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MODELLING OF DAILY PM$_{10}$ CONCENTRATIONS USING MARKOV CHAIN MODEL AT SELECTED AREA IN PENINSULAR MALAYSIA

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ABSTRACT

The purposes of this study are to investigate the occurrences of particulate matter with aerodynamic diameter less than or equal to 10 µm (PM_{10}) concentration and develop the PM_{10} concentration index (PCI). There has been very little work in predicting the sequence of PM_{10} concentration. This study considers the use of the Markov chain model as it has advantages due to the dependency of the previous events and being highly suitable for the pattern of observations. Twelve years of daily PM_{10} concentration data (2002-2013) at three monitoring stations in Peninsular Malaysia were used in this study. The assumption of the Markov chain model was met when the data used possessed the Markov chain properties as successive events that depended on each other. The results showed that the higher order was more appropriate for the monitoring stations with the threshold value less than 100 μgm^{-3} for both decision criteria (AIC and BIC). Based on the optimum order, the occurrence of polluted (or non-polluted) days was found to be depended on the condition of two or three days before the observed day where the prediction of PM_{10} events can be made based on the two or three days before the observed day. However, up to four orders were suggested as the use of the higher order was less practical due to the increasing number of parameters and difficulties to estimate the parameters. Thus, it can be concluded that at least a three-day event before the PM_{10} concentration event is needed to minimise the effect and better precautions can be taken. The proposed PCI describes the severity of exposure impact proneness (EIP) due to the pollutant persistency level in environment. The results show that Shah Alam recorded the highest value of API (PM_{10}) in "Critical EIP" condition followed by Pasir Gudang and Kuala Terengganu.

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CHAPTER ONE

INTRODUCTION

1.1   Background

Air pollution has been around for almost as long as the existence of humans and discussed every day among related bodies and also public. It is well known that health effects are associated with air pollution. Several studies had been published showing an increasing awareness among policy makers or scientific communities about the consequences due to the exposure to air pollution. There are five major air pollutants in Malaysia namely particulate matter with aerodynamic diameter less than or equal to 10 µm (PM_{10}), Carbon Monoxide (CO), Ozone (O_3), Sulphur Dioxide (SO_2), and Nitrogen Dioxide (NO_2) (DoE, 2013b). Subsequently, the existence of these pollutants in the atmosphere is causing air pollution in Malaysia. Afroz, Hassan and Ibrahim (2003) reported other than open burning, mobile and stationary sources are the causes of air pollution in Malaysia.

The ambient air quality in Malaysia is monitored and managed by the Department of Environment (DoE) through 52 monitoring stations (DoE, 2012). The organization that is responsible for collecting the air pollution data for DoE is the Alam Sekitar Malaysia Sdn. Bhd. (ASMA). For the purpose of spotting any significant changes in the air quality that may be harmful to human health as well as the environment, these monitoring stations are strategically placed in the industrial, urban, suburban, and background areas by DoE. Hourly measurements of five major pollutants which are PM_{10}, CO, O_3, SO_2, and NO_2 are obtained from these monitoring stations.

The status of air quality in Malaysia is reported in terms of the Air Pollution Index (API) which is based on the highest reading of the five air pollutants. For example, if the concentration of PM_{10} shows the highest reading recorded on that day, then the API for the day is based on the reading of PM_{10} concentration. Furthermore, according to Ibrahim, Ismail and Hwang (2004), most of the time, the API in Malaysia is based on the concentration of PM_{10}. This API is used to provide simple and easily understood information on the daily air quality to the public. Due to the increase in public concern, DoE in Malaysia has established the air quality standards for PM_{10}