CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Conclusion

The main objective of this research is to develop Bangkok Air Quality Management Policy (BAQMP) through process of model evaluation of the Air Pollution Model (TAPM) version 3.0 as well as the development of Bangkok Vehicle Growth (BVG) model and Daily Traffic Localization (DTL) model that have been formulated. The results of simulation for PM10 emission inventory and future projection of PM10 on Ladphrao and Dindaeng during 2007-2015 have been provided. The others finding could be summarized as following;

(1) The Air Pollution Model (TAPM) version 3.0 is appropriate to apply under subtropical condition like Bangkok. However, there is a need to adjust some parameter in model to improve accuracy level in prediction of surface meteorological parameters under urban canopy. In part of year-long air pollution prediction, model performed well in prediction of CO at annual average value (AVG), 90^{th} and 95^{th} percentile of data compared to the monitoring. The case study simulation revealed good performance of TAPM (with meteorological assimilation) in short-period simulation. However, the simulation of rainfall that play significant role in wash-out (or diluting) air pollutant from urban atmosphere is still need improvement.

(2) The Bangkok Vehicle Growth (BVG) model has been formulated base on quasi-logistic function suggested by Buttun et al. (1993) because of availability of data and suitability of research objectives. Screening method has been done to test correlation of the 15-years historical vehicle data toward annual Bangkok vehicle registration number and then estimated the explanatory coefficient by nonlinear regression analysis by SPSS program. The confidence in prediction is 92.6% (justified from adjusted R^2) and the BVG model could be written as follow;

$$P = \frac{1.5}{1+e^{2.120}\, GNP^{-0.017}\, T^{-0.817}}$$

Where P is Bangkok Vehicle Registration Number per Bangkok' population, GNP is Gross National Product based on 1988 price and T is time variable from base year (1989)

(3) The Daily Traffic Localization (DTL) model has been constructed based on P value from BVG model and analysis of relationship between ratio of daily traffic on study road to the Bangkok vehicle registration number (DD_r and LP_r). The model has been formulated on quadratic function and coefficient estimation by regression analysis (curve fit method) of SPSS program. The model was customized with on-site vehicle count data to simulated daily traffic volume (all types) that would occupy on Ladphrao and Dindaeng road in given simulation year. The degree in prediction confidence (justified from R^2) of DTL model for Ladphrao and Dindaeng are 79.5% and 59.9%, respectively. The model to simulate daily traffic for Ladphrao and Dindaeng could be expressed as bellowed equation, whereas BKK_{pop} is Bangkok population and P is value from BVG model

For Ladphrao: Daily traffic = $[0.234 - 0.521(P) + 0.300(P^2)]\ [P * BKK_{pop}]$
For Dindaeng: Daily traffic = $[0.263 - 0.571(P) + 0.325(P^2)]\ [P * BKK_{pop}]$

(4) The definition and calculation of deterioration-applied emission factor (DET-EF) have been clarified as well as the equations to quantify accumulated kilometer (ACM-KM) and engine age also discussed. According to high level of PM10 at roadside that occasionally exceeded the National Air Quality Standard, TAPM was configured to simulate future level of PM10. The four steps in estimation of hourly PM10 emission rate as essential input data (*lse file) required for model simulation have been described into four fundamental steps. The fundamental needs for this estimation are hourly vehicle profile (from on-site traffic count), number of vehicle registration number since 1989, and the percentage of vehicle registration number among summation number of annual vehicle registration since 1989.

(5) As for determination of PM10 background from monitoring data during 02.00-04.00 am (the lowest traffic period), the level of PM10 was in range of 43.6-109.4 μg/m^3 derived from outskirt area to inner Bangkok area. The results

indicated that the level of PM10 background is independent variable which not showing association with time of the day but showed strongly correlated with the distance of monitoring station from heart of Bangkok. Therefore, the simulation result in this research is not combined with urban PM10 background until the reliable PM10 background level would be determined in the future.

(6) The estimation of PM10 emission inventory on Ladphrao and Dindaeng road was estimated based on PM10 emission rate and length of each road link, and then projected to the future year. At period of 2007-2015, the inventory of PM10 at Ladphrao is in range of 251.4-552.2 ton/year and Dindaeng is in range of 126.0-246.8 ton/year. Because of emission inventory is directly proportional to the length of road link that causing inventory of Ladphrao is larger than Dindaeng even though level of air pollution in Ladphrao is weaker.

(7) The simulation of PM10 for the future year, the 24-hours average of simulated PM10 during 2007-2015 in Ladphrao ranges from 45.7-90.1 $\mu g/m^3$ and Dindaeng ranges from 72.3-143.0 $\mu g/m^3$. However, by simulation result, level of simulated PM10 (not included background) at Dindaeng would exceed the national air quality standard (120 $\mu g/m^3$) on year 2014-2015 that need special concern based on air management point of view

(8) For policy analysis, the most effective approaches are the policies that directly deal with reduction on vehicle emission. The simulation also reveals that only 10% of vehicle operated in EURO III and IV on study roads, the pollution in future year would be reduced up to 9.6%. In order to recommend the appropriate policy, the Bangkok Air Quality Management Policy (BAQMP) should be in approach of vehicle emission reduction policy.

5.2 Recommendations for Future Work

Based on the experiences gained in this study, the main recommendations regarding to BAQMP and model improvement can be summarized as follow;

(1) The study of urban PM10 background should be further investigated in order to improve level of accuracy in future simulated air quality.

(2) To exactly quantify the changing of vehicle composition due to air management policy enforcement. The in-depth policy impact toward changing of vehicle profile would be recommended as well as on-site traffic count also suggested in order to quantify the changing of traffic composition at particularly roads.

(3) In order to increase accuracy level in prediction of surface meteorological parameter in subtropical condition like Bangkok. More validation and improvement study should be effort while effect of urban heat island (UHI) and urban canopy should be more considered.