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DEPLETION OF WATERCOURSES IN NORTH-EASTERN ROMANIA. CASE STUDY: THE MILETIN RIVER

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Abstract: The article focuses on the droughts occurring in the Miletin hydrographic basin, in order to underline the impact of this meteorological phenomenon on certain hydrological hazards in a region lacking sufficient water resources. A better insight into droughts and drying-up phenomena underlines clearly that regulation projects need to be implemented for the course of the Miletin River, in order to ensure the amount of water necessary for certain economic sectors, mostly in the summer. Several mathematical indices have been applied to identify the drought phenomenon. The drought is increased by the torrential character of the precipitations, with very high values of rainfall during very short time periods (a maximum of 90.3 mm/24 hours), and the presence of long periods entirely lacking rainfall (two-three consecutive months). In the warm period of the year, the more accentuated droughts determine a considerable reduction of discharges and even the emergence of the drying-up phenomenon in the upper basin of the Miletin River. The minimal recorded discharge was 0 m^3/s registered at the Nicolae Balcescu station (the upstream sector) and 0.002 m^3/s registered at the Halceni station (the downstream sector). The 1, 2 and 3 rank (Horton-Strahler system) watercourses dry up completely, while those of superior ranking register persistent outflow. Complete dry up has been recorded in 1968, 1969 and 1987.

Key words: drought, drying-up period, mathematical analysis indices, minimum discharge, water resources

1. INTRODUCTION

In the past few years, the meteorological and hydrological hazards have increased in number and intensity. This is why scientists should become more interested in elaborating studies to analyze these phenomena. The droughts have a particular impact on the hydrographic basins as they lead to the reduction of the water reserves. Both human activities and the elements of the natural setting are affected by the existing rainfall deficit.

In the past decades, the Romanian territory has been intensely affected by hydrological hazards, often associated with hydrological drought. In 2012, the worst Romanian drought in the history of rainfall and hydrological records was registered. The hydrological regime of the Miletin River is similar to that of the rivers in Eastern Europe: Dniester, Southern Bug, Dnieper, Don, etc. The drought topic has often been given much attention in both the national (Chiriac et al., 2005; Diaconu, 1961; Lupu et al., 2010; Mihailescu et al., 2007; Moldovan et al., 2002; Pantazica & Schram, 1967; Romanescu et al., 2012a; Romanescu & Stoleriu, 2013a; Stancalie et al., 2003; Topor, 1964; Ujvari et al., 1958) and in the international literature (Adler, 1994; Bonacci, 1993; Fleig et al., 2006; Hisdal et al., 2001; Lloyd-Hughes & Saunders, 2002; Wilhite & Glantz, 1985; Yurekli & Kurunk, 2005; Zelenhasic & Salvai 1987), because it has had a special influence on the economy of a country or of a region.

This study proposes an analysis of the drought phenomenon in a region characterized by a rainfall regime with considerable monthly and annual fluctuations. There is a focus on the impact of drought as hydrological hazard and on its implications for local economy. At the same time, the discharge difference between the tributaries in the upper and those in the lower basin is highlighted.

2. GEOGRAPHIC LOCATION AND THE LIMITS

The Miletin hydrographic basin is situated in the central southeast part of the European continent; it ranges between the parallels of 47º20'25'' and 47º43'11'' N. latitude and between the meridians of 26º34'26'' and 27º21'35'' E. longitude. The Miletin hydrographic basin is situated in the NE part of Romania and of the Moldavian Plateau. It crosses two geographic subunits: the Suceava Plateau and the Moldavian Plain (Fig. 1).

3. METHODOLOGY

For the analysis of this meteorological phenomenon, many of data used were provided by the Prut Waters Direction and by the Moldova Regional Centre of Iasi (subordinated to the "National Meteorological Administration"). The data were taken over from the rainfall stations of Cristesti (1962–2008), Nicolae Balcescu (1962–2008), Plugari (1962–2008), Chiscareni (1962–1994), and Halceni (1991–2008) and from hydrometric stations of Nicolae Balcescu (1962–2008), Sipote (1962–2008) and Halceni–downstream (1991–2008). In this sense, the discrete continuous variables of 47 terms at the most, some of them long enough to do the statistical analyses, have been processed. Data from Halceni–downstream have also been analyzed, though the variables that characterize the rainfall and hydrological regime of this region have an 18-year time limit.

The data were processed and interpreted in EXCEL. The processing process was divided into two phases:

-the statistical analysis within which the following parameters were used: arithmetic means, rolling means, standard deviations, frequencies, as well as various calculation formulas to underline the dry and rainy periods.

-the elaboration of graphs in EXCEL.

The digital terrain model (DTM) was elaborated using 1:5000 topographic maps, in the software ESRI ARCWIEW vs. 9. 3. 1. This model helps determining the altimetric levels and the positioning of hydrological and rainfall stations compared to the landform units and subunits.

4. RESULTS

Atmospheric drought is a state of the atmosphere when the degree of precipitations is very low and the air humidity reduced (Chiriac et al., 2005; Topor, 1964). The drought phenomena can be underlined based on different criteria, depending on typology, on the environments where they occur, on the sectors affected, etc. Various climatic, pedologic, agrometeorological parameters, etc are considered. The most common methods to characterize of the drought phenomena are either mathematical (indices), or graphic (climograms or climographs). Among the mathematical methods used to identify the drought phenomena, we mention the following: Hellmannn quotient, Topor rainfall index, Angot's value, and the standardized precipitation index.

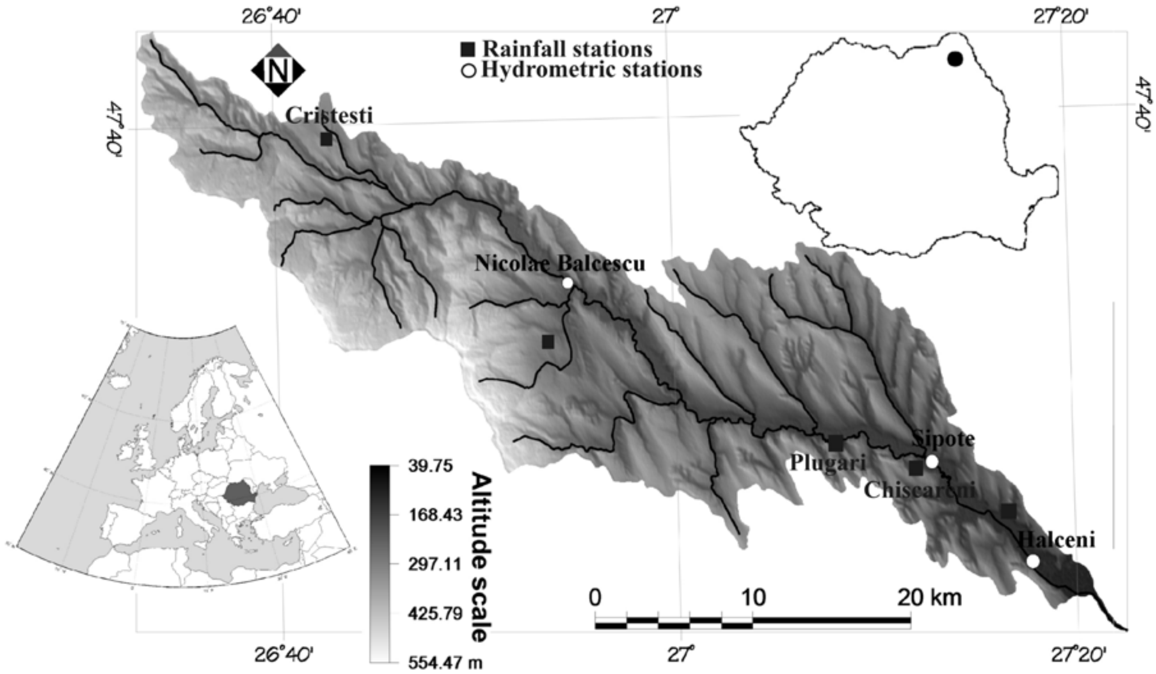

Figure 1. The geographical location of the Miletin hydrographic basin in Romania and Europe

In the Miletin hydrographic basin, the drought phenomenon can be analyzed by using these criteria in processing the data from the rainfall and hydrological stations. The Hellmannn rainfall index is calculated based on the percentage deviations of the monthly amounts of precipitations compared to the multiannual mean of that month. Considering this quotient, the following aspects are assessed:

- normal month (NM) – when the amount of precipitations varies between +10% and –10% compared to the multiannual rainfall mean;
- moderately rainy month (MRM) - when it varies between +10.1% and +20%;
- rainy month (RM) – when it varies between +20.1% and +30%;
- very rainy month (VRM) – when it varies between +30.1% and +50%;
- extremely rainy month (ERM) – when it varies by over 50%;
- moderately dry month (MDM) – when it varies between –10.1% and –20%;
- dry month (DM) – when it varies between –20.1% and -30%;
- very dry month (VDM) – when it varies between -30,1% and –50%;
- extremely dry month (EDM) – when it varies by over 50% (Topor, 1964).

The weighting of the precipitation qualifiers for the three rainfall stations within the basin has different values (Tables 1, 2, 3). The dominance of extremely dry months and of extremely rainy months (over 20% of the cases) has been noticed. This underlines the high frequency of droughts within the temperate continental transitional climate in the NE part of the country.

Torrentiality – characterized by the very high percentage values of rainfall extremes (90.3 mm/24 hours, June 18, 1979; 87.4 mm/24hours, June 19, 1979) – increases within the basin of the Miletin River, from upstream towards downstream, as well as from a temporal perspective (Flez & Lahousse, 2004; Menani & Bennedjai, 2009; Nadal-Romero et al., 2012; Rousset & Guiomar, 1999; Sanz et al., 2005; Stefanidis et al., 2010).

Table 1. Percentage of the precipitation qualifiers, at Cristesti, Nicolae Balcescu, Plugari, in the period 1962–2008 (by the Hellmannn quotient)

Monthly characteristic/ Rainfall station	EDM	VDM	DM	MDM	NM	MRM	RM	VRM	ERM
Cristesti	26.24	12.77	8.16	6.74	10.64	3.55	4.08	6.91	20.92
Nicolae Balcescu	26.77	13.65	5.5	6.56	10.64	6.56	4.96	7.09	18.26
Plugari	18.62	7.63	6.21	4.79	10.64	7.09	4.97	12.94	27.12

EDM-extremely dry months; VDM-very dry months; DM-dry months; MDM-moderately dry months; NM-normal months; MRM-moderately rainy months; RM-rainy months; VRM-very rainy months; ERM-extremely rainy months.

Table 2. Percentage of the precipitation qualifiers, at Cristesti, Nicolae Balcescu and Chiscareni, in the period 1962–1994 (by the Hellmann quotient) (%)

Monthly characteristic/ Rainfall station	EDM	VDM	DM	MDM	NM	MRM	RM	VRM	ERM
Cristesti	26.51	14.14	9.09	6.57	10.86	2.02	3.28	7.58	19.95
Nicolae Balcescu	25.87	14.45	6.99	6.53	10.26	4.90	4.90	6.53	19.58
Plugari	26.77	12.12	7.58	5.30	11.62	5.15	4.55	7.83	19.19
Chiscareni	27.27	13.89	6.82	5.30	9.34	4.29	4.04	8.59	20.45

EDM-extremely dry months; VDM-very dry months; DM-dry months; MDM-moderately dry months; NM-normal months; MRM-moderately rainy months; RM-rainy months; VRM-very rainy months; ERM-extremely rainy months.

Table 3. Percentage of the precipitation qualifiers, at Halceni–downstream, in the period 1991–2008 (by the Hellmann quotient) (%)

Monthly characteristic/ Rainfall station	EDM	VDM	DM	MDM	NM	MRM	RM	VRM	ERM
Cristesti	24.07	15.74	4.17	5.56	13.89	3.71	4.17	11.11	17.59
Nicolae Balcescu	25.93	11.11	6.95	4.63	17.13	4.63	6.02	6.02	17.59
Plugari	29.16	12.50	4.17	5.56	12.04	4.63	5.56	6.95	19.44
Halceni	28.70	11.11	6.48	4.63	13.43	3.24	2.31	6.48	23.61

EDM-extremely dry months; VDM-very dry months; DM-dry months; MDM-moderately dry months; NM-normal months; MRM-moderately rainy months; RM-rainy months; VRM-very rainy months; ERM-extremely rainy months.

At Cristesti and Nicolae Balcescu, the frequency of extremely dry months and extremely rainy months is lower than in the middle basin (Plugari, Chiscareni), where 27.27% extremely dry months and 20.45% extremely rainy months were registered. At Cristesti, an accentuated torrentiality has been manifesting (Plesoianu & Olariu, 2010; Romanescu et al., 2012a). The extreme months, rainfall wise, are more numerous than at Nicolae Balcescu, due to slight “foehnisation” processes occurring east from Saua Bucecii (Baumann et al., 2001; Drechsel & Mayr, 2008; Frey, 1986; Gaffin, 2007) (Tables 1, 2, 3, 4).

The Topor rainfall index is calculated depending on the Hellmann quotient, by using the following formula:

$$Ia = \frac{N + 2P}{N + 2S},$$

where:

Ia- the index of the year;

N- number of normal months (MDM+NM+MRM);

P- number of rainy months (RM+VRM+ERM);

S- number of dry months (DM+VDM+EDM).

For values of the rainfall index (Ia) below 0.33, the years are considered exceptionally dry. If the Ia ranges between 0.33 and 0.41, the years are extremely dry. If the Ia ranges between 0.41 and 0.70, the years are considered very dry. If the Ia ranges between 0.71 and 0.84, the years are considered dry, and if the rainfall index has values varying between 0.85 and 1.0, the years are seen as slightly drier. The normal years have an Ia ranging between 1.01 and 1.17, and the least rainy years have values of the rainfall index above 1.18 (Topor, 1964).

In the period 1962–1994, within the Miletin hydrographic basin, the value of the rainfall index increases gradually from Nicolae Balcescu downstream. In the upper basin, the period assessed was dry, while towards the east, in the middle basin, at Plugari and Chiscareni, the years were moderately dry. It is interesting that, considering the increase in the annual Topor index, there has been an increase in the number of extremely dry and very dry months according to the Hellmann quotient, which clearly underlines an increase in torrentiality from the west towards the east (Muresan, 2009; Romanescu et al., 2012a). In the past years (1991–2000), the mean aridity index has had only slight spatial variations and it has remained rather high in the upper basin (Cristesti) (Table 5, Fig. 2). The rainiest periods have been registered between 1971 and 1980 and between 2001 and 2008. This is caused by the increase in rainfall extremes.

Table 4. Percentage of the extreme months rainfall wise (EDM+ERM) within the basin of the Miletin River (%)

Period assessed	Rainfall stations				
	Cristesti	Nicolae Balcescu	Plugari	Chiscareni	Halceni
1962–2008	47.16	45.03	45.74		
1962–1994	46.46	45.45	45.96	48.6	
1991–2008	41.66	43.52	48.6		52.32

Table 5. Multi-annual mean of the Topor aridity index, in the Miletin hydrographic basin

Period assessed	Rainfall stations				
	Cristesti	Nicolae Balcescu	Plugari	Chiscareni	Halceni
1962–1994	0.82	0.79	0.92	0.95	
1991–2008	0.93	0.87	0.88		0.86

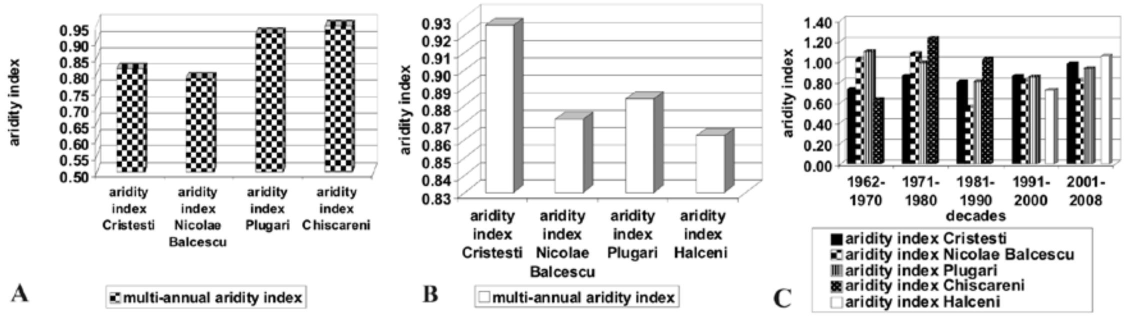

Figure 2. A.Variation of the Topor aridity index within the basin of the Miletin River (1962–1994); B.Variation of the Topor aridity index within the basin of the Miletin River (1991–2008); C.Variation of the Topor aridity index, within of the Miletin hydrographic basin (1962–2008)

Within the multi-annual variation of the dry months, four important periods are underlined: 1962–1970, 1970–1980, 1980–1996, and 1996–2005. After 2005, the frequency of the dry months has been slightly increasing. As regards the variation of the rainy months, no distinct period has been highlighted, but only minor increasing tendencies within the past years (Fig. 3). It is very difficult to make prognoses, even on a short term basis, given that the dry, normal, and rainy months present a high value dispersion degree around the multi-annual mean.

The analysis of monthly rainfall (using Angot's value) emphasizes the distribution of rainfall. Precipitations do not fall evenly throughout a month and the months do not have the same number of days. The coefficient value equals the unit, in the months when precipitations are uniform. When this value is subunit, the months are dry, and when this value is over unit, the months are rainy. This rainfall index is calculated by the following formula:

$$K = \frac{x \cdot 365}{X \cdot n},$$

where:

k – rainfall coefficient;

x – amount of rainfall within a month;

X – annual amount of precipitations;

N – number of days in that month.

The calculations of Angot's value indicate that the rainiest month of the year, in the period 1962–1994, was June, with 1.88 at Cristesti, 2.12 at Nicolae Balcescu and Chiscareni, and 2.15 at Plugari. After 1991, there was a "shift" in the maximum rainfall from June to July (Fig. 4). Due to the climatic changes of the past few years, mostly on the Romanian territory, the thermal convection has become stronger in July–August. The western circulation has intensified and it has become more frequent in July (Lupu et al., 2010; Romanescu & Nistor, 2011; Romanescu et al., 2011, 2012a,b; Stancalie et al., 2003). These aspects can represent the cause of the "shift" in the maximum precipitation from June to July.

The values of this index are 2.7 at Cristesti, 1.98 at Nicolae Balcescu, 1.84 at Plugari, and 2.03 at Halceni. The minimum precipitation has been registered in January, when the advections of continental air are frequent. Within the Miletin hydrographic basin, Angot's values dropped from Nicolae Balcescu to Halceni, during most of the months, because of the increase in the frequency of continental air masses on this direction. The manifestation of the foehnisation process determines lower values of Angot's value in most months, from Cristesti to Nicolae Balcescu. The causes of this monthly variation are determined by the evolution of the baric relief above Europe. In the period April–August, the thermoconvective precipitations add to the frontal ones, and Angot's rainfall coefficient has overunit values.

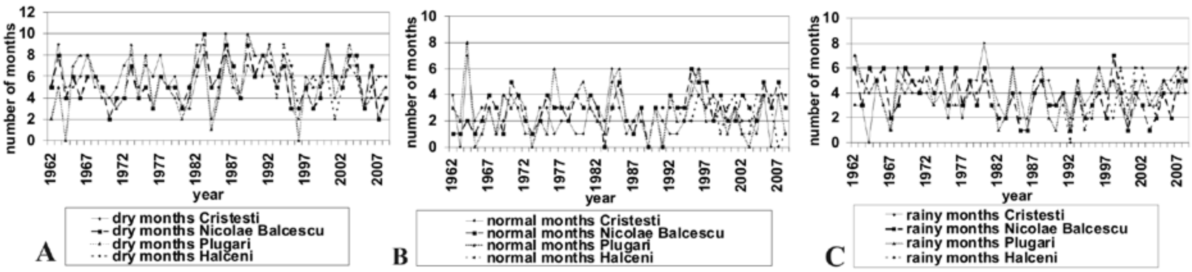

Figure 3. A.Multi-annual variation of droughts within the Miletin basin (1962–2008); B.Multi-annual variation of the normal months within the Miletin basin (1962–2008); C.Multi-annual variation of rainy months within the Miletin basin (1962–2008)

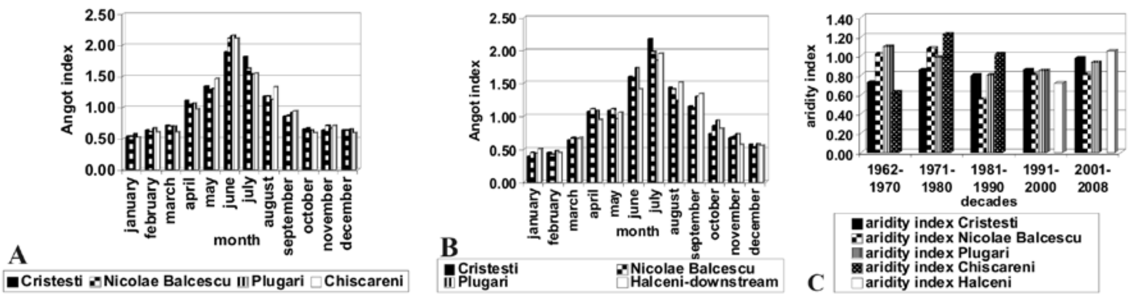

Figure 4. A.Monthly regime of Angot's rainfall index, at the rainfall stations of Cristesti, Nicolae Balcescu, and Plugari, in the period 1962–2008; B.Monthly regime of Angot's rainfall index, at the rainfall stations of Cristesti, Nicolae Balcescu, Plugari and Chiscareni, in the period 1962–1994; C.Monthly regime of Angot's rainfall index, at the rainfall stations of Cristesti, Nicolae Balcescu, Plugari and Halceni, in the period 1991–2008

In the cold season (November–March), when the thermal convection reduces sometimes to zero, thermal inversions persist, the advections of continental air are frequent, and values become subunit. The monthly evolution of Angot's rainfall coefficient emphasize on the monthly character of the monthly regime for the amount of precipitations.

The standardized precipitation index is utilized especially to identify the periods with rainfall deficits, though the variation difference also allows the analysis of surplus (Table 6). This index is calculated by the following formula:

$$ISP = \frac{X - X_{med.}}{\sigma},$$

where:

X – monthly amount of precipitations;

$X_{med.}$ – multi-annual average amount of precipitations;

σ – standard deviation.

Within the Miletin hydrographic basin, the standardized precipitation index is marked very high values of the normal rainfall character (over 55% at the four rainfall stations). Within the normal months, rainfall wise, over 50% present negative deviations compared to the multi-annual mean of that month.

Table 6. Rainfall qualifiers according to the standardized precipitation index (SPI)

SPI	≤–2.00	–1.99- –1.50	–1.49- –1.00	–0.99- +0.99	1.00–1.49	1.50–1.99	≥2.00
Qualifier	Extremely dry	Very dry	Dry	Normal	Wet	Very wet	Extremely wet
Qualifier symbol	ED	VD	D	N	W	VW	EW

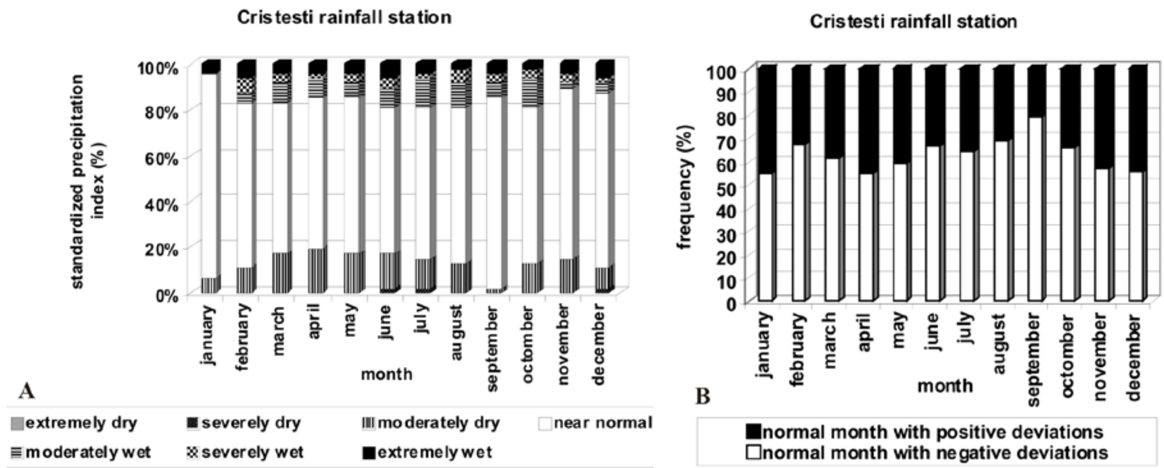

Figure 5. A.Monthly frequency of the standardized precipitation index at the Cristesti rainfall station (1962–2008); B.Frequency of the normal months, with positive and negative deviations from the multi-annual mean for the rainfall station of Cristesti (1962–2008)

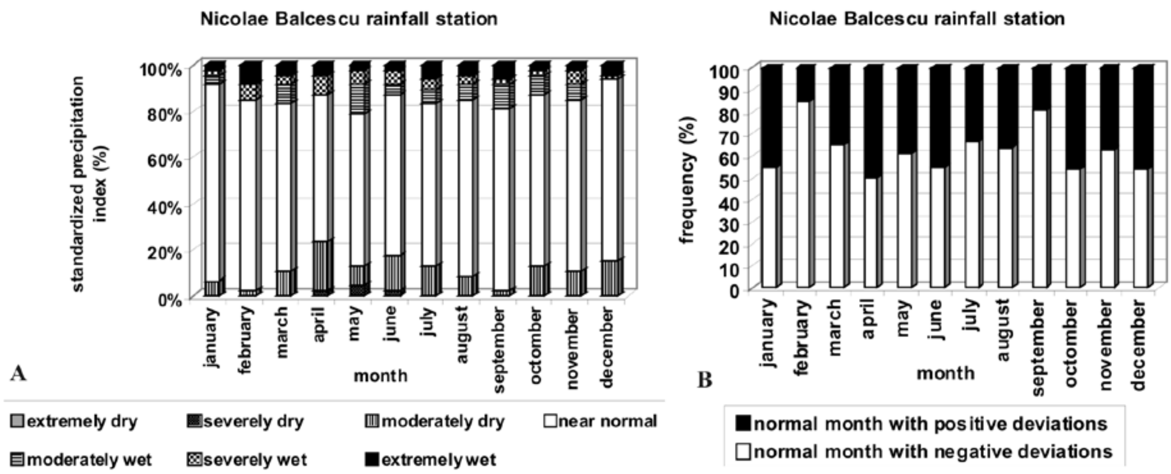

Figure 6. A.Monthly frequency of the standardized precipitation index for the rainfall station of Nicolae Balcescu (1962–2008), B.Frequency the normal months, with positive and negative deviations from the multi-annual mean for the rainfall station of Nicolae Balcescu (1962–2008)

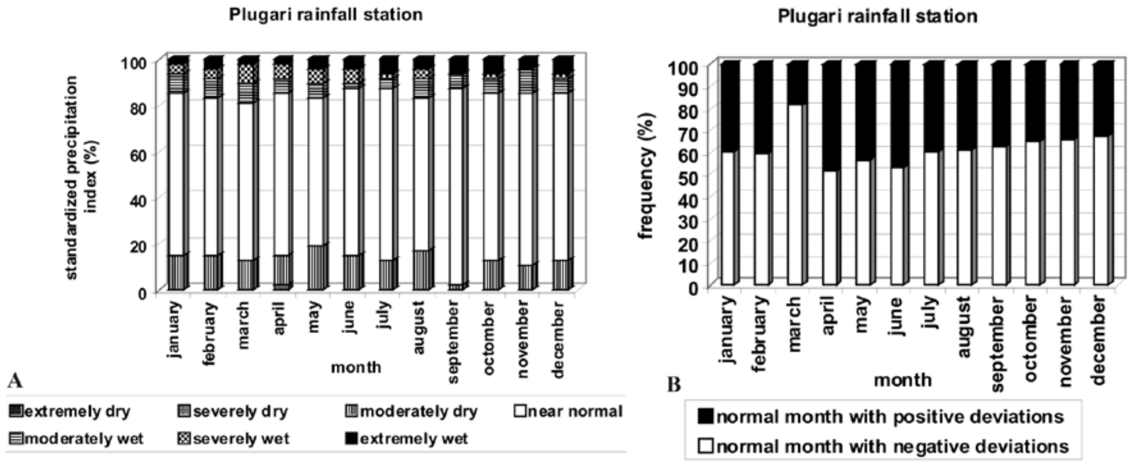

Figure 7. A.Monthly frequency of the standardized precipitation index for the rainfall station of Plugari (1962–2008); B.Frequency of the normal months, with positive and negative deviation, from the multi-annual mean for the rainfall station of Plugari (1962–2008)

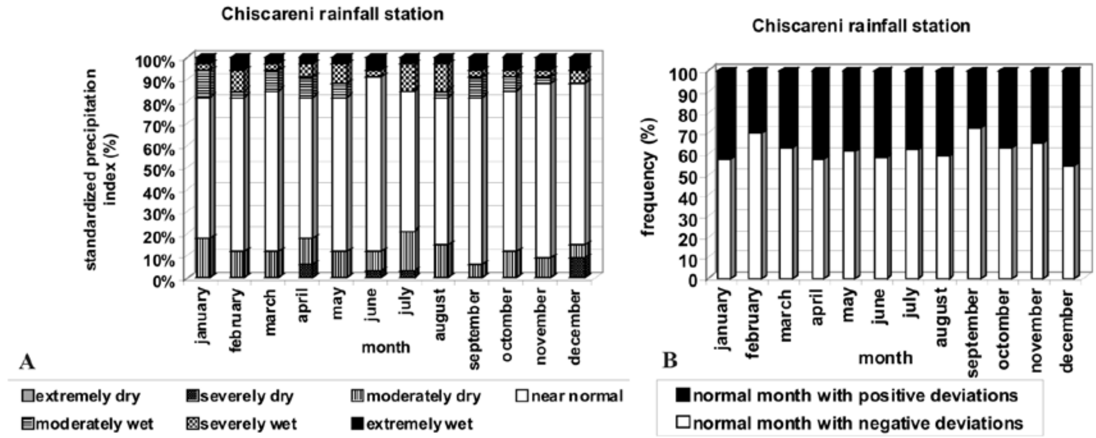

Figure 8. A.Monthly frequency of the standardized precipitation index for the rainfall station of Chiscareni (1962–1994); B.Frequency the normal months, with positive and negative deviations from the multi-annual mean for the rainfall station of Chiscareni (1962–1994)

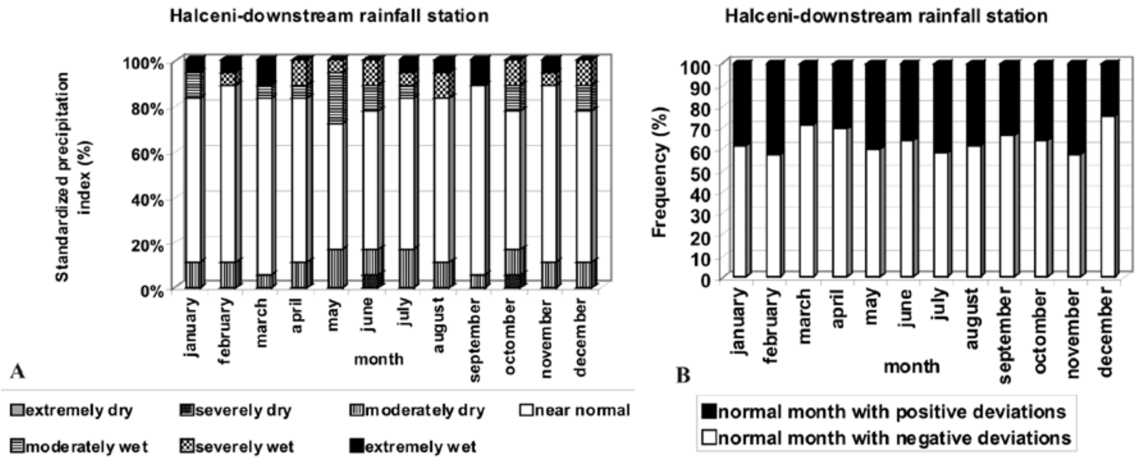

Figure 9. A.Monthly frequency of the standardized precipitation index for the rainfall station of Halceni (1991–2008); B.Frequency of the normal months, with positive and negative deviations from the multi-annual mean, for the rainfall station of Halceni (1962–1994)

For the rainfall extremes, the probability of dry months is higher than rainy months. At the same time, there are no extremely dry months, and the frequency of extremely rainy months is 2.15–6.38% at Cristesti, 2.15–8.51% at Nicolae Balcescu, 2.13–6.38% at Plugari (1962–2008), 3.03–6.06% at Chiscareni (1962–1994). At the hydrometric station of Halceni, the probability of extremely rainy months varies, in the period 1991–2008, between 0% in April–June, October, December, respectively, and 11.11% in the month of March, when the precipitations are more uniform because of the cyclonic areas crossing the Moldavian Plain (Fig. 5, 6, 7, 8, 9).

The percentage distribution of rainfall qualifiers underlines the torrential character of the rains within the Moldavian Plain. The comparative analysis of rainfall qualifiers from the stations of Cristesti, Nicolae Balcescu, and Plugari, for the period 1962–2008, emphasizes on the following:

1. The difference between the months with rainfall deficits from the stations of Cristesti and Nicolae Balcescu is higher than the difference between rainy, very rainy, and extremely rainy months (Table 7).

2. In the eastern part of the hydrographic basin, at Plugari, the frequency of droughts is higher because of the growing influence of the continental air masses.

The higher frequency of droughts from Cristesti is a consequence of the foehnisation characteristic to the contact zone between the high side of the Suceava Plateau and the low sector of the Moldavian Plain.

5. DISCUSSIONS

The mathematical indices used to identify the drought phenomena highlight a high frequency of the dry periods and high amounts of precipitations on short time intervals. Torrentiality increases from the upper basin towards the lower basin (Romanescu et al., 2012a,b; Romanescu & Stoleriu, 2013b). The atmospheric drought phenomenon determines a reduction in the hydrographic network discharge and even the drying-up phenomenon (Fig. 10).

The minim minimorum discharge registered so far for the Miletin River has been 0 m^3/s (drying-up) in the upper basin, at Nicolae Balcescu, on 28–31 January, 1 and 9 February, 6–11 May, 1 and 24 June, 1 and 13 July, 6 and 10 August 1968, 8 and 12 January, 1 and 6 February 1969, 29–31 December 1986, 1 January–15 February, 20 July–4 August and 7 September–19 October 1987. For the middle sector, the minim minimorum discharge was 0.001 m^3/s at Sipote, registered on 9 August and 1–14 September 1990. At Halceni–downstream, the minim minimorum discharge registered in the period 1991–2008 was 0.002 m^3/s on 29 January, 14 February, and 30 November–1 December 2005 (Table 8).

Table 7. Percentage of the precipitation qualifiers, at Cristesti and Nicolae Balcescu, in the period 1962–2008 (according to the standardized precipitation index)

Rainfall stations	ED+VD+D	N	W+VW+EW
Cristești	12.94	71.81	15.24
Nicolae Balcescu	11.17	74.47	14.36
The difference between Cristesti and Nicolae Balcescu	**1.77**	**–2.66**	**0.88**
Plugari	13.3	71.45	15.25

Table 8. The dates of minimal multi-annual discharges at the hydrometric stations of the Miletin basin (1950–2008)

Hydrometric station	Assessed period	Minimum minimorum discharge (m^3/s)	Date
Nicolae Balcescu	1968–2008	0	28–31 Jan. 1968 1 and 9 Feb. 1968 6–11 May 1968 1 and 24 June 1968 1 and 13 July 1968 6 and 10 Aug. 1968 8 and 12 Jan. 1969 1 and 6 Feb. 1969 29–31 Dec. 1986 1 Jan.–15 Feb. 1987 20 July–4 Aug. 1987 7 Sept.–19 Oct. 1987.
Sipote	1981–2008	0.001	9 Aug. 1990 1–14 Sept. 1990
Halceni–downstream	1991–2008	0.002	29 Jan. 2005 14 Feb. 2005 30 Nov.–1 Dec. 2005

Table 9. Rainfall qualifiers for the months with the dry periods that generated minimum minimorum discharges at the hydrometric stations in the basin of the Miletin River

Hydrometric station	Months with Qmin. min.	Hydrometric station		Drought period									
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
Nicolae Balcescu	May–August 1968	Cristesti	-	-	-	ED	N	ED	EP	ED	-	-	-
		Nicolae Balcescu	-	-	-	ED	VD	N	VD	ED	-	-	-
	July–Oct. 1987	Cristesti	-	VD	ED	VD	MD	ED	ED	EP	ED	-	-
		Nicolae Balcescu	-	ED	ED	VD	D	ED	ED	EP	ED	-	-
Sipote	August–Sept. 1990	Cristesti	-	-	-	ED	VD	MD	VD	ED	ED	-	-
		Nicolae Balcescu	-	-	-	ED	VD	MD	VD	ED	ED	-	-
		Plugari	-	-	ED	N	VD	MD	ED	ED	ED	-	-
Halceni–downstream	Nov.–Dec. 1995	Cristesti	-	-	-	-	-	-	-	-	-	ED	VR
		Nicolae Balcescu	-	-	-	-	-	-	-	-	-	ED	N
		Plugari	-	-	-	-	-	-	-	-	-	ED	N

Minimal discharge is caused by two important factors:

1. In the winter, the low values of discharges appear because most of the precipitations fallen are solid and they accumulate on the soil. At the same time, the very low air temperatures determine the blockage of an important amount of water in the circuit (as ice); when the river freezes completely, there is no discharge, which leads to winter drying-up.

2. In the spring–autumn period, the discharge is much reduced because of the atmospheric drought phenomenon and because of the high temperatures that favour evapotranspiration.

The monthly differentiations of the standardized precipitation index and the frequency the normal months, with positive or negative deviations from the multi-annual mean of the Miletin hydrographic basin are reduced. This is due to the fact that the hydrographic basin has a west-eastward direction, reason for which there are insignificant latitude differences. The noticeable differences between the upper and the lower basin are due to the fact that the drained area on one end of the basin is much smaller than the one at the mouth. At the same time, all streams within the first, the second, or the third order (according to the Horton–Strahler classification) often register drying-up phenomena (Fig. 10).

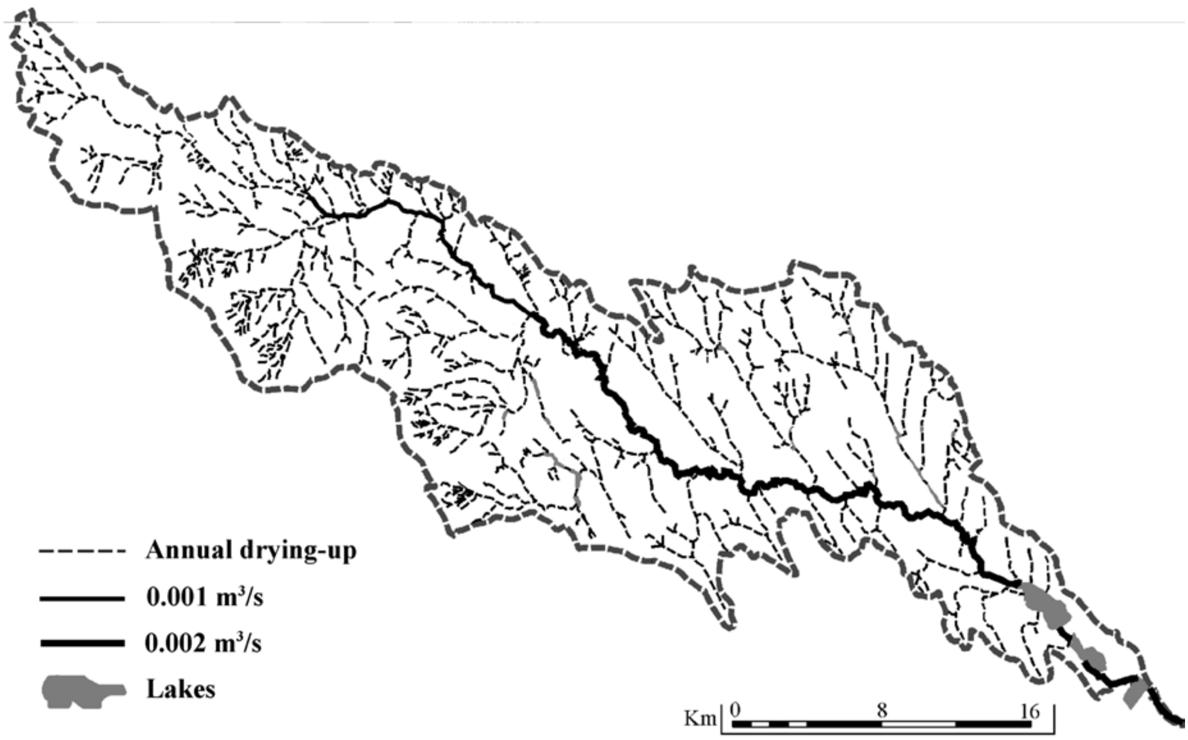

Figure 10. Hydrographic network of the Miletin basin and the river sectors affected by drying-up

In the years 1968, 1969, 1987, 1990, and 2005, significant droughts were registered in the spring, in the summer, and in the autumn. These atmospheric droughts determined important reductions of the discharge for the rivers within the Moldavian Plain. The Miletin River dried up in the upper basin in 1968, 1969, and 1987, while at Sipote, in the middle basin, the discharge dropped to $0.001 m^3/s$ in 1990.

The periods April–August 1968, February–September 1987, April–September 1990, and October–November 2005 were characterized by important decreases in the amounts of atmospheric precipitations; most of the months were extremely dry or very dry, according to the Hellmann quotient (Table 9).

The absence or deficit of atmospheric precipitations is represented by the predominance of the anticyclonic field, with high frequencies of anticyclonic stationary baric formations formed over Central, NE or SE Europe and which can merge with the anticyclonic ridge in the north of the Atlantic Ocean (Mihailescu et al., 2007). The anticyclonic type of weather leads to a clear sky, to atmospheric calmness, with intense sunrays and high temperatures, especially during the warm season.

The southeast part of Europe was dominated by anticyclonic baric formations in the month of May 1968. The atmospheric pressure was between 1015 and 1020mb. This phenomenon generated the absence of precipitations, the appearance of hydrological droughts in the upper basin of the Miletin River, and the drought phenomenon in the period 6–11 May.

The year 1987 was extremely droughty according to Hellmann's classification criterion. There were extended drying-up periods between 20 July and 4 August and 7 September–19 October. In the months of July, August, and September, Atlantic anticylonic formations dominated, while in October air masses from the east of Europe determined the appearance of a clear, rainless sky (Table 9).

6. CONCLUSIONS

The basin of the Miletin River, situated in the southeast of Europe, is influenced by a rainfall regime with significant monthly variations, specific to the temperate continental transitional climate. The months with a rainfall deficit dominate, which determines the drought phenomenon. Drought appears in most years, but it is not extremely accentuated, like in the steppe in the western European extreme. The standardized precipitation index emphasizes on the existence of numerous dry months, but not extremely dry months, too. The high degree of instability is clearly highlighted in the small number of normal months from the rainfall perspective (Hellmann quotient).

The precipitations have a torrential character, proven by the great number of extremely rainy and very rainy months, according to the Hellmann quotient, and by the high frequency of extremely rainy months, according to the standardized precipitation index. The high frequency of droughts in the Moldavian determines a significant reduction in discharge and the drying-up phenomenon in the upper basin of the Miletin River. The drying-up phenomenon does not have a long-term character, considering the unstable character of the atmospheric precipitations regime. No rhythmicity has been underlined in the emergence of droughts or of the drying-up phenomenon. A slight increasing tendency of the months with a rainfall deficit or excess has been highlighted.

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