RESEARCH ON THE INFLUENCE OF SOIL PARTICLES SHAPE ON THE HYDRAULIC CONDUCTIVITY OF SOILS FROM BREAZU STUDY AREA

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Abstract

The present study wants to highlight the influence of the relationship between soil particles characteristics (shape, size and surface area texture) and hydraulic conductivity (saturated and unsaturated).
The study of this relationship wants to note any change that may occur in the hydrological regime of soils in researched areas. Determination of the soil particles characteristics was achieved by: a) size analysis and b) SEM microscopic analysis type. Determination of soil hydraulic conductivity was performed by laboratory methods: the constant-head method (Ks) and the falling head method (Kθ).

Key words: hydraulic conductivity, particle size analysis, microscopic analysis

The study of the influence of the shape and characteristics of corresponding to soil particles on hydraulic conductivity is an important factor in determining the variation rate of percolation of chemical compounds that once you get in rural unsaturated and saturated represent a real threat for the groundwater quality that at today represents one of the most primordial sources of pure water without the human factor to intervene in order to purification for daily consumption.

Soils in general are composed of mineral fragments with different sizes which have most often hydrological regimes differ according to a number particularities such as shape, size and the size of constituent elements. For this reason the determination of these traits requires a complex analysis based on a comparison with a particle witness some ellipticity (Santamarina J.C. *et al*, 2001).

On this occasion we remember that in specialty literature the particles of irregular shape (compared to those with regular shape) occurs in three main staircase of sphericity (Wadell, 1932 Krumbein W.C., 1941; Powers, 1953; Krumbein and Sloss, 1963; Barrett, 1980). Sphericity can be quantitated as the ratio between the diameter of the largest and lowest scores within the district. Roundness is measured as the average radius of curvature of the surface in relation to the maximum radius of the sphere which can be entered in particle. Refers to the characteristics of surface roughness that can be much smaller than the particle diameter (Santamarina. J.C. *et al*, 2003). In the present study the peculiarities analysis which was above mentioned was performed using SEM technique to use as a pillar research the digital image analysis have been provided.

The digital analysis image facilitating the systematic evaluation of the mathematics descriptors that take account of particle shape, including Fourier analysis, used hybrid techniques to achieve an analysis on level fraction (Meloy, 1977; Clark, 1987; Hyslip and Vallejo, 1997, Bowman *et al*, 2001).

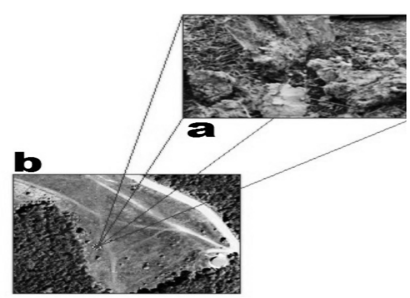

Figure 1 **Presentation of the Breazu location study a) samples harvested, b) zone of sampling soil**

MATERIAL AND METHOD

All research was conducted on soil samples disturbed one for each depth (stored in labeled bags) and undisturbed harvested one for each depth from Breazu study area (*figure 1 b*) (collected by the method of metallic cylinders with a volume of 100 cm^3) shown in *figure 1 a.*

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Soil particles morphology analyses were achieved by: a) size analysis (*figure 2. a*) and b) SEM (Scanning Electron Microscope) microscopic type. Microscopic research was performed using scanning electron microscope Quanta 200, manufactured by FEI COMPANY. All samples (total samples = 24, 6 for each depth) were analyzed in Low Vacuum, approximately 60 Pa to 20 Kv shown in *figure 2. b*).

The analysis of hydraulic characteristics of soil samples was achieved by the laboratory methods, for hydraulic conductivity was the constant-head method(K_s) (Lungu. 2013) give us in *figure 3* a) and the falling head method (K_θ) (Stanciu and Lungu. 2006) presented in *figure 3 b*).

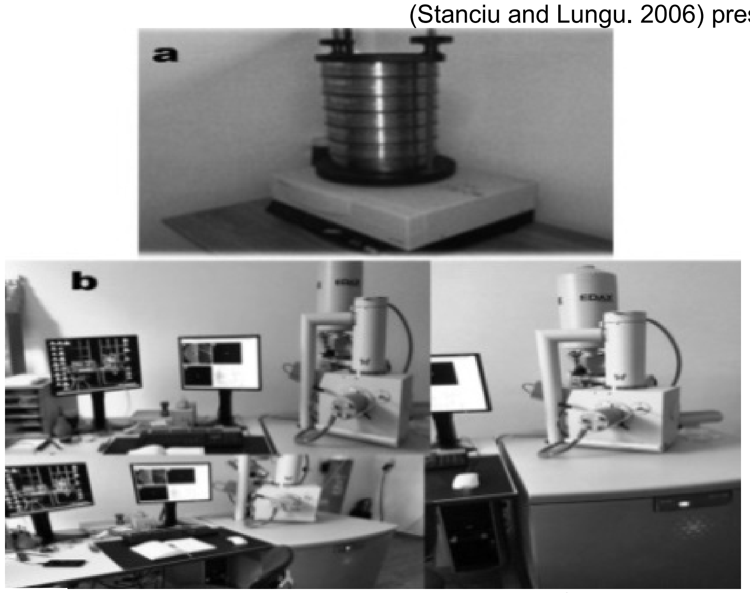

Figure 2 **Equipment used to analyze the morphology of mineral particles: a) shaker electromagnetic; b) equipment used in microscopic analysis SEM**

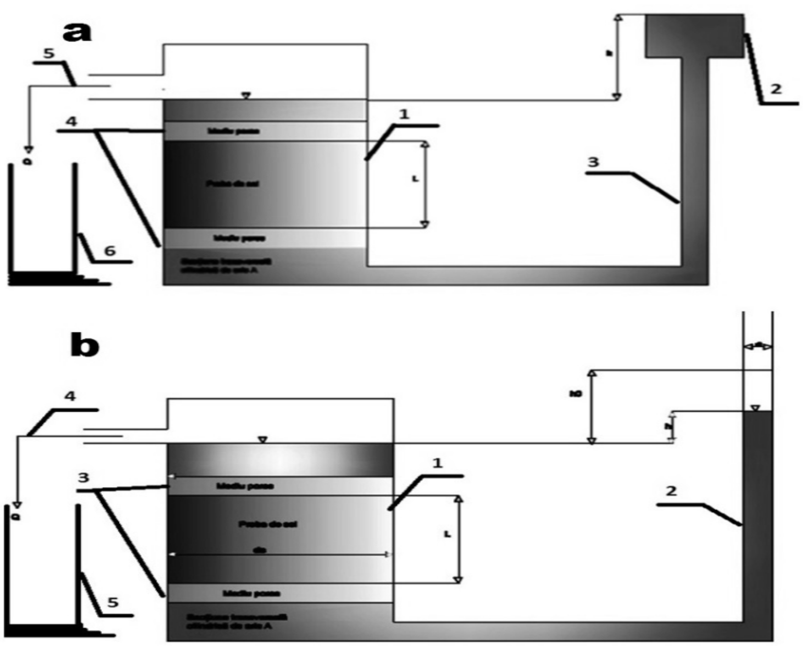

Figure 3 **Equipment used in the study of hydraulic conductivity a) constant-head method; 1: cylindrical soil sample, 2 reservoir:, 3: contact tube 4: poroase- plates., 5: surcharge , 6: graduated cylinder b) falling head method: 1: cylindrical soil sample, 2 graduated contact tube, 3: poroase- plates, 4: surcharge, 5: graduated cylinder**

In the study of the influence of soil particle shape on soil permeability was applied a new method characterized by a framing soil particles in a series of geometric figures whose perimeters were represented by magenta in *figure 4*. From the research of SEM images carried out at very high resolutions was made a classification of surface texture of soil particles with a very high importance when determining the desired action on the morphological properties of soil hydraulic properties analyzed *(tables 2 and figure 5)*.

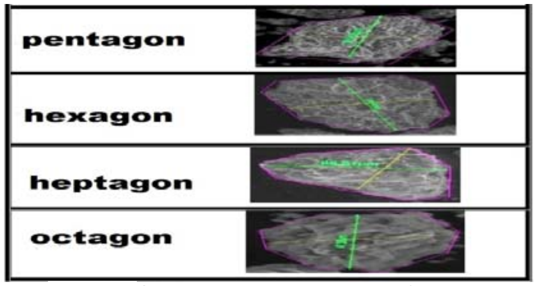

Figure 4 **Soil particle shape classification**

Determining the change of soil hydraulic properties in the Breazu area, only maximum and minimum of two types of pores were taken into account: maximum macro pores surface and minimum surface of nanopores.

To determine relationship between morphological characteristics that belong to particles with different dimensions which are in direct relation to pore system and hydraulic conductivity unsaturated was taken into account only one type of pores – macropores considering that it has a greater carrying capacity than the nanopore. Nanopores were being used for determining the saturated hydraulic conductivity because they have a much lower transmission capacity.

The highest values of K(θ) were attributed to the macro pores and lowest values of Ks have been distributed to the nanopores according to the argument mentioned above. This relationship for first depth is shown in *figure 6,* and for other depths was similary preceded.

Calculation process

Hydraulic conductivity Ks on vertical direction of the water flow is calculated from the relationship (King, L. G., 1965)*:*

Unsaturated hydraulic conductivity values $K_{(\theta)}$ were determined with relation (Dumitru E., 2009).

$$K_S = \frac{V * L}{T * A * h}$$

where:

V- volume of water collected;
L - length of the soil sample;
T - time for the collection volume of water (the excess);
A –cross sectional area of the sample.

$$K_{(\theta)} = \frac{a * L}{T * A} \cdot \ln\left(\frac{h_1}{h_2}\right)$$

where:
a - the cross section of graduated tube;
L - length of the soil sample;
T - time for the collection volume of water (the excess);
A –cross sectional area of the sample;
h_1 and h_2 -height of water column after a time T.

RESULTS AND DISCUSSIONS

In *Table 1* are shows the values of morphological characteristics of soil mineral particles on study section and in table 1 and fig. 4 are mentioned the values of unsaturated, saturated hydraulic conductivity and SEM analysis results will be presented in which will be presented in the morphological characteristics soil mineral fragments for example: 1 mm, 250 µm and < 63 µm to 0-20 cm and 60-80 cm depths - the shape of fragment, the size and the particle surface area (done with AutoCAD 2007) and for other depths was similary.

Table 1

Particle size distribution of Breazu site

µm	B 0-20 cm (%)	B 20-40 cm (%)	B 40-60 cm (%)	B 60-80 cm (%)
< 63	9	5	7.5	6,5
63	10	4	7	9
125	6	3	5	7
250	10.5	6	7.5	11.5
500	19	19	17	19
1000	45.5	63	56	47

Table 2

Values of K (θ) and K s depending, on the morphological characteristics of soil particles to B 20-60 cm Breazu site

Breazu	Fraction size	Surface texture S.T.	The pore size P.s. (mm)	Particle size P. S. (mm)	The shape of particle	K (θ) at 15 º C
B 20-40 cm	1mm	middle	0.41	3.14	hexagon	0.05577
B 20-40 cm	500 µm	finely - middle	0.406	1.55	hexagon	0.01977
B 20-40 cm	250 µm	middle - coarse	0.11	0.087	pentagon	0.01057
B 20-40 cm	125 µm	coarse	0.045	0.19	octagon	0.0071
B 20-40 cm	63 µm	coarse	0.026	0.1	heptagon	0.00566
B 20-40 cm	< 63 µm	coarse	0.009	0.03	heptagon	0.0043
B 40-60 cm	1mm	finely	0.864	4.06	heptagon	0.09296
B 40-60 cm	500 µm	finely - middle	0.825	1.96	pentagon	0.02966
B 40-60 cm	250 µm	finely - middle	0.176	0.676	pentagon	0.02266
B 40-60 cm	125 µm	finely - middle	0.046	0.255	hexagon	0.01549
B 40-60 cm	63 µm	middle - coarse	0.033	0.127	hexagon	0.01363
B 40-60 cm	< 63 µm	coarse	0.007	0.02	pentagon	0.01213
Breazu	Fraction size	Surface texture S.T.	The pore size P.s. (mm)	Particle size P. S. (mm)	The shape of particle	K s at 15 º C
B 20-40 cm	1mm	middle	0.019	3.14	hexagon	0.00084
B 20-40 cm	500 µm	finely - middle	0.014	1.55	hexagon	0.00062
B 20-40 cm	250 µm	middle - coarse	0.003	0.087	pentagon	0.00049
B 20-40 cm	125 µm	coarse	0.001	0.19	octagon	0.00044
B 20-40 cm	63 µm	coarse	0.0024	0.1	heptagon	0.00039
B 20-40 cm	< 63 µm	coarse	0.0011	0.03	heptagon	0.00038
B 40-60 cm	1mm	finely	0.07	4.06	heptagon	0.00132
B 40-60 cm	500 µm	finely - middle	0.002	1.96	pentagon	0.00123
B 40-60 cm	250 µm	finely - middle	0.006	0.676	pentagon	0.00105
B 40-60 cm	125 µm	finely - middle	0.002	0.255	hexagon	0.00093
B 40-60 cm	63 µm	middle - coarse	0.001	0.127	hexagon	0.00083
B 40-60 cm	< 63 µm	coarse	0.0009	0.02	pentagon	0.00093

As shown in *tables 2 and figures 6* can easily notice the downward trend in the process of infiltration intensity correlated with the morphological characteristics of particles (particle shape, particle size, size fraction, specific surface texture, pore size) soil types that make up the three sites .

The particle size of soil samples taken from the three study areas has declined in direct proportion to the characteristic interval of fragment size distribution analysis (1m - <63 µm).After analyzing the data in *Table 1 and 2* and the graphs shown in Figures 6 it can be seen the variation of K (θ) in raport to form in the case of mineral fragments of B 0-20 cm, consisting of particles with diameters of 1 mm, 250 µm, 125 µm and 63 µm with pentagonal outline followed by the group of 500 µm particles and <63 µm with hexagonal appearance, had the largest carrying capacity of the four depths.

Other features should not be overlooked such as particle size and surface texture which ranged in size fraction to another. If we refer to the type of surface texture of mineral fragments we notice the presence of texture, coarse in the case the particles in the range of particle size 250 µm - <63 µm which in turn will present a negative trend in terms of speed transit fluid at the level of the particle surface of the ground, characterized by a resistance to flow due to the roughness.

The average value of unsaturated hydraulic conductivity for Breazu site was detected in the B 40-60 cm sample composed of 1mm fractions of heptagonal shape, particles of 500 µm, 250 µm and < 63 µm of pentagonal and 125 µm and corpuscles 63 µm which had a hexagonal layout. In this case of the particle surface roughness of the ground was totally different from referred to above situation as it was mainly segment completion grading curve ranged between 1 mm and 125 µm.

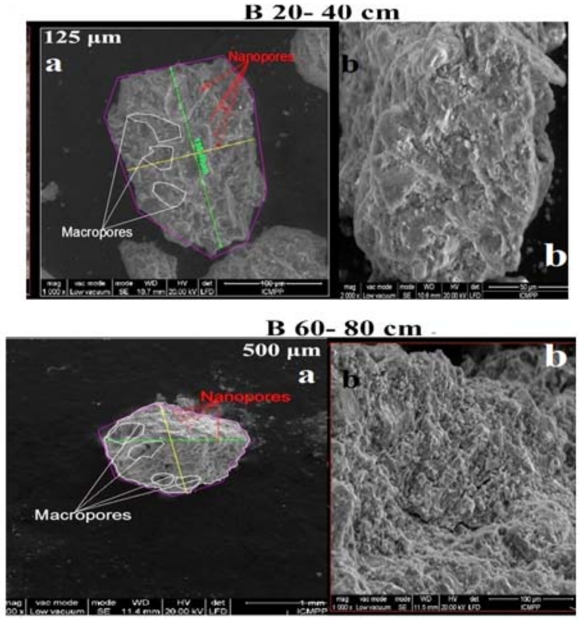

Figure 5 **Morphological characteristics of soil mineral particles on study section a) shape of particles b) surface texture**

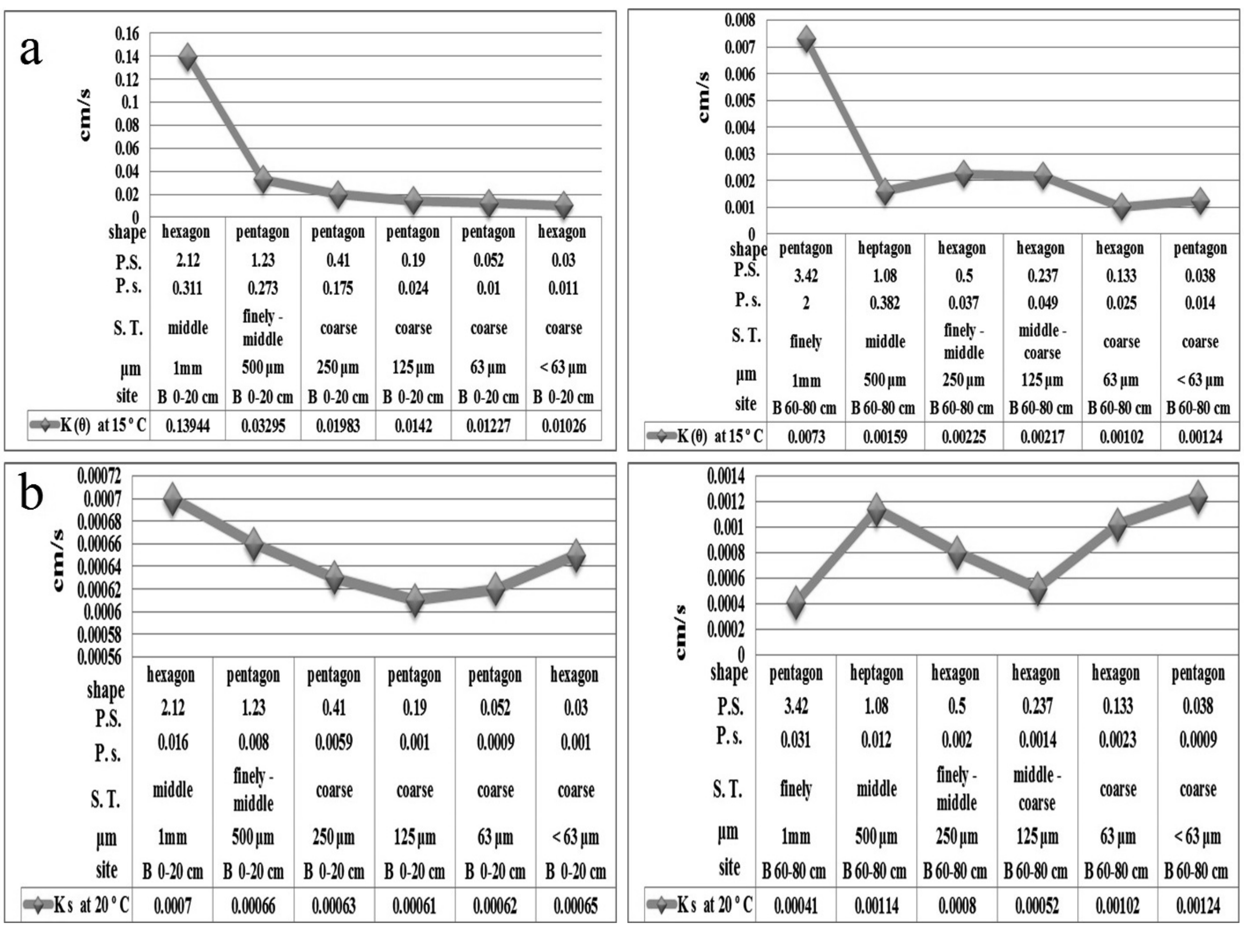

Figure 6 **The relationship between shape and morphological characteristics attributed to soil particles and hydraulic conductivity for Breazu 0-20 cm and Breazu 60-80 cm a) unsaturated hydraulic conductivity b) saturated hydraulic conductivity**

The lowest permeability was observed in B 60-80 cm soil (*noted in figure 6. b*) presented a composition almost similar previous case but if the previous case heptagonal shaped particles have represented the majority in this case of soil type predominates particles with pentagonal shape 1 mm and < 63 µm followed by particles with diameters between 250 µm and 63 µm (9%) surrounded by a perimeter composed of 6 sides and finally fragments of 500 µm with a heptagon form.

In this case, the skeleton elements had a complex texture characterized by morphological variation of this almost the whole range.

The soil sample particles of different shapes, which corresponded to the four forms (pentagon, hexagon, heptagon and octagon) was B 20-40 cm.

Particle surface of the sample extracted from the second harvest threshold noted the existence of a middle-type textures the two extremes (fine-middle and middle coarse).

If we will realize a parallel between the two conductivities will notice the huge gap between values that justified the fluctuation of morphological parameters of particles by different particle size fractions.

The soil from the Breazu site presented among the lowest values of Ks the lowest being observed as in the case of K (θ) - B 60-80 cm sample (observed in *figure 6. a*).

Average capacity transport was notified in section formed in the B 0-20 cm and B 20-40 cm depths (*seen in table 2*).

Filtration process with the highest intensity was observed in soil located at the B 40-60 cm harvesting stage compared to the previous situation characterized by infiltration into the soil before the most powerful B 0-20 cm (*seen in figure 6. b*).

CONCLUSIONS

The distribution of shape and morphological characteristics of soil particles on study section greatly influenced hydric regime of soil from the Breazu site.

When we are referring to the soil we relate at a homogeneous formation composed by well-structured aggregates which are formed to particles with different diameters, sizes and shapes.

The primary characteristics of particles mentioned above are taken in to account when we want to determine the transport mode of all fluids types.

The results of the SEM analysis type help us in making accuracy determination of possible relationship between morphological characteristics representative for each particle and the most important hydraulic properties of the soil with a major impact on water regime corresponding with the each type of soil.

This paper has centered on how the variation of certain of shape and basical characteristics of particles shows the possibility of changing the regime for the various fluids when you want to determine the main particularities of agricultural soils. Soils used for farming activities often after intensive exploitation for satisfying the needs of the last rings of the food chain are in long process of decay with a knowingly subject.

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