Characteristics of melanic epipedon based on biosequence in the physiography of Marapi - Singgalang, West Sumatra

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Abstract. This research aim to express descriptively melanic epipedon based on biosequence middle bevel physiography of Marapi-Singgalang mount representing Upper watershed area from Batang Anai watershed. The sample determined by Stratified Random Sampling at each biosequence. From result of research obtained by difference of melanic epipedon of Marapi mont characteristic with melanic epipedon of Singgalang mount characteristic, so that for the farm in the middle bevel of Singgalang need the existence of land conservation action, passing reboisasi program, utilize to improve again land that function as buffer zone in Batang Anai watershed.

1. Introduction
The soil is the result of natural weathering of rocks or organic (vegetation and animals). The characteristic of the soil comes from the climate and rock material in certain topography condition for a certain period of time. Bedrock, topography and time are the passive factors, while climate and organism are the active factors of the soil forming [1,2,3, 4,5] adds soil that forms on the surface of the earth directly or indirectly develops from rock minerals. Through the weathering process, both physically and chemically and aided by the influence of the atmosphere (rainfall and temperature), the rock disintegrates produce loose parent materials, and subsequently under the effect of pedogenic processes develop into the soil. Soil that forms in the tropics with conditions of rainfall and relatively high temperatures each year would make the process faster. The effect of climate, especially rainfall and temperature, on the development of soil profiles is very large. Climate affects weathering and soil development processes. Indirectly rainfall affects the chemical characteristics of the soil [6,7,8].

According to [9] the effect of vegetation, soil organism, animals and human also very large for soil development. the role of human (farmer), especially in the rural areas are very diverse vertically characterized by the formation of the horizons. The soil horizon is the soil layer due to the process of soil formation. This is the difference of the soil horizon i.e: 1) O-Horizon, is a horizon on the surface of the soil due to the weathering of organic material; 2) A-Horizon is the horizon formed below horizon O which is characterized by the percentage of sand is more dominant than the percentage of dust and clay; 3) B-Horizon, is the horizon below the A-Horizon which is characterized by the percentage of clay is more dominant than the percentage of sand and dust; and 4) C-Horizon, is the lowest horizon and above the R-Horizon (bedrock) which is characterized by the loose rock. While according to [9,10], the entirety of A-Horizon and half of B-horizon will form epipedon. Epipedon is an identifier for the soil classification which formed in topsoil. In the wet tropic areas, epipedon
formed on Andisols soil, that is soil formed from volcanic ash, is melanic epipedon. Epipedon is characterized by relatively high C-organic and N-content, base saturation <50%, value and chroma 2 or smaller, melanic index <1.70, and thickness 30 - 40 cm from ground level.

Furthermore, [11, 12] explain that the characteristic of melanic epipedon can change or having degradation due to rainfall, vegetation, microorganism, animals and human. The relatively high rainfall every year causes the leaching process of A-Horizon because of infiltration, so the elements K⁺, Na⁺, Ca²⁺, Mg²⁺, organics, clay and another characteristic of melanic epipedon disappear and accumulate on B-horizon. Other than that, the effect of vegetation, microorganism and animals also very large to the characteristic of melanic epipedon. The vegetation, microorganisms, and animals that live in it (biosequence) will give different effects on the characteristic of melanic epipedon and other biosequences. Forest biosequence and bush which hasn’t been disturbed by human activities in Andisols soils tend to form melanic epipedon. According to [13,14,15,16,17], this epipedon identified by the high organic material in the soil. This epipedon will have the degradation process and developing into Umbria epipedon, plan epipedon, or anthropic if the forest changed into agriculture area. As a result, the soil will have a low resistance due to run off.

The physiographic region of the middle slope of a young volcano in the western part of Marapi and the physiographic region of the middle slope of the volcanic mountain east of Singgalang has relatively the same biosequence. This area is located in Tanah Datar Regency, which is the upper watershed of the Batang Anai watershed which is very vulnerable to land crises. Identification of melanic epipedon and differences in melanic epipedon in biosequence of forest and bush on Mount of Marapi and Singgalang will provide recommendations for land reclamation and conservation as a result. So, the damage to land in the upper Batang Anai watershed can be minimal and the capacity of the land can be sustainably. Therefore, the characteristics of melanic epipedon will not be degraded and in accordance with the specified criteria, so that the function of the area as a buffer zone in the Batang Anai watershed will be optimal.

2. Research Methods
This research was using descriptive survey method, based on biosequence. Determination and sampling are done by Stratified Random Sampling and biosequence are considered to be the strata. In the research location Marapi mount, 2 observation points were determined, on natural forest land (Ht) and scrubland (sm), as well as the research location on Mount Singgalang. Soil analysis (observed parameters) and the methods used are: 1) analysis of soil C-organic with the Walkley and Black method; (2) analysis of N-total soil by the Kjeldahl method; 3) base cations can be exchanged (Caddy), Mgdd, Kdd, Nadd− with extraction method NH4Oac 1N pH 7; 4) KTK total using NH4Oac 1N washing method pH 7; 5) P2O5 extracted by 1% citric acid solution method; 6) melanic index by Honna method; 7) P retention with the Blackmore method; 8) pH (H2O and KCl) with glass electrode method; 9) NaF pH with combination electrode method; 10) soil texture analysis (3 fractions) with pipette method; and 11) BV using the graphimetry method.

3. Results and Discussion
The results of observations on soil morphology in the form of observations of colours, genetic horizons, thickness, structure and consistency soil layers can be seen in Table 1.
Table 1. Nature of morphology of soil research location

| Physiography | Biosequence | Genetic horizon | Thick (cm) | Soil color | Soil structure | Consistency | Horizon limit |
|--------------|-------------|-----------------|------------|------------|----------------|-------------|---------------|
| forest I     | Ap          | 0-24            | 10 YR 2/2  | crumb      | free           | average     |               |
|              | AB          | 24-55           | 10 YR 3/4  | crumb      | loose          | gradually   |               |
|              | B1          | 55-67           | 7.5 YR     | glob       | loose          | gradually   |               |
|              | BW          | 67-88           | 10 YR 5/6  | glob       | somewhat       | ---         | 4/4           |
|              | 2Bl         | >88             | 7.5 YR     | firm       |               | ----        |               |
|              |             |                 |            |            |                |             |               |
|              | Oa          | 0-2             | 10 YR 2/2  | crumb      | free           | average     |               |
|              | A2          | 2-52            | 7.5 YR     | crumb      | loose          | gradually   |               |
|              | B1          | 52-85           | 7.5 YR     | glob       | somewhat       | flat        |               |
|              | B2          | 85-98           | 7.5 YR     | grain      | somewhat       | average     |               |
|              | BC          | >98             | 7.5 YR     | firm       |               | ----        | free          |
|              |             |                 |            |            |                |             |               |
|              | Ap          | 0-36            | 10 YR 2/2  | crumb      | free           | average     |               |
|              | AB          | 36-69           | 10 YR 3/4  | crumb      | loose          | gradually   |               |
|              | B1          | 69-98           | 7.5 YR     | glob       | somewhat       | average     |               |
|              | B2          | 98-120          | 7.5 YR     | firm       |               | ----        | 4/4           |
|              | BC          | >120            | 7.5 YR     | firm       |               |             |               |
|              |             |                 |            |            |                |             |               |
|              | Oa          | 0-3             | 10 YR 2/2  | crumb      | free           | average     |               |
|              | A1          | 3-24            | 10 YR 2/2  | crumb      | loose          | average     |               |
|              | B1          | 7-24            | 3/4 YR     | glob       | somewhat       | gradually   |               |
|              | B2          | 79-103          | 7.5 YR     | glob       | firm           | ----        |               |
|              | BC          | >103            | 7.5 YR     | firm       |               | ----        | 3/4           |

Note: 1. Physiography of Singgalang's Old Middle Volcanic Slope
2. Physiography of the Western Volcanic Middle Slope of Western Marapi
KP. Profile Code

According to Table 1 above morphology characteristics on biosequence of forest and bush both at the Marapi-Singgalang mount still characterize andisols soil properties, the properties of soil that characterize Andisols soil, the soil color is generally black (2-5 and chroma 1-6), crumb soil structure and the consistency of the soil is generally loose. These also characterize the characteristics of melanic epipedon. The results of the analysis of the physical characteristics of the soil for supporting the identification of melanic epipedon can be seen in Table 2.
Based on Table 2, the observed soil profile has BV values that meet the requirements of the soil properties andik (Andisols soil characteristics), which has BV <0.85 g/cm³. One of the condition of melanic epipedon is part of the A-Horizon and B-Horizon, as well as the overall A-Horizon and B-Horizon, or the entire horizon has Andik soil properties [17,18,19]. BV values ranging from 0.58-0.83 g/cm³ also specify the Melanic epipedon. In profiles I and II on Singgalang physiography (Table 2), the sand fraction is more dominant than the dust fraction and clay fraction, this indicates that the land has undergone an intensive horizontal and vertical washing process. In profiles III and IV in Marapi physiography (Table 2), the dust fraction was more dominant than the sand and clay fractions, so the characteristics of the melanic epipedon in Marapi mount were thicker than the epipedon characteristics of melanic epipedon on Singgalang physiography. In addition to the physical properties and identification of soil morphology, analysis of soil chemical properties is also needed for identification of melanic epipedon characteristics at the research location. The results of the analysis of soil chemical properties can be seen in Table 3 below.

Table 3. Results of analysis of chemical characteristics of soil properties of melanic epipedon

| Biosequence | Genetic Horizon | Thick (cm) | pH Soil | C-Organik | N-total | P2O5 ppm | Kation Basa | Kej-Basa % | KTK me/100g |
|-------------|-----------------|------------|---------|-----------|---------|----------|-------------|------------|-------------|
| Forest I    | B1              | 55-67      | 5,89    | 5,34      | 11,48   | 2,09     | 0,33        | 134,5      | 0,01        | 0,18        | 0,11  |
| AB          | 24-55           | 5,47      | 4,82    | 11,61     | 4,68    | 0,48     | 113,7       | 1,16       | 0,14        | 5,39        | 1,22  |
| B2          | 85-98           | 49,05     | 9,05    | 17,72     | 33,21   | 0,36     | 29,98       | 52,64      | 0,61        | 15,51       | 0,70  |
| BC          | >98             | 31,07     | 36,88   | 31,28     | 0,30    | 3,55     | 1,14        | 11,01      | 32,1        | 0,14        | 1,53  |
| Ap          | 0-24            | 49,09     | 12,48   | 38,77     | Sandy sand | 0,74   |
| AB          | 24-55           | 31,11     | 37,55   | 30,25     | Clay     | 0,77     |
| B2          | 85-98           | 49,05     | 41,07   | 34,98     | Clay     | 0,73     |
| BC          | >98             | 31,07     | 28,87   | Sandstone | 0,69     |
| A2          | 2-52            | 49,99     | 48,05   | 3,52      | 0,79     |
| bush II     | B1              | 52-85      | 33,21   | 22,92     | 43,12    | 0,81     |
| B2          | 85-98           | 49,05     | 17,72   | 33,21     | Sandy Clay | 0,83    |
| BC          | >98             | 31,07     | 28,87   | Clay      | 0,75     |
| Oa          | 2-52            | 49,99     | 52,64   | Clay      | 0,70     |
| AB          | 36-69           | 23,51     | 56,09   | 18,36     | Clay     | 0,78     |
| B2          | 79-103          | 21,61     | 50,15   | 26,01     | Clay     | 0,17     |
| BC          | >103            | 29,34     | 41,05   | 28,59     | Clay     | 0,58     |
| bush IV     | B1              | 69-98      | 19,44   | 48,72     | Clay     | 0,80     |
| IV          | B2              | 98-120     | 25,92   | 42,08     | Clay     | 0,82     |
| BC          | >120            | 37,71     | 25,22   | 36,99     | Clay     | 0,75     |
| Oa          | 2-52            | 49,99     | 52,64   | Clay      | 0,70     |
| A1          | 3-24            | 27,07     | 60,91   | 10,23     | Dusty Clay | 0,59    |
| bush IV     | B2              | 79-103     | 21,61   | 50,15     | Clay     | 0,17     |
| BC          | >103            | 29,34     | 41,05   | 28,59     | Clay     | 0,58     |

Note: 1. Physiography of Singgalang's Old Middle Volcanic Slope

2. Physiography of the Western Volcanic Middle Slope of Western Marapi

KP. Profile Code
The characteristics of epipedon formed on the physiography of the middle slope of the young volcanic part of Marapi mount were also categorized in melanic epipedon. Profile III with which is the same as profile I (forest vegetation) has epipedon thickness 36 cm, C-organic >6%, N-total >0.3%, base saturation <50%, and melanic index <1.7. Profile IV which also has the same profile II (shrub vegetation) also has melanic epipedon characteristics with epipedon thickness of 21 cm. Thus, profiles III and IV have sufficient requirements to characterize melanic epipedon. The characteristics of melanic epipedon in the study location based on biosequence can be seen in Table 4.

pH value of NaF (Table 3) for 60-minute measurements show a range of 10.53-11.72. This NaF pH value indicates that the soil profile observed also has an inherent characteristic. According to [20], that NaF pH is 10 for as large a horizon shows indications of reliable ingredients. In profile I (Table 3), melanic epipedon characteristics are found at 24 cm thickness, this is characterized by the value of chroma in moist 2, organic C 5.67% (<6%), base saturation 47.89% (<50%), the index melanic 1.39 (<1.7) and retention P >85% (89.23%).

In profile II (Table 3), melanic epipedon has a thickness of 50 cm (upper limit of organic layer 2 cm thick), organic C-6.68% (>6%), base saturation 47.01% (<50%), index Melanic 1.66 (<1.7), and retention P>85% (90.14%). The value of chroma and value in epipedon thickness has undergone changes, i.e. chroma and value 4 (>2), but other supporting characteristics show more characteristic of Melanic epipedon at a thickness of 2-52 cm. In profile III (Table 3), Melanic epipedon has a thickness of 36 cm (at a depth of 0-36 cm), organic C-6.61% (>6%), base saturation 30.19% (<50%), Melanic index 1.45% (<1.7), and P retention >85% (91.14%). The characteristics of melanic epipedon in profile IV (Table 3) have a thickness of 21 cm (3-24 cm from ground level), value and chroma 2, C-organic 10.58% (>6%), base saturation 32.42% (>50%), index melanic 1.23 (<1.7), and retention P 94.75% (>85%).

In the [17] it was explained that the characteristics of epipedon in volcanic ash soil is melanic epipedon, which has a thickness of 30 cm or more in total thickness of 40 cm, C-organic 6% or more, value and chroma 2 or smaller, melanic index <1.70, and at epipedon thickness has Andik soil characteristics. Then [18,19] say that the melanic epipedon criteria, in the epipedon, have a base saturation of <50%. Based on these results, the soil formed in the eastern volcanic slope of the eastern Singgalang slope was categorized as having melanic epipedon as the surface soil characterization horizon. Profile I with natural forest (Ht) has a thickness of melanic epipedon 24 cm which is classified as having changed from the required thickness (30 cm or more). In forest management, it does not refer to soil conservation techniques, so that parts of the forest are burnt due to land clearing for agriculture, so that soil erosion because of run-off. Profile II under the shrub (Sm) has a thickness of melanic epipedon 50 cm and has undergone changes in value and chroma value. The thickness of melanic epipedon in profile II is formed through the addition of organic matter due to the intensive weathering of plant debris.
Table 4. The characteristics of melanic epipedon in research location based on biosequence

| Criteria                  | Natural Forest Biosequence (Ht) | Shrub Biosequence (Sm) |
|---------------------------|---------------------------------|------------------------|
|                           | Singgalang Profil I (Ht)        | Singgalang Profil II (Sm) |
|                           | Marapi Profil III (Ht)          | Marapi Profil IV (Sm)   |
| Thickness (cm)            | 24                              | 36                      |
|                           | 50                              | 21                      |
| Value*                    | 2                               | 2                       |
| Chroma*                   | 2                               | 2                       |
| Melanic index             | 1,39                            | 1,45                    |
|                           | 1,66                            | 1,23                    |
| Retention P               | 89,23                           | 91,41                   |
|                           | 90,14                           | 94,75                   |
| Soil Structure            | CR                              | CR                      |
|                           | CR                              | CR                      |
| Consistency               | LO                              | FR                      |
|                           | FR                              | FR                      |
| Texture Class             | SC                              | SiL                     |
|                           | SiL                             | SL                      |
| BV (g/cm³)*               | 0,74                            | 0,70                    |
|                           | 0,79                            | 0,59                    |
| pH H₂O                    | 5,71                            | 6,25                    |
|                           | 5,25                            | 6,01                    |
| pH KCl                    | 5,16                            | 5,56                    |
|                           | 4,97                            | 5,42                    |
| pH NaF*                   | 11,34                           | 10,67                   |
|                           | 10,87                           | 11,11                   |
| C-Organik (%)*            | 5,67                            | 6,61                    |
|                           | 6,68                            | 10,58                   |
| BO (%)                    | 9,74                            | 11,36                   |
|                           | 11,50                           | 18,19                   |
| N-Total (%)               | 0,61                            | 0,65                    |
|                           | 0,58                            | 0,63                    |
| P₂O₅ (ppm)                | 260,33                          | 177,27                  |
|                           | 224,74                          | 123,87                  |
| Kₐd (me/100g)             | 1,23                            | 1,81                    |
|                           | 0,58                            | 0,22                    |
| Naₐd (me/100g)            | 0,18                            | 0,81                    |
|                           | 0,42                            | 0,17                    |
| Caₐd (me/100g)            | 9,06                            | 5,83                    |
|                           | 8,96                            | 6,65                    |
| Mgₐd (me/100g)            | 1,60                            | 0,67                    |
|                           | 0,69                            | 1,81                    |
| Kejenuhan Basa (%)*       | 47,89                           | 30,19                   |
|                           | 47,01                           | 32,42                   |
| KTK (me/100g)             | 25,2                            | 30,2                    |
|                           | 22,4                            | 27,3                    |

Note: Cr, crumbs; LO, release; FR, loose; SC, sandy clay; SL, sandy clay; SiL, dusty clay; * Melanic epipedon condition

4. Conclusion
The characteristics of melanic epipedon found both at the mount Singgalang and at the mount Marapi based on biosequence are still in the stage of completing the conditions for melanic epipedon. The characteristics of melanic epipedon in forest (Ht) and shrub (Sm) in the Marapi location are still haven’t any degradation of epipedon properties, whereas in forests (Ht) and shrubs (Sm) in Singgalang locations have undergone degradation of C-organic thickness and content. This is due to the role of humans (farmers) who’s not referring to soil and water conservation techniques in land management, so the process of soil erosion by run-off. Thus, the role of mount Marapi as Upper Batang Anai watershed area is still capable of being a buffer zone for its downstream area and mount Singgalang locations need land reclamation and land conservation through reforestation programs, to increase soil resistance to erosion or erosion.

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