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ANALYSIS OF RAINFALL INDICES AT JPS AMPANG STATION

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ABSTRACT

Understanding characteristics of rainfall of a region could provide vital information for management of water resources. This study aims to explore the spatial pattern and trends of the daily rainfall data based on seasonal rainfall indices. Rainfall indices are adopted to explain main characteristics of rainfall such as the total amount of rainfall, frequency of wet days, rainfall intensity, extreme frequency, and extreme intensity. In particular, these five rainfall indices are used to capture the changes in a variety of aspects of rainfall distribution at a rainfall station, namely JPS Ampang station in Malaysia. The correlation between total amount of rainfall (TAR), frequency of wet days of at least 1 mm of rain (FREQ), mean rainfall amount on wet days or rainfall intensity (RI), frequency of wet days exceeding the 95th percentile (XFREQ) and rainfall intensity exceeding the 95th percentile (XI) indices is estimated. Results show that there is a strong positive correlation between TAR and extreme indices (XFREQ and XI). There is also high positive correlation between TAR and RI. However, a moderate positive correlation is shown between TAR and FREQ as well as between extreme indices (XFREQ and XI) and FREQ.This indicates that higher XFREQ, XI and RI will result in higher value of TAR at JPS Ampang station. Annual rainfall indices show that higher indices including extremes (XFREQ and XRI) are more prominent during La Nina while lower indices are more prominent during El Nino.

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1. INTRODUCTION

The increase of frequency and intensity of extreme rainfall events is a major concern in recent years across the world. It is believed that rise in both frequency and intensity of extreme rainfall events are the major impacts of global warming [2]. Malaysia experiences unpredictable rainfall events. The increase in massive flood cases, including flash floods and landslides in the last decade, is due to the increase in rainfall intensity. The annual spatial pattern for Peninsular Malaysia is mostly influenced by the Northeast monsoon (NEM) season where the east coast is most affected during this season [5]. Over the years between 1975 and 2004, Peninsular Malaysia experienced an upward trend of rainfall during the Southwest monsoon (SWM) season. [3] had discovered an upward trend in both the aggregate sum of rainfall and the occurrence of wet days during the NEM, which give rise to the increasing trend of rainfall for the period between1971 to 2004. In previous studies, an hourly rainfall model has been established to simulate the hourly rainfall time series throughout Peninsular Malaysia. Different distributions such as Gamma and Weibull have been fitted to gauge rainfall intensity and their performances have been compared. Weibull is found to be well performed mostly for rainfall stations located on the west coast of the peninsular. According to [4], the west coast is highly affected during the inter-monsoon season where high intense rainfall occurs in a relatively short time period (i.e. hourly) which leads to flash floods. Thus, in this study, JPS Ampang station was selected as it receives high rainfall amount during inter-monsoon season. The correlations of five rainfall indices in JPS Ampang are analyzed in this study

2. DATA

In this study, the Advanced Weather Generator (AWE-GEN), developed by [1] model is constructed based on 30 years of historical data (1975-2005). The input data required by AWE-GEN are hourly rainfall, hourly temperature, hourly relative humidity and hourly wind speed. These input data were gathered from 40 rainfall stations across Peninsular Malaysia. JPS Ampang station is selected for further analysis on rainfall indices.

3. METHODS

Five rainfall indices were selected in this study following [3]. Table 1 gives the definition for each rainfall index. Next, the correlation between TAR and FREQ, RI, XFREQ, XI is estimated using:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Table 1. Rainfall indices

Description	Index Name
Total amount of rainfall	TAR
Frequency of wet days of at least 1 mm of rain	FREQ
Mean rainfall amount on wet days or rainfall intensity	RI
Frequency of wet days exceeding the 95th percentile	XFREQ
Rainfall intensity exceeding the 95th percentile	XI

4. RESULTSAND DISCUSSION

Figure 1 depicts the correlations between TAR and the remaining indices while Table 2 gives the correlation values of all indices. There is a strong positive correlation between TAR and extreme indices (XFREQ and XI) with r = 0.95. Similarly, high positive correlation (r = 0.798) is also observed between TAR and RI. This indicates that there is a significant strong linear relationship between the three indices and TAR while the slope is positive. In contrast, a moderate positive correlation is depicted between TAR and FREQ with r = 0.627. Similarly, there is a moderate positive relationship between extreme indices (XFREQ and XI) and FREQ with r = 0.54.

Table 2. Correlation matrix (pearson) for all indices. Values in bold are different from 0 with a significance level alpha=0.05

Variables	TAR	FREQ	RI	XFREQ	XI
TAR	**1**	**0.627**	**0.798**	**0.953**	**0.952**
FREQ	**0.627**	**1**	0.040	**0.545**	**0.544**
RI	**0.798**	0.040	**1**	**0.800**	**0.800**
XFREQ	**0.953**	**0.545**	**0.800**	**1**	**1.000**
XI	**0.952**	**0.544**	**0.800**	**1.000**	**1**

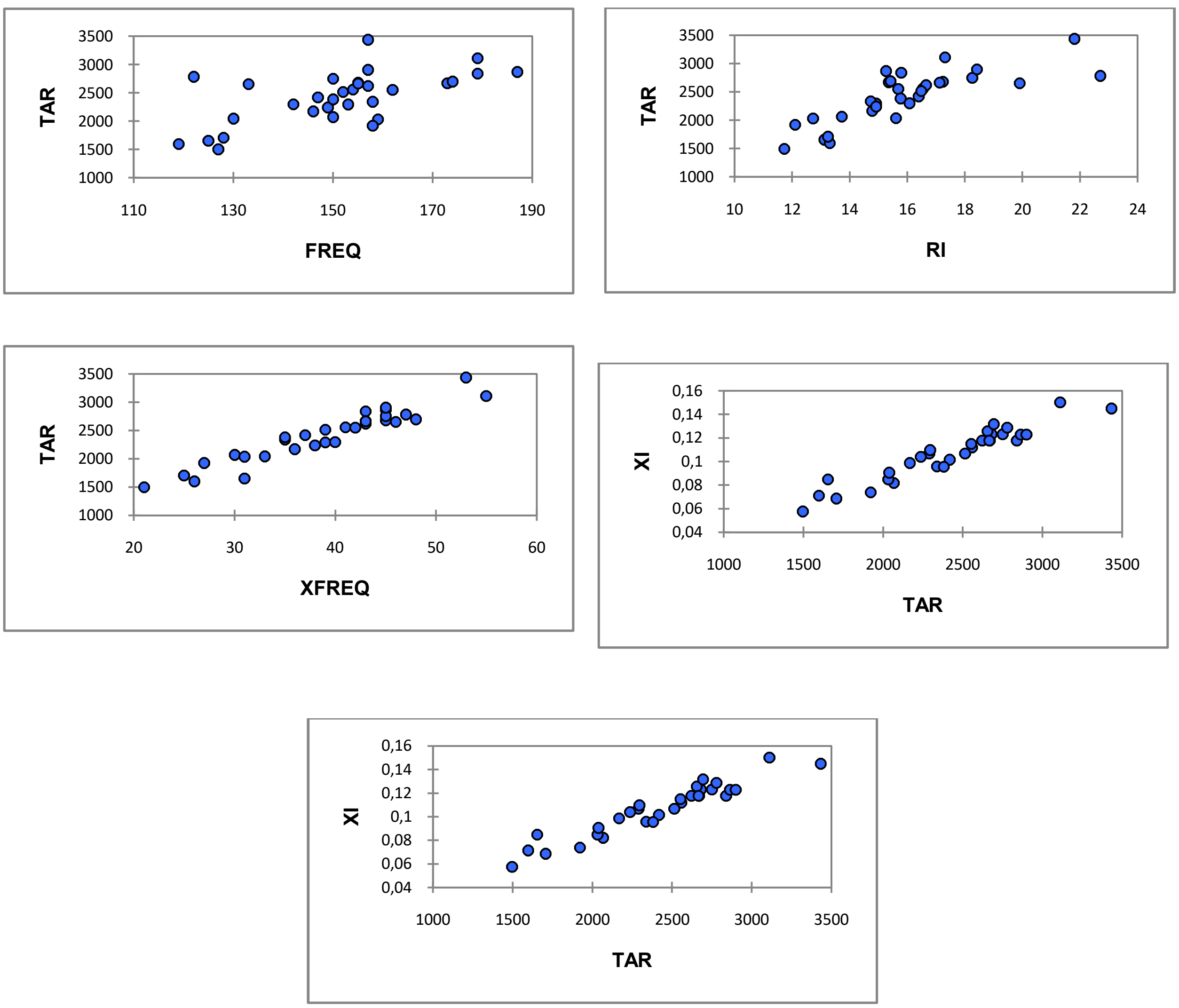

Fig.1. Scatter plots of the correlations between TAR and FREQ, RI, XFREQ and XI

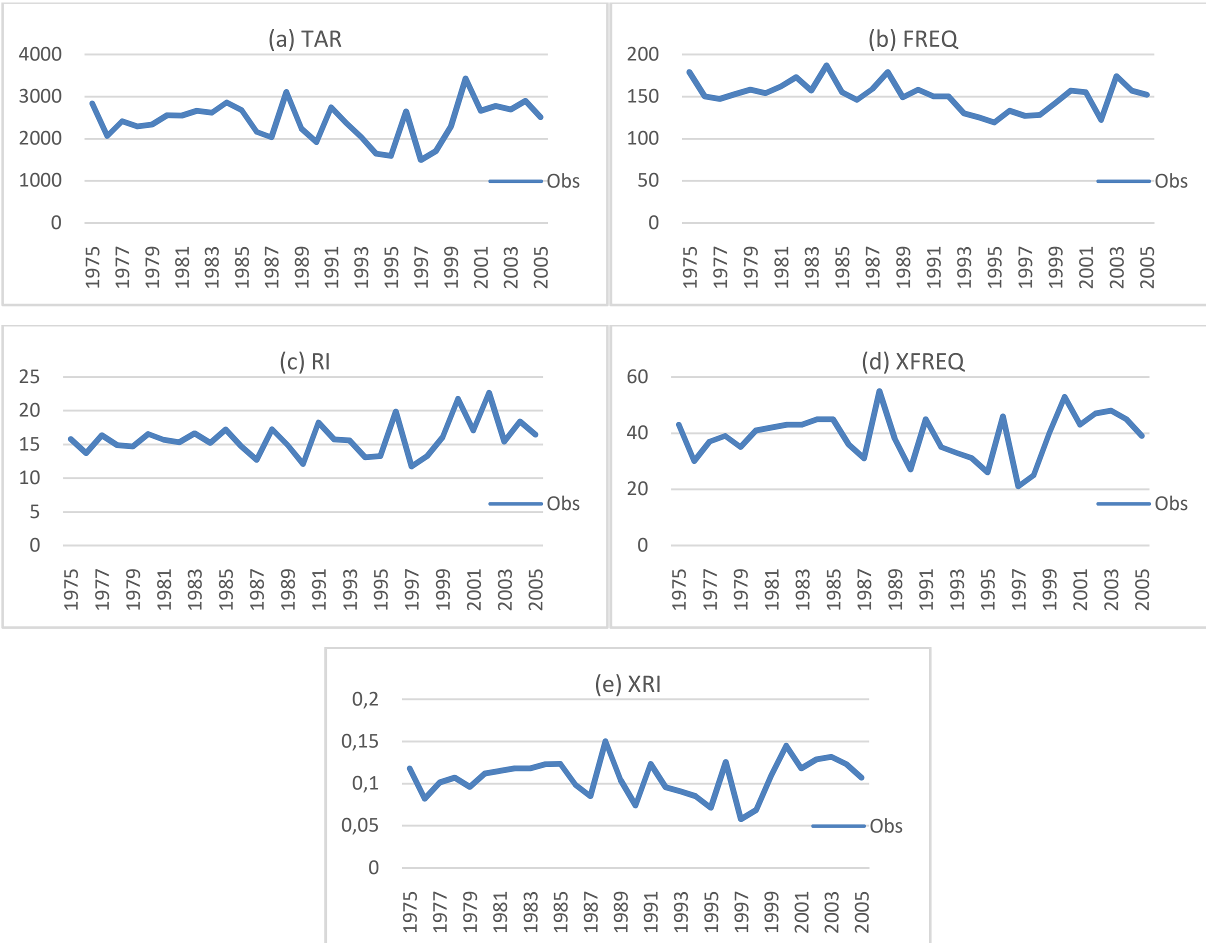

Fig.2. Annual rainfall indices between 1975 and 2005

The worst and most severe El Nino episode was in 1997/1998 where it began in March 1997 and ended in May 1998. After these years, strong La Nina (long phase) occurred between 1998 and 2000 which caused more floods throughout these years. This explains the trend of all indices in Figure 2 which shows an increase from 1997 to 2000. As can be seen in the figure, TAR increased from 1497.1 mm in 1997 to 1706.3 mm (1998), 2295.8 mm (1999) and 3431.9 mm (2000). Similarly, the trend of all indices also seems to be inclined from 1987 to 1988. This is also due to El Nino events which occurred in 1987 while in contrast, Peninsular Malaysia experienced La Nina episodes in 1988. Such eventsexplain the high peak values in 1988 and 2000 captured by all indices, including the extremes (XFREQ and XRI).

5. CONCLUSIONS

Inthis study, it was found that there is some association between the indices. As frequency of wet days exceeding the 95th percentile (XFREQ), rainfall intensity exceeding the 95th percentile (XI) and mean rainfall amount on wet days or rainfall intensity (RI) increase, total amount of rainfall (TAR) tend to increase. This indicates that higher XFREQ, XI and RI will result in higher value of TAR at JPS Ampang station. Meanwhile, annual rainfall indices show that higher indices including extremes (XFREQ and XRI) were more prominent during La Nina years while lower indices were more prominent during El Nino years.

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