Identifying Local Spatially Dependent Driving Factors of Village Development in Jambi Province

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Abstract

Village is the smallest unit of administrative boundaries in Indonesia. There are more than 74,000 villages in our country with various characteristics. One way that can be used to determine the hierarchy of village development is by analyzing the village development index (VDI). The objectives of this study are to calculate VDI and to identify spatial variations in the relationship between VDI and its driving factors in every location. In this study, Jambi Province was selected as the research location. There are 1543 villages in Jambi. The VDI in this study were determined by considering the number of facilities/infrastructure and the accessibility to access those facilities. Villages with higher VDI are more developed rather than other villages. To identify the driving factors of village development, 62 variables from PODES and spatial data were included in the Ordinary Least Square (OLS) model. Based on OLS results, we found 17 variables which statistically significant affecting village development in Jambi. Then, Geographically Weighted Regression (GWR) model was employed to identify the spatial relationship of driving factors to village development. The seventeen variables included number of education, health, and economic facilities; accessibility; percentage of built-up area, household working in agricultural sector, household using electricity, household living in slum area, poor people; number of criminality and people suffering from malnutrition. Studies of the interdependencies between these driving forces which affecting village development in the region remain limited. The presented findings show that the local driving forces affecting village development in Jambi Province vary spatially.

Keywords: Geographically Weighted Regression (GWR); infrastructure; local spatial relationship; spatial variability; Village Development Index (VDI).

1. Introduction

Village is the smallest unit of administrative boundaries in Indonesia. There are more than 74,000 villages in our country with various characteristics. Nowadays, village development is currently becoming an issue which related to the challenge of enhancing prosperity, improving well-being and increasing living standards of local community especially in the developing country. As the smallest unit of administrative boundaries, the village plays an important role in national development. Village development involves a set of projects and policies designed/co-ordinated and aimed at raising the whole pattern of living of a given rural population from a lower to a markedly higher level (Saleh, 2016). This issue is related to the local community's or villagers ability which have more nuanced knowledge of their needs and concerns, of the environment in which they operate, and of the local conditions that would need to be taken into account in any effort to foster improvements in their quality of life (Bebbington et al, 2006). On the other hand, in relation to poverty, most of the poor are lived in the village, therefore development is better focused on the village as an effort to overcome poverty. Most of all this time, development has been directed to the city that causing the tendency of centered economic activity in urban areas, which led to migration from rural to urban areas.

The government should be aware of the importance of development at the village level. Various forms and programs to encourage the acceleration of rural development have been undertaken by the government, but the results are mostly still not significantly improving the quality of life and welfare of the community. Therefore, village development must be conducted by well-planned based by the results of deeply analysis or a thorough assessment of all the potentials as well as the problems faced by the village, so that it can fulfil the real needs of the village community. The development policy in Indonesia especially the development of the village is mostly top down process, therefore it have been implemented autonomy policy effectively since the year of 2001, which provides a valuable learning process especially the essence in the life of building democracy, justice, equality, and regional diversity through government encouragement to grow for the welfare of the community (Imron, 2011). One way that can be used to measure the development of the village is by determining the hierarchy of village development. The hierarchy of village development can be seen from the village development index (VDI). VDI is an index resulted by scalogram analysis. VDI has a value which affected by some dependent variables. The VDI analyzed by the scalogram method is one of the indicators that can be used to measure the success of development, especially in terms of man made resources which includes regional facilities and infrastructures in every village (Rustiadi et al., 2009). Progress of development in a region in line with the increasing of population which will always be accompanied by increasing standards of quality and quantity of life necessities and increasing availability of facilities (Sitorus et al., 2012).

Understanding the village of region means we have to include the pattern of spatial characteristics in each village location. The objectives of this study are to calculate VDI and to identify spatial variations in the relationship between VDI and its driving factors in every location. In this study, Jambi Province was selected as the research location. There are 1543 villages in Jambi Province. The VDI in this study were determined by considering the number of some facilities/infrastructures and the accessibility to access those facilities. The local spatially dependent driving factors that affecting village development in Jambi Province were determined using Geographically Weighted Regression (GWR) model.

GWR or spatial regression model, is a development of a global linear regression model in which the basic idea is derived from nonparametric regression (Fotheringham et al., 2002). Various studies have applied GWR to identify spatial variations in regional development (Yu, 2006), population segregation (Yu and Wu, 2004), natural resources management (Jaimes et al., 2010; Clement et al., 2009), social studies (Farrow et al., 2005; Malczewski and Poetz, 2005) and the relationship between environmental and socioeconomic indicators (Ogneva-Himmelbrger et al. 2009), ecology (Su et al., 2012); urban expansion in metropolitan region (Pravitasari et al., 2015; Pravitasari et al., 2018).

2. Method

2.1. Study Area

Geographically, Jambi Province is located between $0^0$45' – $2^0$45' South Latitude and between 101º0'- 104º55' East Longitude. Jambi Province is located on the east coast of Central Sumatera and its capital is Kota Jambi (Jambi Municipality). Jambi Province is divided into nine regencies (*kabupaten*) and two municipalities (*kota*), which are Batanghari Regency, Bungo Regency, Tanjung Jabung Timur Regency, Kerinci Regency, Merangin Regency, Muaro Jambi Regency, Sarolangun Regency, Tebo Regency, Tanjung Jabung Barat Regency, Jambi Municipality and Sungai Penuh Municipality. There are 138 districts (*kecamatan*) and 1543 villages (*desa*) in Jambi Province with the total area of 50,058.16 km^2. Based on BPS (Statistics Indonesia) criteria, around 11% from the total villages in Jambi Province are categorized as urban area, and 89% has a status as rural area (Figure 1). Economic development in Jambi still depends on the abundance of its natural resources, renewable and nonrenewable, sourced through farming, forestry, agriculture, and mining (Bappeda Jambi, 2011).The topography of Jambi Province generally vary from low land areas in the east and hills and mountainous in the west. Mountainous areas are mostly in Kerinci Regency. Region boundaries of Jambi Province is as follows: Riau Province (northern), South Sumatera Province (southern), West Sumatera Province (western) and South China Sea (eastern).

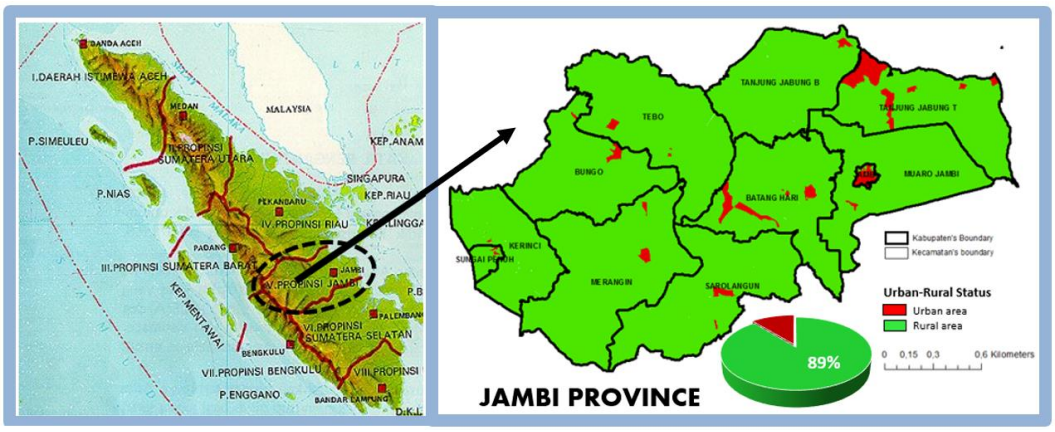


Figure 1. Administration map of Jambi Province

2.2. Materials and Methods

In this study, the driving factors that affecting village development in Jambi Province were identifying using GWR model. GWR is a statistical method to identify local spatial variations. This model works based on the "*Tobler's First Law of Geography*", which mentioned that everything is usually related with everything else, but those which are near to each other are more related when compared to those that are further away. In GWR model, spatial non-stationarity was assumed and tested. This model addresses the non-stationarity and allows the local spatial variations to vary over space. The result of this analysis is a regression model whose parameter values apply only to each location of observation, and different from other locations. In GWR, we use the weighted matrix element W(i) which the amount depends on the proximity between locations. The weighting function to be used for GWR model in this study is Gaussian Kernel function. The GWR is an expansion of the global regression model. However, unlike global regression that is applied in general at every observation location, GWR produces local model parameter estimators for each observation location using the Weighted Least Square (WLS) method. The formulas and variables used in the model are as follows (Fotheringham et al., 2002):

$$Y_j = C_0(u_j, v_j) + \sum_{i=1}^{p} C_i(u_j, v_j) X_{ij} + \varepsilon_j \quad (1)$$

where: Y_j = Dependent variable for observation j; X_{ij} = Independent variable Xi at location *j;* u_j,v_j = Coordinate point for location of observation j; C_0 (u_j,v_j) = Intercept for observation *j;* C_i (u_j,v_j) = Regression coefficient or local parameter estimate for independent variable X*i* at location *j.* The optimal bandwidth of GWR analysis in this study was determined by minimizing the corrected Akaike Information Criterion (AIC's value) with a correction for finite sample sizes, as described in Fotheringham, Brunsdon, and Chalton [15]. The dependent variable (Y) used in this model is Village Development Index (VDI); Seventeen (17) independent variables (X) included in this model are listed in Table 1.

Table 1. List of variable included in GWR model

Code	Variable
X1	Percentage of household working in agricultural sector (%)
X2	Number of food stalls and restaurant per 1000 population (unit)
X3	Number of hostels, hostels, motels, inns per 1000 population (unit)
X4	Percentage of settlements (%)
X5	Number of health facilities per 1000 population (unit)
X6	Percentage of household living in slum area (%)
X7	Percentage of farm worker (%)
X8	Percentage of Indonesian Labor Force (TKI) (%)
X9	Percentage of household using electricity (%)
X10	Distance to the shopping center (km)
X11	Number of markets, minimarkets per 1000 population (unit)
X12	Percentage of number of poverty letter (%)
X13	Number of formal education facilities per 1000 population (unit)
X14	Number of informal education facilities per 1000 population (unit)
X15	Number of people suffering from malnutrition (person)
X16	Number of criminality (evidence)
X17	Percentage of household living in the river banks (%)

3. Results and Discussions

3.1 Measuring VDI to determine the hierarchy of village development in Jambi Province

In this study, the scalogram method is used to calculate the VDI value and measure the hierarchy of all villages in Jambi Province. The results of the scalogram analysis show that the VDI value for all villages in Jambi Province wide ranges from 4.45 - 235.48. The spatial distribution pattern of VDI values for all villages in Jambi Province can be seen in Figure 2. From 1543 villages in Jambi Province (Figure 2), there are only 2 villages (0.12%) which have very high values of VDI (more than 100.00), namely: Kelurahan Pasar Jambi (235.48) and Kelurahan Pasar Sungai Penuh (130.82). Kelurahan Pasar Jambi is located in Pasar Jambi District, Jambi Municipality; whereas Kelurahan Pasar Sungai Penuh located in Sungai Penuh District, Sungai Penuh Municipality (western part of Jambi Province). Two villages in Kerinci Regency and Sungai Penuh Municipality, namely: Bedeng Delapan Village (in Kayu Aro District) and Koto Tinggi (in Sungai Penuh District) have VDI values 77.81 and 84.48, respectively. In general, more than a half of total village in Jambi Province (around 873 villages or 56.58%) have VDI values less than 25.00; around 40.63% (627 villages) from the total villages have VDI values in range between 25.01 – 50.00. There are 39 villages (2.53%) with VDI values between 50.01 – 75.00. Based on the value of VDI, it can be seen that there is a gap or disparity in term of facilities and infrastructure availability in every village in Jambi Province. There is a few number of villages which have high value of VDI. The highest value of VDI is located in Jambi Municipality whi[illegible] extremely high value of VDI (235[illegible]ge development compare with the[illegible]" area which has a lot of public fac[illegible]ng in this area is quite easy to acc[illegible]his area can also access facilities/i[illegible]ore area has an important role to[illegible] Penuh with high hierarchy of villa[illegible]erve facilities or infrastructures fo

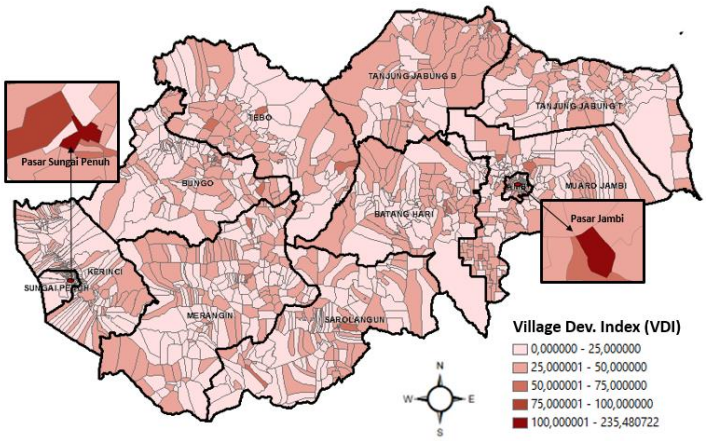


Figure 2. Spatial distribution of Village Development Index in Jambi Province

3.2 Identifying Driving Factors which Affecting Village Development in Jambi Province

We employed 17 variables as driving factors of village development in Jambi Province. Figure 3 illustrates the comparison between the Y variables of the observed data shown on the left-hand map with the variable Y of the model predicted results shown on the right-hand map. From both maps it can be seen that the spatial distribution pattern of Village Development Index of both observation and prediction of the model are almost the same. From the pattern of distribution can be seen that most areas have a low to medium Village Development Index value.

Then, we also analysed another important analysis results from GWR model that is the value of local R^2. The local R^2 of the GWR model was found to range from 0.43 to 0.86 (Figure 4). The highest local R^2 value is located in the south-eastern part of the study area which is covered by red colour area especially located in Jambi Municipality (the capital city of Jambi Province), Muaro Jambi Regency, also southern part of Tanjung Jabung Timur Regency. Those area with a higher local R^2 value areas are more likely to increase VDI values compared with the other area with smaller value of local R^2. The further the village location from Jambi City, the value of local R^2 tends to be lower.

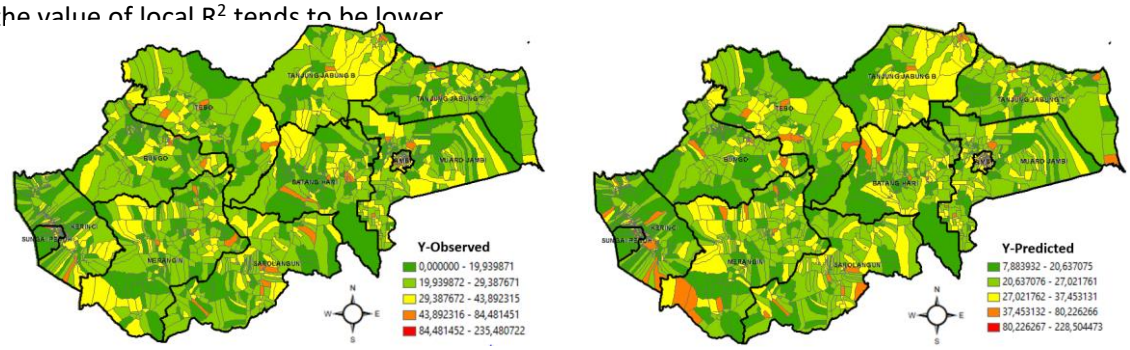


Figure 3. Village Development Index (VDI) in (1) Observed and (2) Predicted based on GWR Model

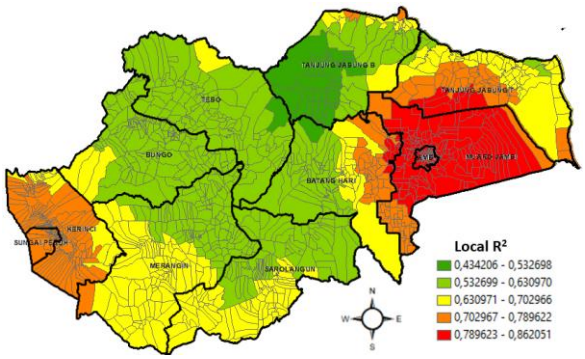


Figure 4. The local R^2 values based on GWR analysis

From the GWR analysis, we can know the value of coefficient or parameter estimates (C) for each X variable used in the model. The spatial distribution maps of the parameter estimates for each independent variable from the GWR model are shown in Figure 5. Based on the analysis, variables which have a significant positive effect on village development in most of area are Number of food stalls and restaurant per 1000 population (C2 X2), Number of hotels, hostels, motels, inns per 1000 population (C3 X3), Percentage of settlements (C4 X4), Number of health facilities per 1000 population (C5 X5), Percentage of household using

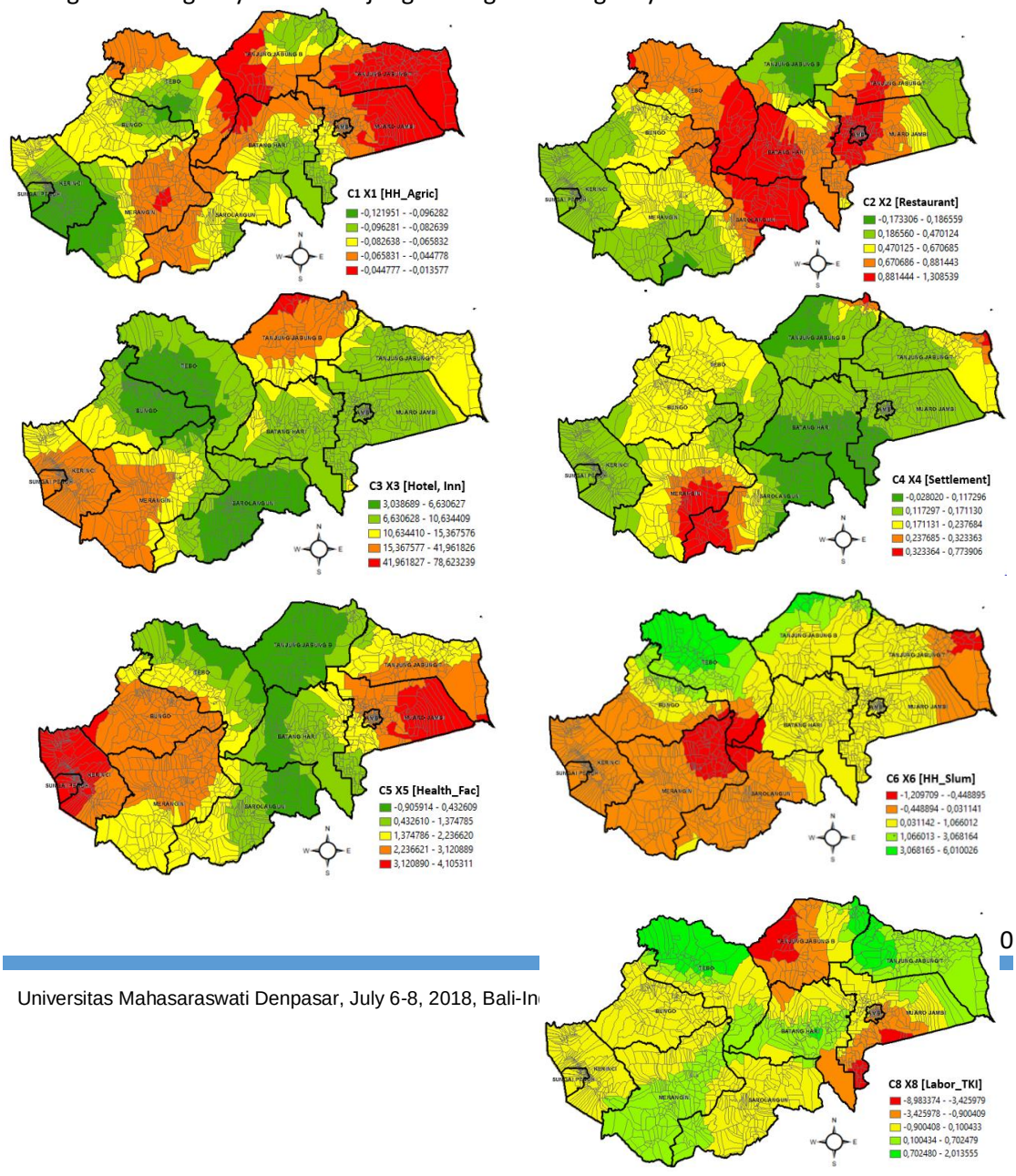
electricity (C9 X9), Number of markets, minimarkets per 1000 population (C11 X11), Number of formal education facilities per 1000 population (C13 X13), and Number of informal education facilities per 1000 population (C14 X14). Positive effect means that those variable has a positive effect or directly proportional to the village development index. Therefore, it is understandable that increasing some of economic facilities such as number of stalls/restaurants, hotels/hostels/motels/inns, settlements, market/minimarket, household using electricity as well as increasing of social facilities such as health and formal or informal education facilities will increase the Village Development Index as well. The red colour area in Figure 4 (C2 X2, C3 X3, C4 X4, C5 X5, C9 X9, C11 X11, C13 X13, C14 X14) are the villages with the big influence of increasing number of restaurants, hotels/hostels/motels/inns, settlements, market/minimarkets, health and formal or informal education facilities on the increasing of village development.

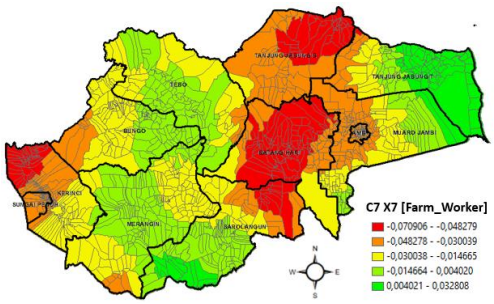
Each variables shows the different pattern of parameter estimates. Thus, VDI will easily increase in Muaro Jambi regency, if the number of restaurants (C2 X2), health facilities (C5 X5), market / minimarket (C1 X11) and formal education facility (C13 X14) increases. While in the north part of Tanjung Jabung Barat regency, VDI will easily increase if more hotels are developed. North part of Tanjung Jabung Barat Regency is a natural reserve area and national park, which is very potential for tourist destinations so that the development of lodging in this area can support the tourism potential, thus it can be affected in increasing of the VDI as well. Then, settlement variable (C4 X4) has a big influence in the south part of Merangin Regency and Sarolangun Regency. While the informal education facilities variable (C14 X14) has a big influence in the most area of Sarolangun Regency. The development of those economic and social facilities in the location of red area will support village development and significantly increase the village development index.

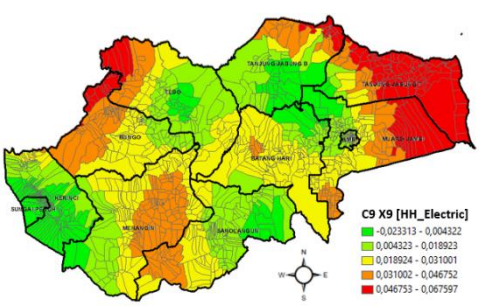
In the other hand, variables which have a significant negative effect on village development in most of area are Percentage of household working in agricultural sector (%) (C1 X1), Percentage of farm worker (C7 X7), Distance to the shopping center (km) (C10 X10), Percentage of number of poverty letter (%) (C12 X12), Number of people suffering from malnutrition (person) (C15 X15), Number of criminality (evidence) (C16 X16), Percentage of household living in the river banks (%) (C17 X17). Figure 5 (C1 X1, C7 X7, C10 X10, C12 X12, C15 X15, C16 X16) show the spatial pattern of the influence of number percentage of household working in agricultural sector, distance to the shopping center, percentage of number of poverty letter, number of people suffering from malnutrition, number of criminality evidence, and percentage of household living in the river banks. Negative effect means that those variable has a negative or inverse effect on the village development index. Thus, increasing percentage of household working in agricultural sector, increasing distance to the shopping center, increasing percentage of number of poverty letter, increasing number of people suffering from malnutrition, increasing number of criminality evidence, and increasing percentage of household living in the river banks will be inversely proportional to the village development index. In the other words, the red area of Figure 5 (C1 X1, C7 X7, C10 X10, C12 X12, C15 X15, C16 X16), indicating that at those location, increasing village development index will be affected by decreasing of percentage of household working in agricultural sector, decreasing distance to the shopping center, decreasing percentage of number of poverty letter, decreasing number of people suffering from malnutrition, decreasing number of criminality evidence, and decreasing percentage of household living in the river banks. In those cases, in order to maintain or increasing village development index,

government should strive to reduce some social problems such as poverty, malnutrition and criminality evidence.

The areas with low negative values of C1 X1 which covered in the red colour, are located in the southeastern part of Muaro Jambi Regency, Tanjung Jabung Timur Regency, and western part of Tanjung Jabung Barat Regency. While the areas with low negative values of C7 X7 are located in the most area of Batang Hari Regency, western part of Kerinci Regency, and northern part of Tanjung Jabung Barat Regency. Then the areas with low negative values of C12 X12 are located in the middle part of Batang Hari Regency, southern part of Tebo Regency, and easthern part of Bungo Regency. This finding implies that the percentage of household working in agricultural sector, percentage of farm worker, and percentage of number of poverty letter are more influencing the VDI on those locations compare with the area with high negative values. The same condition also happened in C15 X15, C16 X16, and C17 X17. The areas with low negative values of C15 X15 are located in the western part area of Tanjung Jabung Barat Regency, southern part of Batang Hari Regency and Muaro Jambi Regency. While the areas with low negative values of C16 X16 is located in the easthern part area of Tanjung Jabung Timur Regency. Then the areas with low negative values of C17 X17 are located in the middle southern part of Tanjung Jabung Barat Regency, middle part of Batang Hari Regency, and north eastern part of Sarolangun Regency. While the distance to the shopping center variable (C10 X10) are mostly located in Muaro Jambi Regency, Tanjung Jabung Timur Regency and of Tanjung Jabung Barat Regency.







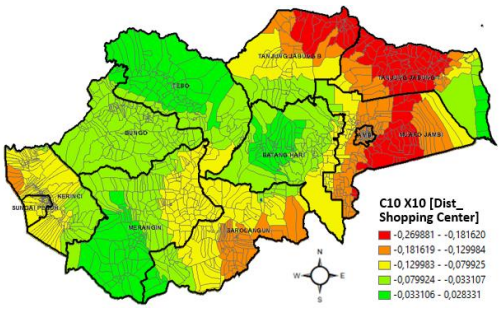
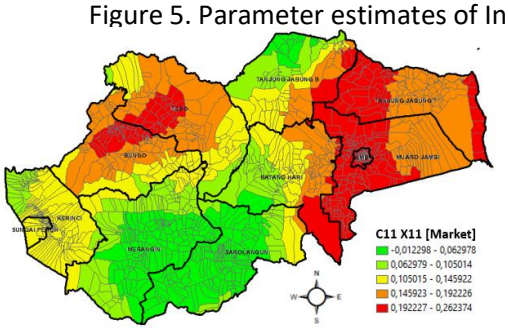
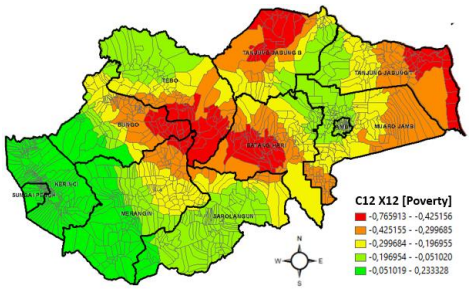
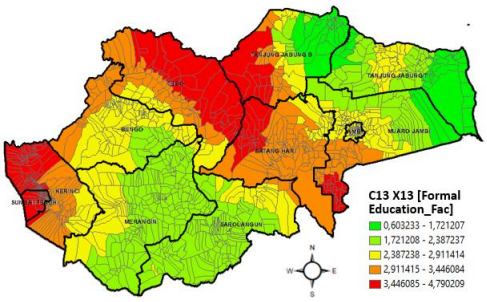
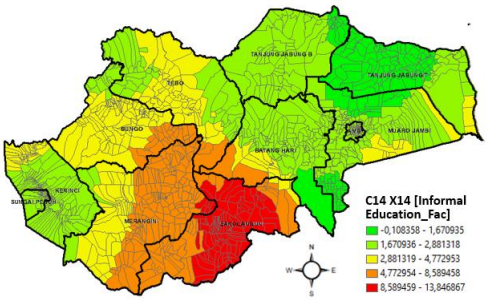


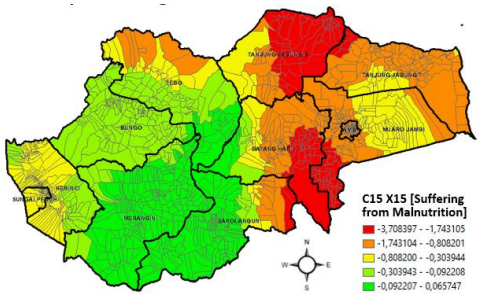
Figure 5. Parameter estimates of Independent Variables used in GWR

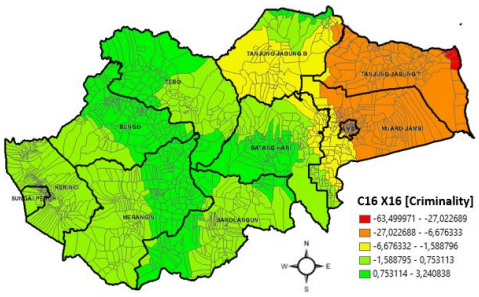












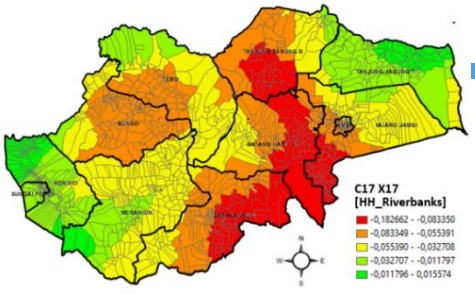


Figure 5. Parameter estimates of Independent Variables used in GWR

Then, the influence of the rest variables consisting of Percentage of household living in slum area (C6 X6) and Percentage of Indonesian Labor Force (C8 X8) show local spatially dependent relationships with village development in certain locations. Therefore the value of coefficient or parameter estimates (C) are not the same, but varies in each location. Percentage of household living in slum area (C6 X6) was found to range from -1,209 to 6,010. It means, the effect of increasing or decreasing number of percentage of household living in slum area to the village development is depend on the location of the village. While for the Percentage of Indonesian Labor Force (C8 X8), the coefficient value ranges from -1.192 to 0.741. It means, the effect of increasing or decreasing number of percentage of Indonesian Labor Force to the village development is depend on the location of the village. However, from the GWR results, it can be seen that the magnitude of the influence of the distance variables vary for each location.

4. Conclusion

Studies of the interdependencies between these driving forces which affecting village development in the region remain limited. The presented findings show that the local driving forces affecting village development in Jambi Province vary spatially. It is time for regional planning to consider the aspect of balance and sustainability through the creation of a rank-size distribution of urban structures with interaction relationships that strengthen each other between rural areas, towns, cities, cities and metropolitan. This requires a better understanding in determining the space structure based on the hierarchy level of each region and the relationship between the hierarchy in order to establish a balanced and sustainable regional system.

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