IMPACT OF CLIMATE CHANGE ON ECONOMIC GROWTH: CASE STUDY IN VIETNAM

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Abstract: ***This arrticle researchs impact of climatic change on economic growth in Vietnam from 1995 to 2023 by applying quantitative research design and secondary data. The data was collected from World Bank, Tradingeconomics, General Statistics Office of Vietnam, ourworldindata.org. SPSS was used for data analysis and statistical methods such as Multiple Regression Analysis and Pearson Correlation was tested to examine the influence of climate variables on economic growth in Vietnam. The dependent variable is GDP while independent variables are population (POP), precipitation (RAIN), temperature (TEMP), annual CO2 emissions (CO2) and Forest area (FORE). The result shows that five independent variables all have a statistically significant impact on the dependent variable, that means climate change has a negative impact on Vietnam's economic development. Based on this, the article proposes some recommendations to minimize the impact of climate change on economic development in Vietnam.***

• Keywords: *climate change, economy growth, Vietnam.*

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1. Introduction

Climate change refers to long-term changes in local, global or regional temperature and weather due to human activities. It now poses a serious risk to both human well-being and the continued existence of biodiversity. The two most frequent signs of climate change are an increase in the average global temperature and intense and unpredictable weather. It has now acquired the importance of global emergency. According to the report of the latest Intergovernmental Panel for Climate Change (AR6 Climate Change 2021), human-induced climate change as is prevalent now is unprecedented at least in the last 2000 years and is intensifying in every region across the globe (IPCC, 2021).

Vietnam is one of the most vulnerable countries to climate change in the world, ranking 127 out of 182 countries according to the Notre Dame Global Adaptation Initiative (ND-GAIN) and ranked 13th out of 180 countries in the Climate Risk Index of Germanwatch 2000-2021. Vietnam, which is placed 91st out of 192 countries on the ND-GAIN Readiness Index, is likewise ill-prepared to manage with severe occurrences, rising sea levels, and harsher temperatures. According to estimates, losses due to climate change were around 79,853 billion VND between 2001 and 2010 and approximately 245,339 billion VND (or almost 11 billion USD) between 2011 and 2022. The World Bank research group estimates that the effects of climate change will cost Vietnam more than $10 billion USD in 2021–2022, or 3.2% of its GDP. The magnitude of these losses, which are anticipated to rise quickly, highlights how urgent it is for Vietnam to adjust to the threats posed by climate change. Meanwhile, Vietnam's vulnerability to climate change stems from the accumulated stocks of GHGs in the atmosphere and the slow response of the largest polluters to reducing GHG emissions, the situation is aggravated by poor planning and unsustainable management of resources.

Therefore, the objectives of this article are: (1) To determine climatic change effect on economy growth of Vietnam; (2) To examine the effect of climate change such as: population, precipitation, temperature, annual CO2 emissions and Forest area on Vietnamese economy.

2. Theoretical basis

Clmate change is a long-term change in the typical or average weather of a region; in the last few decades, industrial and human activities have led to gradually accelerating changes in the climate, including an annually incremental increase in the average surface temperature, which has been defined as climate change (IPCC, 2014). The Intergovernmental Panel on Climate Change

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defines climate change as "a change in the state of the climate that can be identified… by changes in the mean and/or the variability of its properties and that persists for an extended period" (IPCC, 2018). Climate Change, global warming and more recently Climate Emergency have been, in the past decade and longer, terms synonymous with the greatest sustainability challenge of the 21st century (Munasinghe, 2010; Kyte, 2014; Princiotta and Loughlin, 2014; Martens et al., 2016). Changes observed in Earth's climate since the mid-20th century are driven by human activities, particularly fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere, raising Earth's average surface temperature. Natural processes, which have been overwhelmed by human activities, can also contribute to climate change, including internal variability (e.g., cyclical ocean patterns like El Niño, La Niña and the Pacific Decadal Oscillation) and external forcings (e.g., volcanic activity, changes in the Sun's energy output, variations in Earth's orbit) (Nasa, 2024).

Climate change also has noticeable negative impacts on other parts of the planet, like changes in ecosystems and desertification, rise in sea level, flooding, and drought (Hisano et al., 2018; Ouhamdouch et al., 2019). The way climate change impacts weather, the environment, animals, and agriculture affects humanity as well. Around the world, our ways of life from how we get our food to the industries around which our economies are based have all developed in the context of relatively stable climates. As global warming shakes this foundation, it promises to alter the very fabric of society. At worst, this could lead to widespread famine, disease, war, displacement, injury, and death. For many around the world, this grim forecast is already their reality. In this way, climate change poses an existential threat to all human life (NRDC, 2022). UN (2024) presents that climate change led to hotter temperatures, more severe storms, increased drought, a warming, rising ocean, loss of species and more health risks. Changes in the climate and increases in extreme weather events are among the reasons behind a global rise in hunger and poor nutrition. Climate change increases the factors that put and keep people in poverty. Floods may sweep away urban slums, destroying homes and livelihoods. Heat can make it difficult to work in outdoor jobs. Water scarcity may affect crops. As a result of climate change, some sectors of the economy may grow rapidly when compared with other economies and with improvements in the size and composition of their GDP. Different nations can become more diverse. Climate change also has a negative impact on the country's long-term growth prospects.

3. Literature review

Hitz and Smith (2004) assert that there is a direct correlation between energy usage and economic progress. Emissions of greenhouse gases (GHGs) rise in response to energy consumption. Analyses indicate that industrialized countries account for around 75% of global CO2 emissions. This result demonstrates how energy usage that leads to environmental deterioration affects economic development.

Fankhauser and Richard (2005), The economic impact of climate change is usually measured as the extent to which the climate of a given period affects social welfare which are saving and capital accumulation.

According to Hope (2006), climate change might offer some short-term benefits in certain industrialized economies but eventually have negative effects. The detrimental effects of temperature variations on GDP are identified by both theoretical and empirical indicators, according to Pindyck (2011).

Ebkom and Dahlberg (2008) present that there are connections between ecosystems, industrial growth, and climate change, as well as specific challenges related to each of them. Mahfuz (2014) found that the Southern part of Asia is experiencing catastrophic climate change, which is having an impact on the economy. The region's GDP is expected to decline to 8.8% by the year 2100.

Dell, Benjamin and Benjamin (2008) use annual variation in temperature and precipitation over the past 50 years to examine the impact of climatic changes on economic activity throughout the world. We find three primary results. Analysis of decade or longer climate shifts also shows substantial negative effects on growth in poor countries. Should future impacts of climate change mirror these historical effects, the negative impact on poor countries may be substantial.

According to Gornall et al. (2010), rising temperatures can have a significant effect on farm

income, agricultural output, and food security. The effects of climate change differ in humid and temperate locations. It is assumed that agricultural output will rise in middle- and high-latitude regions and then move northward; nevertheless, in many humid-region countries, the opposite is true.

Babatunde, Ayodele (2015), this article examines the empirical linkage between economic growth and climate change in Africa. Using annual data for 34 countries from 1961 to 2009, we find a negative impact of climate change on economic growth. Our results show that a 1°C increase in temperature reduces gross domestic product (GDP) growth by 0.67 percentage point. In addition to impact on Africa, this article provides estimates of the impact of climate change on GDP growth of these 34 countries, which can be valuable in appraising national adaptation plans.

Alagidede, Adu and Frimpong (2016). This study is a contribution to the empirics of climate change and its effect on sustainable economic growth in Sub-Saharan Africa (SSA). Using data on two climate variables: temperature and precipitation. Furthermore, we show that the relationship between real GDP per capita on one hand and temperature on the other is intrinsically nonlinear.

4. Research methods and data

This article applies a quantitative research by using secondary data of Vietnam from 1995 to 2023. The data was collected from World Bank, Tradingeconomics, General Statistics Office of Vietnam, ourworldindata.org. SPSS was used for data analysis and statistical methods such as Multiple Regression Analysis and Pearson Correlation was tested to examine the influence of climate variables on economic growth in Vietnam. The dependent variable is GDP while independent variables are population (POP), precipitation (RAIN), temperature (TEMP), annual CO2 emissions (CO2) and Forest area (FORE).

5. Results and discussion

5.1. Descriptive statistics of the variables

Table 1: Descriptive Statistics

Variable	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
GDP	24.66	408.80	4637.60	159.9172	132.60401	17583.822
POP	73.3	100.0	2651.0	91.414	7.5483	56.977
RAIN	1.67	1.89	52.60	1.8138	0.06554	0.004
TEMP	23.50	25.29	705.51	24.3279	0.61956	0.384
CO2	35.480	322.874	6114.075	210.83017	108.882602	11855.421
FORE	33	47	1122	38.68	4.317	18.639

Source: SPSS's result

The provided results show the descriptive statistics for several variables in the analysis:

GDP is with a mean of 159.9172, a standard deviation of 132.604, and values ranging from 24.66 to 408.80

POP is with a mean of 91.414, a standard deviation of 7.5483, and values ranging from 73.3 to 100.0

RAIN is with a mean of 1.8138, a standard deviation of 0.06554, and values ranging from 1.67 to 1.89

TEMP is with a mean of 24.3279, a standard deviation of 0.61956, and values ranging from 23.50 to 25.29

CO2 is with a mean of 210.83017, a standard deviation of 108.883, and values ranging from 35.48 to 322.874

FORE is with a mean of 38.68, a standard deviation of 4.317, and values ranging from 33 to 47

5.2. Correlation of variables

Table 2: Correlations

		POP	RAIN	TEMP	CO2	FORE	GDP
POP	Pearson Correlation	1	-0.578**	-0.580**	-0.568**	-0.647**	0.582**
	Sig. (2-tailed)		0.001	0.001	0.001	0.000	0.001
	N	29	29	29	29	29	29
RAIN	Pearson Correlation	-0.578**	1	0.579**	0.895**	0.593**	-0.940**
	Sig. (2-tailed)	0.001		0.001	0.000	0.001	0.000
	N	29	29	29	29	29	29
TEMP	Pearson Correlation	-0.580**	0.579**	1	0.655**	0.527**	-0.723**
	Sig. (2-tailed)	0.001	0.001		0.000	0.003	0.000
	N	29	29	29	29	29	29
CO2	Pearson Correlation	-0.568**	0.895**	0.655**	1	0.711**	-0.947**
	Sig. (2-tailed)	0.001	0.000	0.000		0.000	0.000
	N	29	29	29	29	29	29
FORE	Pearson Correlation	-0.647**	0.593**	0.527**	0.711**	1	-0.716**
	Sig. (2-tailed)	0.000	0.001	0.003	0.000		0.000
	N	29	29	29	29	29	29
GDP	Pearson Correlation	0.582**	-0.940**	-0.723**	-0.947**	-0.716**	1
	Sig. (2-tailed)	0.001	0.000	0.000	0.000	0.000	
	N	29	29	29	29	29	29

***. Correlation is significant at the 0.01 level (2-tailed).*

Source: SPSS's result

The significance of the variables population, precipitation, temperature, annual CO2 emissions and Forest area are all less than 0.05, so the variables are correlated.

5.3. Model Summary

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.985[a]	0.971	0.965	24.83110

a. Predictors: (Constant), FORE, TEMP, RAIN, POP, CO2

Source: SPSS's result

Adjusted R Square = 0.965 means the independent variables explain 96.5% of the dependent variable

5.4. ANOVA result

Table 4: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	478165.602	5	95633.120	155.102	0.000[b]
	Residual	14181.425	23	616.584		
	Total	492347.027	28			

a. Dependent Variable: GDP

b. Predictors: (Constant), FORE, TEMP, RAIN, POP, CO2

Source: SPSS's result

Based on table 4, test the hypothesis about the overall fit of the model, F value = 155.102 with sig.=0.000 < 5%. This proves that the R-squared of the population is different from 0. This means that the built linear regression model is suitable for the population.

5.5 Coefficients result

Table 5: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3702.948	466.833		7.932	0.000		
	POP	-1.999	0.918	-0.114	-2.179	0.040	0.459	2.179
	RAIN	-1103.313	169.327	-0.545	-6.516	0.000	0.179	5.593
	TEMP	-45.063	10.697	-0.211	-4.213	0.000	0.501	1.995
	CO2	-0.329	0.119	-0.270	-2.759	0.011	0.130	7.665
	FORE	-5.000	1.759	-0.163	-2.842	0.009	0.382	2.620

a. Dependent Variable: GDP

Source: SPSS's result

Table 5 shows that the values in the VIF column are less than 10 so there is no multicollinearity phenomenon.

Values in column Sig. are all less than 0.05, proving that the 5 independent variables all have a statistically significant impact on the dependent variable. Accepted hypothesis: Climate change has impact on Vietnam's economic development.

Coefficient B of POP = -1.999, meaning that when the POP variable increases by 1%, the GDP variable decreases by 1.999%.

Coefficient B of RAIN = -1103.313, meaning that when the RAIN variable increases by 1%, the GDP variable decreases by 1103.313%.

Coefficient B of TEMP = -45.063, meaning that when the TEMP variable increases by 1%, the GDP variable decreases by 45.063%.

Coefficient B of CO2 = -0.329, meaning that when the CO2 variable increases by 1%, the GDP variable decreases by 0.329%.

Coefficient B of FORE = -5, meaning that when the FORE variable increases by 1%, the GDP variable decreases by 5%.

The results are suitable with the current situation of economic growth in Vietnam. Vietnam is a country that suffers great damage from climate change. During the period 2011-2020, extreme climate caused serious economic damage, with total losses estimated at 229,958 billion VND (equivalent to 10 billion USD, according to 2022 exchange rates). Rising sea levels could cause $43 billion in damage to agriculture. The Mekong Delta is the region suffering the greatest loss, followed by the Red River Delta. About 1.1 million tons of aquaculture, equivalent to 935 million USD, are at risk of loss due to floods every year. Direct damage to public and private property, on average, each year Vietnam loses about 2.4 billion USD (equivalent to 0.8% of GDP) due to extreme weather events (Bao Chau, 2022).

Untill May 7, 2024, Vietnam has had 72 hail storms; Hail, lightning tornadoes and strong winds have caused a lot of economic, social and environmental damage. The flow on rivers and reservoirs in the Northern region is often 30-60% lower than the average of many years. Saltwater intrusion in the Southern region in the dry season of 2023-2024 has come earlier and more severely than the average for many years and 2022-2023. Recent episodes of saltwater intrusion have caused a local shortage of fresh water in some areas that do not have access to centralized water supplies in some coastal provinces (Natural Resource and Environment Communication Center, 2024). Post-disaster losses also include disease caused by contaminated water sources and mental health problems caused by psychological trauma and anxiety and stress. Climate change is also one of the causes of increased migration and forced tens of thousands of households to permanently relocate, posing the risk of losing cultural identity

and local knowledge. According to World Bank, climate change could cause Vietnam to lose about 12% to 14.5% of GDP each year by 2050 and could push up to one million people into extreme poverty by 2030. (Van, 2024)

6. Conclusion and policy implications

This article researchs impact of climatic change on Vietnamese economy growth from 1995 to 2023. The result of the correlation analysis shows a negative relationship between population, precipitation, temperature, annual CO2 emissions, forest area and GDP. In order to minimize the impact of climate change on economic development, Vietnam needs to well implement the following solutions such as:

Firstly, transforming the economic development model: Building a green, circular, environmentally friendly economy; restructure the economy, select appropriate economic sectors to focus on development; Improve the practicality and effectiveness of regional linkages in the overall economy, and convert plant and animal varieties. At the same time, it is necessary to transform the development model based on the ecosystem, respecting natural laws; proactively change the structure of crops, livestock, and farming methods to suit the ecological characteristics of regions and localities.

Secondly, performing well the task of strictly managing, protecting and restoring natural forests associated with biodiversity conservation, landscape protection and ecological environment. Strongly develop and improve the quality of planted forests, especially special-use forests, watershed protection forests, and coastal protection forests.

Thirdly, promoting cooperation with bilateral partners, international organizations and other multilateral partners, seek opportunities to receive financial and technological support, and strengthen capacity for responses with climate change in Vietnam.

Fourthly, it is necessary to strengthen communication and raise awareness at all levels, sectors and people, especially using appropriate communication channels and communication messages for vulnerable "groups" such as women, people with disabilities, ethnic minorities, people living in remote areas and areas prone to natural disasters... about the impact of climate change on safety and their livelihoods.

Fifthly, perfecting the legal system on environmental protection; In particular, there are strong sanctions to deter violators. Strengthen waste discharge monitoring, ensure compliance with technology and environmental protection regulations for industrial development projects. In addition, increasing the proportion of budget spending on environmental activities.

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