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THE IMPACT OF THE PERIODS OF PLUVIOMETRIC EXCESS AND DEFICIT ON THE ENVIRONMENT IN THE PLAIN OF TÂRGOVIŞTE

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Abstract

The study of the periods of pluviometric surplus relied on the calculation and interpretation of the annual, seasonal and monthly values of the Weighted Anomaly Standardized Precipitation index (WASP). This index is calculated according to the formula: WASP = $(X_i – X_{med})/\delta$, where: x_i = term in the series; x_{med} = average of the series; δ = square average deviation (standard deviation). We considered as cases of pluviometric surplus the situations in which the WASP value went over 1.0. The precipitation data come from a number of two meteorological stations, covering a period of 47 years (1961-2010). In order to discern the importance of the precipitation deficit and the succession of the periods of pluviometric deficit, we calculated the negative deviations of the annual, seasonal and monthly quantities compared to the multiannual average considered normal. We have used the Weighted Anomaly Standardized Precipitation index (WASP) applied to the data coming from 2 meteorological stations (Titu and Târgovişte), for the interval 1963-2010. The frequency of the pluviometric excess years ranges between 26% (Târgovişte) and 22.7% (Titu), values that are lower than those of the years of precipitation deficit (WASP<-0.5). The normal years from a pluviometric perspective (WASP ranging between -0.5 and 0.5) are predominant in the entire plain region, their frequency varying between 44.7% in Târgovişte and 46.8% in Titu. Exceptionally arid and excessively arid years do not exist; the frequency increases from the very arid years (4.3%) to the arid years (10.6%, 12.8%) and then on to the "a little arid" years (14.9-12.8%). The highest frequency of the years that are a little arid (14.9%) has been recorded in Târgovişte. The excess and the deficit of humidity lead to a series of negative effects on the environment.

Keywords: pluviometric excess, pluviometric deficit, environment

INTRODUCTION

The present scientific paper aims first of all to analyze periods of pluviometric excess and deficit in the Plain of Târgovişte, and the effect they trigger in the geographic environment. The periods of pluviometric excess represent a risk with a local extension, unlike those with pluviometric deficit, where the area affected is much larger, and the appearance of this phenomenon and its evolution are slow. The general and unitary analysis has highlighted the relations that appear between the precipitations and the other components of the geographic environment, and has brought to light the local mark of the hydrographic basin of Dâmboviţa and Ialomiţa. The excessive precipitations or, on the contrary, their absence, can generate a major environmental disequilibrium. The analysis of the main climatic elements permits a characterization of the geographic area of the Târgovişte Plain. It has been made based on the data recorded at the meteorological station of Târgovişte (situated at a 228 m height, at $44^0$56' northern latitude, $25^0$26' eastern longitude), and the meteorological station of Titu (situated at an altitude of 125 m, at $45^0$36' northern latitude and $26^0$25' eastern longitude) in the interval 1961-2008. We have calculated and interpreted the annual, seasonal and monthly values of the Weighted Anomaly of Standardized Precipitations (WASP).

METHODOLOGY

In order to realize this study, we have used a series of statistical data, the observations carried out at each of the stations under analysis from the Plain of Târgoviste, the existing specialized literature, the geographic information literature, the informatized sites based on which we were able to analyze the periods of pluviometric excess and deficit in the Plain of Târgovişte. In this study, we had in view the regime and the repartition of the meteorological parameters, which required the application of a scientific method of climatic data processing and interpretation. We have calculated and interpreted the annual, seasonal and monthly values of the Weighted Anomaly Standardized Precipitation index (WASP). We considered as cases of pluviometric excess the situations when the WASP value went over 1.0, and cases of pluviometric deficit the situations when the WASP value was lower than -1.0. The periods of dryness and drought were analyzed accompanied by graphs or synthetic statistic tables containing average multiannual, annual, seasonal, monthly and daily values and their impact on the environment.

THE PERIODS OF PLUVIOMETRIC EXCESS AND DEFICIT

Precipitations are determined by the general atmospheric circulation and the local specific conditions of the Plain of Târgovişte. The sum of the annual precipitations varies between 536 and 631.8 mm, of which 2/3 are recorded in the warm semester and 1/3 in the cold semester.

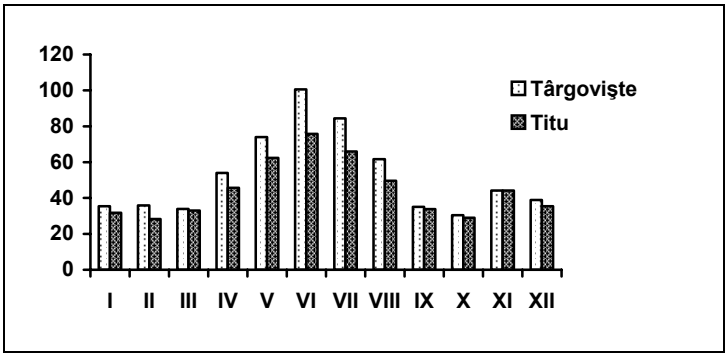

Fig. 1. Average monthly quantity of precipitations (1961-2010)

Analyzing the monthly values, one can notice a pluviometric maximum during the interval May-June, sometimes postponed even towards July, being connected to the action of the Azoric anticyclone and a minimum in February-March, on the background of a great frequency of the continental air (Gâştescu, Zăvoianu, Bogdan, Breier & Driga, 1970). A particular aspect is presented by the massive precipitations falling during short time intervals, which come especially from strong downfalls of a frontal or convective nature (Bogdan, Niculescu, 1999). So, in July 1991, 238.5 mm of precipitations were recorded (the monthly average of July being of 65 mm). There are also torrential rains, with large quantities of water falling during a small period of time, as it happened on October 1, 1924, when 155.6 mm of precipitations were recorded. There are also dry years when the precipitations fallen do not reach even half of the average multiannual quantity, as it happened in 1937, when 136 mm were recorded; this year also represented the year of maximal drought in the interval 1896-2010.

Tab. 1. Maximum quantity of precipitations in 24 hours (1896-2010) (mm)

Meteorological station		MONTHS												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Tgv.	mm	34.0	28.	34.6	35.0	67.	119	72.	96.3	72.	155.6	67.	37.2	155.6
	year	192	195	198	191	192	197	197	1900	194	1924	191	194	1.X.1924
Titu	mm	43.0	40.	51.0	46.0	59.	65.	78.	63.4	80.	71.2	50.	28.0	80.0
	year	191	191	195	193	189	194	193	1949	191	1991	195	194	27.IX.191

The quantity of precipitations is larger in the urban area of the Plain of Târgovişte compared to the area surrounding it because of the high density of the condensation nuclei. At the same time, slightly higher quantities are recorded over the main industrial units and over the transport axes. The closeness of the Special Steels Aggregate Works "Mechel" (Combinatului de Oţeluri Speciale Mechel S.A.) to the railway axis (CFR station) determines slightly more significant precipitations, due to the condensation nuclei. (Păun, 2004)

Yearly pluviometric excess

The frequency of the rain excess years is comprised between 25.6% (Târgovişte) and 23.4% (Titu), recording lower values than that of the rain deficit years (WASP<-0.5). It results that the normal years in point of rain with a WASP between -0.5 and 0.5 are predominant in the entire plain region, their frequency being of 44.7% in Târgovişte. The exceptionally and excessively rainy years have a very low frequency: 2.1 %. So, the rain excess is generally given by the rainy years, whose frequency is comprised between 6.4% (Târgovişte) and 10.6% (Titu). As far as the frequency of the consecutive excess years is concerned, there is a clear dominance of the situations with two consecutive years, during the periods 1970-1971 and 1979-1980. The situations with three consecutive rainy years had a lower frequency, just one such situation being recorded, in Titu (1970-1972). The repartition of the rain excess seasons, according to the WASP index, highlights a rare occurrence of the exceptionally and excessively rainy seasons, especially during spring and

summer. The most frequent very rainy season was summer, while the most frequent rainy season was autumn. A precipitation excess can be recorded for two or several seasons in a row (Dragotă, 2006). The most frequent coupling was of two consecutive seasons, with a maximum frequency for the spring-summer couple (both for Târgovişte and for Titu).

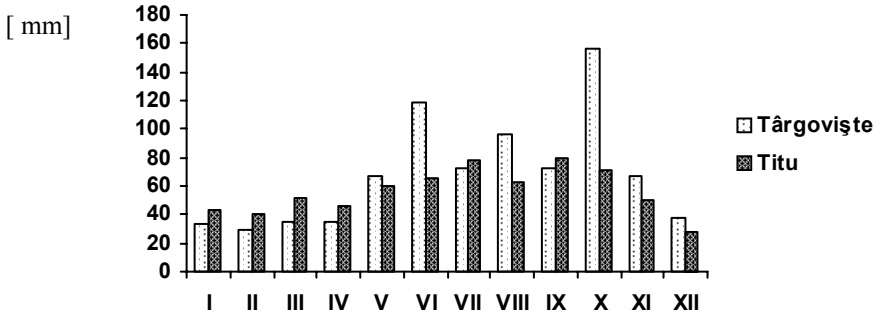

Fig. 2. Maximum quantity of precipitations in 24 hours (1896-2010)

Tab. 2. Târgovişte – the year of maximum drought (1896-2010)

Station	Arid year	Precipitations fallen [mm]	Average multiannual quantity	Difference [mm]	% of the average quantity
Târgovişte	1937	136	576	-449	23,6

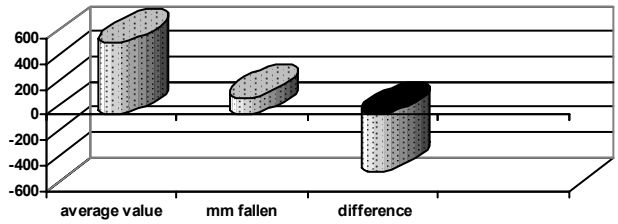

Fig. 3. Târgovişte – the year of maximum drought (1896-2010)

Monthly rain excess

Compared to the values considered normal, which have a frequency of 37-40%, the highest frequency goes to the months with little rain for each station: Târgovişte 9.2% and Titu 9.6% (Sencovici, 2009). (tab.no.3). Then follow, in a decreasing order, the rainy (5.3%-7.8%), very rainy (3.5%-3.7%), excessively rainy (2.0-1.6) and then exceptionally rainy months (2.3%-2.0%). (fig. no. 3)

Tab. 3. Frequency of the months with pluviometric excess

	Exceptionally rainy		Excessively rainy		Very rainy		Rainy		A little rainy		Total surplus	
WASP	>2.5		2.5…2.0		2.0…1.5		1.5…1.0		1.0…0.5		>0.5	
Station	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%
Târgovişte	13	2.3	11	2.0	20	3.5	30	5.3	52	9.2	126	22.3
Titu	11	2.0	9	1.6	21	3.7	44	7.8	54	9.6	139	24.6

Years of rain excess

Among the exceptionally rainy years, there are: 1969, 1972, 1979, and 2005.

In *1969*, the rain excess varied between 271 and 280.9 mm. The values recorded were of 927.4 mm in Titu, and 903.7 mm in Târgovişte. *The year 1979* is also part of the category of the extremely rainy years. The rain excess was of 280.9 mm. Extremely high water quantities were recorded in Târgovişte (1015.2 mm).

Then followed the year *2005* with extremely high precipitation values, which culminated in the month of August: 268.3 mm in Târgovişte and 199.6 mm in Titu. Actually, in Titu, the recorded quantity was 1269.7 mm, which represents the absolute extreme quantity, and in Târgovişte: 1026.8 mm.

Rain excess seasons

The winter of 1969-1970 was exceptionally rainy (with liquid and solid precipitations). The recorded quantities were 318.6 mm in Târgovişte and 325.7 mm in Titu. (Sencovici, 2010)

The summer of 1979 was remarkable for its very rich precipitations, which reached 443.1 mm in Titu and 605 mm in Târgovişte.

Rain excess months

The analysis of the highest monthly quantities of precipitations indicates the possibility of their occurrence during any month of the year, and especially during the months of pluviometric maximum, when the highest values are reached.

October 1972, despite being an autumn month, which generally means few precipitations, recorded rich precipitations: Târgovişte 242.5 mm, and Titu 195.3 mm.

In August 1997, abundant rains covered a large area: 295.4 mm (absolute monthly maximum) were recorded in Târgovişte.

August 2005 was extremely rainy in almost the entire plain, both of the stations recording high values: Târgovişte 268.3 mm and Titu 163.8 mm.

Yearly rain deficit. Calculating the total of the rain deficit periods of different durations, determined according to the WASP criterion, we noticed that most of them were recorded by Titu station. There were neither exceptionally dry nor excessively dry years. The frequency increased from the very dry (4.3%), to the dry years (10.6%, 12.8%) and then to the years with little drought (14.9-12.8%). The highest frequency goes to the years with little drought, being recorded in Târgovişte (14.9%). (Tab. no. 4)

Table. 4. Frequency of the years of pluviometric shortage

Station	Exceptionally dry		Excessively dry		Very dry		Dry		A little dry		Total shortage	
	<-2.5		-2.5…-2.0		-2.0…-1.5		-1.5…-1.0		-1.0…-0.5		<-0.5	
	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%
Târgo-viște					2	4.3	5	10.6	7	14.9	14	29.8
Titu					2	4.3	6	12.8	6	12.8	14	29.8

*Seasonal rain deficit. T*he variation of the seasonal quantities shows that the highest negative deviations were recorded during the summer, for both of the meteorological stations (90-115 mm); during autumn, the negative deviations are of 73.8-73.9 mm, and during winter, the deviations recorded are lowest (50-60 mm). There are no exceptionally dry seasons, and the highest frequency goes to the autumn in Titu (29.75%) (Sencovici, Mihaela, 2010).

It is very important to know the succession of the rain deficit seasons from one year to the next. So, the winters and springs with rain deficit can appear for three years in a row, the summers and autumns can appear consecutively for two years, while the winters never occur for two years in a row for either of the stations (Dumitraşcu, Dumitraşcu, Douguedroit, 2001).

It is important to know as well the frequency of the series of two rain shortage seasons, during the same year. In this sense, it has been noticed that for the Titu station, the frequency is higher (15%). This explains as well the vulnerability of these areas to the lack of humidity, which can last for a longer period of time.

Monthly pluviometric deficit. By comparison with the values considered normal (38.3-44%), the highest frequency for each station goes to the months with a little drought (23-27.8%). This frequency slightly decreases from 27.8% in Titu to 23% in Târgovişte. The most frequent very dry months are: October-November (Târgovişte) and October (Titu).

THE IMPACT OF THE PERIODS OF PLUVIOMETRIC EXCESS AND DEFICIT ON THE ENVIRONMENT

During the interval 1971-2010, because of the significant precipitations recorded, with high intensity and humidity excess, generalized in the hydrographic basins of the rivers Dâmbovița and Ialomița, significant, catastrophic high floods occurred in the years 1972, 1975, 1991, 1997, 2001 and 2005, with flows comprised between 300 and 700 m³/s, for the main rivers and 200-250 m³/s, for the tributaries. In the hydrographic basin of Ialomița River, significant high floods occurred during the years, of which the most representative were in August 2-4, 1997, when the flows recorded were between 150 m³/s and 200 m³/s, a maximum of 563 m³/s being attained in Târgoviște, and in June 2001, when the high flood represented a climax through its size and through the participation of the whole basin up to Târgoviște. Following the 2004 floods, several households, agricultural lands and the bridge on the national road DN 61 were affected (Petrești Commune, the rain of April 13, 14); in the Aninoasa Commune, 22 wells were damaged (following the rain of June 23, 2004), School no. 2 Șotânga Goleasca, and the health center of Teiș and the wells in Teiș were affected (following the rain of July 10, 2004).

In the year 2005, in the Plain of Târgoviște, the largest quantity of precipitations fell in the month of August (268.3 mm/m^2) being recorded at the meteorological station of Târgoviște. An area affected by these precipitations was that of the Aninoasa Commune, situated near Târgoviște Town, a commune that includes the villages: Aninoasa, Săteni, Viforâta. Landslides were recorded in this area.

In the present case, the lithology of the surface deposits, made up of clays and marls, plays a particular role in the triggering of the landslides. The presence of an inclined clay stratum, over which there is a permeable stratum filled with water constitutes the essential condition for the occurrence of landslides. So, the landslides caused by the floods of 2005 combined with the melting of the snow affected in the Aninoasa Commune in April: the county road DJ 712 A from the national road DN 72 to Dealu Monastery; 30 m wall from the hospital personnel villa and the pillar no. 16 supporting the electric network in the same area. Also in the Aninoasa Commune, several other entities were flooded during this period: 10 households; 4 ha of agricultural land; 4 wells with drinkable water. The floods of May affected 15 ha of agricultural land; 5 homes; 0,035 km of county road. The torrential rains of August 14-25, 2005 affected even more the Aninoasa Commune: 60 homes; 177 household annexes; 8 bridges; 2.11 km of county road and communal road; 29 ha agricultural land; 250 dead animals. The torrential rains of September 1, 2005 affected 0.3 km of the county road DJ 718 A, a parapet consolidating the slope cracked. From what we have mentioned so far, it can be noticed that floods can affect, at least temporarily, the environmental quality. The negative effects of these phenomena are perceivable in the economy, in the social life and even in the physical environment.

The high quantities of precipitations fallen in the spring of 2005 also affected Valea Voievozilor, a village that is part of the Răzvad Commune situated near Târgoviște Town. They triggered the occurrence of floods, causing damages in the households and in agriculture. Another locality affected by the floods of 2005 is the Sălcioara Commune, made up of the villages Băneşti, Cătunu, Cuza Vodă, Ghineşti, Mircea Vodă, Moara Nouă, Movila, Podul Rizii and Sălcioara. In Movila Village, several households were flooded because of the local people's inadequate management: there were no ditches to collect the rain water and a bridge was blocked by waste. The intervention of the Environmental Guard (Garda de Mediu) was needed to realize the ditches and some de-clogging works. In Ghineşti, in the area of the bridge going over the Dâmbovița River, following the increase of the water level, the Dâmbovița River went out of its normal riverbed and eroded certain areas. In Mircea Vodă, 1 ha of agricultural land was affected and it was no longer possible to use it because the water stagnated there. In the same commune, the rains of July 12 affected 50 ha of agricultural land, compromising the cultures on a part of this land. The rains of 2005 affected Târgoviște Town as well, especially those of August 5-8.Three points were the most affected: the County Hospital, the Valahia University and the entrance in Târgoviște from the Priseaca neighborhood. The reasons that led to the blocking of the access to Târgoviște Town from Priseaca are: the large quantity of precipitations fallen during a short interval, the lack or the clogging of the ditches meant to collect the rain water in the sectors limited by slopes, the uplifted road ramparts, the lack of connection between the access roads ditches and the main roads ditches, the clogging of the valleys of the rivulets in the area, inadequately calibrated ditches. So, the national road DN 72 A was flooded, the road traffic was blocked, 40 households situated by the national road were flooded, 8 electric networks were affected.

Following the abundant precipitations of the respective year, more flooding occurred in other areas as well, namely: Lucieni – the rains of May 7-10, 2005 affected 20 homes, 600 household annexes, 1 km county road, 20 ha agricultural land and those of September 19-25 brought damages for: 75 household annexes, 6 km county and communal road, 20 ha agricultural land, 35 wells; Ulmi – the rains of May 7-10

affected a bridge, 10 ha agricultural land, a riverside defense dam, those of August 14-25 triggered damages for: 12 household annexes, 1 km county and communal road, while those of September 19-25 affected 14 household annexes, 0.2 km forest road, 30 ha agricultural land, 60 wells; Văcăreşti - 20 ha agricultural lands were affected by the rains of May 7-10 and 17 household annexes by those of July 12; Nucet – 0.03 km county and communal roads were affected by the rains of August 5-8, while the rains of September 19-25 had a negative impact on 6 houses, 67 household annexes, 12 km county and communal road, 30 wells.

In June 26, 2007, strong storms affected the localities of the Dâmbovița County (Băleni – large areas of cultivated land), the national road DN 72 Târgovişte-Găeşti was blocked for over an hour; in Târgovişte, scores of trees were broken down, hundreds of cars, as well as electric, drinkable water and telephone networks were damaged. Among the effects of the drought of the year 2000, we can mention: on *July 5, there occurred 10 fires (they burnt 3000 m^2 wheat field near COS Târgovişte, 500 kg straws in Ulmi, 800 m^2 dry vegetation near Calea Câmpulung; other less large fires occurred in Dragomireşti, Lucieni, Gura Şuții); July 2007- 90% of the corn in the localities Sălcioara, Produleşti as well as 80% of the potatoes in Finta were affected by the drought; August 25, 2007 – a large fire destroyed 6 ha of land (Source – The Agricultural Department of Dâmbovița County / Direcția Agricolă Dâmbovița).*

The evolution of the hydrometeorological situation and the recordings made on a national level beginning with the autumn of 2006 until the summer of 2007, highlighted that the maximum temperature of June 26, 2007 was very close to the absolute maximum recorded in June 70 years before (being just one tenth of Celsius degree away from it).

CONCLUSIONS

Precipitations have both local and zonal effects. Often, the precipitations' effects determine irreversible modifications. The precipitations' effects on the components of the natural and socio-economic environment are both positive and negative. The temporal analysis of the precipitations' effects on the components of the natural and socio-economic environment takes into account the multiannual, annual, seasonal, monthly regime and especially the precipitations fallen in an interval of 24 hours. Interesting is the analysis of both the quantity and the frequency with which the precipitations go over different characteristic thresholds. The characterization of the effects produced by the long term rains and also by the torrential rains was carried out through the prism of the risk they induce in the natural and in the anthropic environment.

REFERENCES

Bogdan, Octavia, Niculescu, Elena (1999), *Riscurile climatice din România* (Climatic Hazards in Romania), edited by Compania Sega Internațional, Bucureşti.

Dragotă, Carmen-Sofia, (2006), *Precipitațiile excedentare în România* (Excessive Precipitations in Romania), Editura Academiei Române.

Dumitraşcu, Monica, Dumitraşcu, C., Douguedroit, Annick (2001), *Seceta şi impactul acesteia asupra mediului în Câmpia Olteniei* (The Drought and Its Impact on the Environment in the Plain of Oltenia), Revista Geografică, VII, Bucureşti.

Gâştescu, P., Zăvoianu,I., Bogdan, Octavia, Breier, Ariadna & Driga, B. (1970), *Excesul de umiditate din Câmpia Română de Nord-Est (1969-1973)* (The Humidity Excess in the Northeast of the Romanian Plain), Edit. Academiei Române, Bucureşti: 254p.

Păun, C. (2004), *Cantitatea şi intensitatea precipitațiilor maxime căzute în 24 de ore pe Câmpia Înaltă a Târgovişte*i (The Quantity and the Intensity of the Maximum Precipitations Fallen in 24h in the High Plain of Târgovişte), Revista Geografică, T.X- 2003- Serie Nouă

Sencovici, Mihaela, (2010), *Studiul geografic al mediului în Câmpia Târgovişte*i (*A Geographic Study on the Environment of the Plain of Târgovişte*), Editura Transversal, Târgovişte, 283 p.