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Analysis of soil-forming factors and soil classification using soil taxonomy system: A case study of Baraka District, Enrekang Regency

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Abstract. The difference in the soil-forming factors can affect the nature of the soil formed. The method was used in this research is quantitative descriptive based on primary and secondary data. The field survey was conducted using the random stratified method at 15 soil profile divided into four north-south transects. The determination of soil characteristics value were adjusted by the Soil Survey Laboratory Manual method, while the determination of dominant soil minerals used the Fourier Transform Infra-Red (FTIR). Determination of soil type used the soil taxonomy system, which refers to the 12th edition of the soil taxonomy key book. The results of the study showed that there are two soil orders in the Baraka district, Enrekang Regency that is Alfisols and Inceptisols. Alfisols was found in the six soil profile that classified as Typic Paleustalfs (subgroup) mixed family of Isohypethemic Typic Paleustalfs, Kaolinitic with Isohypethemic Typic Paleustalfs, while Inceptisol was found in the nine soil profile that classified as Lithic Haplustepts, Dystic Haplustepts, Typic Dystrudepts and on the family category that is clay mixture Isohypethemic Typic Dystrustepts, clay mixture Isohypethemic Dystric Haplustepts, clay mixture Isohypethemic Lithic Haplustepts, Carbonatic compound Isohypethemic Dystric Haplustepts. The results of this research also indicate that the dominant soil-forming factors in the Baraka District, Enrekang Regency are the parent material, vegetation, and slopes.

1. Introduction

One of the districts that contribute to the agriculture sector in the Enrekang Regency is Baraka District. Based on the Enrekang Regency Spatial Plan for 2011-2031, Baraka District has been designated as coffee plantation areas and a horticultural cultivation area. Therefore, it can be said that the Baraka district has great potential in agriculture [1].

The land is a non-renewable natural resource, so knowledge about the physical, chemical, and biological properties of soil is needed because each soil has different levels of fertility, and the ability to support the growth of plants on it also varies [2]. In addition to physical, chemical, and biological soil factors, there are differences in soil-forming factors, which also greatly influence soil characteristics such as differences of time, parent material, climate, and topography. Topography is very influential on pedogenesis and soil characteristics that are formed so that each location has different soil characteristics. In every land, there are both basic and general differences. If the soil is different then diversity will also be different, whereas the same soil has the same characteristics [3]. Other factors are chemical composition, physical properties, and surface properties [4].

The different soil characteristics cause the level of soil fertility in each soil type also different, so it is very important to classify the soil to get knowledge about the characteristics of soil properties. Generally, the level of soil information that we often encounter on Land System RePPot maps (1989) scale of 1:250,000 that only at the great group level, such as Dystropepts, Humitropepts, and Tropohumults but there is no limit on the distribution of soil types. So it is necessary to make a map of the soil types with a more detailed scale.

On the several classification systems to determine the type of soil that develops in the world, one of which commonly used is the Soil Taxonomy by the United States Department of Agriculture (USDA). The "Soil Taxonomy" system is a soil classification system was developed by world soil science experts with comprehensively, systematically, and used a morphometric (quantitative) approach, this system demands data complete with standard analytical methods [5].

The Soil Taxonomy classification system by the United States Department of Agriculture (USDA) has advantages, that is in terms of naming or nomenclature, definitions of character horizon, and several other traits used to determine soil type [6].

2. Methods

Soil sampling was conducted based on the land units where the determination of profile points based on a straight line (transect). Four transects that will represent the research location, so that the number of observation profile points is 15 soil profile. The first transect line with three soil profiles, the second transect line with five soil profiles, the third transect line with four soil profiles, and the fourth transect line with three soil profiles.

3. Results and discussion

In the process of soil formation, soil-forming factors such as parent material, topography, climate, organisms, and time do not work alone but work together to produce soil. In general, the soil body can be seen as a dynamic medium. In certain condition, one or more soil-forming factors can be more dominant than other factors, so that the properties of the soil that is formed become heterogeneous [7].

Soil types were found in Baraka district, Enrekang regency are Inceptisol and Alfisol, from 15 soil profiles, Inceptisol in the nine profiles and Alfisol in the six profiles. Inceptisol soil types consist of the Dystric Haplustepts, Typic Dystrudepts, and Lithic Haplustepts subgroups, while Alfisol consists of Typic Paleustalfs (table 1 and 2).

3.1. Inceptisols

3.1.1. Dystric Haplustepts. Soil type was found in profiles (3, 6, 11, 12 and 14) with the Bukit Balang (BBG) land system and the parent material limestone silt and limestone sandstone. Slope ranges from 15-35% (profiles 3, 6, 11) and 35-45% (profiles 12 and 14) at an altitude 800-1200 masl. Soil-forming factors were dominated by climate that is moderate rainfall ±1,325 mm/year. Moderate rainfall and land use that inhibits leaching in this profile, which causes slow soil development shown by increasing clay from horizon A to B but not including horizon E.

3.1.2. Typic Dystrudepts. Soil type was found in the profiles (5 and 10) with the Bukit Balang (BBG) land system and the parent material limestone silt, limestone sandstone, reef limestone, quartz sandstone and conglomerates on the slope of 8-15% (profile 5) and 15-35% (profile 10) at an altitude of 800-1,000 masl. Typic Dystrudepts have a characterization that is not much different from the type of soil Haplustepts, and the difference is only in the type of mineral. In the Typical Dystrudepts, do not find carbonate minerals at each horizon.

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3.1.3. Lithic Haplustepts. Soil type was found in the profiles (2 and 9) in the Bukit Balang (BBG) and high cliff (TTG) land systems, with the parent material limestone, limestone sandstone (profile 2) and siltstone, filite, ake, quartzite, limestone, siltstone (profile 9). Slope ranges from 15-35% (profile 2) and 35-45% (profile 9) at an altitude 980-1,350 masl. The formation of the soil was influenced by climate factors (rainfall) and the slope. The moderate rainfall is affecting soil development, where soil washing not intensive and slope classified as steep, causes shallow solum, which was indicated by the presence of lithic contact in the profile so that this soil type was classified into Lithic Haplustepts.

3.2. Alfisols

3.2.1. Typic Paleustalfs. Soil type was found in the profiles (1, 4, 7, 8, 13, and 15) with the Bukit Balang (BBG) and high cliff (TTG) land systems. The parent material limestone silt, limestone sand (profiles 1, 4 and 7), reef limestone, conglomerate quartz, sandstone (profiles 8, 13) and slate, filit, wake, quartzite, limestone, siltstone (profile 15). Slope ranges from 8-15% (profiles 4, 7, and 8), and 15-45% (profiles 1, 13 and 15), with an altitude 600-1,700 masl. This soil type has an argillic horizon, where there is an increase in clay from horizon A to B. The presence of clay accumulation was caused by moderate rainfall, so this type of soil is classified into Typic Paleustalfs.

Table 1. Soil type and formation factor

Profile	Land system	Parent material	Slope (%)	Topography (mas)	Land Use	Type of soil	Family
1	BBG (Bukit Balang)	Limestone silt and limestone sandstone	34-45 %	980	Shrubs	Typic paleustalfs	Mix, clay, isohyperthermik, Typic Paleustals
2	BBG (Bukit Balang)	Limestone silt and limestone sandstone	15-35 %	980	Dryland	Lithic Haplustepts	Mix, clay, isohyperthermik, Lithic Haplustepts
3	BBG (Bukit Balang)	Limestone reefs	15-35%	980	Dryland	Dystric haplustepts	Mix, clay, isohyperthermik, Dystric Haplustepts
4	BBG (Bukit Balang)	Limestone reefs and conglomerate quartz sandstone	15-35 %	1,100	Shrubs	Typic paleustalfs	Mix, clay, isohyperthermik, Typic Paleustals
5	BBG (Bukit Balang)	Limestone silt and limestone sandstone	8-15 %	800	Plantation	typic dystrustepts	Mix, clay, isohyperthermik, Typic Dystrustepts
6	BBG (Bukit Balang)	Limestone silt and limestone sandstone	15-35 %	800	Plantation	Dystric haplustepts	Carbonatik, clay, isohyperthermik, Dystric Haplustepts
7	BBG (Bukit Balang)	Limestone silt and limestone sandstone	8- 15 %	600	Plantation	Typic paleusatalfs	Kaolinite, clay, isohyperthermik, Typic Paleustalfs
8	BBG (Bukit Balang)	Limestone reefs and conglomerate quartz sandstone	8- 15 %	600	Plantation	Typic paleustalfs	Mix, clay, isohyperthermik, Typic Paleustalfs

Table 2. Soil type and formation factor.

Profile	Land system	Parent material	Slope (%)	Topography (masl)	Land Use	Type of soil	Family
9	TTG (Tebing Tinggi)	Slatestone, Filit wake, quartzite, limestone, siltstone	35- 45 %	1,350	Plantation	Lithic Haplustepts	Mix, clays, isohyperthermik, Lithic Haplustepts
10	BBG (Bukit Balang)	Limestone reefs and conglomerate quartz sandstone	15- 35 %	1,000	Plantation	Typic Dystrustepts	Mix, clay, isohyperthermik, Typic Dystrustepts
11	BBG (Bukit Balang)	Limestone reefs and conglomerate quartz sandstone	15- 35 %	950	Rain fed paddy field	Dystric Haplustepts	Mix, clay, isohyperthermik, Dystric Haplustepts
12	BBG (Bukit Balang)	Limestone reefs and conglomerate quartz sandstone	35- 45 %	1,000	Plantation	Dystric Haplustepts	Mix, clay, isohyperthermik, Dystric Haplustepts
13	TTG (Tebing Tinggi)	Limestone reefs and conglomerate quartz sandstone	35-45 %	1,300	Shrubs	Typic Paleustalfs	Mix, clay, isohyperthermik, Typic Paleustalfs
14	BBG (Bukit Balang)	Limestone reefs and conglomerate quartz sandstone	35- 45 %	1,200	Plantation	Dystric haplustepts	Mix, clay, isohyperthermik, Dystric Haplustepts
15	TTG (Tebing Tinggi)	Slatestone, Filit wake, quartzite, limestone, siltstone	35- 45 %	1,700	Forest	Typic paleustalfs	Mix, clay, isohyperthermik, Typic Paleustals

4. Conclusion

The soil characteristics of the Baraka District, Enrekang Regency, have a slightly acidic pH value, the CEC value is relatively high, with relatively low rainfall and were dominated by carbonate minerals. Depth of the solum from shallow to deep, with a slope ranging from 3% -45% at an altitude of 600-1,700 masl.

There are two main soil orders found that are Inceptisols and Alfisol, and four types of soil (subgroups), such as Typic dystrudepts, Dystric haplustepts, Lithic haplustepts, and Typic paleustalfs. Soil-forming factors of Alfisol were influenced mainly by vegetation (shrubs that are classified as dense) and parent material (dominant silt and lime), while for Inceptisol were influenced by parent material (dominant sandstone).

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