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# THE IMPACT OF THE COMPACTION PROCESS ON THE VARIATION OF SOIL HYDROPHYSICAL PROPERTIES FROM BREAZU AND DANCU AREAS

BY

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**Abstract.** The present study wants to highlight the influence it has compacting process on the variation of hydrophysical.properties of three types of soil

In solving this unfavorable soil phenomenon this paper tries to noting the main effects exerted by the compaction process on the hydrophysical.properties distribution in time and space by applying laboratory methods for determining the physical and hydraulic properties of soils in Breazu and Dancu areas. Principal physical characteristics were determined: soil density, soil bulk density, texture and soil porosity.

Hydraulic properties analyzed in order to mark the variation of water regime were: hydraulic conductivity (saturated and unsaturated) and soil suction. All these basic attributes of soil were determined in laboratory methods of applying wish traced internationally.

**Keywords:** compacting; physical properties and hydraulic properties.

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## 1. Introduction

The soil compaction is one of the main causes of the phenomenon of negative character entitled degradation. From the multitude of effects due to the emergence and further development of the compaction process reduced the hydraulic conductivity and soil water but should not be neglected increasing the water retention (soil suction).

In terms of hydraulic soil is a porous medium which is reflected in complex structure its rather complicated system of canals and trails variable called soil pores that support the movement of fluids through them. In this regard it was found that for the transport of water and chemical compounds in the soil is necessary to have two environments: solid medium (soil matrix) and a stream of water moving through the pores of the soil (Stătescu & Pavel, 2011).

During the process pierce soil by fluid, his permeability is altered. Thus, based on dry ground, in the first instance, the permeability is high and then decreases rapidly, until the soil is saturated with water. Since then, the amount of water that enters the soil becomes constant. Water entering for unsaturated soil is made by infiltration (I.C.P.A., 1980).

## 2. Materials and Methods

Of the three study areas (Breazu Fig. 1 a, and Dancu Fig. 1 b were extracted a series of samples in undisturbed Fig. 1 f and disturbed condition Fig. 1 d and Fig. 1 e) one for each depth (0,...,20 cm, 20,...,40 cm, 40,...,60 cm and 60,...,80 cm ) of study sections (0,...,80 cm).


Fig. 1 – Presentation of the location study a, b zone of sampling soil; d and e: samples harvested.

Physical properties were analyzed in the laboratory with the following methods: soil density and soil bulk density (oven drying method and pycnometer method Fig. 1 b), texture (pipetting method performed using Eijkelkamp Pipette Apparatus (Fig. 1 a).

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 Fig. 2 d) and the falling head method ($K_\theta$) (Stanciu & Lungu, 2006) presented in Fig. 2 e. Suction was determined on a value range between pF 0 and pF 4.2 using experimental plant comprising: sandbox (pF 0 – pF 1.8) remarked in Fig. 2 a), sand/kaolin box pF 2 – pF 2.7) shown in Fig. 2 b), and the pressure membrane apparatus (pF 3 –pF 4.2) noticed in Fig. 2 c) (Dumitru, 2009)


Fig. 2 – The tools used in research: 1: equipment used to analyze the physical properties: a) shaker electromagnetic; b) Eijkelkamp Pipette Apparatus c) drying machine 2: all equipment used in the study of hydraulic properties a) sandbox; b) sand/ kaolin box; c) pressure membrane apparatus; d) constant-head method; e) falling head method.

Soil density. is calculated with eq. 1 (Filipov & Lupaşcu, 2003)

$$\mathrm{D} = \frac{m_2 - m_0}{m_1 + m_2 - m_0 - m_3}\rho_1, \tag{1}$$

where: D is the soil density, [g/cm$^3$], $m_0$ – mass of empty pycnometer, [g], $m_1$ – mass of pycnometer with liquid, [g], $m_2$ – mass of pycnometer with soil, [g], $m_3$ – mass of pycnometer with soil and liquid, [g], $\rho_1$ – liquid density, [g/cm$^3$].

Soil bulk density is calculated from the relationship (Rogobete, 1993)

$$\mathrm{DA} = \frac{m_2 - m_1}{V_t},\ [\mathrm{g/cm^3}], \tag{2}$$

where: $m_1$ is the mass of empty cylinder gol, [g], $m_2$ – mass of cylinder with dry soil at 105°C, [g], $V_t$ – the total volume of the soil sample from cylinder, [cm$^3$]. Soil porosity is calculated with (King, 1965):

$$\mathrm{PT} = \left(\frac{V_p}{V_t}\right)\cdot 100 = \left(1 - \frac{\mathrm{DA}}{D}\right)\cdot 100, \tag{3}$$

where: PT is the total porosity [%], $V_p$ – pore volume [cm$^3$], $V_s$ – the volume of the solid part of the soil [cm$^3$], $D$ – soil density [g/cm$^3$], DA – the bulk density of the soil, [g/cm$^3$].

Hydraulic conductivity $K_s$ on vertical direction of the water flow is calculated from the relationship (King, 1965):

$$K_s = \frac{V \times L}{T \times A \times h}, \tag{4}$$

where: $V$ is the 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.

Unsaturated hydraulic conductivity values $K_{(\theta)}$ were determined with (King. 1965):

$$K_{(\theta)} = \frac{a \times L}{T \times A}\ln\left(\frac{h_1}{h_2}\right), \tag{5}$$

where: $a$ is 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 $T$.

The dates of water retention curve in the soil were obtained using the relation (Ahuja, 1998):

$$W = \frac{\text{Weight of soil water} \times 100\%}{\text{Weight of soil}}, \tag{6}$$

$$\rho_d = \frac{\text{dry soil weight (without ring.canvas)}}{\text{Weight of soil}}, \tag{7}$$

$$\theta = W\rho_d, \tag{8}$$

where: $\theta$ is the volumetric water content [%], $W$ – soil humidity [%], $\rho_d$ – soil bulk density, [g/cm$^3$].

## 3. Results and Discussions

In Table 1 are presents the results obtained after applying the research methods of the physical properties of soils in the two areas studied.

**Table 1**
*Physical Properties of Soils for Breazu and Dancu*

| Sample | DA g/cm$^3$ | D g/cm$^3$ | PT % | Clay % | Silt % | Sand % | $K_{(\theta)}$ cm/s | $K_s$ cm/s |
|---|---|---|---|---|---|---|---|---|
| B 0-20 cm | 1.22 | 2.14 | 43 | 21 | 29 | 50 | 0.021481 | 0.001987 |
| B 20-40 cm | 1.45 | 2.3 | 37 | 24 | 31 | 45 | 0.00942 | 0.013731 |
| B 40-60 cm | 1.56 | 2.45 | 36.3 | 26 | 45 | 29 | 0.019892 | 0.01372 |
| B 60-80 cm | 1.59 | 2.57 | 33.5 | 28 | 64 | 8 | 0.003203 | 0.000917 |
| D 0-20 cm | 1.08 | 2.15 | 49.8 | 8 | 29 | 63 | 0.023891 | 0.02476 |
| D 20-40 cm | 1.18 | 2.21 | 46.7 | 19 | 41 | 40 | 0.028621 | 0.027608 |
| D 40-60 cm | 1.38 | 2.27 | 39.3 | 7 | 34 | 59 | 0.025084 | 0.025084 |
| D 60-80 cm | 1.43 | 2.51 | 37.5 | 3 | 52 | 45 | 0.004282 | 0.000326 |

Soil bulk density of samples taken from the three study areas varied gradually from 0,...,80 cm depth. In the case of study area Breazu can see a little difference between bulk density values for the depth of 40,...,60 cm and 60,..., 80 cm depth harvesting.

After analyzing samples from the site - the Dancu was revealed a very small discrepancy between these values ranging normal with changing depth of the soil profile. The soil in the Tatarasi area recorded major variations compared to the other two areas.

As can be seen in Table 1, density, as the basis property of the soil physics varied according to the increase of depth of the three locations.

The highest value was registered in the soil taken from a depth of 60,...,80 cm in the Dancu area due to the emergence natural compaction process.

The other two locations revealed density values that varied little from one harvest to the next step.

The nearest values were noted for soil samples which taken from the Breazu site this can be attributed to anthropogenic pressure and non-permanent.

Compared to the density and bulk density of the soil, porosity decreased concomitantly with the enhancement the density of the two types.

The lowest values were noted in the case of Breazu study area, they ranged from 43% in the first 20 cm to 33.5% for the 60,...,80 cm depth.

The mean values of total porosity on the three areas have been highlighted in the type of soil collected from Dancu site, the latter being in the range of 49.8%,…,37.5% compared to the maximum percentages found in soil samples taken from other site. All these variations in the values of total porosity is attributable to the content of sand, dust and clay varied according to depth and location.

Preliminary data obtained (Table 1) from the $K_{(\theta)}$ analysis showed a speed of transport which gradually varied from a depth to another depending on the physical properties (density, bulk density, texture etc) of the environment in which there is process of infiltration.

The principal case, the smalles values, for Breazu site the $K_{(\theta)}$ values decreased initially from the first depth to the last. This change in flow regime can be justified by the increase of both types of density (density ($\rho$) and bulk density (DA)) which exerted a great influence on the total porosity (PT) limiting access of water in soil pores (routes drain).

In the case of the Dancu study area, unsaturated hydraulic conductivity values (Table 1) were lower than those of $K_s$ for D 0,...,20 cm depths ($K_{(\theta)}$ 0.0238 cm/s and $K_s$ 0.0247 cm/s) and D 40,...,60 cm ($K_{(\theta)}$ 0.0198 cm/s and $K_s$ 0.0250 cm/s).

For depths D 20-40 cm and D 60,...,80 cm $K_{(\theta)}$ values were higher than D 20,...,40 cm ($K_{(\theta)}$ 0.0286 cm/s and $K_s$ 0.0276 cm/s) and D 60,...,80 cm ($K_{(\theta)}$ 0.0042 cm/s and $K_s$ 0.00032 cm/s).

Saturated hydraulic conductivity values obtained from the analysis of soil samples taken from the perimeter Dancu, differed, as in other cases from one deep to another for D 0,...,20 cm $K_s$ was less than D 20,...,40 cm, D 40,..., 60 cm. As with soil Breazu physical variation played a leading role.

If we compare water content $\theta$, resulting from the determining water retention capacity of soil in the Breazu study area (Fig. 3), we find that it fluctuated as in hydraulic conductivities, depending on the changing physical characteristics and depths studied.

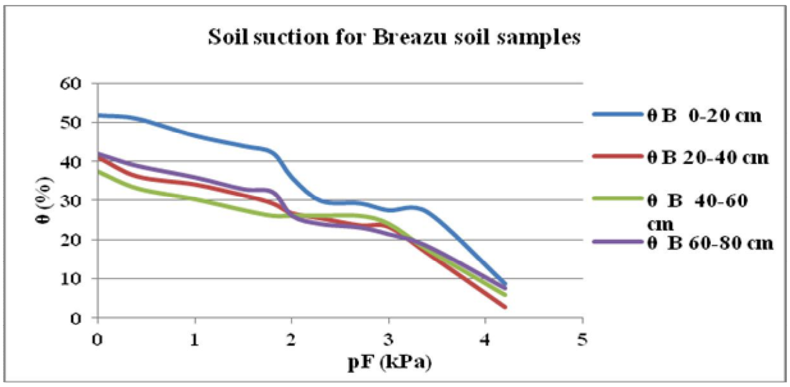


Fig. 3 – Water content values of all thresholds for soil suction Breazu site.

For example B 0-20 cm retained at pF 1 a higher amount (50.74%) than B 20,...,40 cm (40.97%), B 40,...,60 cm (37.32%) and B 60,...,80 cm (41.79%). At 2.0 pF, predominantly clay soil collected from Breazu site, highlighted a range of θ, water content values which differed from 35.77% for B 0,...,20 cm to 26.05% assigned B 60,...,80 cm.

Last threshold suction – pF 4.2 generated a dataset which ranged from 2.67% to 8.67%. The greatest value of this interval was recorded in soil collected from B 0,...,20 cm depth and the lowest in the sample taken from the next depth (B 20,...,40 cm).

In the case of B 40,...,60 cm and B 60,...,80 cm steps, percentages differ slightly 5.82% and 7.62% so we can justify this by the fact that the two depths analyzed showed moderate values of total porosity 36.3 % for B 40,...,60 cm and 33.5% for B 60,...,80 cm.

Soil samples collected from the Dancu area the first level of suction exhibited a range of values of the water content as in the previous case (Breazu) were particularly the location and depth to the other but not in direct proportion to the increase in depth. Thus water content for each depth can be seen in Fig. 4.

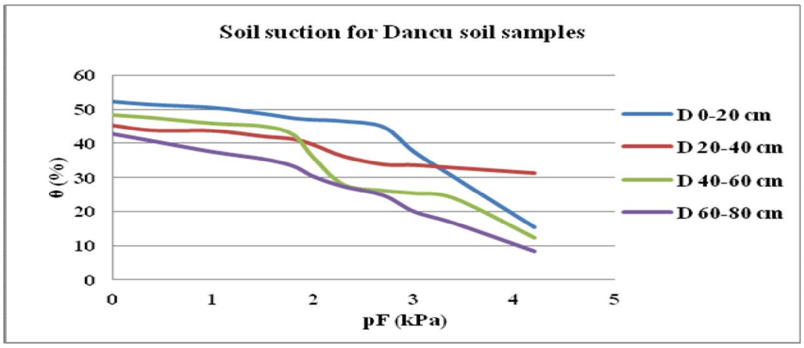


Fig. 4 – Water content values of all thresholds for soil suction Dancu site.

It noted a lower content in soil sample as compared to the depth D 20,...,40 cm D 40,...,60 cm. The highest value 52.21% was obtained in the first depths, has the highest total porosity compared to the lowest found in soil D 60,...,80 cm.

At pF 2 D 20,...,40 cm managed to store more water content than the D 40,...,60 cm. This remark can be substantiated by the presence of large quantities of clay and dust.

The highest rate was determined on soil samples collected from the first depth, and the lowest rate was observed in soils extracted from a depth of D 60,...,80 cm.

If things change value of pF 4.2, suction does not change from depth to another depth as if pF 2, but shows varying values depending on soil type, so the lowest values of $\theta$ water content 34.25% were observed at D 20,...,40 cm soil. The maximum was observed in D 0,...,20 cm soil, and the medium in D 40,...,60 cm.

## 4. Conclusions

Making an overall analysis we can mention the following:

The compaction process greatly influenced the distribution in time and space of hydrophysical properties in entire section study depending on the site geology and the action of natural and anthropogenic factors.

The physical properties varied from one area to another one - in the case of soil in the Breazu area can be discussed by a slump by natural origin which in the presence of a higher content of clay, silt and sand generated a number of effects worse than soil Dancu area that is subject to this compaction (natural) but the existence of large quantities of organic matter could influence the water regime.

Regarding the storage capacity of the soils analyzed can easily observe its variation that can be substantiated by the distribution of physical properties that changed simultaneously with migration percentages of clay, silt and sand on 0-80 cm section for each type of analyzed soil.

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IMPACTUL PROCESULUI DE COMPACTARE ASUPRA PROPRIETĂȚILOR HIDROFIZICE ALE SOLURILOR DIN ZONELE BREAZU ŞI DANCU

(Rezumat)

Studiul de față dorește să evidențieze influența pe care o are procesul de compactare asupra variației proprietăților hidrofizice a trei tipuri de sol. În rezolvarea

acestui fenomen nefavorabil solului, această lucrare încearcă să observe principalele efecte exercitate de procesul de compactare asupra distribuției în timp şi spațiu a proprietăților hidrofizice prin aplicarea metodelor de laborator pentru determinarea proprietăților fizice şi hidraulice ale solurilor din zonele Breazu, şi Dancu.

Principale caracteristici fizice determinate în acest studiu au fost: densitatea solului, densitatea aparentă a solului, textura şi porozitatea solului.

Proprietățile hidraulice analizate în vederea evidențierii variației regimului apei au fost: conductivitatea hidraulică (saturată şi nesaturată) şi sucțiunea solului.

Toate aceste trasături de bază ale solului au fost determinate în laborator prin aplicarea metodelor folosite la nivel internațional.