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THE IMPLEMENTATION OF GEOGRAPHICALLY WEIGHTED REGRESSION (GWR) METHOD ON OPEN UNEMPLOYMENT RATE IN REGENCY/CITY OF SUMATRA ISLAND

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ABSTRACT

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Unemployment is a condition where a person who is included in the labor force but does not have a job and is not actively looking for work. The number of unemployed is measured using the Open Unemployment Rate (OUR) indicator. OUR is obtained by comparing the number of job seekers and the number of labor force. This study aims to obtain a model of OUR in each district / city of Sumatra Island and what factors influence it using the Geographically Weighted Regression (GWR) method and Fixed Gaussian Kernel Function weighting, and describe predictor variables on thematic maps. The GWR method is one of the statistical methods that can prevent the presence of spatial aspects in the data. The parameters estimated by the local regression model vary at each location point and are estimated using the Weighted Least Square (WLS) method. Based on the research results obtained from this study, the GWR models obtained amounted to 154 different local models in each district / city on the island of Sumatra. Variables Labor Force Participation Rate, Population Growth Rate, Population Density and Average Years of Schooling have a significant influence on each location, meanwhile variable Percentage of Poor Population and variable Poverty Line have no influence on any location. These variables are able to explain the OUR by 57.2%, where the remaining 42.8% is explained by other factors that are not explained in the model.

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1. INTRODUCTION

Indonesia is a developing country with the fourth largest population in the world. Based on data from BPS, Indonesia's population was 272.68 million in 2021. One of the problems that occurs in the midst of the population density in Indonesia is the problem of unemployment. Based on BPS data as of August 2021, the Open Unemployment Rate (OUR) in Indonesia is 6.49%, where in 2021 there was a decrease in OUR in almost all of provinces in Indonesia. The number of unemployed people in Indonesia in August 2021 was 9.10 million.

OUR is influenced by different factors in each region because OUR has a spatial tendency that pays attention to regional aspects. If the data that has a spatial tendency is analyzed by using classical linear regression analysis, it will obtained by inaccurate results and inaccurate conclusions [1]. Meanwhile, to get the best model, it is required to fulfill the assumptions of non-autocorrelation (errors are not mutually dependent) and homoscedasticity. Therefore, a statistical method is needed that can prevent spatial dependence and spatial heterogeneity.

The spatial dependency and spatial heterogeneity problems can be prevented by using the Geographically Weighted Regression (GWR) method. This method models response variables and predictor variables on a regional or area basis which is an extension of the global regression method into a local regression model. One of the weights that can be used in the GWR method is to use a kernel function. The GWR method have to selection the weight matrix for the main step because it will affects the result of GWR model [2]. The closer one location is to another location, the greater the weight value obtained.

This research will use the Gaussian Fixed Kernel Function because this function uses the concept of distance between observation locations that are continuous, so it is expected to get a good analysis [3]. Some studies that use the GWR method include those conducted by [4], [5], and [6], this study examines the factors that affect OUR. Another study was also conducted by [7], which used the GWR method in modeling the factors that cause traffic accidents in West Kalimantan. Overall, the research that has been conducted shows that the GWR method can model in every region. Previous research conducted included modeling in regions other than Sumatra and some used weights other than Fixed Gaussian Kernel.

Based on the background that has been described, a model will be studied using the GWR method with the Fixed Gaussian Kernel weighting function that can analyze what factors affect the OUR on the island of Sumatra and then describe the predictor variables on the thematic map of the Open Unemployment Rate in the district / city of Sumatra Island using QGIS software. So that it is expected to provide deeper insight and become input for policy makers in the region, to analyze and overcome unemployment cases in the region.

2. RESEARCH METHODS

2.1 Data Sources and Research Variables

The type of data in this study is secondary data taken from Provincial data in Figures in 2022 which is an official publication of BPS [8]–[17]. This study also uses data on latitude $(\boldsymbol{u_i})$ and longitude $(\boldsymbol{v_i})$ coordinate points obtained through the Github.com site, where the coordinate points $(\boldsymbol{u_i}, \boldsymbol{v_i})$ are used to calculate the Euclidean distance value between location i and location j. The variables used consist of one response variable (y) and 6 predictor variables (x). The data were taken based on regencies/cities on the island of Sumatra, which includes 120 regencies and 34 cities. The predictor variables to be studied are presented in Table 1.

Table 1. Research Variables

Variable	Variable Name	Unit
y_i	i-th location Open Unemployment Rate	Percent (%)
x_{1i}	i-th location Labor Force Participation Rate	Percent (%)
x_{2i}	i-th location Population Growth Rate	Percent (%)
x_{3i}	i-th location Population Density	People/km^2
x_{4i}	i-th location Percentage of Poor Population	Percent (%)
x_{5i}	i-th location Poverty Line	Rupiah
x_{6i}	i-th location Average Years of Schooling	Year

2.2 Research Procedure

GWR is one of the statistical methods that can be used to overcome data problems that have spatial aspects. This method is an extension of the global regression model into a local regression model, where the parameter estimation is done at each point of geographic location. This can balance the existing variance (there's no similarity) at each observation location. The GWR model can be written as follows [18]:

$$\boldsymbol{Y_i = \beta_0(u_i, v_i) + \sum_{k=1}^{p} \beta_k(u_i, v_i) x_{ik} + \varepsilon_i} \tag{1}$$

where

Y_i : observation value of the response variable at the i-th location,
x_{ik} : observation value of the k-th predictor variable at the i-th location,
(u_i, v_i) : observation coordinates point (longitude, latitude) at the i-location,
$\beta_0(u_i, v_i)$: intercept value in GWR regression model,
$\beta_k(u_i, v_i)$: regression parameter of the k-th predictor variable for the i-th location,
ε_i : error at the i-th location.

The procedures carried out in this research are as follows:

1. Calculating the Euclidean distance value

   Euclidean distance is a calculation to measure the distance between location i and location j located at coordinates (u_i, v_i) [19]. The coordinates (u_i, v_i) are obtained based on a geographic coordinate system following latitude and longitude. The equation of the Euclidean distance can be written as follows:

$$\boldsymbol{d_{ij} = \sqrt{(u_i - u_j)^2 + (v_i - v_j)^2}} \tag{2}$$

2. Determining the optimum bandwidth value

   One method of determining the optimum bandwidth value is to use the CV or Cross Validation method [18] with the following equation:

$$\boldsymbol{CV = \sum_{i=1}^{n} \left[y_i - \hat{y}_{\neq i}(b)\right]^2} \tag{3}$$

3. Spatial weight matrix formation

   The spatial weight matrix used in the OUR data in Sumatera Island is 154 × 154. The weight value using the Fixed Gaussian Kernel function can be calculated using the equation:

$$\boldsymbol{w_j(u_i, v_i) = \exp\left[-\frac{1}{2}\left(\frac{d_{ij}}{b}\right)^2\right]} \tag{4}$$

   The element of the W matrix is w_j where w_j is worth 1 if it is adjacent or its corner point meets the region of interest and worth 0 otherwise [20].

   The general form of the W matrix is as follows:

$$W_j(u_i, v_i) = \begin{bmatrix} w_{i1} & 0 & \cdots & 0 \\ 0 & w_{i2} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & w_{in} \end{bmatrix}$$

4. Data Multicollinearity Test

   Multicollinearity in the data can be assessed by examining the Variance Inflation Factor (VIF). If the data has a VIF value more than or equal to 10, then there is multicollinearity in the data. Multicollinearity problems can be overcome by changing or eliminating variables with VIF values more than or equal to 10. The multicollinearity test is carried out using **Equation (5)** [21]:

$$\boldsymbol{VIF_j = \frac{1}{1 - R_j^2}} \tag{5}$$

5. Spatial Dependency and Heterogeneity Test

a. Spatial Dependency Test (Moran's I Test)

The spatial dependency or autocorrelation test on the residuals of the regression model is using the Moran's I Test which can be written in the following formula:

$$\boldsymbol{I = \frac{n \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n}(x_i - \bar{x})^2}, i = 1, 2, \dots, n} \tag{6}$$

where

I : Moran's Index
n : The number of observations locations,
x_i : the value of the predictor variable object at the i-th location,
x_j : the value of the predictor variable object at the j-th location,
$\bar{x}$: the mean of the predictor variable
w_{ij} : the weight element between locations i and j,

Based on **Equation (6)**, the hypothesis in the Moran's I Test is as follows:

H_0: $I = 0$ (there is no spatial dependency)
H_1: $I \neq 0$ (there is spatial dependency)

The statistic test in this test follows the Z distribution, with the criteria for the rejection area to determine the decision is to reject H_0 if the $|Z_{(I)}|$value $> Z_{(\alpha/2)}$ or p-value $< \alpha$ **[22]**.

b. Spatial Heterogeneity Test (Breusch-Pagan Test)

Spatial heterogeneity testing is using the Breusch-Pagan Test. This spatial heterogeneity can occur if there is a measurement error which includes model specification errors and missing variables **[18]**. The test statistics used are as follows:

$$\boldsymbol{BP = \left(\frac{1}{2}\right) f' Z (Z'Z)^{-1} Z' f} \tag{7}$$

with the vector element f is:

$$f_i = \left(\frac{e_i^2}{\sigma^2} - 1\right), i = 1,2, \dots, n$$

which,

Z : matrix with size $n \times (k+1)$ which contains standardized vector (Z) at each observation location,
f_i : element vector f,
e_i : residual vector at the i-th observation location,
σ^2 : residual variance e_i,

Based on **Equation (7)**, the hypothesis is as follows:

H_0 : $\sigma_1^2 = \sigma_2^2 = \cdots = \sigma_n^2 = \sigma^2$ (there is no spatial heterogeneity between locations)
H_1 : there is at least one $\sigma_i^2 \neq \sigma^2$ (there is spatial heterogeneity between locations)

The criteria for the rejection area to determine the rejection decision on this test is to reject H_0 if the BP value $> \chi^2_{(k)}$ or the p-value $< \alpha$ **[23]**.

6. Geographically Weighted Regression (GWR) Model Analysis

The steps to analyze the OUR data by using the GWR method are as follows:

a. Estimate the GWR model parameter values for each weight. Estimation is done by using:

$$\boldsymbol{\hat{\beta}(u_i, v_i) = \left(X^T W(u_i, v_i) X\right)^{-1} X^T W(u_i, v_i) y} \tag{8}$$

b. Test the significance of GWR model parameters. The parameter significance test uses a C_i matrix, which,

$$\boldsymbol{C_i} = \left(\boldsymbol{X^T W(u_i, v_i) X}\right)^{-1} \boldsymbol{X^T W(u_i, v_i)} \tag{9}$$

$$\mathbf{t}_{\text{count}} = \frac{\widehat{\boldsymbol{\beta}}_{\boldsymbol{k}}(\boldsymbol{u_i, v_i})}{\widehat{\boldsymbol{\sigma}}\sqrt{\boldsymbol{C_{kk}}}} \tag{10}$$

The criteria for the rejection area to determine the rejection decision on the parameter significance test is H_0 rejected if $|t_{count}| > t_{\alpha/2,df}$ (α=0.05) [4].

c. Form a GWR model based on predictor variables that have a significant which influence on the response variable on the weight of Gaussian Fixed Kernel.

d. Test the Accuracy Model
The R^2 value in the GWR model can be obtained by the equation:

$$\boldsymbol{R^2} = \frac{\boldsymbol{SST_{GWR} - SSE_{GWR}}}{\boldsymbol{SST_{GWR}}} \tag{11}$$

e. Interpret the GWR model to draw a conclusion from the model.

3. RESULTS AND DISCUSSION

3.1 Descriptive Analysis

Descriptive analysis is one of the many quantitative analysis methods. In this study, descriptive analysis aims to analyze the characteristics of OUR and factors that are expected to influence it on the island of Sumatra in 2021.

Table 2. Summary Table of Research Variable Statistics in 2021

Data Centering and Dispersion	Variable						
	y_i	x_{1i}	x_{2i}	x_{3i}	x_{4i}	x_{5i}	x_{6i}
Minimum	0.70	57.77	0.19	2.98	2.38	329308	5.64
Quartile 1 (Q_1)	3.18	65.03	0.89	67.39	7.487	421048.50	8
Median	4.50	68.52	1.31	108.03	9.970	455956.50	8.62
Mean	4.88	68.99	1.31	589.35	10.94	478650.40	8.87
Quartile 3 (Q_3)	6.28	71.94	1.61	282.34	13.87	505562.80	9.71
Maximum	13.37	87.70	3.16	9286.26	26.42	830484	12.83
Standard Deviation	2.39	5.90	0.56	1334.48	4.88	91781.88	1.34

Based on Table 2, data is displayed which shows the value of data concentration and distribution on each research variable. It can be interpreted that the average value of the Open Unemployment Rate variable as variable y in Sumatra Island in 2021 is 4.88 percent. This shows that the Open Unemployment Rate in Sumatra Island in 2021 is not too high when viewed based on national data in 2021 of 6.49 percent.

Figure 1 to Figure 7 shows the data distribution map for each research variable. The distribution of data is done to find out the grouping of each variable value in the district / city on the island of Sumatra which is displayed in the form of thematic maps and illustrated using QGIS Software version 3.28.3. The thematic map is classified into 5 groups, namely “very low”, “low”, “medium”, “high”, and “very high”, which are shown by color gradations that are getting darker in order.

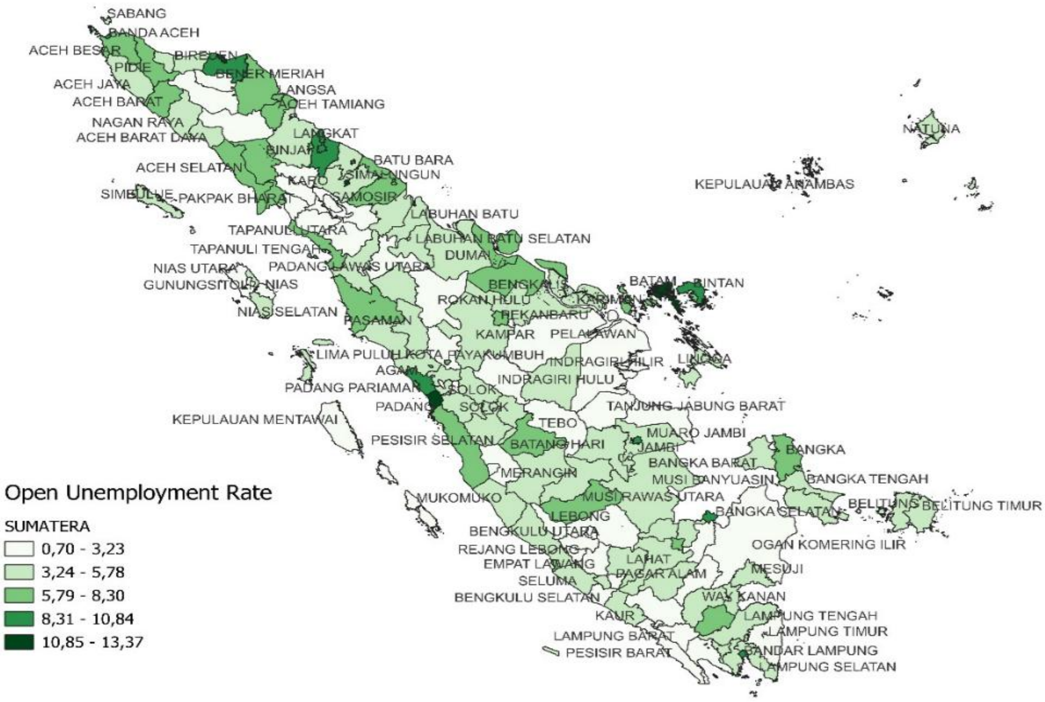

Figure 1. **Distribution Map of Open Unemployment Rate in Sumatera Island in 2021**

Figure 1 shows the condition of the Open Unemployment Rate in the regencies/municipalities of Sumatra Island in 2021 which shows that the data on Sumatra Island in 2021 is not too high when viewed based on the national Open Unemployment Rate in 2021 of 6.49 percent. There are 69 districts/cities in the "high" and "very high" groups with the highest data at 13.37 percent in Padang City in West Sumatra Province and there are 85 districts/cities in the "very low", "low", "medium" groups, with the lowest data at 0.7 percent in Samosir Regency in North Sumatra Province.

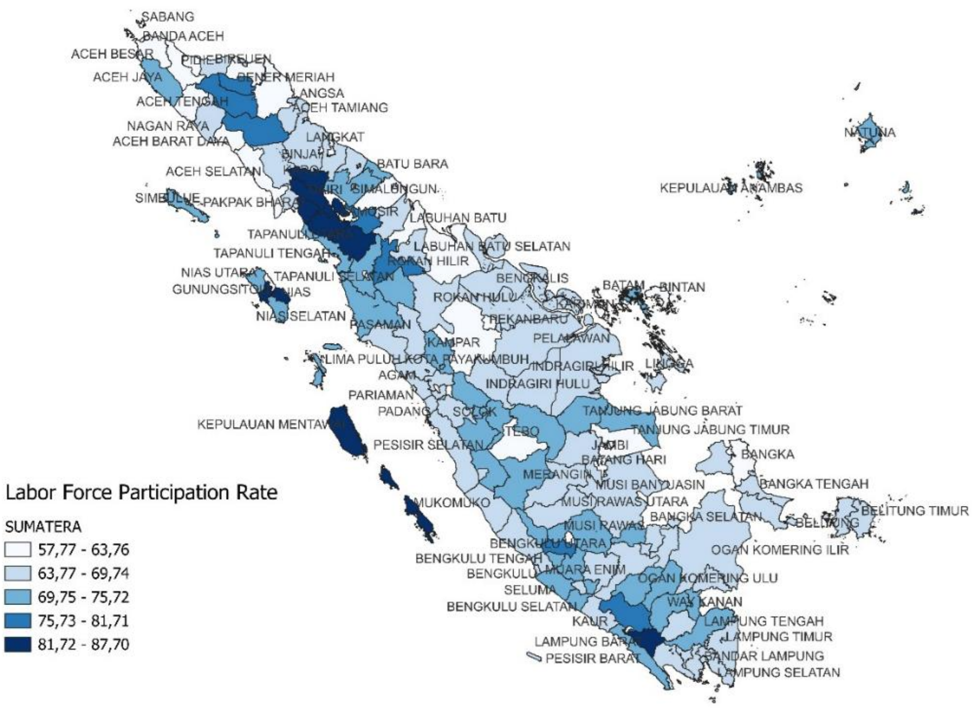

Figure 2. **Distribution Map of Labor Force Participation Rate in Sumatera Island in 2021**

Figure 2 shows the condition of the Labor Force Participation Rate as variable x_1, which is the percentage of the labor force to the total population aged 10 years and over. The Labor Force Participation Rate in Sumatra Island in 2021 has an average of 68.99 percent. There are 70 districts/cities in the "high" and "very high" groups with Labor Force Participation Rates higher than the average with the highest value of 87.7 percent in Pakpak Bharat District in North Sumatra Province and there are 84 districts/cities in the "very low", "low", "medium" groups, with Labor Force Participation Rates lower than the average and the lowest value of 57.77 percent in Pidie Jaya District in Aceh Province.

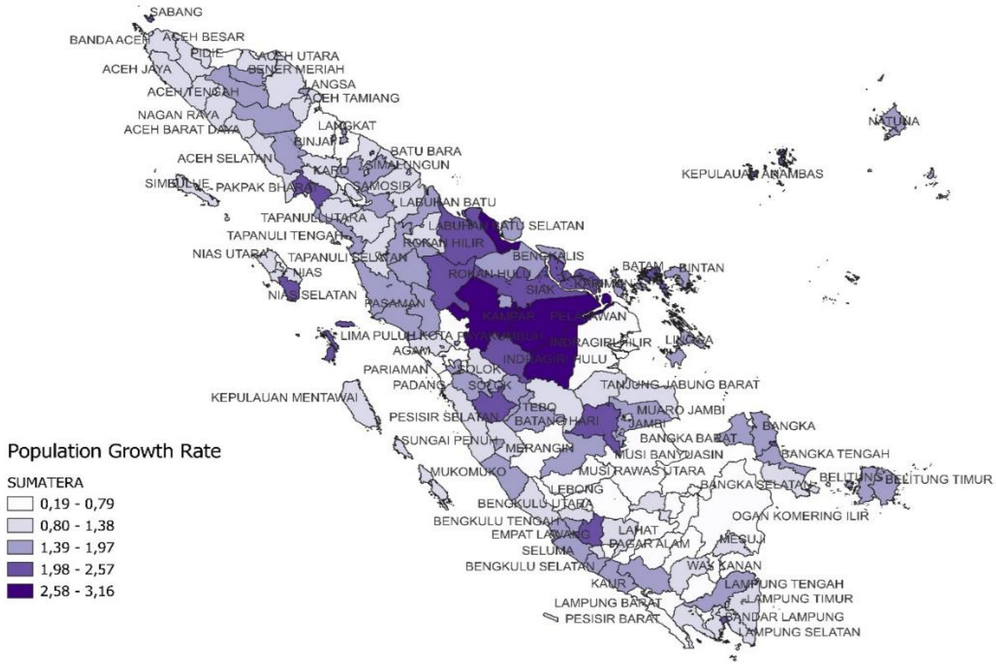

Figure 3. Map of Population Growth Rate Distribution in Sumatera Island in 2021

Figure 3 shows the condition of the Population Growth Rate as variable x_2, which is a number that shows the average rate of population increase per year within a certain period of time. The Population Growth Rate in Sumatra Island in 2021 has an average of 1.314 percent. There are 77 districts / cities in the "high" and "very high" groups with a Population Growth Rate higher than the average, namely 3.16 percent in Pelalawan Regency in Riau Province and there are 77 districts / cities in the "very low", "low", "medium" groups, with LPP lower than the average, namely the lowest value of 0.19 in Tulang Bawang Regency in Riau Province.

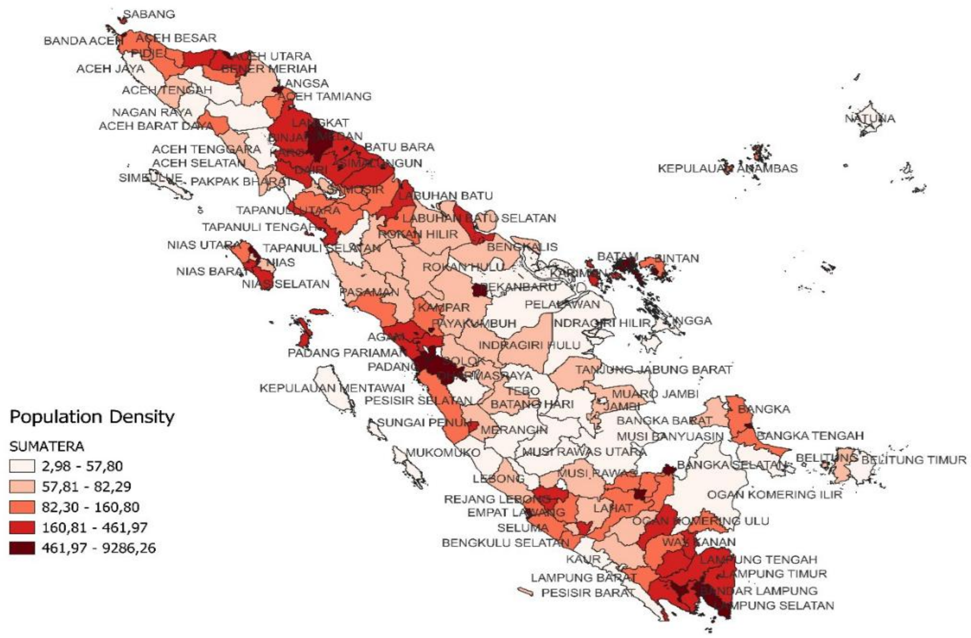

Figure 4. Map of Population Density Distribution in Sumatera Island in 2021

Figure 4 shows the condition of Population Density as variable x_3, which is the number of people per unit area used as the basis for population distribution policies in the transmigration program. Population

Density on the island of Sumatra in 2021 has an average of 589.35 people/km2. There are 28 regencies/cities in the "high" and "very high" groups with Population Density higher than the average and the highest value of 9286.26 people/km2 in Medan City in North Sumatra Province and there are 126 regencies/cities in the "very low", "low", "medium" groups with the lowest value of 2.98 people/km2 in Jambi City in Jambi Province.

Figure 5. Map of the Distribution of the Percentage of Poor Population in Sumatra Island in 2021

Figure 5 shows the condition of the Percentage of Poor Population as variable x_4, which is the population that has an average monthly per capita expenditure below the poverty line. The percentage of poor people on the island of Sumatra in 2021 has an average value of 10.94 percent. There are 68 districts/cities in the "high" and "very high" groups with a Percentage of Poor Population higher than the average value and the highest value is 26.42 percent in West Nias District in North Sumatra Province and there are 86 districts/cities in the "very low", "low", "medium" groups with the lowest value of 2.38 percent in Sawahlunto City in West Sumatra Province.

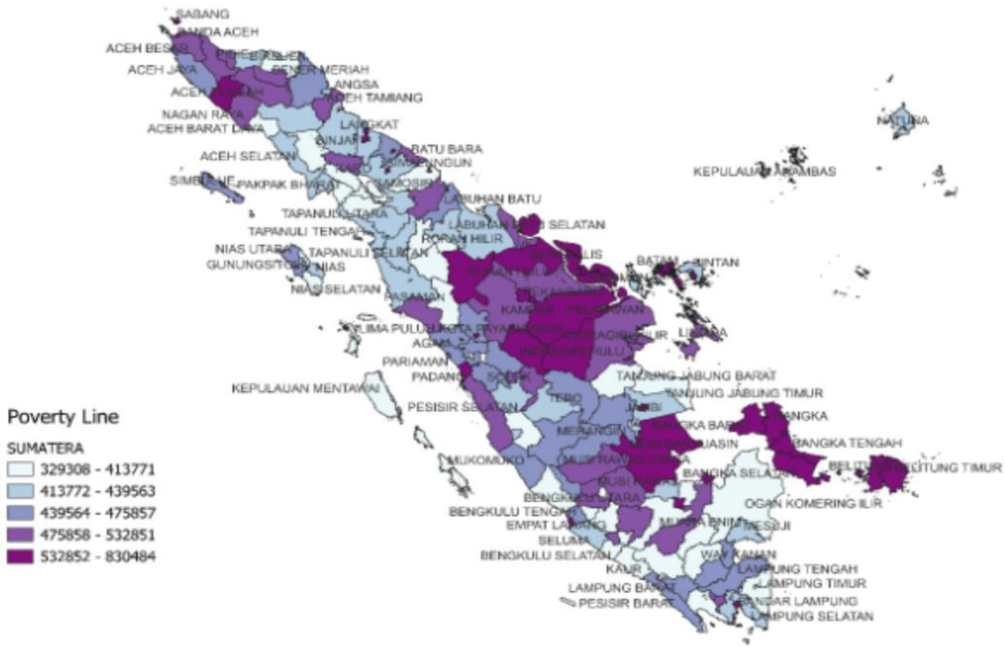

Figure 6. Map of Poverty Line Distribution in Sumatra Island in 2021

Figure 6 shows the condition of the Poverty Line as variable x_5 is the rupiah value of the minimum expenditure required for a person to fulfill their basic needs for a month. The Poverty Line on the island of Sumatra in 2021 has an average value of IDR 478,650. There are 58 districts/cities with a Poverty Line higher than the average value in the "high" and "very high" groups with the highest value of IDR 830,484 in Belitung Regency in Bangka Belitung Islands Province and there are 96 districts/cities in the "very low", "low", "medium" groups with the lowest value of IDR 329,308 in South Nias Regency in North Sumatra Province.

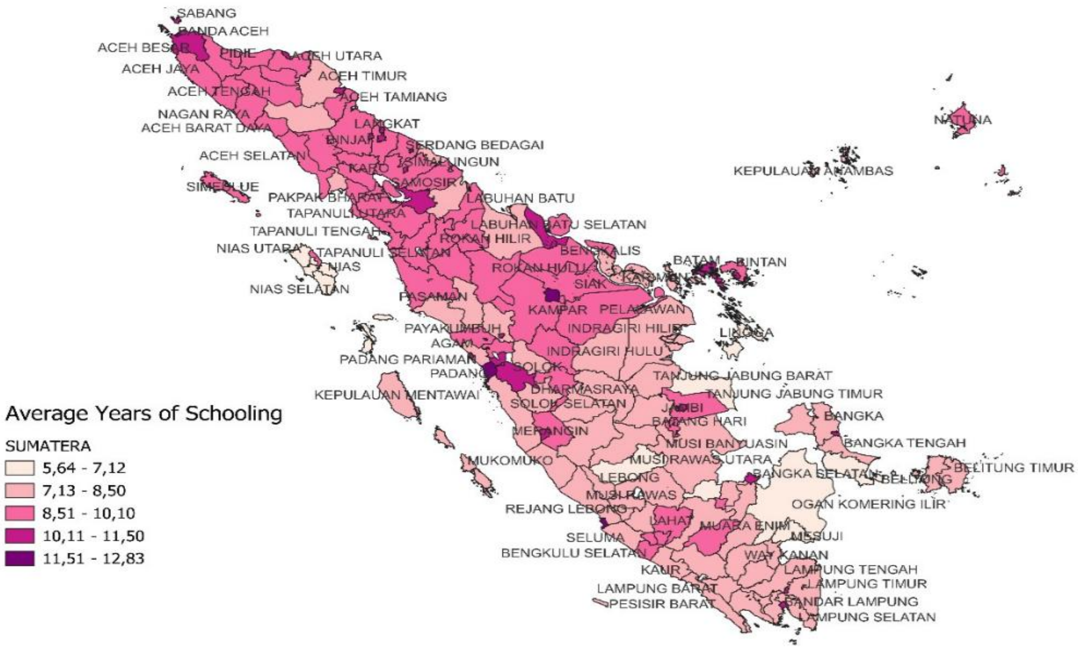

Figure 7. Distribution Map of Average Years of Schooling in Sumatera Island in 2021

Figure 7 shows the condition of Average Years of Schooling in the districts/cities of Sumatra Island in 2021. Average Years of Schooling as variable x_6 is the average number of years spent by the population aged 15 years and over to pursue all types of education ever undertaken. Average Years of Schooling in Sumatera Island in 2021 has an average value of 8.87 years. There are 63 districts / cities with Average Years of Schooling higher than the average value in the "high" and "very high" groups with the highest value of 12.83 years in Banda Aceh City in Aceh Province and there are 91 districts / cities in the "very low", "low", "medium" groups with Average Years of Schooling lower than the average value and the lowest value of 5.64 years in Nias Regency in North Sumatra Province.

3.2 Euclidean Distance

By using **Equation (2)**, the final result of Euclidean distance calculation is obtained which will form a matrix of size 154 × 154 as follows:

$$d_{ij} = \begin{bmatrix} d_{11} & d_{21} & \dots & d_{1541} \\ d_{12} & d_{22} & \dots & d_{1542} \\ \vdots & \vdots & \ddots & \vdots \\ d_{1154} & d_{2154} & \dots & d_{154154} \end{bmatrix} = \begin{bmatrix} 0 & 1.93589 & \dots & 2{,}04053 \\ 1{,}93589 & 0 & \dots & 1{,}33325 \\ \vdots & \vdots & \ddots & \vdots \\ 2{,}04053 & 1{,}33325 & \dots & 0 \end{bmatrix}$$

3.3. Optimum Bandwidth

The bandwidth value used is the optimum value using the CV or Cross Validation method in **Equation (3)** which will be obtained by looking at the minimum value of CV through the iteration process. In this, a bandwidth value of 17.18183 was obtained with a minimum CV of 419.6491.

3.4 Gaussian Fixed Kernel Weighting Value

The bandwidth value in the previous calculation is used to find the weight value. The weight value will form a weight matrix that will be used to provide parameter estimation results at each observation location. The spatial weight matrix that has been obtained for each location will later be used to form a GWR model, thus the model obtained for each district / city will get different results. The value of the weighting function can be obtained by substituting the optimum bandwidth value into **Equation (4)** so that a weighting matrix is formed in all regions as follows:

$$W_{ij} = \begin{bmatrix} w_{11} & w_{21} & \cdots & w_{1541} \\ w_{12} & w_{22} & \cdots & w_{1542} \\ \vdots & \vdots & \ddots & \vdots \\ w_{1154} & w_{2154} & \cdots & w_{154154} \end{bmatrix} = \begin{bmatrix} 1 & 0.99367 & \dots & 0.99297 \\ 0.99367 & 1 & \dots & 0.99699 \\ \vdots & \vdots & \ddots & \vdots \\ 0.99297 & 0.99699 & \dots & 1 \end{bmatrix}$$

3.5 Multicollinearity Test

The VIF value in the multicollinearity test will be presented in **Table 3** as follows:

Table 3. VIF value in multicollinearity test in each predictor variable

Variable	VIF Value
x_1	1.118266
x_2	1.097783
x_3	1.589854
x_4	1.139165
x_5	1.315028
x_6	1.649462

Based on the **Table 3** data, it can be seen that all predictor variables have VIF values < 10. Therefore, it can be concluded that there is no indication of multicollinearity in the predictor variables

3.6 Spatial Dependency Test

The result of the spatial dependency test is a p-value of 0.01509 or less than α = 0.05. In this spatial dependency test, it was decided to reject H_0 with the conclusion that there is spatial dependency between locations.

3.7 Spatial Heterogeneity Test

The results obtained in the Breusch-Pagan test are as follows

Table 4. Spatial Heterogeneity Test

Breusch-Pagan	p-value
18.898	0.00434

Based on the spatial heterogeneity test that has been carried out, the BP value is 18.898, which is greater than the chi-square value of 12.592. This test also obtained a p-value of 0.00434 < 0.05 or p-value < α. Thus, H_0 is rejected with the conclusion that there is spatial heterogeneity between locations.

3.8 Geographically Weighted Regression (GWR) Analysis Model

3.8.1 Parameter Estimation Value

The parameters in the local regression model will vary at each location and are estimated by using the Weighted Least Square (WLS) method, where the weights used in this WLS method will vary at each location. The parameters in this research amounted to 154 for each variable according to the number of regencies/cities on the Sumatera Island which will be displayed in **Table 5** as follows:

Table 5. Parameter Estimates for Each Location

No.	b_0	b_1	b_2	b_3	b_4	b_5	b_6
1	13.00927	-0.18282	-0.72526	0.00043	-0.01646	1.37E-06	0.52988
2	12.98433	-0.1827	-0.72494	0.000429	-0.01576	1.42E-06	0.52788
3	12.99551	-0.1827	-0.72577	0.000429	-0.01615	1.39E-06	0.52882

No.	b_0	b_1	b_2	b_3	b_4	b_5	b_6
4	12.99365	-0.18268	-0.72601	0.000429	-0.01613	1.40E-06	0.52867
5	13.00362	-0.18263	-0.7276	0.000428	-0.01655	1.37E-06	0.52944
6	13.0132	-0.18269	-0.72759	0.000429	-0.01679	1.35E-06	0.53014
7	13.02183	-0.18274	-0.7276	0.000429	-0.01701	1.33E-06	0.53074
8	13.03892	-0.18276	-0.72892	0.000429	-0.01755	1.29E-06	0.53182
9	13.02942	-0.18274	-0.72843	0.000429	-0.01727	1.31E-06	0.53123
10	13.02118	-0.18269	-0.72836	0.000429	-0.01707	1.33E-06	0.53068
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
153	12.96287	-0.18267	-0.72348	0.000428	-0.01498	1.49E-06	0.52583
154	12.98144	-0.18279	-0.72341	0.000429	-0.01551	1.44E-06	0.52757

Table 5 shows the parameter estimation values in each location with 6 parameters for each independent variable. Overall, it can be seen that there are three parameters with negative values, namely parameters b_1, b_2 and b_4, indicating that when variable x_1 (Labor Force Participation Rate), x_2 (Population Growth Rate), and variable x_4 (Percentage of Poor Population) increase, variable y will tend to decrease, while parameter b_5 has a very small positive value, indicating that variable x_5 (Poverty Line) has a very small positive effect. Afterward, more analysis will be carried out to determine the influence of each variable.

3.8.2 Parameter Significance Test

By using **Equation (10)**, the t value for each regency/city in Sumatera Island is obtained as follows:

Table 6. t_{count} Value of The GWR Model for Each Regency/City

No	Region	t_{count} value					
		x_1	x_2	x_3	x_4	x_5	x_6
1	Simeulue	-7.87906	-2.97533	3.52064	-0.58114	0.84501	4.26901
2	Aceh Singkil	-7.88314	-2.97669	3.51578	-0.55693	0.88195	4.25787
3	Aceh Selatan	-7.87847	-2.97856	3.51554	-0.57052	0.86286	4.26285
4	Aceh Tenggara	-7.87758	-2.97954	3.51419	-0.56967	0.86480	4.26184
5	Aceh Timur	-7.86861	-2.98386	3.51017	-0.58437	0.84605	4.26468
6	Aceh Tengah	-7.8673	-2.9827	3.51237	-0.59261	0.83321	4.26826
7	Aceh Barat	-7.86576	-2.98168	3.51409	-0.59999	0.82180	4.27114
8	Aceh Besar	-7.85533	-2.98367	3.51169	-0.61836	0.79686	4.27424
9	Pidie	-7.85998	-2.98338	3.51208	-0.60905	0.80994	4.27238
10	Bireuen	-7.86195	-2.98421	3.51080	-0.60196	0.82070	4.26999
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
153	Batam	-7.88924	-2.97295	3.51432	-0.52965	0.92113	4.24498
154	Tanjung Pinang	-7.88960	-2.97139	3.52037	-0.54818	0.89169	4.25666

Based on **Table 6**, the results of the parameter significance test for each regency/city on the Sumatera Island are obtained. The test uses α = 0.05 and df = 148, with the criteria for the rejection area to determine the rejection decision on the parameter significance test is H_0 rejected if $|t_{\text{count}}| > t_{\frac{\alpha}{2};df}$. It is known that the value of $t_{\text{table}} = t_{\alpha/2,df} = t_{0,025;148} = 1.97612$. If the $|t_{\text{count}}|$ in the regency/city is greater than 1.97612, then there is a significant influence on the observation location.

3.9 GWR Model Formation

The resulting model will be different in each regency/city based on the significance value. The GWR model for each regency/city in Sumatera Island can be seen in the following table:

Table 7. GWR model at each location

	Regency/City	GWR Model
1	Simeulue	$\hat{y} = 13.00927 - 0.182820x_1 - 0.72526x_2 + 0.000430x_3 + 0.52988x_6$
2	Aceh Singkil	$\hat{y} = 12.98433 - 0.182690x_1 - 0.72493x_2 + 0.000430x_3 + 0.52788x_6$
3	Aceh Selatan	$\hat{y} = 12.99551 - 0.182700x_1 - 0.72577x_2 + 0.000430x_3 + 0.52882x_6$
4	Aceh Tenggara	$\hat{y} = 12.99365 - 0.182670x_1 - 0.72600x_2 + 0.000430x_3 + 0.52867x_6$
5	Aceh Timur	$\hat{y} = 13.00362 - 0.182629x_1 - 0.72760x_2 + 0.000430x_3 + 0.52944x_6$
6	Aceh Tengah	$\hat{y} = 13.01320 - 0.182690x_1 - 0.72758x_2 + 0.000430x_3 + 0.53014x_6$
7	Aceh Barat	$\hat{y} = 13.02183 - 0.182740x_1 - 0.72759x_2 + 0.000430x_3 + 0.53074x_6$
8	Aceh Besar	$\hat{y} = 13.03892 - 0.182760x_1 - 0.72891x_2 + 0.000423x_3 + 0.53182x_6$
9	Pidie	$\hat{y} = 13.02942 - 0.182730x_1 - 0.72842x_2 + 0.000430x_3 + 0.53123x_6$
10	Bireuen	$\hat{y} = 13.02118 - 0.182680x_1 - 0.72835x_2 + 0.000430x_3 + 0.53068x_6$
⋮	⋮	⋮
153	Batam	$\hat{y} = 12.96287 - 0.182670x_1 - 0.72347x_1 + 0.000430x_3 + 0.52583x_6$
154	Tanjung Pinang	$\hat{y} = 12.98144 - 0.182780x_1 - 0.72340x_2 + 0.000430x_3 + 0.52757x_6$

3.10 GWR Model Accuracy Test

After testing by calculating R^2 which aims to see the ability of the predictor variables in the regression model to explain variations in the response variable. obtained a coefficient of determination of 0.5722503. This shows that the variables x_1, x_2, x_3, x_4, x_5 and x_6 in this study are able to explain the Open Unemployment Rate variable in the regencies/cities of Sumatra Island by 57.2%, while the remaining 42.8% is explained by other factors not explained in the model.

3.11 Model GWR Interpretation

The GWR model in this study has a coefficient of determination of 0.5722503, which means that this model is quite feasible to be applied to the Open Unemployment Rate in the regencies/cities of Sumatra Island with different models for each observation location. One of the models obtained is as follows:

$$\hat{y} = \mathbf{13.00927 - 0.18282}\boldsymbol{x_1} \mathbf{- 0.72526}\boldsymbol{x_2} \mathbf{+ 0.00043}\boldsymbol{x_3} \mathbf{+ 0.52988}\boldsymbol{x_6}$$

The model mentioned is the GWR model formed for Simeulue District in Aceh Province. The model can be interpreted that if variable x_1 (Labor Force Participation Rate) and variable x_2 (Population Growth Rate) increase by 1 unit, there will be a decrease in the Open Unemployment Rate in Simeulue Regency by the coefficient on variables x_1 andx_2. If variable x_3 (Population Density) and variable x_6 (Average Years of Schooling) increase by 1 unit, there will be an increase in the Open Unemployment Rate by the coefficient on variables x_3 and x_6. For example, in variable x_1, if the Labor Force Participation Rate value increases by 1 unit, there will be a decrease in Open Unemployment Rate by 0.18282, provided that other variables are constant.

4. CONCLUSIONS

The conclusions that can be obtained based on the results of the analysis that has been done in this research are as follows:

1. Using the Fixed Gaussian Kernel weighting function, the GWR model for each district/city in Sumatra Island was obtained, with a total of 154 models as contained in **Table 7**.
2. Based on the parameter significance test that has been conducted, the variables x_1 (Labor Force Participation Rate), x_2 (Population Growth Rate), x_3 (Population Density), and x_6 (Average Years of Schooling) have a significant influence on each location, while the variable x_4 (Percentage of Poor

Population) and variable x_5 (Poverty Line) have no influence on any location. These variables are able to explain the OUR by 57.2%, where the remaining 42.8% is explained by other factors that are not explained in the model, indicating that there are other factors that affect the Open Unemployment Rate that have not been included in the analysis such as customary and cultural factors, the economy, or government policies.

3. The geographical similarity results in the similarity of the factors affecting the OUR in each district/city on the island of Sumatra.

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