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Original Research Article

Mapping Air Pollution and Respiratory Health: A GEE-Based Study on CO and NO_2 Exposure and ARI Incidence

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ABSTRACT

Banjarmasin, a city in South Kalimantan, faced significant challenges in 2024 due to the dual impacts of El Niño and traditional land-clearing activities, leading to widespread forest and land fires. These fires emit harmful air pollutants, notably carbon monoxide (CO) and nitrogen dioxide (NO2), thereby increasing the risk of Acute Respiratory Infections (ARI) among the population. This study was conducted to analyze the correlation between the concentration of these air pollutants and the incidence of ARI in Banjarmasin throughout 2024. Employing a retrospective research method, data on ARI cases were sourced from the Banjarmasin City Health Office. CO and NO_2 concentrations were analyzed using the Google Earth Engine (GEE) with Sentinel-5P satellite imagery and subsequently visualized using ArcGIS. The linear regression test revealed that CO levels showed no significant association with ARI incidence ($p = 0.552$), accounting for only 22.69% of the variance. Similarly, NO_2 levels were not significantly linked to ARI rates ($p = 0.1163$), accounting for only 3.65%. The findings suggest that, despite the presence of air pollutants from land fires, CO and NO_2 have only a weak influence on the incidence of ARI in Banjarmasin.

Keywords: Acute Respiratory Infections; CO Level; NO_2 Level; Google earth Engine; Land Fire

INTRODUCTION

Banjarmasin is one of the cities in South Kalimantan that in 2024 was affected by El Niño and the phenomenon of traditional land clearing activities (Amri et al., 2024). This results in a prolonged dry season, causing widespread forest and land fires. These fires emit air pollutants, including PM2.5 and PM10 particles, as well as harmful gases such as carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and tropospheric ozone (O_3) (Maharani et al., 2021).

Another significant factor contributing to air pollution is the notable increase in the number of motorized vehicles, especially motorcycles and cars. Areas with heavy traffic and commercial activity, household combustion and street vendor operations notably elevated the concentration of nitrogen-based pollutants in the urban areas of Banjarmasin, have been identified as regions with heightened levels of carbon monoxide (CO) and nitrogen dioxide (NO_2) (Lestari & Salim, 2023). These air pollutants are easily inhaled into the deepest respiratory tract and circulate into the blood, increasing the risk of eye and throat irritation, asthma attacks to cardiovascular disorders, and acute respiratory infections (ARI) (Maharani, 2025).

Many studies mention that air pollutants affect the risk of ARI. Research by Song, et al (2023) noted that an increase of 1 mg/m³ CO can increase 41.3% of lower respiratory tract infections and 13.5% of influenza pneumonia. In addition, the study also mentioned that CO levels with <1 mg/m³ already have a negative effect. Meanwhile Perez, et al (2008) explained that NO_2 pollutants significantly increase the risk of ARI-related hospital visits in the elderly. Research by Chen, et al (2022) states that NO_2 pollutants play a role in increasing the risk of asthma and ARI.

Carbon monoxide (CO) produced from fires can bind strongly to hemoglobin in the blood

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and carboxyhemoglobin (COHb) which inhibits the binding and transportation of oxygen to body tissues. The inhibition causes hypoxia in the airways and lungs, leading to damage to airway epithelial cells (Aoki et al., 2023). The damage results in a decrease in the mucociliary ability to clear microorganisms or foreign particles. This decrease has an impact on the occurrence of infection. (Becker et al., 2024)

Meanwhile, nitrogen dioxide (NO_2) is irritative and oxidative to lung tissue. NO_2 can penetrate the lower airway, causing inflammation and damage to bronchial epithelial tissue and alveolus (Xu et al., 2024). This mechanism creates ideal conditions for pathogens to enter and trigger respiratory infections. NO_2 can also promote an exaggerated immune response (bronchial hyperresponse), exacerbating ARI symptoms such as cough, shortness of breath and asthma (Croft et al., 2021; Husna et al., 2022). An increase in NO_2 concentration in ambient air increases the incidence of ARI by 1.5-fold, especially in areas with poor air quality due to forest fires (Liu et al., 2023).

Research by Togatorop, et al (2023) explains that NO_2 and CO levels in the air can be determined with the Google Earth Engine (GEE) platform using Sentinel 5p satellite imagery. The study states that Sentinel-5P TROPOMI Image Processing with GEE cloud-computing for carbon monoxide (CO) nitrogen dioxide (NO2) data extraction shows the effect of the implementation of the First Total PSBB policy on the density of CO and NO2 gas emissions in DKI Jakarta.

Hartanto et al (2023) also mentioned that monitoring NO2 levels in Kalimantan Island can use Sentinel 5p satellite imagery. The results of the study also concluded that NO2 levels in South Kalimantan province always had the highest NO2 levels compared to other provinces of South Kalimantan since 2019-2023. However, the study has not explained the relationship between pollutant levels and ARI occurrence. Therefore, this study will analyze the relationship between CO and NO_2 levels with the incidence of ARI in Banjarmasin in 2024.

METHOD

The research employs an analytical observational approach, utilizing a retrospective cohort study design in conjunction with survey research methods. This design focuses on observing events to identify factors related to their causes (Budiarto, 2004). Data collection for this study was carried out from January to December 2024 in Banjarmasin City. The study location was determined using the Global Positioning System (GPS) and supported by a topographic map. Air pollutant data was gathered through the Google Earth Engine (GEE), a cloud computing platform that facilitates the analysis and visualization of GeoBigData. Satellite imagery for this study was obtained from the Sentinel-5P satellite. Additionally, data on ARI cases were sourced from secondary data provided by the Provincial Health Office of South Kalimantan.

This study employs satellite data from NASA's Sentinel-5P mission to assess CO and NO_2 pollutants. Launched by the European Space Agency (ESA) in 2017, Sentinel-5P is equipped with the TROPOMI (Tropospheric Monitoring Instrument), which gathers essential data for monitoring atmospheric pollutants. The collected data is accessible in real time and can be utilized with JavaScript. Subsequently, the data was visualized using ArcGIS. The relationship between CO and NO_2 levels and the incidence of ARI was examined through linear regression techniques. When a notable correlation was identified, multiple linear regression analysis was conducted. All statistical analyses were conducted on a web-based platform accessible at https://stats.blue/index.html.

RESULTS AND DISCUSSION

Based on the GEE data obtained, the CO content data is presented in Figure 1.

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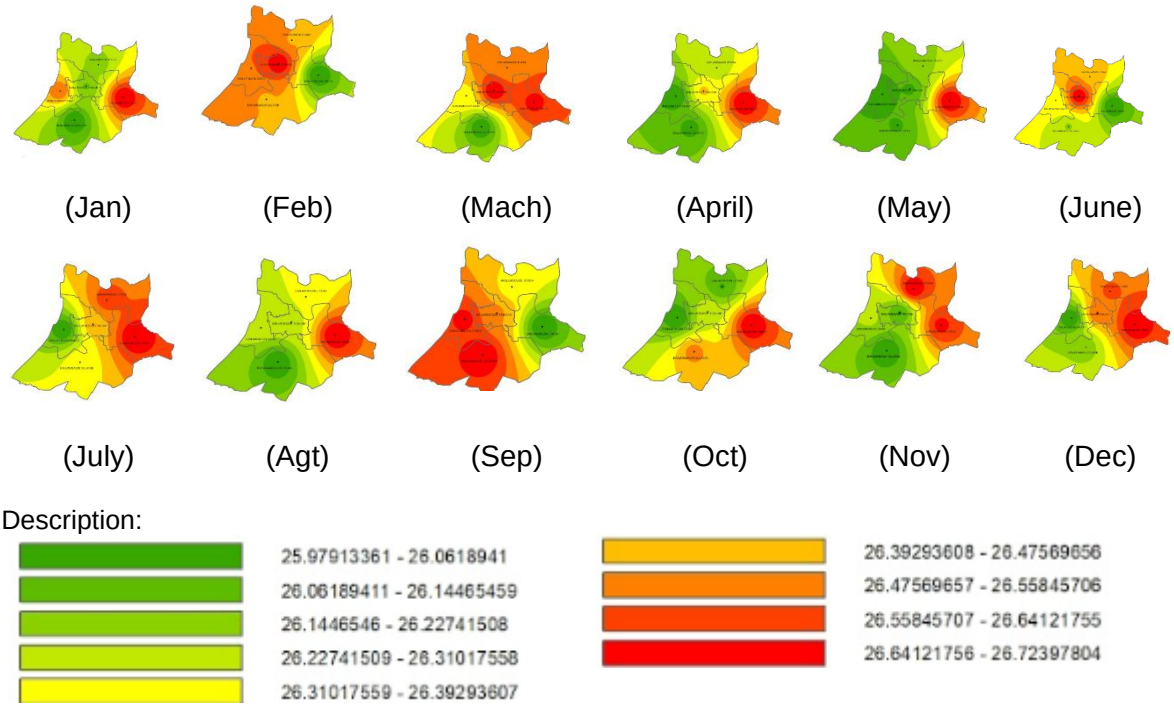

Figure 1. Distribution of CO pollutants in Banjarmasin in 2024

In addition to CO levels, NO_2 levels in Banjarmasin were also determined using the GEE platform as shown in Figure 2.

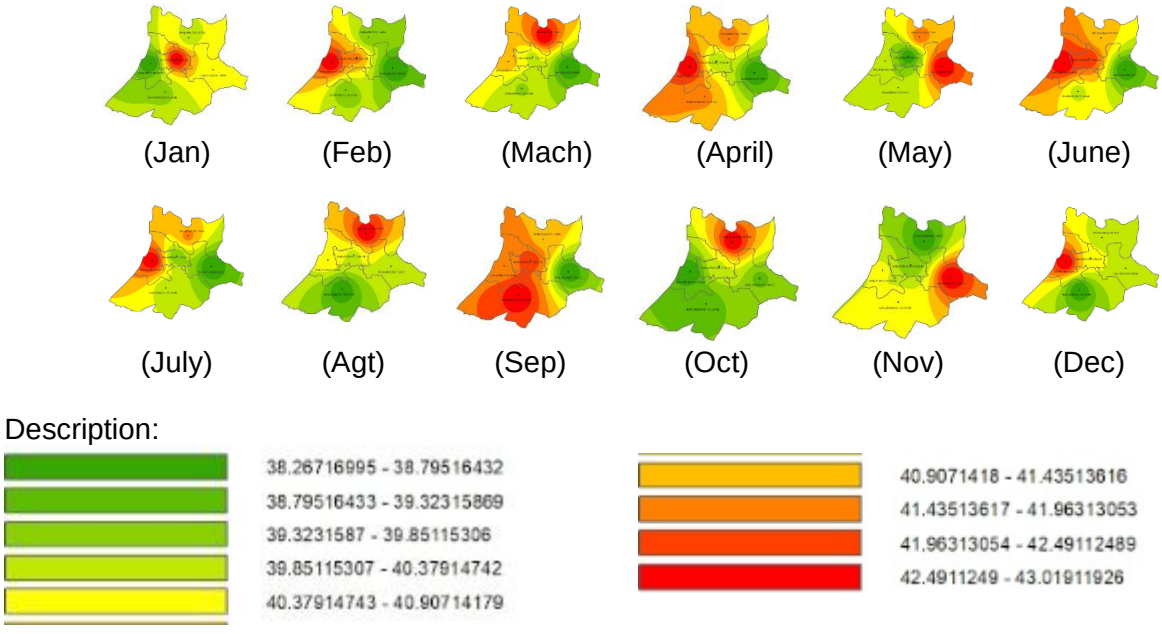

Figure 2. Distribution of NO_2 pollutants in Banjarmasin in 2024

In Figures 1 and 2, above-average CO and NO2 are shown in pink to red. In February and

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March, there was a shift from West Banjarmasin to North Banjarmasin. This is due to land fires in South Banjarmasin District on February 20, 2024 and North Banjarmasin District on March 24, 2024. Meanwhile, fires also occurred in North and South Banjarmasin in July and September 2024 (Hartanto et al., 2024). Apart from forest fires, South Banjarmasin is also an industrial area that also produces CO pollutants, while North Banjarmasin is a densely populated area (Putera et al., 2024).

However, linear regression test results showed that CO levels were not significantly associated with ARI incidence (p=0.552; p>0.05). The relationship between ARI incidence and CO levels is shown in Figure 3.

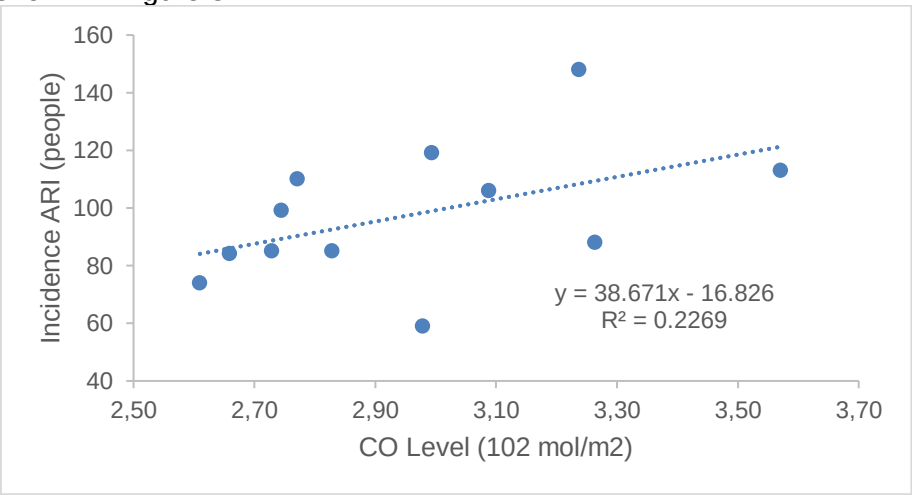

Figure 3. Relationship between ARI incidence and CO levels

Figure 2 shows that the value of R2 = 0.2269, which means that CO levels only contribute 22.69% in causing ARI. Meanwhile, 77.31% is caused by other factors not examined in this study.

In addition to CO levels, the relationship between NO2 levels and ARI incidence is presented in Figure 4. The results of the linear regression test in the figure show that NO2 levels are not significantly associated with ARI incidence (p=0.1163; p>0.05).

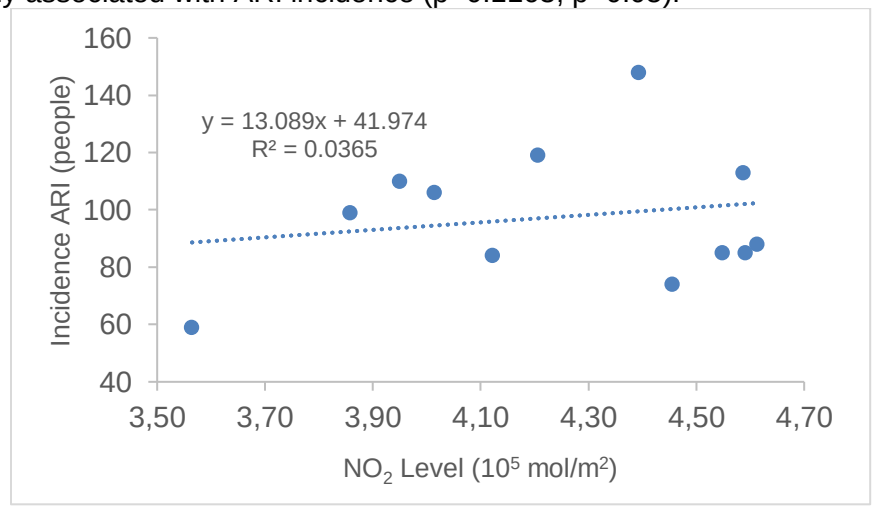

Figure 4. Relationship between ARI incidence and NO_2 levels

Figure 3 shows that the value of R2 = 0.0365, which means that NO2 levels only contribute 3.65% in causing ARI. Meanwhile, 96.35% is caused by other factors not examined in this study.

In this study, CO and NO_2 levels had a weak relationship with the incidence of ARI/ Many factors that cause ARI besides CO levels include environmental conditions, such as damp houses, poor ventilation, and high occupancy density. Humid homes, minimal sunlight, and lack of ventilation create ideal conditions for the growth of microorganisms such as bacteria, viruses, and fungi that can attack the respiratory tract (Aristatia, 2021; Falah et al., 2023). Poorly circulated air also causes a buildup of dust indoors, which can irritate the airways, especially in children and the elderly. In densely populated areas, interactions between individuals accelerate the transmission of viruses that cause ARI, especially if one family member is already experiencing symptoms such as cough or runny nose (Gusti et al., 2025).

Parental smoking, especially in the house or near the child, is also one of the main risk factors for ARI in children under five. Cigarette smoke contains more than 7,000 chemicals, including fine particles (PM2.5), carbon and other toxic compounds such as formaldehyde and benzene (Jamal et al., 2022). When parents smoke around toddlers, cigarette smoke will be inhaled directly by the child (passive smoking) or stick to the surface of objects such as clothes, sofas, and walls (third-hand smoke), then enter the child's body through breathing or skin contact (Sari et al., 2021; Prasetyoko et al., 2022).

The results of the study are in accordance with Hidayat et al (2024) which states that the incidence of ARI in Kendari is associated with SO2 pollutant levels. Meanwhile, NO2 and SO2 levels are not associated with the incidence of ARI. In addition, research by Azhari, et al (2022) also stated that NO_2 and CO levels were not associated with the incidence of ARI in toddlers in Cilegon city.

Although the levels of No2 and CO were not significant, there was an increasing trend of pollutant levels associated with ARI. Thus, prevention efforts are needed with the behaviour or culture of wearing masks as personal protective equipment.

CONCLUSION

Based on the results of the study, the spread of NO_2 and CO in Banjarmasin is caused by various factors such as forest and land fires and due to human activities, namely industrial areas and population density. Meanwhile, NO_2 and CO pollutant levels have a weak relationship with the incidence of ARI in Banjarmasin. CO levels contribute 22.69% in causing ARI, while NO2 levels only contribute 3.65%.

REFERENCES

Amri, A., Akhirman, A., Rizki, C., Harianja, L. M., Prameswari, N., Vauzia, V., & Putri, W. N. (2024). Dampak bencana kebakaran hutan terhadap lingkungan dan upaya penanggulangan di Indonesia. Jurnal Riset Tindakan Indonesia, 9(2), 159-166.

Aoki, Y., Walker, N. M., Misumi, K., Mimura, T., Vittal, R., McLinden, A. P., & Lama, V. N. (2023). The mitigating effect of exogenous carbon monoxide on chronic allograft rejection and fibrosis post-lung transplantation. The Journal of Heart and Lung Transplantation, 42(3), 317-326.

Aristatia, N., & Yulyani, V. (2021). Analisis Faktor-Faktor Yang Berhubungan Dengan Kejadian Infeksi Saluran Pernafasan Akut (Ispa) Pada Balita Di Puskesmas Panjang Kota Bandar Lampung Tahun 2021. Indonesian Journal of Health and Medical, 1(4), 508-535.

Azhari, M., Nurjazuli, N., & Darundiati, Y. H. (2022). Hubungan Kadar Pencemaran SO2 Dan NO2 Dengan Incidence Rate ISPA Pada Balita Di Kota Cilegon Tahun 2018-2020. Jurnal Keselamatan Kesehatan Kerja dan Lingkungan, 3(1), 22-29.

Becker, M. E., Martin-Sancho, L., Simons, L. M., McRaven, M. D., Chanda, S. K., Hultquist, J. F., & Hope, T. J. (2024). Live imaging of airway epithelium reveals that mucociliary clearance modulates SARS-CoV-2 spread. Nature communications, 15(1), 9480.

Chen, Z., Liu, N., Tang, H., Gao, X., Zhang, Y., Kan, H., Deng, F., Zhao, B., Zeng, X., Sun, Y., Qian, H., Liu, W., Mo, J., Zheng, X., Huang, C., Sun, C., & Zhao, Z. (2022). Health effects of exposure to sulfur dioxide, nitrogen dioxide, ozone, and carbon monoxide between 1980 and 2019: A systematic review and meta-analysis. Indoor air, 32(11), e13170.

Croft, D. P., Burton, D. S., Nagel, D. J., Bhattacharya, S., Falsey, A. R., Georas, S. N., & McCall, M. N. (2021). The effect of air pollution on the transcriptomics of the immune response to respiratory infection. Scientific Reports, 11(1), 19436.

Falah, M., Lismayanti, L., Sari, N. P., Handayani, H., & Fadhilah, N. (2023). Lingkungan Fisik Rumah Penderita Infeksi Saluran Pernafasan Akut (ISPA) di Kota Tasikmalaya. JI-KES (Jurnal Ilmu Kesehatan), 6(2), 122-128.

Gusti, A., Iqbal, W., & Afifah, F. (2025). Komponen Fisik Rumah yang Berhubungan dengan Kejadian Infeksi Saluran Pernafasan Akut pada Nelayan. Jurnal Keselamatan Kesehatan Kerja dan Lingkungan, 6(1), 10-18.

Hartanto, N., Mauliya, D. J., Al fath'qi, R. R., Julpa, I. S., Fariz, T. R., Haris, A., & Jabbar, A. (2024). Kajian Konsentrasi Nitrogen Dioxide (NO2) dan Sulphur Dioxide (SO2) Di Pulau Kalimantan Menggunakan Google Earth Engine. Envirotek: Jurnal Ilmiah Teknik Lingkungan, 16(1). 48-52

Hidayat, M. T., Jayadipraja, E. A., Asrullah, M., & Astawa, K. W. (2024). Time Trend Analysis of Ambient Air Quality and Increased ISPA in Kendari City. Miracle Journal of Public Health, 7(1), 53-65.

Husna, S., Sakdiah, S., Idayati, R., Safri, M., & Mulia, V. D. (2022). Hubungan Sumber Polutan dalam Rumah dengan Kejadian ISPA pada Balita di Puskesmas Lubuk Sanai, Mukomuko, Bengkulu. Jurnal Kedokteran Nanggroe Medika, 5(1), 1-10.

Indriyaningtyas, S., Hasandy, L. R., & Dewantoro, B. E. B. (2021). Dinamika Konsentrasi Emisi Gas Karbon Monoksida (CO) Selama Periode Psbb Menggunakan Komputasi Berbasis Cloud Pada Google Earth Engine. Majalah Ilmiah Globe, 23(1), 35-42.

Jamal, S., Hengky, H. K., & Patintingan, A. (2022). Pengaruh Paparan Asap Rokok Dengan Kejadian Penyakit Ispa Pada Balita di puskesmas Lompoe Kota Parepare. Jurnal Ilmiah Manusia Dan Kesehatan, 5(1), 494-502.

Lestari, N., & Salim, A. (2023). Spatial analysis of nitrogen dioxide pollution in urban markets of Banjarmasin. Diversity: Journal of Environmental Health, 5(2), 110–120. https://journal3.uin-alauddin.ac.id/index.php/diversity/article/view/26084

Liu, C., Chen, R., Lei, J., Zhu, Y., Zhou, L., Meng, X., & Kan, H. (2023). Ambient Nitrogen Dioxide and Hospitalizations of Full-Spectrum Respiratory Diseases: A National Case-Crossover Study. Environment & Health, 1(2), 130-138.

Maharani, D., Azra, D. A., Aprilia, S., Ziqma, U., & Pontoh, R. S. (2021). Pengaruh Luas Kebakaran Hutan dan Lahan Terhadap Tingkat Pencemar Udara PM10. Jurnal Ekologi, Masyarakat Dan Sains, 2(2), 60-65.

Maharani, S. (2025). Analisis Dampak Pencemaran Udara terhadap Kesehatan Pernapasan Masyarakat Perkotaan. Journal of Medical and Health Sciences, 1(1), 10-15.

Perez, L., Tobias, A., Querol, X., Künzli, N., Pey, J., Alastuey, A., & Sunyer, J. (2008). Coarse particles from Saharan dust and daily mortality. Epidemiology, 19(6), 800-807

Prasetyo, A. P., & Syafei, A. D. (2022). Kajian Konsentrasi NO2, O3 Dan PM10 Di Udara Terhadap Kejadian Penyakit ISPA Pneumonia Dan Non-Pneumonia Di Wonorejo, Surabaya Dan Sekitarnya. Jurnal Purifikasi, 21(2), 80-92.

Putera, G. M. P., Suhartrono, E., Prihatini, N. S., Adhani, R., & Mahyudin, R. P. (2025). Synergizing Google Earth Engine For Potential Impact of Several Pollutants on Periodontal Disease Incidence In Banjarbaru, South Kalimantan, Indonesia. Revista de Gestão Social e Ambiental, 19(2), 1-12.

Xu, X., Yin, J., Yang, Y., Liu, H., Yu, J., Luo, X., & Song, X. (2024). Advances in co-pathogenesis of the united airway diseases. Respiratory Medicine, 107580.

Sari, R. S. E. (2021). Hubungan Kelembaban dan Kebiasaan Merokok Penghuni Di Dalam Rumah Dengan Penyakit ISPA Pada Balita. Jurnal Sanitasi Profesional Indonesia, 2(1), 11-19.

Song, J., Qiu, W., Huang, X., Guo, Y., Chen, W., Wang, D., & Zhang, X. (2023). Association of ambient carbon monoxide exposure with hospitalization risk for respiratory diseases: A time series study in Ganzhou, China. Frontiers in public health, 11, 1106336.

Togatorop, J. P. E., Perdana, A. R., Firdaush, R. B., Wulandari, I. P., & Saputra, A. H. (2023). Analisis Dampak Pemberlakuan PSBB Total Pertama terhadap Kualitas Udara NO2 dan CO di DKI Jakarta Menggunakan Citra Sentinel-5P. Jurnal Aplikasi Meteorologi, 2(1), 33-44.