Analysis of the Influence of Cities/Regencies Existence Towards Land Cover Change in West Java Based on Geospatial Data

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Abstract. As one of the province that borders DKI Jakarta, West Java has been named the most populous province in Indonesia. This has an impact on land cover change in the region. For example, a lot of land that was once a vegetation land, is now converted into built up land. From previous studies, changes in land cover are caused by several factors, one of which is the existence of cities/regencies in the West Java region itself. However, it is not yet known for certain that changes in land cover are influenced by only the closest city/regency or all cities/regencies. Therefore, an analysis of the influence of cities/regencies existence towards land cover change in West Java is needed based on geospatial data. One calculation method to determine the influence of cities/regencies existence towards land cover changes is Binary Logistic Regression (BLR). BLR is used to analyse binary phenomenon. This study shows that to determine land cover change at a point in the province of West Java it is sufficient to be seen not only from the influence of the closest city/regency, but also necessary to be seen from the influence of all cities/regencies.

1. Introduction

Based on data released by Badan Pusat Statistik Indonesia [1], the population in Indonesia is around 260 million people, with the largest distribution being in the area of West Java (18% of the total population of Indonesia). Therefore, land requirements in West Java will increase, so land cover change will occur.

Land cover change is a phenomenon where the type of land cover shifts from one type to another followed by an increase or decrease in the type of land use. Changes that happen in the land cover is enlargement or reduction of the area. Land cover change occur due to several factors that affect it. Based on previous studies, one of the factors that influencing land cover changes is the distance between a point to the cities/regencies.

However, it is not yet known whether to see changes in land cover is sufficiently influenced by the closest city/regency or is influenced by all cities/regencies contained in West Java. Therefore, it needs research that can analyze the effect of the presence of cities/districts on land cover changes in West
Java based on geospatial data. This study will use Binary Logistic Regression as a tool to determine changes in land cover.

2. Data and methods

This study uses land cover map of West Java in 2005 and 2010 with a scale of 1:1,500,000. The data is obtained from Badan Informasi Geospasial (BIG), so that it can be seen the change of land cover. In addition, this study also uses administrative boundary data of West Java to see the central point of all cities/regencies in West Java. The method scheme of this research is as following:

![Figure 1. Flowchart of research method](image)

![Figure 2. Administrative boundary data of west java](image)

1. Bandung
2. West Bandung
3. Bekasi
4. Bogor
5. Ciamis
6. Cianjur
7. Cirebon
8. Garut
9. Indramayu
10. Karawang
11. Bandung City
12. Banjar City
13. Bekasi City
14. Bogor City
15. Cimahi City
16. Cirebon City
17. Depok City
18. Sukabumi City
19. Tasikmalaya City
20. Kuningan
21. Majalengka
22. Purwakarta
23. Subang
24. Sukabumi
25. Sumedang
26. Tasikmalaya
2.1. Euclidean distance

Euclidean Distance is a method of calculating the distance between two points to obtain the closest straight distance from each source cell to the destination cell [3]. This method is used to calculate the distance between a point to the nearest cities/regencies and the distance between a point to the whole cities/regencies. This distance will have a role as an independent variable (x) in the Binary Logistic Regression.

2.2. Spatial analysis

Spatial Analysis is the process of overlaying the several maps in order to retrieve some spatial summaries [2]. This process is used to obtain land cover change that happen in West Java from 2005 to 2010. This change will have a role as a dependent variable (x) in the Binary Logistic Regression.

2.3. Binary logistic regression

Binary Logistic Regression or commonly abbreviated as BLR is a regression model that formulated to predict and explain phenomena (dependent variables) that are binary (dichotomous) using all data types as independent variables [4]. Binary characteristic in the dependent variable will produce a type of data that consists only two category values, in this case such as changing or not changing. These two category values have a 0 or 1 probability of occurrence.

A regression model can be said to be feasible if it has a probability value (p-value) < 0.05 at a 95% confidence level. If there are variables that have p-value > 0.05, these variables are not used in the subsequent calculation process [5]. The basis of decision making used is as follows:
1. If the \( p \)-value > 0.05, \( H_0 \) is accepted,
2. If the \( p \)-value < 0.05, \( H_0 \) rejected or \( H_1 \) accepted.

The BLR equation can be written as follows:

\[
\logit \pi(x) = \ln \frac{\pi_l}{1 - \pi_l} = \alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n \tag{1}
\]

\[
\pi(x) = \frac{\exp(\alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n)}{1 + \exp(\alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n)} \tag{2}
\]

3. Result and discussion

From the BLR calculation, we will get constant values, significance values (\( p \)-values), regression coefficient values (\( B \)), and \( \exp(B) \) values. These values will later become components in the BLR equation and objects to be analysed. The BLR equation will be validated by seeing an error from the comparison between the land cover change initial data and the BLR results.

Validation is done by inputting all distance value data to the BLR equation that has been obtained. Furthermore, the output is the results of calculations using the BLR equation. These results will be categorized into 0 or 1, based on the specified threshold value.

This research determines the threshold in the form of upper quartile value of the entire distance value data. If the calculated \( y \) value (\( \pi(x) \)) is greater than the threshold, the \( y \) value is categorized as 1. However, if the calculated \( y \) value (\( \pi(x) \)) is smaller than the threshold, the \( y \) value is categorized as 0.

3.1. BLR results with the closest distance variable

BLR with the closest distance variable needs to be done to determine the effect of the closest city to a point so that it caused land cover changes. Below, we can see the results obtained from the calculation of BLR in table 1. From table 1, it can be seen that the BLR produces a \( p \)-value = 0, meaning that the regression model can be said to be feasible and the closest distance variable is proven to significantly affect land cover change.

| Variable       | B         | Sig. | Exp(B)   |
|----------------|-----------|------|----------|
| Closest Distance | -0.0000321 | 0    | 0.9999679 |
| Constant       | -1.8113556 | 0    | 0.1634324 |

From the existing results, the exponential BLR equation is as follows:

\[
\pi(x) = \frac{\exp(-1.8113556 - 0.0000321 \times X_i)}{1 + \exp(-1.8113556 - 0.0000321 \times X_i)} \tag{3}
\]

The \( \pi(x) \) value is the value of \( y \) as a result of BLR calculation. To find a categorized point to 0 or 1, it is necessary to input all distance value data. The \( \pi(x) \) value will be limited by a predetermined threshold value. The threshold value for the BLR equation with the closest distance variable is 0.2228640.

After that, the study continued by looking at the error between the BLR calculation results and the land cover change initial data. The error value of the BLR equation with closest distance variable is 28%. This means that as much as 72% of the data is in accordance between the initial data and the BLR results.
3.2. **BLR results with the whole distance variable**

BLR with all distance variables needs to be done to find out how much influence the existence of all cities/regencies in West Java towards a point so that it caused land cover changes. Below, we can see the results obtained from the calculation of BLR. These process shows that the *p*-value on the distance variable from West Bandung Regency to all points in West Java has a value of 0.0761. That means the West Bandung Regency variable is not used in the subsequent analysis process because it does not have a significant influence on land cover change. In table 2 below, the results can be seen after the insignificant variables are not included in the calculation process. So, the *p*-value < 0.05 for all variables, which is the regression model can be said to be feasible and the distance variable of each city/district in West Java is significant in influencing land cover changes.

**Table 2. BLR results for the whole distance variable**

| Variable       | B       | Sig. | Exp(B)   |
|----------------|---------|------|----------|
| Bandung        | 0.0002342 | 0    | 1.0002343 |
| Bekasi         | -0.0001893 | 0    | 0.9998107 |
| Bogor          | 0.0000084  | 0    | 1.0000084 |
| Ciamis         | -0.0001781  | 0    | 0.9998219 |
| Cianjur        | 0.0000612   | 0    | 1.0000612 |
| Cirebon        | 0.0000390   | 0    | 1.0000390 |
| Garut          | -0.0001290  | 0    | 0.9998710 |
| Indramayu      | 0.0000436   | 0    | 1.0000436 |
| Karawang       | 0.0000129   | 0    | 1.0000129 |
| Kuningan       | -0.0000184  | 0    | 0.999816 |
| Majalengka     | -0.0000504  | 0    | 0.999496  |
| Purwakarta     | -0.0000112  | 0    | 0.999888 |
| Subang         | -0.0000116  | 0    | 0.999884 |
| Sukabumi       | -0.0000176  | 0    | 0.999824 |
| Sumedang       | 0.0000294   | 0    | 1.0000294 |
| Tasikmalaya    | -0.0000479  | 0    | 0.999522 |
| Bandung City   | 0.0000093   | 0.041| 1.0000093 |
| Banjar City    | 0.0000276   | 0    | 1.0000276 |
| Bekasi City    | 0.0001991   | 0    | 1.0001991 |
| Bogor City     | 0.0000287   | 0    | 1.0000287 |
| Cimahi City    | -0.0001300  | 0    | 0.998700 |
| Cirebon City   | -0.0000630  | 0    | 0.999370 |
| Depok City     | -0.0008888  | 0    | 0.999112 |
| Sukabumi City  | -0.000557   | 0    | 0.999443 |
| Tasikmalaya City | 0.006334  | 0    | 1.006336 |

| Constant       | 1.0976942   | 0    | 2.9972469 |

From the results above, we must input constant values and regression coefficient values (*B*) into the BLR equation (1) and the BLR equation (2) same as the previous BLR calculations. Moreover, the
BLR equation with the whole distance variable also has a predetermined threshold to limit the $\pi(x)$ value. Threshold value for the BLR equation with the whole distance variable is 0.28508231397764. Furthermore, it is the same as the previous BLR calculation, which calculates the error between the BLR calculation results with the land cover change initial data. The error value for the BLR equation with the whole distance variable is 23%. This means that as much as 77% of the data is in accordance between the initial data and the BLR results.

3.3. Analysis

From the results of the validation process that has been done, it can be seen that the error generated by the BLR with the whole distance variable is smaller when compared to the results of the BLR error with the closest distance variable. Logically, land cover change at a point should be sufficiently influenced by the nearest city/regency because of its proximity. However, it is possible that there is more than one city/regency that has an influence on land cover changes, so that it seems to form city/regency groups that have the same effect. For this reason, mathematically, BLR with the whole distance variable produces smaller errors. In addition, BLR with the whole distance variables also has more than one variable. This causes the resulting BLR to be better, because there will be variables that have a role as a driving factor of land cover changes and also variables that are less influential on land cover changes. When the coefficient value $B > 0$, the variable becomes a driving factor of land cover changes. However, when the coefficient value $B < 0$, the variable is less influential on land cover changes. Otherwise, different things happen to BLR with the closest distance variable. BLR with the closest distance variable only has one type of variable, namely a variable with a coefficient value that smaller than 0 ($B < 0$) which means that the variable has less effect on land cover changes. So, to see which cities/regencies affect the land cover changes becomes quite difficult.

4. Conclusion

Based on the results of the study, to see land cover changes of West Java, it is necessary to calculate the whole city/regency and it is not enough to just from the closest city/regency. This is because of the error generated by the BLR with the whole distance variables is smaller than the error generated by the BLR with the closest distance variable.

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