Water Content Influence to Electrical Properties From Soil Volcanic

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Abstract. The use of geophysical methods in agricultural studies requires a full understanding on the characters of soils, including the electrical properties. In turn, these properties might be affected by soil composition and mineralogy as well as the water content. In this study, models of volcanic soil were reconstructed using river sediments in the slope of a Bukit Tunggul, a mountain near Bandung, West Java, Indonesia. The sediments were sieved to obtain the component three textual components of soils, i.e., sand, silt, and clay. Furthermore, next compositions base on ternary diagram i.e., loam, sandy loam, silty loam, sandy clay loam and silty clay loam. These soil samples were then inundated and dried while their volumetric water content, electrical conductivity as well as dielectric constant were observed every 2 minutes using EM50 Data Logger. The results show that the water content was dissolved media for ions mineral soil and didn't major factors in controlling electrical properties.
Keywords: volcanic soil, water content, electrical conductivity, dielectric permittivity

INTRODUCTION

Soil as plant growth media have certain criteria to be categorized as a fertile land, where the fertile soil can improve the quality of agricultural production. The ability of geophysics to interpret in the subsurface in each region varies, depending on the characteristics including soil and water availability as the media portrayal of the subsurface. Interpretation in geophysics related to soil characteristics depend on the parameters of mineral deposits, the physical properties of soil texture, etc. Where the physical properties of soil texture dominated by the physical properties of sand, silt and clay (Heil and Schmidhalter, 2012).

In Indonesia there are several characteristics of the soil, but in this research is more emphasis to the volcanic soil on the slopes of Bukit Tunggul Mount where along Mount Tangkuban Perahu is part of an ancient Sunda Mountain is an active volcano. The research location in a mountainous area that has volcanic soil conditions caused by the fact that the population density in Indonesia once it is in the region of the volcano, caused by volcanic soils good for agriculture.

The ability of the soil to absorb water well is one of the characteristics of the volcanic soil and can be classed as a good planting medium. Water entering the soil has several uses, such as: media weathering of minerals in the soil, as a means of transportation and land evaporation, to maintain the carrying capacity of the land, and so on. Therefore it is important to know the water content in the soil that can be expressed in volumetric count.

Characteristics of groundwater and function of the permeability of the water content, is one of the parameters in the analysis of seepage water and predict the water pressure, which results in the characteristic curve of ground water which is the relationship between the suction force of the soil and the volumetric water content or saturation level (Ng and Pang, 2000), Based on volumetric water availability in each composition of soil texture then will be presented several parameters in electrical properties.

CONTENT AND METHOD

Content

Soil is a vital part of the plant to grow, as a medium to grow the components of minerals, organic matter, water and air must be provided in proportion of which 45% contain minerals, 5% organic matter, 25% water and 25% air, variations in the percentage of water and air depends on the season, soil type and soil depth. The formation of soils derived from volcanic deposits, has some special properties that are normally found on the parent material other material. Some of the unique nature of the volcanic soil is to have varying values, water storage capability and phosphates, has a low bulk density, soil aggregate stability is more stable. This special properties that help make a great contribution in the formation of materials including non-crystalline aluminum (Al) and the compound Fe (iron). Material non-crystalline together with the total organic material in the soil formation of ground volcanic material commonly called andosol in soil pedogenesis (Dahlgren et al, 2004).

The physical properties of the soil has close relationship with the parent material constituent, i.e. when the soil is predominantly clay materials are the parent derived from igneous rock base and sedimentary rocks that are easily weathered, soil texture quartz sand will still look bearish even though the land has been classified as old as it comes of minerals weathered difficult, finely textured soil produced from the parent material is finely textured and high water absorbent that is rich in organic matter. (Hanafi, 2005). The soil texture is said to be good if the combination of sand, silt and clay is almost balanced. Land is called clay. The finer the soil grains (each grain clay), the stronger the soil holds water and nutrients.

The water content plays an important role as a solvent, carrier ions and triggers reactions in the soil energy. The availability of water in the soil is generally varied, which depends on the texture of the soil. The water content of the clay soil textured has greater absorbent rate than silt and sand. This influence is related to the proportion of colloidal materials, space porous and surface of the absorbent, the finer texture of the soil, the greater the storage capacity of the water. To see the electrical properties of the soil volcanic there are some approaches that do such: volume water content, electrical conductivity and dielectric permittivity.

Volume water content (VWC) A value close to zero is very likely because it's difficult to fully remove water in the soil. On sandy soils, its highest value equal to the total porosity is also difficult to achieve because it's difficult to completely eliminate all air bubbles in the soil which has been saturated with perfect though. On one side, clay fraction expand when it's wet condition so the value could exceed the total value of porosity.

Soil Electrical conductivity (EC) is the physical properties of the soil used in standard measurements of soil conductance (the inverse of resistance) (Hartsock et al, 2000). Electrical conductivity is the ability of a material or substance to electrical current (Schmidhalter and Heil, 2012). The electrical conductivity is the total salt content on the water. The salt content in the water gives the ions are electrically charged causing the flow of electric current. The more ions contained in the water the greater conductivity of the electricity could generated.

Dielectric permittivity (DP) is a kind of electrical insulating material that can be polarized by placing the dielectric material into the electric field. When the material is located in an electric field, the contained of electrical charge will not flow, so the current does not arise. Soil Dielectric properties does not have a fixed value, but depends on several factors, such as frequency electric field, water content, density and others. Based on Sehah (2009), one of the factors that can alter the dielectric properties of the soil is the value of porosity, soil porosity which is generally filled by a fluid, such as air, gas, or water, so the value changes depending on the fluid that fills the porosity of the medium.

Method

The research location is in the region PTPN VIII Bukit Tunggul, samples were taken from river sediments that are 48 m from the slopes (MSL) Bukit tunggul Mountain with a height 1430 ft above sea level (Augustine et al, 2011).

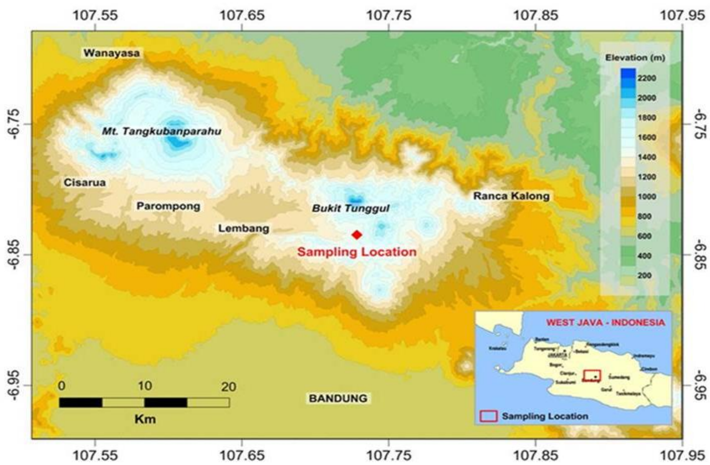

Figure 1 Map of research location at Bukit Tunggul Mountain

Samples were taken from river sediments Bukit Tunggul then performed in situ sample filtration process using a metal sieve to sort fractions of sand, silt and clay. Fraction of sand and silt was placed in a plastic container that is dried in the laboratory at room temperature 25 C° for 5-7 days. While the clay is placed in a plastic container then allowed to stand for 7 days until the particles separated from the water and the water evaporated. All samples were dried and then weighed mass, next dried again in oven at 105 C° temperature for 2 hours. Oven drying process is carried out in 3-4 times until the mass sample does not change anymore.

After getting the three basic size composition of the grain size of soil, then by ternary diagram in Figure 2.2 (Agus et al, 2006) made eight samples with the following composition: sand , silt, clay, loam, silty clay loam, silty loam, sandy clay loam and sandy loam. This eighth samples will be observed in dry condition and wet condition. Furthermore, for the analysis of the electrical properties samples used EM50 Data Logger that has two types of sensors, 5TE and EC-5.

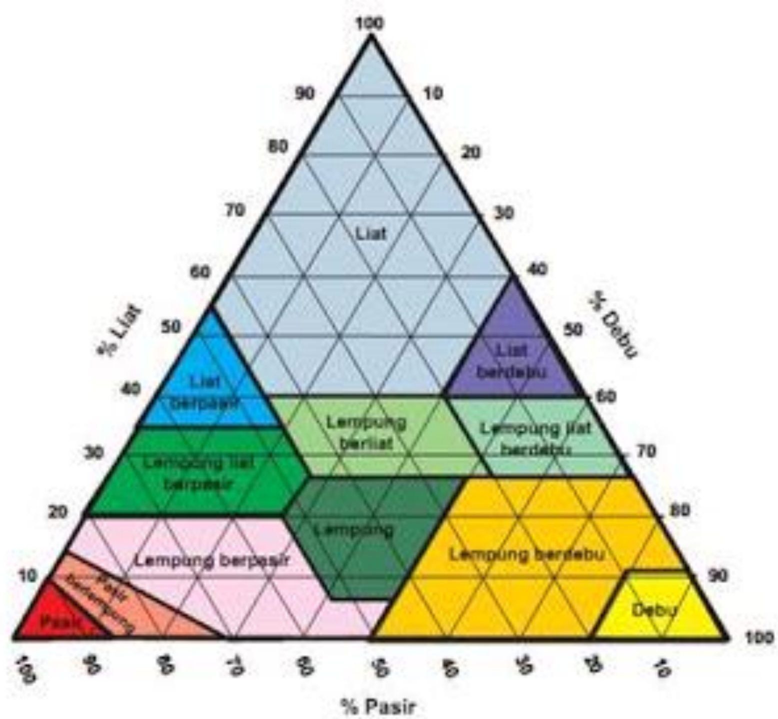

Figure 2 Ternary Diagram

The composition of the eight samples can be seen in the table below:

Table 1 8 Samples compotision based on Ternary diagram

No	Samples	Sand Content (%)	Silt Content (%)	Clay Content (%)
1	Sand	100	0	0
2	Silt	0	100	0
3	Clay	0	0	100
4	Loam	40	40	20
5	Sandy Loam	70	20	10
6	Silty Loam	20	60	20
7	Sandy Clay Loam	60	10	30
8	Silty Clay Loam	10	60	30

RESULTS AND DISCUSSION

Dry Condition

Table 3.1 Electrical properties of reconstruction soil in dry condition

No	Samples	Sand (%)	Silt (%)	Clay (%)	VWC (m^3/m^3)	EC (mS/cm)	DP
1	Sand	100	0	0	0.035	0.00	3.350
2	Silt	0	100	0	0.050	0.00	3.840
3	Clay	0	0	100	0.020	0.00	3.030
4	Loam	40	40	20	0.048	0.00	3.900
5	Sandy Loam	70	20	10	0.072	0.00	4.180
6	Silty Loam	20	60	20	0.053	0.00	3.840
7	Sandy Clay Loam	60	10	30	0.048	0.00	4.010
8	Silty Clay Loam	10	60	30	0.050	0.00	4.970

Wet Condition

Before measured the electrical properties sample in a wet condition, first measured value of the electrical properties of aquabidest: value of VWC 0,972 m3/m3, EC 0.00 mS / cm and value of DP 46.68. After measured, next step mixing with each dry samples, where the result is described as below,

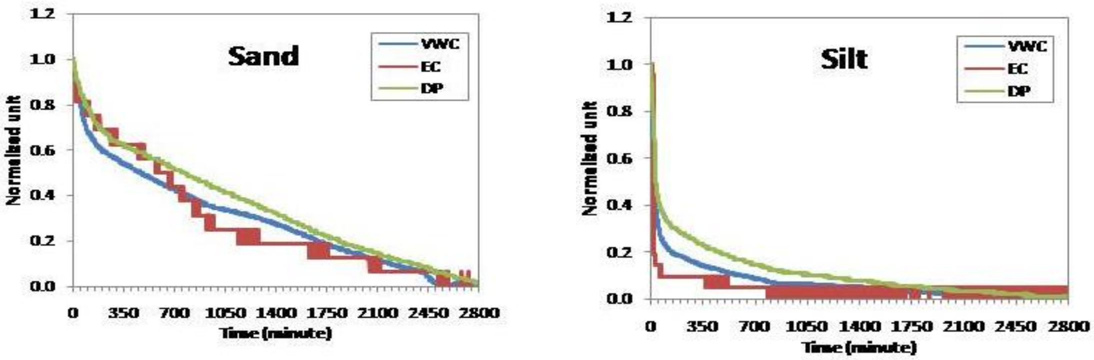

Figure 3 Reconstruction soil of sand and silt with compotition 100% sand and 100% silt

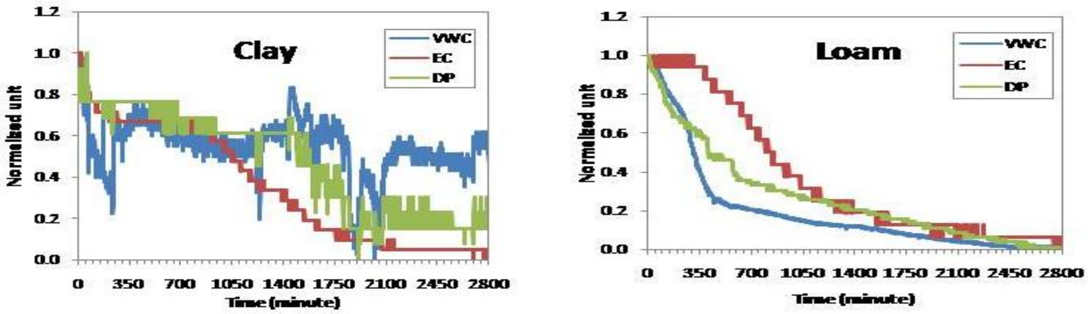

Figure 4 Reconstruction soil of clay and loam with composition 100% clay and for loam 40% sand, 40% silt and 20% clay

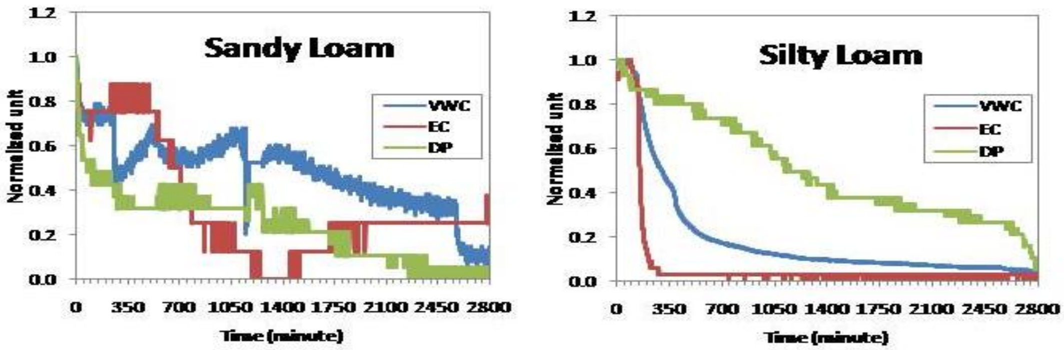

Figure 5 Reconstruction soil of sandy loam and silty loam with composition for sandy loam 70% sand, 20% silt and 10% clay, for silty loam the composition 20% sand, 70% silt and 10% clay

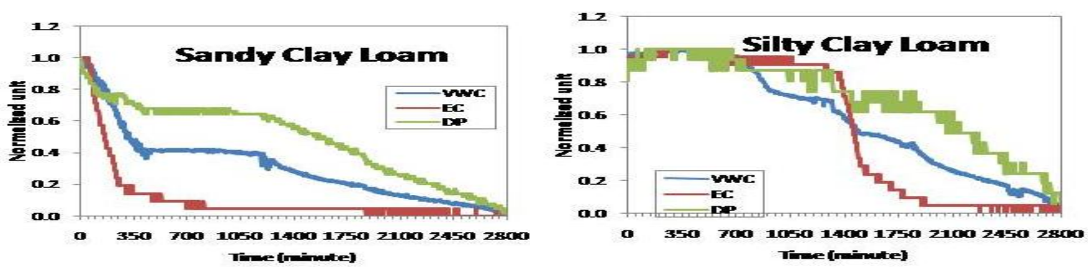

Figure 6 Reconstruction soil of sandy clay loam and silty clay loam with composition of sandy clay loam 60% sand, 10% silt and 20% clay, for silty clay loam the composition 10% sand, 60% silt and 20% clay

Discussion

Based on the results of measurements in both of dry and wet conditions appears that the composition of the soil is 45% mineral which a controller of the value of electricity, because aquabidest is the water mixing samples that has been distilled in two stages which can eliminated the carriers of free charge and the water salinity, so possibility of VWC controlling their electric current be a very small. This argument strengthens can be seen on the electrical properties in a dry condition, it appears that the EC value for each sample is zero it's the same for aquabidest, but in case of mixing or measuring in wet condition electrical properties it appears that each of the samples giving values vary according to the composition of the mix tends. Where in wet condition, the water content plays an important role as a solvent, a carrier ions and triggers reactions in the soil energy.

This anomaly can be answered by looking aquabidest DP value very high (46.68), where DP is the ability of a material polarized electric charges that have free charge. Although a material or substance has no free charge of carriers but these materials in wet conditions still pass current due to the influence of the total available water in the porous space. In this measurement the role of VWC is as a liaison to the minerals contained in each sample so that the samples measurement initially has a value of EC = 0 can have diverse values.

In each graph the results of a sample is obtained that the VWC as a reference value to the high value of DP, it's because the soil sample is a dielectric material is a kind of electrical insulating material that can be polarized by placing the dielectric material into the electric field. When the material is located in an electric field, the contained of electrical charge will not flow, so the flow does not arise. On one side aquabidest is the water that does not have a charge so that when a soil sample mixed with aquabidest the value of curve DP generated high or close to the value of the VWC, due to the interaction of soil samples with aquabidest not cause internal electric field internal (inside the dielectric material) could cause that the number of overall surrounding electric field decreases dielectric material.

Dielectric material can be classified based on the permittivity. Materials that do not have free charge carriers such as ions and electrons, appears still able to pass current when voltage is applied, meaning that the energy drawn from the voltage source to move charge where freight moving molecules bound to the material. Permittivity of a medium is described by how much the electric field can be generated in each part of the medium. Permittivity of the soil is largely influenced by the total water at room porous soil, because the permittivity of a solid matrix typically has a very low value for a wide range of frequencies. On the other hand the value of DP influence on the value of EC. Although the value of EC is relatively lower than the DP, which proves that not all free charge existing in the mineral sample produces an electric current.

From the data processing, the value of graph from electrical properties of clay a very volatile than the other main components, sand and silt. From the previous explanation value VWC declared contributed to the value of DP, it was explained that the volatile curve of clay VWC was caused by the water content of textured clay soil has a higher absorption than silt and sand. Moreover, the share of colloidal materials, as well as the surface area of the clay absorbent giving more ability to store water. The ability of clay soil is also caused by negatively charged clay particles able to pull water through a positive polar water molecules, the smaller size of 2mμ showed clay particles composed by 20,000 oxygen atoms so the clay fraction can be mixed or as a constituent of other fractions.

CONCLUSION

The water content of the electrical properties as the solvent acts for free charge medium in mineral soil samples and not as a determinant value of EC and DP. The research method to reconstruct volcanic soil samples good to explain the influence of water on the electrical properties at dry condition which value of EC = 0 but when wet EC value ≠ 0.

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