

# Geographic Information System-Based Mapping Of Malnutrition Children In The Philippines

Racquel L. Pula, Rosanna A. Esquivel

**Abstract:** The research focused on mapping the malnutrition cases in Philippines specifically in the City of Cabanatuan using the Geographic Information System (GIS). In this study, data were collected from Day Care Centers and Elementary Schools across the eighteen barangays of District I of Cabanatuan City. The barangay attributes were also considered in this study. The study was cross-sectional in design and the data obtained were analyzed using the QGIS 3.10 coruña version. GIS revealed that Barangays Palagay and Balite have the highest malnutrition density with respect to land area which ranges from 8 to 10 students per hectare, while Barangays Talipapa, Claudillo, Sto Niño and Pamaldan have the highest malnutrition density with respect to population which ranges from 57 to 64 malnutrition cases per 1,000 population. Recommendations include increasing the number of health workers in areas with high malnutrition density per hectare, and refocusing nutrition programs in areas with high malnutrition density per population.

**Index Terms:** Cabanatuan City, GIS, Health Management, Malnutrition, Mapping, QGIS, Day Care Center, Elementary School

## 1 INTRODUCTION

Despite the Gross Domestic Product (GDP) growth by the Philippines in the last quarter of 2019, the nutritional status of Filipinos remains poor. The most common nutritional problem of roughly 108,000,000 Filipinos is malnutrition. Malnutrition is described as a degree of “overnutrition” and “undernutrition”<sup>3</sup>. The United Nation International Children’s Emergency Fund (UNICEF) finds that the health and nutrition of children is a major cause of concern as it directly affects the health status of children as malnutrition changes their body composition and diminishes certain function of their body<sup>15</sup>. The Philippines has a significant number of malnutrition cases, which, despite extensive intervention programs on malnutrition, makes the country lag behind its neighboring countries in combatting this health issue – Philippines ranks 88<sup>th</sup> out of more than 130 countries worldwide with the most malnourished children<sup>9</sup>. Cabanatuan City, a first-class city that lies in the center of the Nueva Ecija province, has a total land area of 19,066.63 hectares and is comprised of 89 barangays. Forty-five barangays are classified as urban while the remaining forty-four are classified as rural. Farming is the main source of livelihood in the City. According to the records of the City in 2018, Cabanatuan City has a gross harvest of about 100,000 metric tons of rice. The cropping areas in the City are dominated by palay, followed by lowland vegetables such as bittermelon, eggplant, corn, cucumber, and the like. Production of fruits such as mango, citrus and calamansi is also considered in the rich-soil areas of Cabanatuan. The employed individuals in the City in 2018 were 164,337, of which 31,602 were in the agriculture sector, 31,602 were in the industry sector, and the remaining 109,563 were in the service sector.

The employment rate in the City is 89.20%. As of 2015, the City has a total of 68,247 households. The crude birth rate is 22.09 per 1,000 population, and the crude death rate is 5.17 per 1,000 population. There are five (5) rural health units and 21 barangay health units in the City<sup>5</sup>. The leading cause of morbidity in the City is acute respiratory infections such as colds and coughs while the leading causes of mortality are hypertensive-cardiovascular disease, and pneumonia. Records of malnutrition, which covers two broad conditions – undernutrition (underweight and micronutrient deficient) and overnutrition (overweight and obesity disease) – is also prevalent in the City. In terms of education facilities, there are 57 Department of Education (DepEd)-supervised public schools in the City which offer the Kindergarten and Grades 1 to 6 curricula. There are also 60 private schools in the City that offer kindergarten, Grades 1 to 6, Grades 7 to 10, Grades 11 to 12, and college undergraduate programs. The application of several technologies in assessing the health and nutrition of a population has become a trend nowadays. One such technology is the Geographic Information Systems or GIS – a set of computer software tools that visualize and locate patterns of a phenomenon<sup>6</sup>. The application of GIS on a set of data enables the placement of information on a map, and pinpoints specific conditions or variables through geographic positioning system<sup>13</sup>. Aliyu (2013)<sup>1</sup>, in his study on the management of health infrastructure in Nigeria, employed GIS and found that despite having identified 151 health facilities, there was still a need to establish more health facilities as the existing ones were not enough to support the whole country. Thus, with the help of GIS, he was able to identify the locations where the Nigerian government has to establish more hospitals and primary health care centers. GIS has the ability to capture, store, check and display information related to the Earth’s surface, making it capable of analyzing and understanding the pattern and magnitude of different information such as spatial distribution of dengue, malaria, and malnutrition. Through this, an immediate intervention can be done to avoid such outbreak. As such, the application of GIS as a tool in surveying schistosomiasis in the province of Davao de Norte was able to characterize high risk areas through the visualization of various schistosomiasis determinants and ecological principles. However, they also added that there was still a need for an up-to-date and accurate spatial and temporal information<sup>2</sup>.

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## 2. METHODS

In this study, the research focused on the application of Geographic Information System and as such, a composite map of Cabanatuan City which was obtained through georeferencing and digitizing land features from LandSat satellite image. The data used were secondary data coming from the Local Government Unit of Cabanatuan City, and Department of Education-Cabanatuan City for the analysis of the malnutrition cases. The researchers used macro-analysis method in analyzing the malnutrition cases in the City of Cabanatuan.

### 2.1 Study Design

The study was cross-sectional in design – as the researcher measured the outcomes of the participants in the study, where she utilized data from the Local Government Unit of Cabanatuan City and Department of Education Cabanatuan City. Cross-sectional design of study is the best type of research design in studying population-based studies and in assessing prevalence of diseases, such as prevalence of malnutrition<sup>12</sup>. In addition, cross-sectional study fits best in public health monitoring and planning. Malnourished children were identified based on their nutritional weight status – underweight, wasted, and stunted – but grouped as one and considered as malnourished.

### 2.2 Study Locale

Cabanatuan City aims to be of the Highly Urbanizing City (HUC) in the Philippines and is considered a center of trade and commerce of the Province of Nueva Ecija. Due to the large rural area of Cabanatuan City, it is predominantly classified as agricultural land<sup>5</sup>. Cabanatuan City is also divided into five districts: District I, II, III, IV, and V. The district where the data was collected is from District I which is composed of 18 barangays: Mayapyap Sur, Samon, Talipapa, Mayapyap Norete, Sto. Nino, Cinco-cinco, Barlis, Balite, Caalibangbangan Ibabao-bana, Sapang, Pamaldan, Buliran, Dalampang, Polilio, Pula, Claudillo, Emuscado, and Palagay<sup>4</sup>.

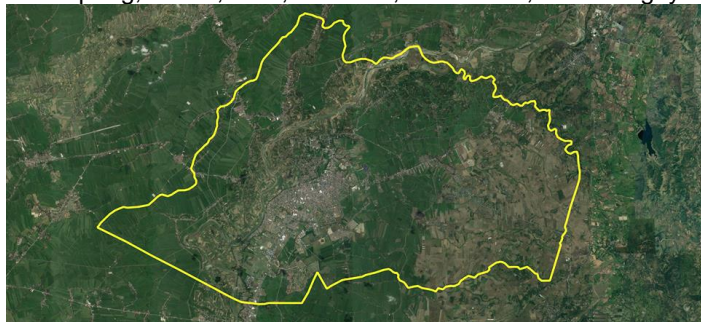


Figure 1. The Study Area

### 2.3 Sample Size

The participants from thirty-seven (37) day care centers and elementary schools of District I of Cabanatuan City were considered in this study. Data were based from the record of the City Government of Cabanatuan and Department of Education-Cabanatuan City.

### 2.4 Statistical Analysis of Data

Spatial data were checked and analyzed using QGIS version 3.10, a free open software. The barangays' locations through their latitude and longitude decimal coordinates were converted into two dimensional coordinates using a map

projection. The data from the City Government of Cabanatuan City and Department of Education-Cabanatuan City were plotted into excel file using a comma separated values (csv), and then the properties or attributes in the Cabanatuan data sets were inputted.

## 3. RESULTS AND DISCUSSION

A total of 37 day care centers and elementary schools from 18 barangays from the District I of Cabanatuan City were included in this study. Table 1 shows the number of malnourished students from day care centers and elementary schools across the District I of Cabanatuan City.

**Table 1.**  
*Number of Malnourished Children in District I of Cabanatuan City*

NAME OF SCHOOL	BARANGAY	MALNUTRITION CASES
AGL Height Day Care Center	Caalibangbangan	50
Angels of God Day Care Center	Mayapyap Norte	50
Balite Elementary School	Balite	33
Barlis Elementary School	Barlis	35
Buliran Elementary School	Buliran	57
Calibangbangan Elementary School	Caalibangbangan	184
Cinco-cinco Elementary School	Cinco-cinco	8
Claudillo Elementary School	Claudillo	58
Dalampang Day Care Center	Dalampang	29
Dalampang Elementary School	Dalampang	41
Emuscado Elementary School	Caalibangbangan	9
Fortunate Day Care Center	Claudillo	41
Guardian Angel Day Care Center	Pamaldan	60
Ibabao-bana Elementary School	Ibabao-bana	58
Little Angel Day Care Center	Caalibangbangan	45
Little Children Day Care Center	Barlis	42
Little Flock Day Care Center	Pula	50
Little Hearts Day Care Center	Cinco-cinco	45
Little Star Day Care Center	Sapang	35
Marciano del Rosario Elementary School	Pamaldan	167
Mayapyap Sur Day Care Center	Mayapyap Sur	56
Morning Star Day Care Center	Balite	40
Morning Star Day Care Center	Talipapa	52
Palagay Integrated School	Palagay	18
Polilio Elementary School	Polilio	31
Pula Elementary School	Pula	26
Rainbow Day Care Center	Palagay	50
Sacred Hearts Day Care Center	Polilio	50
Samon Elementary School	Samon	33
San Roque Day Care Center (II)	Caalibangbangan	85
Sapang Elementary School	Sapang	21
Shining Star Day Care Center	Ibabao-bana	50
Smart Kids Day Care Center	Buliran	50
Sto Niño Day Care Center	Sto Niño	44
Sto Niño Elementary School	Sto Niño	57
Talipapa Elementary School	Talipapa	60
Twinkle Little Star Day Care Center	Samon	55
TOTAL	-	1875

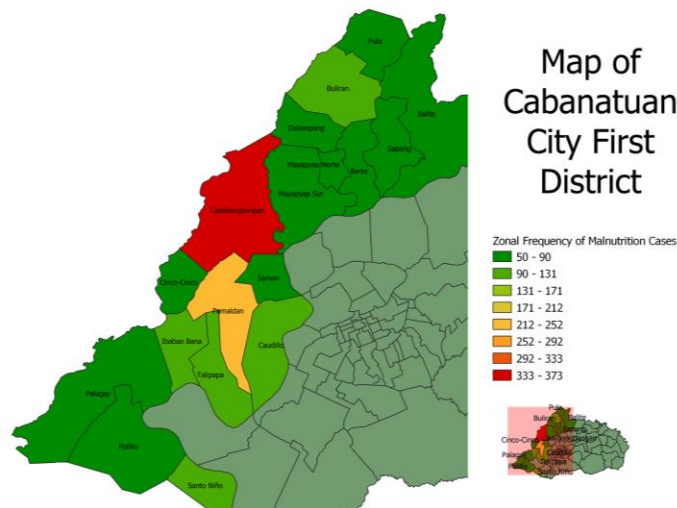
It can be gleaned from Table 1 that of the three (3) day care centers and elementary schools with the most cases of malnutrition, two (2) belong to Barangay Caalibangbangan. This can be attributed to the fact that Caalibangbangan hosts three (3) day care centers and two (2) public elementary schools while the rest of the other barangays, with the exception of Mayapyap Norte and Mayapyap Sur, each host one (1) day care center and one (1) public elementary school each; Mayapyap Norte and Mayapyap Sur only each has one (1) day care center and no public elementary school. Based on

the Ecological Profile of Cabanatuan City, Caalibangbangan is classified as an agro-industrial zone<sup>5</sup> and has the largest population among all the barangays investigated (Table 2). school.

**Table 2.**  
*Malnutrition Cases per Barangay with respect to Population and Land Area*

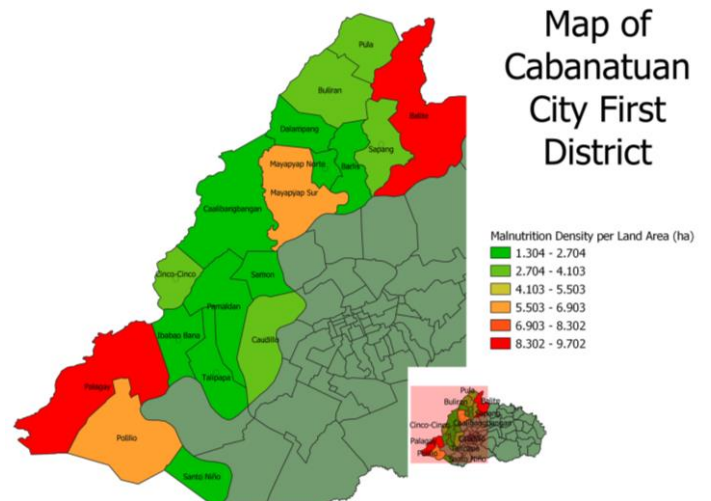
Barangay	Land Area (Hectare)	Popula-tion	Malnu-trition Cases
Balite	630.62	7,596	73
Barlis	207.78	2,066	76
Buliran	315.25	3,322	107
Caalibangbangan	572.48	11,112	373
Claudillo	315.21	1,614	99
Cinco-cinco	145.71	1,816	53
Dalampang	197.23	2,057	70
Ibabao Bana	205.42	2,313	108
Mayapyap Norte	51.93	2,288	50
Mayapyap Sur	363.75	5,473	56
Palagay	715.28	2,221	68
Pamaldan	319.14	3,870	227
Polilio	447.12	2,605	81
Pula	225.74	1,708	76
Samon	133.53	1,713	88
Sto. Niño	183.8	1,807	104
Sapang	203.36	1,382	56
Talipapa	189.25	1,726	110
TOTAL	5,029.99	53,581	1875

Of the 18 barangays investigated in this study, it can be seen from Table 2 that Barangays Palagay, Balite and Caalibangbangan have the biggest land areas, while Barangays Caalibangbangan, Balite, and Mayapyap Sur have the biggest population. Barangays Palagay and Balite are both agricultural barangays, while Barangays Caalibangbangan and Mayapyap Sur are agro-industrial barangays. In terms of malnutrition cases, Barangay Caalibangbangan has the highest prevalence with 373 cases followed by Pamaldan, and Talipapa with 227 and 110 cases respectively. Figure 2 graphically illustrates the malnutrition cases in District I of Cabanatuan.



**Figure 2.** Malnutrition Cases in District I of Cabanatuan City

Spatial analysis of the malnutrition cases in District I of Cabanatuan City reveals the concentration of malnutrition prevalence in Barangay Caalibangbangan. Data reveals that the malnutrition cases across the three (3) day care centers and two (2) elementary schools in barangay Caalibangbangan accounts for 373 cases which is about 4% of the total population of the barangay. Moreover, Barangay Caalibangbangan is the most populated barangay in Cabanatuan City wherein 3% of the City's total population reside. This peak in the zonal frequency of malnutrition cases is next seen in Barangays Pamaldan and Talipapa. It is noteworthy that the number of malnutrition cases for these two (2) barangays are much less than in Barangay Caalibangbangan as the GIS of District I of Cabanatuan City shows that the malnutrition cases for these barangays are at the lower end of the spectrum. Initially, it would seem that the concentration of malnutrition cases in District I of Cabanatuan City occurs at Barangay Caalibangbangan as this barangay has the greatest number of malnutrition cases. However, The GIS of District I wherein the malnutrition density per hectare is detailed reveals that Caalibangbangan is not the epicenter of malnutrition cases in District I.

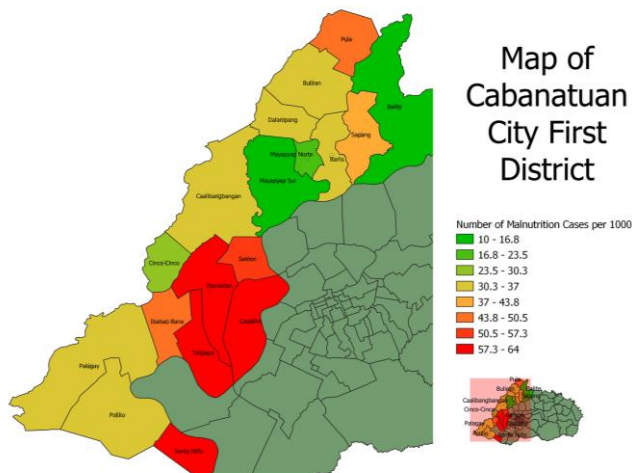


**Figure 3.** Malnutrition Density per Hectare in District I of Cabanatuan City

Figure 3 shows that Caalibangbangan is at the lower end of the malnutrition case spectrum. Moreover, about 9 barangays or 50% of the research locale have only 1 to 3 malnourished children per land area. The figure shows that Barangays Palagay and Balite have the greatest number of malnutrition cases in relation to land area with an average of 8 to 10 children per hectare having malnutrition. Barangay Palagay is an agricultural barangay having a land area of 715.28 hectares while Barangay Balite, also an agricultural barangay, has a land area of 630.32 hectares. These two barangays are far from the City Proper where major social and medical services and institutions are located; Barangay Palagay is adjacent to the Municipality of Sta Rosa, while Barangay Balite is adjacent to the City of Palayan, Nueva Ecija. Research has found that access to quality health and nutrition services play an essential role in the growth and development of children<sup>16</sup>. Thus, health services lead to better health outcomes<sup>15</sup>. Figure 4 shows the malnutrition density per 1,000



population in District I of Cabanatuan City.



**Figure 4.** Malnutrition Density per 1,000 Population

In terms of density with respect to population, Figure 4 shows that four (4) barangays – Talipapa, Claudillo, Pamaldan and Sto. Niño – have the highest density of malnutrition cases. Analysis revealed that the malnutrition density in these barangays range from 57 to 64 malnutrition cases per 1000 population. These four (4) barangays are agricultural barangays producing rice, corns, and other lowland produces. Studies have shown that malnutrition is prevalent in rural areas<sup>18</sup> and households headed by fisherfolks and farmers have high prevalence of malnutrition among children<sup>17</sup>, and this may be the reason for the high density of malnutrition in these barangays as the main livelihood therein is farming. Since malnutrition is a complex concept, several factors are being observed in the causes of malnutrition, and it includes inaccessibility to health services, limited physical activity, poor eating habits, and decreased crop yield due to increasing numbers of typhoon hitting the province. One of the immediate causes of malnutrition is inadequate food intake, and a food insecure household<sup>10</sup>. Another factor is the limited physical activity of children due to the excessive use of gadgets which may lead to becoming overweight – one of the classifications of malnutrition. The National Nutrition Council reported that 3% of children from Region 7 who use gadgets excessively and have limited activity were considered obese and overweight<sup>7</sup>. Thus, they are suggesting that children should be involved in physical and outdoor hobbies. Similar to the other factors, natural disasters such as typhoon is also a lead factor of malnutrition. Typhoon can dramatically affect the food supply and distribution. One of the recent typhoons that greatly devastated the Province of Nueva Ecija, including the City of Cabanatuan, is Typhoon Lando (Koppu) in 2015. Typhoon Lando is the strongest typhoon that hit the City of Cabanatuan and as such, the whole City was unexpectedly flooded<sup>11</sup>. The report from the Official Gazette of the Philippines shows that the total agricultural damage of the typhoon nationwide is more than 8 billion pesos. Due to this, existing food rations, production of crops and livestock, and damages create malnutrition problems.

#### 4. CONCLUSIONS AND RECOMMENDATIONS

The strength of this study is that the data came from the City Government of Cabanatuan City and Department of

Education – Cabanatuan City. Through the application of GIS, it was observed that malnutrition is still prevalent in the City of Cabanatuan, particularly in District I. GIS helped in determining the geographic distribution of malnutrition in the City and identified high-priority areas which need nutritional care. Due to this, the study is able to provide a valuable information on the elevated risk of malnutrition in Cabanatuan City. It can be concluded that in terms of malnutrition cases in relation to land area, Barangays Palagay and Balite have the highest density per hectare. On the other hand, Barangays Talipapa, Caudillo, Sto. Niño, and Pamaldan can be concluded as having the most malnutrition cases in District I of Cabanatuan City as these barangays have the highest malnutrition case density per population. From the above results, the City Government of Cabanatuan should employ more efficient, relevant, and small-scale yet effective malnutrition programs to address the malnutrition cases in the City. GIS is a tool that can be used in determining the distribution of malnutrition and it can show relationship between the geographical location and malnutrition. Maps can be utilized in identifying barangays with high cases of malnutrition, and an immediate intervention can be done to avoid increase cases in the future. To attain this, the following recommendations are offered:

1. The number of health care personnel assigned in barangays with high malnutrition density per hectare may be increased in order to mitigate the prevalence of these cases in the City.
2. Refocusing and enhancing nutrition programs in barangays with high malnutrition density per population may diminish the number of cases in these locales.
3. The use of Geographic Information System in assessing the malnutrition cases in other districts of Cabanatuan City may be undertaken in order to represent the malnutrition cases in the entire City.

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#### REFERENCES

- [1] Aliyu, Y. A., 2013. Using GIS in the management of health infrastructure within Kaduna Metropolis, Nigeria. *Mediterranean Journal of Social Science*, September 2013.
- [2] Belizario, V. Y., delos Trinos, J. C. P., Silawan, B., de Veyra, C. M., Hornido, A. B., Amouis, H., Bsalo, D., Demala, C., Mantilla, I., Layan, R., 2017. The use of geographic information system as a tool for schistosomiasis surveillance in the province of Davao del Norte, the Philippines. *Geospatial health* 2017; volume 12-540
- [3] Blossner, M., Onis, M., 2005. Malnutrition: quantifying the health impact at national and local levels. *World Health Organization*.
- [4] Cabanatuan City Government, 2019. City Nutrition Plan. Technical Report. Cabanatuan City Health Office.
- [5] Cabanatuan City Government, 2019. Socio-Economic Profile.
- [6] Dibari, F., Seal A., Paron, P., 2014. Applying GIS to Nutrition Surveys. *Field Exchange*. Retrieved from [enonline.net/fex/26/applying](http://enonline.net/fex/26/applying)
- [7] Food and Nutrition Research Institute, 2015. National

- nutrition survey.
- [8] Leonardo, L., Crisostomo, B. A., Solon, J. A., Rivera, P. T., 2007. Geographical information systems in health research and services delivery in the Philippines. *Geospatial health* 1(2):147-55
  - [9] Lina, Joey D., 2018. Malnutrition: a gnawing crisis needing urgent action. Retrieved from <https://www.pressreader.com/> on March 04, 2018.
  - [10] Philippine Information Agency, 2018. Feature: Metro Manila Fights Back Malnutrition. [pia.gov.ph](http://pia.gov.ph)
  - [11] Pula, Tumibay, Esquivel, and Tumibay, 2019. Predictive Analysis of Malnutrition among Children in the City of Cabanatuan, Nueva Ecija Using Data Mining Approach.
  - [12] Rappler, 2015. Damage from Typhoon Lando soars to P6B. [Rappler.com](http://Rappler.com)
  - [13] Setia, M. S., 2016. Methodology Series Module 3: Cross-sectional Studies. [Ncbi.nlm.nih.gov](http://Ncbi.nlm.nih.gov)
  - [14] Spongier, A.A., C. Hannah, E. Spangenberg, J. Eigenbrod, 1995. Application of Geographic Information System (GIS) to Analyze metropolitan and non-metropolitan distribution patterns of Nutrition risk in a survey of 11891 older persons. *Journal of the American Dietetic Association*.
  - [15] United Nations International Children's Emergency Fund, 2018. Malnutrition rates remain alarming: stunting is declining too slowly while wasting still impacts the lives of far too many young children. Retrieved from <https://data.unicef.org/topic/nutrition/malnutrition/>
  - [16] Tyrovolas, S., Y. Tountas, E. Polychronopolous, and D. Panagiotakos, 2011. The implications of nutrition services within the healthcare system on the quality of life and longevity, in developed countries: a reanalysis of 38 studies. *Central European Journal of Public Health*
  - [17] Capanzana, M., D. V. Aguila, and K. Montecillo, 2018. Nutritional status of children ages 0-5 and 5-10 years old in households headed by fisherfolks in the Philippines. *Archives of Public Health*