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Research Article

Classification of Soil Distribution on the Island of Saparua Based on the Soil Classification System National and the Equivalent to Soil Taxonomy

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ABSTRACT

This research aims to classify the distribution of soils on Saparua Island, Central Maluku Regency, based on the Subardja, D, et al, (2016) and soil taxonomy (SSS, 2022). The benefit of this research is to find out the distribution of soils on Saparua Island to support the regional development plan. The method used is the survey method, with a semi-detailed survey level of a 1:50,000 scale. The pattern of the approach used is a physiographic analysis approach to landscapes, in which the research area is divided into terrestrial units based on the similarity of the properties of the variables that influence soil formation. The base map used in this study is a land unit map with a scale of 1:50,000. The results showed that the factors and processes involved in soil formation in the study area were parent material and topography, leaching, and eluviation processes. The soils found consisted of seven types of soil with 11 subgroups, namely: Regosol Eutric (Typic Udipsamments and Lithic Udipsamments), Litosol (Lithic Udorthents), Kambisol Distrik (Typic Dystrudepts), Kambisol Litik (Lithic Eutrudepts), Gleisol Eutrik (Typic Endoaquents and Aquic Eutrudepts), Gleisol Distrik (Typic Haplaquepts), Podsolik Kandik (Typic Hapludults and Typic Kandik), and Organosol Hemik (Hydric Tropohemists) were also found.

Keywords: *Classification, Saparua Island, Soil Distribution*

Introduction

Jenny (in Mariuzza et al., 2022), stated that soil is a dynamic natural system consisting of organic matter and minerals that interact with the physical and biological environment. Soil plays an important role in providing a place to grow for plants, providing water and nutrients for plants, as well as being a habitat for soil microorganisms. Therefore, understanding the concept of soil is very important in the sustainable management of soil resources (Ahmad et al., 2021).

Soil according to the definition of the Soil Survey Staff (in Sabin, 2021), namely as a natu-

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ral object composed of solids (mineral and organic materials), liquids, and gases that occupy the land surface, occupy space, and are characterized by one or both of the following: horizons or layers that are distinguishable from the parent material as a result of processes of addition, loss, transfer, and transformation of energy and materials or the ability to support rooted plants in the natural environment (Gordon et al., 2019).

On Saparua Island, not much is known regarding the parent material data, and the distribution of soil properties. Therefore, the distribution of soil properties needs to be grouped into soil units according to the property equation according to certain criteria known as "Soil Classification". Through soil classification, the level of distribution of soil units with their characteristics can be identified and used as the basis for land use planning (Hasanpour & Hatami, 2020).

Soil classification is a way of collecting and grouping soils based on similarities and similarities in morphological, physical, and chemical properties and characteristics, as well as mineralogy, then given names so that they are easily recognized, remembered, understood, and used and can be distinguished from one another (Das et al., 2021). Classified soil is a natural body consisting of solids (minerals and organic matter), liquids, and gases, which are formed on the earth's surface from the weathering of the parent material by the interaction of climatic factors, relief, organisms and time, in layers and capable of supporting growth. plants, 2 m deep or up to the limit of soil biological activity (Hamzah et al., 2019).

A national soil classification system needs to be developed and owned by each country according to the needs and developments in soil science and technology (Johnston et al., 2022). The pre-existing soil classification system has been made as simple as possible so that it is easily understood and applied by agricultural field practitioners (Thompson et al., 2020). Meanwhile, other classification systems such as the Soil Taxonomy System (USDA) which belong to the international community and have been used by researchers and teaching staff at universities in Indonesia can continue to be used as a reference and as a means of communication, especially with soil experts in and around the world. overseas. The classification system is very detailed and requires complete soil analysis data but it is not easy to communicate it among users and implementers in the field. Therefore it is necessary to develop a national land classification system in a language that is relatively easy to understand (Erasito et al., 2022).

This research aims to classify the distribution of soils on Saparua Island, Central Maluku Regency based on the national soil classification system (Qian et al., 2020) and Soil Taxonomy (SSS, 2022). The benefit of this research is to find out the distribution of soils on Saparua Island to support the regional development plan.

Methods

The research method used is a survey method, with a semi-detailed survey level of 1:50,000. The approach pattern used in this survey is a physiographical analysis approach to the landscape, in which the survey area is divided into terrain units based on the similarity of the properties of the variables that influence soil formation (Nendissa et al., 2021). The variables used for the division of terrain units in this survey are based on geomorphic units, namely: landscape, part of the landscape, parent material, landform, and relief. In the same terrain units, it is suspected that the formation of the soil that has occurred is also the same, for this reason, a field check was carried out (Haque et al., 2021).

The base map used in this study is the result of the interpretation of aerial photographs and is assisted by other maps such as topographical and geological maps, which produce land unit maps at a scale of 1: 50,000. presented in Figure 1 below.

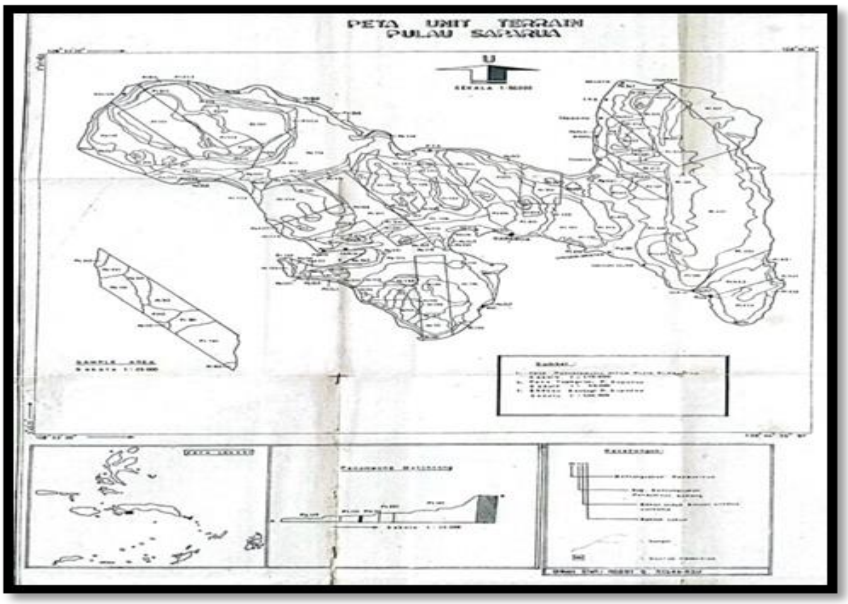

Figure 1. Base Map of Study Area

Result and Discussion

Saparua Island is included in the cluster of small islands of Ambon and Lease which has a climate that is strongly influenced by the maritime air mass of the Banda Sea which is quite extensive. Laimeheriwa (2014) and Laimeheriwa et al. (2018) report that this region has a localized rainfall pattern; namely the reverse rain pattern with the monsoonal rain pattern that generally occurs in Indonesia. The rainy season usually takes place in the period May-August and the dry season takes place in the period November-February. March-April is a transition period (transition) from the dry season to the rainy season and September-October is a transition period from the rainy season to the dry season (Rehatta et al., 2022).

Annual rainfall in this area is quite high, which is an average of 3264 mm, where the peak of rainfall usually takes place in June with an average of 671 mm and November is the driest month in a year with an average rainfall of 65 mm. The annual average temperature is 26.6˚C, and is usually high in November-December (27.7˚C) and low in July-August (25.3˚C). Based on the Schmidt-Ferguson climate classification system, Saparua Island has a climate type A, which is a very wet area with tropical rainforest vegetation, and according to the Oldeman classification system, it is included in the agro-climatic zone C 1 with a long plant growth period of 11 months; December – October.

Noted that the southern part of Maluku consists of three geological formations, namely the Seram Formation, the Banda Formation, and the Ambon Formation. The Seram Formation consists of older sedimentary and volcanic rocks than the Banda Formation, while the Ambon Formation consists of younger rocks. Saparua Island lies between the Seram and Ambon formations and is thought to consist of older volcanic and sedimentary rocks.

Hamilton (in Qiu & Duan, 2019), also noted that in the southern part of Maluku, there are two zones separated by faults, namely the Seram zone and the Banda zone. Saparua Island is located in the Seram zone, which consists of sedimentary and volcanic rocks that are older than the Banda zone. These two records indicate that Saparua Island is located between two different geological formations or zones, namely the Seram and Ambon formations or the Seram and Banda zones, which consist of older volcanic and sedimentary rocks. However, for more detailed information about the geology of Saparua Island, further research is needed by considering available geological data and evidence specifically for the island.

Geological events that occur periodically, also cause faults or faults, such as those that extend on volcanic landscapes and limestone uplifts on the plateau at the southeastern tip (from Ouw - Ulat to Itawaka). With the part of the landscape in the form of a sharp and steep taper shape, beside the shape of the table. Based on the geological sketch map (in Van Bemmelen, 1949) then combined with the geological map sheet Masohi, Maluku scale 1: 250,000 by S. Tjokosapoetra, et al, (1993) the results are used as a base map. While the description of the geomorphological unit was carried out by referring to the criteria put forward by Zink (1988/1989), stereoscopic studies, and field research. Based on what was stated, the research area as a whole can be grouped into three main landscapes, namely hills, highlands, and plains. Presented in Figure 2.

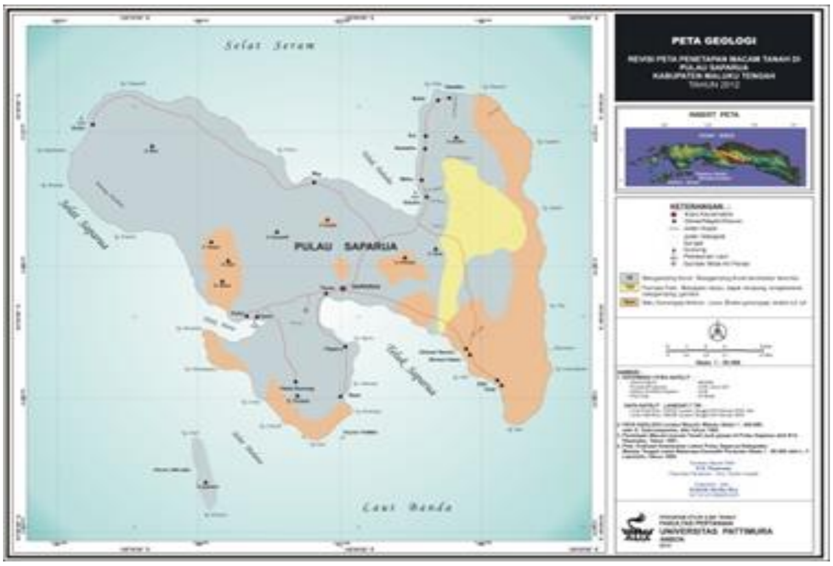

Figure 2. Geological Map of Saparua Island

The natural vegetation of Saparua Island shows differences in line with differences in climate, soil conditions, and human influences (Adzigbli, Hao, et al., 2020). The main types of vegetation found on Saparua Island can be differentiated into: 1. Woody meadows; 2. Desert; 3. Bush; 4. Timber forest; 5. Open forest; 6. Sago forest; and 7. Mangrove forest. Presented in Figure 3.

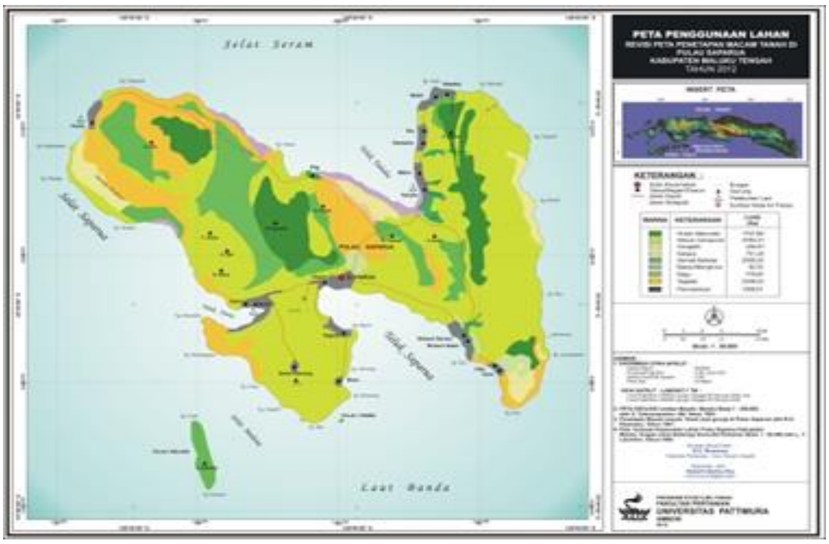

Figure 3. Land Use Map of Saparua Island

Soil Formation

In the study area, parent material factors and topography play a role in soil formation besides vegetation, climate, and time. The climate component plays a role in rainfall, especially soil moisture and soil temperature. In areas of concave plains, waterlogging usually occurs for a long time causing a reduction process down to the top layer (50 cm), this results in the formation of Organosol Hemik (Hydric Haplohemists), Gleisol Eutrik (Typic Endoaquents and Aquic Eutrudepts) soils. in mangrove and sago vegetation, the soil formation processes that occur are humification and gleization.

Furthermore, other soil formation processes that play a role are leaching and eluviation. The process of leaching nutrients can dissolve and disappear from the soil, when rainfall exceeds evapotranspiration, solutes can be dissolved by percolation water. In this process a kambik B horizon is formed, so that the soil formed is Kambisol Distrik (Typic Dystrudepts) and Kambisol Litik (Lithic Eutrudepts). Meanwhile, in the eluviation process humus usually occurs at the bottom, where washing occurs mechanically so that a Bt horizon with a high clay content with a well-formed structure is formed, as seen in the Podsolik Kandik soil types, Typic Hapludults and Typic Kandiudults subgroups (Syeda et al., 2022).

Based on the factors and processes of soil formation above, Saparua Island according to the results of the Aerial Photograph Interpretation and the results of field observations can be grouped into 3 main terrain which generally differs in physical and chemical properties from one unit to another according to the basic materials they contain.

In the main terrain unit hills (Hi) are hilly areas in volcanic andesite rocks having a basic material, especially the texture of the topsoil (topsoil) is dusty clay, in the lower layer (horizon B) the texture of loamy clay; the level of development is moderate-advanced; Cation Exchange Capacity (CEC) is low; low base saturation, low pH. In volcanic andesite rocks, intercalated limestone is a basic transitional material with the presence of soil textures varying from sandy loam to loamy clay; shallow-deep soil depth; weak-moderate development level of soil; Low Cation Exchange Capacity (CEC), low-high base saturation; acid-neutral pH (Ghodszad et al., 2022).

In crystalline limestone rocks, generally, the soil is shallower, and more rock is found above the surface, both in the form of spreading on the surface and in the form of outcrop rocks. The level of development is weak (not yet developed) to moderately developed, and the texture, Cation Exchange Capacity (CEC), base saturation, and soil acidity vary.

In the main plateau unit terrain (Pl) is an area of uplifted coral that infiltrates or intercalates volcanic andesitic limestone. Limestone intercalation spreads from the Southeastern Peninsula extending to the north of the Hatawano Peninsula. The soil in this parent material is a transitional soil from undeveloped to highly developed with varied texture, Cation Exchange Capacity (CEC), base saturation, and soil acidity. In light limestone rocks and limestone crystals, they are generally shallow soils, there are many rock outcrops and faults where rocks are only found both on the ground surface and on the walls of rock crevices. This soil is more common on the Pia - Kulur Peninsula, especially on the landscape (P1).

The main plains terrain unit (Pa) is an upland plain and lowland area originating from young marl, limestone, and young deposits in the form of sand, gravel, the remains of weathered plant materials, and other micro-organisms. In young marl rocks, limestone is a shallow soil that is mostly used for settlements and shifting cultivation businesses such as annual crops such as tubers for daily consumption by the community (Saravanan et al., 2022).

The high intensity of use (2-3 times/year) shows critical physical signs, especially the top layer which is getting thinner and often found rocks, broken pieces, and easy corals that cover the soil surface. Only in low areas or narrow depressions where soil material is transported from the top of the slopes is soil that is deep with a level of development that is not yet being developed. The land in this unit has been partially abandoned and overgrown with reeds, melastoma grass, and teak wood. Soil material of young coral sand (coastal deposit) has been widely used by the community for semi-sedentary farming, the soil is shallow, the texture is sandy loam, sandy loam, base saturation is more than 50%, Cation Exchange Capacity (CEC) is low; land development has not yet developed until it is developing; neutral acidity (Andréfouët et al., 2022).

The soil on easy sediment material with sago vegetation is always affected by water which is always stagnant. The texture of the soil is loamy to dusty clay loam; with medium soil development; Low Cation Exchange Capacity (CEC), low base saturation, and acid-neutral soil acidity. Soils along the coast with mangrove soil also contain a lot of semi-decayed plant remains and are always affected by tides, located on young coral rocks, especially in terrain units (Pa 243).

Soil Classification

The soil classification used in this study is the National Soil Classification system (Lake-Thompson, 2018) and is equivalent to Soil Taxonomy (Chen et al., 2019). Categories that describe the level of soil types (Sub Group). Determination of soil chemical properties to determine soil fertility status using.

Based on field data and results of laboratory analysis, the physical and chemical properties of the soil were identified including color, texture, structure, organic matter content, pH, base saturation, and cation exchange capacity. Then combining the two, it can be determined 7 types of soil with 11 subgroups, namely: Regosol Eutrik (Typic Udipsamments and Lithic Udipsamments), Litosol (Lithic Udorthents), Kambisol Distrik (Typic Dystrudepts), Kambisol Litik (Lithic Eutrudepts), Gleisol Eutrik (Typic Endoaquents and Aquic Eutrudepts), Gleisol Distrik (Typic Haplaquepts), Podsolik Kandik (Typic Hapludults and Typic Kandiudults), and Organosol Hemic (Hydric Haplohemists).

Distribution of Physical and Chemical Properties of Soil in the Study Area.

Regosol. Regosol soil is soil that has deep depth, there is a deep A horizon <80cm and a thin horizon (<25 cm). This soil is a young soil made of sand, silt, and clay deposits from the basic ingredients of coral sand and limestone. The texture varies from loam, sandy loam to sandy loam, low - very low CEC (1.392 - 9.022%), moderate to high KB (51.55->100%). The level of development has not progressed. According to Subardja, D, et al, (2016), it is included in Regosol Eutrik because it contains sand (> 60%), with KB (> 50%). Soil Taxonomy Equivalent (SSS, 2022), included in the Typic Tropopsamments subgroup. Distribution on terrain units (Pa242) and (Hi115), and Lithic Tropopsamments subgroup distribution on terrain units (Pa114).

Gleisol. Gleisol soil is soil that is always or often affected by water, showing hydromorphic properties at depths between 0 - 50 cm and showing symptoms of reduction as a result the color of the soil changes to glei or pale. This soil is always found in areas of depression in the lowlands near the coast. Derived from young sedimentary materials such as sand, silt, and clay, which are undeveloped to developing soils. Soil depth is deep (<80cm), soil color is dark brown - pale red, sandy loam texture, there is the influence of water at depths between 12-80 cm, development is weak, granular structure forms until loose, low CEC (1.450 - 6.816%) and High KB (> 100%). According to the National Soil Classification (2016), the soil type is Gleisol Eutrik. This soil is contained in the terrain unit (Pa231). Soil Taxonomic Equivalent (SSS, 2022), included in the Typic Endoaquents Subgroup.

Another Gleisol soil found in the middle of a slightly concave flat area with sago vegetation is water-saturated and has a gray-brown soil color, dark brown-gray on the top layer and light gray – an olive on the bottom layer, the level of development is developing due to the horizon B kambik, very low CEC (1.305 - 4.785%), low-medium KB (3.72 - 22.25%), moderate soil pH (5.52 - 6.69). According to Subardja, D, et al, (2016), it is included in the Gleisol Distrik land type. This soil can be seen in the unit therein (Pa112). The Soil Taxonomic Equivalent (SSS, 2022) belongs to the Typic Haplaquepts subgroup.

Other Gleisol soils with mangrove vegetation with a gravel and easy rock base have a shallow soil depth (<32 cm), black soil color with a dusty clay soil texture and massive structure, very low CEC (2,349 - 2,784 %), and KB (>50 %), with groundwater depth < 32 cm. According to the National Soil Classification system, it is classified as a Gleisol Eutrik soil type. These soils are generally found in terrain units (Pa243). The Soil Taxonomic Equivalent (SSS, 2022) belongs to the Aquic Eutrudepts subgroup.

Litosol. Litosol soil is soil that has a very shallow depth (5 - 15 cm), and there is a thin A horizon directly adjacent to solid rocks of limestone marl, limestone crystals, and volcanic andesite (A, C, R). The level of development has not yet developed, the color is dark gray-dark yellowish brown, and the texture is sandy loam-clay; Medium pH (6.78 - 6.85), very low-low CEC (0.538 - 7.211), medium-high KB (29.47->100). This soil is a very dominant soil distribution, especially in units (PL111 - PL331) and in units (Hi112 - Hi213). According to the national soil classification system, it is included in Litosol (I). The Soil Taxonomic Equivalent includes the Lithic Udorthents subgroup.

Kambisol. This soil is formed from several parent materials originating from volcanic andesite intercalation of limestone and limestone or a mixture of sand, silt, and clay depending on the material of formation. This soil is a developing soil with a cambic B horizon in its cross-section. In general, the depth of the soil varies from shallow to deep. This soil belongs to the order of Inceptisols (Han et al., 2022). Soil color varies from dark reddish brown, very dark gray - dark reddish brown, yellowish mersh on the top layer to dark yellowish brown, dark reddish brown, light brownish gray on the bottom layer, loamy texture, dusty clay loam up to clay of medium structure, cuboid. rounded, Cation Exchange Capacity (CEC) very low (1.740 - 7.743), base saturation less than 50%, medium soil pH (5.62 - 6.39), soil depth (92-150 cm). According to the National Land Classification System (Lodeiros et al., 2018), the Kambisol Distrik land tiger is distributed in terrain units (Hi211, Hi132, PL431). Soil Taxonomic Equivalents (2022) are included in the Typic Dystrudepts subgroup because there is no lithic or paralithic contact at a depth of 50 cm and with a base saturation of less than 50% (Ahmed et al., 2022).

Another Kambisol soil has a cambic B horizon with a soil depth of 25 cm and >50% base saturation. According to Subardja, D, et al, (2016), it is included in the Kambisol Litik soil type. This soil is distributed on terrain units (Hi134, Pa112). Soil Taxonomic Equivalent (Le Moullac et al., 2018), is included in the Lithic Eutropepts subgroup (Latchere et al., 2018).

Podsolik. This soil is a soil with advanced development showing an argillic horizon in the lower layer (horizon B), which is the result of characterizing or translocating fine materials such as clay and silt from the upper layer (eluviation) to the lower layer (illuviation). These soils are more dominant in volcanic andesitic rocks, generally having a KB of less than 50% with very low - low soil CEC. Soil color varies from dark brown, dark brown gray - dark brown on the top layer to red yellow - light gray on the bottom layer; Medium soil pH (5.47 - 5.95). According to Subardja, D, et al, (2016), it is included in the Podsolik Kandik soil type. This soil is distributed on terrain units (Hi114, P1431). Soil Taxonomic Equivalent (SSS, 2022), included in the Typic Kandiudults subgroup.

Other podsolik soils have a very dark grayish brown color, dark brown-brown, reddish yellow on the top layer, and dark reddish brown-red with (2.5 YR 5/8, 7.5 YR 4/6); rounded cube structure; with an advanced level of development, CEC is very low - low, has an argillic horizon in the lower layer (horizon B). According to Subardja, D, et al, (2016), it is included in the Podsolik Kandik soil type. Types of soil distribution in terrain units (Hi144, P1431, P1121). Soil Taxonomic Equivalent (SSS, 2022), included in the Typic Hapludults subgroup.

Organosol. Having weathered to semi-decomposed material with a thickness of organic matter less than 70 cm deep in the A1 and A2 horizons in cross-section, under coral limestone. The color of the soil is black-reddish, with a loamy texture, moderate soil pH, very low CEC - low with medium KB. According to Subardja, D, et al, (2016), it is included in the Organosol Hemik soil type. This soil is distributed on terrain units (Pa243). Soil Taxonomic Equivalent (SSS, 2022), belongs to the Hydric Haplohemist subgroup. Land unit distribution maps and land unit maps are presented in Figures 4 and 5 below.

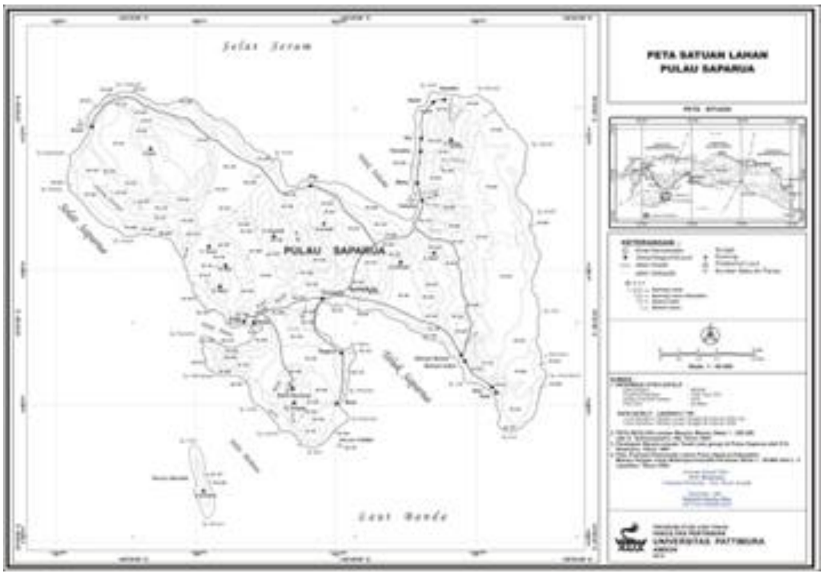

Figure 4. Distribution Map of Saparua Island Land Units

Figure 5. Land Unit Map of Saparua Island

Conclusion

From the results of the research, several things can be concluded including (1). The dominant soil formation factors are parent material and topography in addition to vegetation, climate, and time. (2). Soil formation processes that play a role are leaching and eluvial. (3). Found 7 types of soil with 11 subgroups, namely: Regosol Eutrik (Typic Udipsamments and Lithic Udipsamments), Litosol (Lithic Udorthents), Kambisol Distrik (Typic Dystrudepts), Kambisol Litik (Lithic Eutrudepts), Gleisol Eutric (Typic Endoaquents and Aquic Eutrudepts), Gleisol Distrik (Typic Haplaquepts), Podsolik Kandik (Typic Hapludults and Typic Kandiudults), and Organosol Hemik (Hydric Haplohemists).

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