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The Analysis of Forest and Land Fire and Carbon and Greenhouse Gas Emissions on the Climate Change in Indonesia

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Due to forest and land fires and various industrial emissions, climate change has become a big issue today. The current article explores the effects of forest and land fire, carbon dioxide (CO2) emissions, greenhouse gas (GHG) emissions, population expansion, and industrialization on Indonesia's climate change. This article gathers statistics from 1991 to 2020 using the World Development Indicators (WDI) and Statista. The researchers utilized dynamic Auto-regressive Distributed Lags (DARDL) to examine the relationship between substudy components. Forest and land fire, CO_2 emissions, greenhouse gas emissions, population expansion, and industrialization were positively associated with climate change in Indonesia. The report provides policymakers with suggestions for formulating climate change policies utilizing forest and land fire, CO_2, and GHG emissions.

Key words: Forest and land fire, CO_2 emission, GHG emissions, population growth, industrialization, climate change in Indonesia.

1. INTRODUCTION

Over the past few decades, one of the world's most significant problems has been combating climate change to protect future generations from its terrible repercussions. As a result of global warming, the global temperature is rising rapidly (Krikken et al., 2021; Venäläinen et al., 2020). This temperature shift affects the ozone layer in the form of human deaths, comparable to a heat wave. There are several causes of climate change, including pollution, the generation of energy from traditional resources (such as fossil fuels and coal), forest fires, and industrialization. Urgent action is required in the form of energy production from renewable resources, investment in green energy projects, and less chemical use in industry to mitigate the devastating effects of climate change. The population and development of Indonesia are strongly impacted by climate change and its environmental implications. Due to sound economic policies and political stability, Indonesia's economy has grown rapidly during the past two decades. Climate change has made the goal of development for emerging economies more challenging. Indonesia is already experiencing the negative effects of climate change due to the frequency of heat waves and floods (Nawaz et al., 2020; Shair et al., 2021). If these repercussions persist and escalate in Indonesia, the threat to the country's development challenge will increase. In December 2007, when the Indonesian government hosted the United Nations Climate Change Conference in Bali, climate change in Indonesia also garnered international notice. About 10,000 individuals attended the meeting to discuss Indonesia's and the world's concerns on climate change (Abram et al., 2021; Sesana et al., 2021).

Indonesia is the largest archipelagic state in the world, with more than 17,500 islands and more than 81,000 kilometers (km) of coastline. It has a population of 270.6 million and was Southeast Asia's largest economy until 2019. (Halofsky et al., 2020; Iriyadi et al., 2021). The country's islands' landscape, geology, and climate are highly diverse, ranging from peat bogs and mountainous forests to sea and coastal systems. Indonesia is very vulnerable to the

consequences of climate change, which include catastrophic events such as floods and droughts as well as long-term changes caused by sea level rise, changes in rainfall patterns, and rising temperatures (Parks et al., 2020; Wang et al., 2020). Regarding climate risk, Indonesia ranks in the top third of countries due to its sensitivity to all types of floods and extreme temperatures (Heinrich et al., 2021; Xu et al., 2020). It is projected that these hazards will become more severe as the climate changes. Without successful adaptation, population vulnerability will increase (Fonseca et al., 2019; Lucash et al., 2018). Between 2035 and 2044, a catastrophic river flood could affect an additional 1,400,000 people. Indonesia is the fifth most populous country in terms of population density in low-elevation coastal zones, making it particularly susceptible to sea level rise. Without adaptation, more than 4,2 million people could live in permanently flooded areas by 2070–2100. The availability of water, disaster risk reduction, urban development, especially in coastal areas, and health and nutrition are also anticipated to be impacted by climate change, with repercussions for poverty and inequality. Carbon dioxide emissions are one of the primary causes of climate change (Li, 2021; Rehman et al., 2022; Zhao et al., 2021). Figure 1 depicts the carbon emission for Indonesia.

The dreadful effects of climate change, which portend a bleak future for the upcoming generation, are one of the past research gaps that this study will address. Although in the race for economic growth, countries, particularly developing nations, ignore environmental degradation. This issue must be examined from economic and environmental perspectives, such as the economy and greenhouse gas emissions. Although climate change has been studied extensively, the combination of factors such as carbon, greenhouse gas emissions, industrialization, forest and land fires, and economic growth has not yet been explored.

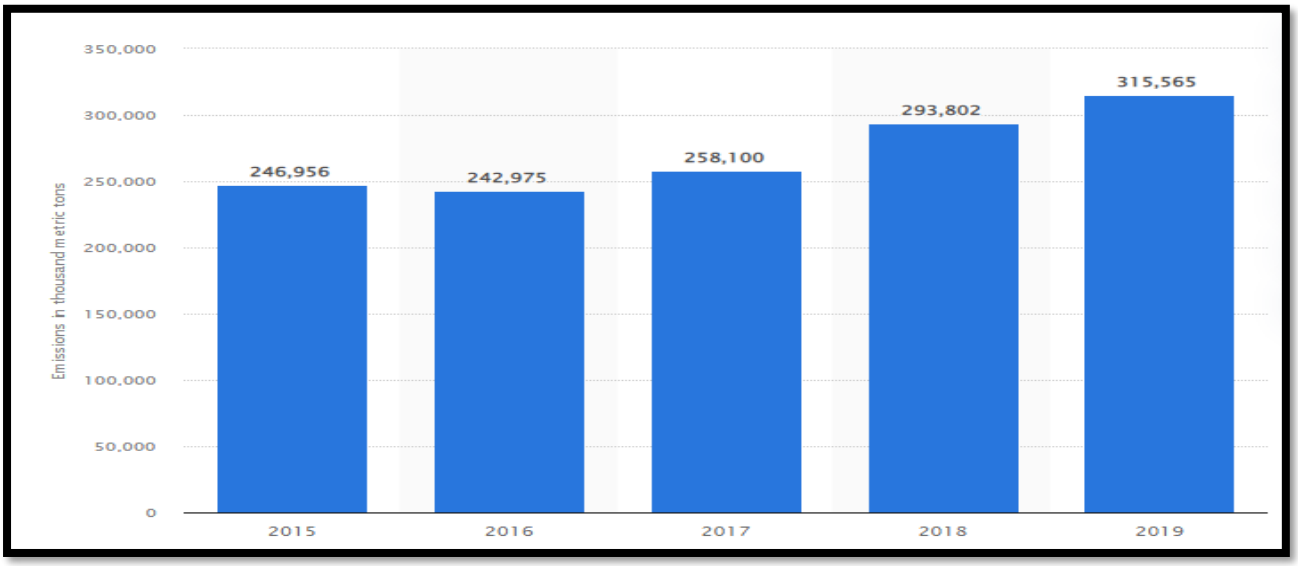

Figure 1. Carbon Emissions in Indonesia

As a result, the present study will fill this gap by investigating climate change from multiple perspectives. 2) Zheng et al. (2019) examined the relationship between greenhouse gas emissions and climate change; however, the current study will also focus on climate change, with the addition of carbon emission, industrialization, forest and land fires, and economic growth in Indonesia, using a new data set. 3) even though multiple equations relating to climate change have been explored, the model comprising climate change, carbon emission, greenhouse gas emission, industrialization, forest and land fire, and economic growth has not previously been tested, particularly in Indonesia in recent years. 4) Khan et al. (2022) studied the relationship between climate change and carbon risk; however, the current study will also focus on climate change, with the addition of industrialization, greenhouse gas emission, forest and land fire, and economic growth, using a new data set. 5) Abram et al. (2021) studied the effect of forest fires on climate change. The current study will also examine this topic and add carbon emissions, industrialization, greenhouse gas emission, and economic growth in Indonesia. 6) Jorgenson et al. (2019) worked on the drivers of global climate change; however, the present study will also examine their work along with carbon and greenhouse gas emissions using a sample of new data. The significance of the present investigation is twofold: 1) climate change is one of the most pressing issues of our time, and the resolution of this issue is crucial to safeguard the future generation; therefore, the present investigation will emphasize the significance of climate change for the world; and 2) the present investigation will also assist environment-related professionals in understanding and revising their policies to control climate change.

2. Literature Review

The world is experiencing rapid climate change, leading to a rise in global temperature. This rising temperature impacts every element of existence, including the melting

of glaciers, the increase in energy demand, and the health problems caused by the ozone layer He et al. (2020); (Zheng et al., 2019). Considering the future of the next generation, the world is highly concerned about the catastrophic effects of climate change (Breton et al., 2018; Rehman, Ma, & Ozturk, 2021). Carbon emission is one of the fundamental contributors to climate change (Chami et al., 2019; Zheng et al., 2019). In this regard, Khan et al. (2022) explored whether or not a correlation exists between climate change and carbon emission risk. The research was conducted on 129 economies. As a sample, the investigation utilized data spanning 30 years, from 1190 to 2020.

The collected data were examined using a GMM estimator. The analysis indicated that economies with greater levels of renewable energy generation and consumption had a more substantial capacity to slow environmental degradation over time by reducing their total carbon emissions. Using system GMM approaches modifies these correlations, highlighting the significance of FDI inflows. Numerous factors significantly impact climate change, including culture, economy, and socio-culture. In this context, Jorgenson et al. (2019) conducted a literature assessment on the four dimensions of cultural, economic, geographic, political, and sociocultural factors that can cause climate change to increase or decrease. According to the investigation's findings, all four components significantly impact climate change. Amazon is one of the world's most extensive forests.

Consequently, it has been one of the most significant carbon sinks during the past few decades. These carbon sinks diminished due to deforestation. Gatti et al. (2021) worked on the carbon resources that affect climate change in this context. The Amazonia probe was conducted in the United States. As a sample, the investigation used information spanning eight years, from 2010 to 2018. The collected data were evaluated using AVP measurements. The analysis indicated that eastern Amazonia had higher carbon emissions than the western region, primarily due to differences in the distribution of carbon monoxide-forming fire outputs. Specifically, Southeastern Amazonia contributes to the net carbon source in the atmosphere. During the past four decades, eastern Amazonia has seen more significant deforestation, warming, and moisture stress than its western counterpart, particularly during the dry season, with the southeast experiencing the most drastic alterations. It is observed that, due to their more significant population, cities create more carbon emissions than small towns. This overproduction contributes negatively to climate change. In this regard, Mi et al. (2019) examine the effects of urban carbon emissions on climate change. In China, the investigation was conducted. The inquiry sampled and analyzed data from 2012 as a representative sample. The analysis indicated that urban areas require more energy, typically derived from fossil fuels. The production of fossil fuels generates carbon emissions, which in turn cause climate change. In recent decades, environmental deterioration has been one of the world's most pressing concerns (Dino et al., 2019; Tarroja et al., 2018). Numerous factors, including energy generation from traditional resources, carbon emissions, and greenhouse gas emissions, contribute to this phenomenon. This study attempted to examine the relationship between climate change and greenhouse gas emissions (Tribouillois et al., 2018; Zhang et al., 2021). Zheng et al. (2019) studied whether greenhouse gas emissions play a role in climate change in this environment. The examination encompassed both G7 and BRICS economies. As a sample, the investigation included data spanning 37 years, from 1990 to 2017. Comparative analysis was used to analyze the acquired data.

In comparison to BRICS nations, per capita greenhouse gas emissions have increased in G7 countries, according to the findings of the analysis. Energy intensity, economic growth, and carbon factor are the primary determinants of greenhouse gas emissions per capita increase in both sets of countries. The carbon factor, based on greenhouse gas emissions per unit of total direct energy supply, quantifies the carbon intensity of a country's energy sector. Similarly, the global community is obligated to enact stringent regulations to limit the effects of climate change. The Paris agreement mandates this for all nations. In this context, Eskander et al. (2020) examined greenhouse gas emissions from the perspective of climate change legislation. The study was conducted in 133 nations. As a sample, the investigation used information spanning seventeen years, from 1999 to 2016. The data was analyzed with the aid of FMOLS. According to the study's findings, each new law may reduce annual carbon emissions per unit of GDP by 0.78 percent in the short term (during the first three years) and by 1.78 percent in the long term (after three years). Legislative legislation and nations with a competent legal system determine the results. As a result of existing climate restrictions, the global Carbon Dioxide (CO_2) emissions in 2016 were lowered by 5.9 GtCO per year, which was greater than the US CO_2 production that year. From 1999 to 2016, overall CO_2 emissions decreased by 38 $GtCO_2$, equivalent to one year of global CO_2 production. Other greenhouse gases are influenced much less. Jiang et al. (2020) also investigated the relationship between climatic change and greenhouse gas emissions. The analysis found that releasing greenhouse gases is one of the primary causes of climate change.

The forest covers a vast portion of the world's surface. Some regions are under the rigorous supervision of humans. However, a vast region is beyond the world's approach and control. Multiple forest fires, caused by various factors, result in irrecoverable losses, release a substantial quantity of carbon emissions, and environmental deterioration (Ertugrul et al., 2021). The Black Summer bushfire crisis in southeast Australia in 2019-2020 was unprecedented in terms of the quantity of burned forest, the radiative intensity of the flames, and the extraordinary frequency of fires that became intense pyro-

convective events. As 2019 was the warmest and driest year on record in Australia, the ground was prepared for wildfires when subjected to hazardous fire conditions and ignition. Abram et al. (2021) studied whether there is a correlation between climate change and forest fires in this scenario.

In Australia, the investigation was carried out. The analysis indicated that forest fires are one of the most significant contributors to climate change, as they emit a substantial amount of carbon dioxide, which has a detrimental impact on the climate. Back in 2018, there was a fire incident in Sweden. In this context, Krikken et al. (2021) examined the relationship between climate change and forest fires. In Sweden, the investigation was conducted. The research indicated that the 2018 forest fire in Sweden resulted in the discharge of a substantial amount of carbon emissions. This carbon output contributes negatively to climate change.

Similarly, Michetti et al. (2019) examined the relationship between forest fires and climate change. In Italy, the investigation was conducted. As a sample, the investigation used information spanning eleven years, from 2000 to 2011. The collected material was examined using the pearl technique. The analysis indicated that forest fires emit carbon, contributing to further environmental devastation. Countries with a high proportion of forest area guarantee optimum safety to prevent forest fires caused by any incident. Countries worldwide are in a race to ensure their economic development to provide a bright future for future generations and improve the standard of living of the current generation. This economic growth has various secondary effects, including environmental damage and industrialization. Ceesay et al. (2023) explored the relationship between economic development and climatic change in this environment. The investigation took place in Gambia. As a sample, the study used information spanning 57 years, from 1960 to 2017. The collected data was evaluated using the ARDL methodology. The investigation revealed that 1) the Gambia's increasing fish and livestock output had a significant positive impact on GDP growth, 2) the expansion of agricultural and food imports harms GDP growth, 3) there is a one-way relationship between lagged GDP growth rates and rates of growth in the availability of food, 4) lagged values of GDP growth indicate a direct link between Granger and lagged values of agricultural growth, and 5) lagged values of GDP growth indicate a direct link between Granger and la Similarly, Guedie et al (2022) studied whether economic development and climate change are related. The investigation was conducted in ASEAN nations. As a sample, the analysis used information spanning 32 years, from 1982 to 2014. With the aid of FMOLS, the collected data was examined.

Environmental degradation (CO_2 emissions) and financial and economic development, as well as FDI, were found to have a statistically significant long-term co-integrating relationship in the selected ASEAN economies. Moreover, FDI, financial expansion, and economic progress increase environmental degradation in the ASEAN-5 countries. The quadratic term for economic development had a negative influence on environmental deterioration. In addition, Shimada (2022) explored the connection between climate change and economic growth. The investigation took place in Africa. As a sample, the study utilized data spanning 52 years, from 1961 to 2011. PDRM analysis was employed to examine the collected data. The analysis indicated that natural disasters caused by climate change affect poverty, agriculture, and economic development in Africa. In addition, they led to violent clashes. The calamities with the most significant adverse effects are shortages, severely damaging crops such as maize and coffee, increasing urban poverty, and violent warfare.

In contrast, foreign aid has a positive impact, but it pales compared to the devastation caused by climate-related natural disasters. Cereal food aid has a negative crowding-out effect on cereal production. International funders should reassess their projects to improve Africa's adaptability to disasters. Due to government efficiency, the number of fatalities has dropped, and this is an area where Africa's attempts to adapt are supported. To improve their economic performance, the nation’s pursue diverse strategies. Business expansion is one of the primary drivers. In this way, the business community serves as a fulcrum. In this setting, governments promote industrialization to attract investment from internal and external sources. This growth in industrialization leads to increased chemical usage, increasing carbon emissions. This carbon output contributes to adverse climate change. In this context, Abram et al. (2021) examined whether industrialization plays a role in climate change or environmental deterioration. In Australia, the investigation was carried out. As a sample, the study included data spanning 35 years, from 1980 to 2014. The collected data were examined with the assistance of EKC. The analysis indicated that there is a relationship between the short- and long-term varying variables. Economic expansion, energy consumption, industrialization, stock market growth, and CO_2 emissions display bidirectional causality in the near run. On EKC, however, there are not much-supporting data. This is due to the long-term positive effects of financial development, energy consumption, and trade openness on CO_2 emissions. It is interesting to notice that industrialization does not affect CO_2 emissions. Similarly, Wang et al. (2020) explored the relationship between industrialization and climate change regarding carbon emissions. The investigation was conducted in APEC member states. As a sample, the study included data spanning 25 years, from 1990 to 2014. With the aid of DSUR, the acquired data was evaluated.

According to the inquiry's findings, industrialization harms the environment by emitting carbon dioxide into the atmosphere. In addition, growing CO_2 emissions have been attributed to urbanization, energy intensity, and economic growth. In addition, a one-way causal

relationship is observed between industrialization and CO_2 emissions. In addition, Zafar et al. (2020) explored whether industrialization contributes to climate change through environmental contamination. The research was conducted on Asian economies. As a sample, the investigation included information spanning 26 years, from 1991 to 2017. With the aid of FMOLS, the collected data was examined. The analysis indicated that industrialization has a substantial long-term impact on carbon dioxide emissions. In addition, different industrialization development approaches should be implemented based on economic growth rates to reduce emissions.

In addition, the report advised that the selected Asian economies specialize in limiting carbon emissions from industrialization. In addition, Lin et al. (2015) examined whether industrialization affects climate change regarding carbon emissions. The investigation took place in Nigeria. As a sample, the analysis utilized data from 31 years from 1980 to 2011. The collected data were evaluated using the ADF test. The study indicated that long-term strategies that inflict permanent shocks on the variables are required to accomplish sustained economic growth, industrialization, and CO_2 reduction. According to the analysis's conclusion that there is a substantial inverse relationship between industrial value-added and CO_2 emissions, there is no evidence that industrialization in Nigeria raises carbon emissions. GDP per capita and population have significant and positive effects on CO_2 emissions. At a 10% concentration, energy and carbon intensities have a marginally positive impact on CO_2 emissions.

3. Research Methods

The article investigates the impact of forest and land fire, CO_2 emissions, GHG emissions, population growth, and industrialization on climate change in Indonesia. The article used the WDI and Statista for the data collection and collected the data from 1991 to 2020. The study established the estimated equation with the help of understudy variables given below:

$$CC_t = \alpha_0 + \beta_1 FLF_t + \beta_2 CO2E_t + \beta_3 GHGE_{it} + \beta_4 IND_t + \beta_5 EG_t + e_t \quad \textbf{(1)}$$

Where;

CC	=	Climate Change
t	=	Time Period
FLF	=	Forest and Land Fire
CO2E	=	Carbon Dioxide Emissions
GHGE	=	Greenhouse Gas Emissions
IND	=	Industrialization
EG	=	Economic Growth

The article measured climate change as a function of temperature rises in degrees Celsius as the dependent variable. In addition, the study utilized three predictors, including forest and land fire as measured by land and forest burned (kilo hectare), CO_2 emissions as measured by CO_2 emissions (metric tons per capita), and GHG emissions as measured by total GHG emissions (percent change from 1990). In addition, the paper employed two control constructs: population increase as assessed by population growth (annual percent) and industrialization as measured by industry value added (percent of GDP). Table 1 displays all measurements of variables under investigation.

Table 1. Variables with Measurements

S#	Variables	Measurement	Sources
01	Climate Change	Temperature increases in degrees Celsius.	Statista
02	Forest and Land Fire	Land and forest burned (kilo hectare)	Statista
03	Carbon Dioxide Emissions	CO2 emissions (metric tons per capita)	WDI
04	Greenhouse Gas Emissions	Total GHG emissions (% change from 1990)	WDI
05	Industrialization	Industry value added (% of GDP)	WDI
06	Population Growth	Population growth (annual %)	WDI

The article applies descriptive statistics that expose the details of all understudy variables. Moreover, the study also applies the correlation matrix that describes the correlation among constructs. In addition, the article provides the unit root of the variable using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The equation for the unit root test is given below:

$$d(Y_t) = \alpha_0 + \beta t + \gamma Y_{t-1} + d(Y_t(-1)) + \varepsilon_t \quad \textbf{(2)}$$

In addition, the article also applies the (Westerlund et al., 2008) approach to analyze the co-integration that is important to apply a suitable model. The equations are mentioned below:

$$LM_{\varphi}(i) = T\hat{\varphi}_i\,(\hat{r}_i/\hat{\sigma}_i) \quad \textbf{(3)}$$

$$LM_{\tau}(i) = \hat{\varphi}_i/SE(\hat{\varphi}_i) \quad \textbf{(4)}$$

In the equations mentioned above, the standard error is shown by $\hat{\boldsymbol{\varphi}}_{\boldsymbol{i}}$, and the long-run measured variance is shown by $r^{2}{}_{i}$.

Moreover, the article applies the ARDL model because the unit root test shows that some constructs are stationary at level, but others are stationary at first difference. The ARDL model controls the effects of heteroscedasticity and autocorrelation (Zaidi et al., 2018). The equation of the approach is mentioned below:

$$\Delta CC_t = \alpha_0 + \sum\delta_1 \Delta CC_{t-1} + \sum\delta_2 \Delta FLF_{t-1} + \sum\delta_3 \Delta CO2E_{t-1} + \sum\delta_4 \Delta GHGE_{t-1} + \sum\delta_5 \Delta IND_{t-1} + \sum\delta_6 \Delta PG_{t-1} + \varphi_1 CC_{t-1} + \varphi_2 FLF_{t-1} + \varphi_3 CO2E_{t-1} + \varphi_4 GHGE_{t-1} + \varphi_5 IND_{t-1} + \varphi_6 PG_{t-1} + \varepsilon_t \quad \textbf{(5)}$$

Finally, the article applies the DARDL model because it is the latest approach introduced by Jordan et al. (2018). This model can cover the issues that the ordinary ARDL model did not overcome. The equation of the approach is mentioned below:

$$\Delta CC_t = \alpha_0 + \sum\delta_1 \Delta CC_{t-1} + \sum\delta_2 \Delta FLF_t +$$

$$\sum\delta_3\Delta FLF_{t-1} + \sum\delta_4\Delta CO2E_t + \sum\delta_5\Delta CO2E_{t-1} + \sum\delta_6\Delta GHGE_t + \sum\delta_7\Delta GHGE_{t-1} + \sum\delta_8\Delta IND_t + \sum\delta_9\Delta IND_{t-1} + \sum\delta_{10}\Delta PG_t + \sum\delta_{11}\Delta PG_{t-1} + \varepsilon_t \quad (6)$$

4. Findings

The article employs descriptive statistics that reveal the specifics of all variables under consideration. The output showed that thirty observations were collected between 1991 and 2020. In addition, the study revealed that the average CC value was 26.092 degrees Celsius, the average FLF value was 1.102 hectares, and the average CO_2 emissions per capita was 1.558 kilograms. The study results also revealed that the average GHGE value was 10.536%, the average IND value was 43.073%, and the average PG value was 11.369%. Table 2 summarizes the results of the study.

Table 2. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CC	30	26.022	0.544	25.607	26.417
FLF	30	1.101	0.735	0.936	1.787
CO2E	30	1.553	0.348	0.887	2.295
GHGE	30	10.552	73.423	-46.574	332.646
IND	30	43.072	3.022	38.254	48.064
PG	30	1.362	0.151	1.063	1.737

Moreover, the study also applies the correlation matrix that describes the correlation among constructs. The outcomes indicated that forest and land fire, CO_2 emission, GHG emissions, population growth, and industrialization positively affect climate change in Indonesia. Table 3 highlights the outputs of the study.

Table 3. Matrix of Correlations

Variables	CC	FLF	CO2E	GHGE	IND	PG
CC	1.000					
FLF	0.674	1.000				
CO2E	0.394	0.489	1.000			
GHGE	0.662	0.644	0.488	1.000		
IND	0.634	-0.334	0.747	0.749	1.000	
PG	0.776	-0.195	-0.536	-0.646	0.736	1.000

In addition, the article provides the unit root of the variable using ADF and PP tests. The outcomes revealed that the CC, FLF, IND, and PG are stationary at level, but CO_2 emissions and GHGE are stationary at first difference. Table 4 highlights the outputs of the study.

Table 4. Unit root Test

ADF PP				
Series	Level	First difference	Level	First difference
CC	-3.839***	------	-3.563***	------
FLF	-3.768***	------	-2.902***	------
CO2E	------	-4.567***	------	-4.674***
GHGE	------	-4.873***	------	-5.744***
IND	-3.098***	------	-3.921***	------
PG	-2.954***	------	-4.093***	------

In addition, the study employs the (Westerlund et al., 2008) method for analyzing co-integration, which is essential for applying an appropriate model. The results revealed that t-statistics are more than or equal to 1.96, and p-values are less than 0.05. These results indicated the existence of co-integration. Table 5 summarizes the results of the investigation.

Table 5. Co-integration Test

Model	No Shift		Mean Shift		Regime Shift	
	Test Stat	p-value	Test Stat	p-value	Test Stat	p-value
LM_τ	-5.343	0.000	-5.734	0.000	-6.496	0.000
LM_φ	-5.986	0.000	-5.837	0.000	-6.102	0.000

Due to forest and land fires and various industrial emissions, climate change has become a big issue today. The current article investigates the effects of forest and land fire, CO_2 emissions, GHG emissions, population growth, and industrialization on Indonesia's climate change. The researchers utilized the DARDL to examine the relationship between substudy constructs. Forest and land fire, CO_2 emissions, greenhouse gas emissions, population expansion, and industrialization were positively associated with climate change in Indonesia. Table 6 summarizes the results of the study.

Table 6. Dynamic ARDL model

Variable	Coefficient	t-Statistic	Prob.
ECT	-3.783***	-5.883	0.000
FLF_{t-1}	5.192***	4.739	0.000
FLF	4.328***	4.902	0.000
$CO2E_{t-1}$	6.361***	5.383	0.000
CO2E	2.910**	2.121	0.021
$GHGE_{t-1}$	3.673**	2.673	0.015
GHGE	2.547**	2.121	0.021
IND_{t-1}	5.655***	5.673	0.000
IND	2.673***	4.641	0.000
PG_{t-1}	3.562***	4.273	0.000
PG	3.102***	4.332	0.000
Cons	3.775***	4.901	0.000

R square = 62.675 Stimulation = 5000

5. Discussion

Due to forest and land fires and various industrial emissions, climate change has become a big issue today. The current article explores the effects of forest and land fire, CO2 emissions, GHG emissions, population expansion, and industrialization on Indonesia's climate change. The results indicated that forest and land fires affect climate change positively. These findings are consistent with Stephens et al. (2020), who note that forest development preserves climate equilibrium by reducing greenhouse gas emissions, stabilizing the temperature, and regulating water flow. When woods are burned by fire, the climate becomes unbalanced and causes problems for living things. These findings are further corroborated by Prichard et al. (2021), who demonstrate that forests and land fires are detrimental to the environment. The fire plumes and their further diffusion could produce hazardous compounds that, when mixed with air, can disrupt the climate's equilibrium. These findings concur with Venäläinen et al. (2020) 's examination of the influence of forest and land fires on natural climate. According to the study, if a large forest or land fire gets out of control, it creates smog, causes greenhouse gas emissions, and raises the temperature.

The results demonstrated that CO_2 emissions influence climate change positively. Following Nguyen et al. (2021), the natural greenhouse effect that keeps the earth's atmosphere above freezing would be insufficient if CO_2 emissions were eliminated. By emitting more carbon dioxide into the atmosphere, humans accelerate the natural greenhouse effect and raise the planet's temperature. Hence, CO_2 emissions cause climate change. These findings are also corroborated by Adedoyin et al. (2020), who propose that the amount of CO2 emissions in the atmosphere is maintained by nature. When human activities increase, CO_2 levels rise, resulting in increased greenhouse effects and climate imbalance. To Dusenge et al. (2019), one of the most significant climate changes is global warming. By forming a layer, CO_2 emissions from human activities trap heat in the earth. Hence, CO_2 emissions cause Climate change.

Results demonstrated that greenhouse gas emissions influence climate change positively. These findings are also consistent with Beach et al. (2019), which indicate that fire is burned to provide energy to power various devices and conduct operations. In this process, which yields energy, greenhouse gases are also emitted. GHGs create heat for a specific period and limit the sun's heat to the earth's surface. Thus, increasing GHG emissions result in a shift in climate equilibrium. These findings are also supported by Mikhaylov et al. (2020), who found that the GHGs, as a result of practices involving the combustion of fossil fuels, waste emissions from manufacturing firms, and the use of chemical-based products, deplete the ozone layer and allow the sun's warmth to increase globally. Changes in climate and weather patterns may occur during this time. Similarly, these results concur with Manabe (2019). According to the previous study, climate change is likely to occur when human activities result in high GHG emissions.

The results demonstrated that industrialization affects climate change positively. These results are also consistent with Rehman, Ma, Ahmad, et al. (2021)'s finding that as industrialization increases, manufacturing units expand, and as trade increases, transportation increases as well. In these processes, fossil fuels such as coal, oil, gas, petroleum, and ore are burned to produce energy. However, hazardous gases such as carbon dioxide, methane, and nitrous oxide, among others, are also emitted during these processes, and these gases cause climate change. These findings are also corroborated by Dong et al. (2021), who assert that industrialization dramatically alters the lifestyles of rural residents. As the standard of living rises, so do human want, and the use of fossil fuels and chemical processes to meet these requirements emits chemicals, generating the greenhouse effect. Climate change constitutes the end of the greenhouse effect. Following the findings of Opoku et al. (2020), if industrialization occurs, machines will increase to facilitate and accelerate human practices. The increased use of machinery produces pollutants that could alter the natural climate equilibrium.

The results demonstrated that economic expansion affects climate change positively. These findings are also consistent with Abram et al. (2021) 's assertion that when a nation experiences rapid economic growth, businesses develop the capacity to acquire machines, plants, and a variety of supporting technologies as the skills to interact

with them. When humans use a growing number of devices, plants, and technologies, toxic substances are produced that deplete the ozone layer and cause climate change. These results are also supported by Albert (2020), who asserts that imports of energy resources, transport vehicles, and manufacturing technologies are high whenever the economy is expanding, and trade is robust. In this scenario, the nation's use of energy and chemicals increases and becomes a significant source of greenhouse gas emissions. Increasing greenhouse gas emissions alter the climate. These findings are also consistent with Dodson et al. (2020) 's conclusion that economic growth improves the financial position of both private businesses and government revenues. In this circumstance, they struggle to complete developmental projects, and the construction work, use of technologies, and consumption of energy release contaminated substances into the air, resulting in climate change.

6. Implication

The current study can provide authors with guidelines for its contribution to literature. The study investigates the effects of forest and land fires, CO_2 emissions, greenhouse gas (GHG) emissions, industrialization, and economic growth on climate change. Separate studies have already addressed the relationship between forest and land fires, CO_2 emissions, greenhouse gas emissions, and climate change. This study examines the role of forest and land fires, CO_2 emissions, and greenhouse gas emissions in climate change. This study contributes to the existing literature by analyzing the relationship between these factors and climate change in Indonesia.

Climate change is a major concern for nearly all nations today. The current is crucial for growing economies such as Indonesia. The report provides guidelines for addressing climate change challenges. The study suggests that policies should be designed to prevent forest and land fires to combat climate change. It also indicates that CO_2 emissions-causing practices and resources must be discouraged to avoid climate change. It is suggested to policymakers that efforts must be made to reduce GHG emissions by modifying policies. This might be beneficial for preventing climate change. The study also reveals that the government must manage industrialization and the economic changes it brings to prevent climate change. The study provides policymakers with guidelines for establishing climate change policies using forest and land fire, CO_2, and GHG emissions. In addition, the study indicates that if a country experiences rapid economic growth, the government must adopt environmentally friendly practices to prevent climate change.

7. Conclusion

The study aimed to examine the effects of forest and land fires, CO_2 emissions and GHG emissions, industrialization, and economic growth on climate change. Indonesian-collected empirical data about the factors. Forest and land fires, CO_2 emissions, GHG emissions, industrialization, and economic development affect climate change positively. The results indicated that if forests catch fire or if a fire breaks out elsewhere on the land, smog, heat, and harmful gases are produced, which may lead to climate change. These results also demonstrated that after destroying the ozone layer, CO_2 emissions trap heat in the earth and cause climate change. In addition, the results demonstrated that when humans emit greenhouse gases, they increase the amount of sunlight reaching the planet's surface, causing climate change. In addition, the results show that economic growth generates a situation in which GHG emissions and numerous harmful substances are produced. This results in global warming. In addition, the study found that industrialization increases the consumption of the chemical, energy, and technological resources. The conclusion is climate change.

8. Limitations

This research has several limitations. With their expertise, future authors can eliminate these limitations from the study. The study investigates the effects of factors such as forest and land fires, CO_2 emissions, and greenhouse gas emissions on climate change. However, numerous other factors can either contribute to climate change or be used to combat it. Using limited elements to evaluate climate change renders the study insufficiently exhaustive. Future climate change research must incorporate a more significant number of variables. In addition, the time frame of the present study is constrained, and data were collected from a single economy, Indonesia, to support the relationship between forest & land fire, CO_2 emissions, GHG emissions, industrialization, and economic growth on climate change. This restricts the study's applicability to a particular generation and nation. It is anticipated that future authors will collect data from more countries over an extended period.

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