DETERMINATION OF AEROSOL OPTICAL THICKNESS FROM SPECTRAL SKY TRANSMITTANCE

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ABSTRACT
The objective of this study is to test the feasibility of the proposed technique for retrieving spectral aerosol optical thickness (AOT) from the spectral transmittance measurements. The measurements have been acquired around Penang Island, Malaysia. Ground-based measurements were made with a handheld spectroradiometer. The measured spectral transmittance data were then converted to AOT values 6 spectral bands between 400 and 900 nm. Spectral AOT maps were generated using Kriging interpolation method for the 6 spectral bands. Air quality map was produced using this technique.

1.0 INTRODUCTION

Knowledge of the parameters that are related to the optical properties of atmospheric aerosols is essential for the determination of their climatic effects, development of techniques for remote sensing of aerosol from space or the necessary correction of atmospheric effects in satellite imagery (Sanchez, et al., 1998). Particulate matter (PM), or aerosol, is the general term used for a mixture of the solid particles and the liquid droplets were found in the atmosphere (Wang and Christopher, 2003). AOT, τ, is a measure of aerosol loading in the atmosphere (Christopher, et al., 2002). Generally, a higher AOT value indicates higher column of aerosol loading and therefore low visibility (Wang and Christopher, 2003). The Penang atmosphere is often affected by large plumes of dust especially from the industrial areas.

many researchers have conducted satellite monitoring of the AOT [Husar, et al., (1997), Sanchez Oliveros, et al., (1998) and Liu, et al., (2002)]. In this study, we present results from ground-based measurements. Our purpose is to generated spectral AOT map over Penang. The well knows Beer-Lambert law was used in this study to retrieve AOT values from the measured transmittance value. Finally, AOT maps were generated using Kriging interpolation technique. Ung et al., (2001) and Patil et al., (2003) also applied interpolation technique in their studies (air quality mapping).

2.0 STUDY AREA

The study area is the Penang Island, Malaysia, located within latitudes 5° 12’ N to 5° 30’ N and longitudes 100° 09’ E to 100° 26’ E (Figure 1). The corresponding PM10 measurements were collected at several selected locations.

Figure 1 Study area

3.0 DATA ANALYSISI AND RESULTS

The data that have been used in this study were collected at 40 locations in Penang, Malaysia. The measured data were transmittance values. The AOT is related to the transmission by the expression

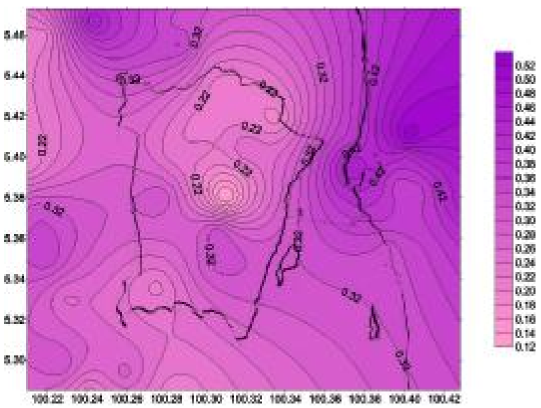
$$T_{d\lambda} = e^{-\frac{\tau_\lambda}{u_s}} \quad \text{(Vermote, et al., 1997)} \quad (1)$$

where

$T_{d\lambda}$ = transmittance for direct irradiance at wavelength, λ

u_s = cosine (θ), θ is the zenith angle

The transmittance values were measured using a handheld spectraradiometer. The sensitivity of this type of spectroradiometer is between the spectral wavelengths from 350 nm to 1050 nm. We selected 6 spectral wavelengths in this study centred at 400.5 nm, 500.5 nm, 600.5 nm, 700 nm, 800 nm and 900 nm. These selected 6 bands are based on the Wehrli 1985 AM0 Spectrum. Then the transmittance values were used to derive the AOT values using Equation (1). AOT maps were created using Kriging interpolation technique for estimating aerosol values to be associated to their distribution patterns (Figure 2).



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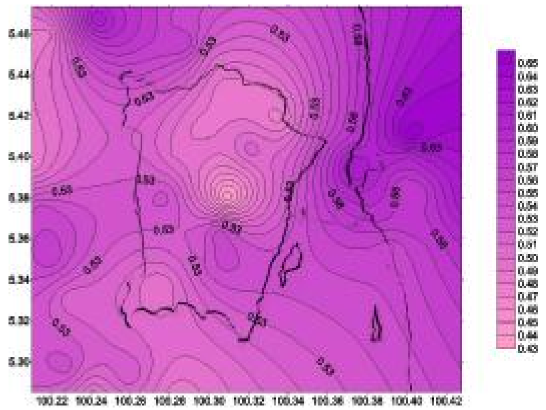

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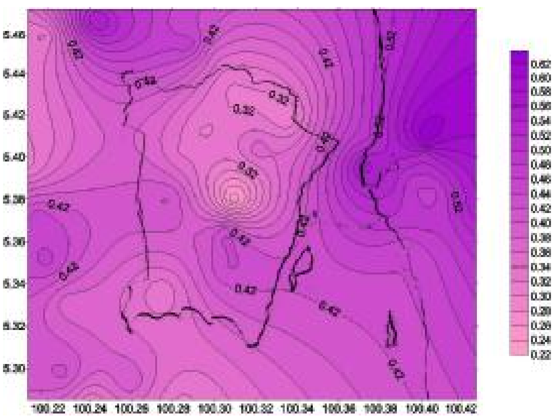

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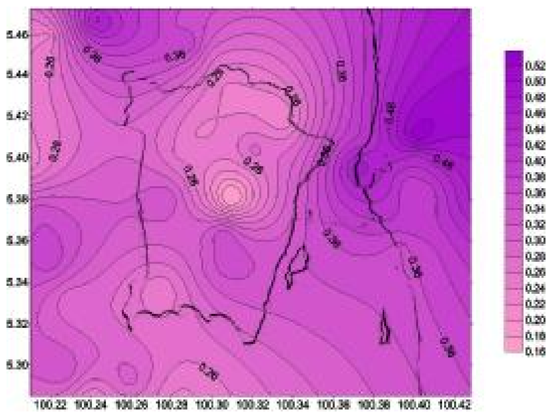

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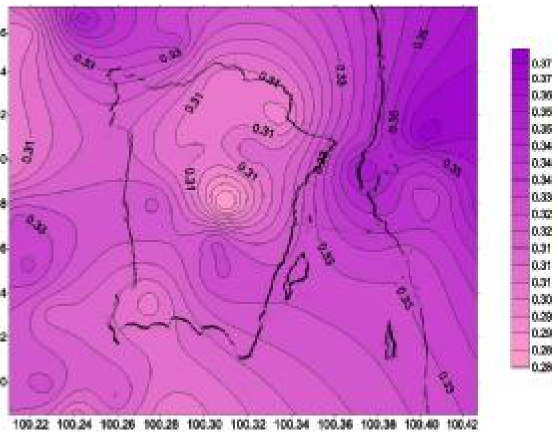

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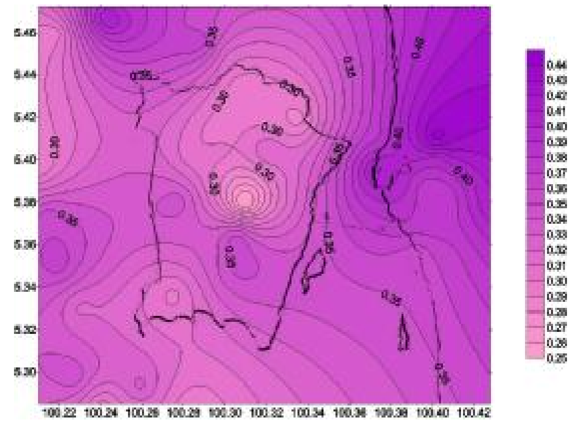
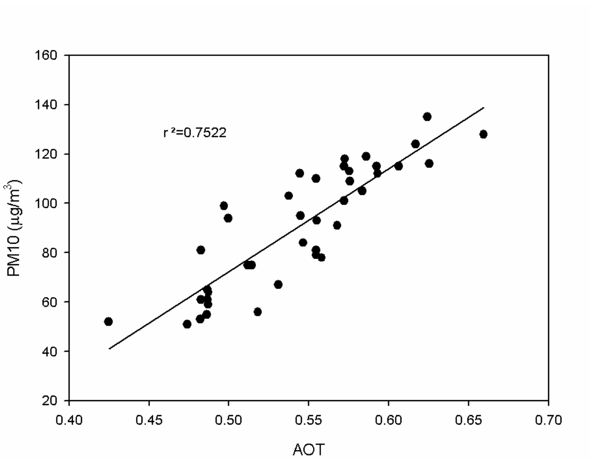


(f)

Figure 2 AOT map for (a) 400.5 nm, (b) 500.5 nm, (c) 600.5 nm, (d) 700 nm, (e) 800 nm and (f) 900 nm

In this study, we used PM10 as air quality parameter measurements over Penang Island. The relationship between AOT and PM10 was investigated in this study and we discovered that there was a linear relationship between PM10 and AOT. The linear correlation coefficient (R) was greater than 0.8 (Figure 3). Several studies have indicated linear relationship between these parameter [Christopher and Wang, (2003) and Wang and Christopher, (2003)]. We can clearly see from Figure 3 that PM10 values was increasing as the AOT values increasing. Therefore AOT is a useful information for retrieval of PM 10 values.



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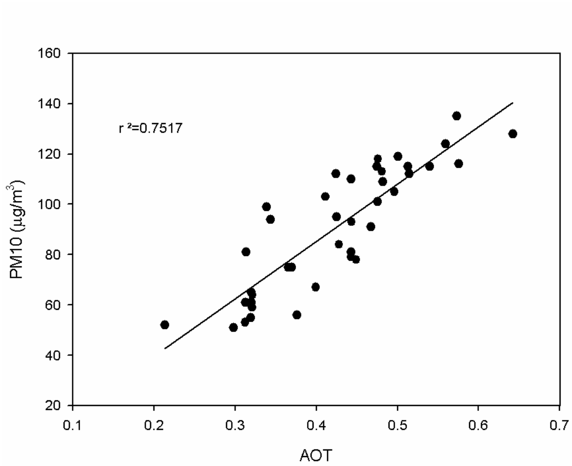

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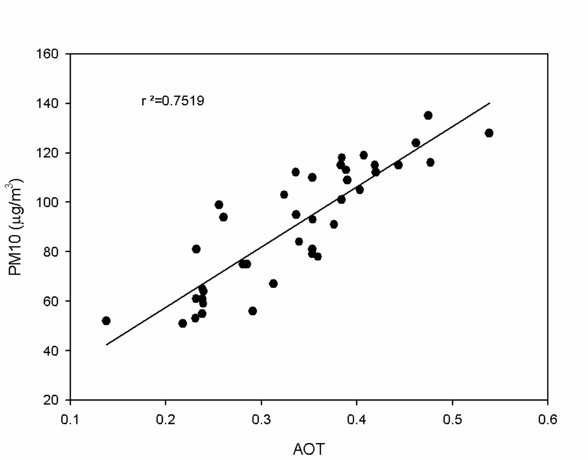

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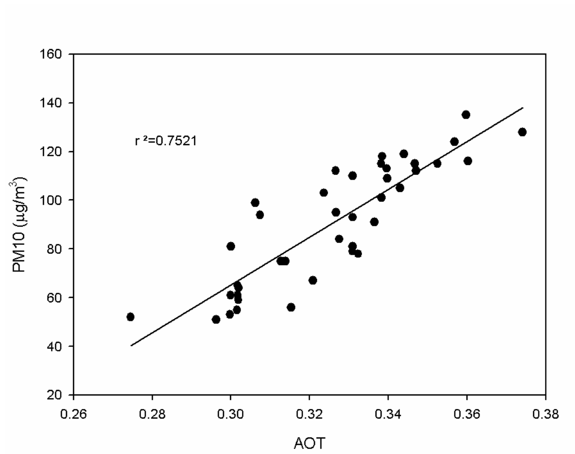

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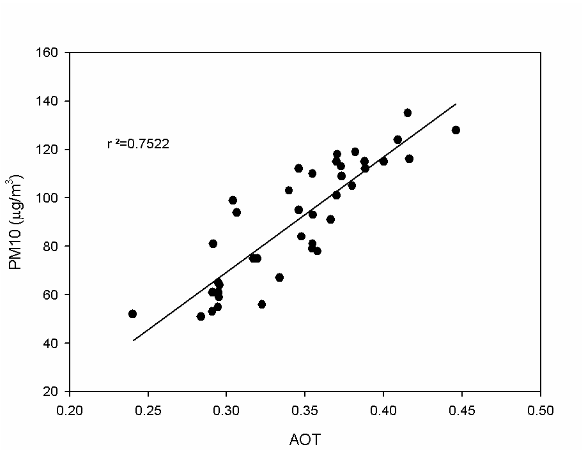

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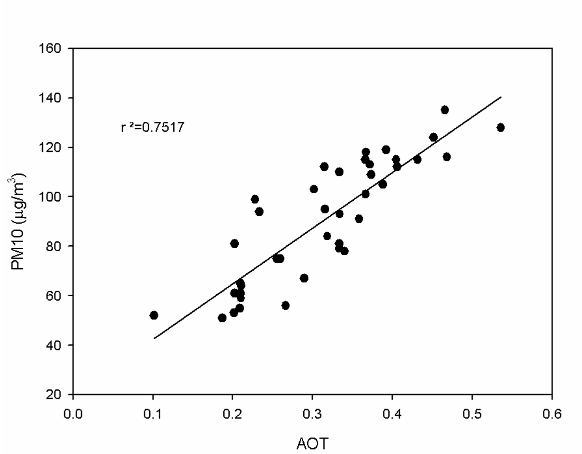

(f)

Figure 3 A linear correlation between AOT and PM10 (µg/m^3) values for (a) 400.5 nm, (b) 500.5 nm, (c) 600.5 nm, (d) 700 nm, (e) 800 nm and (f) 900 nm

4.0 CONCLUSION

This study produced a promising result for AOT mapping. This indicates that the air quality can be retrieved from the spectroradiometer transmittance measurements. This preliminary analysis showed that this technique could be applied to generate an air quality map of a study area.

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