REGIME OF PRECIPITATIONS IN THE ÎNTORSURA BUZĂULUI DEPRESSION AND THE ENVIRONMENTAL IMPACTS

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ABSTRACT. Regime of precipitations in the Întorsura Buzăului Depression and the environmental impacts. The paper analyzes the annual average precipitation quantities, their non-periodic variability, which highlights the situations in which the highest annual precipitation quantities were recorded. This is the case of 2005 and 2007, in which the fallen rains generated intense processes of slope erosion, massive landslides, intense floods, tree falls and large floodings on the localities.

Key-words: fluvial hazards, Întorsura Buzăului Depression, average annual quantities, maximum amounts of precipitation, period 1961-2010.

1. INTRODUCTION

Besides the air temperature, another climatic parameter of great importance for the Întorsura Buzăului Depression is represented by the precipitation, which plays an important role in the Întorsura Buzăului Depression, on which the life and anthropic activity depends largely. Along with external agents that cause changes in the earth's crust, rainwater can generate a number of negative effects, which requires special attention.

The rainfall regime is very uneven, both in time and space, due to the great variability of the atmospheric circulation on the European continent, the main genetic factor of precipitation, giving it a random character (Bogdan, 2008).

Located approximately in the center of the country, in the mountain area, the Întorsura Buzăului Depression is situated at the intersection of air masses with oceanic influences from the west with the continental ones from the east. The shape and position of the depression favors the production of strong temperature inversions in winter and a very high frequency of minimum temperatures below -15 ... -20ºC (Elena Mihai, 1984).

Întorsura Buzăului Depression is located in the north-western part of the Buzău Mountains and extends along the wide alluvial stretches of Buzău River and its tributaries, and on a short mountain range with heights of 700 - 850 m, whose slopes abruptly sink below alluvia (M. Iancu, 1971). The average altitude of the depression is 730-740 m. However, a difference in height appears between the two

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depressions. If in the eastern bay the altitude drops to 665m, in the village of Crasna (village belonging to Sita Buzău commune), in its western bay ascends up to 800m near Dălghiu (component village of Vama Buzăului commune), resulting in an altitude difference of 135m.

The configuration of the bordering mountain space gives to the atmospheric precipitations a series of particularities, respectively the quantity, the type of precipitations and their intensity, the changing of the air mass direction and intensity of displacement speed, the time of year when it occurs, etc.

Thus, the slopes with western and north-western exposure are subject to oceanic influences, which increase the amount of precipitation; on the eastern slopes can be observed a gradual decrease of them (foehn effects).

The way water infiltrates from rainfall depends on the lithological substrate that determines different types of drainage through which the movement of water in its natural circuit is ensured. The different degree of permeability, which the lithological structure presents generates on the altitudinal steps strong differentiations in the erosion, infiltration or drainage system. The quantities of water from the precipitations flow quickly on the steep slopes, with weakly permeable rocks in the mountainous regions. As a result, the torrential rains that fall here can generate, depending on their intensity, large floods and numerous land degradation (Dragotă, 2006).

In conclusion, we can mention that both the geographical position and the small extent of the surface, but especially the altitude and the presence of the surrounding mountain massifs, give to the Întorsura Buzăului Depression specific climatic characteristics.

2. METHODS AND DATA USED

The methods used were both classic and modern and consisted of:

Selecting the closest weather stations that allowed us comparisons to better highlight the pluvial specificity of this depression;

Choosing the observation period for the characterization of all climatic parameters (1961-2010), but also for comparisons (1961-2000);

Data processing using modern computing techniques following the proposed purpose of highlighting the pluvial specific features of this depression compared with those from other mountain depressions areas located also in the Carpathians, as well as from the surrounding mountain area;

Establish the non-periodic variability of the amount of precipitation, using various parameters (annual average precipitation, monthly average precipitation with emphasis on those of the extreme months, the highest and the lowest monthly and annual average precipitations), all to be able to detect the possible climatic changes most evident after 2000.

To highlight them we used the ANM sites as well as the satellite photos from the important European Meteorological Centers.

3. RESULTS AND DISCUTIONS

3.1. Annual rainfall quatity

As in the case of air temperature, precipitations have a large variability of spatio-temporal nature, as well as a discontinuity regarding their duration, intensity and frequency.

At the level of Romania, the average amount of precipitation decreases from west to east and increases with increasing altitude.

Thus, if in the west side of the country falls on average 650 mm, in the east falls about 150-200 mm less. However, in intramontane depressions, compared to the surrounding mountain area, precipitation quantities are lower due to the presence of temperature inversions that are generated, in particular, by the anticyclonic regime, which, in principle, does not favor the formation of precipitation clouds. In addition, the presence of the snow layer accentuates the cooling in the lower layers of the atmosphere, thus intensifying the inversions. Under these conditions, in the Întorsura Buzăului Depression, 648.5 mm is recorded annually almost as in the west of the country.

The values close to those in the western part of the country are explained by a number of factors whose influence is imprinted on the general characteristics of precipitation quantities (Table 1), such as: the altitude of the depression area itself, the height of the bordering massifs, the direction of orientation of them, as well as their massiveness.

From the mentioned table it is observed that in the bordering mountainous area, at altitudes of 1500-2500 m, the average precipitation amounts exceed 800-900 mm, respectively 988.4 mm at the Omu Peak and 828.3 mm at Lăcăuţi, because at the altitudes specific to the mountain depressional areas (500-1000 m) the average annual values of precipitation are between 500 mm and 650 mm, respectively 648.5 mm at the Întorsura Buzăului; 607.9 mm at Brașov and 516.6 mm at Târgu Secuiesc. Thus, their reduction with the altitude and from the west (Brașov) to the east (Târgu Secuiesc).

Table 1. Montly and annual average rainfall quantites (1961-2010)
Source: data processed after National Meteorological Admistration Archive

No. Crt.	Meteo station	MONTHS												Average (mm)
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1500-2500 m														
1.	Vf.Omu	60,1	58,0	65,1	75,9	103,6	133,3	141,2	110,3	69,8	52,0	53,6	65,5	988,4
2.	Lăcăuţi	37,6	41,1	42,3	53,9	97,5	124,5	127,2	110,3	73,1	42,3	37,6	40,8	828,3
500-1000 m														
3.	Întorsura Buzăului	30,1	27,3	29,6	50,2	78,7	98,0	97,1	80,7	53,8	40,9	31,1	31,0	648,5
4.	Braşov	25,9	25,4	30,4	44,6	71,4	87,1	93,1	76,1	52,7	37,7	34,1	29,5	607,9
5.	Târgu Secuiesc	19,5	18,4	21,1	44,4	67,6	81,4	80,5	68,1	43,7	30,1	21,2	20,1	516,6

Thus, we can deduce that the rainfall's territorial distribution is closely related to the general atmospheric circulation, on the one hand, as well as to the geographical position and the configuration of the relief, on the other hand (Fig. 1).

Following the territorial distribution of the amounts of precipitation on the map of the annual droughts (Clima României, 2008), we conclude the following:

- **the largest amounts of precipitation (800-1000 mm)** are recorded in the surrounding mountainous area, at over 1500 m, as well as on the slopes with western exposure. In these situations, solid precipitation from the cold period of the year is taken into account when the snowfall at these altitudes, especially during the strongest winds and even more so during blizzards, is not fully received by the rain gauge, the snow being scattered due to the small angle, which the trajectory of the flakes with the horizontal does (Zăvoianu et al., 2011)

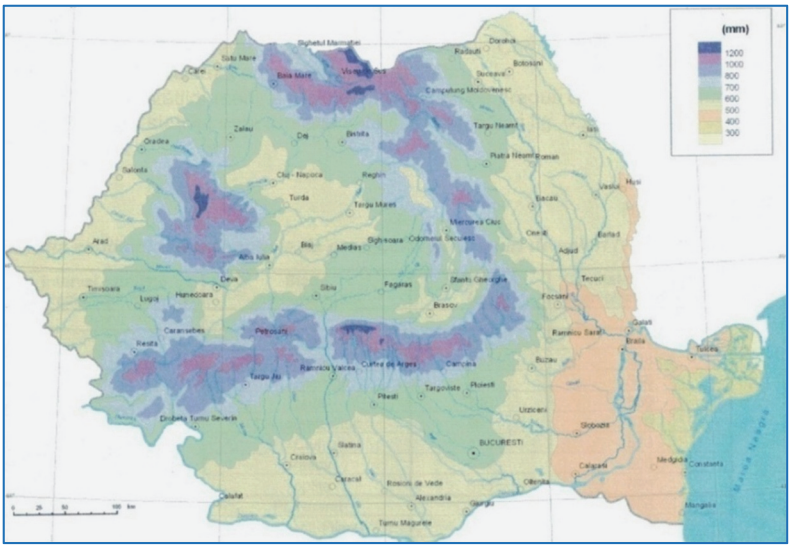

Fig. 1. Space repartition of annual rainfall quatities (1961-2000), after *Clima Romaniei*, 2008

- **the difference of the amounts of precipitation between the stations located in the mountain and those in the depression area**, can be explained also by the Carpathians' role of orographic dam, as well as by the condensation level at which the stations in the mountain area are located (De Martonne, 1902, Neamu, Teodoreanu, 1972). However, the fact that in the last decade (2001-2010) in the mountain area more precipitations have fallen than in the depression area (Fig. 2), this can be explained by the heating of the climate.

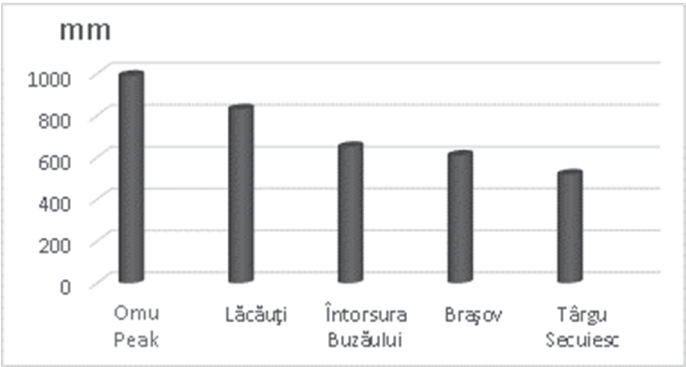

Fig. 2. Variation with altitude of annual average rainfall quatities (1961-2010)

3.2. Non-periodic variability of annual average rainfall quatities and their evolution trend

The non-periodic variability of the average annual precipitation, as shown in Fig. 3 and Fig. 4, at the five weather stations analyzed, is highlighted by their year-on-year succession from 1961-2010.

This non-periodic variability reflects three periods, better defined in the mountain area, at Omu Peak and Lăcăuți, as follows: 1961-1979 and 1991-2010, richer in precipitation (> 1000 mm) and a period between the two, 1980 -1989, with low precipitation quantities (below 1000 mm).

In contrast to the mountainous area where the highest amounts of precipitation are made in, at Omu Peak, followed by Lăcăuți (due to the altitude), in the depression area there are smaller periodic variations at Târgu Secuiesc and Brașov and slightly more pronounced in Întorsura Buzăului, which both by altitude and by the amount of precipitation occupies an intermediate place (Fig. 4).

Regarding the evolution trend, it has been observed a linear trend of pronounced decrease of the annual rainfall quantities in the mountain area bordering the depression areas analyzed where a slight increase is noticed.

This decrease in the average annual amount of precipitation in the mountain area, both at Omu Peak and at the Lăcăuţi weather station, is explained by the increase in temperature.

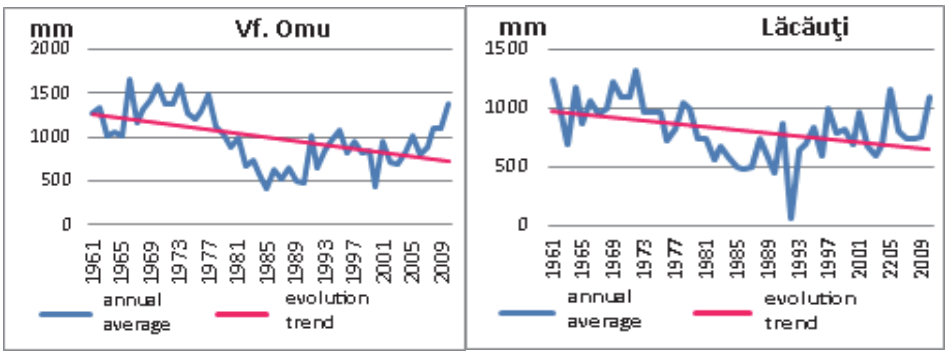

Fig. 3. The non-periodic variability of the average annual precipitation quantities (1961-2010) in the mountain area and the evolution trend

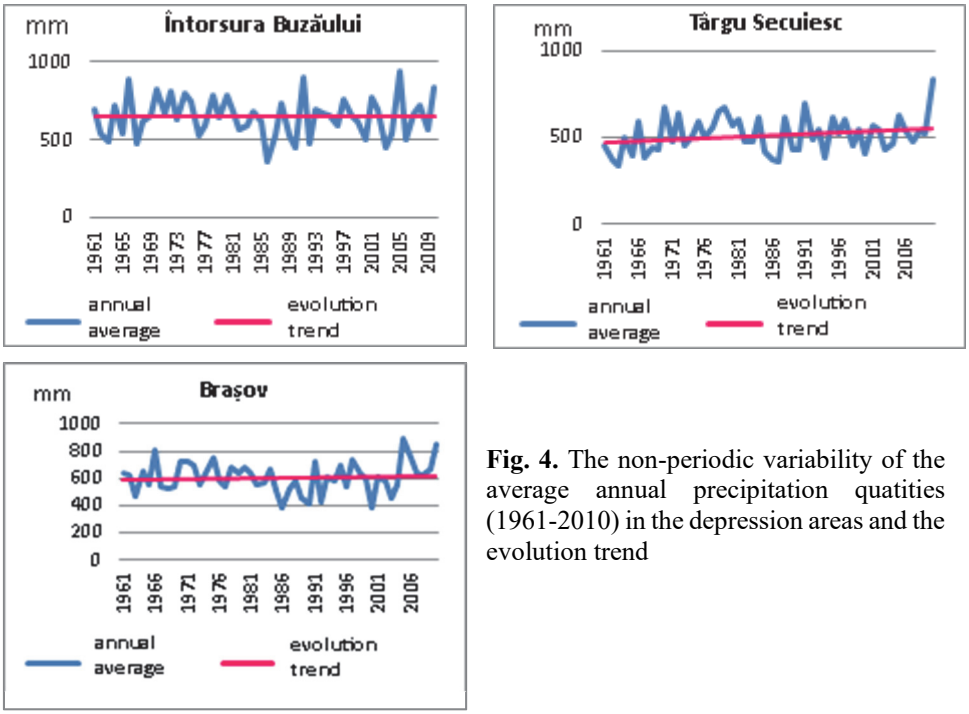

Fig. 4. The non-periodic variability of the average annual precipitation quatities (1961-2010) in the depression areas and the evolution trend

3.3. The highest annual rainfall quatities

The non-periodic variability of the annual precipitation quatities highlights the highest and lowest values (Table 2), some of which present a climatic hazard.

Tabel 2. The highest annual rainfall quatities (mm) (1961-2010)
Source: data processed after National Meteorological Admistration Archive

Meteorological station	Quantity (mm)	Year	Normal	ΔP
Omu Peak(2004 m)	1652,3	1966	988,4	+663,9
Lăcăuți (1776 m)	1319,9	1972	828,3	+696,4
Întorsura Buzăului (707 m)	945,1	2005	648,5	+296,6
Târgu Secuiesc (568 m)	830,5	2010	516,6	+313,9
Brașov (534 m)	887,4	2005	607,9	+279,5

From the above table it is noted that the largest annual rainfall quatities occurred during the rainiest years of the analyzed period. In the mountain area, the values achieved in these years were almost double compared to the multiannual average considered normal, which influenced the erosion of the slopes.

Thus, for example, at Omu Peak there were 1652.3 mm / 1966 which means 663.9 mm more than normal, and at Lăcăuți, although at a lower altitude, this deviation from the normal was much higher - 696.4 mm. Here, the highest annual rainfall quatities in the 50 years analyzed were 1319.9 mm.

In the depression area, the largest annual amounts of precipitation occurred at Întorsura Buzăului (945.1 mm), occupying an intermediate position between those in the mountain area and the others (Brașov and Târgu Secuiesc) in the depression area. In this case, the deviation of the largest annual rainfall quatities at Întorsura Buzăului were 296.6 mm (Fig. 5).

The quantities of precipitations that fell in 2005 generated catastrophic floods in the Întorsura Buzăului Depression, as in all the south of Romania.

Similar situations were recorded in 2007 (669 mm), when such rainfalls flooded most of the perimeter of the in the Întorsura Buzăului village (Fig. 5).

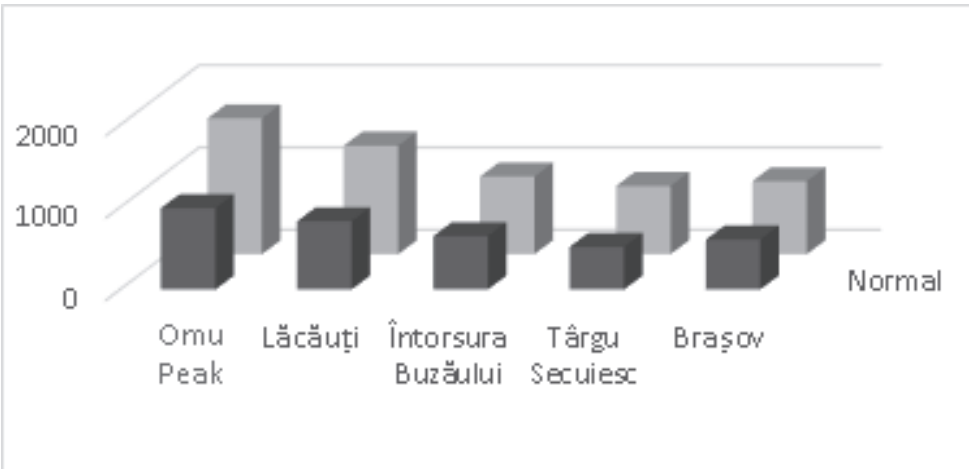

Fig. 5. The highest rainfall quatities compared with the multiannual average, considered normal

The highest amounts of rainfall per 24 hours were recorded on September 20th, 2005, and reached the maximum levels of 48.28mm.

In 2007 (annual average recorded record values, 669 mm), the highest f precipitation quatities in 24 hours reached a maximum of 33.46 mm / August 26th, when such precipitations flooded most of the perimeter of the in the Întorsura Buzăului village (Figure 6).

Fig. 6. Floods in the Întorsura Buzăului locality
(23 March 2007, the rainfall quantities in 24 hours was 25,49 mm)

On Strâmbu Valley, near Vama Buzăuli, such quantities caused large floods and floodings that generated strong erosion processes, tree breakings, distructions of bridges over the river (Fig. 7), landslides (Fig. 8, a, b) and tree falls (Fig.10).

Fig. 7. Floods on Strâmbu Valley

Fig. 9. Trees fallen due to rainfall intensification.

Fig. 8. Massive landslides on Strâmbu Valley slopes

4. CONCLUSIONS

- Atmospheric rainfalls are a climatic element of great importance for ecosystems, ensuring the water supply needed for the vegetation cycle. On the other hand, they can generate risk phenomena that lead to the change of the geographical environment and can have a negative impact on the anthropic activities;
- Throughout the year it presents an uneven distribution in terms of space and time, being in a close correlation with the general circulation of the atmosphere and with the role of orographic dam of the mountain frame;
- After analyzing the data collected and processed by us for the study period 1961-2010, we conclude that the highest annual average precipitation quantities (> 800-900 mm/year) belong to the meteorological stations located above 1000 m altitude;
- In the two comparatively analyzed intramontane depression spaces, respectively the Întorsura Buzăului Depression and Brașov Depression, the smallest annual average amounts of precipitation are recorded, much diminished compared to the surrounding mountain range, due to the frequent occurrence of temperature inversions that favor the formation cloudy by maintaining downstream air currents;
- The largest monthly average precipitation quatities were recorded in the summer months and belong to the mountainous frame which is in the path of air masses, with the role of orographic dam, and in the depression areas belong to the Întorsura Buzăului weather station (239.2 mm / V.1970), a situation explained by the geographical position at the base of the mountain

slopes, exposed to the western circulation on the one hand, as well as the influence of the Mediterranean Cyclones, on the other hand;

- The smallest monthly average amounts of precipitation are usually recorded in the first part of the year (January-March), when the water vapor content of the cold and dry air masses is reduced;
- The seasonal quantities of precipitation at Întorsura Buzăului reach the highest values in summer (> 275.8 mm), with a maximum in June or July, and the lowest values in winter (> 85 mm), recorded in January (Table 3);
- Throughout the year, from the total precipitation recorded in the area of Întorsura Buzăului Depression, about 2/3 belong to the warm season, when the cyclonic and thermoconvective activity is the most pronounced;
- In the cold season, at all the analyzed stations fall 1/2 to 2/3, from the average precipitation quatities during the time, 648.5 mm representing the multiannual average for the year (Întorsura Buzăului Depression - 510.9 mm compared to 741,1 mm) (Table 3), phenomenon attributed to anticyclonal activity;
- **The absolute maximum monthly quantities in 24 hours** that became absolute maximums during the period were registered in the warm semester and exceeded 100 mm in the bordering mountain area, while, in the depression area they were 60-80 mm, rule being 10-20 mm lower than the average of the months in which they occurred;
- In the cold semester of the year, they were < 40 mm;
- In some cases, the maximum absolute precipitation quantities in 24 hours of have a torrential character, during which time the largest amount of water triggers soil erosion, numerous slope processes, vegetation destruction, as well as other damage to the population, human settlements as a whole, and the environment in general.

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