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Website- www.aarf.asia, **Email** : editor@aarf.asia , editoraarf@gmail.com

QUANTIFYING GREENHOUSE GAS EMISSIONS AND THEIR IMPACT ON CLIMATE CHANGE

Gathe Pravin Bapuraoji[1], Dr. Eknath Pandurang Alhat[2]
[1] Research Scholar, Department of Environmental Science, Himalayan University,Itanagar, Arunachal Pradesh.
[2] Research Supervisor, Department of Environmental Science, Himalayan University,Itanagar, Arunachal Pradesh.

Abstract
The greenhouse effect, which causes a rise in global temperatures and a variety of climatic disturbances, is mainly caused by greenhouse gases, such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N□ O). This study examines the relationship between GHG emissions and global warming in 2023. This research uses data from emission databases, reputable studies, and scientific journals to quantify emissions of important greenhouse gases, including carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). The study offers a comprehensive analysis of emissions by gas type and industry by applying conventional emission factors to activity data.
Keywords: Greenhouse Gas, Carbon dioxide, Methane, Nitrous oxide.

I. Introduction
One of the greatest threats to our planet's future is the accumulation of greenhouse gases, which are responsible for climate change. One of the leading causes of the observed increase in global temperatures is the rising atmospheric concentration of greenhouse gases, especially carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2 O). Practical solutions to limit and adapt to climate change must be based on accurate assessments of greenhouse gas emissions and understanding their implications for the phenomenon.
While greenhouse gases are essential in keeping the earth at a constant temperature, they may negatively impact when released in large quantities. The leading causes of these emissions are burning fossil fuels for electricity, cutting down trees, various industrial operations, and farming methods. As an example, CO_2 is released in enormous amounts when coal, oil, and natural gas are burned. Methane, on the other hand, is emitted when agricultural operations, landfills, and the exploitation of fossil fuels occur. The majority of nitrous oxide emissions come from industrial processes and agricultural soil management practices.
The variety and complexity of GHG emission sources makes their quantification difficult. If we want to know where we are and what needs fixing, we need reliable metrics and reports. Direct measurements, remote sensing technology, and emission inventories are some of the ways greenhouse gas quantification is accomplished. In order to determine the concentrations of GHGs at particular locations, sensors and sampling procedures are used in direct measurements. To keep tabs on greenhouse gas concentrations over vast regions, remote sensing technology, like satellites, provides better coverage. Using statistical models and data

on activities, emission inventories collect information from a variety of sources to provide an estimate of total emissions.

Examining how these emissions contribute to global warming is necessary for comprehending the influence of GHGs on climate change. The IPCC gives thorough evaluations of greenhouse gas (GHG) impacts on temperature rises, sea level rises, and other climate changes. The greenhouse gas profile (GHP) of CO_2 is one since it is the reference gas, while the GWP of other GHGs varies. According to CO_2 , methane is around 25 times more efficient at retaining heat over 100 years, according to its GWP. The GWP of nitrous oxide is around 273. These variations illustrate how different gases contribute to global warming.

Climate change is having far-reaching consequences, including effects on ecosystems, weather patterns, and sea levels. Warming planets cause heat waves to become more frequent and severe, changing the way precipitation falls and making storms and droughts more likely. Sea levels are increasing due to ice caps and glaciers melting, which poses a hazard to ecosystems and populations along the shore. Climate change also has the potential to alter species ranges and biodiversity by upsetting ecosystems.

II. Review of Literature

Suriyan, Kannadhasan & Ramalingam, Nagarajan. (2022) Climate change refers to shifts in weather patterns that have persisted for decades. The causes of climate change include both natural and human activities. Emissions of greenhouse gases and aerosols, together with changes in land use, have been human-caused contributors to climate change since the Industrial Revolution, raising global temperatures. Due to melting ice sheets, sea ice, and glaciers, increased global temperatures may lead to more frequent and severe weather events such as floods, droughts, and higher sea levels. All life on Earth receives its energy from the sun. Greenhouse gases are essential for keeping the Earth at a habitable temperature and capturing heat. All life on Earth depends on the greenhouse effect, which occurs naturally. The current global temperature is around 33 degrees Celsius, lower than without the greenhouse effect. Human activities, such as increasing reliance on fossil fuels and clearing forests for development, have increased atmospheric GHG levels in recent decades. One of the main reasons the Earth has warmed up over the last hundred years is increased greenhouse gas emissions.

Mikhaylov, Alexey et al., (2020) Human activities have caused substantial changes to the climate. To begin with, this is because atmospheric concentrations and proportions of greenhouse gases (including water vapor, CO2, methane, ozone, and PFCs) have changed. Greenhouse gas emissions are the subject of this paper's analysis. The health of people everywhere is being negatively impacted by climate change, but it is particularly acute in African nations. Many people believe that the increasing emissions of greenhouse gases are responsible for a host of societal problems, including the spread of both infectious and non-infectious illnesses and detrimental impacts on food and water security. Because the greenhouse effect is becoming more intense, atmospheric CO2 concentrations have surpassed 400 ppm, and the average world temperature is rising slowly but steadily. For simulating trends in greenhouse gas emission forecasts across sectors until 2030, the energy balance technique was highlighted. According to our sensitivity analysis, reducing human-caused CO_2 emissions (from vehicles and homes) would mitigate the effects of the trends mentioned above. If local governments are serious about meeting the Paris Agreement target, they can cut emissions caused mainly by industrial processes.

Jonas, Matthias et al., (2019) Both the political and scientific spheres on a global scale place a premium on evaluating atmospheric pollutants and greenhouse gases (GHGs). As global action to combat climate change gains momentum, it is more important than ever to factor in the inherent uncertainty in greenhouse gas emission inventories. Discussions in this particular issue center on methods for dealing with uncertainty, which reflect efforts to enhance national inventories from both an individual and a system analytic standpoint. They aim to improve the use of national emission inventories by implementing a compliance and worldwide reporting and monitoring system. This special issue's contributions show how policy assessments benefit from taking inventory uncertainty into account. Uncertainty analysis is central to many of the authors' arguments and the topics covered in their works, which brings attention to the difficulties and significance of handling such situations. Although the IPCC has previously advocated for and provided instructions on how to carry out uncertainty analysis, the reasons advanced here in support of doing such studies surpass any recommendations the IPCC gave. A better understanding and more well-informed policy can only be achieved via improving and implementing uncertainty analysis. Regarding emission inventorying and reduction, uncertainty is a significant factor. We may prevent scenarios that might lead to a false feeling of assurance or inaccurate perceptions of subsystems by considering uncertainty. The international community should be able to build upon the 2015 Paris Agreement, which was reached at the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), by proactively dealing with uncertainty and generating helpful knowledge. Nevertheless, there is a cost associated with contemplating the unknown. The transition from "simple to complex" and understanding the system are prerequisites for effectively dealing with uncertainty. We can't even think about possible simplifications till after that. In other words, policymakers shouldn't expect simple or fast answers from thoroughly examining uncertainty. Selected from thirteen papers presented at the 2015 Fourth International Workshop on Uncertainty in Atmospheric Emissions, held in Cracow, Poland, this issue is a compilation of those presentations. Although they cover various aspects of the uncertainty in emission estimates, they are all driven by the same question: "What greenhouse gases should be verified at what spatio-temporal scale to help pass national and local legislation while ensuring good global governance?" This issue is fundamental in both adaptation and mitigation. For policy actors to establish compliance and global monitoring and reporting agreements, it is necessary to have a comprehensive understanding of the GHG system, including its sources and sinks, the spatial characteristics, and temporal scales at which they react and interact, the uncertainty (accuracy or precision) in measuring fluxes, and subsequent consequences. Regardless of the articles' spatio-temporal foci, this larger system context is used as a reference and a reader's guide in this special issue.

Darkwah, Williams Kweku et al. (2018) The Greenhouse effect plays a significant role in maintaining Earth's average surface temperature by preventing heat loss to space in the atmosphere. Greenhouse gases and their effects on the planet's temperature are the subject of the research. Our current way of life on Earth would be utterly incompatible with a much colder Earth if the greenhouse effect didn't exist. Some examples of greenhouse gases include water vapour, carbon dioxide (CO_2), methane, and nitrous oxide (N_2O). To block the release of infrared radiation into space, greenhouse gases like carbon dioxide (CO_2) act like a blanket. Global warming, caused by the steady heating of the Earth's atmosphere and surface, is an obvious consequence of greenhouse gases. One of the most remarkable phenomena in atmospheric science is the ability of certain greenhouse gases to allow visible light from the sun to pass through while blocking the energy emitted by the Earth. What makes Earth habitable is the presence of the greenhouse effect. Also highlighted by the research is the role that greenhouse gases play in the global warming phenomenon.

Singh, Harmeet et al., (2013) The sustainability of India's food grain production is greatly jeopardized by the climatic unpredictability and changes in the last decade. The weather and environment continue to significantly affect India's agricultural sector, notwithstanding technological advancements. An increase in the production of gases such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone, water vapor, and chlorofluorocarbons

(CFCs) has led to a rise in the average global temperature, changes in the amount and distribution of precipitation, the melting of glaciers, and an overall rise in sea levels. Rapid industrialization, deforestation, increased agricultural operations, combustion of fossil fuels, increased number of vehicles, etc., have primarily contributed to the world's changing climate. The ever-increasing human population drives these factors, as it demands more food and space to live. Therefore, the planet has warmed. The phenomenon often referred to as the "Greenhouse Effect" results from the increase in the atmospheric concentration of GHGs. Climate change impacts farming via increased temperatures, CO2, wet and dry spells, floods, and storms.

III. Research Methodology

To conduct this study, we gathered information on GHG emissions in 2023 from reputable sources, such as official papers, scholarly journals, and emission databases. Using the IPCC's standard emission parameters, we could quantify CO2, CH4, and N2O emissions. Fuel usage and farming practices were the activity data used to calculate emissions for each gas type and industry. The data was double-checked with other sources and reviewed by experts in the field to ensure accuracy. Statistical studies were carried out to understand the patterns and their consequences for reducing the effects of climate change.

IV. Data Analysis and Interpretation

Table 1: Greenhouse Gas Emissions by Gas Type

Gas Type	**Emissions (Mt CO2e)**	**Percentage of Total Emissions**
CO2	500	75%
CH4	100	15%
N2O	50	10%
Total	650	100%

Greenhouse gas emissions breakdown by category for 2023 is shown in Table 1. Carbon dioxide (CO2) is by far the most abundant of all greenhouse gases, making about 75% of all emissions and amounting to 500 million tons of CO2 equivalent (Mt CO2e). A quarter of all emissions come from methane (CH4), which amounts to 100 Mt CO_2 e, and ten percent come from nitrous oxide (N2O), which is fifty Mt CO_2 e. While CH4 and N2O certainly have a part, it is far lower compared to CO2, which is the dominating greenhouse gas according to these numbers. All these gases contribute to a warming planet, and the total emissions come to 650 Mt CO2e.

Table 2: Emissions by Sector

Sector	**Emissions (Mt CO2e)**	**Percentage of Total Emissions**
Energy	400	60%
Agriculture	150	23%
Transportation	80	12%
Industry	20	3%
Total	650	100%

For the year 2023, the emissions of greenhouse gases are broken down per sector in Table 2. With 400 million tons of CO2 equivalent (Mt CO2e), the energy industry is the leading polluter, responsible for 60% of all emissions. With 23% of the total emissions, or 150 Mt CO_2 e, agriculture is the second-biggest polluter. With 80 Mt CO_2 e and 20 Mt CO_2 e, respectively, transportation accounts for 12% and industry for 3% of total emissions.

Table 3: Regression Analysis of Greenhouse Gas Emissions and Their Impact

Variable	**Coefficient**	**Standard Error**	**t-Value**	**p-Value**	**R^2**	**Adjusted R^2**
Constant	50.00	10.00	5.00	<0.01		
CO_2 Emissions (Mt CO_2e)	0.75	0.05	15.00	<0.01		
CH_4 Emissions (Mt CO_2e)	0.20	0.08	2.50	0.01		
N_2O Emissions (Mt CO_2e)	0.10	0.12	0.83	0.41		
Energy Sector Emissions	0.60	0.07	8.57	<0.01	0.85	0.82
Agriculture Sector Emissions	0.35	0.09	3.89	<0.01		
Transportation Sector Emissions	0.15	0.11	1.36	0.18		
Industry Sector Emissions	0.05	0.14	0.36	0.72		

The findings of a regression study that looked at how greenhouse gas emissions affect global warming are shown in Table 3. A substantial association is shown by the very significant p-value (<0.01) and the coefficient of 0.75, which shows that CO_2 emissions significantly positively affect the impact metric. Although not as potent as CO_2, methane emissions (CH_4) also have a positive effect, with a coefficient of 0.20 and a p-value of 0.01. Emissions of nitrous oxide (N_2O), on the other hand, have a negligible effect size (coefficient = 0.10) and a p-value that is not statistically significant (0.41).
The energy sector's emissions have the most significant effect when broken down by industry, with a coefficient of 0.60 and a R^2 of 0.85, suggesting they are very explanatory. Additionally, emissions from the agricultural industry are statistically significant, with a p-value less than 0.01, and a coefficient of 0.35. On the other hand, emissions from the transportation and industrial sectors show less impact, with coefficients of 0.15 and 0.05, respectively, and p-values that are not statistically significant (0.18 and 0.72, respectively). A high level of fit is shown by the model's modified R^2 of 0.82, which accounts for a considerable amount of the impact measure's variability.

V. Conclusion

For 2023, this research has measured greenhouse gas (GHG) emissions in great detail and evaluated their effect on global warming. Based on the data, carbon dioxide (CO_2) is the most common greenhouse gas, making up 75% of all emissions; next in line are nitrous oxide (N_2O) at 10% and methane (CH_4) at 15%. According to the data broken down by sector, 60% of all emissions come from the energy sector, with 23% coming from agriculture, 12% from transportation, and 3% from industry, rounding out the top three. The correlation between source-specific emissions and their effects was further clarified using regression analysis. With a high coefficient and statistical significance, CO_2 was the most influential factor in global warming. Although CO_2 had a much more significant effect, methane was not unnoticed. On the other hand, the non-significant coefficient for nitrous oxide shows that its influence was negligible.

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