



DESIGN A SOIL CLASSIFICATION TOOL USING PYTHON IN ARCGIS

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ABSTRACT

Background: Countries rely on taxonomic methods in knowing the type of soil, especially in agricultural countries, given the importance of this in obtaining high-quality agricultural products, and the optimal investment of existing groundwater wells, or for drilling new wells. **Methods:** through our research on soil classification methods, we found that an experiment the granular analysis and classification of the soil into its three components are sand, clay, and sand. One of the most important and most widespread methods used in the world is relying on the soil triangle. So we presented in this research a classification tool that relies on this triangle using the model building in the ArcGIS program and the Python programming language, to become a common tool for all researchers in this field. **Results:** This tool gives a classification of the soil according to the soil triangle, which is divided into 12 types of soil, by entering the data of soil boards consisting of the ratio of each of the sand, clay, and silt, using mathematical equations for projection and determining the type of soil directly on the classification triangle. **Conclusion:** The importance of this tool comes to all ArcGIS users in the world, as it provides an easy classification of the soil using a global classification, which is the soil triangle.

Keywords: Soil triangle, model builder, python.

1. INTRODUCTION

Soil texture refers to the proportion of sand, silt, and clay in a soil. Texture influences almost every aspect of soil use, both in agricultural and engineering applications, and even how natural ecosystems function. Many scientists consider soil texture the most important soil property as it can influence soil/water relationships, gas exchange, and plant nutrition. Accurately determining soil texture in a lab requires time and money. Therefore, it is often necessary to estimate soil texture in the field by feel, which can be very accurate if done correctly [1].

The three building blocks of soil—sand, silt, and clay—feel very different and lend different properties to a soil. Although the three types of soil particles are differentiated by their size (Table 1), which is a physical property, the relative amount of each of these components has a large influence on the physical, chemical, and biological properties of a soil. The pore spaces between soil particles are largely responsible for the amount of water a soil can hold. Finer soil textures have greater surface area, smaller soil pores, and slower water infiltration into the soil profile.

- Sand is the largest soil particle, measuring 0.05 to 2 mm in diameter, and can be seen by the naked eye. Sand feels gritty to the touch and holds very little water.
- Silt is the medium-sized component of soil, measuring 0.002 to 0.05 mm in diameter. Dry silt particles feel like flour or baby powder. When wet, silt will feel smooth. Silt only holds a moderate amount of water.
- Clay is the smallest particle in the soil, measuring less than 0.002 mm in diameter, and can only be seen with powerful microscopes [2, 3].

Table 1: The table presents the particle sizes for soil separates.

Soil Separate	Diameter (mm)
Clay	<0.002
Silt	0.002 to 0.05
Sand	0.05 to 2.0
Very fine sand	0.05 to 0.10
Fine sand	0.10 to 0.25
Medium sand	0.25 to 0.5
Coarse sand	0.5 to 1.0
Very coarse sand	1.0 to 2.0

The United States Department of Agriculture (USDA) soil texture triangle (Figure 1) is used to divide soils into 12 distinct classes based on their particle size distribution, or the relative amount of sand, silt, and clay in the soil. In the laboratory, we would first determine the relative amount of sand, silt, and clay particles in a soil sample as a percent of the sample's weight, follow the arrows from each side to where they intersect, and identify what texture class the soil belongs to. For example, if we determined that a soil had 30 percent sand, 40 percent silt, and 30 percent clay, it would be called a clay

loam. However, we can also estimate soil texture by feel fairly accurately with practice [3, 4]. However, we aimed to presented in this research a classification tool that relies on this triangle using the model building in the ArcGIS program and the Python programming language, to become a common tool for all researchers in this field.

2. MATERIALS AND METHODS

A soil classification tool depends on the classification of the soil based on the proportions of the three components: silt, sand and clay, using the Python programming language within the ARC GIS10.6 environment, after digitization represented the global soil as a SHAPE FILE layer, as this tool depends on equations (1), (2), (3), to drop any soil layer containing three express components and distribute it on the triangle to know the properties of this soil and its nomination coefficient.

The work was done according to several classification steps. The programming language shows what has been done to produce this tool:

```
# soil_tool_s.py
# Set the necessary product code
# Import arc info
# Import arcpy module
# Script arguments
# Local variables:
# Process: Add XY Coordinates
# Process: new y
# Process: Calculate new y
# Process: X1
# Process: Calculate X1
# Process: new x
# Process: Calculate new x
# Process: Make XY Event Layer
# Process: Make Feature Layer
# Process: End layer
# Process: Spatial Join
```

The principle of the coordinates of the soil triangle has taken the lower left corner of the triangle, which is the starting point for the percentage of clay and 100 percent for the sand.

After programming and testing this tool, Figure 1 shows the interface of the software tool intended for classification. This tool can classify any shape file bitmap into another bitmap placed on the soil triangle, which is a polygon layer in the ArcGIS environment.

2.1 Equation:

$$Y = ((\text{silt} + \text{sand} + \text{clay}) - (\text{silt} + \text{sand})) * \sin(60) \quad (1)$$

$$X1 = ((\text{silt} + \text{sand} + \text{clay}) - (\text{silt} + \text{sand})) * \cos(60) \quad (2)$$

$$X = (\text{silt} + \text{sand} + \text{clay}) - (X1 + \text{sand}) \quad (3)$$

3. RESULTS AND DISCUSSION

Using the soil texture triangle, scientists have created classes which break the distribution of particle sizes (soil textures) into 12 categories: clay, sandy clay, silty clay, sandy clay loam, clay loam, silty clay loam, sand, loamy sand, sandy loam, loam, silt loam, silt [4].

The soil texture triangle is one of the tools that soil scientists use to visualize and understand the meaning of soil texture names. The textural triangle is a diagram which shows how each of these 12 textures is classified based on the percent of sand, silt, and clay in each. Note: these percentages are based on the USDA definition of sand and silt only [4, 5].

Follow these steps to determine the textural class name of your soil sample:

- 1) Determine the percent sand of your sample and find that number on the bottom of the triangle. Note that the numbers read from right to left, not left to right. For example, if your sample is 65% sand, then you need to pick a point to the LEFT of the 60 mark.
- 2) Draw another line to correspond to the percent clay. Let's say you had 27% clay.
- 3) Where the lines intersect should also indicate percent silt. On the graph above, you can see that it is about 8% silt.
- 4) Wherever your lines intersect indicates the soil type you have. In this situation, with 65% sand, 27% clay, and 8% silt, it is sandy clay loam [6].

Hence the importance of this tool comes in terms of saving time in the projection on the soil triangle, and since most of the programmed sites for the soil triangle allow entry of only one point to know its classification, while our tool helps in entering a complete file with many infinite points and dropping it on the soil triangle, provided One that the raster layer contains three columns in its table are: sand, silt and clay are clearly and explicitly mentioned, so that the tool can process them and use the aforementioned equations and give us a new raster layer containing the classification and all the characteristics of the type of soil that the point occurred in.

This tool can classify any shape file bitmap into another bitmap placed on the soil triangle, which is a polygon layer in the ArcGIS environment, as shown in Figure 2.

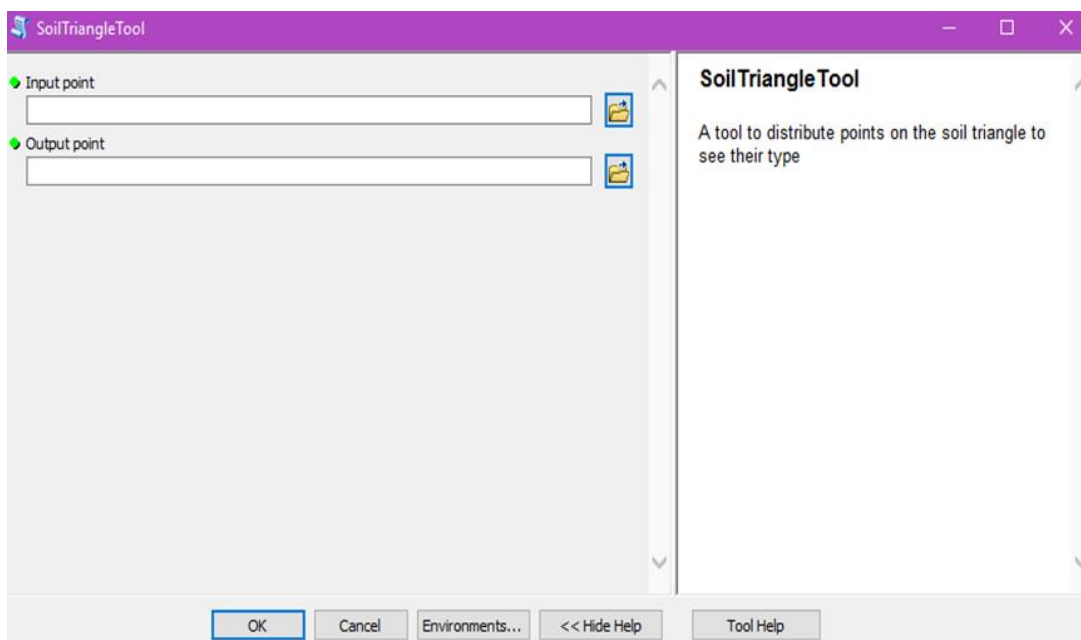


Figure 1: The figure present the Interface Of The Software Tool Intended For Classification.



Figure 2: The figure presents the points distributed on the soil triangle using the SOIL TRIANGLE TOOL software tool.

4. CONCLUSION

The importance of this tool comes to all ArcGIS users in the world, as it provides an easy classification of the soil using a global classification, which is the soil triangle.

Adoption of the classification tool according to the methodology used in the cluster, in order to generalize it to be used by all researchers in the field of water studies, and those interested in soil affairs.

5. REFERENCES

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