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Spatial Analysis of Hospitalized Dengue Patients in Cabanatuan City: Demographics and Risk

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***Keywords*— Dengue, Spatial Analysis, Spatial Pattern, GIS, Cabanatuan City.**

***Abstract*—** *This study employed spatial pattern analysis of a prospective dengue epidemic in one of the cities in Nueva Ecija Philippines – Cabanatuan City. It aims to give strategic information for the dengue management effort in the face of constrained capacity. The researchers examined the demographic pattern of dengue cases to add to the knowledge needed for successful policy-making. Weekly records of dengue cases from multiple Disease Reporting Units (DRU) in Cabanatuan City were gathered as the database. This includes barangay, sex, age, and DRU types from January 2014 to December 2018. Each recorded dengue fever patient's barangay was geocoded to map and clustered. This research found a substantial correlation between reported incidents and particular demographic groupings among male, age 10-14, mostly admitted in a government hospitals and weeks 28 to 42 where the virus transmission is high. Furthermore, the dynamic growth of the aggregation of disease incidence (hotspots) for dengue patients in Cabanatuan City was displayed using spatial analysis utilizing geographic information system (GIS). It is hoped that the research results shall provide strategic information for dengue control program planning and design.*

I. INTRODUCTION

Mosquito had been a well-known transmitter of disease. The most dangerous is the malaria which according to World Health Organization's (WHO) latest world malaria report, there were an estimated 241 million malaria cases and 627,000 malaria deaths worldwide in 2020 [1] [2] [3]. Despite the fact that mosquitoes are responsible for many malaria deaths, there were more dengue cases around the world, and there is no specific treatment for dengue/severe dengue [4] [5]. But early identification of illness development associated with severe dengue, and availability to adequate medical care decreases mortality rates of severe dengue to below 1 percent. But if not treated, this may lead to severe dengue - the Dengue Hemorrhagic Fever (DHF). This disease could cost one's life. Modelling estimates show that 400 million dengue virus infections occur each year, with 96 million of these manifesting clinically [6]. According to another study on the prevalence of dengue, 3.9 billion people are at risk of infection with dengue viruses. Despite the fact that there is a risk of infection in 129 countries, Asia bears 70% of the actual burden [7].

Dengue is an acute viral infection transmitted through a bite of a dengue-carrying mosquito. It has four (4)

virus types: DENV 1, DENV 2, DENV 3 and DENV 4. Dengue mosquitoes are usually in dark places and they breed in clear stagnant water. The metamorphosis from larvae to mosquito usually takes 10-12 days. Dengue carrying mosquitoes are "day biters" and frequents 2 hours before the sun sets. Humans are infected with the virus by the bites of infected female mosquitos, typically the Aedes aegypti mosquito. Other Aedes species can also operate as vectors, although their contribution is secondary to that of Aedes aegypti. Dengue can be life threatening when not managed early. Persons experiencing any of these symptoms: high fever, skin flushing, bleeding, nausea and vomiting must seek immediate medical attention [8].

In 2019, 27 countries reported 4,363 cases of dengue, of which 4,020 were confirmed. The number of cases in 2019 was almost double that for 2018, reflecting the intense circulation of the virus on a global scale. "Dengue is endemic primarily in urban and semi-urban tropical or subtropical regions of the world." [9] [10] This means that it is frequently available case in that specific area. According to Bilal Tariq 2007, Dengue mosquito-borne disease is becoming a serious public health problem worldwide, especially in tropical and subtropical areas, and dengue fever is among the main mosquito-borne diseases in addition to malaria [11].

The dengue virus replicates in the mosquito midgut after feeding on a DENV-infected individual before spreading to secondary tissues such as the salivary glands [12] [13]. When the ambient temperature is between 25 and 28°C, the extrinsic incubation period (EIP) takes roughly 8-12 days [14]. Variations in the extrinsic incubation period are determined not only by ambient temperature, but also by a variety of parameters such as the amplitude of daily temperature swings, virus genotype, and starting viral concentration. Once infected, the mosquito may transmit virus for the remainder of its life [15] [16].

As regards the transmission of the virus, mosquito vectors are the principal method of transmission between people. However, there is evidence of the possibility of maternal transfer (from a pregnant mother to her baby). While vertical transmission rates appear to be modest, the risk of vertical transmission appears to be associated with the time of the dengue infection during pregnancy. When a mother has a DENV infection while pregnant, her infants may experience pre-term delivery, low birthweight, and fetal distress [17] [18].

On the other hand, only a few cases of transmission by blood products, organ donation, and transfusions have been documented. Transovarial transmission of the virus within mosquitoes has also been documented. While the majority of dengue infections are asymptomatic or have moderate symptoms, it can sometimes produce a severe, flu-like sickness that affects newborns, young children, and adults but rarely results in death. After an incubation period of 4–10 days following a bite from an infected mosquito, symptoms normally last for 2–7 days [19]. WHO classified dengue fever into two categories: mild dengue (with or without warning signals) and severe dengue. The categorization of dengue with or without warning signals is intended to assist health practitioners in triaging patients for hospital admission, guaranteeing close surveillance, and reducing the risk of developing more severe dengue.

The overall worrisome increase in dengue case counts over the last two decades can be attributed in part to a shift in national methods for recording and reporting incidents to Department of Health and the WHO. Hence, the need for a systematic reporting of dengue illness cases. When effective vector control methods are in place, dengue prevention and management can be done properly. In addition, vector control efforts can significantly improve if long-term community engagement will be established [20].

Between 2014 – 2018, the highest cases of dengue in the whole province of Nueva Ecija were recorded in Cabanatuan City [21]. But due to lack of effective monitoring method the incidence estimates or reporting may be erroneous since there is no mechanism available to closely monitor these incidences; hence, this study.

This study aims to use spatial analysis to identify the dengue-affected barangays in Cabanatuan City particularly in the year 2014 – 2018. In addition, it is also hoped that through this study, medical health practitioners will be able to characterize and identify the profile of dengue-prone individuals in the city.

II. OBJECTIVES

With the use of Spatial Analysis, the researchers aim to identify the barangays in Cabanatuan City where highest number of dengue cases are recorded in the last 5 years, 2014 -2018. With these data, they can identify statistically significant spatial clusters of high value phenomena and put red alert status on barangays where dengue outbreaks are identified. This will help them in developing a more efficient health policies and possible intervention that can help prevent or limit the number of dengue cases in the city. Likewise, this study will characterize demographic data of people affected by Dengue Fever.

III. LITERATURE REVIEW

According to the Bill Gate's Informatics (2014), the deadliest animal is the mosquito. This is from the point

of view on the data gather on the number of people that were killed by an animal per year. There are about 600,000 recorded deaths brought about by the virus transferred by mosquito. Such diseases are malaria, dengue, yellow fever or Japanese encephalitis, Zika virus, chikungunya and west nile to name a few. There are more than 2,500 species of mosquitoes thriving in every region of the world except Antarctica [22].

Malaria cases are brought by anopheles' mosquitoes. For dengue virus Aedes Aegypti and Aedes Albopictus mosquitoes are the assailant. The former are more aggressive and only female bites because they need it to lay their eggs [23].

From the article of Rachel Nuwer (2014), she stated that "…mosquitoes kill more humans than humans' murderers do". Many people would assume the creature that they most afraid with would be snake, wild animals like lion or tiger or right out in the amazon - the crocodile or anacondas. But data show that the recorded 475,000 people being murdered by other people from car accident to robbery was topped by 725,000 number of deaths caused by mosquito virus [24] [25].

Fig.1. Mosquito (Aedes Aegypti)

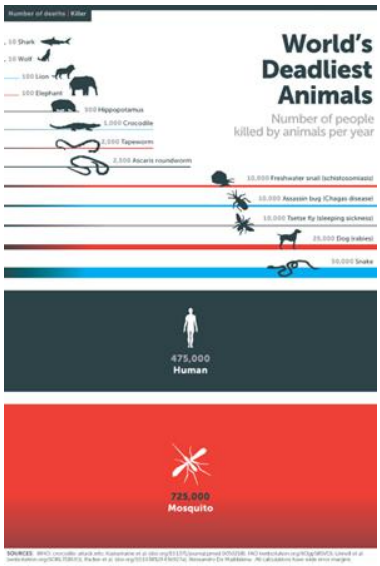


Fig.2. Bill Gates Infographics [8]

On the other hand, the article written by Miguel Prudencio in 2020 dubbed as "In fairness to Mosquitoes" reported that it is not the mosquitoes that kill people directly; but it was the multiple diseases that they transmit. He further states that a mosquito bite may include pain, itchiness and discomfort but no deaths were being reported. He also emphasizes that data on human-to-human transmission of fatal infections such as TB, AIDS, coronavirus diseases 2019 (COVID-19), and other infectious illnesses should be added to the list of murderers, and it would almost certainly be the unchallenged leader in any list of killers [26].

In the Philippines, the compendium of dengue monthly report of the Department of Health (DOH) from 2014-2018, show that the highest dengue cases reported was in the year 2016 where 1,021 out of 208,805 cases are reported as morbidity. The Table 1 below shows the complete information of the reported dengue cases. It is also noteworthy to mention, that in Region III where the research locale is situated, highest dengue cases for 2 years, 2015 and 2018, were recorded. While it ranked 2nd in the year 2014 and 2017 [27].

Table 1. Dengue cases and deaths in the Philippines

Region	2014		2015		2016		2017		2018	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Philippines	**121,580**	**465**	**87,411**	**272**	**208,805**	**1,021**	**152,224**	**811**	**127,478**	**655**
I	6,985	18	7,702	24	8,139	20	8,206	23	9,988	38
II	3,854	17	7,799	11	3,869	11	5,306	34	6,701	18
III	14,471	19	12,035	9	19,642	65	24,865	82	19,307	61
IV-A	15,111	30	11,893	48	23,331	110	22,318	104	16,005	92
IV-B	2,591	15	1,933	6	3,935	20	2,735	14	4,761	36
V	2,329	11	952	3	2,419	17	3,190	26	2,033	23
VI	8,489	27	4,360	11	25,836	88	10,302	86	9,551	67
VII	6,566	26	4,042	19	26,318	232	13,735	119	7,584	39
VIII	5,239	21	916	4	5,280	28	4,285	24	4,219	26
IX	6,755	28	4,625	14	6,911	37	4,607	27	3,493	28
X	11,752	65	5,550	27	17,080	70	6,671	24	11,223	71
XI	8,561	44	2,670	10	11,667	94	3,551	25	3,371	15
XII	7,247	40	5,599	16	17,937	77	9,432	37	5,383	26
BARMM	1,501	10	720	8	2,364	30	454	2	1,601	18
CAR	2,582	7	4,837	4	10,397	22	3,991	13	4,332	7
Caraga	8,618	43	2,664	14	7,879	40	2,679	13	3,450	13
NCR	8,929	44	9,114	44	15,801	60	25,897	158	14,476	77

In addition to the significant information presented above, the Philippine Health Agenda of 2016 – 2022 recognizes that dengue is one of the prevalent communicable diseases in the country as shown in figure 3 below [28].

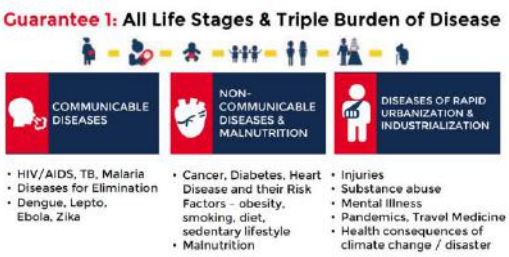


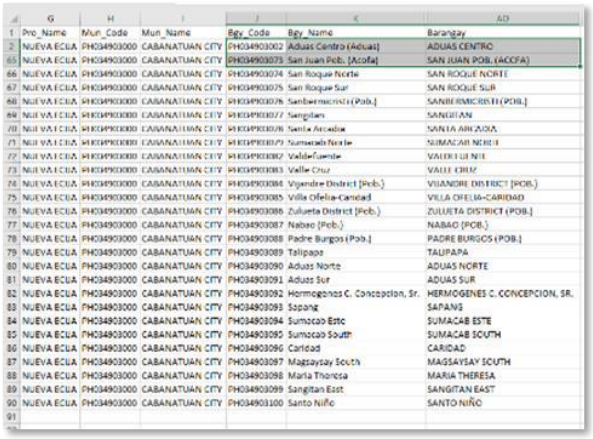
Fig.3. Department of Health Agenda of 2016-2022

IV. METHODS

Using the shapefile of the Map of the Philippines,

downloaded from namria website, together with their respective codes, the data were joined via barangay name. This done to map the counts of the admitted dengue patients.

From the dengue case per barangay, the researchers inserted additional column to append the barangay code on the shapefile of the barangay boundary in the Philippines. These codes were later on combined polygon shapefile available in the namria website. Typically, it is done by joining a table of data to a dataset by a field value found in both tables. In this case, the barangay code is utilized. The researchers made used of barangay Campo Tinio, as an example. They coded this barangay as PH034903022. Upon successful join, with no usual error, like the name of barangay San Juan Pob. (Acofa) and Aduas Centro (Aduas) to San Joan Pob. (ACCFA) and Aduas Centro shows in Figure below. In symbology, graduated color can be assigned to the polygon, like red for most extreme value to blue for a lesser value and clear or white for no value. Assignment of colors was based on count of attributes that fall inside the polygon or its equivalent value.



	G	H	I	J	K	AD
1	Pro_Name	Mun_Code	Mun_Name	Bgy_Code	Bgy_Name	Barangay
2	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903002	Aduas Centro (Aduas)	ADUAS CENTRO
65	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903073	San Juan Pob. (Acofa)	SAN JUAN POB. (ACCFA)
66	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903074	San Roque Norte	SAN ROQUE NORTE
67	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903075	San Roque Sur	SAN ROQUE SUR
68	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903076	Sanbermicristi (Pob.)	SANBERMICRISTI (POB.)
69	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903077	Sangitan	SANGITAN
70	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903078	Santa Arcadia	SANTA ARCADIA
71	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903079	Sumacab Norte	SUMACAB NORTE
72	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903082	Valdefuente	VALDEFUENTE
73	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903083	Valle Cruz	VALLE CRUZ
74	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903084	Vicandre District (Pob.)	VICANDRE DISTRICT (POB.)
75	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903085	Villa Ofelia-Caridad	VILLA OFELIA-CARIDAD
76	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903086	Zulueta District (Pob.)	ZULUETA DISTRICT (POB.)
77	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903087	Nabao (Pob.)	NABAO (POB.)
78	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903088	Padre Burgos (Pob.)	PADRE BURGOS (POB.)
79	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903089	Talipapa	TALIPAPA
80	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903090	Aduas Norte	ADUAS NORTE
81	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903091	Aduas Sur	ADUAS SUR
82	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903092	Hermogenes C. Concepcion, Sr.	HERMOGENES C. CONCEPCION, SR.
83	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903093	Sapang	SAPANG
84	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903094	Sumacab Este	SUMACAB ESTE
85	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903095	Sumacab South	SUMACAB SOUTH
86	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903096	Caridad	CARIDAD
87	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903097	Magsaysay South	MAGSAYSAY SOUTH
88	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903098	Maria Theresa	MARIA THERESA
89	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903099	Sangitan East	SANGITAN EAST
90	NUEVA ECIJA	PH034903000	CABANATUAN CITY	PH034903100	Santo Niño	SANTO NIÑO
91						

Fig.4. Shows the joined data via barangay code in ArcMap

The researchers also labelled the he names of the barangays occupying the top three (3) range per year so that the names would not overlap and that the value or count of the incidence will be shown up in the label inside the parenthesis.

In addition, the dengue case data were also processed in a geo-spatial program called ArcMap. This is performed to identify and classify the data that were collected. These data include the frequency of admitted patients, gender mostly prone to the dengue virus (DENV), age bracket reported to have high admission to hospitals, and weeks with notably high count of DENV reflected on the 5-year data the researchers had analyzed.

Locale of the Study

Cabanatuan City is a first-class city in the Philippines situated in the province of Nueva Ecija. It has a population of 327,325 people, making it the most populous city in the province and the fifth-most populous city in the whole Central Luzon [29].

According to the 2020 census, Cabanatuan, is a first-class component city comprising of 89 barangays, with its own charter granted by Republic Act No. 526, and serves as Nueva Ecija's principal commercial, educational, medical, and entertainment center. (Cabanatuan LGU City Official Website, n.d.). It is also recognized as the business capital of the province. And dubbed as the "Tricycle capital of the Philippines" were 30,000 registered motorized tricycles and has become the source of livelihood of over 10,000 families [30].

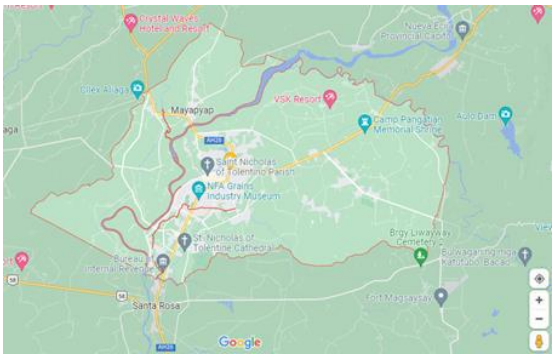


Fig.5. Locator Map [31]

Figure 5 above shows the location map of Nueva Ecija highlighting the research locale, the city of Cabanatuan.

Data Source

Data gathered on weekly monitoring report of admitted patients diagnosed with Dengue Fever (DF) from January 2014 to December 2018 (5-year dengue data) were obtained from Cabanatuan City Health Office sourced from the 89 barangays in Cabanatuan City. Data show that there were 4,532 reported DF cases in this city for that period alone. The report also includes the demographic data of DF infection categorized by gender, age group, and the Disease Reporting Unit (DRU). The DRU Category was classified as follows: hospital; City Health Office (CHO); City Epidemiological and Surveillance Unit (CESU); or Rural Health Unit (RHU) where DF infected patients were admitted.

To plot the collected data, the researchers made use of the ArcMap application. The ArcMap is the centerpiece of Esri's ArcGIS family of geospatial processing products, and it is primarily used to view, modify, produce, and analyze geographic data [32]. The 4,532 dengue cases of admitted patients are plotted per year. It enables the researchers to examine data inside a data collection,

represent features, and generate maps accordingly.

Data Models in GIS

Spatial Analysis

This research uses spatial analysis often known as locational analysis. It is a sort of geographical analysis that aims to explain patterns of human behavior and its spatial expression in terms of mathematics and geometry. It aims to explain patterns of human behavior and its spatial expression in terms of mathematics and geometry.

Fig.6. Vector and Raster Data in GIS [33]

On the data sets of dengue cases

Table 2 shows the distributed admitted patients of dengue virus in Cabanatuan City. They were subdivided per year from 2014 to 2018 and distributed per barangay around the City of Cabanatuan.

Statistical Analysis of Data

GIS software was used to evaluate and analyze the spatial data collected for this study.

The barangay shapefiles were obtained from the namria website. They are in the vector data storage format for recording geographic features' position, shape, and attributes. These information were obtained via the Philippine Integrated Disease Surveillance and Response (PIDSR) program utilized at the City Health Office and is monitored by the Provincial Health Office.

ArcGIS 10.6 (also known as ArcGIS Desktop), an Esri GIS software, was used to map the dengue cases of admitted patients from 2014 to 2018.

V. RESULTS AND DISCUSSION

Dengue has been a very important public health problem in the Philippines. In 2019, there had been a report of 8 deaths in Nueva Ecija; two each in San Jose City and Pantabangan; one each in Cabanatuan City, Gapan City, Cabiao and Gabaldon. With the growing dengue cases with 1,576 as of July 10, 2020, Cabanatuan had the most number with 171 [34].

ARCMAP on dengue cases

In 2014, with the dengue cases with a value greater than 7 were highlighted. The researchers were able to easily identify that the barangay Magsaysay district had around 33 dengue cases throughout the aforementioned year. On the other hand, it was seen in the map that in 2015 barangay Caalibangbangan (84), Campo Tinio (61) and Magsaysay District (54) were the areas with the highest number of hospitalized patients. The map showing the 2016 data reveals that barangay Macatbong has 31 dengue cases indicated by a red color.

In 2017, the map depicts the following data: barangay Caalibangbangan (22), Aduas Norte (23), Bagong Sikat (26), Bantug Norte (24), Suamcab Norte (19), Bangad (22), Campo Tinio (24) and Barrera District (Pob) (20). And in 2018, the map shows whopping 127 dengue patients admitted were from barangay San Juan Pob. (Accfa). This report calls the attention of the medical experts to investigate the matter and to devise ways to determine the classification/s of mosquitos infesting the residents of the said barangay and determine the causes of such huge increase of reported cases.

Figure 7 in the next page shows the resulting map created in ArcMap from the admitted patients with dengue cases in Cabanatuan City between January 2014 to December 2018.

On the 22nd August 2018, the Epidemiology Bureau (EB) of the DOH received an Event-based Surveillance and Response (ESR) report on Dengue Outbreak in 36 cases in Barangay San Juan ACCFA, Cabanatuan City, Nueva Ecija. On 3rd September of the same year, the Field Epidemiology Training Program (FETP) team was sent to the area with the following objectives: 1) to verify the diagnosis; 2) to determine the existence of an outbreak; 3) to identify the source and mode of transmission; 4) to identify risk factors; and 5) to recommend control and preventive measures [35].

Figure 8 shows the distribution of dengue cases per gender. It shows that in year 2016, most of the dengue case admitted where male and that female are impervious.

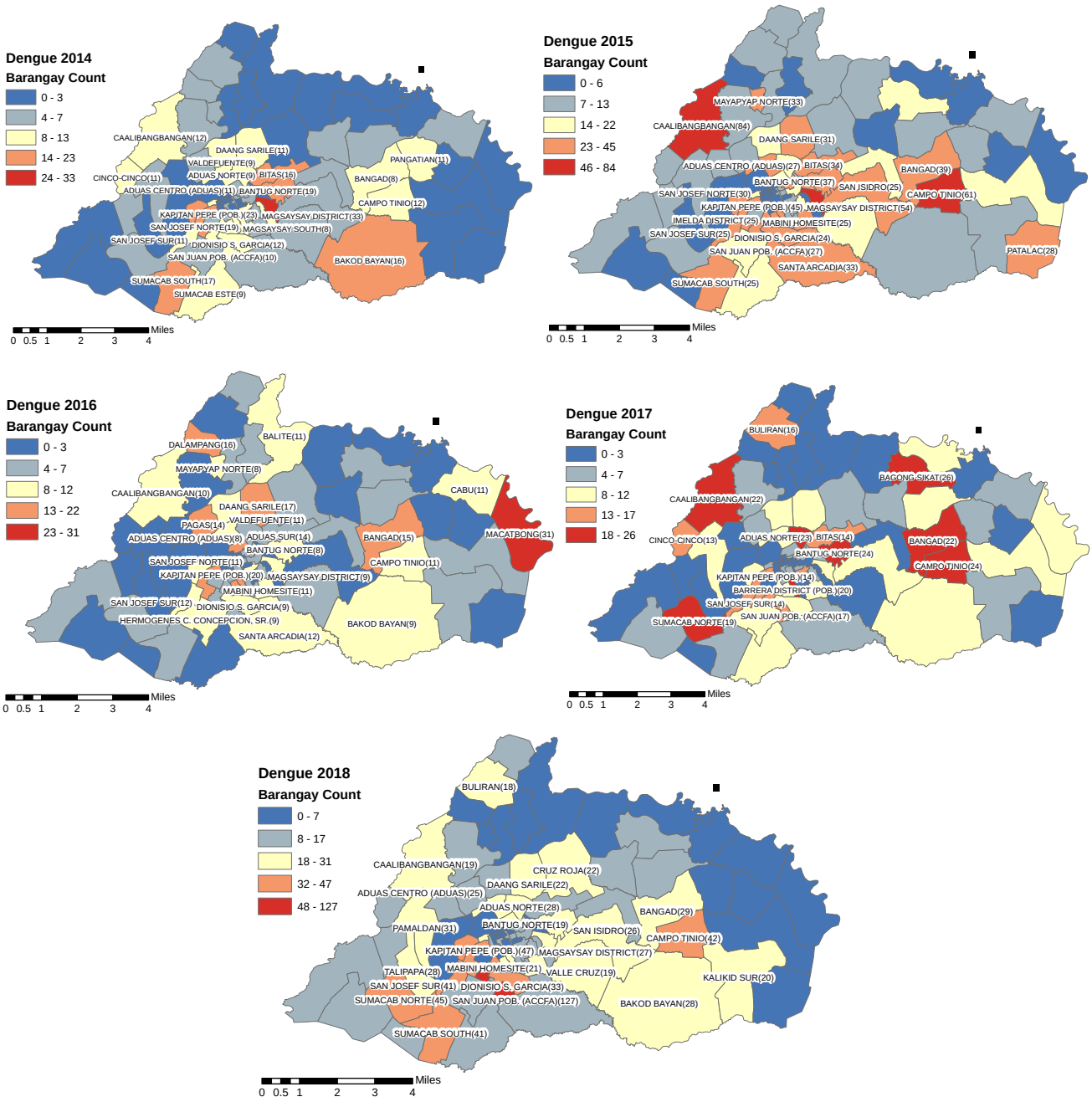


Fig.7. Dengue Cases for the year 2014 to 2018

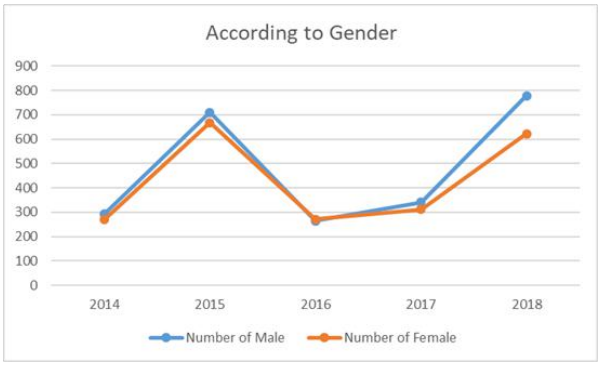


Fig.8. Graph categorized the patients by gender

Figure 9 shows the distribution of dengue cases as regards age. Findings show that most dengue case admitted in the year 2018 are between ages 10-14 years old, 314 patients. This was followed by the age bracket 15-19 in 2015 at 255 cases. Generally, the graph shows that individuals belonging to 5-24 years old are prone to DENV infections.

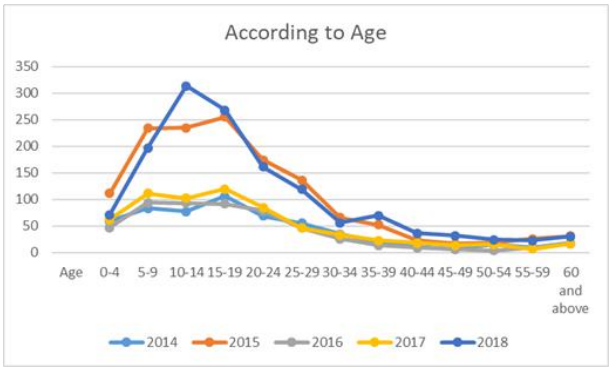


Fig.9. Graph categorized the patients by age bracket

Figure 10 shows the distribution of DRU all over Cabanatuan City. These DRUs include the following health units: City Health Office, rural health office situated in some barangays, and private hospitals such as Wesleyan University General Hospitals and Cardiovascular Center, Nueva Ecija Good Samaritan Health Care System Inc, Premiere Medical Center, Immaculate Conception Medical Center of Central Luzon Inc, Nueva Ecija Doctors Hospital Inc. Government hospitals were included, these are: E.L. Joson Memorial Hospital, Dr. Paulino J. Garcia Memorial Research and Medical Center and M.V. Gallego Cabanatuan City General Hospital.

The graph shows that the health centers or units with highest admission rate is the Government DRU.

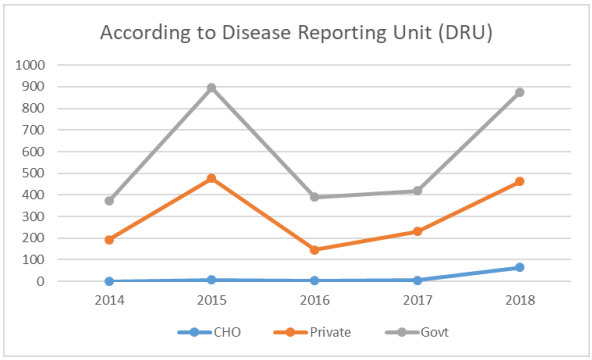


Fig.10. Graph showing the Dengue Case categorized by DRU

Figure 11 presents the dengue cases admitted in different health facilities distributed on a weekly basis. Data shows that dengue cases shoot up from week 28 to week 42. This occurs between the months of July to October. This is the period where rainy season is expected to commence.

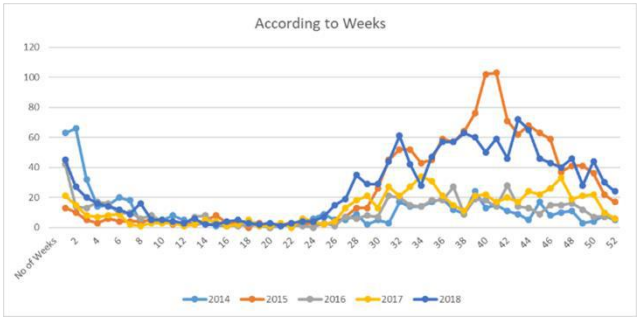


Fig.11. Graph showing the distribution of dengue patients according to weeks

VI. CONCLUSION AND RECOMMENDATIONS

Using a ranking method and choosing the top 10 barangays per year from 2014 to 2108, Barangay Kapitan Pepe (Pob.) and Campo Tinio showed up 4 times in a consecutive manner. While Barangay Bantug Norte, Calibangbangan and Bangad showed up 3 times. It is noteworthy to mention that barangay Bangad also appeared in 3 consecutive years namely 2015 to 2017.

The highest cases being recorded is at Barangay San Juan Pob. (ACCFA) with 127 admitted patients in year 2018 alone. Capturing of mosquitoes were done to test the virus outbreak in the locality. City Health Office officials attest that reason for the outbreak was due to the frequent tropical storm during that year and since the barangay is in a low-lying area, uncollected garbage and accumulated waters on container are some of the possible causes of mosquito reproduction. This also calls for a close monitoring of the situation. Netting mosquito to check what type they are and identifying which among the barangays needed the control and prevention the most.

In terms of Demographic information, results indicated that majority of the Dengue cases are males except for 2016 where the female were more susceptible. As regards, age bracket patients from 10 to14 years old is at 314 followed by those belonging to 15-19 with 255 in the year 2018 and 2015, respectively. Additionally, most of the dengue patients decided to be admitted to public hospitals. The occurrence of dengue cases accrues in weeks 28 to 42 which can be explained by the start of the rainy season.

The use of GIS in determining Dengue Cases was proven to be effective, hence, the results from the study can be a reliable and relevant information that can be used in order to strictly implement the health policies for dengue cases, prevention of dengue outbreaks, health care interventions, budget allocation and the effective implementations of heath programs in the different barangays in the city of Cabanatuan.

The Philippine government must continue to implement, evaluate and improve the dengue response plan at the regional, provincial, and municipal levels (WHO-ROP, 2019). This must be done to: conduct daily dengue epidemiology analysis at the barangay level, notify any cluster of dengue cases to DOH/EB for appropriate follow up, advocate for community and school-based health education campaigns and clean-up drives, ensure supply of sufficient insecticides for vector control, and work closely with LGUs, the DOH has directed all regional health offices and the MOH-BARMM to activate their disaster risk reduction and management councils, lead in the 4 a.m. daily habit and ensure its institutionalization and implementation down to the community level, collaborate with PhilHealth on the dengue benefit package and point-of-service enrolment, and strengthen its information campaign, including through social media.

At the national level, the Philippine government, through the DOH, must continue to implement the following measures (WHO-ROP, 2019): coordination of response efforts with CHDs via the Task Force for Prevention, Control, and Response to Dengue Outbreak, sustained disease surveillance, sustained advocacy campaigns, hospital preparedness for surge capacity, leadership of the NDRMMC's Health Cluster, and mobilization of human resources, logistics, and funds to affected regions.

The researchers also recommend that this spatial analysis be done regularly to help detect and monitor the occurrence of dengue in the different barangays covered in this study.

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CONFLICT OF INTEREST

The authors declare no conflict of interest regarding the publication of this paper.

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Table 2. Dengue Case distributed by year and per barangay (2014-2018)

Barangay	Dengue Cases					
	2014	2015	2016	2017	2018	Total
1. Aduas Centro	11	27	8	9	25	80
2. Aduas Norte	9	17	6	23	28	83
3. Aduas Sur	7	16	14	6	22	65
4. Bagong Buhay	0	0	1	0	2	3
5. Bagong Sikat	0	16	4	26	11	57
6. Bakero	4	8	4	9	9	34
7. Bakod Bayan	16	12	9	12	28	77
8. Balite	3	10	11	2	2	28
9. Bangad	8	39	15	22	29	113
10. Bantug Bulalo	2	24	3	5	7	41
11. Bantug Norte	19	37	8	24	19	107
12. Barlis	2	7	6	2	1	18
13. Barrera District (Pob.)	11	29	22	20	21	103
14. Bernardo District (Pob.)	7	1	4	6	3	21
15. Bitas	16	34	4	14	16	84
16. Bonifacio District (Pob.)	10	14	5	6	24	59
17. Buliran	5	10	2	16	18	51
18. Caalibangbangan	12	84	10	22	19	147
19. Cabu	6	12	11	5	5	39
20. Calawagan (Kalawagan)	1	5	2	10	7	25
21. Campo Tinio	12	61	11	24	42	150
22. Caridad	4	8	2	1	10	25
23. Caudillo	2	4	0	1	7	14
24. Cinco-Cinco	11	9	2	13	10	45
25. City Supermarket (Pob.)	0	2	0	0	0	2
26. Communal	1	0	1	1	2	5
27. Cruz Roja	2	12	7	4	22	47
28. Daang Sarile	11	31	17	11	22	92
29. Dalampang	5	6	16	1	4	32
30. Dicarma (Pob.)	9	7	8	14	9	47
31. Dimasalang (Pob.)	3	6	5	5	5	24
32. Dionisio S. Garcia	12	24	9	8	33	86
33. Fatima (Pob.)	0	4	0	2	4	10
34. General Luna (Pob.)	7	11	7	3	14	42
35. Hermogenes C. Concepcion, Sr.	7	20	9	11	11	58
36. Ibabao Bana	6	7	2	3	17	35
37. Imelda District	13	25	4	11	37	90
38. Isla (Pob.)	3	2	1	0	6	12
39. Kalikid Norte	3	15	7	12	1	38
40. Kalikid Sur	3	8	5	6	20	42
41. Kapitan Pepe (Pob.)	23	45	20	14	47	149
42. Lagare	4	6	3	6	12	31
43. Lourdes (Matungal-tungal)	5	20	6	0	12	43
44. M.S. Garcia	10	32	17	9	29	97
45. Mabini Extension	6	22	5	7	16	56
46. Mabini Homesite	7	25	11	11	21	75
47. Macatbong	2	3	31	11	4	51

48. Magsaysay District	33	54	9	9	27	132
49. Magsaysay South	8	0	0	3	15	26
50. Maria Theresa	2	4	1	5	1	13
51. Matadero (Pob.)	2	4	2	3	6	17
52. Mayapyap Norte	7	33	8	3	6	57
53. Mayapyap Sur	5	13	3	6	14	41
54. Melojavilla (Pob.)	1	0	0	1	6	8
55. Nabao (Pob.)	0	6	1	4	4	15
56. Obrero	2	8	2	2	5	19
57. Padre Burgos (Pob.)	4	13	0	3	3	23
58. Padre Crisostomo	8	7	6	3	14	38
59. Pagas	5	7	14	7	11	44
60. Palagay	2	7	5	2	9	25
61. Pamaldan	7	12	3	11	31	64
62. Pangatian	11	10	3	4	6	34
63. Patalac	0	28	2	1	4	35
64. Polilio	2	4	1	7	12	26
65. Pula	2	12	6	1	15	36
66. Quezon District (Pob.)	7	14	4	2	10	37
67. Rizdelis (Pob.)	2	6	2	2	4	16
68. Samon	0	12	0	1	8	21
69. San Isidro	7	25	3	10	26	71
70. San Josef Norte	19	30	11	12	33	105
71. San Josef Sur	11	25	12	14	41	103
72. San Juan Pob. (Accfa)	10	27	6	17	127	187
73. San Roque Norte	3	7	5	3	9	27
74. San Roque Sur	1	4	3	11	13	32
75. Sanbermicristi (Pob.)	6	3	1	6	8	24
76. Sangitan	4	26	4	4	9	47
77. Sangitan East	2	11	3	4	5	25
78. Santa Arcadia	7	33	12	4	16	72
79. Santo Niño	2	3	2	3	10	20
80. Sapang	1	1	7	0	4	13
81. Sumacab Este	9	18	3	11	17	58
82. Sumacab Norte	7	12	5	19	45	88
83. Sumacab South	17	25	4	7	41	94
84. Talipapa	2	3	0	1	28	34
85. Valdefuente	9	19	11	8	10	57
86. Valle Cruz	6	15	7	2	19	50
87. Vijandre District (Pob.)	1	5	2	1	9	18
88. Villa Ofelia-Caridad	5	8	5	4	2	24
89. Zulueta District (Pob.)	4	7	4	3	5	23
TOTAL	***563***	***1, 378***	***537***	***653***	***1,401***	***4,532***