PATTERNS OF THE MAXIMUM RAINFALL AMOUNTS REGISTERED IN 24 HOURS WITHIN THE OLTENIA PLAIN

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ABSTRACT. – P**atterns of the maximum rainfall amounts registered in 24 hours within the Oltenia Plain.** The present study aims at rendering the main features of the maximum rainfall amounts registered in 24 h within the Oltenia Plain. We used 30-year time series (1980-2009) for seven meteorological stations. Generally, the maximum amounts in 24 h display the same pattern as the monthly mean amounts, namely higher values in the interval May-October. In terms of mean values, the highest amounts are registered in the western and northern extremity of the plain. The maximum values generally exceed 70 mm at all meteorological stations: D.T. Severin, 224 mm, July 1999; Slatina, 104.8 mm, August 2002; Caracal, 92.2 m, July 1991; Bechet, 80.8 mm, July 2006; Craiova, 77.6 mm, April 2003. During the cold season, there was noticed a greater uniformity all over the plain, due to the cyclonic origin of rainfalls compared to the warm season, when thermal convection is quite active and it triggers local showers. In order to better emphasize the peculiarities of this parameter, we have calculated the frequency on different value classes (eight classes), as well as the probability of appearance of different amounts. Thus, it resulted that the highest frequency (25-35%) is held by the first two classes of values (0-10 mm; 10.1-20 mm). The lowest frequency is registered in case of the amounts of more than 100 mm, which generally display a probability of occurrence of less than 1% and only in the western and eastern extremities of the plain.

Key words: maximum rainfall amounts in 24 h, frequency, probability, Oltenia Plain

1. INTRODUCTION

According to the latest report of Intergovernmental Panel on Climate Change (IPCC, 2007) '*wet extremes are projected to become more severe in many areas where mean precipitation is expected to increase, and dry extremes are projected to become more severe in areas where mean precipitation is projected to decrease.'* Presently, most climatologists are convinced that a warmer atmosphere certainly leads to a higher evaporation, and thus, to a greater energy potential, the consequences of which are the increase in intensity, frequency, and duration of extreme rainfall events (Christensen & Christensen, 2004; Easterling et al., 2000; Ekström M. et al., 2005; Fowler H.J et al., 2005; Jones and Reid, 2001; Meehl et al., 2007; Palmer and Räisänen, 2002). However, there is a great variability of

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rainfalls related to the occurrence of extreme events and their intensities. The variability of the total precipitation is induced by the change in the frequency of events or in the intensity of precipitation, or by both in certain cases. If simulations of extreme temperatures indicate a clear increase, extreme precipitation is difficult to be rendered, especially for the intensities and patterns of heavy rainfalls, which are affected by the local conditions (IPCC, 2001).

In Romania, climatologists' attention was drawn especially by torrential rainfalls (Bogdan and Niculescu, 1999; Dragotă and Bălteanu, 2000; Marinică, 1999, 2003; Niculescu, 1996), and less by the issue of maximum rainfall amounts in 24 hours (Apăvăloae et al., 1993-1994; Călinescu et al., 1993-994; Croitoru et al., 2002). The present study aims at analysing the patterns of maximum rainfall amounts registered in 24 hours – maximum amounts, evolution trends, frequency of different value classes, as well as their occurrence probability, using reliable, consistent and sufficient number of data.

2. DATA AND METHODS

The meteorological data were supplied by Oltenia Regional Meteorological Centre and they cover a period of 30 years (1980-2009). There were analysed seven stations (Table 1) distributed within the plain or in its immediate proximity.

Table 1 ***The geographical position of the meteorological station***

Station	Altitude (m)	Latitude	Longitude
Dr. Turnu-Severin	77	44°38`	22°38`
Bechet	36	43°47`	23°57`
Calafat	61	43°59`	22°57`
Băileşti	57	44°01`	23°20`
Craiova	192	44°19`	23°52`
Caracal	106	44°06`	24°22`
Slatina	172	44°26`	24°21`

In terms of methodology, there were first extracted the highest maximum values for each station and the date they occurred at, aiming at rendering local differences within the plain area. The evolution trend was analysed based on linear regression and moving averages (5-year periods). There was also calculated the frequency on eight value classes. For the amounts below 50 mm, which corresponds to most of the monthly mean amounts of precipitation in the study area, there were established five classes (0-10 mm, 10.1-20 mm, 20.1-30 mm, 30.1-40 mm, 40.1-50 mm), while the other three classes cover higher amounts (50.1-75mm, 75.1-100 mm, > 100 mm), which have a lower probability of occurrence. Experts consider that a daily amount of more than 10 mm may be critical for some environmental aspects and human activities. In order to better emphasize the risk induced by heavy rainfalls, there was calculated the frequency of occurrence of specific maximum precipitation amounts in 24 hours over the whole period 1980–2009.

3. RESULTS

3.1 Maximum values. The highest precipitation amounts registered in 24 hours generally correspond to spring and summer months, especially July, when thermal convection is more active and generates high intensity showers. In most of the cases, these amounts are greater than the monthly average, the values oscillating between 40 and 100 mm. During the cold season the maximum amounts vary between 30 and 40 mm (Table 2). However, there are important local differences induced by atmospheric circulation and predominant exposure of the plain area to the penetration of either warm and humid or dry continental air masses and by local features of the relief. Thus, the western part of the plain (D.T. Severin) registers the highest monthly amounts during winter and autumn (36.9 mm – 66.5 mm), while the northern (Craiova) and eastern (Slatina, Caracal, Bechet) extremities display the highest amounts during the second half of spring and in summer (44.1 mm – 104.8 mm). The highest amount registered during the period of study within the entire plain reached an exceptional value, 224 mm (D.T. Severin, July 1999), which corresponds to 1/3 of the mean annual amount. This exceptional precipitation amount was generated by a particular synoptic situation – presence of a weak depression over the Mediterranean Sea, a strong cyclone over Northern Europe, and an anticyclone extended from the Atlantic Ocean to Eastern Europe. Thus, the warm humid air from the Mediterranean Sea was transported northwards and it came into contact with the cold arctic continental air penetrating on the northern slope of the anticyclone. The convergence area of the two air masses produced in the west of Oltenia and it generated violent rainfalls (Vlăduţ, 2002).

Table 2 ***Maximum monthly amounts of precipitation registered in 24 hours (mm) within Oltenia Plain, 1980-2009***

Month	Station						
	D.T.Sev.	**Calafat**	**Bechet**	**Băileşti**	**Caracal**	**Slatina**	**Craiova**
I	40.8	32.5	33.1	39.5	29.4	21.3	30.8
II	36.9	31.1	34.4	31.9	29.1	30	34.5
III	42.4	34.4	33.8	36.5	33.5	32.4	36.3
IV	59.6	36.2	56.3	55.5	48.5	42	77.6
V	47	46.6	56.7	55.4	44.1	50.6	60
VI	55.6	56.2	38.4	38.1	47.8	93.2	71.9
VII	224	48.7	80.8	62.4	92.2	80.2	74.2
VIII	46.4	61.7	65.6	59.4	73.6	104.8	56.4
IX	62.6	76.8	34.8	48.1	34.7	37.3	77.2
X	56.2	84.8	59.5	58	54.2	52.4	54.4
XI	66.5	33.1	29.6	31.9	28.3	31.1	38.2
XII	60.3	27.3	23.4	35.3	27.9	23.3	30.6
Max. am. /Date	224/July 1999	84.8/Oct. 1981	80.8/ July 2006	62.4/ July 1995	92.2/ July 1991	104.8/ July 2002	77.6/April 2003

3.2 Evolution trends. Precipitations were usually studied as events influenced by linear trends or by discontinuities in long-term averages. The analysis of the maximum rainfall in 24 hours generally points out to an increase, which has to be studied in relation with the observations at local scale. Thus, linear regression indicates a stationary evolution and even an overall negative trend in the west and south-west of the plain (D.T. Severin and Calafat), while the rest of the plain is subject to an obvious increase in the maximum amounts. The highest increase corresponds to the south-eastern and northern extremities (Bechet and Craiova). The moving averages (5-year periods) indicate the same positive trend for most of the plain, trend that is however marked by a series of discontinuities mainly corresponding to the intervals 1990-1996 (total annual precipitation amounts decreased as well much below the normal) and 2000-2004 in the south-east (Bechet and Caracal) (Fig. 1).

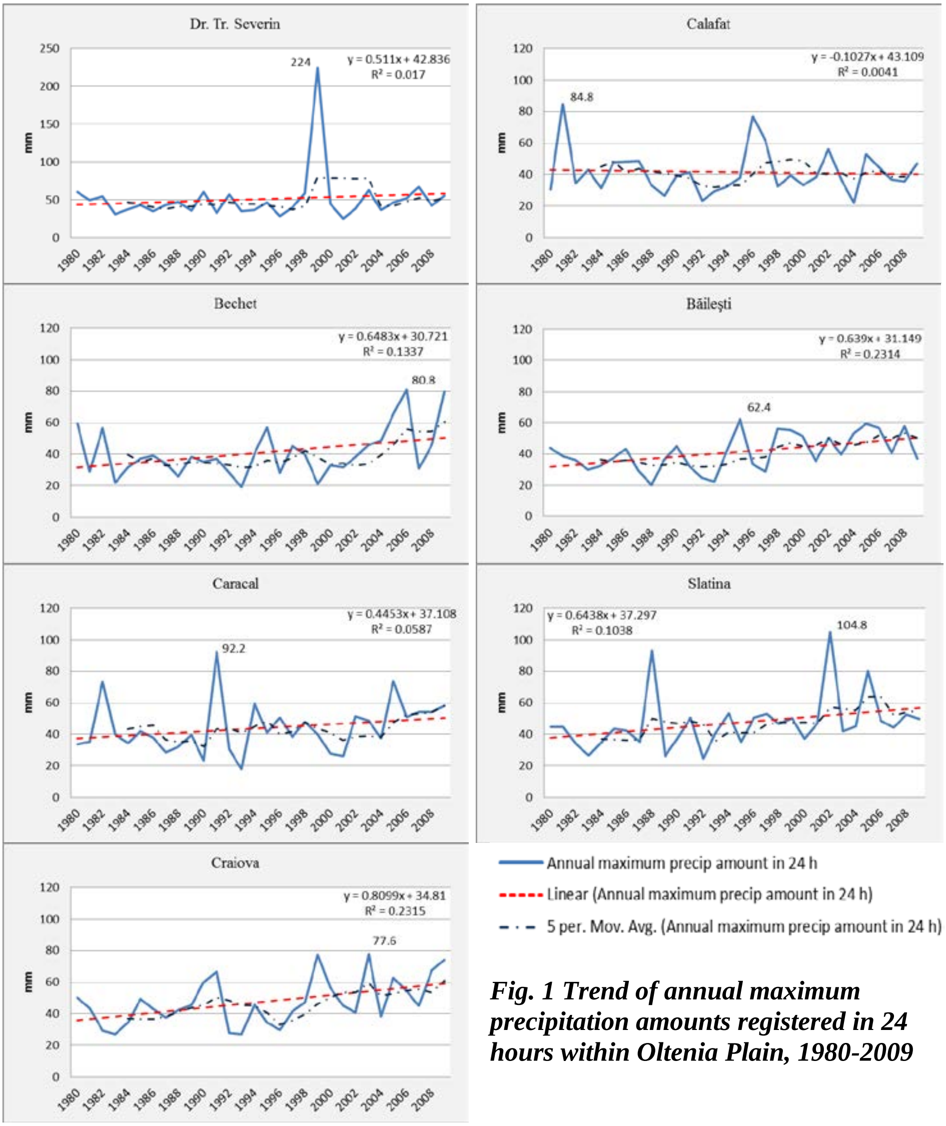

Fig. 1 Trend of annual maximum precipitation amounts registered in 24 hours within Oltenia Plain, 1980-2009

3.3 Frequency of precipitation amounts on different value classes. In about 30% of the cases, the highest amount of precipitation in 24 hours exceeded the sum in the respective month, in some exceptional cases, almost four times (D.T. Severin, July 1999). Thus, the analysis of the frequency of different value classes is extremely useful in establishing certain patterns of the annual distribution of the maximum precipitation amounts in 24 hours. Overall, the highest frequency is displayed by the first two classes (0-10.0 mm and 10.1-20 mm) (Fig. 2). The lowest frequency is registered in the west (27.78% at D.T. Severin for the first class and 32.75% at Calafat for the second class), while the highest values in the east (34.72% at Bechet, respectively 39.72% at Caracal).

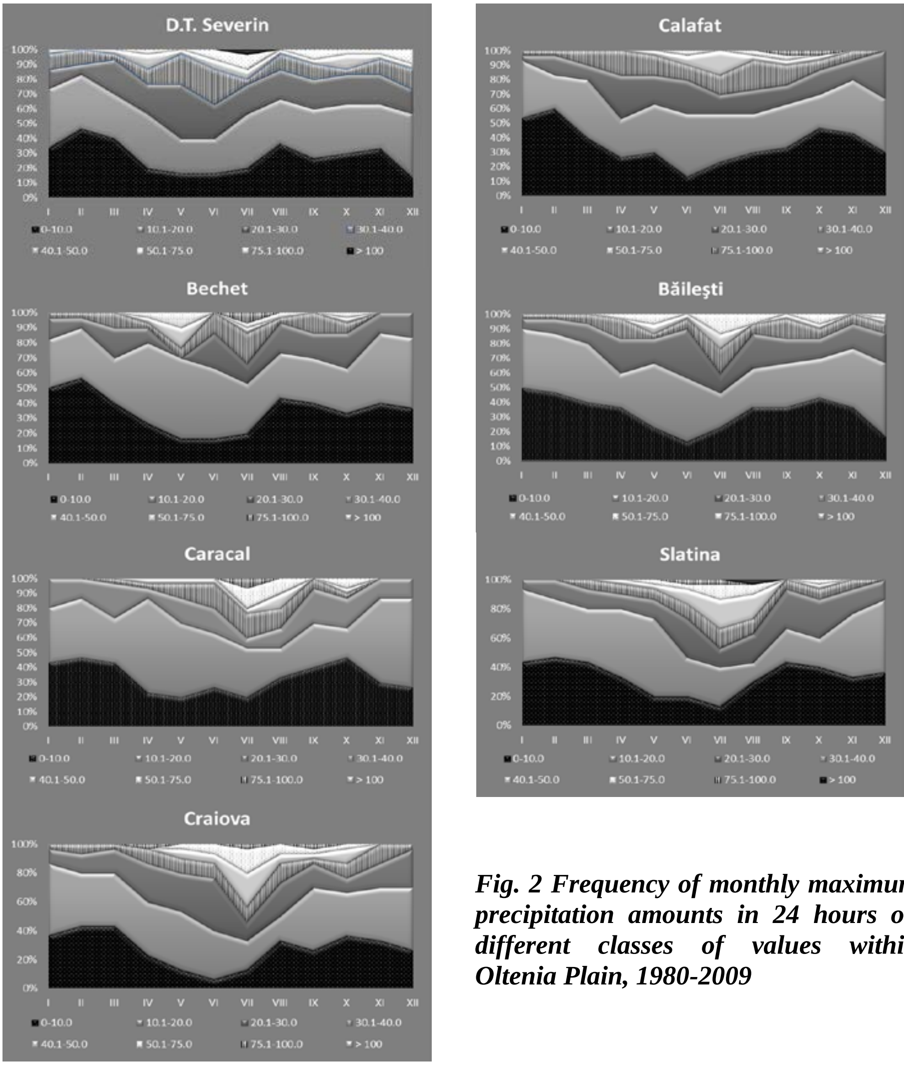

Fig. 2 Frequency of monthly maximum precipitation amounts in 24 hours on different classes of values within Oltenia Plain, 1980-2009

The amounts 20.1-30.0 mm are more homogeneously distributed within the plain, the frequency varying between 20% (D.T. Severin and Craiova) and 14.72% (Bechet). All the stations located in the east of the plain register lower values (below 16%). The frequencies of the other four value classes are extremely reduced, below 10% for the class 30.1-40 mm, below 5% for the class 40.1-50 mm, and below 3% for the other two classes; however, there should be mentioned the same distribution pattern, namely higher values in the west and north. In the first case, heavier rainfalls are generated by the more frequent penetration of humid warm air masses and peculiarities of the location (mainly for D.T. Severin – depression area, near the Danube), while in the second it is about altitude and influence of the city.

At monthly level, the highest percentages of the first two classes of values are registered during winter and autumn, as well as in the first month of spring (40-60%), with the highest values in the south, along the Danube. The lowest rates correspond to summer months (7-25%), with some exceptions – August, which is generally a dry month in the region, registers high percentages, mainly in the west, more than 35%. On the contrary, the last three classes (more than 50 mm) register the highest frequency during summer months, mainly July (13% in the west – 20% in the north, at Craiova).

3.4 The probability of occurrence. The probability of occurrence greatly depends on the dynamic factors and peculiarities of local conditions. The analysis of the data series emphasized that the greatest probability is registered by the amounts of 20 mm (55-75%), the percentage being lower in the west of the plain where higher amounts (30-40 mm) display higher probability (10-15%) than within the rest of the plain (5-10%). Within most of the plain, the amount of 90-100 mm has a probability of 1%, except for the western extremity (Fig. 3). Quite frequently precipitation is caused by the westerly cyclonic air flow; however it usually does not give high daily totals. Heavy rainfalls are induced by the Mediterranean advection and disturbances in this area.

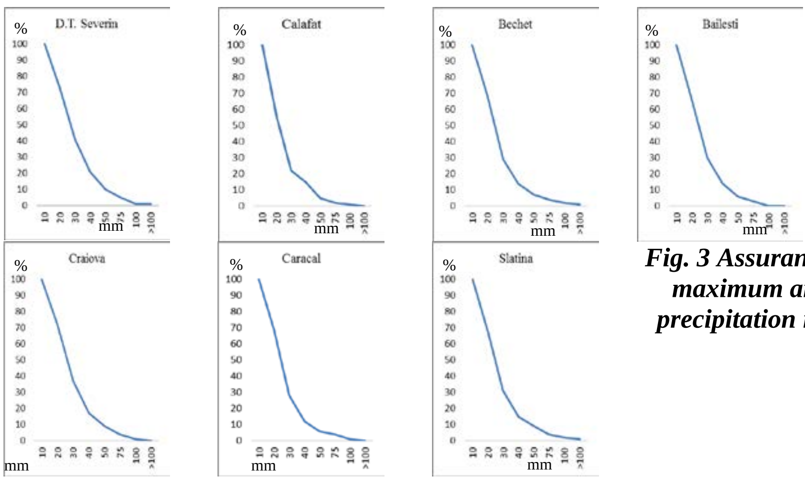

Fig. 3 Assurance degree of maximum amounts of precipitation in 24 hours

4. CONCLUSIONS

The influence of atmospheric circulation is only one key factor in the occurrence of favourable rainfall conditions. Other important factors refer to relief features, convection, moisture content of air masses, etc. All these factors lead to varied precipitation conditions, mainly in non-homogenous areas. This is quite obvious in case of extreme rainfalls, which can be quite different even within small regions, such as Oltenia Plain. At all the meteorological stations, the maximum precipitation amounts in 24 hours were higher than the average of the month in which they occurred. The values varied between a minimum of 62.5 mm at Băileşti and an exceptional maximum of 224 mm at D.T. Severin, most of them varying between 80 and 100 mm. Consequently, almost the entire analysed region is characterized by an increased homogeneity in terms of maximum amounts, induced by the high similarity of precipitation triggering factors.

There clearly resulted a positive trend of the annual maximum amounts in 24 hours within most of the plain area, except for the south-west and west, where the evolution is either stationary or the trend is negative. This general upward trend, emphasized by both linear regression and moving average (5-year periods), is much well stressed in the eastern and northern parts of the plain. Even if at annual level the 20 mm threshold is exceeded in at least one month (the average being 3-4 months per each year), the highest cumulated frequency belongs to the first two classes of values (0-10 mm, 10.1-20 mm), more than 60% at all the stations (60% at D.T. Severin in the west and 73% at Caracal in the east). The lowest frequency is registered by the class 75.1-100 mm (1-2%) and > 100 mm (0.28% at only two meteorological stations). The probability of occurrence of maximum amounts in 24 hours decreases as the amounts increase, the lowest rate being registered in case of 90-100 mm and > 100 mm, generally 1%. Thus, at least some parts of the studied region are quite vulnerable to extreme rainfalls.

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