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SPATIAL ANALYSIS OF HOTSPOTS AND COLDSPOTS OFPOVERTY INCIDENCE IN DAVAO CITY, PHILIPPINES

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ABSTRACT

The Philippines' National Economic and Development Authority (NEDA) envisions Davao Region as the nation's Rising Global Frontier. With this, the utmost focus has been given to a faster decline in its poverty numbers. A closer look therefore at the poverty situation in Davao City, being the capital of Davao Region, is essential in the accomplishment and assessment of this goal. Spatial and regression analyses on poverty incidence in Davao City for the year 2015 were conducted in this study. Results of the Spatial Autocorrelation (Moran's I) test performed in ArcGIS confirmed that there is a significant clustering of high and/or low values of poverty incidence among the 'barangays' (smallest administrative divisions) of the city. Running the Hotspot Analysis (Getis-Ord Gi) tool of ArcGIS, it was found that 18 barangays formed hotspots while 24 barangays formed coldspots of poverty incidence. Notably, these hotspots or significant clusters of high poverty incidence were found mostly in the rural areas of Davao City. In performing regression analysis, the Ordinary Least Squares regression model in this paper was found to be suitable. In particular, the variables,namely access to safe sanitation and agriculture as a source of income were found to be significant predictors of poverty incidence in Davao City, Philippines.*

KEYWORDS:*ArcGIS, Coldspot,Hotspot, Hotspot Analysis, Poverty Incidence, Regression Analysis, Spatial Autocorrelation*

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INTRODUCTION

Davao Region is envisioned as the Philippines' Rising Global Frontier based on the Davao Regional Development Plan for 2011-2016 prepared by the National Economic and Development Authority (NEDA). In line with this vision, Davao Region focused on the goal of a faster decline in its poverty numbers by 2016 (NEDA, 2011). Being the capital of Davao Region, Davao City is clearly plays a major role in the accomplishment of this objective on poverty alleviation.

Davao City emerged as the least poor among the cities and municipalities in Davao Region based on the Small Area Estimates (SAE) conducted by the National Statistical Coordination Board (NSCB) and the World Bank in 2009 (Quiros, 2012). Nonetheless, as Aguirre-Tuburan (2012) mentioned in her report in view of this declaration, being least poor is still being poor. Davao City may be classified as highly urbanized but it should be noted that a number of its

barangays (smallest administrative divisions) remain rural in setting and are extremely difficult to access. Edge Davao (2015) mentions that in going to Tapak, a barangay in the northernmost part of the city, one has to take a circuitous route via the municipality of Kapalong or Panabo in the neighboring Davao del Norte province, passing through an arduous and hilly access road. Unfortunately, the same difficult situation holds true for other barangays especially the ones neighboring Tapak.

Hence, it is of interest to take a look at the poverty situation among the various barangays of Davao City. This can be valuable to concerned authorities, such that poverty alleviation programs can be efficiently targeted toward barangays that form clusters of high poverty incidence. It can also provide insight into the relationship of some explanatory variables to poverty incidence in Davao City which can serve as a guide to decision-makers on the type of intervention programs needed.

This study,therefore aimed to perform spatial analysis and regression analysis on poverty incidence in Davao City in the year 2015. Specifically, this study sought to test for the presence of significant clustering among barangays in terms of poverty incidence, identify hotspots andcold spots of poverty incidence, and conduct regression analysis to describe and model the relationship of selected explanatory variables to poverty incidence in Davao City.

METHODOLOGY

Data were acquired through the City Planning and Development Office (CPDO) which collated the surveys done by each of the 182 barangay offices in Davao City in 2015. The survey form, entitled Barangay Poverty Profiling, included various information on demographic, economic efficiency, and social adequacy indicators of poverty. Spatial and regression analyses of the acquired data were then performed using ArcGIS, a geographic information system (GIS) developed by the Environmental Systems Research Institute (ESRI).

Since the data for poverty incidence in each barangay was not readily available, this was computed through the household income data provided in the Barangay Poverty Profile. Based on the estimate from the Philippine Statistics Authority (PSA, 2016), the monthly per capita poverty threshold for Davao del Sur in 2015 was Php1, 820.50 and using CPDO data, Davao City has an average household size of four (4), which means that the 2015 monthly poverty threshold for each family/household in Davao City can be estimated at Php7, 282. Note that the monthly household income data of Davao City are classified into: below Php6,000, Php6,000-8,000, Php8,0001-15,000, Php15,001-20,000, and Php20,001 and over. Since the second range of income still covers the poverty threshold amount, the author of this researchdecided to use the lowest range which is below Php6, 000 for the computation in this study. The procedures undertaken in this paper are summarized in Figure 1 as follows.

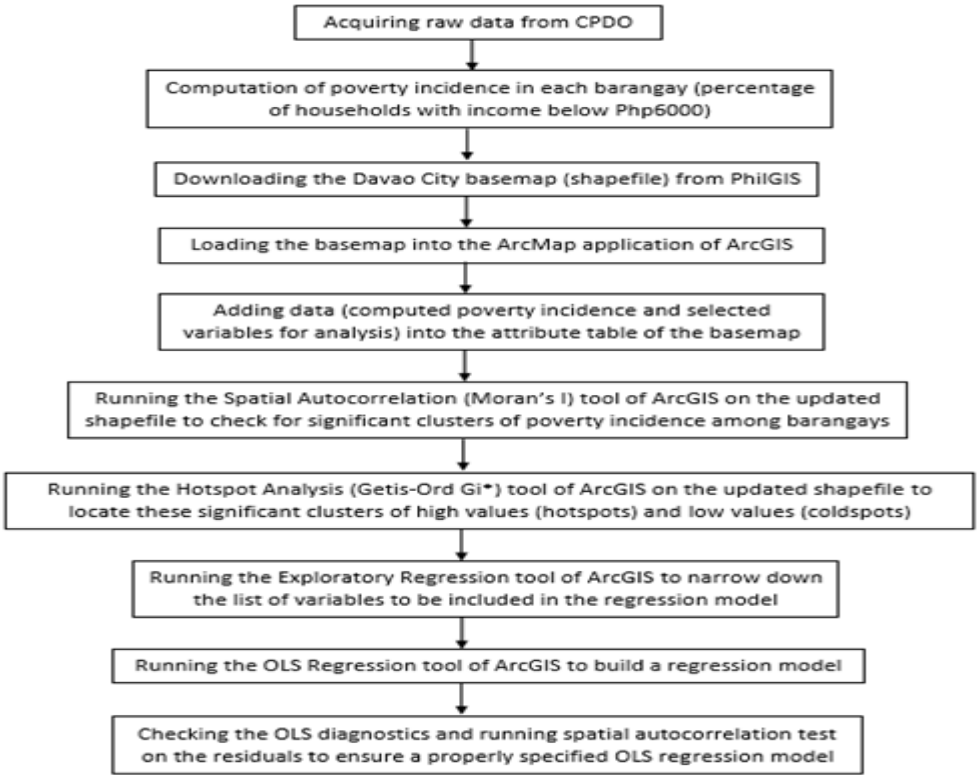

Figure 1: Methodology for Spatial and Regression Analyses

RESULTS AND DISCUSSIONS

In running the Spatial Autocorrelation (Moran's I) tool of ArcGIS, the conceptualization of spatial relationships that was chosen was polygon contiguity since the barrages are represented as polygons in the baseman. This means that only neighboring polygon features that share a boundary influenced computations for the target polygon feature. The results of the test for spatial autocorrelation are presented in Figure 2.

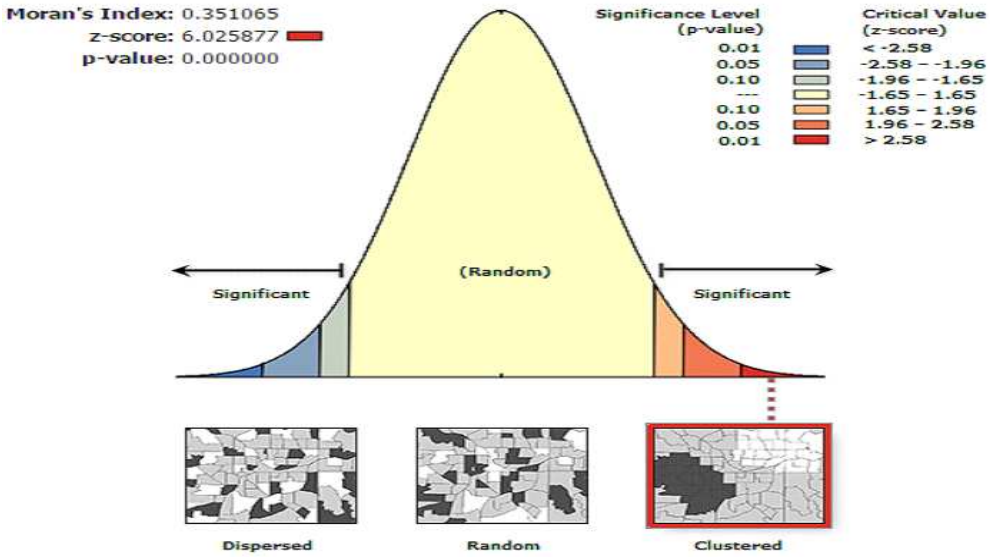

Figure 2: Results of Spatial Autocorrelation Test

As displayed in Figure 2, the computed Moran's Index is 0.351065 with a *Z*-score of 6.025877 which suggests a significant spatial clustering of high values and/or low values of poverty incidence in Davao City. The very small *p*-value indicates that there is less than 1% likelihood that the clustered pattern observed could be the result of random chance. This confirms that indeed there are neighboring barangays in the city that share similar high or similar low proportions of families living below the poverty line.

Using the same conceptualization of spatial relationships (*Contiguity_Edges_Only*) to run the Hotspot Analysis (Getis-Ord Gi*) tool of ArcGIS, hotspots and cold spots at different levels of significance were identified. Figure 3 shows the resulting map generated after running the analysis.

Hotspots signify the barangays with high poverty incidence and are surrounded by other barangays with high poverty incidence as well. Cold spots, on the other hand, signify the barangays with lowest poverty incidence and are surrounded by other barangays with lowest poverty incidence. In the generated hotspot map, the areas in shades of red indicate the identified hotspots while the areas in shades of blue indicate the identified cold spots. Note that the areas in white are the barangays with no data submitted to the CPDO. Looking at the hotspot map, a clear difference that can be seen immediately is that areas identified as hotspots consist of barangays that cover larger areas than those of the identified cold spots.

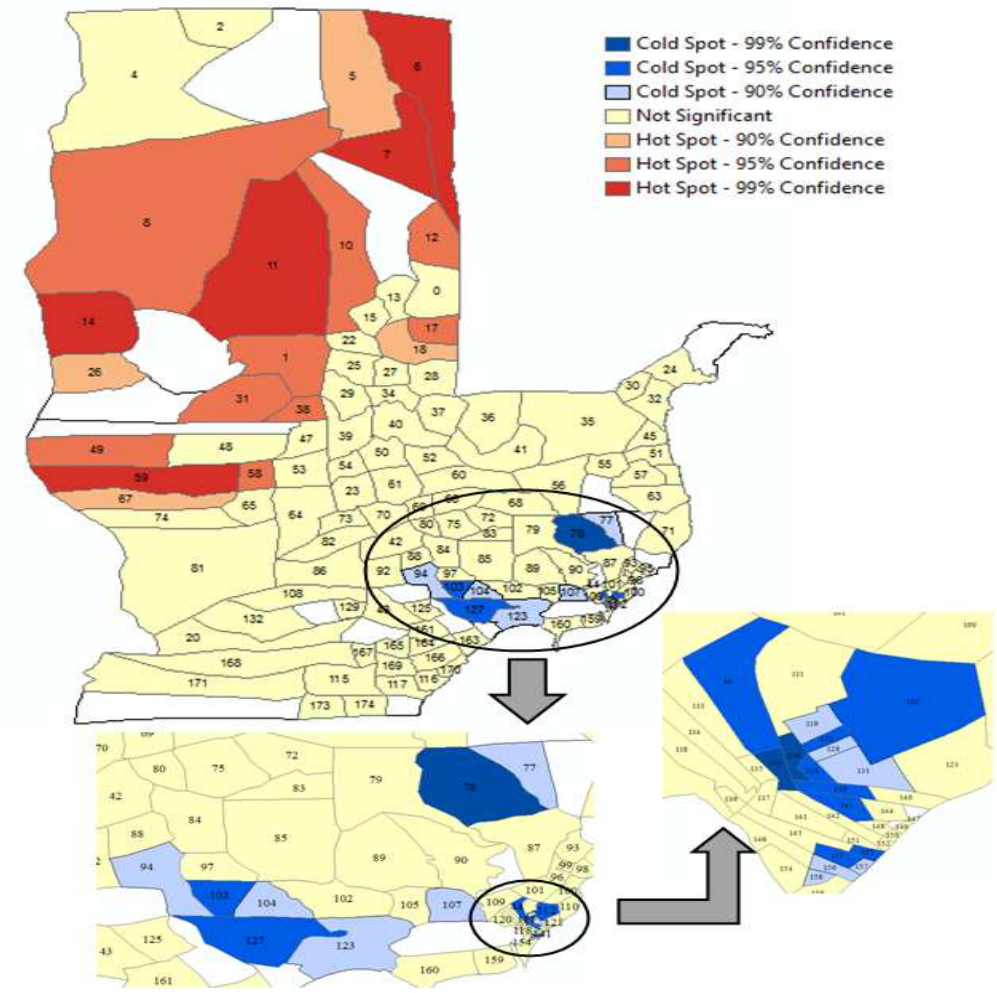

Figure 3: Results of Hotspot Analysis (Getis-Ord Gi)

Table 1: Barangays in Davao City in the Identified Hotspots of Poverty Incidence

Congressional District	Administrative District	Barangay	Map Label
District 2	Paquibato District	Colosas	6
		Salapawan	7
		Lumiad	10
		Mabuhay	17
		Pandaitan	12
		Malabog	18
		Tapak	5
District 3	Baguio District	Tawan-Tawan	59
		Baguio Proper	58
		Tambobong	49
		Cadalian	67
	Calinan District	Saloy	1
	Marilog District	Bantol	11
		Dalag	14
		Baganihan	8
		Malamba	31
		Suawan	38
		Magsaysay	26

Table 2: Barangays in Davao City in the Identified Cold Spots of Poverty Incidence

Congressional District	Administrative District	Barangay	Map Label
District 1	Poblacion District	12-B	133
		13-B	124
		14-B	134
		17-B	122
		19-B	44
		29-C	143
		30-C	138
		36-D	155
		38-D	153
		15-B	131
		16-B	128
		18-B	119
		37-D	157
		39-D	156
		40-D	158
	Talomo District	Bago Gallera	127
		Catalunan Pequeño	104
		Ma-a	107
		Talomo Proper	123
District 2	Agdao District	Agdao Proper	112
	Buhangin District	Tigatto	78
		Cabantian	77
District 3	Tugbok District	Sto. Niño	103
		Bago Oshiro	94

As can be observed from Table 1, the hotspots are located in Districts 2 and 3 only, with seven (7) and 11 barangays, respectively. Interestingly, these barangays are all classified as rural areas, except for Baguio Proper, based on the classification cited in the 2015 General Profile from the CPDO. Note that poverty incidence is computed through the household income. Therefore, the high poverty incidence in these neighboring barangays may be accounted for by the

limited sources of income in these places. This is in contrast to urbanized areas where there is more access to various employments, hence, better chances of earning a higher income. As expected, it is from these urban areas that the identified cold spots of poverty incidence were found. The majority of these barangays come from District 1 with 19 barangays, while there are only three (3) from District 2 and two (2) from District 3, as presented in Table 2.

Having identified areas in Davao City, where hotspots and cold spots of poverty incidence exist, it is also valuable to take a look at the relationship of some variables to poverty incidence. The collected data from the CPDO provides numerous barangay attributes that may be important contributing factors to poverty incidence in the city. Nonetheless, only eight (8) of them were chosen in this paper to be examined as possible explanatory variables. However, finding the best combination of explanatory variables to include in an Ordinary Least Squares (OLS) regression model can be quite difficult and tedious. Hence, data on these variables were first subjected to the Exploratory Regression tool of ArcGIS. This data mining tool tries out all possible combinations of explanatory variables and generates a report of the models with the highest Adjusted R-squared values and which pass the OLS diagnostics which the tool automatically checks. Based on the generated report, the four (4) most significant variables to be used in the regression model were a percentage of households with access to safe sanitation, the percentage of households whose source of income are agriculture, the percentage of households with access to Level III potable water, and percentage of households with DLPC connection.

Having narrowed down the list of explanatory variables to poverty incidence, modeling their relationships was then done using the OLS Regression tool of ArcGIS. A summary of the OLS results is presented in Table 3 below.

Table 3: Summary of Ordinary Least Squares Regression Results

Variable	Coefficient	*p*-value	VIF
Access_SafeSan	-0.258570	0.024510*	3.321120
Emp_Agri	0.222507	0.00174*	2.298021
Access_L3Water	-0.041728	0.410334	2.089242
DLPC	-0.039911	0.738872	3.161636
Intercept	65.765087	0.00000*	----------

*An asterisk next to a number indicates a statistically significant p-value ($p< 0.05$).

$$Pov\_Inc = -0.258570 * \text{Access\_SafeSan} + 0.222507 * \text{Emp\_Agri} - 0.041728 * \text{Access\_L3 Water} - 0.039911 * \text{DLPC} + 65.765087 \quad \textbf{(4.1)}$$

Based on the coefficients, the variables *Access_SafeSan*, *Access_L3Water*, and *DLPC* all exhibits a negative relationship with poverty which means that as the values of these variables decreases, the incidence of poverty increases. These results are supported by findings in Cambodia as mentioned in the Poverty Manual of the World Bank Institute (2005), as well as in previous studies such as the one published by Amarasinghe et al. (2005) on poverty in Sri Lanka. On the other hand, *Emp_Agri*exhibits a positive relationship which means that as the percentage of households relying on agriculture for income increases, the incidence of poverty also increases. This result is consistent with findings from previous studies such as those of Reyes et al. (2012) on poverty and agriculture in the Philippine setting and Sowunmi (2016) in Nigeria. It should be noted, however, that there are in fact countries where people employed in the agriculture sector earn a high income. In the case of the Philippines, the perennial problem of high poverty incidence observed among people relying on agriculture is influenced by certain issues, foremost of which is low farm productivity (Habita, 2016).

Checking the OLS diagnostics, the specified model passed the Joint F and Wald tests for overall model significance. Moreover, theKoenker (BP) and Jarque-Bera statisticswere not statistically significant which means that the model passed the tests for stationary and normality of the residuals. Lastly, performing spatial autocorrelation test on the residuals, it was found that the spatial pattern formed by the residuals is not significantly different from randomconfirming that there is no need to proceed with building a spatial regression model. Hence, the OLS regression model, as shown in Eq. (4.1), was found to be sufficient in this study.It should be noted thoughthat in this model, only the variable access to safe sanitation and employment in agriculture was found to be statistically significant predictors of poverty incidence in Davao City.

CONCLUSIONS AND RECOMMENDATIONS

This study confirmed that there is spatial clustering of poverty incidence in Davao City, Philippines. Specifically, clusters of high poverty incidence can be found among rural barangays. Access to safe living conditions and agriculture as the primary source of income of the household were both found to be significant determinants of poverty incidence in Davao City.

It is thereby recommended that poverty alleviation programs be focused on the identified hotspots of poverty incidence in Davao City. Since the analyses done in this study all points to the importance of focusing on rural areas, it is suggested that providing access to urban services and more diversified sources of income are highlighted in these programs. It is also recommended that the gathered data from the barangays be updated and/or completed for further analysis and comparison of results. Lastly, this paper merely explored some of the variables and how they relate to poverty incidence. This study can therefore, be extended by examining other explanatory variables for poverty incidence that could add more information in understanding and be addressing this problem.

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