CHAPTER I

INTRODUCTION

1.1 Background

In recent years, a large number of quarries, stone processing plants have been operated to serve the need of the construction industry, particularly, in Saraburi Province, which has plenty of superior limestone sources scattered in Tumbol Nah Pra Laan and the vicinity as well as the advantage of its location which is not so far away from the capital city. At present, over 45 stone processing plants located in Nah Pra Laan and vicinity have caused the increase of ambient particulate concentration with fugitive dust from the process and the transportation. The fugitive dust with diameter less than 10 micrometer (PM_{10}) has affected both air quality and human health, such as respiratory symptoms or changes in pulmonary function, including mortality and morbidity. At least, it causes a nuisance for people working or living nearby those plants, as well as adverse effects on the vegetation, crop, ecosystems, visibility, and other environmental impacts.

The 24-hr average concentrations of PM_{10} measured at the local monitoring station of the Pollution Control Department (PCD) in the study area were found to exceed the Thailand National Ambient Air Quality Standard of 120 $\mu g/m^3$ regulated by PCD for almost 80% of the monitoring period during December, 18, 1996 to September, 6, 1997. (Meechumna, P. et al., 1999). The observation lead to several practical strategies for reducing fugitive dust from those stone processing plants.

In practice, air quality dispersion modeling is adopted in several applications to support the control efforts. For example, it is employed to estimate the ambient air quality along a certain time in the past and/or in the future (Schulman et al. (1985), Taylor, R. K. (1996), Kumar, A. et al. (1999), Hoa, J. et al. (1999)). Sometimes it is utilized to investigate the efficacy of a dust control strategy or facility that has not yet been constructed (Blackman et al., 1999). These applications are the conventional ways of the environmental impact assessment or efficacy determination of pollution control measures. Typically some selected models are simulated using past meteorological data and measurements, even though the predicted results are intended for future use. As one can see, the estimated or projected meteorological parameters are important inputs for air quality modeling and they always contain some uncertainty where intended for future use.

Furthermore, even if the same dust control technology were applied to all crushed stone processing plants, with known apparent capacities, the difference in technological level and individual constraints would result in different values of the dust emission factor. As a result, uncertainties in both meteorological inputs and emission factor inevitably contribute to uncertainty in the predicted concentrations of fugitive dust even if a perfect accurate model is available.

The present work proposed and applied stochastic analysis as a rational alternative for the estimation of the uncertainty level of future fugitive dust concentration resulting from stone-processing plants in Nah Pra Laan, Saraburi Province, after the dust emission rate of each plant is assumed to be reduced by 80% with the installation of suitable dust suppression systems by applying Monte-Carlo simulation to the ISCST3 (Industrial Source Complex Short-Term 3) model with plume depletion due to dry deposition effect.

1.2 Objectives of Present Study

The main objective of this study is to propose and apply stochastic analysis using Monte-Carlo technique with the ISCST3 model as a rational alternative for the estimation of the uncertainty level in the future concentration of fugitive dust from stone-processing plants in Nah Pra Laan, Saraburi Province after the supposed adoption of the dust control system.

1.3 Scope of Study

In order to accomplish the above goals, this study encompasses the following aspects:

1) The atmospheric pollutant of interest is limited to fugitive dust with less than 10 μm in diameter (PM_{10}) formed by the processing of stone in Saraburi Province.
2) The study area covers 48 stone-processing plants in Tumbol Nah Pra Laan and its vicinity.
3) The U.S. EPA regulatory model, Industrial Source Complex Short Term 3 (ISCST3), is adopted to assess the ambient concentration of PM_{10}.
4) The modeling domain encompasses an area of 9 x 7 km^2 with 500-m x 500-m horizontal grid spacing whereas the receptor height of interested is 2 meters above the ground level.
5) Input variables to be investigated are meteorological data, such as wind speed, wind direction, ambient temperature, atmospheric stability and mixing height, and emission rates by using emission factor of stone processing plants in the study area.

6) Historical meteorological data for the study area are obtained from the observatories of the Pollution Control Department (PCD) located in Saraburi Province, were hourly average ambient temperature, wind speed, and wind direction, whereas local cloudiness and mixing height data were obtained from the meteorological stations of Thai Meteorological Department (TMD) in Lopburi and Bangkok, respectively.
7) Under the assumption of an 80% reduction in the plant emission rate, the results obtained via Monte-Carlo simulation using 50 random sets of statistically generated meteorological inputs are statistically analyzed to estimate the uncertainty level of the predicted outputs.
8) The statistical time trend and magnitude of 24-hour and annual average concentration of PM_{10} as well as the probability of exceedance of the PM_{10} concentration over the air quality standard are also presented.
9) Using the meteorological data of the base year in 1996 the applicability of the ISCST3 model is checked by comparing the predicted concentration with measured concentration of PM_{10} at the monitoring observatory of PCD at Nah Pra Laan School.
10) The relative background values from other nearby sources, for example, dust re-entrainment by road traffic, dust generation during transportation, construction activities, etc. are not considered in this study.
11) In general, quarry, stockpiles, and stone crushing activity represent low-level or ground-level releases without plume rise, and should be considered as an area source. The ISCST3 model accepts only rectangular areas as area source with the plant dimension, angles of the plant orientation related to the north-

south orientation and the precise plant layouts. Because of the lack of those information on most of the 48 stone-processing plants, the present study has assumed the point source instead of area source for each stone-processing plant.

1.4 Obtained Benefits

1) The proposed stochastic approach is suitable to estimate the degree of fluctuation and statistical parameters of fugitive dust concentration when the effect of uncertainty in the inputs and model parameters are of concern.
2) The time trend of the fugitive dust concentration with uncertainty can statistically be obtained in order to predict the probability of exceedance of the concentration occurring in specific areas or at some specific periods.