CHAPTER VI

CONCLUSION AND RECOMMENDATION

Conclusion and recommendation of this study are presented in this chapter. Conclusions on the substance flux analysis, AnnAGNPS and TREX modeling, and scenario analysis are presented. The recommendation purposed provide guidelines for future model development for other catchments, and for implementing environmental management practices within SLB.

6.1 CONCLUSION

6.1.1 Substance Flux Analysis

Distributed parameter cell-based models were widely used in studies related to non-point source pollution transport problems. Though there are several sophisticated models, but results could be appreciable to tester only if the data input to the spatially distributed cells are of good quality and faithful to reality. This is a severe problem in most situations where a well-established database of spatially distributed data is not available. The situation is not very much different in the SLB. Methods used and approximations made in previous studies on estimated phosphorus and cadmium loads to the lake were often rough and not of adequate accuracy. Data obtained from those studies should therefore be considered only as a starting point. The wide range of phosphorus and cadmium content recorded in previous different studies suggested the need for further measurement specific to the SLB situation so as to be able to describe it more accurately. Good estimates of phosphorus and cadmium accumulation in the agricultural soil of the SLB are necessary as the input for cell-based transport models to trace the transport of these chemicals via storm water runoff flowing into the lake. The findings were that 41,745 ton/year of phosphorus and 273 kg/year of cadmium from phosphate fertilizer were induced into SLB. The stock calculation for phosphorus and cadmium were found to be 248.7 ton/year and 62.8

ton/year respectively. By using SFA, accuracy of information was revealed, the study found that approximately 562,010 ton of chemical fertilizer was applied in the SLB agricultural soil in the year 2004, whereas Sereewatthanachai (2003) reported 55,307 ton in 2002. The result also showed that possibility of cadmium accumulation in the system could occur(agricultural soil and river) due to unbalance of input and output sources of which later can enter into other boundary (crop cultivation and animal farming) and could pose a risk human by exposure. Policy setting up, for example minimizing or controlling of cadmium entering into the system by phosphate fertilizer could be initiated based on SFA finding

6.1.2 AnnAGNPS and TREX Modeling

In this study, AnnAGNPS was used to simulate the phosphorus transport while TREX was used to simulate the cadmium transport on surface runoff.

AnnAGNPS model is a batch-process, continuous-simulation, surface runoff pollutant loading (PL) computer model used to predict the pollutant loadings (water, sediment, & chemicals), to assist with the selection of best management practices, settings for TMDLs, and risk analysis. The model was widely used and appreciated by most users due to its ease and friendly interface. TREX, a distributed numerical model development from CASC2D was used to simulate the transport and fate of chemicals across watersheds,. As part of TREX development, CASC2D's underlying hydrologic and sediment transport submodels were significantly enhanced before chemical transport and fate components were added to create the TREX, inputs were not automated and doesn't contain friendly user interface. Both AnnAGNPS and TREX models require extensive amount of input data, in different formats. AnnAGNPS data and model preparation were managed mostly through GIS, while for TREX, all data is input in the program as an ASCII format. Delineating the watershed was considered as the most crucial part of model execution, for AnnAGNPS the delineation was automated within the extension, while for TREX the delineation was managed manually using GIS and additional plug-ins, however, additional massive amount of work was necessary to create links and node maps for TREX. A relative error between observed and simulated of phosphorus, using AnnAGNPS, and cadmium, using TREX, for Klong Pa Payom & Thanae sub watershed were found between 1.0 - 2.8% and 12.1 - 91.4% respectively, Nathom sub watershed were found between 0.1 – 23.3% and 22.9 – 108.9% respectively, Tachiad sub watershed were found between 2.3 – 29.8% and 31.8 – 104.1% respectively, Pa Bon watershed were found between 0.3 – 18.5% and 13.7 – 104.9% respectively, Phru Poh and Rattaphum sub watershed were found between 0.1 – 25.6% and 11.3 – 103.8% respectively, U-Tapao and Eastern Coast Sub Basin 4 sub watershed were found between 0.0 – 32.7% and 10.5 – 106.2% respectively, Eastern Coast Sub Basin 2 and 3 sub watershed were found between 5.4 – 23.8% and 11.2 – 92.0% respectively, Eastern Coast Sub Basin 1 sub watershed were found between 0.7 – 30.2% and 20.8 – 102.4% respectively. The major phosphorus and cadmium contributing to SLB was U-Tapao and Eastern Coast Sub Basin 4 sub-watershed. The result showed that U-Tapao and Eastern Coast Sub Basin 4 sub watershed posing the highest potential for phosphorus and cadmium relative loading in the sediment runoff (Table 4-21). Considered together with physical factors of U-Tapao and Eastern Coast Sub Basin 4 sub watershed including high runoff, horticultural crops, steep slope, high organic matter, high erosion, acidity, high clay percentage, and high total metal , it is clearly seen that why the area has the highest potential for phosphorus and cadmium loading and such action should be taken to minimize the load.

6.1.3 Scenario Analysis

A total of three scenarios were considered and tested with U-Tapao and Eastern Coast Sub Basin 4 sub watershed. The results showed that by changing fertilizer from high to low cadmium-contaminated type alone leads to a significant decrease of cadmium contribution from the watershed, especially in the U-Tapao and Eastern Coast Sub Basin 4 sub watershed where overall physical conditions including high runoff, horticultural crops, steep slope, high organic matter, high erosion, acidity, high clay percentage, and high total metal could promote the transport of cadmium through the watershed (Fig.5-11 and 5-12). However, with other scenarios, by either changing the types of crops grown in the area (Fig.5-13 and 5-14) or by lowering the fertilizer rate (Fig. 5-3 to Fig. 5-10) could practically enhance the results in a lower cadmium contribution to the SLB as a whole. Phosphorus distribution was also incorporated to demonstrate the impact of the scenarios applied; however, the impact of phosphorus to eutrophication in the lower part of SLB was not included in this study.

6.1.4 Decision Support

The scenarios demonstrated the choices and options for decision makers and community planners e.g. The Committee for Master Plan of SLB or The Office of Natural Resources and Environmental Policy and Planning to take into account when planning for crop cultivation and agricultural extension, and to provide awareness that non point source pollution within SLB will slowly become a problem if mitigated actions are not considered and practiced properly.

6.2 RECOMMENDATION

The model was set up by having 8 model grids to simulate 8 watersheds. However, TREX is also designed to allow treating this as one model domain having 12 different channel networks inside it. By working on 8 different models, several advantages could be taken into account. Watershed delineation was conducted from several small segments and could be adjusted to effectively determine the watershed coverage area. Preparation of other input parameters took less time per model, the input can be checked easily if there should be any error from manual input while making development of the links and nodes. The computation time is practically between 1-3 hours depending on the complexity of the model. Calibration of the model is less complex and easier to achieve the results due to the fact that the constraint characteristics are known and manageable. In order to achieve the objective of this research, the results of all models have to be combined. This could have been easier to achieve if the model was developed as one model domain having 12 different channel networks inside it. However, scenario analysis focusing on the sub watershed having relatively high loading is better achieved with higher accuracy. TREX does a lot of calculation and can handle a wide range of cases. However, as the number of grid cells and model state variables increase, the run times will go up tremendously. Therefore, there will always be a tradeoff between complexity, scale, and computer power needed.

In terms of environmental management, the results of this study should provide an option to SLB Management Program due to the fact that the area is still considered safe from phosphorus and cadmium contamination. In the long provision, by changing fertilizer formula to a less cadmium contaminated type, which is already available in the market, together with recommendation of lowering fertilization rate and crop changes, problem of cadmium accumulation could tremendously be reduced. However, while working on this study, it was found that SLB Plan is reactive than before. There is a tendency to address issues when problem rise to critical level where the cost of rehabilitation and permanent loss is large. Also, most problems are not foreseen ahead of time when less costly preventive measures can be taken. The SLB problem is exacerbated in environmental development planning by lacking of a socio-economic development overview. Environmental situations are intimately linked to economic activities: Environment resources serve both as natural inputs to production and as receptacles for waste outputs, and there is little prioritization among projects competing for limited resources. Overall cases affecting SLB could be profusely mentioned as follows: First and foremost is the lack of the decision framework at the watershed level to deal with inter-regional interest, for example, contrasting careers, people in one area are interested in crop cultivation where in another area are aiming at fisheries. Secondly, is the lack of cross sector co-ordination, especially between water users and land-use management initiatives. Negative impacts of opposing projects, such as reservoir construction and habitat conservation projects, are of contracting interest. Thirdly, there is a lack of co-ordination among local government agencies. Finally, linkages between people and business groups are weak e.g. poor public relations and/or different language. These highly fractured obstacles dramatically reduce opportunities to achieve synergy between projects. There are a number of comprehensive plans that have been approved (e.g., Provincial Investment Plans, Provincial Environmental Plans, etc.), if implemented, would address many concerns outlined above. But many of the proposed projects have never been implemented as planned. Funding provision, or approval for the project at central government level, is often withheld. Unexpected public opposition can quash a facility proposal. In order to cope up with the above obstacles, serious consideration should be taken by appropriate people and/or group of people in the future.