CHAPTER IV

RESULTS AND DISCUSSIONS

4.1 Landuse Change

The landuse change in Mae Sot was observed and calculated from two interpreted images of Landsat TM5 (taken on 25 February 1988 and 10 December 1994) in comparison with two landuse maps of Mae Sot District in the years 1984 and 2000 reported by Land Development Department (LDD). Landuse from those different years were classified into 8 types which are forest, paddy field, field crop, city and town, village, water body, mine and others. The area of each was summarized and present in Table 4.1. It indicates that most area of Mae Sot District have been occupied by forest and then field crop and paddy field in order of largest to smaller areas, respectively. All 8 categories of landuse show a different trend of changes from the year 1984 to 2000 as illustrated in Figure 4.1. The forest area was firstly decreased from 69.99% to 61.77% between 1984 and 1988, and then continuously increased up to 63.67% in 2000. This would be a result of reforestation policy in the recent day that is effectively bringing back forest. It has been proved by the reforestation area in Mae Sot District reported by The National Park, Wildlife and Plant Conservation Department (DNP) as showed in Table 4.2. It can be concluded that the area of reforestation increases 0.168% from the years of 1990 to 2001. This is such a partial reforestation area; there are some other areas, public reforestation in particular, which were not recorded by the DNP. Therefore, the expansion of reforestation found under this study is in turn larger and may be more reliable than that was recorded by the DNP. For the changes of an agricultural area, paddy field and field crop are not on the similar way. Paddy field shows a little decrement of 10.3% to 9.6% whereas field crop is extended from 18.23% to 24.34%. The residential area, city, town and village, have small enlargement. City and town have been increased from 0.37% to 0.66% while village increases from 0.87% to 1.31%. Mining area occupied the area about

0.21% and had a little change. For other land uses, reservoir and other infrastructures, such as roads, track and stream present slightly changes.

Table 4.1 Summary of landuse area (Rai) in Mae Sot District, Tak Province within 4 different years. Data of years 1984 and 2000 are from LDD whereas those of 1988 and 1994 are interpreted using Landsat TM5 images.

Landuse	1984		1988		1994		2000	
	Area (Rai)	%	Area (Rai)	%	Area (Rai)	%	Area (Rai)	%
Forest	751825.29	69.99	663524.37	61.77	675679.98	62.90	683968.26	63.67
Paddy Field	110676.62	10.30	105008.43	9.78	101293.12	9.43	103600	9.64
Field Crop	195796.74	18.23	291901.23	27.17	280600.01	26.12	261427.09	24.34
City, Town	3933.62	0.37	4443.34	0.41	5860.09	0.55	7074.18	0.66
Village	9302.55	0.87	6559.54	0.61	7473.41	0.70	14106.13	1.31
Water Body	1669.87	0.16	589.76	0.05	778.34	0.07	929.21	0.09
Mine	-	-	2214.44	0.21	2556.16	0.24	2305.09	0.21
Others	1036.42	0.10	-	-	-	-	831.15	0.08
Total	1074241.11	100	1074241.11	100	1074241.11	100	1074241.11	100

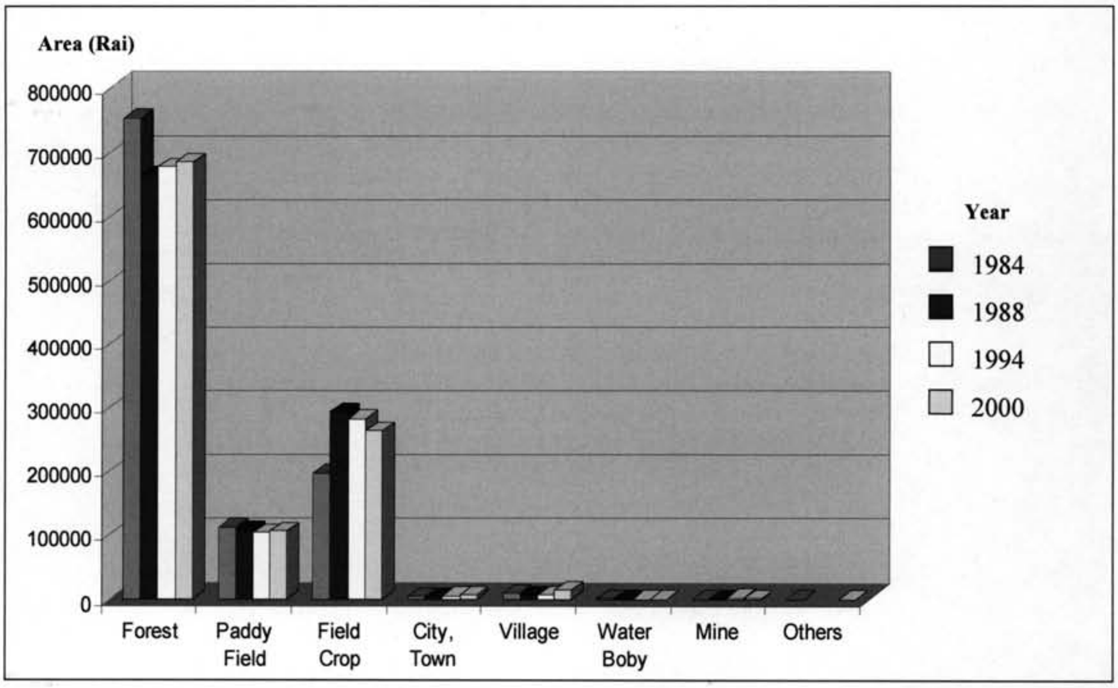

Figure 4.1 Comparing areas (Rai) of each landuse in Mae Sot area within 4 different years (data from Table 4.1).

Table 4.2 Reforestation area and forest area of Mae Sot District, Tak Province in 1988 to 2001.

Year	Reforestation Area (Rai)	Accumulate Reforestation Area (Rai)	% Accumulate Area	Forest Area (Rai)	% Forest Area
1988				663524.37	61.770
1989					
1990	50	50	0.005		
1991	500	550	0.051		
1992	200	750	0.070		
1993	250	1000	0.093		
1994	600	1600	0.149	675679.98	62.900
1995					
1996					
1997					
1998					
1999					
2000				683968.26	63.670
2001	200	1800	0.168		
Total Area of Mae Sot District = 1074241.11 Rai					

Source: The National Park, Wildlife and Plant Conservation Department

As previously mentioned, forest area occupies mostly the whole area of Mae Sot District and also shows a markedly decrease from 1984 towards 2000; this matter is then discussed. From 1984 to 2000, forest area in Mae Sot District has been changed into other types of landuse as shown in Figure 4.2 and Table 4.3; however, 90% of forest is still remaining. More than 7% of forest in 1984 had been converted into field crop which is mostly located along the western area. Only about 0.1% has been utilized by mining activities.

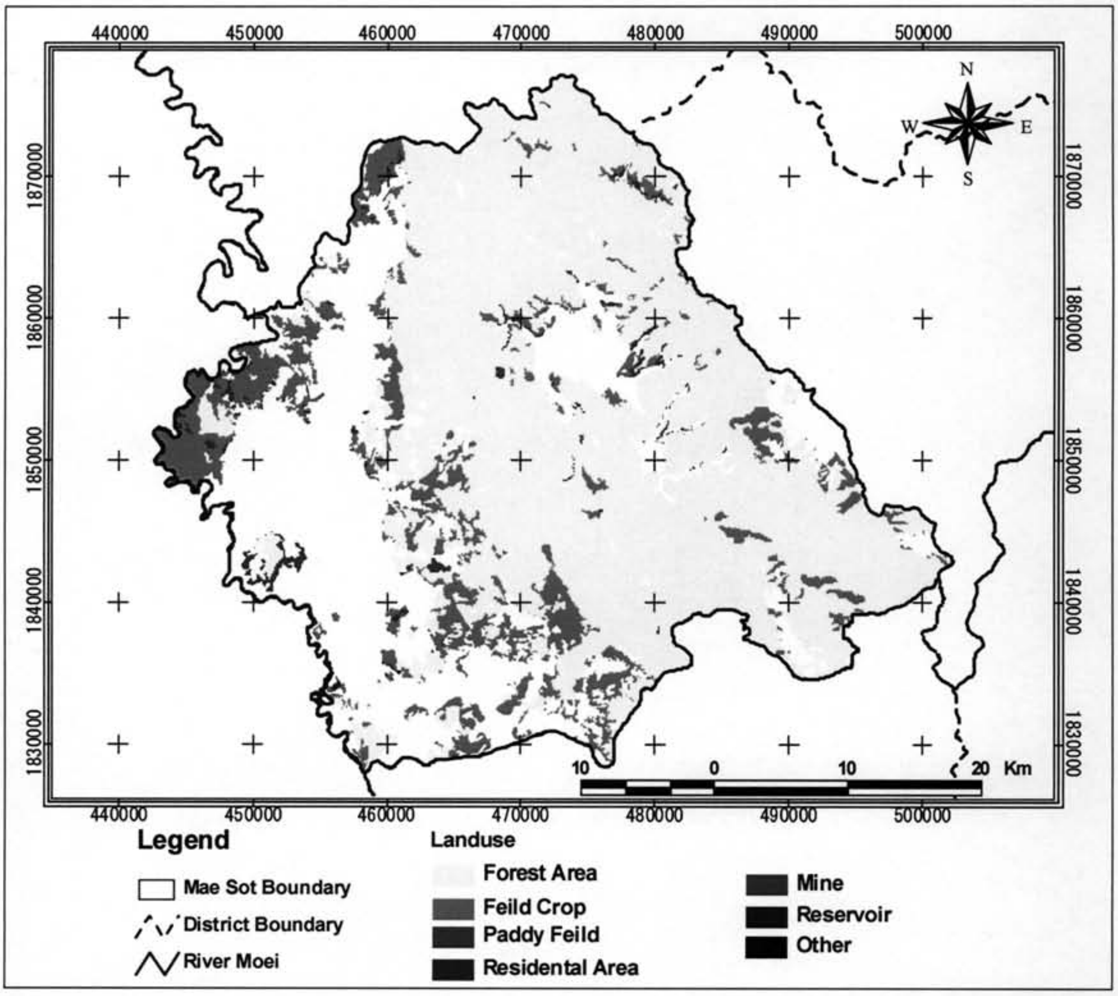

Figure 4.2 Superimposed map showing forest areas in 1984 changing into several landuse with different ratios in 2000 (Adapted from LDD).

Table 4.3 Area (Rai and %) of landuse in the year 2000 which had been changed from the forest area in 1984.

Landuse (year 2000)	Area (Rai)	Area (%)
Forest	683968.26	90.97
Field Crop	57782.63	7.69
Paddy Field	7505.33	1.00
Mine	1307.04	0.17
Residential Area	1097.91	0.15
Reservoir	84.77	0.01
Others	79.35	0.01
Total	**751825.29**	**100.00**

Source: Land Development Department

4.2 Effect of Rainfall and Flooding

The 21-year back rainfall data sets (Appendix B in Tables B-4 to B-7) measured at 4 weather stations around the Mae Sot District are the major data for this purpose. These stations are Mae Sot Station, Tak Station, Umphang Station and Bhumibol Dam Station, in which their locations are illustrated in Figure 4.3. Moreover, Figure 4.3 also presents isohyetal lines which were generated from a mean annual rainfall amount of each station shown in Table 4.4. The average annual rainfall amount of Mae Sot Station, Tak Station, Umphang Station and Bhumibol Dam Station are 1418.2, 1024.1, 1470.1 and 996.4 mm, respectively. The isohyetal lines in Figure 4.3 indicate that Mae Sot District has a high level of precipitation especially in the southwestern part.

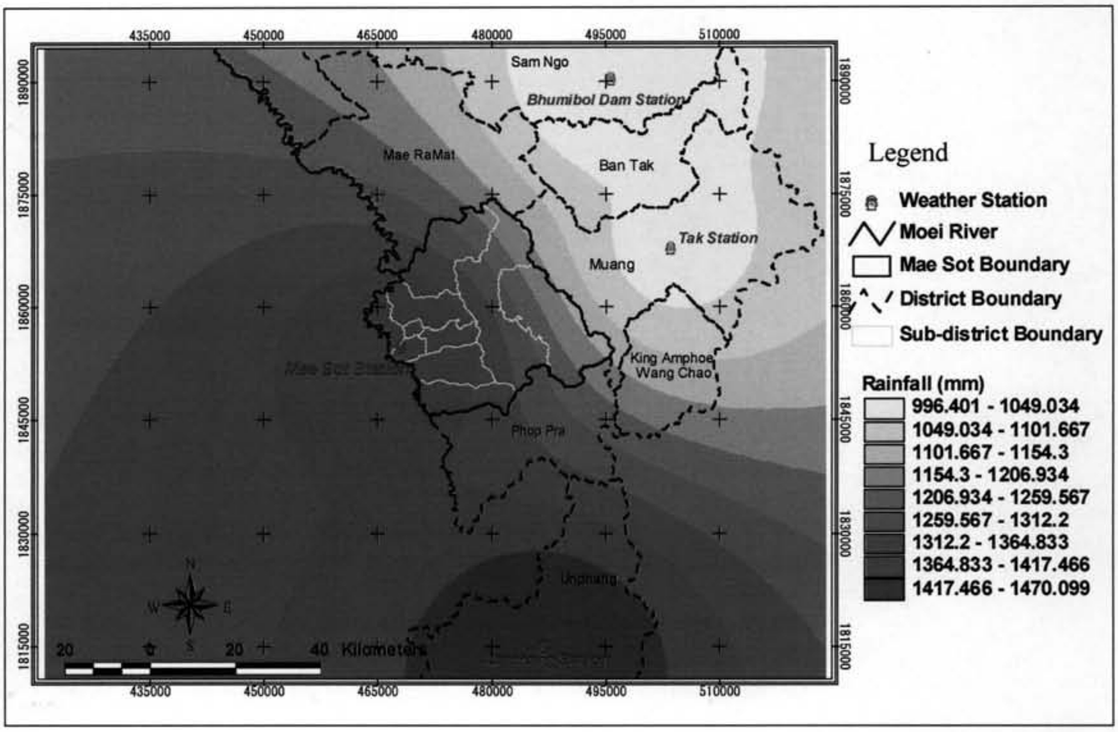

Figure 4.3 Map showing 4 weather stations around Mae Sot District and isohyetal lines constructed covering Mae Sot District and its adjacent area.

Table 4.4 The 21-year back annual rainfalls measured at 4 stations and average rainfall of each station.

Year	Rainfall (mm)			
	Mae Sot Station	**Tak Station**	**Umphang Station**	**Bhumibol Dam Station**
1985	1601.1	1111.7	1475.3	968.4
1986	968.9	1094.4	1455.0	794.8
1987	1382.5	978.5	1468.9	1072.4
1988	1138.1	1226.4	1941.6	1375.1
1989	909.9	1092.4	1165.8	793.5
1990	1474.4	946.8	1289.2	928.2
1991	1728.0	909.7	1558.4	898.2
1992	1239.7	968.1	1333.2	1046.9
1993	1245.5	651.1	1154.7	768.0
1994	2047.9	936.3	1976.6	944.3
1995	1532.3	1004.9	1601.9	871.1
1996	1402.7	1267.6	1676.0	1548.9
1997	1675.2	694.6	1263.2	799.6
1998	732.2	725.3	979.9	763.5
1999	1388.0	1554.3	1323.1	1200.7
2000	1435.5	1338.5	1895.5	1353.8
2001	1346.8	1162.5	1516.2	1200.9
2002	1908.0	1181.1	1731.3	1281.3
2003	1212.5	859.9	1500.6	782.0
2004	1753.6	897.0	1254.9	719.2
2005	1654.4	882.0	1232.6	846.0
Average	**1418.2**	**1024.1**	**1470.1**	**996.4**

Source: Thai Meteorological Department (TMD)

Focus on Mae Sot District, Table 4.5 presents monthly and annually rainfall amounts measured at Mae Sot station. The highest level of average annually rainfall amount is 107.7 mm occurred in the year 1994 and the lowest of average annually rainfall amount is 61.0 mm appeared in 1998 (Figure 4.4). Concerning on the monthly rainfall rate, July usually yields statically the highest amount of precipitation with average of 328 mm, whereas January appears to have the lowest rate of about 1.3 mm (Figure 4.5). In conclusion, Mae Sot District, within the last two decades, has the highest rainfall of 908.2 mm in July 1994 which has been recorded as a period of flooding in Tak Province. Isohyetal lines of the year 1994 covering Mae Sot District in Figure 4.6 indicate that the western part of the area which is a low land has a high level of precipitation and all of 7 sub-catchments are in the heavy rainfall area.

Table 4.5 Monthly and annually rainfall rates measured at Mae Sot station.

Month / Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	MEAN
1985	0	0	0	86.5	202	385.2	171.2	374.3	187.5	138.6	55.8	0	1601.1	133.4
1986	0	0	0	7.7	172.9	152.8	284.2	170.5	122.1	56.5	0	2.2	968.9	80.7
1987	0	0	28.7	92.5	71.9	240.9	300.4	367.9	134.3	62.3	83.6	0	1382.5	115.2
1988	0	2.4	0	73.3	166.7	308.3	175.8	174.6	76.3	132.6	28.1	0	1138.1	94.8
1989	2	0	36.9	0	165.7	170.2	266	121.7	86.6	59	1.8	0	909.9	75.8
1990	0	0	8.5	59.4	240.7	312.2	336.6	175.8	92.4	202.6	46.2	0	1474.4	122.9
1991	0	0	0.2	37.1	36.5	568.3	349.2	397.3	224.3	104	0	11.1	1728	144.0
1992	13	103.7	0	0.3	62	153.4	245	290.7	123.2	172	14.7	61.7	1239.7	103.3
1993	0	0	23.7	45.4	265.4	101.8	192.1	331.8	216.4	68.9	0	0	1245.5	103.8
1994	0	0	42.8	26.4	194.3	224.4	908.2	493.8	97.1	53.2	7	0.7	2047.9	170.7
1995	0	0	2.6	2	251.1	151.3	302.8	358.4	319.2	96.3	48.6	0	1532.3	127.7
1996	0	36.2	0	40.6	133.7	124.5	399.5	272.3	270.7	60.4	64.8	0	1402.7	116.9
1997	0	0	0.8	21.8	70.8	178.6	588.1	546.7	143.5	101.7	23.2	0	1675.2	139.6
1998	0	0	0.5	0	108.1	106.4	151.3	212.4	120.9	15.8	16.2	0.6	732.2	61.0
1999	0.9	5.5	21.4	64.6	199.7	147.7	256.9	484.3	114.4	72.4	19.7	0.5	1388	115.7
2000	0.4	10.5	21.6	114.2	175.1	200.8	312.2	256.3	202.8	141.5	0	0.1	1435.5	119.6
2001	1	0	68.2	9	186	228.4	367.4	303.2	126.7	56.9	0	0	1346.8	112.2
2002	0	15	5.6	68	290	204	363.7	339	426.6	44.4	116	35.7	1908	159.0
2003	0.5	0	66.3	39	115.7	368.8	231.4	207.3	164.8	18.7	0	0	1212.5	101.0
2004	10.6	4.5	0	39.6	319.7	631.7	187	364.4	189.9	6.2	0	0	1753.6	146.1
2005	0	0	48	29.3	85.5	250.9	498.3	460.2	186.1	83.7	7.9	4.5	1654.4	137.9
Average	1.3	8.1	18.5	40.8	167.3	248.1	328	319.2	172.7	83.2	25.4	5.6	1418.2	

Source: TMD

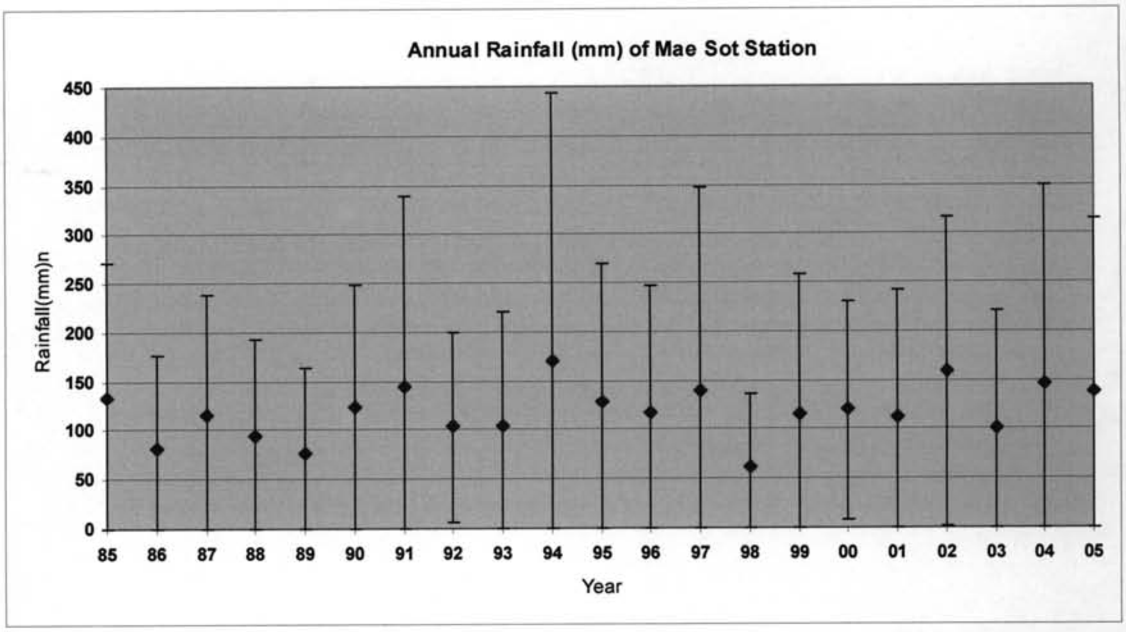

Figure 4.4 Graph presents mean annual rainfalls and their deviation bars calculated from data of Mae Sot Station from the years 1988 to 2005.

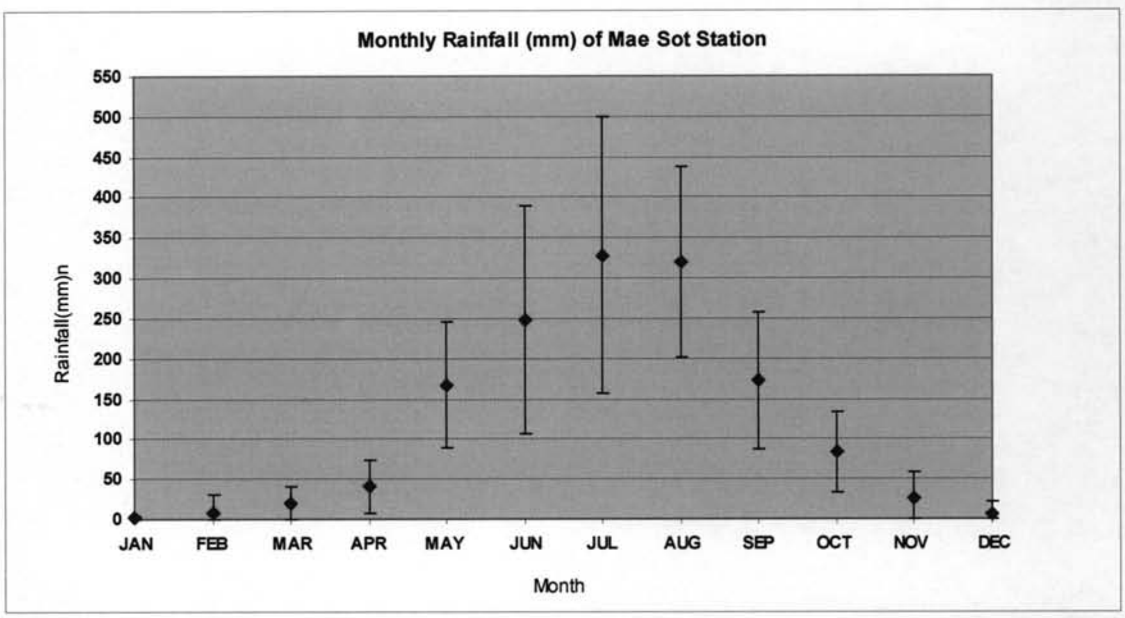

Figure 4.5 Graph presents averages of monthly rainfalls and deviation bars measured at Mae Sot station during 1988 to 2005.

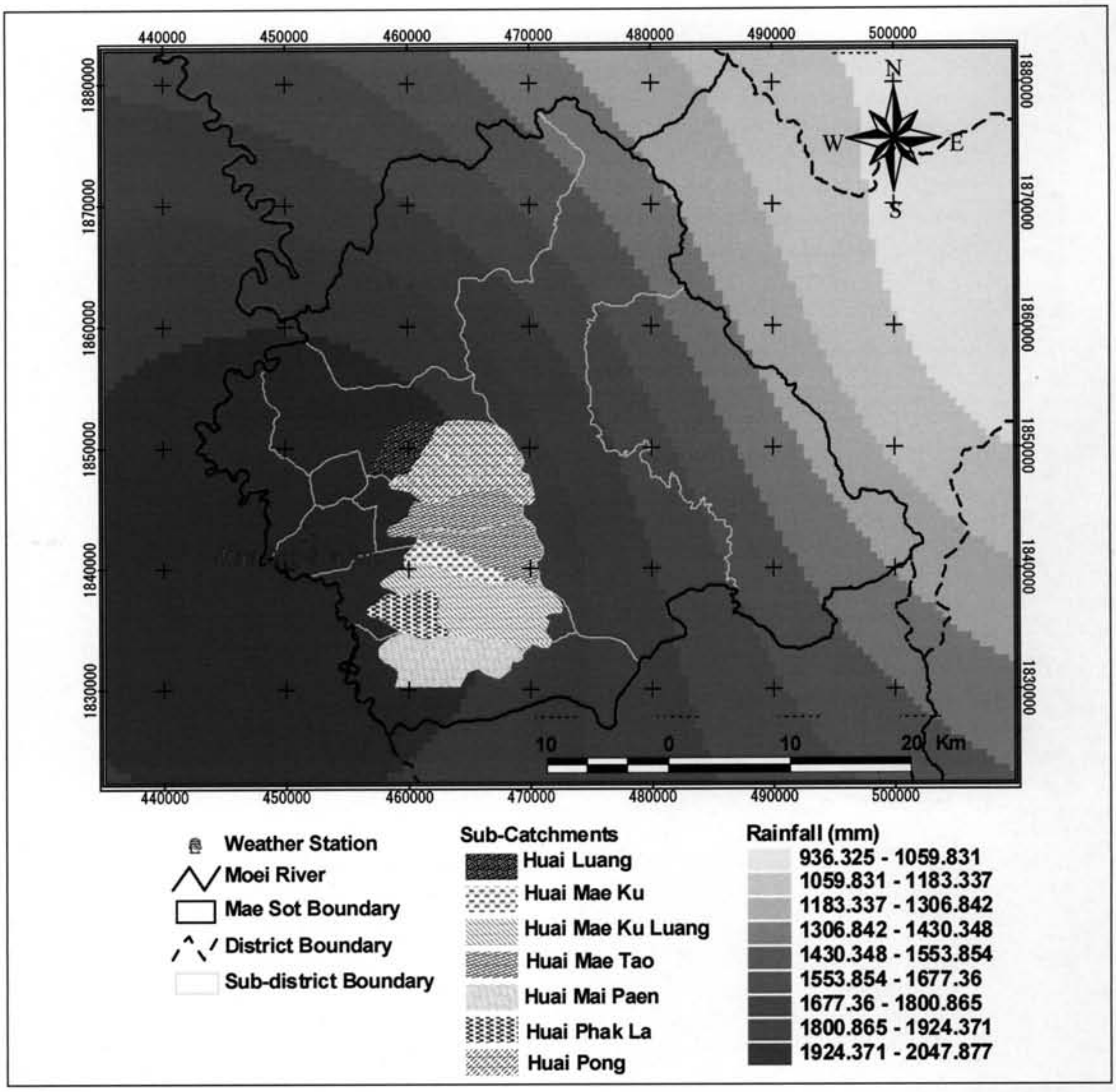

Figure 4.6 Map showing isohyetal lines of the year 1994 around Mae Sot District.

The effects of flooding and heavy rain on the landuse change of Mae Sot District are subsequently considered. Two satellite images of Landsat TM5 taken on March 13, 1994 (before heavy rain) and December 10, 1994 (after heavy rain) were interpreted to find out the changes. From the interpretation (Figures 4.7 and 4.8), landuse of Mae Sot District was classified into 7 types which are forest, paddy field, field crop, city-town, village, reservoir, and mine. Area (Rai and % proportion) of each landuse type for both periods is present in Table 4.6. In addition, histogram in Figure 4.9 shows a comparing between % area of each landuse type in Mae Sot District on March 13, 1994 and those on December 10, 1994. As a result, there is a very little change on each landuse type. Forest area, mining area and residential area both of city and village were decreased less than 1%. In the other hand, paddy field, field crop, and reservoir were increased less than 1%. This can be concluded that heavy rain and flooding have not any effect on landuse change. However, when focusing on the study area, the heavy rain has caused the flooding areas especially along Mae Tao and Mae Ku creek as shown in Figure 4.10. The flooding area in Figure 4.10 are identified from the Landsat TM5 image taken on December 10, 1994 by digitize technique. It seems to be flooded extensively, although landuse may not have been changed.

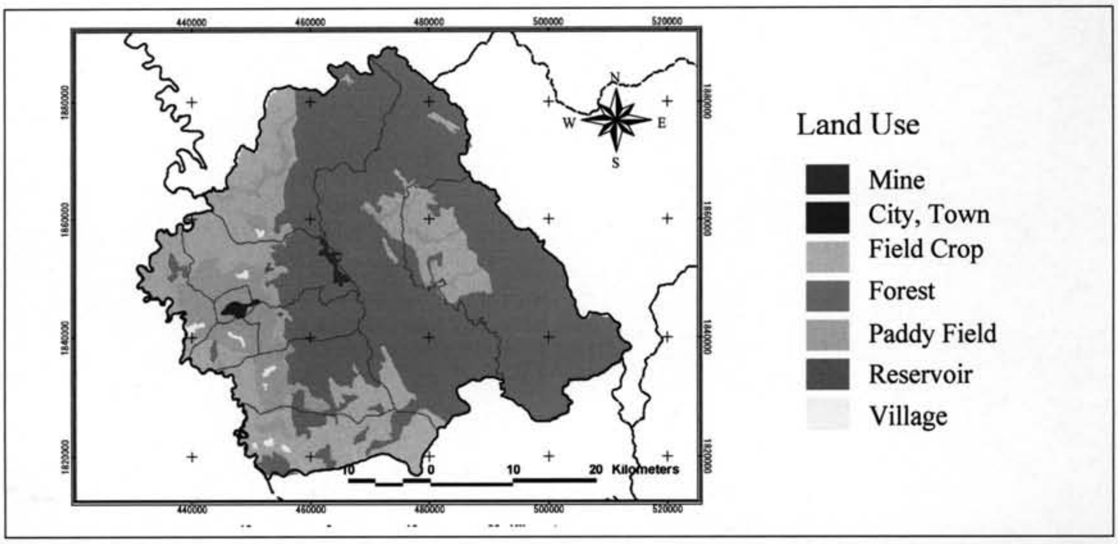

Figure 4.7 The interpreted-image from Landsat TM5 taken on March 13, 1994 showing landuse of Mae Sot District, Tak Province.

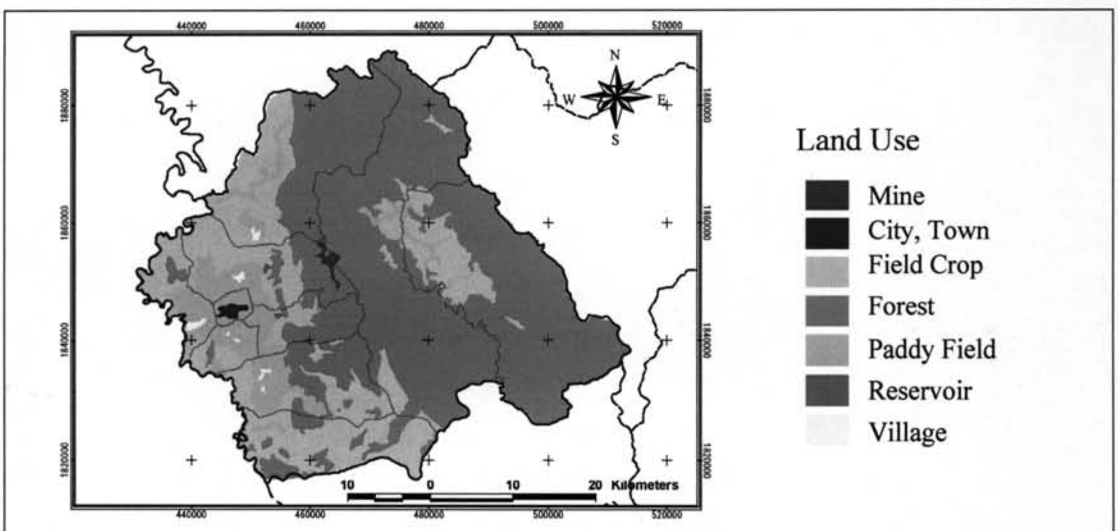

Figure 4.8 The interpreted-image from Landsat TM5 taken on December 10, 1994 showing landuse of Mae Sot District, Tak Province.

Table 4.6 Area (Rai and % proportion) of each landuse type in Mae Sot District on March 13, 1994 and December 10, 1994.

Landuse	March 13, 1994		December 10, 1994	
	Area (Rai)	Area (%)	Area (Rai)	Area (%)
Forest	679967.27	63.30	675679.98	62.90
Paddy Field	95915.44	8.93	101293.12	9.43
Field Crop	279073.04	25.98	280600.01	26.12
City, Town	6370.54	0.59	5860.09	0.55
Village	9387.74	0.87	7473.41	0.70
Reservoir	578.36	0.05	778.34	0.07
Mine	2948.72	0.27	2556.16	0.24
Total	**1074241.11**	**100.00**	**1074241.11**	**100.00**

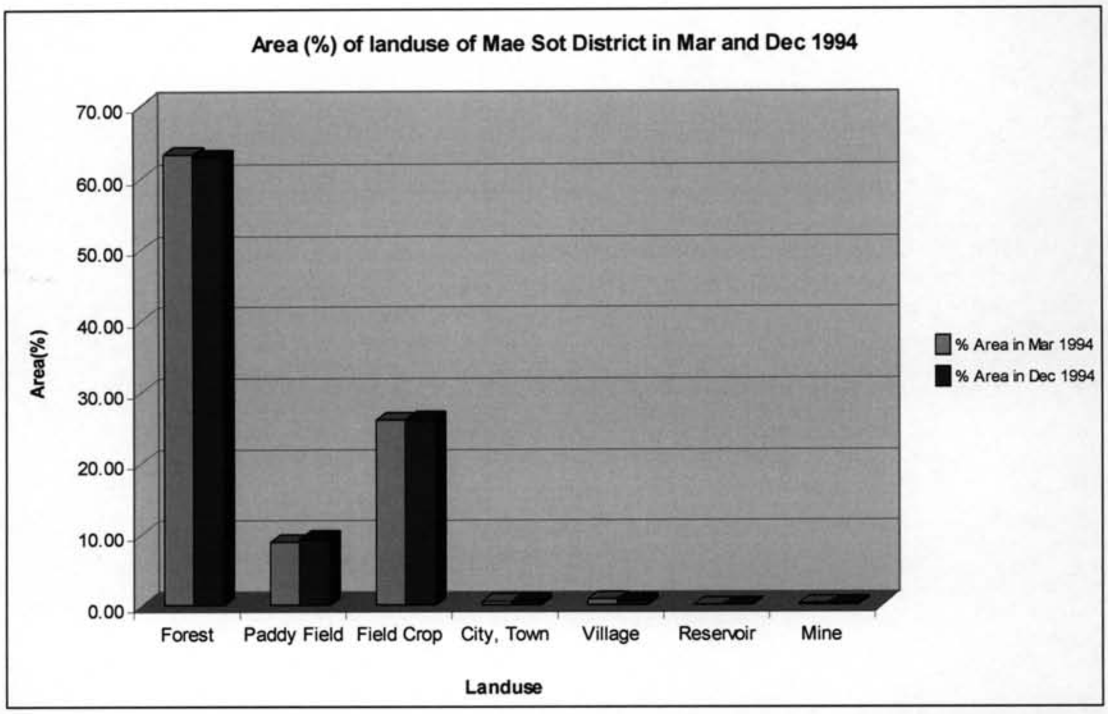

Figure 4.9 Graph presents % area of each landuse type in Mae Sot District on March 13, 1994 and December10, 1994, showing very slightly change in landuse caused by flooding.

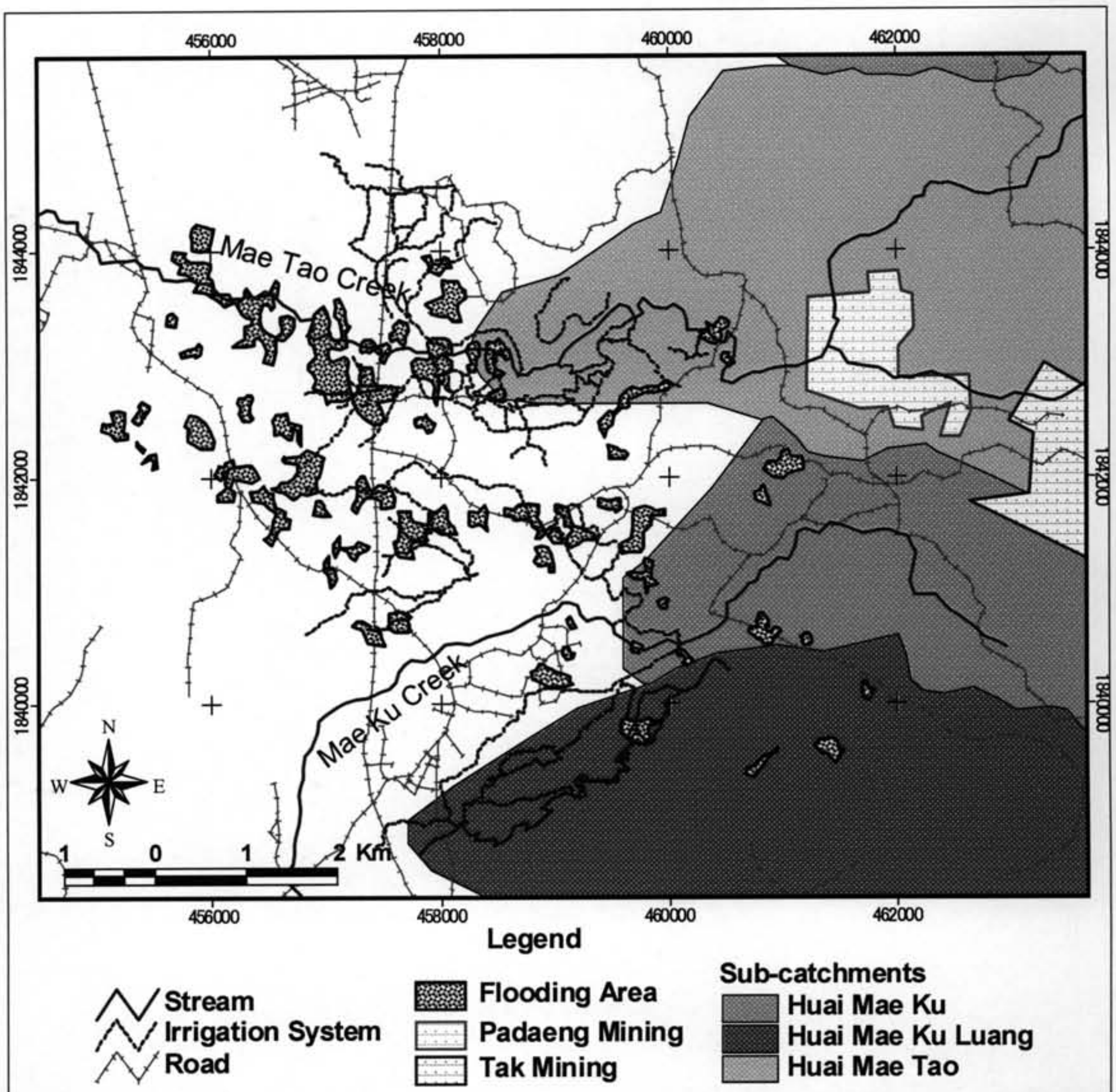

Figure 4.10 Flooding areas along Mae Tao and Mae Ku creek occurred after the heavy rain in 1994, interpreted from Landsat TM 5 image.

4.3 Cadmium and Zinc Distributions in Soil

There are several previous studies conducted the chemical analyses of soil in the study area; however the results of NRC-EHWM (2005) and Janpho (2006) were selected for this study. Combining those 2 data sets together and overlying them with other datum layers (e.g., irrigation, stream, mining area, flooding area and sub-catchments); all soil sample stations were located in the area of Huai Mae Ku, Huai Mae Tao and extended further west of Huai Mae Tao.

From the cadmium and zinc concentrations of soil samples in the study area, to determine the distribution and assign the background levels of cadmium and zinc deposited in area, histogram was used to analyze the combining data and the results are described below.

Cadmium: The histogram used to analyze cadmium distribution in soil and assign the background levels of cadmium in the area is illustrated in Figure 4.11. The slope changing point of the histogram was found at 3 mg/kg. It means that the cadmium contents in soil under this point can be classified as the background level of the soil in study area and the cadmium concentrations in soil, which is higher than this point, are assigned as anomaly value. The anomaly values of cadmium concentration in the soil samples can also be divided into two levels: (1) low anomaly level which the value of cadmium concentrations ranging between > 3 and 10 mg/kg and (2) high anomaly level containing more than 10 mg/kg. Moreover, from those 2 previous studies, it was also noted that the background concentration of cadmium in this area is at around 3 mg/kg since this area and the vicinity are considered as zinc deposit which are often found cadmium in association. From the comparison between the background value of this area and the combining data, it was found that about 47% of soil samples contain cadmium concentration lower than the background level (3 mg/kg) (see Table 4.7). According to anomaly values, about 35% of soil samples were in the range of low anomaly level (> 3 to 10 mg/kg) and about 18% of soil samples were in the high anomaly level.

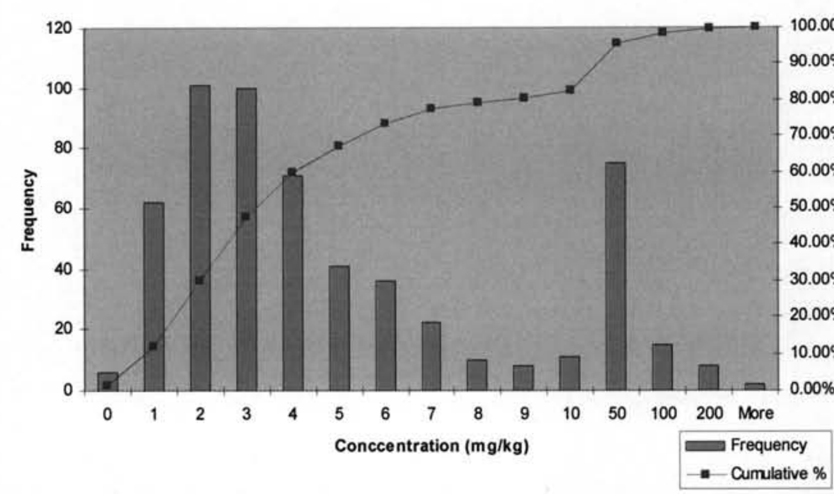

Figure 4.11 Histogram and cumulative curve of Cd concentration in soil samples (data from NRC-EHWM, 2005 and Janpho, 2006).

Table 4.7 Cumulative soil samples of Cd concentration.

Concentration (mg/kg)	Frequency	% samples	Cumulative %
0	6	1.06	1.06
1	62	10.92	11.97
2	101	17.78	29.75
3	100	17.61	47.36
4	71	12.50	59.86
5	41	7.22	67.08
6	36	6.34	73.42
7	22	3.87	77.29
8	10	1.76	79.05
9	8	1.41	80.46
10	11	1.94	82.39
50	75	13.20	95.60
100	15	2.64	98.24
200	8	1.41	99.65
>200	2	0.35	100.00
Total	**568**	**100.00**	**100.00**

Source: NRC-EHWM (2005) and Janpho (2006)

Zinc: In order to analyze zinc distribution in soil and assign the background levels of zinc in the area, histogram shown in Figure 4.12 was used. The histogram shows the changing point of the slope at 50 mg/kg which means the zinc concentrations in soil under this point could be the background value. The low anomaly level for this area ranges between >50 and 400 mg/kg and the high anomaly level is higher than 400 mg/kg. According to the background level of this area, it was found that about 35% of soil samples contain zinc concentrations below the background level of 50 mg/kg (see Table 4.8). Half of the samples are found in the range of low anomaly value and about 18% present as a high anomaly value (see also Table 4.8).

According to the background level of cadmium and zinc in this area, the area was classified into 3 levels of cadmium and zinc contamination as shown in Figures 4.13 and 4.14, respectively. The characteristics of cadmium and zinc distributions in the soil present a similar pattern which indicates high concentration levels of cadmium and zinc near the stream or river. As a result, it may be significant that the concentrations of both heavy metals are related to the river flow.

Figure 4.12 Histogram and cumulative curve of Zn concentration in soil samples (data from NRC-EHWM, 2005 and Janpho, 2006).

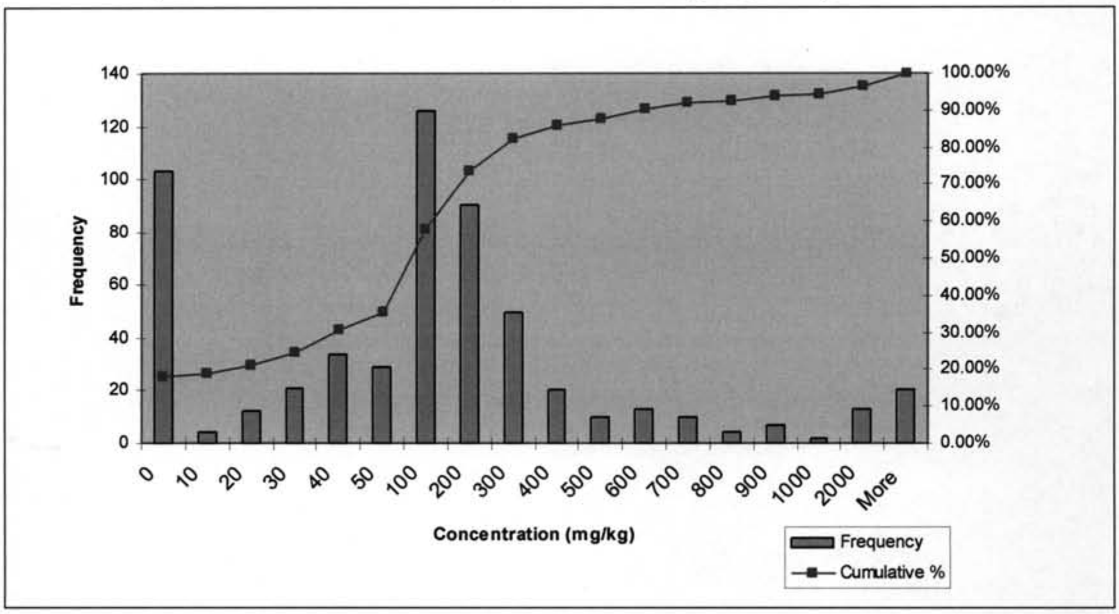

Table 4.8 Cumulative soil samples of Zn concentration.

Concentration (mg/kg)	Frequency	% samples	Cumulative %
0	103	18.13	18.13
10	4	0.71	18.84
20	12	2.11	20.95
30	21	3.70	24.65
40	34	5.98	30.63
50	29	5.11	35.74
100	126	22.18	57.92
200	90	15.85	73.77
300	50	8.80	82.57
400	20	3.52	86.09
500	10	1.76	87.85
600	13	2.29	90.14
700	10	1.76	91.90
800	4	0.71	92.61
900	7	1.23	93.84
1000	2	0.35	94.19
2000	13	2.29	96.48
>2000	20	3.52	100.00
Total	**568**	**100.00**	**100.00**

Source: NRC-EHWM (2005) and Janpho (2006)

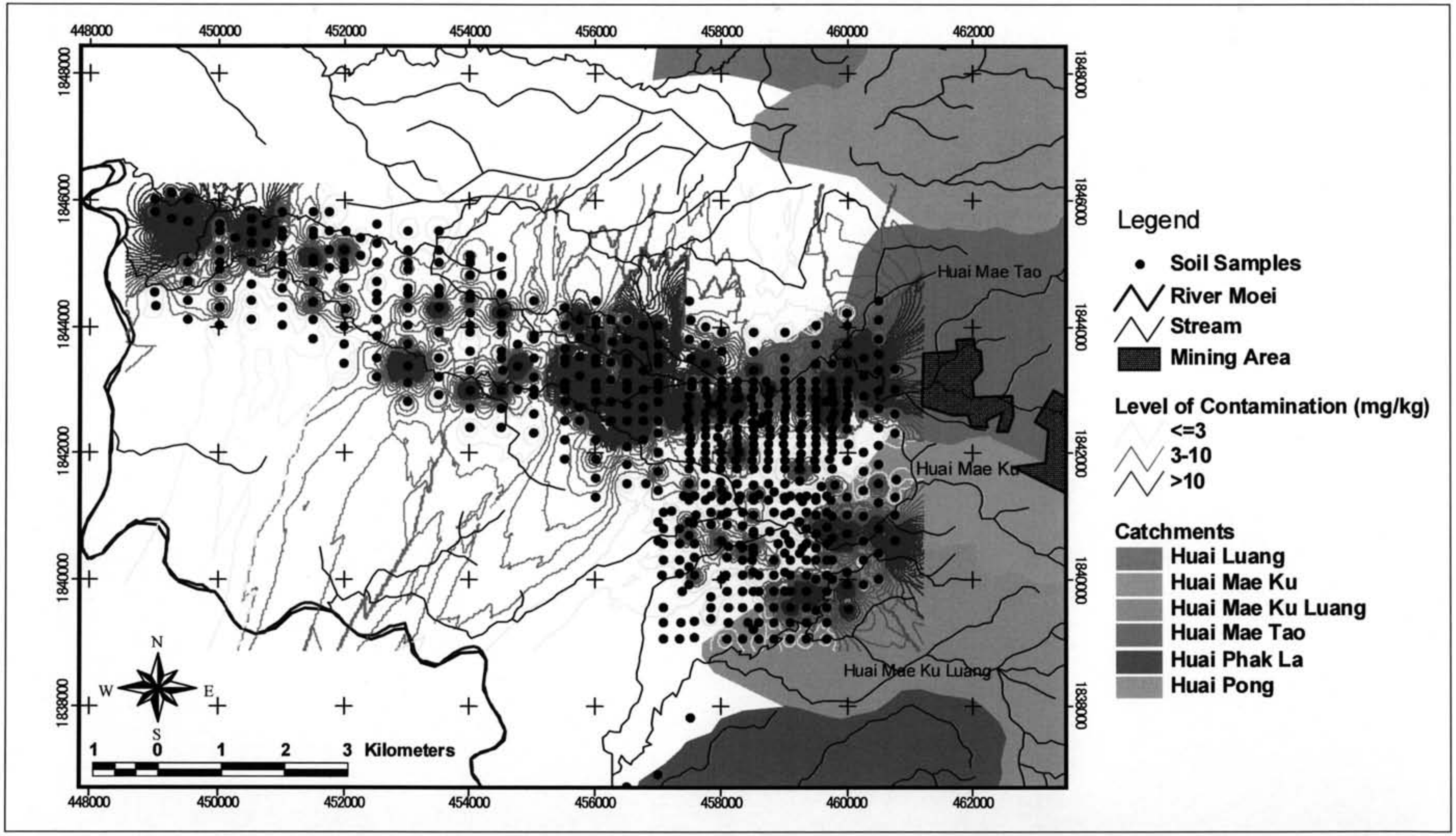

Figure 4.13 Soil sample localities and their cadmium distributions (data from NRC-EHWM, 2005 and Janpho, 2006).

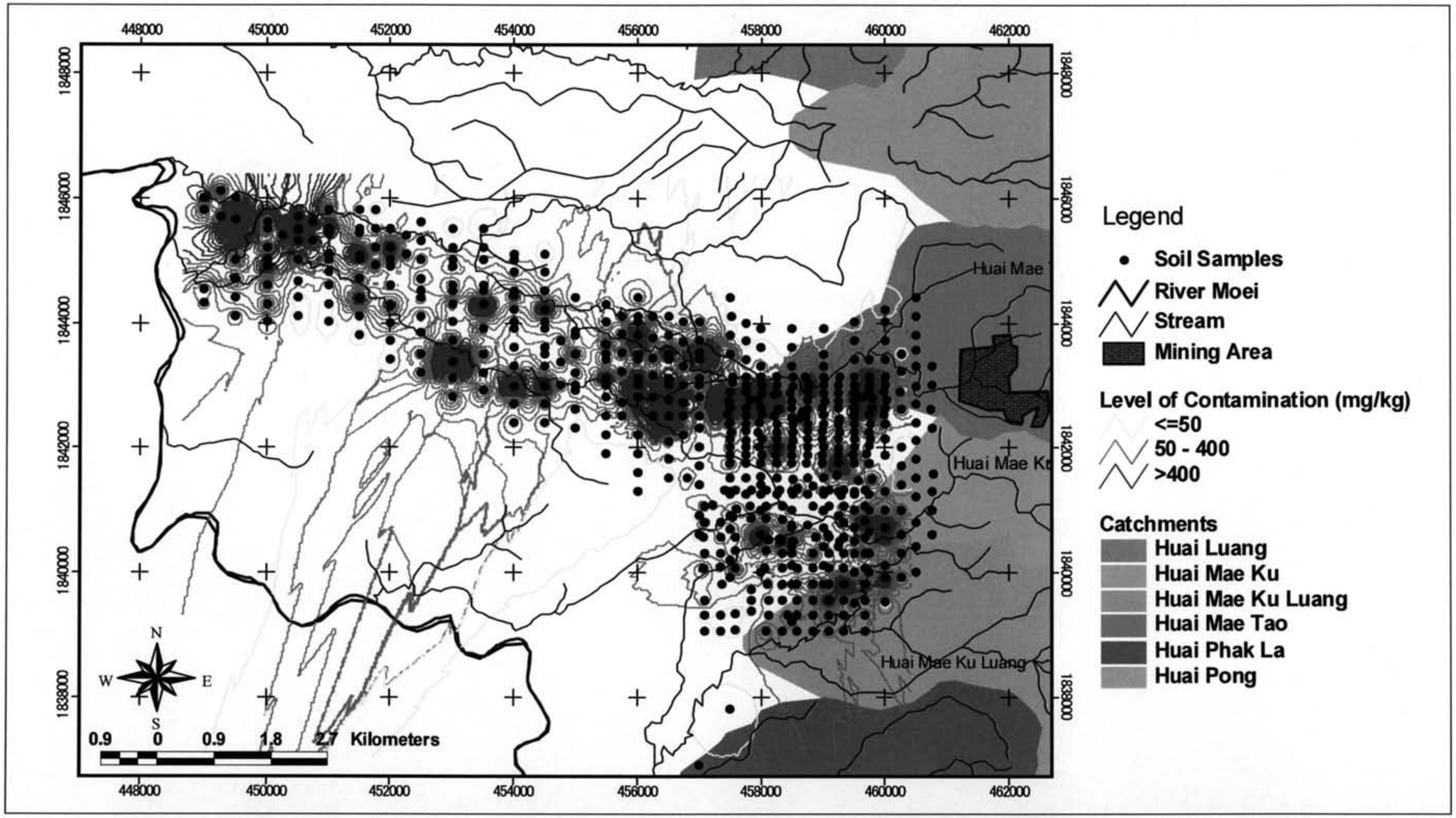

Figure 4.14 Soil sample localities and their zinc distributions (data from NRC-EHWM, 2005 and Janpho, 2006).

4.4 Cadmium and Zinc Distributions in Stream Sediment

The results of chemical analysis from the studies of Maneewong (2006) and DPIM (2006) were collected and used in this step. Combining 2 sets of data together before importing into GIS system, a layer of 59 stream sediment sample points which cover Mae Tao creek, Mae Ku creek and Huai Nong Kheio creek were then created and were subsequently overlain them with other layers. In order to determine the distribution and to assign the background levels of cadmium and zinc deposited in the area, the same procedure applied in the section 4.3 was also applied here.

Cadmium: The histogram used to analyze the distributions of cadmium in stream sediment is illustrated in Figures 4.15. It shows slop changing point at the concentration of 50 mg/kg. Consequently, cadmium concentrations under this point were set up as background level of the area. Hence, two levels of anomaly values of cadmium in the stream sediments were classified as low anomaly level at cadmium range of 50-1,000 mg/kg, and high anomaly level at cadmium contents higher than 1,000 mg/kg. From the cumulative samples of cadmium concentration shown in Table 4.9, abundant samples (74.58%) contain cadmium concentration within the background level (50 mg/kg). Concerning to anomaly values, 23.73% of stream sediment samples are in the range of low anomaly level (> 50 to 1,000 mg/kg) and only 1.69% of samples are in the high anomaly level.

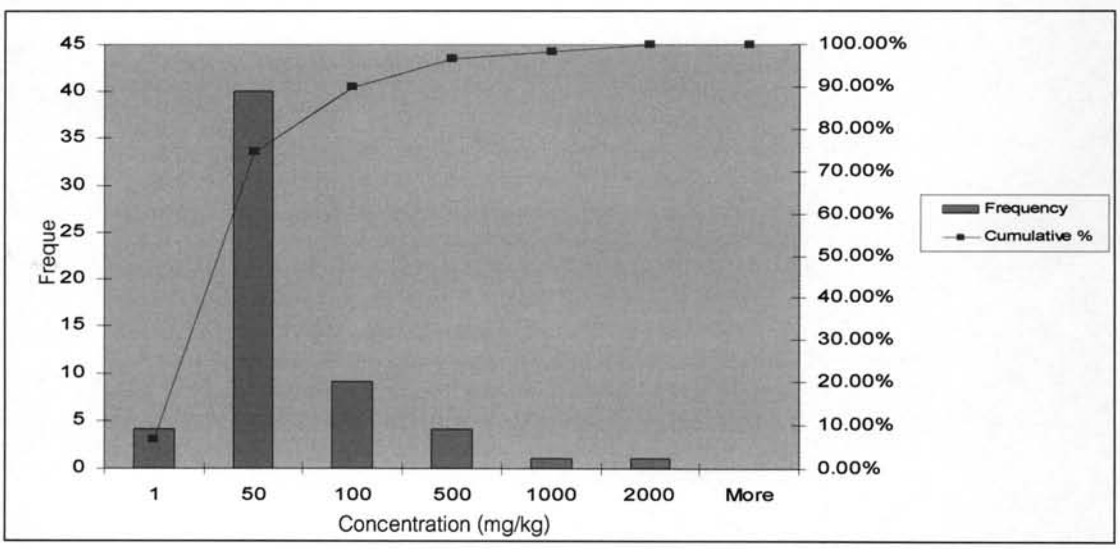

Figure 4.15 Histogram and cumulative curve of Cd concentration in stream sediment samples (data from Maneewong, 2006 and DPIM, 2006).

Table 4.9 Cumulative stream sediment samples of Cd concentration.

Concentration (mg/kg)	Frequency	% samples	Cumulative %
1	4	6.78	6.78
50	40	67.80	74.58
100	9	15.25	89.83
500	4	6.78	96.61
1000	1	1.70	98.31
2000	1	1.69	100.00
>2000	0	0.00	100.00
Total	**59**	**100**	**100.00**

Source: Maneewong (2006) and DPIM (2006)

Zinc: The analysis for zinc distributions in stream sediment were plotted as histogram and cumulative curve as shown in Figure 4.16. The background level of zinc concentrations in stream sediment is consequently marked at 5,000 mg/kg based on the changing slope of the cumulative curve, whereas, the low and high anomaly levels of zinc are assigned at 5,000-15,000 mg/kg and higher than 15,000 mg/kg, respectively. The cumulative stream sediment samples of total zinc concentration are shown in Table 4.10. It can be noted that 81.36% of the samples contain zinc concentration lower than the background level (5,000 mg/kg). Only 16.95% and 1.69% of the samples are in the low and high anomaly levels, respectively.

The characteristics of the cadmium and zinc distributions in the stream sediment are illustrated in Figures 4.17 and 4.18, respectively. Both cadmium and zinc in stream sediment present quite similar distribution pattern. It is obviously shown that Huai Mae Tao appears to have the highest concentrations of zinc and cadmium. In addition, the concentrations of heavy metals are likely decreasing towards west lowland and alluvial.

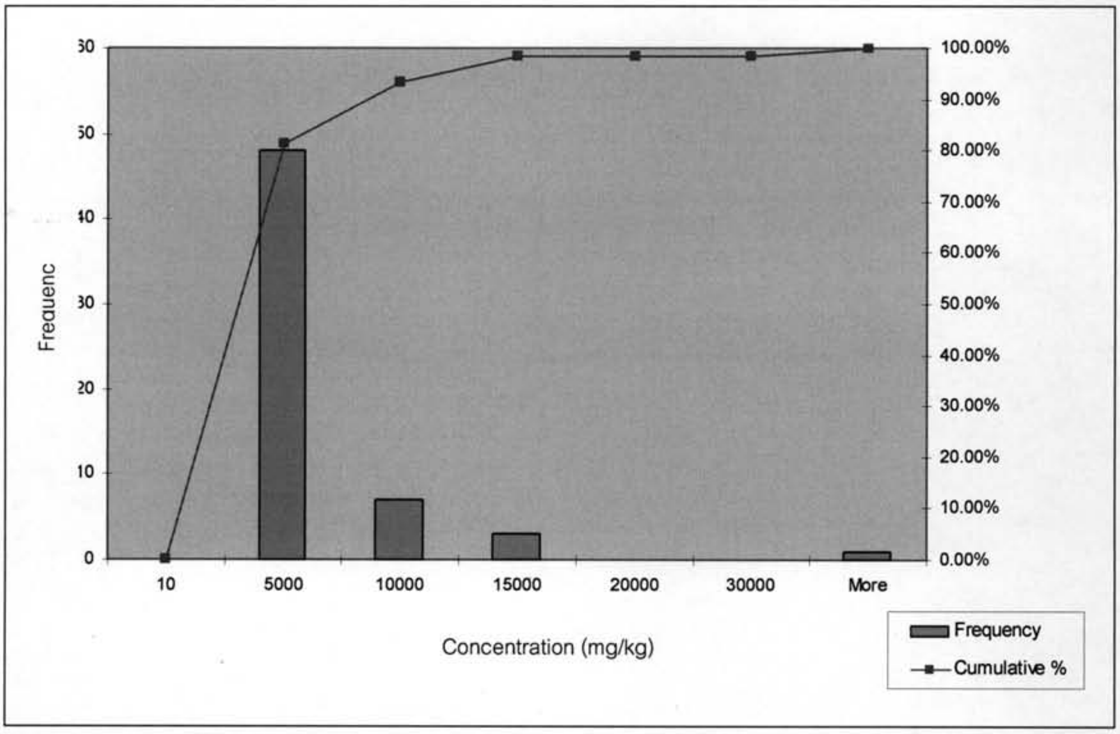

Figure 4.16 Histogram and cumulative curve of Zn concentration in stream sediment samples (data from Maneewong, 2006 and DPIM, 2006).

Table 4.10 Cumulative stream sediment samples of Zn concentration.

Concentration (mg/kg)	**Frequency**	**% samples**	**Cumulative %**
10	0	0.00	0.00
5000	48	81.36	81.36
10000	7	11.86	93.22
15000	3	5.09	98.31
20000	0	0.00	98.31
30000	0	0.00	98.31
>30000	1	1.69	100.00
Total	**59**	**100.00**	**100.00**

Source: Maneewong (2006) and DPIM (2006)

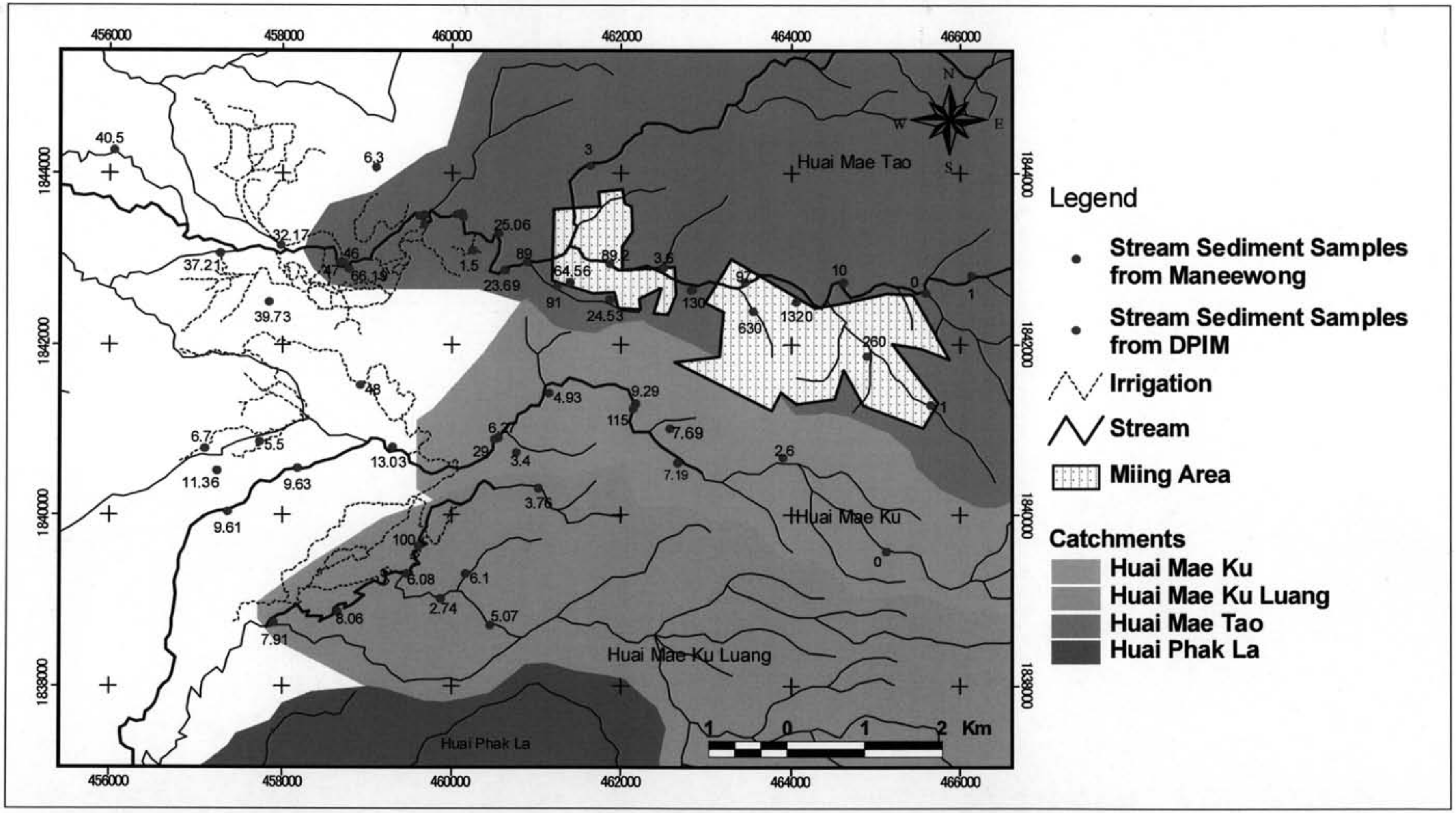

Figure 4.17 Stream sediment sample localities and their cadmium concentrations (ppm) (data from Maneewong, 2006 and DPIM, 2006).

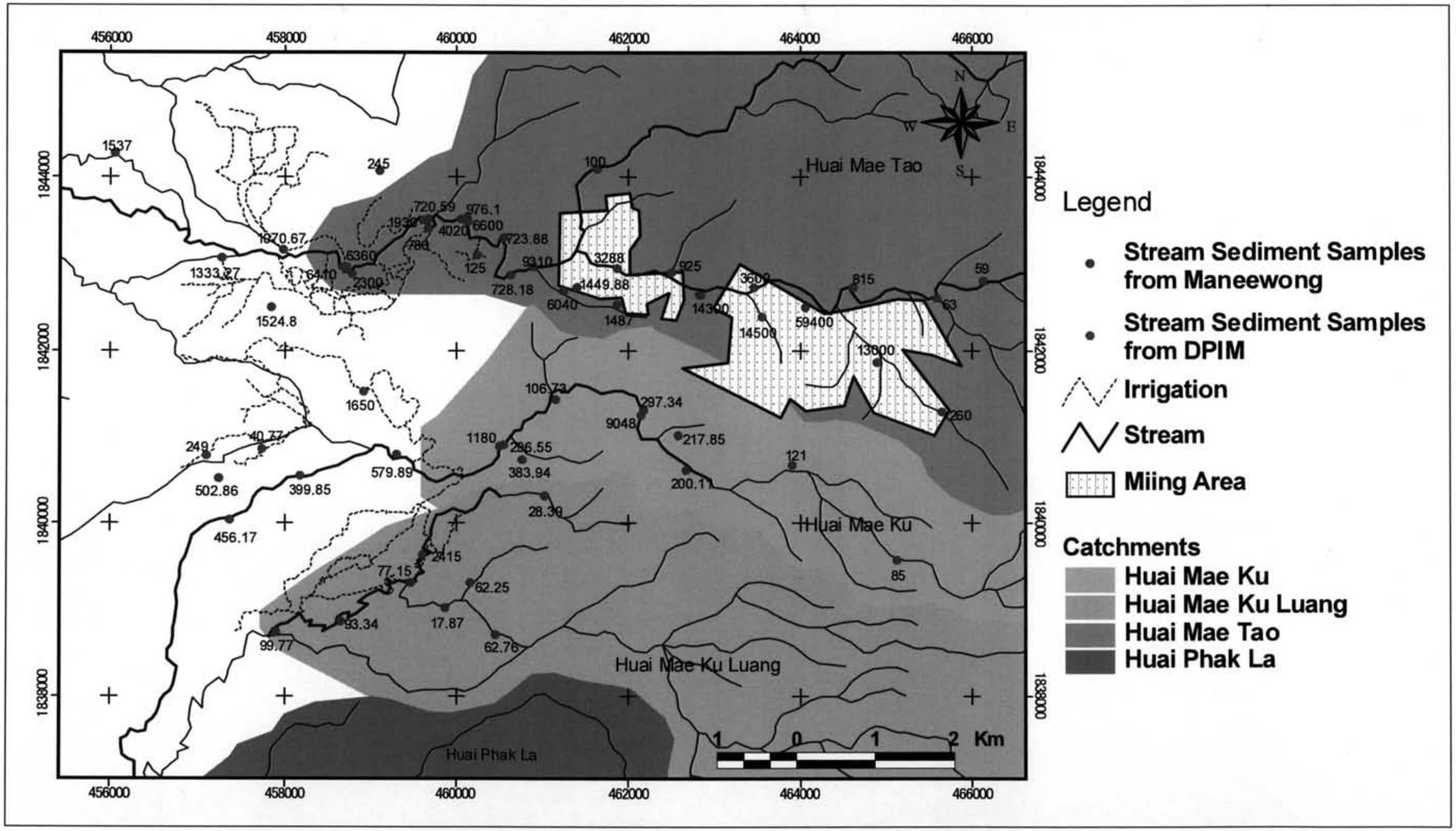

Figure 4.18 Stream sediment sample localities and their zinc concentrations (ppm) (data from Maneewong, 2006 and DPIM, 2006).

4.5 Erosion

The utility of the ErosView program reported by LDD can separate area of Mae Sot District, Tak Province into 2 types consisting of low land and high land. The high land covers 63.46% of the area, whereas 36.54% of the area is occupied by the low land. Based on the program, the erosion rate in the area is classified into 5 levels including; very low (0-2 ton/km^2/yr), low (2-5 ton/km^2/yr), moderate (5-15 ton/km^2/yr), high (15-20 ton/km^2/yr) and extremely high (>20 ton/km^2/yr); these are summarized in Table 4.11. Generally, the erosion of the low land is relevant to the very low level; on the other hand, the high land usually yields the low or moderate levels.

Table 4.11 Summary of the erosion rate occurring in Mae Sot District, Tak Province.

Erosion Rate	Area (%)	
	Low land	**High land**
Very low (0-2 ton/km^2/yr)	28.96	4.86
Low (2-5 ton/km^2/yr)	6.48	22.77
Moderate (5-15 ton/km^2/yr)	0.80	34.44
High (15-20 ton/km^2/yr)	0.04	0.00
Extremely high (>20 ton/km^2/yr)	0.27	1.39
Total	**36.54**	**63.46**

Source: ErosView Program, LDD

According to scope of the study, the study area is mainly focused on Mae Tao and Mae Ku sub-catchments; therefore, the classification of the erosion around this study area is illustrated in Figure 4.19. The figure indicates that upstream of Huai Mae Tao (mostly high land) in which zinc potential area and mining areas are located is significantly related to the high erosion areas (15-20 ton/km^2/yr) and some part of the mining areas also yield the extremely high level (>20 ton/km^2/yr). This is quite similar to the upstream of Huai Mae Ku which presents a high erosion area, even though, it is classified as low land, and there is no zinc deposit. In addition, the high erosion areas upstream of both Huai Mae Tao high land and Huai Mae Ku low land are mainly occupied by corn field and teak; besides, those high land area of Huai Mae Tao have been changed from the forest area. This can be implied for instant that the high erosion rate of the study area may be resulted from the deforestation and cultivation.

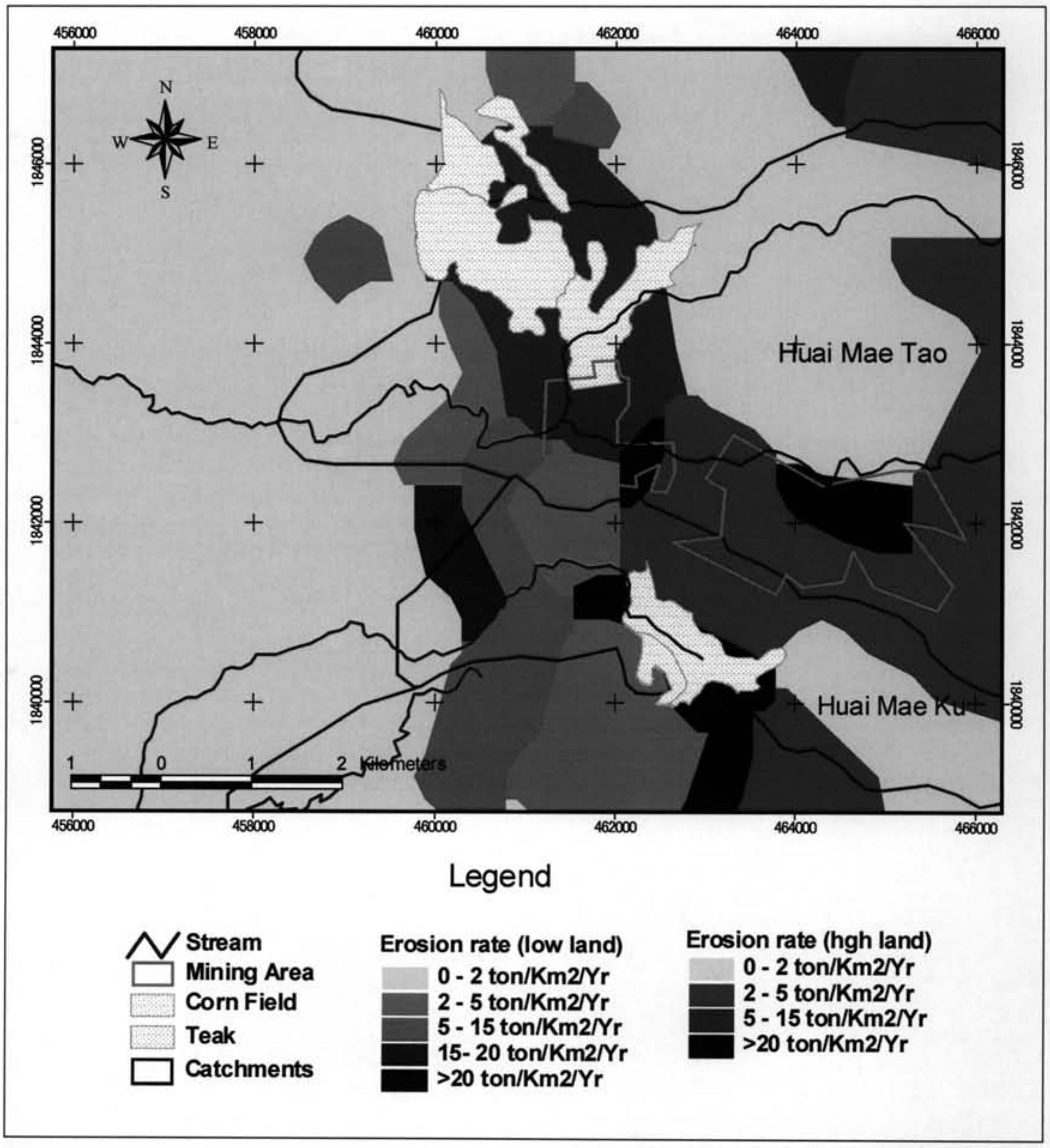

Figure 4.19 Map showing the erosion rate around the study area (Adapted from LDD).

4.6 Potential Source of Contamination

After the analyses several factors, the results of each were then combined and integrated to identify the contaminated area and finding out the sources of contamination. Figure 4.20 shows the overall combination among all related factors including cadmium level in contaminated area, erosion rate, stream, mining area, flooding area, land use, sub-catchments and irrigation system.

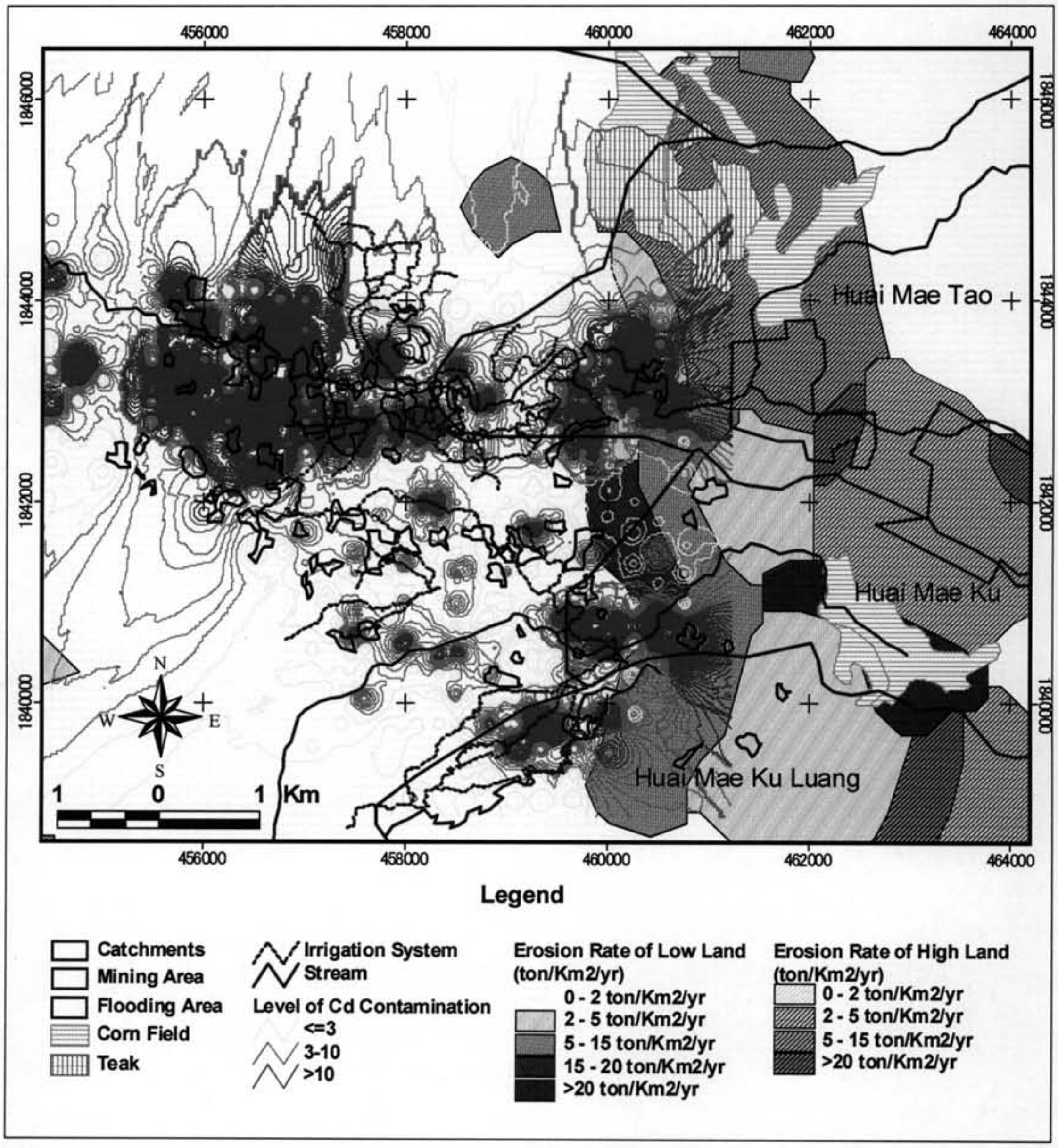

Figure 4.20 An overall combination of all related factors in the study area.

The explanations of that figure are given as fallowing. According to the background value of soil in the area analyzed in section 4.3, the study area has been classified into 3 levels of cadmium contaminated area which are low level (>3 mg/kg), moderate level (3–10 mg/kg) and high level (>10 mg/kg). The high level of contamination is usually occurred along the Mae Tao and Mae Ku creek which is likely resulted from the transportation of the sediment accumulated from runoff in the highland in the western part. Moreover, the high level of cadmium-contaminated areas are widely related to the flooding area and irrigation system which means flooding and constructed-canal can transport Cd-containing sediment and consequently cause the cadmium accumulation. Regarding to upstream of the area, both of Mae Tao and Mae Ku creek have high erosion areas either high land or low land, which are normally occupied by the agricultural area, particularly corn field and teak. This can be implied that the high erosion which generates the sediment would result from the cultivation and deforestation. In addition, upstream of the Mae Tao creek is not only be a high erosion area but also be the location of zinc deposit area in which two zinc mine are located. Therefore, the nature of certain area is also considered as a source of the contamination which has mining activities being activation.