
A Case Study on the Preliminary Impact of Enhanced Community Quarantine on the Air Quality During COVID-19 Pandemic in the National Capital Region

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ABSTRACT

Objective: COVID-19 has been one of the foci of the daily life of every human being starting in the first quarter of 2020. The implementation of enhanced community quarantine, or in some countries termed as lockdown, was one of the immediate solutions to facilitate mitigation and prevention of the disease' transmission. One of the impacts seen of ECQ is the healing of the environment. In the Philippines, particularly in the National Capital Region (NCR), initial assessment of its impact was translated into the quality of air before and into the ECQ weeks. This case study used secondary data on air population levels (PM 2.5) and NO₂ levels to present the impact of ECQ on air quality in the NCR.

Methods: The secondary data were requested from the environmental scientists from the University of the Philippines-Diliman. Limited sharing of data and the agreement with their partner organization posed a difficulty in gathering comprehensive historical data.

Results: Both the air pollution levels gathered through the air quality monitoring system and NO₂ levels through the satellite sensor gave a significant drop from two weeks prior to ECQ to two weeks into it. The 3rd week of ECQ gave variable levels both in air pollution (PM 2.5) and NO₂ levels.

Conclusion: The consequences of the implementation of enhanced community quarantine in the NCR, primarily the enforced public transportation system halt and reduced human mobility and activities, have significant impact on air quality as reflected in the reduced air pollution levels and NO₂ levels two weeks into the ECQ.

Key words: Enhanced Community Quarantine, COVID-19, air quality, air pollution, particulate matter, nitrogen dioxide level

May 9, 2020 marked the 100th day after the first confirmed COVID-19 case was announced in the Philippines. She was a 38-year old female from Wuhan. The highest level of alert was activated in the World Health Organization (WHO) headquarters in Geneva, declaring COVID-19 as a global public health emergency. As a response, the Philippine government immediately gathered a collaborative group from different sectors, to respond to the needs of

the country in relation to COVID-19. The Interagency Task Force (IATF) on Emerging Infectious Diseases came about with the Department of Health (DOH), leading it. A national effort was at the focus in mitigating the effects across areas specifically in healthcare through the concretized National Action Plan (NAP). With the announcement that COVID-19 is already a pandemic and with the rising number of cases in the National Capital Region (NCR) on March 16, 2020, the Enhanced Community Quarantine (ECQ) was implemented, extending to some areas of Luzon, and other parts of the country.¹ During this time, only essential services were opened which included hospitals, drugstores, major groceries and markets, and few others like gasoline stations and limited branches of banks and government agencies deemed

essential, while all other industries were closed. Mass gatherings were prohibited and public transportation stopped operations. Only one member per household bearing the quarantine pass was allowed to go out to do all necessary things for the family. Few weeks into ECQ, several reports and photographs came out revealing sceneries which were not evident due to poor air quality and smog in the metropolis.

Studies and reports from different countries emerged on the different environmental effects of lockdown to the environment, particularly air pollution. An unpublished case study on China by Wang et al, 2020², stated that the decline in industrial activities particularly production which significantly reduced coal consumption, as well as the limitation in urban transportation was observed. Comparing the lockdown period to the same period of 2019, there was a significant reduction in CO₂ emissions by 25% or more. The data indicated that China's reduction in CO₂ emissions was equivalent to 6% less of global emissions, that is about 1 million tons. Moreover, NO₂ levels were also collected through the Copernicus Sentinel-5P satellite of the European Space Agency (ESA). Comparing the concentration of NO₂ in North and Northeast China, which are both highly industrialized areas a week before and within the week of lockdown, national NO₂ emissions were found to be significantly lowered.

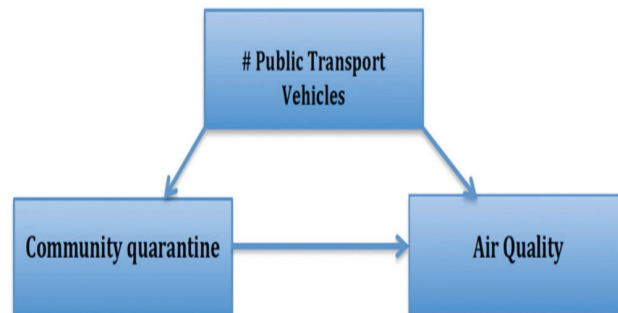
In the Philippines, particularly the NCR, data on air quality and NO₂ emissions were likewise collected. These data were used to assess the preliminary impacts of community quarantine on the environment, particularly the air quality.

The study results on air quality and particulate matters specifically NO₂ levels during the enhanced community quarantine may be used as evidence to support future guidelines in fixing the public transportation system of the country. Innovative preventive measures to control air pollution consequently reducing health risks, can be developed, which are anchored on the number of vehicles out in the streets vis-à-vis the number of people and human activities.

The objective of the study was to assess the impact of community quarantine on the air quality in NCR.

The study used only secondary data. The limited resources and historical data on air quality do not reflect the whole status of the National Capital Region (NCR). Though the Air Quality Monitoring System project has four major areas, the data collected only reflected two areas, the Quezon Ave-Lung Center of

the Philippines and EDSA-Muñoz. Another air quality measurement collected was the NO₂ level using a satellite sensor which gave a more comprehensive visual mapping. No other air pollutants measurements were gathered and used.



The above theoretical framework shows the effect of community quarantine on the environment's air quality. The primary and immediate factor which directly affects both community quarantine and air quality is the number of public transport vehicles in the streets. It directly affects community quarantine since the availability of vehicles limit the number of people going out of their homes. On the other hand, number of vehicles which use gas and/or diesel has definite direct effect on air quality particularly the level of air pollution in the metropolis.

MATERIALS AND METHODS

Study Area

The National Capital Region (NCR) is the center for finance, commerce and industry of the Philippines. The estimated population is 13.9 million. Temperatures range from 20°C to 38°C due to its proximity to the equator. It is subdivided into 17 local government units (LGUs) with 16 cities and one municipality. The cities are Caloocan, Quezon City, Las Piñas, Makati, Malabon, Manila, Mandaluyong, Marikina, Muntinlupa, Navotas, Parañaque, Pasay, Pasig, San Juan, Taguig and Valenzuela. Pateros is the only municipality. The borders of NCR are the following: on the north, the province of Bulacan; on the east, the province of Rizal; Cavite to the southwest, and on the south, the province of Laguna. Two important bodies of water are also important landmarks: the Manila Bay

to the west and Laguna de Bay to the southeast. The transportation system is directed based on extensive system of highways connecting the various cities and municipality. There are ten radial roads considered as major ones, branching out from central Manila and additional five circumferential roads forming the series of concentric semi-conductor arcs around the city. The public transportation system consists of city buses, jeepneys, express utility vans and two rapid transit systems, the Manila Light Rail Transit System, and the Manila Metro Rail Transit System.³ The study focused on areas where air quality monitoring stations are found, specifically Ayala-Makati, EDSA-Munoz, UST-España and Quezon Ave-Lung Center of the Philippines. In addition, the areas, if not whole of NCR covered by the satellite sensor Sentinel 5P TROPOMI L3 products for NO₂ level monitoring.

Data and Method of Collection

Secondary data were used and collected through both online search and directly from the UP- College of Geodetic Engineering and the Environmental Pollution Studies Laboratory through the Air Quality Monitoring System project with the Rotary Club. An email was sent to the environmental experts of the University of the Philippines. Data were shared accordingly, with the other data on air quality monitoring system only limited historical data available online.

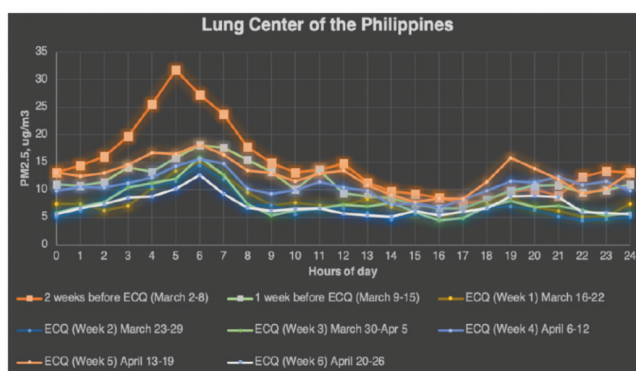
RESULTS AND DISCUSSION

Level of Air Pollution in the National Capital Region

The Air Quality Monitoring System stationed in four areas in NCR measured the air quality in the central and northern parts of the metropolis. Historical data prior and during the ECQ showed downward trend of the air pollution index both in the central (Figure 1) and the northern (Figure 2) areas.

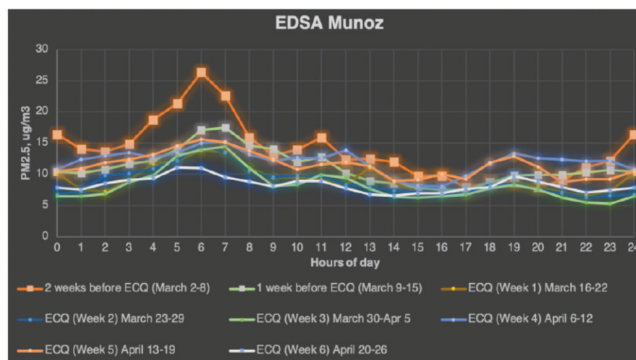
The indices were measured hourly by airtoday.ph 2 weeks prior to the implementation of the ECQ until the 6th week before transitioning to modified ECQ. According to DENR, motor vehicles are responsible for 65% of air pollution in the country and focused primarily on NCR. The quality of air is important because a report released in February 2020 by Center for Research on Energy and Clean Air (CREA) indicated that air pollution secondary to fossil fuels,

that is, coal, oil and gas, cause around 27, 000 premature deaths annually in the Philippines which is translated to an estimate of 1.9% of its Gross Domestic Product (GDP), a significant economic loss.⁴ With the forced decrease in the number of motor vehicles operating in the metropolis during ECQ, the drop in the air pollution index in the central and northern areas are enough indicators that indeed controlled number of motor vehicles operating around NCR significantly contribute to air quality. Although the drop of air pollution index was noticeable, a minimal ebb and flow of air pollution indices were observed starting from week 3 until week 6 of the ECQ, which are still below that of the recorded two weeks prior.



Adapted from the report of Cayetano M., UP-EPSTL

Figure 1. Hourly plots of PM2.5 levels in the LCP

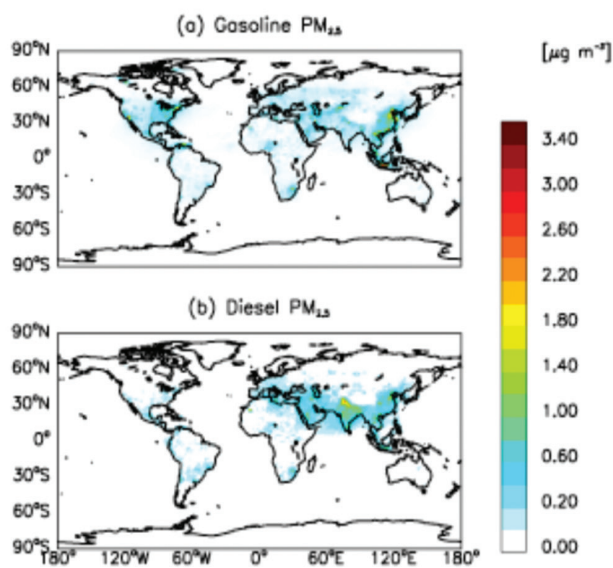


Adapted from the report of Cayetano M., UP-EPSTL

Figure 2. Hourly plots of PM2.5 levels in EDSA-Munoz

In a report done in Rio de Janeiro (2013)⁵ it was stated that the proportion of trucks and other cargo vehicles present in the streets for delivery and continuous flow of products for supermarkets, drug stores and other markets is an important consideration. These vehicles mainly powered with diesel become the main sources for particulate matters and NO₂ giving specific quality to air. Thus, with ECQ in the country being implemented, the constant presence

of delivery trucks and other private vehicles can explain the minimal ebb and flow of air pollution indices. Despite the closure of a lot of industries and significant reduction in human activities and movements, maintaining air quality remains to be an important concern during ECQ. As weeks of the ECQ matures, the number of delivery trucks, cargo vehicles and private vehicles present in the streets for purposes of product transport and for sustenance of other essential services, had gradually increased. On one hand, according to the recent LTO registered jeepneys, around 48,000 of them stopped operations. Most of these vehicles use diesel and thus significantly contributed to the shown improvement of breathing level-air quality. PM_{2.5} are minute particles suspended in air that cause untoward health risks and effects. The country's air quality monitoring system measures hourly averaged PM_{2.5}. To further illustrate how gasoline powered, and diesel powered land transportation vehicles affect the surface PM 2.5 concentration, Figure 3 shows the global annual mean surface concentration. The emissions from gasoline and diesel resulted to increases by up to 6.0 and 3.0 $\mu\text{g m}^{-3}$, respectively averaged annually-as surface PM_{2.5} concentrations. The countries which showed large increases for gasoline are China, Southeast Asia, and North America. For regions such as India, China, and the Middle East, a substantial rise in the mean surface PM 2.5 concentration for diesel is evident.⁶



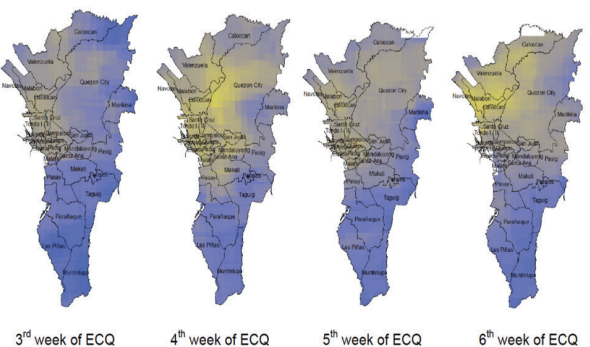
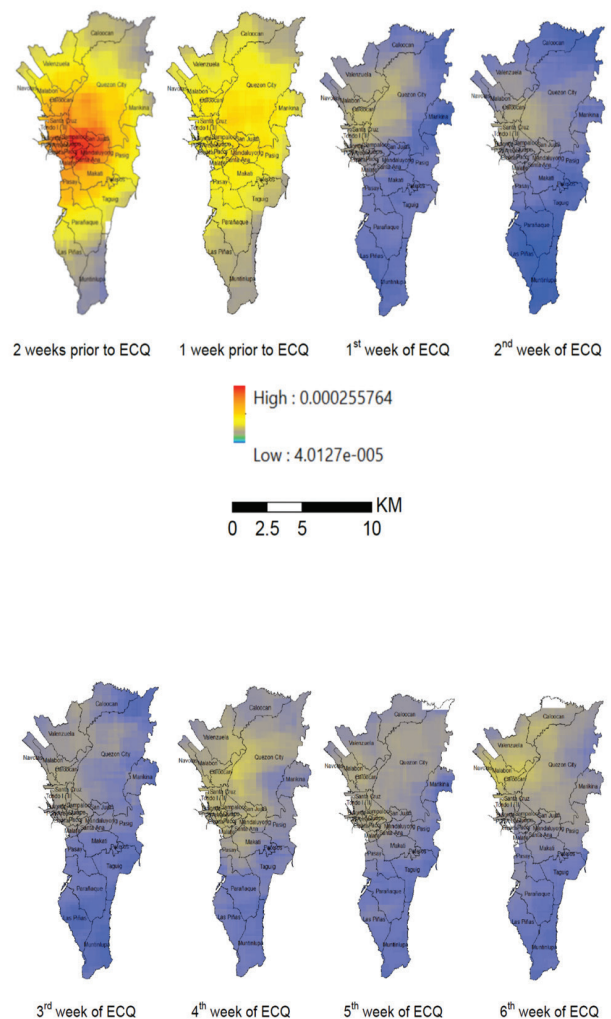
Adapted from Huang et al, 2020

Figure 3. Global annual mean surface PM_{2.5} concentrations for (a) gasoline and (b) diesel vehicle fleet emission sectors

Level of Nitrogen dioxide in the National Capital Region.

An important criteria air pollutant is nitrogen dioxide (NO₂). The formation of photochemical smog is possible because of the contributory effect of NO₂. This gives the deleterious effect to human health. NO₂ like carbon monoxide (CO) comes from common sources primarily fossil burning for fuel consumption: gas, coal and oil. About 80 % of NO₂ in cities originates from land vehicular exhaust system. The other 20% comes from petrol, manufacturing industries, metal refining, power stations using coal and food processing.⁷

The figures below show mapping of the average daily NO₂ levels as derived from satellite sensor Sentinel 5P TROPOMI L3 products two weeks before until week 6 of the ECQ in the NCR, adapted from a study done by UP College of Geodetic Engineering.



The figures indicate several findings, with weekly averages of NO₂ Total Vertical Column density for 8 weeks (2 weeks before ECQ and 6 weeks during ECQ), namely: 1) High averages of NO₂ total vertical column density significant concentrated on the central going towards the northern part of the metropolis 2 weeks prior to the implementation of the ECQ, 2) significant drop of the NO₂ average levels during the first two weeks of ECQ, and 3) variable NO₂ levels observed in the northern part of the region.

These findings resemble what were observed with air pollution level in the same period. A significant drop of pollutant indicators on the first two weeks of ECQ, with minimal variability in the levels weeks thereafter. Since NO₂ is a by-product of burning fuel, levels of which directly correlates with the number of land transportation vehicles operating on grounds.

The first two weeks of ECQ highly enforced halting all public transportation, and the stay-home scheme with only one member per household, that is limited mobility of people and significant reduction of social activities are essential factors in the resulting better air quality reflected as lowered air pollution and the NO₂ levels specifically in the central and northern parts of NCR.

In a study conducted in Almaty, Kazakhstan by Kerimray et al, assessing the impacts of traffic-free urban conditions during lockdown, carbon monoxide (CO) and NO₂ levels correlated well.⁸ The reduction by 49% for CO and 35% for NO₂ from the period prior to lockdown were substantial. Aside from the possible compounding effect of rains during some days in lockdown compared to days prior to lockdown, these findings could both be partially associated with rains and originator of such pollutant levels come from the same source, mainly land transportation vehicular system. CREA's findings post ECQ further validates that the presence of delivery trucks and diesel-powered utility vehicles account for about 82% of NO₂ emissions. The cities in NCR like Marikina, Manila and Quezon City were observed to have highest increases in air pollution levels. These cities have the most major connecting roads which are pivotal in the transportation of supplies and services during the implementation of ECQ, thus with more visible operational vehicles on grounds.

SUMMARY AND CONCLUSION

The consequences of the implementation of enhanced community quarantine in the NCR,

primarily the enforced public transportation system halted and reduced human mobility and activities, have significant impact on air quality.

This was measured as air pollution level (PM_{2.5}) and NO₂ level more apparently observed on the first two weeks. The availability of historical data from air quality monitoring system limits the observation on the central and northern areas of the metropolis. The similar trend of significant drop on the first 2 weeks of ECQ, transitioning to slight ebb and flow from 3 weeks until 6 weeks of the air pollution levels, can be associated to the presence, on a limited number, of delivery trucks and diesel-powered vehicular utility vans to maintain constant flow of supplies and other services for the whole NCR.

Similar trends have been found in other countries like China, Iran, Rio de Janeiro and Kazakhstan with case studies on the impact of lockdown on air quality. Significant drop in the level of air pollutants in cities on both partial and complete lockdown were observed, especially in areas where public transportation system was stopped, human activities and mobility reduced. The use of and the number of operational land transportation vehicles, directly contribute to the levels of NO₂ emissions and the level of air quality in almost all countries aforementioned.

RECOMMENDATIONS

The evidence collected from the air quality monitoring system and NO₂ level satellite mapping are enough for authorities and law makers to re-examine the transportation system of NCR. Combined with the evidenced based findings of health risks and pre-mature deaths from air pollution, the case study gives a preliminary guideline to facilitate planning and organizing the public transportation system. The feasibility of servicing the population of the NCR with prioritized routes and number of operational land vehicles can be facilitated based on the findings during ECQ and now, post-ECQ on air quality. Sustaining air quality beyond lockdown is still a major issue affecting the whole population both in terms of health risks and a share in the GDP.

REFERENCES

1. <https://www.who.int/philippines/news/feature-stories/detail/100-days-ofcovid-19-in-the-philippines-how-who-supported-the-philippine-response>

2. Wang Q and Su M. A preliminary assessment of the impact of COVID-19 on environment – A case study of China. *Science of the Total Environment* 2020; <https://doi.org/10.1016/j.scitotenv.2020.138915>
3. <https://www.nnc.gov.ph/2-uncategorised/244-ncr>
4. CREA. SPECIAL REPORT: Managing air quality beyond COVID-19. (2020)
5. NEI, 2014. Inventário Nacional de Emissões Atmosféricas por Veículos Automotores Rodoviários. http://www.antt.gov.br/backend/galeria/arquivos/Inventario_de_emissoes_por_veiculos_rodoviaros_2013.pdf
6. Huang Y, Unger N, Harper K & Heyes C. Global climate and human health effects of the gasoline and diesel vehicle fleets. *GeoHealth* 2020; 4(3): e2019GH000240.
7. <https://www.environment.gov.au/protection/publications/factsheetnitrogen-dioxide>
8. Kerimray A, Baimatova N, Ibragimova OP, Bukenov B, Kenessov B, Plotitsyn P & Karaca F. Assessing air quality changes in 19 large cities during COVID-19 lockdowns: The impacts of traffic-free urban conditions in Almaty, Kazakhstan. *Science of the Total Environment* 2020; 139179.