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# Study of Soil Development and Classification on the South Slope of Mount Pucung, Bumiaji Kodya Batu District

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**ABSTRACT**

The main objective of this research are: To study influence of slope position and slope level and also landuse system to the soil development that coming from volcanic ash materials of Mount Pucung and To study level of soil development in southern slope of Pucung Mountain. While the hypothesis is: Difference of slope position, slope level and heighth result to the existence of difference of soil development 2) Difference of landuse have an effect on reality to the soil development. This research is hired at Pucung Mountain toposekuen which consist of 4 observation soils profile at various solpe position that is P1 (Volcanic plain, flat-wavy, Lower Slope), P2 (Footslope, surging, Middle Slope), P3 (Foot Slope, hilly, Upper Slope) and P4 (Volcanic plain, flat, Top). This research through some step that is 1) survey preliminary phase 2) field survey phase which soil profile description, interview and take of soil sample 3) soil physics and soil chemistry laboratory analysis, and 4) Soil cassification phase come up with category of sub-grup pursuant to Soil Taxonomy USDA year 1999. Observation parameter are soil morphology that is forming of horison, colour, structure, to analyse the nature of physical that is texture, Bulk Density, Soil aggregate stability while soil chemistry pparameters is organic materials content, Base Saturation, CEC, percentage of Al ½ Fe, Soil Acidity and retention of P used as indicator of soil development. Result of from this research are 1) Level of soil development in southern slope of Pucung mountain influenced by topographic position, degree and also landuse management 2) Topography and difference of landuse management cause the differences of soil development of morphology, chemistry and physical soil characteristic so that cause change to arranging the name of soil classification and 3) Soil development at P1 and P2 with landuse of apple garden in lower and middle slope, classified as Aquic Eutrudepts and Andic Eutrudepts while at P3 classified as Typic Hapludands and for the P4 (Top) classified as Typic Melanudands.



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## 1. INTRODUCTION

Soil is a collection of natural objects on the earth's surface that are arranged in horizons, consisting of a mixture of mineral matter, organic matter, water and air, and is a medium for plant

growth (Hardjowigeno, 2003). According to (Joffe in Poerwowidodo, 1991) soil is a natural body differentiated into horizons of various depths, different from the parent material underneath in terms of morphology, physical, chemical properties, composition and biological characteristics. Soil which is formed from parent material and is influenced by climatic conditions, topography and organisms within a certain time will experience development. According to Munir (1985), soil development (pedogenesis) is a product of the activities of soil-forming factors in the form of parent material, climate, organisms, topography and time. These five factors are directly or simultaneously interrelated and influence in determining the nature of the soil formed. In studying pedogenesis where parent material, organisms, climate and time are considered to be relatively fixed, while topographical factors are variables, pedogenesis in such circumstances is called toposesequence.

Bulukerto Village, Bumiaji District, Batu Municipality is known to be an apple development center that has moderate regional capacity with relatively fertile soil. Most of the land is developed into an apple plantation area which has quite high potential if developed and is a source of income for most of the people in the research location, because it is able to absorb labor in agriculture.

The soil sequence in Bulukerto Village, Bumiaji District, Batu Municipality where the research was conducted is on the southern slope of Mount Pucung which is the lower slope of Mount Arjuno. This soil originates from the same parent material, namely volcanic ash, as a result of the influence of Mount Arjuno's activities, which then developed at the same time, with relatively the same climatic conditions. Topographical conditions vary between 900 meters to 1320 meters above sea level.

Based on the differences in topography as reflected by the slope and altitude of the place, it is necessary to know to what extent its role in soil pedogenesis originating from volcanic ash and the influence of land use at each altitude is related to the level of soil development.

According to Dharmawijaya (1990), different types of land use will likely result in different levels of soil development, and this factor may be directly dominant. Supported by the distribution of parent material and regional conditions with undulating to mountainous topography, for a certain period of time as well.

To get a general description of soil development or soil pedogenesis, in this case soil characteristics based on morphological, physical and chemical properties, a soil survey is required to classify soil types using the classification system issued by the USDA (Soil Survey Staff, 1998). It is hoped that the information on soil characteristics obtained can be used as a basis and reference in estimating land suitability evaluations.

## 2. METHOD

### 2.1 Place and time

This research was conducted on Mount Pucung in Bulukerto Village, Bumiaji District, Batu. The slopes of Mount Pucung stretch from the lower slopes to the upper slopes. Mount Pucung is the lower southern slope of Mount Arjuno. Soil analysis was carried out at the Laboratory of Soil Physics and Chemistry, Department of Soil, Faculty of Agriculture, University of Brawijaya Malang. This research was conducted in October 2005.

### 2.2 Tools and materials

The tools and materials used in the study were as follows: Administration Map (1 : 25,000), Geological Map (1 : 100,000), Shovel and soil drill, Munsell Soil Color Chart, Ring samples, spray bottles, Altimeter and Compass, Clinometer and meter and Balance.

### 2.3 Research Implementation

The procedure for carrying out the research activities carried out was divided into several stages, namely the pre-survey stage, the implementation of the land survey, the taking of soil samples, the soil analysis, the soil classification stage and the reporting stage.

## 3. RESULTS AND DISCUSSION

### 3.1 Research result

#### 3.1.1 Soil Development

**a. Pedon 1 (lower slope)**

Based on the results of the soil profile description and laboratory analysis, the soil on pedon 1 (lower slope) is classified as Aquic Eutrudepts. The cross section of the soil profile P1 is shown in Figure 1.

**Figure 1.** Cross-section of the Downslope Soil Profile

Aquic Eutrudepts on the downslope including the Inceptisol order are characterized by the presence of an ochric epipedon and a cambic horizon with a fine texture, having an uphill moisture regime and isothermic soil temperature regime, the percentage of base saturation (with NH4OAc) is 60% or higher (Figure 1) on one horizon or more than 25-75 cm below the mineral soil surface, has aquic conditions at most times of the normal year and redox depletion with chroma of 2 or less in one or more horizons within 60 centimeters of the mineral soil surface (Soil Survey Staff, 1998).

**b. Pedon 2 (Middle slope)**

Based on the results of the soil profile description and laboratory analysis, the soil on pedon 2 (middle slope) is classified as Andic Eutrudepts. A cross-section of the soil profile P2 is shown in Figure 2.

**Figure 2.** Cross-section of the Middle Slope Soil Profile

Andic Eutrudepts on the mid-slope are classified as Inceptisols having andic soil properties throughout or in one soil horizon with a total thickness of 18 cm at a depth of 75 cm from the mineral soil surface, with a bulk density of less than 1.0 gram/cm3 and percentages of Al and ½ Fe is greater than 1.0%, but does not meet the requirements for the P retention value of andisol 46,

which is greater than 85%, so it cannot be classified as an andisol soil. This soil is classified as an Inceptisol which has andic soil properties in the soil horizon.

**c. Pedon 3 (upper slope)**

Based on the results of the soil profile description and laboratory analysis, the soil on pedon 3 (lower slope) is classified as Typic Hapludands. A cross-section of the P3 soil profile is shown in Figure 3.

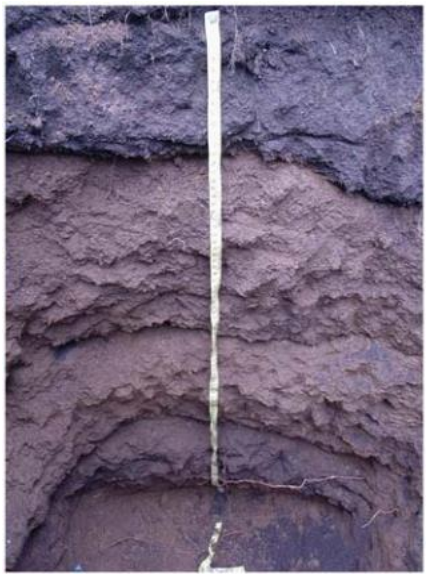

**Figure 3.**Cross-section of the Upper Slope Soil Profile

Typic Hapludands is a soil belonging to the Andisol order, because it fulfills the requirements for andic soil properties, namely in the fine soil fraction it has a bulk density of less than 0.85 gram/cm3, the percentage of Al and ½ Fe (with ammonium-oxalate) is more than 2.0 % and have phosphate retention of 85% or more (Figure 3). Andisols are other soils that have andic soil properties at 60 percent or more of the profile thickness (Soil Survey Staff, 1998).

**d. Pedon 4 (Peak)**

Based on the results of the soil profile description and laboratory analysis, the soil on pedon 1 (lower slope) is classified as Typic Melanudands. The cross-section of the soil profile P1 is shown in Figure 4.

**Figure 4**. P4 Peak Soil Profile Section

Typic Melanudands at the top is included in the Andisol order, because it fulfills the requirements for andic soil properties, namely in the fine-earth fraction it has a bulk density of less than 0.85 gram/cm3, the percentage of Al and ½ Fe (with ammonium-oxalate) is 2.0% or more and have phosphate retention of 85% or more (Soil Survey Staff, 1998). Typic Melanudands are Andisols that have a melanic epipedon because they meet the requirements to be categorized in a melanic epipedon, namely within 30 cm of the mineral soil surface with a cumulative thickness of 30 cm or more and have andic soil properties with a moist color value and chroma of 2 or less and organic matter content of 6 % or more as a weighted average (Soil Survey Staff, 1998), has a cambic horizon with a fine texture, has an udic moisture regime and isothermic soil temperature regime.

Schematically the level of development and naming of soil types at the study site is presented in Figure 5.

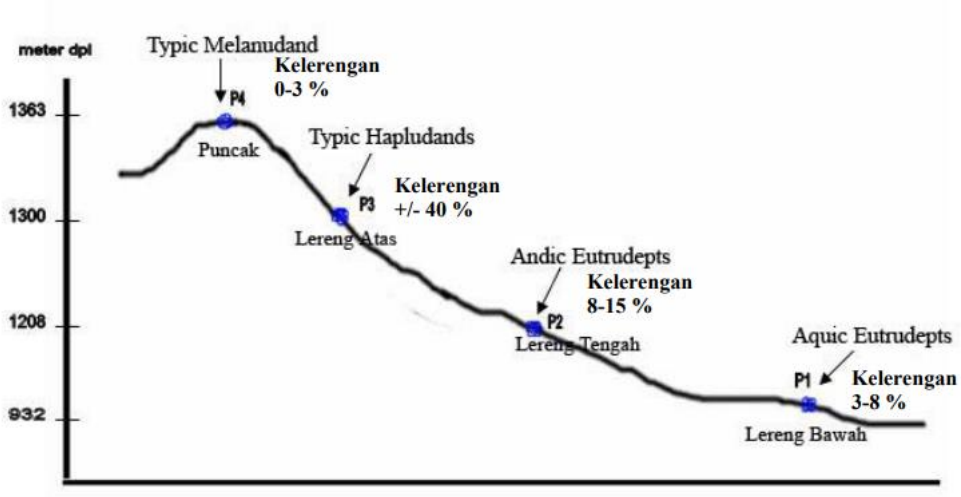


**Figure 5.** Cross-sectional description of Observational Soil Order Profile

### 3.1.2 The Effect of Topography on Soil Development

Topography as one of the main soil-forming factors has a very large influence in the process of soil formation and development. The influence of topography on soil development in the study area can be explained through a mechanism, namely what soil properties can be affected and changes in soil properties that occur in the field based on soil observations and laboratory analysis. The level of soil development that occurs can be seen from the morphological, physical and chemical development of the soil. The topography at the study site, in general, can be described as having a sloping topography with wavy slopes (3-8%) to hilly (±40%), so that on each slope a different soil development process occurs, supported by the influence of various factors. other soil builders.

In the peak area which has a rather flat or slightly convex topography (0-3%), the level of soil development is still low because as previously explained that the rather flat topography and dense land cover cause pedogenic processes in this case reduced surface runoff and weathering is slightly inhibited so that the soil structure is still not developed, namely it has a crumb structure in the surface layer.

In general, the steep slopes and relatively high rainfall in profile 3 are very influential in modifying the soil profile, the continuous removal of surface soil causes a thinner solum and if this occurs over a long period of time will result in the loss of the surface layer, besides The topography markedly influences the physical and chemical properties of the soil. Physically, in the soil profile, a finer soil texture is formed due to leaching of the accumulated clay in the layer below, namely an increase in the clay content in the B horizon and has a more stable structure. Chemically, there will be a change in the chemical composition as a result of more intensive washing.

In the observation of profile 2 on the middle slope with wavy to wavy topography (8-15%), morphological developments can be seen, namely there is an ochric epipedon formed due to material deposits transported by surface runoff from the slope above it and the practice of clearing land into apple orchards which is managed for a sufficiently long period of time causes the soil color to become lighter in the upper layer, so that it does not meet the criteria for other epipedons.

In addition, horizon differentiation is formed, namely the existence of lithological discontinuities which indicate the presence of deposited material from the slope above with indications of contrasting textural changes (Soil Survey Staff, 1998), so that horizons 2A and 2AB are formed below the B1 horizon.

From the observation of the soil profile on the downslope (P1), the soil has reached a further development stage compared to other observation points. This is due to the lower position which is an area that is piled up by erosion from the slope above it or an area where deposits of material are transported due to soil erosion by water.

### 3.1.3 Effect of Land Use on Soil Development

At the research location, soil management practices including tillage practices carried out by the community (farmers) have a real influence on modifying soil properties, both morphologically, physically and chemically formed. So that in general it can affect nomenclature in land classification.

At the profile 4 observation point (P4) where the land use is agroforestry with the main crops being pine, acacia, cypress, grasses and shrubs, soil development that occurs at the observation point can be said to be still proceeding naturally, meaning that human influence in the formation and soil development is still minimal. Morphologically, the soil development process that occurs is the surface layer which is identified as a dark melanic epipedon 10 YR 2/2, from the thickness it meets the criteria for a melanic epipedon and has andic soil properties in its layers so that it can be classified in the Andisol order.

Land use at the profile 3 observation point (upper slope) has a significant influence on the development of the soil that occurs, this can be identified from the morphological changes in the observed soil profile, namely the thinning of the surface layer of the soil, due to land clearing into an agroforestry-based agricultural system. with corn and vegetable crops.

The morphological and physical characteristics of the visible soil development are the top soil layer identified as the ochric epipedon, because it does not meet the criteria for mollic, umbric, melanic epipedons and argillic horizons in terms of color and thickness (Soil Survey Staff, 1998), the formation of clump soil structures rounded with a more stable level of structural development, fine soil texture i.e. dusty loam to loam with the color of the soil matrix in the lighter surface layer which is dark yellowish brown (10 YR 3/4) and in the lower layer it is known as the cambic horizon. Low unit weight values range from 0.79 gram/cm3 to 0.83 gram/cm3 , and the percentage of Al + 1/2 Fe which is more than 1.0 % indicates the presence of allophane clay minerals and has andic soil properties in each horizon. the land.

The visible morphological changes are the topsoil which is identified as the okhric epipedon because it does not meet the other epipedon criteria because the soil color value is too high and the formation of a rounded lumpy soil structure on the entire horizon with a steady level of structural development, this is an indication of the effect of breaking and breaking. soil aggregates, especially in the surface layer due to tillage treatment. The presence of Fe rust on the bottom layer indicates poor drainage conditions based on the physiography of the observation site.

## 3.2 Discussion

From the analysis of physical properties it is known that Aquic Eutrudepts has a globular lump structure with a loose to firm consistency, in the soil matrix there are reductionmorphic symptoms which are characterized by the presence of Fe rust, rock distribution in each horizon and the appearance of rock weathering.

Pedon 2 was identified as having an ochric epipedon and a cambic horizon with a fine texture, an updic soil moisture regime and an isothermic soil temperature regime, a base saturation percentage (with NH4OAc) of 60% or higher in one or more horizons between a depth of 25-75 cm from the mineral soil surface. . It has a rounded lumpy structure with a loose to firm consistency, with rusty patches of 10 to 20% Fe in the soil matrix.

Typic Hapludands is a soil that has an ochric epipedon because it does not meet the thickness for the mollic, umbric and melanic epipedons. It has a cambic horizon with a fine texture, an uphill moisture regime and an isothermic soil temperature regime. Has a crumb structure to a rounded lump on the soil horizon.

In general, soil organic matter gives the soil a dark color, meaning that if the original soil is yellow or light brown, the organic matter content causes the color to tend towards dark brown. The more stable the organic matter, the darker the color and the stable black humus (Dharmawijaya, 1997).

At the observation point of profile 3 (upper slope), although in general it has almost the same characteristics and properties as the soil in profile 4, the topographical factors have a very large influence on the morphological characteristics of the soil, seen from the thinning of the surface layer that occurs due to surface runoff which eventually becomes soil material. transported will be deposited to the lower slope. Fine materials are deposited farther or vice versa due to sediment movement which is influenced by the aspect of the slope itself (Renard, 2002). With a relatively steep slope, it will increase the sensitivity of the soil to the effects of erosion caused by rainwater.

Changes in the physical properties of the soil, namely the formation of a rounded lumpy structure with a more stable level of soil structure development and having a finer texture on the soil horizon and there are symptoms of redoximorphic concentrations which are characterized by the presence of rusty Fe scattered in the soil matrix ± 10-20%, so that it is identified as cambic horizon because it does not meet the requirements for argillic, natric and kandic horizons (Soil Survey Staff, 1998).

A lower topographical position causes an increase in air temperature and soil temperature, thus the mineral weathering process and clay leaching process occur more quickly resulting in an increase in the soil unit weight value which is also affected by a decrease in the amorphous and organic matter content of the soil. The soil unit weight values ranged from 1.09-1.24 gram/cm3 causing the soil at this observation point to not meet the criteria for andic soil properties which are the main requirement for being classified into the Andisol order. The soil classification on this pedon is identified as Aquic Eutrudepts.

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## 4. CONCLUSION

From the results of the analysis and discussion carried out, it can be concluded from this study that: The level of soil development on the southern slopes of Mount Pucung is influenced by topographical position, degree of slope and land use patterns. Topography and differences in land use lead to different levels of development of morphological, physical and chemical properties, causing changes to the nomenclature of soil classification. Soil development at P1 and P2 with the use of apple orchards on the lower and middle slopes was classified as Aquic Eutrudepts and Andic Eutrudepts while at P3 it was classified as Typic Hapludands and for P4 (peak) it was classified as Typic Melanudands.

## ACKNOWLEDGEMENTS

The suggestions given in this study are: The soil management system at the study site should pay attention to soil conservation rules so that it does not cause land degradation 2. There is a need for further research related to soil conservation efforts at the study site, especially those relating to Andisol soil with its allophophane mineral composition.

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