

PAPER • OPEN ACCESS

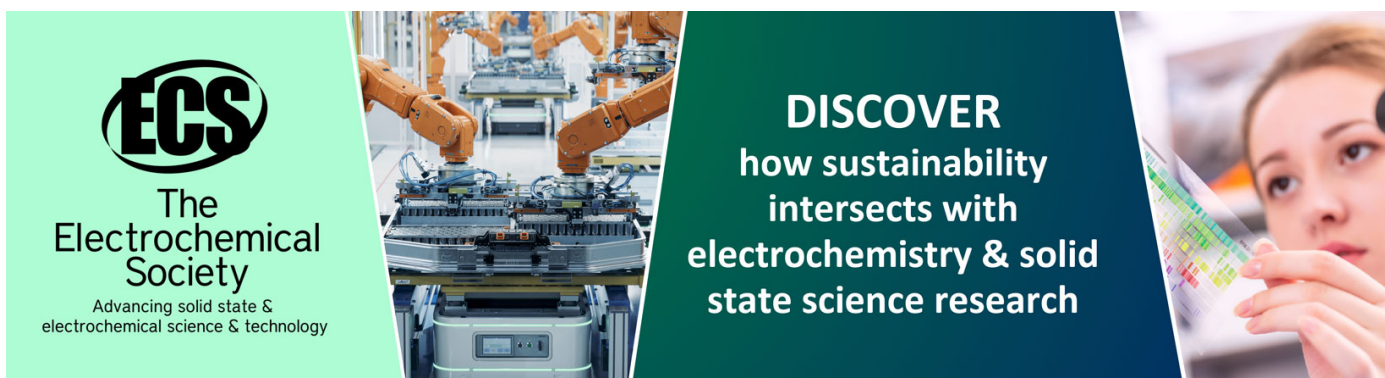
Improvement of Jakarta's air quality during large scale social restriction

To cite this article: R Rahutomo *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **729** 012132

View the [article online](#) for updates and enhancements.

You may also like

- [Rainfall modeling based on early predicted and season zone characteristic in the BMKG season zone over Lombok river basin](#)
S C Noviadi
- [Seismicity around Sunda strait and its surroundings based on hypocenter relocation using 3-D velocity: a preliminary result of relocated hypocenter database construction from the BMKG catalog](#)
M Ramdhan, Priyobudi, R Triyono et al.
- [Site characterizations of BMKG seismic network, Indonesia, based on HVSR analysis](#)
Muzli Muzli, R A P Kambali, J Nugraha et al.



ECS
The
Electrochemical
Society
Advancing solid state &
electrochemical science & technology

DISCOVER
how sustainability
intersects with
electrochemistry & solid
state science research

Improvement of Jakarta's air quality during large scale social restriction

R Rahutomo^{1,*}, K Purwandari², J W C Sigalingging³, and B Pardamean⁴

¹ Information System Department, School of Information Systems
Bina Nusantara University Jakarta, Indonesia 11480

² Computer Science Department, BINUS Graduate Program –

Master of Computer Science Program, Bina Nusantara University, Jakarta, Indonesia 11480

³ Database Center Division of BMKG, Meteorological, Climatological, and Geophysical
Agency, Jakarta, Indonesia 10720

⁴ Bioinformatics & Data Science Research Center Bina Nusantara University
Jakarta, Indonesia 11480

E-mail: reza.rahutomo@binus.edu

Abstract. After Large-Scale Social Restriction (PSBB) established in Jakarta, a change of air quality was indicated by the citizens. Representatives of Indonesia's Agency for Meteorology, Climatology, and Geophysics (BMKG) supported as the fact that mobility of Jakarta's citizen and commuters were reduced. With utilizing Weather Data Acquisition System managed by BMKG, this research compared fluctuations of Jakarta's air quality during two periods of time: Pre-PSBB and During-PSBB. This study proved that Jakarta's air quality has positively improved compared to the previous year, although in the lower range of unhealthy level.

1. Introduction

After the President of Indonesia declared Corona Virus Disease 2019 (COVID-19) outbreak has reached the country in the middle of March 2020 and Jakarta as the center of it, Large-Scale Social Restriction or *Pembatasan Sosial Berskala Besar* (PSBB) was considered effective immediately instead of lockdown [1]. Large scale social distancing which considered as partial lockdown, was chosen with consideration to minimize the damage in economy. The President believed if people complied with physical distancing during outdoor activities, the spread of COVID-19 can be minimized [2]. On April 10th 2020, as an area where the most confirmed cases and death toll occurred in Indonesia, Jakarta established PSBB as a strategy to minimize disease contamination probability.

Those who carried Work From Home (WFH) initiative during PSBB experienced positive and negative impacts. A study by Purwanto found that school teachers have several advantages such as flexible time, no commuting required, less stress due to traffic jam, and more spare time. Consequently, data security, electricity and Internet bills increased [3]. On the other side, Praptana and Riyanto also studied the impact of WFH according to State Civil Apparatus. Unlike the previous study revealing pros and cons, this study found the effectiveness of work affected by supervision whether it is conducted at the office or home [4].

Katadata.co.id reported that PSBB has changed commercial activities in Jakarta. Citizens who accustomed to meet their daily needs in shopping malls and grocery stores moved to e-commerce to



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

purchase groceries. This phenomenon affected an expedition company that operates in Jakarta named SiCepat. Summarized in the report of katadata.co.id, package delivery workload of SiCepat increased by 13% after PSBB was declared [5].

Despite many unexpected changes happening due to COVID-19 outbreak, Indonesia's Agency for Meteorology, Climatology, and Geophysics (BMKG) stated that Jakarta's air quality was improving as citizen mobility and operational of several factories reduced [6], [7]. This case becomes a motivation to have phenomenological study to describe the condition of Jakarta's air quality after the local government announced self-quarantine and restricted mobilities due to COVID-19 spread.

This study aims to prove whether the establishment of PSBB improves Jakarta's air quality. As Particulate Matter (PM) 2.5 is one of the major pollutants monitored in many air quality standards, this study also focused on the fluctuation of PM 2.5 during two periods of time: Pre-PSBB and During-PSBB. With utilizing dataset from Weather Data Acquisition System of BMKG, this study concludes the improvement of Jakarta's air quality refers to Air Quality Index from the United States Environmental Protection Agency.

2. Previous studies

Caraka et al. [8] studied rainfall pattern in the region of East Java to produce monthly analysis and predictions. With utilizing annual rainfall data in six locations in East Java during January – March 2018, this study used generalized space-time autoregressive and generated an accuracy Mean Absolute Percentage Error (MAPE) out sample amount 2.95% while Root Mean Square Error (RMSE) out sample amount 4.77. The prediction model that created at this research could facilitate Indonesia's agriculture and irrigation sectors to plan and make decisions within the next 1 to 3 months related to climatic conditions, especially rainfall.

Kusumaningtyas et al. has examined air quality of Jakarta on two periods: June 29th 2016 to July 13th 2016, and June 17th 2017 to July 1st 2017 [9]. Those periods were chosen as holiday of Ied Al Fitr or Hari Raya was celebrated. During Hari Raya celebration, Jakarta's air quality is presumably clearer since most of Jakartans are leaving the city for homecoming. The result of the examination showing on Hari Raya 2016, the amount of Particulate Matter (PM) 2.5 concentration had a tendency to increase while in the following year it was decreasing. The comparison of minimum amount of PM 2.5 on 2016 and 2017, which were quite significantly different, supported the finding for both periods. On 2016, the minimum amount of PM 2.5 is nearly 40 $\mu\text{g}/\text{m}^3$ while 2017 is less than 10 $\mu\text{g}/\text{m}^3$.

To enrich our conception of Jakarta's air quality, researchers looked after various studies with similar topic. Kusuma et al. [10] compared the air quality of Jakarta to Taipei as a fair comparison of capital cities. The research was conducted in longer coverage as from January 1st 2016 to December 31st 2018. While the amount of PM 2.5 in Taipei was practically stable throughout the years, Jakarta's amount of PM 2.5 was rising up to 50 $\mu\text{g}/\text{m}^3$ in the first six months and falling to 20 $\mu\text{g}/\text{m}^3$ in the following semester. This research summarized that the period of March to April is the time when the amount of PM 2.5 in Jakarta rises.

3. Methodology

This research analyzed data from a Weather Data Acquisition System (WDAS) managed by BMKG. As a Non-Departmental Government Institution, BMKG is responsible in regulatory tasks in the fields of Meteorology, Climatology, Air Quality and Geophysics in compliance with relevant legislation and regulations. One of the functions of BMKG is the management of air quality data through observation stations and automated equipment. BMKG managed three observation points in Jakarta, namely: Kemayoran – Central Jakarta, The United States Consulate – Central Jakarta and The United States Consulate – South Jakarta. Data set of The United States Consulate – South Jakarta is utilized in this research since the completeness and the accuracy of the records is the first priority. Compared to another observation points, data set of South Jakarta has the least missing data that leads to better accuracy. The transformation from daily time series format to weekly average is utilized for data aggregation.

The air quality parameters observed by BMKG varied. PM 2.5, PM 10, and Carbon Monoxide (CO), are the examples of the primary parameters to determine Pollutant Standards Index (PSI) based on Government Regulation of the Republic of Indonesia Number 41 of 1999 about controlling air pollution.

The parameters such as temperature, humidity, and pressure are measured by the respective sensors in WDAS to convert the records into digital form [11]. Typically, Data Acquisition Systems (abbreviated using the acronym DAS or DAQ) components covered these following points [12]:

- A. Sensors which convert parameters to electrical signals.
- B. Circuitry of signal conditioning to transform sensor signals into a shape that can be translated to digital values.
- C. Analog-to-digital converters converting to digital values driven sensor signals.

The design of weather monitoring system utilized by BMKG to record and monitor Jakarta's weather is depicted in Figure 1. The particulate sensor module and the CO gas sensor module provide input data for the microcontroller. Microcontroller as receiver and processor of data output from sensors and Real Time Clock (RTC). In addition, the microcontroller also functions to regulate and display data visualizations through LCD screens and connected personal computers. To support the performance of the system, a composition of PPD42NS dust sensor, MQ-7 gas sensor and using ATmega 328 microcontroller are utilized as a data processing center.

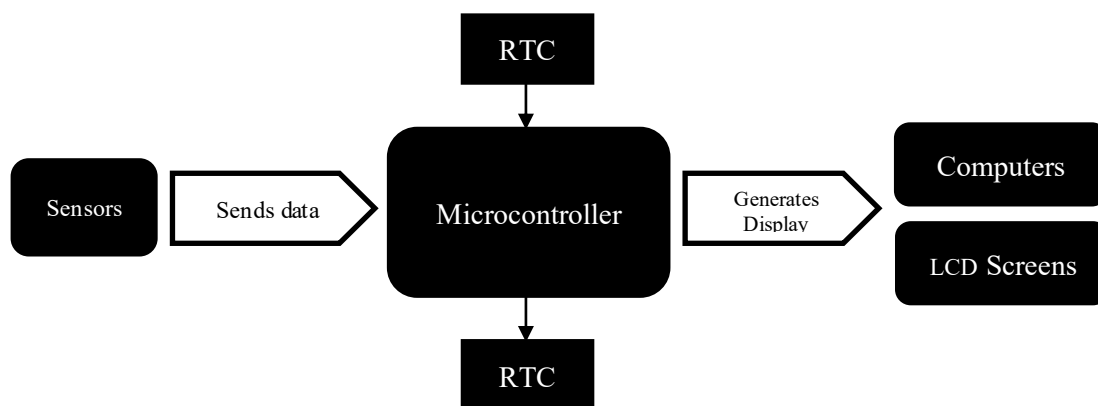


Figure 1. Air Pollution Monitoring System

The United States Environmental Protection Agency (US EPA) [13] provided Air Quality Index with the specific calculations of PM 2.5 as provided in Table 1.

Table 1. Categorizations of Air Quality Index (AQI)

AQI Category	24-hr Average PM 2.5 Concentration
Good	0 – 15.4
Moderate	15.5 – 40.4
Unhealthy for Specific Groups	40.5 – 65.4
Unhealthy	65.5 – 150.4
Very Unhealthy	150.5 – 250.4

4. Results and discussions

The researchers discussed the concentration PM 2.5 that fluctuate when an observation was conducted from June 2019 to April 2020. Figure 2 illustrates the improvement of monthly average of PM 2.5 during the observation. Overall, the air quality during January – February was better than what occurred during June – December. The amount of PM 2.5 remains constant in the range of 140 – 150 $\mu\text{g}/\text{m}^3$ during June to October 2019. The finding is contrary to the fact that the monthly average of PM 2.5 concentration never surpasses 130 $\mu\text{g}/\text{m}^3$ between January to April 2020. According to Table 1, these findings are categorized in unhealthy level.

The research followed by observing the fluctuation of PM 2.5 between January to April 2020. We separated the observation into two timeframes, namely Pre-PSBB (January – February 2020) and During-PSBB (March – April 2020).

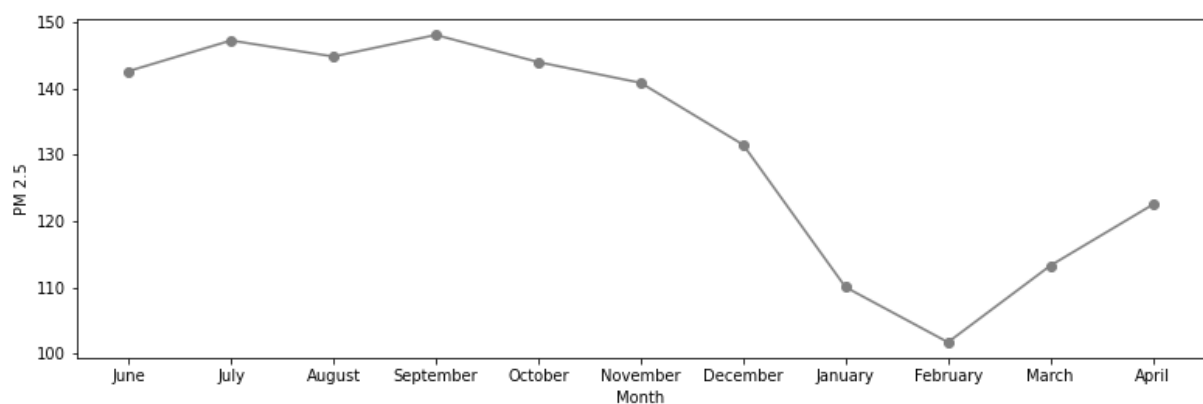


Figure 2. Jakarta's Monthly Average of PM 2.5 during June 2019 to April 2020

Figure 3 illustrated the contrast of PM 2.5 fluctuation during Pre-PSBB and During-PSBB. Even though they were measured in the same nine-week observation, different trends occurred on both curves. While the amount of PM 2.5 encounters downward trend on Pre-PSBB, the curve of During-PSBB symbolized upward trend. This summarized that the establishment of PSBB on the sixth week of During-PSBB did not deliver much impact.

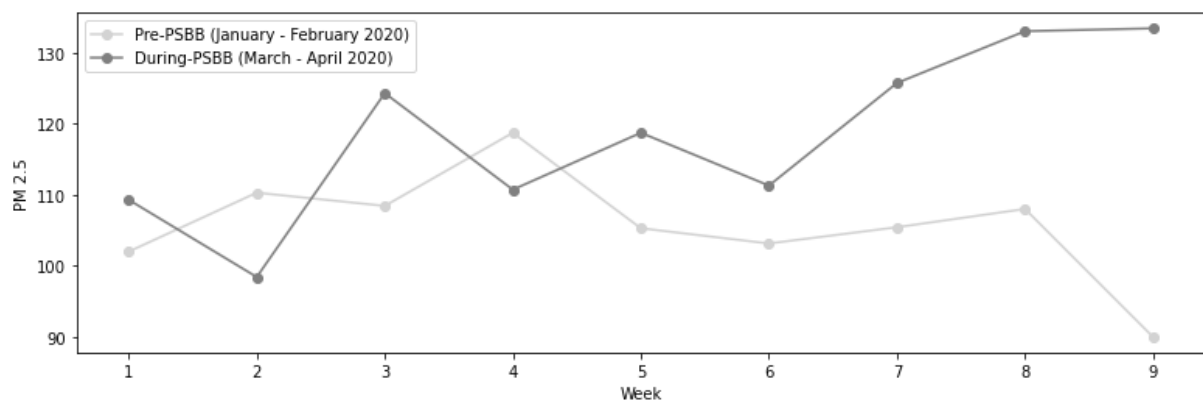


Figure 3. Jakarta's Weekly Average of PM 2.5 on Pre-PSBB and During-PSBB

4.1. Discussion

As illustrated on Figure 2, Jakarta's air quality had been consistently unhealthy level during June – December. The trend of monthly average PM 2.5 as discovered in Figure 2 signifies the actual activity in Jakarta. The air quality on Pre-PSBB that categorized in lower range of unhealthy level is suspected the beginning of economic recession and the trending news of COVID-19 outbreak on the Internet especially outside Indonesia were presumably the reasons why some people losing their enthusiasm to commute and followed by the low unhealthy level of PM 2.5. As illustrated on Figure 3, on both Pre-PSBB and During-PSBB, the air quality improved but still considered as unhealthy. As the fasting season was about to start, the desire to supply foods and daily needs had definitely increased and made PSBB ignored.

The first semester of every year in Jakarta is known as the time when the level of PM 2.5 increases [10]. Since the spread of COVID-19 forced most Jakartans to work at home and home schooling, there was less traffic jam. This phenomenon affected the air quality of Jakarta to be similar to when Jakarta residents left the city for homecoming to celebrate Hari Raya in the end of June 2017. The sudden establishment of PSBB caused the air quality fluctuation of Jakarta completely different. Therefore, this fluctuation of PM 2.5 affected the clarity of Jakarta's visibility. The better analysis could be generated if the concentration of Carbon Monoxide (CO) was provided as it correlated to PM 2.5 for air quality determination. Nevertheless, the improvement of PM 2.5 can be recognized easily since the weekly average compilation generates a comprehensive visualisation.

On the other side, BMKG-managed WDAS shows fragility in constant data recording. Compared to popular weather systems, a more intense maintenance is necessary due to lack of capacity to keep routine records can lead to significant data gaps [14]. Since some weather stations had been already equipped with external power supply such as small size battery to avoid blackouts, the utilization additional power supply could be an optimal consideration. Wireless data communication also can be a consideration for further optimization of data acquisition strategy. If data were transmitted wirelessly, adopting Artificial Neural Network for real time classification with high accuracy would be able to be realized [15], [16].

5. Conclusion

Large-Scale Social Restriction (PSBB) suddenly established a strategy to limit the spread of COVID-19 in Indonesia, especially in Jakarta. Moreover, Jakarta's air quality on Pre-PSBB (January – February 2020) and During-PSBB (March – April 2020) has improved compared to June – December 2019, even though in the lower range of unhealthy level.

References

- [1] Andriyanto H and Tambun L T 2020 Jokowi Orders "Large-Scale" Social Distancing But Still No Lockdown [Internet]. jakartaglobe.id. [cited 2020 May 5]. Available from: <https://jakartaglobe.id/news/jokowi-orders-largescale-social-distancingbut-still-no-lockdown>
- [2] Desk N. No Lockdown for Indonesia, Jokowi Insists as COVID-19 Cases Continue to Rise [Internet]. The Jakarta Post. 2020 [cited 2020 May 5]. Available from: <https://www.thejakartapost.com/news/2020/03/24/no-lockdown-for-indonesia-jokowi-insists-as-covid-19-cases-continue-to-rise.html>
- [3] Purwanto A 2020 Studi Eksplorasi Dampak Work From Home (WFH) Terhadap Kinerja Guru Selama Pandemi Covid-19. *EduPsyCouns: Journal of Education, Psychology and Counseling*. 2 no. 1 p 92–100.
- [4] Praptana A D and Riyanto S 2020 Analysis of the effectiveness of the implementation of Work from Home (WFH) for State Civil Apparatus. Retrieved from https://www.academia.edu/42809251/Analysis_of_the_Effectiveness_of_the_Implementation_of_Work_From_Home_WFH_for_State_Civil_Apparatus?auto=download
- [5] Aria P 2020 Panic buying dan ancaman virus Corona menjangkiti bisnis retail [Internet]. katadata.co.id. Available from: <https://katadata.co.id/telaah/2020/03/17/panic-buying-dan-ancaman-virus-corona-menjangkiti-bisnis-retail>

- [6] Syukra R 2020 Selama PSBB kualitas udara di Jakarta membaik. investor.id. [cited 2020 May 6]. Available from: <https://investor.id/national/selama-psbb-kualitas-udara-di-jakarta-membaik>
- [7] Supriyanto B 2020 Dampak PSBB, dinamika mobilitas warga pengaruhi kualitas udara Jakarta [Internet]. bisnis.com. [cited 2020 May 6]. Available from: <https://jakarta.bisnis.com/read/20200430/77/1235132/dampak-psbb-dinamika-mobilitas-warga-pengaruhi-kualitas-udara-jakarta>
- [8] Caraka R E, Ulhusna M, Darmawan S B, Goldameir N E, Hutapea B, Darmawan G, et al. 2019 Generalized spatio temporal autoregressive rainfall-enso pattern in East Java Indonesia. *1st 2018 Indones Assoc Pattern Recognit International Conference Ina 2018 - Proc.* p. 75–79.
- [9] Kusumaningtyas S D A, Aldrian E, Wati T, Atmoko D and Sunaryo 2018 The recent state of ambient air quality in Jakarta. *Aerosol Air Qual Res.* **18** no. 9 p 2343–2354.
- [10] Kusuma W L, Chih-Da W, Yu-Ting Z, Hapsari H H and Muhamad J L 2019 Pm2.5 pollutant in asia—a comparison of metropolis cities in indonesia and taiwan. *International Journal Environmental Research and Public Health.* **16** no. 24 p 1–12.
- [11] Kang W S, Hong S S, Han Y K, Kim K R, Kim S G and Park E W 2010 A web-based information system for plant disease forecast based on weather data at high spatial resolution. *The Plant Pathology Journal.* **26** no. 1 p 37–48.
- [12] Gosavi S K, Pathak A and Mawale P 2015 Weather data acquisition system. *International Journal for Research in Applied Science and Engineering Technology.* **3** no. 6 p 116–118.
- [13] Mintz D 2006 Guideline for reporting of daily air quality - Air Quality Index (AQI) [Internet]. Available from: <https://archive.epa.gov/ttn/ozone/web/pdf/rg701.pdf>
- [14] Colston J M, Ahmed T, Mahopo C, Kang G, Kosek M, de Sousa Junior F, et al. 2018 Evaluating meteorological data from weather stations, and from satellites and global models for a multi-site epidemiological study. *Environ Res* [Internet]. **165** p 91–109. Available from: <https://doi.org/10.1016/j.envres.2018.02.027>
- [15] Mestre G, Ruano A, Duarte H, Silva S, Khosravani H, Pesteh S, et al. 2015 An intelligent weather station. *Sensors (Switzerland).* **15** no. 12 p 31005–31022.
- [16] Rahutomo R and Gunawan F E 2018 Design deep learning neural network for structural health monitoring. *J Theor Appl Inf Technol.* **97** no. 5 p 1634–1643.