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Factors influencing the environment: A current Status Overview and Proposing solutions for Vietnam

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Abstract

The strong development of the current economy leads to increasing environmental pollution, which directly impacts people when faced with natural disasters that occur every year and with high frequency. Analysis of the current environmental situation in Vietnam shows that the process of socio-economic development has caused environmental pollution to continue to become complicated, causing serious consequences and threatening ecological security. The current situation and trends of Vietnam's ecological environment in recent years show that Vietnam's environment is facing huge challenges in the coming years, so timely solutions are needed. Therefore, this study examines factors affecting the environment and evaluates the current environmental situation in Vietnam. In this study, the authors collected data from 12 countries worldwide from 2000 to 2021 and analyzed it using Stata software. Meanwhile, factors such as GDP per capita, forest area, and energy consumption impact the environment; factors such as FDI, Level of urbanization, and Trade openness do not have an impact on the environment. From the above analysis, the authors will provide solutions for the current situation in Vietnam to improve environmental problems while ensuring economic development.

Key Words: *Vietnam; Pollution; Environment; Solutions.*

INTRODUCTION

The rise of environmental pollution began with the dawn of industrialization and has not abated since. Human-caused pollution from activities such as trash generation, industrial processes, and unsustainable agriculture methods has severe effects on Earth's fragile and afflicted ecosystems. contamination can take many forms, including light and noise, but the three most common

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varieties are air, land, and water contamination, all of which represent existential dangers to humanity (Tiseo, 2024).

In fact, climate change and global warming are the most significant concerns confronting the modern world economy (Dogan et al., 2023). Climate change has different effects inside and across regions, as "approximately 3.3-3.6 billion people are highly vulnerable to climate change" (IPCC, 2022). Unsustainable development methods aggravate climate change, which harms humans and the environment. The Intergovernmental Panel on Climate Change's states that to prevent global warming to 1.5°C, global greenhouse gas emissions must peak before 2025 and be cut by 43% by 2030 (Calvin et al., 2023). Climate change is a critical issue on the international environmental, political, and economic agenda, and as a result, agents are more aware of the need to seek alternative solutions to the imbalance in the environmental, social, and economic ecosystems (Leitao et al., 2021). Climate action is fundamental to sustainability because it supports climate-resilient development (Dogan et al., 2023). Besides, 315 natural disasters occurred worldwide in 2018, the majority of which were climate-related (Fawzy et al., 2020). There were 16 droughts, 26 extreme temperatures, 127 floods, 13 landslides, 95 storms, and 10 wildfires. In 2018, natural disasters harmed 68.5 million people, with floods, storms, and droughts accounting for 94% of the total. Natural disasters caused a total of $131.7 billion in economic damage in 2018, with storms ($70.8 billion), floods ($19.7 billion), wildfires ($22.8 billion), and droughts ($9.7 billion) accounting for around 93% of the total cost (CRED, 2019). The economic loss caused by wildfires alone in 2018 was roughly comparable to the cumulative damage from wildfires over the previous decade, which is highly frightening (CRED, 2019).

Current Status Overview of Vietnam

Vietnam's rapid expansion and industrialization have had a severe influence on the environment and natural resources. Vietnam is one of the top five most vulnerable countries to climate change (World Bank, 2017). Typhoons, floods, droughts, and landslides regularly endanger a large percentage of the country's population and economic assets, which are located along its long, densely populated coastline. Vietnam's rapid economic expansion and rising energy demand have resulted in an exponential increase in greenhouse gas emissions, with the country having the second-highest air pollution levels in Southeast Asia in 2019 (Thomas et al., 2023). According to the USAID (2023), Vietnam has some of the fastest-growing per capita GHG emissions in the world. Furthermore, the World Bank (2022) stated that Vietnam's rapid economic growth has resulted in a quadrupling of per capita GHG emissions this century, from 0.79 metric tonnes of carbon dioxide equivalent in 2000 to 3.81 metric tonnes in 2018, and that emissions are increasing at one of the fastest rates in the world. Furthermore, Vietnam's national carbon intensity per GDP rose by 48% between 2000 and 2010, ranking second in East Asia. Carbon emissions nearly doubled between 2010 and 2020, driven mostly by coal-fired power generation, industrial expansion, and an expanding transportation sector (Thomas at al., 2023). Pollution caused by these emissions harms health and productivity; resource depletion and climate change have already harmed trade and investment.

It can be seen that environmental pollution is becoming more and more serious not only in Vietnam but also around the world. Therefore, finding factors that affect the environment is the key to providing appropriate solutions to ensure economic development and environmental protection for Vietnam in particular and the world in general.

REVIEW OF RELATED LITERATURE

In this study, the authors chose Carbon emissions to represent the environment. In addition, the factors GDP per capita, FDI, Energy consumption, Forest area, Level urbanization, Trade openness are also considered to impact the environment.

Carbon emissions

The National Aeronautics and Space Administration defines carbon dioxide, commonly referred to as CO2, as an important heat-trapping gas, also known as a greenhouse gas, emitted by the extraction and combustion of fossil fuels (such as coal, oil, and natural gas) as well as wildfires and natural processes such as volcanic eruptions. According to the World Bank (2023), carbon dioxide is produced by the combustion of fossil fuels and biomass, as well as by shifts in land use as well as other industrial processes. It is the primary anthropogenic greenhouse gas that serves as the reference gas for other greenhouse gases, implying that it can cause global warming. Since the Industrial Revolution, the use of carbon-based fuels has significantly boosted global carbon dioxide concentrations, hastening global warming and contributing to anthropogenic climate change (World Bank, 2023). It is also a major source of ocean acidification since it dissolves in water and produces carbonic acid. This causes an increase in the earth's surface temperature, which has ramifications for climate, increasing sea levels, and global agriculture.

Besides, IEO (2016) also found that carbon dioxide (CO2) emissions come from burning oil, coal, and gas for energy, burning wood and waste materials, and industrial operations like cement manufacture. Emission intensity is defined as the standard deviation of the emission rate of a given contaminant from a given source about the intensity of a certain activity. Emission intensities are also used to assess the environmental impact of various fuels and activities. The related phrases, emission factor and carbon intensity, are frequently used interchangeably. A country's carbon dioxide emissions represent only one type of greenhouse gas. Gases such as methane and nitrous oxide should be considered to provide a better picture of how a country contributes to climate change (IEO, 2016). This is especially essential in agricultural economies. The environmental implications of carbon dioxide are of great interest. Carbon dioxide (CO2) accounts for the majority of greenhouse gases that contribute to global warming and climate change.

Factors affecting carbon emissions

GDP per capita: GDP expansion inevitably causes a rise in carbon emissions, and GDP and environmental deterioration are inextricably linked (Guo et al., 2016). The study found that carbon emissions rise with GDP, but the effect of GDP growth on carbon emissions declines following the economic shift. Liu (2005) investigated the effects of GDP on CO2 emissions. According to the findings, there is a positive correlation between income and CO2 emissions. Meaning, the increasing trend in GDP has resulted in a high rate of power generation and consumption, which contributes to increased carbon emissions. Furthermore, Begum et al (2017) stated that rising GDP would reduce carbon emissions. Their study's findings reveal that, from 1970 to 1980, per capita CO2 emissions declined as per capita GDP climbed (economic expansion); however, from 1980 to 2009, per capita CO2 emissions increased rapidly as per capita GDP increased even more. The findings also show that per capita energy consumption

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and GDP have a long-term positive impact on per capita carbon emissions.

Foreign Direct Investment (FDI): In the field of environmental economic literature, FDI is a large contributor to carbon emissions (Huang et al., 2019), and academics have focused on its impact on carbon emissions during the last decade. The environmental literature focuses on two competing assumptions about the relationship between FDI and carbon emissions. A single sentence follows the pollution haven hypothesis (Walter et al., 2017), which contends that FDI can also harm the environment (Nasir et al., 2019). On the one hand, the pollution haven theory implies that FDI inflows can worsen environmental degradation. According to the hypothesis, firms in pollution-intensive industries are more likely to be situated in nations or regions with inadequate environmental regulations, which might result in over-pollution or suboptimal environmental outcomes. Several studies have shown evidence to support the pollution haven theory, with FDI inflows increasing carbon emissions (Abid et al., 2022). They discovered that the scale effect of trade and investment not only raises the risk of carbon emissions in host nations but also causes "carbon leakage" from FDI.

Energy consumption: Energy and environmental challenges have emerged as important threats to global sustainable development. The rise in CO_2 emissions poses a significant threat to developing countries. Developed countries encourage heavy energy use, which results in surplus and waste being discharged into nature, potentially leading to environmental damage (Saidi et al., 2015). The majority of CO_2 emissions are caused by the use of fossil fuels such as coal, the primary source of energy for the automotive sector, which is closely tied to economic growth and development. According to Ortiz and colleagues' research on energy consumption and carbon dioxide emissions in E7 countries in 2020, energy consumption is the primary source of CO_2 emissions, resulting in global warming issues (Ortiz et al., 2020). CO_2 emissions push E7 countries to adopt effective regulations for energy consumption and environmental damage. Another example from China demonstrates high energy consumption intensity as a result of rising home consumption and the development of energy-intensive sectors, both of which have boosted carbon emissions. From 2005 to 2016, China's total carbon emissions accounted for about one-third of global total carbon emissions, with a greater overall carbon emissions intensity than the global average (C. Wang et al., 2019).

Forest area: According to Waheed et al. (2018), forests have long-term negative and significant effects on CO_2 emissions, implying that increasing renewable forest area can reduce CO_2 emissions. Forests play an important part in environmental sustainability management because they have a significant impact on climate change mitigation and adaptation. Forests, being the world's greatest ecological carbon sequestration systems, play an important role in lowering CO_2 emissions, and countries all over the world are actively growing their forest areas. Following Jandl et al. (2015), forests constitute the world's largest terrestrial carbon sink, accounting for approximately 27% of global yearly fossil fuel emissions. Without these natural sinks, the rate of CO_2 buildup in the atmosphere would be significantly greater. Furthermore, Zhu et al. (2023) suggested that regulating or eliminating deforestation activities is one of the most cost-effective approaches to reduce CO_2 emissions.

Level of urbanization: Many empirical research, Wang et al. (2021) has a negative perspective on the relationship between urbanization and carbon emissions. They say that urbanization (which includes expanding development sites, increasing traffic flow, and so on) is the primary cause of rising carbon emissions. According to a study conducted by the Association of Southeast Asian Nations, for each percentage point rise in city population, carbon emissions increase by 0.20% (Khan et al., 2021). In addition, Han et al. (2019) claim that urbanization contributes positively to fulfilling emission reduction targets and lowering environmental pressure. Zhu et al. (2019) found that urbanization can increase the efficiency of green development. Furthermore, there is a belief that the impact of urbanization on carbon emissions will evolve.

Trade openness: Farhani et al. (2014) argue that the environmental impact of trade openness is determined by the net effects of the scale, technique, and composition effects. According to Shahzad et al. (2017), free trade increases trade volume and output, which has a negative environmental impact. The scale effect states that economic expansion caused by trade results in higher levels of carbon emissions due to increased output and energy consumption. However, freer commerce and higher income levels can lead to environmental gains at higher levels of development (Ertugrul et al., 2016). Regarding the technique effect, increased commerce helps improve technology, lowering carbon emissions (Shahzad et al., 2017). Transferring renewable energy technologies has recently been more effective at lowering CO_2 emissions in poor nations (Sebri et al., 2014). Finally, in the composition impact, emerging countries attract polluting businesses, which contribute to environmental degradation (Shahzad et al., 2017).

RESEARCH METHODOLOGY

Hypotheses development

H1: GDP per capita has impact on Carbon emissions

H2: FDI has impact on Carbon emissions

H3: Energy consumption has an impact on the Carbon emissions

H4: Forest area has an impact on the Carbon emissions

H5: Level urbanization has an impact on the Carbon emissions

H6: Trade openness has an impact on the Carbon emissions

Data collection method

During the data collection process, the author included independent variables such as GDP per capita, FDI, energy consumption, forest area, urbanization level, trade openness and carbon emissions as dependent variable in the model. The researchers used panel data covering 22 years from 2000 to 2021 across 12 countries. Furthermore, reliable sources such as World Bank and World in Data are used to collect data. Next, the researchs selected OLS, FEM, REM, FGLS models on Stata software to clearly analyze the influence of the above independent factors on the dependent variable.

Note:

Name Variable	Meaning	Units	The expected result of Coefficient Bata
LnCAR	Carbon emissions	Million tons	

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Name Variable	Meaning	Units	The expected result of Coefficient Bata
LnGDP	GDP per capita	USD/people	+/-
FDI	Foreign Direct Investment (net inflow)	% of GDP	+/-
LnENE	Energy consumption	Twh	+/-
LnFOR	Forest area	Km^2	+/-
LOU	Level urbanization	% of total population	+/-
TOP	Trade openness*	%	+/-

* Trade openness = {(Import+Export)/GDP}*100

RESULTS AND DISCUSSION

Results

Table 1: Descriptive statistics

T	Obs	Mean	Std. dev.	Min	Max
LnCAR	264	19,417	2,079	14,496	23,151
LnGDP	264	9,489	1,574	5,708	11,445
FDI	264	4,307	7,026	- 32,637	32,691
LnENE	264	7,303	1,857	3,150	10,689
LnFOR	264	11,298	2,561	5,0363	14,947
LOU	264	72,998	21,266	18,586	100
TOP	264	96,869	88,843	19,559	437,326

Source: Calculating result from Stata

This study has 264 observations collected to support the model testing process as shown in table 1.

Table 2: OLS regression

LnCAR	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
LnGDP	-0,172	0,014	-11,61	0,000	-0, 202	-0,143
FDI	0,00046	0,0028	0,17	0,869	-0, 005	0,005
LnENE	1,077	0,11	97,08	0,000	1,055	1,099
LnFOR	-0,002	0,012	-0,16	0,874	-0,027	0,023
LOU	0,0044	0,0011	4,01	0,000	-0,002	0,006
TOP	-0,003	0,2204	9,32	0,000	-0,003	-0,002

Source: Calculating result from Stata

The OLS regression model is used by the author to evaluate the relationship between variables included in the model. In this model, Prob > F = 0.0000, which implies that the P value is less than 0.05 and R-squared = 0.9887.

Table 3: VIF

Variable	VIF	1/VIF
LnFOR	5,58	0,179
TOP	4,53	0,220
LOU	2,92	0,342
LnGDP	2.89	0,345
LnENE	2,24	0,446
FDI	2,04	0,489
Mean VIF	3,37	

Source: Calculating result from Stata

The results of Table 3 show that no multicollinearity occurs between the variables after removing the LnPOP variable because their VIFs are all less than 10. Besides, after checking heteroscedasticity in the OLS model, the detection Prob > chi2 = 0.0000 < 0.05 (Appendix 1), which indicates heteroscedasticity. Therefore, using the OLS model for this investigation is not appropriate.

Next, the author runs the FEM and REM models to determine the relationship between the variables in the model. Then, the researcher selects the best-fitting model using the Hausman tool. The result of this test is that the P-value (Prob>chi2 = 0.0000) is less than 0.05 (Appendix 2), because the FEM model is considered more suitable than the REM model. When conducting other tests for the FEM model, the author noticed the phenomenon of heteroskedasticity in the model (Prob>chi2 = 0,0000 < 0,05) (Appendix 3). Besides, autocorrelation was detected in the model (Prob > F = 0.0443 < 0,05) (Appendix 4).

Lastly, to solve the shortcomings of the preceding models, the author employs FGLS regression.

Table 4: FGLS regression

LnCAR	Coefficient	Std. err.	z	P>|z|	[95% conf. interval]	
LnGDP	-0,094	0,016	-5,69	0,000	-0.126	-0,061
FDI	0,00009	0,0007	-0,13	0,899	-0,001	0,001
LnENE	1,074	0,015	71,34	0,000	1,044	1,103
LnFOR	0,030	0,014	2,08	0,037	0,001	0,059
LOU	0,0008	0,001	0,58	0,562	0,002	0,003
TOP	-0,00005	0,00003	-0,18	0,854	-0,0006	-0,0005

Source: Calculating result from Stata

Concluding that the FGLS model has solved the drawbacks of earlier models, with Prob>chi2 = 0.000, indicating that this table will depict the relationship between the dependent and independent variables.

Discussion of findings

The results of the FGLS model show that while the variables GDP per capita, Energy consumption and Forest area have a significant impact on carbon emissions.

It can be seen that GDP per capita hurts carbon emissions, meaning that when the level of GDP per capita increases, the level of carbon emissions will decrease. As a result of this study, Guo et al. (2016) stated that GDP growth leads to increased production rates, industrial activities, and electricity consumption, leading to increased carbon emissions. In addition, the speed of economic development in countries increases, leading to stronger energy

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consumption activities, causing the amount of waste causing typical environmental pollution such as carbon gas to also increase (Begum et al, 2015).

As originally predicted by the author, energy consumption was found to have a positive impact on carbon emissions. Saidi et al (2015) said that in developing countries, promoting strong energy use in production and releasing excess waste into the environment has led to environmental degradation. Another study in China also shows that as economic development leads to increased levels of industrial development, from 2005 to 2016, carbon emissions in China reached 1/3 of the world (Wang et al, 2019). The main reason comes from the excessive use of energy production when carbon emissions from fossil fuels in the world are 36.3 billion tons per year and nearly half come from China.

Next, Forest area has an impact on carbon emissions, the results of the model suggest that this is a positive relationship. A study by Zhu et al (2023) also showed similar results stating that Carbon emissions did not decrease even though forest area increased; instead, they increase simultaneously causing adverse effects. In contrast to this study, many other studies suggest that forest area has a negative relationship with carbon emissions. Forests play an important role in reducing carbon emissions and are considered a large carbon sink and can absorb about 27% of annual fossil fuel emissions (Jandl et al, 2015; Waheed et al, 2018). Therefore, without these natural sinks, the rate of increase of carbon in the atmosphere would increase even faster.

Besides the variables that impact carbon emissions, variables such as FDI, Level urbanization and Trade oppenness have no impact on carbon emissions.

CONCLUSION AND RECOMMENDATIONS

Conclusion

To summarize, our investigation has identified several significant elements influencing the environment and the current state of the environment in Vietnam. From growing urbanization and energy consumption to unsustainable farming practices and pollution, the challenges are numerous and pressing. In essence, the environmental issues that Vietnam faces are formidable, but not insurmountable. By taking a comprehensive strategy that includes legislative reforms, technological innovation, and grassroots activities, we can pave the path for a more sustainable and resilient future for Vietnam and the world.

Recommendations

Research has proven that factors such as GDP per capita, energy consumption and forest area affect carbon emissions, so solutions for Vietnam can be built based on these issues:

Firstly, education and awareness efforts are critical for engaging the public and cultivating an environmental stewardship culture. We may progressively transition to a more environmentally conscious society by empowering individuals to make educated decisions and adopt sustainable lifestyles.

Secondly, strict rules and enforcement mechanisms are required to make industries and businesses responsible for their environmental impact. Implementing and enforcing environmental legislation, as well as encouraging environmentally friendly behaviors, can help to offset the negative consequences of industrial activity on the environment.

Thirdly, investing in renewable energy and green technologies can help reduce reliance on fossil fuels and greenhouse gas emissions. Transitioning to a more sustainable energy infrastructure benefits the environment while also promoting economic growth and energy security.

Fourthly, protecting and restoring natural habitats such as forests and wetlands is critical for ensuring biodiversity and ecosystem services. Conservation initiatives must be combined with community engagement and sustainable land management approaches to maintain long-term ecological resilience.

Finally, international cooperation and collaboration are critical for solving transboundary environmental concerns including climate change and marine pollution. Vietnam may increase its effect and contribute to collective efforts toward a healthier world by forming partnerships with neighboring countries and engaging in global projects.

APPENDIX

Appendix 1: hettest

Breusch–Pagan/Cook–Weisberg test for heteroskedasticity

Assumption: Normal error terms

Variable: Fitted values of LnCAR

H0: Constant variance

chi2(1) = 214.83

Prob > chi2 = 0.0000

Appendix 2: Hausman test

---- Coefficients ----

	(b) Fem	(B) rem	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
LnGDP	-.0226974	-.0752602	.0525627	.0364637
FDI	-.0023642	.002246	-.0046102	.
LnENE	1.108075	1.059048	.049027	.0673668
LnFOR	-2.965076	.0604204	-3.025497	.1994485
LOU	.0150485	.0021564	.012892	.003277
TOP	.004556	-.00142	.005976	.0003268

b = Consistent under H0 and Ha; obtained from xtreg.
B = Inconsistent under Ha, efficient under H0; obtained from xtreg.
Test of H0: Difference in coefficients not systematic
chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 149.71
Prob > chi2 = 0.0000
(V_b-V_B is not positive definite)

Appendix 3: xttest3 test

Modified Wald test for groupwise heteroskedasticity

in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (12) = 1751.14

Prob>chi2 = 0.0000

Appendix 4: xtserial test

Wooldridge test for autocorrelation in panel data

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H0: no first-order autocorrelation

F(1, 11) = 5.151

Prob > F = 0.0443

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