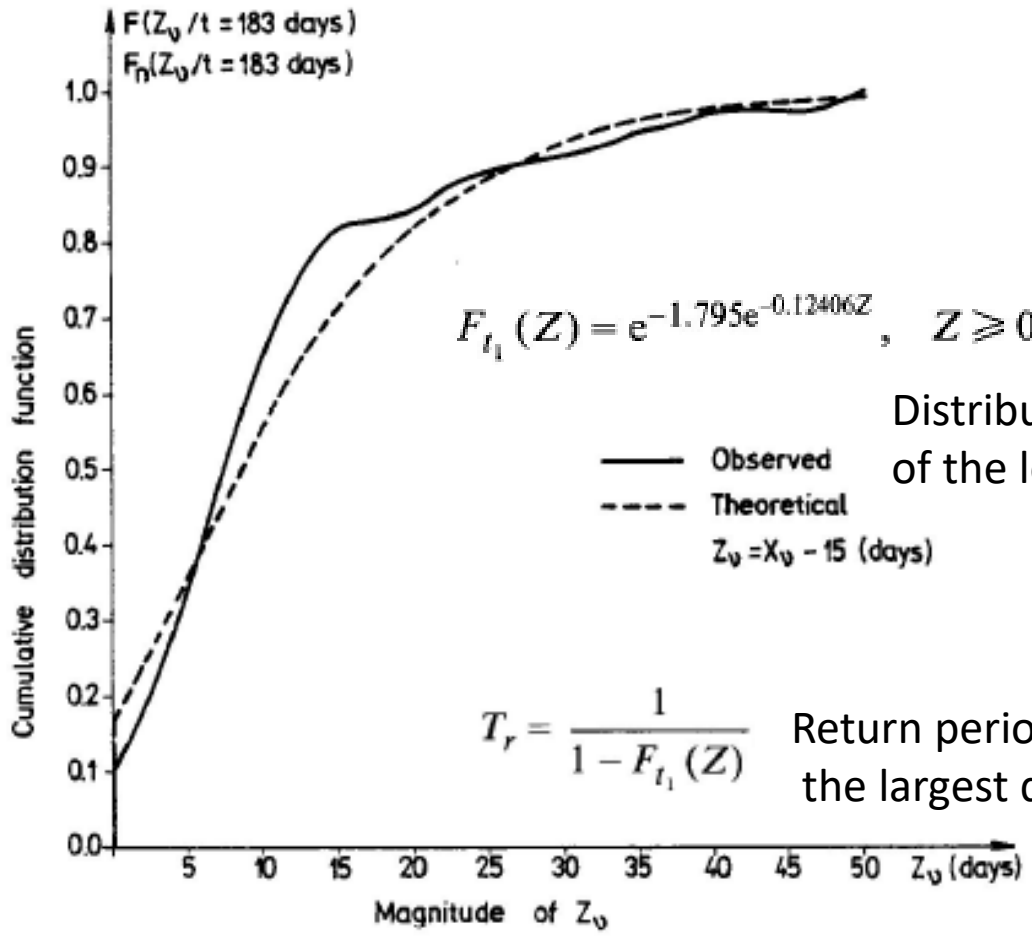
1. Parameters (station id, period of analysis, number of droughts, steps of ZT method to be executed)
2. Data about all identified drought events during vegetation season Apr-Sep above reference level of 20 days (and less than 3 mm per day), for multi-year period at given meteorological/rainfall station.
    - Number of drought
    - Year
    - Middle datum of drought
    - Duration of drought

DRZTM

OUTPUT

Step #1: Print all droughts data and determine time of occurrence of droughts
Step #2: Distribution of the number of droughts for different time periods
Step #3: Distribution of drought lenghts
Step #4: Distribution of the longest yearly droughts
Step #5: Distribution of the time of occurrence of the second drought
Step #6: Distribution of the time of occurrence of the largest drought

Example double exponential cummulative distribution of the longest drought at given station



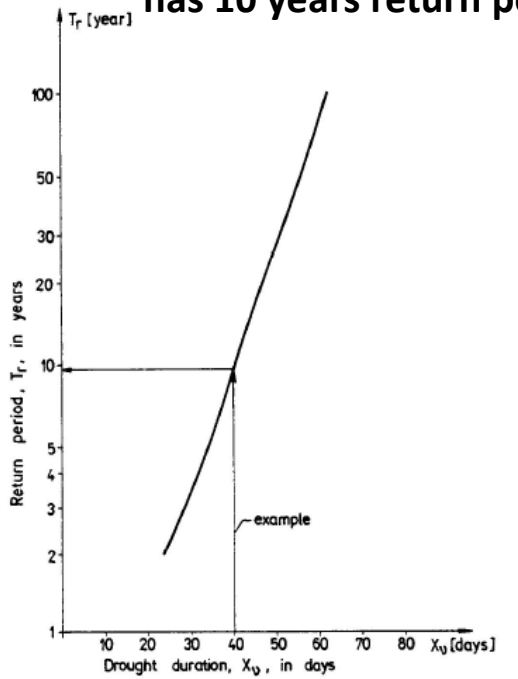
$$F_{t_1}(Z) = e^{-1.795e^{-0.12406Z}}, \quad Z \geqslant 0$$

Distribution
of the longest droughts

$$T_r = \frac{1}{1 - F_{t_1}(Z)}$$

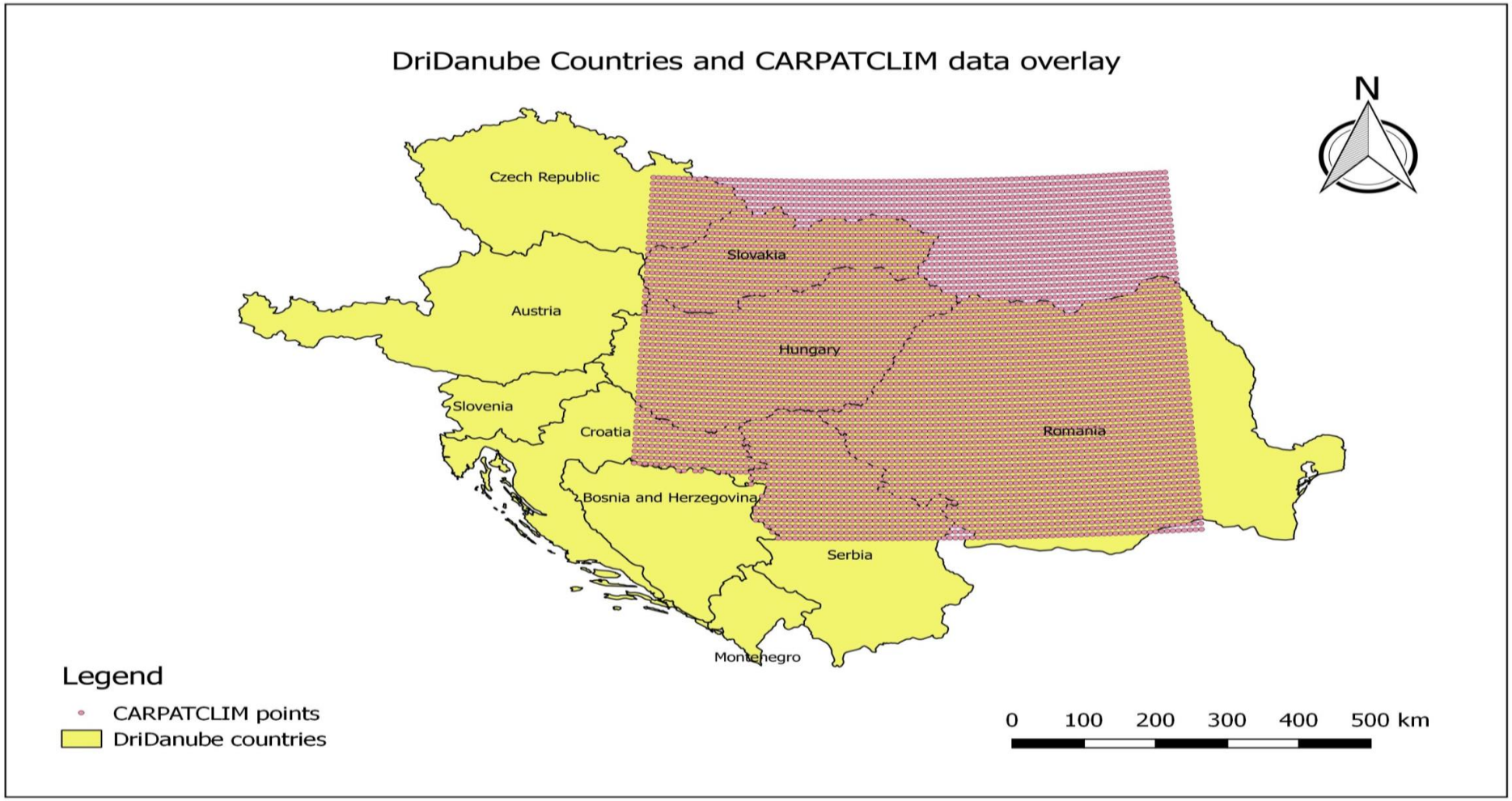
Return period of
the largest droughts

Example: longest yearly drought duration of 40 days has 10 years return period



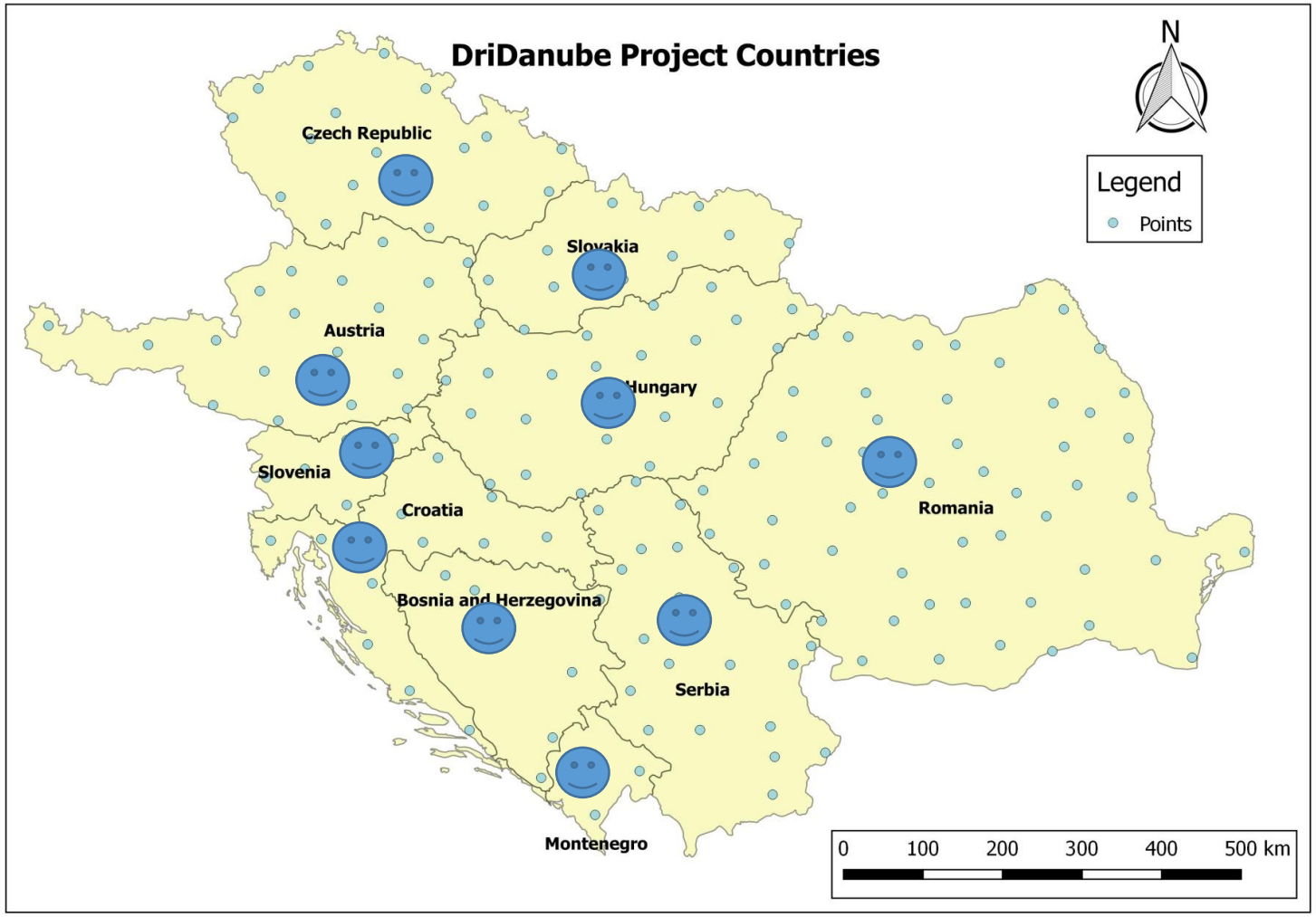
RAINLESS PERIODS (DROUGHTS) in DRIDANUBE COUNTRIES

FOR RETURN PERIODS OF
100, 50, 20, 10, 5 and 2 years



Grided and observed data are used to compute durations of longest rainless periods with 100, 50, 20, 10, 5, and 2 years return period for all partner countries (total of 170 locations used and mapped)

Representative locations for all partner countries



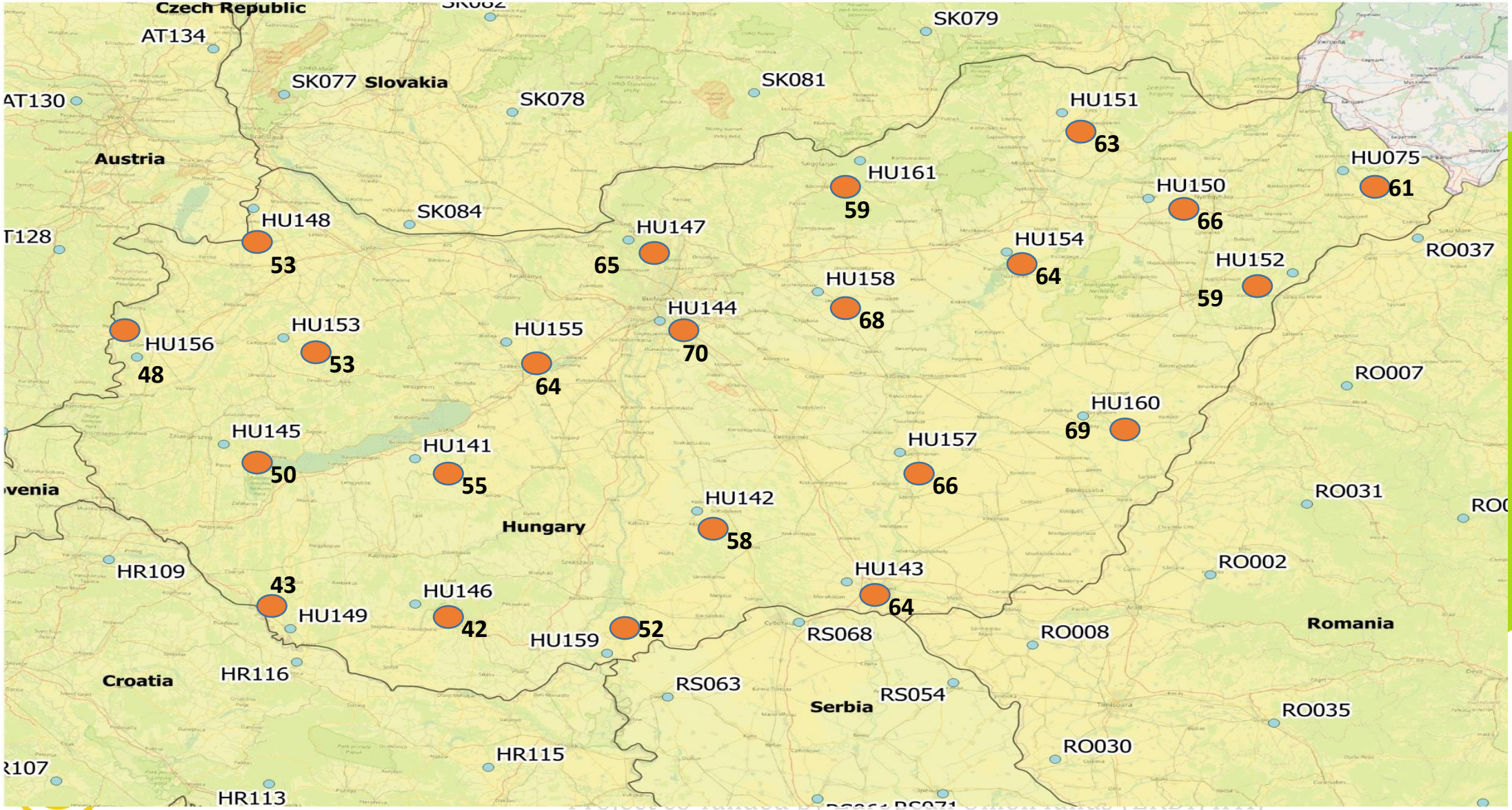
Daily raiinfall data (1981-2010).

Partner country	Number of points	Source of daily rainfall data
Austria	19	HISTALP
Bosnia and Herzegovina	6	DanubeClim
Czech Republic	17	Missing information
Croatia	12	Observed data
Hungary	22	CarpatClim + DanubeClim
Montenegro	4	DanubeClim
Romania	43	CarpatClim
Serbia	20	CarpatClim + DanubeClim
Slovakia	22	CarpatClim
Slovenia	5	Observed data

HUNGARY

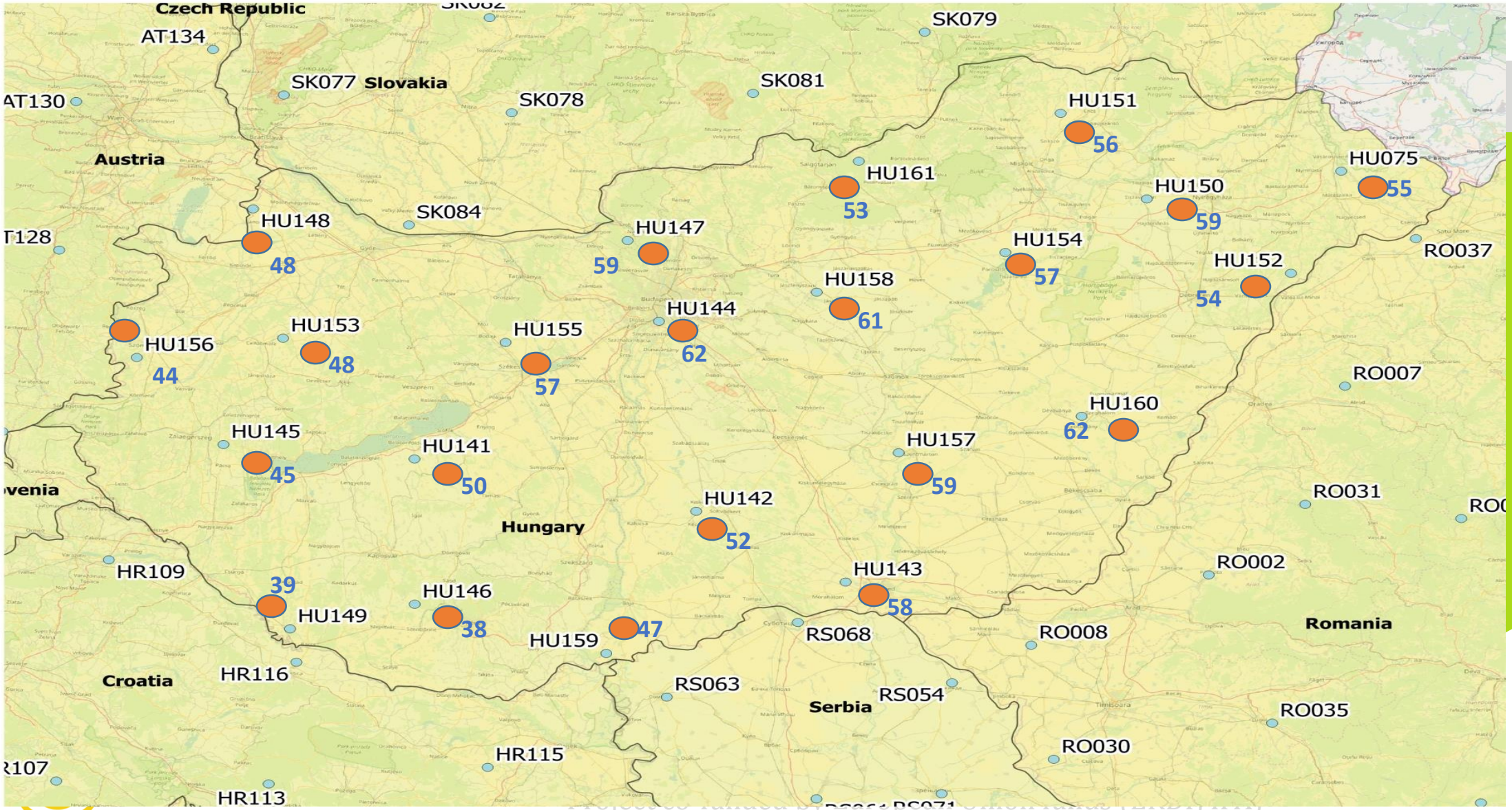
HUNGARY

RAINLESS PERIODS (duration in days)
Return period **T = 100** (years)



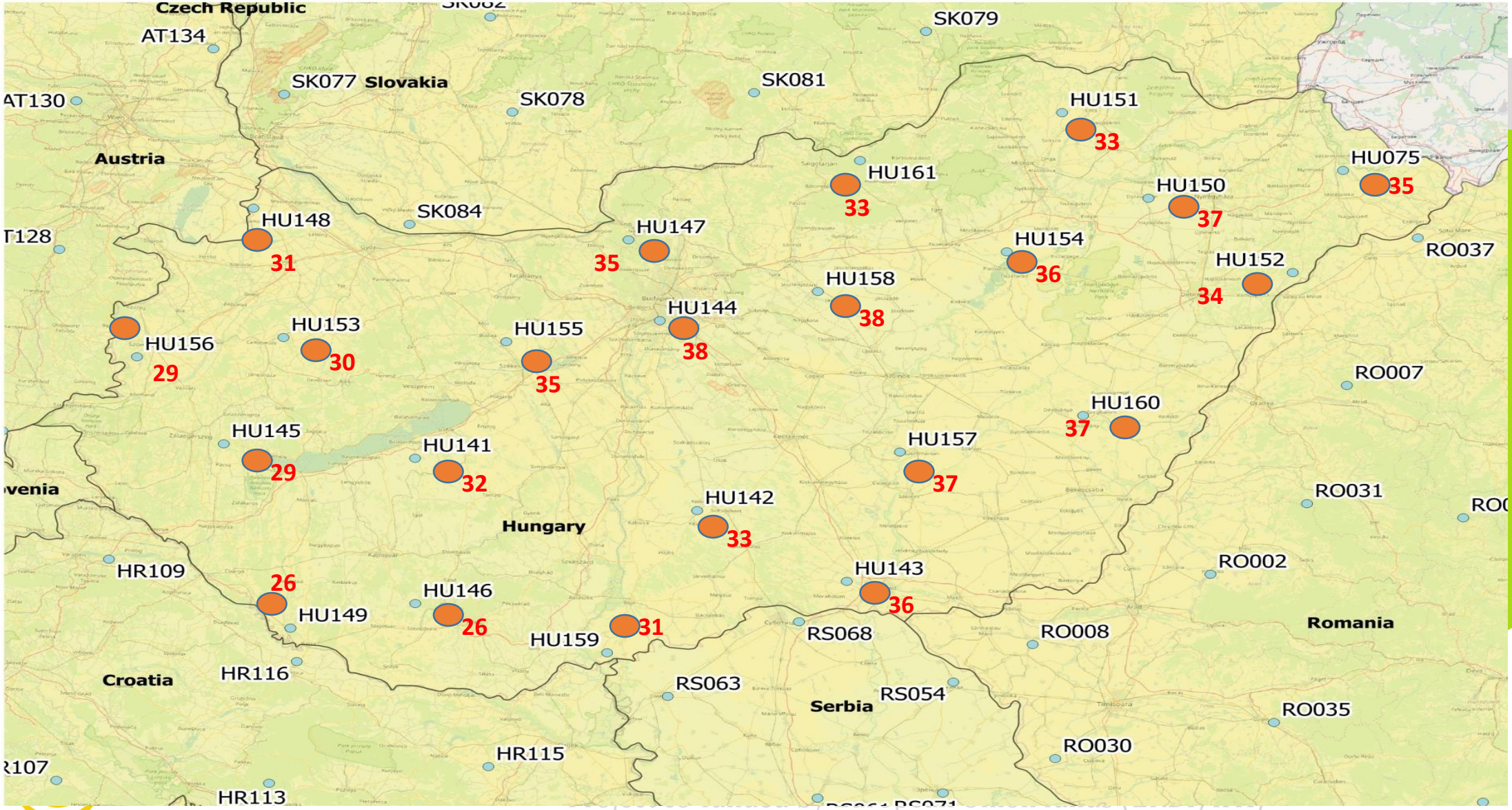
HUNGARY

RAINLESS PERIODS (duration in days)
Return period **T = 50** (years)



HUNGARY

RAINLESS PERIODS (duration in days)
Return period **T = 5** (years)



Output data for locations in Hungary

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History

Z-T Method

Number of RP

Longest RP

Day in the year

Average sum of rainfall during veg season

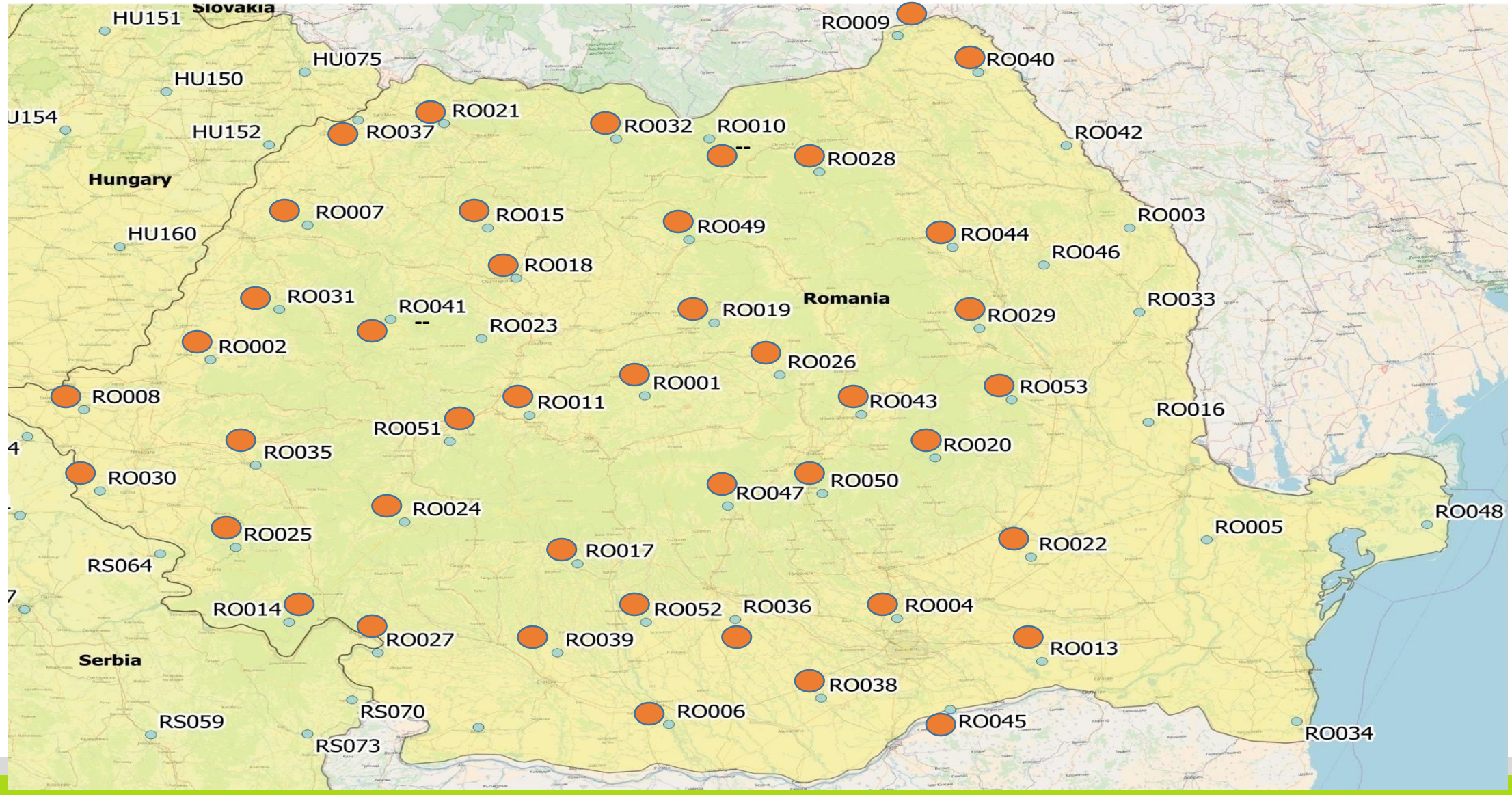
Pt_ID	Cntr_nam	100g	50g	20g	10g	5g	2g	NO of RP	LNGST RP	YEAR	STRDAT	ENDDAT	MIDDAT	TAU	AVESUM
HU141	Hungary	55	50	43	38	32	24	35	50	1992	1307	3108	708	219	353.5
HU142	Hungary	58	52	45	39	33	24	34	43	1984	1008	2109	109	244	330.8
HU143	Hungary	64	58	49	43	36	26	40	52	1993	1604	606	1205	132	326.1
HU144	Hungary	70	62	53	46	38	26	38	60	2009	104	3005	105	121	310.3
HU145	Hungary	50	45	39	34	29	21	23	41	2001	2004	3005	1105	131	404.4
HU146	Hungary	42	38	34	30	26	21	24	33	2007	104	305	1804	108	395.3
HU147	Hungary	65	59	50	43	35	24	32	59	2009	104	2905	105	121	366.4
HU148	Hungary	53	48	41	36	31	23	31	47	1992	1607	3108	908	221	343.8
HU149	Hungary	43	39	34	30	26	20	19	33	2007	104	305	1804	108	427.5
HU150	Hungary	66	59	51	44	37	26	41	55	1993	1704	1006	1505	135	333
HU151	Hungary	63	56	47	40	33	22	26	46	1993	1504	3005	805	128	377.5
HU152	Hungary	59	54	46	40	34	25	36	51	2009	104	2105	2704	117	356.9
HU153	Hungary	53	48	41	36	30	22	26	41	1992	1307	2208	308	215	367.7
HU154	Hungary	64	57	49	42	36	26	39	52	1993	1604	606	1205	132	311.4
HU155	Hungary	64	57	49	42	35	25	35	50	1992	1307	3108	708	219	329
HU156	Hungary	48	44	38	33	29	21	26	37	1990	1107	1608	3007	211	401.9
HU157	Hungary	66	59	51	44	37	26	38	56	1993	1604	1006	1405	134	312.6
HU158	Hungary	68	61	52	45	38	27	43	60	2000	2604	2406	2605	146	321.9
HU159	Hungary	52	47	41	36	31	23	32	47	1992	1407	2908	708	219	350.2
HU160	Hungary	69	62	52	45	37	26	37	55	1993	1704	1006	1505	135	319.6
HU075	Hungary	61	55	47	41	35	25	36	59	2009	104	2905	105	121	361.8
HU161	Hungary	59	53	45	39	33	24	34	56	2009	104	2605	2904	119	388.9
	AVERAGE	58	53	45	39	33	24	32	49					156	354
	MAX	70	62	53	46	38	27	43	60					244	427.5
	MIN	42	38	34	30	26	20	19	33					108	310.3

Budapest

Tau=156 corresponds to June 5th (ave mid day)
RP= 10.05.-30.06.

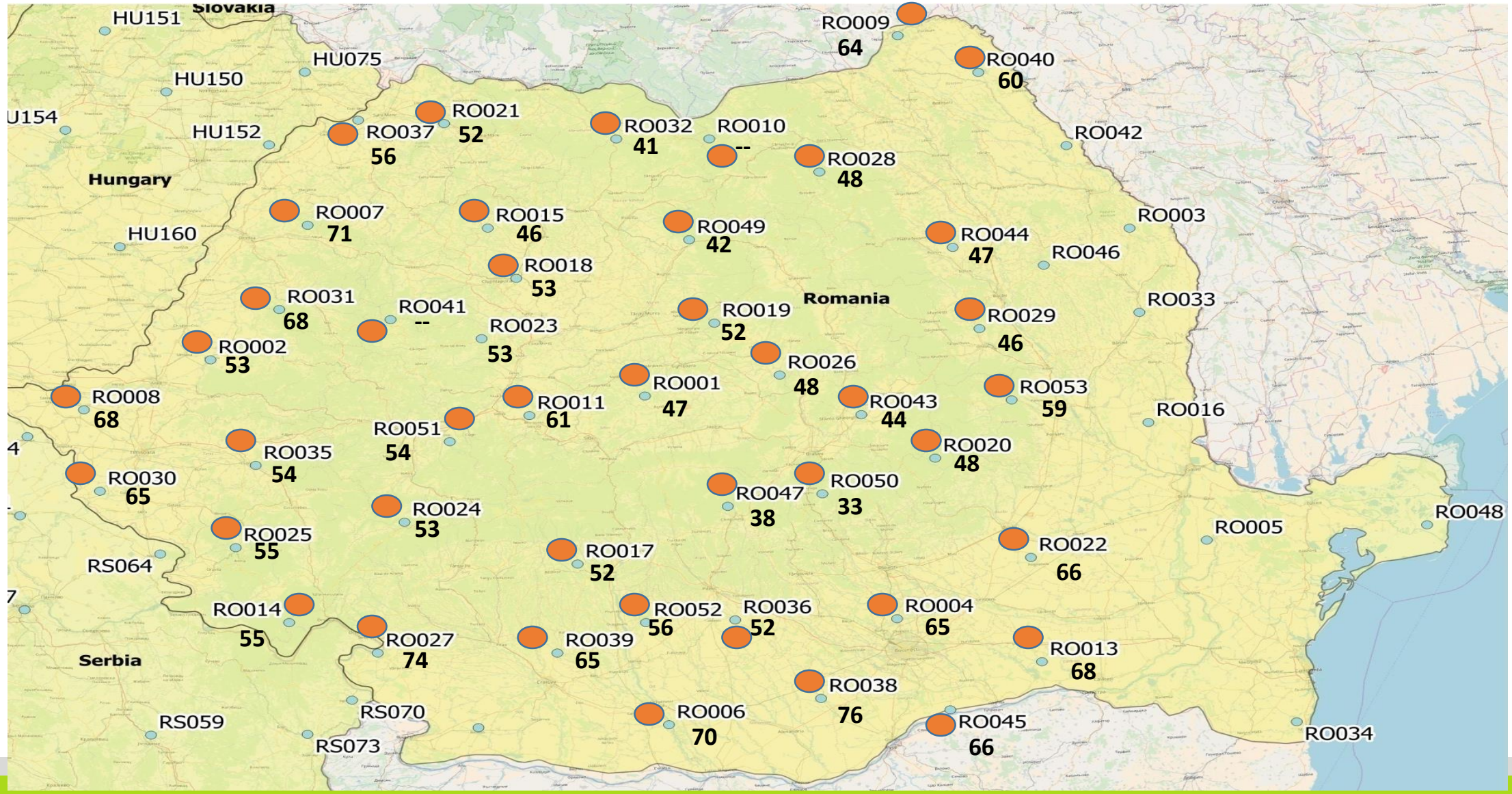
ROMANIA

ROMANIA


HU151
Slovakia
HU075
HU150
U154
HU152
RO021
RO037
RO032
RO010
RO009
RO040
RO042
RO028
Hungary
RO007
RO015
RO049
RO003
HU160
RO044
RO046
RO018
RO031
RO041
RO019
Romania
RO033
RO029
RO023
RO002
RO026
RO001
RO053
RO008
RO011
RO043
RO016
RO051
RO020
RO035
RO030
RO050
RO047
RO024
RO048
RO025
RO005
RO022
RO017
RS064
RO014
RO052
RO036
RO004
RO027
RO039
RO013
Serbia
RO038
RS070
RO006
RO045
RS059
RO034
RS073

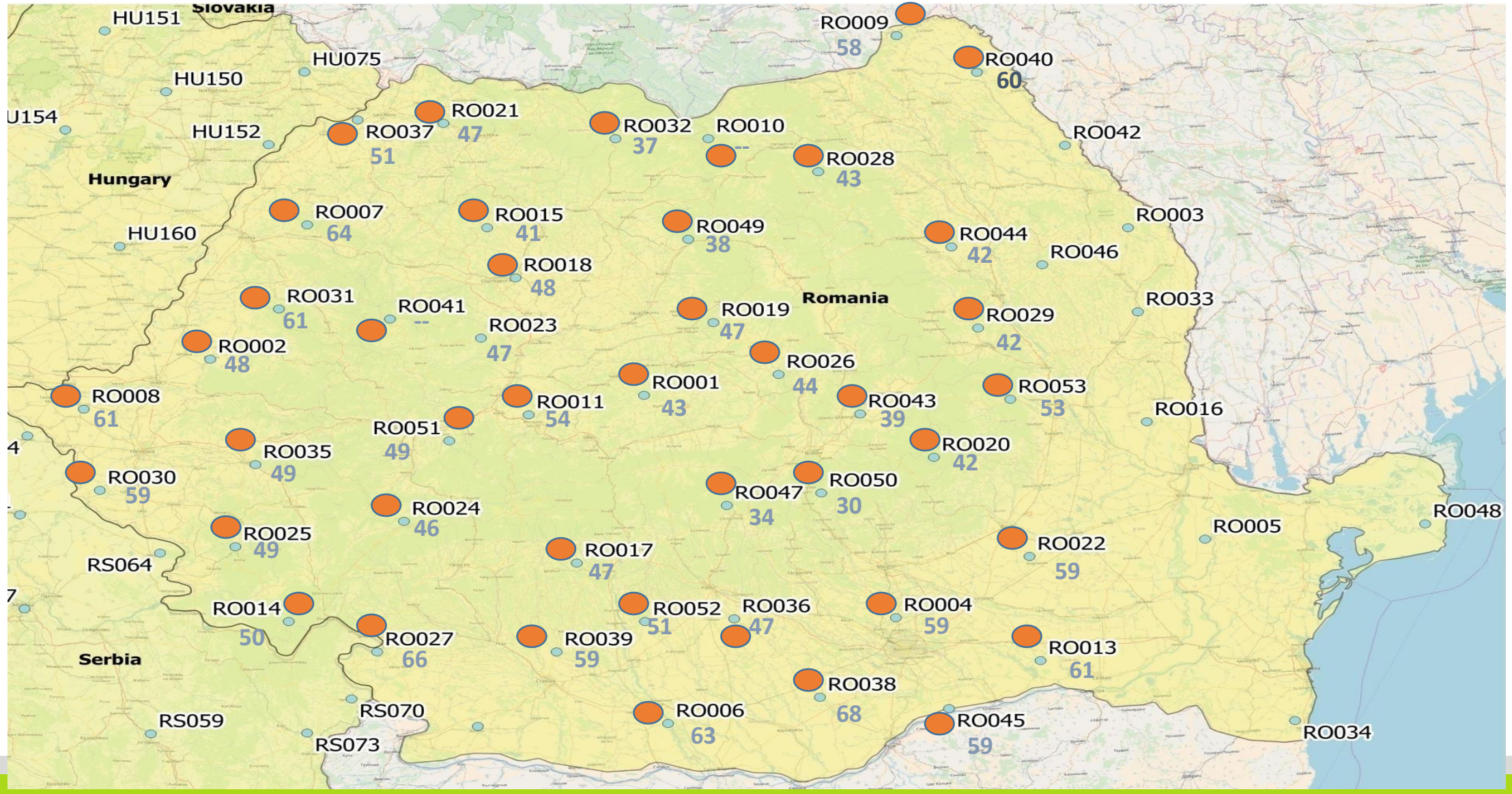
ROMANIA

RAINLESS PERIODS (duration in days)
Return period **T = 100** (years)



ROMANIA

RAINLESS PERIODS (duration in days)
Return period **T = 50** (years)



ROMANIA

RAINLESS PERIODS (duration in days)
Return period **T = 5** (years)

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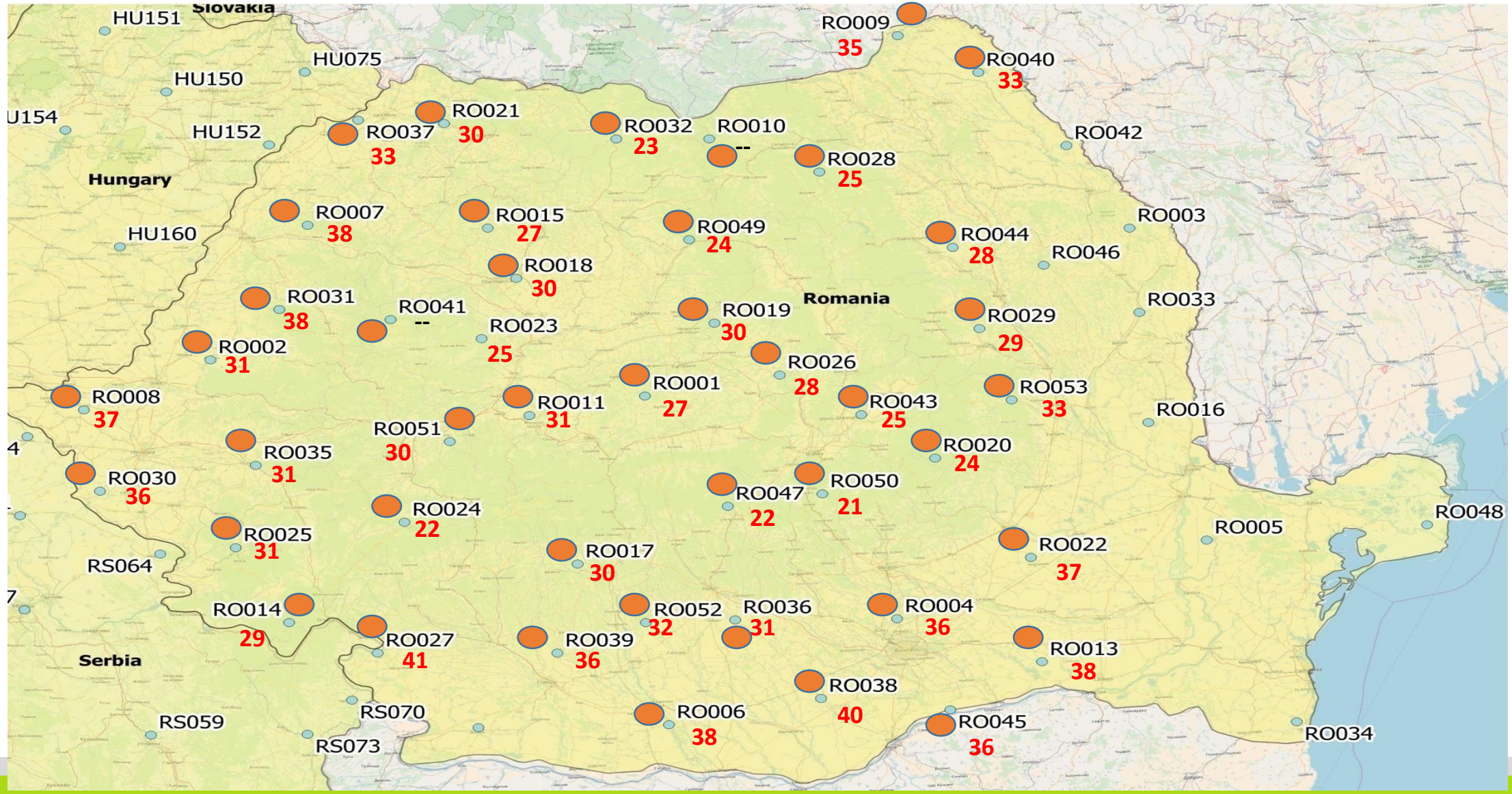
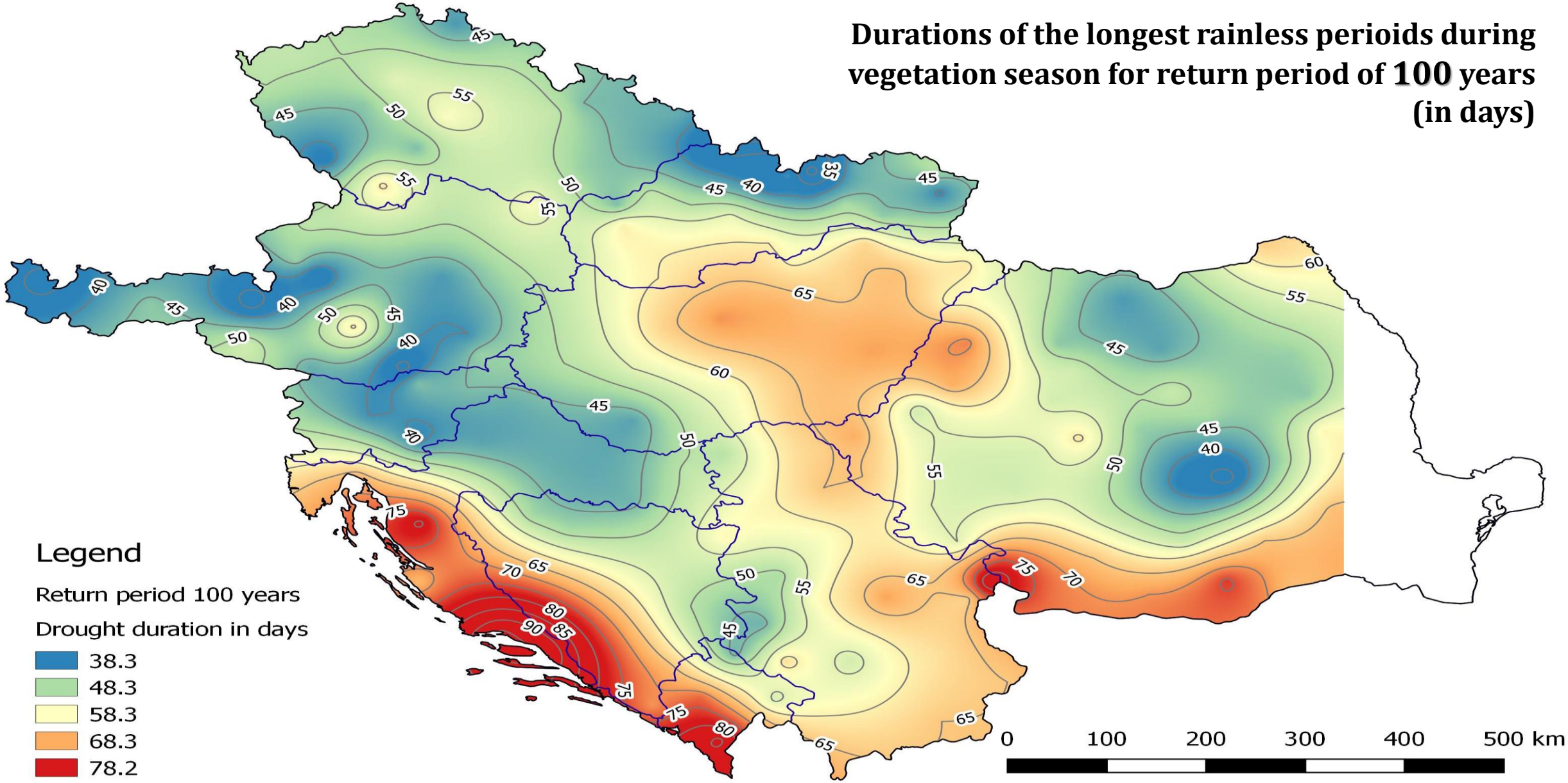


Interpretations
Interpolations
Mapping – CONNECTION WITH DUS

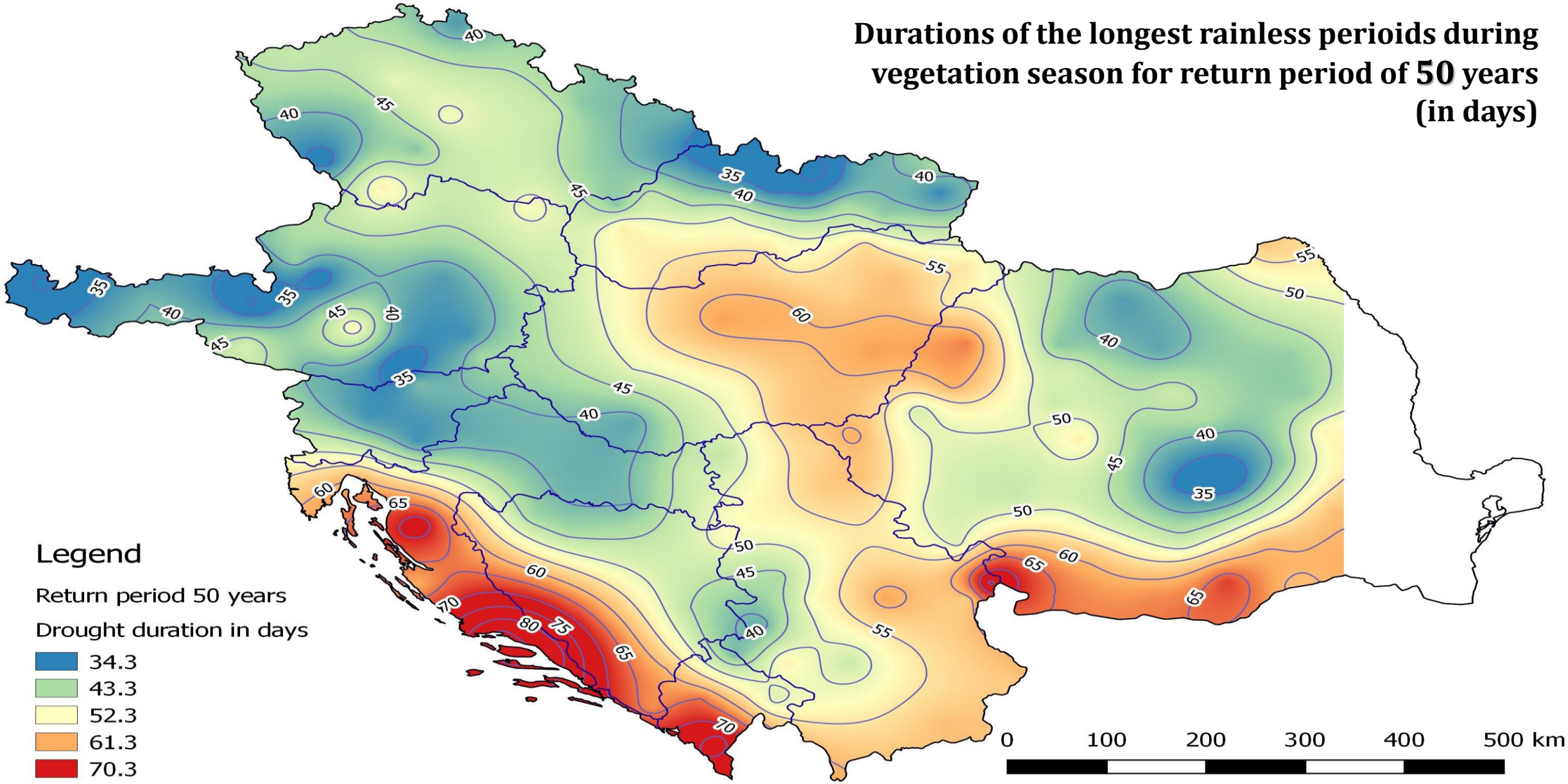
Interpolations and Mapping

... OF THE RESULTS OBTAINED BY THE STOCHASTIC ANALYSIS OF EXTREME RAINLESS PERIODS (DROUGHTS) IN THE DRIDANUBE COUNTRIES

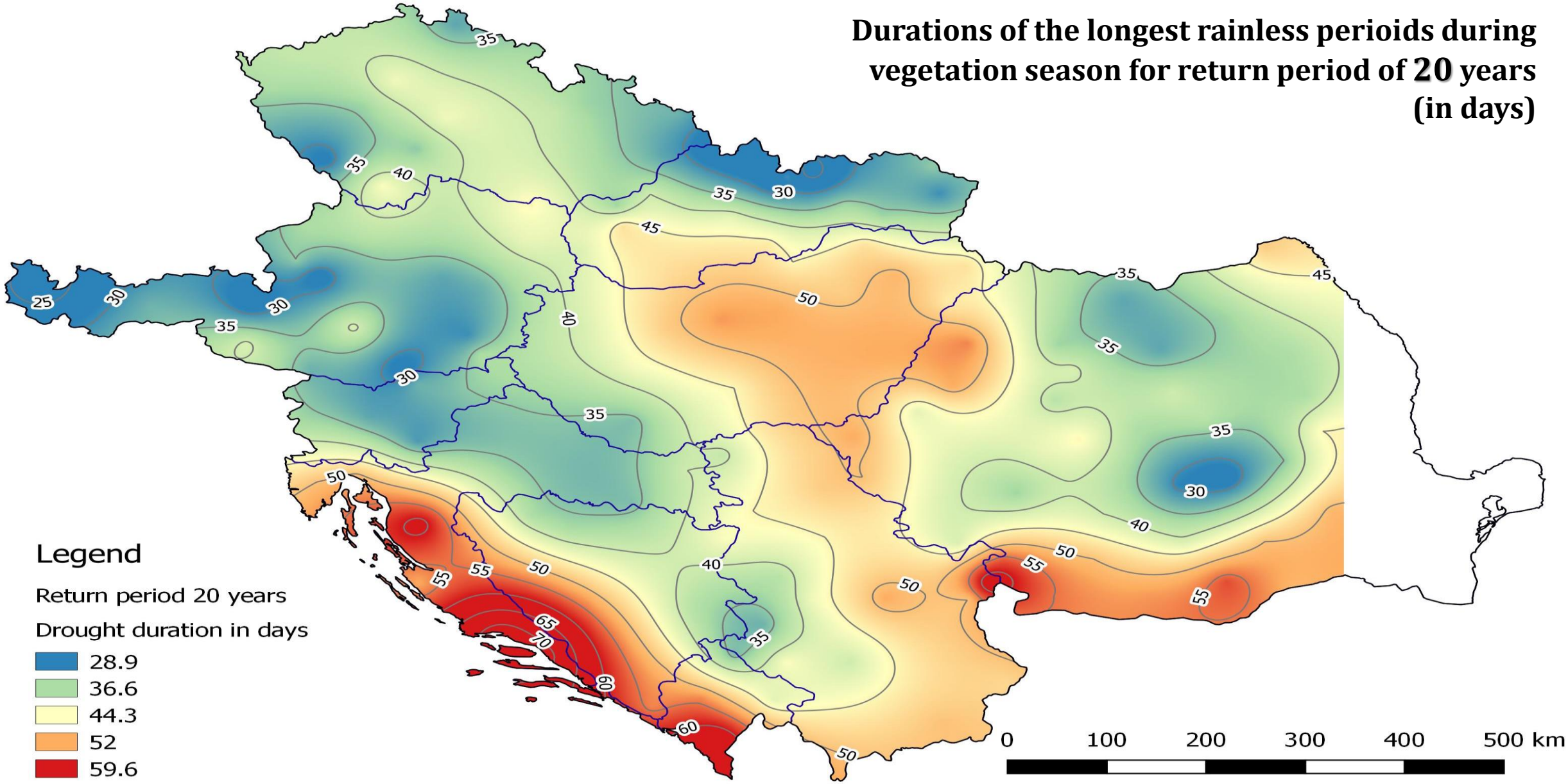
Durations of the longest rainless perioids during vegetation season for return period of 100 years (in days)



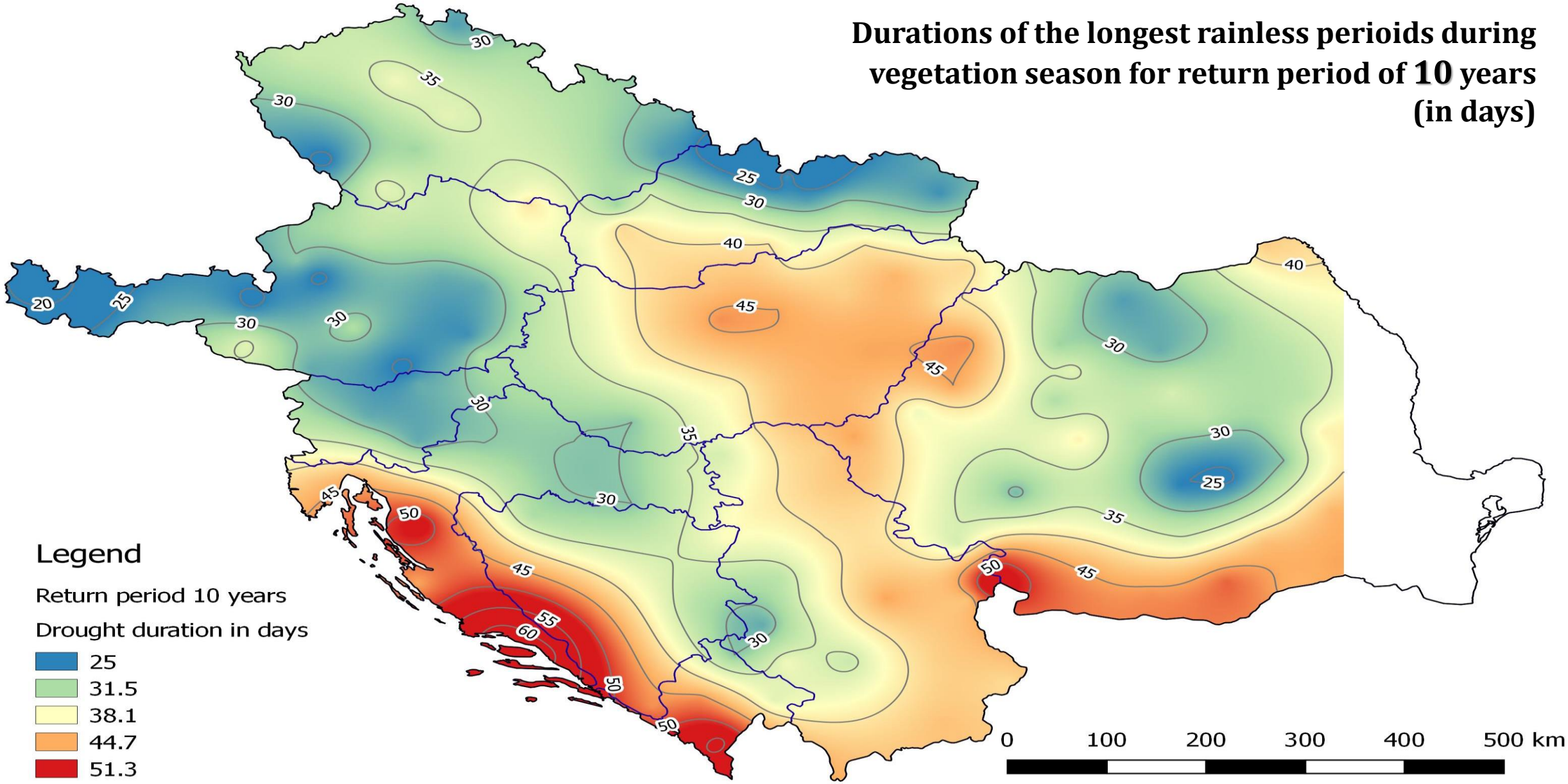
Durations of the longest rainless perioids during vegetation season for return period of 50 years (in days)



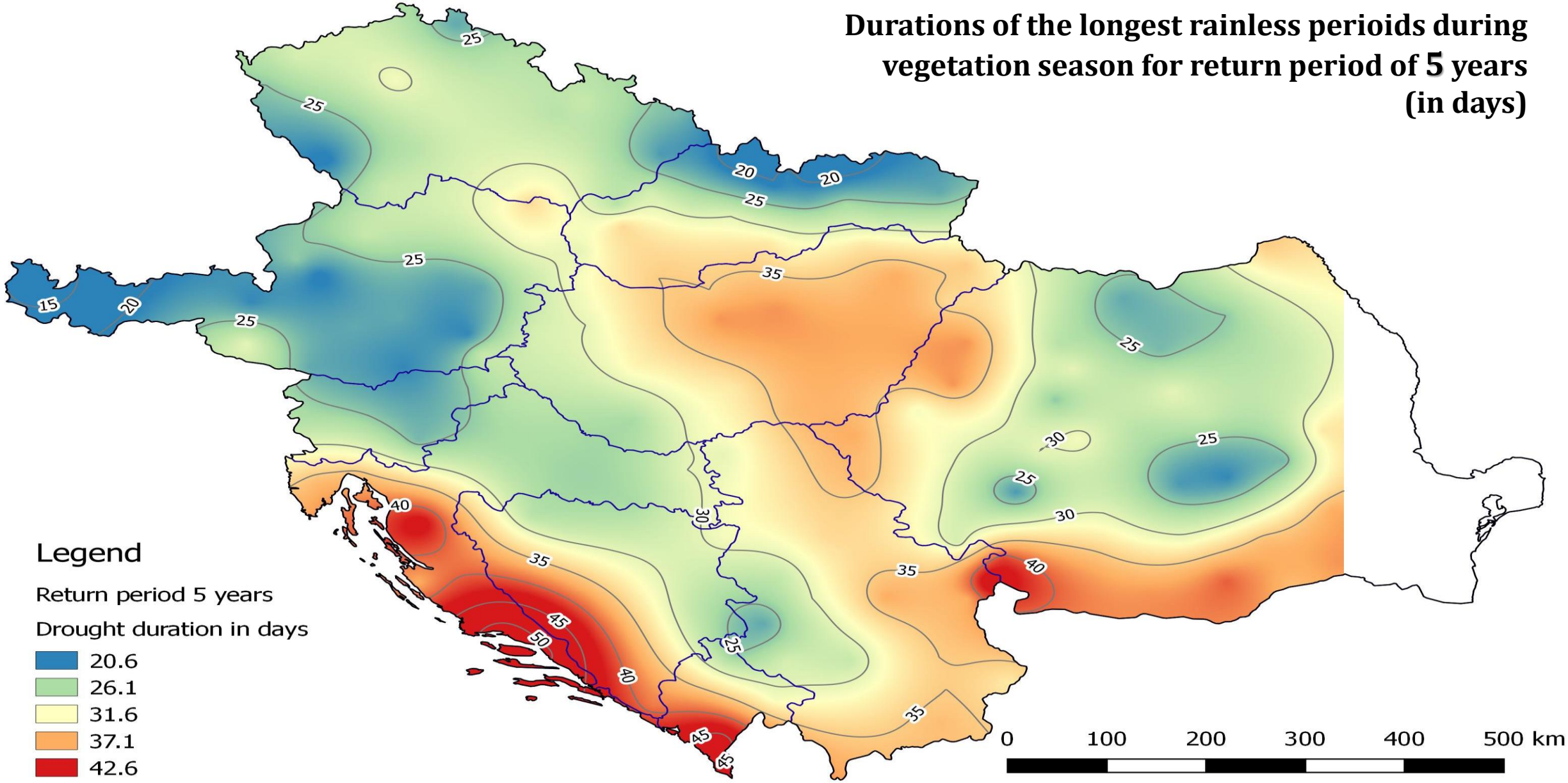
Durations of the longest rainless perioids during vegetation season for return period of 20 years (in days)



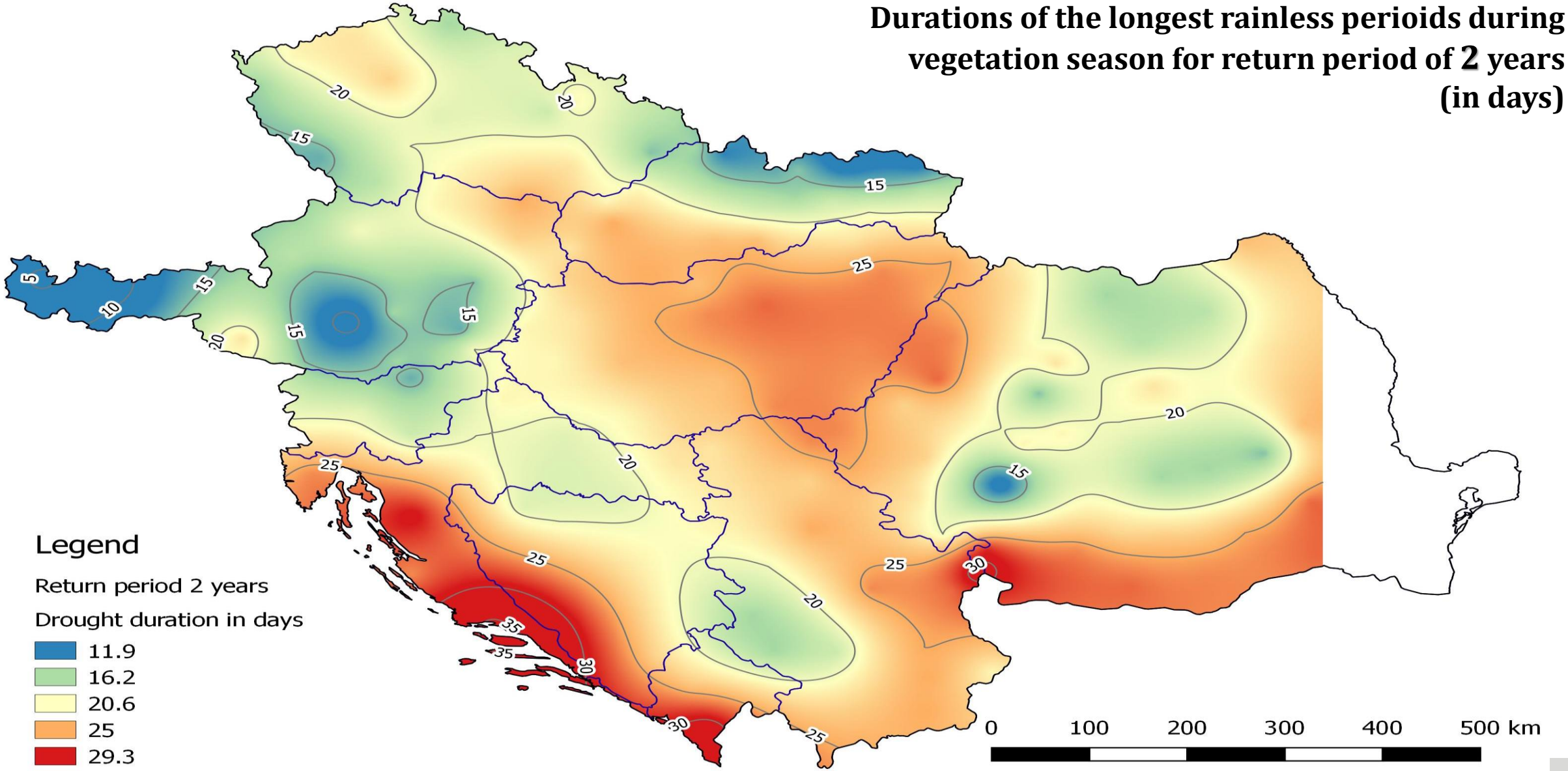
Durations of the longest rainless perioids during vegetation season for return period of 10 years (in days)



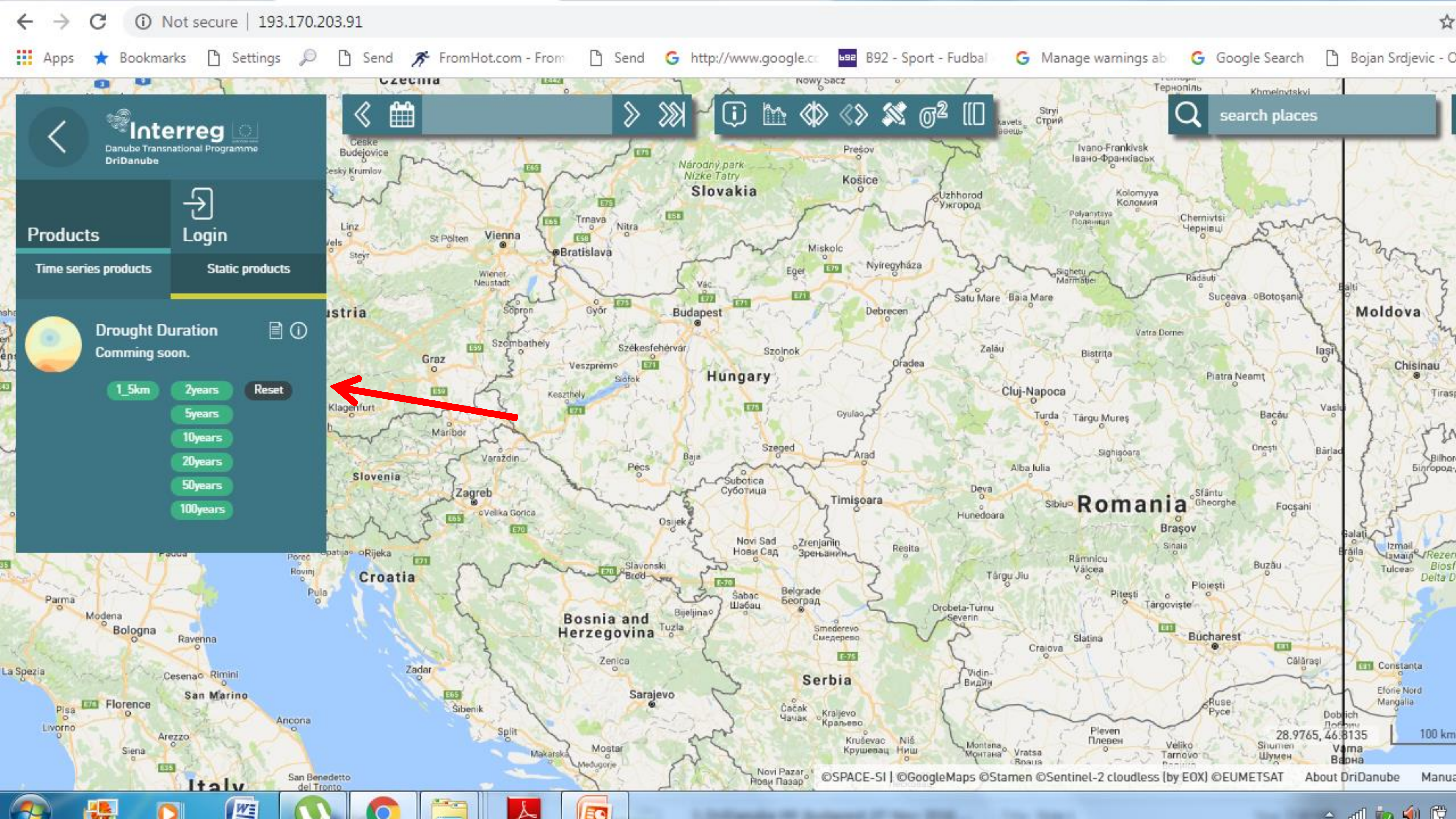
Durations of the longest rainless perioids during vegetation season for return period of 5 years (in days)



Durations of the longest rainless perioids during vegetation season for return period of 2 years (in days)



http://193.170.203.91/


Not secure | 193.170.203.91
Apps
Bookmarks
Settings
Send
FromHot.com - From
Send
http://www.google.c
B92 - Sport - Fudbal
Manage warnings ab
Google Search
Bojan Srdjevic - C
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Products
Login
Time series products
Static products
Drought Duration
Comming soon.
1_5km
2years
Reset
5years
10years
20years
50years
100years
search places
28.9765, 46.8135
100 km
©SPACE-SI | ©GoogleMaps ©Stamen ©Sentinel-2 cloudless (by EOX) ©EUMETSAT
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Moldova
Slovenia
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Bosnia and Herzegovina
Serbia
Italy
Budapest
Vienna
Bratislava
Zagreb
Bucharest
Sarajevo

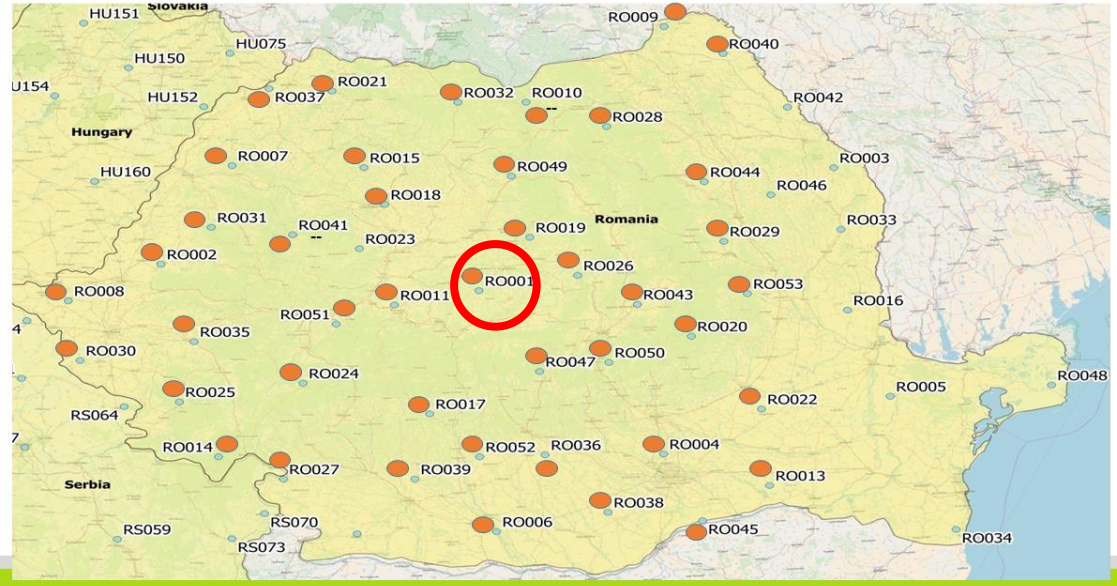
'On - a - click' - for each point in the region (170)
3 tables can be opened

IDENTIFICATION DATA	Example
Point identification	RO001
Country	Romania
Position (Logitude/Latitude)	24.52835/46.04163
Place (Closest known geographical location)	

DATA FOR HISTORICAL PERIOD (30 years: 1981-2010)	Example
Total number of droughts	21
Average number of droughts per year	0.70
Duration of the longest rainless period / Year of occurence	39 /2009
Starting, ending and middle date of the longest rainless period	03/04 ; 11/05; 23/04

RETURN PERIODS OF LONGEST RAINLESS PERIODS	DURATION IN DAYS
Once in 100 years	47
Once in 50 years	43
Once in 20 years	37
Once in 10 years	32
Once in 5 years	27
Once in 2 years	20

ROMANIA



Example is given for location RO001 in Romania

Thank you !