

THE RISK OF EXCESS RAINFALL OVER THE REPUBLIC OF MOLDOVA TERRITORY

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Abstract. In this study we aim to highlight the risk of excess rainfall over the Republic of Moldova territory, analyzing the magnitude and frequency of maximum diurnal, seasonal and annual rainfall. The research is based on data from three meteorological stations (Briceni, Chisinau and Cahul) for the period 1950-2015. The maximum rainfall analysis from the three stations in the republic indicates a decrease of maximum annual averages from north toward south. Regarding the frequency of rainfall excess that reach and exceed the threshold of 50 mm - stands south of the country, being influenced by Mediterranean Cyclones. In annual aspect, for all analyzed stations, the highest frequency rank the classes reaching values of 500-600 mm, each station having its peculiarities.

Introduction

At present, the evolution of atmospheric circulation influences the maximum rainfall regime, and requires the study related to excess rainfall manifested in the regional aspect. The maximum rainfall diurnal multiannual manifestation have a tendency to increase their amounts over the most territory of Republic of Moldova, in the most cases causing the triggering to flooding events.

Atmospheric precipitation being a climate element that is characterized firstly, by discontinuity and large variations in time and space. Intensity, extension and position of baric centers determine the forms and types of atmospheric circulation, affecting the genesis weather and the origin of the thermal and precipitation surplus.

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1. Data and methods

In the present study data from three stations were considered: Briceni - for north of the republic; Chisinau - center of the country and Cahul - south of the country. Data for a period of 66 years (1950-2015) were analyzed. Using Statgraphics Centurion for statistical analysis frequencies and probabilities manifestation of maximum precipitation were determined.

2. Results

In temporal aspect as can be observed from Table 1, excess rainfall attested lately were recorded in 2005, 2008, 2010 and 2013. At Briceni station, the highest amount of precipitation was attested in 2010; 952.1 mm, at Chisinau station the same year ranks as second among the most rainy years, with 735 mm of rainfall, and at Cahul weather station - 2010 ranks as the eighth position; 698.4 mm. If in the north of the country the most humid year was 2010, in central and southern republic the 1966 year is the one that had the greatest amounts of precipitation - 744 mm, respectively 818 mm.

Table 1. Rankings years with annual precipitation excess (1950-2015)

Briceni		Chişinău		Cahul	
2010	952.1	1966	774	1966	818
1998	892	2010	735	1997	813
1996	834	1955	721	1972	740
1969	802	1980	712	1974	721
2005	800	1996	711	1979	721
1981	796	1995	702	1958	720
2008	773	1979	684	2013	717.2
1978	765	1991	673	2010	698.4
1955	759	1970	672	1999	674
1970	747	1984	669	1969	661

During the winter (Table 2) in the last period, the 2005, 2007, 2010, 2012 were the years with the highest precipitation amounts.

Thus, for all three weather stations' data taken in the study, years 2010, 2012 were ranked as second and third places in the top years with excess rainfall. Absolute maximum, however, belong to the '60s (1963, 1966, 1969). At the same time, we find that during the cold season of the year the highest values of rainfall are registered in the south, which is largely determined by the influence of Mediterranean cyclones.

During the spring season, in the north of the country, the surplus amount of precipitation for the past 15 years are registered in 2005, 2006 and 2008 (Table 3).

In the central part of the country, 2006 ranks second in the top years with rainfall excess. For meteorological station Cahul - 2014 ranks among the first 10 years with rainfall surplus. We note that in the north the absolute values of rainfall were recorded in 1962 (246 mm), in the center 1984 (265 mm) and for the south of the country in 1991 (283 mm).

Table 2. The rankings years with seasonal precipitation excess (winter)
(1950-2015)

Briceni		Chişinău		Cahul	
1966	219	1963	247	1966	270
2012	195	2010	231	1969	268
2010	178	1966	229	2012	244
1996	176	1969	203	1956	211
1963	176	1996	189	1963	202
1970	175	2012	174	1965	169
1969	171	2007	168	1953	152
1953	168	1984	165	1952	149
2005	166	1999	162	1986	148
1952	161	1967	159	1984	142

Table 3. Rankings the years with seasonal precipitation excess (spring)
(1950-2015)

Briceni		Chişinău		Cahul	
1962	246	1984	265	1991	283
2006	233	2006	223	1984	238
2005	226	1988	204	1978	238
1978	221	1991	204	1993	225
1970	221	1993	203	1988	213
1981	211	1979	199	1966	207
2008	208	1970	188	1979	204
1971	203	1962	185	2014	201
1995	201	1980	171	1971	190
1965	190	1978	166	1958	177

During the summer season is summed the highest amount of precipitation with a significant share of the total annual amount of precipitation. Analyzing the maximum amount of rainfall in this season (Table 4) shows that in the period 1950 – 2015 the highest values were recorded in 1997 - in the south of the republic (447 mm); in 2010 – for the north of the country (435 mm) and 1983 - in center of the country (349 mm). At the same time we note that during 2000-2015, among the wettest summers stands out 2002 for central and southern of the republic; 2005 - the center and north of the country; 2010 - for the north and south of the country.

Table 4. Rankings the years with seasonal precipitation excess (summer) (1950-2015)

Briceni		Chişinău		Cahul	
2010	435	1983	349	1997	447
1969	414	1955	324	1983	383
2003	399	1991	307	1972	362
1998	392	1985	307	1999	314
1972	362	1980	298	1974	304
1988	339	1952	298	2010	293
1955	334	1954	278	2002	290
2005	329	2005	276	1958	289
2006	329	2002	275	1985	267
1989	328	1983	273	1968	255

In the autumn, seasonal maximum amounts of rainfall decrease, compared to the summer season, thus maximum values are below 351 mm; registered in 2013, in south of the country, at meteorological station Cahul. In the north and center of the country, the wettest autumn in the period under review it was in 1996, when 274 mm and 324 mm respectively were registered. In the top of autumns' excess rainfall from the last 15 years, the 2001 year is highlighted (the third position in the north and center of the country and fourth in the south).

Table 5. Rankings the years with seasonal precipitation excess (autumn) (1950-2015)

Briceni		Chişinău		Cahul	
1996	274	1996	324	2013	351
1998	273	1998	295	1974	256
2001	235	2001	243	1972	247
1960	219	1976	224	2001	247
1974	216	1981	221	1952	233
1968	213	1972	215	1998	218
1976	212	2002	207	1964	216
1955	197	1995	207	1962	210
1964	197	1964	191	1981	205
1959	187	2014	188	2015	199

As can be seen from Figure 1, in the north of the country a greater frequency have precipitation excess with values between 450 and 700 mm. During the period under review, there were 51 cases with annual rainfall amounts between these

values. Of these, in eight cases the amounts of rainfall ranged between 434 and 476 mm, and in eight cases between 602 and 644 mm.

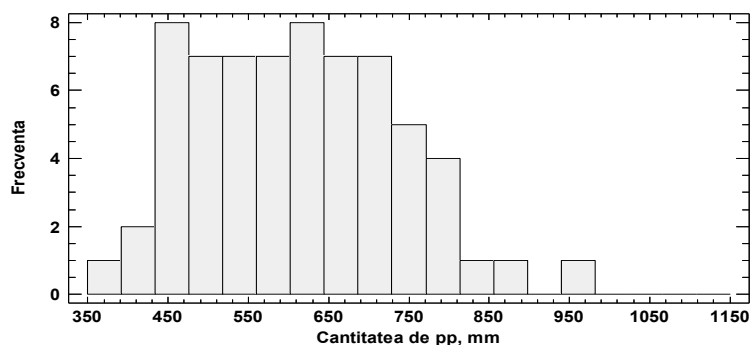


Figure 1. The frequency of annual excess rainfall manifestation, Briceni st. (1950-2015)

Towards southern region, there is a decrease of annual excess rainfall frequency of over 600 mm, as well those below 500 mm. At Chisinau meteorological station, during the 1950-2015 period there were eight cases with amount of rainfall between 530 and 556 mm, and 9 cases - between 580 and 610 mm (Figure 2). These two classes of values constitute 26% in the 66 analyzed years.

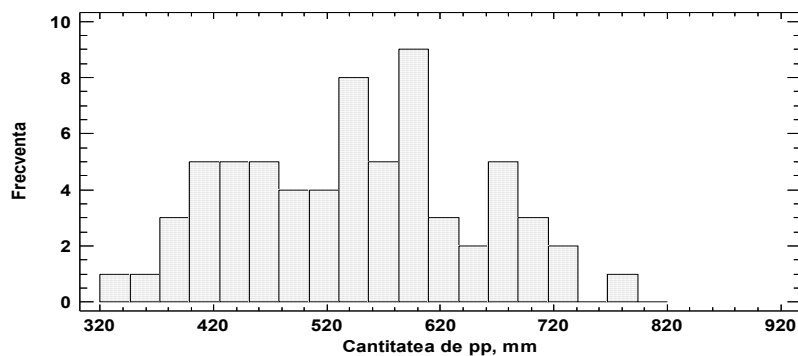


Figure 2. The frequency of annual excess rainfall manifestation, Chişinău st. (1950-2015)

In the southern region of the country in the period 1950-2015, nine years have been reported with rainfall amounts summarized 438 and 470 mm (Figure 3). In the other 30 cases annual rainfall values were between 500 to 627 mm. Extreme

values at Cahul meteorological station during the study period were recorded in 2003 - with minimum of 307 mm and 1966 - with a maximum of 818 mm.

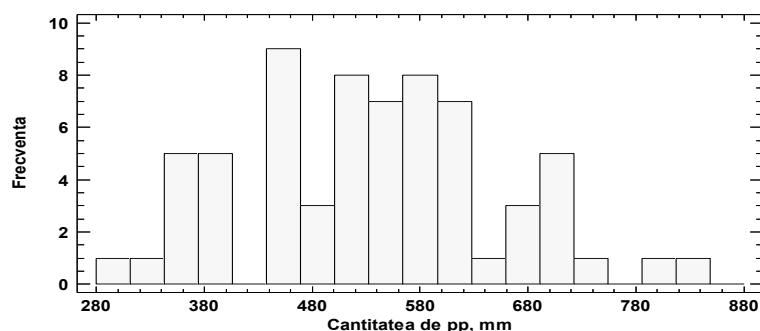


Figure 3. The frequency of annual excess rainfall manifestation.
Cahul st. (1950-2015)

An important feature of the precipitation regime is the maximum quantities of atmospheric precipitation fallen within 24 hours. They have the largest and most direct negative influence in triggering other risks, especially hydrological and geomorphological ones. Maximum amounts of rainfall in 24 hours can reflect the rainfall's instability. It is sometimes possible as the diurnal rainfall to exceed the average monthly amount. Therefore, we believe it is extremely important to know their intensity and frequency of manifestations.

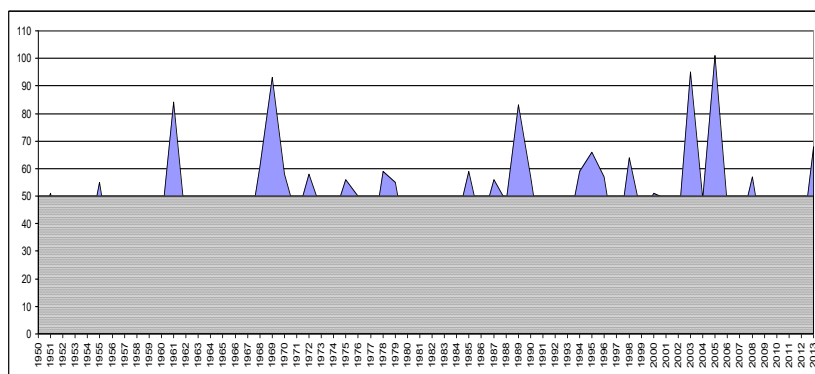


Figure 4. The maximum amounts of diurnal precipitation exceeding the threshold of 50 mm, Briceni st. (1950-2013)

In terms of their origin, in one hand they are linked to intense frontal activity, on the other hand by heat convection that stimulates the development of clouds and rainfall intensification [5].

The evolution of diurnal rainfall peaks ≥ 50 mm (1950-2013) indicate that the north (Figure 4) occurred in 17 cases, in the central part - 15 (Figure 5) and in the south of the country - in 19 cases (Figure 6) being largely explained by the manifestation of atmospheric circulation, including the Mediterranean cyclones.

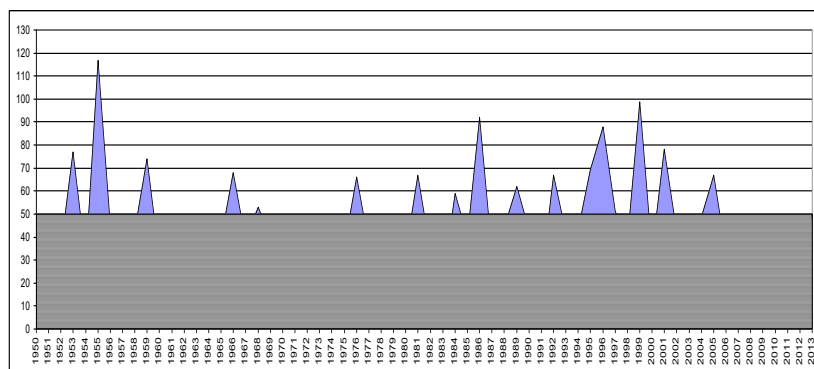


Figure 5. Daytime maximum rainfall exceeding the threshold of 50 mm, Chişinău st. (1950-2013)

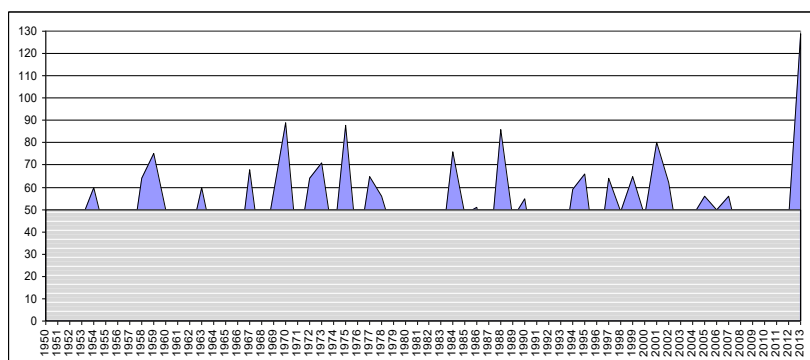


Figure 6. The maximum amounts of diurnal precipitation exceeding the threshold of 50 mm, Cahul st. (1950-2013)

At Chisinau meteorological station, in the last decade, it was reported only one case with daytime maximum amounts of over 50 mm – in 2005, when the maximum amount of rainfall for 24 hours was 67 mm. While at Briceni and Cahul stations such cases, at the same time were three times - in 2005, 2008 and 2013 at Briceni, with the maximum amount of 101 mm in 2005, and in the years 2005, 2007 and 2013 - in Cahul, with the maximum amount of 129 mm in 2013, which is also the absolute maximum for the entire period.

Conclusions

Following the analysis of different frequencies of monthly precipitation amounts, it was found a great variability; as according to the synoptic situation, excess rainfall can occur over the whole analyzed perimeter.

In the case of annual maximum rainfall, their mean value decreases from the north (Briceni - 611.8 mm) to south (Cahul - 536.6 mm), maximum rainfall diurnal the highest average value recorded in south of the country - 49.1 mm, while the average recorded in Chisinau is 45.8 mm, and meteorological station Briceni - 47.4 mm.

The highest value of annual maximum rainfall was recorded at Briceni station - 952.1 mm in 2010, while the lowest - in Chisinau - 774 mm in 1966. Also in 1966 there was the absolute maximum at the Cahul meteorological station (818 mm).

Across all analyzed stations the highest frequency values are held within the values classes - 500-600 mm, each station having its peculiarities. So, in the south of the republic is highlighted one more class with a greater frequency, less than 500 mm (437.9 to 469.5 mm; 9 cases) and in the north, are reported frequencies as high for classes of values from 434.2 to 518.4 mm; 15 cases, but for monthly maximum quantities over 600 mm (602.6 to 728.9 mm; 22 cases).

In the case of the excess rainfall frequency that reach and exceed the threshold of 50 mm stands south of the country, where the influence of Mediterranean Cyclones in their retrograde evolution generate long-lasting heavy rainfall, while in winter; particularly heavy snow and mixed precipitation.

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