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Analysis of the Suitability of Clove Plants in Pelabuhan Ratu Sub-District

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A R T I C L E I N F O

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A B S T R A C T

Indonesia is the largest clove-producing country in the world because cloves are native plants from Indonesia, which are also supported by natural conditions, climate, and topography. In Sukabumi Regency, cloves are the main production center in West Java. This study uses the scoring method by overlaying the data used. The data used in this study are rainfall, soil type, slope, and altitude data. The results of this study found that the area for the "very suitable" class is quite dominant when compared to the "suitable" and "less suitable" class. The "less suitable" class has an area of 12.79 Km2 with a percentage of 13.81%, the "suitable" class has an area of 29.95 Km2 with a percentage of 32.33%, and the "very suitable" class has an area of 49.91 Km2 with a percentage of 53.86%.

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1. Introduction

Cloves (Syzygium aromaticum, syn. Eugenia aromaticum is a plant native to Indonesia, this clove is widely used as a spice for spicy dishes in many European countries, and as the main ingredient for Indonesian clove cigarettes. Cloves are grown mainly in Indonesia (Banda Islands) and Madagascar; besides that, cloves are also cultivated in Zanzibar, India, and Sri Lanka (Enny Randriani, et al, 2011). Cloves are a type of spice that has high antioxidant activity because of its high eugenol content. Clove essential oil (Eugeniacaryophylus) is used as a local anesthetic (Khalaf et al., 2007). Indonesia is the largest clove producing country in the world, this is because cloves are native plants from Indonesia which are also supported by natural conditions, climate, and topography. In 2011, Indonesia's clove production reached 75,757 tons, while demand for the same year reached 120,000 tons (Wahyudi, 2018). Based on Ministry of Agriculture production data (2014), Indonesia is the country that produces the largest cloves in the world. Indonesia's clove production in 2012 was tons, equivalent to 70.99 percent of the world's total clove production. Based on the average world clove production from 2008 to 2012, Indonesia is also the largest clove producer in the world. Indonesia's average contribution to world clove production in that period was % per year. Likewise, Indonesian clove production is compared with clove production in other countries in the ASEAN region. Indonesian clove production also dominates clove production in ASEAN, in Indonesia contributing as much as a percent of ASEAN clove production (Ministry of Agriculture, 2014). The large production of Indonesian cloves is a large capital for the development of Indonesian clove exports in the international market. Apart from production, the quality of Indonesian cloves is also the best on the international market. This is due to the large demand to produce clove cigarettes, because cloves are the raw material for cigarette production. Clove plantations have spread throughout the country and are generally people's plantations which support around 18 million people (Gonarsyah, 1995 in Naomy, 2018).

The clove plant in West Java province is the third largest commodity in its plantation area after coconut and tea. In Sukabumi Regency, cloves are the main production center in West Java. In 2010 the clove planting area reached 7,489.37 Ha, with details of 372.10 Ha of immature plants (TBM), 5,498.97 Ha of mature plants (TM) and although the plants that produce are quite a lot, the plants that do not produce are also not less numerous 1,618.30 Ha of damaged plants (TR). Dominant clove plantations are spread over several areas of Cikakak, Cisolok, Pelabuhanratu, Sukaraja, Ciemas, Middle Jampang and Simpenan Districts, with a production of 1,828.47 tons and an average productivity of 332.51 Kg/Ha/year (Plantation Statistics, Forestry Service and Sukabumi Plantation, 2020).

The overlay technique is an approach that is often and well used in land use/landscape planning. This technique is formed using overlapping (series) maps that each represent important environmental or land factors. The overlay technique approach is effectively used for the selection and identification of the various types of impacts that arise. The drawback of this technique is the inability to quantify and identify impacts (relationships) at the secondary and tertiary levels. The development of the overlay technique is currently leading to computerized techniques. (Canter, 1977). In GIS there is also scoring thecnique. The meaning of score in a geographic information system is the process of assigning weights or the value of map polygons that represent certain phenomena in a region spatial analysis suite. Scoring is also the value given to map polygons for represents the level of closeness, relatedness, or severity of a particular impact on something spatial phenomena (Widiastuti, T, 2019).

Based on the data above, it can be concluded that clove plants can be useful for the local community both in terms of health and regional economic development, for this reason it is important for researchers to see the suitability of which land is suitable for planting clove plants, where the Geographic Information System can be used to facilitate the processing data and in visualizing the results of spatial data processing.

2. Methods

1. Study Area.

Pelabuhan Ratu, is a tourist spot on the coast of the Indian Ocean in the south of West Java. The location is about 60 km to the south from Sukabumi City. This beach is known for having very strong waves and therefore dangerous for beach swimmers. The topography is a combination of steep and sloping beaches, steep cliffs, crashing waves, and nature reserve forests.

To the north, Pelabuhan Ratu sub-district is bordered by Cikakak and Cikidang sub-districts, to the south by Simpenan sub-district, to the east by Bantargadung and Lengkong sub-districts, to the west by Pelabuhan Ratu Bay and the Indian Ocean. In general, the indigenous people of Sukabumi district, as well as those in the Palabuhanratu sub-district, are Sundanese, as well as other immigrant tribes such as Javanese, Cirebonese, Betawi, Batak, Minangkabau, Bugis and others. The language used is generally Sundanese, apart from the official language, Indonesian.

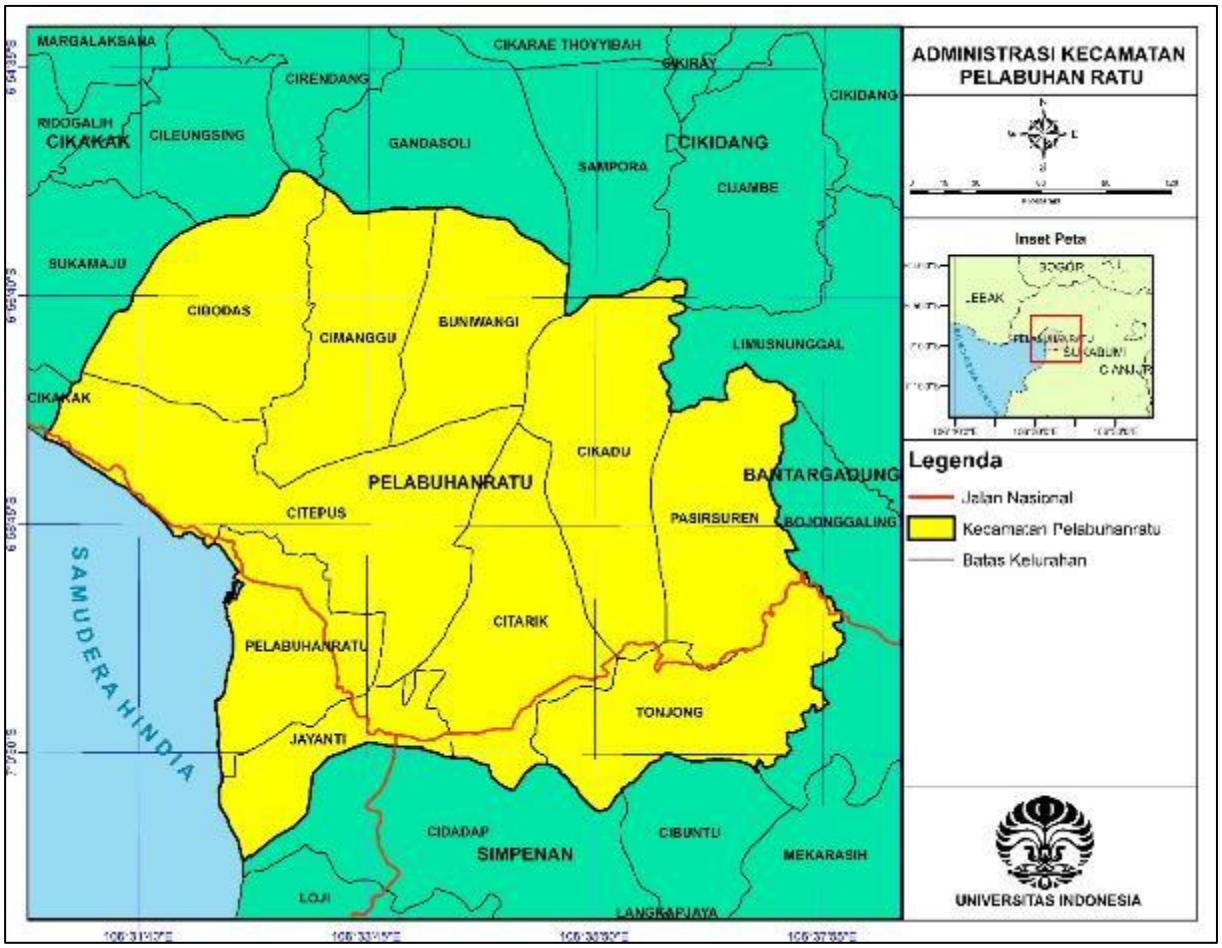

Figure 1. Pelabuhan Ratu Adiministration Map

2. Skoring and Weighted Overlay

Each land suitability for clove plants parameter's weighting and grading came from earlier studies on land suitability for clove plants. The weighted overlay approach inserts multiple maps of land suitability for clove plants parameters that have been previously processed in a raster format to examine spatial data using overlay techniques. The weighted overlay equation is as follows, with Z as the result value, was weight, and c as parameters from 1 to n;

$$Z = ((w1 \times c1) + (w2 \times c2) + \cdots + (wn \times cn))/(w1+w2+\cdots wn)$$

From the processing result, a suitability map will be obtained, where each level Clove Suitabiliy is divided into three classes: low, medium, and high. In this study, due to the limitations of previous research where the weighted overlay method was not widely used to examine the suitability of clove land, the weights for each variable were equalized.

Table 1.
The Weighted of Research Variables

Variable	Weight
Soil Type	25%
Altitude (m)	25%
Slope (%)	25%
Precipitation	25%

Source: Takdir Tausar with modification, 2016.

Table 2.
Soil Type, Altitude, Slope and Precipitation

Soil Type	Score	Altitude (m)	Score	Slope (%)	Score	Precipitation	Score
Alluvial	2	0 – 150	1	0 – 2	1	100 – 1500	2
Andosol	3	151 – 300	1	3 – 7	1	1501 – 3000	3
Gleisol	1	301 – 450	3	8 – 15	3	> 3000	1
Kambisol	1	451 – 600	3	16 – 35	3		
Mediteran	1	> 600	2	> 35	2		
Podsolik	3						

Source: Takdir Tausar with modification, 2016.

3. Rainfall Data

In this study the rainfall data used is CHIRPS data, where the data is downloaded in raster form, then extracted by mask, after that the data is reclassified and the rainfall results are as follows:

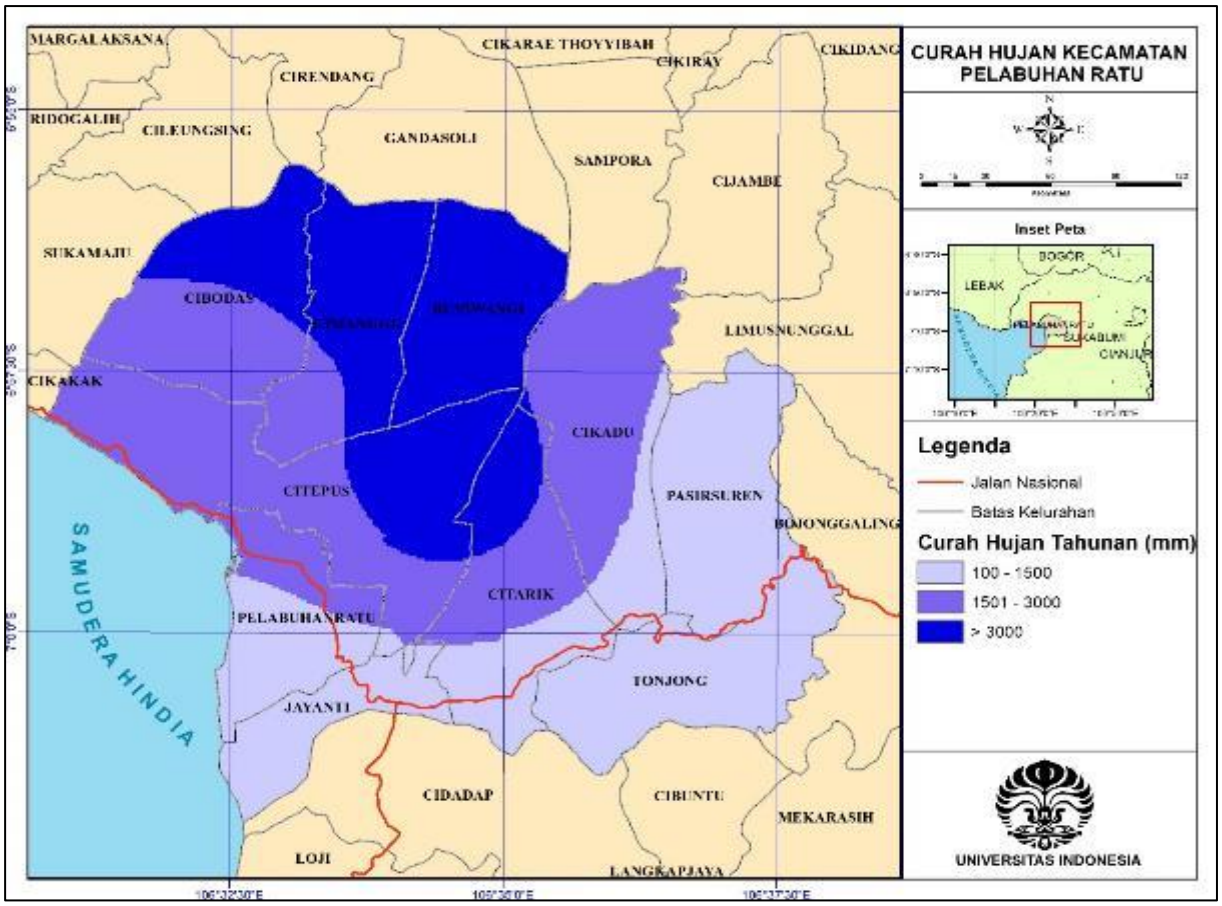

Figure 2. Annual Rainfall Map

For the 100 mm - 1500 mm rainfall class, it has an area of 34 km2 with a percentage of 36.5% of the entire Pelabuhanratu subdistrict area. for the 1501 mm - 3000 mm rainfall class has an area of 33.6 km with a percentage of 36.1% of the total area of Pelabuhanratu sub-district and for the > 3000 mm rainfall class it has an area of 25.5 km with a percentage of 27.4% of the area the entire port district.

4. Slope Data

In this research, we use DEM data which will be processed into slope data, where the classification is divided into five classes according to van zuidam classification.

Table 3.
Slope Classification

Slope (%)	Area (Km2)	Precentage (%)
0 – 2	24,2	26
3 – 7	7,9	8,5
8 – 15	24,3	26
16 – 35	35	37,6
> 35	1,7	1,9

Source: Van Zuidam Classification, 1985

We process the DEM data using the ArcMap 10.8 application and divide it into several steps, the first of which is to input the DEM data into ArcMap, then process it using the tools in the arc toolbox, namely slope, then classify it according to the table above and calculate the area using the calculate geometry tools.

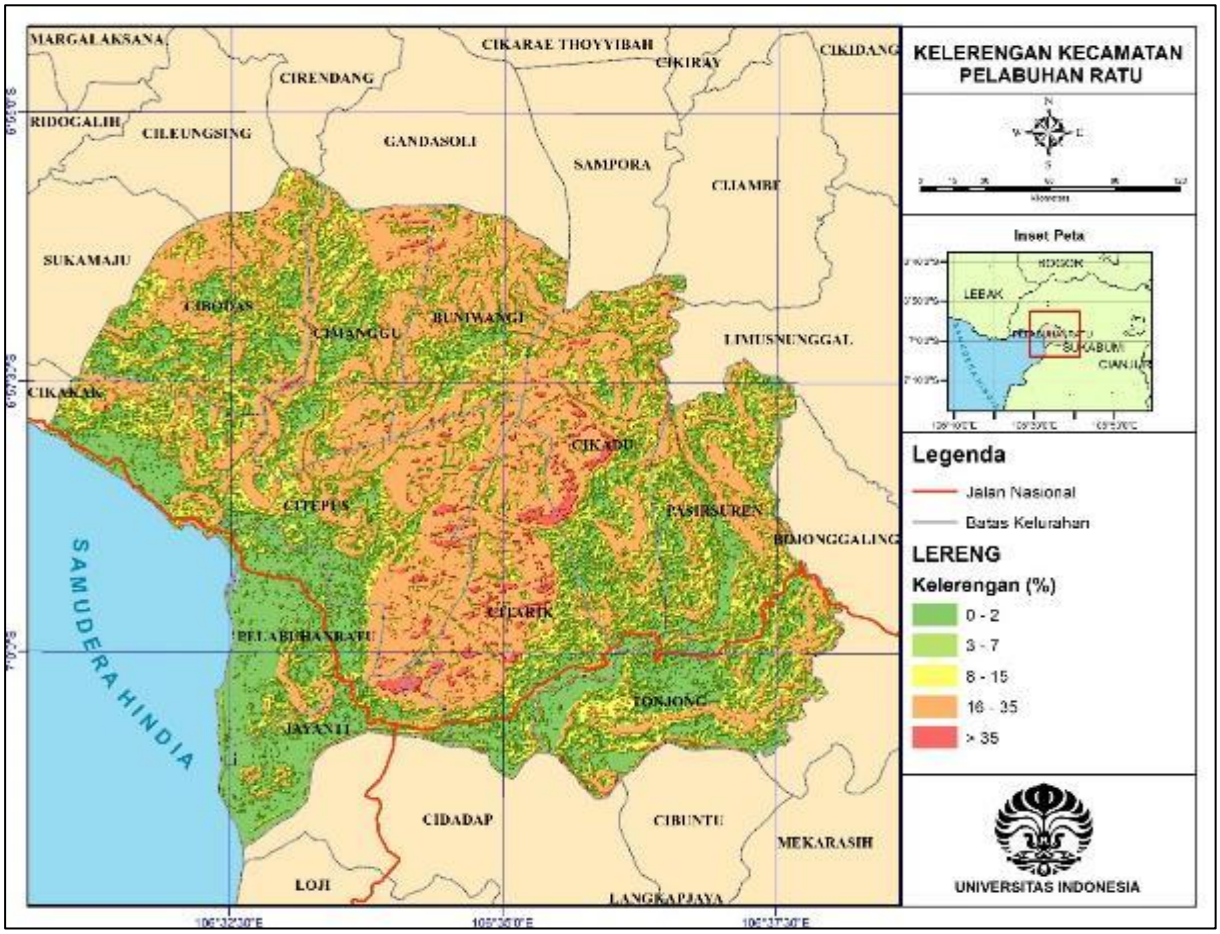

Figure 3. Slope

The area with a slope class of 0-2% is 24.2 Km^2 with a percentage of 26% of the area of Pelabuhanratu District, then the area with a slope class of 3-7% is 7.9 Km^2 with a percentage of 8.5% of the area of Pelabuhanratu District, for the slope class of 8-15% has an area of 24.3 Km^2. With a percentage of 26% of the total area of Pelabuhanratu District, then for the slope class of 16-35% has an area of 35 Km^2 with a percentage of 37.6% of the total area of Pelabuhanratu District and for the slope class of more than 35% has an area of 1.7 Km^2 with a percentage of 1.9% of the total area of Pelabuhanratu District. From the results of this data processing, it was found that Pelabuhanratu District is dominated by the slope class ranging from 16-35%.

5. Altitude

The altitude data used in this research is also sourced from the DEM. The classification used for altitude data in this study is divided into:

Table 4.
Altitude Classification

Altitude (m)	Area (Km²)	Precentage (%)
0 – 150	19,5	20,9
151 – 300	21,5	23
301 – 450	29,1	31,2
451 – 600	17,7	19
> 600	5,5	5,9

Source: Takdir Tausar with Modification, 2016.

The data Digital Elevation Model (DEM) is downloaded from the DEMNAS website and then processed using the ArcMap 10.8 application. The process is divided into the following steps: Importing the DEM data into ArcMap. Combining the DEM data using Mosaic to New Raster tools in ArcMap. Cropping the data to the desired area using the Extract by Mask tools in ArcMap. Reclassifying the data to obtain the desired classification.

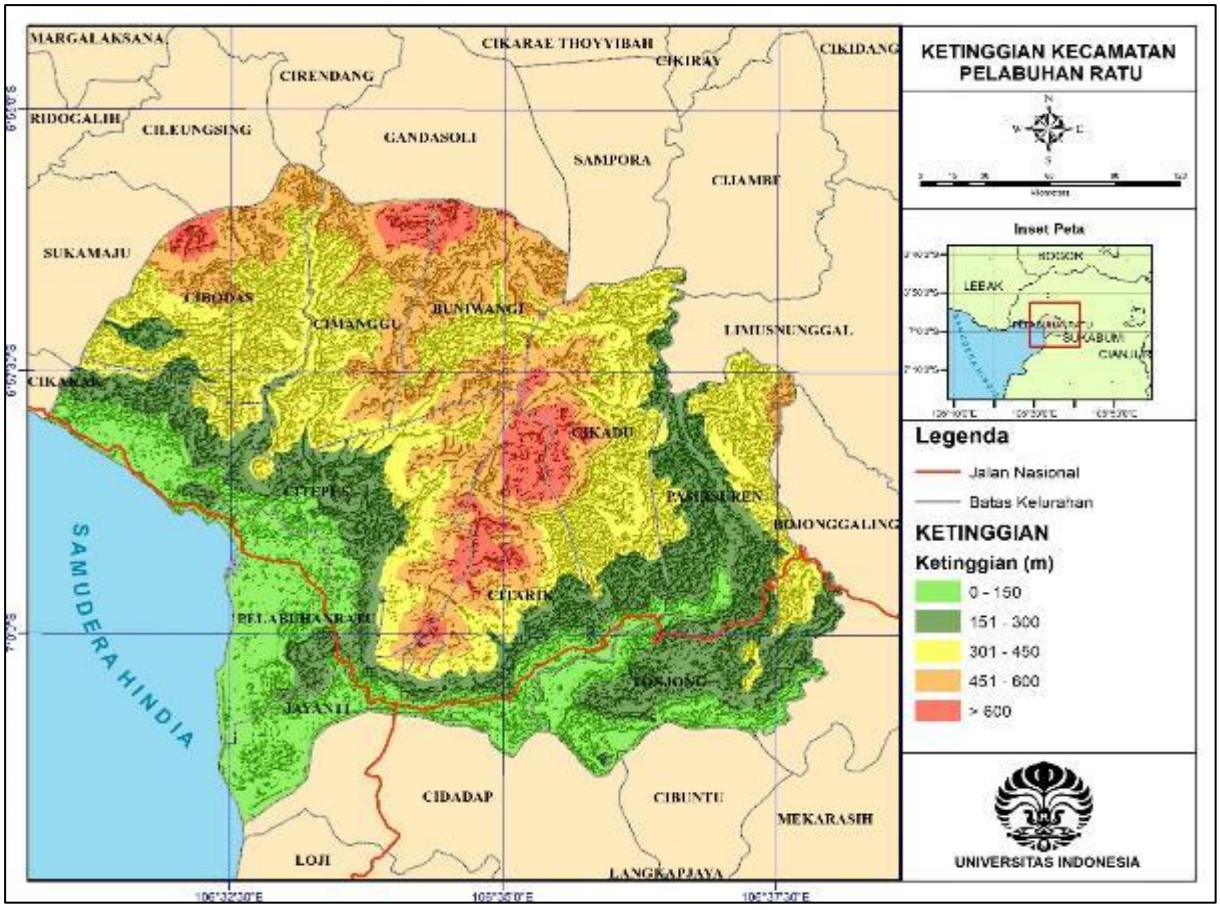

Figure 4. Altitutde

From the data processing, five classes were obtained, namely 0-150m, 151-300m, 301-450m, 451-600m, and more than 600m. The 0-150m class has an area of 19.5 with a percentage of 20.9% of the total area of Pelabuhanratu District, the 151-300m class has an area of 21.5 with a percentage of 23% of the total area of Pelabuhanratu District, the 301-450m class has an area of 29.1 with a percentage of 31.2% of the total area of Pelabuhanratu District, then the 451-600m class has an area of 17.7 with a percentage of 19% of the total area of Pelabuhanratu District, and the class with an altitude of more than 600 has an area of 5.5 with a percentage of 5.9% of the total area of Pelabuhanratu District. Based on the processed data, the Pelabuhanratu District area is dominated by an altitude of 301-450m.

6. Soil

The data on soil types used in this research is classified into several categories, namely podsolic, mediterranean, cambisol, gleisol, andosol, and alluvial.

Table 5.
Soil Type Klasification

Soil Type	Area (Km2)	Percentage (%)
Alluvial	1,5	1,6
Andosol	60,3	64,7
Gleisol	11,7	12,6
Kambisol	10	10,7
Mediteran	3,9	4,2
Podsolik	5,8	6,3

Source: Takdir Tausar, 2016

The result of the processed data shows that the area of alluvial soil is 1.5 Km^2 with a 1.6% percentage of the total area of the Pelabuhanratu district, then for andosol soil the area is 60.3 Km^2 with a 64.7% percentage of the total area of the Pelabuhanratu district, for gleisol and cambisol soil the area is 11.7 Km^2 and 10 Km^2 with a 12.6% and 10.7% percentage respectively, while for mediterranean and podsolic soil the area is 3,9 Km^2 and 5.8 Km^2 with a 6.3% percentage of the total area of the Pelabuhanratu district. It can be seen from the map produced that most of the Pelabuhanratu district is dominated by andosol soil with a total area of 60.3 Km^2.

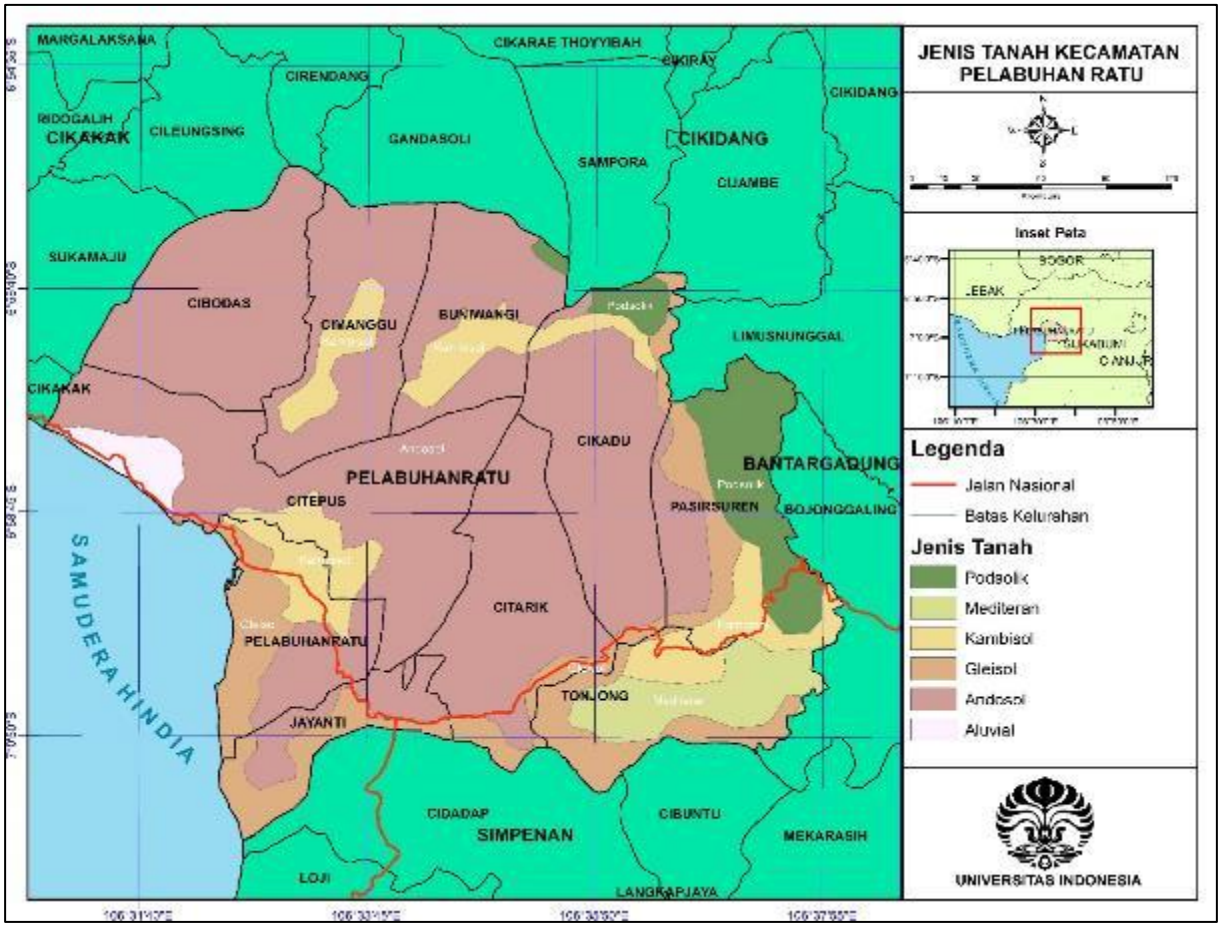

Figure 5. Soil Type Classification

3. Result and Discussion

The variables have each been processed using ArcMap and then processed using the weighted overlay tools, where each class of variables is given a score to determine how influential the class of variables is in the weighted overlay process that will be carried out. In this project we assumed that all the variables have the same weight percentage. The table for the scores of each variable is as follows.

Table 6.
Scores of Research Variables

Soil Type	Score	Altitude (m)	Score	Slope (%)	Score	Precipitation	Score
Alluvial	2	0 – 150	1	0 – 2	1	100 – 1500	2
Andosol	3	151 – 300	1	3 – 7	1	1501 – 3000	3
Gleisol	1	301 – 450	3	8 – 15	3	> 3000	1
Kambisol	1	451 – 600	3	16 – 35	3		
Mediteran	1	> 600	2	> 35	2		
Podsolik	3						

Source: Takdir Tausar with modification, 2016

From the processing using the weighted overlay method, the suitability of the clove plant area in the Pelabuhan Ratu district was obtained, where the result will be divided into 3 classes: very suitable, suitable, and (less)unsuitable.

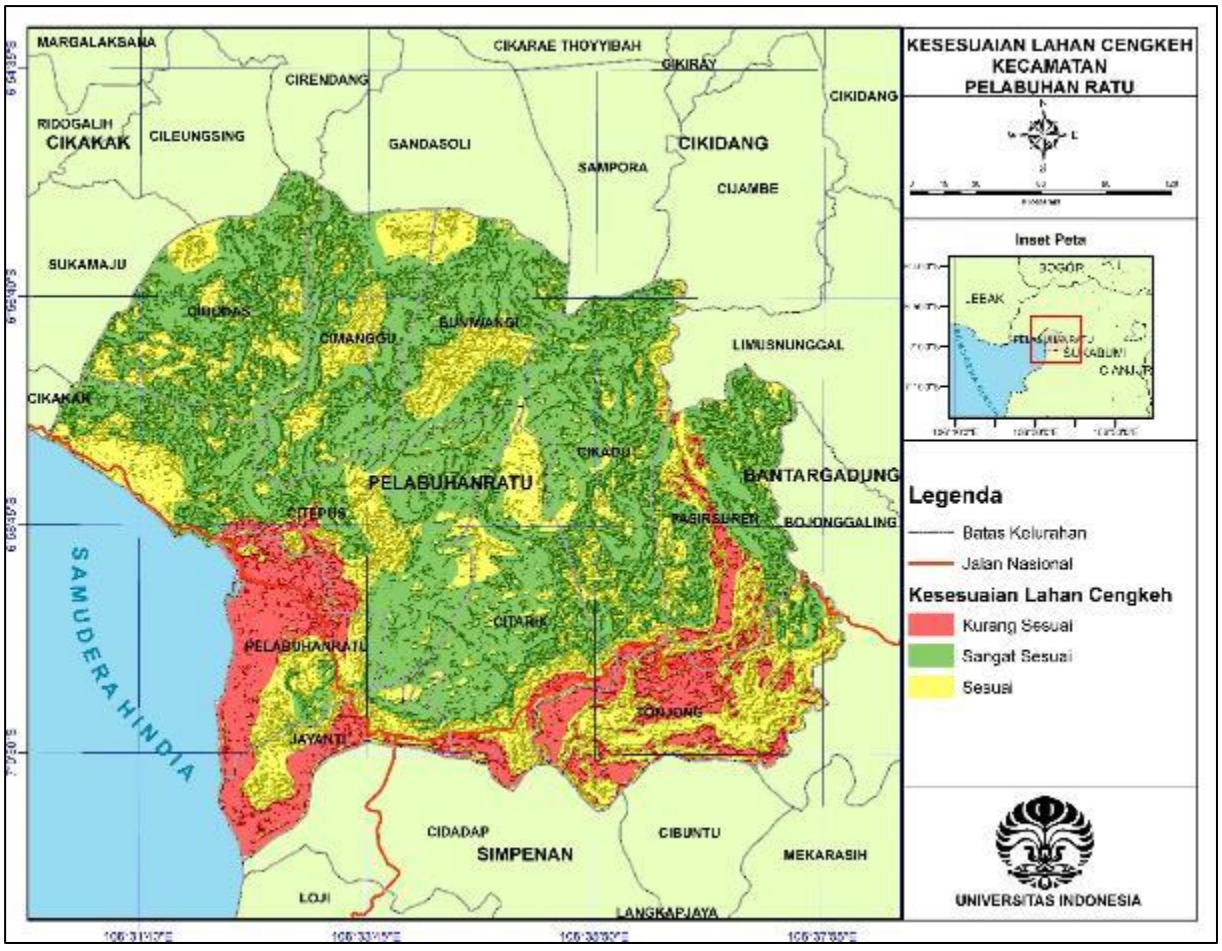

Figure 6. Clove land suitability

From this map the area for the "very suitable" class is quite dominant when compared to the "suitable" and "less suitable" class. for the "less suitable" class has an area of 12.79 Km^2 with a percentage of 13.81%, then for the "suitable" class it has an area of 29.95 Km^2 with a percentage of 32.33% and for the "very suitable" class has an area of 49.91 Km^2 with a percentage of 53.86%. However, there is a problem found from the BPS data, namely that there are still quite a few plants that fail to harvest or do not bear fruit, which causes community unrest because clove prices are getting better but production in their area is not even getting better. After further interviews with the Sukabumi District Agriculture Service it was found that basically

there had been an increase in rainfall over the past few years, this was what caused the clove plants to not bear fruit and ultimately crop failure.

4. Conclusions and recommendations

From the results of the study, it was found that in general the Pelabuhanratu sub-district area has a suitability area with a very suitable class that dominates where this can be beneficial for the surrounding community who have gardens or plant cloves because the price of clove commodities is quite high. The results obtained are divided into three classes, namely, very suitable, suitable, and less suitable. The results of this research were only obtained using 4 variables, namely soil type, slope, height, and precipitation, where each of these data was weighted equally, namely 25%. The suitable area is 29.95 Km^2, for the very suitable class it has an area of 49.91 Km^2 and for the less suitable class it has an area of 12.79 Km^2 From the results obtained from data processing and observations in the field, it is true that many of the suitable and very suitable areas on the map are planted with clove plants. but due to climate change that is happening it makes it difficult clove plants to produce fruit, the people who generally have a big opinion of the clove plants are finally experiencing economic difficulties and also changes in livelihoods and even though their plants have not bear fruit for about 3 years, the clove plants in their gardens are still fertile and do not withered, because of this the community still have hope that this plant will bear fruit again in the future. For this reason, it is necessary to carry out further research and studies regarding this research together with plant experts and plant engineering.

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