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Covid-19 is impact to air quality transformation based on Landsat: a case from Makassar City, Indonesia

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Abstract. Makassar is city center in Eastern Indonesia, so that many sectors such as industry, services, settlements, education, trade, and transportation are developing rapidly. These various activities produce exhaust emissions, such as SO_2 (Sulfur Dioxide) and NOx (Nitrogen Oxide), which can be bad for health. Landsat is a measuring tool used to monitor air quality in a large area. The research objective was to measure changes in SO_2 and NOx using Landsat 8 OLI in Makassar City before covid (October 2019) and during covid (during PSBB/June 2020 and after PSBB/October 2020). Kruskal Test is used to analyze transformation difference significantly on SO_2 and NOx before the covid pandemic and during a covid pandemic. The result shows that SO_2 is higher before covid. That is 220 ppm in October 2019. While covid, it is 42 ppm on June 2020 and 98 ppm on October 2020. The same thing happened to NOx. NOx is higher before covid that is 177 μ/m^3. But while covid, it is decreased. That is 173 μ/m^3 in June 2020 and 175 μ/m^3 in October 2020. Kruskal Test shows a significant difference between SO_2 and NOx before and during a covid pandemic.

1. Introduction

CoronaVirus (Covid 19) has caused a global pandemic that spreads rapidly, so that whole countries introduce various types of preventing this virus. Some of them are restrictions on activities outside the home. This limitation of activities outside the house is an attraction for environmentalists to measure pollutants, especially in urban areas. Based on air quality measurements that have been carried out in 12 cities across the globe, among others, Kuala Lumpur, Paris, Wuhan, Milan, London, California, Baghdad and Dhaka have shown a decrease concentration of air pollutants, including PM2.5, PM10, NO_2, SO_2, and O_3 during covid[1-4].

Makassar City is one of the cities in Indonesia, which is the center in Eastern Indonesia, so that Makassar is growing rapidly in many sectors such as industry, services, education, trade, and transportation. These various activities can produce exhaust emissions, including PM_{10}, CO, SO_2, NOx, and O_3[5,6]. These pollutants can be bad for health [7]. Some papers write about pollutants in Makassar, showing CO pollutants in the dangerous category, namely 454.02 $\mu g/m^3$ [8]. In addition, CO measurements have been carried out around electric steam power plant Tello, which shows that CO concentrations during the day are higher (9.5 $\mu g/m^3$) than at night (5.3 $\mu g /m^3$) [9].

Landsat 8 is one of the satellite images used to measure pollutants [10-12]. This is because Landsat can monitor over a wide area coverage and at affordable costs[13]. The research that has been done by

[10] shows Landsat 8 can estimate transformation PM_{10}, CO, SO_2, NOx from 2004 to 2019 around the Cirebon electric steam power plant (PLTU). In this study, we measured SO_2 and NOx over Makassar City using Landsat 8 OLI. Speaking about preventing Covid, Indonesia Government is running a program. It is called large-scale restrictions or PSBB. PSBB is the Indonesian government's effort to prevent the transmission of Covid 19 by limiting activities outside the home. Furthermore, this paper explains covid's impact on air quality of SO_2 and NOx. The air quality algorithm is used to measure SO_2 and NOx transformation. Kruskal Test is used to analyze if there are transformation differences significantly on SO_2 and NOx before covid, during PSBB, and after PSBB.

2. Methodology

This research is located in Makassar City with administrative boundaries. Landsat 8 OLI imagery observed were 1st June 2020 (during PSBB), 23th October 2020 (after PSBB), and 21st October 2019 (before covid). In this study, the air quality parameters analyzed are SO2 and NOx.

2.1. Image pre-processing

Before applying the air pollutant algorithm, each Landsat band (which in this case is band 10) must go through a correction phase such as geometric, atmospheric, and radiometric. The geometric correction by selecting the original image map projection is converted from the original image coordinate system to the map coordinate system. The following is the radiometric correction step:

1. Change the digital number (DN) value in band 10 to Top of Atmospheric Spectral Radiance (TOA Radiance). The formulas are taken from the USGS web page[14]:

$$L = M_L \times Qcal + A_L \quad (1)$$

where L_λ = TOA spectral radiance (Watts / (m^2sradμm)); M_L = Band-specific multiplicative rescaling factor from the metadata (RADIANCE_MULT_BAND_x, where x is the band number); A_L= Band-specific additive rescaling factor from the metadata (RADIANCE_ADD_BAND_x, where x is the band number); Q_{cal} = Quantized and calibrated standard product pixel values (DN)

2. Conversion TOA Radiance to Brightness Temperature[14,15]:

$$BT = \frac{K_2}{\ln\left(\frac{K_1}{L\lambda}+1\right)} - 273{,}15 \quad (2)$$

where BT = Brightness temperature (celcius); L_λ = TOA spectral radiance; K_1 = Band-specific thermal conversion constant from the metadata (K1_CONSTANT_BAND_x, where x is the thermal band number); K_2= Band-specific thermal conversion constant from the metadata (K2_CONSTANT_BAND_x, where x is the thermal band number)

Conversion BT to Land Surface Temperature[16]:

$$LST = \frac{BT}{1+\frac{WL \times BT}{c} \times \ln\ln(e)} \quad (3)$$

where LST = Land surface temperature (celcius); BT = Brightness temperature; WL = Wavelength of emmited radiance for band 10, which 10.60 μM; c = coefficient, which 1.4388 × 10-2; e = surface emission, which 0.9575.

2.2. Data analysis

The SO2 and NOx algorithms calculation uses a calculation formula involving band 10, where band 10 produces LST. The following algorithm is:

$$SO_2 = (0.0117 \times LST^3) - (0.3282 \times LST^2) + (2.837 \times LST) - 6.4733 \quad (4)$$

$$NOx = 163.88 + 0.3908 \times LST \quad (5)$$

After getting the values of SO_2 and NOx, a quantitative approach is carried out to calculate changes in air quality before covid and during covid, namely the Kruskal Test. We choose this test because the image values consisted of thousands of points, making it difficult to enter them into SPSS. Therefore, the image values are divided into five classes, so that the data type, which is initially interval, changes to ordinal/non-parametric. The Kruskal Test is a non-parametric test that is used for more than two independent variables.

3. Results and discussion

LST processing using Landsat 8 OLI imagery in October 2019, June 2020, and October 2020 show that the smallest LST is less than 20^{0}C and the highest LST is more than 35^{0}C. From three months, October 2019 (before covid) is the month with the highest LST, namely from 25^{0}C to 47^{0}C compared to June 2020 during PSBB (17^{0}C -29^{0}C) and October 2020/after PSBB (19^{0}C - 35^{0}C). LST decreased by 13^{0}C during PSBB and increased by 4^{0}C after PSBB. In Figure 1, the highest LST distribution is in the westernmost and easternmost parts. This distribution follows landuse character or topography. The highest LST values are in built-up land, while the low LST values are in vegetation and wetland. LST before covid (October 2019) is around 37^{0}C in settlement and industrial areas. During PSBB (June 2020), LST is drop become 26^{0}C for settlement area and around 23^{0}C for industrial areas. Then LST increased After PSBB (October 2020). It is around 30^{0}C for settlement areas and the industrial area is around 32^{0}C.

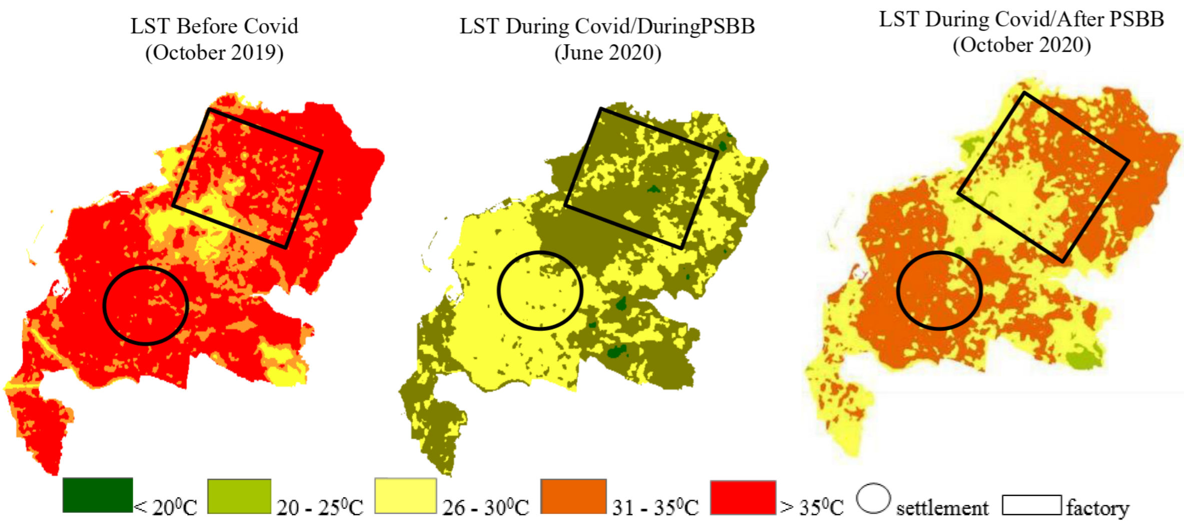

Figure 1. Land surface temperature.

Table 1. Polutant concentration and Kruskal-Wallis test.

Pollutant	Minimum	Maximum	Mean	Standard Deviation	P-Value
SO_2 Before covid (ppm)	48	623	220	66	.000
SO_2 During PSBB (ppm)	6	95	42	13	.000
SO_2 After PSBB (ppm)	11	202	98	28	.000
NOx Before Covid (μ/m^3)	173	182	177	1.14	.000
NOx During PSBB (μ/m^3)	170	175	173	0.62	.000
NOx After PSBB (μ/m^3)	171	177	175	0.82	.000

Data processing results show NOx is not more than 182 μ/m^3 and less than 170 μ/m^3. From three months, October 2019 (before covid) is the month with the highest NOx, starting from 173 μ/m^3 to 182 μ/m^3 compared on June 2020/during PSBB is lowest (170 μ/m^3 - 175 μ/m^3) and on October 2020/after PSBB (171 μ/m^3 - 177 μ/m^3). NOx decreased significantly since PSBB implementation, namely 4 μ/m^3 with a p-value of 0.000 (see table 1). Then NOx increased 2 μ/m^3 after four months since PSBB was not running again or since October 2020. That means NOx maybe increase rapidly in the future and has the same value as NOx in October 2019 after 4 months. The same thing happened to SO_2, which there is a significant difference in SO_2 before covid and during covid (p-value 0.000). The highest SO_2 value occurred in October 2019/before covid compared to during covid. The difference in these values is 178 ppm during PSBB and 122 ppm after PSBB (see table 1). The difference in value between during PSBB and after PSBB is 56 ppm. That means after 4 months, SO_2 may increase 56 ppm. A decrease in pollutants has also occurred in other countries since Covid. Such as, In Kazakhstan, a reduction of NO_2 (35%) [19] was found and in Barcelona and Madrid, NO concentrations were reduced 62% significantly [20]. Move to the west part, In US, NO_2 declined around 25.5% during the COVID-19 pandemic as compared to 2017–2019 levels [21].

The threshold value for NO_2 and NOx are 200 μ/m^3 (1 hour average) or 40 μ/m^3 (1 year average), while SO_2 is 350 μ/m^3 (1 hour) or 125 μ/m^3 (1 day) [22]. Based on estimates, it shows that the NOx value before covid or during covid is normal. That is under 200 μ/m^3 (1 hour average). Unlike the case with SO_2, which is above the threshold, more than 200 ppm before covid and after PSBB. During PSBB, SO_2 is normal cause under 95 ppm.

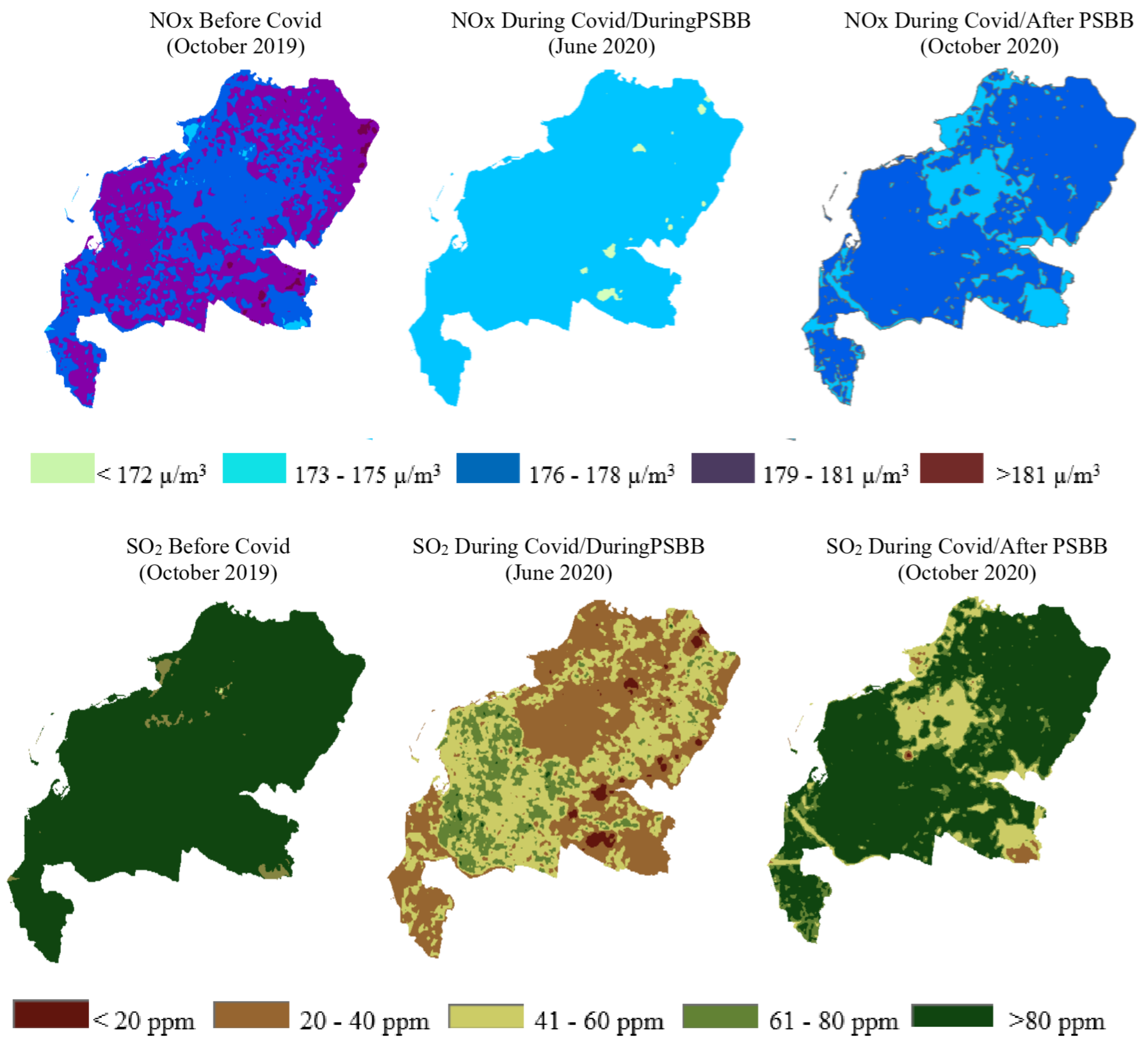

Figure 2. NOx and SO_2 transformation dynamic.

Figure 2 shows that the distribution of the highest NOx values (176 µg/m³ -178 µg/m³) and the highest SO_2 (> 80ppm) are in residential and industrial areas. This explains that the sources of NOx and SO_2 come from residential and industrial areas. Nitrogen oxides (NOx) are primarily emitted as NO from combustion sources vehicle exhausts, industries, power plants, residential heating and are converted to NO_2 after fast oxidation processes, which is recognized as a tracer of anthropogenic combustion activities and precursor of nitrate aerosol and ozone). As a major pollutant, NOx can cause respiratory diseases, asthma, and cellular inflammation and is considered highly lethal to human health and harmful for the total environment by forming nitric acid (HNO_3) and acid rain.

4. Conclusion

Based on the spatial distribution of NOx and SO_2 concentration values, NOx and SO2 decreased during covid (during PSBB or after PSBB). NOx decrease as much as 4 µg/m³ and 178 ppm for SO_2. Although there is a decrease, NOx and SO_2 experienced an increase after PSBB as much as 2 µg/m³ for NOx and 56 ppm for SO_2. Decreased concentration occurs significantly based on the Kruskal Test. Residential and industrial are areas that affect this significant decline NOx and SO_2.

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References

[1] Espejo W, Celis J E, Chiang G and Bahamonde P 2020 *Sci. Total Environ.* **747** 141314
[2] Rahman M S, Azad M A K, Hasanuzzaman M, Salam R, Islam A R M T, Rahman M M and Hoque M M M 2021 *Sci. Total Environ.* **762** 143161
[3] Mohammed B, Al-naseri S K, Al-maliki A and Al-ansari N 2021 *Sci. Total Environ.* **754** 141978
[4] Cristina M, Rose C De, Abbà A, Baldi M, Bertanza G, Pedrazzani R, Sorlini S and Carnevale M 2021 *Process Safety and Environmental Protection* **146** 952–60
[5] Li B, Shi X, Liu Y, Lu L, Wang G, Thapa S, Sun X, Fu D, Wang K and Qi H 2020 *Environ. Pollut. J.* **267**
[6] Selokar A, Ramachandran B, Elangovan K N and Dattatreya B 2020 *Mater. Today Proc.* **33** 4566-72
[7] Barnett-Itzhaki Z and Levi A 2021 *Environ. Res.* 110723
[8] Utama D A 2019 *J. Nas. Ilmu Kesehat.* **2** 9–20
[9] Aslim M A F ., Ihsan N and Yani A 2019 *Jurnal Sains dan Pendidik. Fis.* **15** 36–44
[10] Dede M, Widiawaty M A, Nurhanifah, Ismail A, Artati A R P, Ati A and Ramadhan Y R 2020 *Jambura Geosci.* **2** 78–87
[11] Omari K, Abuelgasim A and Alhebsi K 2019 *Pollut. Res.* **10** 1075–83
[12] Hernawati R and Darmawan S 2020 *IOP Conf. Ser. Earth Environ. Sci.*
[13] Muhtar G A and Purwandhi I 2019 *J. Azimut* **2** 95–106
[14] USGS 2013 *Using United States Geol. Surv. Landsat 8 Prod.*
[15] Avdan U and Jovanovska G 2016 *J. Sens.* 1–8
[16] Cheval S, Popa A, Șandric I, Iojă I, Coandă H and Force A 2020 *Urban Clim.* **34** 100696
[17] Hasan G, Al-Kubaisy M A, Nahhas F H, Ali A A, Othman N and Hason M M 2014 *J. Civ. Environ. Engin* **4**
[18] Alseroury F A 2015 *Int. J. Mech. Prod. Eng.* **3** 17–21
[19] Kerimray A, Baimatova N, Ibragimova O P, Bukenov B, Kenessov B, Plotitsyn P and Karaca F 2020 *Sci. Total Environ.* **730** 139179
[20] Baldasano J M 2020 *Sci. Total Environ.* **741** 140353
[21] Berman J D and Ebisu K 2020 *Sci. Total Environ.* **739** 139864
[22] European Environment Agency 2018 *Air quality in Europe — 2018 report* (Luxembourg)