

# Identification of Slum Distribution Patterns Based on GWR (Case Study: Panjang District, Bandar Lampung City)

Ratna Mustika Sari<sup>a,1\*</sup>, Melantika Sihombing<sup>a,2</sup>, Rizky Ahmad Yudanegara<sup>a,3</sup>, Meraty  
Ramadhini<sup>a,4</sup>

<sup>a</sup> Geomatics Engineering, Institut Teknologi Sumatera, Lampung, Indonesia

<sup>1</sup>ratna.sari@gt.itera.ac.id\*;<sup>2</sup>melantikasitohang05@gmail.com;  
<sup>3</sup>rizkyahmadyuda@gmail.com;<sup>4</sup>meraty.ramadhini@gt.itera.ac.id  
\* corresponding author

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## ABSTRACT

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Slums are densely populated settlements that are not habitable, the building density is very high in a very limited area, causing various problems such as being prone to social diseases and diseases. The distribution of slums in an area can be analyzed using geographic information systems as an innovative strategy to visualize geospatial information accurately, allowing for more in-depth and data-based analysis to support decision making. This study uses the *Geographically Weighted Regression (GWR)* method. *Geographically Weighted Regression (GWR)* is a statistical analysis that allows researchers to evaluate spatial variations in the relationship between dependent and independent variables, using the Fixed Gaussian kernel function to provide constant weighting across research locations, so that they can understand complex and different spatial relationships in each location. Based on data processing on seven indicators and 16 slum parameters stipulated in PUPR Regulation No. 14 of 2018, Panjang District, Bandar Lampung City, there are 5 sub-districts that are categorized as light slums with slum distribution points spread across various locations without clear concentration. The results of the *Geographically Weighted Regression (GWR)* model show that the independent variables (X) and dependent variables (Y) reflect a complex relationship with variable X<sub>11</sub> (non-standard wastewater management system) having the highest coefficient of 0.213830. The results of the GWR model in the ANOVA table show that the GWR model does not provide significant improvement.

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## I. Introduction

Housing and settlements are one of the basic human needs and are important factors in improving human dignity and quality of life in a just and prosperous society [1]. Slums are densely populated settlements that are not habitable because they are located on land that is not in accordance with the designation/spatial planning, the building density is very high in a very limited area, thus causing various problems in the community environment such as being prone to social diseases and environmental diseases [2]. This condition is a major challenge for the government and society to create a healthy and sustainable environment [3]. The problem of slum settlements needs to be analyzed, the calculation of slum areas as stated in PUPR Ministerial Regulation No. 14 of 2018 contains seven indicators and 16 parameters of slums.



The use of geographic information system technology as an innovative strategy in visualizing geospatial information accurately enables the analysis of the distribution and classification of slum levels in an area [4]. *Geographically Weighted Regression Method* (GWR) is used to understand the spatial relationship between variables that influence slums [5]. The *Geographically Weighted Regression* (GWR) method allows for more accurate identification of relationships between variables that influence slums, such as building conditions, roads, and water supply [6].

Bandar Lampung City is one of the cities that is inseparable from the problem of slum settlements caused by rapid population growth, in addition to limited land availability [7]. Based on this, Panjang District, Bandar Lampung City is one of the areas facing similar challenges. Slums in Panjang District, Bandar Lampung City are of concern to the local government, non-governmental organizations, and the wider community. This study aims to identify the level of slums, slum distribution patterns and the results of slum settlement models using the *Geographically Weighted Regression* (GWR) method in Panjang District, Bandar Lampung City.

## II. Theoretical basis

### A. Settlement

Settlement based on Law Number 1 of 2011 settlement is part of a residential environment consisting of more than one housing unit that has infrastructure, facilities, public utilities, and has other supporting functional activities in urban or rural areas. Settlement is a place of residence for residents in an area with different environments and life patterns where humans can develop harmoniously in favorable conditions [4].

### B. Slums

According to Law No. 1 of 2011 concerning Housing and Residential Areas, slums are settlements that are not suitable for habitation due to building irregularities, high building density, and substandard building quality and facilities and infrastructure. High building density with very limited area, prone to social and environmental diseases, low general building quality, inadequate environmental infrastructure services so that it can endanger the survival and lives of its residents [2].

### C. Slum Parameters

According to the Ministry of Public Works and Public Housing in PUPR Regulation No. 14 of 2018, there are seven indicators and 16 parameters of slums used to determine the location and level of slums. The seven indicators in PUPR Regulation No. 14 of 2018 are building conditions, environmental road conditions, drinking water supply conditions, environmental drainage conditions, wastewater management conditions, waste management conditions, and fire protection conditions and 16 parameters of slums are building irregularities, building density, non-compliance with building technical requirements, coverage of environmental road services, quality of environmental road surfaces, availability of safe access to drinking water, unfulfilled drinking water needs, inability to drain water runoff, unavailability of drainage, quality of drainage construction, wastewater management systems that do not meet standards, wastewater management infrastructure and facilities do not meet technical requirements, wastewater infrastructure and facilities do not meet technical requirements, waste management systems that do not meet technical standards, unavailability of fire protection infrastructure, and unavailability of fire protection facilities.

### D. Geographic Information System

Geographic Information System (GIS) is a system-based technology improvement that is useful for activities related to spatial data and textual data, which is a function of mapping. The use of GIS can help researchers in combining, processing, and producing existing data and information easily [8]. Geographic Information System (GIS) also has an important role in assisting in data collection and spatial data processing, but also in data analysis and visualization to obtain more accurate and relevant information [8].

E. *Geographically Weighted Regression (GWR)*

*Geographically Weighted Regression (GWR)* is a statistical analysis method developed to address the problem of spatial heterogeneity in data [9]. GWR can be used to classify the level of slum settlements using different scores in each location, so that it can provide a more accurate picture of the condition of slum settlements in various regions [10]. *Geographically Weighted Regression (GWR)* allows for understanding complex and different spatial relationships in each location, so that it can provide a more accurate picture of the phenomenon being studied [11]. The GWR model can be written according to the formula:

$$y_i = \beta_0(u_i, v_i) + \sum \beta_k(u_i, v_i) x_{ik} + \epsilon_i, i = 1, 2, \dots, n$$

Where:

- $y_i$  : observation value of the  $i$ -th dependent variable
- $x_{ik}$  : value of observation of the  $k$ th independent variable in observation  $i$
- $\beta_0(u_i, v_i)$  : intercept value, GWR regression model
- $\beta_k$  : regression coefficient
- $u_i, v_i$  : point coordinates (latitude, longitude of  $i$ -th location
- $\epsilon_i$  :  $i$ -th observation error

III. Methodology

A. Research Location

The study area in this research is Panjang District, Bandar Lampung City. Geographically, Panjang District, Bandar Lampung City is located at 5°20' - 5°30' LS and 105°28' - 105°37' BT which borders Sukabumi District and South Lampung Regency to the east, Lampung Bay to the south and Bumi Waras District and Lampung Bay to the west.

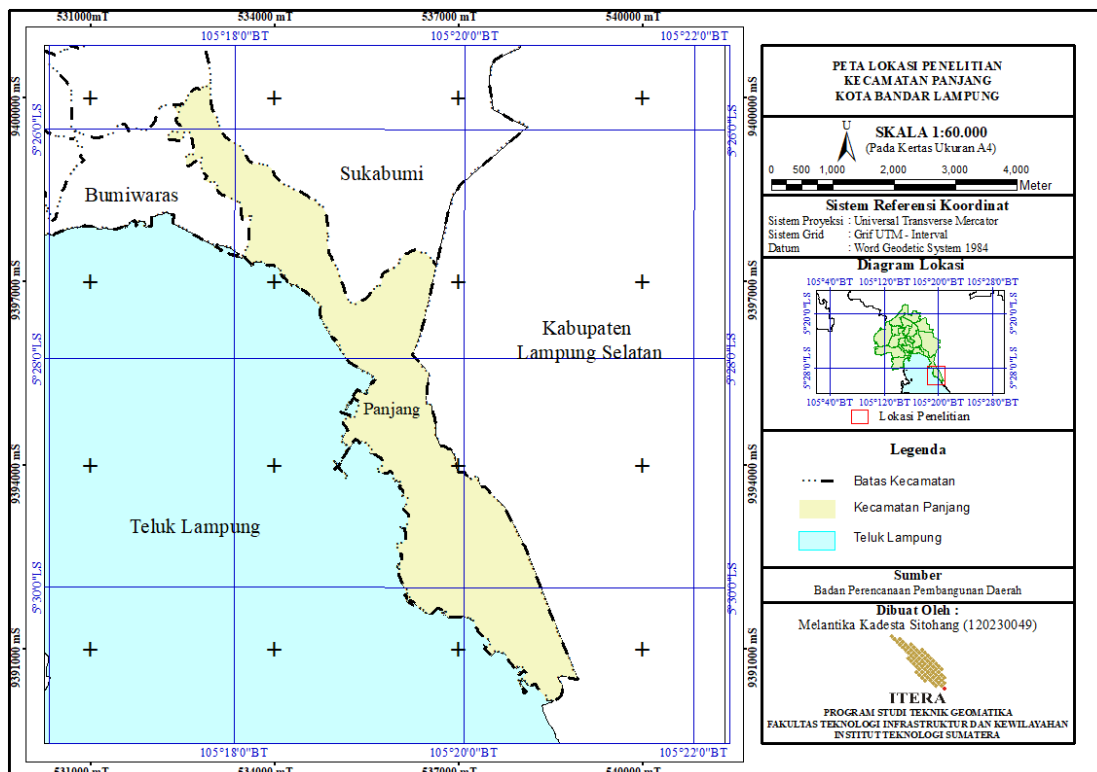


Fig 1. Research Location Map

B. Research Materials

The materials used in this study are as follows:

1. Administrative boundary data Panjang District, Bandar Lampung City, obtained from the Regional Development Planning Agency (BAPPEDA).

2. Logbook containing condition data Building construction, condition road environment, provision of drinking water, conditions drainage environment, wastewater management, waste management and protection fire Panjang District, Bandar Lampung City, obtained from the Regional Development Planning Agency (BAPPEDA).

C. Research Implementation

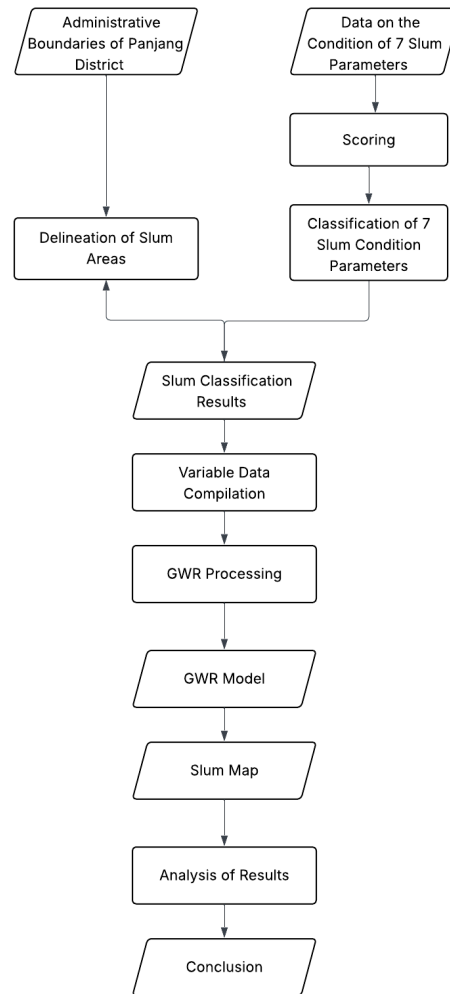


Fig 2. Flowchart

1. Literature Study

Literature study done to find ideas or sources references in research. Literature studies can help identify the problems that will be investigated with compare and analyze results study previously.

2. Data collection

Data collection aims to provide accurate depiction about situation and conditions latest in the region research. The data used in this study are administrative data. Panjang District and *logbook* containing condition data building, road environment, drinking water supply, drainage environment, waste water management, waste management, and protection fire from the KOTAKU Team.

3. Data processing

a. Scoring

Scoring assessment is used to assess the level of slums based on seven indicators and 16 parameters. The slum score assessment is calculated based on the Directorate of

Residential Area Development in 2018. Each parameter is given a score based on the following criteria:

- quality (0%-25%): score 0
- Quality quite good (26%-50%): score 1
- Quality (51%-75%): score 3
- Very poor quality (76%-100%): score 5

b. GWR Processing

This process begins with data preparation arranged in .csv format. Make sure the data includes the village score as a dependent variable that can represent the results to be analyzed. Then the numeric value of each village as an independent variable and place its coordinates. Next, the data is called using GWR4 software. Then determine the dependent variable and independent variable, and define the coordinates to be used in the analysis. After the model is defined, the next step is to select the type of kernel function using Fixed Gaussian (distance) with bandwidth selection using the Golden section to determine the optimal bandwidth. The criteria used are *Akaike Information Criteria corrected* (AICc). After all the settings are complete, the processing process is carried out by pressing the Execute This Session option.

4. Distribution Pattern Map Settlement Slum

Results obtained from evaluation scoring based on seven parameters of slums. Next *overlay* and classification processes are carried out, then done processing use device soft spatial data processor. The results of classification interpreted in map form to see level squalor and pattern distribution settlement slums in Panjang District.

5. Results Analysis

Results obtained done analysis that aims to describe and provide systematic interpretation, based on facts, and careful to information or characteristics that are being researched so that it can be presented in a way effective.

#### IV. Results and Discussion

##### A. Slum Level

Based on data processing on seven indicators and 16 slum parameters stipulated in PUPR Ministerial Regulation No. 14 of 2018, Panjang District, Bandar Lampung City has slum areas in Ketapang Village, Karang Maritim Village, Panjang Utara Village, Pidada Village, and Srengsem Village.

Table 1. Scoring Classification of Slum Levels

No	Ward	Slum Score	Slum Criteria
1	The Ketapang	24	Light Slum
2	Maritime Coral	16	Light Slum
3	North Length	16	Light Slum
4	Speech	18	Light Slum
5	Srengsem	19	Light Slum

The results of the scoring process show that all sub-districts have scores ranging from 16 to 24, indicating that Panjang District is in the light slum category. The lowest scores are Karang Maritim and Panjang Utara Sub-districts, while the highest score is Ketapang Sub-district with a score of 24. Although all sub-districts are included in the light slum category, the variation in scores indicates that there are differences in the quality of infrastructure and basic services in each sub-district. This is very important to improve the quality of the environment and the welfare of the community in Panjang District.

## B. Slum Distribution Pattern

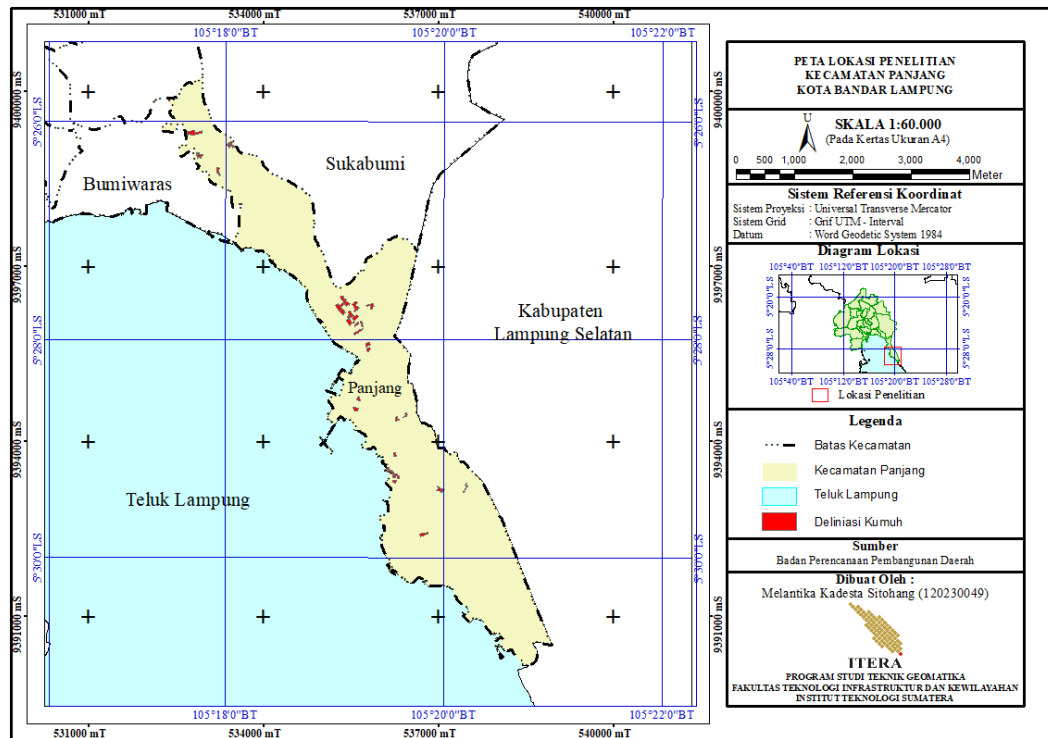


Fig 2. Map of Slum Distribution

The results of the analysis show that the distribution of slums in Panjang District has a significant pattern in the influence of factors that affect the level of slums. Based on the results of the study, there are points of distribution of slums that are spread across various locations without clear concentration. This distribution pattern can be described as a scattered pattern, where slums are not concentrated in one particular area, but are distributed irregularly.

*Geographically Weighted Regression (GWR)* method is used to identify factors that influence the level of slums. The results of the analysis show that infrastructure and accessibility contribute significantly to the increase in slum areas. This study shows that Panjang District has five sub-districts consisting of 24 RTs that are in the light slum category, with variations in scores indicating differences in the quality of infrastructure and basic services in each sub-district. This pattern indicates that handling slums in Panjang District must develop more effective strategies in improving the quality of life of residents.

C. Analysis of *Geographically Weighted Regression (GWR)* Results

*Geographically Weighted Regression (GWR)* processing was carried out for each sub-district in Panjang District by entering the sub-district score as the dependent variable and the numerical value of the slum parameters of each sub-district as the independent variable. The *Geographically Weighted Regression (GWR)* model generated from the GWR4 software shows an effective approach in analyzing the relationship between variables that affect the level of slums in Panjang District. In general, the mathematical model of GWR generated from GWR4 software is  $\hat{y} = 21.708355 + 0.033774x_1 + 0.038964x_3 + 0.004880x_4 + 0.001075x_5 - 0.044689x_6 + 0.025166x_7 + 0.008096x_9 + 0.000529x_{10} + 0.213830x_{11} - 0.021235x_{12} - 0.008484x_{13} + 0.027776x_{14} + 0.043508x_{15} - 0.026334x_{16}$ .

This model reflects the complex relationship between independent variables (X) and dependent variables (Y), where each coefficient shows the relative influence of each variable on the level of slums. From the results of the model, variable  $X_{11}$  has the highest coefficient of 0.213830, which indicates that an increase in the value of this variable has a significant effect on increasing the level of slums in Panjang District.

Table 2. Anova

Source Diversity	SS	DF	MS	F count	F table
Global Residuals	79,774	9,000			
GWR Improvement	0.000	0.000	3,642		
Gwr Residual	79,774	9,000	8,864	0.410876	5.12

## V. Conclusion

1. Research result show that in Panjang District only there are two classes settlement slum that is not shabby and slum light. Classification score slum the largest is Ketapang Subdistrict with value 24.
2. Distribution pattern settlement slums in Panjang District show no pattern regular in various locations in Panjang District.
3. *the Geographically Weighted Regression (GWR)* model show that there is no change significant seen from higher F - value small from F- table value. Variable  $X_{11}$  is the most influential variable in increasing slum Because have coefficient the highest, but other variables also contribute influence level slums in Panjang District, Bandar Lampung City.

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