MANAGING AIR QUALITY – A SIMPLISTIC APPROACH

Nor Azam Ramli
School of Civil Engineering, Universiti Sains Malaysia, Engineering Campus,
Nibong Tebal, 14300, Pulau Pinang, Malaysia.

ABSTRACT

Traffic management is a long established practice in developed country. The focus was to facilitate faster traffic movement with little regards on the air environment. Modern traffic management tends to include air quality but conducted in a fairly loose manner as compared to the actual guidelines. This paper offers a simplistic approach for air quality management in urban areas, which can be conducted fairly effectively by a non-environmental scientist.

Keywords: *Emissions, Model, Air Quality, Motor Vehicles,BATNEEC*

INTRODUCTION

Motor vehicles emissions are main contributors of urban air pollution (De Nevers, 2000). Direct emissions from motor vehicles include emissions from exhaust pipes, blow-by from engine crankcase, fuel evaporative emissions from fuel tank and the carburetor, and emissions caused by the wear and tear of tires and brakes (Ramli, 2001). These emissions also contribute to the production of derived (secondary) pollutants in the atmosphere due to transformation of primary pollutants.

THE APPROACH

This suggested approach consists of three main activities namely, modelling, option testing and real time application. Activity one, the modelling process is shown in Figure 1. A validated traffic model is created for the study area so that for each link in the daily operations situations, traffic volumes, speeds and percentage of heavy vehicles can be assessed. These data are then fed into the an emission model to calculate link emission rates which in turn feeds into a dispersion model, along with estimated worst case meteorological conditions and emission rates from non-traffic sources to calculate the worst case pollutant concentrations for the normal daily operation situations.

It is prudent at this stage that the entire model is validated so that the modellers are confident that the worst case pollutant concentrations estimated are representative of the actual pollutant concentrations.

For line sources, the simplistic dispersion model in used by many researchers is the 'evoluted' Gaussian model,

$$q(x,z) = 1.414\pi\ (Q/\bar{u}\sigma_z)\ \exp\left[-z^2/2\sigma_z^2 \right]$$ where Q is the source strength. (1)

Source emission rates R can be calculated as a function of vehicle flow and speed.

R, source emission rates for a particular road can be estimated by equations;

$$R = 1\ (1.031FV^{-0.795})/10{,}000. \qquad (2)$$

The units for R can be presented in g/m/s or kg/m/s, depending upon the purpose of the measurement being conducted. The main input in this equation is the vehicle fleet flow and speed.

Results of a study in Kerian District municipal road is shown in Table 1.

Table 1: Source emission rates for a busy municipal road.

Road	**R**	**One hour**	**One day**
Route 1 (North)	0.011	39.6	950.4
Route2 (South)	0.0064	23.04	552.96

For specific pollutant emissions, this equation has been adopted:

$$R_{(CO)} = 281\ V^{-.630} \quad \text{in g/km} \qquad (3)$$

Emission rates for CO, for the same road links is shown in Table 2. This estimate is made for a one-kilometer portion of the investigated road as a function of vehicle type and speed.

Table 2: Emission rates of CO for a municipal road.

Road	**Emission rate**
Route 1 (North)	27.5
Route 2 (South)	27.5

Having established the source emission rates and specific pollutant emission rates, the ambient concentrations can be calculated. Comparisons between the calculated and the measured concentrations of specific pollutants could verify the reliability and limitations of the model.

Second activity, is to amend the road network and geometry, traffic volumes or the emission rates from non-traffic sources. Road geometry and network should change with the changes in traffic profile and townships development. Road layout designed ten year ago, should not be expected to be effective for current situations. For example, Taiping Road in Kerian District was designed as a rural town road, prior to the completion of PLUS highway and changes in regional landuse from palm oil plantations into townships in Parit Buntar as well as the neighbouring Transkrian where the newly built USM campus is located.

Thus, as far as air quality is concern, the best option is a combination of models that would allow f··dback from dispersion model into the traffic assignment model to allow it to ass·. n traffic to optimise air quality or emission rates, as well as traffic speeds and junc·ion delays. Observations made suggested that the level of service for this road varies from B-C during normal operations and could change into F during peak hours (Ibrahim and Ramli, 2001). Emission loads during traffic jams can be very high. Concentrations of CO for example, could reach more than 69000 ppm while idling, as compared to 29000 ppm if cruising.

Both, signal ti· ·ing and traffic re-routing away from pollution hot spots are effective means of red· ·ng air pollutant concentrations. However, the former is suitable for medium size ·wnships, and combination of both should overcome air quality deterioration du· to traffic in bigger towns and cities. Park and ride or pedestrian only system should ·· assigned to town or city centre to reduce motor vehicles. Permanent manual and s· ·i-automatic message sign are believed to be the best and cheapest mean of info· ·ing motorists of restricted and permitted areas during known peak hours. Auto· ted message systems can be employed as a good complementary means in ma· ·ging air quality, as there tends to be substantial delay prior to information a· ·ars on automated message board. This extra capacity resulted from road closures · l re-routing in pollution hot spot may incur substantial investment and administr·· ·e will as well as cooperation from the public.

Thirdly, real · ·ne application will come into picture as soon as decision has been made over wh· ·h system to be adopted. On site traffic detectors should be install or the existing t· ·fic signal loops that exist in most towns can be used to register number of v· ·cles entering 'grey-area' nearing peak hour. These information coupled with · ·sonal and daily trend data could provide the expected peak hour traffic, which · ·then fed into the traffic assignment model. Meteorological and air quality data d· ·ing the nearing peak hour are inserted into dispersion model. The models are ru· ·and these should calculate the expected air pollutants concentrations during the no· ·al operation and peak-hour situations. Due action should be taken depending up· ·he calculated and measured air quality.

CONCLUSI··

This simplis· · approach can be applied especially to certain hot-spot zone. Nevertheless. ·icro' air environment information can provide local air quality conditions, w· ·h can contribute significantly to 'macro' scale intentions. Traffic lights 'cycle · ·e' should be managed systematically to reduce traffic congestion, which has co· ·buted to the deterioration of air quality in town areas. It is believe that the best a· ·able technique not entailing excessive cost (BATNEEC) principle's should be ado· ·d in managing air quality in most of developing towns in Malaysia.

REFERENCES

De Nevers, N. (2000) *Air Pollution Control Engineering*. McGraw-Hill.

Ibrahim W.H.W. and Ramli N.A. (2001) *Investigating Vehicle Emissions at Traffic Light Junction at Parit Buntar Intersection*, ECOMOD 2001.

Ramli N.A. (2001) *Diurnal and Locational Variations of Particulate Matter in Towns in Wales and Malaysia*. PhD Thesis (unpublished)

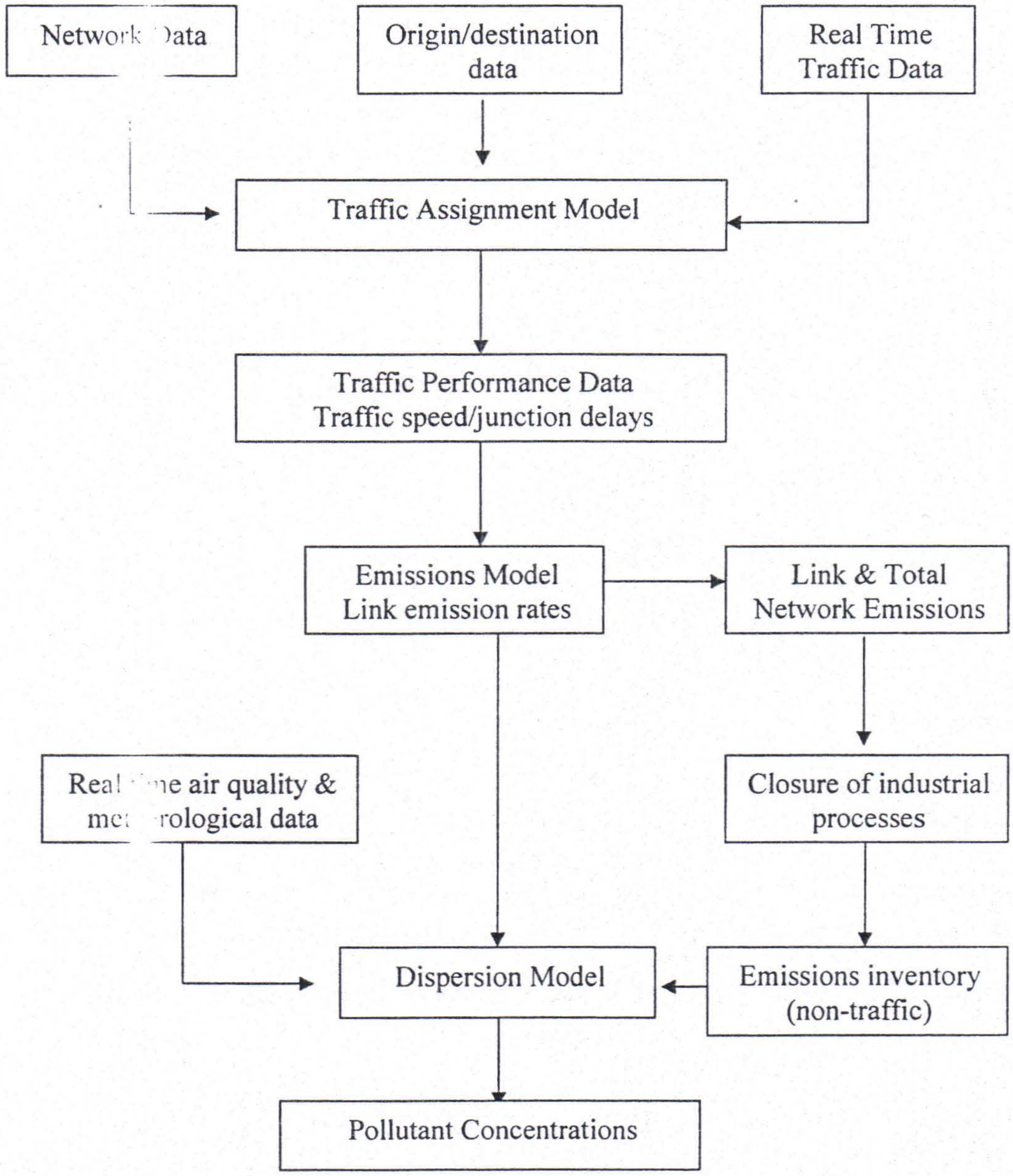

Figure 1: Scheme for Air Quality Management Design

Air pollutants trend time series plots for Penang state.

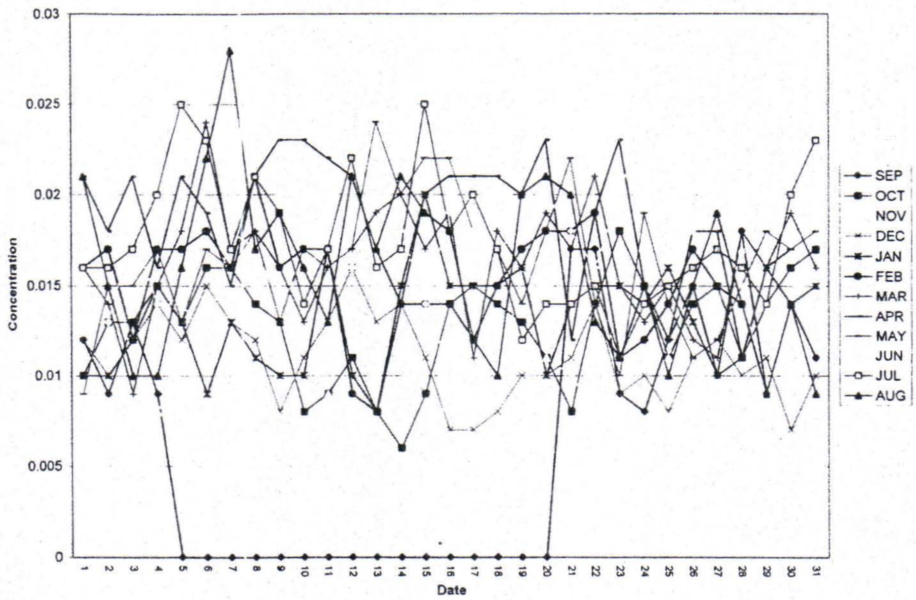

Figure 1: Nitrogen Dioxide Daily Average Concentrations at Mainland Site.

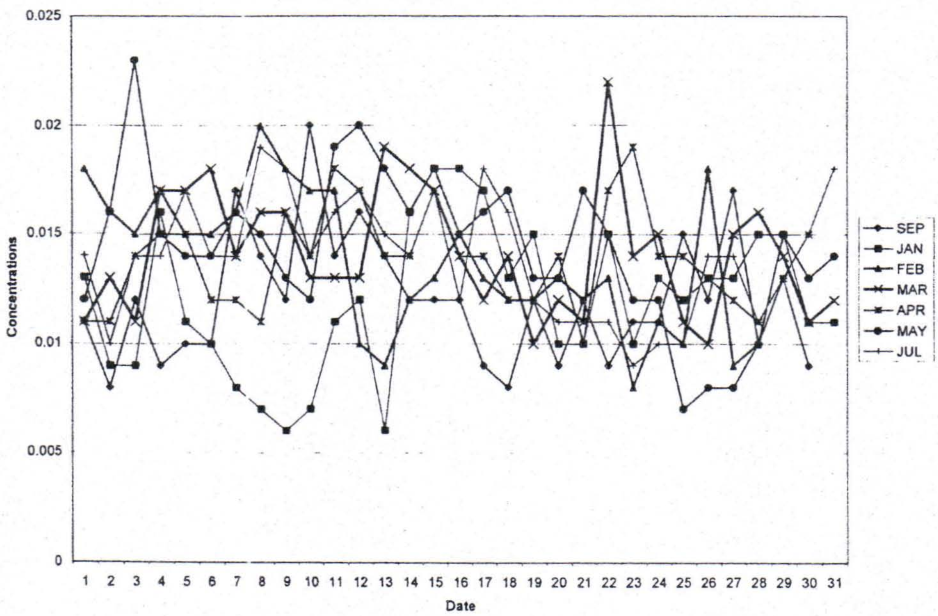

Figure 2: Nitrogen Dioxide Daily Average Concentrations at Island Site.

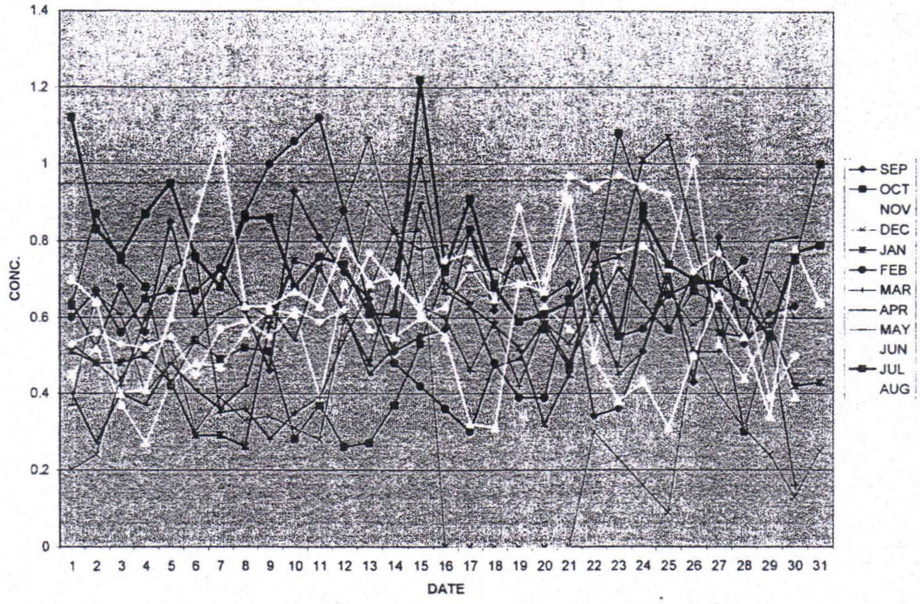

Figure 3: Carbon monoxide - mainland

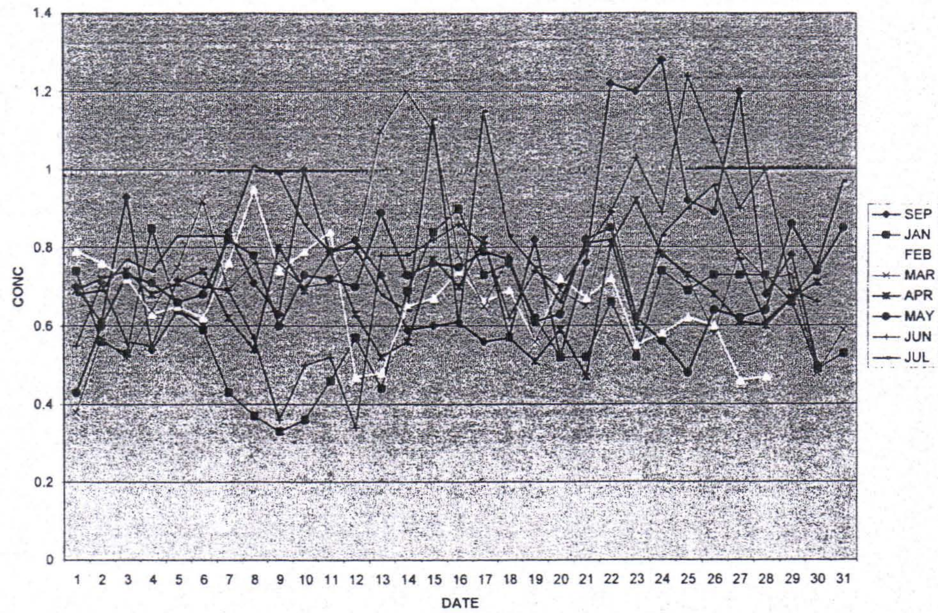

Figure 4: Carbon monoxide - island

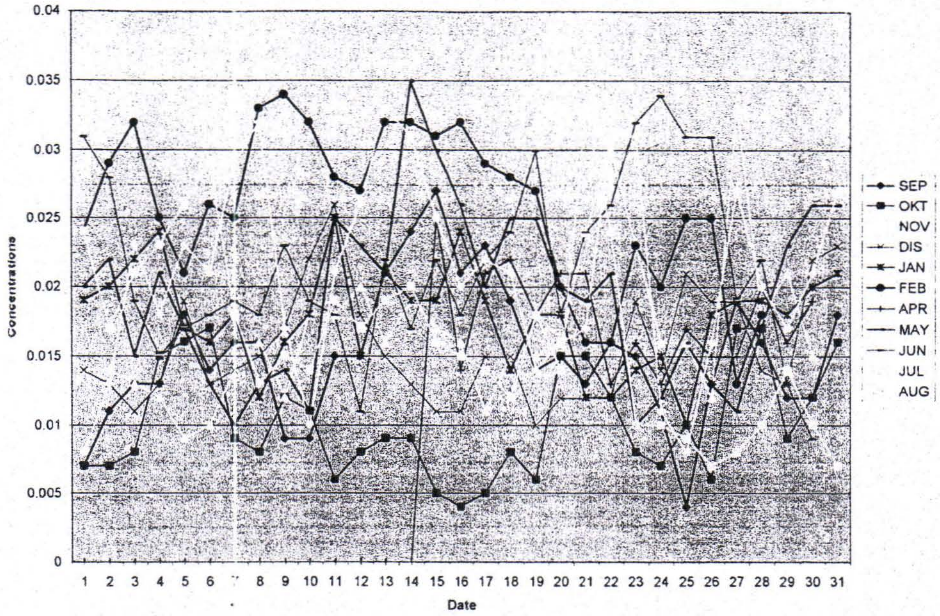

Figure 5: Ozone - mainland

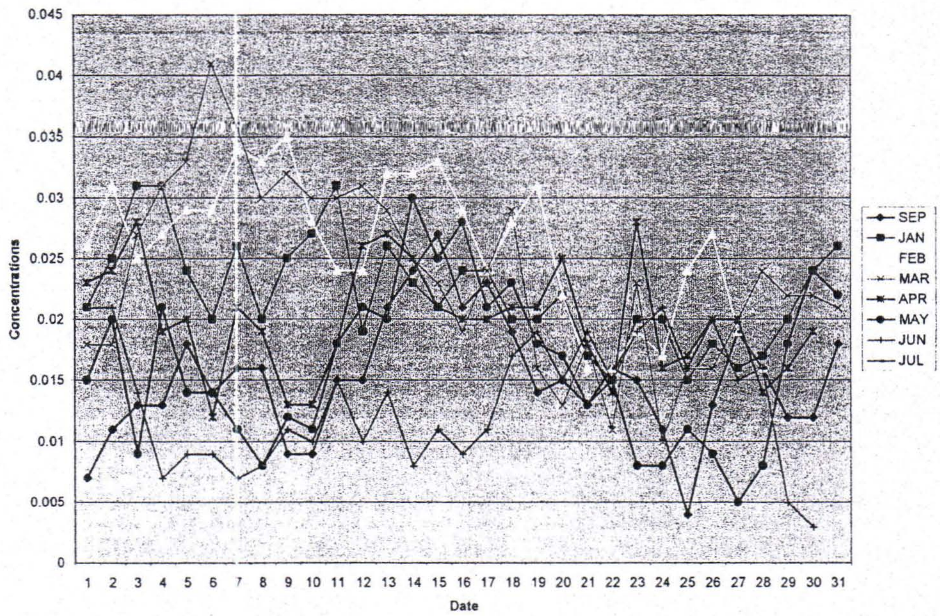

Figure 6: Ozone - island

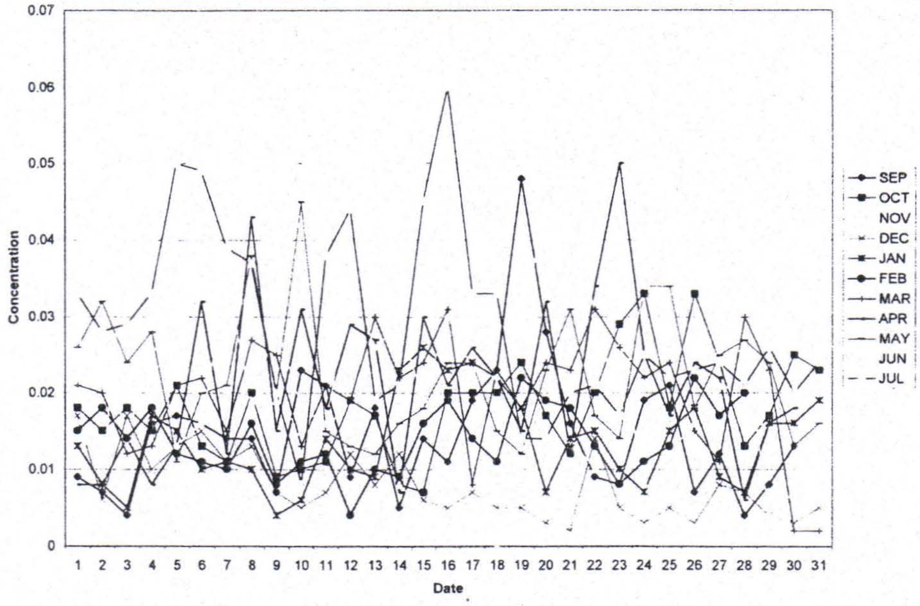

Figure 7: Sulfur dioxide - mainland

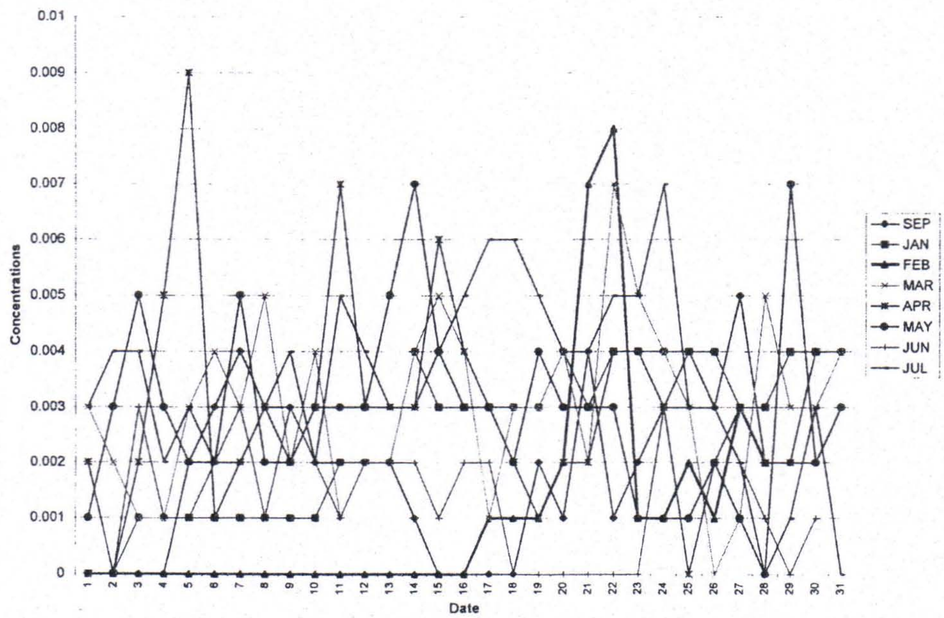

Figure 8: Sulfur dioxide - island

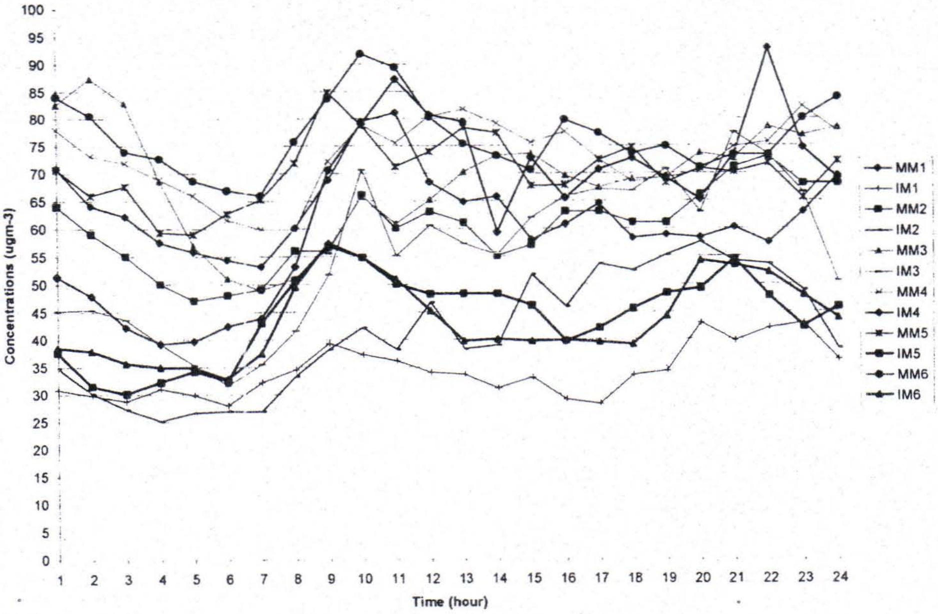

Figure 9: Particulate matter – comparative values.