JURNAL PENELITIAN GEOGRAFI
Vol (13), No (2), (2025), pp. 407-416
Doi: http://dx.doi.org/10.23960/jpg

Original Article

Spatial Assessment of Carbon Emissions Caused by Industrial Activities in Batang Anai, West Sumatra

Nabila Novelia [1], Rozana Eka Putri [1], Arie Zella Putra Ulni [1]

[1] Department of Geography Education, Universitas PGRI Sumatera Barat, Padang, Indonesia
Corresponding Author : rozanawirman@gmail.com *

ABSTRACT
This study aims to analyze: 1) the spatial distribution of carbon emissions in Batang Anai District, Padang Pariaman Regency, and 2) the impact of carbon emissions on environmental quality and community settlements. The primary focus of this study is to map the distribution of carbon emissions while also assessing the socio-economic and public health implications. The research method used is descriptive quantitative with a spatial analysis approach using a Geographic Information System (GIS) supported by ArcGIS software. Data were obtained through field surveys, interpretation of land cover imagery from 2015 and 2025, calculation of potential carbon stocks, and distribution of questionnaires to residents living within a 2-km radius of industrial areas in three villages (Kasang, Katapiang, and Sungai Buluh). The analysis was conducted using overlay techniques for carbon emissions and land cover maps, calculation of carbon concentrations, and processing of questionnaire data using a Likert scale to measure perceptions of environmental, health, and socio-economic impacts. The results of the study: 1) Show that the spatial distribution of carbon emissions in Batang Anai District is divided into three classes: Low, Medium, and High. 2) Impacts felt by the community include decreased air quality, increased dust and air temperature, respiratory problems, and decreased comfort of life. Overall, this study confirms the need for industrial zoning-based carbon emission control and increased buffer vegetation around industrial areas to support environmental sustainability.

KEYWORDS
Carbon Emissions; Spatial Distribution; Impact of Carbon Emissions on the Environment.

Received: August 18, 2025 **Acepted**: August 29, 2025 **Published**: September 30, 2025

Citation:
Novelia, N., Putri, R. E., & Ulni, A. Z. P. (2025). Spatial Assessment of Carbon Emissions Caused by Industrial Activities in Batang Anai, West Sumatra. *Jurnal Penelitian Geografi, 13*(2), 409-418. http://dx.doi.org/10.23960/jpg.v13.i2.33628

INTRODUCTION

Industry is a crucial sector in economic development because it contributes significantly to increasing regional income, creating jobs, and accelerating economic growth (Suparyanto, 2023; Utra et al., 2021). However, industrial activity also creates environmental problems,

particularly carbon emissions, which play a significant role in global warming and climate change (IPCC, 2020). Carbon emissions in industrial areas not only impact air quality but also affect public health, reduce the comfort of life, and threaten the sustainability of the environment surrounding the industrial area (Pipit Muliyah, 2020; Ayuningsasi, 2024). This situation makes the study of carbon emissions in industrial areas a strategic issue that requires serious attention, especially in areas with high industrial concentrations such as Batang Anai District, Padang Pariaman Regency.

A number of previous studies Studies have highlighted the relationship between industrial activity and carbon emissions, but with different focuses. Renda Avista (2014) examined CO_2 emissions in the sugar industry using a direct observation approach, while Labiba et al. (2018) analyzed the distribution of CO_2 emissions in Kendal to support low-carbon city-based spatial planning. Pavita Ramadhani's (2020) research focuses more on the quality of carbon emission disclosure across various industry types. Internationally, Caldeira (2021), Gillillan et al. (2021), and Schipper et al. (2021) emphasize the dominant role of the energy, industry, and transportation sectors in contributing to global carbon emissions.

Meanwhile, research by Suhardi (2020) and Kelvin et al. (2021) emphasizes the accumulation of greenhouse gases due to human activities since the industrial revolution. Other studies by Davis (2020), Widyawati et al. (2021), and Fairuz et al. (2024) showed that population density, industrial spatial patterns, and transportation activities contribute to the rate of carbon emissions. However, research integrating spatial analysis of carbon emissions based on Geographic Information Systems (GIS) in the Batang Anai region is still very limited, making this study novel and an important contribution to both academic literature and environmental policy.

Based on these conditions, this study aims to analyze the spatial distribution of carbon emissions in Batang Anai District and identify their impacts on environmental quality and public health around the industrial area. Using a GIS-assisted spatial analysis approach, this study is expected to provide a more comprehensive picture of the distribution of carbon emissions and serve as a basis for formulating mitigation and spatial planning policies oriented towards environmental sustainability.

METHOD

This study uses a quantitative descriptive approach with Geographic Information System (GIS) -based spatial analysis to illustrate the spatial distribution of carbon emissions in Batang Anai District, Padang Pariaman Regency. The study area covers three villages within the Batang Anai District. Primary data was obtained through field surveys, GPS point coordinate measurements, observations of the impact of carbon emissions on the community, and data collection on land cover related to carbon emissions. The sampling technique used purposive sampling considering affected areas within a 2 km radius of the industrial site.

Data processing was carried out through two stages of analysis. First, the spatial distribution of carbon emissions was analyzed using ArcGIS software to map the distribution of carbon emissions. Second, an analysis of affected settlements was conducted using a Likert scale to assess the level of impact on the community. The results of the analysis were then presented in the form of maps, tables, graphs, and descriptive narratives, thus providing a comprehensive overview of the spatial condition of carbon emissions in Batang Anai District.

Research Location

This research was conducted in Batang Anai District, Padang Pariaman Regency, West Sumatra Province . The location was selected based on several rational considerations, namely:

1. The concentration of industrial activity in Batang Anai has the potential to be a source of carbon emissions, so it is relevant to study its environmental impact.
2. Diverse land cover conditions , including forest areas, settlements, agricultural land, and industrial areas, allow for analysis of differences in carbon stocks and emissions in each land use category.
3. The proximity of residential areas to industrial areas , so that the potential impact of carbon emissions on environmental quality and public health can be directly observed.
4. Availability of spatial data and regional accessibility , which facilitates field data collection and analysis based on Geographic Information Systems (GIS).

With these considerations, Batang Anai is considered representative as a research location to describe the spatial distribution of carbon emissions while assessing their impact on the environment and surrounding communities.

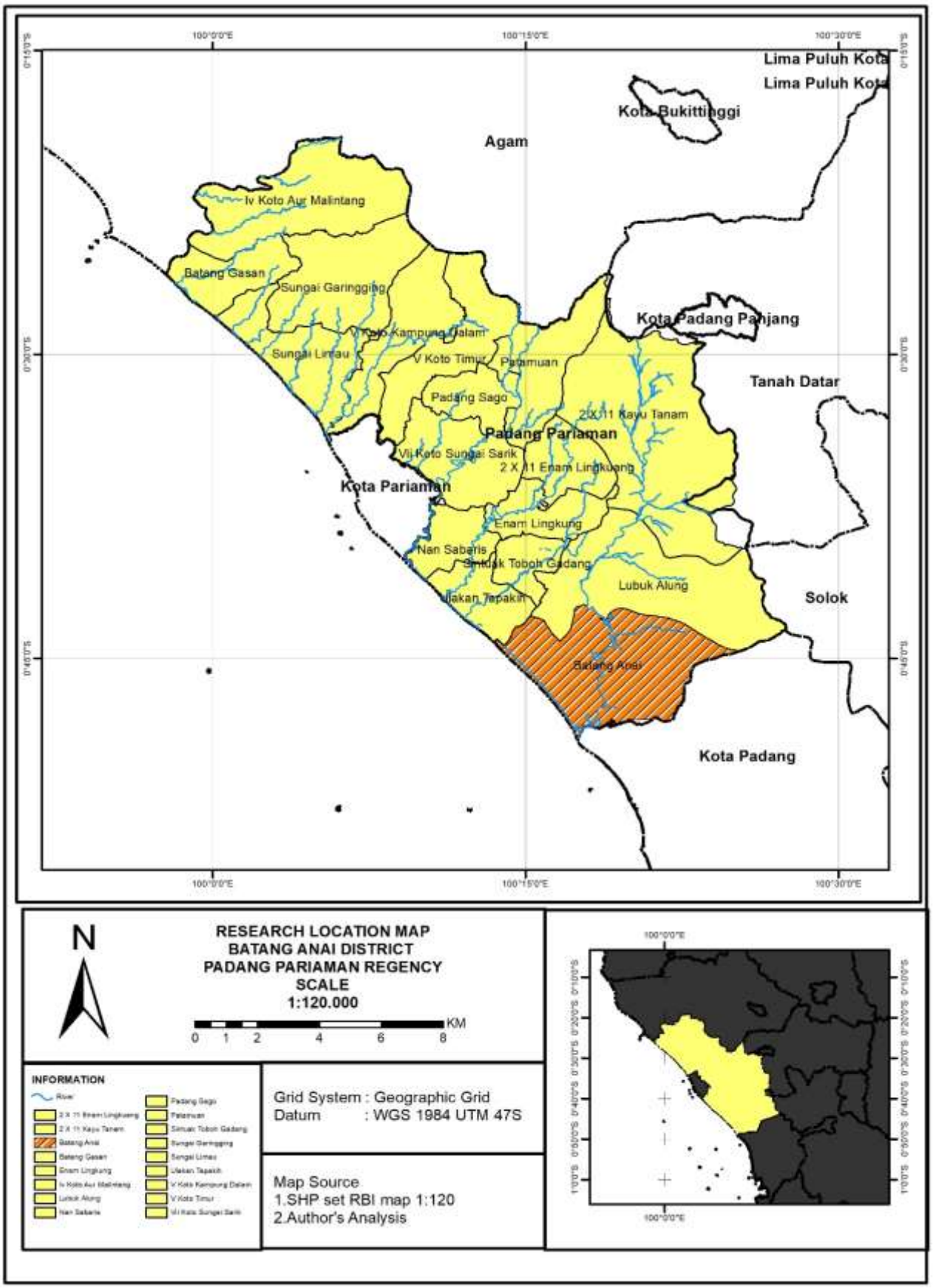

Figure 1. Research Location

Research Approach

This research uses a quantitative descriptive approach with spatial analysis. This approach was chosen because it aims to objectively describe the phenomenon of carbon emissions due to industrial activities, based on numerical data obtained from field measurements, image interpretation, and community survey results. This approach is suitable for explaining actual conditions without manipulating the research variables (Ardi Isnanto, 2023).

Quantitative descriptive methods are combined with Geographic Information Systems (GIS)-based spatial analysis. The use of GIS is based on the need to map the distribution of carbon emissions, link them to land cover, and identify areas with varying levels of emission risk. GIS enables the integration of spatial data (industrial locations, land-use changes) with attribute data (emission concentrations, public perceptions), resulting in more comprehensive visual and analytical information (Budiman, 2016; Kemp, 2008).

The research design used was a regional case study, specifically Batang Anai District, as a representative strategic industrial area in Padang Pariaman Regency. This location was selected based on the high concentration of industry in three main villages (Kasang, Katapiang, and Sungai Buluh) and indications of significant ecological and social impacts. This design allows the research to examine phenomena in depth within a specific regional context while simultaneously providing practical contributions to spatially based environmental management policies.

Research Procedures

This research procedure was carried out through several systematic stages so that the results obtained could represent the actual condition of carbon emissions in Batang Anai District. The initial stage was pre-research, which began with a literature review on carbon emissions, industry, and the use of Geographic Information Systems (GIS). During this stage, secondary data was also collected in the form of land cover maps for 2015 and 2025, industrial data, and population data from relevant agencies. Next, the researchers prepared research instruments such as questionnaires, GPS devices, and ArcGIS software as the main tool for spatial data processing. These stages include:

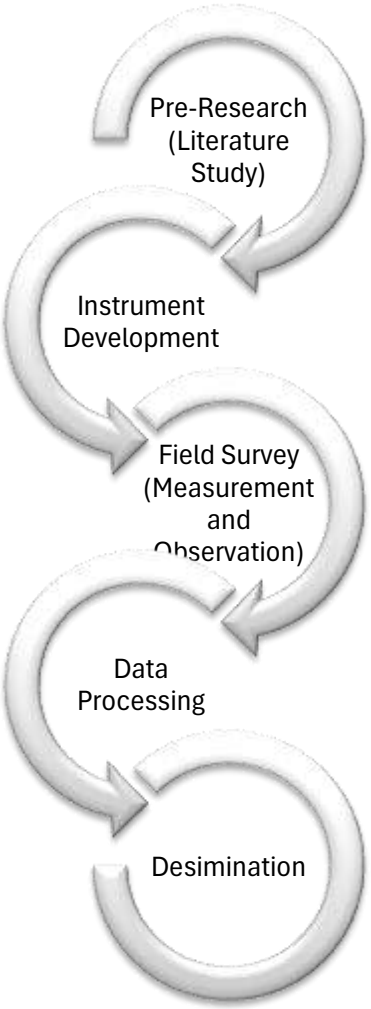

Figure 2. Research Procedure Diagram

Specifically, it is explained as follows:

1. Pre-Research
   i. Conducting literature studies related to carbon emissions, industrial activities, and the use of Geographic Information Systems (GIS).
   ii. Collecting secondary data in the form of land cover maps for 2015 and 2025, industrial data, and population data from relevant agencies.
   iii. Prepare research instruments, such as questionnaires, GPS devices, and ArcGIS software.

2. Field Data Collection
   i. Primary data : obtained through field surveys to measure the coordinates of industrial locations using GPS, observing environmental conditions around the industrial area, and distributing questionnaires to 100

respondents living within a 2 km radius of the industrial area in Nagari Kasang, Katapiang, and Sungai Buluh.

ii. Secondary data: obtained from official institutions such as BPS, KLHK, and local governments regarding the number of industries, air quality data, and demographic conditions of the community.

3. Spatial analysis : performed using overlay techniques using ArcGIS software to combine carbon emission maps with land cover maps. Carbon emission concentrations were calculated using the following formula:

$$Chilang = C.Awal - C.Akhir$$
$$CO2\_eq = C.Hilang\ X\ 44/12$$

Data Collection Instruments

The data collection instruments in this study were designed to obtain primary and secondary data relevant to the research objectives. The main instrument used was a questionnaire.

, a Global Positioning System (GPS) device, Geographic Information System (ArcGIS) software, and documentation tools such as a camera and field notes. A questionnaire was used to explore public perceptions regarding the impact of carbon emissions on health, environmental quality, and socioeconomic conditions. The selection of this instrument was based on the questionnaire's ability to produce measurable quantitative data and allows researchers to identify variations in respondents' responses through the questionnaire (Table 1).

Table 1. Questionnaire Question Items

No.	Question's Item
1.	The air around the residence feels stuffy or smells
2.	Often see thick smoke in the home environment
3.	Frequently smelling unusual odors, such as smoke or chemicals, in the living environment
4.	Often see fog or a thin layer of smoke in the air, especially at certain times.
5.	When breathing outside the house, you often feel like you are inhaling fine dust particles or dirt.
6.	Visibility in residential areas is often impaired due to air pollution.
7.	The plants or trees around my house look dull, wilted, or covered in a layer of dust.
8.	The smell of industry often lingers in the house.
9.	The air feels hotter or less fresh than usual due to pollution.
10.	Water surfaces (e.g. in a bathtub or bucket) exposed to the outside air often appear cloudy or oily.

In addition to questionnaires, GPS was used to determine the coordinates of industrial and residential locations around the research area. This instrument was chosen for its high accuracy in mapping spatial positions, allowing the obtained data to be directly integrated with ArcGIS software. ArcGIS itself functions as a spatial analysis tool to overlay carbon emission maps with land cover maps, visualize the spatial distribution of emissions, and generate thematic maps for analysis. Meanwhile, field documentation was used to strengthen the empirical findings and provide a more comprehensive descriptive picture.

Data analysis

Data analysis in this study was conducted by combining Geographic Information System (GIS)-based spatial analysis and quantitative descriptive analysis. Spatial analysis was used to map the distribution of carbon gas emissions based on industrial locations and land cover changes in 2015 and 2025. Overlay techniques in ArcGIS software were applied to combine carbon emission maps with land cover maps to obtain an overview of low, medium, and high emission zones. Carbon concentration was calculated using the following formula:

$$Chilang = C.Awal - C.Akhir$$
$$CO2\_eq = C.Hilang\ X\ 44/12$$

(Gibbs et al., 2022), which allows researchers to quantitatively assess changes in carbon stocks.

Furthermore, the questionnaire data was analyzed descriptively using a Likert scale to measure public perceptions of the impact of carbon emissions on health, the environment, and socioeconomics. Each question was scored between 1 and 5, which were then processed to obtain frequency distributions and percentages. These results were used to identify respondents' level of achievement on each indicator, which was then

categorized into very good, good, sufficient, poor, and very poor.

The final step is interpretation of the results, which involves integrating spatial data with public perception data to obtain a comprehensive picture of the distribution of carbon emissions and their impacts. With this approach, data analysis not only provides a visual map of emissions distribution but also explains their implications for air quality, public health, and socioeconomic conditions. This analysis technique was chosen because it aligns with the research objectives, area .

which sought to address the spatial distribution of carbon emissions in Batang Anai District and its impact on the environment and communities surrounding the industrial

RESULTS AND DISCUSSION

The research results show that the spatial distribution of carbon emissions in Batang Anai District is divided into three categories: low, medium, and high. The overlay map shows the land cover for 2015-2025.

LAND COVER CONDITION OF STUDY AREA

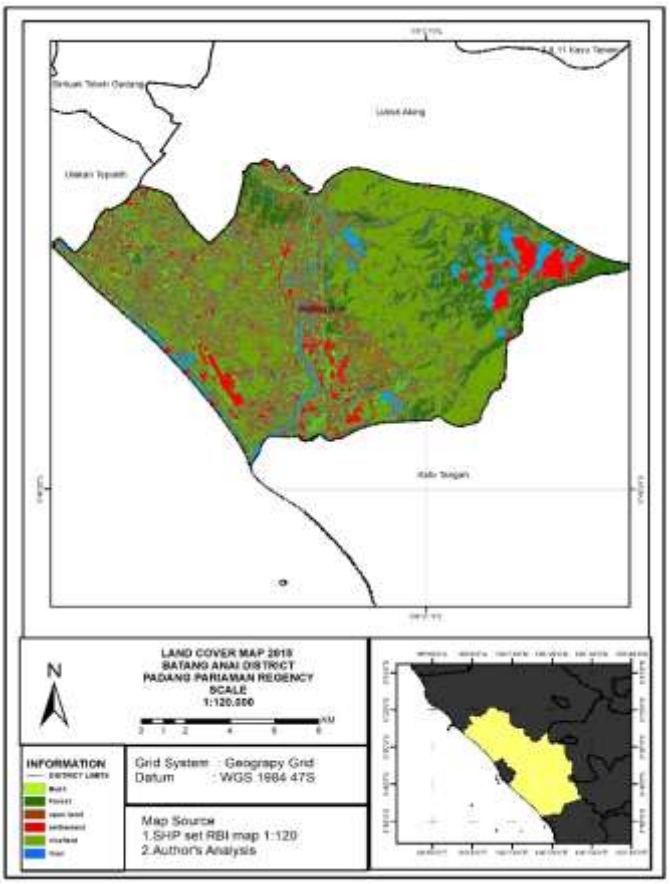

Figure 3. Land cover 2015

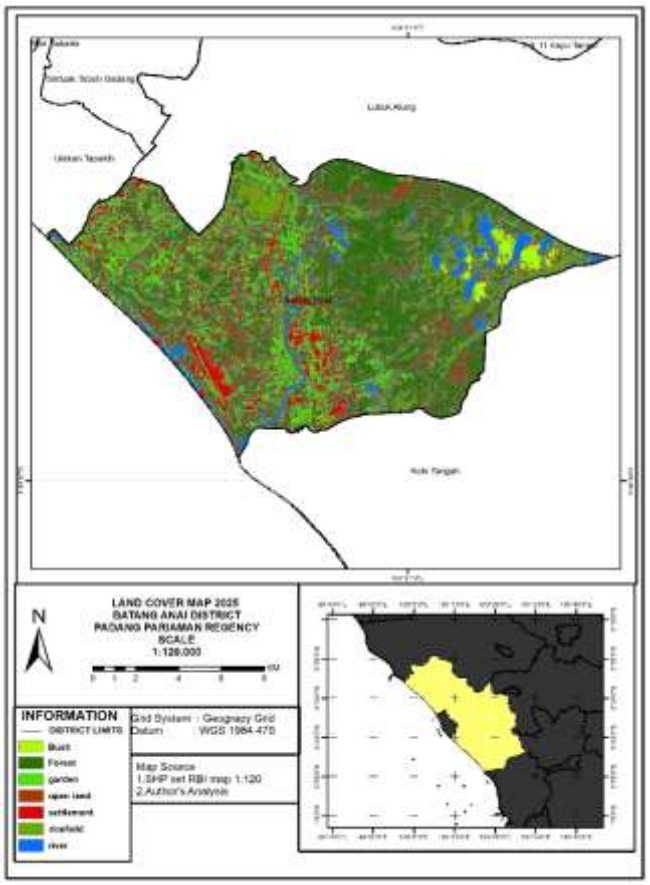

Figure 4. Land Cover 2025

Kasang Village has the highest emission levels with significant carbon concentrations, followed by Katapiang Village at a moderate level, and Sungai Buluh Village at a relatively low level. The high emissions in Kasang are related to the presence of eight large industries, including palm oil processing and manufacturing plants, which require large amounts of energy, resulting in higher carbon emissions. This is in line with the findings of Gilfillan et al. (2021) who stated that the industrial and energy sectors are major contributors to global carbon emissions.

This indicates a significant decrease in carbon stocks in vegetation and agricultural land surrounding industrial areas. The calculation formula, C.loss = C.initial – C.final, indicates that the loss of carbon stocks is caused by land conversion to industrial and residential

areas. This condition supports the research findings of Widyawati et al. (2021), which found that increasing population density and land use conversion are directly correlated with increased carbon emissions.

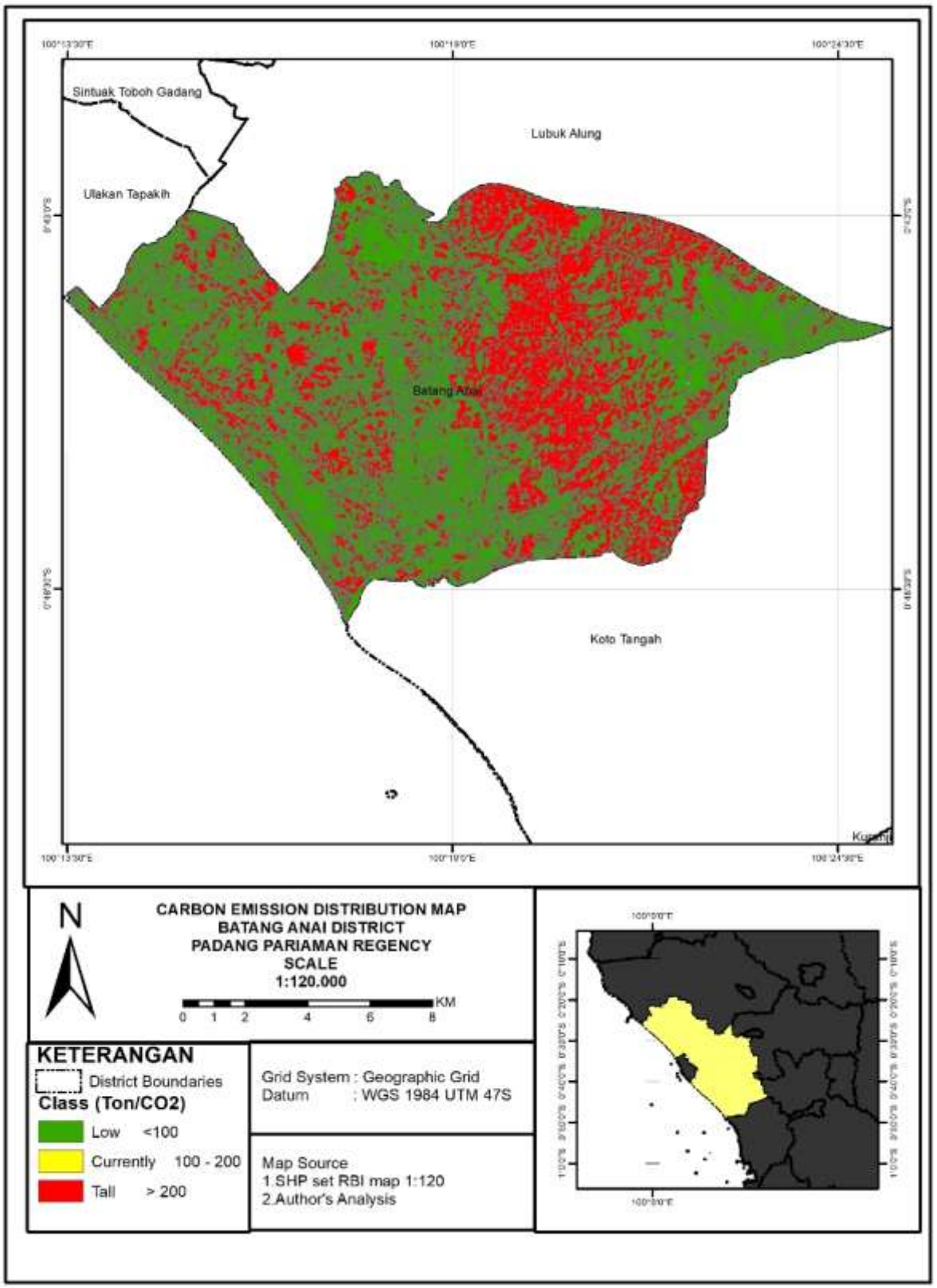

Figure 5. Information on the Distribution of Carbon Gas Emissions

Table 2. Information of Carbon Emission Distribution

No	Information	Wide	Score	Carbon
1	River	703,341	0	0
2	Settlement	1122.23	10	11222.3
3	Forest	2057.2	150	747208
4	Open Land	2023.54	2	4047.08
5	Thicket	272,438	30	8173.15
6	Ricefield	1727.91	5	8639.54
7	Garden	3253.99	50	162700
	Total	**11160.5**	**247**	**941990**

Source: Data Analysis (2025)

A field survey of one hundred respondents in three villages showed that 72% of residents felt a decline in air quality, 64% reported an increase in dust and air temperature, and 58% experienced respiratory problems such as coughing, shortness of breath, and irritation. These results align with research by Fairuz et al. (2024) which confirms that carbon emissions impact public health, particularly in the form of respiratory diseases. Furthermore, 43% of respondents stated that their work productivity decreased due to unhealthy air quality, while 39% reported a decrease in agricultural yields, which impacted household income. This aligns with Taftazani's (2024) findings that industrial air pollution not only impacts health but also reduces the productivity of the agricultural sector and the local economy.

Compared to previous research, this study provides a novel contribution through the use of GIS-based spatial analysis, which can map the distribution of carbon emissions in greater detail down to the village level. Renda Avista (2024) only focused on analyzing the carbon footprint of a single industry without considering spatial aspects, while Labiba et al. (2021) highlighted the distribution of carbon emissions in Kendal but did not integrate spatial data in depth. Therefore, this study broadens our understanding of how emission distribution is related not only to the number of industries but also to land use patterns and settlement density.

The findings of this study also align with Pavita Ramadhani (2020), who emphasized the importance of transparent disclosure of carbon emissions by companies, although this study focused more on spatial aspects than on information disclosure. Furthermore, this study corroborates the conclusions of Davis (2020) and Schipper et al. (2021) that transportation and industrial activities are the dominant sectors contributing to increasing carbon emissions, as seen in Batang Anai, which has dense transportation access to the port and airport. For further clarity, see Figure 5.

Theoretically, the results of this study also reinforce the concept of Environmental Risk Theory, which states that communities living near industrial areas are more susceptible to diseases caused by exposure to air pollution (Kelvin et al., 2023). The conditions of the Batang Anai community, the majority of whom live within a radius of less than two kilometers from the industrial area, demonstrate the relevance of this theory. Thus, this study confirms that the risks of carbon emissions not only impact ecology but also have implications for public health and socio-economic sustainability.

Based on the research results, it can be concluded that the spatial distribution of carbon emissions in Batang Anai is influenced by industrial density, changes in land cover, and high fossil fuel consumption. These impacts include decreased air quality, health problems, and decreased economic productivity. Integrating spatial analysis with social survey data provides a more comprehensive picture and reinforces the urgency of implementing industrial zoning-based emission control policies and the development of green belts around industrial areas. However, this study has limitations, including the limited availability of up-to-date secondary data, the limited scope of the field survey, and the failure to account for seasonal factors such as wind direction and rainfall, which can also influence emission distribution patterns.

CONCLUSION

Distribution of Carbon Gas Emissions in Batang Anai District shows significant differences between land cover types. The highest emissions were found in forest land with a value of 274 tc/Ha , while the lowest emissions were found in river land with a value of 0 tc/Ha . This finding identifies that forest land cover plays a major role in carbon emissions , so forest management plays an important role in climate change mitigation efforts in the region. The impact of carbon emissions on environmental quality and public health in Batang Anai. From a physical perspective, air quality has declined, visibility has been impaired, and the odor of smoke and water pollution have emerged, reducing the comfort of the settlement. From a health perspective, the questionnaire results indicated a "sufficient" category, with frequent symptoms including coughing, shortness of breath, eye irritation, and fatigue,

which have begun to disrupt residents' daily activities. Meanwhile, from a socio-economic perspective, carbon emissions have affected living comfort and social interactions, and increased household costs, particularly for health and additional needs due to poor environmental quality. Overall, these conditions confirm that carbon emissions have reduced the quality of life of the community and require immediate action to prevent more serious impacts.

Acknowledgements, The authors express their deepest appreciation to the University of PGRI West Sumatra, especially the Faculty of Geography, for providing academic support and facilities for this research. They also express their gratitude to the Padang Pariaman Regency Government, the Environmental Agency, and the Central Statistics Agency for providing the necessary secondary data. Special appreciation is extended to the communities in Kasang, Katapiang, and Sungai Buluh villages, Batang Anai District, who took the time to participate as respondents in the field survey. The author also thanks his supervisor and fellow students for their guidance, input, and support throughout the research process and the writing of this article. This research was supported by the author's own funding, with no external funding affiliations, but received moral and technical support from academic institutions and related parties.

Conflict of Interest: The author has no competing interests to declare that are relevant to the content of this article.

REFERENCES

Sendi, S. 2018. *Distribusi Spasial Industri Di Kabupaten Padang Pariaman*, Program Study Pendidikan Geografi, STKIP PGRI Sumatera Barat, 2018

Accuweather. (2025). *indeks kualitas udara*.

Aini, A. (2023). Sistem Informaasi Pengertia Dan Aplikasinya. *Angewandte Chemie International Edition, 6(11), 951–952.*, 5–24.

Anasiru, Rahmat HanifAnasiru, R. H. (2018). Analisis Spasial Dalam Klasifikasi Lahan Kritis Di Kawasan Sub-Das Langge Gorontalo. Informatika Pertanian, 25(2), 261. https://doi.org/10.21082/ip.v25n2.2016.p261-272.(2018).

Analisis Spasial Dalam Klasifikasi Lahan Kritis Di Kawasan Sub-Das Langge Gorontalo. *Informatika Pertanian*, *25*(2), 261. https://doi.org/10.21082/ip.v25n2.2016.p261-272

Ardi isnanto, B. (2023). (1. 2. 3 : *Detikproperti*, *09*, 119–121.

BPS Sumatera Barat. (2023). Badan Pusat Statistik Provinsi Sumatera Barat. *BPS Sumbar*, 1.

Budiman, E. (2016). Analisis Spasial Data Jaringan Internet Service Provider Di Kecamatan Sungai Pinang Kota Samarinda Berbasis Mobile. *ILKOM Jurnal Ilmiah*, *8*(1), 1–8. https://doi.org/10.33096/ilkom.v8i1.5.1-8

Darajati, Nugroho, D., & Rianto, A. (2022). Strategi Indonesia Dalam Mengurangi Emisi Karbon Dioksida (Co2) Di Masa New Normal. *Prosiding Ilmu Pemerintahan*, *1*(1), 228–242. https://e-journal.umc.ac.id/index.php/IP/article/view/2712

Davis, S. J., & Caldeira, K. (2020). Consumption-based accounting of CO2 emissions. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(12), 5687–5692. https://doi.org/10.1073/pnas.0906974107

De Koninck, R., & Rousseau, J.-F. (2020). Industrie. *Les Poids Du Monde*, *3*, 133–166. https://doi.org/10.2307/j.ctv18pgmp6.9

Dekanawati, V., Astriawati, N., Setiyantara, Y., Subekti, J., & Kirana, A. F. (2023). Analisis Pengaruh Kualitas Pelayanan Diklat Kepabeanan Terhadap Kepuasan Peserta Pelatihan. *Jurnal Sains Dan Teknologi Maritim*, *23*(2), 159. https://doi.org/10.33556/jstm.v23i2.344

Fairuz Rofifah Arifin. (2024). Analisis Pengaruh Emisi Zat Karbon terhadap Kerusakan Kualitas Udara dan Pencemaran Lingkungan. *Journal Innovation In Education*, *2*(1), 278–287. https://doi.org/10.59841/inoved.v2i1.1043

Febryanti, Syah, N., & Razak, A. (2024). Analisis Jejak Karbon Dalam Produksi Dan Konsumsi Energi :Menuju Ekonomi Hijau. *Gudang Jurnal Multidisiplin Ilmu*, *2*(1), 197–201.

Firdaus, A. R., Vynatria, A. D., Husna, S. L., Alfareza, M. F. N., & Hidayah, A. A. (2024). Ekonomi Kreatif Sebagai Lokomotif Baru Perekonomian Indonesia Menuju Indonesia Yang Maju. *MANABIS: Jurnal Manajemen Dan Bisnis*, *3*(2), 44–52. https://doi.org/10.54259/manabis.v3i2.2518

Gilfillan, D., Marland, G., Carolina, N., & Carolina, N.

(2021). *CDIAC-FF : global and national CO 2 emissions from fossil fuel combustion and cement manufacture : 1751 – 2017*. 1667–1680.

Hikmah, J. (2020). Paradigm. *Computer Graphics Forum*, *39*(1), 672–673. https://doi.org/10.1111/cgf.13898

Informasi, S., Sig, G., Lokasi, M., Wibowo, K. M., Kanedi, I., & Jumadi, J. (2025). *PERTAMBANGAN BATU BARA DI PROVINSI BENGKULU*. *11*(1), 51–60.

Kelvin, C., Daromes, F. E., & Ng, S. (2022). Pengungkapan Emisi Karbon Sebagai Mekanisme Peningkatan. *Dinamika Akuntansi, Keuangan, Dan Pebankan*, *6*(1), 1–18.

Kulonprogo, D. I. K. (n.d.). *APPLICATION OF MAPPING AND SPATIAL ANALYSIS TO STUDY THE POTENCY OF SMALL RUMINANT LIVESTOCK IN KULONPROGO DISTRICT*. 1–11.

Lingkungan, K., Dan, H., Direktorat, K., Pengendalian, J., Dan, P., & Lingkungan, K. (2020). *Statistik Kualitas Air, Udara, dan Tutupan Lahan STATISTIK 2020*. 1–226.

Pangestu, R. C. K., & Ayuningsasi, A. A. K. (2024). Pengaruh Konsumsi Energi Sektor Industri, Rumah Tangga, dan Transportasi terhadap Emisi Karbon di Indonesia. *Inisiatif: Jurnal Ekonomi, Akuntansi Dan Manajemen*, *3*(4), 297–311.

Perusahaan, T. N. (2020). *304918614*. *22*(1), 42–52.

Pipit Muliyah, Dyah Aminatun, Sukma Septian Nasution, Tommy Hastomo, Setiana Sri Wahyuni Sitepu, T. (2020). *Journal GEEJ*, *7*(2).

Putra, R. A., Nasution, M. A., & Suriadi, A. (2021). Analisis Peranan Dinas Perindustrian Dan Perdagangan Dalam Pengembangan Industri Kecil Di Kota Medan. *GOVERNANCE: Jurnal Ilmiah Kajian Politik Lokal Dan Pembangunan*, *8*(1), 39–47. https://doi.org/10.56015/governance.v8i1.32

Taftazani, F. A. (2024). Penanggulangan Pencemaran Teluk Jakarta Untuk Menurunkan Emisi Karbon. *Riset Sains Dan Teknologi Kelautan*, *7*(1), 16–21. https://doi.org/10.62012/sensistek.v7i1.31616

Tumbelaka, V., Kindangen, J. I., & Rengkung, J. (2022). Morfologi Kawasan Permukiman Akibat Keberadaan Kawasan Kampus Universitas Sam Ratulangi Di Kelurahan Bahu Dan Kleak. *Spasial*, *6*(1), 59–67.

Wasis, B., Saharjo, B. H., Arifin, H. S., & Prasetyo, A. N. N. (2022). Perubahan Penutupan Lahan dan Dampaknya terhadap Stok Karbon Permukaan pada Daerah Aliran Sungai Ciliwung. *Jurnal Silvikultur Tropika*, *03*(02), 108–113.

Widodo, S., Ladyani, F., Asrianto, L. O., Rusdi, Khairunnisa, Lestari, S. M. P., Wijayanti, D. R., Devriany, A., Hidayat, A., Dalfian, Nurcahyati, S., Sjahriani, T., Armi, Widya, N., & Rogayah. (2023). Metodologi Penelitian. In *Cv Science Techno Direct*.

Widyawati, R. F., Hariani, E., Ginting, A. L., & Nainggolan, E. (2021). Pengaruh Pertumbuhan Ekonomi, Populasi Penduduk Kota, Keterbukaan Perdagangan Internasional Terhadap Emisi Gas Karbon Dioksida (CO2) Di Negara ASEAN. *Jambura Agribusiness Journal*, *3*(1), 37–47. https://doi.org/10.37046/jaj.v3i1.11193