Geosfera Indonesia
p-ISSN 2598-9723, e-ISSN 2614-8528
available online at : https://jurnal.unej.ac.id/index.php/GEOSI
Vol. 9 No. 1, April 2024, 91-100

https://doi.org/10.19184/geosi.v9i1.47481

Research Article

The Impact of Cement Industry Activity on The Environmental Quality of Settlements in Tipar Kidul Village, Ajibarang, Banyumas

Farah Khansabyla, Sri Rum Giyarsih*
Department of Environmental Geography, Faculty of Geography, Universitas Gadjah Mada, Yogyakarta, 589709, Indonesia
*Corresponding author, email : srirum@ugm.ac.id

ARTICLE INFO

Received :
30 August 2023

Revised :
15 April 2024

Accepted :
25 April 2024

Published :
29 April 2024

ABSTRACT

The quality of settlement environments surrounding industries is crucial as it reflects the living conditions affected by industrial activities. A study conducted in Tipar Kidul Village aimed to determine the impact of cement industry activities on the settlement environment. The method of this research uses survey within a multistage random sampling survey. The data collection uses interview. The data analysis is simple linear regression with the accuracy testing including validity, reliability, normality, and linearity tests. The research showed that a majority (62%) of the settlement environments conducted in medium-quality conditions. The researched showed industries play a significant role in taking negative impacts on settlements. Industries tend to make settlements uncomfortable to live in due to various activities. Moreover, a significant correlation was observed, indicating a significant influence with a very strong strength that 76.1% between the quality of settlement environments in Tipar Kidul Village and the activities of the cement industry. The cement industry activities impacted to settlement by affecting air pollution, noise from trucks, and machines. Corporate social responsibility program in Tipar Kidul Village included two program, funding program that gave 50.000 rupiah/person and in 2017 cement industry company helped Tipar Kidul Village to reconstruct along Tipar Kidul Village.

Keywords: settlement; environment quality; cement industry; regression

INTRODUCTION

Settlements are identified as both artificial and natural formations, along with all their components within, which individuals and groups use to conduct their lives (Yunus, 1987). The need for living space often becomes a problem in Indonesian settlements (Vollmer & Grêt-Regamey, 2013). The demand for settlement space, not matched with an increase in living area and rapid population growth, becomes a serious issue related to settlement problems, especially the quality of the settlement environment (Dovey & Recio, 2024). The quality of the settlement environment refers to the environment's capacity to provide suitable living conditions (Soemarwto, 1988). The quality of the settlement environment shows the characteristics of the living environment, house cleanliness and aesthetics, and sanitation (Scovronick et al., 2015). The quality of the settlement environment also reflects the conditions of the community that inhabits it (Kamjou et al., 2024). According to Jochem et al (2021), settlement issues require special attention, as the decline in the quality of the settlement environment is not solely caused by the

conditions or qualities of the community itself (Putri et al., 2019). The quality of the settlement environment is also influenced by external factors such as industrialization. Industrialization can have positive benefits, such as providing employment for the local workforce (Fahy Bryceson et al., 2020). Besides its positive impacts, research by Ouzounis et al (2013) explains that industries have negative effects, especially on the quality of the settlement environment due to decreased living comfort caused by pollution.

Tipar Kidul Village is located in the Ajibarang as one of the villages in Banyumas Regency. It is located especially in Ajibarang Sub-District.

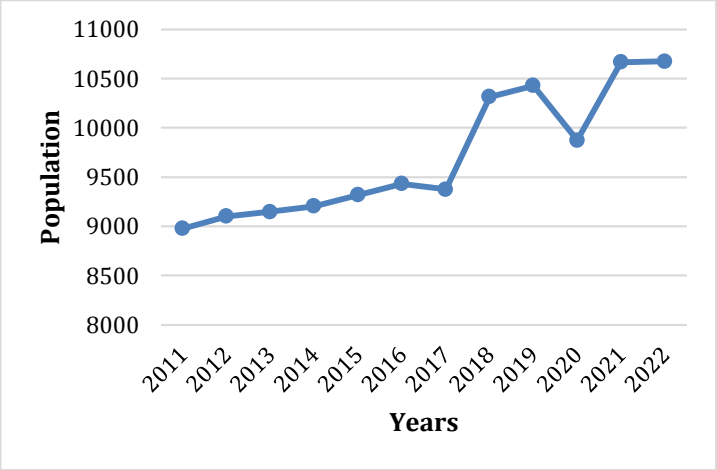

Figure 1. Population of Tipar Kidul Village in 2011-2020 (Statistic Bureau of Banyumas Regency, 2020)

Based on figure 2, the population growth in Tipar Kidul Village shows the increase linear. High population growth will have an impact on the quality of settlements (Bintarto & Surastopo, 1978).

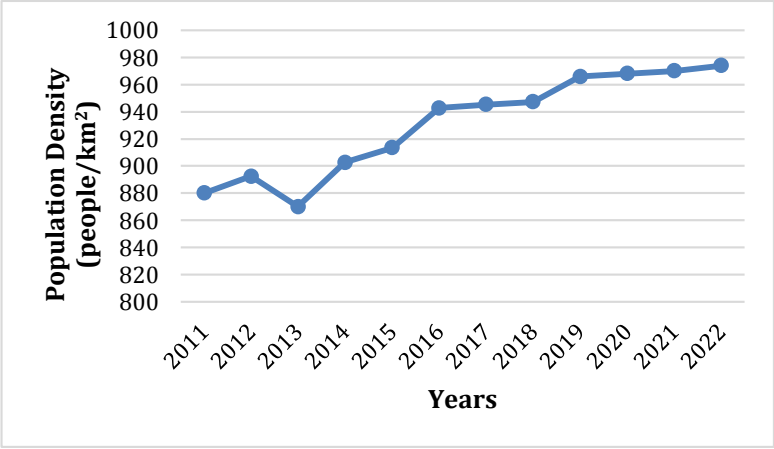

Figure 2. Population Density of Tipar Kidul Village in 2011-2020 Years (Statistic Bureau of Banyumas Regency, 2021)

Based on Figure 2, the growth of the population in Tipar Kidul Village is directly proportional to the increase in population density. High population density reflects a high demand for housing, so if the land cannot meet the housing needs, a problem of settlement quantity will be arise, or it can be named as settlement density (Kabo & Giyarsih, 2018).

The issue of settlement environmental quality cannot be separated from the activities of the cement industry (Tang et al., 2017). Problems arise due to mining activities, processing of raw materials, loading of production materials, and distribution of products, it must be based on the regulations of the industry (Sushanti et al., 2020). The transportation of materials and distribution of products using large vehicles and employee vehicles passing through roads around the settlement become new problem. The settlement roads ,especially their width, are not built to withstand heavy loads (Constantin et al., 2015), resulting in many potholes on the roads of Tipar Kidul Village.

Residents of Tipar Kidul Village requested compensation for clean water, but cement industry company did not respond to the contamination of water due to the mining of raw materials in the surrounding settlement area. The presence of the industry located on the Ajibarang-Wangon Road, which is a provincial highway, worsens the environmental conditions of the settlement. The activities conducted by cement industry have an impact by the surrounding activities, such as air and noise pollution, which can reduce the quality of life for people around the industrial area (Kesarwani & James, 2017). Dovey (2024) explained that pollution is an inseparable aspect of industries. Air pollution problems in Tipar Kidul Village need attention because cement industries produce particles such as total suspended particulates (TSP), nitrogen dioxide, sulfur dioxide, and even carbon monoxide (Wood, 2022). Additionally, the mixture of air pollutants with oxygen and nitrates in the air creates a strong and unpleasant odor (Omwene et al., 2018).

Research on the impact of cement industry activity has not been conducted in Tipar Kidul Village before and this study is the first of its. Studies on settlement environmental quality in the term of industries are still relatively rare compared to studies on settlement quality. One of the strengths of this research is not only examines settlement environmental quality, but the variables used can also explain the relationship between the environmental quality of Tipar Kidul Village and cement industry activities. The aim of this research is to determine the impact of cement industry activities on the settlement environmental quality in Tipar Kidul Village. This study is expected to contribute academically and benefit both Tipar Kidul Village and cement industry company by providing insights as a basis for future policy decisions.

METHODS

The data used in this study consists of primary and secondary data. Primary data are directly collected from Tipar Kidul Village. The data collection methods in this research are interviews and field observations. Broadly, the collected data was the characteristics of the living environment, house cleanliness and aesthetics, and sanitation to represent the quality of the settlement environment. Secondary data are obtained from relevant institutions such as population figures, geographical conditions, monograph data, and spatial data (SHP). The population for this study includes all households in Tipar Kidul Village. Tipar Kidul Village located in Central Java especially in Banyumas District, Ajibarang Sub District. The map of Tipar Kidul Village can be shown on Figure 3.

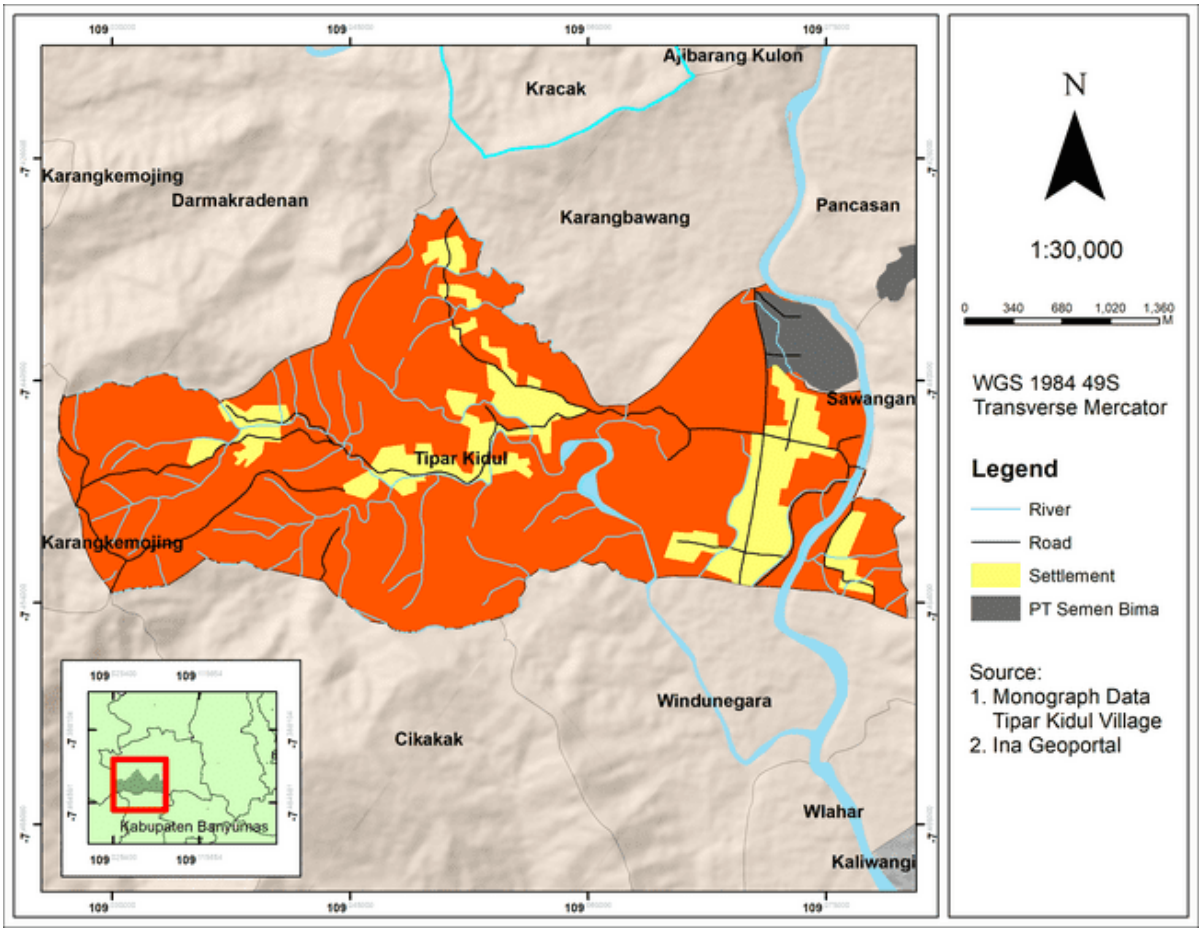

Figure 3. The Administration Map of Tipar Kidul Village

Tipar Kidul Village which is comprised of 13 RW (Hamlet) and 62 RT (Neighbourhood) (Statistic Bureau of Banyumas Regency, 2020). This study used a sampling method, specifically a multistage random sampling technique. The sampling process is divided into several stages. The first stage involves categorizing the population into groups and selecting RW 1. The selection of RW 1 is based on its proximity to cement factory, which is approximately 10 to 300 meters away. The number of households (KK) in RW 1 is 134. The second stage involves calculating the sample size of selected households within RW 1. The determination of the sample size follows the Isaac and Michael method (Gunawan, 2016). Based on calculation, the sample size is 100 households (KK).

$$S = \frac{\lambda^2 \times N \times P \times Q}{d^2(N-1) + \lambda^2 \times P \times Q} \quad (1)$$

Note :
S: Sample size
N: Population size
P: Probability of success (0.5)
Q: Probability of failure (0.5)
λ^2: Chi-square, with a 5% level of significance, Chi-square equals 3.841

Data processing in this study involves several software applications such as Microsoft Excel, SPSS, and ArcGIS. Microsoft Excel is used to process the results of structured interviews, weighting, and classify with Strugess method before conducting regression analysis in the SPSS application. ArcGIS software is used to create maps when processing spatial data. Research Hypotheses on this study aims as:

- H0: The independent variable does not affect the dependent variable
- H1: The independent variable affects the dependent variable

Data analysis is divided into two parts: descriptive and inferential. Descriptive analysis is used to explain the quality of the settlement environment in Tipar Kidul Village. However, the questions in the questionnaire are scored or ranked, then summed up and classified into low, medium, and high classes. Inferential analysis in this study involves regression analysis. Regression analysis is used to determine the relationship between the activity of cement industry and the quality of the settlement environment. Before conducting a simple linear regression test, validity, reliability, normality, and linearity tests are taken.

- If the significance value < 0.05, then H0 is rejected and H1 is accepted, indicating significant influence between the variables.
- If the significance value > 0.05, then H0 is accepted and H1 is rejected, indicating no significant influence between the variables.

Table 1. Correlation Each Variables

Value	Correlation
0.01 – 0.25	Very Weak Correlation
0.26 – 0.50	Sufficient Correlation
0.51 – 0.75	Strong Correlation
0.76 – 0.99	Very Strong Correlation
1	Perfect Correlation

RESULTS AND DISCUSSION

The quality of settlements in this study is assessed based on the scoring weight of three parameters: housing environment characteristics, cleanliness and maintenance of houses, and sanitation. Each respondent has a different total score for settlement quality. The higher the settlement quality score, the better the settlement environment quality. Conversely, the lower the settlement quality score, the lower the respondent's settlement quality condition. Based on the calculation of settlement environment quality scoring in terms of housing environment characteristics, cleanliness and maintenance of houses, and sanitation, the lowest score obtained is 49 and the highest score is 88. The scoring results are classified using the Strugess method into three classes: good, moderate, and poor.

Based on the research that shown in Figure 4, there are there are 25 houses (25%) with poor settlement environmental quality, 62 houses (62%) with moderate quality, and 13 houses (13%) with good quality. The majority of houses in the research location have a moderate settlement environment quality. This means that several aspects regarding settlement environment quality have been applied in community life towards an ideal settlement, thus avoiding poor settlement environment quality. This aligns with research by Chirisa & Nel (2022) stating that settlement quality in industrial areas tends to be moderate because communities still want to maintain a healthy settlement despite negative influences from industrial activities. Additionally, research by Manimoy et al. (2021) on industries explains that there are external

factors such as assistance from industries or factories as Corporate Social Responsibility (CSR). The parameter with the poorest quality in the community is the characteristics of housing environment, including the presence of protective trees, cleanliness, and beauty.

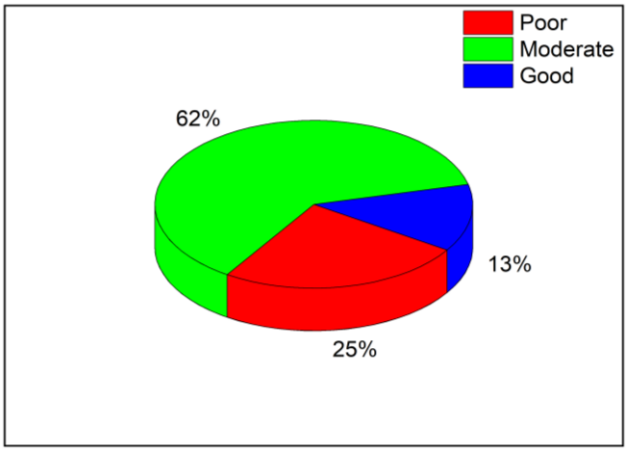

Figure 4. Settlement Environmental Quality in Tipar Kidul Village

The settlement environmental quality in Tipar Kidul Village is closely related to the activities of cement industry. According to the study by Ouzounis et al (2013) showed industries play a significant role in taking negative impacts on settlements. Industries tend to make settlements uncomfortable to live in due to various activities. This is aimed by the residents of Tipar Kidul Village, especially respondents living within 100 meters of cement industry. Respondents feel that the machine noises from the cement factory lead to noise pollution as the machine noises are heard non-stop for 24 hours. The findings of this study also align with the research by Halda et al., (2020) which explained that three blocks located less than 100 meters from a Class C sand mining site in the environmental quality due to the influence of sand mining activities, especially excavation and drilling.

The settlement environment quality in Tipar Kidul Village averages at a moderate level despite the research location being within 0 – 200 meters from PT Semen Bima. This is the result of efforts by the Tipar Kidul Village community to keep the surrounding environment clean and avoid indiscriminate waste disposal. The Tipar Kidul Village community regularly conducts communal work every two weeks. These efforts are also supported by the involvement of the Tipar Kidul Village Government. The efforts of the Tipar Kidul Village Government include paying attention to criticisms, suggestions, and complaints from the community, especially those living around PT Semen Bima, so that they can be formulated and further addressed. In 2018, thanks to the intervention of the Tipar Kidul Village Government, PT Semen Bima's CSR repaired the damaged road in the rear alley of PT Semen Bima. According to Chrisa and Nel (2022), industrial activities significantly impact settlement environmental quality, particularly in relation to air pollution.

The regression test results between the independent variable, cement industry activities, and the dependent variable, settlement environmental quality in Tipar Kidul Village, show a significance value of 0.000. This implies that there is an influence of cement industry activities on the settlement environmental quality in Tipar Kidul Village. The R Square value between the two variables is 0.761, or 76.1%, indicating a very strong relationship. The Standardized Coefficient Beta value is -0.872, which means that the influence of cement industry activities on settlement environmental quality in Tipar Kidul Village is negative or inverse. In other words, the higher the value of cement industry activities, the lower the quality of the settlement environmental quality in Tipar Kidul Village. In simpler terms, more extensive industrial activities of cement industry lead to worse settlement environmental quality in Tipar Kidul Village. The reduced settlement

environmental quality around industries aligns with Shekhar et al. (2019) stated that the overall environmental conditions of villages can change over time due to factors such as population, land use, and industries.

Table 2. Regression Test Results of Cement Industry Activities on Settlement Environmental Quality

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.872[a]	.761	.759	2.835

a. Predictors: (Constant), Cement Industry Activities

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	74.711	1.983		37.667	.000
	Cement Industry Activities	-.920	.052	-.872	-17.667	.000

Note : a. Dependent Variable: Environmental Settlement Quality

Mass industrialization is a chain of pollution from various aspects such as water, air, soil, and biodiversity (Patnaik, 2018). PT Semen Bima is part of mass industrialization, evident from its significant impact on the environment. The level of PT Semen Bima's influence on the quality of the settlement environment can be seen in Figure 4. Pollution is felt by the residents of Tipar Kidul Village who live around PT Semen Bima. The most dominant pollution is air pollution. Interview results explain that 64% of the community complain about air pollution such as dust and smoke from processing machines. This is exacerbated by smoke from material transport vehicles of PT Semen Bima passing through the residential alleys of Tipar Kidul Village. 59% of the community feel disturbed by the pollution or smoke from vehicles owned by PT Semen Bima. This condition leads to air degradation which will then be followed by degradation of public services, settlement quality, and social interactions (Putri et al., 2019). Several times, the cement processing machines of PT Semen Bima experienced malfunctions resulting in dust showers. Industrial air pollution can be exacerbated by high energy consumption to meet production targets, imbalance in energy usage, slow progress in sustainable energy, and political-economic reasons (Hao, 2022).

The second factor contributing to the strong influence of cement industry activities on settlement environmental quality is noise. Noise is also experienced by the residents of Tipar Kidul Village. Based on interviews, 23% of the residents feel noise due to the large vehicles carrying raw materials passing through the settlement alleys, mostly every day. Moreover, noise from production machinery is almost continuous for 24 hours. About 70% of the residents complain about the discomfort caused by the very loud noise from cement industry production machinery. Noise is part of mass industrialization, forming a chain of pollution affecting various aspects like water, air, soil, and biodiversity (Patnaik, 2018).

The water condition in Tipar Kidul Village does not experience pollution due to PT Semen Bima. Only residents claim that their well water is contaminated. These residents live just 3 meters from the rear boundary fence of PT Semen Bima. The quality of well water for residents living 50-100 meters from PT Semen Bima is good, clear, and odorless. This condition is the result of efforts by the Tipar Kidul Village Government, which requested PT Semen Bima to improve its waste disposal system so that industrial waste does not leak and pollute the surrounding environment. In contrast to the clean well water condition, the drainage and wastewater channels owned by the residents of Tipar Kidul Village are heavily polluted. 19% of residents living directly behind PT Semen Bima have their drainage channels covered by stagnant wastewater. The water

stagnation is caused by the blocking of the drainage channels by the walls of PT Semen Bima, preventing the water from flowing.

Corporate Social Responsibility (CSR) is a form of corporate responsibility in reducing the impact of industrial activities. CSR is part of business as it is considered to enhance the company's reputation (Frederiksen, 2018). PT Semen Bima's CSR provides compensation in the form of money amounting to Rp50,000/person/year in RW 1, especially RT 1 and RT 8. The recipients of this compensation feel that the money provided by PT Semen Bima as "compensation" is not commensurate with the suffering they experience daily. The community perceives this money as useless and desires additional financial assistance or other forms of aid. According to the Tipar Kidul Village officials, aside from the Rp50,000/person/year cash aid, there is no CSR support from PT Semen Bima. The last non-cash assistance provided to affected residents was drainage renovation. The drainage renovation by PT Semen Bima was carried out in 2017 due to flooding in the residential alleys (Khansabila, 2023).

CONCLUSION

The majority of settlement environmental quality in Tipar Kidul Village falls within the medium category, accounting for 62%. There is an influence between the settlement environmental quality in Tipar Kidul Village and cement industry activities, demonstrated by the significance value of 0.005 with a strength of 76.1% or within the strong category. This suggests that the condition of settlement environmental quality in Tipar Kidul Village is strongly controlled by cement industry activities. Further research is needed in coordination with cement industry regarding future efforts and Corporate Social Responsibility (CSR) plans.

ACKNOWLEDGMENTS

This paper is a part of an undergraduate thesis written by the first author under the guidance of the second author. Authors extend gratitude to cement industry company and the Tipar Kidul Village Government for their support in this research.

DECLARATIONS

Conflict of Interest

We declare no conflict of interest, financial or otherwise.

Ethical Approval

The research has been approved by the Research Committee of Universitas Gadjah Mada. All research was carried out in accordance with Universitas Gadjah Mada research ethics guidelines applicable when human participants are involved.

Informed Consent

Before conducting the study, we had obtained the consent of all the research subjects involved in the study. To maintain the confidentiality of the data, the research subjects were coded or anonymous.

DATA AVAILABILITY

Data used to support the findings of this study are available from the corresponding author upon request.

REFERENCES

Bintarto, & Surastopo, H. (1978). *Metode Analisis Geografi*. BP3S.

Statistic Bureau of Banyumas Regency (2021). *Statistic of Banyumas Regency 2020-2021*. BPS.

Chirisa, I., & Nel, V. (2022). Resilience Thinking in the Rural Human Settlements' Development and Management. *International Journal of Rural Management, 18*(1), 146–160. https://doi.org/10.1177/09730052211001674

Constantin, V., Ştefănescu, L., & Kantor, C. M. (2015). Vulnerability assessment methodology: A tool for policy makers in drafting a sustainable development strategy of rural mining settlements in the Apuseni Mountains, Romania. *Environmental Science and Policy, 52*, 129–139. https://doi.org/10.1016/j.envsci.2015.05.010

Dovey, K., & Recio, R. B. (2024). Inventraset assemblages: The spatial logic of informal street vending, transport and settlement. *Urban Studies, 00420980231223060*. https://doi.org/10.1177/00420980231223060

Fahy Bryceson, D., Bosse Jønsson, J., & Clarke Shand, M. (2020). Mining mobility and settlement during an East African gold boom: Seeking fortune and accommodating fate. *Mobilities, 15*(3), 446–463. https://doi.org/10.1080/17450101.2020.1723879

Frederiksen, T. (2018). Corporate social responsibility, risk and development in the mining industry. *Resources policy, 59*, 495-505.https://doi.org/10.1016/j.resourpol.2018.09.004

Gunawan, G. (2016). *Pengantar Statistika Inferensial*. Rajawali Press.

Halda, J. P., Janeček, V. P., & Horák, J. (2020). Important part of urban biodiversity: Lichens in cemeteries are influenced by the settlement hierarchy and substrate quality. *Urban forestry & urban greening, 53*, 126742. https://doi.org/10.1016/j.ufug.2020.126742

Hao, Y. (2022). Effect of economic indicators, renewable energy consumption and human development on climate change: An empirical analysis based on panel data of selected countries. *Frontiers in Energy Research, 10*, 841497. https://doi.org/10.3389/fenrg.2022.841497

Kesarwani, S., & James, A. (2017). Effect of air pollution on human health problems residents living around the cement plant, Chandrapur, Maharashtra, India. *Journal of Pharmacognosy and Phytochemistry, 6*(5), 507-510.

Khansabila, F. (2023). *Analisis Pengaruh Keberadaan PT Sinar Tambang Artha Lestari (PT Semen Bima) Terhadap Kualitas Lingkungan Permukiman di Desa Tipar Kidul Kecamatan Ajibarang Kabupaten Banyumas*. Undergraduate Thesis Draft. Faculty of Geography UGM (Not Published).

Jochem, W. C., Leasure, D. R., Pannell, O., Chamberlain, H. R., Jones, P., & Tatem, A. J. (2021). Classifying settlement types from multi-scale spatial patterns of building footprints. *Environment and Planning B: Urban Analytics and City Science, 48*(5), 1161–1179. https://doi.org/10.1177/2399808320921208

Kabo, H. E. D. P. R., & Giyarsih, S. R. (2018). Kualitas Permukiman di Basin Wonosari dan Perbukitan Kars Gunungsewu di Kabupaten Gunungkidul. *Majalah Geografi Indonesia, 32*(1), 68. https://doi.org/10.22146/mgi.33584

Kamjou, E., Scott, M., & Lennon, M. (2024). A bottom-up perspective on green infrastructure in informal settlements: Understanding nature's benefits through lived experiences. *Urban Forestry and Urban Greening, 94*, 128231. https://doi.org/10.1016/j.ufug.2024.128231

Manimoy, H., Tonu Lema, Y. E., Klaping, E. D., Tang, M., & Botahala, L. (2021). Study of Chemical Concentration of Main Ingredients for Making Portland Composite Cement. *Scientific Journal Widya Teknik, 20*(1), 28–32.

Omwene, P. I., Öncel, M. S., Çelen, M., & Kobya, M. (2018). Heavy metal pollution and spatial distribution in surface sediments of Mustafakemalpaşa stream located in the world's largest borate basin (Turkey). *Chemosphere, 208*, 782–792. https://doi.org/10.1016/j.chemosphere.2018.06.031

Ouzounis, G. K., Syrris, V., & Pesaresi, M. (2013). Multiscale quality assessment of global human settlement layer scenes against reference data using statistical learning. Pattern *Recognition Letters, 34*(14), 1636–1647. https://doi.org/10.1016/j.patrec.2013.04.004

Patnaik, R. (2018). Impact of Industrialization on Environment and Sustainable Solutions - Reflections from a South Indian Region. *IOP Conference Series: Earth and Environmental Science, 120*(1). https://doi.org/10.1088/1755-1315/120/1/012016

Putri, R. F., Wibirama, S., Giyarsih, S. R., Pradana, A., & Kusmiati, Y. (2019). Landuse change monitoring and population density analysis of Penjaringan, Cengkareng, and Cakung Urban Area in Jakarta Province. *E3S Web of Conferences, 76*. https://doi.org/10.1051/e3sconf/20197603004

Scovronick, N., Lloyd, S. J., & Kovats, R. S. (2015). Climate and health in informal urban settlements. *Environment and Urbanization, 27*(2), 657–678. https://doi.org/10.1177/0956247815596502

Shekhar, H., Schmidt, A. J., & Wehling, H. W. (2019). Exploring wellbeing in human settlements - A spatial planning perspective. *Habitat International, 87*, 66–74. https://doi.org/10.1016/j.habitatint.2019.04.007

Soemarwto, O. (1988). *Analisis Dampak Lingkungan*. Gadjah Mada Univeristy Press.

Sushanti, I. R., Jauhari, L., & Abednego, I. A. (2020). Settlement's feasibility parameters in the village outer mining area. *IOP Conference Series: Earth and Environmental Science, 413*(1). https://doi.org/10.1088/1755-1315/413/1/012019

Tang, L., Ruth, M., He, Q., & Mirzaee, S. (2017). Comprehensive evaluation of trends in human settlements quality changes and spatial differentiation characteristics of 35 Chinese major cities. *Habitat International, 70*, 81–90. https://doi.org/10.1016/j.habitatint.2017.10.001

Vollmer, D., & Grêt-Regamey, A. (2013). Rivers as municipal infrastructure: Demand for environmental services in informal settlements along an Indonesian river. *Global Environmental Change, 23*(6), 1542–1555. https://doi.org/10.1016/j.gloenvcha.2013.10.001

Wood, D. A. (2022). Local integrated air quality predictions from meteorology (2015 to 2020) with machine and deep learning assisted by data mining. *Sustainability Analytics and Modeling, 2*, 100002. https://doi.org/10.1016/j.samod.2021.100002

Yunus, H. S. (1987). *Beberapa Determinan Perkembangan Permukiman Kota (Dampak dan Pengelolaannya)*. Fakultas Geografi UGM.