CHAPTER V

SCENARIO ANALYSIS

5.1 SCENARIO ANALYSIS

The major phosphorus and cadmium contributing sub-watershed to SLB was found to be U-Tapao and Eastern Coast Sub Basin 4 sub-watershed. Phosphorus was found between 1.23 - 231.54 mg.P/kg and cadmium at 25 ppb, the highest among all sub-watersheds. Results of the simulation are shown in Fig. 5-1 and Fig. 5-2. Therefore, a scenario analysis will be conducted on U-Tapao and Eastern Coast Sub Basin 4 sub-watershed in order to find suitable actions to minimize the loading of the phosphorus and cadmium to the lake. Three scenarios will be evaluated using models developed in this study as a decision support too. The results can be beneficial to the Songkhla Lake Environmental Management decision making process.

From SFA results (Fig 3.4), phosphate fertilizers happens to be the major contributing non point source introducing phosphorus and cadmium into the SLB, thus scenario analysis shall be focus on how to alter or minimize the contributing scale. Best practice management suggested that changes of fertilizer application rate, changes of fertilizer formula and changes of crops cultivated are methods that could be done to achieve such goal.

5.1.1 Scenario 1: Changes of fertilizer application rate

Information obtained from survey through questionnaires and interviewing farmers, agricultural dealers, agricultural related agencies and extension officers in the area, as well as fertilizer analysis found that three fertilizer formula: 8-24-24, 13-13-21 and 15-15-15 containing cadmium at different contents are used in the watershed. The 8-24-24 and 13-13-21 has generally contained high cadmium content at around 7.2 ppm whereas 15-15-15 has low cadmium content, less than 1.4 ppm. Information gathered also indicated that pollution occurred in U-Tapao and Eastern Coast Sub

Basin 4 sub-watershed where mainly horticultural crops especially Longan and Mangosteen were grown and where fertilizer application was heavy, 150-250 kg/acre/year. Results from simulation also agree with the previously obtained information (Table 4-21). However, in model simulation, if one increased or decreased fertilizer application rate, the amount of cadmium contribution did not change correspondingly. The reason could be that only 5.86 percent of U-Tapao and Eastern Coast Sub Basin 4 Sub-watershed area are horticultural crops. These horticultural crops are found to be grown near the river with good irrigation. The rest of the area is rubber plantation, so changes in fertilizer application rate could not be noticeably detected. Other reasons could be that runoff of fertilizer is not a rally certain pattern due to amount of fertilizer absorbed by plants, fixation by soil, as well as by percolation etc.This scenario provides an understanding of relative impact of fertilizer usage on phosphorus and cadmium distribution in the basin and run off from surrounding watershed into the lake.

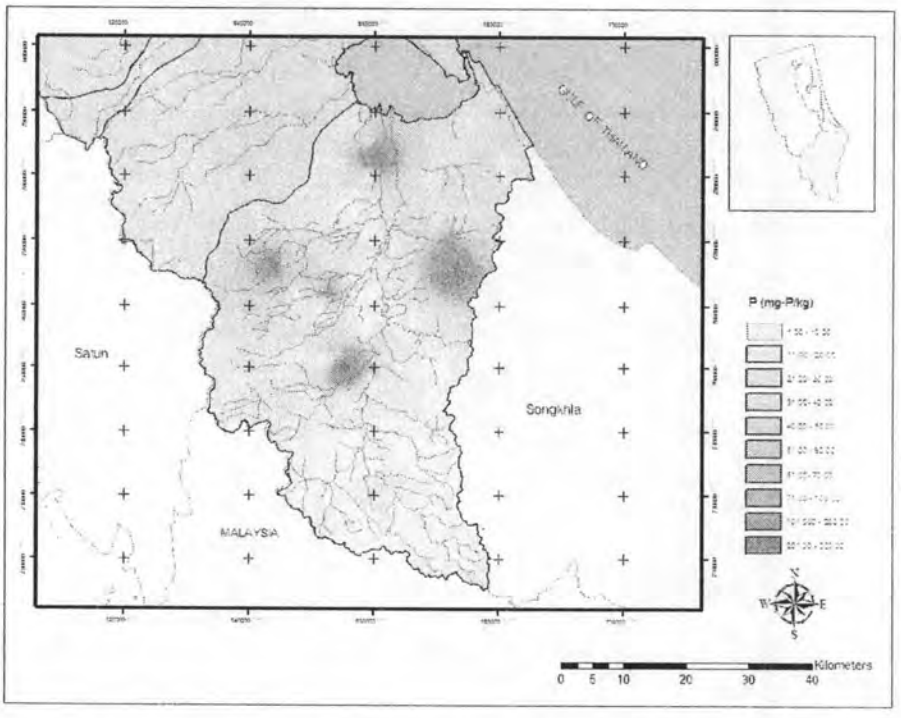

Figure 5-1 AnnAGNPS result before applying scenario test

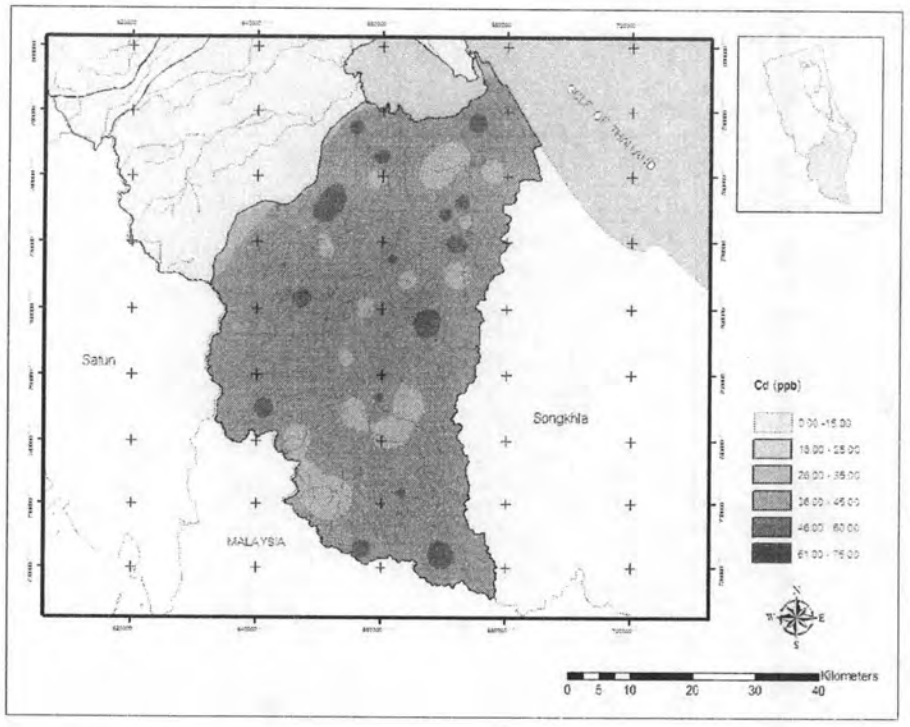

Figure 5-2 TREX result before applying scenario test

An overall increase for the fertilizer usage within the area of 10% was simulated. The results, Fig. 5-3 and 5-4, shows that the amount of phosphorus and cadmium contamination increases especially for phosphorus in rubber fields and cadmium in mixed orchards near the rivers.

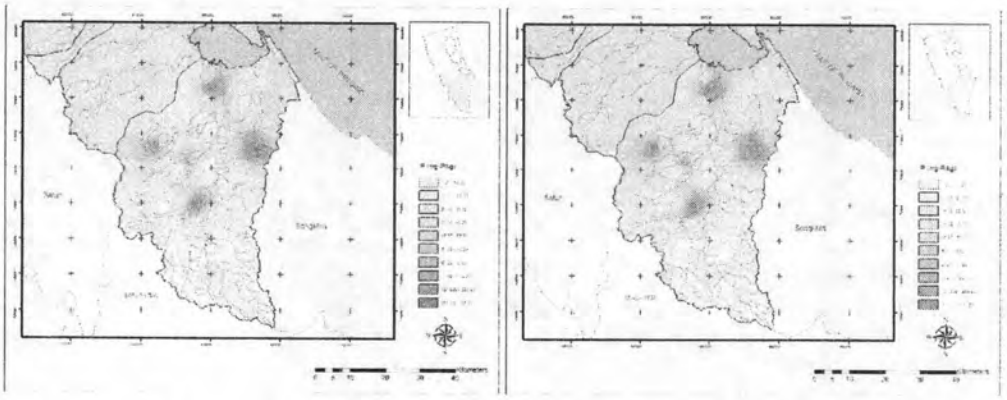

Figure 5-3 Comparison of AnnAGNPS results after increase 10% fertilizer

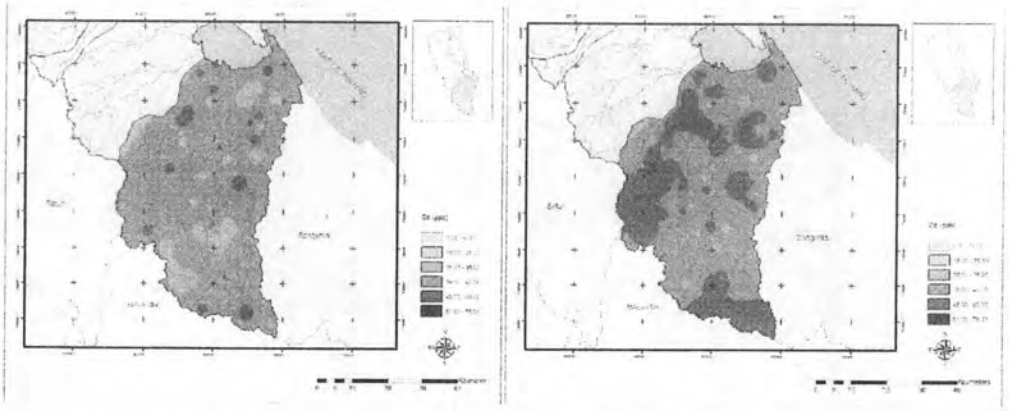

Figure 5-4 Comparison of TREX results after increase 10% fertilizer

An overall increase for the fertilizer usage within the area of 50% was simulated. The results, Fig. 5-5 and 5-6, shows that the amount of phosphorus and cadmium contamination significantly increases throughout the sub-watershed.

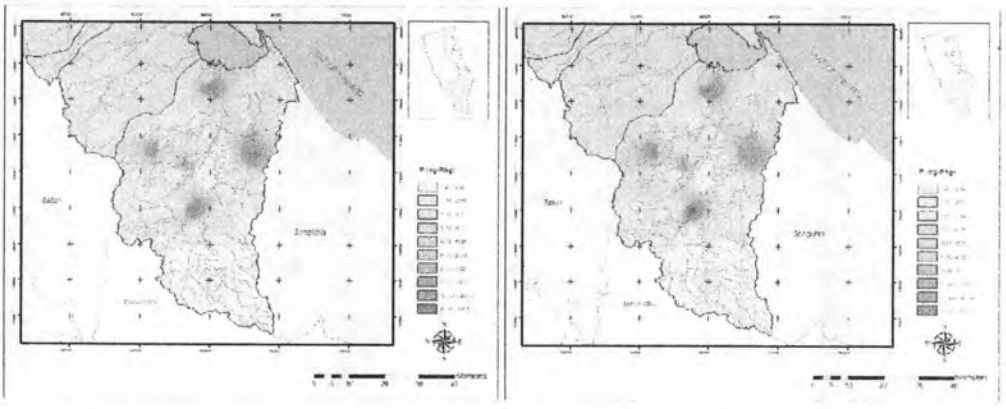

Figure 5-5 Comparison of AnnAGNPS results after increase 50% fertilizer

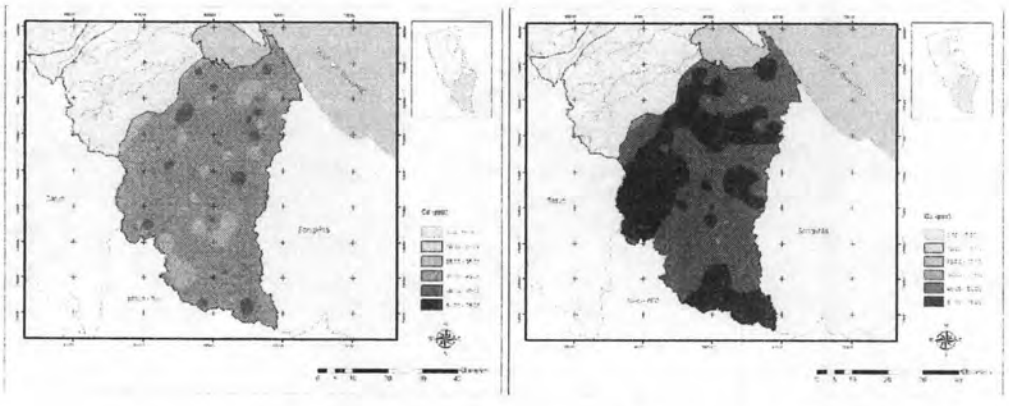

Figure 5-6 Comparison of TREX results after increase 50% fertilizer

An overall decrease for the fertilizer usage within the area of 10% was simulated. The results, Fig. 5-7 and 5-8, shows that the amount of phosphorus and cadmium contamination significantly decreases. The cadmium content near the aggregated rivers near the lake is still high.

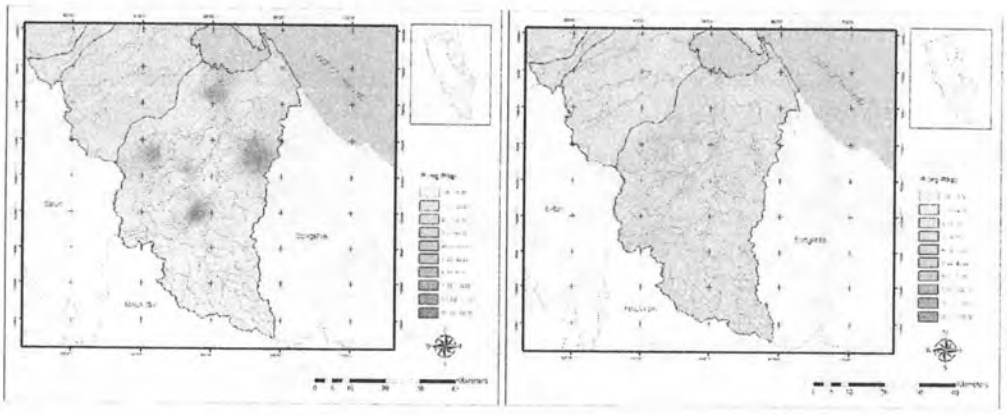

Figure 5-7 Comparison of AnnAGNPS results after decrease 10% fertilizer

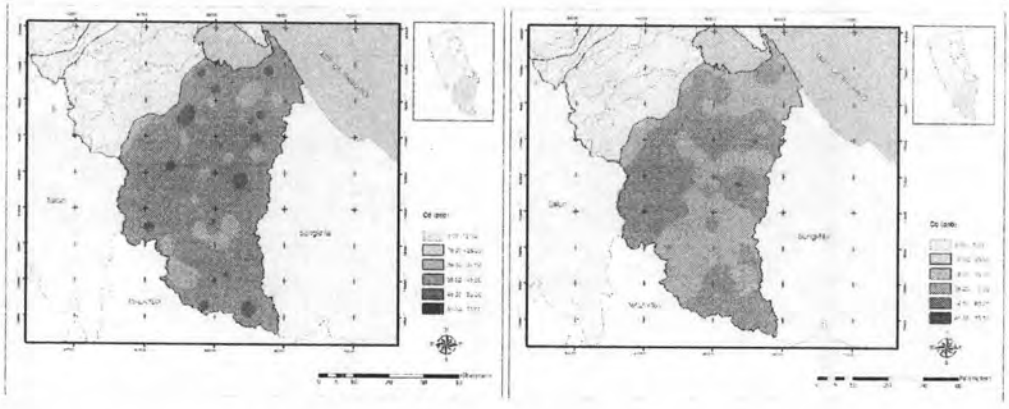

Figure 5-8 Comparison of TREX results after decrease 10% fertilizer

An overall decrease for the fertilizer usage within the area of 50% was simulated. The results, Fig. 5-9 and 5-10, shows that the amount of phosphorus and cadmium contamination significantly decreases. The cadmium content near the aggregated rivers near the lake has appreciably decreased.

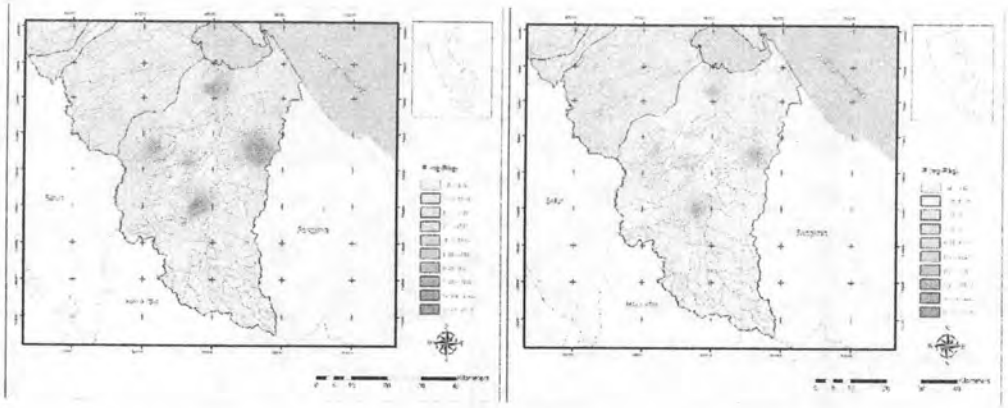

Figure 5-9 Comparison of AnnAGNPS results after decrease 50% fertilizer

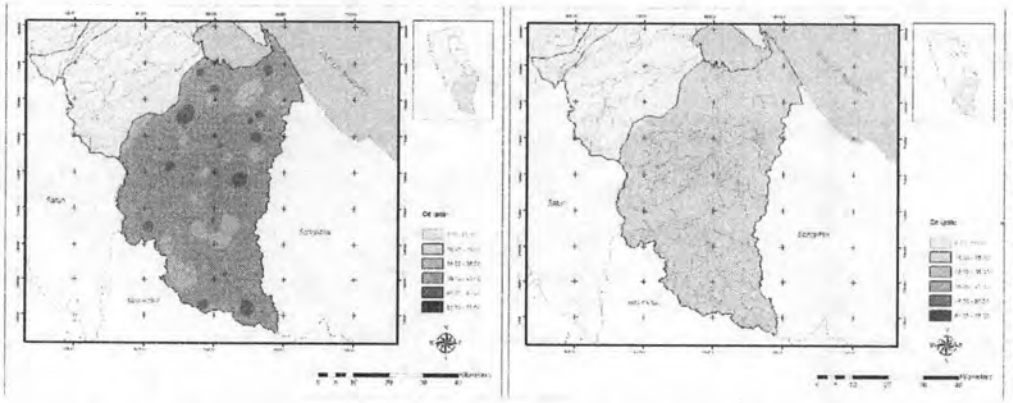

Figure 5-10 Comparison of TREX results after decrease 50% fertilizer

5.1.2 Scenario 2: Changes of fertilizer formula

A collection of 35 samples of fertilizers were taken from farmers for analysis in laboratory for the amount of phosphorus and cadmium content. Obtained results indicated that fertilizer formula 15-15-15, one of the three formulas widely used in the area, consisted of cadmium at low content, less than 1.4 mg-Cd/kg fertilizer . A change from high to low cadmium content fertilizer was simulated. The results, Fig. 5-11 and 5-12, shows that the amount of phosphorus and cadmium contamination significantly, a magnitude of more than 5 times, decreased. Therefore, if the government or related agencies provide appropriate policies for fertilizer usage in the area, then the load of phosphorus and cadmium to the basin could drastically be decreased. This scenario is focusing on alternatively appropriate choice of fertilizer application to the crops. For this issue, if concerned agencies provide suitable

fertilizer formula at reasonable cost, it will be a crucial incentive for growers to use the appropriate formula.

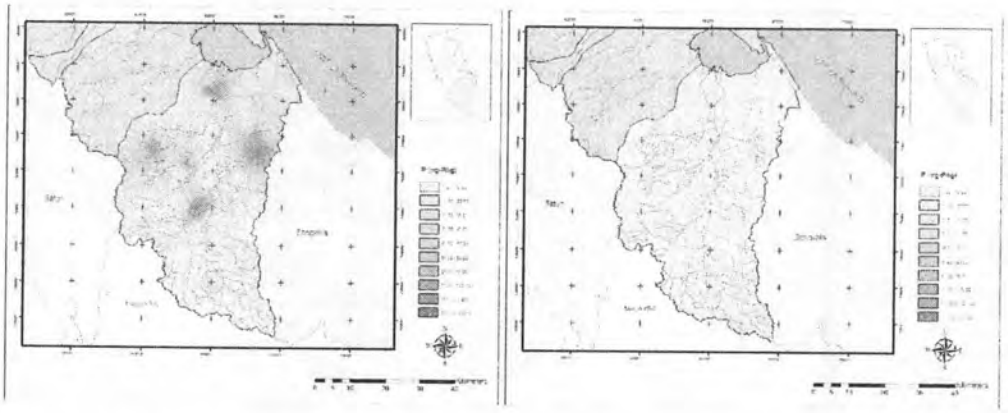

Figure 5-11 Comparison of AnnAGNPS results after changing fertilizer formula

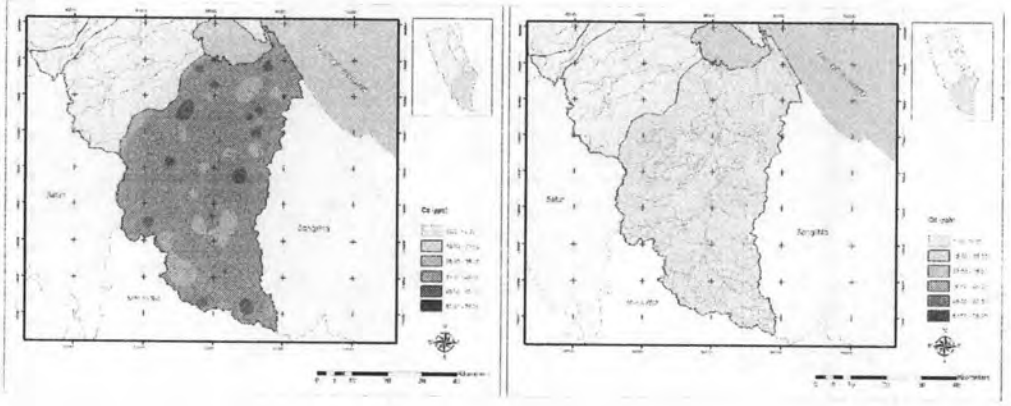

Figure 5-12 Comparison of TREX results after changing fertilizer formula

5.1.3 Scenario 3: Changes of crops cultivated

It is obvious from physical field observation that fertilizer 8-24-24 (Fig. 5-15) and 13-13-21 (Fig. 5-16) having high cadmium content, 7.2 and 7.3 mg-Cd/kg fertilizer respectively, were applied to two main crops, Longan and Mangosteen at high rates, 150-250 kg/acre/year. A change from horticultural crops to rubber crop was simulated. The results, Fig. 5-13 and 5-14, shows that the amount of phosphorus and cadmium contamination significantly decreases.

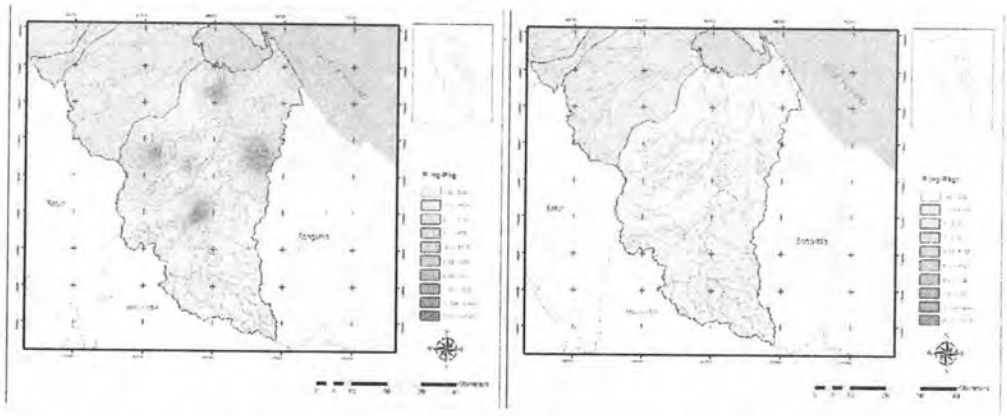

Figure 5-13 Comparison of AnnAGNPS results after changing crops

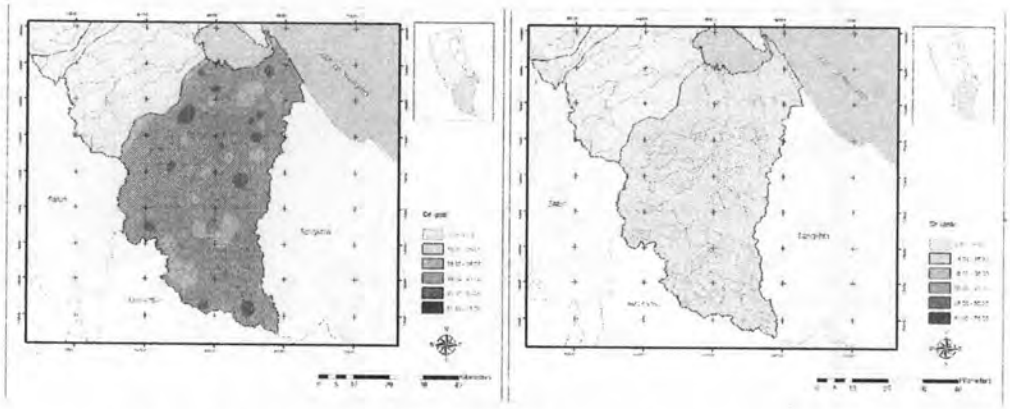

Figure 5-14 Comparison of TREX results after changing crops

Also, it was found that the cadmium problem occurred at U-Tapao and Eastern Coast Sub Basin 4 Sub-watershed where Longan, Mangosteen and other horticultural crops were heavily grown, suggesting that the two fertilizer formulae, 8-24-24 and 13-13-21, in combination with the two crops are major sources of cadmium pollution problem. Therefore, if any other crops are to be grown instead of the two mentioned crops, the cadmium pollution problem could be reduced drastically. However, the alternative crops should be economically comparable for the area to the two crops and should be manageable by the farmers. This scenario is both economically and socially of concern. Information from field observations indicated that rubber crops are suitable to the area and farmers applying fertilizer formula 15-15-15 normally contain of low cadmium content (Fig. 5-17 and Fig. 5-18). On top of that, rubber crop produces large income per unit area so rubber crop could be considered economically and socially acceptable replacement.

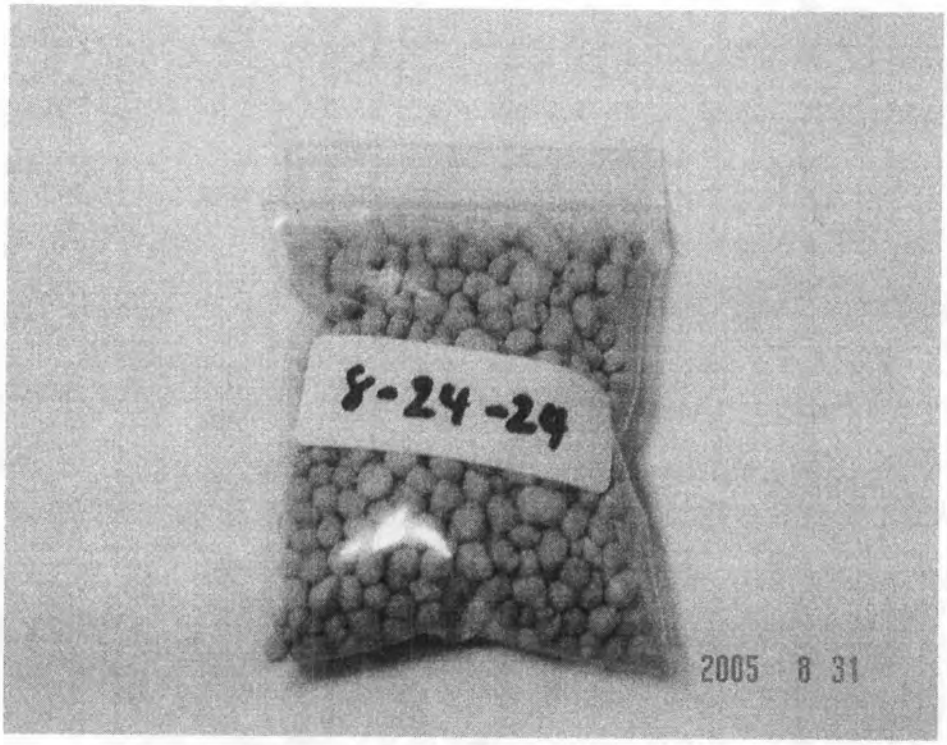

Figure 5-15 Fertilizer formula 8-24-24 contains 7.19 mg-Cd/kg fertilizer

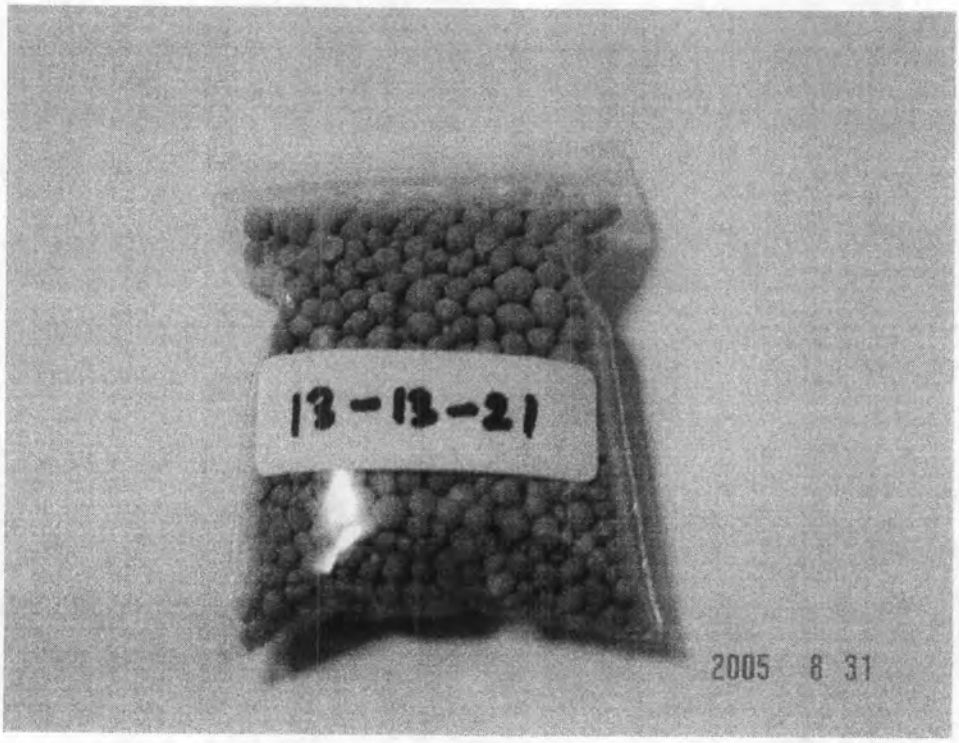

Figure 5-16 Fertilizer formula 13-13-21 contains 7.27 mg-Cd/kg fertilizer

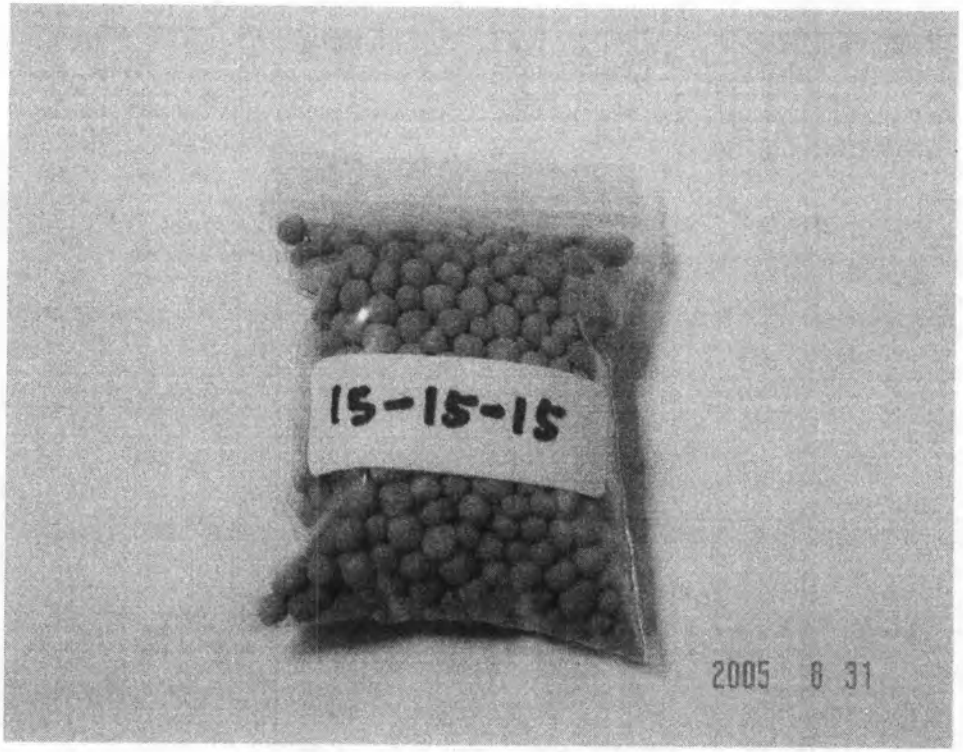

Figure 5-17 Fertilizer formula 15-15-15 contains 2.94 mg-Cd/kg fertilizer

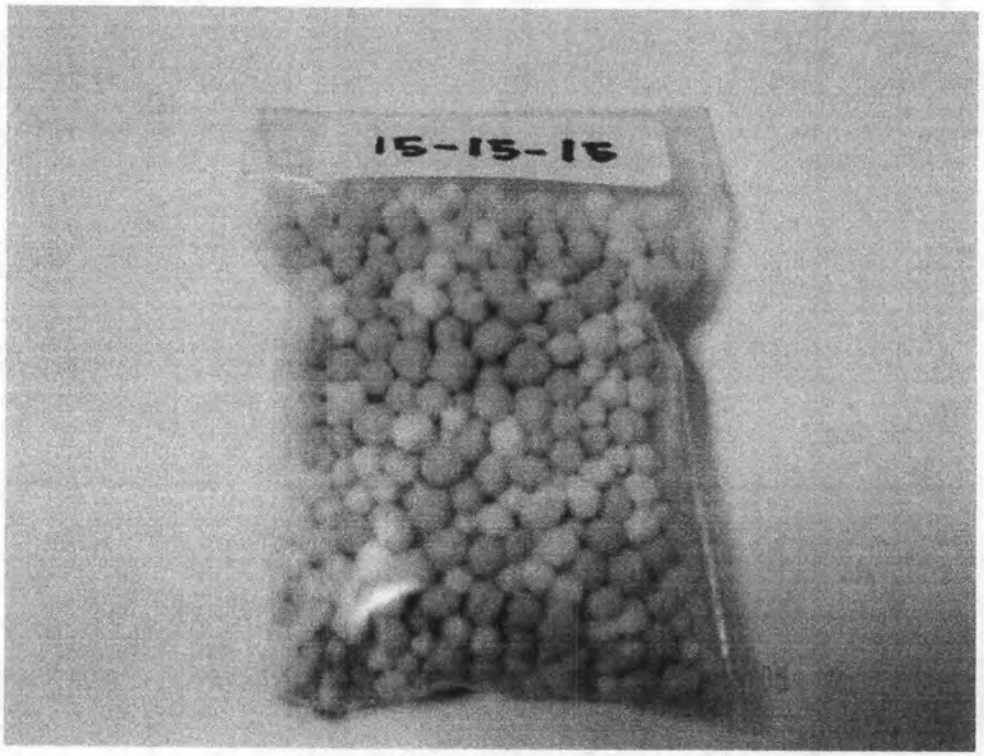

Figure 5-18 Fertilizer formula 15-15-15 contains < 1.4 mg-Cd/kg fertilizer

5.2 DECISION SUPPORT

Three scenarios were considered and tested. The results showed that by changing the fertilizer from high to low cadmium-contaminated type alone leads to a significant decrease of cadmium loading from the watershed, especially in the U-Tapao and Eastern Coast Sub Basin 4 sub-watershed where the 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. The scenarios demonstrated the choices and options for decision makers and planners of the SLB to take into consideration when planning for crops and agricultural extension and to provide awareness that non point source pollution within SLB can slowly become a problem if mitigative actions are not carried out.