A Mapping Analysis of Air Quality Issues in Indonesia: An Atlas.ti Approach

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Abstract. The highly complex activities in national development lead to various issues affecting air quality. This research aims to analyze and map the problems influencing air quality in Indonesia. This is done because it is suspected that the causes of air quality, whether good or bad, cannot be directly attributed to the variables under study, such as GDP per capita. GDP per capita alone cannot provide a comprehensive overview of the activities within it that affect air quality. Therefore, the use of Atlas.ti can help categorize these activities. This research is qualitative and utilizes analytical techniques using Atlas.ti. The data used is derived from secondary sources, including mass media information, electronic media, and documents issued by both governmental and non-governmental organizations. The research findings indicate that air quality is a cause of climate change. Changes in air quality can occur due to five triggering factors: land cover narrowing, population, economic activities, technology and energy, and other factors.

Keywords: Air Quality, Mapping, Atlas.ti, Indonesia

1 Introduction

Environmental degradation and economic growth are two sides of a coin, known as a trade-off. The relationship between economic growth and ecological degradation is expressed as the Environmental Kuznets Curve (EKC) hypothesis. This hypothesis states that environmental degradation will rise at the beginning of a period of increasing per capita income, reaching a maximum point, and then degradation will decrease as per capita income increases. There is a lot of quantitative research to prove the EKC hypothesis. Studies by [1], [2], [3], [4], [5] validated this hypothesis, while other research by [6], [7], [8], [9] gave different results.

The frontier study has used the Air Quality Index (IKU) with indicators other than CO2 emissions, as an indicator of environmental degradation, and focuses more on the regional level. Quantitative research by [10] using the 2014 Air Quality Index in 289 cities in China, [11] using SO2 and PM10 concentrations was carried out in 282 cities in China in 2012, [12] using the air quality indicator, PM2.5, in 2000 - 2014 in 30 provinces in China and [13] in 103 cities for the 2014-2019 period. Indonesia is a country that is unique and heterogeneous in terms of, among others; The region is in the form of an archipelagic country which is divided into 34 provinces, natural factors (endowments), and biological-non-biological diversity. This uniqueness has an impact on the economy and environment of each region.

The very complex activities in national development mean that many problems at the regional level cannot be described from quantitative research. Qualitative research is needed to support research findings using quantitative methods [14] which are currently widely used to look at the relationship between air quality and economic activity. The research utilizes the Atlas.ti method to enhance the quantitative analysis of the regional air quality improvement model in Indonesia. This approach was chosen because it was believed that the variables studied, such as GRDP per capita, did not directly account for the quality of air. GRDP per capita alone does not provide a complete

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understanding of the activities influencing air quality. Therefore, using Atlas.ti can help categorize activities, which can further enrich the quantitative analysis. The research aims to analyze and map the real issues affecting air quality in Indonesia using the Atlas.ti method. The significance of this research lies in its ability to provide a comprehensive problem map offering a richer perspective on air quality in Indonesia. Consequently, it can bolster the findings of the relationship between air quality and economic activity derived from quantitative studies.

2 Method

In this research, problems affecting air quality in Indonesia were mapped and analyzed using the Atlas.ti method. Atlas.ti is a qualitative data analysis (QDA) software, which is very useful in social science research [15]. It can process various types of data such as audio, video, images, and written materials (articles, books, surveys, or interview transcripts), enabling triangulation across different data sources [16].

The Atlas.ti method is used to make initial reflections about ideas and knowledge construction from the beginning of the research process [17] and highlight important points in each section that are interesting to build a research narrative and analysis [18]. The results of this reflection are realized from network mapping results from Atlas.ti analysis. The stages that will be carried out using the Atlas.ti method in this research is illustrated in Figure 1.

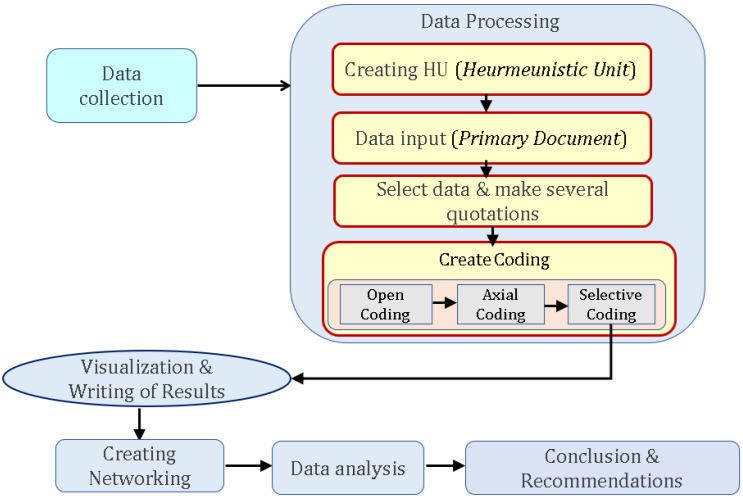

Figure. 1. The stages of Atlas.ti Analysis

Figure 1 shows that the data processing stage will be carried out after various types of data, such as audio data, video data, image data, or written data such as mass media, print media or online media have been obtained. During data processing, researchers will engage in three coding processes[19]. First, Open Coding is a process of identifying concepts in data by breaking it down into parts, scrutinizing similarities and differences, and grouping related elements into categories. These categories produce codes, which are then grouped into broader categories, serving as indicators of specific phenomena. Second, Axial coding is the process of linking categories to subcategories, known as "axial," to gather fragmented data from open coding. It involves grouping codes into broader categories based on supporting theories. Selective coding is the final stage of coding in which the categories identified during open and axial coding are combined to form a broader scheme, known as the main category. It's similar to axial coding, as it involves integrating the core category with other categories to determine its meaning.

It is essential to carefully consider the findings of the Atlas.ti analysis when making decisions at the end of the research. By utilizing these methods, more comprehensive analysis results and research outcomes can be achieved. Moreover, the use of Atlas.ti will streamline and organize the process, as this tool can arrange, code, and analyze research data efficiently and in a structured manner.

3 Results and Analysis

This study aims to analyze and map the factors that impact air quality in Indonesia. The chosen approach to accomplish this goal is through the use of the Atlas.ti method. The data utilized is derived from secondary sources such as mass media, electronic media, and documents issued by various institutions, including both governmental and non-governmental organizations. By using the Atlas.ti 22 software, triangulated results were obtained regarding the determinants of air quality.

Air quality is determined by several factors, including narrowing of land cover, population, economic activity, technology and energy and other factors. The proportion of each factor is shown in Figure 2.

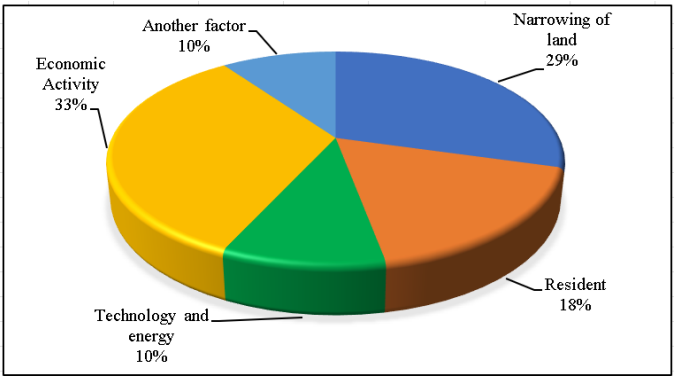

Figure. 2. Air Pollution Caused

According to Figure 2, economic activity is cited as the primary cause of air pollution in 33% of the sources processed using Atlas.ti. The second leading cause is land shortage at 29%, followed by population at 18%, technology & energy at 10%, and other factors at 10%.

The data processing also reveals that economic activities contributing to pollution stem from various sources, including the industrial sector, fisheries and livestock, human activities, agricultural activities, electricity generation, and household activities. The contribution of each activity is illustrated in Figure 3.

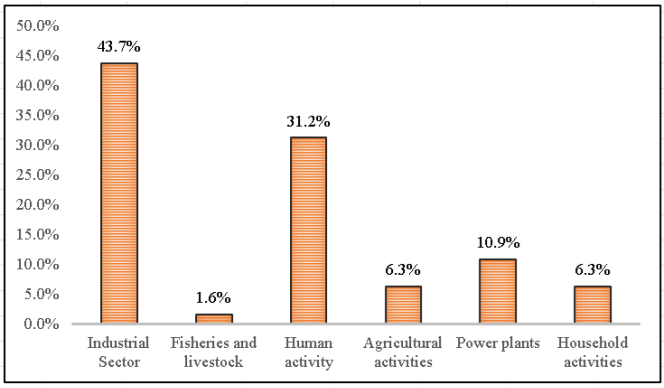

Figure. 3. Air Pollution from Economic Activities

In Figure 3, it is evident that industrial activities (43.7%) and human activities (31.2%) contribute the most to pollution. Within human activities, transportation accounts for 78.5%, while the remaining 21.5% is attributed to consumption activities. Fishing and livestock activities have the lowest contribution (1.6%) to air pollution. Pollution from fisheries is caused by the release of harmful exhaust gases and substances from the cooling systems of various types of ships, which can lead to ozone layer depletion.

Livestock activities can lead to decreased air quality due to the production of methane (CH4) and ammonia (NH3) from animal waste. These emissions can increase the amount of carbon in the atmosphere, posing a risk of contributing to the greenhouse effect if the quantity becomes substantial. The second source of pollution arises from the reduction of land coverage. Activities associated with land reduction are depicted in Figure 4.

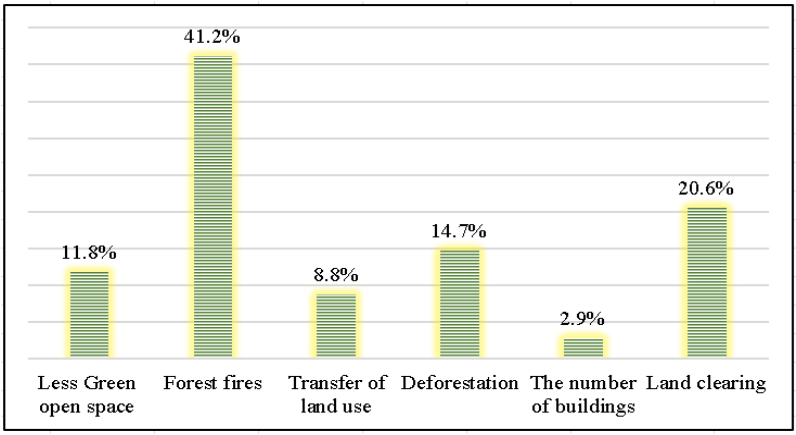

Figure. 4. Causes of Pollution Due to Land Restriction

In Figure 4, the results of data analysis using Atlas.ti are shown. The main causes of land pollution are forest fires (41.2%) and land clearing (20.6%). These activities are often seen in provinces outside Java, such as Kalimantan, Sulawesi, Maluku, and Papua, where forests are burned or cleared for foreign investment purposes. This leads to a decrease in environmental capacity and poses a significant threat to air quality in Papua Province and its surrounding areas [20]. The Presidential Instruction (INPRES) No. 3 of 2020 aims to manage forest and land fires, hoping to prevent a worsening of air quality in Papua Province. Buildings make the smallest contribution (2.9%) to air quality

decline, mostly seen on the island of Java. Land narrowing is mainly caused by land conversion and an increase in the number of buildings.

The conversion of large amounts of green and productive land into residential areas and factory buildings has led to negative impacts on the environment. The construction of high-rise buildings in an area has the potential to create air pollution traps, where polluted air becomes trapped due to the presence of numerous skyscrapers. According to [21] high-rise buildings can affect airflow and distribution patterns in their surroundings, leading to the emergence of "dead zones" and high-concentration "hotspots" in areas where they did not previously exist.

The third cause of pollution arises from population factors, consisting of urbanization (40%), population explosion (50%), and population dynamics (10%) (Figure 5).

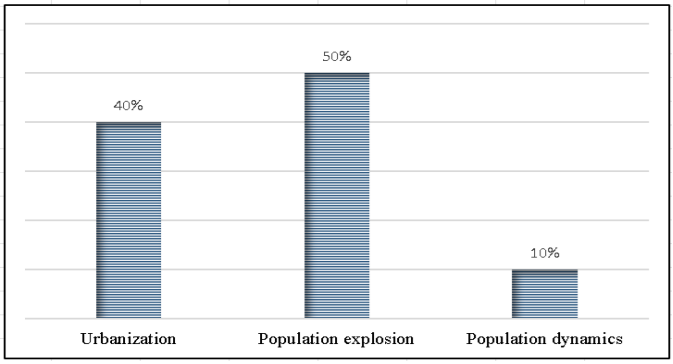

Figure. 5. Causes of Pollution from Population

The population explosion is the primary contributor to pollution. Population growth is not limited to urban areas and is also prevalent in rural areas. This growth is associated with the utilization of natural resources and the environment to fulfill living requirements.

Urbanization leads to the migration of populations to urban areas or the modern sector. According to Atlas.ti result, urbanization is the second leading cause of pollution affecting air quality. The third cause is population dynamics, which refers to the levels, patterns, and structures of populations influenced by fertility, mortality, and migration rates. These dynamics dictate the population size in an area. A high fertility rate can lead to a population explosion, resulting in an increasing number of inhabitants.

It's important to note that in areas with high population death rates, the overall population will decrease. The actions of residents can either positively or negatively impact air quality. Increased environmental awareness among urban residents can lead to better air quality ([22], [23], [11], [24], [3], [25]. However, the opposite effect is observed in Java Island. According to Indonesian Statistics data for 2022, of the total 272.68 million people in Indonesia in 2021, 56% live on the island of Java, which covers only around 6.75 percent of Indonesia's territory. Therefore, the population density is expected to reach 1,180 people per km^2 in 2021. These findings are consistent with studies conducted by [26], [27], [28], [29] and [30].

Other factors causing pollution that affect air quality are technology and energy. Emissions resulting from increased energy consumption not only occur in urban areas but also in rural areas, where emissions result from increased consumption of energy in other forms. For example, wood and other solid fuels used for cooking, as well as kerosene used for lighting, are significant contributors to pollution in rural areas. In Figure 6, it is clear that the primary cause of pollution from technology and energy is the increase in energy consumption, which has reached 60%.

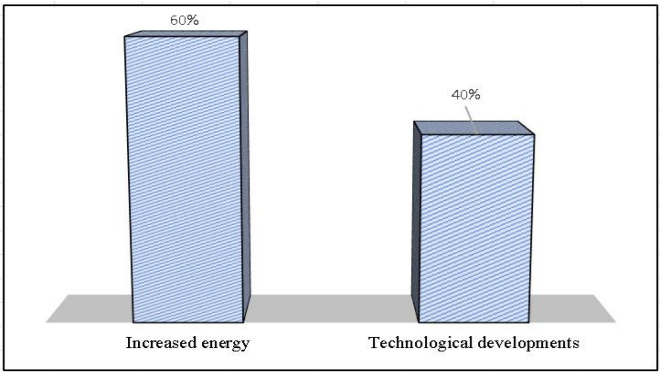

Figure. 6. Causes of Pollution from Technology and Energy

The second major cause of pollution is technological development, which accounts for 40% of technological and energy factors (Figure 6). These developments can have both positive and negative impacts on the environment. If technological advances do not incorporate control measures for emissions and air pollution, It can contribute to air pollution.

In addition to economic activity, land use changes, technological and energy factors, and population growth, air quality can also be affected by government regulations related to the environment, waste incineration, and natural factors (see Figure 7).

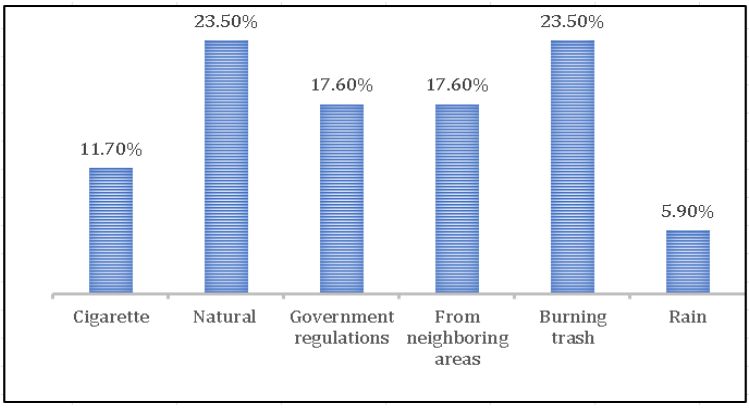

Figure. 7. Causes of Pollution from Other Factors

In Figure 7, it is evident that the largest contribution to air pollution from other factors comes from nature and waste burning, both accounting for 23.5%. Weather conditions such as wind direction, wind speed, temperature, and seasonal variations have a significant impact on air quality in a particular area. According to the Centre for Research on Energy and Clean Air (CREA) in 2020, the paths of the wind passing through concentration points of pollutants like NOx and SO2 in Banten Province and West Java Province have contributed to three types of air pollution in DKI Jakarta Province. During the dry season, low wind speeds lead to the suspension of particles like dust, including PM2.5, in the air.

The causes of pollution originating from regulations contributed to 17.6% of the problem. Current regulatory policies are outdated and inadequate to protect public health in Indonesia's main cities. In several cases related to regulations, many parties exploit people's ignorance for profit. This often happens to indigenous communities on Papua and Maluku Islands who sell their land rights to foreign companies. The foreign companies claim that the land agreement has been made by Indonesian

regulations. They further state that legal ownership of the land lies with the Indonesian government, not the indigenous communities who hold "customary rights" to the land. This condition causes many forests to be used inappropriately for purposes other than intended.

The data was collected and analysed with Atlas.ti shows that 17.6% of pollution in several provinces is attributed to neighboring areas. The air quality in these regions is deteriorating due to forest fires in adjacent areas. For example, in Riau Province, especially in Pekanbaru City, dense smoke is caused by forest fires in Riau and shipping from neighboring provinces like Jambi and South Sumatra. This situation is worsened by northward wind gusts. Similarly, East Kalimantan Province experiences smoke pollution from neighboring provinces such as Central Kalimantan, South Kalimantan, and West Kalimantan, rather than from fires within the region.

Another cause of pollution is rain, which contributes 5.9%. Some argue that rain has a positive effect as it can reduce dust levels in the air. However, others believe that rainwater mixing with pollutants in the air can lead to the formation of acid rain, making it incorrect to assume that rain helps remove pollution from the air.

Based on the results above, a network map can be created to illustrate air quality issues in Indonesia, as depicted in Figure 8.

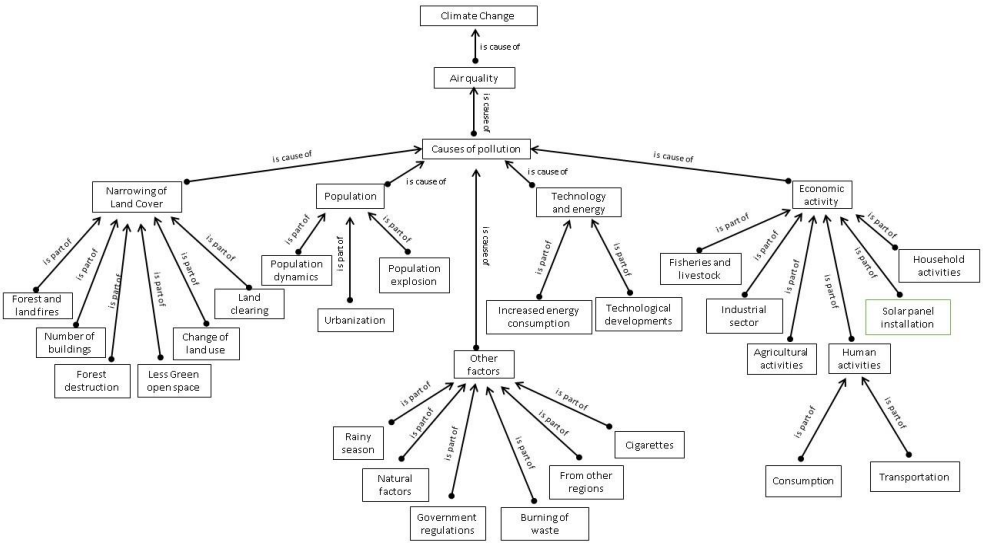

Figure. 8. Network Analysis of Air Quality Determinants

Figure 8 illustrates that climate change in Indonesia is significantly affected by global warming. Air quality stands out as the strongest indicator that determines the severity of the earth's temperature rise. Key factors influencing air quality in Indonesia include narrowing of land cover, population, economic activities, technology and energy, economics activity, and other factors. These factors are interconnected and often result from activities that can produce air pollutants.

This research also shows that the complexity of human activity, which spans various sectors, has one main goal: economic growth and development. This goal aims to meet people's living needs and increase the level of welfare. However, in the process, these activities contribute to decreasing air quality which ultimately affects climate change. In more detail, the narrowing of land cover occurs due to land conversion for residential, industrial, and agricultural purposes, all of which have the potential to reduce air quality through deforestation and land degradation. Increasing population also increases demand for natural resources, energy and infrastructure, which in turn increases pollutant emissions.

Intensive economic activity, including industry and transportation, is a major source of greenhouse gas emissions and other air pollutants. The use of technology that is not environmentally friendly and dependence on fossil energy worsens air quality conditions. All these factors show how important sustainable environmental management and policies that support emission reduction are to improve air quality and reduce the impacts of climate change.

4 Conclusion

This research emphasizes the need for collaborative action between government, industry, and society to reduce pollutant emissions through the application of environmentally friendly technology, increasing energy efficiency, and better management of natural resources. Such efforts are not only important for air quality and human health but also for global climate stability and long-term sustainability. Based on research using the Atlas.ti method, it can be concluded that climate change in Indonesia is significantly affected by global warming. Key factors influencing air quality in Indonesia include reduction of land cover, population growth, economic activities, technology usage, and energy consumption. These factors are interconnected and often result from activities that can produce air pollutants. The research shows that human activities aimed at economic growth and development contribute to decreasing air quality, ultimately affecting climate change. Intensive economic activity, including industry and transportation, is a major source of greenhouse gas emissions and other air pollutants. Sustainable environmental management and policies supporting emission reduction are crucial to improving air quality and reducing the impacts of climate change. Collaboration between government, industry, and society to reduce pollutant emissions through the application of environmentally friendly technology, increasing energy efficiency, and better management of natural resources is essential for air quality, human health, global climate stability, and long-term sustainability.

5 References

1. Grossman GM, Krueger AB. Environmental Impacts of a North American Free Trade Agreement. 1991. doi: 10.3386/w3914.
2. Tanger SM, Zeng P, Morse W, Laband DN. Macroeconomic conditions in the U.S. and congressional voting on environmental policy: 1970-2008. Ecol Econ. 2011;70(6):1109–20. doi: 10.1016/j.ecolecon.2010.12.021.
3. Borhan H, Ahmed EM, Hitam M. The Impact of CO2 on Economic Growth in ASEAN 8. Procedia Soc Behav Sci. 2012;35(December 2011):389–97. doi: 10.1016/j.sbspro.2012.02.103.
4. Gómez M, Rodríguez JC. Analysis of the environmental Kuznets curve in the NAFTA Countries, 1971-2014. Econoquantum. 2020;17(2):57–79. doi: 10.18381/eq.v17i2.7151.
5. Adebayo TS. Testing the EKC Hypothesis in Indonesia: Empirical Evidence from the ARDL-Based Bounds and Wavelet Coherence Approaches. Appl Econ J. 2021;28(June). Available: https://econpapers.repec.org/article/risapecjn/0054.htm
6. Dogan E, Turkekul B. CO2 emissions, real output, energy consumption, trade, urbanization and financial development: testing the EKC hypothesis for the USA. Environ Sci Pollut Res. 2016;23(2):1203–13. doi: 10.1007/s11356-015-5323-8.
7. Özokcu S, Özdemir Ö. Economic growth, energy, and environmental Kuznets curve. Renew Sustain Energy Rev. 2017;72(April 2016):639–47. doi: 10.1016/j.rser.2017.01.059.
8. Nikensari SI, Destilawati S, Nurjanah S. Studi Environmental Kuznets Curve Di Asia: Sebelum Dan Setelah Millennium Development Goals. J Ekon Pembang. 2019;27(2):11–25. doi: 10.14203/jep.27.2.2019.11-25.
9. Noor MA, Saputra PMA. Emisi Karbon dan Produk Domestik Bruto: Investigasi Hipotesis Environmental Kuznets Curve (EKC) pada Negara Berpendapatan Menengah di Kawasan ASEAN. J Wil dan Lingkung. 2020;8(3):230–46. doi: 10.14710/jwl.8.3.230-246.
10. Fang C, Liu H, Li G, Sun D, Miao Z. Estimating the impact of urbanization on air quality in China using spatial regression models. Sustain. 2015;7(11):15570–92. doi: 10.3390/su71115570.
11. Lin B, Zhu J. Changes in urban air quality during urbanization in China. J Clean Prod. 2018;188:312–21. doi: 10.1016/j.jclepro.2018.03.293.
12. Wang S, Hua G, Li C. Urbanization, Air Quality, and the Panel Threshold Effect in China Based on Kernel Density Estimation. Emerg Mark Financ Trade. 2019;55(15):3575–90. doi: 10.1080/1540496X.2019.1665016.
13. Jiang W, Li Y, Xie L, Xu J, Zhao S. Spatio-temporal heterogeneity of air pollution and its key influencing factors in the Yellow River Economic Belt of China from 2014 to 2019. J Environ Manage. 2021;296(May). doi: 10.1016/j.jenvman.2021.113172.
14. Creswell JW, Plano Clark VL. Designing and Conducting Mixed Methods Research. 3rd ed. Los Angeles: SAGE Publications, Inc.; 2018.
15. Hwang S. Utilizing Qualitative Data Analysis Software. Soc Sci Comput Rev. 2008;6(24):519–27. Available: https://journals.sagepub.com/doi/pdf/10.1177/0894439307312485?casa_token=BW4BTdZSFHMAAAAA:YjdAUjzPoBaxKNrBIG00ckxzuF7tCsBRxEG2slQzueN_tbfYjih1-Q6BVBr86x4eT5eaqBk6a9-7kw
16. Afriansyah EA. Penggunaan Software ATLAS.ti sebagai Alat Bantu Proses Analisis Data Kualitatif. Mosharafa J Pendidik Mat. 2018;5(2):53–63. doi: 10.31980/mosharafa.v5i2.260.
17. Rambaree K. Three Methods Of Qualitative Data Analysis Using ATLAS.ti: 'A Posse Ad Esse'. ATLAS.ti User Conf. 2013;:1–15. Available: http://www.opus4.kobv.de/opus4-tuberlin/frontdoor/deliver/index/docId/4427/file/14_rambaree_4427.pdf

18. Gunawan H, Bressers H, Mohlakoana N, Hoppe T. Incorporating air quality improvement at a local level into climate policy in the transport sector: A case study in Bandung City, Indonesia. Environ - MDPI. 2017;4(3):1–17. doi: 10.3390/environments4030045.
19. Sandy BC, Manongga D, Iriani A. Analisis Sentimen terhadap Kenaikan Harga Bahan Bakar Minyak (BBM) pada Media Online. In: Prosiding Semmau 2015. 2015. p. 24–30. Available: http://digilib.mercubuana.ac.id/manager/t!@file_artikel_abstrak/Isi_Artikel_399042311231.pdf
20. Nihayah DM, Mafruhah I, Hakim L, Suryanto S. Application of Klassen Typology in the Pattern of Environmental Carrying Capacity and Its Role in Regional Economic Development. In: International Conference on Environmental Management 2022 23/09/2022 - 24/09/2022 Online, Indonesia. 2023. p. 1–10. doi: 10.1088/1755-1315/1180/1/012052.
21. Aristodemou E, Koussouris S, Markatos NC. How tall buildings affect turbulent air flows and dispersion of pollution within a neighbourhood. Environ Pollut. 2018;233:782–96. doi: 10.1016/j.envpol.2017.10.041.
22. Ali HS, Abdul-Rahim A, Ribadu MB. Urbanization and carbon dioxide emissions in Singapore: evidence from the ARDL approach. Environ Sci Pollut Res. 2017;24(2):1967–74. doi: 10.1007/s11356-016-7935-z.
23. Akorede YF, Afroz R. The relationship between urbanization, CO2 emissions, economic growth and energy consumption in Nigeria. Int J Energy Econ Policy. 2020;10(6):491–501. doi: 10.32479/ijeep.9355.
24. Ergas C, Clement M, McGee J. Urban density and the metabolic reach of metropolitan areas: A panel analysis of per capita transportation emissions at the county-level. Soc Sci Res. 2016;58:243–53. doi: 10.1016/j.ssresearch.2016.03.002.
25. Chikaraishi M, Fujiwara A, Kaneko S, Poumanyvong P, Komatsu S, Kalugin A. The moderating effects of urbanization on carbon dioxide emissions: A latent class modeling approach. Technol Forecast Soc Change. 2015;90(PA):302–17. doi: 10.1016/j.techfore.2013.12.025.
26. Ahmed Z, Wang Z, Ali S. Investigating the non-linear relationship between urbanization and CO2 emissions: An empirical analysis. Air Qual Atmos Health. 2019;12(8):945–53. doi: 10.1007/s11869-019-00711-x.
27. Amin A, Aziz B, Liu XH. The relationship between urbanization, technology innovation, trade openness, and CO2 emissions: evidence from a panel of Asian countries. Environ Sci Pollut Res. 2020;27(28):35349–63. doi: 10.1007/s11356-020-09777-y.
28. Salehnia N, Karimi Alavijeh N, Salehnia N. Testing Porter and pollution haven hypothesis via economic variables and CO2 emissions: a cross-country review with panel quantile regression method. Environ Sci Pollut Res. 2020;27(25):31527–42. doi: 10.1007/s11356-020-09302-1.
29. Nathaniel S, Khan SAR. The nexus between urbanization, renewable energy, trade, and ecological footprint in ASEAN countries. J Clean Prod. 2020;272:122709. doi: 10.1016/j.jclepro.2020.122709.
30. Nihayah DM, Mafruhah I, Hakim L, Suryanto S. Spatial Effects of Economic Activity and Environmental Carrying Capacity on Air Quality in Java and Bali Islands. IOP Conf Ser Earth Environ Sci. 2023;1248(1). doi: 10.1088/1755-1315/1248/1/012025.