

The Effect of the COVID-19 Pandemic on Ambient Air Quality in Yogyakarta Urban Area Parameters SO₂, CO and, NO₂ with Inverse Distance Weighting (IDW)

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Preface

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PREFACE

It is my great pleasure to grace all of your presence to the 6th ICSBE 2021 virtually. The International Conference on Sustainable Built Environment is bi-annual conference started from 2010 till now. At first, the 6th ICSBE was scheduled in 2020 however, the COVID-19 pandemic altered all of our life order including this conference that have to be postponed into 2021 and conducted virtually. This conference is held for 2 days in 19 – 20 October 2021 conducted in Faculty of Civil and Planning Engineering, Universitas Islam Indonesia, Yogyakarta-Indonesia.

The main theme of the 6th ICSBE 2021 is "sustainable infrastructure and environment for the smart cities". This theme was dedicated to discuss and deliver an implementable solution to address the issues of urban planning, transport systems, water and sanitation, waste management, disaster risk reduction, access information, education, and capacity-building. Therefore, it is important to mapping, planning and designing a sustainable environment and infrastructure that may greatly encounter and reduce those issues above to reach the sustainable development goals. Based on this, this conference focuses the following topics but not limited to livable rural and urban environment, green infrastructure, sustainable resource management, sustainable city and disaster management.

In this conference, we received more than 80 papers at the beginning, which were covering in five topics. All the submitted papers were reviewed by peer to peer and double blind with two reviewers. The 6th ICSBE highly applied strong and accurate review process prior to be published in the IOP conference proceeding indexed Scopus in the series of Earth Environmental Science (EES). Finally, we are accepting 50 papers to be presented in this conference. The conference model is plenary session and parallel session which is held for 2 days. In the plenary session, there are 3 invited speakers for the 1st day and 2nd day. Each invited speakers are allowed to give presentation for 30 minutes. The question answer is given after all invited speakers finished their presentation for 40 minutes. In the parallel session, there are 5 subtopics delivered in 2 days. In the 1st day, 3 subtopics: Green Infrastructure, Sustainable Resource Management, and Sustainable City are delivered. There are 26 presenters delivered their paper. In the 2nd day, 2 subtopics: Disaster Management, and Livable Rural and Urban Environment, are delivered. There 24 presenters delivered their paper. Each presenters have 12 minutes to give presentation and 3 minutes for question and answer. All the conference presentation is delivered by using zoom technology belongs to Universitas Islam Indonesia with 1000 capacity of participants. This conference is participated by audience from Indonesia, Turkey, Japan, USA, Malaysia, and Germany.

The 6th ICSBE 2021 is organized by the faculty of Civil Engineering and Planning, Universitas Islam Indonesia and supported by partner universities; Gifu University (Japan), University of Malaya (Malaysia), University of Rhode Island (USA), National Cheng Kung University (Taiwan), University of Boras (Sweden), University Hawaii at Manoa (USA), Hokkaido University (Japan), Alanya Alaaddin Kaykubat University (Turkey), Behaus-Universitaet Weimar (Germany), National University of Singapore (Singapore), and other international institutes,



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Last but not least, I would express our sincere gratitude to the keynote speaker: The Governor of Jakarta, Anies Rasyid Baswedan, Ph.D, to the invited speakers Prof. Nobouto Nojima, Prof. Noor Choliz Idham, Prof. Frank Eckardt, Asso. Prof. Anita Petterson, Assoc. Prof. Anita Pettersson, and Prof. NG How Yong, and as well as all participants for joining and sharing of idea, knowledge, and friendship in a relaxing environment. And, the most important, I would to sincere and great appreciation to the organizing committee, editors, scientific committee, and reviewers for all their solidity, harmony, and synergy work. We do hope all participants are going to enjoy the conference in terms of both its academic and social atmosphere.

Dr. Joni Aldilla Fajri, ST., M. Eng.

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The Effect of the COVID-19 Pandemic on Ambient Air Quality in Yogyakarta Urban Area Parameters SO₂, CO and, NO₂ with Inverse Distance Weighting (IDW)

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Abstract. In early March 2020, a pandemic disrupted human activities, especially in the Yogyakarta Urban Area. The area is experiencing development or becoming a tourist center in the Province of the Special Region of Yogyakarta. With these developments, this study would carry out data processing related to air quality, remove it comparing the concentration of SO₂, CO, and NO₂ parameters before the pandemic in 2019 and after the pandemic in 2020. The results of this study are that the ambient air quality in urban areas Yogyakarta tends to experience a decline and the monitoring locations are located around industries and major road junctions. So, the mapping of ambient air quality itself can facilitate visualization research.

1. Introduction

The world is being troubled by the Covid-19 pandemic. Since the first case appeared in Wuhan City, Hubei Province, China until now, positive cases Covid-19 worldwide based on WHO data as of May 10, 2020, the number almost 4 million people, with the death toll of more than 275,000 people spread over 245 countries, including Indonesia [1]. There was a pandemic with a limitation related to activities carried out by humans [2]. Almost all people in the world carry out activities by switching to remote work, restricting travel so that there is an observation related to air quality [3]. The relations between COVID 19 and air pollution are observed at this time because after observing the air looks clean [4]. The Covid-19 pandemic emerged as a significant and extraordinary factor affecting air quality during 2020, namely the consumption of fossil fuels experienced a significant reduction in air pollution, namely in 2019 by 84% while in 2020 as much as 65% so that there was a recovery in concentration conditions air [5]. According to data from the Ministry of Environment and Forestry (KLHK) in Indonesia, there is a decrease in air pollution from 2019 until 2020 and Indonesia has around 26 air quality monitoring stations. The station that has been operated can monitor air quality in the form of concentration parameters PM_{2.5}, PM₁₀, NO₂, SO₂, CO, HC, O₃, and meteorological parameters such as wind direction and speed, solar radiation, temperature, air pressure, humidity, and rainfall. The air pollutant concentration data is then informed to the public in the form of the Air Quality Index (AQI) to describe the ambient air quality conditions at the location, especially related to air pollution. Air pollution can be a serious problem on earth because air pollution is one of the causes of global warming, leading to climate change [6]. The condition of the earth that is starting to become unhealthy due to human



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activities has a very bad impact on the survival of life now and in the future. World Health Organization (WHO) data as quoted from Greenpeace Indonesia shows that nine out of 10 people in the world breathe air containing high pollutants [7]. That high air pollution also becomes a fourth leading cause of premature death in the world [7].

The study location was in the Province of the Special Region of Yogyakarta, but the location is a reference in the urban area of Yogyakarta which consists of several areas in Yogyakarta City, Bantul Regency, and Sleman Regency. The area has pollution of ambient air quality that is triggered by population, especially population density and increased transportation. There were 52.5% cases of pneumonia and Acute Respiratory Infection (ARI) cases, which increased by 28.66% from 2018 [8]. Therefore, a technology regarding spatial analysis with digital mapping modeling through Geographic Information Systems (GIS) aims to determine the distribution pattern of ambient air quality in 2019-2020 to compare air quality conditions, especially at concentrations of SO₂, CO, and NO₂ before the occurrence. a Covid-19 pandemic and during the Covid-19 pandemic in the Urban Area of the Special Region of Yogyakarta in the form of a distribution map by modeling using *Inverse Distance Weighting* (IDW).

2. Materials ad methods

2.1. Material tools

There are tools and data used to process data, namely hardware tools are consisting of Processor Intel (R) Core (TM) i3-6006U CPU @ 2.00 GHz, 4.0 GB RAM System. Type 64-bit Operating System, x64-based processor, and software consisting of ArcGIS Software version 10.6, SAS Planet, Google Earth Pro, Microsoft Word, Microsoft Excel. The data used in this study is the InaGeoportal spatial analysis map database with a scale of 1:25,000 and the Digital Elevation Model (DEM) SRTM 30.

2.2. Data Analysis Stages

This research was conducted in 2019-2020 using the KLH Yogyakarta Special Region database. The analysis was carried out using the parameters SO₂, CO and, NO₂. This study uses a qualitative descriptive and spatial analysis. This approach is an approach by identifying cases by available information [9]. After that, the data was processed using Inverse Distance Weighting (IDW). IDW is a deterministic method that is carried out simply and with consideration of the surrounding points [10]. This study uses secondary data from the Environmental Agency of Yogyakarta Province Report 2019 and 2020. The next step is inputting coordinate data using Microsoft Excel and adding data to ArcGIS version 10.6 software. Then do the mapping using the Inverse Distance Weighting (IDW) method. The mapping focuses to visualize air quality conditions in 2019 and 2020. After that, there is an analysis related to wind speed from 2019 and 2020. The data can be analyzed using the WRPLOT software. Wind speed data were obtained from the Indonesian Agency for Meteorological, Climatological, and Geophysics in 2019 and 2020.

2.3. Research Sites

Research locations on ambient air quality monitoring in the Yogyakarta Urban Area are in 2019 and 2020, with 174 points spread over 23 sub-districts and located in 72 villages. The monitoring locations are spread across the City of Yogyakarta, parts of the Sleman Regency, and the Bantul Regency. The following is the distribution of the location points used in the study and plotting of the area is carried

out using Indonesian Rupa Bumi (RBI) with a scale of 1:25,000. The following (Figure 1.) is the research location.

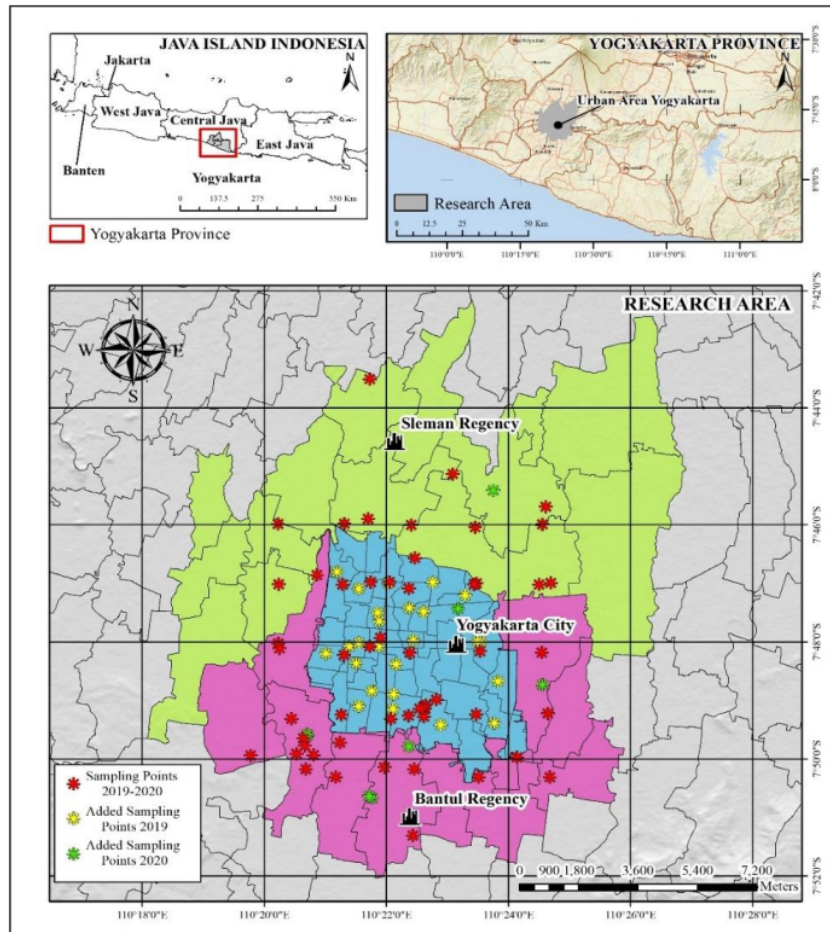


Figure 1. Air Quality Location Mapping in the Yogyakarta Urban Area in 2019 and 2020.

There are differences in the number of monitoring points each year. Namely, in 2019 there were 83 location points and in 2020, there were 91 location points. The following (Table 1.) are the location points used in the study in the Yogyakarta Urban Area.

Table 1. Air quality monitoring point

No.	Year	City/Regency	Number of Measurement Points	Total Number of Measurement Points
1	2019	Part of Sleman Regency	14	83
		Part of Bantul Regency	19	
		Yogyakarta City	50	
2	2020	Part of Sleman Regency	15	91
		Part of Bantul Regency	25	
		Yogyakarta City	51	

3. Results and discussions

3.1. Research result Windrose

The wind has a major role in pollutant dispersion. These polluting particles will move towards the direction of the moving wind. The strength of the wind also affects the speed at which pollutants spread from their source. The variations in wind speed that occur can be seen in Figure 2. The minimum wind speed occurs with a value of 2.13 m/s in 2019 and the maximum wind speed occurs with a value of 2.27 m/s in 2020. From (Figure 2.) it can be seen that the direction of the dominant wind at the confluence from South to North with 40% of frequency in 2019 and 32% in 2020. The distribution direction of SO₂, CO, and NO₂ pollutant emissions shows the connection between wind direction characteristics and pollutant radiation. Strong wind movement can mix the air pollutants and causes the pollutant concentration to be small, whereas if the wind movement is weak then the turbulence will be weak as well and the pollutant concentration will be high.

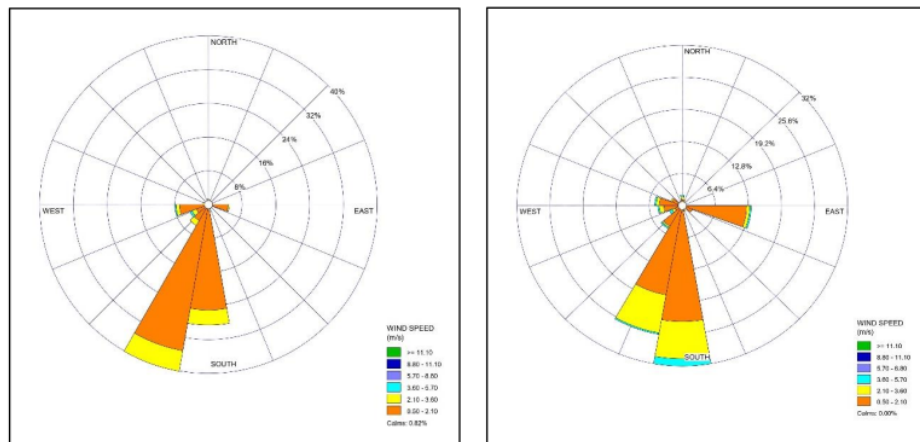


Figure 2. Windrose in the Yogyakarta Urban Area in 2019 (left) and 2020 (right)

3.2. Research result SO₂ Parameters

The result of the 2019 SO₂ monitoring, has a minimum value of 0.1 μm^3 and a maximum value is 93.3 μm^3 . The result of SO₂ monitoring in 2020 is that it has a minimum value of 0.1 μm^3 and the highest concentration is 105.5 μm^3 . Locations that have values above the quality standard are almost on average located in industrial areas. The release of SO₂ gas was caused by burning which contains sulfur so that when people burn waste it will trigger the emergence of SO₂, it is usually found around landfills [11]. The following (Figure 3.) is the result of IDW mapping with SO₂ parameters.

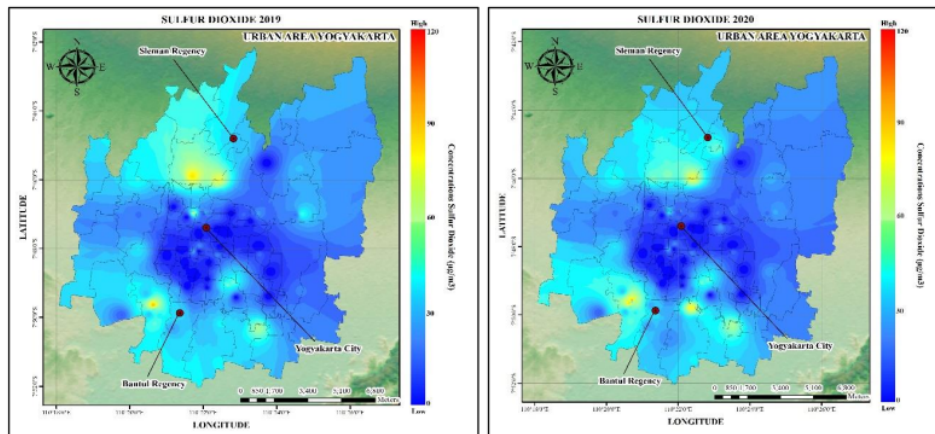


Figure 3. Mapping on Ambient Air Quality Distribution SO₂ Parameters in the Yogyakarta Urban Area in 2019 (left) and 2020 (right)

3.3 Research result CO Parameters

The results of CO monitoring in 2019 have a minimum value of 0.3 μm^3 and have the maximum value is 5545.7 μm^3 in red in the mapping. In addition, CO monitoring in 2020 has a minimum value of 0.3 μm^3 and have a maximum value is 3010.8 μm^3 . The Center for Clean Energy and Air Research (CREA) noted that, from February 3 to March 1, CO₂ emissions fell by at least 25 percent, after the enactment of Covid-19 related policies [12]. This condition indicates that the air quality is below the quality standard so that it is green in the mapping. The location where the ambient air quality value is almost close to the quality standard occurs because it coincides with a terminal and is close to the flyover. Parameter CO levels in urban areas are quite varied and influenced by several community activities, especially in motorized vehicles. The increasing number of vehicles causes an increase in the need for fuel oil (BBM), especially gasoline and diesel fuel. The combustion process that occurs imperfectly can cause high gas emissions. The following (Figure 4.) is the result of mapping IDW with Parameter CO.

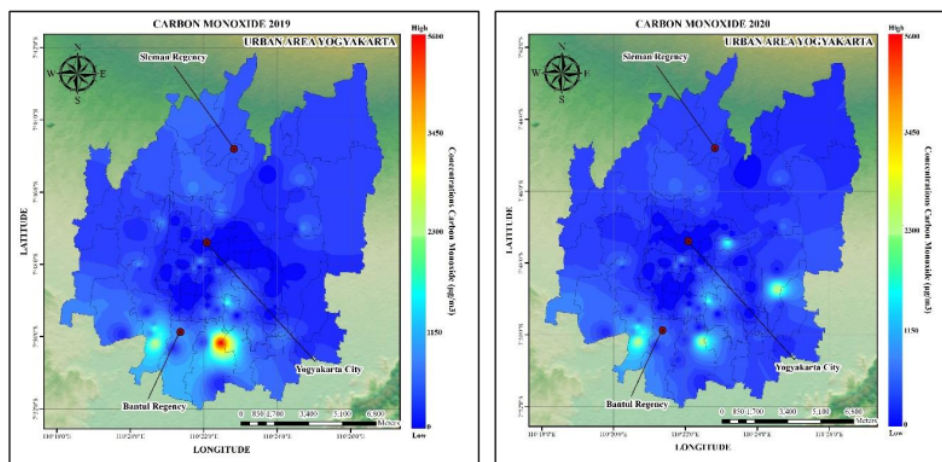


Figure 4. Mapping on Ambient Air Quality Distribution SO₂ Parameters in the Yogyakarta Urban Area in 2019 (left) and 2020 (right)

3.4 Research result NO₂ Parameters

The results of NO₂ monitoring in 2019 had a minimum value of 0.2 µ/m³ so that it was green while the maximum value was 87.9 µ/m³ with red in the mapping. The results of NO₂ monitoring in 2020 have a minimum value of 0.2 µ/m³ while the maximum value is 90.7 µ/m³. The high level of NO₂ is due to the location of this research point coincides with the trading centers and souvenirs, which are located in front of the Janti shopping centers which are adjacent to the Gedongkuning Flyover three intersection. The number of vehicles affects the amount of NO₂ concentration because the emissions released by vehicles are the primary source, the more the number of vehicles, the NO₂ levels will increase. The negative impacts on human health such as respiratory problems, decreased visibility and can cause death if exposed to NO₂ in the long term [13]. Satellite images from the European Space Agency (ESA) show reduced levels of nitrogen dioxide, a by-product of fossil-fuel burning which leads to problems with the respiratory [14]. The following (Figure 5.) is the result of mapping IDW with Parameter NO₂.

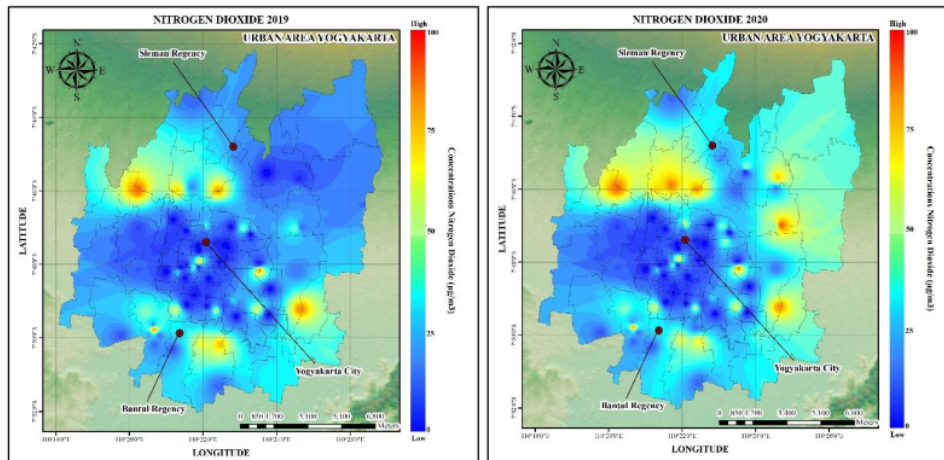


Figure 5. Mapping on Ambient Air Quality Distribution NO₂ Parameters in the Yogyakarta Urban Area in 2019 (left) and 2020 (right)

3.5 Research result Mapping Conditions

Discussion results were obtained on the parameters used in the study, namely SO₂, CO, and NO₂. The condition of the SO₂ parameter in 2019 before it affected the COVID-19 pandemic had a lower value than 2020, the increase was around 13%. As for the CO and NO₂ parameters, the results decreased from 2019 to 2020. This situation occurred due to the reduction in motorized vehicles due to restrictions on activities for people in the urban area of Yogyakarta. Almost all people carry out activities with a remote system and work from home. The sharp decline in offline human activities positively impacts the ecology, making it more natural and healthier [15]. Air pollution is reduced because of the large number of quarantines, and people are more active at home (work from home) so that the air quality in several countries improves [16]. Countries affected by Covid-19 are struggling to find ways to break the chain of transmission. Among them are implementing the policy of working from home (work from home), maintaining social distance (social distancing), maintaining physical distance (physical distancing), staying away from crowds, and various other health protocols [16]. The following can be seen in (Figure 6.) which is an overlay mapping of these parameters used in the study.

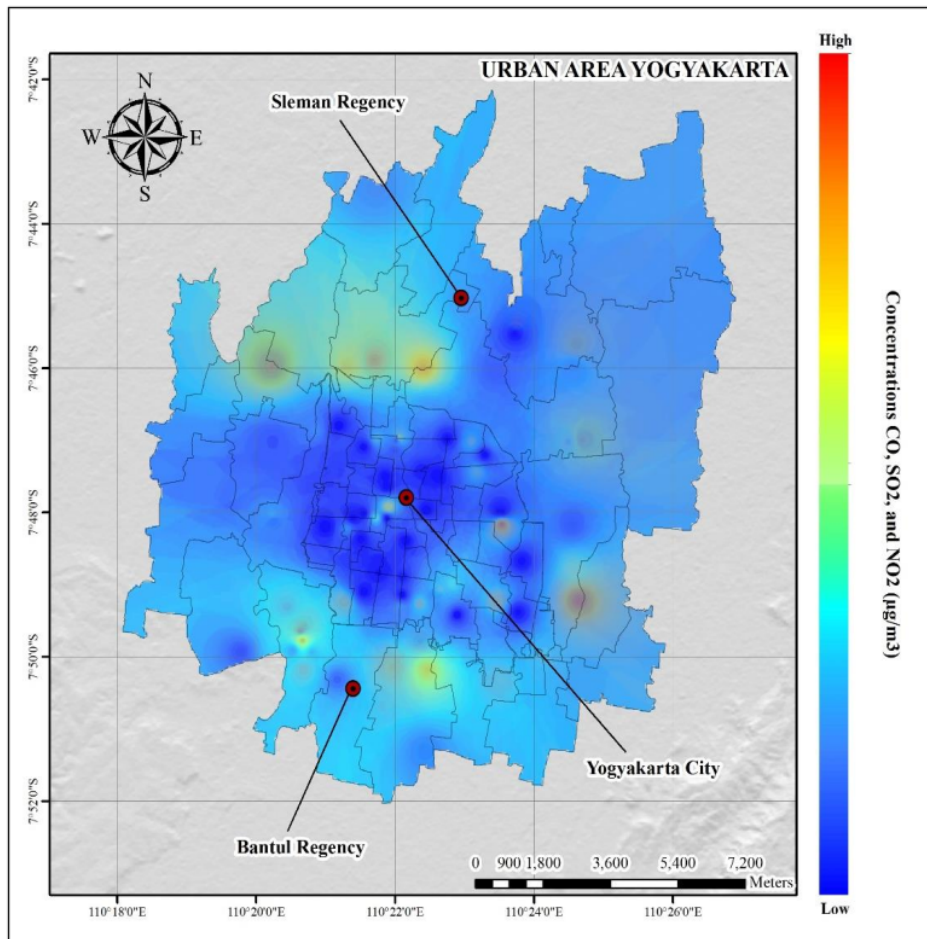


Figure 6. Ambient Air Quality Overlay Mapping SO₂, CO, and NO₂ Parameters.

Road segment performance is measured based on the volume per capacity that occurs as a comparison of the traffic volume and the capacity of the road segment. The analytical method used is the Indonesian Road Capacity Manual for the Transportation of Yogyakarta Province Report 2021. Traffic performance is used as an indicator of the level of road service of a particular road segment. The level of road service is used as a measure of the level of congestion and traffic density on certain roads. The following presents the performance of roads in 2020 in the Yogyakarta urban roads and their agglomerations. The following (Figure 7.) represents the ratio of vehicles in 2019 and 2020. It can be seen that in Sleman Regency, Yogyakarta City, and Bantul Regency there is a decrease in the ratio of traffic to road capacity. This indicates that there is a decrease in pollutants so that the COVID-19 pandemic in 2020 can reduce the number of vehicles so that concentration conditions decrease.

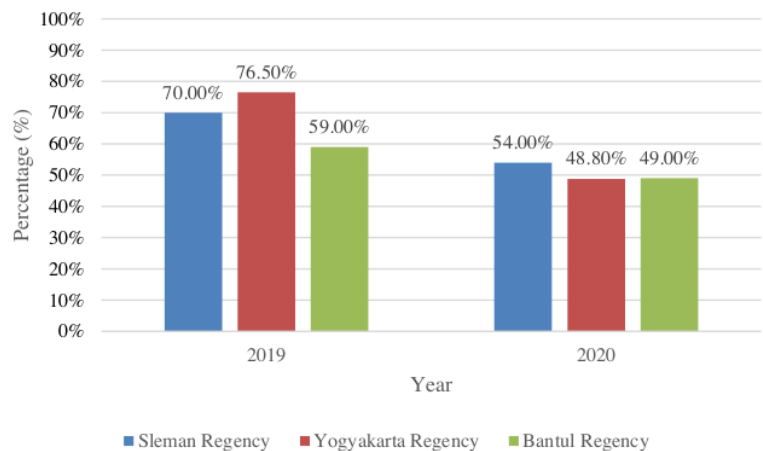


Figure 7. The ratio of Traffic Volume and Road Capacity in the Yogyakarta Urban Area [17]

According to the Transportation of Yogyakarta Province Report 2021, the number of passengers for land transportation types such as buses and other public transportation in 2019 had 5,282,737 passengers, while in 2020 it had 2,776,667 passengers. so that it can be seen the decline in passengers that occurred in 2019 and 2020. This indicates that the work from home makes people reduce travel and minimize pollutants caused by the number of vehicles operating. So that the form of mapping of SO₂, CO, and NO₂ pollutants will decrease in 2020. The following can be seen in (Figure 8.) which is a decrease in total passengers in the Yogyakarta Urban Area.

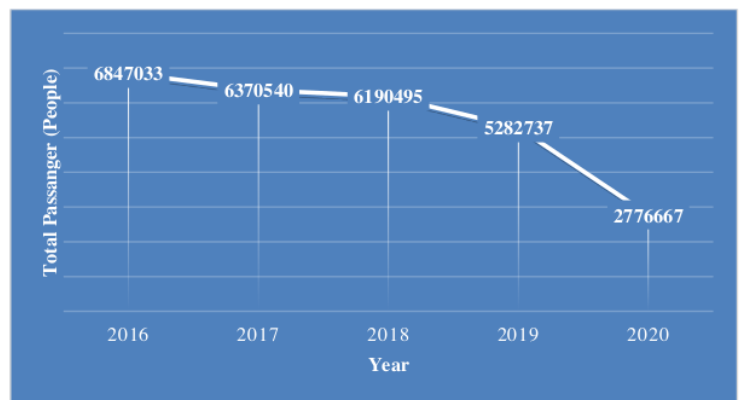


Figure 8. Total Passenger in the Yogyakarta Urban Area [17]

4. Conclusion

The distribution pattern of the 2019-2020 ambient air quality mapping with SO₂, CO, and NO₂ parameters tends to decrease so that the air quality improves. However, several monitoring points in the sow parameter have increased but are still within the allowable level. Decreasing air quality and

improving air conditions due to the COVID-19 pandemic in 2020 so that people reduce activities outside the home and switch to working remotely so that they are limited to doing activities.

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The Effect of the COVID-19 Pandemic on Ambient Air Quality in Yogyakarta Urban Area Parameters SO₂, CO and, NO₂ with Inverse Distance Weighting (IDW)

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