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Optimization of Agrometeorological and Climatological Information to Reduce Risk Based on Spatial Data Agriculture

By Charitas Fibriani
Universitas Kristen Satya Wacana

Abstract- Indonesia is an agricultural country that relies on the agricultural sector to support the lives of its people. The agricultural sector is dependent on climatic and weather conditions which often cause failure and success in farming. At this time the agriculture department has never conducted an analysis of climatology data to manage agricultural data so that it is difficult to analyze accurate data. For spatial analysis, climatological data is needed in spatial form. This journal will discuss the process of analyzing climatological spatial data, food security data and crop data of an area combined with the overlay method. So we get a rule related to the relationship between client data and plant data. The output of this journal is spatial-based climatology data modeling for climate visualization and agricultural commodities suitable for planting in certain regions and more accurate agrometeorological data.

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I. Introduction

Indonesia is an agricultural country that relies on the agricultural sector to support the lives of its people. The agricultural sector is dependent on climatic and weather conditions which often cause failure and success in farming (Effendy, 2001). Concrete impacts of climate on agricultural production, especially food crops, include crop failures due to mismatches between climate and commodities, decline in agricultural production due to climate distortions that affect periods of growth. If this happens permanently, it will cause losses to farmers and will ultimately threaten national food security.

Food independence is one of the government's program. Food independence can be achieved when food self-sufficiency can survive according to a predetermined target for the amount of agricultural production. The term agriculture appears when humans can benefit from regulating plant growth. The agricultural products are still the mainstay of several countries including Indonesia to meet people's needs and to contribute to foreign exchange. However, at present, almost all plant productivity is still far from its potential, on the other hand, the cost of production goes up. Climate change and environmental conditions also influence agricultural conditions. Agricultural production that does not provide results according to these targets raises several concepts, one of the technologies used to address these problems is Precision Farming (PF) technology (Khanal, 2019). The basic concept of Precision Farming is to measure the diversity of land conditions (soil, climate, plants) and then manage that diversity through the provision of agrochemical inputs and all other cultivation actions according to the Physico-chemical characters of the soil and plants' needs as effectively and efficiently as possible, by integrating agronomy principles and technological applications. This means that precision care is needed for each plant by following the plant's characteristics condition, in which the treatment applies to technology. Through the effective, selective and efficient management, then the plant productivity will be obtained to its potential, maximizing profitability, managing risks and being environmentally friendly both physically and socially (Susilowardani, 2015).

At this time the agriculture department has never conducted an analysis of climatology data to manage agricultural data so that it is difficult to analyze accurate data. For spatial analysis, climatological data is needed in spatial form, the advantage of using spatial data for analysis is data in clear format, cheaper because it does not have to be a field survey, data can be recalled, data management processes can be carried out so that the analysis process can be carried out efficiently (Prahasta, 2002). The area to be used as a case study is Boyolali District, Central Java, Indonesia.

This journal will discuss the process of analyzing climatological spatial data, and crop data of an area combined with the overlay method. In order to obtain a rule related to the relationship between client data and plant data that can be useful to reduce the risk of failure of farming, increase and availability of local food production and reduce the risk of food and nutrition insecurity. So that it will produce modeling for spatial-based climatology data for visualization of climate and agricultural commodities suitable for planting in certain regions and more accurate agrometeorological data. This modeling will enrich theoretical studies regarding the implementation of information technology. The purpose of this modeling is to reduce agricultural risks and prevent high production costs. This model is expected to be able to add climatology indicator references for the future to be able

Author: Universitas Kristen Satya Wacana, Salatiga, Jawa Tengah, Indonesia. e-mail: charitas.fibrianie@uksw.edu

to know the effects of changes in the global environment on climate change.

II. Literatur Review

The research entitled "Food Stability Mapping of Madiun Regency" discusses the mapping of food stability in Madiun Regency into the Geographic Information System (GIS). This research was conducted to measure the magnitude of the food identification indicator in Madiun Regency and determine the food stability status for each sub-regency in Madiun Regency. The indicators used are (1) aspects of food availability, (2) percentage of population living below the poverty line, percentage of population without access to clean water, percentage of illiterate women, percentage of population without four-wheel access, (3) percentage of under-weight infant, life expectancy, percentage of infant mortality rate, percentage of population without access to clean water, percentage of population living far from the Community Health Center. The method used in this study is descriptive quantitative and uses secondary data taken from the related agencies. The results of this study are data on food stability levels in the Madiun Regency that are resistant to food based on the determined composite (Addibi, 2016).

The study entitled "Factors Affecting Food Stability and Instability and Its Policy Implications in Rembang Regency" has discussed several issues that threaten food stability, namely socio-economic problems, reduced agricultural land as well as a decrease in production caused by climate change. research in the form of spatial and statistical analysis. Spatial analysis was used to map the distribution of stability status and village level of food instability with weighted overlays by overlaying maps and weighting scoring on observed variables. The statistical analysis uses factor analysis to find out the factors that lead to food stability and instability in each village in Rembang Regency. This study aims to identify resistant and food-prone villages with spatial analysis and statistical analysis using factor analysis to determine factors causes of food stability and instability. The results showed that most of the villages in Rembang were in a status of low-medium food stability (105 villages), followed by food-resistant villages (90 villages) but there were still 10 villages that were classified as highly food-insecure which required major attention (Hapsari, 2017).

III. Data Spasial

Spatial data is a type of data that has a spatial reference, meaning that every point in the data is related to the real world. Spatial data consists of 2 parts, namely the geometric and attribute tables of the map. There are 2 types of spatial data, namely: (1) Raster Data, (2) Vector data. Raster data is data that is represented in the form of a grid, meaning that each grid represents an area. Examples of raster data are aerial photography and remote sensing. While vector data is a type of data that represents the condition of the earth's geography, both human geography and physical geography, using the shape of points, lines and polygons (Fibriani, 2019). The data model is a representation of recorded geographic objects so that they can be recognized and processed by computers. (Gumelar, 2007) describes the vector data model into several more sections (can be seen in Figure 4), while the explanation of the data model will be discussed in the following sections.

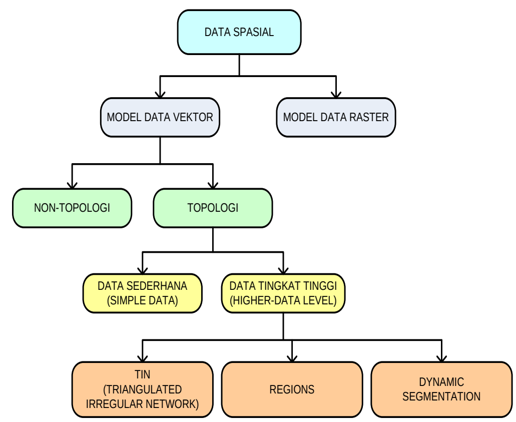

Figure 1: Classification of Spatial Data Models (Gumelar, 2007)

IV. Overlay Method

The analytical method used is the overlay method, where this method requires at least two groups of digital image data in the process. This overlay method is suitable for identifying a large area through digital image visualization. The results of this overlay method can be information that contains data that is a combination of data that is put together, so that the overlay data can be used for the analysis process (Prahasta, 2002). The concept of overlay can be seen in Figure 2.

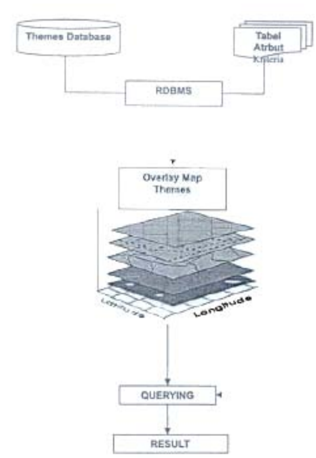

Figure 2: Methods of overlaying spatial data (Prahasta, 2002)

This method helps in data analysis with digital visualization so that it makes decision making needed as needed. For example, information on identifying water catchment areas in an area that requires decisions or policies on the utilization of groundwater in the surrounding area. This research proposes using the method of overlaying spatial data to combine spatial climatological data and spatial data on food production with digital maps of Boyolali district.

V. Data Analysis

Climatological spatial data used are: (1) Rainfall, (2) Temperature, (3) Slope. Rainfall is the average rainfall data in a year in an area, the unit is a millimeter (mm), data is obtained from a rain station. The values for rainfall data are of 3 classes, namely: (1) <1500, (2) 1500-3000, (3)> 3000. Rainfall data representation is in the form of polygons. Geometry data for rainfall data can be seen in Figure 3.

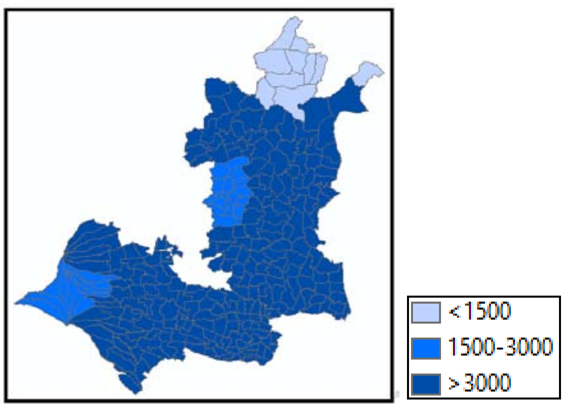

Figure 3: Rainfall Map

Temperature is the temperature of the air in an area. Air temperature is related to the height of an area above sea level so that it affects the temperature of an area. The temperature unit is degrees Celsius. Where the values for temperature data are 3 classes, namely: (1) <23, (2) 23-26, (3)> 26. Temperature data representations are polygons. Geometry data for temperature data can be seen in Figure 4.

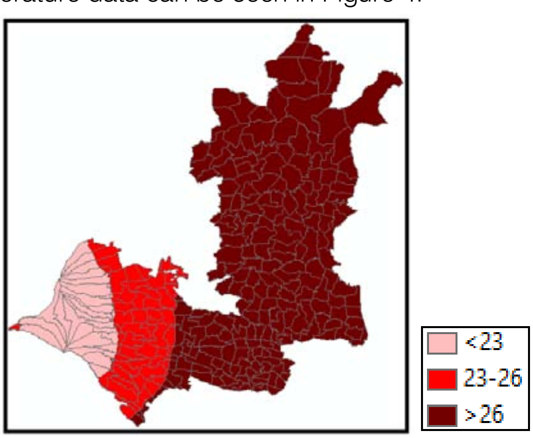

Figure 4: Temperature Data

The slope is the angle formed by the difference in surface height of an area. The slope unit is percent. The values for the slope data are 4, namely: (1) 0-8, (2) 8-15, (3) 15-40, (4)> 40. The slope data representation is in the form of polygons. Geometry data for rainfall data can be seen in Figure 5.

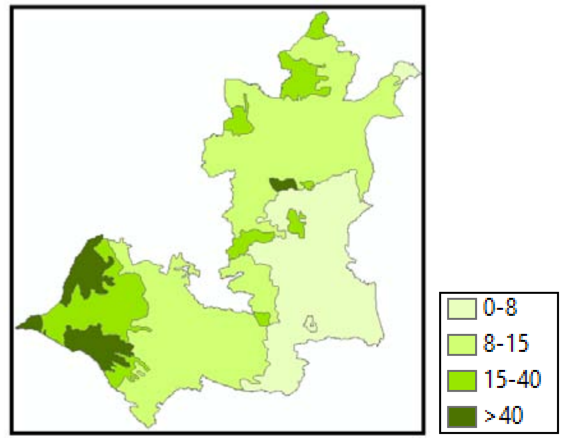

Figure 5: Slope Data

While non-climatological spatial data used are Plant Data. Plant data is the type of plant variety recommended in an area based on the physical characteristics of the area. The values for the tanaman data are 4, namely: (1) Annual Crop Cultivation (plantations), (2) Forestry, Productive Forests, Protected Forests, (3) Agroforestry, (4) Intensification. Representation of plant data is in the form of polygons. Geometry data for plant data can be seen in Figure 6.

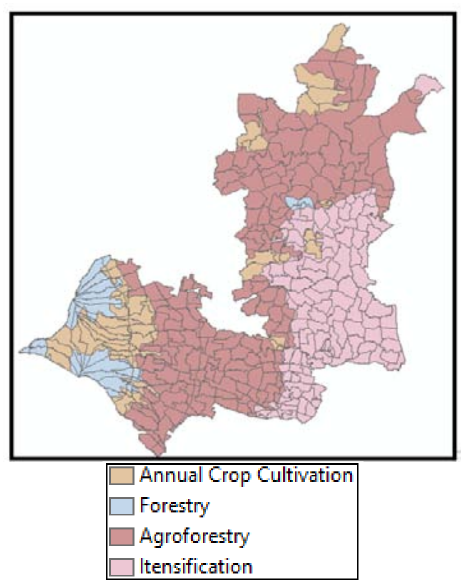

Figure 6: Crop Data

The parameters of the attribute data from the spatial data used can be seen in Table 1.

Table 1: Parameter Attributes

Data	Representation	Deskripsion	Value
Rainfall	Polygon	The average rainfall in a year	<1500
			1500-3000
			>3000
Temperature	Polygon	Temperature of an area	<23
			23-26
			>26
Slope	Polygon	The slope of an area surface	0-8
			8-15
			15-40
			>40
Varieties	Polygon	Varieties of an area	Annual Crop Cultivation
			Forestry
			Itensification
			Agroforestry

VI. Spatial Analysis

Overlaying of rainfall data, temperature data, slope data, plant data and resilience data is then carried out to analyze the data. The results of the overlay of the five data can be seen in Figure 8.

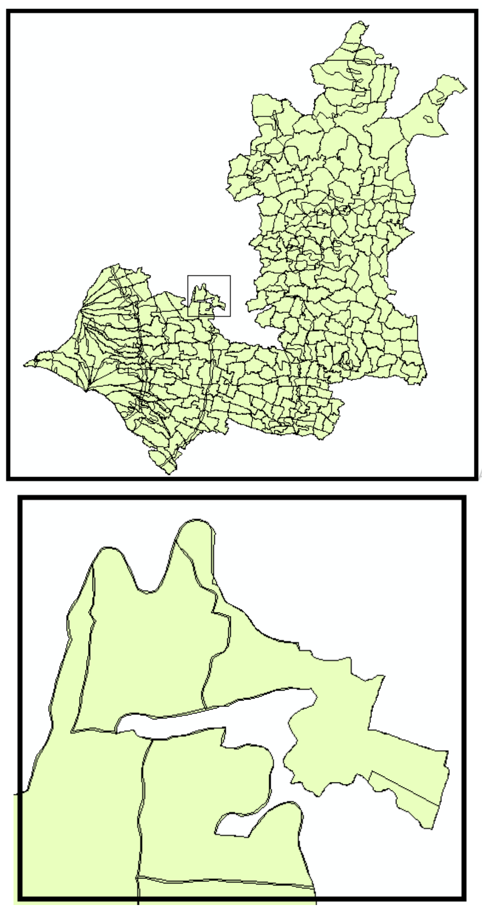

Figure 7: Overlay Map

As for the attributes of the overlay process data can be seen in Table 2. Where the total record data on the overlay attribute is 4205.

Table 2: Overlay attributes

FID	Rainfall	Slope	Temperature	Varieties
2028	>3000	8-15	25-26	Agroforestry
1619	>3000	8-15	25-26	Agroforestry
2803	>3000	8-15	25-26	Agroforestry
2048	>3000	8-15	25-26	Agroforestry
97	>3000	8-15	>26	Agroforestry
…	…	…	…	…

Rainfall, slope and temperature data are the criteria while variety data are the attribute of the destination. Then the analysis process is carried out namely the classification function in data mining on the three attributes using IF. AND. THEN logical expression so that 36 rules are obtained in Table 3.

Table 3: Classification Rules

Rules	Slope	Temperature	Rainfall	Zona
1	0-8	>26	<1500	AX1
2	0-8	>26	1500-3000	AX2
3	0-8	>26	>3000	AX3
4	0-8	23-26	<1500	AY1
5	0-8	23-26	1500-3000	AY2
6	0-8	23-26	>3000	AY3
7	0-8	<23	<1500	AZ1
8	0-8	<23	1500-3000	AZ2
9	0-8	<23	>3000	AZ3
10	8-15	>26	<1500	BX1
11	8-15	>26	1500-3000	BX2
12	8-15	>26	>3000	BX3
13	8-15	23-26	<1500	BY1
14	8-15	23-26	1500-3000	BY2
15	8-15	23-26	>3000	BY3
16	8-15	<23	<1500	BZ1
17	8-15	<23	1500-3000	BZ2
18	8-15	<23	>3000	BZ3
19	15-40	>26	<1500	CX1
20	15-40	>26	1500-3000	CX2
21	15-40	>26	>3000	CX3
22	15-40	23-26	<1500	CY1
23	15-40	23-26	1500-3000	CY2
24	15-40	23-26	>3000	CY3
25	15-40	<23	<1500	CZ1
26	15-40	<23	1500-3000	CZ2
27	15-40	<23	>3000	CZ3
28	>40	>26	<1500	DX1
29	>40	>26	1500-3000	DX2
30	>40	>26	>3000	DX3
31	>40	23-26	<1500	DY1
32	>40	23-26	1500-3000	DY2
33	>40	23-26	>3000	DY3
34	>40	<23	<1500	DZ1
35	>40	<23	1500-3000	DZ2
36	>40	<23	>3000	DZ3

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VII. Conclusion

Based on the rules in Table 3 that are applied to the overlay attribute in Table 2, a number of conclusions can be obtained. Forest varieties depend on rainfall data, where the ideal rainfall for forest varieties is rainfall 1500-3000 and> 3000, where land conditions are moist to wet. While agroforestry varieties, annual crop and intensification are strongly affected by land slope. Agroforestry is directed to 8-15% slope or rather steep surface conditions. For annual crops it is recommended to tilt 15-40% or steep surface conditions. As for the slope of the land 0-8% or flat surface conditions are recommended for itensification.

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