HYDROPHYSICAL INDICATORS OF THE SOILS IN HOROIATA BASIN

Ionuț Vasiliniuc[1]

Key words: hydrophisical indicators, soil physical quality, crop production.

Abstract. Soil physical state directly influences environmental and production quality. The indicators of soil physical state include depth, soil structure, texture, useful volume, density, porosity, water retention capacity and other hydric parameters. The different importance that the soil-plant relationships and the different water contents in soil have in practical applications led to the defining of some conventional values of humidity, accepted as indicating significant changes in the mobility and accessibility of water for plants. These conventional values make up the hydrophysical indices (Canarache, 1969, 1990). We have computed these indices for the soils in Horoiata basin, so as to see how soils developed on sandy deposits of this area behave from this viewpoint.

Introduction

According to the Romanian Soil Taxonomy System 2003, in Horoiata basin have been identified 18 taxonomic units at the subtype level, belonging to 9 soil types and 5 classes. The statistical analysis reveals the clear dominance of Chernisols, which sum up more than half of the study area (58.13%), followed by Luvisols (17.68%). Together these two classes make up over 70% of the area and give the defining aspect of the soil cover of the basin and implicitly of Tutovei Hills. Also an interesting aspect is the large occurrence of the Protisols (16.91%), mainly Regosols, which together with the Erodosols give a character of the region. Finally, with low proportions are met Antrosols and Hidrisols.

The different importance that the soil-plant relationships and the different water contents in soil have in practical applications led to the defining of some conventional values of humidity, accepted as indicating significant changes in the mobility and accessibility of water for plants. These conventional values make up the hydrophysical indices (Canarache, 1969, 1990).

[1] „Alexandru Ioan Cuza" University, Iaşi, vasiliniucionut@yahoo.com

The hygroscopicity coefficient (CH) corresponds to a pF value on the suction curve of 4.7. For the mineral soils unaffected by salts CH is strongly correlated to the clay content. Due to this strong correlation with clay, its determination is used for the indirect estimation of soil texture, and also for that of the wilting point.

The wilting point (CO) is the first of the main hydrophisical indices. It was introduced by Briggs and Schantz (1912), who defined it as the humidity under which crops wither irreversibly. The wilting point represents the lower limit of humidity accessible to plants, under which their development is not possible. In field conditions, crops may survive to humidity quantities lower than CO, and this is why it is better to define an interval of the wilting point.

Somehow conventional, the determination of the wilting point on this basis is largely used: CO = 1.5 CH. The pF point on the suction curve corresponding to the wilting point is not strictly determined, but for non saline soils the value 4.2 of pF is usually accepted. CO depends mainly on soil texture, the organic matter, calcium carbonate and soluble salts' contents.

Field capacity (CC) represents the upper limit of the humidity interval significant for crop growth, because under this value water is no longer sustainable retained by the soil. Field capacity of mineral soils depends mainly on soil texture and bulk density. Thus we'll have a more accentuated increase of CC for sandy soils and a reduced one for the medium textured ones, according to the increase in the clay content. At the same clay content, a higher proportion of sand determines an increase in field capacity, while a higher content of sand decrease it. A high influence on CC values is exercised by bulk density. At the same clay content, a moderately compacted soil has CC values smaller with 1-6% then medium or heavy textured soils.

The interval between the wilting point and field capacity makes up the *available water capacity* (CU) and represents the water quantity that the soil can retain and deliver to crops. It is thus the main indicator of the soil's function as water reservoir, and shows how much rainfall water can be retained for the further use of plants. Available water capacity varies according to the same factors that influence field capacity and the wilting point. The maximum values characterize loamy – sandy-loamy soils, strongly decreasing for sandy soils.

The maximum water quantity that a soil can retain when its pores are filled with water and air lacks makes up the *total water capacity* (CT). It corresponds on the suction curve to the 0 pF point. In mineral soils total water capacity is directly correlated with bulk density values.

The interval between field capacity and total capacity characterizes *draining capacity* (CD). It corresponds to the large pores, through which water excess circulates freely and usually occupied by air. It is also an index of permeability and aeration, of the soil's easiness of being drained. In light soils the values of draining capacity are always above the critical limit of 6-7%, while in compacted, heavy ones they are below this limit.

1. Matherial and methods

The database used is made up of over 300 profiles sampled by OSPA Vaslui. A delicate problem was the lack of measured values of hydrophisical indices. Being difficult and costly to determine, these parameters do not enter the usual determinations conducted in the Romanian soil surveys.

To estimate them, we appealed to pedotransfer functions (PTF), statistical correlations between soil texture, organic matter, water potential and hydraulic conductivity (Lyn et al., 1999; Pachepsky and Rawls, 2003; Pachepsky ey al., 2006), which may offer quite correct estimates (Canarache et al., 1994; Saxton and Rawls, 2006). In recent papers may be found a multitude of such PTF, and also studies that tried to evaluate / compare such functions (Oliver and Webster, 1990; Tietje and Hennings, 1996; Wagner et al., 2001; Borgensen and Schaap, 2005; Manyame et al., 2007).

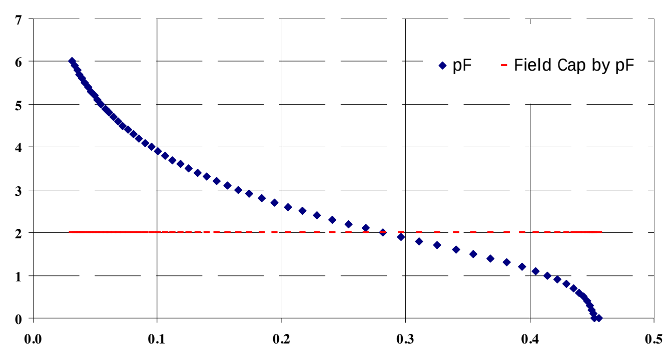

Fig. 1 - Example of suction curve (Haplic Aluviosol)

The analysis of some statistical parameters, together with comparing evaluated data with those existent in some studies made us choose Wosten's (1997) equations, which predicted with higher accuracy hydraulic conductivity and hydrophisical parameters. In this way, we constructed suction curves and obtained the hydraulic parameters from the pF values corresponding to them (fig 1).

2. Results and discussions

The mean values of the **hygroscopicity coefficient** at the soil type level oscillate between 4.53 and 15.28, the average being 12.27. Higher values are characteristic to soils with high clay content at their upper part (Luvosols, Cambic Chernozems) and the lower ones to young soils or soils that from a certain reason (erosion, sedimentation) have at their upper part high contents of sand (Aluviosols, Regosols, Erodisols, Luvisols) (fig. 2).

Table 1. Statistical variables of some hydrophisical parameters of the Horoiata basin soils' upper horizons*

Parameter	Maximum	Minimum	Median	Average	Standard deviation
CH	21.41	8.34	11.59	12.27	2.58
CO	22.3	1.00	10.3	10.25	4.71
CC	45.00	2.00	29.4	28.42	6.82
CU	22.70	4.00	19.1	18.73	2.78
CT	99.25	23.99	32.68	37.87	12.36
CD	62.55	1.00	6.65	9.33	10.42

*CH = hygroscopicity coefficient; CO = wilting point; CC = field capacity; CU = available water capacity; CT = total capacity; CD = draining capacity.

Regarding the **wilting point** mean values, they vary approximately between 7 and 23, being directly proportional with those of CH. The average characterizes this parameter as having medium values (10.3). As in the case of CH, the highest values are characteristic to soils with high clay content, and the smallest to those with sand content, mainly Aluviosols, Regosols, Erodosols. The profile variations, dependent on soil texture, register in most cases a decrease with depth, except for the Cambic Chernozems, Stagnic Luvisols and Cambic Erodosols (fig. 3).

In what regards the spatial distribution of the hygroscopicity coefficient values (and implicitly of the wilting point), we see that they increase from the upper basin to the lower one (fig. 6). Thus the northern half of the basin is characterized by the lower part of the medium values class of CO (8-10), around Hupca and south of Unțeşti being met values of 10-12. Values of CO considered high (12-16) occur in the southern part of the basin, around Horoiata.

Field capacity, depending on soil texture, has the same variations as the wilting point, the absolute values oscillating between 2 and 45%, the average being 29.4%. If we average the main soil types, values vary between 20 and 32%, being considered high and very high. Increasing with the clay cointent and decreasing as the percentage of coarse fraction does, values of CC in the upper horizon are very high for the Luvisols and Greyic Phaeozems. High values (26-30 g/g) are characteristic to Haplic Phaeozems and Regosls, while mean values are typical for the largest part of the area, mainly in the case of Chernozems and Aluviosols (fig. 7, 8).

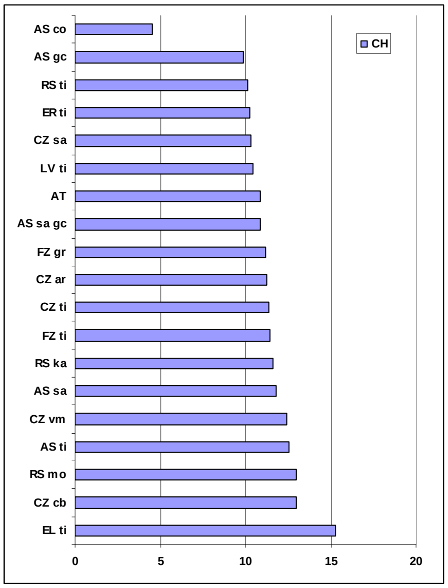

Fig. 2 - Values of hygroscopicity coefficient for the main soil types

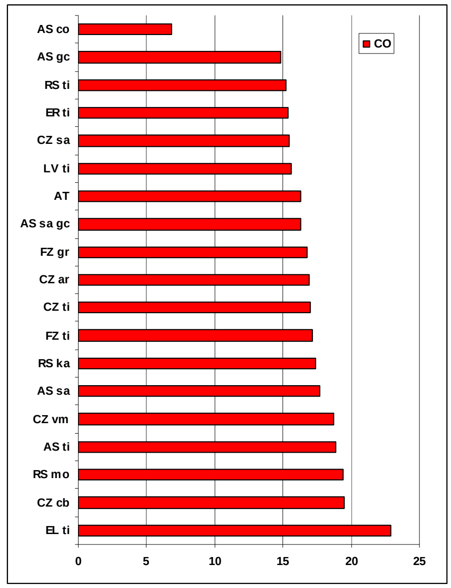

Fig.3. Values of the wilting point for the main soil types

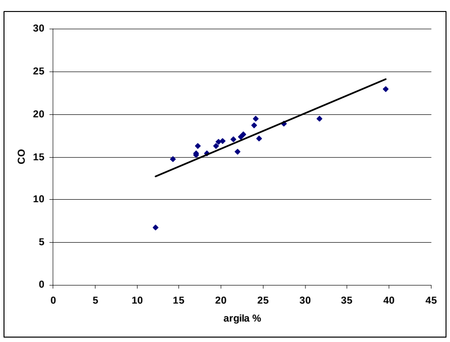

Fig. 4 - Correlation between clay content and wilting point

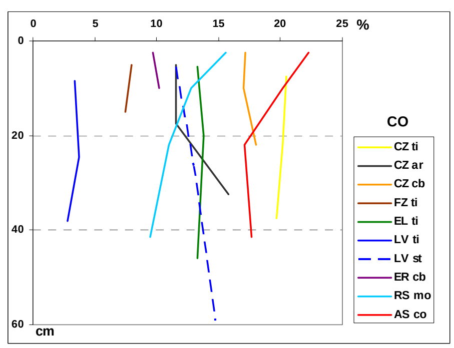

Fig. 5 - Depth variation of wilting point values

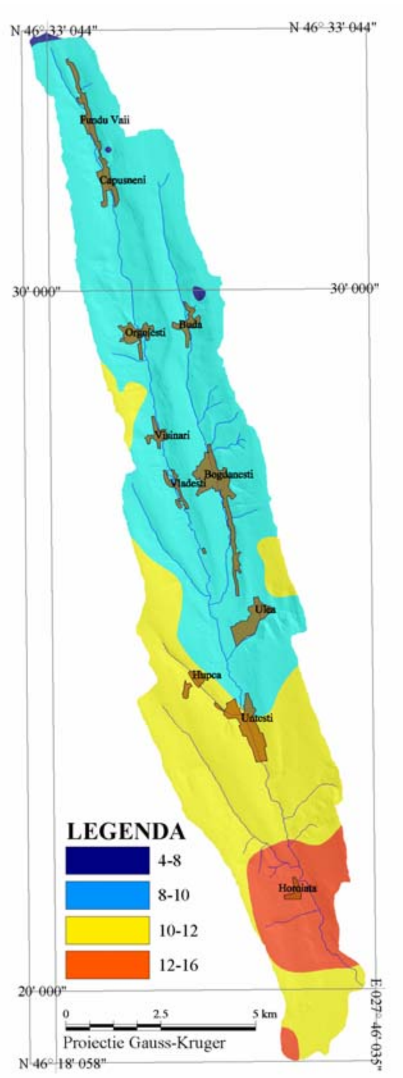

Fig. 6 - Spatial distribution of hygroscopicity coefficient values

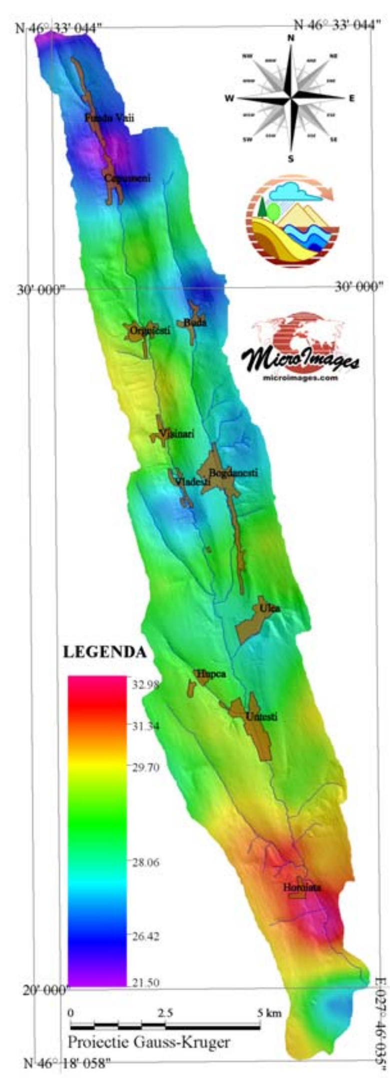

Fig. 7 - Spatial distribution of field capacity values

Approximately similar is the situation of ***available water capacity***, only that on the first place is situated the Greyic Phaeozem (fig. 8). In the case of this indicator there are no large variations, the largest part of the values being between 15-20%, soils being thus characterized as having a high and very high available water capacity. This implies the storage of high quantities of water, yet in some cases with a weak retention due to the sandy component of soil texture.

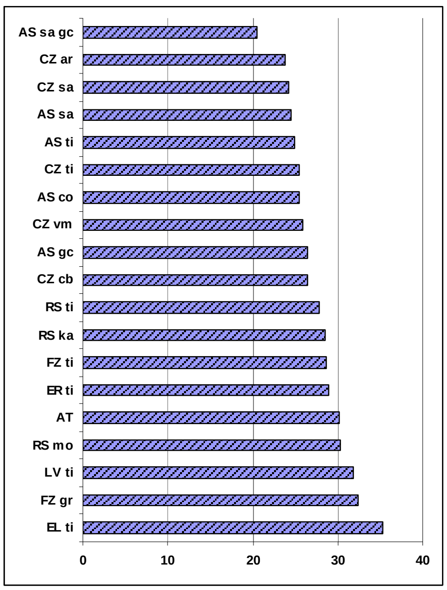

Fig. 7 - Values of field capacity

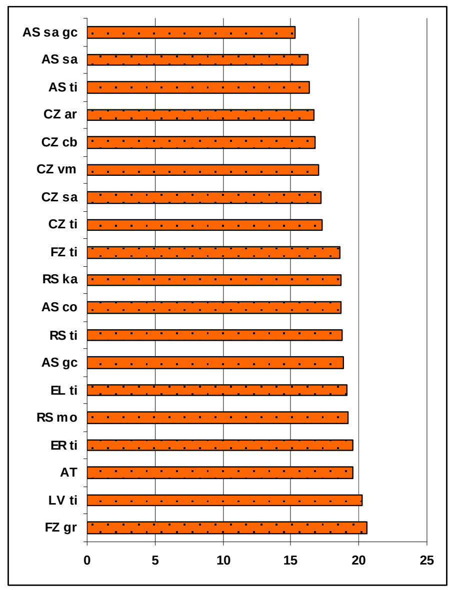

Fig. 8 - Values of available water capacity

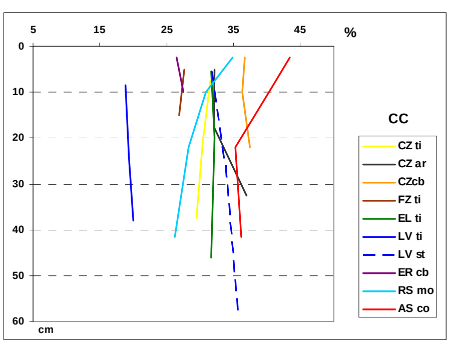

Fig. 92 - Depth variation of CC values

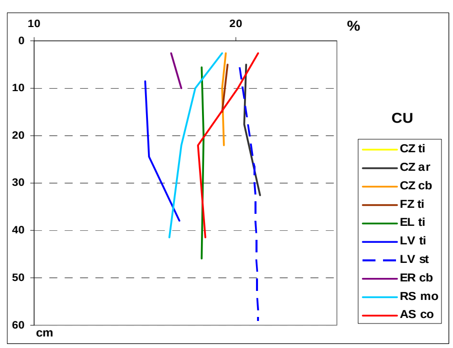

Fig. 30 - Depth variation of CU values

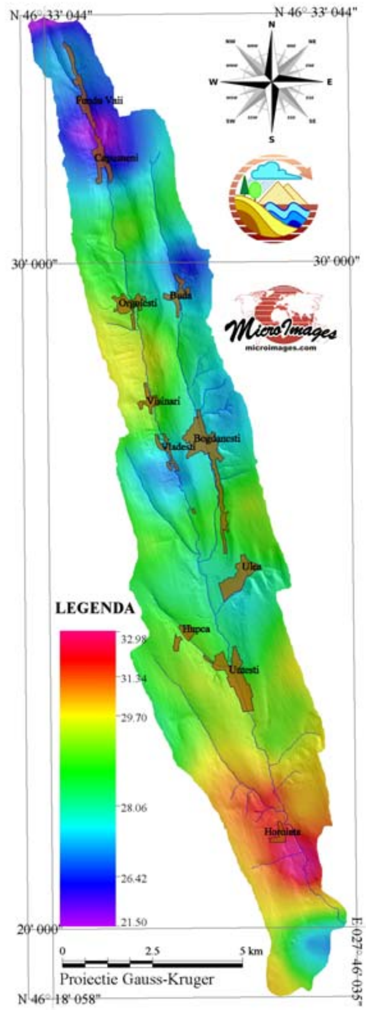

Fig. 41 - Spatial distribution of available water capacity values

Fig. 52 - Spatial distribution of total water capacity

Field capacity and available water capacity have very similar profile variations. Thus, with very few exceptions, there is a decrease with depth. In what regards field capacity, there are small increases in the first 60 cm for the Cambic Chernomems and Luvisols, while significant decreases are specific to Aluviosols, Mollic Regosols and Haplic Chernozems, correlated to an increase in clay content or decrease of the sand one (fig. 9).

Field capacity is also influenced by the clay content. Due to this reason, the highest values (very high capacity) are met in the southern sector, around Horoiata (30-32%). The largest part of the basin is characterized by values considered high (28-30%). Areas with somehow smaller values of CC, between 25 and 28%, occur around Vlădeşti and Bogdăneşti, continued on the left bank of Bogdăneşti up to Buda. Areas with similar values occur south of Ulea, but also in the upper part of the basin, around Căpuşneni and Fundu Văii.

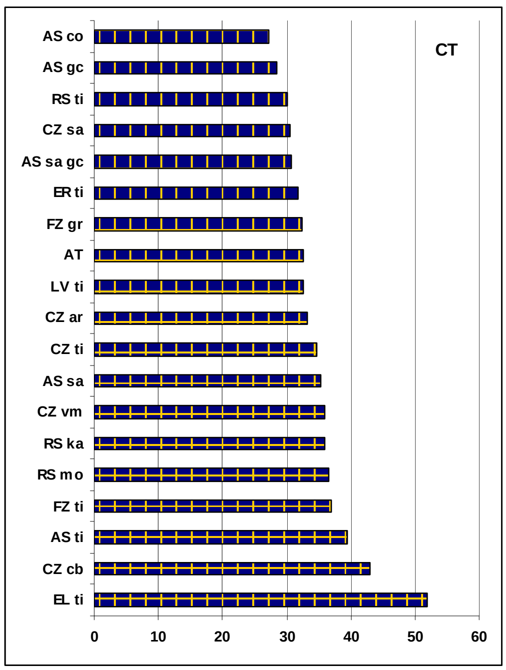

Fig. 6 - Distribution of total water capacity values

Available water capacity has a different distribution in comparison to CO or CC. Lower values, of 17-18% or even smaller, occur in the south of the basin (fig. 11), but also in the northern part, as a “pole” around Căpuşneni, continued till Fundu Văii. The largest part of the basin is characterized by values of 18-19%, while higher values, up to 20%, occur in the central part, between Orgoieşti, Vişinari and Bogdăneşti (on the right of Bogdăneşti brook), continued to south on the left bank up to Ulea. An important area with values between 19 and 20% is found between Unțești and Horoiata, and a smaller one around Hupca.

The situation remains relatively unchanged in the case of ***total water capacity***, evolved soils such as Entic Luvisols or Cambic Chernozems being characterized by the highest values of this parameter, of over 40% (very high capacity). At the lower part of the graphic are met Aluviosols, Regosols and Erodosols, with values characterized as medium (28-30%). Total water capacity has its values distributed on a quite large scale, variations being determined by the clay content (CT increases directly proportionally to clay content, the relation having a correlation coefficient of 0.98).

Total water capacity has a spatial distribution similar to the one of the wilting point (fig. 12). Thus, the smallest values of CT, under 30%, are met on a reduced surface, in the northern extremity of the basin, on the plateau of Lipovăț. The largest part of the basin is characterized by high values of total capacity (30-35%, 35-40%). The southern, lower portion of the basin has high values of this indicator, of 40-45% or even 45-50%.

Conclusions

In conclusion, we see that the hydrophisical coefficients are, as normally expected, strongly correlated first of all themselves, and then mainly with soil texture. The content of the clay and sand fractions are the factors that determine the high or low values of these parameters. As the majority of the soils in this area are formed on sandy deposits, the coarse texture leads to high values of water capacities, characterized as being good for soil crops. Still, the same coarse texture leads to a poor retaining of water in soil, and thus to frequent situations of soil drought.

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