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PRECIPITATION IN ŁÓDŹ IN THE PERIOD 1931–1995

OPADY W ŁODZI W OKRESIE 1931–1995

Monthly precipitation totals from Łódź-Lublinek meteorological station from the period 1931–1995 have been used. Basic statistical features of monthly, seasonal and annual totals such as mean, standard deviation, extreme values, asymmetry and coefficient of variability were presented together with frequency distributions of monthly totals. Relations of monthly totals to NAO index and frequencies of selected circulation types were analysed.

The precipitation record from meteorological station Łódź-Lublinek was used in this paper. The station is located at airport on south-west from the city ($\varphi = 51^{\circ}44'N$, $\lambda = 19^{\circ}24'E$, $h = 184$ m). The record began on 1st May 1930. There were few gaps in the record: in the second half of 1939 (from August to December), in 1945 and in January 1946. They all were connected with beginning and ending of The Second World War.

In analysed period mean annual precipitation was 560.2 mm (Tab. 1). In annual course the maximum was in July (83.8 mm on average) and minimum in February (29.3 mm). Minor maximum was in October (37.2 mm) just before minor minimum in November (45.7 mm). The variability of monthly totals, defined by extremal values and standard deviation was the largest in July and the lowest in March. However the relative variability, described by coefficient of variation, was the highest in October (80%) and the lowest in March and April (48%). The skewness of monthly totals distributions for all months was positive, it means that they have right-hand asymmetry (Tab. 2). Especially strong asymmetry existed during warm season from April to July and in October and November, the smallest asymmetry was in March and December.

The heaviest precipitation was in Łódź in decade 1972–1981 with annual average 617.7 mm. High precipitation sums of summer and autumn with values only slightly lower than 10-year maximum contributed to it. The driest was the decade 1950–1959 with annual average 508.7 mm. It was because very low spring totals and lower than normally totals in winter and summer.

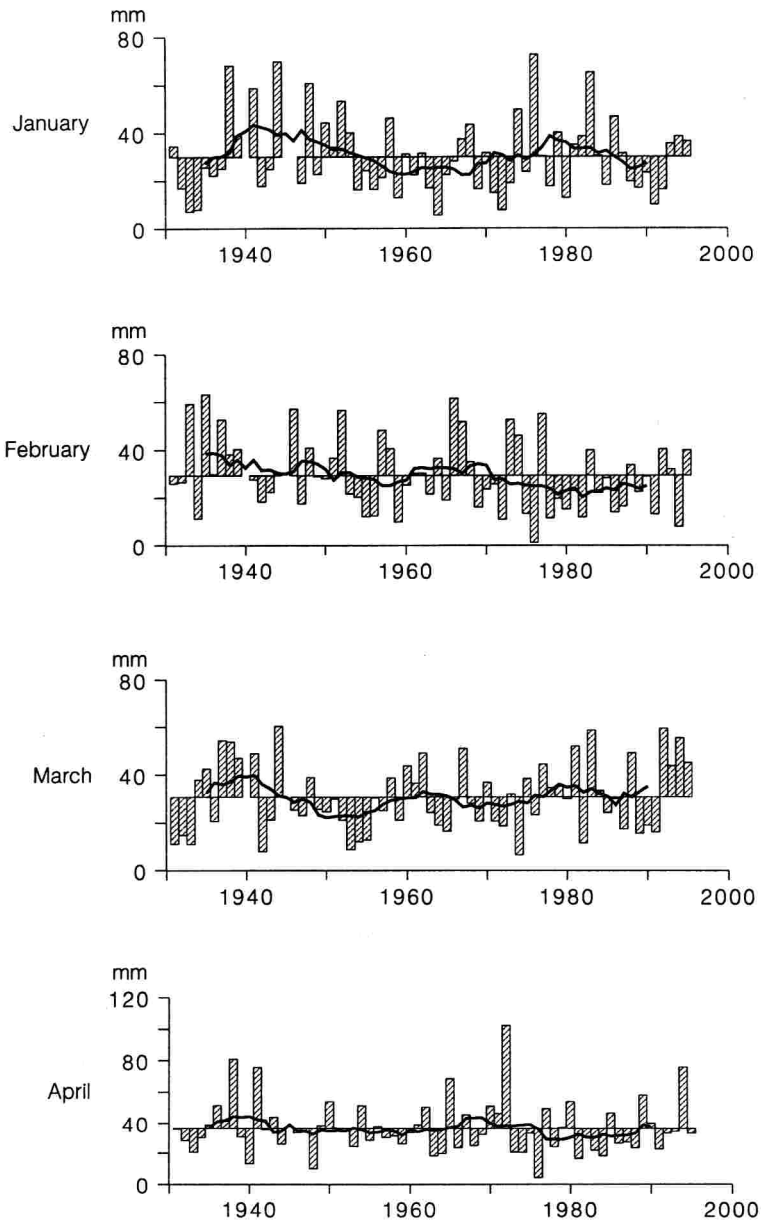


Fig. 1. Monthly precipitation totals (in mm) as deviations from mean value for the period 1931–1995 (bars) and 10-year running averages (solid line). January–April

Rys. 1. Miesięczne sumy opadu (w mm) w Łodzi w okresie 1931–1995 w odchyleniach od średniej miesięcznej (słupki) i 10-letnie średnie ruchome (linia ciągła). Styczeń–kwiecień

Table 1

Statistical characteristics of monthly precipitation totals in Łódź in the period 1931–1995

Charakterystyki statystyczne miesięcznych sum opadu w Łodzi w okresie 1931–1995

Month	Mean	Standard deviation	Maximum		Minimum		Skewness	Coefficient of variation
			value	year	value	year		
January	30.0	16.3	72.4	1976	5.4	1964	0.88	0.54
February	29.3	15.1	63.0	1935	1.1	1976	0.53	0.51
March	30.7	14.7	60.2	1944	6.3	1974	0.33	0.48
April	36.4	17.4	102.1	1972	4.2	1976	1.37	0.48
May	50.0	25.0	156.6	1962	5.5	1959	1.24	0.50
June	67.3	35.2	229.5	1980	16.4	1938	1.70	0.52
July	83.8	43.3	258.1	1957	13.7	1963	1.30	0.52
August	67.3	32.5	189.6	1985	13.9	1992	0.98	0.48
September	47.8	28.5	126.2	1984	3.2	1951	0.72	0.60
October	37.2	29.6	141.4	1974	0.0	1949	1.29	0.80
November	45.7	28.0	192.5	1931	5.8	1959	2.58	0.61
December	38.6	20.1	80.7	1988	4.4	1968	0.34	0.52
Spring	117.1	36.1	255.8	1962	52.6	1959	1.29	0.31
Summer	216.3	62.4	396.4	1980	80.7	1983	0.54	0.29
Autumn	130.7	49.2	326.1	1931	21.7	1959	0.91	0.38
Winter	98.2	30.9	162.5	1937/38	34.0	1933/34	-0.05	0.31
Year	560.2	98.6	780.6	1931	363.9	1959	0.20	0.18

Table 2

Frequency distribution of monthly totals in Łódź in the period 1931–1995

Rozkład miesięcznych sum opadu w Łodzi w okresie 1931–1995

Class limits (mm)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0–10	5	3	3	1	2				3	12	1	3
10–20	16	16	13	6	4	3	1	3	6	8	4	12
20–30	12	18	17	16	8	3	2	5	10	9	14	9
30–50	22	17	22	29	21	15	10	10	19	19	25	21
50–70	6	9	8	8	19	15	19	18	12	7	9	12
70–100	1			3	9	18	10	18	10	6	9	6
100–150				1		9	18	8	3	2		
150–200					1		3	1			1	
200–250						1						
250–300							1					

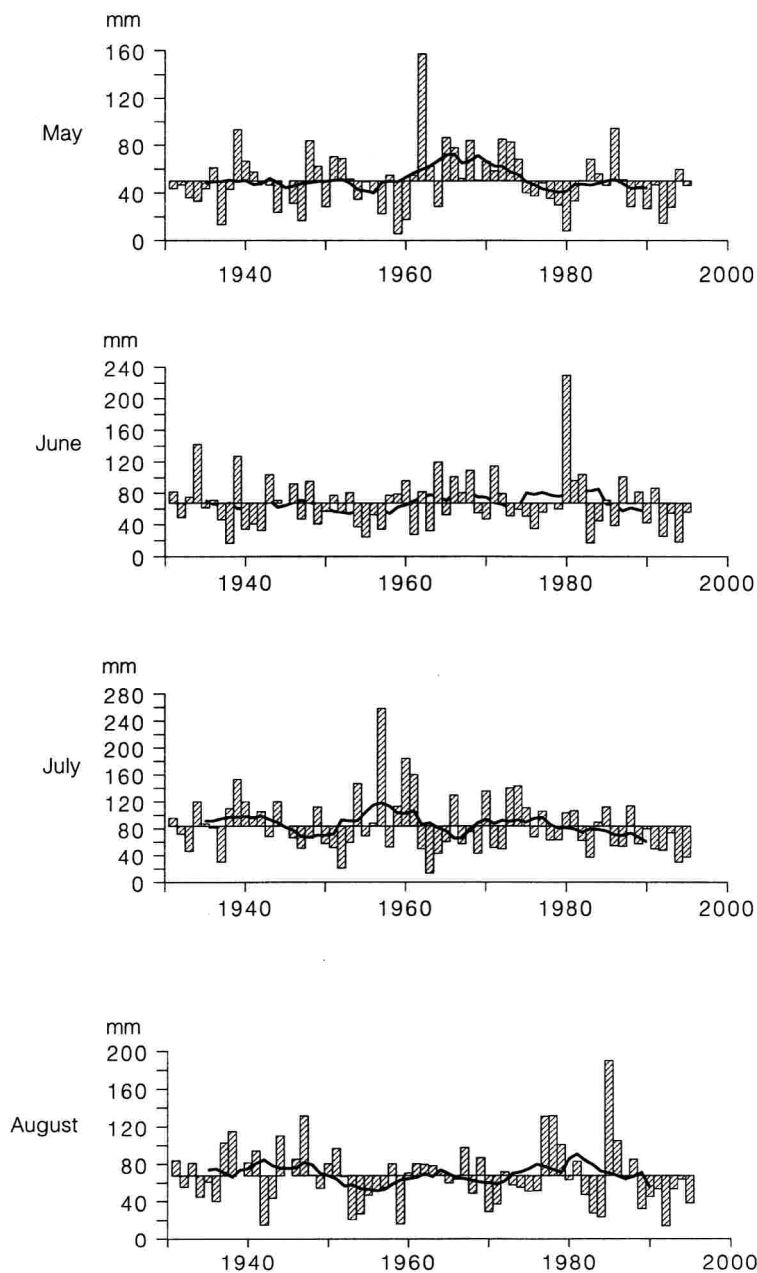


Fig. 2. Monthly precipitation totals (in mm) as deviations from mean value for the period 1931–1995 (bars) and 10-year running averages (solid line). May–August

Rys. 2. Miesięczne sumy opadu (w mm) w Łodzi w okresie 1931–1995 w odchyleniach od średniej miesięcznej (słupki) i 10-letnie średnie ruchome (linia ciągła). Maj–sierpień

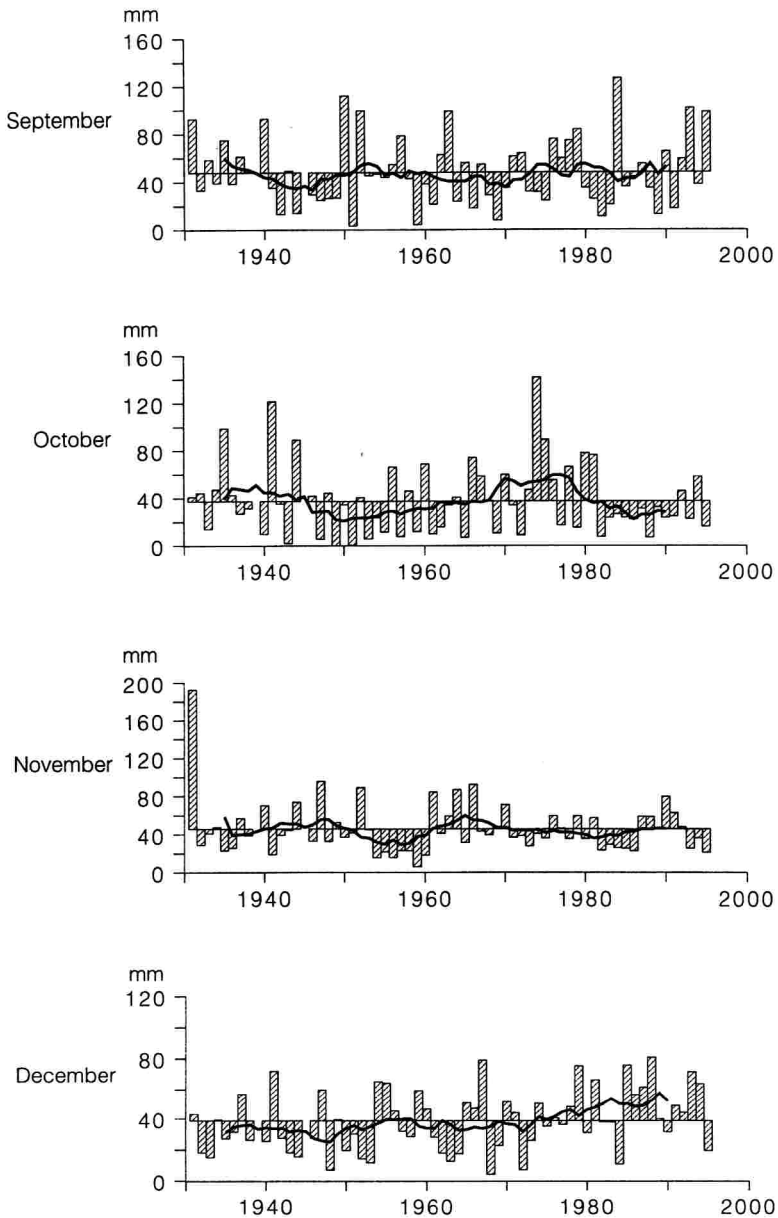


Fig. 3. Monthly precipitation totals (in mm) as deviations from mean value for the period 1931–1995 (bars) and 10-year running averages (solid line). September–December

Rys. 3. Miesięczne sumy opadu (w mm) w Łodzi w okresie 1931–1995 w odchyleniach od średniej miesięcznej (słupki) i 10-letnie średnie ruchome (linia ciągła). Wrzesień–grudzień

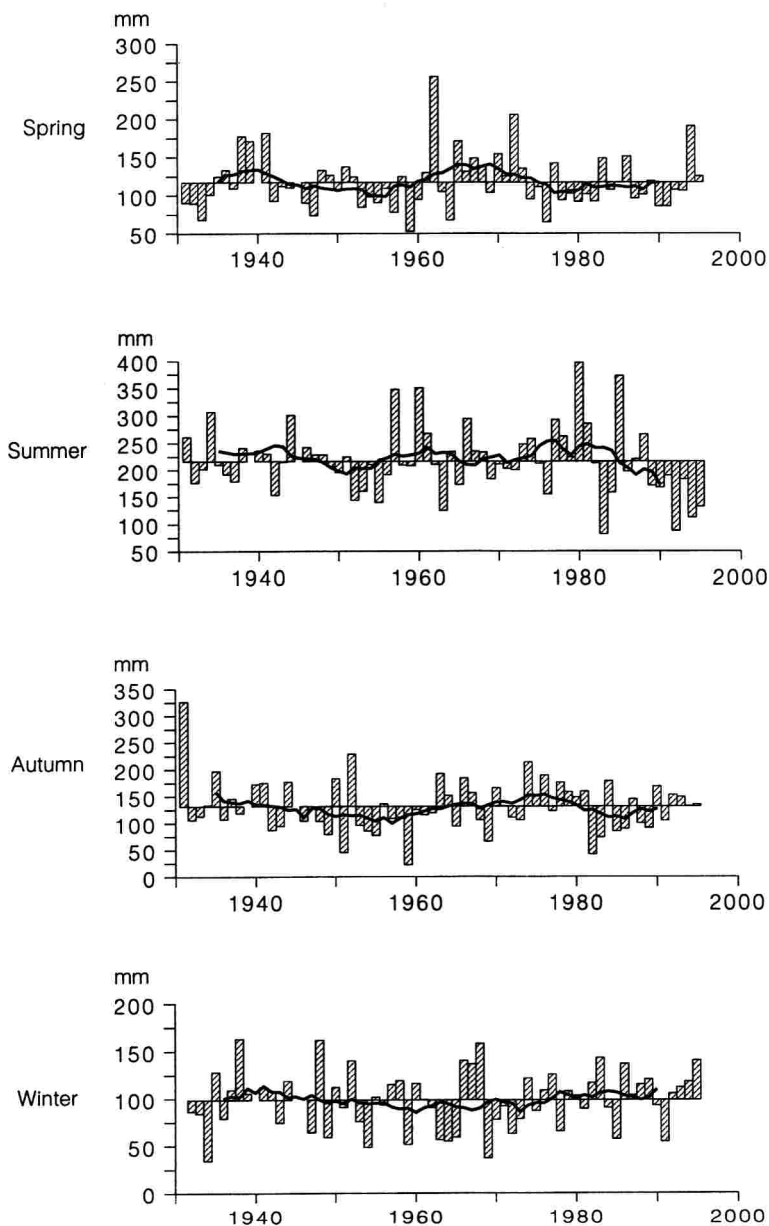


Fig. 4. Seasonal precipitation totals (in mm) as deviations from mean value for the period 1931–1995 (bars) and 10-year running averages (solid line)

Rys. 4. Sezonowe sumy opadu (w mm) w Łodzi w okresie 1931–1995 w odchyleniach od średniej (słupki) i 10-letnie średnie ruchome (linia ciągła)

The highest annual total (Fig. 5) in analysed period was in 1931 (780.6 mm), and then in 1966 and 1941 (745.0 and 744.6 mm respectively). The driest was the year 1959 with 393.9 mm of precipitation. Very dry were also years 1942, 1955 and 1969 with totals 395.2, 406.6 and 406.9 mm. Very dry year 1969 was just after sequence of wet years 1966–1967.

The driest spring (Fig. 4) was in 1959 with 52.6 mm of precipitation (45% of an average value), dry were also springs in 1976, 1964 and 1933 with totals 88.8, 67.1 and 67.6 (about 58% of the average). During summer only twice the totals were below 100 mm, in 1983 (80.7 mm i.e. 35% of the average) and in 1992 (86.6 mm – 40% of the average). The driest autumn was in 1959 with only 21.7 mm (17% of an autumn average), dry were also year 1982 and 1951 with precipitation of 41.6 and 45.2 mm (32 and 35% of the average). The driest winter was in 1933/34 with 34 mm of precipitation, i.e. 35% of an winter average.

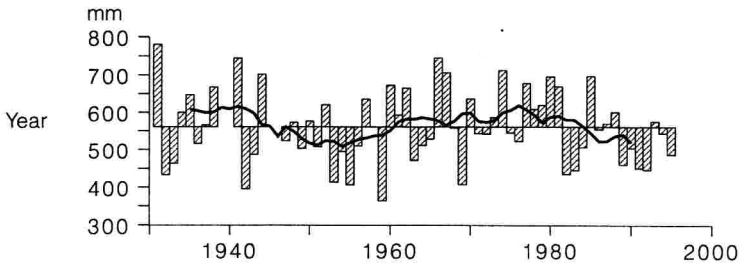


Fig. 5. Annual precipitation totals (in mm) as deviations from mean value for the period 1931–1995 (bars) and 10-year running averages (solid line)

Rys. 5. Roczne sumy opadu (w mm) w Łodzi w okresie 1931–1995 w odchyleniach od średniej (słupki) i 10-letnie średnie ruchome (linia ciągła)

Twice in the analysed period spring totals exceeded 200 mm. In 1962, when precipitation reached 255.8 mm (218% of a spring average) and in 1972. The precipitation was then 204.4 mm (175%). Three summer seasons had totals higher than 350 mm. In summer 1980 the value was 380.9 mm (176% of a summer average), the next were years 1985 and 1960 with totals 372.4 and 350 mm respectively (172 and 162%). The heaviest autumn precipitation were in 1931 (326.1 mm – 250% of an autumn average), 1952 (230.6 mm – 176%) and in 1974 (213.7 mm – 165%). The wettest winters were in 1937/38 (162.5 mm – 165% of a winter average), 1967/68 (157.2 mm – 160%), 1982/83 (142.7 mm – 145%) and in 1951/52 (141.7 mm – 144%).

Among 759 monthly totals only 32 values not exceeded 10 mm (Fig. 1, 2, 3). As much as 12 fallen on October. In October 1949 there was no

Table 3

The correlation coefficients between monthly precipitation totals and frequencies of occurrence of circulation classes (according to Osuchowska-Klein typology) and NAO index by Hurrell

Współczynniki korelacji pomiędzy miesięcznymi sumami opadów a częstościami występowania poszczególnych klas cyrkulacji (wg typologii Osuchowskiej-Klein) i indeksem NAO wg Hurrella

Month	Western types	Eastern types	Cyclonic types	Anticyclonic types	NAO index
January	0.140	-0.175	0.432**	-0.481**	0.182
February	0.364**	-0.471**	0.441**	-0.498**	0.080
March	0.154	-0.373**	0.415**	-0.513**	0.142
April	0.104	-0.191	0.214	-0.250**	0.183
May	0.036	0.029	0.481**	-0.348**	0.128
June	-0.072	0.021	0.069	-0.169	-0.097
July	-0.029	-0.248*	0.269*	-0.527**	0.095
August	-0.155	0.145	0.287*	-0.167	-0.131
September	0.066	-0.185	0.473**	-0.551**	-0.152
October	0.062	-0.217	0.516**	-0.564**	-0.120
November	0.085	-0.115	0.173	-0.160	0.009
December	0.266*	-0.304*	0.469**	-0.584**	0.041

* Significant at 95% level. Istotne na poziomie 95%.

** Significant at 99% level. Istotne na poziomie 99%.

precipitation at all, in October 1951 the monthly total was only 0.5 mm. The next was February 1976 (1.1 mm). During summer months (June, July, August) precipitation never dropped below 10 mm. In analysed period 46 months had precipitation greater than 100 mm. Most of them occurred during summer (21 in July, 10 in June, 9 in August). There were also per two such cases in September and October and per one in May and November. In cold season from December to April precipitation was always lower than 100 mm. Definitely wettest was July 1957 (258.1 mm), and then in diminishing sequence followed June 1980 (219.6 mm), November 1931 (192.5 mm), August 1985 (189.6 mm) and July 1960 (184.1 mm). July 1997 with 256 mm of precipitation is then the second largest monthly total since 1931.

To describe the circulation impacts the Osuchowska-Klein typology was used (Osuchowska-Klein 1978, 1991). As can be seen from the Tab. 3 the monthly precipitation totals were in strong relation to character of circulation (cyclonic or anticyclonic). The influence of direction of air mass advection (western or eastern) was of much lesser importance. The influence of North Atlantic Oscillations described by Hurrell's NAO (Hurrell 1995) index did not reach the significance level.

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REFERENCES

- Hurrell J. W., 1995, *Decadal Trends in the North Atlantic Oscillation: Regional Temperatures and Precipitation*, Science, Vol. 269, p. 676–679
- Osuchowska-Klein B., 1978, *Katalog typów cyrkulacji atmosferycznej*, WKiŁ, Warszawa
- Osuchowska-Klein B., 1991, *Katalog typów cyrkulacji atmosferycznej (1976–1990)*, IMGW, Warszawa

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STRESZCZENIE

W pracy wykorzystano miesięczne sumy opadu ze stacji Łódź–Lublinek z okresu 1931–1995. Przedstawiono podstawowe charakterystyki statystyczne miesięcznych, sezonowych i rocznych sum opadu: średnią, odchylenie standardowe, wartości ekstremalne, asymetrię, współczynnik zmienności oraz rozkłady częstości miesięcznych sum opadu. Analizowano związki między wartościami miesięcznych sum opadu a indeksem NAO i częstościami wybranych klas cyrkulacji.