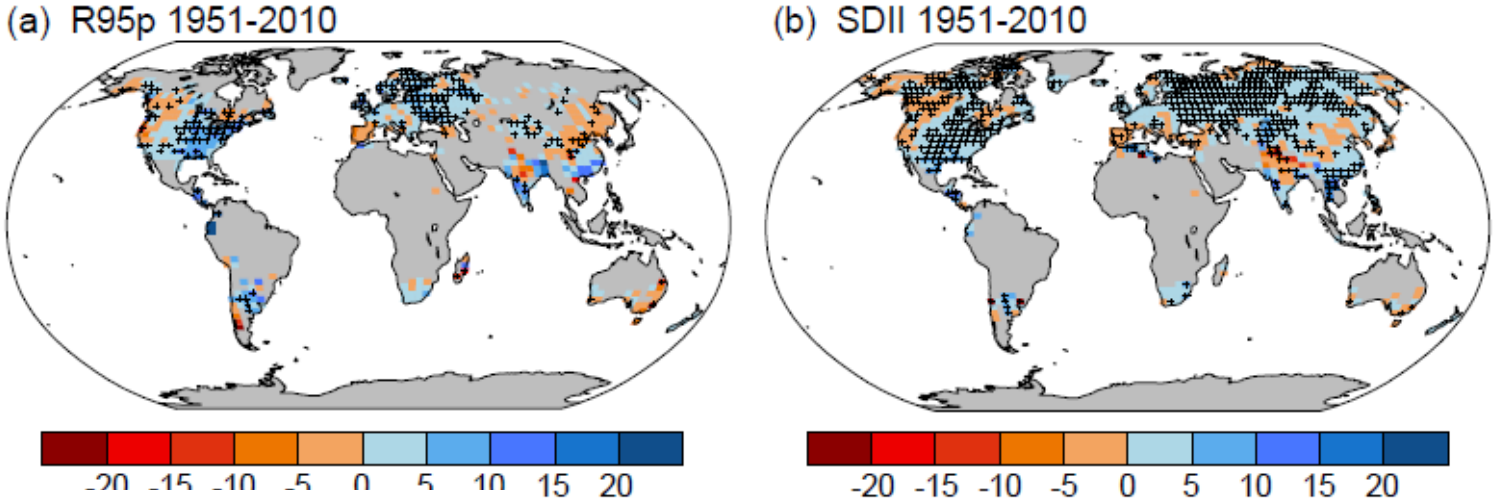
Az intenzív csapadékok előfordulásának és erozivitásának elemzése automata adatok alapján

Lakatos Mónika
Országos Meteorológiai Szolgálat
Éghajlati Osztály

Motiváció

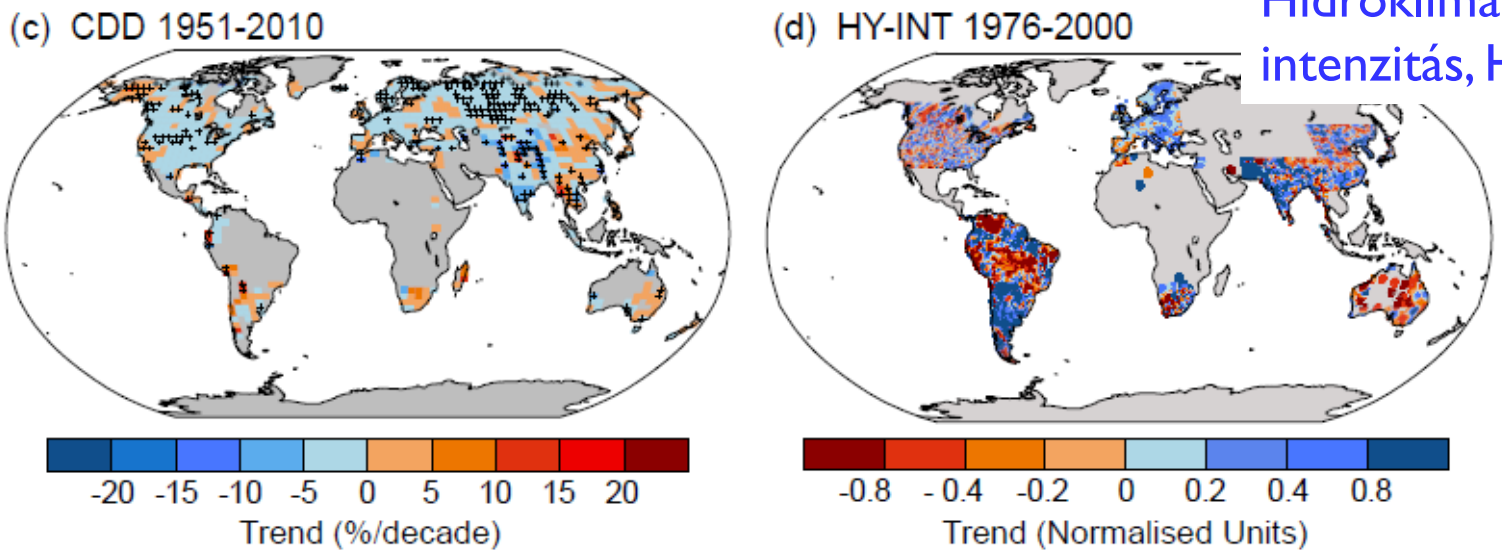
nagy csapadékok aránya az évi összegben, R95p

Napi intenzitás, SDII



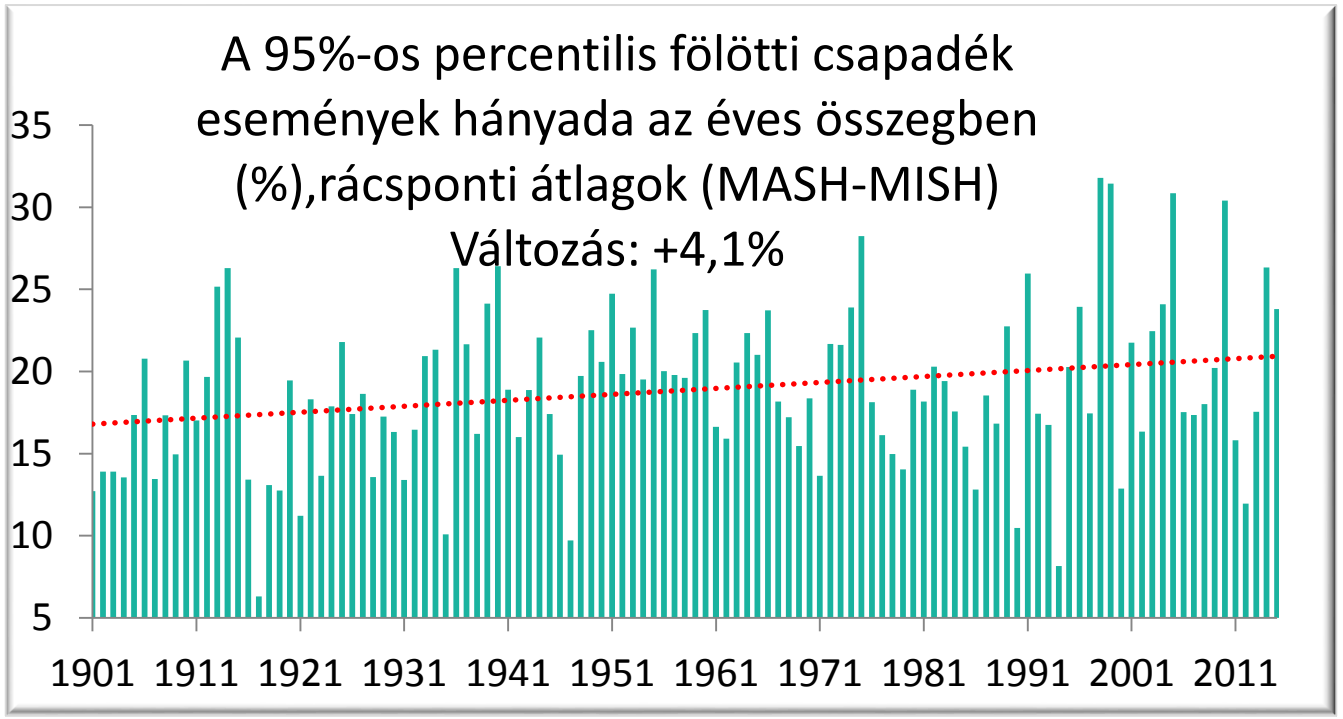
Max száraz időszak, CDD

Hidroklimatológiai intenzitás, HY-INT



IPCC AR5

Motiváció – hazai trendek

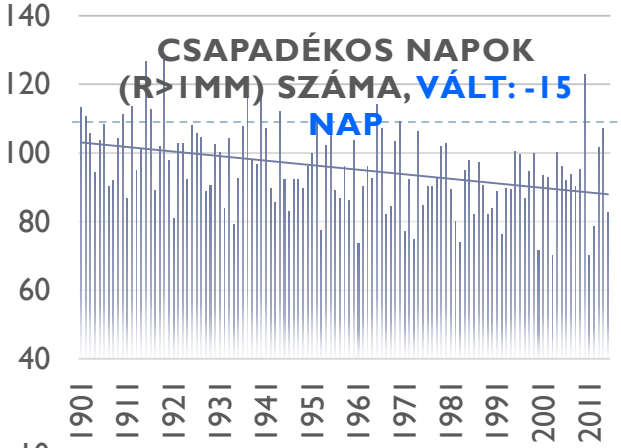


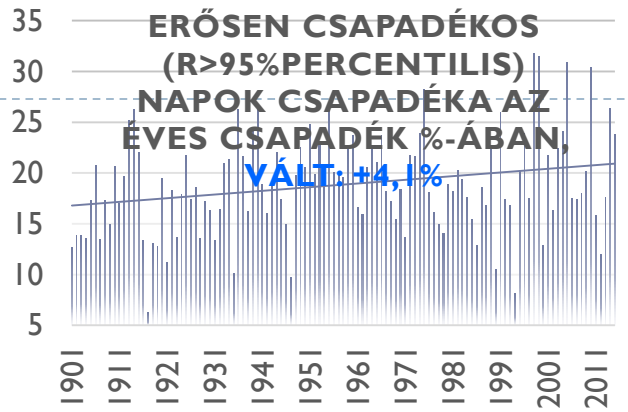
Indicator name	Indicator definitions	Units
Hottest day TXx	Hottest day Monthly maximum value of daily max temperature	°C
Coldest Night TNn	Coldest night Monthly minimum value of daily min temperature	°C
Cool nights TN10p	Cool nights when daily min temperature<10th percentile	days
Cool days TX10p	Cool days when daily max temperature<10 th percentile %	days
Warm nights TN90p	Warm nights when daily min temperature>90 th percentile %	days
Warm days TX90p	Warm days when daily max temperature>90th percentile %	days
Growing season length (5degree) GS5L	Annual count between first span of at least 6 days with TG>5 °C and first span after July 1 of 6 days with TG<5 °C (where TG is daily mean temperature)	days
Growing season start (5degree) GS5Start	Daynumber at the end of the first span of at least 6 days with TG>5 °C (where TG is daily mean temperature)	daynumber
Growing season end (5degree) GS5End	Daynumber for the end of the last span of at least 6 days with TG>5 °C (where TG is daily mean temperature)	daynumber
Growing season length (10 degree) GS10L	Annual count between first span of at least 6 days with TG>10 °C and first span after July 1 of 6 days with TG<10 °C (where TG is daily mean temperature)	daynumber
Growing season start (10 degree) GS10start	Daynumber at the end of the first span of at least 6 days with TG>10 °C (where TG is daily mean temperature)	daynumber
Growing season end (10 degree) GS10End	Daynumber for the end of the last span of at least 6 days with TG>10 °C (where TG is daily mean temperature)	daynumber
Ice days ID	Ice days Annual count when daily maximum temperature<0°	days
Severe cold days ECD	Severe cold days Annual count when daily minimum temperature<-10°	days
Frost days FD	Frost days Annual count when daily minimum temperature<0°	days
Summer days SU	Summer days Annual count when daily max temperature>25°	days
Hot days HD	Hot days Annual count when daily max temperature>30°	days
Extremely hot days EHD	Extremely hot days Annual count when daily max temperature>35°	days
Warm spell duration WSDI	Warm spell duration index Annual count when at least six consecutive days of max temperature>90th percentile	days
Cold spell duration CSDI	Cold spell duration index Annual count when at least six consecutive days of min temperature <10th percentile	days
Max 1 day precip RX1day	Max 1 day precipitation amount Monthly maximum 1 day precipitation	mm
Max 5 day precip RX5day	Max 5 day precipitation amount Monthly maximum consecutive 5 day precipitation	mm
Simple daily intensity SDII	Simple daily intensity index The ratio of annual total precipitation to the number of wet days (≥1 mm)	mm/day
Heavy precipitation days R20	Number of very heavy precipitation days Annual count when precipitation≥20 mm	days
Consecutive dry days CDD	Consecutive dry days Maximum number of consecutive days when precipitation<1 mm	days
Contribution from very wet days R95pTOT	R95pTOT Contribution from very wet days. Annual total precipitation from days>95 th percentile	%

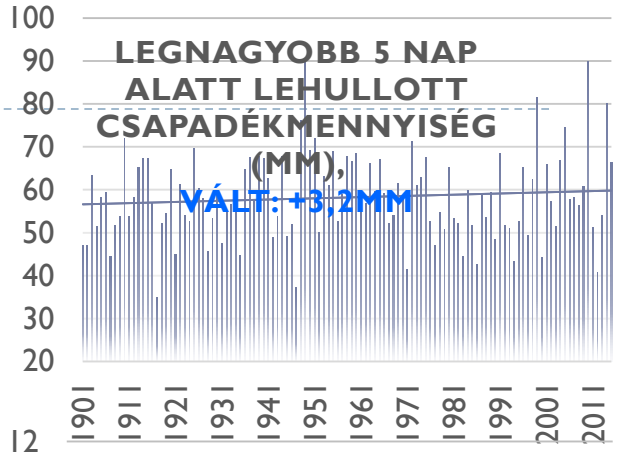
Éghajlati indikátorok/csapadék indexek

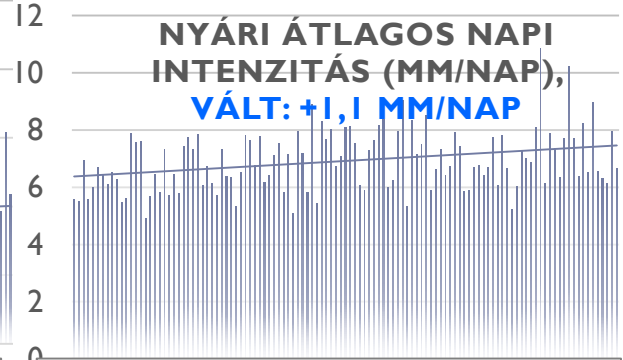
- ✓ 38 féle hőmérséklet és 15 féle csapadék index
- ✓ Percentilis küszöbök: 1961-1990 időszak alapján
- ✓ Éves, évszakos értékek, csapadék indexekre havi értékek is
- ✓ Időszak választás lehetősége
- ✓ Trendillesztés
- ✓ Rácsponti változások

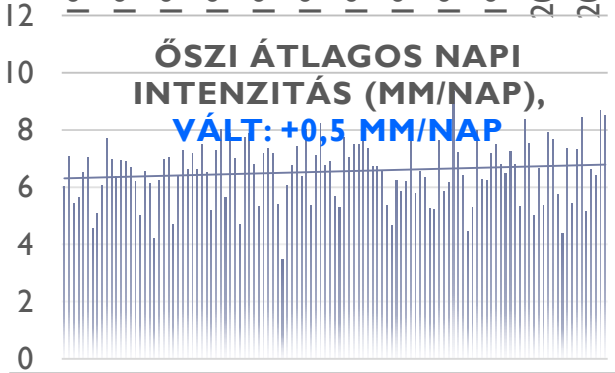
Csapadék indexek 1901-2015 és a változás térben, 1961-2015

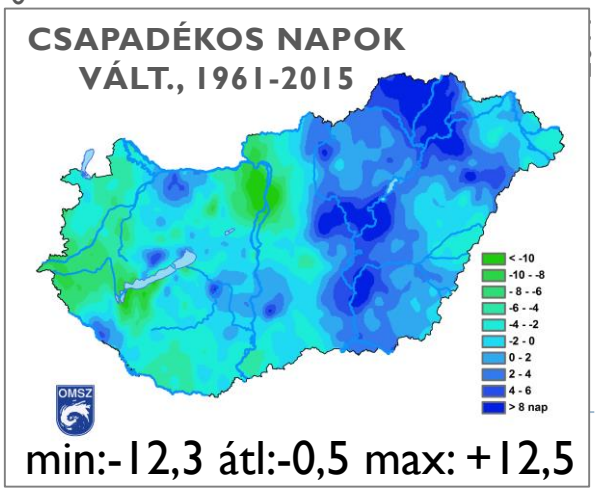




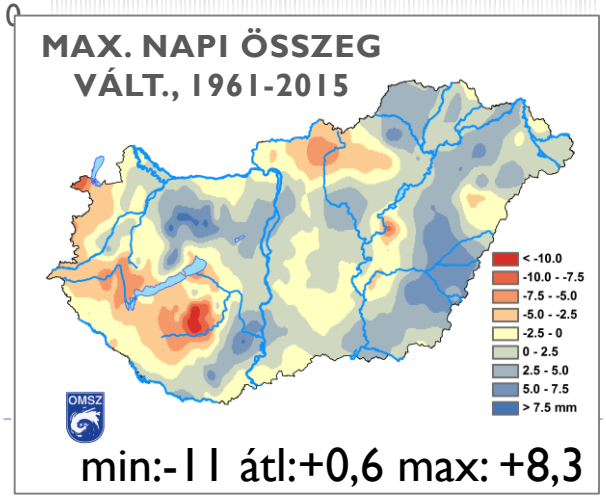




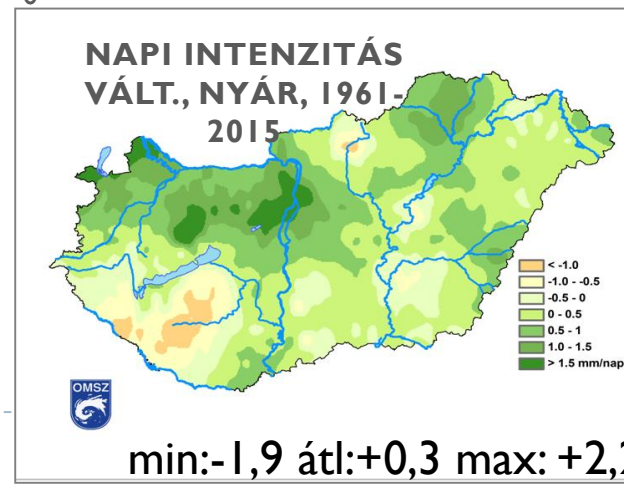




min:-12,3 átl:-0,5 max: +12,5

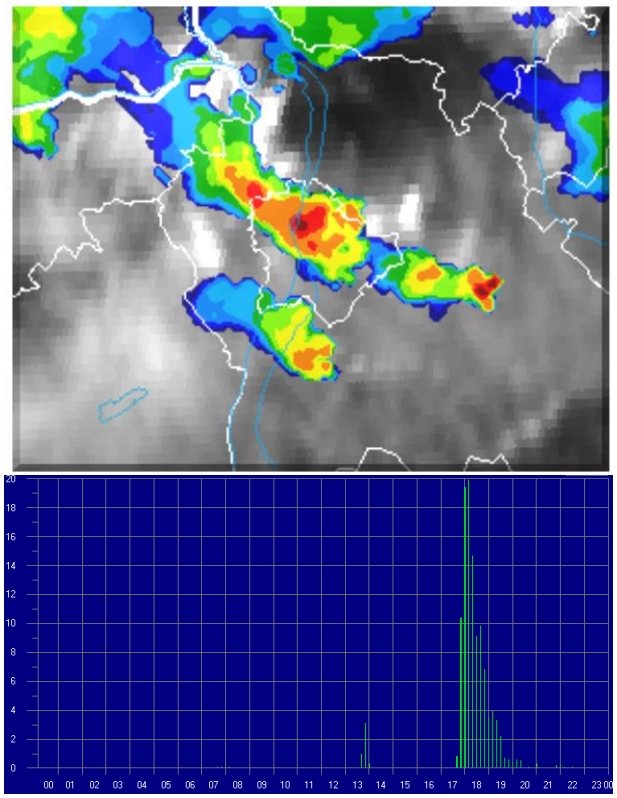


min:-11 átl:+0,6 max: +8,3



min:-1,9 átl:+0,3 max: +2,2

Rövidülő visszatérési idő – 2015. augusztus 17. Budapest

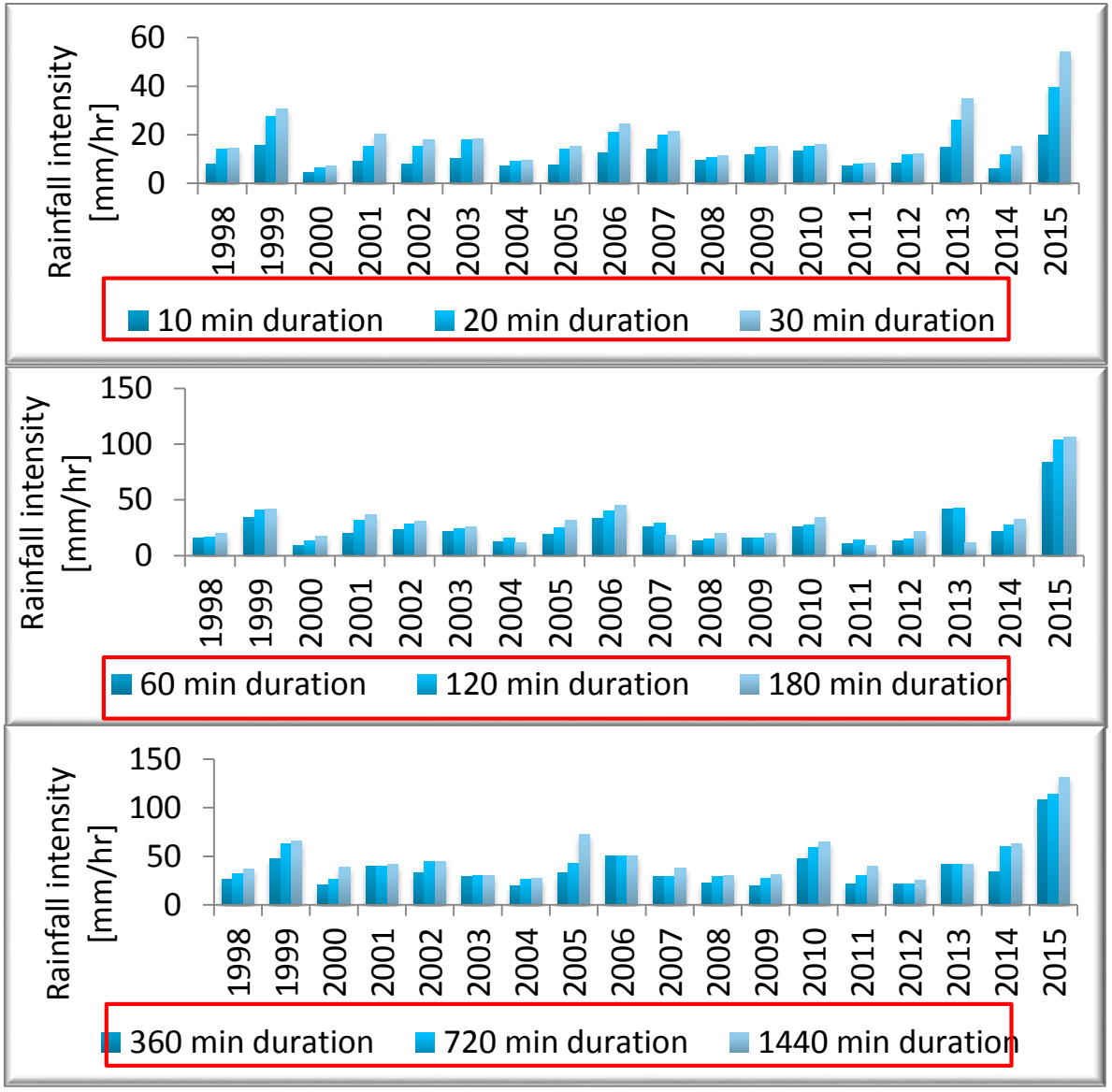


1 óra alatt 83.3mm 18 UTC, Budapest-belterület állomás

60 perces összegek visszatérési értékei (mm)

Vissz. per.	2	4	5	10	20	50	100	200
1998-2014	19.3	25.5	27.4	33	38.7	46.4	52.5	58.9
1998-2015	19.6	28,3	31.4	42.3	55.9	79.9	103.9	134.8

- A különböző tartamok maximumai Budapest-Belterület állomáson, 1998-2015

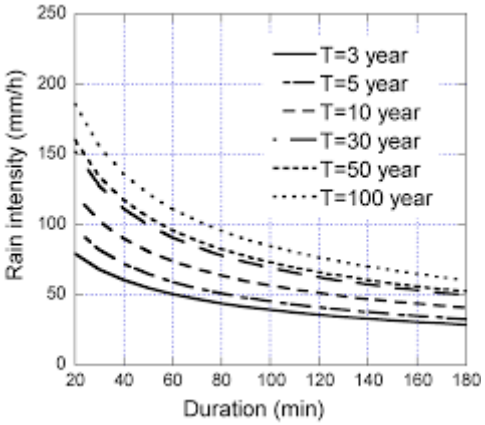


Rövid idejű csapadékok vizsgálata

Intenzitás-tartam-gyakoriság: IDF görbék

Mérnöki feladatok – csatornázás

Módszer: GEV eloszlás (Gumbel) illesztés



10 min duration
(yearly max: avg= 10.41 mm, std=4 mm)

T_{ret} (years)	Gumbel freq. fact.	$Prec_T$ (mm)	$Intensity_T$
2	-0.164	9.75	58.52
5	0.720	13.29	79.75
10	1.305	15.64	93.81
20	1.867	17.88	107.30
50	2.594	20.79	124.75
100	3.138	22.97	137.83

30 min duration
(yearly max: avg= 19.22 mm, std=11.34 mm)

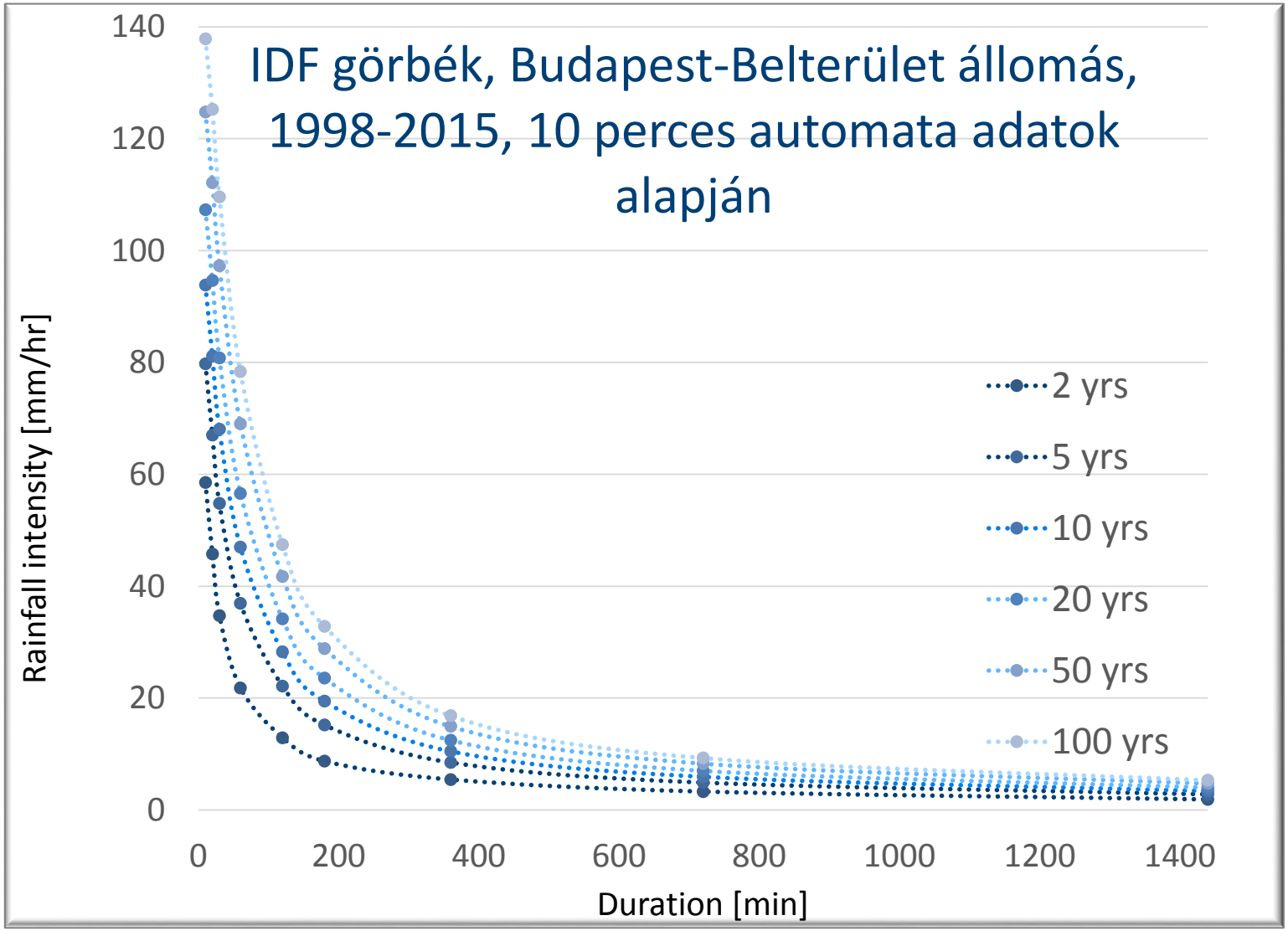
T_{ret} (years)	Gumbel freq. fact.	$Prec_T$ (mm)	$Intensity_T$
2	-0.164	17.36	34.72
5	0.720	27.38	54.76
10	1.305	34.02	68.03
20	1.867	40.38	80.76
50	2.594	48.62	97.24
100	3.138	54.79	109.59

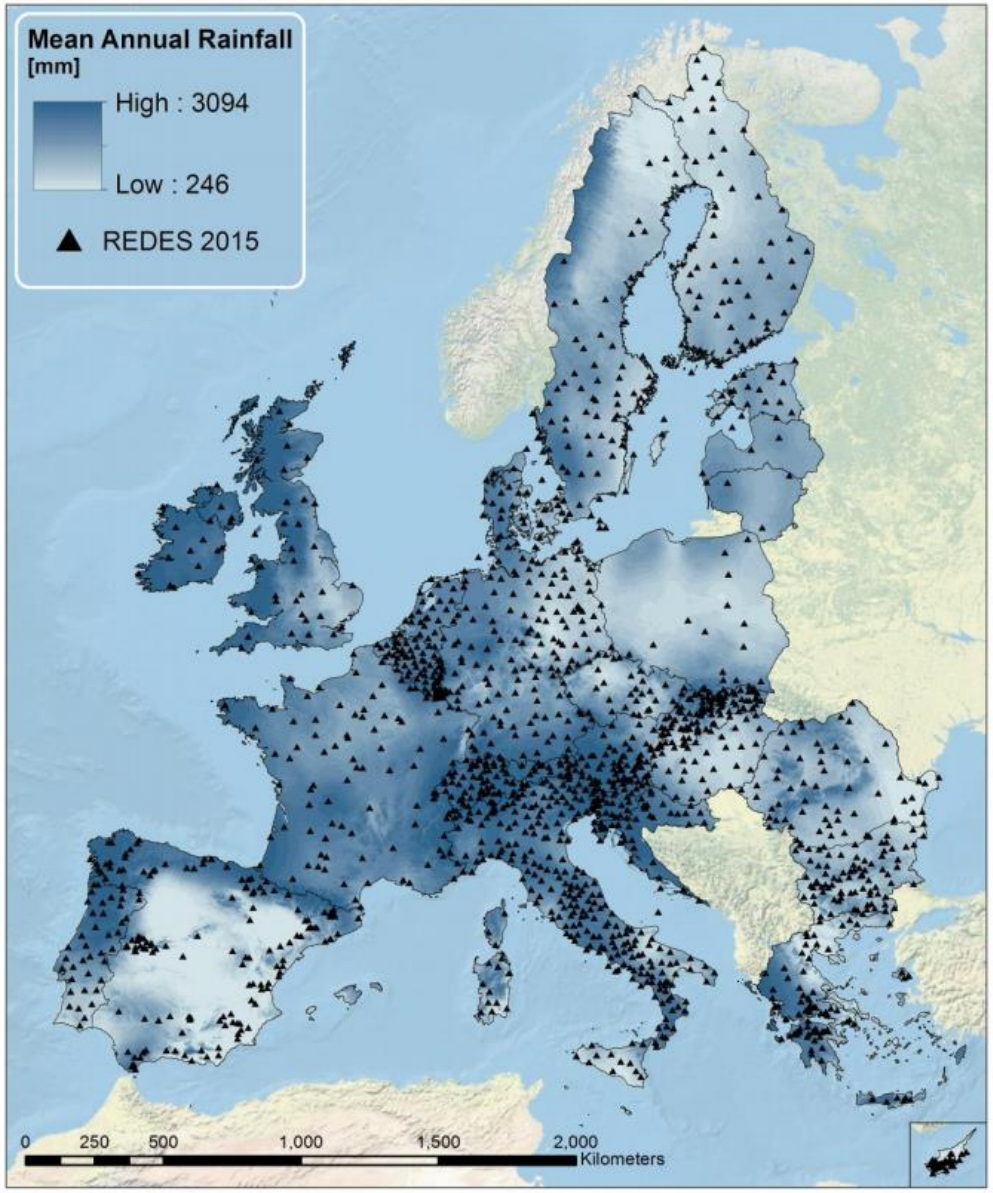
60 min duration
(yearly max: avg= 24.61 mm, std=17.12 mm)

T_{ret} (years)	Gumbel freq. fact.	$Prec_T$ (mm)	$Intensity_T$
2	-0.164	21.80	21.80
5	0.720	36.93	36.93
10	1.305	46.95	46.95
20	1.867	56.56	56.56
50	2.594	69.00	69.00
100	3.138	78.33	78.33

180 min duration
(yearly max: avg= 29.69 mm, std=21.91 mm)

T_{ret} (years)	Gumbel freq. fact.	$Prec_T$ (mm)	$Intensity_T$
2	-0.164	26.09	8.70
5	0.720	45.46	15.15
10	1.305	58.29	19.43
20	1.867	70.59	23.53
50	2.594	86.51	28.84
100	3.138	98.44	32.81


IDF görbék, Budapest-Belterület állomás, 1998-2015, 10 perces automata adatok alapján
Rainfall intensity [mm/hr]
Duration [min]
0
20
40
60
80
100
120
140
0
200
400
600
800
1000
1200
1400
2 yrs
5 yrs
10 yrs
20 yrs
50 yrs
100 yrs



Csapadék erozivitás számítás

REDES: Rainfall Erosivity Database at European Scale

RUSLE talajeróziós modell

R-factor: 1568 állomás 17 évnyi adata

Évi, évszakos, havi (az erozivitás és a felszínborítottság, talajművelés változékonyak éven belül)

30 perces adatok

- RUSLE Rainfall erosivity factor (Brown and Foster, 1987) évi átlagos erozivitás (MJ mm ha^{-1} h^{-1} yr^{-1}):

$$R = \frac{1}{n}\sum_{j=1}^{n}\sum_{k=1}^{mj}(EI_{30})_k$$

- Egy esemény eróziós hatása:

$$EI_{30} = \left(\sum_{r=1}^{0} e_r v_r\right) I_{30}$$

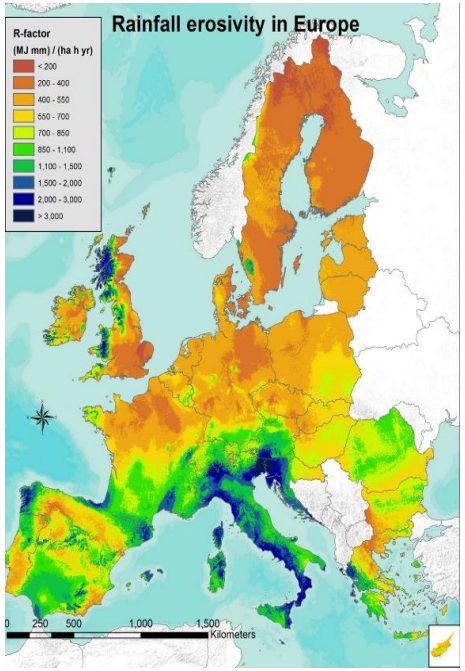
- Egységnyi csapadék energia: e_r:

$$e_r = 1099[1-0.72\exp(-1.27 i_r)]$$

- i_r csap. intenzitás (mm h^{-1}) adott időintervallumban

Brown, L.C., Foster, G.R., 1987. Storm erosivity using idealized intensity distributions.Transactions of the ASAE 30, 379–386.

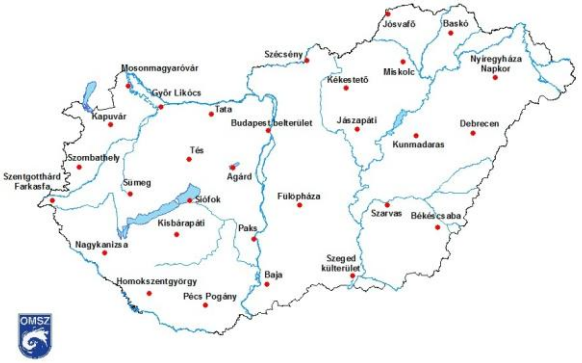
Évi átlagos erozivitás - JRC



Panagos, P., Ballabio, C., Borrelli, P., Meusburger, K., Klik, A., Rousseva, S., Tadić, M.P., Michaelides, S., Hrabalíková, M., Olsen, P., Aalto, J., Lakatos, M., Rymszewicz, A., Dumitrescu, A., Beguería, S., Alewell, C. Rainfall erosivity in Europe. Sci Total Environ. 511 (2015), pp. 801-814. DOI: 10.1016/j.scitotenv.2015.01.008

R-faktor

Date MO/DA/YR	PRECIP mm	DURATION hrs	MAX_5 mm/hr	MAX_15 mm/hr	MAX_30 mm/hr	MAX_60 mm/hr	ENERGY MJ/ha	EI30 MJ*mm/ha*hr
01/20/98	32.50	35.83	3.600	3.600	3.439	3.021	3.175	10.917
04/08/98	15.20	23.00	8.391	6.494	3.836	2.726	1.549	5.940
04/17/98	21.10	12.00	4.800	4.800	4.800	4.200	2.245	10.776
04/18/98	30.10	15.17	9.782	9.368	8.203	7.116	3.584	29.401
05/04/98	25.90	14.50	6.002	5.299	4.407	4.014	2.820	12.425
05/17/98	14.30	9.17	11.406	11.007	10.008	7.355	1.896	18.973



RUSLE Monthly Averages for Period of Data Processed.
Reporting Period: 01/98 - 12/13

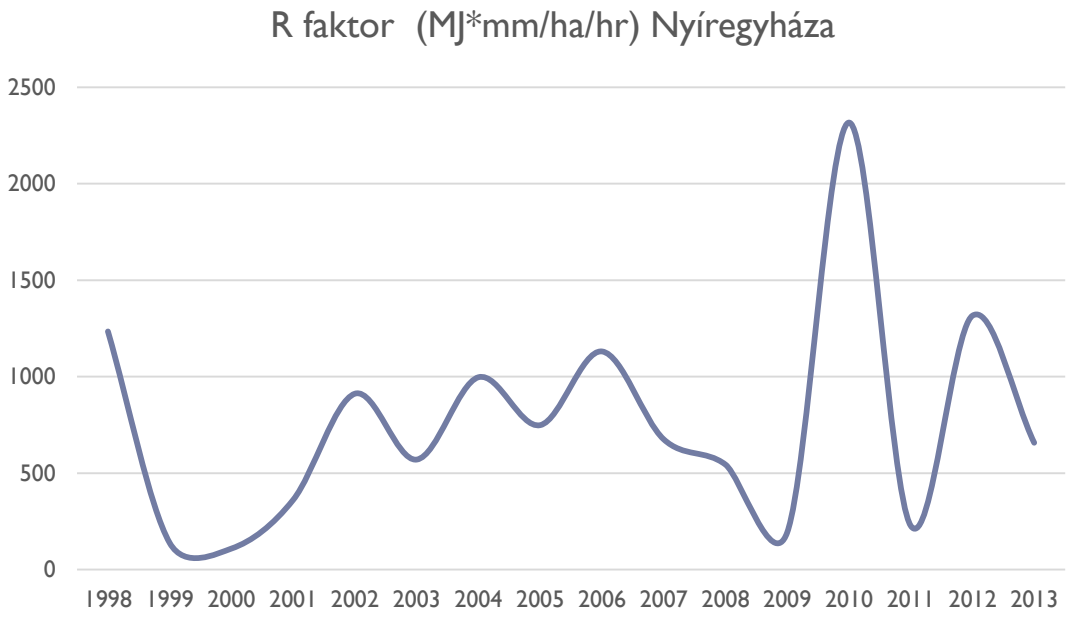
MONTH m	PRECIP mm	ENERGY MJ/ha	EI30 MJ*mm/ha*h	Erosivity_Density MJ/ha*h
1	30.87	1.02	3.32	0.11
2	28.49	0.67	2.09	0.07
3	34.29	1.41	6.59	0.19
4	40.56	2.40	15.29	0.38
5	58.93	5.24	121.22	2.06
6	71.88	9.24	283.83	3.95
7	67.43	7.36	149.77	2.22
8	58.48	8.29	324.38	5.55
9	45.31	3.27	33.59	0.74
10	38.07	2.33	16.75	0.44
11	45.61	2.56	16.48	0.36
12	38.13	1.37	6.28	0.16

RIST eljárás: USDA, 2014. United States Departnment of Agriculture. Rainfall Intensity Summarizaion Tool (RIST). Accessed from http://www.ars.usda.gov/News/docs.htm?docid=3251 [Jun 2014]

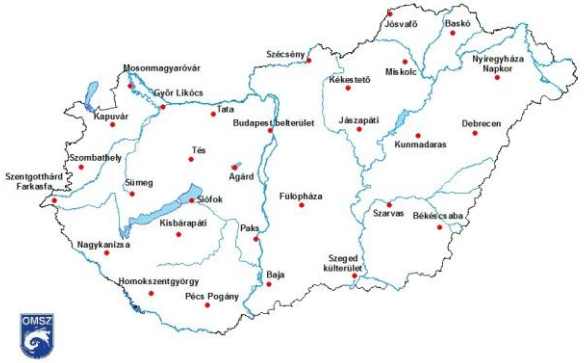
30 db automata állomás 10 perces adataira, 1998-2013

Ouput:

- egyes események erozivitása
- intenzitások különböző tartamokra
- havi átlagos erozivitás



R-faktor

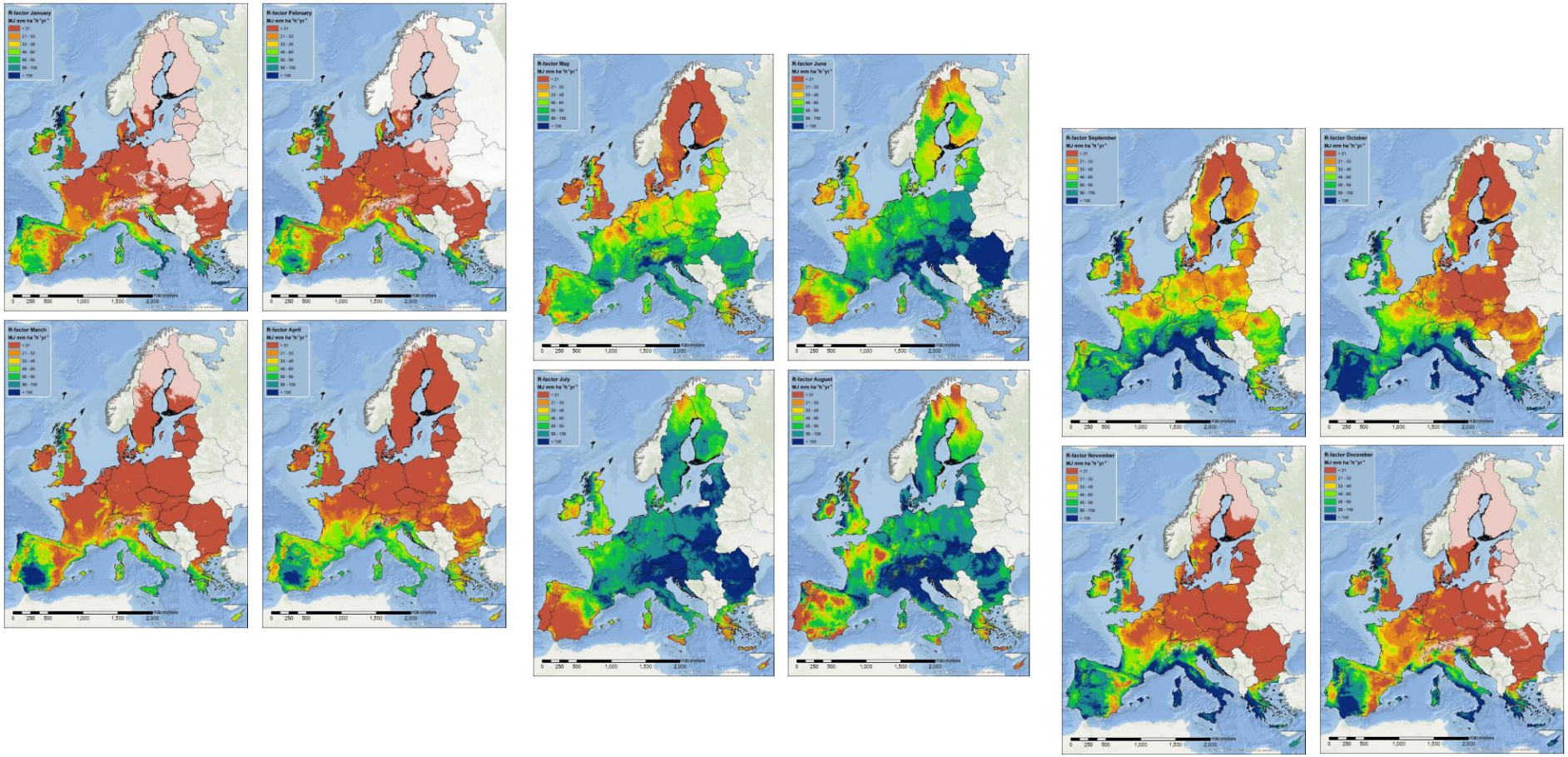


30 db automata állomás 10 perces adataira, 1998-2013

Ouput:

- egyes események erozivitása
- intenzitások különböző tartamokra
- havi átlagos erozivitás

Havi erozivitás térképek



Ballabio, C., Borrelli, P. , Spinoni, J., Meusburger, K., Michaelides, S., Beguería, S., Klik, A., Petan, S., Janecek, M., Olsen, P., Aalto, J., Lakatos, M., Rymszewicz, A., Dumitrescu, A., Tadić, M.P., Nazzareno, D., Kostalova, J., Rousseva, S., Banasik, K., L., Alewell, C. , Panagos, P. . In Press. **Mapping monthly rainfall erosivity in Europe**. Science of the Total Environment , DOI: 10.1016/j.scitotenv.2016.11.123

Köszönöm a figyelmet!

Alapítva: 1870