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Joanna Wibig, Krzysztof Fortuniak

THE EXTREME PRECIPITATION CONDITIONS IN ŁÓDŹ IN THE PERIOD 1931–1995

EKSTREMALNE WARUNKI OPADOWE W ŁODZI W OKRESIE 1931–1995

Record of daily precipitation totals from Łódź from the period 1931–1995 has been analysed. The annual courses of frequencies of days without precipitation and with precipitation in particular ranges were presented. It was shown that occurrence of precipitation is stronger related to the character of circulation than to direction of air mass advection. Long-term variability of frequencies of days without precipitation, days with totals exceeding 10 mm/day and long-term variability of the highest daily total during the year were analysed. It was shown that the highest daily totals occur in day with circulation of type E_0.

INTRODUCTION AND DATA

The aim of the paper was to analyse the interannual and long-term variability of daily precipitation in Łódź with special attention on extreme events. The record of daily precipitation totals from meteorological station Łódź-Lublinek was used. The station is located at airport on south-west from the city ($\varphi = 51°44'$N, $\lambda = 19°24'$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 Second World War. To compare the highest precipitation totals with the extreme precipitation events in July 1997 the daily totals from this month were also used (*Codzienny Biuletyn...*, 1997). Circulation was described by Osuchowska-Klein (1978, 1991) classification.

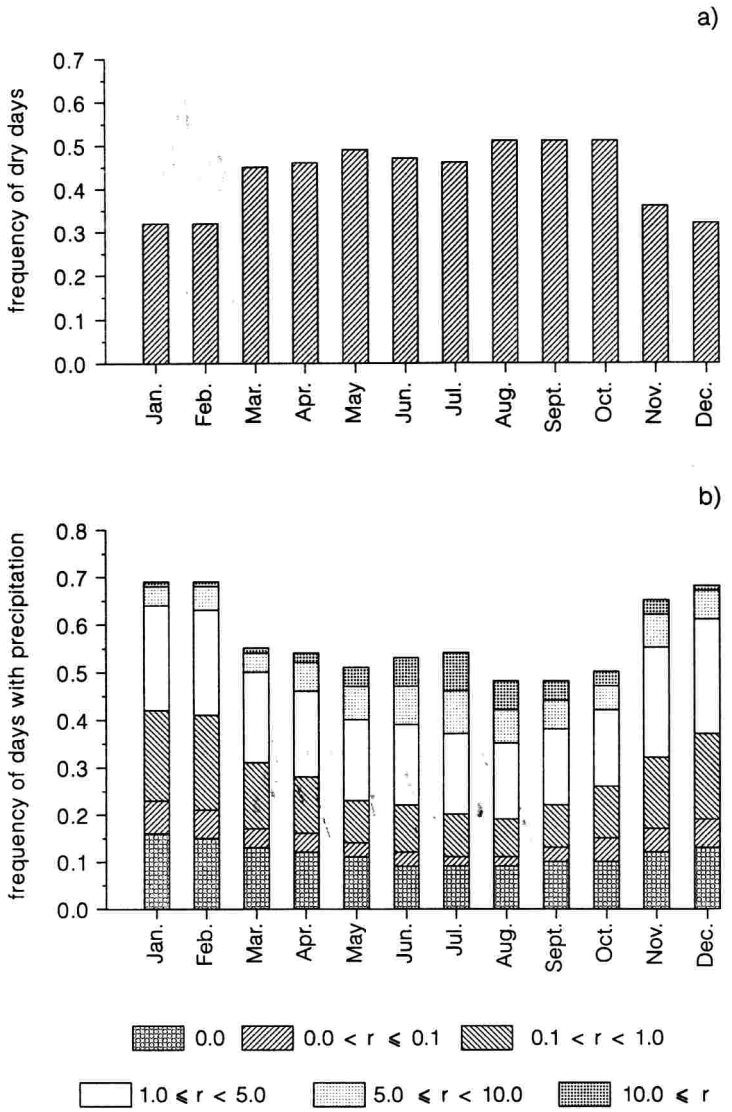

Fig. 1. Relative frequencies of days without precipitation (a) and days with precipitation within selected limits (b)

Rys. 1. Częstość dni bez opadu (a) i dni z opadem w wybranych przedziałach (b)

INTERANNUAL VARIABILITY

The relative frequency of dry days (Fig. 1) shows the maximum during late summer and early autumn (from August to October) and minimum in winter (December–February). Reversal course is for frequency of days with precipitation. For all values below 5 mm per day the probability of precipitation occurrence is the greatest during winter and the lowest in summer. In the case of daily totals higher than 5 mm per day the maximum falls in summer and the minimum in winter. It was found that character of circulation (cyclonal or anticyclonal) is of a crucial importance for occurrence of precipitation (Fig. 3), whereas the direction of air mass advection (western or eastern) constitutes only a second – rate factor.

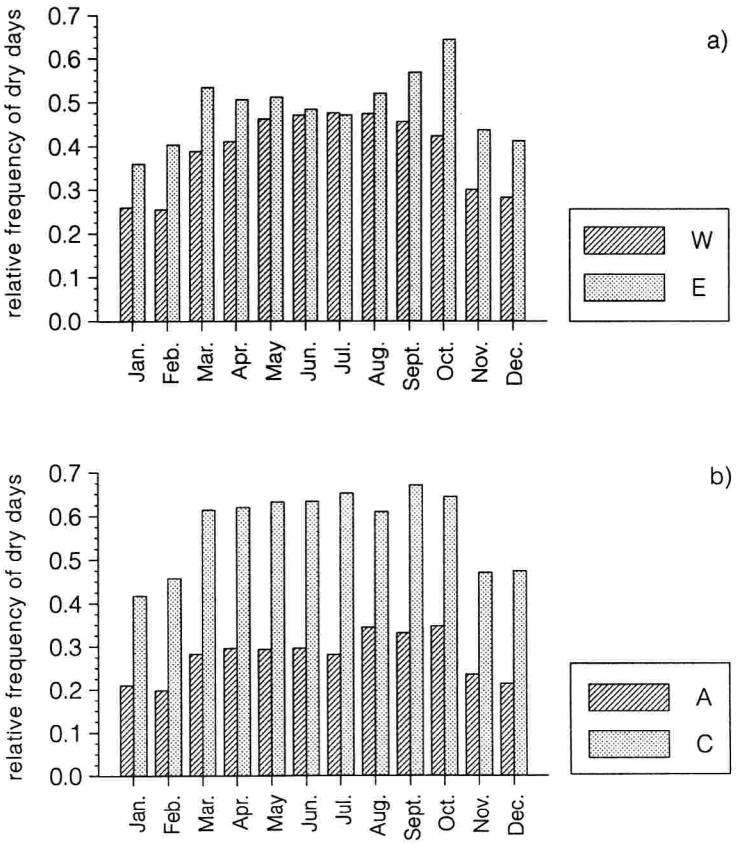

Fig. 2. Relative frequency of dry days in relation to circulation classes: western (W) or eastern (E) types (a) and anticyclonic (A) or cyclonic (C) types (b)

Rys. 2. Częstość dni bez opadu w zależności od typu cyrkulacji: typy zachodnie (W) i wschodnie (E) (a) oraz typy antycyklonalne (A) i cyklonalne (C) (b)

LONG-TERM VARIABILITY

The long-term variability of frequency of dry days was also investigated. This frequency decreases (Fig. 3) during warm season (from April to October) as well as during cold one (November–March) and of course also in a year as a whole. Only the last two trends are statistically significant at 5% level.

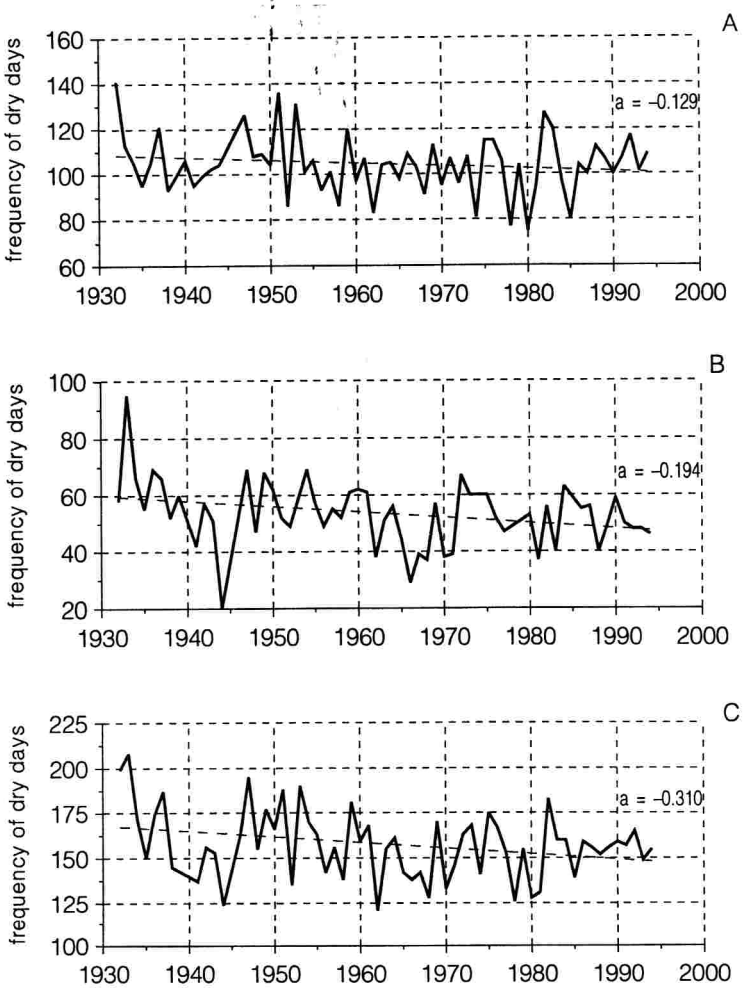

Fig. 3. Frequency of dry days during warm season, from April to October (A), cold season, from November to March (B), and during hydrological year, from November to October (C). The trend line (dashed one) and the slope "a" are given

Rys. 3. Liczba dni bez opadu w sezonie ciepłym, od kwietnia do października (A), chłodnym, od listopada do marca (B) i w roku hydrologicznym, od listopada do października (C). Linia przerywana przedstawia trend, podano współczynnik nachylenia „a"

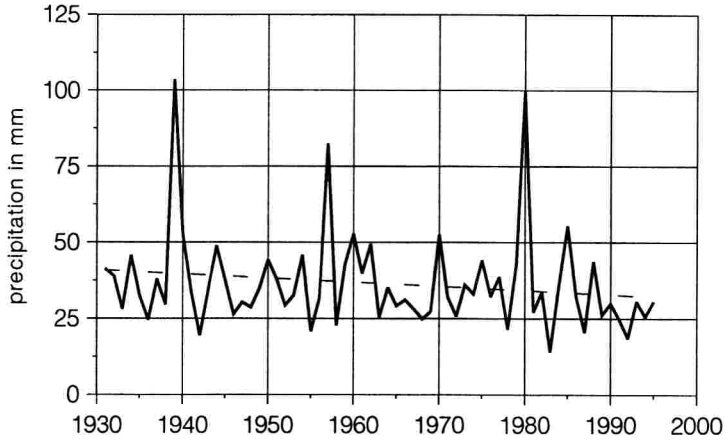

Fig. 4. The highest daily totals in particular year with its trend (dashed line)

Rys. 4. Najwyższe roczne sumy dobowe z zaznaczoną linią trendu (krzywa przerywana)

A record of the highest daily totals in particular year was also looked into (Fig. 4). There is slightly decreasing tendency, but below the level of statistical significance. Also the sequence of annual frequencies of days with totals exceeding 10 mm per day (Fig. 5) did not show any trend.

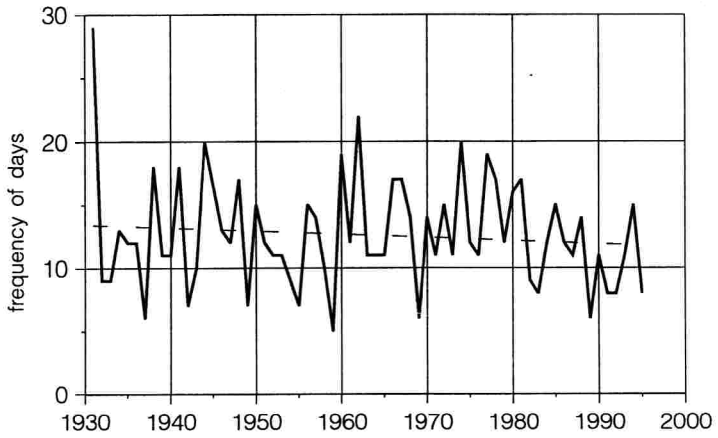

Fig. 5. Relative frequency of days with precipitation higher than 10 mm per day with trend (dashed line)

Rys. 5. Częstość dni z opadem dobowym przekraczającym 10 mm, zaznaczono linię trendu (krzywa przerywana)

DRY AND WET SPELLS

A dry spell was defined as a sequence of days completely without precipitation. The distributions of such spells according to their lenght is shown at Fig. 6. Only spells equal or longer than five days were taken into consideration. The longest one lasted 45 days. A wet spell was defined as a sequence of days with precipitation even if its amount was unmeasureable (i.e. lower than 0.1 mm). Their distribution (Fig. 7) indicates that the longest one persisted 34 days.

EXTREME PRECIPITATION EVENTS

Twenty the longest daily totals in Łódź in analysed period were chosen. Most of them fell in July (Fig. 8) and during days with north-eastern and eastern cyclonic circulation (type E_0 in Osuchowska-Klein classification).

The highest daily total in Łódź reached 103.5 mm and the twentieth one was 39.8 mm. During extremely high precipitation events in July 1997 two daily sums fell into this range (62 mm on 6th and 44 mm on 7th July).

There were also in Łódź 22 cases of short wet spells with totals exceeding 50 mm. All days within these spells were analysed. Most of them were in July (Fig. 9), but they were found even in November. They usually occurred during days with north-eastern and eastern cyclonic circulation. The highest precipitation sum during these periods was 132.3 mm. During extremely high precipitation events in July 1997 were two such spells with sums 168 mm (from 5th to 9th July) and 60 mm (from 19th to 23rd July).

In recorded history there were three other cases of such two-spell clusters (Tab. 1). The one in July 1997 had the highest total.

Table 1

Characteristic of precipitation during four the most extensive clusters of wet spells (in m m)

Charakterystyka opadu podczas czterech najintensywniejszych podwójnych okresów opadowych (w mm)

Year	First spell	Second spell	Total precipitation
1944	16–18 Jul. (95.3)	31 Jul.–03 Aug. (90.6)	185.9
1957	16–17 Jul. (115.9)	21–23 Jul. (74.6)	190.5
1980	31 May–02 Jun. (65.0)	15–16 Jun. (117.0)	182.0
1997	05–09 Jul. (168.0)	19–23 Jul. (60.0)	228.0

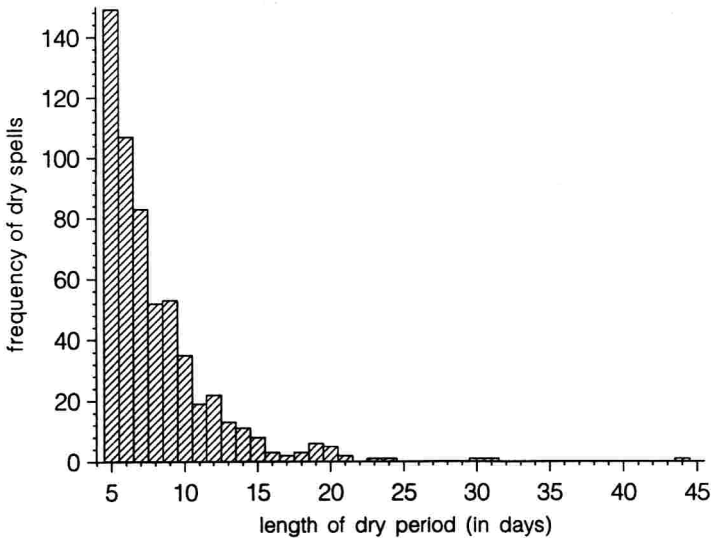

Fig. 6. Frequency of dry spells longer than 4 days during analysed period

Rys. 6. Liczba okresów bezopadowych dłuższych niż 4 dni w analizowanym okresie

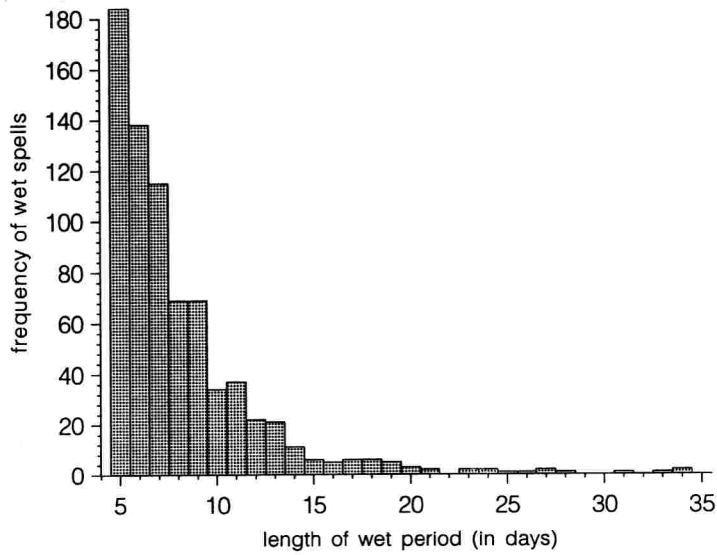

Fig. 7. Frequency of wet spells longer than 4 days during analysed period

Rys. 7. Liczba okresów opadowych dłuższych niż 4 dni w analizowanym okresie

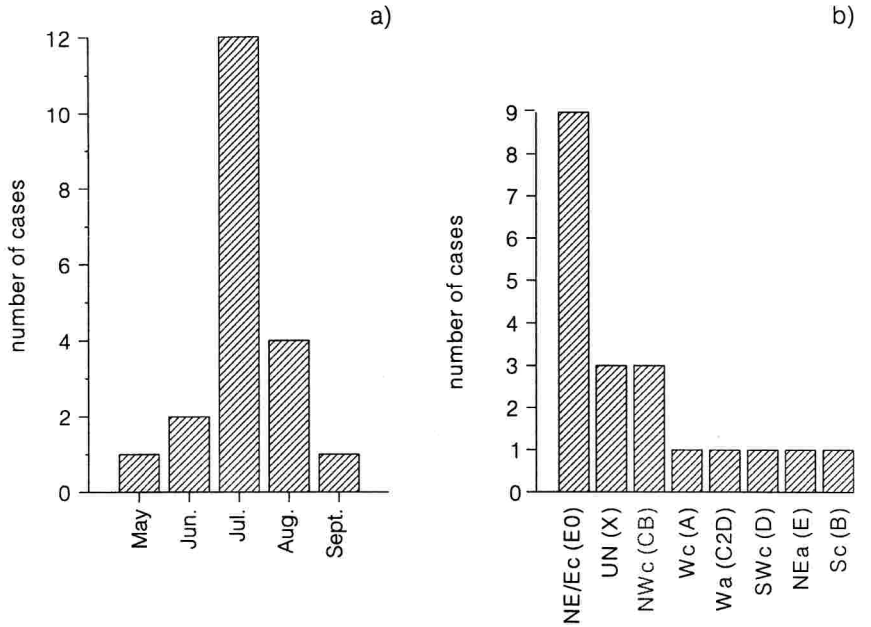

Fig. 8. The distribution of twenty the highest daily precipitation totals according to month of occurrence (a) and circulation type (b)

Rys. 8. Rozkład 20 dni z najwyższymi dobowymi sumami opadu w zależności od miesiąca, w którym wystąpiły (a) i panującego typu cyrkulacji (b)

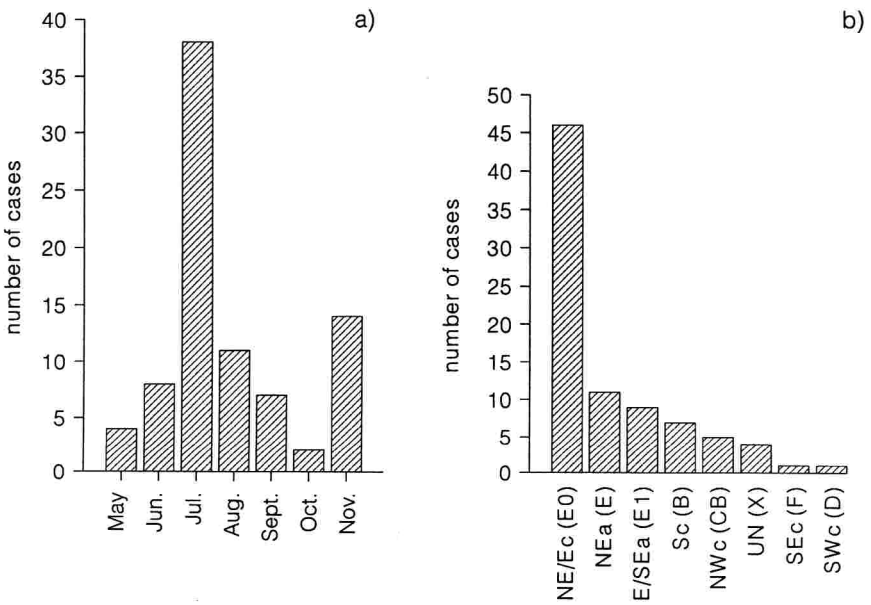

Fig. 9. The distribution of days within the 22 spells with precipitation sums exceeding 50 mm according to month of occurrence (a) and circulation type (b)

Rys. 9. Rozkład dni z 22 okresów opadowych o sumach przekraczających 50 mm w zależności od miesiąca, w którym wystąpiły (a) i panującego typu cyrkulacji (b)

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Department of Meteorology and Climatology
University of Łódź

STRESZCZENIE

W opracowaniu analizowano szereg dobowych sum opadu z Łodzi z okresu 1931–1995. Przedstawiono roczny bieg częstości występowania dni bez opadu i z opadem w poszczególnych przedziałach wartości. Stwierdzono, że pojawienie się opadu zależy w większym stopniu od charakteru cyrkulacji niż od kierunku napływu mas. Badano długoletnią zmienność częstości dni bez opadu, dni z sumą opadu powyżej 10 mm i największej dobowej sumy opadu w roku. Pokazano, że najwyższe dobowe sumy opadu pojawiają się w dniach o cyrkulacji E_0.