Developing and Validating a Mathematical Model to Quantify Air Quality in Colombo

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Abstract

Air pollution is a major problem in Sri Lanka due to rapid urbanization and the development of industries. In Sri Lanka, the quality of air has a profound impact on the economy. The most obvious of these impacts is related to health problems associated with poor air quality and the corresponding cost of medical care and treatments. Therefore, it is important to build air quality models, which are mathematical descriptions of the concentration of ambient pollutants. In this study, the main focus is on the pollutant dispersion models and decision support models.

Wavelet approach is used to identify, whether there is a specific period during the year in which the pollutant concentration oscillates and to investigate the relationship between air quality and meteorological phenomena. According to the results, pollutants have similar periodic oscillatory behavior from January to March and from October to December, due to the monsoon effect in Sri Lanka.

The dispersion of air pollutants of petroleum refinery process in Sapugaskanda, Sri Lanka is modeled using two different dispersion models such as advection diffusion equation and turbulence model. The turbulence model is used to account for velocity, mass and heat transfer, dissipation rate and turbulent kinetic energy of pollutants. The finite difference method is used to solve the problem numerically and two dimensional solutions are obtained. Sensitivity analysis is carried out considering the advection diffusion equation in order to identify the dynamic behavior of air pollution model with respect to parameters.

Dispersion models and other methods available to measure air quality based on direct measures of concentration of pollutants. The concentration of air pollutants cannot be measured continuously in countries like Sri Lanka due to limited number of resources. Therefore, indirect measurements are considered to build decision support models. Five most significant factors such as industries, population density, traffic intensity, green

coverage and weather conditions are considered. The boundaries of the factors cannot be well defined. Therefore, fuzzy set theory is applied. These decision support models are used to identify the levels of the air pollution in Colombo Municipal Council area and to develop control strategies to improve the quality of air. These models can be used to identify the air pollution risk in other cities in Sri Lanka