CHAPTER 1

INTRODUCTION

1.1 Background and Rationale

Like many mega-cities in the world, Bangkok is experiencing deterioration of air quality which are largely in response to the growth in vehicle population. In 2002, there were estimated to be about 5.4 million vehicles in the metropolitan area and in 2003 an additional half a million vehicles were added. From 2004-2005, more than 700,000 of newly vehicles have been introduced into traffic surface; enlarging the ratio of registered vehicle number and population that totally reached 1.11 ratios at the end of 2005. The volume of pollution generated from these vehicles depends not only on the number, but also on how efficiently they are being operated and the length of time they are running. Traffic congestion not only increases the time of operation, but will normally also decreases a vehicle's operating efficiency. As such, increasing traffic congestion will have an amplified effect on the production of air pollution particularly on roadside area.

In response, Bangkok has made continuous attempts to control air pollution over the past decade, even through the 1997 economic crisis during which emissions seem to be temporarily dilute. The Pollution Control Department (PCD) and the Bangkok Metropolitan Administration have been work together to implement a number of pollution reduction policies, including the regular cleaning of dust from the roads, the reduction of pollution from construction sites by applying dust protecting material, the promotion of replacing 2-stroke motorcycles with efficient 4-stroke systems, and the identification and removal of heavily polluting vehicles. In the case of carbon monoxide, catalytic converters are common requirement in gasoline powered vehicles.

However, from continuous monitoring evidences, reveal that in spite of these attempts, pollution levels continually increased, obviously affected by vehicle emission. The 2004 annual report from PCD indicated that many roadside areas in Bangkok were facing strongly concentrated of air pollution, in which the fine particulate matter (PM10) has been in repeatedly concern. Average 24 hours concentration of PM10 was in the range of 21.5 - 215.9 $\mu g/m^3$, which exceeded national standard for 243 times or equally to 10 percent of data. At Rama VI road, the maximum observed data was found at 215.9 μg/m^3, the number of monitoring days that exceeded standard rise from 60 days to 290 days (PCD, 2004). These evidences indicate the necessity of appropriate air quality management policy (AQMP) that able to tackle urban vehicle emission effectively in urban area like Bangkok.

In general, air quality management consists of knowledge of the generation, evolution and removal of the various pollutants. This information is data-intensive and requires spatial expression which can be categorized into 3 groups (Koussoulakou, 1994)

1) Information associated with the causes of air pollution; meaning source data and emissions inventories.

2) Information about current levels of air quality; in general, ambient air quality monitoring data are commonly required for this stage.

3) Information about future potential levels of air quality; the estimation and forecasting of urban ambient air quality is calculated as an output from dispersion models or empirical modeling work.

The integration of this information is needed and necessary for fundamental of calculation series process in air quality models. The role of air quality model is to illustrate how well or bad of air quality, which dominated by input air emission sources, in specific receptor position. Fundamentally, general air pollution models also require basic meteorological data (e.g. winds, pressure, temperature and humidity) and surface geographical information (e.g. topography, vegetation, and surface moisture.) The model will then produce forecasts of pollution concentration based on strength of emission sources that play dominated role in calculation. Both the emissions information and the model output are importantly required for decision maker to generate an appropriate air management policy that ensures future air quality standards.

Today Bangkok has come to the challenging frontline of deterioration of urban air quality. Without employ powerful and effective air quality management, irreversible and immeasurable harmful will taking place causing tremendous adversity to everyone in this metropolitan.

1.2 Objectives

This research aimed to develop next 10 years air quality management policy for Bangkok Metropolitan that will lead to attain air quality standards by the year 2015. The policy would base upon both current observations and projections which based upon numerical simulations. The specific objectives are described as follow;

1.2.1. To further develop the current emissions inventory of critically selected air pollutant for Bangkok.

1.2.2. To evaluate the performance of The Air Pollution Model (TAPM) as an air management tool for Bangkok against roadside monitoring data.

1.2.3. To create potential future emissions inventory for the period of 2007-2015 based on various growth scenarios and abatement strategies.

1.2.4. To employ these future emissions in TAPM to illustrate the potential level of air pollution over the next 10 years.

1.3 Scope of the study

This research emphasized on creation of appropriate air quality management policy focusing on traffic-induces air pollution that would be employed over Bangkok Metropolitan area during 2007-2015, all potential policies were evaluated and simulated through the series of model calculations. The Air Pollution Model (TAPM) was selected to be used as air management tool; calculation and forecasting of roadside air quality was based on various growth scenarios of traffic-induced air pollutants particularly on Ladphrao and Dindaeng road. The driving forces causing the emission growth of roadside concentration of carbon monoxide (CO) and fine particulate matter (PM10) have been investigated and analyzed through statistical analysis. The heavy duty diesel vehicle (HDDV), light duty diesel vehicle (LDDV), light duty gasoline vehicle (LDGV) and motorcycle (MC) were representative of common vehicles in Bangkok.

1.4 Conceptual Framework

The idea of air quality management policies were formed through the combination of future scenario of vehicle volume and emission factor which having strong probability to take place in study road. The statistical analysis of driving force leading to the growth of vehicle would be considered and then local vehicle growth model in Ladphrao and Dindaeng would be created. Consequently, the emission scenario from 2007 to 2015 will be estimated and then applied into model prediction. Since projection of future air level was forecasted, air quality abatement policies will be tested again by air quality model. Finally, the guideline of air management policy will be concluded in order to attain national air quality before 2015.

1.5 Limitations of this research

Because the research was designed to focus particularly on traffic-induced air pollution at Ladphrao and Dindaeng road, so air management policies that developed by the research are considerably limited only 2 study roads. The air management policies introduced by research were evaluated on the basis of air pollution reduction efficiency; the economic and socio-economic approaches have not been taken into consideration.

To conduct air quality model, an important factor that the model generally required is meteorological information which consists of wind direction, wind speed, temperature, mixing height and atmospheric stability class; during model simulation, these information need to be assume from 15-year history of meteorological data obtained from Meteorological Department. The unusual meteorological conditions that may occurr unpredictably in the next 10 years are not covered by this research.

Documentation and data gathering were sorted from primary and secondary document; PCD reports, research articles, annual statistic report and manual hand counting are example of data collection done by researcher.

1.6 Expected Outcomes

(1) An understanding of the ability and limitation of TAPM simulations to Bangkok will be known.

(2) The factors influence the annual vehicle growth and predictive vehicle growth model will be developed.

(3) The guidance of potential policy focused on traffic-induced air pollution for Bangkok will be discovered.

(4) The future vehicle profile of dense-traffic road and normalized daily traffic volume in Ladphrao and Dindaeng road will be created.

1.7 Research Outline

(1) The evaluation of The Air Pollution Model (TAPM) version 3.0

TAPM will initially run on Bangkok's existing data (traffic volume, vehicle types, meteorological data and geographical information), which has been collected directly on the study site (Ladphrao and Dindaeng road). The simulations have been set to focus on carbon monoxide emissions. The simulated air pollution concentrations and meteorology were compared with the hourly monitoring data from roadside air monitoring stations generated by the Pollution Control Department (PCD). The influences of wet and dry seasons on TAPM prediction are carefully evaluated. The Index of Agreement (IOA), the root mean square error (RMSE) and the robust highest concentration (RHC) have been applied to determine performance of the TAPM calculations.

(2) The development of Bangkok traffic scenario

The on-site traffic count will be conduct in order to construct Bangkok Vehicle Growth model and Daily Traffic Localization model. The traffic-related data since 1898 have been collected and analyzed for model coefficient estimation in order to formulate these models.

(3) Simulation of future Bangkok's air quality

Various scenarios of future emission inventories would have been developed for the TAPM simulations. The underlying assumptions for each scenario are clearly documented to forecast future air quality in Bangkok. The explanation concept of this method is shown in figure 1.1

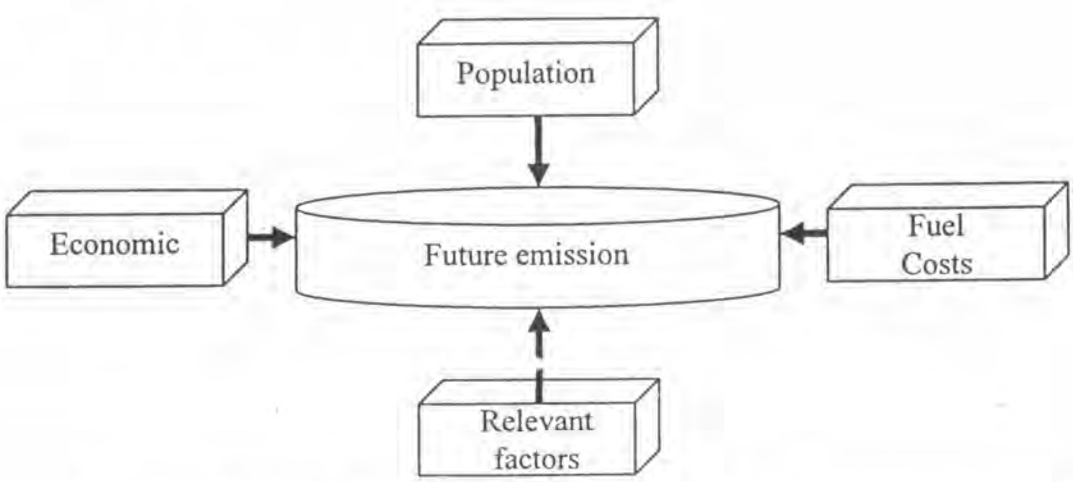

Figure 1.1: Conceptual procedure for simulation of future emission inventory

(4) The model analysis of Bangkok Air Quality Management Policy

The combinations of the future scenarios of the Bangkok emissions inventory and TAPM simulations have been taken into account in order to the development of an Air Quality Management (AQM) Strategy for Bangkok while the period of 2007-2015 are targeted. The illustration of work-flow chart in creating air quality management policy has been shown on figure 2.

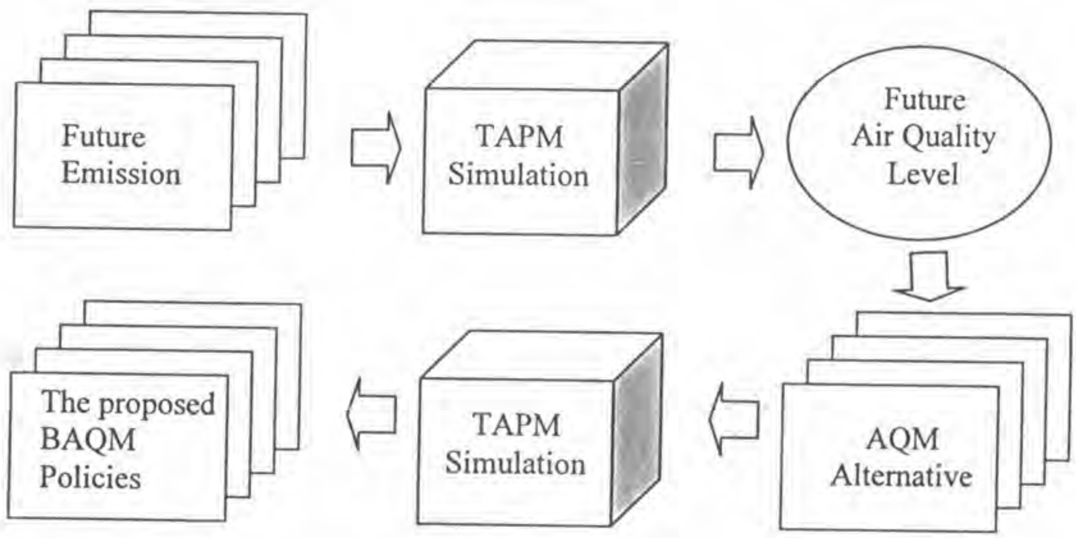

Figure 1.2: Conceptual procedure for development of Bangkok air quality management policy