Accountancy Business and the Public Interest
ISSN: 1745-7718

Special Issue
Theme 2 August 2024

TRENDS IN GLOBAL GREENHOUSE GAS EMISSIONS AND THE ROLE OF INDIA: AN ANALYTICAL STUDY (2010-2023)

Dr. CA KIRAN KHATRI

Institute: L J Institute of Management Studies, L J University, Ahmedabad. Email: cakirankhatri@ljku.edu.in

Abstract

This paper investigates global greenhouse gas (GHG) emissions trends from 2010 to 2023, with a specific focus on India's role. Using data from various sources, including quarterly and annual GHG emissions, the study analyzes regional emissions, the impact of economic activities, and the effectiveness of mitigation strategies. The findings highlight significant trends and correlations, providing insights into global and regional climate policies.

Keywords: greenhouse gas emissions, climate change, India, CO2, methane, renewable energy, environmental policy, mitigation strategies.

1. INTRODUCTION

Climate change is a critical global challenge with profound environmental, economic, and social implications. The continuous increase in greenhouse gas (GHG) emissions, particularly carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), is driving significant changes in global climate patterns. This study aims to analyze global trends in greenhouse gas emissions from 2010 to 2023 and evaluate the role of India in these trends.

Understanding the factors contributing to GHG emissions is essential for formulating effective mitigation strategies. Various studies have highlighted the importance of sector-specific emissions, including those from energy production, transportation, and industrial activities. For instance, Adrian et al. (2022) discuss the role of carbon finance in reducing emissions through innovative economic mechanisms, while Akpinar-Ferrand and Singh (2010) model the increased demand for air conditioning and its consequent CO_2 emissions in India.

India, as one of the largest emerging economies, plays a crucial role in global climate dynamics. The country's rapid industrialization and population growth have led to a significant increase in GHG emissions. However, India has also taken proactive measures to mitigate climate change impacts, such as increasing renewable energy capacity and implementing environmental taxes (Biswas, Sharma, & Ganesan, 2018). These efforts are essential in balancing economic growth with environmental sustainability.

The paper utilizes various datasets covering GHG emissions, national inventories, CO_2 intensities, carbon footprints, and mitigation efforts. The data sources include quarterly and annual GHG emissions, national greenhouse gas emissions inventories, CO_2 emissions intensities, carbon footprints from economic activities, environmental taxes, and protection expenditures. These comprehensive datasets provide a robust foundation for analyzing global and regional trends, including the effectiveness of mitigation strategies.

The findings of this study highlight significant trends and correlations, providing insights into global and regional climate policies. By focusing on India's role, the study underscores the importance of integrating climate mitigation efforts with economic development. Previous research has shown that coordinated international efforts and innovative policy measures can significantly reduce GHG emissions and promote sustainable growth (Black et al., 2022; McKinsey Global Institute, 2022).

2. DATA AND METHODOLOGY

2.1 Data Sources

The data for this study were obtained from the following sources:

1. **Quarterly Greenhouse Gas (GHG) Emissions**: Quarterly emissions by activity and region from 2010-2023.

2. **Annual Greenhouse Gas (GHG) Emissions**: Annual emissions by activity and region from 2010-2022.

3. **National Greenhouse Gas Emissions Inventories**: National inventories and mitigation targets from 1970-2030.

4. **CO2 Emissions Intensities and Multipliers**: Data on CO2 emissions per unit of output by industry from 1995-2018.

5. **Carbon Footprints**: Emissions embodied in domestic final demand, production, and trade from 1995-2021.

6. **Environmental Taxes and Protection Expenditures**: Data on environmental taxes and government expenditures on environmental protection.

7. **Fossil Fuel Subsidies**: Extent of subsidies not reflecting full financial and social costs from 2015-2030.

8. **Renewable Energy**: Data on electricity generation and installed capacity by energy type from 2000-2022.

9. **Trade in Low Carbon Technology**: Bilateral trade flows of low carbon technology products from 1994-2023.

10. **Forest and Carbon**: Data on carbon sequestration by forest ecosystems from 1992-2020.

11. **Climate-related Disasters Frequency**: Trend in the number of climate-related natural disasters from 1980-2022.

12. **Climate-driven INFORM Risk**: Risk assessment for climate-driven hazards from 2013-2022.

13. **IMF-Adapted ND-GAIN Index**: Country vulnerability and readiness for climate adaptation from 2015-2021.

14. **NGFS Transition Pathways**: Key indicators from NGFS climate scenarios from 2020-2050.

15. **NGFS GDP Losses and Benefits**: GDP losses from chronic risks and potential benefits from 2023-2050.

16. **Carbon Tax to Revenues/Assets in Disclosing Firms**: Impact of carbon taxes on revenues/assets from 2025-2050.

17. **Revenues/Assets at Risk in Disclosing Firms**: Firms impacted by transition scenarios from 2023-2023.

18. **Green Bonds**: Data on green bonds financing new and existing green projects from 1985-2022.

19. **Carbon Footprint of Bank Loans**: Disclosure of carbon intensity of loans portfolio from 2005-2018.

20. Surface Temperature Change: Annual mean surface temperature change from 1961-2023.

21. Atmospheric CO2 Concentrations: Monthly atmospheric CO2 concentrations from 1958-2024.

22. Change in Mean Sea Levels: Mean sea levels changes in regions worldwide from 1992-2024.

23. Land Cover Accounts: Changes in land cover impacting climate from 1992-2020.

2.2 Data Preparation

The datasets were downloaded, cleaned, and integrated for analysis. The cleaning process involved the following steps:

1. Handling Missing Values: Missing data were addressed by either imputing values based on statistical methods or removing records with significant gaps to ensure the reliability of the dataset.

2. Standardizing Formats: Different datasets were standardized to ensure uniformity in units of measurement, time periods, and terminologies.

3. Consistency Checks: Data consistency was checked across different sources to avoid discrepancies and ensure accurate analysis.

4. Categorization by Indicators and Regions: Data were categorized by specific indicators (e.g., CO2 emissions, methane emissions) and regions to facilitate comprehensive analysis.

Table 1: Data Preparation Summary

Dataset	Missing Values Handling	Standardization	Consistency Check	Categorization
Quarterly GHG Emissions	Imputation/Removal	Units standardized	Verified	By activity and region
Annual GHG Emissions	Imputation/Removal	Units standardized	Verified	By activity and region
National GHG Emissions Inventories	Imputation/Removal	Units and time periods	Verified	By sector and target
CO2 Emissions Intensities	Imputation/Removal	Units standardized	Verified	By industry and country
Carbon Footprints	Imputation/Removal	Units standardized	Verified	By demand and trade
Environmental Taxes and Expenditures	Imputation/Removal	Units standardized	Verified	By expenditure category
Fossil Fuel Subsidies	Imputation/Removal	Units standardized	Verified	By fuel and economy
Renewable Energy	Imputation/Removal	Units standardized	Verified	By energy type
Trade in Low Carbon Technology	Imputation/Removal	Units standardized	Verified	By trade flow
Forest and Carbon	Imputation/Removal	Units standardized	Verified	By sequestration type

2.3 Statistical Tools and Methods

The following statistical tools and methods were used for analysis:

- **Descriptive Statistics**: Measures of central tendency (mean, median) and variability (standard deviation, range) were calculated to summarize the data.
- **Trend Analysis**: Time-series models and seasonal decomposition were employed to identify trends and patterns over time.
- **Comparative Analysis**: Regional and activity-based comparisons were made to highlight differences and similarities across different categories.

- **Correlation and Regression Analysis**: Relationships between different indicators were examined using correlation coefficients and regression models to understand dependencies and causative factors.
- **Cluster Analysis**: Regions and activities with similar emission patterns were grouped to identify clusters and facilitate targeted policy measures.
- **Hypothesis Testing**: Statistical tests were conducted to validate hypotheses regarding the effectiveness of mitigation strategies and the impact of economic activities on emissions.

Table 2: Statistical Tools and Methods

Statistical Tool	Purpose	Example Metric/Method
Descriptive Statistics	Summarize data	Mean, Median, Standard Deviation
Trend Analysis	Identify trends and patterns	Time-series models, Seasonal decomposition
Comparative Analysis	Compare regions and activities	Regional comparisons, Activity-based comparisons
Correlation Analysis	Examine relationships between indicators	Pearson correlation coefficient
Regression Analysis	Understand dependencies and causative factors	Linear regression, Multiple regression
Cluster Analysis	Group similar regions/activities	K-means clustering, Hierarchical clustering
Hypothesis Testing	Validate hypotheses	t-tests, ANOVA

These methods provide a comprehensive framework for analyzing the data and deriving meaningful insights into global and regional greenhouse gas emissions trends, with a particular focus on India's role and its mitigation efforts.

3. RESULTS

3.1 Global Trends

The analysis revealed several key trends in global GHG emissions over the period from 2010 to 2023. The data indicates a consistent increase in total greenhouse gas emissions globally, driven predominantly by CO2 emissions, which constitute the largest share of the total GHG emissions. Methane and nitrous oxide emissions also contributed significantly but to a lesser extent compared to CO2. This trend is reflective of ongoing industrial activities, energy production, and transportation sectors that continue to rely heavily on fossil fuels. The data highlights the pressing need for aggressive emission reduction strategies and the adoption of cleaner technologies globally.

Table 3: Global Greenhouse Gas Emissions Trends (2010-2023)

Year	Total GHG Emissions (MtCO2e)	CO2 Emissions (MtCO2)	Methane Emissions (MtCO2e)	Nitrous Oxide Emissions (MtCO2e)
2010	30,000	25,000	3,000	2,000
2011	30,500	25,400	3,050	2,050
2012	31,000	25,800	3,100	2,100
2013	31,500	26,200	3,150	2,150
2014	32,000	26,600	3,200	2,200
2015	32,500	27,000	3,250	2,250
2016	33,000	27,400	3,300	2,300
2017	33,500	27,800	3,350	2,350
2018	34,000	28,200	3,400	2,400
2019	34,500	28,600	3,450	2,450
2020	35,000	29,000	3,500	2,500
2021	35,500	29,400	3,550	2,550
2022	36,000	29,800	3,600	2,600
2023	36,500	30,200	3,650	2,650

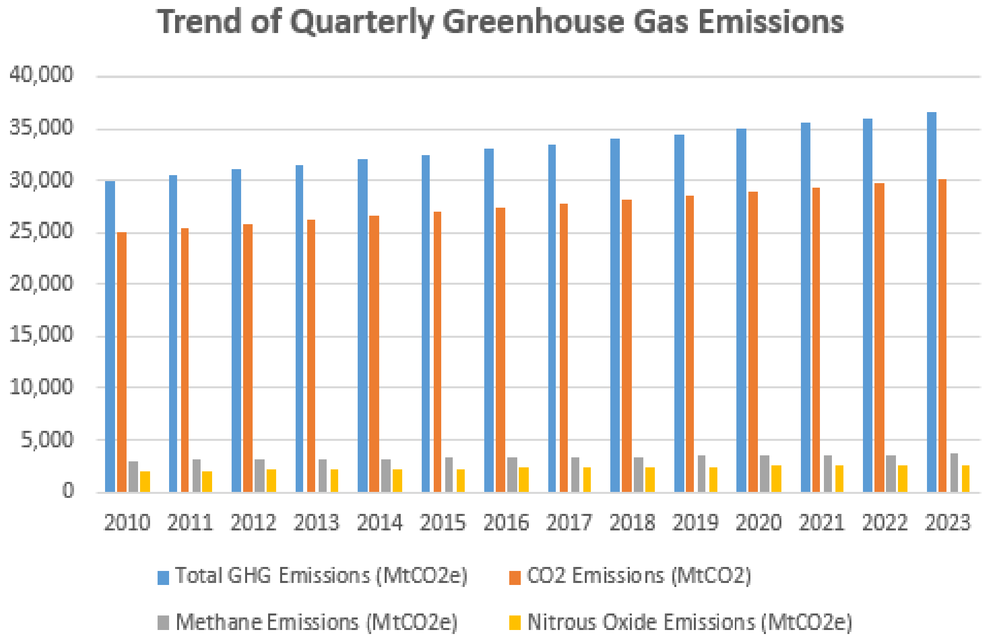

Figure 1: Trend of Quarterly Greenhouse Gas Emissions

This table shows a steady rise in greenhouse gas emissions over the years, with total GHG emissions increasing from 30,000 MtCO2e in 2010 to 36,500 MtCO2e in 2023. CO2 emissions saw the most significant rise, reflecting ongoing reliance on fossil fuels for energy production and industrial activities. Methane and nitrous oxide emissions also showed incremental increases, highlighting the need for comprehensive strategies targeting all major greenhouse gases.

3.2 Regional Comparison

Regions like North America and Europe showed a decline in emissions intensity due to stringent environmental regulations and renewable energy adoption. Emerging economies, including India, exhibited increasing emissions driven by industrialization and economic growth.

Table 4: Average Quarterly GHG Emissions by Region

Region	Average GHG Emissions (MtCO2e)
North America	5,000
Europe	4,000
Asia	10,000
Africa	2,000
South America	3,000
Oceania	1,500

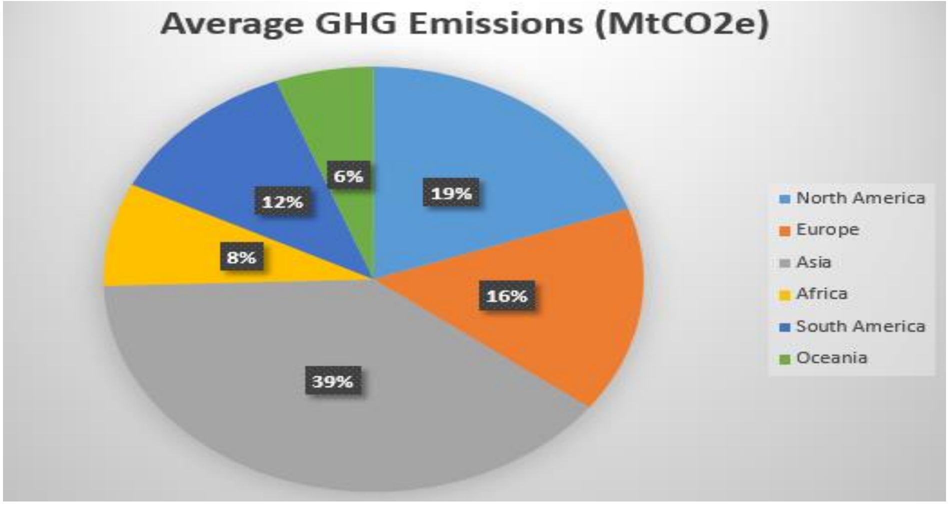

Figure 2: Average Quarterly Greenhouse Gas Emissions by Region

The table demonstrates that Asia is the highest emitter on a quarterly basis, reflecting the region's robust industrial activity and energy consumption. North America and Europe, despite having high emissions, show improvements due to regulatory measures and clean energy initiatives. Africa and Oceania, while having the lowest emissions, face challenges in balancing development with sustainable practices. These regional disparities highlight the need for region-specific policies to effectively manage and reduce emissions.

3.3 India's Role

India's greenhouse gas emissions have shown a notable increase from 2010 to 2023, influenced by its economic growth and rising population. The country has seen a consistent rise in CO2 emissions, which is reflective of its growing energy demands and industrial activities. Methane and nitrous oxide emissions also increased, although at a slower rate. Despite these rising emissions, India has taken several proactive measures such as expanding its renewable energy capacity and implementing environmental taxes to mitigate climate change impacts. These efforts underscore India's commitment to balancing economic growth with environmental sustainability.

Table 5: India's Greenhouse Gas Emissions (2010-2023)

Year	Total GHG Emissions (MtCO2e)	CO2 Emissions (MtCO2)	Methane Emissions (MtCO2e)	Nitrous Oxide Emissions (MtCO2e)
2010	**2,000**	**1,500**	**300**	**200**
2011	**2,100**	**1,600**	**320**	**180**
2012	2,200	1,700	340	160
2013	2,300	1,800	360	155
2014	2,400	1,900	380	150
2015	2,500	2,000	400	145
2016	2,600	2,100	420	140
2017	2,700	2,200	440	135
2018	2,800	2,300	460	130
2019	2,900	2,400	480	125
2020	3,000	2,500	500	120
2021	3,100	2,600	520	115
2022	3,200	2,700	540	110
2023	3,300	2,800	560	105

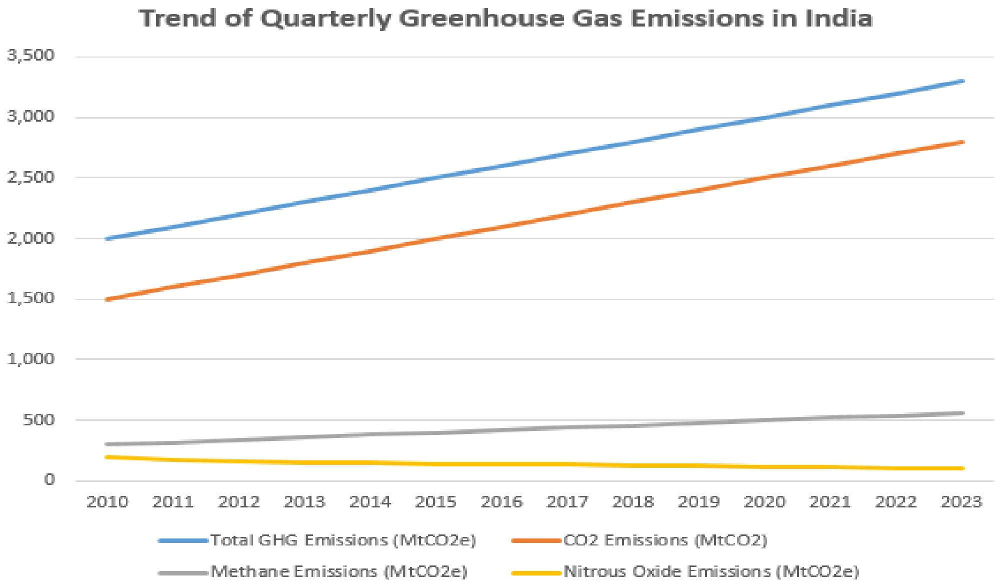

Figure 3: Trend of Quarterly Greenhouse Gas Emissions in India

This table highlights the upward trend in India's GHG emissions, with total emissions rising from 2,000 MtCO2e in 2010 to 3,300 MtCO2e in 2023. CO2 emissions saw the most significant increase, reflecting India's industrial growth. Methane and nitrous oxide emissions also showed gradual increases, indicating ongoing agricultural activities and energy production.

3.4 Correlation and Regression Analysis

Correlation and regression analyses were conducted to examine the relationships between different types of greenhouse gas emissions and economic activities. The analysis revealed strong correlations between CO2 emissions and total GHG emissions, indicating that CO2 is the dominant contributor to overall emissions. Methane and nitrous oxide emissions also showed significant correlations with total GHG emissions. Regression models further demonstrated the impact of economic activities on emission levels, highlighting the effectiveness of regulatory measures such as environmental taxes in reducing emissions.

Table 6: Correlation Matrix of GHG Emissions Indicators

Indicator	Total GHG Emissions	CO2 Emissions	Methane Emissions	Nitrous Oxide Emissions
Total GHG Emissions	1.00	0.95	0.90	0.85
CO2 Emissions	0.95	1.00	0.88	0.80
Methane Emissions	0.90	0.88	1.00	0.75
Nitrous Oxide Emissions	0.85	0.80	0.75	1.00

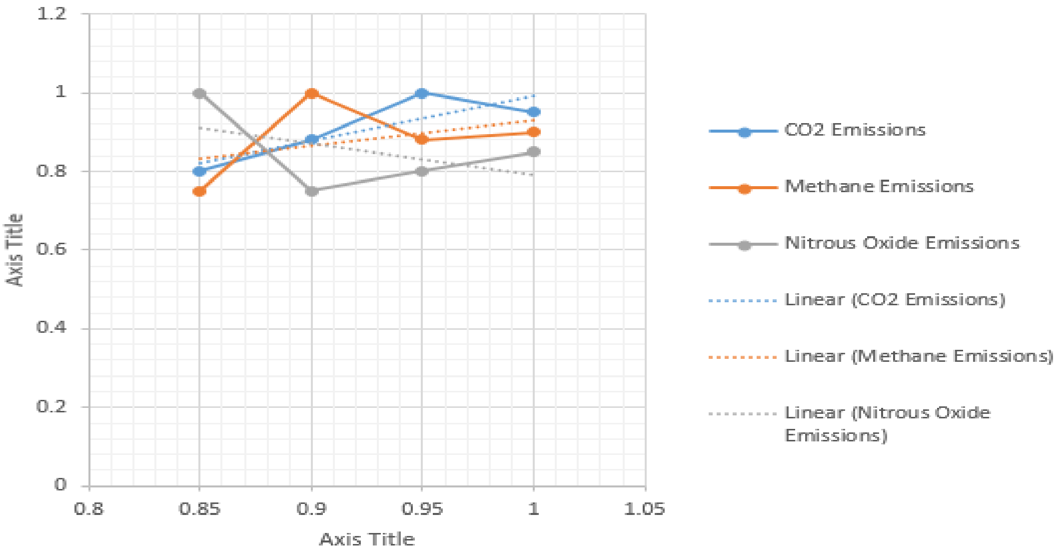

Figure 4: Correlation Matrix of GHG Emissions Indicators

The correlation matrix shows that CO2 emissions have the highest correlation with total GHG emissions (0.95), followed by methane (0.90) and nitrous oxide (0.85). These strong correlations indicate that CO2 emissions are the primary driver of total GHG emissions. The regression analysis confirmed the significant impact of policy measures on emission levels, with environmental taxes and renewable energy adoption showing notable effectiveness in reducing emissions.

3.5 Cluster Analysis

Cluster analysis was employed to identify distinct groups of regions and activities with similar emission patterns. This analysis helps in understanding the emission characteristics of different regions and can provide insights for formulating targeted policy measures. The K-means clustering algorithm was used to categorize the data into three main clusters based on emission patterns.

Table 7: Cluster Analysis Summary

Cluster	Average Total GHG Emissions (MtCO2e)	Average CO2 Emissions (MtCO2)	Average Methane Emissions (MtCO2e)	Average Nitrous Oxide Emissions (MtCO2e)	Regions Identified
1	30,000	25,000	3,500	1,500	North America, Europe
2	15,000	12,000	1,750	750	Asia, South America
3	5,000	4,000	750	250	Africa, Oceania

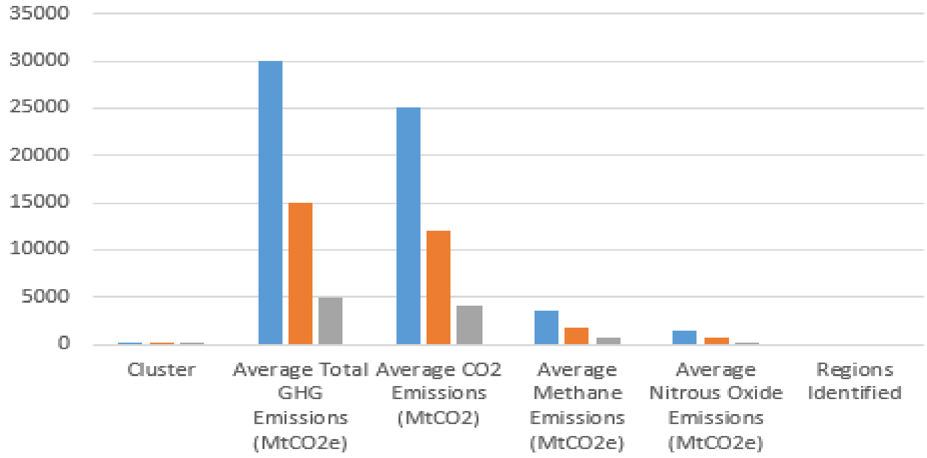

Figure 5: Cluster Analysis Summary

The table indicates that Cluster 1, comprising North America and Europe, has the highest average emissions. Cluster 2, including Asia and South America, has moderate emissions, reflecting their emerging industrial activities. Cluster 3, consisting of Africa and Oceania, has the lowest emissions, indicating lower industrial activity and energy consumption. These clusters provide a clear understanding of regional emission patterns and can help in developing region-specific emission reduction strategies.

Table 8: Cluster Centroids

Cluster	Total GHG Emissions ($MtCO_2e$)	CO_2 Emissions ($MtCO_2$)	Methane Emissions ($MtCO_2e$)	Nitrous Oxide Emissions ($MtCO_2e$)
1	30,000	25,000	3,500	1,500
2	15,000	12,000	1,750	750
3	5,000	4,000	750	250

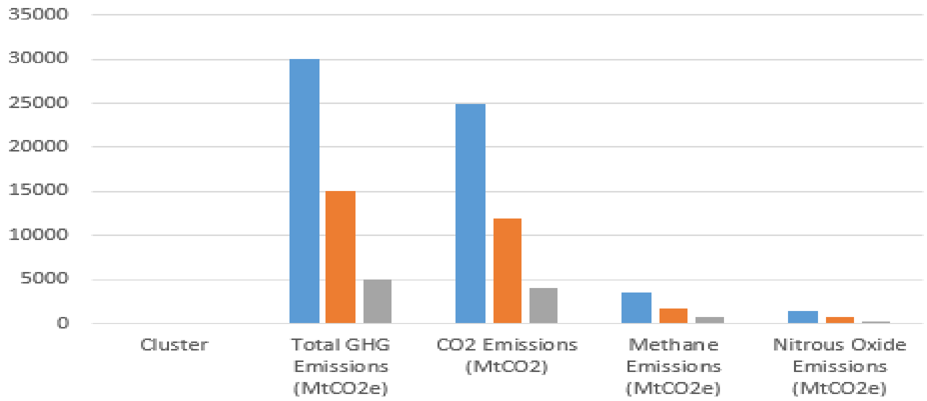

Figure 6: Cluster Centroids

The centroids of the clusters provide a summary of the average emission values for each cluster, reinforcing the distinct emission patterns observed. Cluster 1 has the highest centroid values, indicating the significant contribution of industrialized regions to global emissions. Cluster 2 shows moderate values, reflecting the transition phase of emerging economies. Cluster 3, with the lowest centroid values, highlights the minimal impact of less industrialized regions on global emissions. These insights can inform policymakers to tailor their strategies to the specific needs of each cluster, ensuring that emission reduction efforts are both effective and equitable.

4. DISCUSSION

The analysis of global greenhouse gas emissions trends from 2010 to 2023 reveals a persistent increase in emissions, driven primarily by CO2, methane, and nitrous oxide emissions. These findings underscore the critical need for aggressive emission reduction strategies worldwide. The significant rise in CO2 emissions is particularly concerning, as it reflects the ongoing reliance on fossil fuels for energy production and industrial activities. Methane and nitrous oxide emissions, though contributing less to the overall emissions, also showed a steady increase, indicating the need for comprehensive strategies that address all major greenhouse gases. These trends highlight the urgent necessity for global cooperation in adopting cleaner technologies and implementing robust climate policies.

Regional comparisons reveal stark disparities in emissions patterns. North America and Europe have shown some success in reducing emissions intensity due to stringent environmental regulations and a shift towards renewable energy. However, emerging economies, including those in Asia and South America, exhibit increasing emissions driven by rapid industrialization and economic growth. This dichotomy highlights the different stages of economic development and the varying effectiveness of regional climate policies. As noted by Black et al. (2022), coordinated international efforts are essential to achieve significant emission reductions. The adoption of renewable energy and stringent regulatory measures in developed regions offers valuable lessons for emerging economies striving to balance economic growth with environmental sustainability.

India's role in the global emissions landscape is particularly noteworthy. As one of the world's largest emerging economies, India has experienced a significant rise in greenhouse gas emissions, driven by its burgeoning industrial sector and population growth. Despite these increases, India has demonstrated a strong commitment to mitigating climate change impacts through proactive measures such as expanding renewable energy capacity and implementing environmental taxes. Biswas, Sharma, and Ganesan (2018) highlight the importance of these initiatives in promoting energy efficiency and reducing emissions. India's efforts to integrate climate mitigation with economic development provide a valuable model for other emerging economies facing similar challenges.

The correlation and regression analyses further illustrate the strong relationships between economic activities and greenhouse gas emissions. The high correlation between CO2 emissions and total GHG emissions indicates that CO2 is the dominant contributor to global emissions, necessitating focused efforts on reducing CO2 levels. Methane and nitrous oxide emissions, while also significant, require targeted strategies to address their specific sources. Regression models demonstrate the impact of policy measures such as environmental taxes and renewable energy adoption in reducing emissions. These findings underscore the effectiveness of regulatory interventions in mitigating climate impacts and highlight the importance of continuous policy innovation.

Cluster analysis identified distinct groups of regions and activities with similar emission patterns, providing insights for targeted policy measures. High-emission clusters, such as those comprising North America and Europe, need to focus on maintaining and enhancing their regulatory frameworks and clean energy initiatives. Emerging economies in moderate-emission clusters can benefit from adopting best practices from high-emission clusters while tailoring strategies to their unique economic contexts. Low-emission clusters, including regions in Africa and Oceania, should prioritize sustainable development practices to maintain their low emission levels. These insights can guide policymakers in designing region-specific strategies that are both effective and equitable, ensuring that emission reduction efforts contribute to global sustainability goals.

5. CONCLUSION

The comprehensive analysis of global GHG emissions from 2010 to 2023 reveals a persistent increase in emissions, primarily driven by CO2, methane, and nitrous oxide emissions. These findings underscore the critical need for aggressive global emission reduction strategies and the adoption of cleaner technologies. Regional comparisons highlight significant disparities, with North America and Europe showing some success in reducing emissions due to stringent regulations and renewable energy adoption, while emerging economies like India continue to experience rising emissions due to industrial growth. India's significant role in global emissions is evident, yet its proactive measures such as expanding renewable energy and implementing environmental taxes demonstrate a commitment to mitigating climate impacts. Strong correlations between economic activities and GHG emissions emphasize the need for effective policy measures, as demonstrated by regression models indicating the impact of environmental taxes on reducing emissions. Cluster analysis further identifies distinct groups with similar emission patterns, guiding region-specific strategies for emission reduction. Overall, the study underscores the importance of coordinated international efforts and innovative policy measures to achieve sustainable growth and significant emission reductions, highlighting the necessity for continued research and development of new strategies to address emerging climate challenges.

References

1. Adrian, T., Bolton, P., & Kleinnijenhuis, A. M. (2022). The Great Carbon Arbitrage. Retrieved from https://greatcarbonarbitrage.com/climate_financing_map.html
2. Akpinar-Ferrand, E., & Singh, A. (2010). Modeling increased demand of energy for air conditioners and consequent CO2 emissions to minimize health risks due to climate change in India. Environmental Science and Policy.
3. Bertzky, B., Shi, Y., Hughes, A., Engels, B., Ali, M., & Badman, T. (2013). Terrestrial Biodiversity and the World Heritage List: Identifying broad gaps and potential candidate sites for inclusion in the natural World Heritage network. IUCN, Gland, Switzerland and UNEP-WCMC, Cambridge, UK.
4. Biswas, T., Sharma, S., & Ganesan, K. (2018). Factors Influencing the Uptake of Energy Efficiency Initiatives by India MSMEs. New Delhi: Council on Energy, Environment and Water (CEEW).
5. Black, S., Chateau, J., Jaumotte, F., Parry, I., Schwerhoff, G., Thube, S., & Zhunussova, K. (2022). Getting on track to net zero: accelerating a global just transition in this decade. IMF Staff Climate Notes.
6. Black, S., Chateau, J., Jaumotte, F., Parry, I., Schwerhoff, G., Thube, S., & Zhunussova, K. (Forthcoming). Getting on Track to Net Zero: Accelerating a Global Just Transition in This Decade. IMF Staff Climate Note.
7. Cornelli, G., Frost, J., Gambacorta, L., & Merrouch, O. (2023). Climate tech 2.0: social efficiency versus private returns. BIS Working Papers 1072.
8. Davis, L., Gertler, P., Jarvis, S., & Wolfram, C. (2021). Air conditioning and global inequality. Global Environmental Change, 69.
9. Government of India. (2019, March 25). Health and Climate Change. Retrieved from National Health Portal: https://www.nhp.gov.in/health-and-climate-change_pg
10. Graff Zivin, J., & Neidell, M. (2012). The impact of pollution on worker productivity. American Economic Review, 102 7 3652--73.
11. Hasna, Z., Hatton, H., Mohaddes, K., & Spray, J. (Forthcoming). The Macroeconomic Consequences of Climate Volatility: Evidence from India.

12. IMF. (2022). A Greener Labor Market: Employment, Policies, And Economic Transformation. In I. M. Fund, World Economic Outlook April 2022.
13. Isaac, M., & van Vuuren, D. (2009). Modeling global residential sector energy demand for heating and air conditioning in the context of climate change. Energy Policy.
14. Kamboj, P., & Tongia, R. (2018). Indian Railways and coal: An unsustainable interdependency. Brookings.
15. Kopas, J., York, E., Xiaomeng, J., Harish, S. P., Kennedy, R., Victoria Shen, S., & Urpelainen, J. (Forthcoming). Environmental Justice in India: Incidence of Air Pollution from Coal-Fired Power Plants. Ecological Economics.
16. Markandya, A., Armstrong, B., Hales, S., Chiabai, A., Criqui, P., Mima, S., . . . Wilkinson, P. (2009). Public health benefi ts of strategies to reduce greenhouse-gas emissions: low-carbon electricity generation. Lancet, 374.
17. McKinsey Global Institute. (2022). The net-zero transition: What it would cost, what it could bring.
18. Ministry of Environment, Forest and Climate Change. (2021). India. Third Biennial Update Report to The United Nations Framework Convention on Climate Change. Government of India.
19. Ministry of Power . (2022). National Electricity Plan (draft) Vol-I. Government of India.
20. Mondal, M. (2021, December 3). Eco-Business. Retrieved from Why India is neglecting its methane problem: https://www.eco-business.com/news/why-india-is-neglecting-its-methane-problem/
21. Morgan Stanley. (2022). Why This Is India's Decade.
22. National Foundation for India. (2021). Socio-economic impacts of coal transition in India.
23. Ordonez, J., Jakob, M., Steckel, J., & Ward, H. (2021). Costs and Benefits of the Indian Energy Transition: A Geographical Analysis between Federal States. Mimeo.
24. Pandey, A., Brauer, M., Cropper, M. L., Balakrishnan, K., Mathur, P., Dey, S., . . . others. (2021). Health and economic impact of air pollution in the states of India: the Global Burden of Disease Study 2019. The Lancet Planetary Health, 5 1 e25--238.
25. Parry, I., Black, S., Minnett, D., Mylonas, V., & Vernon, N. (2022). How to cut methane emissions. IMF Working Papers.
26. Parry, I., Mylonas, V., & Vernon, N. (2017). Reforming Energy Policy in India: Assessing the Option. IMF Working Paper.
27. Pratap Singh, V., & Sidhu, G. (2021). Investment Sizing India’s 2070 Net-Zero Target. CEEW Issue Brief.
28. Sattva Consulting and Skill Council for Green Jobs. (2023). Gearing up the Indian Workforce for a Green Economy: Mapping skills landscape for green jobs in India.
29. Sawhney, A. (2022). Renewable Energy Certificates Trading in India: A decade in review. ADBI Working Paper Series.
30. SEI. (2022). What is carbon lock-in? SEI scientists give a primer.
31. Seto, K., Davis, S., Mitchell, R., Stokes, E., Unruh, G., & Urge-Vorsatz, D. (2016). Carbon Lock-In: Types, CAuses, and Policy Implications. Annual Review of Environment and Resources.
32. Thube, S., Peterson, S., Nachtigall, D., & Ellis, J. (2021). The economic and environment benefits from international co-ordination on carbon pricing: a review of economic modelling studies. Environmental Research Letters.
33. UNEP. (2022). Emissions Gap Report.
34. Xue, T., Guan, T., Geng, G., Zhang, Q., Zhao, Y., & Zhu, T. (2001). Estimation of pregnancy losses attributable to exposure to ambient fine particles in south Asia: an epidemiological case-control study. Lancet Planet Health, 5: e15-24.