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THE PRECIPITATION DEFICIT FROM THE HYDROGRAPHICAL BASIN OF TIMIŞ RIVER (1965 - 2009)

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Abstract: The precipitation deficit from the hydrographical basin of Timiş river. The present study is based on the statistical processing of the series of data referring to the monthly and annual average quantities of precipitations, recorded during 1965 - 2009, at five meteorological stations located in the hydrographical basin of Timiş river and a station location outside this basin. For a more accurate identification of the deficient pluviometric periods, the values of the standardised precipitation index were calculated for the entire period and for all the studied meteorological stations. The situations where ISP recorded smaller values than -1 were considered high risk periods regarding the precipitation deficit. The present study may contribute to set the vulnerability degree that the Timiş hydrographical basin has at the risk induced by the precipitation deficit.

Key words: pluviometric deficit, climatic risk, Standardized Index of Precipitations, frequency.

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INTRODUCTION

The hydrographical basin of Timiş river is located in the western part of the country and has a total surface of 10,352 sqkm, of which only 5,795 sqkm are located on the territory of Romania, meaning about 2.44% of the surface of our country. Timiş river, the main hydrographical artery of the historic region of Banat, springs from the crystal massif of Semenic, under the peak of Piatra Goznei from the altitude of approximately 1135 m and drains the waters that spring from Banat Mountains, Ţarcu Mountains, Godeanu Mountains, Poiana Ruscă Mountains and finally the piemountainous hills of Lugoj and Pogonis (Munteanu, 1998).

The deficient pluviometric periods are those time intervals characterised by the lack or the drastic decrease of precipitation quantities, which may determine the risky climatic phenomenon, called drought, with a negative impact on human lives (Bryant, 1991, quoted by Moldovan, 2003).

Among the multitude of factors that lead to the setting of drought and dryness phenomena, the most important is the absence of atmospheric precipitation, which is due to the main anticyclonic weather, determined by the predominance of the stationary baric anticyclonic formations, with a large extension in Europe, influencing even the entire territory of Romania (Bogdan & Niculescu, 1999).

In order to reach the main purpose of our paper, the identification of the deficient pluviometric periods, within the interval 1965 - 2009, which constituted climatic risks for the

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hydrographical basin of Timiş river, the values of the Standardised Precipitation Index (SPI) were calculated for all the meteorological station within the basin through statistical methods.

The Standardised Precipitation Index (SPI) is based on the cumulative probability of rain that occurs at an observation point from a mathematical point of view, and according to the World Organisation of Meteorology, this may be calculated using the following formula (Moldovan et al., 2002):

$$SPI = \frac{x_i - \bar{x}}{\sigma}$$

Where:

x_i – term of the series, $\bar{x}$ - the average of the series, σ – the deviation from the square average that has the formula:

$$\sigma = \sqrt{\frac{\sum\left(x_i - \bar{x}\right)^2}{n}}$$

where:

x_i – the value of the term i of the series, $\bar{x}$ - the average of the series, n – the no. of values.

According to the values of SPI and according to the classification system achieved by McKee et al. in 1993 (table 1), the intensity of the droughty years from the studied period could be established, using data from the six meteorological stations within the basin (Croitoru, 2006).

Table 1. Identification criteria of the intensity of the periods with a deficit and an excess of precipitations (Data source: adapted from McKee et al., 1993, completed by Croitoru, 2006)

SPI value	Qualification	Type of risk
≥ 2	extremely wet	high risk
1,5 ... 1,99	very wet	average risk
1 ... 1,49	moderately wet	low risk
- 0,99 ... 0,99	almost normal	no risk
-1 ... -1,49	moderately droughty	low risk
-1,49 ... -1,99	very droughty	average risk
≤ -2	extremely droughty	high risk

THE RISK IMPOSED BY THE PLUVIOMETRIC DEFICIT

For the studied period 1965 - 2009 in this paper, we could identify the years with a pluviometric deficit, the years with excess of precipitations and the years with a normal pluviometric level at all the meteorological stations in the basin, as seen in table 2.

In the case of mountainous meteorological stations, the values of the frequencies for all 3 major types of risk are similar, and, for the stations found at a lower altitude, these values vary very much from one meteorological station to another.

Analysing figure 1 and figure 2, we may notice that, for all the stations in the basin, approximately 12 years, representing 26.7% from the 45 years analysed, were deficient from a pluviometric point of view. These years are 1973, 1982, 1983, 1984, 1985, 1986, 1988, 1990, 1991, 1992, 1993, 1994 and 2000.

The frequency and the qualification of the years with different types of risk, regarding the pluviometric deficit, differ from a meteorological station to another. In table 3, we notice that the highest frequency is recorded at the meteorological station from Lugoj, with 10 deficient pluviometric years (22.2%), from the total of 45 years analysed, followed by the station from Ţarcu, Cuntu, and Semenic with 9 deficient pluviometric years (20%), then a frequency of 8 years (17.8%), recorded at the station from Caransebeş, and, finally, the lowest frequency, recorded in 6 cases, (13,3%), the Banloc station, located at the lowest altitude.

Table 2. The frequency of the years with risk of deficit and excess, recorded at the meteorological stations
(Data source: the Archives of the Regional Meteorological Centre (C.M.R.) Banat - Crişana, Timişoara)

Type of risk	Deficit		Excess		Without risk	
SPI	> -1,0		> 1,0		-1,0 ... 1,0	
Frequencies	No. cases	%	No. cases	%	No. cases	%
Ţarcu	9	20,00	8	17,78	28	62,22
Cuntu	9	20,00	8	17,78	28	62,22
Semenic	9	20,00	8	17,78	28	62,22
Caransebeş	8	17,78	7	15,56	30	66,67
Lugoj	10	22,22	10	22,22	25	55,56
Banloc	6	13,33	10	22,22	29	64,44

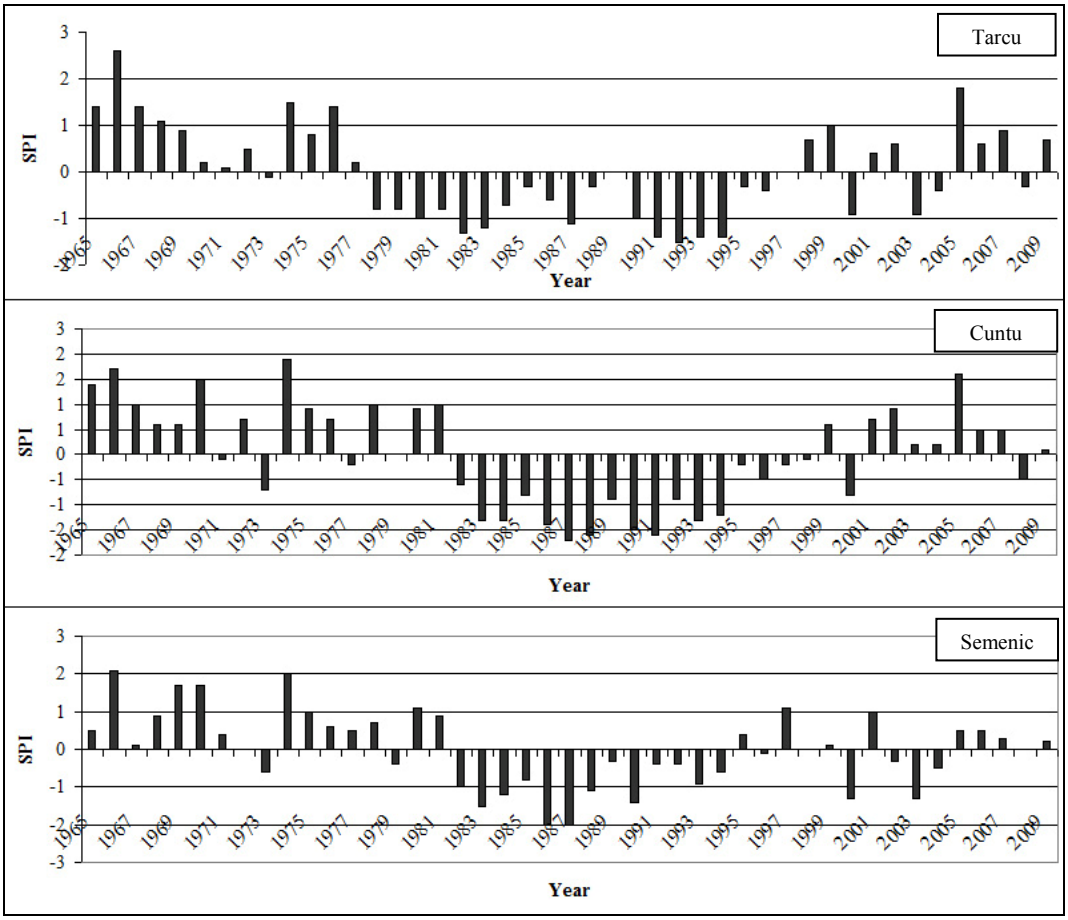

Figure 1. The chronological variation of SPI values, at the meteorological stations from the basin (1965 - 2009)

The fact that the Banloc meteorological station has a reduced frequency regarding the number of deficient pluviometric years is explained through its position, in the western extremity of the basin, much more exposed to the oceanic masses of air, coming from the west side of the continent, than the other meteorological stations from the basin. The highest frequency of the extremely droughty years was recorded at the Semenic meteorological station (2 cases: 1986 and 1987); at the stations from Caransebeş and Banloc, their frequency was reduced (1 case: year 2000 for both stations), while, at the stations from Ţarcu, Cuntu and Lugoj, no extremely droughty years were recorded.

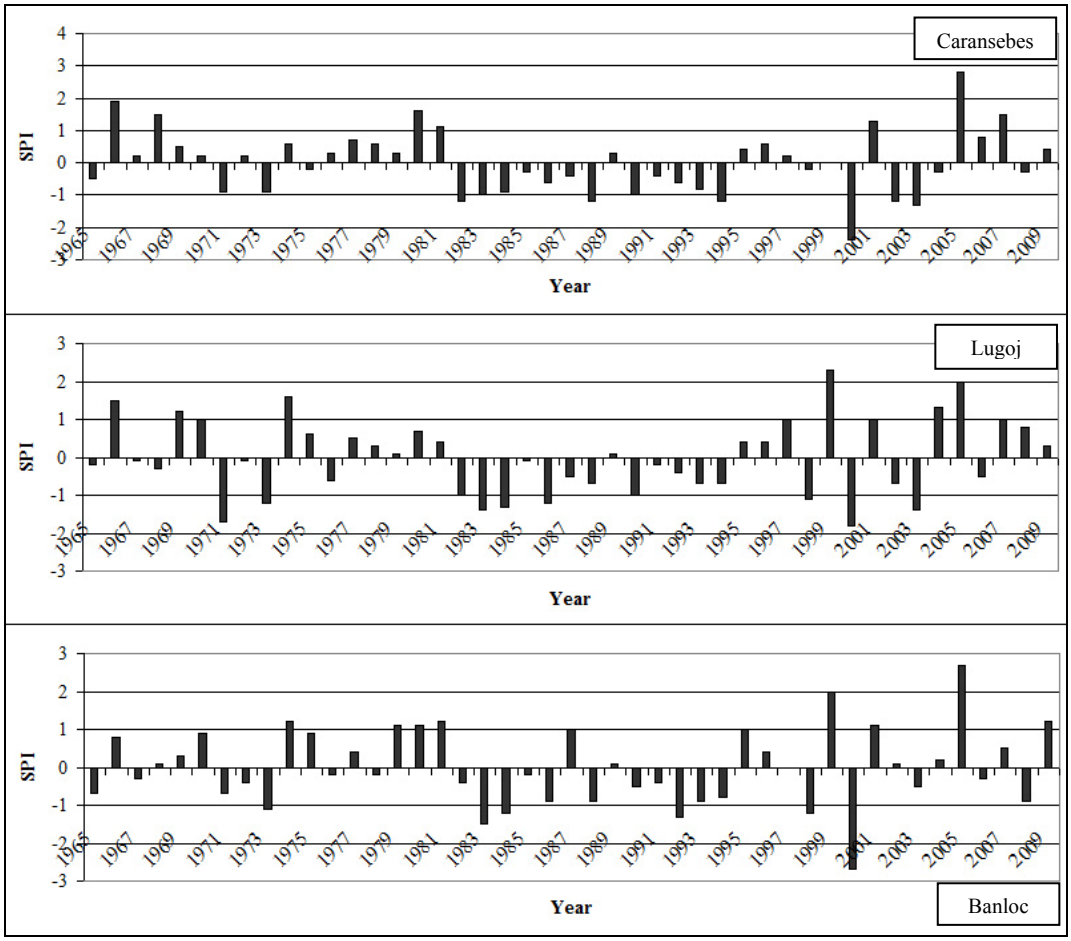

Figure 2. The chronological variation of SPI values, at the meteorological stations from the basin (1965 - 2009)

Table 3. The frequency of the years with risk regarding the pluviometric deficit, according to SPI

Qualification	Moderately droughty		Very droughty		Extremely droughty	
SPI	-1 ... -1,49		-1,49 ... -1,99		≤ -2	
Frequencies	No. cases	%	No. cases	%	No. cases	%
Ţarcu	8	17,78	1	2,22	-	-
Cuntu	5	11,11	4	8,89	-	-
Semenic	6	13,33	1	2,22	2	4,44
Caransebeş	7	15,56	-	-	1	2,22
Lugoj	8	17,78	2	4,44	-	-
Banloc	4	8,89	1	2,22	1	2,22

Analysing table 4, we may conclude that the longest consecutive periods with pluviometric deficit were recorded at the mountainous meteorological stations from Cuntu and Semenic, except for the Ţarcu station, located at a high altitude. The values of the negative deviances from each meteorological station are presented in table 5, which shows what the droughtiest years are and what the drought intensity is for the respective years. The annual smallest precipitation quantities vary between 300-500 mm and are due to the oceanic and submediterranean influences, but also to the local influences, related to the relief characteristic of the analysed hydrographical basin.

Tabel 4. Deficient pluviometric periods with a high and average risk and with different durations (consecutive years)

Nr. crt.	Meteorological station	Period		
		1 year	2 years	3 years
1	Ţarcu	1992	-	-
2	Cuntu	-	1987-1988 1990-1991	-
3	Semenic	1983	1986-1987	-
4	Caransebeş	2000	-	-
5	Lugoj	1971, 2000	-	-
6	Banloc	1983, 2000	-	-

Tabel 5. The deficient pluviometric years with negative deviances > 100 mm (1965 - 2009)

Meteorological station	Year The deviation from the multi-annual average - mm									
Ţarcu	1978 -215,0	1979 -226,0	1980 -273,8	1981 -224,7	1982 -360,0	1983 -325,8	1984 -196,8	1986 -153,5	1987 -301,2	1990 -283,2
	1991 -377,9	1992 -407,8	1993 -392,5	1994 -389,4	2000 -248,1	2003 -257,6	2004 -116,1	-	-	-
Cuntu	1973 -219,8	1982 -188,3	1983 -400,9	1984 -374,0	1985 -233,8	1986 -412,0	1987 -493,0	1988 -466,4	1989 -269,0	1990 -458,3
	1991 -474,2	1992 -279,8	1993 -399,5	1994 -356,2	1996 -149,2	2000 -229,4	2008 -138,5	-	-	-
Semenic	1973 -157,0	1982 -245,3	1983 -368,1	1984 -294,9	1985 -205,1	1986 -500,4	1987 -485,5	1988 -267,4	1990 -350,0	1993 -228,8
	1994 -145,6	2000 -314,8	2002 -315,5	2003 -129,0	-	-	-	-	-	-
Caransebeş	1971 -139,6	1973 -139,5	1982 -178,5	1983 -147,5	1984 -138,6	1988 -171,4	1990 -146,3	1993 -120,3	1994 -175,6	2000 -360,3
	2002 -173,4	2003 -189,9	-	-	-	-	-	-	-	-
Lugoj	1971 -207,7	1973 -143,8	1982 -131,1	1983 -179,5	1984 -160,9	1986 -144,7	1990 -123,2	1998 -139,1	2000 -227,2	2003 -178,8
Banloc	1973 -123,1	1983 -165,9	1984 -140,9	1992 -150,8	1993 -106,2	1995 -134,0	2000 -310,8	-	-	-

Generally, between the deficient pluviometric periods, with different durations, there are normal and excess pluviometric periods, but also isolated years with a pluviometric deficit, which have negative deviances of over 100 mm (100 l/sqm).

The frequency of the isolated years, with pluviometric deficit, differ from one meteorological station to another, increasing as the altitude decreases, recording values from a single case at the station from Ţarcu (year 2000) and up to seven cases at the meteorological station from Lugoj (1971, 1973, 1986, 1990, 1998, 2000 and 2003). During the year, the largest pluviometric deficit is recorded in spring, in March and April, in autumn, especially in September and during summer, in July and August.

From the analysis of table 6, we may identify the minimum extreme precipitation quantities, the monthly as well as the annual ones, from each meteorological station.

During the studied period, the smallest annual precipitation quantity, fallen on the entire basin, was recorded at the Banloc meteorological station, in 2000 and it was of 297.3 mm.

The minimum absolute precipitation quantities were recorded at the other meteorological stations from the basin, but their values were not as reduced as in Banloc. We may notice in table 6 that the values of the minimum absolute precipitation quantities increase in general, as the altitude increases.

However, the largest value is not recorded at the highest altitude, but at the station from Semenic due to its different position compared to the adequacy of the masses of air from the western and south-western parts. The Semenic meteorological station is located on the western slope of Semenic Mountains, reason for which the climbing of the masses of air from the west and south-west favour the intensification and the increase of the precipitation quantities (Stanciu, 2002).

Tabel 6. The annual and monthly minimum extreme precipitation quantities recorded at the stations from the Timiş basin (1965 - 2009)
(Data source: the Archives of the Regional Meteorological Centre (C.M.R.) Banat-Crişana, Timişoara)

Meteorological station	Month (the year of the occurrence)						Annually
	I	II	III	IV	V	VI	
Ţarcu	7,3 (1989)	5,8 (1976)	5,1 (1972)	13,1 (2007)	22,8 (1993)	34,8 (2000)	554,4 (1992)
Cuntu	6,4 (1989)	2,3 (1976)	0,8 (1972)	6,8 (2007)	33,2 (1993)	70,2 (1991)	559,4 (1987)
Semenic	7,7 (1989)	3,4 (1976)	7,9 (1972)	6,1 (2007)	48,4 (1990)	11,9 (2000)	672,0 (1986)
Caransebeş	3,0 (1971)	0,8 (1976)	1,6 (1974)	3,0 (2007)	25,2 (1993)	17,3 (2000)	420,6 (2000)
Lugoj	5,3 (1989)	0,3 (1976)	3,0 (1972)	8,1 (2007)	20,6 (1986)	32,2 (1968,1972)	473,1 (2000)
Banloc	1,7 (1990)	2,1 (1998)	0,7 (1972)	0,4 (2007)	8,2 (1962)	24,2 (1996)	297,3 (2000)
Meteorological station	Month (the year of the occurrence)						Annually
	VII	VIII	IX	X	XI	XII	
Ţarcu	32,2 (1988)	15,8 (1992)	7,1 (1986)	2,9 (2000)	7,1 (1978)	2,0 (1972)	554,4 (1992)
Cuntu	25,0 (1988)	22,3 (2003)	7,4 (1986)	4,3 (2000)	1,2 (1986)	0,5 (1972)	559,4 (1987)
Semenic	36,3 (1985)	28,3 (2001)	5,9 (1986)	6,2 (1995)	0,5 (1986)	3,4 (1972)	672,0 (1986)
Caransebeş	40,1 (1992)	9,2 (2003)	5,1 (1986)	1,7 (1965)	0,9 (1986)	0,6 (1972)	420,6 (2000)
Lugoj	10,3 (1985)	5,0 (2003)	7,2 (1986)	1,1 (1995)	0,7 (1986)	0,5 (1972)	473,1 (2000)
Banloc	12,2 (1985)	1,8 (1992)	0,0 (2009)	0,0 (1965)	2,1 (1986)	0,8 (1972)	297,3 (2000)

In addition, we may notice in this table that certain months with a pluviometric deficit were not characteristic of one single station, but they characterised at the same time several meteorological stations, like the months of April of 2007 and December of 1972, meaning that these climatic records did not have a local feature, but they were extended to the entire surface of the basin.

CONCLUSIONS

The present study emphasises that, for most of the meteorological stations from the basin, the deficient pluviometric periods have a higher frequency than the excess pluviometric periods, and the frequency of the years with these two categories of pluviometric risk, is inferior to the frequency of the normal years from a pluviometric point of view. However, the western region of the country, where the hydrographical basin of Timiş river is located, dominated by moderate oceanic influences, records a relatively low frequency, duration and intensity of the drought and dryness phenomena, compared to other parts of the country.

Taking into account the negative consequences of the precipitation deficit and the significant frequency of the years when these phenomena took place, having a climatic record feature, the need to draw up such studies regarding the risk induced by the precipitation deficit is quite obvious, constituting a small step in the analysis of the vulnerability that certain regions have at the risk induced by the pluviometric deficit.

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