RESEARCH ARTICLE **(Open Access)**

Determining the best fit equations to represent the cumulative particle – size distribution curves in soils of Albania

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Abstract

There is no doubt about the need to replace the textural triangle by the cumulative particle – size distribution curves in the research context of Albanian soils. Beside all, it creates the necessary space to establish the relationships between the cumulative particle – size distribution curves and the most important hydraulic properties of soils. Therefore, having the cumulative particle – size distribution curve belonging to a specific soil, it becomes possible the recognition of hydraulic properties of this very soil. There are many efforts to determine the best fit equation reflecting the cumulative particle – size distribution curves. However, the best fit in our research seems to be exponential law function in its closed form. This conclusion became possible to be drawn based on a considerable large textural data base collected throughout the soils of Albania. Whether this conclusion is true for the soils where the clay predominates, or silt and sand predominate; or whether it has the same significance as for fitting to the process of data transfer from one scheme to another, it requires further research.

Keywords: cumulative particle – size distribution curve; exponential law function; textural triangle.

1. Introduction

Since the first theoretical proposal done by D. Hillel, there are plenty of efforts to establish equations of a relatively universal nature to describe the mineral particle size distributions in a particular typical soil. In his famous books [1, 2, 3, 4]. Hillel stated that the method to determine the texture of a given soil by the textural triangle is rather "arbitrary", which is a call for replacing it by the particle-size distribution curves. The efforts done later in this area of research did face difficulties, because of the existing of various models of mineral particles classifications, as it is shown in the following table:

Table.1 The various methods to determine the cumulative distribution of particles (clay, silt, sand) within the ranges called respectively as VF – very fine; F – fine; M – medium; C – coarse; VC – very coarse.

Particle size mm	The classification it belongs to	The particles Involved
0,001	Katschinski	clay fine
0,002	USDA&ISSS	clay
0,01	Katschinski	clay +fine silt
0,05	USDA&Katschinski	clay + fine silt + coarse silt
0,1	USDA	clay + fine silt + coarse silt + VF sand
0,25	USDA&Katschinski	clay + fine silt + coarse silt + (VF + F) sand
0,5	USDA&Katschinski	clay + fine silt + coarse silt + (VF + F+ M) sand
1	USDA&Katschinski	clay + fine silt + coarse silt + (VF + F + M + C) sand
2	USDA&ISSS	clay + fine silt + coarse silt + (VF + F + M + C+ VC) sand

2. Material and Methods

The method to be followed in this research is going to be in substance a quantitative analysis establishing relationships between the size (diameter) of mineral soil particles and their respective cumulative percentage in various textural soils. The quantitative analysis to be applied is the regression analysis. Meanwhile, the data base of the relative participation in percentage of mineral soil particles of various size ranges and in various typical textural soils, is going to be provided from the source referred as, [9].

In the following figure, the three typical particle – size cumulative curves are presented schematically

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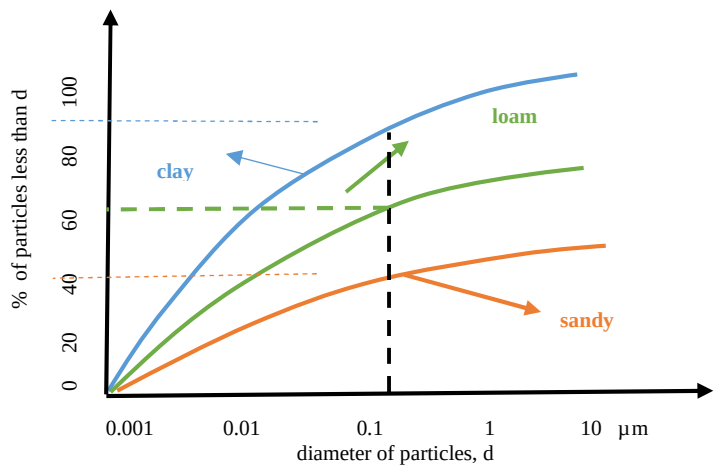

Figure 1. Particle-size distribution curves belonging to different textures schematically presented

The above seen curves will be quantified in a concrete way by applying the regression analysis and the constants that are going to get appeared in these equations, will be analyzing for their physical meaning. After, the found equations will be tested for their fitness towards the specific and various soils. Therefore, their significance will be applied to determine their suitability.

3. Results and Discussion

This study will use the final equations determined by Rousseva ,[7]. Both types of the equations are going to be considered: exponential and power equations in their closed forms, as it is appeared in the following:

$$F_1(D) = a + (100 - a)\frac{D^n}{1 + b^{mD}} \qquad (1)$$

$$F_2(D) = a + (100 - a)\frac{D^n}{1 + bD^m} \qquad (2)$$

; where

F1(D) is the function of "% of particles less than d" from the size range of a given mineral particle type in the case of having a closed exponential equation type.

F2(D) is the function of "% of particles less than d" from the size range of a given mineral particle type in the case of having a closed power equation type.

a is the percentage of particles less than 0,001 mm

b, m, n are the coefficients to be released by the regression analysis. However, they have an well determined physical meaning. So, after Rousseva, the coefficient b represents the ratio between the percentages of particles coarser than 0,01 mm with the particles between 0,001 mm and 0,01 mm. As the

coefficients m and n determine the slope of the curves represented by the above mentioned equations.

The both equations are going to be build up by using the data collected from the source referred as,[9].

The data found in this source are absolutely sufficient and with a trustable status to be used for meeting the aim of this study.

4. Conclusions

1. The data collected from various soils in Albania about their textural nature are sufficient and reliable to be applied for meeting the purpose of this research.
2. Both forms of closed equations, exponential and power, are going to be tested in the conditions of soils in Albania.
3. There are sufficient data to believe that the soils in Albania need to be grouped based on their texture nature in order to build more realistic and reliable equations for fitting them.

5. References

1. Hillel, D. 1971. “Soil and water”, pg. 82-94; 103-109; 201-220; 225-239, New York 6.
2. Hillel, D. 1980. “Fundamentals of Soil Physics”, Academic Press, New York 7.
3. Hillel, D. 1998. “Environmental Soil Physics », Academic Press, 771 pg. Inc. 525 B Street, Suit 1900, San Diego, CA 921014495.
4. Hillel, D. 2003. “Introduction to Environmental Soil Physics”, Academic Press, 449 pg. Hardbound.
5. Kool, J.B., J.C. Parker, and M.Th. van Genuchten, 1985, “Determining soil hydraulic properties from one-step outflow experiments by parameter estimation: I. Theory and numerical studies. Soil Sci. Soc. Am. J. 49:1348-1354.
6. Mohammad H. M.; Marnik V., 2011: “Predicting the Soil Moisture Characteristic Curve from Particle Size Distribution with a Simple Conceptual Model”, Vadose Zone Journal 10(2):594.
7. S. S. Rousseva, 1997 “Data transformation between soil texture classes” European Journal of Soil Science, December 1997, 48, 749-758
8. Van Genuchten, M. Th. 1980: “A closed-form equation for predicting the hydraulic conductivity of unsaturated soils”, Soil Sci. Soc. Am. J. 44:892-898.
9. Zdruli, P. 1997, “Benchmark Soils of Albania. – Soil and Site Characteristics”, p. 202.