RAINFALL AGGRESSIVENESS EVALUATION IN REGHIN HILLS USING FOURNIER INDEX

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Abstract: Aggressiveness erosive force of rainfall is the express of kinetic energy and potential energy of rain water runoff on slopes. In the absence of a database for the analysis of parameters that define the torrencial rainfall, the rainfall erosivity factor was calculated by Fournier Index, Modified Fournier Index based on the monthly and annual precipitation.

Key words: rainfall aggression, soil erosion, Fournier Index, Modified Fournier Index

1. INTRODUCTION

Reghin Hills constitue the division of subarpathian hills alignment axed on Mureş Valley, situated in the inner part of Eastern Carpathian **(**Transylvanian Sub-Carpathians, Mac, 1972), enclosed between the exit of Mureş River from Toplita-Deda gorge sector and the interfluve of Teleac and Caluşer Valley, which marks the southern boundery along Ernei Locality. They are delimited from Bistrita Hills (N) and Transylvanian Plain (V) by Luţ Valley and in the east they overlap the Gurghiu and Caliman Piedmont Strip (Pop, 2001).

The intensity of erosion process is influenced by a series of natural factors (lithology, climate, slope pitch and length, soil type and texture, type and grade of vegetation cover) as well as human factors, whose activities can slow down or amplify the erosion processes.

Among the climate factors, the major factor is the atmospheric rainfall with direct or indirect implications, which plays the decisive role in breakout, reactivation and maintanance of erosion processes.

The annual average rainfalls register increase from Mureş Corridor toward the actual sub-mountainous area due to the morphometric relief change and to the mountain area influence. The analysis of probability and the assurance degree of the different rainfall quantity in the western extremity of the studied area shows the highest frequencies of rainfall quantity between 600-700 mm/year and the highest

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assurance (81,9%) represents the rainfall quantity between 550-600 mm/year. In the eastern sub-mountainous area, at Eremitu Station, the highest frequency of rainfall quantity registers values is between 951-1000 mm/year, which represents 19,4%, followed by the intervals between 751-800 mm/year and 851-900 mm/year with 16,1% according to the studied years. The rainfall analysis acording to Angot index denotes the highest rain overflow for the interval May-September and according to the susceptibility classes, the months with the highest susceptibility concerning the slope processes and erosion are June and July (Szilágyi et al, 2013).

The torrential nature of the precipitation in the warm season plays an important role, which due to the denudation, splash, erosion, rain wash and laminar flow processes include an increased soil erosion potential, with more significant effects under conditions of events preceeded by a longer period of rain deficiency.

2. MATERIALS AND METHODS

In the absence of a database necessary for the analysis of parameters which define the precipitation (duration, intensity, water quantity and core position), the Fournier Index has been calculated in order to evaluate the rain aggressiveness. The modified Fournier Index is based on the rainfall quantity registered between 1978-2008 at the stations as follows: Târgu Mureş (φ=46°32', λ=24°32‘, H =308m), Eremitu (φ = 46°40', λ=25°00‘, H =510m) and Gurghiu (φ=46°46', λ=24°51‘, H=415m), as well as the interval between 1987-2008 at Batoş Station (φ = 46°54', λ=24°39‘, H =449m) .

Fournier Index (FI) estimates the rain aggressiveness according to the rainfall quantity of precipitation of the most rainy month of the year (p_{max}) and the annual quantity of precipitation (P) and it is expressed by the following formula: **$IF = p^2_{max}/P$** (Fournier, 1960).

Modified Fournier Index (MFI) proposed by Arnoldus (1980) holds a bigger relevance because it estimates the rainfall aggressiveness considering the rainfall quantity registered in each month (p_i) and de annual rainfall quantity (P) according to the equation: $\boldsymbol{IFM = \sum p_i^2/P}$

The obtained results have been interpreted on the basis of the included values in the table below:

Table 1. Rain aggressiveness classes according FI and MFI

FI	Rain aggressiveness classes	MFI
0-20	Very low	0-60
20-40	Low	60-90
40-60	Moderate	90-120
60-80	Severe	120-160
80-100	Very severe	> 160
>100	Extremely severe	

3. RESULTS AND DISCUSSION

The multi-annual average values of the Fournier Index for the period under review is 21,5 mm at Târgu Mureş, 24,7 mm at Batoş, 25,5 mm at Gurghiu and 32,8 mm at Eremitu Stations, values which show a low rainfall aggressiveness for the whole studied area.

According to this index, the greatest frequencies was registered by the years with a very low and low rainfall aggressiveness, which represents weightof 22,6-50%, as well as of 45,2-51,6% from all the studied cases. The number of the years with a moderate rainfall aggressiveness has registered a frequency between 3,2-16% of the cases and those with a severe aggressiveness have registered a frequency of 3,2% at Târgu Mureş and Gurghiu Stations and 9,7% in the submountainous area, at Eremitu Station (Fig. 1 and 2).

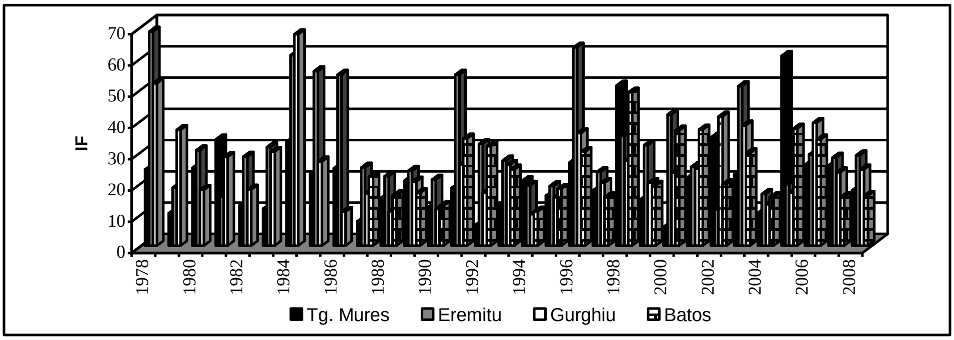

Fig. 1. The annual variation of Fournier Index 1978-2008

According to Modified Fournier Index, the multi-annual average values for the same period is 69,6 mm at Târgu Mureş, 74,7 mm at Batoş, 84,4 mm at Gurghiu and 101,4 mm at Eremitu, values which indicate a low to moderate rainfall aggressiviness for the studied area.

The frequency of years with positive deviation has registered a frequency of 51,6 % at Târgu Mureş, 38,7% at Eremitu, 41,9% at Gurghiu and 45,5% at Batoş. The highest values of positive deviation of this index are situated between 4 and 26 mm, with maximal values of 34 mm (2007) and 45 mm (2005) at Târgu Mureş, 31 mm (1978) at Eremitu, 47,7 mm (1978) at Gurghiu and 25,2 (2005) mm at Batoş (Fig.3).

The percentage of rainfall aggression classes (Fig.4) shows an increase of field vulnerability for the rainfall erosion from West towards East. This way, for Batos Hills and Mureş Corridor, the Modified Fournier Index shows a very low rainfall agressiveness in 13,6-32,3% of cases, a low aggressiveness in 61,3-77,3%

and a moderate aggressiveness in 6,4-9,1% of the cases. In the eastern sub-mountainous area, the number of the years characterized by low rainfall aggressiveness have a share of 22,6% of cases, and those with a moderate and severe aggressiveness have share of 64,5% and 12,9% of cases.

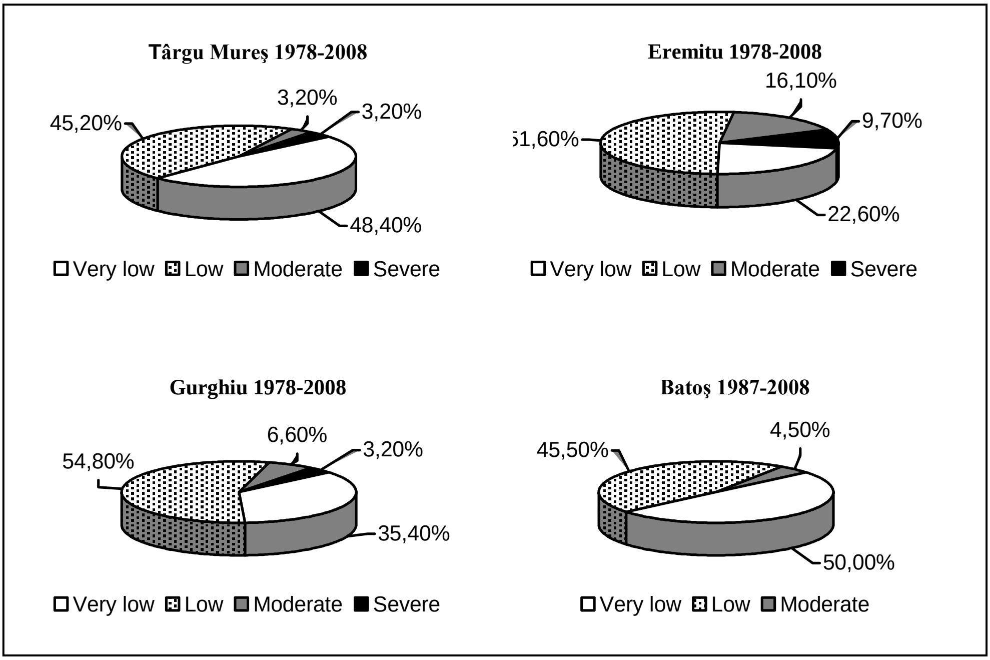

Fig. 2. The weight of rainfall aggressiveness classes according to Fournier Index

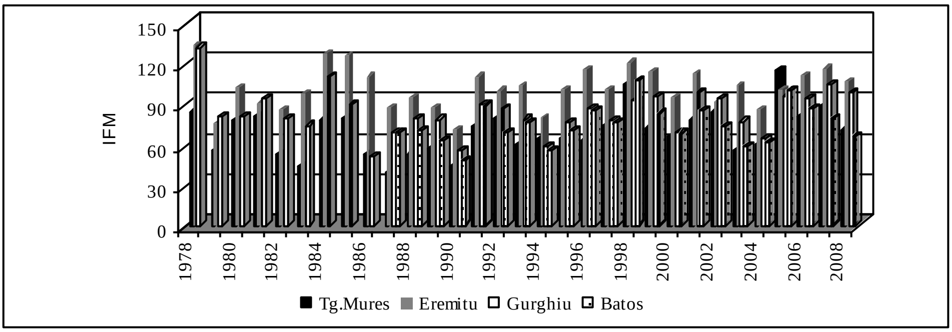

Fig. 3. The annual variation of Modified Fournier Index 1978-2008

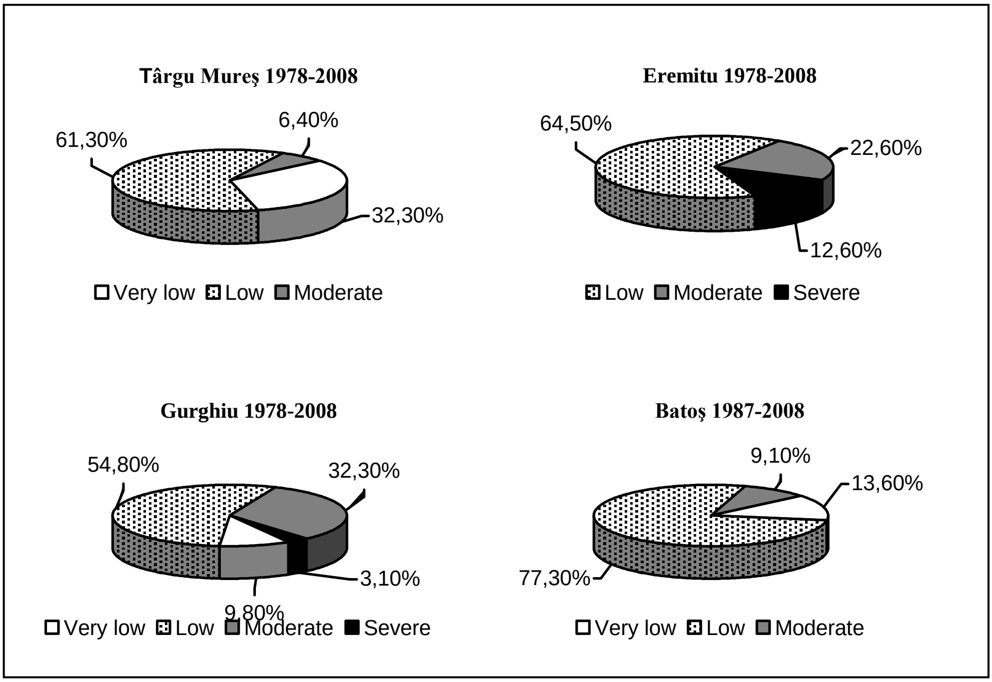

Fig. 4. The annual change of Modified Fournier Index

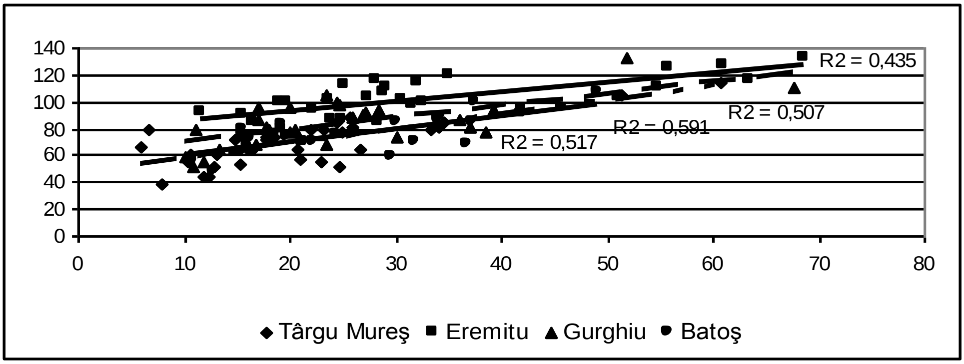

Fig.5. The correlation between the Fournier Index and the Modified Fournier Index 1978-2008

The correlation between IF and IFM (Fig. 5) highlights a significant connection value between the two indices: r ε[0,4;0,6]. The correlation index shows higher values at Târgu Mureş (0,59) and Batoş (0,51) and gets lower at higher altitudes (Eremitu 0,43). This decrease is influenced by the mountain area upon the pluviometric characteristics in the eastern division of the studied area, fact which explains also the difference between the degrees of rainfall agressiveness showed by the two indices of the sub-mountainous areas.

4. CONCLUSIONS

Fournier Index shows a low rainfall aggressiveness for the western and central area and a low to moderate aggressiveness in the eastern sub-mountainous area. The lowest erosion susceptibility presents the cold season of the year, but the periods with rain gauge overflow of this season could influence the evolution of slope processes in the very next period. The water resulted from the rainfalls and from the snow melting ensures the humidity excess of the substratum, offering this way a high vulnerability to the fields toward the slope processes, increasing also the susceptibility toward reactivation and triggering of mass movements (superficial landslide) under the conditions of rain gauge excess in spring season.

The field vulnerability toward denudation, splash erosion, rain wash and laminar flow can be amplified or dimmed by the other erosion influence factors, such as the slope length and pitch, soil type and texture, type and grade of vegetation cover, the usage method of the fields, as well as by the applied measures against erosion.

REFERENCES

1. Arnoldus, H.M.L. (1980), *An approximation of rainfall factor in the Universal Soil Loss Equation*. Assessment of erosion (M. De Boodt & D. Gabriels, eds.), Wiley, Chichester, U.K., 127 –132.
2. 2.Costea , Mărioara (2012), *Using the Fournier Indexes in estimating rainfall erosivity. Case study: The Secaşul Mare Basin*, în Aerul şi apa componente ale mediului, pp.313-320, Editura Presa Universitară Clujeană, Cluj Napoca.
3. Fournier, F. (1960), *Climate et erosion*, P.U.F., Paris
4. Ioniţă, I. (2000), *Geomorfologie aplicată. Procese de degradare a regiunilor deluroase*, Editura Universităţii „Al.I.Cuza”, Iaşi.
5. Irimuş, I. A. (2006), *Hazrde şi riscuri asociate proceselor geomorfologice în aria cutelor diapire din Depresiunea Transilvaniei*, Editura Casa Cărţii de Ştiinţă, Cluj-Napoca.
6. Irimuş, I. A., Szilágyi , J., (2013), *Considerations on the thermal conditions in the Reghin Hills*, Riscuri şi Catastrofe, An XII Vol.12, Nr. I⁄2013, ISSN 1584-5273, Casa Cărţii de Ştiinţă, Cluj Napoca, p.66-76.
7. Mac, I. (1972), *Subcarpaţii Transilvaniei – Studiu geomorfologic*, Editura academiei R.S.R., Bucureşti.
8. Moţoc, M. (1963), *Eroziunea solului pe terenurile agricole şi combaterea ei*, Editura Agrosilvică, Bucureşti.

9. Niculescu, Elena, Bogdan, Octavia (1999), *Riscurile climatice din România*, editura Academia Română, Bucureşti.
10. Pop,Gr. (2001), *Depresiunea Transilvaniei*, Presa Universitară Clujeană, Cluj Napoca.
11. Szilágyi, J., (2011), *Fenomenul de brumă si riscurile asociate în Subcarpatii Reghinului*, în volumul conferinţei anuale a SGR Geografia şi societatea umană, Baia Mare.
12. Szilágyi, J., (2011), *Frecvenţa şi intensitatea inversiunilor termice în Subcarpaţii Reghinului,* GEIS, Vol.XV, CCD, Deva
13. 13.Szilágyi , J., Irimuş, I. (2012), *The deficit of humidity and the associated risks in the Reghin Hills,* Studia UBB, Geographia, Anul LVII,2, Cluj Napoca.
14. Szilágyi , J., Irimuş, I. (2013), *The excess of humidity and its associated risks in the Reghin Hills*, in Riscuri şi Catastrofe, An XII Vol.12, Nr. I⁄2013, ISSN 1584-5273, Casa Cărţii de Ştiinţă, Cluj Napoca, p.89-98.
15. Szilágyi , J., Irimuş, I. (2014), *The Risks associated to The Hoarfrost Phenomenon in the Reghin Hills,* in Riscuri şi Catastrofe, An XIII Vol.15, Nr. 2⁄2014, ISSN 1584-5273, Casa Cărţii de Ştiinţă, Cluj Napoca, p.80-90.
16. *** *Tabele meteorologice TM 11* (1978-2008).