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SNOW, TEMPERATURE AND PRECIPITATION CONDITIONS OF WINTERS IN POZNAŃ IN RELATION TO THE WOLF NUMBERS

Abstract: This study was based on daily data concerning the occurrence of snow cover, temperature and precipitation during winter months in Poznań over the period 1920-1990. The Pearson's correlation coefficients between aforementioned parameters and following year number were calculated. The tendency of changes appeared to be statistically significant only in a few cases. Furthermore, cyclic fluctuations of snow cover occurrence were found out, employing the Fourier's method. Finally, the relationships between the number of days with snow cover, temperature, precipitation and Wolf numbers were determined using the Pearson's correlation coefficient.

Key words: snow cover, temperature, precipitation, Wolf numbers, winter.

Snowfalls and snow cover are inseparable, although not permanent elements of winter season in our climatic zone. Existence of snow cover is an effect of the relationship between air temperature and precipitation and as such it is a good parameter characterising climatic conditions of winters. Therefore, mainly snow cover and additionally air temperature and precipitation were taken into consideration to discover the changes of the nature of winters in Poznań over the period 1920 – 1990.

The number of days with snow cover, the temperature and precipitation from November to March were assumed as basic parameters describing the temperature – humidity relationship. All calculations were based on daily data on the occurrence of snow cover with depth ≥1 cm, mean daily temperatures and precipitation. 67 winters (1920/21 – 1989/90) were analysed, excluding the war years of 1939/40, 1944/45 and 1945/46. In addition, monthly Wolf numbers were used in order to find out the relationship between the activity of the Sun and the aforementioned parameters.

In the first stage, the most and the least snowy winters over the studied period were distinguished. Mean annual number of days with snow cover and its standard

Tab. 1. The most and the least snowy winters in Poznań according to the criterion of number of days with snow cover. Data for years 1920-1990.

The most snowy winters		The least snowy winters	
	Number of days with snow cover		Number of days with snow cover
1923/24	78	1924/25	11
1928/29	91	1926/27	14
1930/31	77	1929/30	11
1941/42	83	1937/38	18
1946/47	79	1947/48	16
1962/63	84	1948/49	16
1964/65	75	1949/50	15
1965/66	74	1951/52	12
1968/69	75	1972/73	11
1969/70	121	1974/75	8
1978/79	82	1988/89	2
1985/86	75		

deviation were estimated. Winters with the number of days with snow cover bigger than **x+sd=71** days (**x** – mean number of days with snow cover, **sd** – standard deviation) were considered the most snowy. Several such winters were reported in the 1960s, with the most snowy winter of 1969/70 (121 days with snow cover). The winters at the turn of the 1930s/1940s and at the beginning of the 1940s observed quite a large number of days with snow cover. The least snowy winters (with the annual number of days with snow cover smaller than: **x-sd=21** days) appeared at the turn of the 1940s/1950s, when the first clear minimum of the annual number of days with snow cover was recorded. Another such minimum was observed in the 1970s (Tab. 1, Fig. 1).

According to Boryczka (Boryczka et al. 1992), in the course of the meteorological parameters over the long period, a linear component of the time trend and components of cyclic changes may be distinguished. In the present study an attempt was made to determine a linear trend, which would show a positive or negative tendency of changes

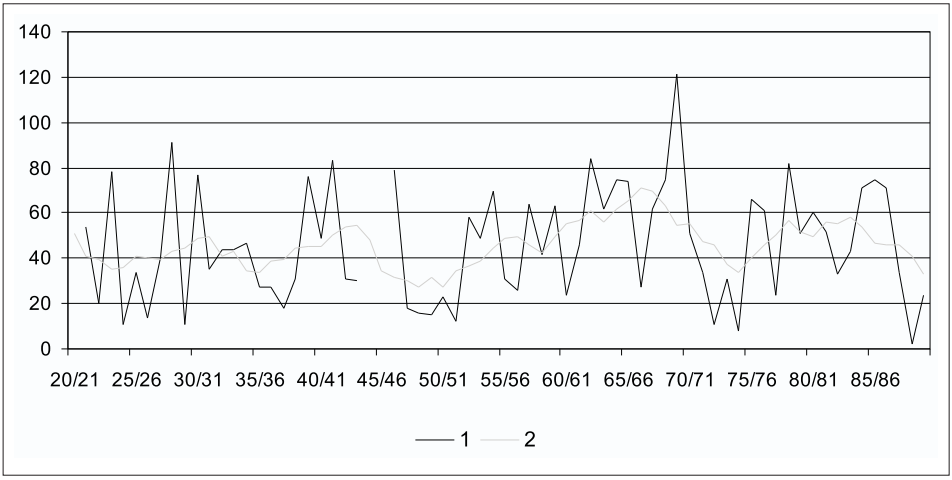

Fig. 1. Number of days with snow cover in Poznań over the winters 1920/21-1989/90. 1- real numbers; 2 - 7-year moving average.

in relation to the occurrence of snow cover over the studied period. To that end, a Pearson's correlation coefficient between the following year number and the number of days with snow cover was calculated. The number of days with snow cover in particular months (from November to May) was also taken into consideration. Besides, correlation with the following year number was calculated for the dates of the first occurrence and final disappearance of snow cover, as well as for the potential length of the period over which the ground could be covered with snow. Negative correlation was obtained for the dates of the first occurrence of snow cover; for the other characteristics the correlation was positive, however in most cases it was not statistically significant. On the basis of the obtained results we may only speculate that there is a tendency towards the extension of the potential period of snow cover occurrence over the years. However, there are no grounds to claim that the snowiness of winters in Poznań increased over the studied period.

In addition, an attempt was made to discover the tendency of changes of the Wolf numbers, temperature and precipitation of winter months over the years. It was found that the Wolf numbers and the temperature of winter months were characterised by increasing tendency, however it was statistically significant at the level of 0.05 only for the Wolf numbers in January, February and March. The precipitation in the winter months increased, however the increase was statistically significant only in December (Tab. 2).

An attempt was also made to find out the cyclic fluctuations of snow cover occurrence. Fourier's method of spectrum analysis was employed and the assay was performed for the annual number of days with snow cover. The largest values of the periodogram were obtained in the case of the following lengths of the cycle: 5.7 years, 2.3 years, 7.6 years and 2.6 years (frequencies: 0.18, 0.44, 0.38, 0.13 for the periodogram values: 6091, 3738, 3264, 3232). In general, it may be assumed that the

Tab. 2. Pearson's correlation coefficient between chosen parameters and following number of year.

	Wolf numbers	Number of days with snow cover	Mean air temperature	Precipitation
Winter months (XI-III)	0.2410	0.1370	0.1702	0.1960
November	0.2138	0.1519	0.0864	0.0671
December	0.2233	0.1076	0.2105	**0.3071**
January	**0.2614**	0.1674	0.0287	-0.0362
February	**0.2403**	0.0345	0.0937	-0.0681
March	**0.2643**	0.0260	0.0880	0.0819
April	**0.2533**	**0.2837**	0.0155	0.0786
Date of the first occurrence of snow cover				-0.208975
Date of the final disappearance of snow cover				0.170598
Potential number of days with snow cover				**0.260907**

Boldface statistically significant at 95%

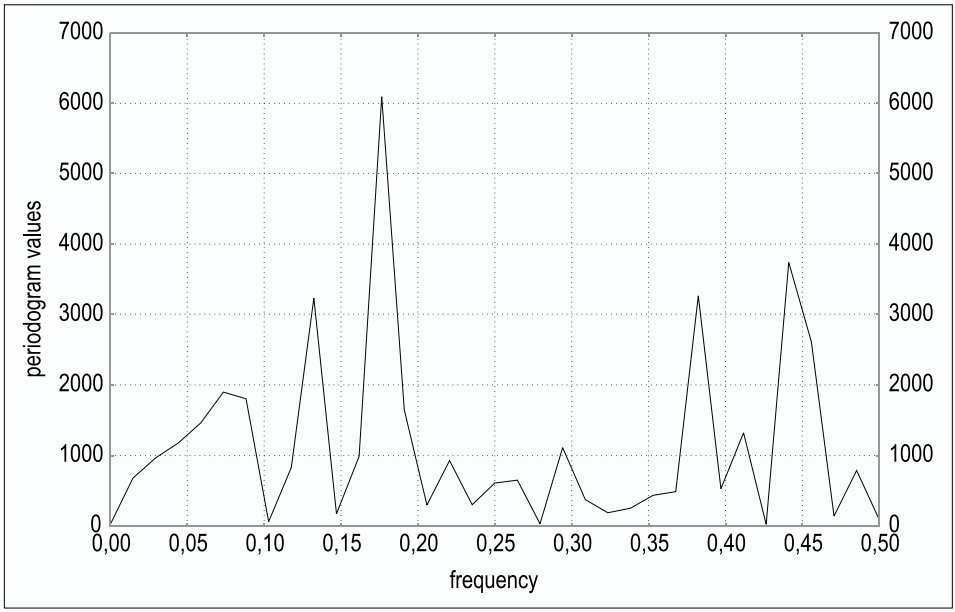

Fig. 2. Periodogram of Fourier's spectrum analysis for the number of days with snow cover in Poznań over the winters 1920/21-1989/90.

occurrence of snow cover changes its intensity in the periods of 6-7 years and 2-3 years (Fig. 2). Similar length of periods – about 7 years – was obtained for changes of winter months temperature in Poznań.

Furthermore, relationships between the number of days with snow cover and other meteorological parameters were determined. Strong negative correlation was observed between the number of days with snow cover and the monthly mean temperature. Besides, positive and statistically significant correlation was found between the temperature and precipitation.

Boryczka (Boryczka et al. 1992) described the influence of the activity of the Sun on the temperature of the winter months in Warsaw. Therefore, in this study monthly Wolf numbers from November to March were taken into consideration and their correlation with the three aforementioned variables was calculated. Negative correlation was obtained for the number of days with snow cover and positive correlation – for the temperature. In both cases, however, the correlation was not statistically significant. Correlation of the Wolf numbers with the amount of snowfall was low, positive or negative, statistically significant only for March (Tab. 3).

The performed calculations do not allow us to formulate any tenable conclusions concerning the change of climatic conditions in the winter months over the years. However, it may be stated with certainty that the character of the interim spring season does change: more and more days with snow cover are observed in April and the potential period of snow cover occurrence extends.

Tab. 3. Pearson's correlation coefficients between chosen parameters.

Winter months XI-III				
Parameter	Wolf numbers	Number of days with snow cover	Temperature	Precipitation
Wolf numbers	1.0000			
Number of days with snow cover	-0.1091	1.0000		
Temperature	0.1802	**-0.7845**	1.0000	
Precipitation	0.1535	-0.0730	0.2280	1.0000
November				
Parameter	Wolf numbers	Number of days with snow cover	Temperature	Precipitation
Wolf numbers	1.0000			
Number of days with snow cover	-0.0141	1.0000		
Temperature	0.0357	**-0.5051**	1.0000	
Precipitation	-0.1051	-0.1265	**0.3161**	1.0000
December				
Parameter	Wolf numbers	Number of days with snow cover	Temperature	Precipitation
Wolf numbers	1.0000			
Number of days with snow cover	-0.0753	1.0000		
Temperature	0.0688	**0.6633**	1.0000	
Precipitation	0.1333	-0.0096	**0.3969**	1.0000
January				
Parameter	Wolf numbers	Number of days with snow cover	Temperature	Precipitation
Wolf numbers	1.0000			
Number of days with snow cover	-0.0225	1.0000		
Temperature	0.0706	**-0.7774**	1.0000	
Precipitation	-0.1120	-0.0474	**0.3156**	1.0000
February				
Parameter	Wolf numbers	Number of days with snow cover	Temperature	Precipitation
Wolf numbers	1.0000			
Number of days with snow cover	-0.1304	1.0000		
Temperature	0.1206	**-0.8211**	1.0000	
Precipitation	0.0704	-0.2340	**0.3658**	1.0000
March				
Parameter	Wolf numbers	Number of days with snow cover	Temperature	Precipitation
Wolf numbers	1.0000			
Number of days with snow cover	-0.0133	1.0000		
Temperature	0.1630	**-0.7413**	1.0000	
Precipitation	**0.2938**	0.1468	0.1022	1.0000

Boldface statistically significant at 95%

References

Boryczka J., Stopa-Boryczka M., Kicińska B., Żmudzka E., 1992, *Atlas współzależności parametrów meteorologicznych i geograficznych w Polsce t. VII. Zmiany wiekowe klimatu Polski*, Wydawnictwa Uniwersytetu Warszawskiego.

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