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LAND USE PLANNING FOR BEEKEEPING USING GEOGRAPHIC INFORMATION SYSTEM IN SUKABUMI REGENCY, WEST JAVA

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Abstract. *Beekeeping is one of the alternative businesses that can be developed without converting the existing land use. Deveoping the business of beekeeping should consider the biophysically suitable area for bees themselves and also for the bee forage availability. The objective of this study was to provide the direction of development area for beekeeping. The methods used consist ofa combination of remote sensing, geographic information system, and analytical hierarchy process. The recommended area for beekeeping in Sukabumi regency consists of two areas: forest and dry land agriculture area. The protected area has two priorities: The first priority area for beekeeping is 3,335.52 ha (6.4%), while second priority is 48,415.22 ha (93.6%) that covered 14 sub-districts. The cultivation area has three priorities: First priority area is 1,163.92 ha, second priorityarea is 6,044.98 ha, and third priority area is 2,651.21 ha that covered 9 sub-districts. Based on result of analysis with the existing beekeeping in Sukabumi regency, local government of Sukabumi regency or local farmer could develop program for beekeeping in such as sub district: Cibadak, Cicurug, Cidahu, Ciemas, Cikidang, Ciracap, Cisolok, Kabandungan, Kadudampit, Kalapanunggal, Nagrak, Pelabuhan Ratu, Sukabumi, Sukaraja, Jampang Kulon, Pabuaran, Sagaranten, Surade, and Tegalbuleud.*

Keywords: *analytical hierarchy process, bee forage, beekeeping, geographic information system, landuse planning*

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1. Introduction

The increase of Indonesian population is considerably rapid. In the year 2010, the population was 237 million people, which increased to become 254.9 million people in the year 2015 (BPS, 2016). This high rate of population growth has impact on social, economic and ecological aspects of the people's life and environment (CICRED, 1974; Muhidin, 2002). Population increase creates many impacts, such as the need formore space, either for living, working and food supply. Further, such additional needs will have effect on land conversion, including conversion offorest to other land utilization type (Simorangkir, 2006). Negative impacts such as flood, erosion, drought and other natural disasters could occur when the forest conversion could not be limited, because forest has an important function in ecological preservation. Minimizing such forest conversion is important (FAO, 2011). Under this condition, increasing the value of existing forestbecomes imperative.

In order to minimize forest conversion, finding a land utilization which has a high value is important. Beekeeping is one of the alternative businesses that can be developed in the forest, as well as in the cultivated area in the forest margin (Hilmi *et al.,* 2011; Widiatmaka *et al*., 2015). Besides its function of preserving the forest utilization beekeeping has economic benefits.

The average production of honey from bee colonies in year 2010 through 2014 was 25.37 ton/year (Ministry of Environment and Forestry, 2014). Besides that, Ministry of Forestry also stated that honey production in Indonesia was 5,000 ton/year, whereasmost of them were produced by natural honey (Irmansyah, 2016). The actual consumption rate of Indonesia for honey was about 10 to 15 gram/person/year, much lower than the consumption in Japan and Australia which were around 1,200 to 1,500 gram/person/year (Novandra and Made, 2013). With assumption that honey consumption rate is 30 gram/year/person and the actual Indonesian populationis 254.9 million, Indonesia requires at least 7,647 ton per year. The gap between demand and supply of honey becomes a great opportunity to develop beekeeping business.

One of the problems faced by Indonesian beekeeping is the low production, actually at around 1-3 kg of honey per colony per year. This production is much lower than the optimal and potential productions which canattain 5-10 kg per colony per year (Saepudin, 2011; Kuntadi, 2013). In order to increase the production, determining the suitable area for beekeeping can become one of the solutions, to acquire high production. Besides suitable for the bee itself, the suitable area for beekeeping needs also be

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suitable for bee forage (Widiatmaka*et al.,* 2015). The suitable area, eitherbiophysically and availability of bee forage will support the metabolism and reproduction of bees, and therefore will increase the productivity of bees and prevent bee migration (Bohart *et al.,* 1956). The parameters which were impact to productivity of bees are land use land cover, rain fall, elevation, temperature, distance to the road, and distance to the river (Abou-Shaara, 2014; Amiri and Shariff, 2011; Girling *et al*., 2013; Karunaratne and Edirisinghe, 2008; Kuhnholz and Seeley, 1997; Rachmawati *et al*., 2015; Somerville, 1999; Widiatmaka *et al*., 2015).

With such background, the main objective of this research was to provide direction for development of beekeeping in Sukabumi Regency. To achieve the main objective there are specific objectives of this research which one: to update the existing land use and land cover, to analyze and determine the biophysically suitable area for beekeeping, to analyze and determine the suitable area for bee forage, to analyze and determine direction of development beekeeping.

2. Methodology

This research was held in Sukabumi Regency, West Java Province from August to December 2014. For this research, land use and land cover map was provided by Ministry of Forestry and satellite imagery (Landsat 8) was downloaded from USGS (http://earthexplorer.usgs.gov/) at acquisition date of 17 February 2014 path 122 row 65. The administration map such as road, river and sub district was provided by Geospatial Information Agency. Elevation map was derived from ASTER GDEM resolution 30m, downloaded from http://earthexplorer.usgs.gov/. Map of Land System was provided by Regional Physical Planning Program Transmigration (RePProT), Ministry of Transmigration (1989). The climatic data, which consists of temperature and rainfall were obtained from www.globalwheather.tamu.edu and Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG). Other documents which were use did this study such as regional spatial planning, population, agriculture potency, etc., were collected from local government of Sukabumi Regency.

Tools which were used in this study consist of hardware and software. The hardwares being used consist of GPS receiver, digital camera, and computer. They were used for ground checking, documentation, and processing of data.The software was used in this study was Arc GIS 10.1 to analysis the spatial data and processing the satelliteimagery. The spatial data analysis was conducted at laboratory of Master of Information Technology for Natural Resource Management, South East Asian Regional Center for Tropical Biology (MIT-SEAMEO BIOTROP). Generally, the methodologies could be grouped into four steps: (1) updating the existing land use and land cover map, (2) providing map of the biophysically suitable area for bee, (3) providing map for the suitable area for bee forage (4) providing land suitability map for beekeeping.

The land use and land cover of Sukabumi regency consisted of thirteen land use and land cover classes, namely settlement, dry land primary forest, dry land secondary forest, plantation forest, shrubland, plantation, bare land, water body, secondary mangrove forest, dry land agriculture, dryland agriculture mixed with shrub, paddy field, and fish pond. These classes were simplified in this research to become nine classes, namely settlement, forest, dry land agriculture, plantation, bare land, shrub land, paddy field, water body and fish pond. This class simplification does not give significant effect to the study.

This land use and land cover was updated by using Landsat 8. The method used was visual image interpretation, based on human vision system to interpret pattern and colors in the image. Spontaneous recognition and logical inference are distinguished (Janssen, 2000). To enhance the image used a pan sharp, where each band was changed from 30m to 15m spatial resolution. The composite band for Landsat 8 was used true color (Red: 4, Green: 3, Blue: 2). Validation was done by ground truth and Google earth check. The ground truth was done by checking thirty locations, selected by purposive sampling.

Common validations in remote sensing were using user's accuracy, procedures accuracy, overall accuracy, and Kappa accuracy. This accuracy was calculated using Microsoft Excel. The formulas used for accuracy measurement are as follows (Janssen, 2000).

The biophysically suitable area in this analysis consist of six criterias, namely land use, distance to the river, distance to the road, temperature, elevation and rainfall. The selected criteria based on literature review as well as the data availability (Amiri and Shariff, 2011; Widiatmaka *et al*., 2015; Rachmawati *et al*., 2015) and result of interview with the local stakeholders that consist of experts, farmers, and local government officers.

These criterias have effect to life, activity of bee and production of honey. The land cover was related to the source of bee forage, where the flower of plant providing nectar and pollen (Liferdi, 2008; Van Der Steen, 2015).

Elevation has strong relation with temperature and bee activity. When elevation is too high, temperature will decrease that would affect the activity of bee. This means that the productivity of honey will decrease. The elevation that is too high will create difficulty for farmers in maintaining, overseeing and moving the hive to other place (Karunaratne and Edirisinghe, 2008).

Table 1. Classification of the biophysically suitable criteria

No	Criteria	S1 Most Suitable 2	S2 Moderately Suitable 2	N Not Suitable 0
a.	Land use and land cover	Dry land agriculture and Shrub	Forest and plantation	Bare land, settlement, paddy field, water body, and fishpond
b.	Elevation	below 500 meter (above sea level)	500 – 1000 meter (above sea level)	Above 1000 meter (above sea level)
c.	Temperature	25 – 30 ^{0}C	20 – 25	Less than 20^{0}C and more than 30^{0}C
d.	Rainfall	2500-3000 mm/year	3000-3500 mm/year	3500-4000 mm/year
e.	Distance to the river	0-1500 m	1500-3000 m	more than 3000 m
f.	Distance to the road	0.5 – 2 km	2 – 4 km	less than 0.5 km and more than 4 km

Bee is active in specific temperature which is also related to the production of honey. Bee is active at temperature between 20 – 30 ^{0}C. At temperature below the range, bee is less active and so, honey production will decrease, while above that range limit, bee could die (Somerville, 1999; APRIARI, 2003).

Rainfall is related to the production of nectar and pollen in plant and also related the activity of bees. The high rainfall will make nectar and pollen fall into the ground and the bees can not take it. Rain also makes bee difficult to get nectar because bee cannot fly freely to get the nectar (Somerville, 1999). Bees need water in their production and activity.

Water supply in this research is considered to come from river around the study area. The bee colony adaptively controls the collection of water, increasing it when high temperatures necessitate evaporative cooling inside the hive and decreasing it when the danger of overheating has passed (Kuhnholz and Seeley, 1997).

Distance to the road is related to noise of vehicle, because bee can be stress and cannot active properly. The diesel fume exhaust can decrease the foraging efficiency of honey bee workers by reducing the ability of worker bees to recognize floral odors (Girling *et al*., 2013; Abou-Shaara, 2014).

The suitability of each criteria was classified into three classes, namely most suitable (S1), moderately suitable (S2) and not suitable (N). The table of criteria is shown in Table 1.

This research was used Pairwise comparison method developed by Saaty (1980) as part of AHP concept. Comparison between each factor was consulted to the expert team, which have experiences and objectiveness to make judgment on importance of each pair factor. Values of each factor as result of interview and discussion inputted to matrix pair wise comparison and ready to compare. Next step was normalization, to normalize the matrix it need to total the numbers in each column. Each entry in the columns was divided by the column sum to yield its normalized score. When summed each column will gain score 1.

Table 2. Pairwise comparison matrix

Criteria	Landuse land cover	Water supply	Road access	Temperature	Elevation	Rainfall	Weight
Landuse land cover	1.00	3.37	3.73	3.10	2.35	0.64	28.8%
Water supply	0.30	1.00	1.43	1.55	1.89	0.39	13.2%
Road access	0.27	0.70	1.00	0.70	1.25	0.30	8.8%
Temperature	0.32	0.64	1.43	1.00	1.25	0.42	10.7%
Elevation	0.43	0.53	0.80	0.80	1.00	0.61	10.2%
Rainfall	1.55	2.55	3.37	2.41	1.64	1.00	28.4%

N : 5
λ_{max} : 6.197866
CI : 0.039573
RI : 1.45
CR : 0.031

Consistency analysis, the purpose of this step was to ensure that original preference ratings were consistent. First step was measure the consistency index (CI). In such formula, RI is a random index from Saaty (1980), the limit of consistency ratio ≤ 0.1 was applied. This limit indicates that comparisons of criteria were perfectly consistent and the relative weights are appropriate for use in land suitability for beekeeping.

It should be noted, that when the result of judgment from an expert is not consistent, it is important to check the judgment one by one. To merge values of expert judgment, geometric mean method (Marimin, 2008) was applied.

The results of the pairwise comparisons conducted in this study are given in Table 2. The consistency ratio was 0.031, indicating that this value is acceptable (Saaty, 1980). The weight resulted from such process were then applied for a process of weighted overlay in Arc GIS 10.1 to obtain the suitability map for bee.

The third step of the research consisted of providing land suitability map for bee forage. The data used in this step is land system data, provided by RePProt (Ministry of Transmigration, 1989) at scale of 1:250,000. In such map, Sukabumi Regency was consisted of 76 land units. There are ten parameters in the data, however there were only four parameters being used in this study, namely temperature, rainfall, slope, and soil texture (Table 3).

The bee for age analyze din this study wasthe bee forage species resulting from an interview with the local farmer. The consideration in selection of plant species includes the flowering period, kind of forage (nectar or pollen), location suitability, and other benefits obtained from those plants such as fruit, wood, and leaf (Subharani *et al.,*2012 and Sihombing, 2005). With such process, the species chosen in this research were corn, rambutan, paddy, rubber, and calliandra. Land evaluation process was done by matching method (Hardjowigeno and Widiatmaka, 2007). This method was conducted by matching the land characteristic with the land requirement of each species (Hardjowigeno and Widiatmaka, 2007). The criteria used were shown in Table 3.

There are two combinations of bee forage considered in this research: first, the combination of suitable area consider in five kinds of bee forage and second, the combination of suitable area considering four kinds of bee forage.

The fourth step is providing land suitability map for beekeeping according to the forest area and cultivaated area. The biophysically suitable area was overlay with the forest area. This condition because the forest area not posible to planting/growing the selected species. The suitable area for beekeping in cultivated area were overlay between dry land agriculture, biophysically suitable area and suitable area for bee forege.

Table 3. Growth requirement of species of bee forage

a. Paddy (*Oryza sativa*)*

Land Quality/ Land Characteristic	Class of land suitability	
	S	N
Temperature (TC)		
Average temperature (ºC)	18-35	18>N>35
Availability of water (WA)		
Agroclimatic zone (Oldeman)	A1, A2, B1, B2, C1, C2, C3, D1, D2, D3, D4, E1, E2, E3	E4
Rooting media (RC)		
Texture	Fine, moderately fine, medium, Fine, moderately fine, medium, Medium rock	Rock
Slope	3-15	>15

b. Corn (*Zea mays*)*

Land characteristic	Class of land suitability	
	S	N
Temperature (TC)		
Average temperature (ºC)	16-32	16 >N >32
Availability of water (WA)		
Rainfall	300-1600	<300
Texture	Fine, moderately fine, moderate , Fine, moderately fine, moderate , Moderate rock	Rock
Slope	<15	>15

c. Rambutan (*Nephelium lappaceum*)*

Land characteristic	Class of land suitability	
	S	N
Temperature (TC)		
Average temperature (ºC)	20-32	20>N>35
Availability of water (WA)		
Rainfall	1250-4000	1250>N >4000
Texture	Fine, moderately fine, moderate, very fine, moderate rock, very fine	Rock
Slope	15-30	>30

d. Rubber (*Hevea brasiliensis*)*

Land characteristic	Class of land suitability	
	S	N
Temperature (TC)		
Average temperature (ºC)	22-34	>34 and <22
Availability of water (WA)		
Rainfall	1500-4000	<1500 and >4000
Texture	Fine, moderately fine, moderate, moderate rock	Rock
Slope	<30	>30

e. Calliandra (Calliandra colonthyrsus)**

Land characteristic	Class of land suitability	
	S	N
Temperature (TC)		
Average temperature (°C)	22-28	>29 - < 21
Availability of water (WA)		
Rainfall	700-4000	< 699 - > 4000

* Hardjowigeno and Widiatmaka (2007)
**Rachmawati *et al.* (2014)

3. Result and Discussion

3.1. Existing Land Use and Land Cover

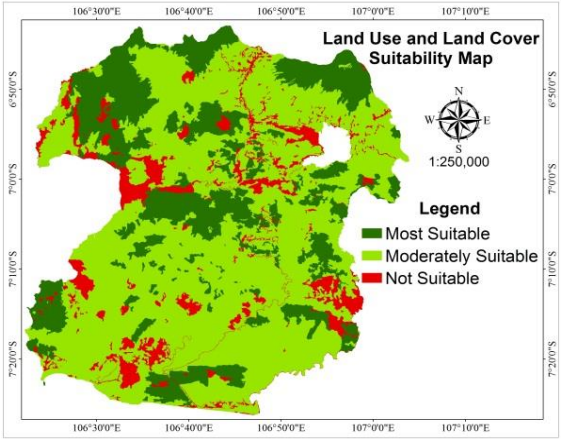
The analysis results of existing land use and land cover shown that in this regency, dry land agriculture has the largest area, around 256,051.4 ha (61.5%), followed by forest area which covers 82,190.2 ha (19.8%). The plantation covers 31,115.1 ha (7.5%), while paddy field covers 26,530.2 ha (6.4%). The settlement area in this regency is not too extensive, covering area of 8,299.9 ha (2.0%). Other land uses occupy small area, where bare land and shrubland covers 5,190.9 ha (1.3%) and 5,043.7 ha (1.2%) respectively. The water body and fish pond covers 1,735.8 ha (0.4%) and 42.7 ha (0.01%) respectively.

The producer's accuracy in this research ranges from 67% to 100%; the user's accuracy ranges from 67% to 100%; the overall accuracy has 90% and Kappa accuracy has 88.6%. These values indicate that the training set is good, which means that training set are homogeneous, the training classes are spectrally separable and the classification strategy being employed works well in the training area (Liliesand *et al.*, 1987).

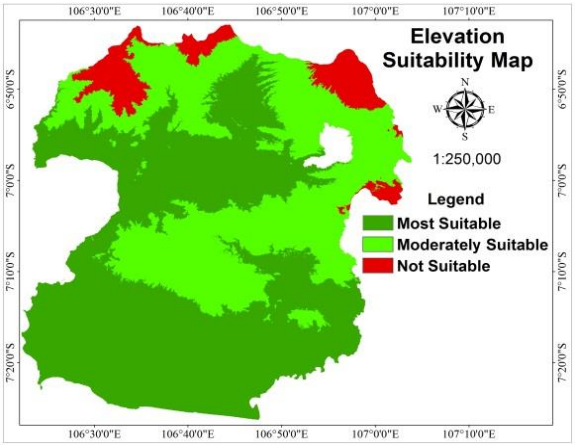
3.2. The Biophysically Suitable Area for Bee

In this study, the following factors were believed to be the important factors to be considered in the biophysically suitable for bee, which are: land use and land cover; elevation; temperature; rainfall, distance to the river; and distance to roads.

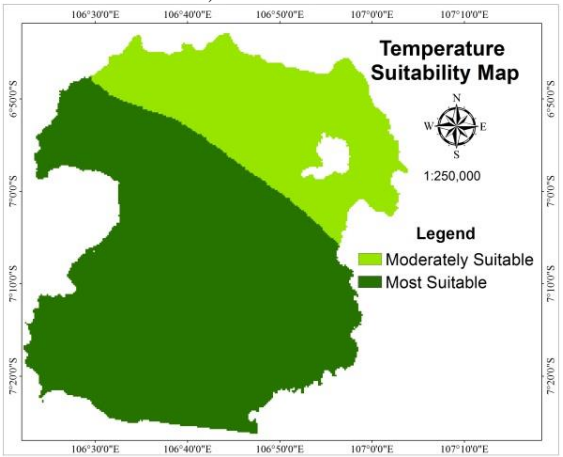
The maps of the suitable area for bee according to each of the criteria used are shown in Figure 1.The land use was related to the source of bee forage, i.e.flowering plants which provides nectar and pollen (Van Der Steen, 2015). When applied to spatial analysis, the result indicate that according to land use and land cover criteria, the most suitable land for beekeeping is 107,391.6 ha (26%), the moderately suitable occupy 268,391.3 ha (64%), while the not suitable area according to land use and land cover was 40,417.1 ha (10%). These results indicate that generally, land use and land cover in Sukabumi Regency are suitable for beekeeping



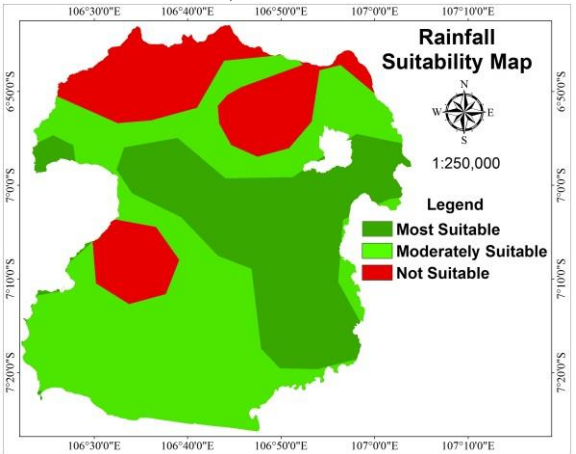
a) Land cover



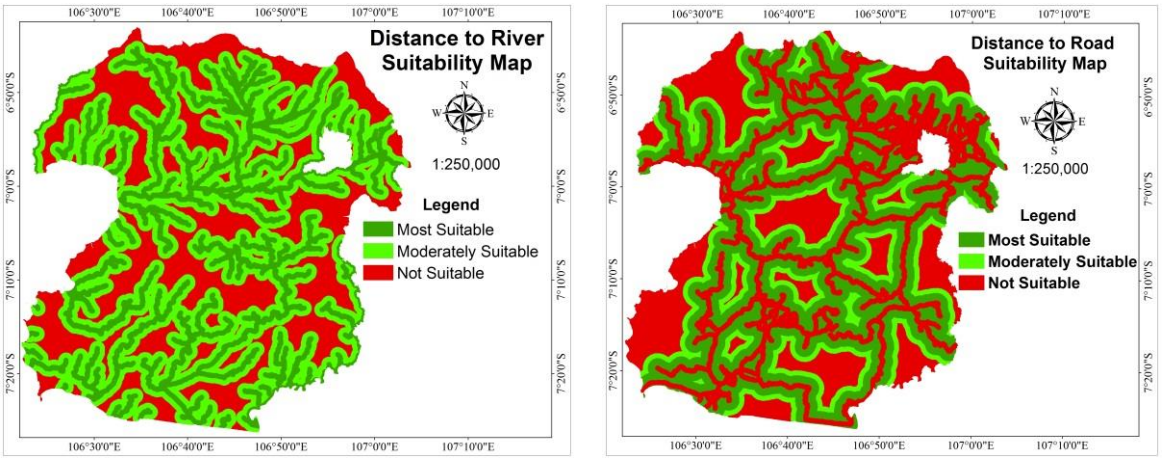
b) Elevation



c) Temperature



d) Rainfall



e) Distance to the river *f) Distance to the road*

Figure 1. Map of Suitability Land each criteria

The analysis result according to the criteria of distance to river indicates that the most suitable area (S1) for bee was 111,553.8 ha (27%), the moderately suitable (S2) area was 170,281.9 ha (41%) and the area which was not suitable for bee was 134,364.3 ha (32%).

Results of analysis for criteria distance to road indicate that the most suitable area is 161,365.9 ha (39%), the area which moderately suitable was 99,216.7 ha (24%), while the area which is not suitable was 155,593.6 ha (37%). This results show that the suitable area based on distance to the road for bee was mostly suitable at more than 50% area of Sukabumi Regency.

Sukabumi has two suitability classes based on temperature criteria, which are most suitable and moderately suitable. The most suitable area was 297,261.4 ha (71%) while the moderately suitable area was 118,938.6 ha (29%).

The most suitable area for beekeeping based on elevation was 152,034.9 ha (37%), the moderately suitable area was 235,522.9 ha (57%), while the unsuitable area was 28,642.2 ha (7%).

The suitability analysis results based on rainfall indicate that the most suitable area was 121,863.1 ha (29%), the moderately suitable area was 204,419.6 ha (49%), while the unsuitable area was 89,917.3 ha (22%).

The result of AHP was given in Table 2. Such results show that land use and land cover has the highest weight. The lowest weight was the distance to the road. The consistency ratio of these criteria is 0.031. The biophysically suitable area for beekeeping is shown in Figure 2.

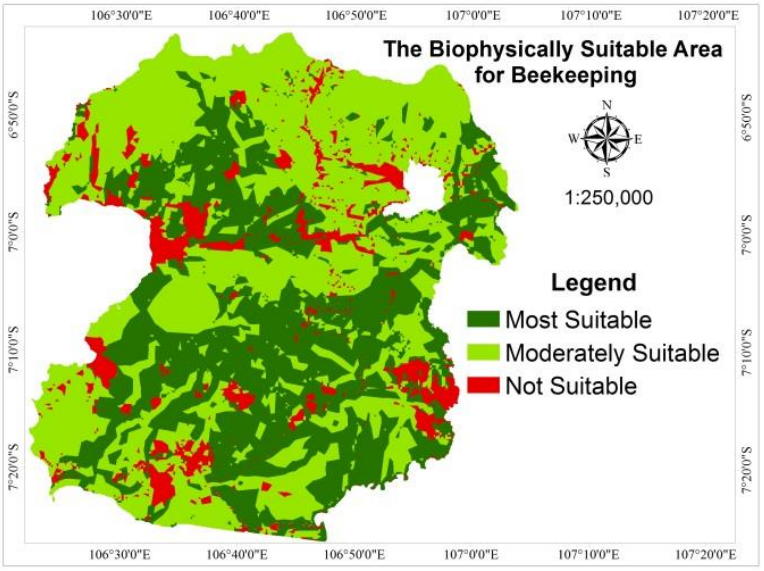


Figure 2. The biophysically suitable area for bee

The biophysically suitable area for bee was shown Table 4. Results of analysis indicate that the most biophysical suitable area for bee was 162,516.9 ha (39%), the area which moderately biophysical suitable for bee was 214,750.8 ha (52%), while the biophysical unsuitable area for bee was 38,832.3 ha (9%). Such results indicate that more than 90 percent of Sukabumi Regency was biophysically suitable for bee, only 9 percent of the area can be considered as biophysically not suitable for bee. Therefore in general, Sukabumi

Regency was suitable to develop beekeeping regarding the biophysical aspect.

Tabel 4. Biophysically suitable areafor bee in Sukabumi Regency

No	Class of Suitability	Area	Percentage
1	Not Suitable	38,841.6	9%
2	Moderately Suitable	214,802.4	52%
3	Most Suitable	162,556.0	39%
	Total	416,200.0	100%

3.3. The Suitable Area for Bee Forage

According to local farmer experiences, there are 72 plant species around their villages which can be considered as source of bee forage. Only several selected plant species will be analyzed in term of their suitability, namely calliandra, rubber, rambutan, paddy, and corn. Land suitability evaluation is carried out at level of orders, due to lack of land evaluation criteria at the level of sub-class.

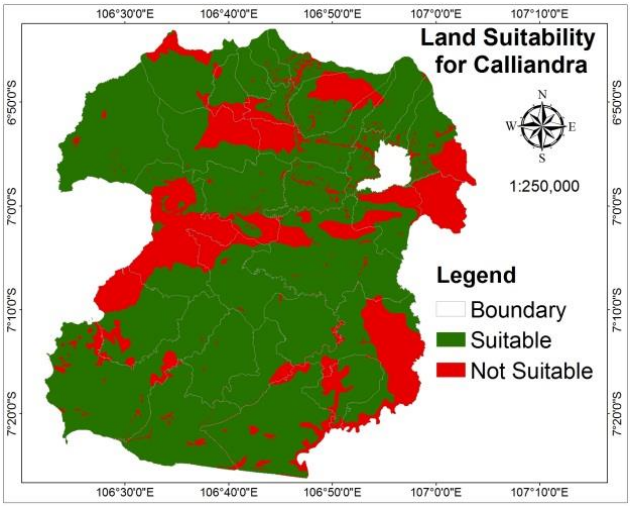
Calliandra (*Calliandra calothyrsus*) is usually shrubs or small trees, and rarely herb or large tree. It is 12 m tall. Stem can reach 20 cm diameter at base. Branchlets trite, striate, occasionally angulate, brown. *Calliandra calothyrsus* occurs in primary, secondary, and low land forest, as well as in submontane forests which are seasonally dry to wet sub-tropical forest, especially along river margins. Results of suitability analysis of calliandra indicate that the suitable area was 313,733.2 ha (75.38%), while the area which is not suitable was 102,466.8 ha (24.62%) (Figure3a).

Corn (*Zea mays*) is a type of seed crop from grass family (Graminaceae). Corn plants from tropical regions can adapt to environment outside it native area. Corn does not demand strict environmental requirements, can grow on a variety of sites, and even on rather dry soil conditions. The corn is planted by people in agriculture dry land around settlement area. The amount of corn being planted depends on each farmer, as there is no obligation to cultivate this plant. Cropping season varies greatly, usually done in the dry season because corn is not resistant to high rainfall. Analysis of land evaluation results on each unit shows that land area suitable for corn was 37,568.6 ha (9.03%), while that which was not suitable was 378,631.4 ha (90.97%) (Figure 3b).

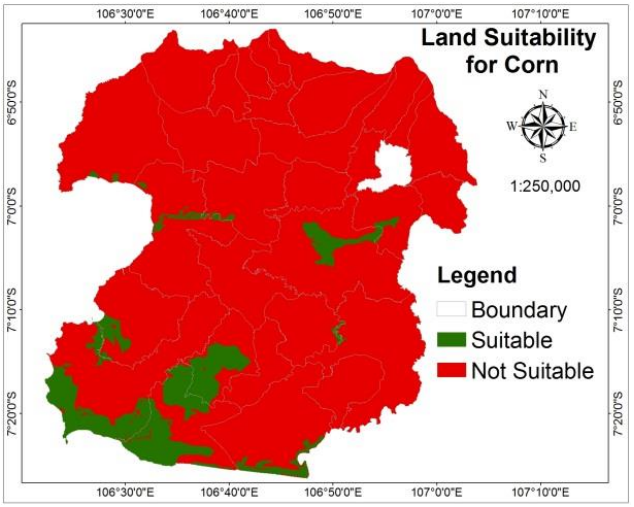
Sukabumi has rubber plantation which is planted by some private and national companies. Currently the rubber plantations only produce sap as raw material for tire product, and to increase the value of rubber plantation, the flower of rubber can be used as bee forage. When flowers bloom they produce nectar as source of carbohydrate for bees. The results of land evaluation show that the suitable area for rubber was 88,802.3 ha (21.34%), while the area which not suitable was 327,397.8 ha (78.66%) (Figure 3c).

Paddy *Oryza sativa* is the most widely grown crop in the world, including Asian, North and South American, European Union, Middle Eastern and African countries. In Indonesia, paddy is processed to rice to be used as a staple food. Paddy produce pollen for bees, the same phenomenon with that of corn. Results of land evaluation for rice crops give results similar with that of corn. This is because the two crops have similarity in limiting factor in each unit of land. The suitable area for paddy in Sukabumi was 55,929.52 ha (13.44%), while the area which not suitable was 360,270.35 ha (86.56%), the map of suitable area for paddy was shown in Figure 3d.

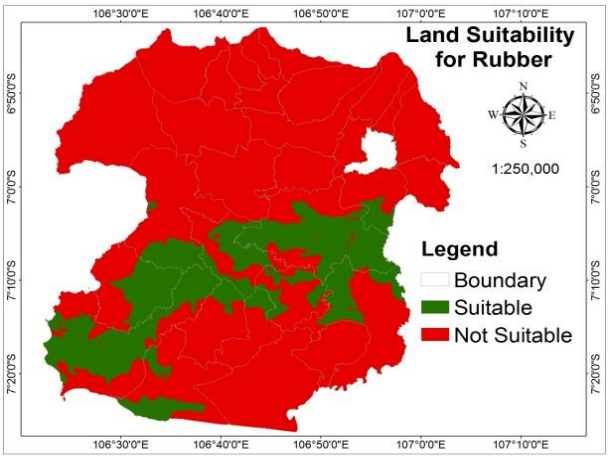
Rambutan (*Nephelium lappaceum*) is a tropical fruit plants and belongs to family Sapindaceae. The plant thrives in tropical humidity. Rainfall desired by plant rambutan ranges between 2000-3000 mm/year with an annual average temperature of 22-35^{0}C. This plant grows well at altitude of 0-600 masl. Rambutan prefers soil with texture of clay loam, and pH of 5-6.5, although it can be grown in a wide range of soil types, even on soils with poor drainage but not water logged (Orwa *et al*., 2009). The suitable area for rambutan in Sukabumi was 90,503.64 ha (21.75%), while the area which not suitable was 325,696.23 ha (78.25%). (Figure 3e).



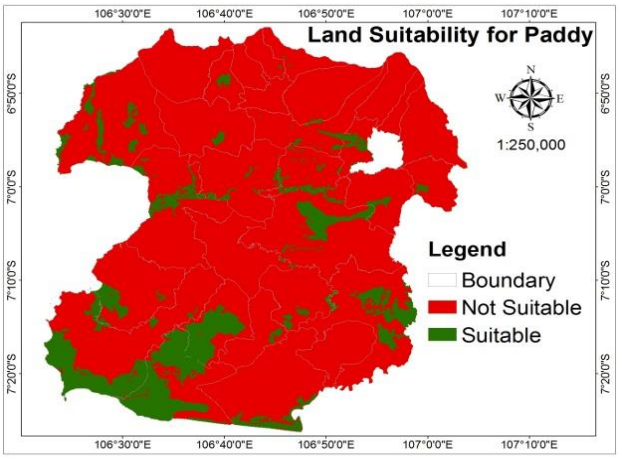
a. The land suitability for Calliandra



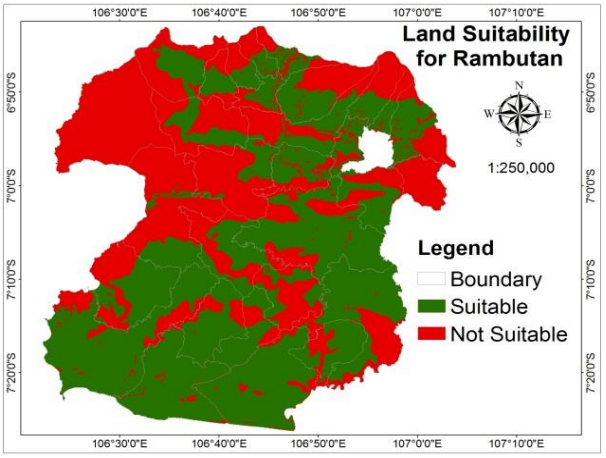
b. The land suitability for Corn



c. The land suitability for Rubber



d. The land suitability for Paddy



e. The land suitability for Rambutan

Figure 3. Land suitability for each bee forage

Results of combination of bee forages, obtained nine combinations. The combinations are differentiated on the basis of limiting factors. In this study, the analysis only displays two combinations: suitable area for four plants and suitable area for five plants. These combinations mean that on a land unit which was suitable, there can be planted, four or five selected plants.

The area which suitable for four combinations was 22,428.67 ha, located in Ciemas, Ciracap, Jampang Kulon, Jampang Tengah, Pabuaran, Surade, Sagaranten, Pelabuhan Ratu and Tegalbuleud. The area which suitable for five combinations was 11,660.69 ha, located in Jampang Tengah, Nyalindung, Ciracap, Surade and Palabuhan Ratu. The Map of suitable area for bee forage was shown in Figure 4.

3.4. Proposed Suitable Area for Beekeeping

Beekeeping development in protected areas can be done especially in protected forest and conservation forest, with regards to preserve the forest function. This circumstance is in accordance with the Government Regulation No. 6 Year 2007 about Forest Governance, Preparation of Forest Management Plan and Forest Utilization, which explained in detail by Minister of Forestry Regulation No. P.47/Menhut-II/2013 about the Guidance of Criteria and Standard of Forest Utilization in Specific Area on Protected Forest Management Unit and Production Forest Management Unit.

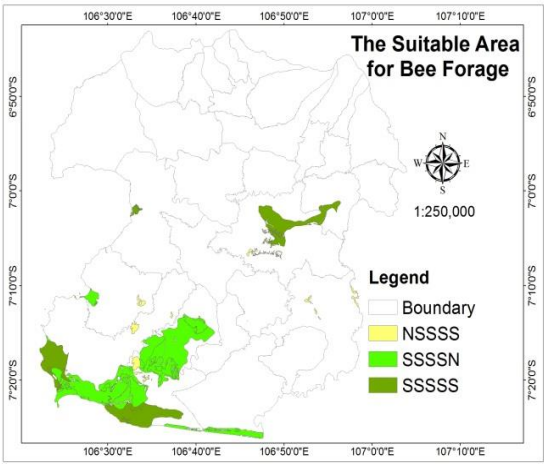


Figure 4.Map of suitable area for bee forage

Based on the regulation of protected forest and conservation forest which not allowed to be planted with fruit tree and season plant, thus for the land suitability analysis for beekeeping in protected area and conser-

vation area only overlaid to biophysical suitability for beekeeping.

The cultivated area on Regional Spatial Planning of Sukabumi Regency consists of 9 types. Dry land agriculture is possible to develop beekeeping, with regards this area is suitable to be planted with five selected species of bee forage. Overlaid done from the analysis of suitable area for beekeeping with dry land agriculture. The recommendation area for beekeeping was shown in figure 5.

The protected forest area is 51,750.74 ha, this is representing 12.43% of Sukabumi Regency. Overlay proses give result that the first priority area for beekeeping in protected area was 3,335.52 ha (6.4%), while second priority was 48,415.22 ha (93.6%) that covered 14 sub-districts namely Cibadak, Cicurug, Cidahu, Ciemas, Cikidang, Ciracap, Cisolok, Kabandungan, Kadudampit, Kalapanunggal, Nagrak, Pelabuhan Ratu, Sukabumi, Sukaraja.

The dry land agriculture area was representing the cultivated area. The dry land agriculture area was 124,606.62 ha or 29.94% of Sukabumi regency. The result of analysis was done give us three priorities area for beekeeping in cultivated area. The first priority area was 1,163.92 ha, second priority area was 6,044.98 ha, and third priority area was 2,651.21 ha that covered 9 sub districts namely Ciemas, Ciracap, Jampang Kulon, Jampang Tengah, Nyalindung, Pabuaran, Sagaranten, Surade, Tegalbuleud.

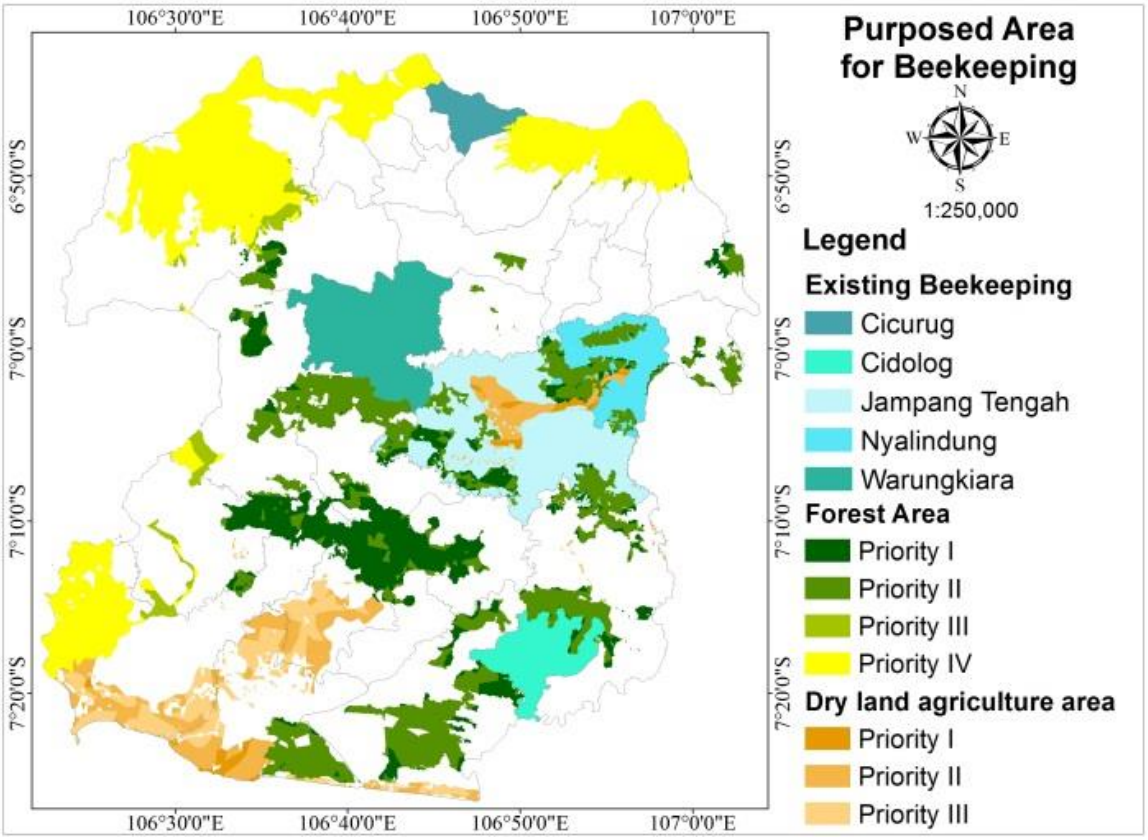


Figure 5. The Purposed development area for beekeeping

Based on result of analysis with the existing beekeeping in Sukabumi regency, local government of Sukabumi regency or local farmer could develop program for beekeeping in such as sub district:Cibadak, Cicurug, Cidahu, Ciemas, Cikidang, Ciracap, Cisolok, Kabandungan, Kadudampit, Kalapanunggal, Nagrak, Pelabuhan Ratu, Sukabumi, Sukaraja, Jampang Kulon, Pabuaran, Sagaranten, Surade, and Tegalbuleud.

4. Conclusion

The existing land use and land cover of Sukabumi Regency were classified into several classes including dry land agriculture, forest area, plantation, paddy field, settlement, bare land, shrub land, water body and fish pond. Overall accuracy was 90% and 88.6% according to Kappa accuracy.

Based on biophysical aspects and sets of criteria, the main factors to be considered in beekeeping were land use and land cover, distance to the road, distance to the river, temperature, elevation and rain fall. All of these factors indicating the potency of Sukabumi Regency for beekeeping and development.

There are five plant has selected namely *Calliandra, corn, paddy, rubber and rambutan*. The four combinations area is 20,623.1 ha, spread into five sub district namely Ciemas, Ciracap, Jampang Kulon,

Surade and Tegalbuleud. The five combinations area was 11,450.5 ha which were located in Jampang Tengah, Nyalindung, Ciracap, Surade and Palabuhan Ratu.

The recommended area for beekeeping in Sukabumi regency consists of two areas: protected and cultivation area. The protected area has two priorities: The first priority area for beekeeping was 3,335.52 ha (6.4%), while second priority was 48,415.22 ha

(93.6%) that covered 14 sub-districts. The cultivation area has three priorities: First priority area was 1,163.92 ha, second priority area was 6,044.98 ha, and third priority area was 2,651.21 ha that covered 9 sub-districts.

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