Impact of Weather Conditions on COVID-19 Incidence in Select Regions of the Philippines: National Capital Region (NCR), IV-A (CALABARZON), and VII (Central Visayas)

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Abstract: - Studies have indicated a significant correlation between weather parameters and Coronavirus Disease (COVID-19) incidence; however, few have investigated the relationship within the Philippines and used such to predict COVID-19 trends. This study aimed to determine and correlate weather parameters (temperature, rainfall, and humidity) of the National Capital Region (NCR), Region IV-A (CALABARZON), and Region VII (Central Visayas) to their respective COVID-19 incidence rates; and to assess the ability of such to predict COVID-19 incidence trends. Descriptive statistics was used to assess COVID-19 cases and weather conditions in the regions, while Pearson correlation and time series analysis were used to determine the correlation between the variables and to evaluate the ability of the former to predict incidence trends. Recorded weather parameters and COVID-19 incidence are reflective of the country's climate and the population density of the three regions selected for study. The strength and direction of the correlation between the meteorological factors and COVID-19 cases varied between locations; but generally, COVID-19 cases were found to have a positive relationship with a weak correlation with rainfall and temperature, while a weak negative correlation is seen with respect to relative humidity. Generated predictive models yielded r-square values of 0.67, 0.65, and 0.57 for NCR, CALABARZON, and Central Visayas implying the ability of said weather parameters to predict historical data accurately. These findings ultimately suggest that weather conditions and the number of COVID-19 cases are correlated and that models utilizing such can predict COVID-19 incidence trends with relative accuracy. Despite the significant findings, this study has its limitations, which must be addressed for the betterment of future research. The authors recommend the inclusion of other regions within the country to obtain more comprehensive results. In addition, it was suggested that the time frame of data collection be extended to cover longer periods to provide stronger conclusions. The inclusion of other factors related to viral transmission and personal health (i.e. virus resistance, lock-down protocols, limited testing capacities, population endurance, population mobility, sanitation practices, hand washing habits, and personal hygiene) must also be considered.

Key Words: — *COVID-19, Weather condition, COVID-19 cases Philippines, Incidence.*

I. INTRODUCTION

In the city of Wuhan situated within Hubei, China, a severe acute respiratory syndrome coronavirus (SARS-CoV-2) was detected in December 2019 which was found to have caused an outbreak of pneumonia in the area – a disease that would be later referred to as the Coronavirus Disease 2019 or COVID-19 [1, 2]. SARS-CoV-2 succeeded in transitioning from animals to humans; however, its route of transmission and zoonotic source remain unknown [3, 4]. Its identification makes it the 7th coronavirus known to infect humans in addition to SARS-CoV and MERS-CoV, which cause severe diseases, and HKU1, NL63, OC43, and 229E, which are linked to common colds and mild symptoms [5]. The first clinical sign of COVID-19 was pneumonia. There are also reports of gastrointestinal symptoms and asymptomatic infections in addition to such. Observations

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have suggested a mean incubation period of five days and a median incubation period of three days. According to Velavan and Meyer [3], "clinical manifestations typically begin less than a week for symptomatic patients". These were said to consist of "fever, cough, nasal stuffiness or congestion, tiredness and other symptoms of the upper respiratory tract infections." They also indicated that infections could worsen and result in dyspnea and chest symptoms typical of pneumonia. According to the World Health Organization (WHO) [6], such disease is able to spread directly or through close contact with infected individuals or contaminated objects.

On January 30, 2020, the World Health Organization (WHO) had announced a global health emergency because of the increasing case rates in China and in some international locations. They subsequently announced a global pandemic on March 11 of the same year [3, 7]. In the Philippines, the first case of COVID-19 was confirmed on January 31, 2020, and was admitted to the San Lazaro Hospital (SLH). The second confirmed case was found to be a close contact with the first patient and was the first death confirmed to be caused by the disease in the country and outside of China. Both cases were foreigners or travelers from China. On March 5, 2020, the first confirmed local transmission case of COVID-19 in the country was reported [7]. According to Edrada et al. [8], "there were 633 suspected cases reported during March 1, 2020". Moreover, as stated by Salva et al. [7], by May 2, 2020, there were already 8,772 confirmed cases reported in the country. By September 26, 2020, this number had ballooned to 299,361 with the majority of cases being confined to the National Capital Region (NCR), Region IV-A (CALABARZON), and Region VII (Central Visayas) (DOH).

Recent studies have determined several weather conditions that appear to affect the number of COVID-19 cases and have investigated the correlation between such. The findings of Tosepu et al. [9] concluded that average temperatures in Indonesia were strongly associated with COVID-19 incidence rates. Xie and Zhu [10] have also analyzed the correlation between COVID-19 infections in China and temperature. The study asserted that there was a positive linear association between the average temperature and the number of COVID-19 cases. The impact of temperature variation as variables of viral transmission was further elaborated by Ma et al. [11] which indicated a negative correlation between ambient temperature and COVID-19 mortality. The study also suggested a negative correlation between humidity and the death rate of the disease, a finding that was supported by the study of Wu et al. [12]. On the other hand, rainfall levels in Norway were also seen to have a negative association with the incidence of COVID-19 [13].

Despite the growing number of international studies indicating the significance and correlation of such parameters to COVID-19 incidence, there is a noticeable lack of research that investigates the said relationship within the Philippines and that uses such meteorological factors to predict COVID-19 incidence trends. This study aimed to determine the significant weather conditions (temperature, relative humidity, and rainfall level) that correlate with COVID-19 cases in the Philippines and use them to predict COVID-19 incidence rates. The findings from this study can either conclude whether there are or there are no weather conditions that significantly correlate to the incidence of COVID-19 cases in the top three afflicted regions in the Philippines. In addition, it may also conclude whether or not the data on weather conditions, specifically temperature, humidity, and rainfall level can predict COVID-19 incidence trends. It is worth noting that the study did not take into consideration the demographic profiles of the infected COVID-19 patients, the specific names of the hospitals to where the said patients are confined, and the duration of the availability of test kits and testing centers. Affecting factors other than the stated weather conditions were not evaluated for their possible impacts on the incidence rate of COVID-19.

This study offers valuable knowledge to the community and can inform local and global health authorities' decisions. If variations in weather conditions were determined to have an impact on COVID-19 incidence, it is possible to introduce new strategies to improve health services or methods of social isolation, depending on temperature, humidity, and rainfall trends. This would ultimately help delineate transmission patterns that could contribute to the formulation of seasonal preventive measures that may help the general public from contracting the virus. In addition, it offers new insights into the relationship between temperature, humidity, and rainfall level, and new cases of COVID-19, and might support local policymaking in the country which adds to the efforts against COVID-19 as new weather seasons can be matched to the lock-down strategy of the country accordingly. Furthermore, the scientific findings of this research also add to the limited pool of knowledge about the factors, which increase the transmissibility of the virus. In the field of medical technology, it can further contribute to the understanding of the relationship between virus transmission and environmental determinants such as weather conditions.

II. Framework

2.1 Theoretical Framework

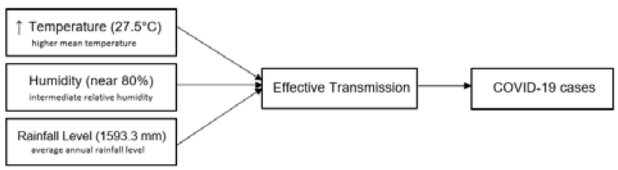

Fig.1. Graphical Illustration of the Theory by Auler et al.

Studies have been conducted to determine whether there is an impact on the number of COVID-19 cases from varying weather conditions. A theory from a similar study suggests that different factors, like the weather conditions, affect the number of cases that would state the effectiveness of the viral transmission. Figure 1 shows that a theoretical framework from the theory suggested by Auler et al. [14] that through varying increase and decrease temperature, humidity, and rainfall level, would result in a virus being suspended on the environment that would allow the transmission to be widely observed causing an increase or decrease to the cases of COVID-19.

In connection to the theory of Auler et al. [14], Araújo and Naimi [15], explained that the atmosphere can mediate SARS-CoV-2 from human to human, and unsuitable climates can rapidly destabilize the virus, thus decreasing its epidemic potential. The theory of Lin and Marr [16] also tried to explain that the inactivation of the virus is brought about by its exposure to increasing solute concentrations in evaporating droplets that likely damage the viral structure, which mainly suggests that relative humidity affects viral transmission. Sarkodie and Owusu [17] also stated in their study that precipitation and rainfall levels reduce temperature and create moist and cold environments that are conducive for viral survival and transmission.

The theory of Auler et al. [14] is the most relevant to the aims of the study, given the emphasis that specific weather conditions such as temperature, humidity, and rainfall levels contribute to the effectiveness of viral transmission that affects the number of COVID-19 cases in the top three afflicted regions in the Philippines. Thus, this theory was used to formulate the theoretical framework.

2.2 Conceptual Framework

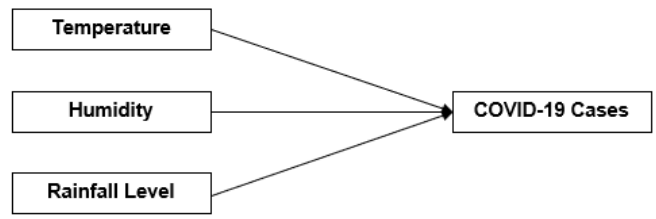

Fig.2. Paradigm of the Study

Understanding how various factors affect the incidence of COVID-19 cases in the country is of utmost importance as it may allow the formulation of effective policies and regulatory measures that would protect the general public from the disease. This study aimed to evaluate a small portion of these supposed factors by determining which of them correlate with the number of COVID-19 cases in the Philippines and by assessing their ability to predict the COVID-19 incidence.

Figure 2 depicts the research paradigm of the study. Three variables, namely temperature, humidity, and rainfall, were chosen to represent the country's weather conditions. Their individual correlations to COVID-19 cases from the top three afflicted regions of the country were assessed and evaluated for statistical significance. In addition, their capability to predict the number of COVID-19 cases were also determined.

III. Methodology

3.1 Research Design

A descriptive-exploratory design was utilized in this study. As an exploratory study, it explored what weather parameters affected the high incidence of COVID-19 cases in the top three regions of the country. Exploratory research often forms the basis for descriptive research because it can provide the hypothesis while the descriptive approach is used to prove the hypothesis. In that case, this study is also descriptive because it determined the effects of weather parameters on predicting COVID-19 incidence. One basic type of descriptive research study for collecting data in longitudinal studies with the main objective of observing changes occurring over a period of time.

This study is also retrospective because the researchers utilized secondary data from two different agencies, DOH and PAGASA.

3.2 Subjects and Study Site

The data set is collected from the top three regions of the country with the highest number of COVID-19 cases. First, the researchers gathered archival data of weather parameters from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). The data was obtained upon the approval of the research proposal to the Ethics Review Board (ERB) as instructed by the Climate and Agrometeorological Data Section of PAGASA. The weather parameters from PAGASA that were utilized in the study include rainfall amount, maximum temperature, minimum temperature, average temperature, and relative humidity. The weather parameter data was then correlated with and used to predict the incidence of COVID-19 cases in the Philippines from the Department of Health (DOH) website. Based on the COVID-19 tracker of DOH, the areas with the highest number of cases recorded weekly and daily are as follows: National Capital Region (NCR), Region IV-A CALABARZON, and Region VII Central Visayas. To be specific, the top three regions with the highest number of recorded cases from March to June of 2020 were included in the study.

3.3 Data Measure/Instrumentation

Statistical Package for Social Sciences (SPSS) software was utilized to perform the necessary statistical analysis such as descriptive statistics, on the obtained data, to assess the regions in the Philippines with the highest COVID-19 case and their respective weather conditions, as well as plot the changes in weather over time in relation to the number of COVID-19 cases in the country. Specifically, the study applied summary measures such as mean, standard deviation, and minimum and maximum to the number of cases, rainfall, temperature, and relative humidity.

Furthermore, the standard deviation will measure the dispersion of the values. Moreover, time series analysis (temporal causal model) and Pearson correlation coefficient were also used for the assessment of the predictive capability of the weather parameters and to determine the relationship and influence of the weather variables on the COVID-19 incidents respectively.

3.4 Data Gathering Procedure

Secondary data of daily COVID-19 cases for the period of March 1 to June 30, 2020, were obtained from the Department of Health Data Drop website. Whereas, information regarding the components of weather conditions, including temperature (°C), humidity (%), and rainfall (mm) during that period, were collected from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). The data gathering procedure is illustrated in figure 3.

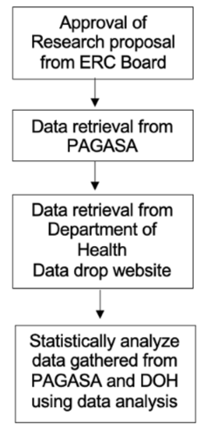

Fig.3. Graphical Summary of the Study's Data Gathering Procedures.

3.5 Ethical Considerations

In respect of COVID-19 patients, their personal information and demographic data were not disclosed and made strictly confidential. This was done in compliance with the "Data Privacy Act of 2012". Only the number of positive cases in the regions of National Capital Region (NCR), Region IV-A CALABARZON, and Region VII Central Visayas was disclosed. Permission to acquire data of positive cases and archival data of PAGASA regarding the weather parameters were obtained via email.

3.6 Data Analysis

Descriptive statistics was used to assess the regions in the Philippines with the highest COVID-19 case and their respective weather conditions. According to Ross (2020), descriptive statistics is defined as an area in statistics that is concerned with the description and summarization of data. Specifically, the study applied summary measures such as mean, standard deviation, and minimum and maximum to the number of cases, rainfall, temperature, and relative humidity.

Furthermore, the standard deviation will measure the dispersion of the values.

Pearson correlation coefficient was utilized to determine the relationship and influence of the weather variables on the COVID-19 incidents. Due to the nature of both dependent and independent variables, being a scale variable, this tool was able to determine the strength of association between the two variables.

Time series analysis was used for the assessment of the predictive capability of the weather parameters. According to Shumway and Stoffer [18], time series analysis is a statistical tool which analyzes the relationship between variables that change over time, such as data of a particular time period or interval that occurred in series. In particular, temporal causal modelling, a time series analysis technique which determines key causal relationships from time series data [19], was utilized. Time series models are essential in the field of epidemiology as it predicts epidemiological behaviors by modeling historical surveillance data [20].

IV. RESULTS AND DISCUSSION

The following describe the findings of the study with regard to its objectives in determining and correlating weather parameters (temperature, rainfall, and humidity) of the National Capital Region (NCR), Region IV-A (CALABARZON), and Region VII (Central Visayas) to their respective COVID-19 incidence rates; and to assess the ability of such to predict COVID-19 incidence trends.

4.1 Characterization of the Daily COVID-19 Cases and Meteorological Conditions

Descriptive statistical analysis was used for the characterization of the daily COVID-19 cases and meteorological conditions in select regions (National Capital Region, Region IV-A, and Region VII) of the Philippines. Last March 2020 to June 2020, data from DOH and PAGASA showed an average of 110.38 cases daily ranging from 0 to 1036 cases, 3.36mm rainfall, 29.04°C for temperature, and 73.63% relative humidity when the data from the following regions were combined. These results reflect the climate in the Philippines that has 2 seasons—dry and rainy season, dry being observed from December to May and rainy in June to November [21].

Table.1. Combined Data for the Select Regions (NCR, CALABARZON, and Central Visayas) of the Philippines

Variables	Minimum	Maximum	Mean	Std. Deviation
Cases	0.00	1036.0	110.38	133.43
Rainfall (mm)	0.00	176.80	3.36	12.92
Maximum Temperature (°C)	26.90	37.30	33.03	1.62
Minimum Temperature (°C)	21.20	29.20	25.06	1.42
Average Temperature(°C)	24.80	32.50	29.04	1.32
Relative Humidity (%)	40.00	94.00	73.63	8.58

Table.1. reveals the breakdown of the overall data for each selected region of the Philippines. The reported average daily cases of NCR, CALABARZON, and Central Visayas from March to June 2020 were 212.31, 45.88, and 72.96 cases, respectively. It can be observed that the average daily case of NCR is significantly higher than that of Central Visayas and CALABARZON. This is likely to happen given that the population density and foot traffic in NCR is higher than that of the other two regions. For the average temperature, NCR is still the highest among the three, with 29.60°C. In terms of the average rainfall level and relative humidity, however, CALABARZON has a value of 5.09 mm and 81.29%, respectively, which values were higher than NCR and Central Visayas.

4.2 Associations between the Number of COVID-19 Cases and Meteorological Factors

Table.2. Relationship of COVID-19 Cases and Meteorological Factors

Meteorological Conditions	Correlation	National Capital Region	CALABARZON	Central Visayas	Total
Rainfall	Pearson's R	0.152	0.104	0.347	0.099
	Significance	0.095	0.255	<0.001	0.059
Maximum Temperature	Pearson's R	-0.118	0.014	-0.137	0.184
	Significance	0.195	0.875	0.131	<0.001
Minimum Temperature	Pearson's R	0.232	0.003	0.068	0.187
	Significance	0.010	0.971	0.458	<0.001
Average Temperature	Pearson's R	0.068	0.014	-0.042	0.215
	Significance	0.454	0.879	0.649	<0.001
Relative Humidity	Pearson's R	0.397	0.139	0.483	-0.159
	Significance	<0.001	0.127	<0.001	0.002

Table.2. illustrates the possible correlation between the meteorological conditions and COVID-19 incidence. The combined data for the three regions, represented by the total column, show a positive relationship with a weak correlation was seen in the number of COVID-19 cases and the amount of rainfall (R=0.099; p=0.059) as well as minimum temperature (minimum: R=0.187; p<0.001), maximum temperature

(maximum: R=0.184; p<0.001) and average temperature (average: R=0.215; p<0.001), implying an increase in COVID-19 cases, with possible enhanced transmission occurs, when the amount of rainfall is large as well as when the temperature is high.

Studies held in Jakarta [9] and Turkey [22] showed similar results in terms of the strength in the correlation between COVID-19 incidence and temperature; however, in both instances, the relationship was found to be negative and the increase in the number of cases was supplemented by an increase in population density and a decrease in temperature which promotes the transmission of the disease. In addition, higher temperatures were found to reduce the virus' survival capability thus decreasing its transmission [17]. The results of the current paper refute this idea and support the findings of Auler et al. [14] which also attest the positive relationship between the two variables. The cited study found that the conclusion that higher temperatures limit COVID-19 transmission may not readily apply in tropical locations in which great transmission of the virus is observed. In the context of the current research, this may mean that there were high transmission rates in the three regions selected for study which invalidates the effect of temperature on the survival of the virus. The relationship between COVID-19 incidence and rainfall amount affirms the findings of Sarkodie and Owusu [17] which indicate a strong positive correlation between the number of confirmed cases and moisture-based meteorological factors (i.e. rainfall amount). According to the authors, large amounts of precipitation tend to moisten the environment, a condition that is said to be conducive for SARS-CoV-2 survival and transmission.

Table 2 also displays a weak negative correlation between COVID-19 incidence and relative humidity (R=-0.159; p=0.002); suggesting that there was a decrease in the number of cases as relative humidity increases. This was consistent with the findings of Ward, Xiao, and Zhang [23] and Liu et al. [24], which found that reduced humidity allows better spreading of the disease as it suspends the causative virus in the air for a long period of time.

Generally, using Guilford's interpretation of the magnitude of correlation, rainfall was found to have a slight or weak relationship with the continuous increase in COVID-19 cases as well as significant relationships observed between COVID-19 incidence, and temperature and relative humidity. On the other hand, the different regions exhibited varying levels of significant relationships. In Central Visayas, there were low significant positive relationships between the number of COVID-19 cases with rainfall (R=0.347; p<0.001) and relative humidity (R=0.483; p<0.001) implying that as the rainfall and relative humidity increases, the number of cases also increases. As for NCR, minimum temperature (R=0.232; p=0.010) and relative humidity (R=0.397; p<0.001) showed a low significant positive relationship as well. For CALABARZON, the meteorologic conditions did not show any relationship with the continuous increase in the number of cases. These discrepancies in correlations may be due to the difference in geographic location and rate of transmission of the three regions.

Ultimately, these results could indicate that certain meteorological factors affect the continuous increase in COVID-19 cases and are of statistical significance.

4.3 Predicting the Number of COVID-19 Cases

Temporal causal modeling is a time series analysis technique that determines the effects of time series factors (i.e., meteorologic conditions) on a set of time-series data (i.e., number of COVID-19 cases). It employs the principle of Granger causality in which past values of certain variables (Granger-causes) may be used to forecast the current value of another variable [25]. The results of the test would ascertain the impact of the meteorological conditions on the number of COVID-19 cases within the three selected areas for study and whether such parameters are able to predict previous COVID-19 incidence data.

The NCR temporal causal model acquired an r-square value of 0.67 and the top five most important predictors were determined to be the number of cases, average temperature, rainfall amount, relative humidity, and minimum temperature. Figure 4 presents the trendline for the actual data, predicted values, as well as forecast values and intervals.

The r-squared value of 0.67 is evident, as the predicted and observed values do not differ on a large scale. The forecasted values show an abrupt drop followed by a sudden rise in COVID-19 cases within the next ten days.

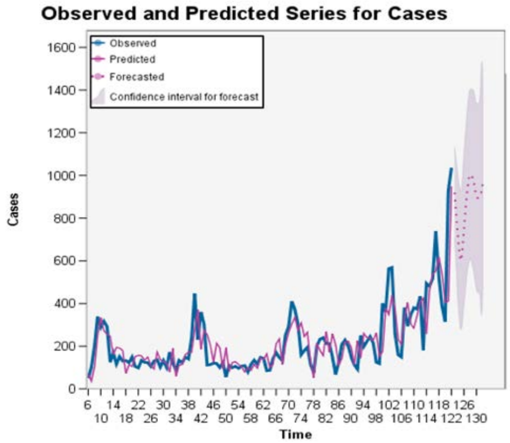

Fig.4. The Observed and Predicted Series for Cases in NCR

The CALABARZON temporal causal model had an r-square value equal to 0.65 with the top five most important predictors being the number of cases, maximum temperature, minimum temperature, relative humidity, and rainfall amount. Figure 5 discusses the trendline for the actual data, predicted values, as well as forecast values and intervals. The model's r-square value of 0.65 was observed as there was a great similarity between the predicted and observed values. The forecasts, on the other hand, show a gradual drop in the number of COVID-19 cases for the next ten days.

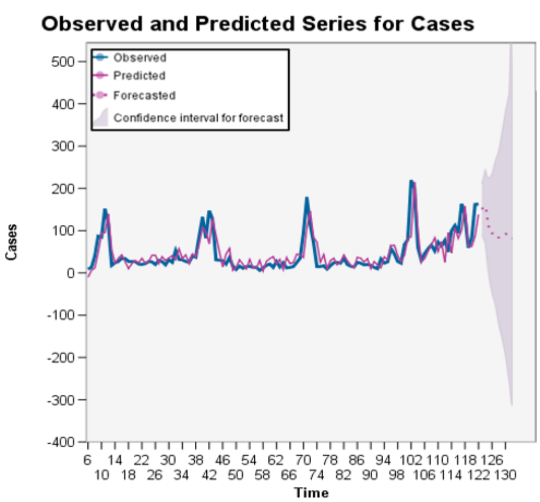

Fig.5. The Observed and Predicted Series for Cases in CALABARZON

The Central Visayas temporal causal model garnered an r-square value of 0.57 and ranked the top five most important predictors as the number of cases, rainfall amount, relative humidity, minimum temperature, and maximum temperature. Figure 6 tackles the trendline for the actual data, predicted values, as well as forecast values and intervals. The model's r-squared value of 0.57 was evident with a small variation between the predicted and observed values. The forecasts show a gradual drop, a minimal rise, and then a decrease in the number of COVID-19 cases for the next ten days.

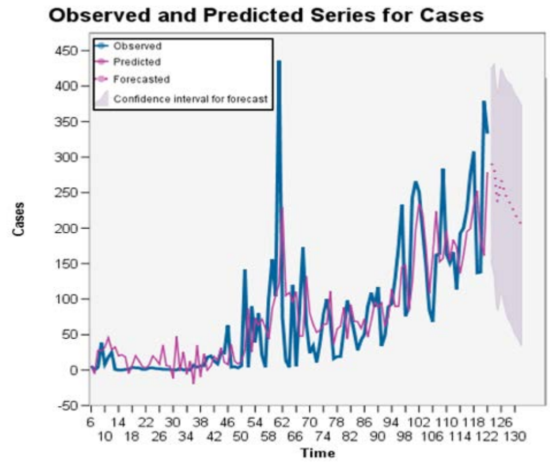

Fig.6. The Observed and Predicted Series for Cases in Central Visayas

The above-mentioned results and models for the National Capital Region (NCR), Region IV-A (CALABARZON), and Region VII (Central Visayas) imply that weather parameters were able to predict the number of past COVID-19 cases with relative accuracy – having correctly predicted 67%, 65%, and 57% of historical data from the aforementioned areas.

These results largely support a study by Chen et al. [26], which found weather parameters as important factors in determining COVID-19 epidemic trends. Their multi-factorial model involving air temperature, wind speed, and relative humidity had an r-square value greater than 0.6, which is comparable to that of the generated models. The study also conforms to the findings of Da Silva et al. [27] which concluded that climatic variables have a positive influence on the accuracy of predicting COVID-19 cases. Together, these papers, along with the current study, attest to the usefulness of weather parameters and models utilizing such in predicting trends in COVID-19 incidence and could promote further studies into developing such. In addition, the predictive nature of models may indicate their capability to forecast future trends [28]. It may be worth concluding that the generated models may be used to determine future COVID-19 incidence trends; however, it must be taken into consideration that, although the generated models had r-squared values similar to that of other weather based COVID-19 predictive models such as those seen in the study by Chen et al. [26], a large amount of variability still exists indicating that the models may not adequately and correctly predict the number of future COVID-19 cases.

It is also worth noting that the time series analysis was able to rank the top five predictors per geographic location. It is evident that the number of COVID-19 cases in all three regions depends primarily on its previous values. This is expected since the number of infected persons will depend upon the number of those who are previously infected. In addition, it was observed that there were variations with the weather parameters that were considered as important predictors within each of the given regions. This finding could ultimately imply the necessity to evaluate the meteorologic conditions and their association to COVID-19 cases per geographic location in order to create models that better predict trends of the infection within the areas.

4.4 Limitations

The current study has some limitations that must be acknowledged. It only used meteorologic and COVID-19 incidence data from three selected regions within the Philippines; therefore, caution should be exercised when extrapolating these findings into other locations within and outside the country. In addition, the said data was collected only within the duration of March to June 2020. The results of the study may not accurately reflect the association between the variables for the whole year. It is also worth noting that only temperature, humidity, and rainfall, as references for weather conditions, were used in the study. Several other factors, such as the demographic profile of patients, the healthcare facilities which offered their services to the affected, and the availability of test kits and testing centers, may have acted as confounding variables.

V. CONCLUSION

The NCR showed a drastic increase in COVID-19 cases while CALABARZON and Central Visayas remained flat during March to June 2020. We infer that this happened to the NCR, considering that the flow of people is high, and the area is densely populated. The association of COVID-19 cases and meteorological conditions in the three regions, based on the data in the study, showed a low significant positive correlation with minimum temperature and relative humidity in the NCR while Central Visayas exhibited a low significant positive correlation with rainfall and relative humidity. However, CALABARZON does not show a correlation between the number of COVID-19 cases and meteorological conditions. This result implies that meteorological conditions have a low significant impact on the number of COVID-19 cases, specifically in the regions of the NCR and Central Visayas. Therefore, COVID-19 cases increase when the amount of rainfall and temperature increase and appear to have a direct relationship, while relative humidity appears to have a negative relationship. Estimates of the number of COVID-19 cases in the NCR, CALABARZON, and Central Visayas will depend on the number of the previous cases and is considered one of the important predictors of COVID-19 cases. Regarding meteorological conditions, it can predict the number of COVID-19 cases that occurred in the past. It has correctly predicted historical data of the three regions by 67%, 65%, and 57% for NCR, CALABARZON and Central Visayas, respectively. The important predictors for the NCR are average temperature, rainfall amount, relative humidity, and minimum temperature. For CALABARZON, predictors are maximum temperature, minimum temperature, relative humidity, and rainfall amount, whereas for Central Visayas are rainfall amount, relative humidity, minimum temperature, and maximum temperature. This shows that weather conditions are useful to forecast trends of COVID-19 incidence.

VI. RECOMMENDATIONS

Despite its significant findings, this study has its limitations and recommendations including (1) limited areas or regions utilized in the study. It would be more comprehensive if other areas in the country with moderate to low daily recorded number of cases are included. This will provide additional insight into the influence of weather parameters on virus transmission in these areas. (2) The time frame used did not include months with the highest number of recorded cases daily. Therefore, it is recommended a longer time frame and data set will be utilized to provide a strong conclusion. (3) The significance of the coefficient is measured in the study and the presence of other inputs or causes related to weather parameters and disease mortality were not included which may possibly cause a simple problem on the relationships being estimated.

There are also other factors to be considered about viral transmissions such as virus resistance, lock-down protocols, limited testing capacities, population endurance, and population mobility. The impact of these key factors was not accounted for in this study and is suggested to be investigated. Individual health factors such as sanitation practices, hand washing habits, and personal hygiene may be explored by future studies.

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