THE ANNUAL RAINFALL REGIME IN THE AREA OF ORADEA CITY

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Abstract

Atmospheric circulation, as well as the frequency of air masses with different characteristics that reach Oradea, determine, year after year, different rainfall totals. In the area of Oradea city, the multiannual average of rainfall totals is 617.1 mm/year. Annual totals were below the multiannual average in 53.3% of the cases, while in 46.7% of the years included in the study the annual totals were higher than the multiannual average.

The most frequent rainfall totals were those between 501-550, 551-600 and 601-650 mm/year, which make up 15.55% of the total years included in the study.

According to the Hellman criterion, of the 45 years included in the study, only three years (1977, 1985, 1988) can be considered normal from a rainfall point of view, while the exceedingly droughty years were the most frequent ones (46.7%).

Key words: exceedingly droughty, exceedingly rainy, rainfall totals

INTRODUCTION

In the years with significant rainfall totals there were intense atmospheric circulations from the West, Northwest and Southwest of the continent, which carried towards our country's latitudes wet air masses belonging to cyclonal baric formations that developed either on the northern dorsal of the Azores anticyclone or in the Mediterranean Basin or in the Northwest of the continent, in the area of Iceland, or even atmospheric fronts which developed in the contact zone of two baric formations with different characteristics (Dumiter Aurelia Florina, 2007; Gaceu O., 2005; Moza Ana Cornelia, 2008, 2009; Pereş Ana Cornelia, Köteles N., 2013).

The significant rainfall totals recorded in the area of Oradea can also be attributed to the influence of the city on its own climate, as specific urban activities determine an increase in the amount of rainfalls due to the thermal and humidity contrast with the surrounding areas (Dumiter Aurelia Florina, 2007; Gaceu O., 2005; Moza Ana Cornelia, 2008, 2009; Pereş Ana Cornelia, Köteles N., 2013).

The landforms in the area of Oradea also play an important role. When air masses coming from the western side of the continent meet the Hills of Crişana, they are forced to move upward, where they undergo an adiabatic cooling process, which leads to the condensation of water vapours. The result is formation of rain, especially when in the urban atmosphere

there are condensation nuclei (Dumiter Aurelia Florina, 2007; Gaceu O., 2005; Moza Ana Cornelia, 2008, 2009; Pereş Ana Cornelia, Köteles N., 2013).

MATERIAL AND METHODS

The regime of the multiannual rainfall totals was studied using data recorded at the Oradea weather station over a period of 45 years, that is, the 1970-2014 period.

RESULTS AND DISCUSSION

The multiannual average of rainfall totals in Oradea is 617.1 mm/year.

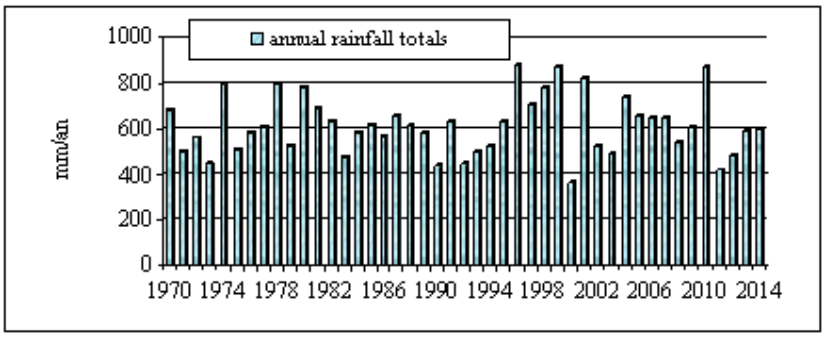

Fig. 1. Annual rainfall totals in Oradea, 1970-2014

The annual rainfall total varied from one year to another, with positive and negative deviations from the multiannual average. Thus, the lowest rainfall total was recorded in 2000, with a value of only 364.2 mm/year. This was the result of an atmospheric circulation coming predominantly from the South-East, which brought to the latitudes of Romania tropical dry air masses. The highest annual rainfall amount was recorded in 1996, the value of 884 mm/year. That year was characterized by a high number of weather fronts generated by frequent air masses coming from the West and North-West of the continent, belonging to cyclones developed on the northern dorsal of the Azores anticyclone, but also to those belonging to the mobile cyclones developed in the Mediterranean Basin. The amplitude for the period of the study is, thus, 519.8 mm (see Figure 1).

Looking at the deviations of the annual totals from the multiannual average, it can be seen that in 53.3% of the cases the annual rainfall totals were below the multiannual average, and in 46.7% of the years included in the study the annual totals were higher than the multiannual average.

Although the number of years with rainfall totals below the multiannual average is higher than that of years with totals above the

average, when comparing the longest period of consecutive years with positive deviations to that of consecutive years of negative ones, the former one is longer than the latter. Thus, the highest number of consecutive years with positive deviations is 5, the 1995-1999 period, against 4 consecutive years with negative deviations, the 2011-2014 period. The years with the highest positive deviations were the following: 1996 (+266.9 mm), 2010 (+259.1 mm) and 1999 (+252.6 mm) (see Figure 2). The negative deviations also reached high values, but their frequency was lower. Thus, high values of negative deviations were recorded in 2000 (-252.9), which is the highest negative deviation against the multiannual average, and 2011 (-199.0) (see Figure 2).

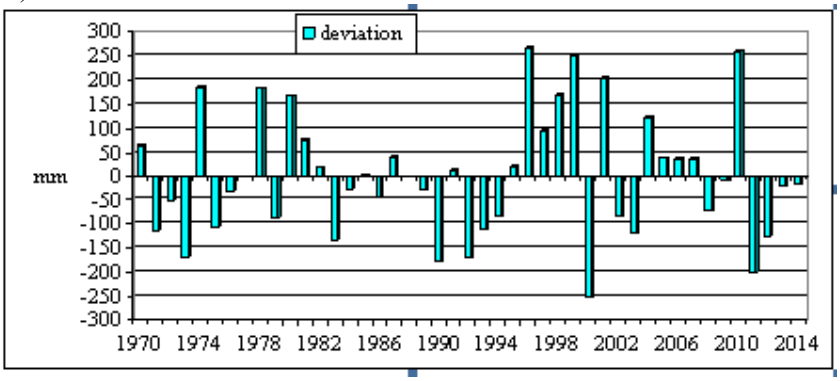

Fig. 2. Deviation of the annual rainfall totals from normal (the multiannual average amount) in Oradea (1970-2014)

Table 1

The frequency of annual rainfall totals and their probabilities in Oradea 1970-2014

Rainfall totals (mm)	No. of cases	Probabiliy
351-400	1	2.22
401-450	4	8.88
451-500	3	6.66
501-550	7	15.55
551-600	7	15.55
601-650	7	15.55
651-700	6	13.33
701-750	2	4.44
751-800	3	6.66
801-850	2	4.44
851-900	3	6.66
Total number of cases	45	

Source of data: A.N.M. archives

By calculating the frequency of various annual rainfall totals, the probability of their occurrence could also be studied. Thus, the rainfall totals

between 501-550, 551-600 and 601-650 mm/year were the most frequent ones, being recorded seven times each, which makes up 15.55% of the total number of years included in the study. The lowest frequency, and, accordingly, the lowest probability to occur, is represented by the totals between 351 and 400 mm, in the 45 years of the study there was only one annual amount between these limits, which means a probability of 2.22%. The totals between 651 and 700 mm were also frequent, their occurrence made up 13.33% of the number of years (see Table 1, Figure 3).

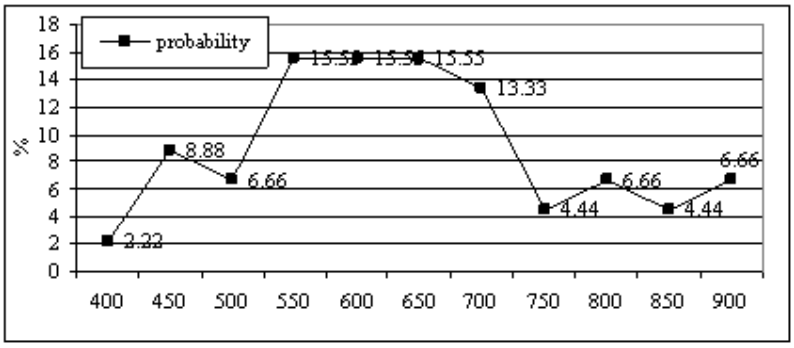

Fig. 3. The occurrence probability of various rainfall totals in Oradea, 1970-2014

Table 2

Rainfall characteristics of years according to the Hellman criterion in Oradea, 1970-2014

Deviation against average %	Rating	No. of cases	Years
<-20	exceedingly droughty	21	1971, 1972, 1973, 1975, 1976, 1979, 1983, 1984, 1986, 1989, 1990, 1992, 1993, 1994, 2000, 2002, 2003, 2008, 2011, 2012, 2013
-20.0…-15.1	very droughty	1	2014
-15.0…-10.1	droughty	0	-
-10.0…-5.1	moderately droughty	1	2009
-5.0…+5.0	normal	3	1977, 1985, 1988
5.1…10.0	moderately rainy	0	-
10.1…15.0	rainy	1	1991
15.1…20.0	very rainy	1	1982
>20.0	exceedingly rainy	17	1970, 1974, 1978, 1980, 1981, 1987, 1995, 1996, 1997, 1998, 1999, 2001, 2004, 2005, 2006, 2007, 2010

Source of data: A.N.M. Archives

In order to show the non-periodic variations of the annual rainfall totals, their deviations from the multiannual average were calculated and

expressed as percentages, which made possible to establish the rainfall characteristics of the years according to the Hellman criterion (see table 2).

It can be seen from the table that in the 45 years included in the study only three years could be regarded as normal ones from a rainfall point of view, that is, 1977, 1985 and 1988. The exceedingly droughty years were the most frequent ones, 46.7%, while the exceedingly rainy ones made up 37.8% of the total number of years. These things can be seen in Figure 2, where the annual deviations of the rainfall totals from the multiannual average are shown, the latter one being defined as an arbitrary absolute zero.

CONCLUSIONS

The multiannual average of atmospheric precipitation is 617.1 mm/an.

The lowest rainfall total was 364.2 mm/year, recorded in 2000, and the most significant rainfall total was 884 mm/year, recorded in 1996, which gives an amplitude of 519.8 mm for the period of the study.

In 53.3% of the cases the annual rainfall totals were below the multiannual average, and in 46.7% of the years included in the study the annual totals were higher than the multiannual average.

According to the Hellman criterion, out of the 45 years included in the study only three can be regarded as normal years (1977, 1985 and 1988). The exceedingly droughty years were the most frequent ones, 46.7%, while the exceedingly rainy ones made up 37.8% of the total number of year.

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