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ANALYSIS OF RAINLESS PERIODS ON EASTERN SLOVAKIAN LOWLAND

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Precipitation and evapotranspiration are basic compounds of hydrologic cycle. Precipitation are crucial natural source of water in the soil. Precipitation amount and temporal distribution of the rainfall is important for water refilling of the environment for balanced periods. Drying of soil profile occurs during long rainless periods. Meteorological drought and subsequently soil drought occurs in case of sufficiently long rainless period. Therefore it is necessary to know size and statistical characteristics of rainless periods (RLP). The aim of the contribution is to identify important rainless periods, quantify temporal lengths, probability characteristics and trends of RLP. Stated knowledge is necessary for research of water regime of the soils during the creation, duration and disappearance of soil drought.

KEY WORDS: rainless periods, probability, trend

ANALÝZA BEZZRÁŽKOVÝCH OBDOBÍ NA VÝCHODOSLOVENSKEJ NÍŽINE. Zrážky a výpar patria medzi základné zložky hydrologického cyklu. Zrážky sú pritom rozhodujúcim prirodzeným zdrojom vody v pôde. Pre doplňanie vody v prírodnom prostredí je dôležitý nielen úhrn zrážok za bilancované obdobie ale aj ich časové rozloženie. V prípade dlhých bezzrážkových období dochádza k vysušovaniu pôdneho profilu. Pri dostatočne dlhom bezzrážkovom období dochádza k tvorbe meteorologického a následne pôdneho sucha. Z toho dôvodu je potrebné poznať veľkosť a štatistické charakteristiky bezzrážkových období (BZO). Cieľom príspevku je identifikovať významné bezzrážkové obdobia, kvantifikovať ich časovú dĺžku pravdepodobnostné vlastnosti a vývojové trendy. Uvedené poznatky sú nevyhnutné pre skúmanie vodného režimu pôd v procese tvorby, trvania a zániku pôdneho sucha.

KĽÚČOVÉ SLOVÁ: bezzrážkové obdobia, pravdepodobnosť, trend

Introduce

Precipitation and evapotranspiration are basic compounds of hydrologic cycle. Precipitation are crucial natural source of water in the soil. Precipitation amount and temporal distribution of the rainfall is important for water refilling of the environment for balanced periods. Drying of soil profile occurs during long rainless periods. Meteorological drought and subsequently soil drought occurs in case of sufficiently long rainless period. Therefore it is necessary to know size and statistical characteristics of rainless periods (RLP).
The aim of the contribution is to identify important rainless periods, quantify temporal lengths, probability characteristics and trends of RLP. Stated knowledge is necessary for research of water regime of the soils during the creation, duration and disappearance of soil drought.

Material and methods

Methodical process of the research consists of three phases: rainless periods selection, statictical characterristic calculation and results interpretation. Climatic station of Milhostov (N 48°39,786´; E 21°43,298´) was chosen for selection of statistically important rainless periods. Station is located at central part of Eastern Slovakian Lowland (ESL) and represents wider area of lowland. Daily precipitation amounts of the 1961-2015 period was examined for the station. 20080 daily precipitation amounts (including zero) were analyzed for the period. Length of RLP was identified separately for whole years of examined periods and separately for vegetation periods (VP). Selections of RLP were applied for VP examination in two ways. Periods with zero daily precipitation amounts were considered in first selection (s0). Daily precipitation amounts lower than

2 mm were considered as zero in second selection (s2). These precipitation are likely to be catched by the plant cover and subsequently vaporized without influencing soil water supply. Selection of rainless periods during VP was done only of those which occurred during vegetation periods (april-spetember). However, periods that starts before VP and overlap to VP and those that starts during VP and finished after VP were considered as well. Rainless periods of the 1961-2015 were probability-evaluated in every selection group. Just (s0) selection was applied during examination of entire year periods. Basic statistical characteristics were calculated after identification of RLP. Probability characteristics of occurrence of different RLP temporal duration were calculated by binomial distribution. The results are indicated in form of frequency curves. Development of number of rainless days during individual years and VP was evaluated. For example - 10 longest RLP during 1961-2015 were selected for every selection.

Results and discussion

Basic characteristics of descriptive statistics are indicated in table 1. It results that 12185 days (60.68 %) were with no precipitation in one year selection data series. Days without rainfall were grouped to 3409 periods. 63.87 % of days without rainfall were in case of VP and s0 selection and 85.12 % days without rainfall in case of VP and s2 selection. The longest RLP duration was 35 days for s0 selection and 53 days for s2 selection.

Eloquent image of probability of occurence of maximal year durations of RLP gives probability of exceedance curves. Curves are indicated in fig. 1. Thereof results that only little differences are between course of yearly and vegetation selections of s0. Length of RLP with p = 50 % probability of exceedance is for this selection of VP 13 days and for the year 15.5 days. This value is 23.3 days for selection s2 during vegetation period.

Table 1. Basic statistical characteristics of rainless periods
Tabuľka 1. Základné štatistické charakteristiky bezzrážkových období

Parameters	*YEAR*	*VP*	*VP*
Selection	f(0)	f(0)	f(2)
Mean	3.57	3.67	6.15
Standard Error	0.06	0.08	0.17
Median	2	2	4
Mode	1	1	1
Standard Deviation	3.52	3.51	6.31
Sample Variance	12.41	12.30	39.84
Kurtosis	10.98	9.66	8.47
Skewness	2.64	2.47	2.45
Range	34	34	52
Minimum	1	1	1
Maximum	35	35	53
Sum	12185	6429	8567
Count	3409	1751	1393
Confidence level(95,0%)	0.12	0.16	0.33

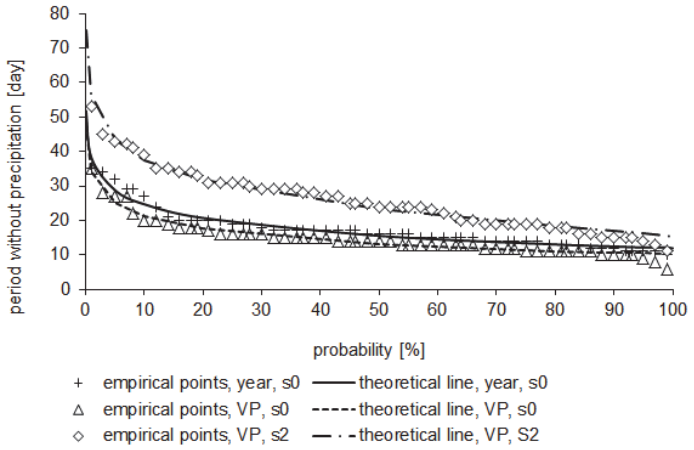

Fig. 1. Empirical and theoretical probability of exceedance curves of maximal year durations of rainless periods.
Obr. 1. Empirické a teoretické čiary prekročenia maximálnych ročných trvaní bezzrážkových období.

The course of probability of exceedance curve is in case of s2 selection moved and more steep. This indicates greater variability and longer duration of RLP.

Numbers of days without rainfall are indicated on fig. 2 for individual years and their vegetation periods for selections s0 and s2. Developmental trends are for all cases parallel with timeline. It is testified by the fact that number of rainy and rainless days is for individual years and their vegetation periods balanced in the long term view. Only duration of rainless events of non-vegetation periods changes in examined periods. It is confirmed by the results that are graphically shown in the figure 3. There are indicated numbers of days of rainless periods that lasts 10 days or more for VP of individual years. From the figure results that trend development of both selections s0 and s2 is stable without change (parallel to the timeline) during vegetation periods. Elongated trend of rainless periods with duration of 9 days or more was identified in case of s0 yearly selection. These results show that this trend is caused by rainless events during non-vegetation periods. Stated fact has influence on creation of water storage during before-spring periods and enlarges risk of drought.

As an example, 10 longest rainless periods with date of its occurrence, theoretical probability and periodicity of incidence is indicated in table 2 for every selection series (year, s0, VP, s0 and VP, s2). Absolutely longest continuous period without rainfall for s0 selection (year, VP) had 35 days and occurred between 25.9.1962-29.10.1962.

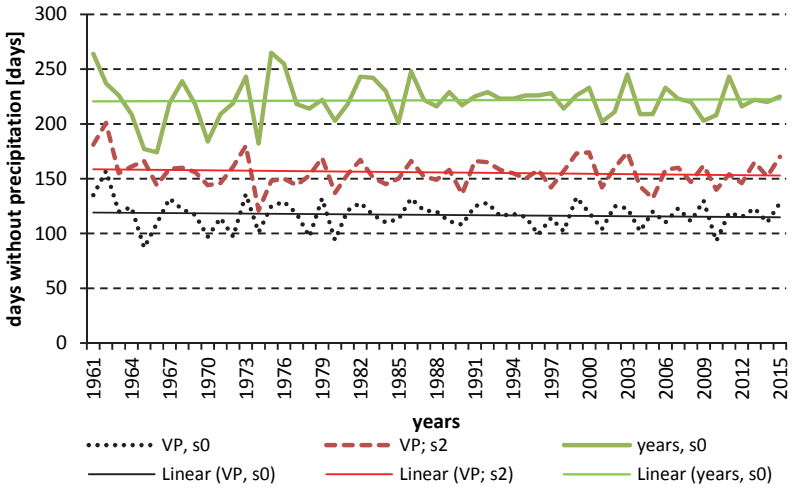

Fig. 2. Number of days without rainfall in individual years during period 1961-2015.
Obr. 2. Počet dní bez zrážok v jednotlivých rokoch obdobia 1961 až 2015.

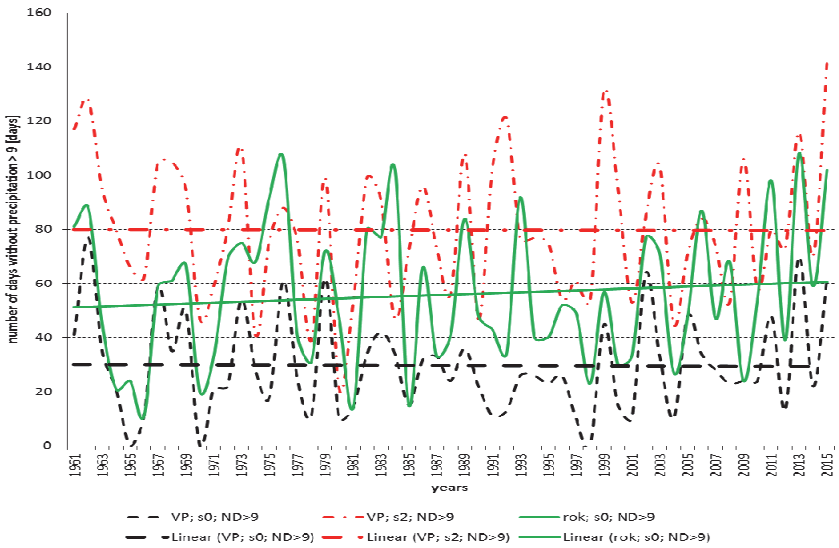

Fig. 3. Number of days during rainless periods with duration of 9 days or more.
Obr. 3. Počet dní v bezzrážkových obdobiach s trvaním viac ako 9 dní.

Table 2. Ten longest rainless periods in every selection series, their theoretical probability of incidence and periodicity

Tabuľka 2. Desať najdlhších bezzrážkových období v každom výberovom rade, ich teoretická pravdepodobnosť výskytu a periodicita

Daily precipitation totals to 0,0 mm; period year					Daily precipitation totals to 0,0 mm; vegetation period					Daily precipitation totals to 2,0 mm; vegetation period				
start PWP	end PWP	number	theoretical value		start PWP	end PWP	number	theoretical value		start PWP	end PWP	number	theoretical value	
from	to	of days	probability	periodicity	from	to	of days	probability	periodicity	from	to	of days	probability	periodicity
date		[days]	[%]	[years]	date		[days]	[%]	[years]	date		[days]	[%]	[years]
25.09.62	29.10.62	35	1,0	105	25.09.62	29.10.62	35	2,3	43	19.07.67	09.09.67	53	2,1	48
22.10.11	24.11.11	34	1,1	87	18.03.74	14.04.74	28	6,0	17	09.09.06	23.10.06	45	4,5	22
30.01.76	01.03.76	32	2,0	49	05.08.76	31.08.76	27	7,2	14	19.09.62	31.10.62	43	5,4	18
16.02.74	16.03.74	29	3,3	30	14.03.05	09.04.05	27	7,2	14	08.09.61	19.10.61	42	6,3	16
22.10.75	19.11.75	29	3,3	30	15.09.11	06.10.11	22	16,8	6	12.08.74	21.09.74	41	7,1	14
18.03.74	14.04.74	28	3,8	26	24.03.99	12.04.99	20	24,2	4	23.09.00	31.10.00	39	8,8	11
05.08.76	31.08.76	27	4,2	24	23.03.02	11.04.02	20	24,2	4	06.04.62	10.05.62	35	14,3	7
14.03.05	09.04.05	27	4,2	24	02.07.06	20.07.06	19	30,0	3	05.09.89	09.10.89	35	14,3	7
05.10.65	28.10.65	24	6,6	15	14.09.75	01.10.75	18	35,8	3	30.07.15	02.09.15	35	14,3	7
15.09.11	06.10.11	22	9,2	11	17.06.76	04.07.76	18	35,8	3	16.05.64	18.06.64	34	16,0	6

Maximal continuous rainless event extends to 53 days in case of s2 selection for vegetation period. This event occurred in time interval 19.7.1967-9.9. 1967. Precipitation amount was only 1.6 mm in this time interval. This time interval can be considered as rainless period. From table 2 results that the most important rainless periods predominantly occurred in 60´s and after the year 2000.

Extremely dry year 2015 does not appear in s0 selection, however, it was identified in s2 selection. 35 day continuous period during which was total precipitation amount of 2.5 mm occurred. This year was unique in that 91 rainless days between 28.5.2015 – 2.9.2015 were associated in 4 seasons by 18, 22, 16 and 35 days in selection s2.

Conclusion

Precipitation amount and temporal distribution of the rainfall is important for water refilling of the environment for balanced periods. Drying of soil profile occurs during long rainless periods. Meteorological drought and subsequently soil drought occurs in case of sufficiently long rainless period. Therefore it is necessary to know size and statistical characteristics of rainless periods (RLP). The aim of the contribution is to identify important rainless periods, quantify temporal lengths, probability characteristics and trends of RLP. Climatic station of Milhostov (N 48°39,786´; E 21°43,298´) was chosen for selection of statistically important rainless periods. Station represents wider area of lowland. Daily precipitation amounts of the 1961-2015 period was examined for the station. 20080 daily precipitation amounts (including zero) were analyzed for the period. Length of RLP was identified in two ways. Periods with zero daily precipitation amounts were considered in first selection (s0). Daily precipitation amounts lower than 2 mm were considered as zero in second selection (s2). Absolutely longest continuous period without rainfall for s0 selection (year, VP) had 35 days and occurred between 25.9.1962-29.10.1962. Maximal continuous rainless event extends to 53 days in case of s2 selection for vegetation period. This event occurred in time interval 19.7.1967-9.9. 1967. Number of rainy and rainless days is for individual years and their vegetation periods balanced in the long term view. Only duration of rainless events of non-vegetation periods changes in examined periods. Growth of time length of rainless days duration was identified in non-vegetation half-year.

Acknowledgement

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ANALÝZA BEZZRÁŽKOVÝCH OBDOBÍ NA VÝCHODOSLOVENSKEJ NÍŽINE

Pre dopĺňanie vody v prírodnom prostredí je dôležitý nielen úhrn zrážok za bilancované obdobie ale aj ich časové rozloženie. V prípade dlhých bezzrážkových období dochádza k vysušovaniu pôdneho profilu. Pri dostatočne dlhom bezzrážkovom období dochádza k tvorbe meteorologického a následne pôdneho sucha. Z toho dôvodu je potrebné poznať veľkosť a štatistické charakteristiky bezzrážkových období (BZO). Cieľom príspevku je identifikovať významné bezzrážkové obdobia, kvantifikovať ich časovú dĺžku pravdepodobnostné vlastnosti a vývojové trendy. Pre výber štatisticky významných bezzrážkových období bola zvolená klimatická stanica Milhostov. Reprezentuje širšie územie VSN. V tejto stanici boli skúmané denné úhrny zrážok v období rokov 1961 až 2015. V tomto období bolo analyzovaných 20080 denných zrážkových úhrnov (vrátane nulových). Dĺžka bezzrážkových období bola identifikovaná dvojakým spôsobom. Pri prvom výbere (s0) boli zohľadňované iba obdobia s nulovými dennými úhrnami zrážok. V druhom prípade (s2) boli denné úhrny zrážok do 2 mm chápané ako nulové. Absolútne najdlhšie súvislé obdobie bez zrážok pre výber s0 (rok, VP) malo 35 dní a vyskytlo sa v čase od 25.9.1962 do 29.10.1962. V prípade výberu s2 pre vegetačné obdobie sa maximálna súvislá bezzrážková udalosť predlžuje na 53 dni. Táto sa vyskytla v časovom intervale 19.7.1967 až 9.9.1967. Počet zrážkových a bezzrážkových dní je v jednotlivých rokoch a ich vegetačných obdobiach z dlhodobého hľadiska vyrovnaný. Mení sa iba dĺžka trvania bezzrážkových udalostí v skúmaných obdobiach. Bol identifikovaný nárast časovej dĺžky trvania bezzrážkových dní v chladnom polroku.

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