Jurnal Serambi Engineering JSE
Volume X, No.2, April 2025 Hal 13244 - 13251
p-ISSN : 2528-3561
e-ISSN : 2541-1934

Mapping the Research Landscape of Greenhouse Gases: A Bibliometric Approach

Nur Faizaturrohmah, Mia Erpinda*, Suci Wulandari

Environmental Engineering Department, Faculty of Infrastructure and Regional Development Technology, Institut Teknologi Sumatera
***Corresponding Author**: mia.erpinda@tl.itera.ac.id

Received: April 01, 2025 Accepted: April 11, 2025

Abstract
Greenhouse gas (GHG) emissions are the primary driver of climate change and have become a significant concern in recent decades due to their increasing atmospheric concentration. This study aims to systematically review research trends on GHG emissions over the past 20 years using bibliometric analysis. A total of 1,035 articles were analyzed through VOSviewer to map knowledge structure, research dynamics, and emerging topics. The results show that GHG emission research is divided into six main clusters: (1) gas emissions, (2) industrial and waste management, (3) air quality and human health, (4) bioenergy and energy systems, (5) food production, and (6) global climate change mitigation. Research trends indicate a shift from sectoral studies, particularly agriculture and livestock production (2005–2016), to a more integrated and systemic approach involving energy systems, air quality, and human health (2020–2024). The density visualization highlights “gas emission” as the most frequent and central keyword. Moreover, keywords such as "Municipal Solid Waste Treatment," "Energy Production," and "Domestic GHG Mitigation" have emerged as future research hotspots. This study provides a comprehensive overview of GHG emission research developments and offers valuable insights for identifying future research directions and supporting GHG mitigation strategies.
Keywords: *greenhouse gas emissions; bibliometric analysis; climate change; mitigation strategy; VOSviewer*

Abstrak
Emisi gas rumah kaca (GRK) merupakan penyebab utama perubahan iklim dan menjadi perhatian global dalam beberapa dekade terakhir akibat peningkatan konsentrasinya di atmosfer. Penelitian ini bertujuan untuk menyusun tinjauan sistematis terhadap tren penelitian emisi GRK selama 20 tahun terakhir melalui analisis bibliometrik. Sebanyak 1.035 artikel dianalisis menggunakan VOSviewer untuk memetakan struktur pengetahuan, dinamika penelitian, dan topik-topik yang berkembang. Hasil penelitian menunjukkan bahwa kajian emisi GRK terbagi ke dalam enam klaster utama, yaitu: (1) emisi gas, (2) sektor industri dan pengelolaan limbah, (3) kualitas udara dan kesehatan manusia, (4) bioenergi dan sistem energi, (5) produksi pangan, dan (6) mitigasi perubahan iklim secara global. Pola penelitian menunjukkan pergeseran dari pendekatan sektoral yang berfokus pada pertanian dan peternakan (2005–2016) menuju pendekatan yang lebih sistemik dengan integrasi sistem energi, kualitas udara, dan kesehatan manusia (2020–2024). Visualisasi kepadatan kata kunci menempatkan "gas emission" sebagai istilah yang paling sentral dan sering digunakan dalam penelitian terkait. Selain itu, beberapa topik seperti "Pengolahan Limbah Padat Perkotaan," "Produksi Energi," dan "Mitigasi GRK Domestik" berpotensi menjadi fokus utama penelitian masa depan. Studi ini memberikan gambaran komprehensif tentang perkembangan riset emisi GRK dan dapat menjadi referensi penting dalam merumuskan strategi mitigasi emisi yang lebih efektif
Kata Kunci: *emisi gas rumah kaca; analisis bibliometrik; perubahan iklim; strategi mitigasi; VOSviewer*

1. Introduction

The increasing unpredictability of climate change is one of the consequences of rising greenhouse gas (GHG) concentrations in the atmosphere. Greenhouse gases are a group of gases capable of trapping infrared radiation emitted by the Earth's surface, thereby inducing a warming effect similar to that of a greenhouse. The primary GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) [1]. These gases exhibit diverse characteristics and emission sources, depending on the human activities contributing to their release. In Indonesia, the industrial sector is the most significant contributor to GHG emissions, accounting

for 37%, followed by the transportation sector (27%) and the electricity and heat generation sector (27%) [2].

Human activities that disregard environmental impacts, particularly excessive resource exploitation, play a significant role in increasing GHG emissions. Numerous studies have highlighted that the primary source of CO_2 emissions originates from the energy sector, particularly the combustion of fossil fuels such as petroleum and natural gas. Additionally, coal combustion for power generation significantly elevates atmospheric CO_2 levels compared to other sectors [3]. Furthermore, industrial activities, biomass burning, livestock farming, agriculture, domestic waste management, and deforestation exacerbate this issue. The agricultural sector, for instance, not only emits CO_2 but also releases CH_4 and N_2O, which have substantially higher global warming potential than CO_2. Methane (CH_4) has a global warming potential 28 times greater than CO_2, while nitrous oxide (N_2O) is 256 times more potent. In the livestock sector, CH_4 emissions primarily result from enteric fermentation in ruminants, whereas N_2O emissions stem from nitrogen losses due to fertilizer application [4].

The increasing atmospheric concentration of GHGs is a primary driver of global warming, which has far-reaching consequences across various aspects of life. These impacts include rising global temperatures, sea level rise, extreme weather pattern shifts, and disruptions to economic, social, educational, and food security sectors [5]. If GHG emissions remain uncontrolled, atmospheric concentrations of these gases are expected to continue increasing, exacerbating the effects of climate change on a global scale.

Over the past few decades, climate change issues driven by carbon-based GHG emissions have remained a critical concern for nations worldwide [6]. This study aims to provide an overview of research trends on greenhouse gases over the last two decades. A systematic bibliometric analysis can help researchers identify approaches, models, and indicators that support the establishment of new research boundaries [7]. Knowledge mapping is a structured method for documenting the current state and content of research, tracing the historical development of a field, and identifying key actors and references. This approach enables academics to track, analyze, and discover relevant sources [8].

2. Material and Methods

Data Collection

This study employs a systematic literature review methodology, encompassing an initial identification phase to locate relevant articles aligned with the research focus, followed by metadata extraction. Directional citation data were retrieved from the Google Scholar database using specific search parameters—five key terms: *Greenhouse Gas Emissions, GHG Mitigation, GHG and Climate Change, and Carbon Emissions.* Literature searches were conducted using *Publish or Perish* version 8.17 software. The applied filters included a 20-year publication period (2004–2024), papers published in English, and 500 relevant scientific articles selected for subsequent bibliometric analysis using VOSviewer 1.6.20 software. Only journal articles were considered, excluding review-type documents. Data processing and analysis were conducted from February to March 2025.

VOSviewer Configuration and Visual Representation

This study utilizes VOSviewer software, applying a minimum co-occurrence threshold of two instances per keyword pair. Each color group represents conceptual linkages among analyzed terms. The results are presented through three visualization formats:

- **Network Visualization:** A network diagram mapping conceptual relationships between the keywords *Greenhouse Gas Emissions, GHG Mitigation, GHG and Climate Change, and Carbon Emissions.*
- **Overlay Visualization:** A layered representation to identify the development of the topics *Greenhouse Gas Emissions, GHG Mitigation, GHG and Climate Change, and Carbon Emissions* over a 20-year and 10-year period.
- **Density Visualization:** A density map illustrating the frequency distribution of terms within the keywords *Greenhouse Gas Emissions, GHG Mitigation, GHG and Climate Change, and Carbon Emissions.*

The VOSviewer analysis resulted in the formation of eight distinct clusters, each represented by a specific color code: Red (Cluster 1), Green (Cluster 2), Blue (Cluster 3), Yellow (Cluster 4), Purple (Cluster 5), Light Blue (Cluster 6), Orange (Cluster 7), and Pink (Cluster 8). The visual markers, including circles and text, are proportionally scaled—the larger the circle and font size, the higher the term's occurrence

frequency in titles and abstracts, facilitating the identification of key research themes within the field [7, 10, 11]. In bibliometric studies, keywords with high occurrence frequencies in specific periods indicate potential research focal points, emerging trends, or key areas of study during that time [9].

3. Results and Discussion

Network visualization

The visualization generated from the bibliometric analysis using the VOSviewer method includes three main types of visualization: *network visualization, overlay visualization, and density visualization*. These visualizations display six distinct clusters, each represented by a different color. The size of the circles within each cluster reflects the frequency of keyword usage; the larger the circle, the more frequently the keyword appears in the literature [12]. Based on the analysis of greenhouse gas emissions research dynamics over the past 20 years using VOSviewer, eight clusters were identified, with six that can be distinguished.

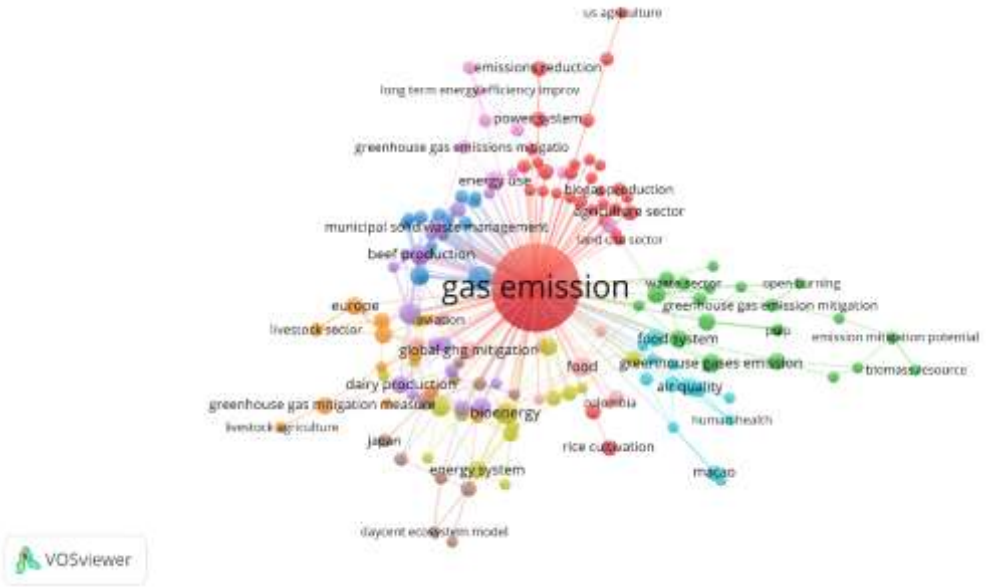

Figure 1. *Network Visualization*
Source: Processed Data Results in *VOSviewer*, 2025

Figure 1 presents a bibliometric visualization of the topic *"gas emission,"* analyzed using VOSviewer software. In this visualization, eight clusters are represented by different colors, each indicating the relationships between keywords in research related to greenhouse gas emissions. The red cluster, centered on *"gas emission,"* includes keywords such as *greenhouse gas emissions mitigation, emissions reduction*, and *energy system*, highlighting emission reduction strategies and climate change mitigation. The green cluster is associated with the industrial sector and waste management, as indicated by keywords such as *pulp, open burning*, and *waste sector*, reflecting the sector's contribution to greenhouse gas emissions and various mitigation efforts. In the pulp and paper industry, coarse woody debris from fallen trees also potentially contributes to CO_2 emissions. This is due to the decomposition process, which does not occur instantly, leading to a gradual release of CO_2 over a certain period [13].

The blue cluster focuses on air quality and its impact on human health, as indicated by the keywords *air quality, human health*, and *greenhouse gas emissions*. The yellow cluster discusses bioenergy and energy systems, including keywords such as *bioenergy* and *energy use*, emphasizing the role of energy transition in reducing emissions. The orange cluster represents the food production sector, including keywords such as *livestock sector* and *livestock agriculture*, demonstrating the agricultural sector's contribution to nitrous oxide emissions [4]. The purple cluster is related to climate change mitigation, with keywords such as *global GHG mitigation* and *long-term energy efficiency improvement*. Overall, this visualization demonstrates that research on greenhouse gas emissions covers various aspects, including emission sources, their impacts, and mitigation strategies involving the energy sector, agriculture, health, and environmental policies.

Overlay visualization

Figure 2 the colors in the 10-year overlay can be grouped based on the year of research. Red and orange represent more recent themes (2020–2024), while blue and green indicate topics that have been studied for longer (2014–2018). In the early period (2014–2016), research focused more on agriculture and livestock production, particularly in Europe. Keywords such as *greenhouse gas emissions mitigation*, *dairy production*, and *beef production* dominated, reflecting concerns about the impact of agricultural activities on GHG emissions. Issues related to *long-term energy efficiency improvement* and *municipal solid waste management* also emerged, indicating efforts to integrate technical and managerial approaches in emission mitigation. Between 2018 and 2020, research diversified with new themes such as *biogas production* and *biomass resources*, signaling a transition toward renewable energy sources. The *land use sector* and *food system* also gained more attention, particularly environmental sustainability. Moreover, research expanded beyond Europe, with the emergence of keywords such as *Japan* and *global gas mitigation*, indicating increased international collaboration in addressing GHG emissions.

In recent years, there has been a growing focus on understanding GHG emissions, their mechanisms, and the influence of various environmental factors, demonstrating advancements in methodologies and technologies over time [14]. During the latest period (2020–2024), research has become more holistic by integrating human health (*human health*) and air quality (*air quality*) issues. Keywords such as *open burning* and *emission mitigation potential* highlight specific practices contributing to emissions. Additionally, the emergence of *energy and power systems* reflects a systemic approach to emission mitigation analysis, considering not just individual sectors but also their interconnections. The overlay visualization reveals strong linkages between the agriculture, energy, and waste sectors. *Biogas production* is connected to *municipal solid waste management* and the *agriculture sector*, reinforcing the role of organic waste as an alternative energy source. *Greenhouse gas mitigation measures* are a central link among different sectors, indicating that mitigation strategies are multi-dimensional.

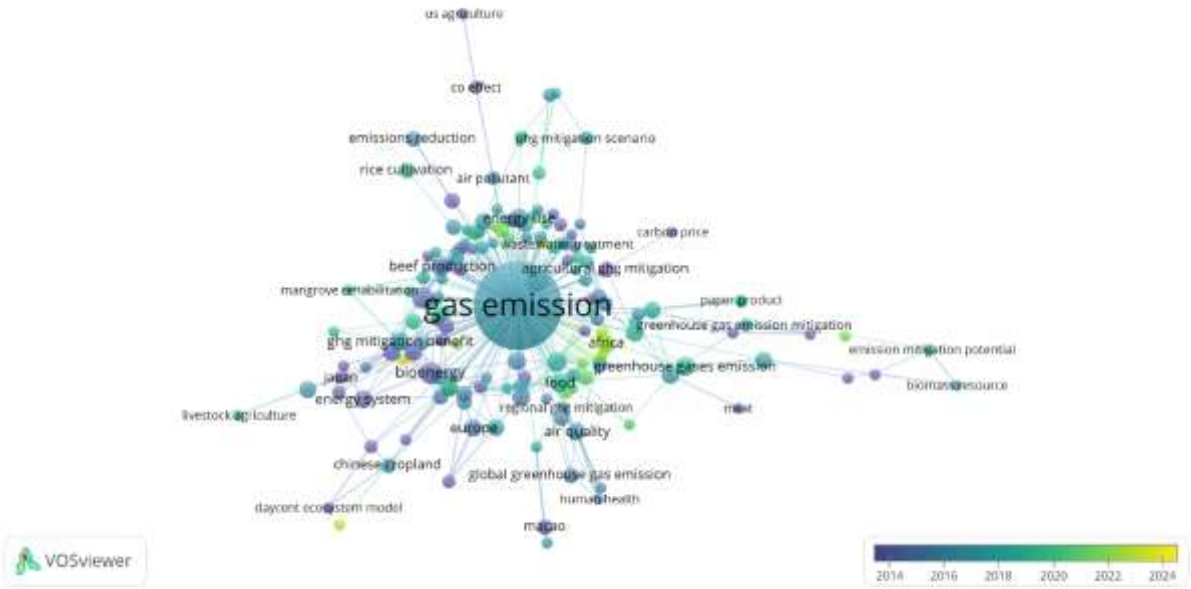

Figure 2. Overlay 2014-2024 (10 years)
Source: Processed Data Results in *VOSviewer*, 2025

The comparative analysis of overlay visualization in VOSviewer (**Figure 3**) reveals significant developments in research trends on greenhouse gas (GHG) emission mitigation between 2005–2020 and 2014–2024. During the early phase (2005–2020), research was dominated by sectoral approaches, as indicated by the concentration of blue-green nodes on specific topics such as rice cultivation and beef production. Mitigation analysis in this period remained exploratory and fragmented, primarily focusing on identifying emission sources rather than formulating comprehensive mitigation strategies. In contrast, the 2014–2024 period marks a paradigm shift toward systemic approaches, characterized by the dominance of yellow-red nodes. This shift signifies integrating multidisciplinary aspects, including energy systems, human health, and air quality. The evolution of research trends indicates a maturation of the field, transitioning from merely identifying emission sources to developing holistic solutions that incorporate technical, environmental, and socio-economic dimensions. This period also emphasizes the role of

renewable energy (biogas production), circular economy (waste management), and intensified international collaborations within sustainable development. The increasing complexity and interconnectedness of research topics suggest a growing recognition of the need for integrated strategies to mitigate GHG emissions effectively.

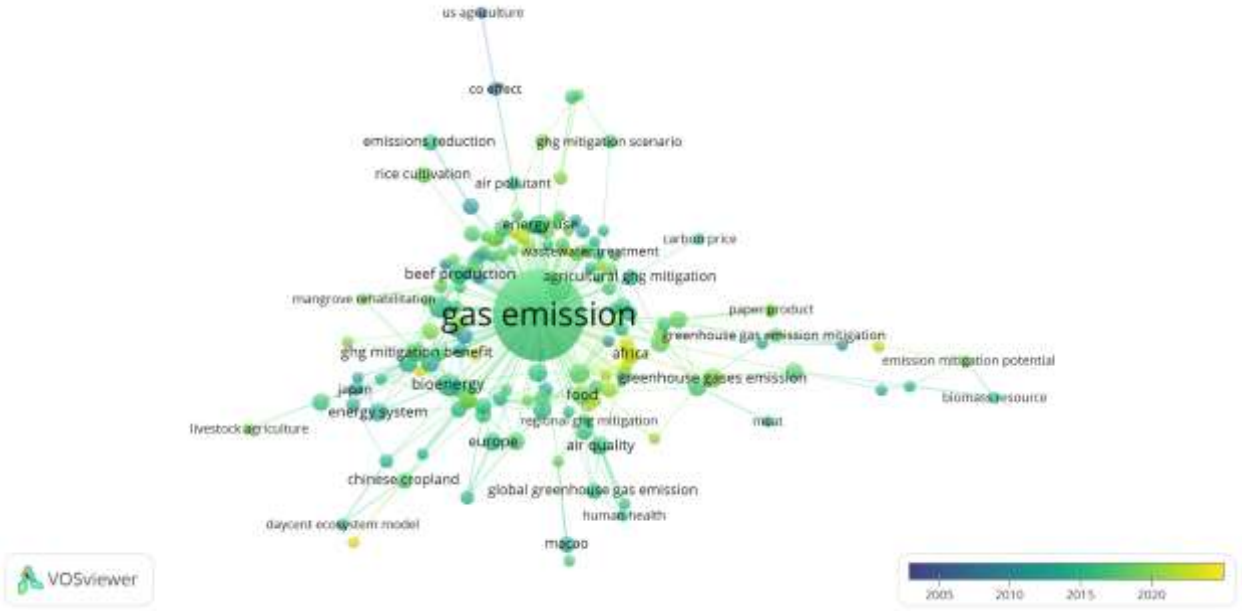

Figure 3. Overlay 2004-2024 (20 years).

Density visualization

VOSviewer provides access to three different maps: network visualization, overlay visualization, and density visualization. This section will discuss density visualization. The density visualization feature in VOSviewer can be an exceptional and highly effective tool for mapping scientific knowledge [15]. Density visualization is a visualization tool that effectively presents the distribution of scalar fields within a specific space [16]. Research related to GHG emissions has rapidly developed across various sectors, such as energy, agriculture, forestry, and food systems. To understand the direction, focus, and interconnections of topics in scientific publications on GHG emissions, bibliometric analysis is needed as a tool to map research trends. One of the most effective visualization methods is density visualization, which illustrates the frequency of keyword occurrences in publications. There are two variants of density visualization: item density visualization and cluster density visualization. Each point in item density visualization has a color that indicates the item density at that point. By default, colors range from blue to green to yellow. The fewer the items around a point and the lower the weight of those items, the closer the point's color is to blue. Conversely, the more items around a point and the higher their weight, the closer the point's color is to yellow [17].

The more yellow the color and the larger the circle’s diameter, the denser or more frequently a keyword appears. The keyword seems less regular if the color fades and blends with the green background. The color's intensity and the circle's diameter in density visualization typically explain the density of a particular feature or keyword, with brighter and larger circles representing higher frequency or density. In contrast, faded colors blending into the background indicate lower occurrences [16]. Research topics that have been extensively studied are indicated by brighter-colored points. The following figure presents the results of density visualization of research topics related to GHG emissions using VOSviewer software.

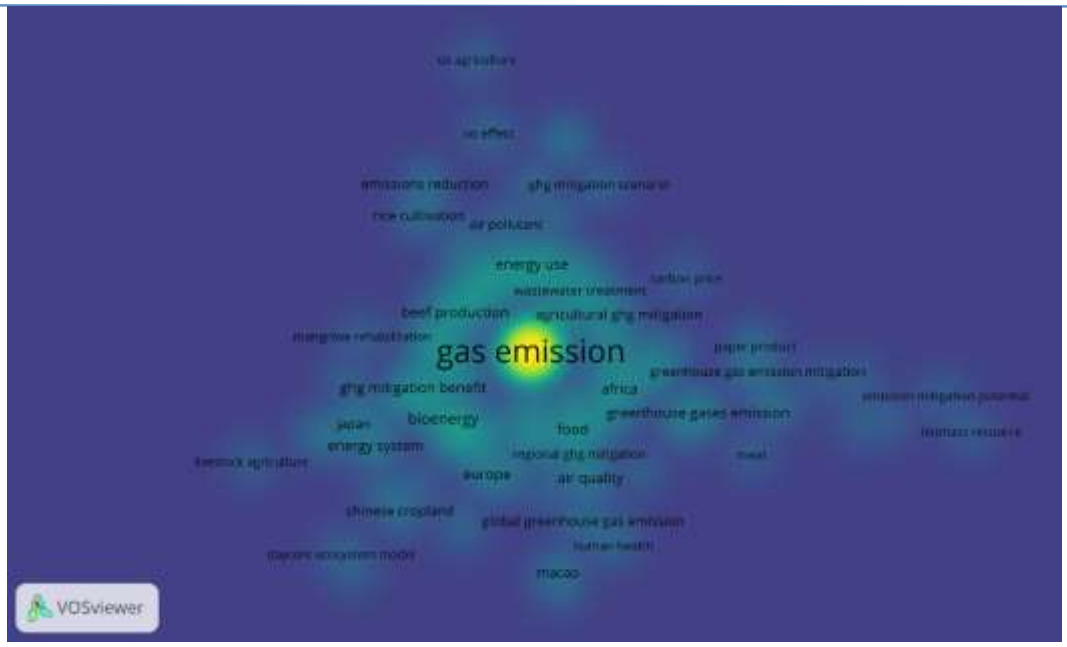

Figure 4. Density visualization of GHG emission research.
Source: Processed Data Results in *VOSviewer*, 2025

The image above is a density visualization generated using VOSviewer, displaying a map of various research topics related to gas emissions. The central point in this visualization is the term "gas emission," which appears as the largest and brightest. This indicates that "gas emission" is a high-frequency keyword in publications related to GHG emissions. The color and font size represent the intensity of the term's occurrence, while the proximity between terms reflects the interrelation of topics in research. Other keywords frequently associated with "gas emission" include *greenhouse gas emission*, *energy use*, *biomass resource*, *agriculture*, and *climate mitigation*. This suggests that research on gas emissions is not only limited to the energy sector but is also closely linked to food production, agriculture, human health, and bioenergy systems. This visualization is useful for mapping research trends and identifying interconnected fields in climate change mitigation studies and greenhouse gas emission reduction. The following table presents the distribution of keywords for GHG emissions research.

Table 1. Distribution of Keywords in Greenhouse Gas (GHG) Emission Research.

No	Keyword	Occurrences	Relevance
1	Gas Emission	5	2.94
2	Biomass Resource	2	3.00
3	Transportation	10	0.98
4	Energy Consumption	10	0.96
5	GHG Mitigation Strategy	42	0.54
6	Greenhouse Gas Emissions Reduction	6	1.17
7	Domestic GHG Mitigation	2	1.93
8	Human Health	2	1.70
9	Tropical Peatland	2	1.70
10	Mitigating Greenhouse Gas	2	1.83
11	Rice Cultivation	4	1.80
12	Open Burning	2	1.77
13	Greenhouse Gas Emission Mitigation Potential	3	1.76
14	Energy Production	2	2.40
15	Municipal Solid Waste Treatment	2	2.36

The **Table 1** above presents the results of bibliometric analysis, listing the most frequently occurring keywords in scientific publications related to GHG emissions, along with their occurrence count and relevance score in the research context. The most frequently appearing keyword is "*GHG Mitigation Strategy*," with 42 occurrences. However, it has a relatively low relevance score (0.54), indicating that the term is general and commonly used in various contexts. Conversely, keywords such as "*Biomass Resource*" and "*Gas Emission*," despite appearing only two to five times, have high relevance scores (3.00 and 2.94,

respectively), suggesting that these terms are concrete and relevant in research related to GHG mitigation topics.

Additionally, several technical keywords such as "*Municipal Solid Waste Treatment*", "*Energy Production*," and "*Domestic GHG Mitigation*" also show high relevance scores (above 2.0), indicating that these topics are emerging and have the potential to become primary focuses in future research. Topics like "*Rice Cultivation*," "*Open Burning*," and "*Tropical Peatland*" also emerge as critical issues closely related to GHG emission sources, particularly in developing countries. From this table, it can be concluded that GHG emission mitigation approaches are not solely focused on the energy and transportation sectors but also extend to agriculture, waste management, and public health [18]. This highlights the necessity of cross-sectoral strategies in addressing climate change challenges.

4. Conclusion

This study will compile a systematic review of research on GHG emissions over the past 20 years. The bibliometric analysis using VOSviewer yielded several key conclusions. Based on the network visualization, the first point indicates that GHG emissions research is divided into six clusters. These six clusters consist of (1) the red cluster, centered on the term "gas emission," (2) the green cluster, related to the industrial sector and waste management; (3) the blue cluster, focused on air quality and its impact on human health, (4) the yellow cluster, discussing bioenergy and energy systems, (5) the orange cluster, reflecting the food production sector, and finally, (6) the purple cluster, associated with global climate change mitigation.

The second point states that GHG emissions research can be grouped based on the year of study. According to the overlay visualization of GHG emissions research over the past 10 years (2014-2024), red and orange colors indicate newer themes (2020-2024), while blue and green represent older topics (2014-2018). In the early period (2014-2016), research focused more on the agriculture sector and livestock production, especially in Europe. Between 2018 and 2020, research diversified with emerging themes such as biogas production and biomass resources, signaling a shift toward renewable energy sources. In the latest period (2020-2024), research has become more holistic, integrating human health and air quality issues.

The third point, based on the overlay visualization of GHG emissions research over 20 years (2005-2025), shows that research was dominated by a sectoral approach in the early phase (2005-2020). This is reflected in the concentration of blue-green nodes on specific topics such as rice cultivation and beef production. Conversely, from 2014 to 2024, there has been a paradigm shift toward a systemic approach, indicated by the dominance of yellow-red nodes, encompassing multidisciplinary integration such as energy systems, human health impacts, and air quality.

The fourth point, derived from the density visualization, shows that the highest density point is on the term "gas emission." This indicates that "gas emission" is a high-frequency keyword in GHG emissions-related publications. The most frequently appearing keyword is "GHG Mitigation Strategy," with 42 occurrences, despite having a relatively low relevance score (0.54). Conversely, keywords such as "Biomass Resource" and "Gas Emission," although appearing only two to five times, have high relevance scores (3.00 and 2.94, respectively).

The fifth point highlights research topics with keywords that have the potential to become significant focuses in future studies, including "Municipal Solid Waste Treatment," "Energy Production," and "Domestic GHG Mitigation," all with high relevance scores (above 2.0). Topics such as "Rice Cultivation," "Open Burning," and "Tropical Peatland" also emerge as crucial issues closely related to GHG emission sources, particularly in developing countries.

5. References

[1] Y. P. Dewi, M. Sihombing, and Y. Setiawan, "Inventarisasi Sumber Emisi Gas Rumah Kaca (Greenhouse Gas) Dari Kegiatan Eksplorasi & Eksploitasi Minyak Dan Gas Bumi PT. MNO," *Prosiding Seminar Nasional XII "Rekayasa Teknologi Industri dan Informasi 2017 Sekolah Tinggi Teknologi Nasional Yogyakarta.*, 2017.

[2] Y. M. Pratama, "Analisis Determinan Pengungkapan Emisi Karbon di Indonesia," *MODUS.*, vol. 33, pp. 120–137, 2021.

[3] K. O. Yoro and M. O. Daramola, "CO2 emission sources, greenhouse gases, and the global warming effect," *Advances in Carbon Capture.*, pp. 3–28, 2020.

[4] A. Sasmita, Isnaini, and R. Zuskita, "Estimasi Gas Rumah Kaca dari Sektor Pertanian, Perkebunan, dan Peternakan di Kabupaten Kampar, Provinsi Riau," *Jurnal Sumberdaya Alam dan Lingkungan.*, vol. 8(1), pp. 42–53, 2021.

[5] I. S. Daeli, "Strategi mengurangi emisi gas rumah kaca untuk mengatasi konflik global akibat perubahan iklim", *Environment Conflict.*, vol. 1(2), pp. 71–82, 2024.

[6] Dias, F. D. O., Bonfim, S., Bombardelli, J., & Batista, G, "*Bibliometric Analysis Of Scientific Production On Carbon Credits (2012-2021) RGSA – Revista de Gestão Social e Ambiental ISSN:*. 1–18, 2023.

[7] Ding. X, and Yang. Z, " Knowledge mapping of platform research: a visual analysis using VOSviewer and CiteSpace", *Electronic Commerce Research*, *22*(3), 787–809, 2022. https://doi.org/10.1007/s10660-020-09410-7

[8] Ianda, T. F., Kalid, R. de A., Pessoa, F. L. P., Medeiros, D. L., Santos, D. S., & Padula, A. D. "A systematic review of approaches developed and used for the environmental assessment of biorefineries", *Journal of Cleaner Production*, *476*(February), 2024. https://doi.org/10.1016/j.jclepro.2024.14367

[9] Haberl, H., Wiedenhofer, D., Virág, D., Kalt, G., Plank, B., Brockway, P., Fishman, T., Hausknost, D., Krausmann, F., Leon-Gruchalski, B., Mayer, A., Pichler, M., Schaffartzik, A., Sousa, T., Streeck, J., & Creutzig, F, "A systematic review of the evidence on decoupling of GDP, resource use and GHG emissions, part II: Synthesizing the insights", *Environmental Research Letters*, *15*(6), 2020. https://doi.org/10.1088/1748-9326/ab842a

[10] Nandiyanto, A. B. D., & Al Husaeni, D. F, "A bibliometric analysis of materials research in Indonesian journal using VOSviewer", *Journal of Engineering Research (Kuwait)*, *9*(December 2021). https://doi.org/10.36909/jer.ASSEEE.16037

[11] Ramadan, B. S., Rachman, I., Ikhlas, N., Kurniawan, S. B., Miftahadi, M. F., & Matsumoto. T, "A comprehensive review of domestic-open waste burning: recent trends, methodology comparison, and factors assessment", *Journal of Material Cycles and Waste Management*, *24*(5), 1633–1647, 2022. https://doi.org/10.1007/s10163-022-01430-9

[12] M. Erpinda, N. Faizaturrohmah, and S. Wulandari, "Analisis Dinamika Penelitian Pencemaran Air Sungai berdasarkan Studi Bibliometrik 10 tahun terakhir," *Jurnal Serambi Engineering.*, vol. 9(4), 2024.

[13] C. S. Deshmukh, A. P. Susanto, N. Nardi, N. Nurholis, S. Kurnianto, Y. Suardiwerianto, M. Hendrizal, A. Rhinaldy, R. E. Mahfiz, A. R. Desal, S. E. Page, A. R. Cobb, T. Hirano, F. Guerin, D. Serca, Y. T. Prairie, F. Agus, D. Astiani, S. Sabiham, and C. D. Evans, "Net greenhouse gas balance of fibre wood plantation on peat in Indonesia," *Nature.*, vol. 616, pp. 740–764, 2023.

[14] Cao, M., Wang, F., Ma, S., Geng, H., & Sun, K, " Recent advances on greenhouse gas emissions from wetlands: Mechanism, global warming potential, and environmental drivers", *Environmental Pollution*, *355*(March), 124204, 2024. https://doi.org/10.1016/j.envpol.2024.124204

[15] Yu, D., Xu, Z. & Wang, W. "A bibliometric analysis of Fuzzy Optimization and Decision Making (2002–2017)". *Fuzzy Optim Decis Making*, 18, 371–397 (2019). https://doi.org/10.1007/s10700-018-9301-8

[16] E. W. Ekaputri and M. A. Zaidan, "Bibliometrics Analysis Using VOS Viewer and Publish or Perish: Trends and Visualization of Soft Computing Research in Deep Learning", *Journal of Informatics and Science Media*, vol. 1, Issue. 1, pag. 17-28, 2024.

[17] N. J. van Eck and L. Waltman, "Manual for VOSviewer version 1.6.14". Universiteit Leiden, 2020.

[18] Barker, T., I. Bashmakov, A. Alharthi, M. Amann, L. Cifuentes, J. Drexhage, M. Duan, O. Edenhofer, B. Flannery, M. Grubb, M. Hoogwijk, F. I. Ibitoye, C. J. Jepma, W.A. Pizer, K. Yamaji, "Mitigation from a cross-sectoral perspective. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA , 2007. doi: 10.1017/CBO9780511546013.