UNIVERSITI TEKNOLOGI MARA

ASSESSMENT OF WATER SCARCITY INDEX – RELATED DROUGHT INDEX FOR URBAN AND SUB URBAN AREA

RAJA MUHAMMAD NAUFAL BIN RAJA AZMAN

Thesis submitted in fulfilment
of the requirements for the degree of
Master of Science
(Civil Engineering)

College of Engineering

January 2024

ABSTRACT

The climate change interference and increase of surface temperature have contributed to the changes at the atmosphere that give a significant effect to the availability of water. Malaysia is one of the countries which effected with this event and had been suffered series of drought events in 1997, 1998, and 2014. These problems contribute to the disruption of country's economic development and quality of life. The using of drought indices for analytical is important and it can estimate the drought affect that are being experienced accurately. The main objective of this study is to assess the relationship between drought index and water scarcity for water security Malaysia. The data for this study was obtained from Malaysian Meteorological Department (Met Malaysia) and Department of Irrigation and Drainage (DID) in order to determine the drought index and water scarcity index. Then, the drought index was determined using The Standard Precipitation Evapotranspiration Index (SPEI) for urban and suburban and the analysis was conducted using R Studio software. The selection of SPEI was due to the availability of data. Meanwhile, the water scarcity index was calculated using Water Exploitation Index Plus (WEI+) according to the formula for urban area. The findings of this study were indicated that the frequency of drought index for Pahang River basin are 26 for SPEI-3, 23 for SPEI-6, and 22 for SPEI-12. Meanwhile, the frequency of drought index for Langat River basin are 54 for SPEI-3, 58 for SPEI-6, and 61 for SPEI-12. As for water scarcity index for Langat River basin was determined in year 2015 until 2018. The value of water scarcity index for Langat River basin are 2.60E-03 in 2015, 3.81E-03 in 2016, 3.39E-03 in 2017, and 3.68E-03 in 2018. In order to assess the relationship between both index for Langat River basin, the Artificial Neural Network and Microsoft Excel is being used and by using Microsoft Excel indicate a strong positive relationship with the value of correlation coefficient, R are 0.9512 for SPEI-3, 0.9735 for SPEI-6, and 0.9756 for SPEI-12. Meanwhile, by using ANN, indicated the strong positive relationship with the value of correlation coefficient, R of 0.9677 for SPEI-3, 0.9545 for SPEI-6, and 0.9633 for SPEI-12. Thus, both tool shows the positive result for the relationship between SPEI and WEI+. From the result of SPEI versus WEI+, it can be concluded that when the higher value of severity index for SPEI, the higher value of WEI+ will be obtained. From that analysis, the recommendation and propose the mitigation can be provided to the related organization to take an action in planning and managing the water supply and to prevent the serious impact on the agricultural as well.

ACKNOWLEDGEMENT

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1   Background Study

Urbanization is a dynamic phenomenon of economic and social capability shifting from rural areas with agriculture-based economy to urban areas with industry and services sectors. In fact, urbanization with high urban densities is also capable of structuring the economic patterns of resource consumption and worldwide environmental quality (Shahbaz et al., 2015). The climate change is one of the effects of uncontrol urbanization and lead to the increase of surface temperature that will be contributed to the changes at the atmosphere and will cause a significant effect to the availability of water. The possibility of climate change for an area is dependent on the historical situation or the prediction of potential climates such as drought, floods, and monsoons (Othman et al., 2018). Drought is a stochastic and persistent natural hazard that has costly and destructive effects on the availability of surface and groundwater, crop production, quality of ecological water, production of electricity (hydropower), modern industrial production, and waterborne transportation (Tri et al., 2019).

In 1998, the severe drought has affected 1.8 million residents in southern Kuala Lumpur City, Bangi, and Kajang. During that year, Malaysia are facing water scarcity problem because the low rainfalls occur and lead to the drought conditions (Shaaban et al., 2003). Drought and water scarcity have become an important issue in Malaysia due to exceptional rainfall deficit which contribute to the water crisis problem, impact on the environment, economic and social activities (Hui-Mean et al., 2018).

Due to this drought and water scarcity problem, the previous researchers come out with a several indices study to overcome the issue. There is a study on drought index by using the Standard Precipitation Evapotranspiration Index (SPEI) in Peninsular Malaysia. The SPEI is widely used in climatology and hydrology studies due to its advantages in combining the sensitivity of Palmer Drought Severity Index (PDSI) to changes of potential evapotranspiration (PET) in simple calculation while maintaining the robustness of the multi-temporal characteristics of Standard Precipitation Index (SPI) (Hui-Mean et al., 2018). The conclusion from the study found that the SPEI that