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The Effect of Drainage System and Natural System on Flood in Kuala Lumpur, Malaysia

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Abstract: Malaysia has been hit by frequent floods, with disastrous consequences. Monsoonal floods have caused significant damage during the last few decades. Many factors are driving the occurrence of flash flood to happen. Some of the factors of flooding are drainage systems and natural system. Flooding has many negative effects on the economy, environment and social. The quantitative approach was used in this study. Using online Google Forms, 384 questionnaires were distributed to the people in Kuala Lumpur. The results of this study were analysed descriptively and correlated using Statistical Package for Social Science (SPSS) version 20.0. The study results show that all objectives and hypotheses have been achieved and accepted. There is a positive correlation between the independent variable and dependent variable, with a significant positive relationship between the factor of flood and the effect of flood. The limitations of this study included a limited number of respondents, samples and selection issues and its only focus on Kuala Lumpur. This study provided some recommendations for future research.

Keywords: Factor of flood, Occurrence of Flash Flood, Natural System, Drainage Systems, Natural System

1. Introduction

Floods are natural catastrophes that occur every year during the monsoon season in Malaysia. (Osman *et al.*, 2015). Annually, the city is hit by a series of flash floods. The city is situated in the heart of a valley, in the river basins of two large rivers (the Klang River and the Gombak River). As a result, flooding is an unavoidable occurrence throughout the city. When poor drainage systems fail to channel the water flow adequately during the seasonal monsoon rain, thus flash floods occur.

Since the 1920s, Kuala Lumpur has been hit by catastrophic floods. The great flood of 1971, on the other hand, is the worst in Malaysian history. The incident occurred in January 1971, when the Klang,

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Batu, and Gombak rivers were overwhelmed by heavy monsoon rains. A total of 32 persons were killed, with 180,000 people affected. Tun Abdul Razak, the Prime Minister at the time, declared a state of national calamity in Western Malaysia. The Kuala Lumpur Flood Mitigation Programme was established as a result of the flooding (Arief Irsyad, 2016).

Floods, on the other hand, are regular in Kuala Lumpur. For example, in 2011, 2012, and 2014, all of which occurred on Kuala Lumpur's main route and resulted in the submergence of multiple automobiles and motorcycles. However, the most recent and one of the most significant floods occurred in 2021, which was declared a "once in a century" disaster by government officials and brought torrential rains to the province for three days. The resultant floods wreaked havoc on eight states across the peninsula, killing at least 54 people and leaving two people missing (Hassan, 2021).

This research was carried out because Malaysia has been hit by frequent floods, with disastrous consequences. Monsoonal floods have caused significant damage during the last few decades. Malaysia is one of the countries with the most significant rainfall, with an average of 2,500 mm across the country in 2010 (Wai & Rohani, 2017).

Aside from that, this research aims to learn more about the effect of drainage system and natural system on flood in Kuala Lumpur. Malaysia was hit by severe flooding, devastatingly impacting the economy, environment, and social life (Mohamad Sukeri and Shazwani, 2015). The overflowing of rivers is also a fundamental cause of flash floods in the city. Following the city's first massive flash flood in 1971, various structural and non-structural measures were implemented, including the improvement of river channels, the construction of levees, the construction of flood by-passes, the construction of depositional traps, and the refinement of hydrogeological data recording (Hong and Hong, 2016).

Many factors are causing the occurrence of flash flood to happen. When a flash flood occurs next to or along a stream or river, it destroys property and kills people. Extreme rain on steep terrain can weaken the soil a lot and cause mudslides, damaging homes, roads, and property and even putting people's lives in danger. Some of the factors of flooding are drainage systems and natural systems.

Therefore, to achieve the research objectives level of drainage system and natural system of flood in Kuala Lumpur are determined. Consequently, the relationship between factor of flood and effect of flood is identified.

This research was conducted to identify the effect of drainage system and natural system on flood in Kuala Lumpur. This research is conducted to enhance the knowledge of researchers on the topics studied. They will be more understanding of this catastrophic event. This study will provide benefits future researchers as this study provides evidence of the between drainage system and natural system on the effect of flood in Kuala Lumpur, Malaysia. Besides that, this study may raise awareness about flood disasters among the citizen of Kuala Lumpur.

2. Literature Review

2.1 The Occurrence of Flood

Flash floods are distinct simply because they are immediate, unanticipated, and in most cases, violent in nature. They can last anywhere from a few hours to a day in a small region and are caused by heavy rain, dam failure, ice melt, and insufficient drainage systems (Bhuiyan *et al*., 2018). In Kuala Lumpur, flash floods are due to rapid development, the loss of greenery and forested regions, and the substitution of natural surfaces with roofing and construction, which has slowed water absorption. Unsuitable design and construction of drainage and rivers, as well as poorly maintained buildings with clogged drains, have all led to flash flooding (Samsuri *et al*., 2018).

Human actions such as deforestation have resulted from overemphasizing developments and economic aspects. The nation's lack of understanding of handling and managing flood dangers resulted in massive flooding. Natural systems cannot adjust to fast changes. Therefore, rapid fluctuations in water yield could be better controlled. Due to overdevelopment, highly populated places such as Kuala Lumpur are frequently flooded (Wai & Rohani, 2017).

2.2 Factor of flood

Due to frequent heavy rain in Kuala Lumpur, floods usually happen quickly in a short period of time. This is because the landscape of Kuala Lumpur wasn't able to handle the rainwater, and urban areas with surfaces made of hard materials like concrete and bitumen, as well as areas with bad drainage systems and sediment barriers, are more likely to be affected. The study has acknowledged that flooding has become more common because there are more places that water can't get through, like paved roads and buildings. It is clear that the connection between development and the natural environment is not given enough attention. Streams, ditches, and ponds are difficult to fix because many people live in those places.

Another reason is that the sewage system is old and poorly irrigated. Besides that, insufficient retention ponds were built to stop water from running into the drainage system. Also, the sewers and drains built aren't big enough to handle the runoff, which causes them to overflow. As land keeps on changing and new projects are done, the flow rate of runoff is likely to increase, which means that drainage design needs to consider environmental changes. Based on the literature reviewed, there are two main factors that cause flooding (Samsuri *et al*., 2018).

2.3 Flooding Due

a) Flooding due to drainage system

In recent years, flooding has become a significant issue for both the government and the general public. The network of drainage and waterways was meant to drain wastewater and rainwater runoff to keep flooding from happening, but sometimes it is ineffective because of how the land was built or because there was too much drainage water during construction. Most flooding problems are caused by irrigation and drainage systems that are ineffective. The drainage system in Kuala Lumpur, which has been there since the city was built, is old and cannot handle water from heavy rains as well as it used to. So, most of the drainage systems that already exist do not seem to work well because there is a lot of water flowing onto the road.

Also, flooding is caused by an old drainage system that is outdated and poorly maintained. Drainage systems need to be maintained frequently and adequately. Flash floods can be stopped by changing how people think about their communities and the environment. This is closely related to social attitudes and environmental consciousness. People casually throw away their trash along the road, where the trash piles up to an already overworked drainage system. So, lack of regular monitoring led to the drainage system getting clogged up and affecting the main road, which was flooded more when it rained heavily (Samsuri *et al*., 2018).

b) Flooding due to natural system

Floods can also happen naturally; too much rain is the main factor that causes flooding. Flooding happens if it rains more than the average amount in a year or if it rains hard in a short time. In the past few years, the amount of rain in Kuala Lumpur has been more than 50mm per hour, which the drainage system can handle (Sinar Harian 2017).

In Kuala Lumpur, the lack of impervious land affects the amount of water and how much the river channel can hold. Most streams get water from surface runoff, through flow, intermediate flow, and

base flow. Because of all these problems, the drainage outflow hydrograph changes over time. The runoff happens when a city grows, and the natural landscape changes into a landscape made by people (Samsuri *et al*., 2018).

2.4 Effects of Flood

a) Economy

Flooding causes destruction on a personal and regional level. Loss of life, property and infrastructure destruction are among the immediate consequences. Damage to property such as homes, offices, hospitals, transportation, and roadways can have a significant impact on people's daily lives (Greater Houston Flood Mitigation Consortium, 2018). Infrastructure damage also affects clean water, wastewater treatment, energy, transportation, education, and health care (Sam, 2021).

Floods result in significant economic losses, both tangibly and intangibly. Kuala Lumpur has many high-rise office buildings, hotels, and shopping malls, as well as a network of large roadways and a commuter rail system. When the frequency of the events increases over time, the losses become too high for a metropolis like Kuala Lumpur. Direct losses include property damage and personal injury. Indirect effects, such as disruptions to public services and economic activity might occur, resulting in more difficulties for a city (Bhuiyan, 2018).

b) Environment

Flooding also creates several long-term issues, such as environmental damage, worsening of human health in impacted areas, and economic distress (Greater Houston Flood Mitigation Consortium, 2018). Flooding has a tremendous impact on water quality, air quality, and energy supply. More affluent, harmful chemicals and hazardous substances will wind up in the water, contaminating water bodies and disrupting the ecosystem's natural equilibrium (Sam, 2021).

Flood debris and cleanup from previous floods pose several significant health risks. As the floodwaters recede, downed electrical lines and gas leaks from pipelines and tanks may cause further terrible consequences, such as fire and explosion, resulting in injuries and deaths. Chemical fertilizers may pose a chemical concern during flood recovery. When clouds of dust and mold from ducts, fans, and ventilators are circulated in the home environment are breathed by workers that engage in cleanups can cause wounds or cuts when cleaning (Nisreen Husain *et al*., 2018).

c) Social

Floods also have lasting indirect consequences for flood-affected individuals and groups. Damage to property and the loss of valuable personal things can have a significant psychological impact on flood victims (Bubeck *et al*., 2017). Victims who have been subjected to flood disasters on a yearly basis have developed tension and anxiety, particularly after prolonged periods of heavy rain, which has harmed their standard of living (Abdullah *et al*., 2015).

Residents living in the flood plain, for example, typically feel apprehensive, concerned, and afraid during the rainy season each year (Samsuri *et al*., 2018). These significant disruptions to numerous social activities might take months or even years to recover from (Sam, 2021).

2.5 Conceptual Framework

The conceptual framework of this study is shown in Figure 1. According to the model, the independent variables are the drainage system and natural system. The dependent variable is the effect of flood disaster.

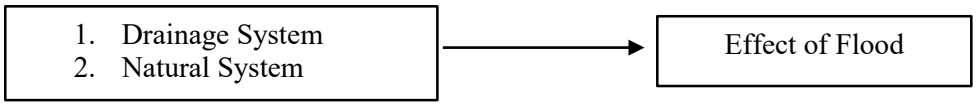

Figure 1: Conceptual framework

2.6 Research Hypotheses

There are two research hypotheses of the study:

H1: There are significant structure of drainage system on effect of flood.

H2: There are significant structure of natural system on effect of flood.

3. Research Methodology

3.1 Research Design

For the research design, the researcher uses descriptive research involves collecting people the researcher is unable to manipulate the variable. Furthermore, the researcher will conduct quantitative research for this study. The data collection will be conducted through survey methods such as questionnaires. The focus of this study will be on the questionnaires that will be sent to respondents to gather data and achieve the research objectives.

Descriptive research involves collecting and identifying the population and sample of the study. Construct research instruments to achieve research objectives. Distributing questionnaires, Data collection, Analysing data, and Conclusions about people's opinions, the researcher is unable to manipulate the variable. Following that, the researcher will conduct quantitative research for this study.

3.2 Population and Sampling

In this study, the researcher uses purposive sampling is a form of non -probability sampling in which the researcher will select members of the population to participate in the survey. Based on the table of Krejcie & Morgan (1970), the total population of the people in Kuala Lumpur is more than 1 million people. So, the study sample is 384 samples involved in this study. Table 1 below is the Sample Size Determination table of Krejcie and Morgan (1970).

3.3 Data Collection

The process of preparing and gathering data sources to answer the research problem, test the hypothesis, and assess the outcomes is known as data collection. There are two sorts of data collecting methods: primary data collection methods and secondary data collection methods.

(a) Primary data

Primary data is information obtained through own experience and knowledge. Primary information is more reliable because primary data has not been changed or manipulated. It has more validity than secondary data. The researcher in this study used a survey approach to gather data on this topic.

(b) Secondary data

Secondary data is information that has been originally published in books, newspapers, magazines, journals, and web portals, along with other places. There is a great amount of information available in various sources, regardless of the nature of the research topic. Thus, raising the levels of research validity and reliability requires adopting an acceptable set of criteria to choose secondary data for use

in the study. To obtain a deeper understanding of the subject, the researcher studied secondary data such as journals, papers, and books.

3.4 Data Analysis

Data analysis is a method of putting facts and statistics together to address a research challenge. Data interpretation, which is obtained from data analysis, is another crucial part of the research. Cronbach's Alpha Reliability Test was used to examine reliability, or internal consistency, by the researcher.

(a) Descriptive analysis

The descriptive analysis involves examining individual variables' characteristics. Thus, the researcher would use data obtained in this study to describe the mean and the central tendency of the studied variables was to use means as measurement at the same time. In addition, this analysis is an effective method for measuring the two factors of effect of flood because it differentiates between each component using a mean distribution that is based on the Likert scale.

(b) Reliability analysis

The reliability study that was performed was used to assess the internal consistency or the number of times that identical data could be obtained inside the same statement (Abowitz & Toole, 2010). Cronbach's alpha (α) is the measurement that is used most often in reliability analysis.

(c) Normality analysis

Kolmogorov-Smirnov and Shapiro-Wilk are the two options for the normalcy test that may be used in this investigation. Both options are accessible. If the probability p is more than 0.05, then the data are considered normal; however, if the probability is less than 0.05, then the data are not considered normal. A Normal QQ plot was used in the research to determine which of the independent variables (factors of flood) is more relevant to the process of forecasting the result of a dependent variable (effect of flood).

(d) Correlation analysis

The purpose of the correlation analysis was to examine the relationship between two or more variables. In the evaluation, which employed the data received from the respondents, it was found that. Statistics helps to find the strength of the association between two or more variables (Kumar, 2016). From the above analysis result, Spearman correlation analysis is used in this study due to the study is not a normal distribution.

4. Results and Discussion

4.1 Response Rate

In this research, the respondents were those who were living in Kuala Lumpur. Based on the population of more than 100,000 people, there were 384 sample sizes based on Krejcie and Morgan (1970). However, the received respondents are very overwhelming and are more than anticipated (received 405 respondents in 5 days). Thus, the questionnaire after 384 is deleted. Therefore, the response rate was 100% which was 384 out of 384, and all the questionnaires were usable. The percentage of completed surveys that were returned is shown in Table 1.

Table 1: Response rate

Item	Description
Population	1.8 million
Sample Size	384
Questionnaire distributed	14,040
Questionnaire form that returned back to the researcher	405
Usable respondent	384
Percentage of respondents' feedback	100%

4.2 Reliability Analysis

The reliability study that was performed was used to assess the internal consistency or the number of times that identical data could be obtained inside the same statement (Abowitz & Toole, 2010). Cronbach's alpha (α) is the measurement that is used most often in reliability analysis.

(a) Reliability of pilot study

A total of 15 respondents were employed. SPSS was used to analyze the results of the questionnaire.

Table 2: Reliability for pilot study result

	Cronbach's Alpha	N-item in scale	Interpretation
Independent Variables			
Drainage System	0.76	6	Good
Natural System	0.68	6	Acceptable
Dependent Variable			
Effect of Flood	0.81	5	Good

(b) Reliability for actual study

The actual study was carried out after the conclusion of the pilot study, which found that the questionnaires were valid and trustworthy. The results of the reliability test that was performed for the actual study are displayed in Table 3. The responders were 384 of people in Kuala Lumpur.

Table 3: Reliability for actual study result

	Cronbach's Alpha	N-item in scale	Interpretation
Independent Variables			
Drainage System	0.77	6	Good
Natural System	0.80	6	Good
Dependent Variable			
Effect of Flood	0.86	5	Good

4.3 Demographic Analysis

Table 4 showed that question designed in part A related with demographic information of the respondent. In general, the inquiry centered on topics such as gender, age, race, marital status and education level. All the information collected from the questionnaires that were filled out has been analyzed, and the findings have been compiled into a table and a pie chart that each shows the frequency and proportion of each response.

Table 4: Demographic information of respondents

Demographic	Details	Frequency	Percentage (%)
Gender	Male	161	40.7
	Female	233	59.3
Age	18-24 years old	127	32.3
	25-34 years old	145	36.9
	35-44 years old	66	16.5
	45-54 years old	37	9.4
	55-64 years old	14	3.6
	≥ 65 years old	5	1.3
Race	Malay	313	79.6
	Chinese	47	12.0
	Indian	23	5.6
	Other	11	2.8
Marital Status	Single	241	61.3
	Married	141	35.6
	Divorce	9	2.3
	Widowed	3	0.8
Education Level	Primary education	10	2.5
	Secondary education	62	15.7
	Diploma	105	26.6
	Degree	175	44.4
	Postgraduate	25	6.3
	Professional certificate etc	17	4.3

4.4 Descriptive Analysis

(a) Descriptive data for effect of flood.

Table 5: Effect of flood

Statement	Mean	Interpretation
1. I believe flooding causes destruction on a personal and regional level such as loss of life, property, and infrastructure	4.65	High
2. I think flooding creates a number of long-term issues, such as environmental damage, worsening of human health, and economic distress	4.58	High
3. I think flooding has a tremendous impact on water quality, air quality, and energy supply.	4.40	High
4. I think the victims of flood disasters on a yearly basis have developed tension and anxiety, which has harmed their standard of living	4.62	High
5. I believe the residents living in the flood plain feel apprehensive, concerned, and afraid during the rainy season each year	4.68	High
Total Average	4.59	High

According to Table 5, the highest mean for effect of flood is that residents living in the flood plain feel apprehensive, concerned, and afraid during the rainy season each year with the mean at 4.68 which has a high central tendency level of the range. While the lowest mean is flooding has a tremendous

impact on water quality, air quality, and energy supply with the mean at 4.40. Overall, the total average mean of effect of flood is 4.59, which is still within the high central tendency level of the range.

(b) Descriptive data for drainage system on flood.

Table 6: Drainage system

Statement	Mean	Interpretation
1. I think the drainage system in Kuala Lumpur is old so it cannot handle water from heavy rains	4.34	High
2. I believe flooding is caused by an old drainage system that are outdated and poorly maintained	4.43	High
3. I feel most of the drainage systems that exists did not seem to work well because there are a lot of water flows onto the road.	4.41	High
4. I think people casually throw away their trash along the road, then the trash piles up leading to flood.	4.58	High
5. I understand that due to Kuala Lumpur's rapid development, many previously grassy or unpaved areas have been covered over.	4.35	High
6. I believe that the streams, ditches, and ponds are difficult to fix because there are a lot of people living in Kuala Lumpur	3.76	High
Total Average	4.31	High

Table 6 shows the highest mean of drainage system is that casually throw away their trash along the road, then the trash piles up leading to flood with the mean at 4.58 which has a high central tendency level of the range. While the lowest mean is the streams, ditches, and ponds are difficult to fix because there are a lot of people living in Kuala Lumpur with the mean at 3.76. Overall, the total average mean of drainage system is 4.31, which is still within the high central tendency level of the range. Most of the respondents believe that casually throw away their trash along the road, then the trash piles up leading to flood is the main factor of flood.

(c) Descriptive data for natural system on flood

Table 7: Natural system

Statement	Mean	Interpretation
1. I think that due to rapid development, the loss of greenery and forested regions has slowed the absorption of water	4.47	High
2. I think the amount of rain in Kuala Lumpur has been increase in the past years	4.12	High
3. I believe the drainage system can't hold all the water from the huge amount of rain	4.48	High
4. I think the lack of impervious land affects the amount of water and how much the river channel can hold	4.33	High
5. I believe the flooding happens when a city grows and the natural landscape changes.	4.24	High
6. I think the landscape of Kuala Lumpur couldn’t handle the rainwater	4.18	High
Total Average	4.30	High

Based on Table 7, shows the highest mean of drainage system is that the drainage system can't hold all the water from the huge amount of rain leading to flood with the mean at 4.48 which has a high central tendency level of the range. While the lowest mean is the amount of rain in Kuala Lumpur has been increase in the past years with the mean at 4.12. Overall, the total average mean of natural system is 4.30, which is still within the high central tendency level of the range.

4.5 Normality Test

Table 8: Result of normality test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig
Dependent Variable Employee Productivity	.241	384	.000	.719	384	.000

a. Lilliefors Significance Correction

Based on Table 8, the significant level of the dependent variable by Kolmogorov-Smirnova is $p< 0.05$, which is a not normal distribution where the value is 0.000. The statistical testing by Kolmogorov-Smirnova is not normal. Due to these findings, the research will proceed with a non-parametric analysis which is the Spearman correlation analysis.

4.6 Correlation Analysis

Table 9: Result of Spearman' correlation

	Drainage System	Natural System	Effect of Flood
Correlation Coefficient	.616**	.522**	.679**
Sig. (2-tailed)	.000	.000	.000
N	384	384	384

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

Table 9 shows the results of Spearman's Correlation Coefficient, r is 0.616 which moderate between drainage system and effect of flood. The correlation analysis supports a positive relationship between drainage system and effect of flood. Therefore, H1 is supported. Next, the result of Spearman's Correlation Coefficient, r is 0.522 which moderate between natural system and effect of flood. The correlation analysis supports a positive relationship between natural system and effect of flood. Therefore, H2 is supported.

4.7 Summary of Hypotheses

Table 10: Summary of hypotheses

Hypothesis	Result
H_1 : There are significant structure of drainage system on effect of flood.	Supported
H_2 : There are significant structure of natural system on effect of flood	Supported

Overall, the study aims to evaluate the relationship between factors of flood and effect of flood. The study found that all the hypotheses are supported which are H1 and H2.

5. Conclusion

In the nutshell, drainage system and natural system have significant relationships with effect of flood. As flood due to drainage system relate closely with how people populate in Kuala Lumpur that keep increasing and poor drainage system. For natural system that show the number of rainwaters also

increase yearly. Thus, the effect of flood has a negative effect the people behaviour, health and economic.

5.1 Limitation of Study

There were some things that made it hard to do the research for this study. First, the time consideration limited the number of respondents. The data collection period for this research is only about two months. Next, the issues with research samples and selection. The data that has been collected through the google form is more likely to have a biased and inaccurate result causing the data may be misleading. Then, because this study is only focus on Kuala Lumpur thus it does not cover and knowing all part of states that affected by the flood like Kelantan, Terengganu, Sabah, Johor and etc. After that, this topic is not being heavily focused in Malaysia thus searching up past studies and documentation are difficult.

5.2 Recommendation for future researchers

Recommendations are required to improve the shortage of research. There are five recommendations that recommendation is given for future researchers. There is a limited number of respondents and a lack of evidence to support this research. First, the research is recommended to be longer as the weather in Malaysia keep on changing. With the current time frame, it is not ideal to assume on what are the majority of how the people in Kuala Lumpur feels about flood. So, the future researcher can extend the time when conducting these studies.

Next, this research is quite hard to conduct as it is only being a handful past researchers covering these issues. So, it is recommended to make more research about these issues as it is a yearly catastrophic event in Malaysia. Besides that, the data of the flood are very hard to find as it is can only being access from the official government website. Thus, it is recommended for future researcher to consult the government agency regarding flood to receive more accurate data and their opinion. After that, the future researcher can focus on other states other than Kuala Lumpur as this research only focus on Kuala Lumpur. Finally, conducting data collection through a set of papers, to help the researcher get more accurate results.

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