CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

The use of flame Atomic Absorption Spectroscopy (Perkin Elmer Model 2380) and the German Standard Method of Pb analysis has determined the level of Pb in soil of Chiang Mai City. The setting of the Perkin Elmer AAS at its optimum operating conditions has resulted in reliable results of soil analysis based on the quality assurance conducted by the use of international soil standards (IAEA Soil 7 and Soil 5) recommended by International Atomic Energy Agency (IEAE), Vienna Austria.

Results in the quality assurance evaluation on the analytical method used, revealed that the mean difference between the lead level of Soil 7 and Soil 5 recommended by IEAE and the analytical method used was very minimal. The accuracy of the results was supported by the level of confidence interval at significance level of 0.05 ppm. The mean values of lead level of Soil 7 and Soil 5 are at 58.08 ppm and 139.10 ppm respectively. These values fall within the recommended confidence interval of IAEA at 55- 71 ppm and 103 - 155 ppm respectively, which confirm the accuracy of the analytical method used in this study.

Based on the above analytical methods, the resulting lead level in soil of Chiang Mai City varies at different grids (Figure 16). The mean level of Pb ranges from 26 19-102.98 ppm at a mean level at 47. 40 ppm. However, they did not differ significantly from one grid to the other. But result showed that the soil of Chiang Mai City had already been contaminated by Pb because of its higher level of lead concentration compared to the crustal average value of Pb in an unpolluted soil which is 25 ppm.

There are many sources by which the soil in Chiang Mai City can be contaminated with lead. Since the study site has anomalous source of lead, the most probable source of lead was found to be the airborne deposition of lead by vehicular emission from vehicles using leaded gasoline. This result could be attributed to the increasing human activities especially in areas with high population pressures associated with the increasing demand of vehicles due to the urbanizing and industrializing process of the city. Evidences showed that the variations of lead level at different sites were the indicators that airborne deposition of lead from motor vehicles using leaded gasoline is the main source of lead accumulation in soil of Chiang Mai City.

Mapping of lead level at different grids revealed that high lead level (ppm) contamination were found in areas where high traffic densities attributed to high population pressures and large human activities could be found. Specifically grids, that are located inside the Chiang Mai moat and near to the main road systems (i.e. G10, G16 and G15 and G21) exhibited the highest lead level compared with the other grids. Moreover, low lead level was found in G20 which is a military zone where vehicular activities are controlled. The above findings could also be supported based on the difference of lead level in control area. Low level of lead was found in the control area at Mae Rim district which is about 12 km away from Chiang Mai City. This result could be attributed to the low density of traffic observed in the area as well as the distance factor on the deposition of lead which is normally high in urban centers/traffic areas. Therefore, based on the evidences gathered, the present accumulation of lead in soil of Chiang Mai City could be mainly attributed by motor vehicles. Furthermore, it was reported that there is an increasing use of motor vehicles in Chiang Mai City and a high percentage of these are possible users of leaded gasoline. However, there is no available data and information yet regarding the effectiveness of the ban on the use leaded gasoline in Thailand since 1996. Thus, further studies must be conducted.

In order to meet the objective to assess the lead accumulation in soil of Chiang Mai City, the use of the lead immobility model after the Sewage-Sludge Regulations (DVWK 1988), the Multi-Criteria Evaluation by Voogd Weighted Linear Combination and the computer-based GIS-IDRISI program had enhanced the risk assessment analysis. The assessment of risk was based on the internationally recommended threshold limit of each parameter for lead mobility in the soil where risk indices were formulated. In the same manner, the use of Multi-Criteria Evaluation by Voogd, Weighted Linear Combination (Voogd, 1983) was able to assess the risk of lead accumulation in soil of Chiang Mai City even without the use of a computer. However, to further analyze the risk in easier way, the computer-based IDRISI-GIS software was used.

Considering factors like organic matter content (%), pH and clay content of soil, in the assessment of risk, the map overlay of the abovementioned factors using the IDRISI-GIS Software produced a risk assessment map of lead accumulation in soil of Chiang Mai City. Results showed that very low risk situation was revealed in most areas except for areas inside the Chiang Mai moat (G10, G15, G16) and areas near to the main road systems. The same result was obtained using the Multi-Criteria Evaluation by manual mapping. Although the present situation does not pose possible risk to the soil environment especially to water resources, however, there is a possibility that the increasing industrialization and urbanization of the City of Chiang Mai will have a futuristic impact on the environment of Chiang Mai City. Considering that there are already areas with medium risk, the prevention of further accumulation should be undertaken. Definitely, if the industrialization and urbanization process of the city is unabated, there will be probable increase in demand for motor vehicles and probable establishment of industries which release lead, thus, possible increase of lead accumulation. Unless otherwise, possible mitigating measures, like any effective regulations and giving of incentives for the use of unleaded gasoline are undertaken could possibly maintain the present condition of lead in soil of Chiang Mai City

Scientifically, further research must be conducted in this regard since the model used was only intended for possible risk on water resources and only one environmental factor and media were considered. The use of a wider range of environmental media like water, plants, dust, sediments and air; more factors and parameters; and other models in risk analysis could probably give a meaningful result to assess the risk of an environment in a holistic manner. Thus, the applicability of the above methods and model used to assess any environment should further be validated. However, result in this study could already be used as the basis in the assessment of risk especially the soil media.