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# The Suggest of Rubber Crops Cultivation Development Zonation at West Bandung Regency

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**Abstract.** This research aims to obtain an overview of the physical conditions that supported the rubber crops cultivation development, and extent the overview of potential rubber crops cultivation development suggestion at West Bandung district. The method which used in this research is survey. This research uses primary and secondary data. The primary data are observation and measurement of physical condition at 39 sample points. The secondary data was obtained from map interpretation, review of various document and literature which are related with this research. The data was analyzed using Geographic Information System. The results indicate that the physical condition at West Bandung district became the supporting capacity of rubber crops cultivation development. The affecting conditions are climate, slope, water availability, condition and type of the soil. The results were presented in maps. The rubber crops cultivation development was suggested to the 21234,728 Ha (16.26%) of West Bandung district. The conclusion of this research is the physical conditions affect the potential development of rubber crop cultivation in West Bandung district. That potential rubber crop cultivation can provide an overview of what potential things can be developed to realize the welfare of society, in order to improve the standart of living society income.

## 1. Introduction

Indonesia has a lot of human resources, and has various forms of natural resources. In particular, land resources related to the potential of agriculture, plantations and forestry. The population increase is not comparable with the availability of relatively fixed land. This causes the demand for meeting human needs is not proportional to the availability of land resources. Therefore, the potential and ability of limited land resources must be used more ecologically and economically for the present and future interests.

Rubber tree is an important industrial crop for natural rubber production due to its unique mechanical properties, such as tearing resistance, compared with synthetic rubber [1]. Sustainable rubber development is a good business opportunity because it is a long-term investment [2].

Rubber is a tropical tree crop which is mainly grown for the industrial production of latex. Rubber trees grow mainly in tropical lowlands below 400m altitude, originally covered by a dense tropical rainforest [3]. Rubber is a vital requirement for everyday human life, this is related to human mobility and goods that require components made of rubber such as vehicle tires, conveyor belts, transmission belts, dock fenders, rubber shoes and sandals. Rubber plants are traditionally known as plantation crops. However, now rubber plants are also known as forest plants. Rubber plantations have the potential for environmental conservation, especially in terms of CO<sup>2</sup> absorption and O<sup>2</sup> producers. In



addition, rubber wood has a good style and quality so that it can substitute several types of wood exploited from the forest [4,5]

Rubber plants also make a very important contribution to environmental conservation. In rubber plants, the energy produced such as oxygen, wood, and biomass can be used to support the function of improving the environment such as land rehabilitation, prevention of erosion and flooding, regulation of water use for other plants, and creating a healthy and pollution-free climate. In critical areas, deciduous rubber leaves can fertilize the soil. The life cycle of such rubber plants will continue to rotate and repeat for one cycle of rubber plants for at least 30 years. Therefore, the existence of rubber plantations is very strategic for the survival of life. This means that rubber plantations can take over the functions of forests that play an important role in regulating water use and reducing the increase in global warming [6]

Rubber plants (*Hevea brasiliensis*) are one of the export commodities that are the source of income for the country and the demand for rubber worldwide increases from year to year. Indonesia has the greatest opportunity to exploit this market potential [7]. The need for natural rubber and synthetic rubber continues to increase in line with increasing human living standards. In terms of economics regarding rubber plants globally, the results of the REP (Rubber Evaluation Project) study state that the demand for world natural and synthetic rubber in 2035 is 31.3 million tons for the tire and non-tire industries, and 15 million tons of which are natural rubber. Production of natural rubber in 2005 was estimated at 8.5 million tons. From this study it is projected that Indonesia's production growth will reach 3% per year, while Thailand is only 1% and Malaysia -2%. Production growth for Indonesia can be achieved through rejuvenation or replanting of large enough rubber, with estimated production in 2020 of 3.5 million tons and in 2035 of 5.1 million tons [8]. Therefore, studies are needed to maximize the production of rubber plants in Indonesia.

This research was conducted in West Bandung Regency. Based on the physical geography in the area of West Bandung Regency, the altitude generally ranges from 200 - 2000 meters above sea level. The morphology appearance of West Bandung Regency is grouped into four morphological units, namely the morphology of flat, sloping, hilly and mountainous morphology. Based on Junghuhn's climate criteria and classification, West Bandung Regency is included in the hot to cool climate zone, because the altitude of West Bandung Regency generally ranges from 200 - 2000 meters above sea level.

## 2. Methods

The method used in this study is a descriptive survey aimed at evaluation. The survey process is carried out by taking a sample from one population, then identifying, classifying and actually and potentially describing the land suitability class at the research location which aims to identify the potential areas for rubber developing cultivation based on physical and social geography, regional development potential and marketing of rubber products, and the potential development of rubber cultivation direction in West Bandung Regency.

The research population used was all agricultural land and rubber cultivation farmers in West Bandung Regency. The sample used in this study consisted of two, namely, human samples and regional samples. Human samples are samples of rubber plantation farmers. To determine the number of respondents using Slovin Formula (1990, in Kusmayadi and Sugiarto, 2000), as follows:

$$n = \frac{N}{1+Ne^2} \quad (1)$$

$n$  is number of sample,  $N$  is number of population,  $e$  is error tolerance. The error tolerance used 10%.

With an error rate of 10%, the samples obtained are 100 farmers. Managers or plantation companies consist of smallholder, private, and state plantations. The distribution of 100 samples was carried out proportionally for all three so that there were 12 smallholder farmers, 51 private plantation farmers and 37 State plantation farmers.

The sampling technique used for the sample region is stratified random sampling. The technique is carried out by taking samples that have the same strata in the land unit as a result of overlaying the slope factor, land use, land, rainfall and altitude while at the same time taking a sample of farmers carried out proportionally to the area of the land unit. The purpose of regional sampling is to analyze the physical geographic conditions that support rubber cultivation in West Bandung Regency, identify potential rubber development areas in West Bandung Regency, and find out the direction of potential rubber cultivation in West Bandung Regency.

The variables in this study consist of two variables, namely the independent variable and the dependent variable. The independent variable is the antecedent while the dependent variable is the consequent. Dependent variable is the variable that is affected by the independent variable [9]. The independent variables in this study are:

- a. Physical factors of the study area: Slope, Place Height, Land Condition, Soil Type, Climate, and Availability of water.
- b. Socio-Economic Factors: Level of education, and experience of rubber farmers, livelihoods, proportion of income, income, transportation, and government policies in West Bandung Regency.
- c. Rubber cultivation aspects: Land area, rubber production facilities, labor, capital, market opportunities, and post-harvest processing.

The dependent variable is variable predicted from independent variable [10]. The dependent variable in this study is the determination of the potential rubber plantation development area based on the conditions of physical and social geography that support rubber cultivation in West Bandung Regency, determining the potential and pattern marketing of cultivated rubber in West Bandung Regency, and determining the direction of rubber cultivation development in West Bandung Regency.

The data classified into two categories, namely primary data and secondary data obtained through several research techniques. Data collection techniques that can be used in this study are: Observation, Interview, Literature Study / Literature, and Documentation Study.

The equipment needed to assist in collecting data in this study are:

- a. Base map consists of:
  1. Digital Topographic Map of Bogor BAKOSURTANAL 2000
  2. Map of West Bandung Regency RTRW
  3. Geological Map of Cianjur 9 / XIII-E by Sujatmiko in 1972
  4. Geology Map of Bandung Sheet 9 / XIII-F by P.H. Silitonga in 1973
  5. Geological Map of Sindangbarang Sheet 1208-5 by M. Koesmono, Kusmana in 1996
  6. Geological Map of Banadarwaru Sheet 1208-2 by N. Suwarna in 1996
  7. Center for Geological Research and Development in Bandung.
- b. Monograph of West Bandung Regency
- c. West Java Rainfall Data
- d. GPS is used to determine the location of the place.
- e. Clinometers and protractors are used to measure slope.
- f. Digital camera.
- g. Checklists field.

The steps taken in this study are: Preparation Phase, Editing, Coding, Scoring, Data tabulation, and Data Interpretation

### *2.1. Matching Technique*

Determination of locations that have the potential for physical rubber development is carried out using matching techniques. This data analysis technique is carried out by comparing the characteristics of the land with the requirements for growing plants. In this land suitability analysis we need land physical data or land characteristics. Land characteristics are obtained from various data collection techniques in the surveys form, literature studies, documentation studies and

laboratory analysis. The characteristics of the land are matched with the requirements for growing rubber plants in the study area. The quality of the land to be matched consists of air temperature, water availability, road conditions, slope, and erosion hazard. Land suitability classification based on Class level: At the class level, land classified as appropriate (S) is distinguished between very suitable (S1), quite suitable (S2), and marginally appropriate (S3).

## 2.2. *Arranging Direction for Policy on Rubber Plantation Development in West Bandung Regency*

The preparation of rubber plantations development direction in West Bandung Regency was carried out spatially and descriptively. The landing map for the development of smallholder plantations is made by overlaying rubber land suitability maps with land use maps, maps of the West Bandung Regency forest area that are adjusted to the West Bandung Regency Spatial Plan and considering Government Regulation Number 6 of 2007 in conjunction with Government Regulation Number 3 of 2008 concerning Forest Arrangement and Preparation of Forest Management Plans and Forest Utilization and Forestry Minister's Regulation Number P.37 / Menhut-II / 2007 concerning Community Forestry and Forestry Minister's Regulation Number p.49 / Menhut-II / 2008 jo number P.14 / Menhut- II / 2010 concerning Village Forests as well as Law No. 41 of 2009 concerning Protection of Sustainable Food Agriculture Land. All maps overlaid on a scale of 1: 200,000. Criteria for determining the direction of rubber plantations development in West Bandung Regency based on actual land suitability classes and land use can be seen in Table 1.

**Table 1.** Determination of rubber plantations development direction

Spatial plan (RTRW)	Penggunaan Lahan	Land Suitability Class	Category
Cultivation Area	Unproductive old rubber plantations, grasslands, reeds, shrubs, community plantations (fields, mixed plantations)	S1, S2, S3 N1, N2	Direction Not direction
	Rice fields, built areas (settlements, buildings), large plantations	S1, S2, S3, N1, N2	Not direction
Protected Area	Whatever type of land use	S1, S2, S3, N1, N2	Not direction

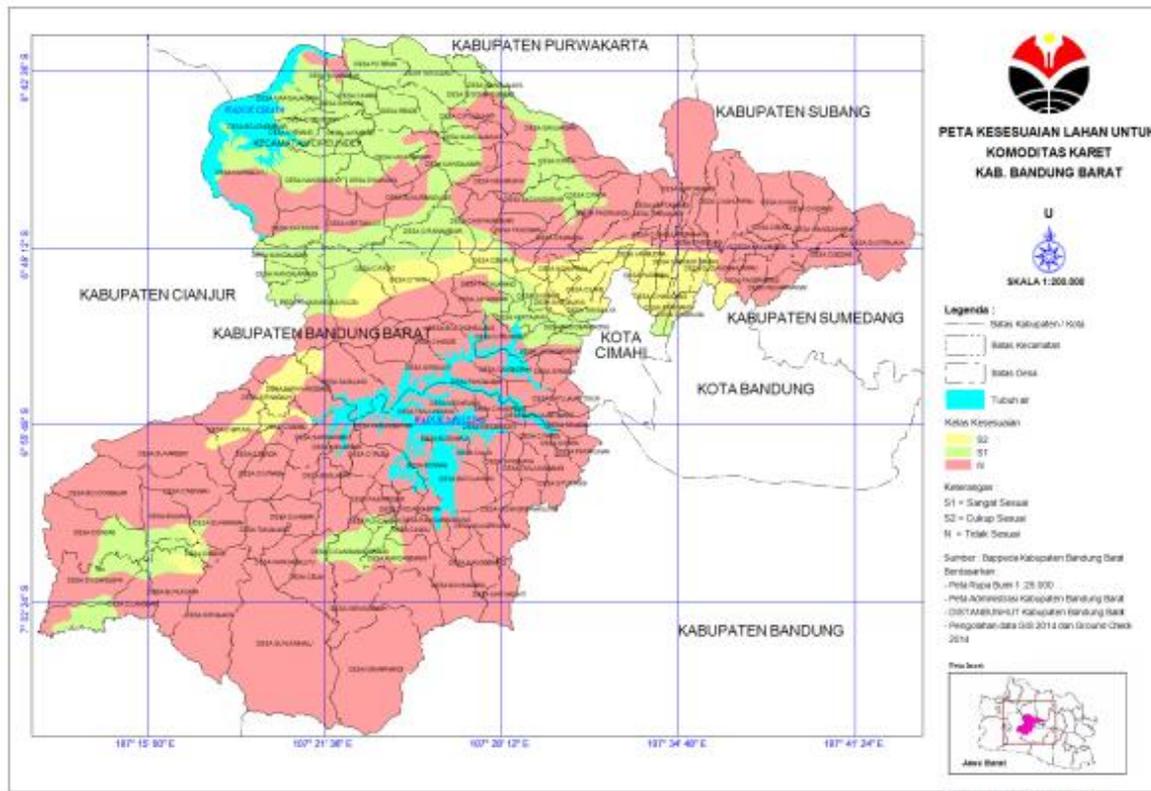
## 3. Result and Discussion

### 3.1. *Population Characteristics and Supporting Samples of Rubber Cultivation in West Bandung Regency*

3.1.1. *Physical factors.* The existence of rubber cultivation who developed by farmers in West Bandung Regency, supported by physical potential and plant growth requirements which include climate conditions, hydrology such as water availability and average rainfall required 2500 - 3000 mm/year, slope <8% or with a flat relief unit to a gentle slope, the state of the soil and has an optimum pH for rubber 4.5 - 5.5.

3.1.2. *Social factors.* While the social factors are supported by the level of education and experience of farmers, livelihoods, capital, abundant labour, the proportion of income, transportation and government support.

3.1.3. *Land Suitability for Rubber Plants in West Bandung Regency.* Based on land suitability analysis in West Bandung Regency, it is suitable for rubber cultivation, which is an area of 36478.8 Ha (29.50%) and inappropriate land 87187.3 Ha (70.50%) of the total area in the West Bandung Regency.



**Figure 1.** Land Suitability Map for Rubber Commodities in West Bandung Regency

Actually most of them are in the *Very Corresponding Class* (S1) covering an area of 26950.6 Ha (21.79%), and land that is included in the *Suitably Adequate* (S2) class of 9528.2 Ha (7.70%) for rubber plants in West Bandung Regency. Spatially the location of the land with the actual land suitability class is presented in the Land Suitability Map for Rubber Commodities in West Bandung Regency (Figure 1). Land with suitability classes S1, S2, and N in each sub-district in West Bandung Regency with varying areas can be seen in Table 2. The district with the widest S1 suitability class is Cipatat sub-district which is 6053 Ha. The land with the largest S2 suitability class is Cipatat sub-district which is an area of 1925 Ha. Subdistricts that have N rubber land suitability classes exist in all sub-districts and the widest is Gunung Halu Subdistrict, which is 24560 Ha.

**Table 2.** Land suitability classes for rubber plants in each class

No	Kecamatan	Suitability Class (Ha)		
		S1	S2	N
1	Cicalongwetan	7536	0	4079
2	Cipeundeuy	5591	0	2867
3	Parongpong	159,6	1440	2638
4	Cisarua	855,3	1196	3418
5	Lembang	0	332	9257
6	Cipatat	6053	1925	4093
7	Padalarang	1811	758,3	2469
8	Ngamprah	562,7	1701	905,3

9	Batujajar	0	203,2	6783
10	Cipongkor	0	1113	6670
11	Cililin	0	0	9939
12	Gununghalu	3033	859,7	24560
13	Sindangkerta	1349	0	9509
<b>Kab. Bandung Barat</b>		<b>26950,6</b>	<b>9528,2</b>	<b>87187,3</b>

### 3.2. *Potential and Marketing Patterns of Rubber Cultivation Results.*

The potential and pattern of marketing cultivated rubber in West Bandung Regency generally depends on the characteristics of the farmers who work on it. The rubber market opportunities applied in West Bandung Regency are carried out by several agencies, including by farmers (smallholders and large plantation farmers). This marketing objective is mostly local, such as being sold to village, sub-district, and factory middlemen around the West Bandung Regency. The government marketing, including promotions through exhibitions, factories, markets, and so on.

### 3.3. *Potential and Marketing Patterns of Rubber Cultivation Results.*

To mapping the location that will be the direction of rubber plants development in West Bandung Regency, a development direction map is needed, in which there is information on the development map of spatial aspects distribution and biophysical aspects suitable for rubber cultivation. The space aspect in this study is the land to be directed in accordance with the Regional Spatial Plan (RTRW) in West Bandung Regency. The biophysical aspect in this study is land that will be directed. The land is suitable land based on the evaluation of land suitability for rubber plants in the West Bandung Regency.

In accordance with the purpose of mapping the rubber cultivation development direction, this is only limited to directing the community to locations that are spatially and physically suitable for the development of rubber plants, it is not considering the existence of other plant commodities. This means that people are welcome to take the policies and decisions of their own cultivation plants what they want and will develop.

The type of land use in wetlands such as irrigated rice fields and rainfed rice fields is not directed to the development of rubber plants because wetlands are a very important type of land use and become a large capital for regional food security. Most wetlands in West Bandung Regency are planted with rice, and other food crops such as corn, and others.

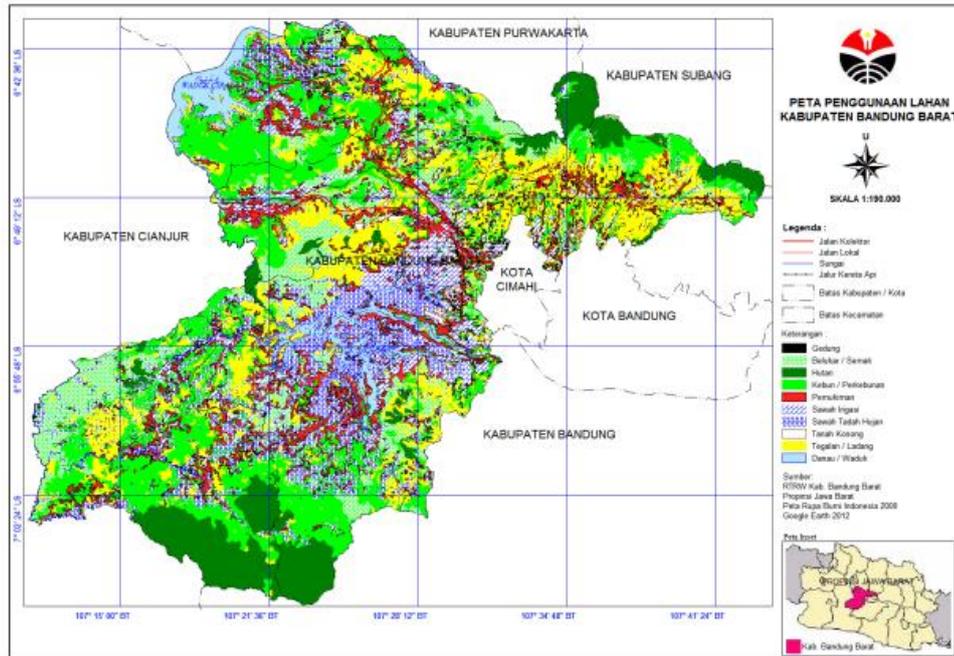


Figure 2. Land Use Map in West Bandung Regency

Based on Figure 2, the information about composition of land use in West Bandung Regency can be enumerated in Table 3.

**Table 3.** Composition of Land Use in West Bandung Regency

No	Land use	Total area (Ha)	Percentage (%)
<b>A Protected Area</b>			
1	Protected area	19171,04	14,65
<b>Total A</b>		<b>19171,04</b>	<b>14,65</b>
<b>B Cultivation Area</b>			
1	Agriculture cultivation area		
a.	Mixed plantation	8758,76	6,70
b.	Plantation	9562,95	7,31
c.	Rice field	16309,44	12,47
d.	Rainfed rice field	19342,69	14,79
e.	Unirrigated agriculture field	24472,31	18,71
<b>Total B1</b>		<b>78446,16</b>	<b>59,96</b>
2	Non agriculture cultivation		
a.	Industry	2270,73	1,74
b.	Institution	251,94	0,19
c.	Street	2000,00	1,53
f.	Railway	52,76	0,04
g.	Market area	776,79	0,59
h.	Settlement	20260,16	15,49
i.	Field	50,02	0,04
j.	Park	35,11	0,03
k.	Mines	114,31	0,09
<b>Total B2</b>		<b>25812,82</b>	<b>19,73</b>
<b>Total B</b>		<b>104256,98</b>	<b>79,69</b>
<b>C Others</b>			
1	Vacant land	3580,125	2,83
2	Grassland	3567,775	2,82
<b>Total C</b>		<b>7147,9</b>	<b>5,65</b>
<b>Total Amount A,B,C</b>		<b>130577,40</b>	<b>100,00</b>

Based on Table 3, the land use group for agricultural cultivation in West Bandung Regency is the largest, namely 78446.16 Ha (59.96%) of the West Bandung Regency area, while those that include protected areas are 19171.04 Ha (14.65%), non-agricultural cultivation covering an area of 25812.82 ha (19.73%) and others covering an area of 7147.9 ha (5.65%), the smallest area of West Bandung Regency.

The direction of rubber plants development location is divided into several priorities by considering the provisions of the rubber plantations development direction in the West Bandung Regency, the status of forest area, suitability class, current land use, and description of farmers and community responses to rubber cultivation. The priority division of development directions can be seen in Table 4.

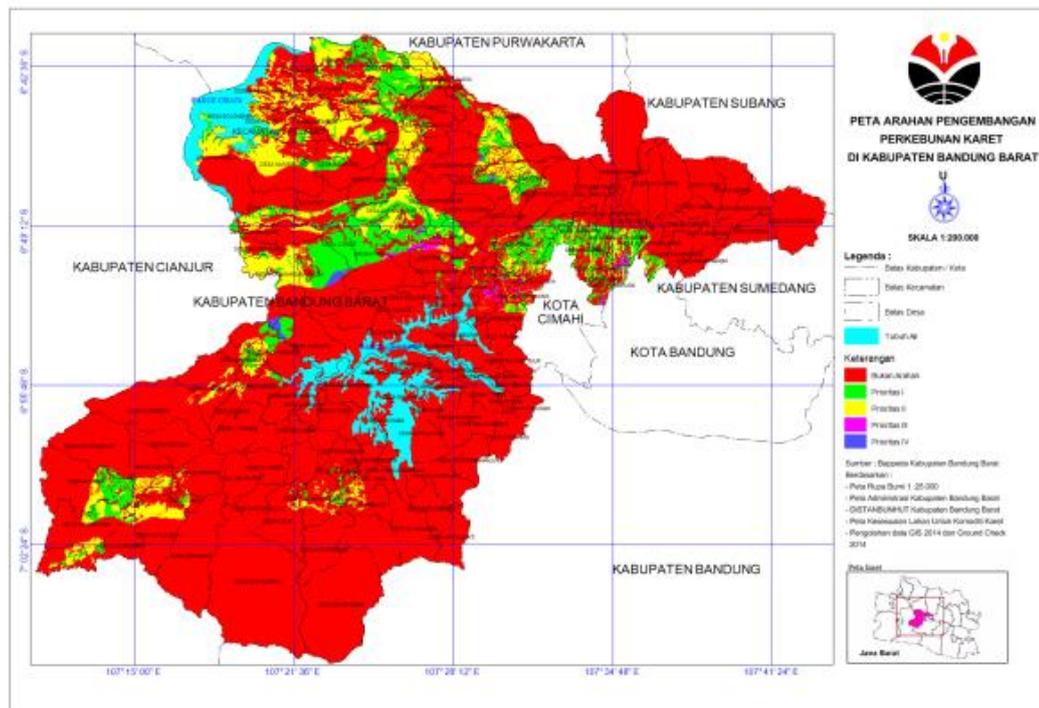
**Table 4.** Priority division of rubber development directions

Priority location	Suitability Class	Land use (Availability)
Priority I	S2	Grasslands, reeds, bushes outside the forest area
Priority II	S1	Old rubber plantation outside the forest area
Priority III	S2	Empty land and plantations outside the forest area designated as Community Plantation Forest area
Priority IV	S1, S2	Grasslands, reeds, bushes, old rubber in production forests, and community plantations in other use areas and production forests

**Table 5.** The direction of rubber plants development location and their priorities

District	Direction rubber plant development priority (Ha)				
	Not direction	I	II	III	IV
Cikalongwetan	6788,03	2020	2781	12,94	13,03
Cipeundeuy	5647,668	514,1	2279	8,616	0
Parongpong	3254,75	600,8	295,6	86,45	0
Cisarua	4036,75	883,8	528,4	0	20,35
Lembang	9367,108	144	73,22	4,672	0
Cipatat	6615,9	3194	2028	98,6	134,5
Padalarang	4101	503,1	269,6	164,6	0
Ngamprah	1994,93	654,9	457,6	61,57	0
Batujajar	6921,32	12,4	0	0	64,88
Cipongkor	7168,1	318,5	296,4	0	0
Cililin	9939	0	0	0	0
Gununghalu	26170,1	797,6	1485	0	0
Sindangkerta	10430,5	129,3	298,2	0	0
<b>Bandung Barat Regency</b>	<b>102435,16</b>	<b>9772,5</b>	<b>10792</b>	<b>437,4</b>	<b>232,8</b>

Based on Table 5, land that has the potential for the development of rubber plants in West Bandung Regency is found in 13 Districts with a total area of 21234,728 Ha or 16.26% of the total West Bandung Regency area. District with the widest potential land is Cipatat district with an area of 5455.1 Ha (4.1%), followed by Cikalongwetan and Cipeundeuy districts with an area of 48.26,97 Ha (3.69%) and 2801.71 Ha respectively. (2.14%) of the West Bandung Regency total area. Spatially, the direction of rubber plants development in West Bandung Regency can be seen in Figure 3.



**Figure 3.** Rubber Development Direction Map in West Bandung Regency.

#### 4. Conclusion

The existence of rubber cultivation developed by farmers in West Bandung Regency, supported by physical potential and plant growth requirements which include climate conditions, hydrology such as water availability and average rainfall required 2500 - 3000 mm / year, slope <8% or with a flat relief unit to a gentle slope, the state of the soil and has an optimum pH for rubber 4.5 - 5.5. While the social factors are supported by the level of education and experience of farmers, livelihoods, capital, abundant labor, the proportion of income, transportation and government support. The potential and marketing pattern of cultivated rubber in West Bandung Regency generally depends on the characteristics of the farmers who work on it. The rubber market opportunities that are applied in West Bandung Regency are carried out by several agencies including by farmers, both smallholders and large-scale farmers in the marketing sector, mostly local, namely to middlemen in villages, sub-districts and factories around West Bandung Regency. While government marketing, including promotions through exhibitions, factories, markets, and so on

Other direction for the development of rubber cultivation in West Bandung Regency can be directed to an area of 21234,728 hectares (16.26%) of West Bandung Regency area. The direction of this development is not to emphasize that the entire area is only suitable for rubber plants, but only as a direction so that people who are interested in developing rubber plants can plant it in this landing area.

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