THE EXCESS AND DEFICIT OF PRECIPITATION IN DEVA, ANALYZED BY THE METHOD OF STANDARDIZED PRECIPITATION ANOMALY

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Abstract

The paper analyzes the annual and monthly precipitation amounts from Deva weather station, during 1961-2012, using the method of Standardized Precipitation Anomaly (SPA). The purpose of this paper was to identify the monthly and annual positive and negative anomalies of precipitation. The climatic hazards generated by the excess and deficit of precipitation were highlighted, on the basis of the positive and negative pluviometric extremes, using the percentile method. The extremely wet/dry years and months have been spotlighted, as well as the polynomial and linear tendencies of the annual and monthly SPA values. The result was that in the Mureşului Corridor, at Deva, the hazards generated by pluviometric excess can produce starting from annual SPA values higher than +1.3 and annual precipitation amounts over 715 mm. Hazards generated by pluviometric deficit may occur from annual SPA values lower than -1.4 and annual precipitation amounts of less than 420 mm. The linear tendency of the annual SPA values is of growth. Both the extremely wet years and the extremely dry ones occurred especially in the last decade (2000-2011) of the analyzed period. The analysis of the monthly SPA values shows that the months of period March-September and December became wetter in recent years, while those of period January-February and November became drier.

Key words: standardized precipitation anomaly, pluviometric excess, pluviometric deficit, climatic hazard, tendency.

INTRODUCTION

Deva weather station is located in the Mureşului Corridor, at 45°52' N latitude, 22°54' E longitude and the altitude of 230 m. This narrow territory, located between Apuseni Mountains in the North and Poiana Ruscă Mountains in the South, is often crossed by air masses of Atlantic or Mediterranean origin. As a result, showers are produced frequently here, which generate large amounts of rainfall in short periods of time. They are accompanied by the thunderstorms, squall or even hail, especially in the warm season. Also, the droughts occur frequently on this limited territory, due to the invasions of tropical air masses, very hot and dry, coming from the North of Africa. The multi-annual average amount of precipitation stood at 574.1 mm in Deva, in the period 1961-2012.

MATERIAL AND METHODS

The paper analyzes the annual and monthly precipitation amounts from Deva weather station, during 1961-2012, using the *method of*

Standardized Precipitation Anomaly (SPA). The data were provided by the archives of the National Meteorological Administration.

The purpose of this paper is to identify the monthly and annual positive and negative anomalies of precipitation. In this way, the paper highlights the climatic hazards generated by the excess and deficit of precipitation, on the basis of the positive and negative pluviometric extremes.

The monthly standardized precipitation anomalies have been calculated using the following formula (Busuioc, 1992):

$$SPA = (x - \bar{x}) / \sigma \qquad \sigma = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$$

where:

$\bar{x}$ - the multi-annual average monthly amount of precipitation;

x - the precipitation amount of a particular month;

σ - the standard deviation (average quadratic deviation) of the monthly amount of precipitation;

n - the length of the data row.

Based on the SPA method, the months and years of the analyzed period receive different pluviometric ratings, from "extremely wet" to "extremely dry".

To better highlight the hazards generated by precipitation, in the present paper *the percentile method* has been used to establish thresholds between the pluviometric ratings, a method considered more efficient (Busuioc, personal communication; Şerban, 2005; Şerban et al., 2008; Şerban, 2010; Şerban, Dragotă, 2014). The method relies on the increasing ordering of the *n* values of a data row and dividing them into *k* equal parts (*n/k*) (Ţarcă, 1998, quoted by Dragotă et al., 2003). Thus, 10 classes of values were established for annual and monthly SPA. The SPA values of the 90-100% class represented hazards generated by pluviometric excess ("extremely wet" months and years) and the values of the 0-10% class, hazards generated by pluviometric deficit ("extremely dry" months and years).

RESULTS AND DISCUSSION

Annual pluviometric anomalies

Based on the values of the annual pluviometric anomalies, pluviometric ratings were given for the years of the period 1961-2012 (Table 1). The wettest year was ***2010,*** and the driest ***2011.***

The positive precipitation anomalies of the 90-100% class are between +1.32 and +1.69, and the negative anomalies of the 0-10% class, are between -1.43 and -2.21 (Table 2). It is noted that the annual negative anomalies vary twice more than the positive ones. Also, negative anomalies reached higher values than positive anomalies, meaning that the pluviometric deficit of the driest years of the period 1961-2012 was more intense than the pluviometric excess of the wettest years, at Deva.

Table 1

The wet, normal and dry years recorded at Deva weather station (1961-2012)

STATION/ YEARS	Extremely wet	Very wet	Wet	Moderately wet	Normal
	2010	1980	1979	1996	1998
	2005	1974	2006	1995	1978
Deva	2004	1966	2007	2012	1999
	2001	1981	1972	1968	1977
	1970	1973	1997	1964	1991
STATION/ YEARS	**Extremely dry**	**Very dry**	**Dry**	**Moderately dry**	1985 2009
	2011	1961	1963	1989	2008
	1962	1992	1987	1969	1975
Deva	2000	1971	1993	1965	1984
	2003	1994	1982	1990	1967
	1983	1986	2002	1988	1976

Table 2

The extremely wet/dry years, the SPA values and annual precipitation amounts corresponding to those years, at Deva weather station (1961-2012)

YEARS	Year	SPA value	Precipitation (mm)
	2010	+1.69	759.1
	2005	+1.63	752.7
Extremely wet	2004	+1.62	752.1
	2001	+1.57	746.5
	1970	+1.32	719.2
YEARS	**Year**	**SPA value**	**Precipitation (mm)**
	2011	-2.21	332.1
	1962	-1.73	384.2
Extremely dry	2000	-1.46	413.8
	2003	-1.45	415.2
	1983	-1.43	417.7

It is noted that both the wettest years and the driest ones occurred especially in the last decade (2000-2011) of the analyzed period. Thus, 7 out of 12 years of the interval 2000-2011 are „extremely". Also, the wettest year (2010) is followed by the driest year (2011) of the analyzed period. *This highlights the climatic extremes, which are emphasized better and better in recent years, around the Globe*.

2012 was an extremely dry year in many regions of Romania. However, it was „moderately wet” at Deva weather station. Also, the year 2000 – an extremely dry year throughout the country – is located only in third place, as the value of pluviometric deficit, in Deva.

Table 2 shows the SPA values and the annual amounts of precipitation starting from the pluviometric hazards are reported in Deva. Thus, *in the Mureşului Corridor, at Deva weather station, the hazards generated by pluviometric excess can produce starting from annual SPA values higher than +1.3. These values correspond to annual precipitation amounts over 715 mm. Hazards generated by pluviometric deficit may occur from annual SPA values lower than -1.4. They correspond to annual precipitation amounts of less than 420 mm.*

Figure 1 shows the years with positive and negative precipitation anomalies, and also periods of consecutive surplus or deficient years. The number of years with high SPA values, over +1 is lower (8 years) than the number of years with SPA values below -1 (10 years). Therefore, we can say that the intensity of dry periods is higher than the intensity of rainy periods, in Deva.

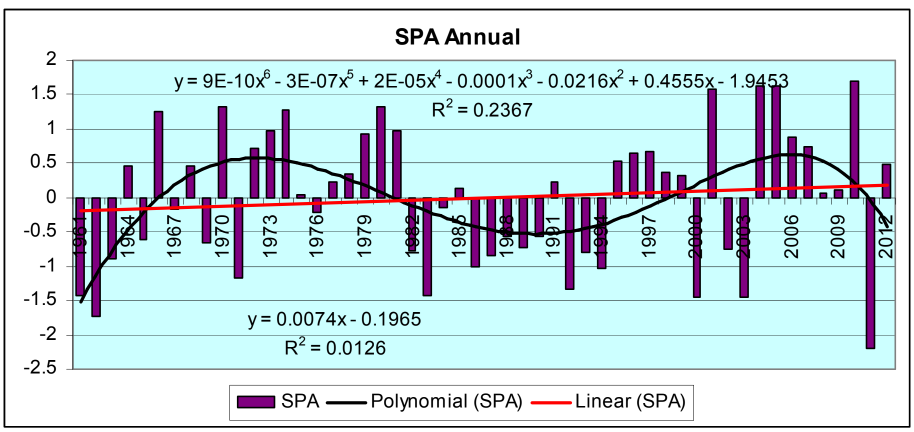

Fig. 1. The linear and polynomial tendency of the annual SPA values, at Deva weather station (1961-2012)

The polynomial tendency of the annual SPA values (Fig. 1) highlights long periods of surplus or deficit in rainfall. Thus, after the drought of the years 1961-1963, a long period of precipitation surplus (1964-1981) follows, then one of precipitation deficit (1982-1994). It continues with a long rainy period (1995-2010), followed by the great drought of 2011. In the long rainy period 1995-2010, three dry and extremely dry years are interleaved: 2000, 2002 and 2003.

The linear tendency of the annual SPA values (Fig. 1) for the period 1961-2012, is of *growth.* The growth is due to the high number of rainy years recorded at the end of the analyzed period, in the last decade and a half.

Monthly pluviometric anomalies

The analysis of the monthly SPA values revealed the extreme months – in terms of precipitation – which occurred in Deva (Table 3).

The extremely rainy months had SPA values between +1.17 and +4.00. However, for the wettest month of the data row, the positive anomalies rose to SPA values between +2.03 (June 1969) and +4.00 (August 2006). The wettest months were: *August 2006* (+4.00 SPA and 214.4 mm precipitation); *January 1976* (+3.65 SPA and 111.5 mm); *December 1999* (+3.32 SPA and 120.3 mm); *April 2012* (+3.22 SPA and 119.0 mm); *May 2012* (+3.03 SPA and 157.0 mm) etc.

Table 3

The wettest and driest months recorded at Deva weather station (1961-2012)

MONTH	Jan.	Febr.	March	April	May	June
The wettest	1976	1999	1993	2012	2012	1969
	July	**August**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
	2001	2006	1996	1973	2004	1999
MONTH	**Jan.**	**Febr.**	**March**	**April**	**May**	**June**
The driest	1964	1976	1972	2007	1963	2003
	July	**August**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
	1987	2012	2011	1965	2011	1972

The extremely dry months had SPA values between -1.07 and -1.95. But for the driest month of the data row, the negative anomalies lowered to SPA values between -1.28 (August 2012) and -1.95 (April 2007). The driest months were as follows: *April 2007* (-1.95 SPA and 9.6 mm precipitation); *June 2003* (-1.95 SPA and 14.6 mm); *November 2011* (-1.90 SPA and 0.0 mm); *December 1972* (-1.60 SPA and 0.4 mm); *March 1972* (-1.60 SPA and 0.3 mm) etc.

It is noted that *the positive monthly pluviometric anomalies are higher, in terms of value, than the negative ones.* Therefore, at the weather station Deva, *the hazards generated by pluviometric excess are more intense than those generated by pluviometric deficit.*

Table 3 shows that the wettest months occurred especially in the last decade and a half, 1995-2012 (8 out of 12 months). In contrast, the driest months are distributed more evenly within the analyzed period.

Table 4 shows the SPA values and monthly precipitation amounts starting from the pluviometric hazards are reported in Deva, for each month of the year. Thus, *in the Mureşului Corridor, at Deva weather station, the hazards generated by pluviometric excess can produce starting from monthly SPA values higher than +1.17 to +1.73 and monthly precipitation amounts over 55-135 mm. Hazards generated by pluviometric deficit can occur from monthly SPA values lower than -1.07 to -1.51 and monthly precipitation amounts of less than 5-30 mm.*

Table 4

The SPA values and monthly precipitation amounts starting from the pluviometric hazards are reported at Deva weather station (1961-2012)

MONTHS		**Jan.**	**Febr.**	**March**	**April**	**May**	**June**
Extremely wet	*SPA*	+1.17	+1.57	+1.65	+1.19	+1.64	+1.73
	Precip.	57.4	54.6	62.1	76.1	115.1	136.0
		July	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
	SPA	+1.42	+1.53	+1.47	+1.67	+1.56	+1.20
	Precip.	122.4	117.4	89.6	86.6	65.8	68.6
MONTHS		**Jan.**	**Febr.**	**March**	**April**	**May**	**June**
Extremely dry	*SPA*	-1.15	-1.09	-1.22	-1.30	-1.20	-1.51
	Precip.	6.7	7.4	7.5	23.4	29.2	29.0
		July	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
	SPA	-1.37	-1.12	-1.29	-1.18	-1.28	-1.07
	Precip.	21.8	12.8	10.3	4.8	11.7	13.2

The linear tendency of the monthly SPA values shows that, between 1961 and 2012, they have been increasing in most of the months. For *March, April, May, July, August, September* and *December* it shows an *increasing* tendency. For *January* and *November* it shows *downward* tendency, and *February, June* and *October* have a *constant* tendency. The highest growth was in April, March, September and July, and the greatest decrease in November (Fig. 2-3).

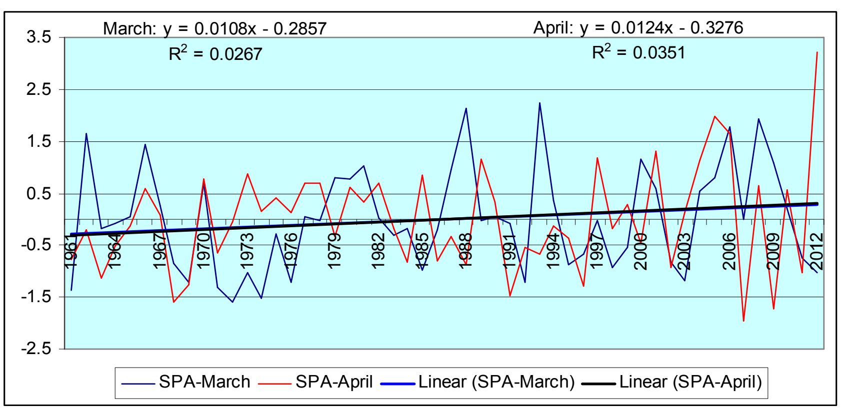

Fig. 2. The linear tendency of the SPA values of March and April, at Deva weather station (1961-2012)

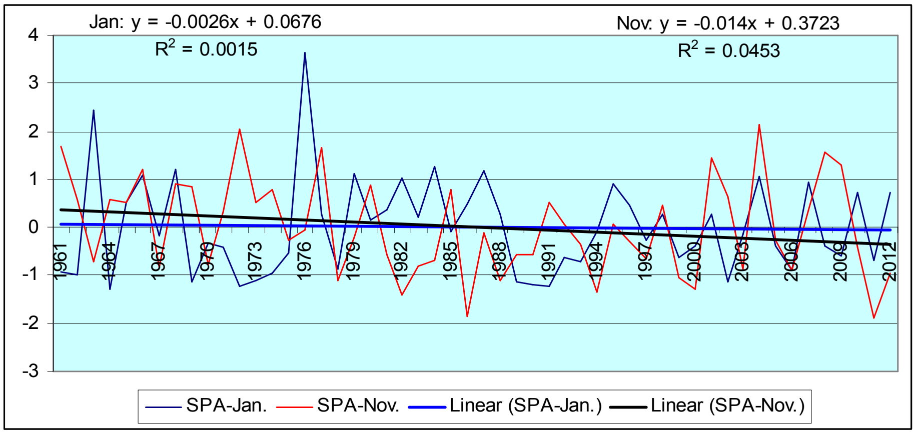

Fig. 3. The linear tendency of the SPA values of January and November, at Deva weather station (1961-2012)

Therefore, we can say that in Deva, *the months of period March-September and December became wetter in recent years,* while *those of period January-February and November became drier*.

CONCLUSIONS

The paper highlights the climatic hazards generated by the excess and deficit of precipitation. In the Mureşului Corridor, at Deva, the hazards generated by pluviometric excess can produce starting from annual SPA values higher than +1.3 and annual precipitation amounts over 715 mm. Hazards generated by pluviometric deficit may occur from annual SPA values lower than -1.4 and annual precipitation amounts of less than 420 mm. The wettest year during 1961-2012 was 2010, and the driest 2011. The linear tendency of the annual SPA values was of growth.

Both the extremely wet years and the extremely dry ones occurred especially in the last decade (2000-2011) of the analyzed period. This highlights the climatic extremes, which are emphasized better and better in recent years, around the Globe.

The analysis of the monthly SPA values shows that the months of period March-September and December became wetter in recent years, while those of period January-February and November became drier.

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