International Journal of Infrastructure Research and Management
Vol. 10 (2), December 2022, pp. 66 - 73

TRENDS IN PENINSULAR MALAYSIA RAINFALL DURING THE SOUTHWEST MONSOON USING DEGREE OF RAINFALL AMOUNT (DORA)

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ABSTRACT

Rainfall distribution patterns and the total amount of rainfall days are important in relation to the effects such as haze, drought, and forest fire during the Southwest Monsoon, which is a dry season in Peninsular Malaysia that starts from late May to September. This research identifies the rainfall distribution pattern and categorizes the rainfall distribution in Peninsular Malaysia during the Southwest Monsoon. By using DORA software, the total amount of rainfall days during the Southwest Monsoon was found to be the lowest in June and highest in August. The Northwest region of Peninsular Malaysia had the lowest total amount of rainfall days compared to other regions. The month of August was found to be prone to occurrence of haze, drought, and forest fire especially in the Southwest region of Peninsular Malaysia. This research provides information on the rainfall distribution pattern and its effects during Southwest Monsoon in Peninsular Malaysia so that mitigation measures can be taken before any disaster happens.

Keywords:
DORA, Peninsular Malaysia, Rainfall Distribution Pattern, Southwest Monsoon, Total Rainfall

INTRODUCTION

In tropical and subtropical climates, monsoons are a common feature across the region in the world, which are characterized with wet and dry seasons accompanied by seasonal reversal of prevailing winds (Geen et al., 2020). In Southeast Asia, the Southwest Monsoon in late May to September, the Northeast Monsoon in November to March, First Inter-Monsoon season in March to April and Second Inter-Monsoon season in October to November affect the SEA countries. In Peninsular Malaysia, the Southwest Monsoon season is generally a dry season with lesser rainfall. It is the most drought vulnerable season with the southern region showing an increasing drought trend (Fung et al., 2020). This drought trend will increase further with the effect of temperature increase due to climate change in the future. Hot and dry weather during the Southwest Monsoon causes small and big scale forest fires. In 2014, forest fires in Peninsular Malaysia were the worst with 56 cases, 2682.6 ha of permanent reserve forest and 70% of peat swamp forest were affected due to prolonged hot and dry periods (Musri et al., 2020). This destroys the natural environment, so prevention and rehabilitation work need to be carried out.

During the Southwest Monsoon, the Southeast Asian region experiences dry season that leads to an increased number of fires where the existing southerly and southwesterly winds bring air pollutants from the burning areas in Kalimantan and Sumatera, Indonesia, causing cross-boundary haze in Peninsular Malaysia nearly every year (Latif et al., 2018). This haze causes health problems to the people due to low air quality in Peninsular Malaysia. Hence, it indicates that Peninsular Malaysia experiences numerous disasters during the Southwest Monsoon period in the past years due to less rainfall that contributes to hot and dry weather. Rainfall is one of the data frequently used to determine climatological data. The rainfall data is important for policy decisions in regards to water resources planning and to study the impact of climate change. The rainfall trends are used to make future predictions or analysis to study rainfall patterns and its effect especially during the monsoon season in Peninsular Malaysia. Particularly in this research, the focus will be on Southwest Monsoon.

During the Southwest Monsoon season from late May to September, Peninsular Malaysia experiences a rather hot and dry climate often with less rainfall and less cloud (Chenoli et al., 2018). Therefore, disasters occur frequently, almost every year during the Southwest Monsoon season.

Chenoli et al., (2018) in the research on onset date for Southwest Monsoon and the associated climatological characteristics over Malaysia, characterized the Southwest Monsoon as high outgoing long-wave radiation, low precipitation, and less cloud using the data from 1981 to 2015 reveals that during the Southwest Monsoon, it is often accompanied by dry spells of less than 10mm of rainfall daily. The Southwest Monsoon season in Peninsular Malaysia experiences a rather hot and dry climate often with less rainfall and less clouds.

Increasing drought trend is an issue that can occur during the Southwest Monsoon season since during this season, Peninsular Malaysia receives less rainfall. Drought is a condition of dry and warm weather that occurs over a period of time that causes water available on land surface to be less than average volume (Hasan et al., 2021). Dry and less rainfall condition together with the trans-boundary haze event during the Southwest Monsoon in Peninsular Malaysia will cause harmful effects towards human health.

To overcome the issues during the Southwest Monsoon in Peninsular Malaysia, two objectives were conducted which (1) To identify the rainfall distribution pattern in Peninsular Malaysia during the Southwest Monsoon and (2) To categorize the rainfall distribution in Peninsular Malaysia during the Southwest Monsoon. The selected locations of the study area are in Peninsular Malaysia, where the rainfall stations are selected based on the four classified regions. The four classified regions are namely the southwest region, which consist of Johor state, the east region, which consists of Kelantan, Terengganu and Pahang state, the west region, which consists of Perak, Selangor, Negeri Sembilan and Melaka, finally, the northwest region, which consists of Perlis, Kedah and Penang. There are a total of 12 rainfall stations selected in this research to consider a daily rainfall amount as an analysed parameter by using the Degree of Rainfall Amount (DORA) method.

The understanding of rainfall patterns during the Southwest Monsoon season is significant in ensuring dry season related disaster mitigation measures can be carried out since less rainfall will be experienced during this season. The study of rainfall during the Southwest Monsoon in Peninsular Malaysia is also important to analyse the effect of less rainfall during the monsoon related to drought, forest fire and haze condition to the people and the environment. This study will benefit the future researchers with the pattern distribution of rainfall during the Southwest Monsoon in Peninsular Malaysia, which can be compared to rainfall trend in Peninsular Malaysia during Northeast Monsoon and mitigation measures can be taken earlier by the authority.

METHODOLOGY

A flow chart was used to show the sequence on how this research was carried out from the beginning until the end as in Figure 1. This research analysis used the data ranging from year 2011 to 2020, covering daily rainfall data for a total of ten years duration. The daily rainfall data for the rainfall station were obtained from the Department of Irrigation and Drainage (DID), Malaysia.

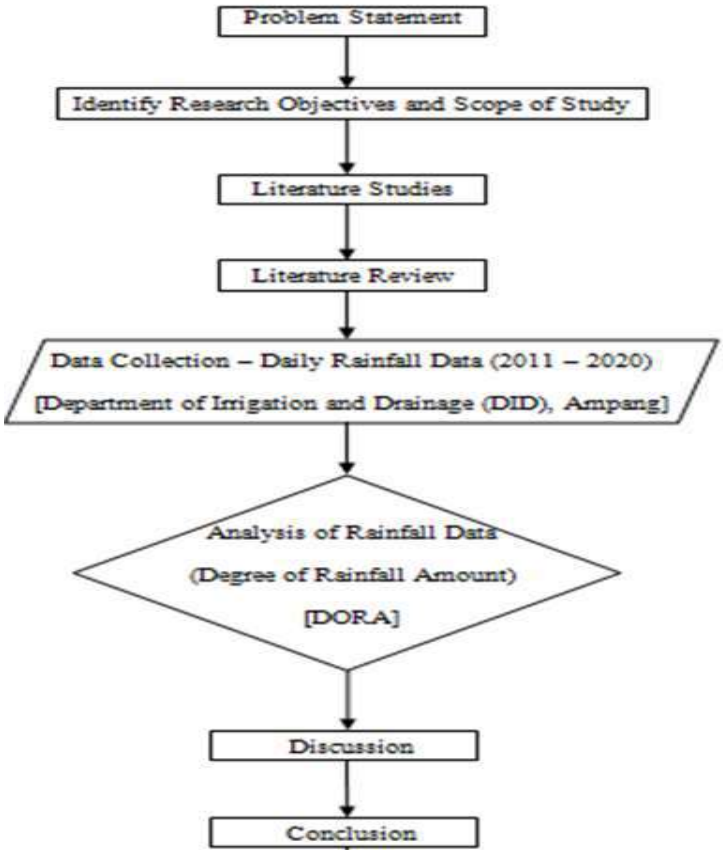

Figure 1: Flow Chart to Conduct Research

There was a total of 12 rainfall stations selected in Peninsular Malaysia, which were classified according to the regions namely, the southwest region, the east region, the west region and the northwest region. The selected rainfall stations according to these regions are shown in Table 1. Based on the daily rainfall data, the categorization of rainfall from 7 days cumulative rainfall was determined by using DORA which is one of the components in the ROSE INDEX. The categorise of degree of rainfall includes Low (L), Moderate (M), High (H), Very High (VH) and Critical (C) degree of rainfall amount in mm as shown in Table 2.

Table 1: Rainfall Station Selected in Peninsular Malaysia

Station ID	Station Name	Latitude	Longitude
Southwest Region			
1832001	Empangan Sg. Machap	01° 53' 10"	103° 16' 20"
1437116	Stor JPS Johor Bahru	01° 28' 15"	103° 45' 10"
1931003	Empangan Sg. Sembrong	01° 58' 25"	103° 10' 45"
East Region			
3631001	Kg. Pulau Manis	03° 39' 10"	103° 07' 10"
4234109	JPS Kemaman	04° 13' 55"	103° 25' 20"
6024074	Bachok	06° 03' 20"	102° 24' 05"
West Region			
2324033	Hospital Jasin	02° 18' 30"	102° 25' 55"
3022001	MARDI Jelebu	03° 02' 59"	102° 13' 40"
3115082	Taman Mayang	03° 06' 44.2"	101° 35' 47.2"
4011144	Rumah JPS Chui Chak	04° 02' 50"	101° 10' 20"
Northwest Region			
5505033	Rumah Pam Pinang Tunggal	05° 33' 26"	100° 30' 25"
5403001	Lorong Batu Lanchang	05° 24' 09"	100° 17' 58"

Table 2: Categories of rainfall using DORA (Roslan et.al,2001)

DORA (mm)	Category
< 90 mm	LOW
90 - 120 mm	MODERATE
120 - 150 mm	HIGH
150 – 190 mm	VERY HIGH
> 190 mm	CRITICAL

ANALYSIS AND DISCUSSION

DAILY RAINFALL ANALYSIS

The intensity of daily rainfall distributions during the Southwest Monsoon season serves as an early indicator on how this season can affect Peninsular Malaysia in terms of environment and the people. The total number of rainfall days are determined as lesser rainfall days contribute to the dry season during the Southwest Monsoon in Peninsular Malaysia. The lower number of rainfall days indicate that there is a possible risk of dryness due to less rainfall that could lead to haze, drought and forest fires. Readings from June to September year 2011 to 2020 on the total number of rainfall days is shown based on the four regions namely the Southwest region, East region, West region and Northwest region in Peninsular Malaysia.

Table 3: Comparison of Total Number of Rainfall Days in the Four Regions

Regions	Total No. of Rainfall Days-Month		Average Total No. of Rainfall Days
	Lowest	Highest	
Southwest	June	August	564
East	June	August	608
West	June	August, September	544
Northwest	June	September	477

Based on Table 3, it was found that the month having the lowest total number of rainfall days in most of the rainfall stations is in June in Southwest region of Peninsular Malaysia. Meanwhile, in the East region, the month having the lowest total number of rainfall days is in June as well. While in the West region, all the rainfall stations recorded the lowest total number of rainfall days in the month of June. In the Northwest region, the total number of rainfall days was lowest in the month of June. From this comparison, it can be seen that in the month of June the total number of rainfall days during Southwest Monsoon season in Peninsular Malaysia is the lowest compared to other months. In terms of rainfall days in the region, Northwest region were found to have lesser total number of rainfall days compared to other regions, which indicate this region is drier during the Southwest Monsoon.

In contrast, the total number of rainfall days during the Southwest Monsoon season in Peninsular Malaysia was the highest in August in most of the rainfall stations in the Southwest region. While in the East region, the total number of rainfall days was the highest in the month of August. Meanwhile, in the West region, the rainfall stations show the highest total number of rainfall days in August and September. In the Northwest region, the total number of rainfall days was the highest in September. Generally, from this comparison, it can be seen that most of the regions in Peninsular Malaysia during the Southwest Monsoon have the highest total number of rainfall days in August. In terms of rainfall days in the region, the East region had a higher total number of rainfall days compared to other regions.

Table 4: Summary of Percentage of Rainfall in the Southwest Region

Rainfall Station	Percentage (%)		Risk Month
	L	M	
Empangan Sg. Machap	97.42	2.58	August
Stor JPS. Johor Bahru	95.45	4.55	August
Empangan Sg. Sembrong	96.48	3.52	July August

Table 5: Summary of Percentage of Rainfall in the East Region

Rainfall Station	Percentage (%)		Risk Month
	L	M	
Kg. Pulau Manis	94.83	5.17	August
JPS. Kemaman	94.04	5.96	July
Bachok	94.73	5.27	July

Table 6: Summary of Percentage of Rainfall in the West Region

Rainfall Station	Percentage (%)		Risk Month
	L	M	
Hospital Jasin	97.09	2.91	July
MARDI Jelebu	97.64	2.36	August
Taman Mayang	93.58	6.42	June August
Rumah JPS. Chui Chak	93.61	6.39	July

Table 7: Summary of Percentage of Rainfall in the Northwest Region

Rainfall Station	Percentage (%)		Risk Month
	L	M	
Rumah Pam Pinang Tunggal	92.51	7.49	July
Lorong Batu Lanchang	92.12	7.88	August

Tables 4, 5, 6 and 7 show the Summary of Percentage of Rainfall in the four regions in Peninsular Malaysia during the Southwest Monsoon. It was based on two major categorizations, which is Low and Moderate. The percentage of the Low category was the highest in the Southwest region, the West region, the East region and followed by the Northwest region. Consequently, the Southwest region had a higher potential occurrence of haze, increased drought trends and forest fires in Peninsular Malaysia during the Southwest Monsoon since the amount of rainfall was less. Overall, the potential critical risk month had less rainfall, which led to the occurrence of haze, increased drought trends and forest fires in Peninsular Malaysia during Southwest Monsoon in August. This finding concurs with Asha'ari and Badrunsham (2014) that from August to September, the fire counts and hotspot events increased due to less rainfall. Besides, based on the results obtained, all the regions were more than 90% in the Low category, meaning less rainfall. This indicates a very high potential occurrence of haze, increasing drought trends and forest fires in Peninsular Malaysia during Southwest Monsoon. However, in this research, the data only highlighted the Low (L) and Moderate (M) categories that were likely to show the potential occurrence of haze, increasing drought trends and forest fires in Peninsular Malaysia during Southwest Monsoon.

Figure 2 Potential Risk Months 2011 – 2020

Overall, based on Figure 2, the potential critical risk month with less rainfall, which might lead to occurrence of haze, increased drought trends and forest fires in Peninsular Malaysia during Southwest Monsoon was in August, since most of the rainfall stations peak at that month. This finding supports Asha'ari and Badrunsham (2014) findings that from August to September, the fire counts and hotspot events increased due to less rainfall. Besides, based on the results obtained, all the regions were more than 90% in the Low category, meaning less rainfall. This indicates a very high potential occurrence of haze, increasing drought trends and forest fires in Peninsular Malaysia during Southwest Monsoon.

CONCLUSION AND RECOMMENDATION

In this research, twelve rainfall stations were selected and divided into four regions, namely the Southwest region, East region, West region and Northwest region, to identify the rainfall distribution pattern and to categorize the rainfall distribution during Southwest Monsoon in Peninsular Malaysia. By using DORA analysis software, the data collected from the Department of Irrigation and Drainage (DID), Ampang was analyzed and results were obtained. There are a few conclusions that can be made based on the analysis and results obtained. It can be concluded that the total amount of rainfall days in June was the lowest during Southwest Monsoon season in Peninsular Malaysia while in August, it was the highest. It was also found that the Northwest region had the lowest total amount of rainfall days compared to other regions.

Besides, it can be concluded that August was the risk month that is prone to occurrence of haze, increasing drought trends and forest fires especially in Southwest region in Peninsular Malaysia during Southwest Monsoon since more than 95% are in the Low category. Overall, it can be concluded that the objectives of this research have been achieved. This research outcome will provide useful information on the distribution pattern of rainfall and the relationship between the rainfall amount during Southwest Monsoon season and the possible effects such as haze, drought and forest fires. By understanding this relationship, people can be more prepared and precautionary steps can be taken before any disaster happens.

Through this research, there are several recommendations for future research projects. The first suggestion is to construct rainfall stations that have complete rainfall data collection equipment that are more accurate for in this research there was about 10% of rainfall data lost. Next recommendation is to increase the number of rainfall stations, so that more areas in Peninsular Malaysia can be covered for a more accurate outcome for in this research mostly covered only the edges of Peninsular Malaysia, hence, the inland was not much covered.

ACKNOWLEDGEMENT

I would like to express my gratitude to the Department of Irrigation and Drainage (DID), Ampang for providing the rainfall data to complete my research work and the Civil Engineering Department, Infrastructure University Kuala Lumpur (IUKL) for the support given.

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