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Identifying Factors Affecting the Local Sustainability Index in Pagar Alam, South Sumatera

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ABSTRACT

Long-term sustainable development requires a balance development strategy between economic, social, and environmental aspects supported by good institutional aspects. The achievement of sustainable development in Pagar Alam is still constrained by many problems in in the economics, socio-institutional, environmental dimensions. This study aims to identify the factors that influence the local sustainability index for each dimension in Pagar Alam, South Sumatera. The analytical model used in this study is Geographically Weighted Regression (GWR) using PODES datasheets in 2018. The results showed that there are several factors that influence the local sustainability index in Pagar Alam City, such as the economic dimension was infrastructure indexes, total built-up/urban land, and number of hotels/hostels/motels/inns; the social dimension was number of informal education institutions, number of worship place and percentage of malnutrition; the environmental dimensions was percentage of plantation area, percentage of water bodies area, and percentage of households that live along the river (riparian).

Keywords: Economic Dimension, Environmental Dimension, Geographically Weighted Regression, Local Sustainability Index, Sustainable Development, Social Dimension.

I. INTRODUCTION

Pagar Alam is an expansion area of Lahat Regency, in 2001 administratively entered the South Sumatera Province. As a city that is centered on agricultural and tourism economic activities is called the city of agro tourism, the achievement of sustainable development in Pagar Alam has its own challenges. Although in regional development planning in Pagar Alam in general, the dimensions of sustainability have been touched upon, however, the achievements of the plan have not yet been seen. The achievement of sustainable development in Pagar Alam is still constrained by various problems in the economic dimension, socio-institutional dimensions, and environmental dimensions. If there is an economic dimension, there are problems such as the rate of economic growth tends to be the same as the inflation rate. The economic growth rate of Pagar Alam City is ranked 11th out of 17 regencies/cities in South Sumatra Province, while the inflation rate of Pagar Alam is ranked 3 of 17 regencies/cities in South Sumatra Province. Then regional competitiveness is still low, where the competitiveness of Pagar Alam City is ranked 10th out of 17 Regencies/Cities in South Sumatra Province. Food security in Pagar Alam in 2001-2010 are still having some problems, such as increased commodity as only as rice, cassava, sweet

potatoes, and fruits, as also occurred in the availability of a protein deficit. This is because city policies and budgets are still focused on the sector of water resources management [1]. Another thing with Trianto [2] explained that the value of the elasticity of employment in Pagar Alam in 2011-2015 had an elastic value. This shows that the growth of employment in Pagar Alam in that period was greater than the percentage of economic growth. However, this condition is not good because of the high level of absorption of work should have implications for the activities of dynamic economic sectors.

In the social dimension there are also problems such as failure to fulfill basic rights that create pockets of poverty such as slum areas and result in increased crime, environmental pollution, and so on. The population of Pagar Alam ranges from 66.99% stating that they cannot afford to buy meat, chicken or milk for family consumption. In addition, healthy and decent dwellings are also still difficult to reach. The condition of the house in terms of the house floor is only cheap wood at 69.95%, the walls of the house building are only 71.89% wood, home lighting and cooking using kerosene amounted to 10.45%. For household irrigation, 68.18% of water sources for poor households come from unprotected sources and 66.7% for defecation empties into rivers. This has an effect on decreasing river water quality. Other conflicts of natural resources and the environment include a decrease in the quality and extent of forests, conflicts over natural resources, and solidarity to work together [3, 4, 5].

In the environmental dimension there are problems such as forest and land fires, forest land conversion, and extensive 7.950 hectares of 8.740 hectares of total forest protection has been damaged and switch functions to farmland or critical land [5] and the low level of public awareness will maintain environmental sustainability, especially in downtown areas that ultimately lead to environmental pollution. The issue is still a major issue that has not been integrated into the development plans in Pagar Alam. Therefore, this research was conducted to identify the factors that influence the local sustainability index (LSI) for each dimension in Pagar Alam.

II. METHODS AND MATERIAL

A. Data

The data used is secondary data from Pagar Alam Regional Development Planning Agency, Pagar Alam Central Bureau of Statistics, Forestry and Estate Crops Service, Environmental Management Agency, Agriculture and Horticulture Agency.

B. Methods

To identify factors that influence the LSI in Pagar Alam, several variables were included in the analysis of Geographically Weighted Regression (GWR). The GWR model generates local parameter estimators at each observation location. The LSI in each dimension is chosen as the dependent variable (Y). This variable was chosen as a proxy for the level of local sustainability in each dimension in each village.

The independent variable (X) in the GWR model in this study is the variable obtained through factor analysis, the variables chosen are considered to influence each of the dimensions of sustainability (economic, social- institutional, and environmental). This analysis uses data in 2018 as a representative year which is the latest year for PODES datasheets. Data for each independent variable (X) and for the dependent variable (Y) used in the GWR model can be seen in Table 1. It was modified from Pravitasari`s research [6].

The Y response variable in the GWR model is predicted by a predictor variable in which each regression coefficient depends on the location where the data is observed. The GWR model can be written as follows [7].

$$Y_i = \beta_0(u_i, v_i) + \sum_{i=1}^{p} \beta_k (u_i, v_i), x_{ij} + \varepsilon_j$$

Note

Y_i : Value of response variable observation for location i

(u_i , v_i) : Stating geographical local coordinates (longitude, latitude) of the observation location to i

$\beta_k (u_i , v_i)$: The regression coefficient predictor variables to *k* at the observation location to *i*

ε_i : Error observing *i* which is assumed to be identical, independent and normally distributed with zero mean and constant variant σ^2

Table 1. X and Y variables used in the GWR model

Variable	Information
Economy:	
Y	LSI of economy (LSI_1)
X_1	Percentage of households that using telephone cable (%)
X_2	Distance to city (km)
X_3	Number of markets, shops, and grocery shops per 1.000 people
X_4	Number of hotels, hostels, motels and inns per 1.000 people
X_5	Percentage of built-up or urban land per total area (%)
X_6	Local infrastructure index
Social:	
Y	LSI of social (LSI_2)
X_1	Number of formal education institutions per 1.000 people
X_2	Number of informal education institutions per 1.000 people
X_3	Distance to formal education institutions (km)
X_4	Number of medical personnel per 1.000 people
X_5	Percentage of malnutrition (%)
X_6	Percentage of disability (%)
X_7	Number of places of worship per 1.000 people
X_8	Number of non-profit organizations per 1.000 people
Environment:	
Y	LSI of environment (LSI_3)
X_1	Percentage of household that live along the river (riparian) (%)
X_2	Percentage of water bodies per total area (%)
X_3	Percentage of forest per total area (%)
X_4	Percentage of plantation per total area (%)
X_5	Percentage of rice fields per total area (%)
X_6	Conversion of rice field to non-agricultural land (ha)
X_7	Conversion of agricultural land to rice fields (ha)

Source: [6] (modified)

III. RESULT AND DISCUSSIONS

Based on the results of the GWR model, it can be compared between the Y variables observed (Y-observed) data shown in the map (A/left) with the predicted Y model shown in the map (B / right) in the economic dimension (Figure 1). Y-observed values range from 0.0 - 100, while Y-predicted values range from 13.14 to 102.89. On both maps, it can be seen that the distribution pattern of LSI_1 from observations and predictions of the models is almost the same, where green areas are areas with the highest LSI_1 in Pagar Alam, namely North Dempo Sub district. In general, each variable included in the GWR model is able to explain the level of sustainability in each region in Pagar Alam approximately >94%. Areas with lower local R^2 mean there are still variables that affect the LSI_1 apart from the 8 variables included as driving factors in the GWR model. The highest local R^2 value in the LSI_1 is mostly found in the village which is included in the administrative area of North Dempo Sub district and part of the Center and South Dempo Sub district, Pagar Alam, which is shown in green on the map (Figure 2). According to Pambudi and Miyasto [8], agglomeration should create a spread effect for regions outside agglomeration. However, agglomeration can cause backward linkage for regions outside of agglomeration when natural resources are absorbed by industrialization or economic activities in agglomeration areas but their area does not experience growth.

The other results of the GWR model is the magnitude of the coefficient or the estimate parameter (C) for each variable X used in the model. The results of the GWR analysis in this study indicate that C in the economic dimension for households that subscribe to cable phone (X_1), number of markets/shops/grocery shops (X_3), number of hotels/hostels/motels/inns (X_4),

built-up land (X_5), and infrastructure indexes (X_6) have a significant effect on increasing the LSI_1 value in Pagar Alam. Whereas distance to city (X_2) have significant influence to decrease LSI_1 value in Pagar Alam. However, the coefficient value or C for the 6 variables for each village area is relatively the same, this indicates that the influence of each variable in one region compared to other regions is not different.

Each variable has a different influence on increasing LSI_1 in Pagar Alam. Based on results of the study (Figure 3) it can be seen that the infrastructure indexes variable has the most dominant influence (26.57-31.10), followed by built-up land variables (19.01-21.16) and number of hotels/hostels/motels (14.05-15.74). It means that the existence of infrastructure indexes, built-in land, and hotels in an area will play a role directly or indirectly towards regional economic growth when compared to the existence cable telephones, distance to cities, and number of markets/shops/grocery shops. As a city of agro tourism, the existence of hotels will create jobs that can reduce unemployment, provide taxes for the region and increase the need for public transportation, and will have an impact on other sectors related to hospitality. A number of hotel rooms have a positive and significant influence on economic growth. The length of time a tourist stays is one other factor that determines the size of the income or foreign exchange received for regions that rely on foreign exchange from the tourism industry. Theoretically, the more number of rooms used and the longer a tourist lives in a tourist destination, the more money is spent in the area. At least for the purposes of eating and drinking as well as accommodation while staying there [9, 10]. This is a way out of the problem in Trianto's study [2] regarding the highest elasticity of employment in 2011-2015 which has no implications for the activities of dynamic economic sectors.

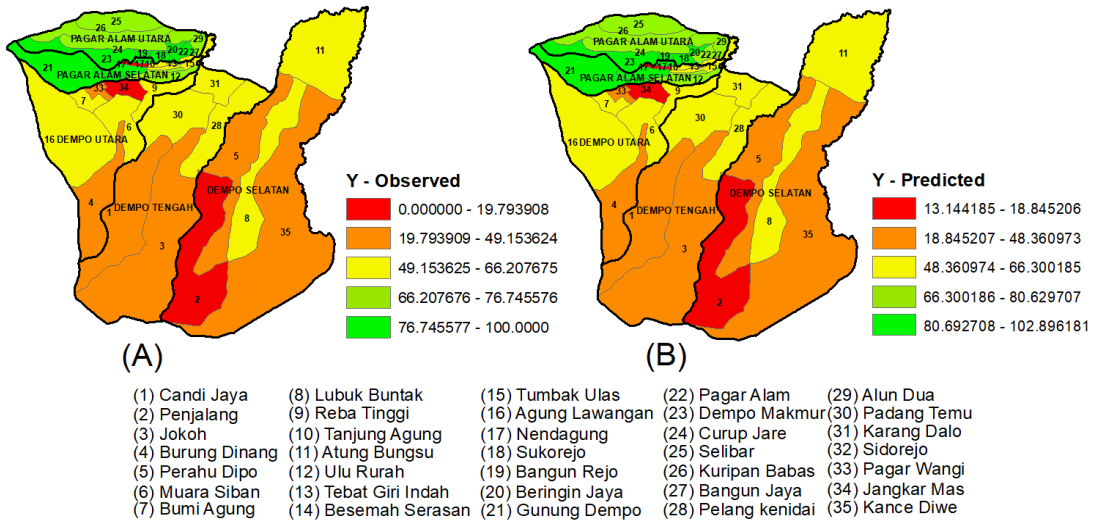

Figure 1: The value of LSI observation (Y-observed) (A) and model prediction (Y-predicted) in the economic dimension

The consequence of economic growth and urban expansion is that a number of agricultural land has been converted into palms and residential buildings. The length of roads and the quality of roads such as paved roads affect economic growth in Indonesia, especially in the West Indonesia region [11]. In addition, a Land Use Land Cover (LULC) simulation using land use data, population growth and economic growth in Daqing City, China indicates that the rapid economic growth policy is a result of the physical development of the region which has increased significantly, while the meadow and wetlands tend to have declining economic growth. The pillar of infrastructure is also closely related to the economy of a region [12]. In Pagar Alam the road network system has a strong influence on the development of the region. The proportion of road length according to good, medium, damaged and severely damaged road conditions is 71.85 km, 224.55 km, 59. 90 km, and 191.25 km [13].

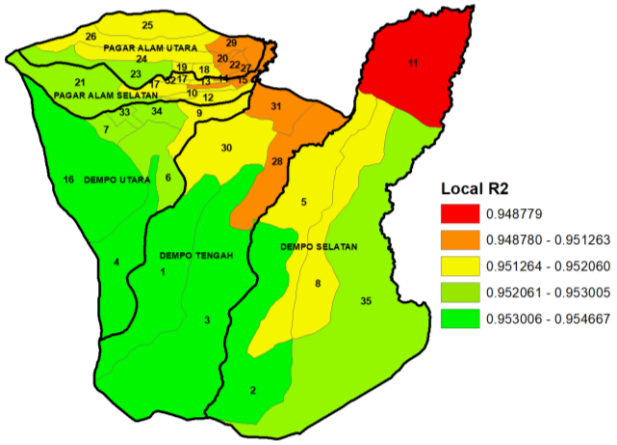

Figure 2: The value of R^2 models as a result of the GWR model of the economic dimension

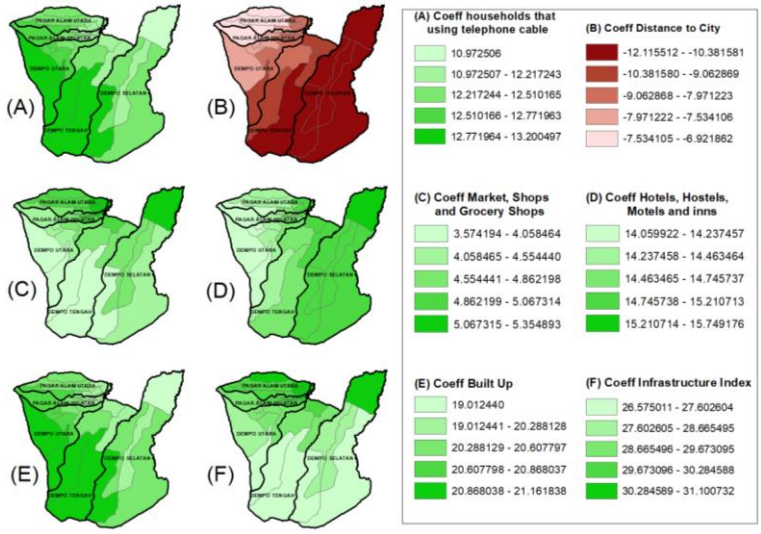

Figure 3: Parameter estimate (C) for the variable of each economic dimension

In the social dimension, the comparison between the observed (A) and predicted (B) variables in Figure 4, the two maps show differences in the patterns of LSI_2 distribution. The observed Y- values range from 0.0-100, while the predicted Y values range from 7.53 to 101.44. On Y-Observed maps and predicted maps of regions that have a LSI_2 value, the urban area is green on the map. The pattern of spatial distribution shown on the map can be categorized as a random pattern, this is because the high value of LSI_2 value is marked by green areas on the map scattered in urban areas that are far from the city centre and not close to each other. This shows that urban areas outside the core of the city are better on the social dimension, this situation can occur because it is caused by conditions in urban areas that tend to be individualistic, as well as places where various cultures and cities tend to be competitive.

The GWR model is able to explain the level of sustainability in each region in the City of Pagar Alam approximately >90%. Areas with lower local R^2 mean there are still variables that affect LSI_2 apart from the 8 variables included as driving factors in the GWR model. The highest local R^2 value in the LSI_2 shown in green on the map is in the area of North and Southern part of Pagar Alam Sub district, while local R^2 in the lowest is located in the South Dempo, Centre Dempo and North Dempo Sub district which is shown in red on the map (Figure 5). A high R^2 value indicates that the 8 variables (driving factors) used in the model are more significant to increase the LSI_2 value in the area of the village compared to other village areas in Pagar Alam. This also shows that the variables used in the model have a large correlation with the increase in LSI_2 values in the area of the village.

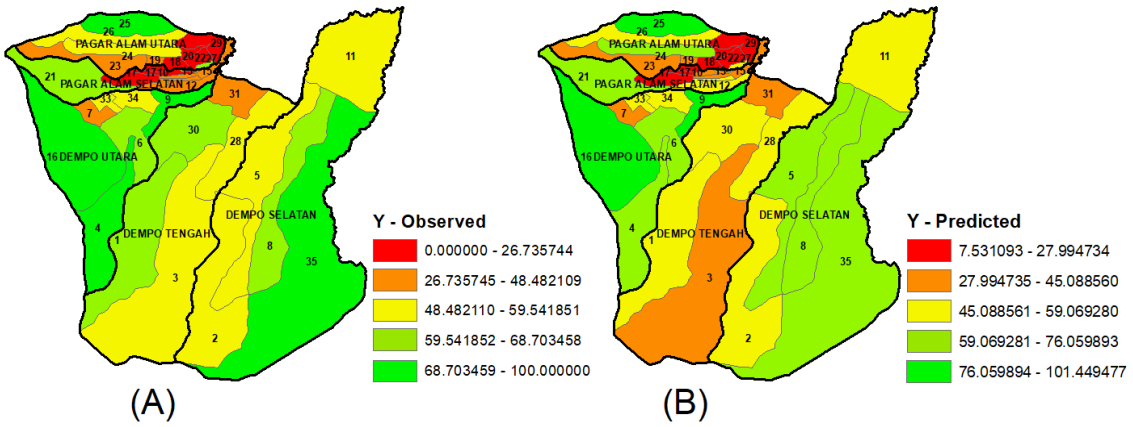

Figure 4: The value of LSI observation (Y-observed) (A) and model prediction (Y-predicted) in the social dimension

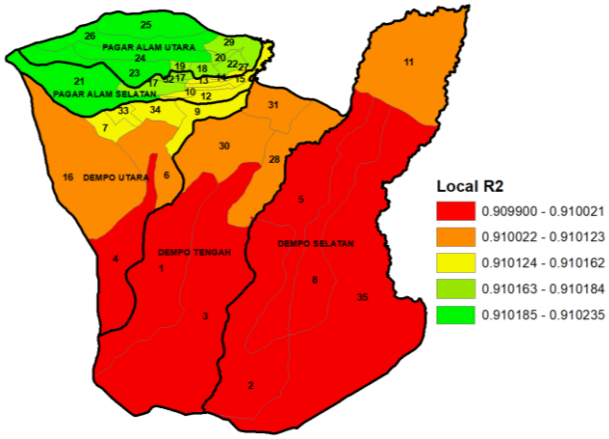

Figure 5: The value of R^2 models as a result of the GWR model of the social dimension

The result of further analysis of the GWR model is the value of C (parameter estimate) for each variable X used in the model (Figure 6). The results of the GWR analysis in this study indicate that the value of C in the social dimension for the variable number of formal education institutions (X_1), number of informal education institutions (X_2), distance to formal education institutions (X_3), number of medical personnel (X_4), number of places of worship (X_7), and number of non-profit organizations (X_8), have a significant effect on increasing the LSI_2 value in Pagar Alam, and number of malnutrition (X_5) and disability (X_6) have a significant effect on decreasing the LSI_2 value in Pagar Alam. However, the C value for the 8 variables for each village area is relatively the same, this indicates that the influence of each variable in one region compared to other regions is not different. Based on the C value of each variable, the C value of the number of informal education institutions is the highest, which ranges from 30.39-30.41, which means that if there is an increase in the number of informal educational institutions, the LSI_2 of Pagar Alam will increase 30.39-30.41 percent. Then, in a number of worship place, the C value ranged between 19.25-19.26. In the percentage of malnutrition, the C value ranged -34.76 to -34.67. It shows that to increase the LSI_2 value in the city of Pagar Alam, it will have a greater influence if it is prioritized on the construction of informal educational institutions, worship place, and handling malnutrition.

Education is very influential on the social conditions of the community, both formal and informal education. Educated people tend to adapt quickly to the social conditions of the surrounding environment. Education is very important, because without having sufficient knowledge and skills obtained through the education process both formal and informal education, people will find difficulties in developing themselves. It can be said that education is a lifelong human need. Therefore, the low welfare of a society will usually be directly proportional to the quality of

education of low family members [14]. Health has an impact both directly and indirectly on the social conditions of the community. Based on the Regional Medium-Term Development Plan (RMDP) of Pagar Alam [13], health facilities in Pagar Alam up to 2017 include as many as 1 hospital, 7 health centers, and 18 auxiliary health centers spread across several sub districts. The utilization and strengthening of health human resources is central to efforts to combat the health crisis and build a sustainable health system. Many health work units lack health human resources according to Ministry of Health Republic of Indonesia Number 75 of 2014. Humanizes service and distribution can also affect the sustainability of the health facility. Health infrastructure variables significantly had a positive effect on public health development [15, 16, 17].

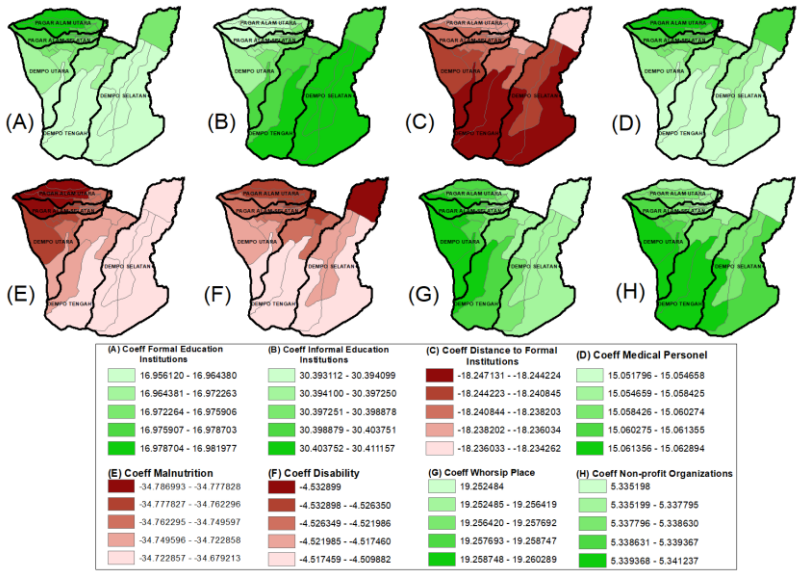

Figure 6: Parameter estimate (C) for the variable of each social dimension

The existence of the community is also determined by health factors. The existence of a disease affects the condition of one's physical health is one aspect that determines the quality of one's life. Health factors greatly influence the social dimension of sustainable development. In Indonesia, the triple nutritional problem is an old problem, one of which is poor nutrition and under nutrition. The main determinants of stunting in children in Indonesia are non-exclusive breastfeeding in the first 6 months, low family economic status, premature birth, short newborn body length, short motherhood, low parental education level, and children living in urban poor areas and in rural areas.

Based on the results of the study it was found that the higher the percentage of people suffering from malnutrition, the lower the value of social sustainability in Pagar Alam. The Pagar Alam Health Office noted in 2012 that there were 4 low birth weight babies in Pagar Alam out of 3,605 live births in the Sidorejo Health Center working area of 3 people and 1 person in the Gunung Dempo Health Center working area. In 2013 the number of low birth weight babies decreased by 1 person from 2,221 live-born babies in the Sidorejo Health Center work area. In 2014 there were no cases of infants with low birth weight [18, 19, 20, 11, 22].

In the environmental dimension the comparison between the variables Y-observed (E) and Y-predicted (F) shows the differences in the pattern of distribution of LSI_3 shown on the two maps (Figure 7). The observed Y- values range from 0.0-100, while the predicted Y values range from 8.29-99.52. The pattern of spatial distribution of LSI_3 values can be categorized as a random pattern, as shown on the Y-Observed and Y-predicted maps, that regions that have high LSI_3 values are scattered and not clustered in one region.

The GWR model is able to explain the level of sustainability in each region in Pagar Alam approximately >79%. Areas with lower local R^2 mean there are still variables that affect LSI_3 apart from the 7 variables included as driving factors in the GWR model. The local R^2 value in the highest environmental dimension is in the North and South Pagar Alam, and the lowest area with local R^2 value is in the southern of Pagar Alam, which is in the South Dempo Sub district (Figure 8). A high R^2 value indicates that the 7 variables (driving factors) used in the model are more significant to increase the LSI_3 values in the village that are marked with green on the map compared to the other village in Pagar Alam. It also shows that the variables used in the model have a large correlation with the increase in the value of the LSI_3 in the area of the village.

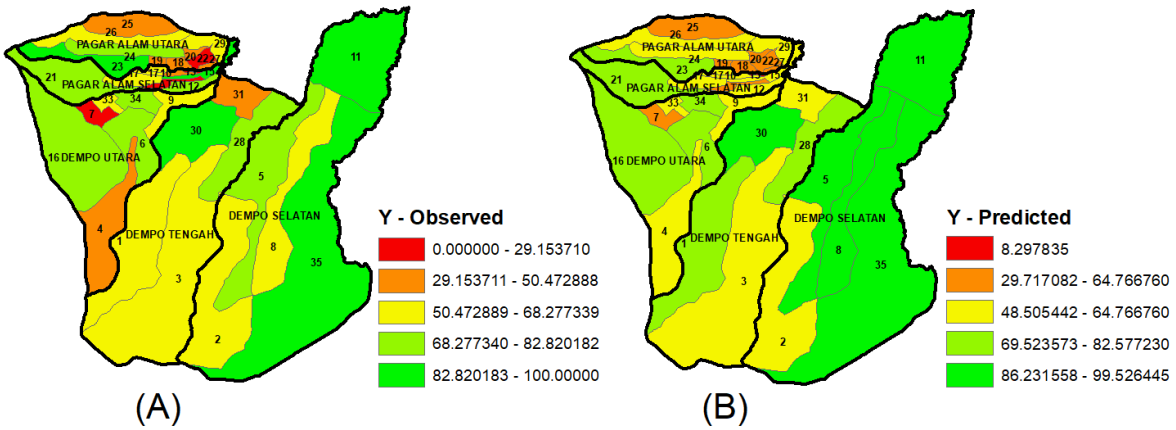

Figure 7: The value of LSI observation (Y-observed) (A) and model prediction (Y-predicted) in the environment dimension

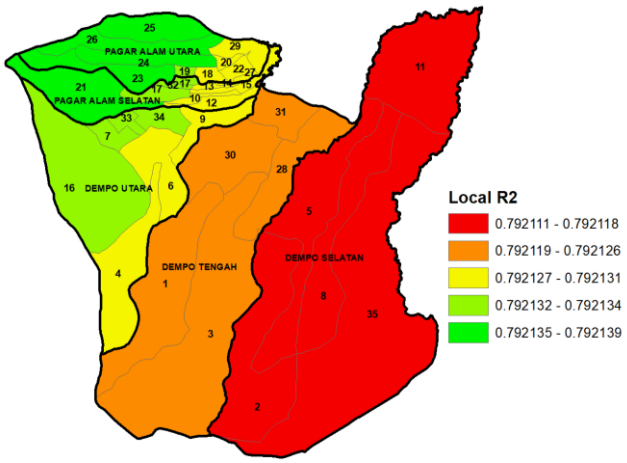

Figure 8: The value of R^2 models as a result of the GWR model of the environment dimension

The result of the subsequent analysis of the GWR model is the value of C for each variable X used in the model. The results of the GWR analysis in this study indicate that the value of C in the environmental dimension for the percentage of household that live along the river (riparian) (X_1), bodies of water (X_2), area of forest (X_3), area of plantation (X_4), and area of rice fields (X_5) significantly increases the value LSI_3 in Pagar Alam, whereas conversion of rice field to non-agricultural land (X_6) and conversion of non-agricultural land to rice field significantly (X_7) decreases the value LSI_3 in Pagar Alam However, the C value for the 7 variables for each village area is relatively the same, this indicates that the influence of each variable in one region compared to other regions is not different.

Based on the C value of each variable (Figure 9), the C value of the percentage of plantation area is the highest, which ranges from 5.20 to 5.21, which means that if there is an additional plantation area of 1 percent, the LSI_3 value in Pagar Alam will increase 5.20 to 5.21 percent. Then, the variable of water bodies, or the parameter value estimate coefficient ranged between 5.07 to 5.08. In the percentage variable the household that live along the river (riparian) is a value of C ranging from -6.567 to -6.561. It shows that to raise the value of LSI_3 in Pagar Alam, will be having a great influence if prioritized to the addition of extensive plantation and water bodies, and also a reduction in the household that live along the river (riparian).

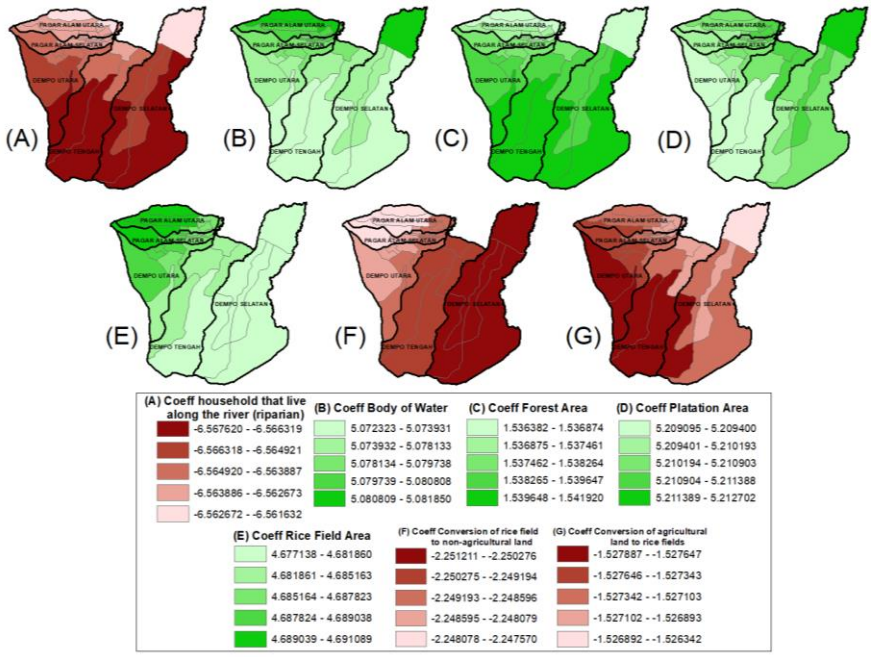

Figure 9: Parameter estimate (C) for the variable of each environment dimension

Environmental conditions are very dependent on the efforts of the environment. Agricultural land in general is a network of ecosystems and a place to absorb rainwater. The increasing environmental conservation of horticultural plants influences the weather even the surrounding climate [23, 24]. Most areas that are not far from settlements are used as farms such as vegetables, coffee, chocolate and fruits [5]. Based on Central Statistics Agency of Pagar Alam [25], the area of plantation dominates the use of non-rice fields. The majority of plantation that are cultivated are Robusta type, besides that for the South Pagar Alam sub district, the plantation that is being cultivated is the plantation owned by PTPN VII. However, [26] explains that land management such as forests which only consider one function will cause deforestation. The Forestry and plantation Service of Pagar Alam reported deforestation of 7.950 ha of 28.740 ha of total protected forest areas by farmers to open coffee or vegetable gardens. Types of coffee gardens with shade trees, clean of litter and grass and rolling can reduce percent surface runoff and total erosion [27].

The pattern of settlement in an area is strongly influenced by the physical condition of the area, socio-economic conditions and others. The influence of this physical condition is very evident in the pattern of settlements in rural areas. The construction of settlements that follow the pattern of river flows can be caused when land for settlements is increasingly difficult to find, because physical conditions in the area are not suitable to be used as settlements, for example the physical conditions of coastal areas are hilly so that the surrounding population find it difficult to settle. However, regardless of the situation, the activities of residents living in the riverbank area will have a negative impact on the quality of the environment, generally residents living in the riverbank area dispose of their

household waste in the river, causing pollution of river water, in addition due to debris that settles in the river will have an impact on siltation of river water due to precipitation of waste [28]. As a result of the activities of the population it will create an unhealthy environment, so that it will adversely affect health, while settlements in slums are created due to increased population growth, urgent economic conditions and lack of adequate financial capacity and limited land for housing are the causes the emergence of slums. Another statement [29, 30, 13] states that in slums the facilities are very limited such as clean water, drainage, etc., this causes slums to be a cause of environmental pollution so that it will add to the environmental burden in the area. The largest percentage of slums in Pagar Alam is located in a village close to the center of Pagar Alam, namely in Pagar Alam village with a percentage of 14 percent of the total.

IV.CONCLUSION

The factors that significantly influence the LSI_1 are local infrastructure index, percentage of built-up or urban land, and number of hotels, hostels, motels and inns. Factors that have a significant effect on the value of LSI_2 are number of informal education institutions, number of worship place, and percentage of malnutrition. Factors that significantly influence LSI_3 values are, percentage of plantation area, percentage of water bodies area, and household that live along the river (riparian).

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