

ANALYSIS OF THE NUMBER INFANT AND MATERNAL MORTALITY IN CENTRAL JAVA INDONESIA USING SPATIAL-POISSON REGRESSION

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DOI: 10.14710/medstat. 11.2.135-145

Article Info:

Received: 21 October 2018
Accepted: 28 February 2019
Available Online: 4 March 2019

Keywords:

Maternal and Infant mortality,
Poisson, GWPR.

This article has been presented on the 8th International Seminar on New Paradigm and Innovation on Natural Sciences and Its Application (The 8th ISNPINSA), on 26 September 2018.

Abstract: Maternal and infant mortality are one of the most dangerous problems of the community since it can profoundly affect the number and composition of the population. Currently, the government has been taking heed on the attempt of reducing the number of maternal and newborn mortality in Central Java which requires data and information entirely. Poisson regression is a nonlinear regression that is often used to model the relationship between response variables in the form of discrete data with predictor variables in the form of discrete or continuous data. In space analysis, GWPR is one of method in space modeling which can model regional-based regression. It is based on some factors including the number of health facilities, the number of medical personnel, the percentage of deliveries performed with non-medical assistance; the average age of a woman's first marriage; the average education level of married women; average amount of per capita household expenditure; percentage of village status; the average rate of exclusive breastfeeding; percentage of households that have clean water and the percentage of poor people. Based on the analysis, it is revealed that the determinants of maternal and infant mortality in Central Java using Poisson and GWPR models, among others are the number of health facilities, the number of medical personnel, the average number of per capita household expenditure and the percentage of the poor. In the maternal and infant mortality model, the AIC value of GWPR model produces better modeling than Poisson regression.

1. INTRODUCTION

One of the Sustainable Development Goal's (SDG's) programs is a reduction in maternal mortality and infant mortality (Trisnantoro *et. al.*, 2010). The maternal mortality rate is the number of maternal deaths per 100,000 live births. Meanwhile, the infant

mortality rate is a number that shows the number of deaths of 0-year-olds from every 1000 live births (Adair *et. al*, 2012).

Figure 1a delineates the infant mortality rate in Indonesia, which highlights a decrease from year to year. Meanwhile, Figure 1b illustrates the maternal mortality rate in Indonesia, which experienced a decrease until 2007 but showed a leap in 2010. Apart from the constant decline from year to year, Indonesia is still ranked second in Southeast Asia after Laos for infant mortality rate (Subramaniam *et. al.*, 2016).

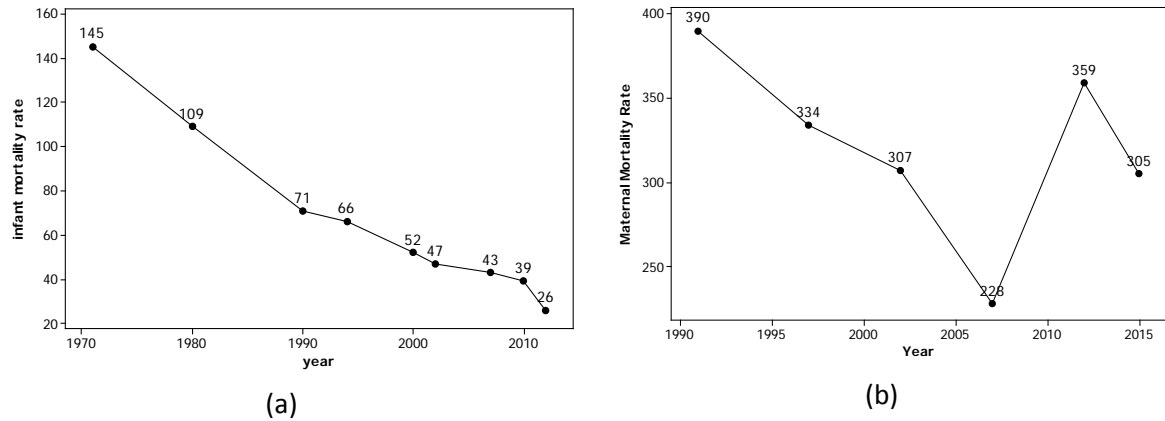
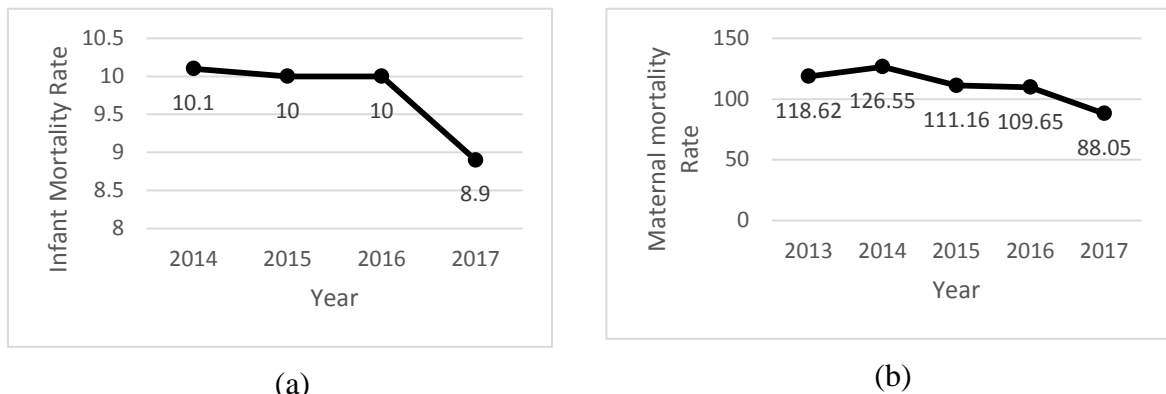


Figure 1a The Infant Mortality Rate in Indonesia;
1b The Maternal Mortality Rate in Indonesia



*Source: Health Ministry

Figure 2a The Infant Mortality Rate in Central Java;
2b The Maternal Mortality Rate in Central Java

Based on Figure 2 show that the maternal and infant mortality rate in central Java. Base on figure the infant mortality rate in 2015 to 2016 stay on the line and in 2017 decline significantly. The maternal mortality rate in 2014 has been increasing and in 2015 until 2017 has been declining.

There are many factors to influence maternal and infant mortality rate in Indonesia, covering both internal and external factors. The internal factors are comprised of maternal understanding during pregnancy, maternal and infant nutrition, and maternal health. Meanwhile, the external factors are attributed to the number of health facilities, number of medical personnel, percentage of deliveries performed with non-medical assistance; the

average age of a woman's first marriage; the average educational background of married women; average amount of per capita household expenditure; percentage of village status; the average rate of exclusive breastfeeding; percentage of households that have clean water and the percentage of poor people (Berkhout and Plug, 2004). Thus, this study will examine the determinants of maternal and infant mortality rates based on external factors.

Regression analysis is a statistical analysis that is used to model the relationship between predictor variables and response variables. It applies Ordinary Least Square (OLS) parameter to estimate regression modeling. Regression analysis can be divided into simple linear regression analysis and multiple linear regression. Simple linear regression analysis applies when the predictor variable consists of only 1 variable, while multiple regression analysis is selected when the predictor variable is more than one variable. In regression analysis, the response variable is continuous. If the response variable is categorical, it will be classified as the categorical regression model (Zamani et. al., 2016).

One of the developments introduced for the regression method is the Poisson regression model. The Poisson regression model is a model whose response variable is Poisson distribution. If the response variable is Poisson distributed, which is modeled by multiple or simple linear regression analysis, it will lead to bias. The parameter estimation of the Poisson regression model is Maximum Likelihood Estimator (MLE) (Berkhout and Plug, 2004).

Spatial analysis is a type of space analysis which is to explain patterns of human behavior and its space expression in terms of mathematics and geometry. Some of method in spatial analysis to model between independent and dependent variable are spatial regression and Geographically Weighted Regression (GWR). They are modelling the spatial data based on dependent and independent variables in some of location.

Poisson regression model bases its analysis on the region. If the Poisson regression is modeled for spatial/space data, despite the relationship between one region and another, the Poisson regression model will be biased. Space analysis One of the developments in the space-based Poisson regression model is Geographically Weighted Poisson Regression (GWPR). GWPR modeling produces a local regression model, meaning that each region has its regression model. A predictor variable which is significant in one location may not always be significant in another location, making it be referred to as a local regression model. Since the GWPR model is comprised of dependency between regions, the kernel of the GWPR modeling is used as the weighting. Therefore, in weighing the GWPR, the optimum bandwidth is selected using Cross Validation (CV) (Nakaya, 2005).

In this study, the number of maternal and infant mortality in Central Java will be modeled using a Poisson regression model and we would like to compared in spatial analysis model such as in GWPR method. The modeling will compare the number of maternal and infant mortality for Poisson regression method and GWPR.

2. LITERATURE REVIEW

2.1. Poisson Regression Model

If μ_i is an average of successful events that occur within a certain time interval and is assumed to not change from one particular data to another independently, then it is possible to model μ_i as follows (Karlis and Ntzoufras, 2005):

$$f(y_i, \beta) = \frac{e^{-\mu(x_i, \beta)} [\mu(x_i, \beta)]^{y_i}}{y_i!}$$

The variable shows the response variable with Poisson distribution, while β shows the estimator, and $\mu(x_i, \beta)$ is the average Poisson or expectation value of y_i . Functions $\mu(x_i, \beta)$ can be selected according to the pattern of the data obtained and are always positive. One function that is used in $\mu(x_i, \beta)$ is $\exp(x_i^T \beta)$, while $(x_i^T \beta)$ is a linear function. This linear function will connect the variables on the mean known as the link function. The Poisson regression model is a Generalized Linear model with the connecting link function of the natural logarithm.

Suppose that μ is mean of y_i , so $\mu = E(Y_i)$ for $i = 1, 2, \dots, n$ if

$$g(\mu) = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \dots + \beta_k x_{ik}$$

$\ln(\mu) = \ln[E(Y_i)]$ so it resulted in

$$\mu_i = \exp(x_i^T \beta) = \exp(\beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \dots + \beta_k x_{ik})$$

The parameter estimation of the Poisson regression model uses the Maximum Likelihood (MLE) method. The MLE method procedure is performed by subtracting the partial ln likelihood from the function of the parameter to be estimated.

$$L(y, \beta) = \prod_{i=1}^n \left\{ \frac{e^{-\mu(x_i, \beta)} [\mu(x_i, \beta)]^{y_i}}{y_i!} \right\}$$

To get the estimator value, it is reduced to β , then solved using the Newton Raphson iteration.

Meanwhile, the parameter significance testing uses the maximum likelihood of ratio test (MLRT).

Hypothesis: $H_0 : \beta_1 = \beta_2 = \dots = \beta_k = 0$; H_1 : at least there is $\beta_k \neq 0$. The test statistic used is

$$\Lambda = \frac{L(\hat{\omega})}{L(\hat{\Omega})} \text{ with } G = -2 \ln \Lambda, \text{ with } L(\hat{\omega}) \text{ as the likelihood value for a simple model without}$$

involving predictor variables and $L(\hat{\Omega})$ is a likelihood for the complete model. The test

criteria used are rejected H_0 if $G \geq \chi_{v, n}^2$ with v as the free degree. Meanwhile, to test the significance of parameters individually, we use the Wald test, with the test statistic of

$$t = \frac{\hat{\beta}}{SE(\hat{\beta})}, \text{ criteria of test rejected } H_0 \text{ if } |t| > t_{\frac{\alpha}{2}, n-1} \text{ [3].}$$

2.2. Geographically Weighted Poisson Regression

GWPR is the development of a Poisson regression model, by including local elements into the Poisson regression model (Nakaya et al., 2005). The GWPR model is a form of local regression from the Poisson regression model so that each region will have its Poisson regression model. The GWPR model can be written as follows [4]

$$E(y_i) = \mu(\mathbf{x}_i, \boldsymbol{\beta}(u_i, v_i)) = \exp(\mathbf{x}_i^T \boldsymbol{\beta}(u_i, v_i)); \quad i = 1, 2, \dots, n$$

With y_i is an observation of i -th while $\mu(\mathbf{x}_i, \boldsymbol{\beta}(u_i, v_i))$ is a function of x_i as predictor variables and β is an estimation of the parameter in the regression model, with $\mathbf{x}_i^T = [x_{1i}, x_{2i}, \dots, x_{ki}]$

and $\beta = [\beta_0, \beta_1, \beta_2, \dots, \beta_k]^T$, (u_i, v_i) as the location of a point (*longitude, latitude*) for i -th location.

Similar to parameter estimation in the Poisson regression model, GWPR model parameter estimation uses the MLE method, then to get parameter estimation using Newton Raphson iteration.

$$\ln L^*(\beta(u_i, v_i)) = \sum_{j=1}^n (y_j \mathbf{x}_j^T \beta(u_j, v_j) - \exp(\mathbf{x}_j^T \beta(u_j, v_j)) - \ln y_j!) w_{ij}(u_i, v_i)$$

Parameter estimation of $\beta(u_i, v_i)$ can be obtained by differencing of log likelihood by $\beta(u_j, v_j)$ resulted:

$$\frac{\partial \ln L^*(\beta(u_i, v_i))}{\partial \beta^T(u_j, v_j)} = \sum_{j=1}^n (y_j \mathbf{x}_j - \mathbf{x}_j \exp(\mathbf{x}_j^T \beta(u_j, v_j))) w_{ij}(u_i, v_i)$$

Then the derivated can be solved use Newthon Raphson's iteraton where

$$\hat{\beta}^{(l+1)}(u_i, v_i) = \left(\sum_{i=1}^n x_i w_{ij}(u_i, v_i) \hat{y}_{i(l)} x_i^T \right)^{-1} \sum_{i=1}^n x_i w_{ij}(u_i, v_i) \hat{y}_{i(l)} \left\{ \left(\frac{y_i - \hat{y}_{i(l)}}{\hat{y}_{i(l)}} \right) + x_i^T \hat{\beta}^{(l)}(u_i, v_i) \right\}$$

Whereas for testing the significance of the parameters of the GWPR model are as follows with the hypothesis

$H_0 : \beta_k(u_i, v_i) = \beta_k \quad ; i = 1, 2, \dots, n \ ; k = 1, 2, \dots, p$ (there is no significant difference between Poisson regression models and GWPR models)

$H_1 : \text{at least one of } \beta_k(u_i, v_i) \neq \beta_k$ (there is a significant difference between Poisson regression models and GWPR models)

Statistics test : $D(\hat{\beta}(u_i, v_i)) = -2 \ln \left[\frac{L(\hat{\omega})}{L(\hat{\Omega})} \right] = 2 [\ln L(\hat{\Omega}) - \ln L(\hat{\omega})]$

$D(\hat{\beta})$ is called likelihood ratio which is Testing the suitability of the GWPR model using a comparison of the deviance value of the Poisson regression model and the GWPR model. Suppose that the Poisson regression model is expressed as model A with df_A degrees of freedom and the GWPR model is expressed as model B with df_B degrees of freedom [5]:

$$F = \frac{\text{Deviance Model A} / df_A}{\text{Deviance Model B} / df_B}$$

F will follow the F distribution with df_A and df_B free degrees. The test of criteria is rejected H_0 if $F > F_{(\alpha; df_A; df_B)}$.

While testing the model parameters is done by testing the parameters partially. This test is to find out which parameters that significantly affect the response variable. The partial model parameter testing hypothesis is:

$H_0 : \beta_k(u_i, v_i) = 0 \quad ; i = 1, 2, \dots, n \ ; k = 1, 2, \dots, p$

$H_1 : \beta_k(u_i, v_i) \neq 0$

The test of statistic as follows as

$$t = \frac{\hat{\beta}_k(u_i, v_i)}{se(\hat{\beta}_k(u_i, v_i))} ; \text{Reject } H_0 \text{ If } |t| > t_{(\alpha/2); n-(p+1)}$$

3. METHODOLOGY OF RESEARCH

In this study, the number of maternal deaths (Y_1) and the number of infant deaths (Y_2) will be modeled using the Poisson regression model and GWPR. The factors to be used, among others are the number of medical personnel (X_1), the average expenditure per capita in a month (X_2), % of married female population aged 15-49 whose labor was helped by an obstetrician for the last child (X_3), Average Length of Exclusive Breastfeeding (10 months) (X_4), % of Toddlers who get Complete Immunization (X_5), % of Households that use Clean Drinking Water Source (X_6), % of Slum Households (X_7), Population Density (X_8). The analysis step in this study is to compare the Poisson model and GWPR for the number of maternal deaths and the number of infant deaths.

4. RESULTS AND DISCUSSION

The following is Descriptive Statistics from the research data

Table 1 Statistics-Descriptive of the data

Variables	Minimum	Maximum	Mean	Std. Deviation
Y_1	3.00	54.00	17.3429	10.51873
Y_2	16.00	444.00	156.7143	84.97736
X_1	97.00	1474.00	290.7143	279.22040
X_2	613941.00	1375419.00	780632.7143	188136.68131
X_3	17.48	69.38	34.3640	12.3425
X_4	8.76	12.48	10.6851	0.81499
X_5	50.18	87.17	70.7640	7.50500
X_6	50.40	98.67	76.8157	10.74790
X_7	.44	9.89	1.9580	1.65704
X_8	477.00	11678.00	2029.7429	2442.16713

Based on Table 1 it can be seen that the number of maternal deaths is at least 3 and the most are 54, while the number of infant deaths is at least 16 while the most are 444. Variance in the number of infant deaths is greater than the number of maternal deaths. The next step is to model the number of maternal deaths and the number of infant deaths using Poisson regression.

The estimated model for the number of maternal deaths is as follows:

$$g_1(x) = 5508.423 + 169.206X_1 + 13.076X_2$$

The model produces a significant likelihood ratio test, meaning that the model is suitable with an AIC value of 228,632. The resulting deviance value is 0, meaning that the Poisson regression model does not experience overdispersion. Thus, it is conclusive that the Poisson regression model for the number of maternal deaths is very appropriate. The next step is to model the number of infant deaths in Central Java. The model estimates for the number of maternal deaths are as follows:

$$g_2(x) = 147803.343 + 1242.708X_1 + 71.492X_2$$

This model produces a significant likelihood ratio test that is equal to 1498.6, meaning that the model is suitable. The AIC value of 305,565 results in deviance value of 0, which indicates that the Poisson regression model does not experience overdispersion.

Thus, it is conclusive that the Poisson regression model for the number of infant deaths is very appropriate.

The next step is modeling the number of maternal and infant deaths in Central Java using GWPR. The kernel function used for weighting is fixed Gaussian. The Cross Validation (CV) method leads to the optimum bandwidth value for modeling the number of infant deaths of 0.6232, while the optimum bandwidth for modeling the number of infant deaths is of 0.8659. The next step is analysis to see whether there is any difference between Poisson regression modeling and GWPR. The calculated F-value resulted in modeling the number of infant deaths was 1.487. As compared to the table value of $F_{0.025;26;14} = 2.767$, then H_0 is accepted, and it is said that there is no difference between the Poisson regression model and the GWPR model on modeling the number of infant deaths. As for modeling the number of maternal deaths, the calculated F value is 1.84. As compared with the table $F_{0.025;26;19} = 2.43$, H_0 is said to be accepted, meaning that there is no difference between Poisson regression modeling and GWPR model. Furthermore, the model is adjusted for accuracy by looking at the calculated Chi-Square value. In modeling the number of infant deaths, the Chi-Square value is calculated at 13.76. Meanwhile, the $\chi^2_{0.05;14,52} = 23.68$ means that H_0 is accepted. In other words, the model of the number of infant deaths for GWPR is not appropriate. Meanwhile, the suitability testing of the GWPR model on the number of maternal deaths reveals that Chi-square values are calculated at 13.45 with $\chi^2_{0.05;19,057} = 30.14$. In this way, H_0 is being accepted, meaning that the model of maternal mortality for GWPR is also not appropriate.

The modeling produced an AIC value of 276,417. While the GWPR model for the number of maternal deaths in Central Java produced an AIC value of 78,177. The descriptive statistics from the estimation model of the number of maternal deaths and the number of infant deaths using GWPR produce the following values:

Table 2 Descriptive Statistic of Estimation Model GWPR

Parameter	Infant Mortality				Maternal Mortality			
	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum
Intercept	4.770070	0.203748	4.725928	5.268572	2.559719	0.126971	2.512069	2.866754
X ₁	0.484937	0.154218	0.140227	0.758520	0.542078	0.061289	0.426375	0.663269
X ₂	-0.234890	0.128938	-0.432020	0.038575	0.057272	0.047403	-0.072700	0.120030
X ₃	0.014743	0.078906	-0.145590	0.156432	-0.144190	0.040011	-0.242350	-0.078360
X ₄	0.049241	0.036466	-0.013270	0.126542	0.103392	0.051128	-0.016860	0.151151
X ₅	-0.115690	0.082905	-0.266680	0.068793	-0.259560	0.074281	-0.374080	-0.131830
X ₆	0.088443	0.053928	0.019974	0.227470	0.008197	0.031289	-0.032890	0.089658
X ₇	-0.058330	0.058785	-0.126930	0.087406	0.092765	0.011453	0.035391	0.119107
X ₈	-0.578780	0.078952	-0.775100	-0.458770	-0.806002	0.036859	-0.902370	-0.761890

On the other hand, the testing of the partialis compared to the value of $t_{0.025;34} = 2.032$. The partial testing for a model of the number of infant deaths in each region can be seen in appendix 1. Based on the attachment, it is observable that the bold, calculated t value

shows a non-significant variable, while the non-bold value indicates a significant variable. The modeling of the number of infant mortality variables of X_1 and X_8 affect all areas, while other variables show some significance for some areas but also show some areas that are not significant.

Meanwhile, for testing the significance of the parameters in the GWPR model, the number of maternal deaths is shown in Appendix 2. Based on Annex 2, it can be seen that GWPR modeling shows that there are 2 variables that are not significant in all regions, namely variables X_2 , X_6 and X_7 . Similar to the GWPR model in the number of infant deaths, the variables of X_1 and X_8 in the GWPR model and the number of maternal deaths is significant in all regions. It is indicates that the variables X_1 and X_8 have a global effect, while the variables X_3 , X_4 , X_5 have a local effect.

When compared with the Poisson regression model, the GWPR model produces a smaller AIC value than the Poisson,regression model. Hence, the GWPR model is very suitable for modeling the number of maternal deaths and the number of infant deaths

5. CONCLUSION

In the modeling of the number of maternal deaths and the number of infant deaths using a Poisson regression model, only two variables are proven to be significant namely the number of medical personnel and the average expenditure per capita. In GWPR modeling, the resulted AIC value is smaller than the Poisson,regression model. However, in the model comparison test, the GWPR model is not different from the Poisson,regression model. In the GWPR modeling, the testing of the suitability of the model reveals that the model was not suitable. In partial testing of the GWPR model, there are global influences and local influences for the modeling of the number of maternal deaths and the number of infant deaths.

ACKNOWLEDGMENT

This research supported by Diponegoro university as a founder in the development and application research (RPP) 2018 in contract number 385-46/UN7.P4.3/PP/2018.

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Appendix 1 Model GWPR for the Number Infant Mortality in Central Java, Indonesia.

Area	$\hat{\beta}_0$	t_{β_0}	$\hat{\beta}_1$	t_{β_1}	$\hat{\beta}_2$	t_{β_2}	$\hat{\beta}_3$	t_{β_3}	$\hat{\beta}_4$	t_{β_4}	$\hat{\beta}_5$	t_{β_5}	$\hat{\beta}_6$	t_{β_6}	$\hat{\beta}_7$	t_{β_7}	$\hat{\beta}_8$	t_{β_8}
Cilacap	5.15	207.91	0.36	6.31	-0.03	-0.47	-0.14	-3.57	0.04	1.15	-0.27	-11.22	0.09	2.90	-0.08	-2.09	-0.55	-9.09
Banyumas	5.14	231.14	0.33	6.27	-0.06	-0.97	-0.09	-2.49	0.02	0.59	-0.25	-10.87	0.09	3.25	-0.04	-1.18	-0.58	-10.33
Purbalingga	5.07	256.55	0.36	8.51	-0.12	-2.26	-0.08	-2.39	0.01	0.19	-0.22	-10.09	0.07	2.70	-0.02	-0.63	-0.56	-10.80
Banjarnegara	5.01	267.52	0.40	10.61	-0.14	-2.94	-0.10	-3.04	0.01	0.59	-0.20	-9.45	0.05	1.91	-0.04	-1.02	-0.53	-10.59
Kebumen	4.99	267.74	0.41	10.78	-0.14	-2.88	-0.15	-4.35	0.02	0.85	-0.19	-8.93	0.05	1.72	-0.06	-1.75	-0.48	-9.34
Purworejo	4.91	274.92	0.44	11.57	-0.16	-3.50	-0.12	-3.72	0.05	2.23	-0.13	-6.04	0.03	1.18	-0.08	-2.30	-0.46	-8.13
Wonosobo	4.94	277.43	0.44	12.28	-0.17	-3.65	-0.08	-2.69	0.04	1.69	-0.16	-8.03	0.03	1.06	-0.05	-1.57	-0.51	-10.28
Magelang	4.87	274.83	0.48	12.70	-0.20	-4.46	-0.07	-2.15	0.06	2.82	-0.11	-4.83	0.04	1.54	-0.08	-2.40	-0.49	-8.61
Boyolali	4.81	253.27	0.55	14.38	-0.29	-6.46	-0.01	-0.22	0.07	2.61	-0.04	-1.56	0.10	4.35	-0.10	-2.55	-0.54	-8.42
Klaten	4.80	247.92	0.53	13.77	-0.28	-6.13	-0.03	-0.91	0.06	2.13	-0.02	-0.58	0.12	4.76	-0.10	-2.48	-0.53	-7.83
Sukoharjo	4.77	230.31	0.58	14.89	-0.33	-7.09	0.00	-0.08	0.05	1.70	0.02	0.50	0.17	6.28	-0.10	-2.26	-0.59	-8.21
Wonogiri	4.73	206.84	0.62	15.27	-0.36	-7.28	0.00	-0.02	0.03	0.93	0.07	1.70	0.23	7.25	-0.09	-1.92	-0.65	-8.18
Karanganyar	4.75	221.99	0.61	15.58	-0.35	-7.40	0.02	0.47	0.06	1.84	0.01	0.38	0.18	6.52	-0.09	-2.08	-0.63	-8.64
Sragen	4.76	226.06	0.63	16.03	-0.36	-7.70	0.05	1.28	0.07	2.53	-0.02	-0.72	0.16	5.82	-0.09	-2.21	-0.63	-9.08
Grobogan	4.78	228.94	0.67	16.65	-0.39	-8.43	0.10	2.87	0.09	3.34	-0.07	-2.22	0.12	4.23	-0.11	-2.62	-0.63	-9.35
Blora	4.74	198.43	0.73	16.87	-0.40	-7.73	0.12	2.95	0.12	3.58	-0.09	-2.33	0.12	3.51	-0.08	-1.58	-0.73	-8.57
Rembang	4.74	195.38	0.76	16.84	-0.43	-8.12	0.16	3.60	0.13	3.81	-0.11	-2.98	0.10	2.62	-0.10	-1.81	-0.72	-8.19
Pati	4.79	223.32	0.70	16.82	-0.43	-8.90	0.14	3.79	0.10	3.53	-0.09	-2.77	0.09	2.98	-0.13	-2.86	-0.63	-8.99
Kudus	4.81	240.18	0.67	16.70	-0.41	-8.84	0.13	3.61	0.09	3.43	-0.08	-2.76	0.08	3.22	-0.12	-3.02	-0.61	-9.36
Jepara	4.85	253.20	0.66	16.65	-0.42	-9.03	0.15	4.26	0.09	3.24	-0.09	-2.96	0.05	1.94	-0.13	-3.08	-0.59	-9.34
Demak	4.83	257.00	0.63	16.33	-0.37	-8.31	0.10	3.09	0.08	3.45	-0.08	-3.17	0.07	2.93	-0.11	-2.98	-0.59	-9.76
Semarang	4.84	268.65	0.56	15.16	-0.29	-6.82	0.04	1.23	0.08	3.38	-0.09	-3.84	0.05	2.48	-0.09	-2.70	-0.56	-9.76
Temanggung	4.89	279.62	0.49	13.39	-0.21	-4.74	-0.04	-1.23	0.06	2.82	-0.13	-6.01	0.03	1.10	-0.07	-2.16	-0.52	-9.88
Kendal	4.90	282.02	0.52	14.47	-0.24	-5.60	0.02	0.74	0.06	2.89	-0.13	-6.27	0.02	0.86	-0.06	-1.93	-0.56	-11.14
Batang	4.96	278.31	0.46	12.85	-0.19	-4.17	-0.02	-0.55	0.04	1.54	-0.17	-8.43	0.03	1.12	-0.03	-0.82	-0.57	-11.82
Pekalongan	5.03	265.54	0.38	10.02	-0.15	-3.01	-0.03	-0.86	0.01	0.26	-0.20	-9.59	0.06	2.34	0.00	0.06	-0.59	-11.72
Pemalang	5.13	243.77	0.28	6.01	-0.09	-1.63	0.03	0.80	-0.01	-0.48	-0.23	-10.01	0.12	4.02	0.05	1.36	-0.67	-12.08
Tegal	5.23	215.94	0.17	3.04	0.00	0.01	0.08	1.82	-0.01	-0.37	-0.25	-10.40	0.16	5.35	0.08	2.04	-0.75	-12.57
Brebes	5.27	206.14	0.14	2.35	0.04	0.57	0.09	2.09	-0.01	-0.18	-0.25	-10.54	0.17	5.69	0.09	2.16	-0.78	-12.78
City of Magelang	4.87	276.35	0.48	12.93	-0.20	-4.55	-0.06	-1.89	0.06	2.85	-0.11	-5.16	0.03	1.42	-0.08	-2.35	-0.50	-8.95
City of Surakarta	4.77	233.81	0.59	15.18	-0.33	-7.23	0.01	0.30	0.06	2.08	0.00	-0.13	0.15	5.98	-0.10	-2.31	-0.59	-8.52
City of Salatiga	4.84	266.73	0.55	14.66	-0.28	-6.39	0.01	0.39	0.07	3.22	-0.08	-3.45	0.06	2.80	-0.09	-2.65	-0.54	-9.27
City of Semarang	4.86	273.60	0.58	15.58	-0.31	-7.12	0.06	2.13	0.08	3.41	-0.10	-4.39	0.04	1.72	-0.09	-2.64	-0.57	-10.37
City of Pekalongan	5.03	266.64	0.39	10.31	-0.16	-3.30	0.01	0.22	0.01	0.27	-0.20	-9.34	0.06	2.36	0.02	0.46	-0.62	-12.17
City of Tegal	5.23	216.13	0.17	3.07	0.00	0.01	0.07	1.78	-0.01	-0.36	-0.25	-10.41	0.16	5.32	0.08	2.00	-0.75	-12.55

Appendix 2 Model GWPR for the Number Maternal Mortality in Central Java, Indonesia

Area	$\hat{\beta}_0$	t_{β_0}	$\hat{\beta}_1$	t_{β_1}	$\hat{\beta}_2$	t_{β_2}	$\hat{\beta}_3$	t_{β_3}	$\hat{\beta}_4$	t_{β_4}	$\hat{\beta}_5$	t_{β_5}	$\hat{\beta}_6$	t_{β_6}	$\hat{\beta}_7$	t_{β_7}	$\hat{\beta}_8$	t_{β_8}
Cilacap	2.83	44.45	0.46	3.24	0.10	0.65	-0.24	-2.29	0.00	0.00	-0.37	-5.72	0.04	0.50	0.04	0.34	-0.76	-4.49
Banyumas	2.81	45.39	0.47	3.47	0.09	0.61	-0.22	-2.17	0.01	0.10	-0.37	-5.73	0.03	0.43	0.06	0.58	-0.78	-4.65
Purbalingga	2.76	47.28	0.50	4.07	0.09	0.63	-0.21	-2.16	0.04	0.58	-0.36	-5.77	0.01	0.17	0.09	0.85	-0.79	-4.95
Banjarnegara	2.72	48.21	0.51	4.39	0.10	0.71	-0.21	-2.24	0.07	1.00	-0.35	-5.72	0.00	-0.04	0.09	0.92	-0.80	-5.07
Kebumen	2.71	48.09	0.51	4.33	0.11	0.77	-0.23	-2.44	0.07	1.02	-0.34	-5.61	0.00	-0.02	0.08	0.79	-0.78	-4.89
Purworejo	2.63	47.92	0.53	4.55	0.12	0.91	-0.21	-2.30	0.12	1.81	-0.30	-5.03	-0.02	-0.31	0.09	0.89	-0.78	-4.87
Wonosobo	2.66	48.69	0.53	4.68	0.11	0.81	-0.19	-2.15	0.11	1.63	-0.32	-5.46	-0.02	-0.31	0.10	1.03	-0.81	-5.19
Magelang	2.60	47.46	0.55	4.73	0.11	0.84	-0.18	-2.03	0.14	2.12	-0.28	-4.69	-0.03	-0.39	0.09	0.98	-0.80	-5.00
Boyolali	2.56	45.05	0.57	4.89	0.08	0.58	-0.15	-1.65	0.15	2.25	-0.23	-3.52	-0.01	-0.12	0.09	0.91	-0.82	-4.84
Klaten	2.56	44.53	0.57	4.79	0.08	0.65	-0.16	-1.74	0.15	2.22	-0.22	-3.36	-0.01	-0.08	0.09	0.85	-0.81	-4.67
Sukoharjo	2.54	42.78	0.59	4.90	0.05	0.41	-0.14	-1.52	0.15	2.07	-0.19	-2.62	0.02	0.24	0.09	0.82	-0.83	-4.58
Wonogiri	2.51	40.36	0.60	4.95	0.03	0.23	-0.13	-1.37	0.14	1.81	-0.14	-1.77	0.05	0.61	0.09	0.77	-0.86	-4.37
Karanganyar	2.53	41.92	0.60	5.00	0.03	0.25	-0.13	-1.38	0.14	1.96	-0.17	-2.28	0.03	0.44	0.09	0.82	-0.85	-4.58
Sragen	2.53	42.47	0.61	5.07	0.02	0.16	-0.12	-1.29	0.14	1.97	-0.18	-2.41	0.03	0.42	0.09	0.84	-0.85	-4.69
Grobogan	2.55	43.18	0.62	5.18	0.00	-0.04	-0.10	-1.05	0.14	1.90	-0.19	-2.50	0.03	0.40	0.09	0.83	-0.86	-4.77
Blora	2.52	39.60	0.65	5.19	-0.05	-0.38	-0.09	-0.88	0.12	1.43	-0.13	-1.51	0.08	0.99	0.10	0.77	-0.90	-4.42
Rembang	2.52	39.43	0.66	5.18	-0.07	-0.50	-0.08	-0.78	0.11	1.33	-0.13	-1.45	0.09	1.02	0.09	0.73	-0.90	-4.34
Pati	2.55	42.96	0.64	5.21	-0.03	-0.25	-0.08	-0.84	0.13	1.74	-0.18	-2.30	0.04	0.50	0.08	0.76	-0.86	-4.67
Kudus	2.56	44.59	0.62	5.21	0.00	-0.03	-0.09	-0.97	0.14	1.98	-0.21	-2.89	0.01	0.16	0.09	0.87	-0.85	-4.91
Jepara	2.58	46.18	0.63	5.27	0.00	0.00	-0.08	-0.85	0.14	2.04	-0.23	-3.38	-0.01	-0.15	0.10	0.96	-0.85	-5.12
Demak	2.58	46.04	0.61	5.19	0.03	0.23	-0.10	-1.15	0.15	2.17	-0.24	-3.57	-0.01	-0.16	0.10	0.99	-0.85	-5.15
Semarang	2.59	46.84	0.58	5.05	0.07	0.53	-0.13	-1.51	0.15	2.27	-0.26	-4.15	-0.02	-0.33	0.10	1.05	-0.83	-5.21
Temanggung	2.62	48.15	0.55	4.85	0.10	0.78	-0.17	-1.91	0.13	2.09	-0.29	-4.96	-0.03	-0.44	0.10	1.08	-0.82	-5.23
Kendal	2.62	48.55	0.57	5.02	0.08	0.64	-0.14	-1.62	0.14	2.10	-0.30	-5.02	-0.03	-0.49	0.11	1.19	-0.84	-5.46
Batang	2.67	48.97	0.55	4.83	0.09	0.69	-0.16	-1.83	0.11	1.63	-0.33	-5.55	-0.02	-0.36	0.11	1.19	-0.83	-5.43
Pekalongan	2.73	48.21	0.52	4.45	0.09	0.63	-0.18	-1.91	0.07	0.99	-0.35	-5.75	0.00	-0.06	0.11	1.11	-0.82	-5.24
Pemalang	2.79	46.56	0.49	3.89	0.08	0.52	-0.16	-1.67	0.03	0.42	-0.36	-5.68	0.02	0.25	0.11	1.10	-0.83	-5.01
Tegal	2.85	44.35	0.44	3.18	0.08	0.52	-0.16	-1.50	-0.01	-0.07	-0.36	-5.52	0.04	0.53	0.11	1.01	-0.82	-4.72
Brebes	2.87	43.55	0.43	2.94	0.09	0.54	-0.16	-1.44	-0.02	-0.21	-0.36	-5.47	0.05	0.61	0.10	0.97	-0.82	-4.63
City of Magelang	2.61	47.65	0.55	4.77	0.11	0.82	-0.17	-1.99	0.14	2.12	-0.29	-4.76	-0.03	-0.40	0.10	1.01	-0.81	-5.07
City of Surakarta	2.54	43.14	0.59	4.95	0.05	0.38	-0.14	-1.48	0.15	2.09	-0.19	-2.73	0.02	0.22	0.09	0.84	-0.84	-4.67
City of Salatiga	2.58	46.52	0.58	4.97	0.08	0.60	-0.14	-1.62	0.15	2.28	-0.26	-4.09	-0.02	-0.30	0.10	1.01	-0.83	-5.10
City of Semarang	2.60	47.51	0.59	5.13	0.06	0.47	-0.12	-1.38	0.15	2.25	-0.27	-4.35	-0.03	-0.41	0.11	1.12	-0.84	-5.36
City of Pekalongan	2.72	48.38	0.53	4.55	0.08	0.59	-0.16	-1.73	0.08	1.10	-0.34	-5.71	-0.01	-0.12	0.12	1.21	-0.84	-5.34
City of Tegal	2.85	44.36	0.44	3.18	0.08	0.52	-0.16	-1.51	-0.01	-0.07	-0.36	-5.53	0.04	0.53	0.11	1.01	-0.82	-4.72

