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The Impact of Natural Disasters on the Income of Vietnamese

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Abstract**:** *The study analyzes the impact of natural disasters on income and its four components based on per capita income data in Vietnam. Panel data for 63 provinces and cities during the period 2018-2023 and data from the International Disaster Database (EM-DAT) were collected and used in the study. The study results show that natural disasters reduce Vietnam's per capita income by 1.07%. Among the four income components, income from other sources is the group most strongly affected by natural disasters. The study also indicates that factors such as education, trade, and the provincial competitiveness index have a positive impact on income. Based on these results, the study proposes several policy implications to mitigate the negative impact of natural disasters on the income of Vietnamese people.*

Keywords: *Natural disasters, income, FEM model.*

I. Introduction

Natural disasters have become a natural phenomenon causing widespread and severe impacts on all aspects of social life, especially the economy. According to World Bank statistics, natural disasters cause billions of USD in damage to the global economy annually. Vietnam is one of the countries severely affected by natural disasters due to its geographical location in the tropical monsoon region, frequently facing typhoons, floods, droughts, landslides, etc. Also, according to a World Bank report (2020), Vietnam is one of the country's most heavily impacted by natural disasters, with an average of about 1-1.5% of GDP damaged annually. Natural disasters not only cause damage to property and infrastructure but also directly affect the income and lives of the people, especially vulnerable groups such as poor households and families relying on agriculture and fisheries. A study by Tran Quang Thang et al. (2019) shows that the income of households in areas affected by typhoons and floods decreased by 5% to 10% compared to other areas not affected by natural disasters.

To contribute further empirical evidence on the impact of natural disasters on social life, this paper focuses on studying the effect of natural disasters on per capita income in Vietnam, while also analyzing the impact of natural disasters on income components (income from salary, income from agriculture-forestry-fishery, income from non-agriculture-forestry-fishery, other income), thereby proposing solutions to help mitigate the impact of natural disasters on income in Vietnam.

II. Research Overview

Many studies have shown that natural disasters not only cause material damage but also negatively impact the income and lives of people, especially vulnerable groups.

Carter et al. (2007) used a panel data analysis method tracking households before and after major natural disaster events such as drought in Ethiopia and hurricanes in Honduras. The results show that households affected by drought and storms took 2-3 years to recover their income to pre-disaster levels. This finding opened up an important research direction on the relationship between natural disasters, asset loss, and household income recovery capacity.

Anttila-Hughes and Hsiang (2013) analyzed the impact of tropical cyclones on household income in the Philippines. The study shows that in the first year after being affected by tropical cyclones, household income decreased by an average of 6.6%. More importantly, the decrease in household expenditure was even greater than the decrease in income, leading to nutritional decline and increased mortality rates among female children. This indicates that the impact of natural disasters on income is not limited to the economic aspect but also extends to social and health aspects.

The study by Karim and Noy (2016) conducted in Bangladesh provided an additional perspective on the impact of floods on household income. Using time series analysis and data from household surveys in frequently flooded areas, the study showed that household income decreased by 2% after each flood event and took at least 5 years to fully recover.

Bui et al. (2014); Arouri et al. (2015); Nguyen Khac Hieu (2020) all indicated that natural disasters reduce per capita income in Vietnam by corresponding rates of 6.9%; from 6.9% to 10.2% depending on intensity, and 4.3%. The studies also showed the persistent nature of the impact of natural disasters on income, especially the income disparity between regions affected differently by natural disasters. Rural households and low-income households were more severely affected by natural disasters, while urban and high-income households were able to recover more quickly. Natural disasters had the most severe impact on the central coastal provinces and the Mekong River Delta, Vietnam. Furthermore, the study by Arouri et al. (2015) also pointed out the important role of social capital and livelihood diversification in mitigating the negative impact of natural disasters on household income.

Using an event study approach to evaluate the impact of Typhoon Durian on the income of households in the afflicted provinces, broken down by income group, Nguyen Khac Hieu and Pham Thi Thu Tra (2020) examined the effects of the storm. The results showed that wealthy households tended to

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recover income faster due to owning reserve assets and having access to insurance. In contrast, poor households lost their main source of income from agriculture and did not have enough financial resources to reinvest in production. The study results estimated that the income of poor households in the affected area decreased by 7.9%, while the impact on wealthy households was almost negligible.

The study by Muhammad Tariq Iqbal Khan et al. (2021) combined indicators of infrastructure, foreign direct investment (FDI), human capital, globalization, and fixed capital formation to analyze the impact of natural disasters on income. The study was conducted on 98 countries from 1995 to 2019, divided into four income groups to clarify the impact of natural disasters across these groups. The results showed that natural disasters had a negative impact on all income groups, particularly severe in low-income countries. Good infrastructure, developed human capital, FDI, and globalization helped mitigate damage and support recovery.

From the analyses of previous studies, it can be seen that natural disasters negatively affect per capita income, with the extent of income reduction depending on the type of disaster, intensity, and the specific context of each country or region. This impact is not only short-term but also lasts for many years, with recovery time ranging from 2-5 years. Particularly, natural disasters have a clear differential impact based on income group, region, and social group, with poor households, women, and children being more severely affected.

III. Research Methods and Data

A. Research Data

The study uses panel data for 63 provinces and cities of Vietnam during the period 2018 - 2023. Data were collected from two sources: the General Statistics Office of Viet Nam (GSO) and the International Disaster Database (EM-DAT) - an international database with statistics on natural disasters for nearly 200 countries and the Disaster Information Management System.

B. Hypotheses and Research Method

1. Research Hypotheses

Based on the overview of related studies, the research proposes the following hypotheses:

H1: *Natural disasters* have a significant negative impact on people's income, especially in developing countries (Tran & Wilson, 2020; Nguyen et al., 2019)

H2: *The poverty rate* is an indicator reflecting the local socio-economic status and has a significant impact on per capita income (Nguyen, H., & Nguyen, L, 2019).

H3: *Healthcare* plays an important role in improving post-disaster recovery capacity. A good healthcare system not only ensures people's health but also contributes to maintaining labor productivity and income. (Vo, T. T & Nguyen, A. H, 2018; Hallegatte, S & Rozenberg, J, 2017)

H4: *Education* is a factor that positively impacts people's income. People with higher education levels often have better adaptability to changes in the environment and living conditions, including fluctuations caused by natural disasters. (Becker, G. S, 1993).

H5: *Trade* has a direct impact on income. In the context of natural disasters, the trade factor helps maintain economic activities, promoting rapid income recovery (Pelling, M. et al., 2018).

H6: *Infrastructure* is a factor that helps mitigate the impact of natural disasters on income (Leeson & Sobel, 2016 and Pelling et al., 2018).

H7: *The quality of local institutions and the business environment* - reflected through the Provincial Competitiveness Index (PCI) (Tran & Vu, 2021). Localities with a high PCI often have better capacity to mobilize resources effectively to overcome the consequences of natural disasters, thereby helping to maintain and restore people's income.

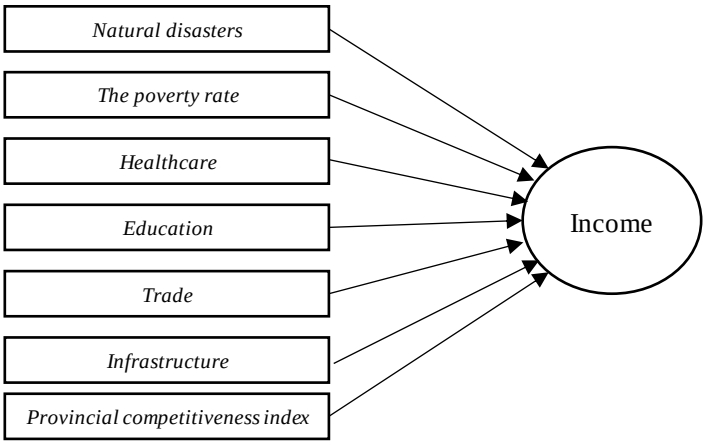

Figure 1: Research Model
(Source: Nguyen Khac Hieu, 2020)

2. Research Model

$Y_{it} = \beta_{1t} + \beta_2$. DISASTER $_{it} + \beta_3$. POV_RATE $_{it} + \beta_4$. DOCTOR $_{it} + \beta_5$. EDU $_{it} + \beta_6$. TRADE $_{it} + \beta_7$.INFR $_{it} + \beta_8$.HDI $_{it} + \beta_9$.PCI $_{it} + u_{it}$

Where: i is the index representing the province (i = 1, 2,...,63); t is the study year (t = 2018,.., 2023). β_{1t} is the intercept coefficient, β_j (j=2,...,9) are the slope coefficients associated with the independent variables, and u_{it} is the random error term.

Y_{it} is the dependent variable. The study performs regression on 5 models with different dependent variables: average per capita income, salary income, agriculture-forestry-fishery income, non-agriculture-forestry-fishery income, and other income. The dependent variables are included in the model in the form of a natural logarithm function. Log transformation helps reduce skewness in the data, as the dependent variable has large value variations. Due to the nature of the collected data being panel data, the study uses Pooled OLS, REM, and FEM models. The variables in the model are specifically described in the following table:

Table 1: Description of variables used in the study

Variable	Sign	Expected sign
Dependent variables		
Per capita income	INCOME	

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Income from salary	INCOME_S	
Income from Agriculture-Forestry-Fishery	INCOME_AFF	
Non-Agriculture-Forestry-Fishery income	INCOME_NAFF	
Income from other sources	INCOME_O	
Independent variables		
Natural disaster	DISASTER	-
Multidimensional poverty rate	POV_RATE	-
Number of doctors	DOCTOR	+
Literacy rate of population aged 15 and over	EDU	+
Total retail sales of goods and consumer service revenue at current prices	TRADE	+
Volume of goods transported	INFR	+
Provincial Competitiveness Index	PCI	+

(Source: Analysis Results of the Authors' Group)

IV. Research Results and Discussion

A. Current Income Situation in Vietnam

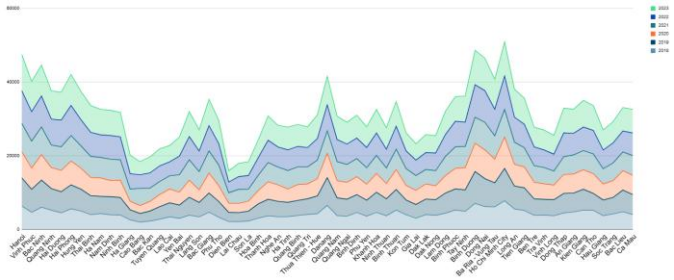

Figure 2: Chart of Average Income Per Capita by Locality (2018 – 2023)
(Source: Data collected by the Authors'Group)

Through the statistical data on average income of provinces and cities nationwide, the income disparity between localities is clearly visible. Accordingly, major cities and key economic regions record significantly higher average income compared to other localities. Specifically, leading is Ho Chi Minh city with an average income of 6,725.4 thousand VND/month, followed by Hanoi capital with 6,157.8 (thousand VND/month) and Da Nang with 5,784.6 thousand VND/month.

B. Descriptive Statistics

Preliminary information on the data series is summarized in the following table.

TABLE 2: Descriptive Statistics

Variables	Mean	Standard deviation	Minimum	Maximum
Per capita income	3,701	0,128	3,314	3,993
Income from salary	3,2425	0,1882	2,7084	3,7202
Income from Agriculture-Forestry-Fishery	2,6934	0,2667	1,3424	3,2033
Non-Agriculture-Forestry-Fishery income	2,8977	0,2189	2,1303	3,4135
Income from other sources	2,5617	0,21068	1,9445	2,9859
Natural disaster	0,505	0,501	0	1
Multidimensional poverty rate	7,585	8,519	0	44,470
Number of doctors	3,039	0,296	1,756	4,267
Literacy rate of population aged 15 and over	93,905	6,255	63,301	99,390
Total retail sales of goods and consumer service revenue at current prices	4,680	0,390	3,656	6,024
Volume of goods transported	4,177	0,505	3,004	5,403
Provincial Competitiveness Index	64,764	2,916	56,287	75,086

(Source: Analysis Results of the Authors' Group)

From the descriptive statistics table, it can be seen that the average per capita income during the study period is 5.2 million VND/month, the maximum value is 9.8 million VND/month, and the minimum value is 2 million VND/month. Besides, the multidimensional poverty rate varies greatly among provinces, with an average of 7.58%, a minimum value of 0%, and a maximum value reaching 44.47%. This shows a clear disparity in poverty levels between regions.

C Regression Analysis Results

1. Impact of disasters on per capita income

TABLE 3: Results of Pooled OLS, FEM, REM models

Variables	Pooled OLS	REM	FEM
DISASTER	-0,0210***	-0,0182***	-0,0100*
POV_RATE	-0,00697***	-0,00764***	-0,00908***
DOCTOR	-0,0197	-0,0340*	0,00971
EDU	0,000243	0,000911	0,00646**
TRADE	0,116***	0,177***	0,531***
INFR	0,0173	0,0125	0,0351
PCI	0,00305**	0,00425***	0,00238*
C	2,987***	2,631***	0,354
R^2	74,1 %		68,7%
***; **; * corresponding to significance level 1%; 5% and 10%			

(Source: Analysis Results of the Authors' Group)

The table above shows that disasters have a negative impact on income. The model fit test results with the F-statistic having a P-value below 5%, and the regression coefficients for the disaster variable all being statistically significant below 5%, indicate that the model is appropriate. The results show that among the 7 factors included in the model, DISASTER, POV_RATE, TRADE, and PCI are statistically significant in most of the 3 models, while variables such as DOCTOR, EDU, and INFR are not statistically significant.

To find the appropriate model, the study conducted the Hausman test to choose between the FEM and REM models, the Breusch - Pagan Lagrangian test to choose between the Pooled OLS and REM models, and the Time fixed effect test to choose between the FEM and Pooled OLS models. The results indicate that the FEM model is appropriate. The FEM model was retested after the study used the Wald test to look for heteroskedasticity and the Wooldridge test to look for autocorrelation. The results indicate that the model exhibits autocorrelation.

To overcome the first-order autocorrelation, the research team used the Generalized Least Squares (GLS) estimation method on the FEM model. The detailed results of the FEM model after being estimated by the GLS method will be presented in the table below:

TABLE 4: Results of FEM model regression after correction

Variables	FEM model regression after correction
DISASTER	-0,0107**
POV_RATE	-0,00566***
EDU	0,00277**

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TRADE	0,159***
PCI	0,00382***
C	2,597***
***; **; * corresponding to significance level 1%; 5% and 10%	

(Source: Analysis Results of the Authors' Group)

After correcting the first-order autocorrelation in the FEM model, we have the equation:

$Y_{it} = 2{,}597 - 0{,}0107.\,DISASTER_{it} - 0{,}00566.\,POV\_RATE_{it} + 0{,}00277.\,EDU_{it} + 0{,}159.\,TRADE_{it} + 0{,}00382.PCI_{it} + u_{it}$

Variables such as disaster (DISASTER) and poverty rate (POV_RATE) have a negative impact on income, which is consistent with many published studies. Disasters reduce income because when the frequency or intensity of disasters increases, the damage to property, infrastructure, production, and people's livelihoods will be greater, leading to reduced income. Furthermore, poor households often face difficulties in investing in production or business, leading to slower economic growth. Specifically, if the number of disasters increases by 1 event, the per capita income of that province will decrease by 1.07%.

If the total retail sales of goods and consumer service revenue increase by 1%, the per capita income of that province will increase by 15.9%. The increase in total retail sales of goods and consumer service revenue (TRADE) helps increase income because when trade and services develop, labor demand increases, creating more job opportunities and increasing income. Partially, local economies with a high level of trade often have better living standards and income.

The coefficient of EDU is 0.00277, indicating that when the literacy rate of the population aged 15 and over increases by 1%, if other factors remain unchanged, per capita income increases by 0.277%. The positive coefficient shows that education has a positive impact on income. When more people are literate, they can access better job opportunities, improve labor productivity, leading to increased income.

The PCI coefficient with a value of 0.003882, although statistically significant at the 1% level, brings complex insights into the local business environment and economic development. This small number does not directly reflect the impact but is a subtle signal about the quality of governance and operational capacity of the local government.

However, variables DOCTOR and INFR can still serve as control variables, helping to ensure that the relationship between the main independent variables and income is not distorted by the omission of important factors.

b. Impact of disasters on each component of income

The results table shows that DISASTER has a negative impact on all sources of income with negative coefficients in all four models. The magnitude of the impact ranges from -0.00900 (for salary income) to -0.0136 (for income from other sources), indicating that when disasters occur, people's income decreases. Notably, all coefficients are statistically significant at the 1% or 5% level, confirming that the negative impact of disasters is significant and not random.

Salary income is often considered the most stable source of income, as it mainly comes from formal labor and is less directly affected by disasters than other income sources. However, the coefficient of -0.00900 (statistically significant at 1%) shows that even salary income is affected when disasters occur. This may stem from disasters disrupting production activities, reducing working hours, or even causing some workers to temporarily lose their jobs.

TABLE 5: FEM regression results with dependent variables being the components of total income

Variables	Ln(Income_S)	Ln(Income_AFF)	Ln(Income_NAFF)	Ln(Income_O)
DISASTER	-0,00900***	-0,0104**	-0,00931*	-0,0136**
POV_RATE	-0,00982***	-0,00449***	-0,0160***	-0,00613***
DOCTOR	0,0106	-0,155***	-0,0871***	-0,0861***
EDU	0,00177	0,000664	-0,00232**	-0,00104
TRADE	0,100***	0,0599*	0,514***	0,220***
INFR	0,131***	-0,210***	0,0516***	0,0774***
PCI	0,00356***	-0,000809	0,00283***	-0,00207
C	1,866***	3,775***	2,378***	1,748***
***; **; * corresponding to significance level 1%; 5% and 10%				

(Source: Analysis Results of the Authors' Group)

Agriculture is the sector most directly and strongly affected by natural disasters. The coefficient of -0.0104 (statistically significant at 5%) reflects the decrease in income for households whose livelihood comes from agriculture. This can be explained by natural disasters damaging crops, killing livestock, and destroying irrigation systems, leading to lower productivity and reduced revenue. Additionally, natural disasters can also disrupt agricultural supply chains. When roads are damaged or transportation is interrupted, farmers may face difficulties in bringing their products to market, reducing their selling prices and profits. Particularly, if natural disasters occur during the harvest season, the damage can be even more severe due to complete loss of products.

Non-agricultural economic activities such as small businesses, services, or handicrafts are also significantly affected by natural disasters. The coefficient of -0.00931 (statistically significant at 10%) indicates that natural disasters can reduce the income of households that do not rely on agriculture but are still vulnerable to indirect impacts. Specifically, when natural disasters occur, consumer demand in the affected area may decrease as people prioritize spending on essential needs. Furthermore, disruption of input supply, power outages, and damage to infrastructure can also affect business and production activities. This lowers the income of small companies, which in turn affects household income.

Among the four types of income, income from other sources is the group most strongly affected by natural disasters, with a coefficient of -0.0136 (statistically significant at 5%). These income sources may include social welfare, investment income, remittances, or irregular activities. One possible reason for this significant impact is that when natural disasters occur, financial support flows from outside may be disrupted. Besides, investment-based income such as house rentals and profits from financial businesses can also decrease when the overall economy of the area is affected. This shows that although income from other sources is not the primary livelihood for many households, it still plays an important role in financial support, especially during difficult times. When this income source is reduced, the household's economic

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recovery capacity after a natural disaster will be significantly diminished.

V. Policy Implications

Regression results from the FEM model have shown the negative impact of natural disasters on income and income components in Vietnam. Natural disasters not only reduce per capita income but also exacerbate income inequality among population groups, especially between rich and poor households. This poses an urgent requirement for formulating and implementing policies to mitigate the negative impacts of natural disasters, support low-income groups to recover quickly, and simultaneously ensure sustainability in socio-economic development.

Firstly, enhance the resilience of the socio-economic infrastructure system.

Strong investment in disaster prevention and control infrastructure is a long-term solution to help minimize damage and protect people's livelihoods.

Secondly, improve financial protection mechanisms and disaster insurance

The financial system needs to be designed to provide more effective support for households and businesses affected by natural disasters.

Thirdly, develop sustainable livelihoods and diversify income sources

Natural disasters most severely affect population groups whose income sources depend on agriculture and vulnerable production sectors. Therefore, policies are needed to support people in transforming production models towards sustainability, applying smart agricultural technology to minimize risks from climate change.

Fourthly, raise community awareness and enhance adaptive capacity to natural disasters

One of the important factors helping to mitigate the impact of natural disasters is raising people's awareness and response capacity.

Fifthly, apply technology to monitor, forecast, and manage natural disaster risks

Technology plays an important role in mitigating the impact of natural disasters.

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