

CLASSIFICATION OF PRECIPITATION INTENSITY DURING VEGETATION SEASON IN CENTRAL-EASTERN POLAND (1971–2005)

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ABSTRACT

The data used in this paper come from nine IMGW stations from central-eastern region of Poland and they were registered between the years 1971–2005. On the basis of daily precipitation sums analysis during vegetation season, the number of days with precipitation was determined in particular classes. In central-eastern Poland during vegetation season days with very little and little precipitation were noted most frequently. Very little precipitation occurred most frequently in April; little, moderate and moderately strong precipitation - in June, and strong precipitation - in July. Whereas very strong precipitation was noted most frequently in June and July. Days with very little and little precipitation were noted most frequently in northern and north-eastern part of the area examined. While the number of days with moderate, moderately strong and strong precipitation showed little spatial diversity. Very strong precipitation was noted the most frequently in the area of Legionowo and Ostroleka. The number of days with very little precipitation during vegetation season was decreasing in subsequent years of the study. Statistically significant negative directional coefficients of the trend were noted most frequently in April. The number of days with very strong precipitation was also decreasing significantly in most of the stations.

Keywords: number of days with precipitation, vegetation season, changes tendencies, central-eastern Poland.

INTRODUCTION

In recent years large variability of the precipitation conditions can be observed, therefore, many studies relate to the characteristics of this meteorological element [Banaszkiewicz et al. 2004, 2007, Hutorowicz et al. 1996, Nowicka and Grabowska 1989, Szwejkowski et al. 2002, Scigalska and Labuz 2009]. Longer periods of precipitation deficiency are the cause of droughts, while even short duration of high intensity precipitation may result in soil erosion [Zyromski 2002] and cause floods. According to Kirschenstein [2002a, b, 2004] on the basis of long-term observation series the variation of a specific meteorological element can be evaluated. The aim of this study was to determine the number of days with different intensity of precipitation in central-eastern Poland during the multiyear 1971–2005.

MATERIAL AND METHODS

Data used in this paper refer to daily precipitation sums and they were registered in nine IMGW stations from central-eastern region of Poland in the years 1971–2005 (Table 1).

During vegetation season the number of days with precipitation was determined in particular classes according to Olechnowicz-Bobrowska criterion [1970]:

Precipitation classes (mm) Days with precipitation:

0,1–1,0	very little
1,1–5,0	little
5,1–10,0	moderate
10,1–20,0	moderately strong
20,1–30,0	strong
>30,0	very strong

Table 1. Geographic coordinates of synoptic and climatic IMGW stations in central-eastern Poland

Station	Geographic coordinates		H _s
	<P°	l°	
Ostroleka	53° 05'	21° 34'	95
Bialowieza	52° 42'	23° 51'	164
Wlodawa	51° 33'	23° 32'	163
Szepietowo	52° 51'	22° 33'	150
Legionowo	52° 24'	20° 58'	93
Biala Podlaska	52° 02'	23° 05'	133
Sobieszyn	51° 37'	22° 09'	135
Pultusk	52° 44'	21° 06'	95
Siedlce	52° 11'	22° 16'	146

Explanations: cp° – geographic latitude, V – geographic longitude, H_s – elevation above sea level.

The direction and significance of changes tendencies of the number of days with precipitation in particular classes was determined on the basis of linear trend equations. The significance of directional coefficient of the trend was estimated with t-Student test where significance level $\alpha = 0,05$.

RESULTS AND DISCUSSION

In central-eastern Poland during the vegetation season (1971–2005) the most frequently were noted days with very little precipitation and little precipitation, 20,73 days and 26,97 days respectively (Table 2). During the analyzed period among all the precipitation classes the least numerous were the days with strong precipitation (2,35 days). While there were almost two times more (4,16) days with very strong precipitation (>30 mm). Days with moderate and moderately strong precipitation during vegetation season were noted 11,24 and 7,15 respectively. Very little precipitation occurred most frequently in April,

little, moderate and moderately strong precipitation – in June, and strong – in July. Whereas very strong precipitation (>30 mm) was noted the most frequently in June and July. Days with observed precipitation (>0,1 mm) constituted about 40% of all the days of vegetation season (IV–IX).

The analysis of spatial distribution of days with precipitation showed that days with very little and little precipitation were noted most frequently in northern and north-eastern part of the area examined (Figure 1). While the number of days with moderate, moderately strong and strong precipitation showed little spatial variety. The number of the days with moderate precipitation during vegetation season ranged from 10,62 (Biala Podlaska) to 11,81 (Bialowieza), with moderately strong precipitation from 6,50 (Siedlce) to 7,79 (Bialowieza), with strong precipitation from 1,78 (Pultusk) to 2,9 (Legionowo). Very strong precipitation was noted most frequently in the area of Legionowo (5,06 days) and Ostrolejca (5,0 days). While the smallest number of days with very strong precipitation during vegetation season occurred in Siedlce (2,67 days). Characterizing precipitation conditions on meteorological station Puczniw between the years 1972–2002 Baryla et al. [2012] concluded that an important characteristics was the probability of high daily precipitation (assumed > 10,1 mm) occurrence. Among that 65% constituted precipitation from the range of 10,1–20,0 mm, occurring throughout the year. Maxima > 50 mm, which may cause material loss in agriculture, constituted barely 2,0% of all the cases and occurred in the period of time between May and August.

On the basis of the analysis of directional coefficients of the trend of the number of days with precipitation in central-eastern Poland, it can be stated that the number of days with very little precipitation during vegetation season decreased in subsequent years of the study (Table 3). Sta-

Table 2. Average number of days with precipitation during vegetation season in central-eastern Poland between the years 1971–2005

Month/Class	0,1–1,0 mm	1,1–5,0 mm	5,1–10,0 mm	10,1–20 mm	20,1–30 mm	>30 mm
IV	4,26	4,76	1,51	0,74	0,28	0,40
V	3,37	4,48	1,75	1,01	0,36	0,59
VI	3,21	4,98	2,29	1,51	0,38	0,87
VII	3,30	4,44	2,06	1,48	0,55	0,87
VIII	2,95	3,72	1,79	1,26	0,45	0,77
IX	3,66	4,59	1,84	1,14	0,33	0,66
Sum IV–IX	20,73	26,97	11,24	7,15	2,35	4,16



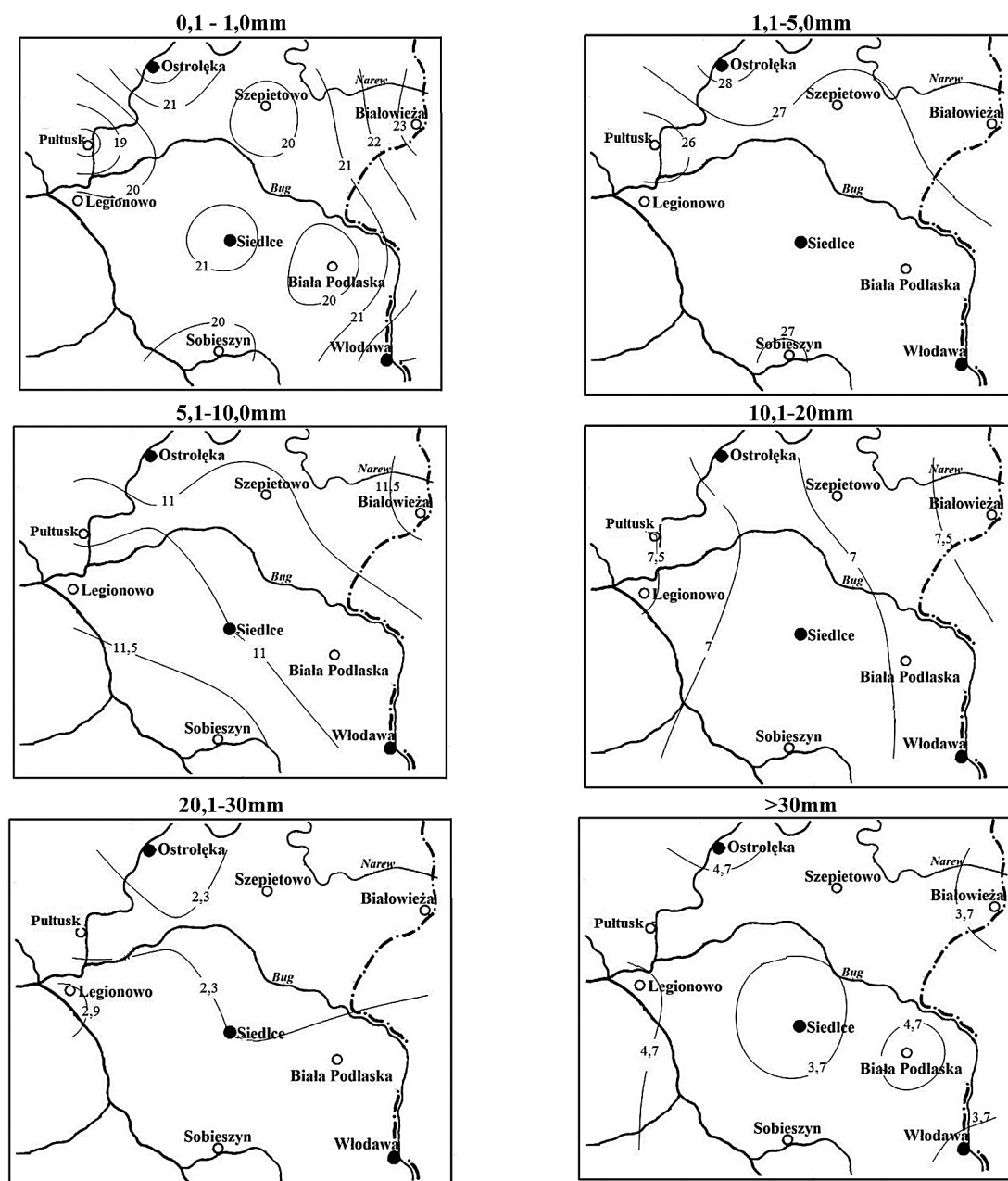


Figure 1. Spatial distribution of the number of days with precipitation during vegetation season (IV–IX) in central-eastern Poland between the years 1971–2005

tistically significant negative directional coefficients of the trend were noted most frequently in April. While in station Pultusk they were significant in all of the vegetation season's months, except for July. The number of days with moderate precipitation increased significantly about 0,5 day in 10 years during vegetation season, especially in July. While the number of days with very strong precipitation during vegetation season was decreasing significantly in most of the stations, however, directional coefficients of the trend values were low (from $-0,11^*$ to $-0,042^*$). In stations Białowieża and Ostrołęka

there were no significant changes in the number of days with very strong precipitation, whereas in stations Włodawa nad Legionowo significances occurred only in June. Uscka-Kowalkowska and Kejna [2009] characterizing variability of thermal-precipitation conditions in Koniczynka (Chelmińskie Lakeland) in the period 1994–2007 concluded that in case of precipitation not only their sum is important but also the temporal distribution. On average 169,9 days with precipitation ($> 0,1$ mm) per year occurred in Koniczynka in the period 1994–2007. Their number was highly variable year by year. The least number of days

Table 3. Directional coefficients of the trend of the number of days with precipitation during vegetation season (IV–IX) in central-eastern Poland between the years 1971–2005

	0,1–1,0 mm	1,1–5,0 mm	5,1–10,0 mm	10,1–20,0 mm	20,1–30,0 mm	>30,0 mm
Białowieża						
IV	-0,106*	-0,035	-0,040*	-0,013	0,005	0,007
V	-0,060	-0,032	0,016	0,007	0,001	0,010
VI	-0,017	-0,036	-0,007	0,004	-0,017*	-0,005
VII	-0,025	-0,015	-0,021	-0,012	-0,006	0,000
VIII	-0,074*	0,082*	0,002	-0,003	-0,021*	0,004
IX	-0,058*	-0,010	-0,033	0,001	-0,005	0,012
Ostrołęka						
IV	0,003	-0,020	0,009	0,013	0,010	0,011
V	-0,063	-0,024	0,035	-0,024	-0,016	-0,011
VI	-0,068	0,012	-0,049	-0,005	-0,006	-0,025
VII	-0,020	-0,106*	0,038	-0,034	-0,021	-0,009
VIII	-0,022	-0,057	-0,005	0,005	-0,021	-0,014
IX	-0,007	-0,046	-0,035	-0,002	-0,004	-0,003
Siedlce						
IV	-0,049	0,029	0,001	-0,010	0,001	-0,019*
V	-0,018	0,027	-0,009	-0,008	-0,005	-0,029*
VI	0,009	0,018	0,001	-0,025	0,002	-0,043
VII	-0,063*	-0,002	0,060*	-0,017	-0,017	-0,036*
VIII	-0,042	0,025	-0,010	-0,027	0,011	-0,038*
IX	-0,015	-0,041	0,046	0,001	-0,026*	-0,027*
Włodawa						
IV	-0,064*	0,060	0,000	0,012	0,013	-0,003
V	0,014	0,014	-0,006	0,013	0,011	-0,015
VI	0,014*	0,008	-0,008	-0,045	0,018	-0,027*
VII	-0,031	-0,034	0,027	-0,009	-0,012	-0,024
VIII	0,022	0,015	0,010	0,015	0,014	-0,018
IX	0,011	-0,042	0,040	0,038*	-0,005	-0,013
Legionowo						
IV	-0,024	0,022	-0,008	0,037*	0,011	-0,010
V	0,034	-0,032	0,020	0,018	0,019	-0,006
VI	0,013	0,032	-0,017	-0,031	0,012	-0,027*
VII	-0,020	-0,031	0,057*	0,008	-0,010	-0,017
VIII	0,030	0,038	0,002	0,043*	0,003	-0,020
IX	0,044	-0,039	-0,001	0,009	-0,006	-0,004
Pułtusk						
IV	-0,123*	0,011	-0,019	-0,001	-0,005	-0,017*
V	-0,055*	0,029	0,015	-0,011	-0,002	-0,029*
VI	-0,074*	0,045	-0,011	-0,005	-0,007	-0,035*
VII	-0,043	-0,062	0,035	0,003	-0,005	-0,032*
VIII	-0,074*	0,038	0,011	-0,024	-0,014	-0,038*
IX	-0,077*	-0,023	-0,018	-0,003*	0,001	-0,030*
Biała Podlaska						
IV	0,071*	0,040	0,035*	-0,011	0,008	-0,013
V	0,000	0,025	0,011	-0,008	-0,012	-0,028*
VI	-0,010	0,035	-0,001	-0,011	-0,001	-0,039*
VII	-0,017	-0,088	0,020	-0,013	-0,024	-0,027*
VIII	0,061	-0,063	0,034	0,036	-0,001	-0,024*
IX	0,068	-0,041	0,076*	-0,031	0,000	-0,009
Sobieszyn						
IV	-0,006	0,020	-0,018	-0,020*	0,013	-0,022*
V	-0,003	-0,055	-0,026	0,008	-0,003	-0,031*
VI	0,036	0,027	-0,005	-0,033	0,013	-0,042*
VII	-0,043	0,004	0,068*	0,027	0,011	-0,040*
VIII	-0,017	0,004	-0,003	0,019	-0,014	-0,033*
IX	-0,007	0,000	-0,033	0,017	-0,010	-0,020
Szepietowo						
IV	-0,065*	0,039	-0,022	-0,020	0,004	-0,011*
V	-0,034	0,003	0,014	-0,006	-0,004	-0,026*
VI	-0,044	0,113*	-0,029	-0,025	-0,038	-0,038*
VII	-0,010	-0,068	0,041*	-0,025	0,004	-0,027*
VIII	-0,042	0,034	-0,010	-0,025	-0,003	-0,029*
IX	-0,037	-0,011	-0,002	-0,007	0,010	-0,019*

with precipitation took place in the year 2003 (145 days), while the highest number – in 2004 (199 days). The number of days with precipitation was characterized by slow increase which, however, was not statistically significant. Analyzing pluvial conditions in Zielonka Forest in the years 1987–2008 Grajewski [2011] noticed that the frequency of days with precipitation from the range of 1,0–9,9 mm shows relative stability, confirmed by a linear trend. Whereas the number of precipitation from the other ranges presents visible downward tendency, the most clearly pointed out in case of precipitation < 1,0 mm. Directional variability of this value of precipitation was not only the highest but also statistically significant ($p < 0,05$).

CONCLUSIONS

1. In central-eastern Poland between the years 1971–2005 days with precipitation (>0,1 mm) constituted about 40% of all the vegetation season's days (IV–IX). Days with very little and little precipitation were noted the most frequently, while days with strong and very strong precipitation – the most rarely.
2. Very little precipitation was noted most frequently in April; little, moderate and moderately strong precipitation – in June, and strong – in July. Very strong (>30,0mm) precipitation occurred most frequently at the beginning of summer (June, July).
3. On the basis of analysis of spatial distribution of the days with precipitation, it was noticed that days with least intense precipitation (till 5,00 mm) occurred most frequently in northern and north-eastern part of the area examined, while days with very strong precipitation – in western and north-western part.
4. During vegetation season the most frequently was noted statistically significant decrease of the number of days with very strong and very little precipitation (especially in April). While the number of days with moderate precipitation showed a rising tendency.

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