The morphometric analysis of the gravels from the Slănic of Buzău bed – preliminary considerations

Florina GRECU, Laura COMĂNESCU

Cuvinte cheie: galeţi, bazinul Slănic, Cernăteşti, Lopătari, indice de rulare, indice de rotunjire, indice de aplatizare, indice de asimetrie

Rezumat: În lucrarea de faţă sunt prezentate principalele elemente ale analizei granulometrice a pietrişului din albia Slănicului. Galeţii au fost recoltaţi din două puncte de colectare: Lopătari în cursul superior, la ieşirea din munte şi Cernăteşti în apropiere de gura de vărsare a Slănicului şi s-au realizat măsurători ai acestora. Pe baza datelor măsurate în doi ani consecutivi 2004 şi 2005, au fost calculaţi mai mulţi indici morfometrici şi anume: indicele de asimetrie, indicele de rotunjire, indicele de aplatizare şi indicele de rulare. Datele obţinute pentru aceşti indici au fost prelucrate statistic, determinându-se media, modulul şi mediana şirului.
Aceşti parametrii au valori diferite în cele două puncte aratând pe de-o parte potenţialul eroziv ridicat al Slănicului, dar şi aportul torenţial de pe versanţi substanţial.

1. General considerations

Knowing the characteristics of the alluvial deposits is important in order to: calculate the riverbed roughness, the river's transportation capacity, evaluate the riverbed's stability, know the relations between the alluvial deposits and the shape of the river's equilibrium profile, establish some problems of dynamics and riverbeds' evolution.

The method of the granulometric analysis, especially the gravels' morphometry, although used for a long time in Romania, it hasn't been adjusted yet. In this respect, the present paper also aims at establishing the main stages of such an analysis (Grecu, Comănescu, 1998).

The hydrographical basin Slănic, the size order 6 in Horton-Strahler system, is situated in the Curved Carpathians and Subcarpathians, a seismic region with an accentuated neotectonics which is also obvious in the relief dynamic. The morphometric characteristics are optimal for a systemic analysis, but also for a careful tracking of the boulders' dynamic: length 64 km; maximum width 10 km; maximum altitude 1373 m; minimum altitude 125m; surface 450 km^2. The river source is 1240m and its flow is in Buzău at 120m. The total length of the riverbed is 73 km, from among which 19 km in the mountainous unit, 54 km in the Subcarpathians.

Being situated at 19 km away from the Slănic source and by the morphometric characteristics of the basin, the Lopătari station reflects the particularities from the superior basin of the river, while the Cernăteşti station, situated at 4 km upstream the confluence mouth of Slănic with the Buzău river, can be considered representative for the basin assembly, controlling about 99% of its surface (fig. 1).

2. Working method

The establishing of the sampling centres is done depending on the goals of the research. It is good to generally choose sampling centres in places where the impact of the anthropic activities is more reduced, and not at the confluences.

In the present paper there were analysed over 250-300 boulders. The shown data are preliminary, we aim to go on with the present analysis in order to allow the diagnosis of the Slănic riverbed's dynamic by means of this method, too. The samples were gathered in 2004 and 2005, from the same place (from the major riverbed), following the sampling rules.

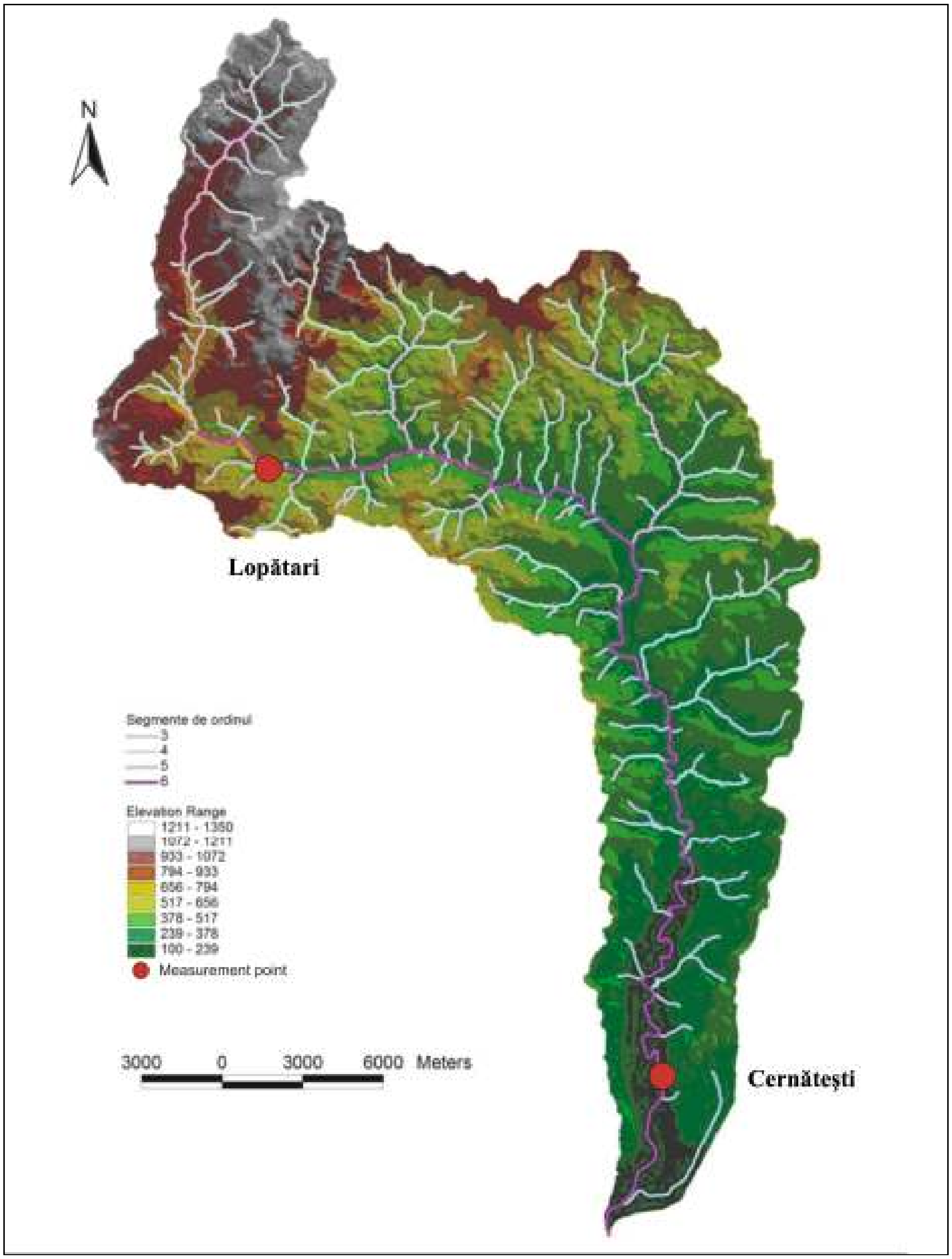

Fig. 1 **The Slanic basin – hypsometric map**

More sampling methods are used: areal sampling, itinerary sampling, and volumetric sampling. In the present paper the areal and itinerary sampling were used.

In achieving this type of sampling, there must be taken into account the morphological unit of the riverbed (island, lateral accumulation along the river, crossing) and the relations riverbed slope within the respective area.

The collecting is done on a certain route and for each boulder from the big toe (it is recommended to collect the boulders with the eyes closed). It is measured the axis *b* of each boulder, which shows the limit in which it is framed (the gravels with the diameter less than 8 mm cannot be evaluated by means of this method) (table 1).

The data are synthetised in a table having the following structure:

Table no. 1

The collecting data

1	2	3	4	5	6	7	8	9
The size of the collected boulder (axis b)	Number of boulders	Average weight of the boulders (gr.)	Total weight (gr.)	Average diameter (d^2)	Col4/ Col5	Percentage from the total	Percentage/ $(\log 2)^{1/2}$	Average size of the diameter
TOTAL	A		B		C	D		

In accomplishing the *volumetric sampling,* the main criterion is the quantity of the sampled material. In Romania there wasn't elaborated a standard regarding the minimum needed quantity. What is important is the difference between the two entities of the riverbed facies: pavement and sub-pavement (the pavement has a depth equal to the diameter of the biggest boulder from the sampled areal) (table 2). In establishing the number of samples, the sampling is done from among more verticals, depending on the dimensional change of the alluvia. For the big material there are done measurements in the field, for the little materials the fine sieving is done. The sampling area was on an areal with a surface of 1 m^2.

Table no. 2

The quantity of needed dry sample, depending on the granulometry

Blocks	minimum	5 kg
Gravels	minimum	2 kg
Gravels and sand	minimum	1 kg

The sample's weight can be established by using criterion 5%, meaning the weight of the biggest boulder should be 5% from the sample's weight (Church et al., 1987, quoted by Ichim and contributors, 1992).

The sampling was done from the sub-pavement, from an areal with a surface of 1m^2, situated in a lateral accumulation along the river at 1 m from the Slanic thalweg at Cernatesti and at 1,5 m at Lopatari.

For the gathered boulders, the following parameters were measured: the big axis or the length – L; the small axis or the width – l; the thickness – g, the smallest beam/ray measured in the same plane with L and l, respectively along the boulder's big circumference; the biggest distance (AC), measured from the intersection of the two axis L and l up to the boulder's extremity (Ruhin, 1966; Grecu, Comănescu, 1998).

The values were synthetised in tables, according to the statistics' rules and they were used for the calculation of the following indices: *the smoothing index* (shows the boulders development in two directions)*; the rolling index* (it shows the relation between length/width in their tendency of becoming equal, when the grain approaches a sphere); *the asymmetry index* (shows the one – dimensional development of the particle).

The values were processed, respecting the statistics' rules from some data ranges, excluding the extreme values which were out of the general tendency. Also, for the values range, there were calculated the position indices of the allocation: *the average, the module, the median line.*

3. The obtained results

The smoothing index describes the amount in which a particle preferentially develops in two directions. It divides into four morphometric classes, as follows:

For the measurements from Cernăteşti in the years 2004 and 2005 (fig. 2, 3) it can be noticed that the same value classes hold the biggest weight, although these are different (54,93% in 2004; 77,77% in 2005). The order of the measurement classes' weight is the same, both for the year 2004 and 2005 (table 3).

At Lopătari the situation is different, the flattening class being dominant, over 15 (both for the year 2004 and 2005), proving the high power of the river's erosion on that sector (fig. 4, 5).

Table no.3

The smoothing index (Relative frequency)

	Cernăteşti 2004 (%)	Cernăteşti 2005 (%)	Lopătari 2004 (%)	Lopătari 2005 (%)
<5	54,93	77,77	17,32	13,83
5-10	30,68	17,28	28,47	30,26
10-15	10,66	2,49	6,75	7,89
Over 15	3,73	2,46	47,46	48,02

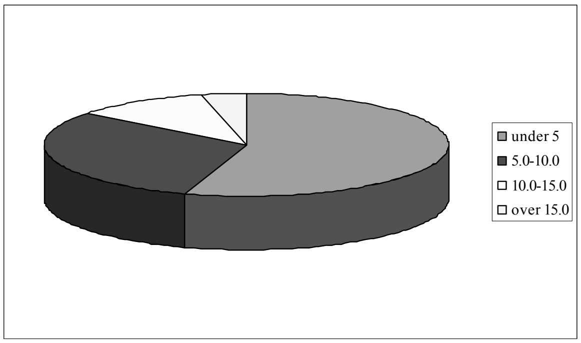

Fig. 2 **The smoothing index – Cernăteşti 2004**

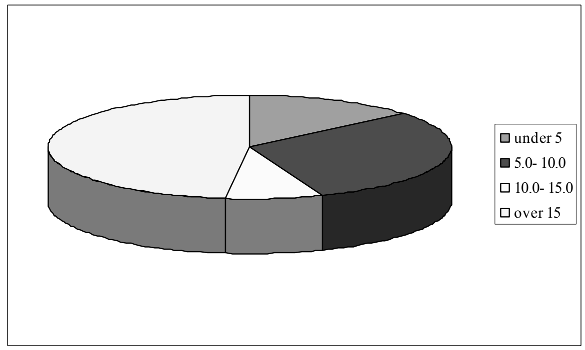

Fig. 4 **The smoothing index – Lopătari 2004**

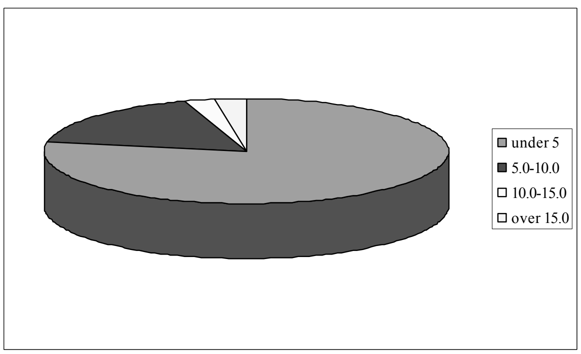

Fig. 3 **The smoothing index – Cernăteşti 2005**

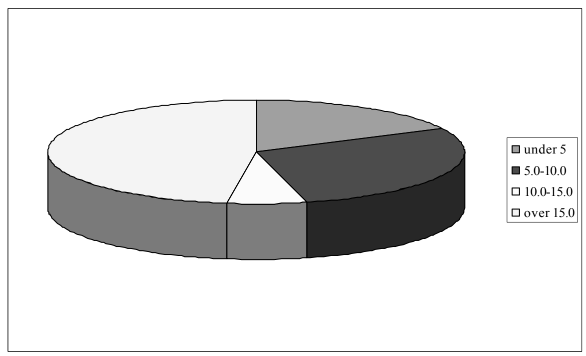

Fig. 5 **The smoothing index – Lopătari 2005**

The asymmetry index shows the one-dimensional development of the particle. The asymmetry index shows obvious variations between the two localities. Upstream, the particles' asymmetry is bigger, compared to the downstream situation (fig. 6, 7, 8, 9). At Cernăteşti, the particles' development is more pronounced and therefore derives their smaller asymmetry degree (table 4).

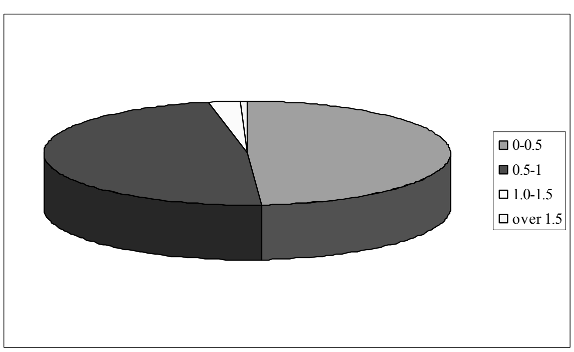

Fig. 6 **The asymmetry index – Cernăteşti 2004**

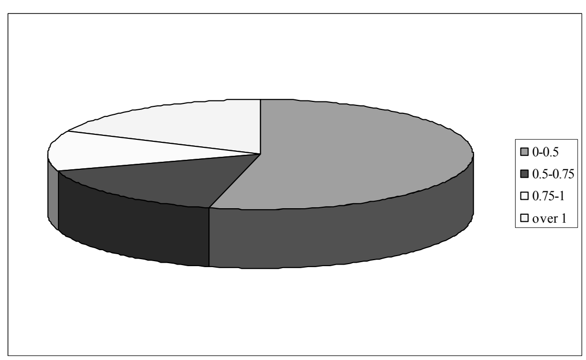

Fig. 7 **The asymmetry index – Cernăteşti 2005**

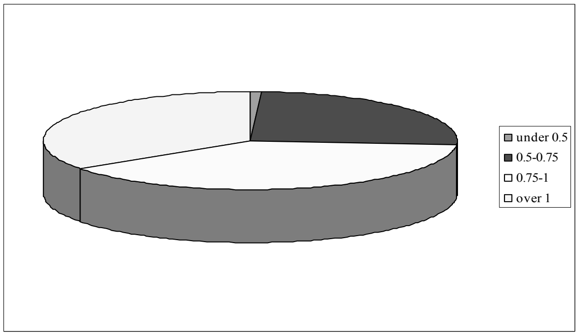

Fig. 8 **The asymmetry index – Lopătari 2004**

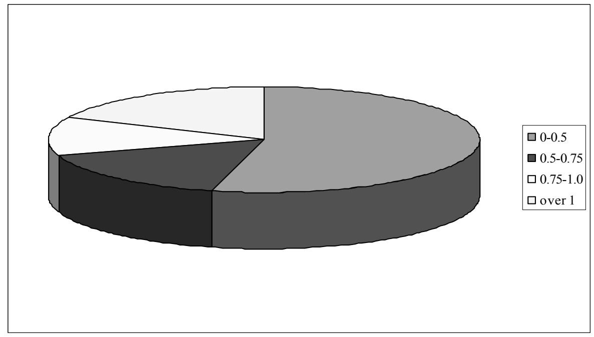

Fig. 9 **The asymmetry index – Lopătari 2005**

Table no. 4

The asymmetry index (Relative frequency)

	Cernăteşti 2004 (%)	Cernăteşti 2005 (%)	Lopătari 2004 (%)	Lopătari 2005 (%)
0-0,5	48,80	1,23	0,89	1,50
0,5-0,75	48,26	24,71	25,5	20,85
0,75-1,0	2,41	37,03	39,00	38,90
peste 1,0	0,53	37,03	34,61	38,75

The rolling index

The rolling index at Cernăteşti presents an approximately similar weight in 2004 and 2005. This index shows a high degree of the development classes with higher values at Lopatari (fig.10, 11, 12, 13). According to the general rules, this index should have higher values at Cernăteşti, where the development is bigger (the distance from the alluvia source increases) but this doesn't happen due to the contribution of the high torrent.

The development and smoothing index have got inverse proportional values (at an increase of the rolling index, the smoothing index decreases). The correlation passes Kirkby's significance test, the correlation index being *r = 0, 87*.

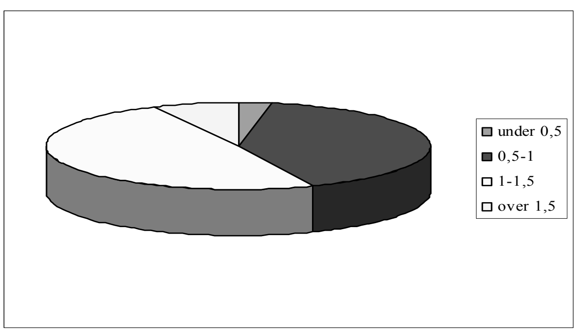

Fig. 10 **The rolling index – Cernăteşti 2004**

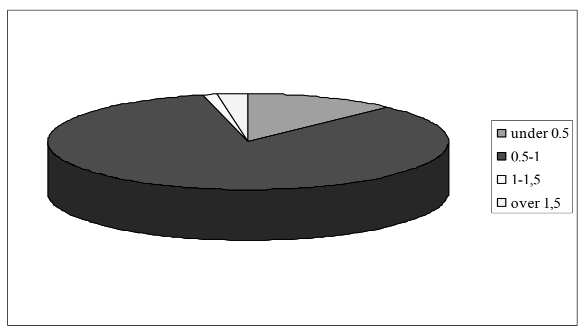

Fig. 11 **The rolling index – Cernăteşti 2005**

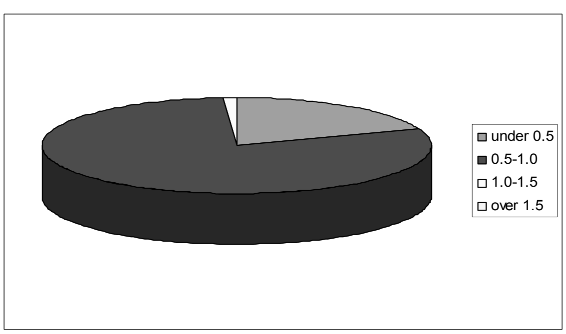

Fig. 12 **The rolling index– Lopătari 2004**

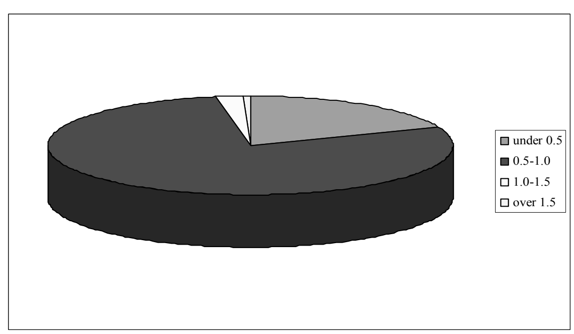

Fig. 13 **The rolling index – Lopătari 2005**

The rounded index

It was calculated based on Wendell's formula:

$$R_0 = \sum (r/R)/N,$$

where

r – the rays of the circles from the corners;
N – corners' number,
R – the ray of the biggest circle which can be inscribed.

For the boulders'analysis there were determined 5 morphometric categories (angularity classes) which are synthetised in the following table:

Table no. 5

The Rounded index (Relative frequency)

	Cernătești 2004 (%)	Cernătești 2005 (%)	Lopătari 2004 (%)	Lopătari 2005 (%)
0-0,5	2,66	12,36	18,75	19,27
0,5-0,75	41,08	83,95	78,36	79,5
0,75-1,0	49,06	1,23	2,41	1,2
peste 1,0	7,2	2,46	0,48	0

Table no. 6

The Rounded index-Morphometric categories

Morphometric categories	The rounded index
angular	0,10-0,25
subangular	0,26-0,34
sub-adjusted	0,35-0,49
adjusted	0,50-0,69
very adjusted	0,7-1

Following the analysis of the data from Cernăteşti and Lopătari, the following values were obtained:

Table no. 7

The Rounded index in Slanic basin- absolute frequency

Categories	Lopătari	Cernătești
0,10-0,25	10	8
0,26-0,34	12	10
0,35-0,49	30	34
0,50-0,69	32	37
0,7-1	16	11

The biggest weight is held by the rounded boulders (32% at Lopătari and 37% at Cernăteşti), demonstrating the high power of the river's erosion but also the fact that their percentage increases from upstream towards downstream. Out of the general total, the sub-rounded, rounded and very rounded boulders hold 75% from the total of the boulders measured at Lopatari and a higher value 82% from the total at Cernatesti (table 6, 7).

4. Conclusions

Table no. 8

Synthetic analysis of boulders

Parameter	The smoothing index				The assymetry index				The rolling index			
	Cernătești 2004	Cernătești 2005	Lopătari 2004	Lopătari 2005	Cernătești 2004	Cernătești 2005	Lopătari 2004	Lopătari 2005	Cernătești 2004	Cernătești 2005	Lopătari 2004	Lopătari 2005
Average	1,82	1,67	1,73	1,84	0,86	0,54	0,61	0,35	0,72	0,67	0,61	0,58
Module	11,46	12,15	11,89	11,69	2,87	2,99	3,56	3,29	1,69	1,87	1,23	1,26
Median	1,69	1,54	1,28	1,49	0,99	0,65	0,47	0,78	0,88	0,56	0,39	0,55

The values of the morphometric indices (table 8) of the boulders vary depending on the rock (in the superior course at Lopătari ere hard rocks and in the inferior course at Cernăteşti are soft rocks); climate (the presence of rain fall whide is more frequently in Subcarpattian); distance (the values of indices are different in the superior course and in the inferior course because the transport it's able to change these), neotectonic moments (uplift moments in the superior course) from the basin, differentiated in time and space. In the basin of Slanic of Buzau the boulders represent a medium development rolling degree (fig. 14). The assymetry depends very much on the type and hardness of the rock; at Cernatesti, soft rocks are predominant and the rocks' assymetry is less pronounced (fig. 15, 16).

The statistical analysis of the smoothing index, assymetry index and rolling shows a „normal distributions".

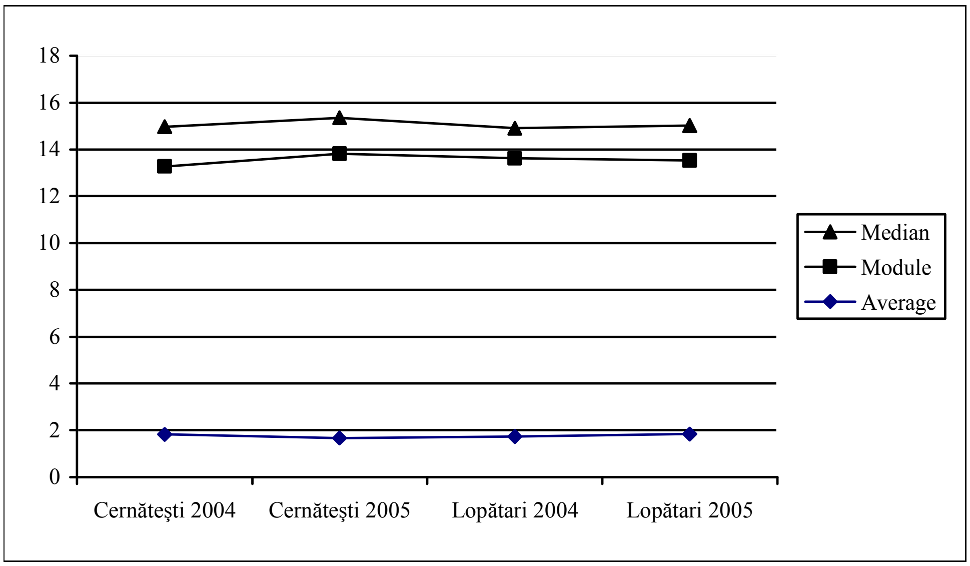

Fig. 14 **The variation of morphometric parameters for smoothing index**

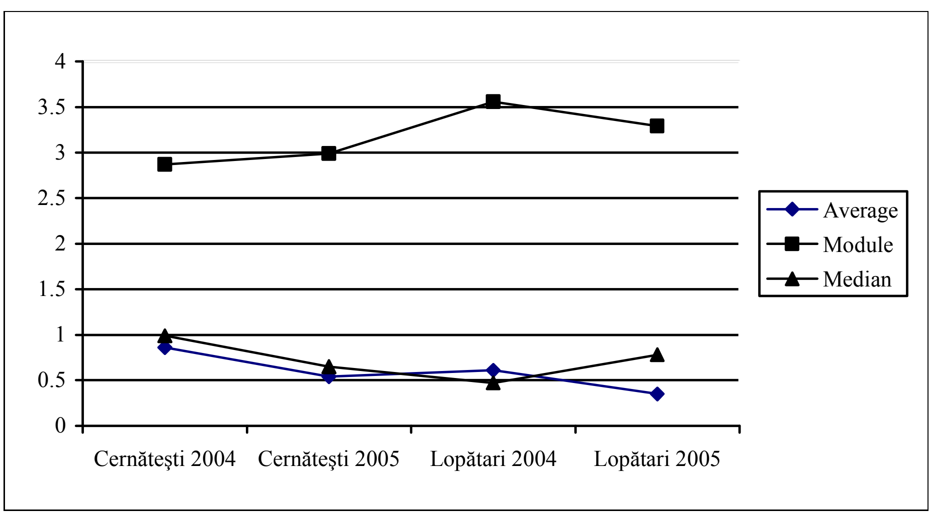

Fig. 15 **The variation of morphometric parameters for assymetry index**

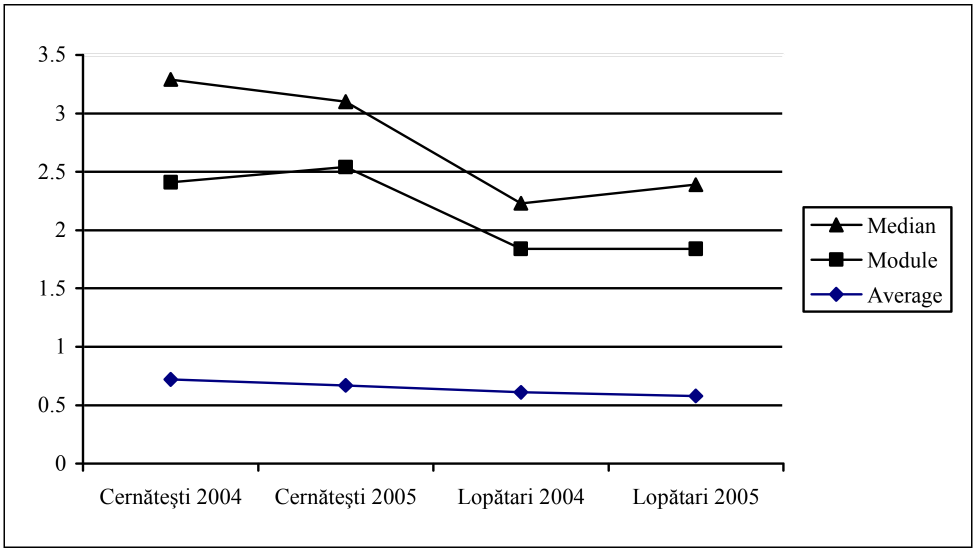

Fig.16 **The variation of morphometric parameters for rolling index**

Thanks
The researches from the hydrographic basin of Slanic were done within the PAI program *Brâncuşi – The complementarity of the hydraulic and geographic researches in the fluviatile dynamic* between the University of Bucharest, Faculty of Geography, the Research Centre Degradation of lands and Geomorphological Dynamic and Cemagref Lyon (project directors: Florina Grecu and Philippe Ramez).

The present paper aims to analyse comparatively the granulometry of materials from the Slanic riverbed to Cernatesti (in the inferior course) and Lopatari (in the superior course).

The measurements were done in the years 2004 and 2005 together with the students from the Dynamic Geomorphology and Protection of the Terrestrial Environment masterate, the course of Riverbeds dynamic, to whom we want to thank.

BIBLIOGRAFIE

GRECU F., COMĂNESCU L. (1998), *Studiul reliefului. Îndrumător pentru lucrări practice*, Editura Universităţii, Bucureşti.

ICHIM I.., RADOANE M., RADOANE N. (1992), *Eşantionarea depozitelor de albie formate din pietrişuri şi bolovănişuri. Metode şi analiză*, Lucrările celui de-al IV-lea Simpozion „Provenienţa şi efluenţa aluviunilor", Piatra Neamţ.

RĂDULESCU D., ANASTASIU N. (1979), *Petrologia rocilor sedimentare*, EdituraTehnică, Bucureşti.

RUHIN L.B. (1966), *Bazele litologiei*, Editura Tehnică, Bucureşti.

University of Bucharest,
Faculty of Geography
Departement of Geomorphology