Economic impact of monsoon flood on the household income in Malaysia: a two-level analysis

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Abstract. Malaysia is located in the north of the equator and composed of two regions which are peninsular Malaysia and east Malaysia. The country is characterized by southwest monsoon which is the drier weather that start from late May to September and northwest monsoon that start from November to March. The Northwest monsoon comes with heavy rains in Peninsular Malaysia, and it usually leads to floods. Floods can have a lot of negative socio-economic impacts on the country such as loss of livelihood and a decrease in purchasing power and production, which subsequently affect the country's economic growth and development. The objective of this study is to investigate the economic impact of monsoon floods on the household income in Malaysia and across its states. The data used in this study were obtained from the Department of Statistics Malaysia and the Department of Irrigation and Drainage Malaysia. The study period covered by the study is from 2016 to 2021. The method used in this study is the panel data regression analysis, which includes the pooled OLS, fixed effect, random effect, and robust model. The result reveals that monsoon flood has a negative impact on household income both at aggregate and disaggregate levels. At Malaysia's level, the number of floods shows a negative impact on household income. While at the state level, the result shows that some of the states such as Kedah, Kelantan, Negeri Sembilan, Pahang, Perak, Perlis, Sabah, Sarawak, Selangor, Terengganu and Wilayah Persekutuan Kuala Lumpur are significantly negatively affected. Meanwhile, the states of

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Johor, Melaka, Pulau Pinang and Wilayah Persekutuan Labuan, are not negatively affected. As such, it is recommended that the responsible authority, such as the government and policymakers should enhance their monsoon flood preparedness and mitigation programs.

1 Introduction

Flooding is a hydrologic hazard as it occurs naturally when triggered by heavy rainfall. The re are a few categories of hazards caused by flooding which are primary hazards, secondary hazards, and tertiary hazards. The primary hazard arises when an area is in direct contact with flood waters after being exposed to the flood. The high velocities of flood water allow the streams to transport larger particles such as rocks, sediments, and even houses. On the other hand, the secondary hazards occur due to the primary hazards. They include the disturbances of the services and the health impacts such as diseases. The last hazard, which is tertiary hazards, has a long-term effect on the ecosystems such as the changes of river channels [1].

The monsoon flood is a natural disaster that occurs around the world. It is a natural phenomenon that occurs when the circulation made by earth on its axis produces different wind movements. Monsoon floods occasionally occur between November and March. This monsoon change is as a result of the rapid development of the city area and urbanization [2]. Household income is the total income received by the members of the households, either in cash or in kind that is received repeatedly within a certain period (e.g. within a year). It is also referred to as gross income. Household income is a tangible indicator that can be utilized to gauge and compare the distribution of unpaid labour both between households and among them [3].

In Malaysia, there are two classifications of floods, namely monsoon floods and flash floods. They occur consistently due to two underlying factors, which are northeast monsoons and typhoons. These two take place in both Peninsular Malaysia and in East Malaysia. According to the official website of the Malaysian Meteorological Department, Malaysia experiences two distinct monsoon seasons, namely; the southwest monsoon and the northeast monsoon. The southwest monsoon seasons in Malaysia are between late May and September, while the other monsoon is between November and March. On the other hand, flash floods are particularly common in areas with rapid development as they occur due to the intensity and duration of rainfall. The distinguishing features of flash floods include the sudden and swift increase in water level, the presence of a large number of debris, and the high velocity at which the flood waters move [4].

The occasional flood that takes place in Malaysia does alter the socio-economy because of the flood damage. The analysis of community vulnerability to flood reveals deficiencies in an effective and proper evacuation plan, mismanagement of flood transit centers, and inadequate flood information and preparedness [4]. Every household in Malaysia possesses a different level of financial capacity when it comes to coping with the occurrence of floods. According to the Department of Statistics Malaysia (DOSM), the average income in 2019 stood at RM7,901, and the median income is RM5,873. This indicates that the median income witnessed a growth of 3.9% as compared to 6.6 in 2014 [5]. In 2014, Peninsular Malaysia experienced the worst devastating floods in decades [5]. This study aims to investigate the impact of monsoon floods on household income in Malaysia and across states of Malaysia.

The rest of the paper is organised as follows. Section two discusses the methodology of the study. Section three presents and analyse the result of the study. Section four concludes and provides recommend policy suggestions.

2 Methodology and Data

2.1 Data Sources

The data used in this study were obtained from the Department of Statistics Malaysia (DOSM) and the Department of Irrigation and Drainage Malaysia (DID). The DOSM and DID are the official government websites which provide various types of data. This study covers 2016 to 2021 period.

2.2 Model Specification

The model specfication for this study follows the works of [5] and [6], which are also based on economic theory. The model is speficified in Equation 1.

$$MEDit = \beta 0 + \beta 1\, NFit + \beta 2\, GDPCit + \beta 3\, ADRit + \beta 4\, MFit + et \quad (1)$$

where $MEDit$ is the median of monthly household gross income, $NFit$ is the number of flood events, $GDPCit$ is the GDP at constant prices (RM million), $ADRit$ is the average daily rainfall (mm), and $MFit$ is the maximum flood period (day).

2.3 Estimation Method

The estimation technique of the panel data estimation method was used in this study. It was used to analyze the impact of monsoon flood occurrence over time on household income. Three different approaches utilised which are the pooled ordinary least squares (PLS)/common effect model, the fixed effect model (FE) and the random effect model (RE).

The PLS is a model that integrates both time series and cross-sectional data. This model assumes that the behaviour of the corporate data remains consistent across different time periods [7]. The OLS technique was employed to estimate the panel data model within panel framework as follows.

$$\text{yit} = \alpha + \beta' \text{Xit} + \varepsilon\text{it} \qquad (2)$$

where yit is the dependent variable, α is the intercept, Xit is the independent variable, εit is the estimation error and i represent individuals (states) and t represents time period.
For i = 1,2, 3……., N and t = 1,2, 3, ...T.

The FE assumes that there are variations in the intercepts across individual cross sections. The purpose of this technique is to identify the differences between intercept components. In this model, it is assumed that the fixed effects capture individual differences through varying intercepts across the cross-sectional units as stated in Equation 3.

$$yit = \alpha i + \beta' Xit + \varepsilon it \qquad (3)$$

where yit is the dependent variable, αi is the random variables, Xit is the independent variable, εit is the estimation error and i represent individual cross-sections (states) and t represents time period.

The RE, also known as generalized least square (GLS) technique is used to estimate panel data when there is a possibility of having correlated disturbances across time and individuals. In this model, the intercepts vary with the error terms of each cross-section [8].

The panel data regression equation for the RE model is stated in Equation 4.

$$yit = \alpha + \beta' Xit + ui + \varepsilon it \qquad (4)$$

where yit is the dependent variable, α is the intercept, Xit is the independent variable, ui is within-entity error term and, εit is the overall error term and i represent individuals cross-sections (states) and t represents time period.

3 Result and discussion

3.1 Panel data estimated results for the impact of monsoon flood on the household income in Malaysia

Table 1 shows the panel data results analysis for the impact of monsoon flood on household income in Malaysia which fulfills the first objective of the study which is to investigate the economic impact of monsoon floods on the household income in Malaysia. It can be seen that the coefficient of number of floods event in PLS model is -8.930 and highly significant at the 1% level, suggesting that an increase in the number of floods results in decrease in household income. The coefficient of GDP is 0.015 and significant at 1% level. This suggests that GDP has a significant positive impact on the household income. The coefficient of the highest average daily rainfall is -1.515 and significant at the 10% level. The Breusch- Pagan LM test for pooled OLS and random effect model is 45.412 and significant, which suggests that random effect is preferred over pooled OLS. This Breusch-Pagan LM test is used to statistically check whether random effect model or pooled OLS model is appropriate [9-10].

In the random effects model, the coefficients of flood events, highest average daily rainfall (mm), maximum flood period (day) and GDP are -0.246, -0.435, 2.319, and 0.002, respectively. The results suggest that all of them are not statistically significant, which means that they do not influence household income.

From the fixed effect model, the coefficient number of flood events and GDP are -8.58 and 0.016, respectively. These results further indicate that both are highly significant at 1% level, and they are consistent with the pooled OLS model. As for the average daily rainfall, its coefficient is -3.616 and not significant. The coefficient of maximum flood period is -0.796 and also not statistically significant.

The result of the hausman test for fixed and random effects models is 34.737 and it is significant at 1% level. Thus, suggesting that the fixed effects model is preferred over the random effects model. This test is used to check which model is appropriate to use in this study between the fixed effects and random effects models [9].

This study additionally conducted a robustness test via robust model. The result of the test shows that the coefficients are similar in sign and level of significance with the fixed effects model. The robust model uses robust standard error to address heteroscedasticity.

Table 1. Panel data estimated results for the impact of monsoon flood on the household income in Malaysia.

	Pooled OLS	Random Effect	Fixed Effect	Robust
Constant	5094.280*** (353.35)	5268.050*** (298.575)	4899.331*** (319.55)	4899.331*** (319.557)
NF	-8.930*** (2.0070)	-0.246 (1.141)	-8.581*** (1.815)	-8.581*** (1.815)
ADR	-3.474* (2.0788)	-0.435 (0.856)	-3.616 (1.880)	-3.616 (1.880)
MF	-1.515 (4.2258)	2.319 (1.606)	-0.796 (3.821)	-0.796 (3.821)
GDPC	0.015*** (0.0018)	0.002 (0.001)	0.016*** (0.001)	0.016*** (0.001)
Breusch Pagan LM test	45.412***		_	_
Hausman test	_	34.737***		
Observations	90	90	90	90

Note: ***, **, and * are significant levels at 1%, 5%, and 10%, respectively. Parentheses are standard error. NF is defined number of flood events, ADR is the highest average daily rainfall (mm), MF is the maximum flood period(Day), and GDPC is the GDP at constant 2015 prices (RM million).

3.2 Panel data estimated results for the impact of monsoon flood on the household income across states of Malaysia

Table 2 shows the panel data results analysis for the impact of monsoon flood on household income across states in Malaysia, which fulfills the second objective of this study. The second objective of this study is to investigate the economic impact of monsoon floods on the household income across states in Malaysia. For each state, there is a corresponding coefficient that represents the estimated impact of monsoon flood on the household income in Malaysia. The positive coefficient suggests a positive impact on household income while the negative coefficient suggests a negative impact.

The coefficients of Johor, Melaka, Pulau Pinang and Wilayah Persekutuan Labuan are 0 .418, -3.6684, -3.088, and 1.002, respectively, and are not significant. This suggests that there is not enough evidence to conclude that monsoon flood has a significant effect on household income in these states. This finding is consistent with [11]. This may be because these states do not experience serious flood events, thus all the work activity is not affected by monsoon flood. According to official website of Malaysian Meteorological Department which is under the Ministry of Natural Resources, Environment and Climate Change Malaysia, the northeast monsoon season does not typically occur in the states of Melaka, Pulau Pinang and Wilayah Persekutuan Labuan [12].

Meanwhile, the coefficient for Terengganu is the highest with -9.466 and it is highly significant at the 1% level which implies that this state has the worst flood events, hence impacting its household income the most. According to [13], Terengganu has shown an inflation of flood occurrence trend, and it is potentially due to the urbanization activities that has been continuing excessively. States such as Kedah, Kelantan, Negeri Sembilan, Pahang, Perak, Perlis, Sabah, Sarawak and Wilayah Persekutuan Kuala Lumpur have the following coefficients : -2.107, -2.765, -1.376, -1.897, -2.069, -1.858, -2.097, -1.863 and -3.614, respectively. All of them have negative coefficients and are significant at 1% level. This suggests that monsoon flood is associated with a decrease in household income in these states. This finding can be supported by [14].

Table 2. The panel data estimated results for the impact of monsoon flood on the household income across states of Malaysia

States	Coefficients	*p*-value
Johor	0.418 (1.215)	0.732
Kedah	-2.107*** (2.788)	0.000
Kelantan	-2.765*** (3.105)	0.00
Melaka	-3.684 (2.999)	0.223
Negeri Sembilan	-1.376*** (2.770)	0.000
Pahang	-1.897*** (2.830)	0.000
Perak	-2.069*** (2.663)	0.000
Perlis	-1.858*** (4.431)	0.000
Pulau Pinang	-3.088 (2.583)	0.236
Sabah	-2.097*** (2.672)	0.000
Sarawak	-1.863*** (3.527)	0.000
Selangor	-1.836*** (2.806)	0.000
Terengganu	-9.466*** (2.827)	0.001
Wilayah Persekutuan Kuala Lumpur	-3.619*** (2.591)	0.000
Wilayah Persekutuan Labuan	1.002 (3.941)	0.690

Note: ***, **, and * are significant levels at 1%, 5%, and 10%, respectively.

4 Conclusion and recommendations

To determine the economic impact of monsoon flood on household income in Malaysia, this study used panel data analysis over the 2016 – 2021 period. This study sought to investigate the economic impact of monsoon flood on the household income in Malaysia and across its states. The panel data results suggested that an increase in the number of monsoon floods is associated with a decrease in household income in Malaysia and in the majority of its states.

In conclusion, in some states, the number of floods indicates a significant negative effect on the household income while in others it does not. The states that are affected by the flood include Kedah, Melaka, Negeri Sembilan, Pahang, Perak, Perlis, Sabah, Sarawak, Selangor, Terengganu, and Wilayah Persekutuan Kuala Lumpur. On the other hand, the household income other states such as Johor, Melaka, Pulau Pinang and Wilayah Persekutuan Labuan are not affected by the monsoon flood.

In order to address this problem, a set of policy recommendations is crucial to mitigate impact of monsoon flood on the household income, especially in the vulnerable communities. The policymakers should consider enhancing the monsoon flood preparedness, response, and recovery so that there is no severe aftermath effect of monsoon flood on the community's income.

Also, the government should set up a permanent flood control committee. The establishment of a permanent committee will allow immediate response so that the time between flood occurrence and the protective measures implementation can be minimized. Additionally, a committee can be set up to work on reducing economic damage especially to the flood victims.

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