3. STUDY AREA

3.1. Topography of the area

Mae Moh Lignite Mine and Power Plant is located in an intermontane basin in Mae Moh District, Lampang Province, latitude $18^0 18'$N, longitude $99^0 2''$ E (Figure 3.1). The Mae Moh Basin is of the syncline type, covering an area of 135 km^2 with 8.8 km maximum width and 18.3 km maximum length (EGAT, 1991). The north boundary of the basin is surrounded by the quartzite mountain Doi Kew-lom. The east and the west boundary is bounded by the limestone and mudrock mountain Doi Chang and Doi Luang. On the south boundary, the basin is bounded by basalt flows overlying the limestone of Doi Pha Hob.

The basin was formed during the Tertiary period on the presumably limestone basement. The sediments filling the basin are mainly semi-consolidated in nature with diversified lithology. Organic deposits of peat and lignite occur in bedded layers along with other sedimentary rocks which are mostly shale and sandstone. The peat and lignite may composed of several elements which were concentrated during the decay period of reducing conditions. In general, the topography of the basin can be classified as flat and low lying terrain with ground elevation throughout the basin ranging between 300 to 350 m. However, the slightly rolling topography is found in places among the flat lying ground of the basin as compared with those of the rugged mountainous surrounding area. Figure 3.2 shows geological map of Mae Moh area.

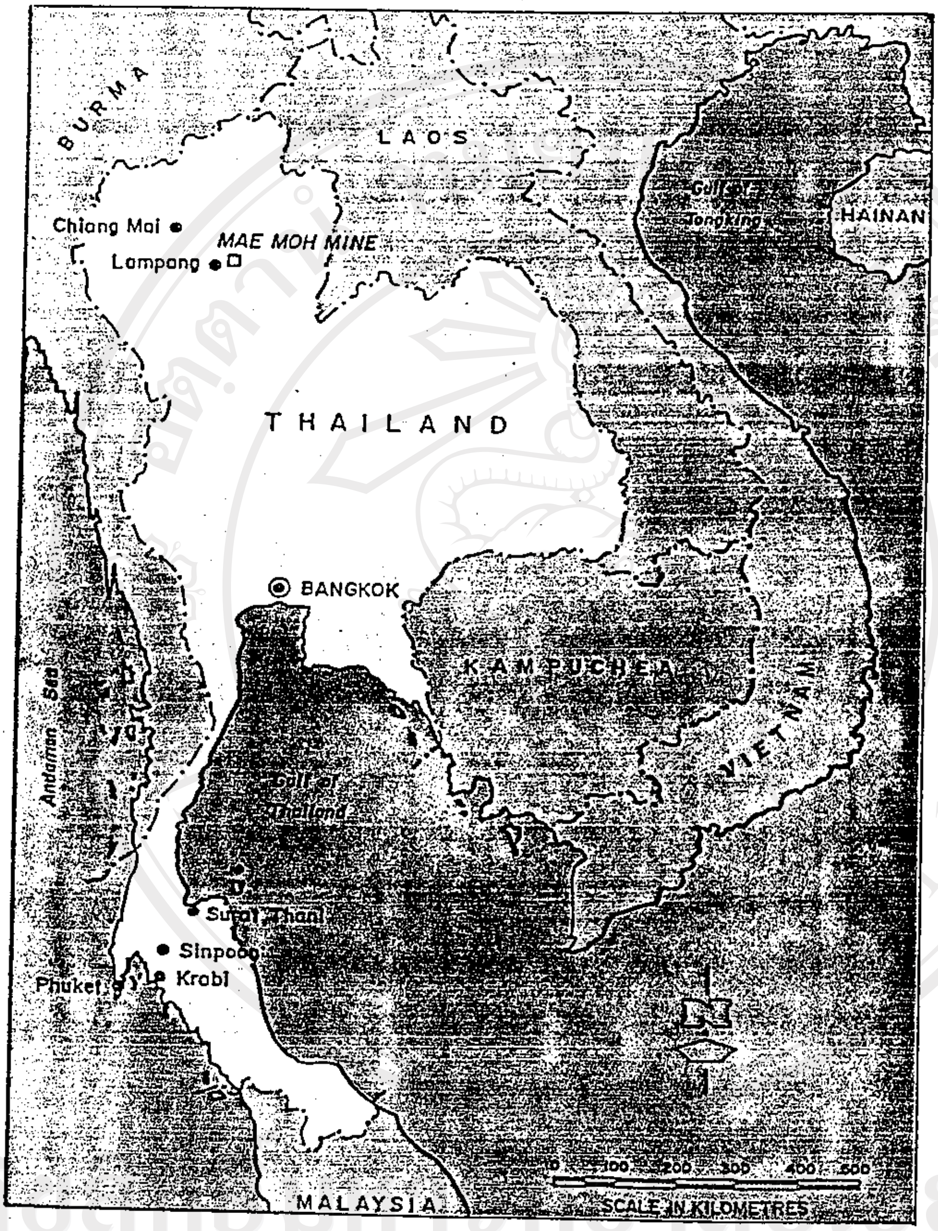

Figure3.1 Map showing location of Mae Moh Lignite Mine and Power Plant

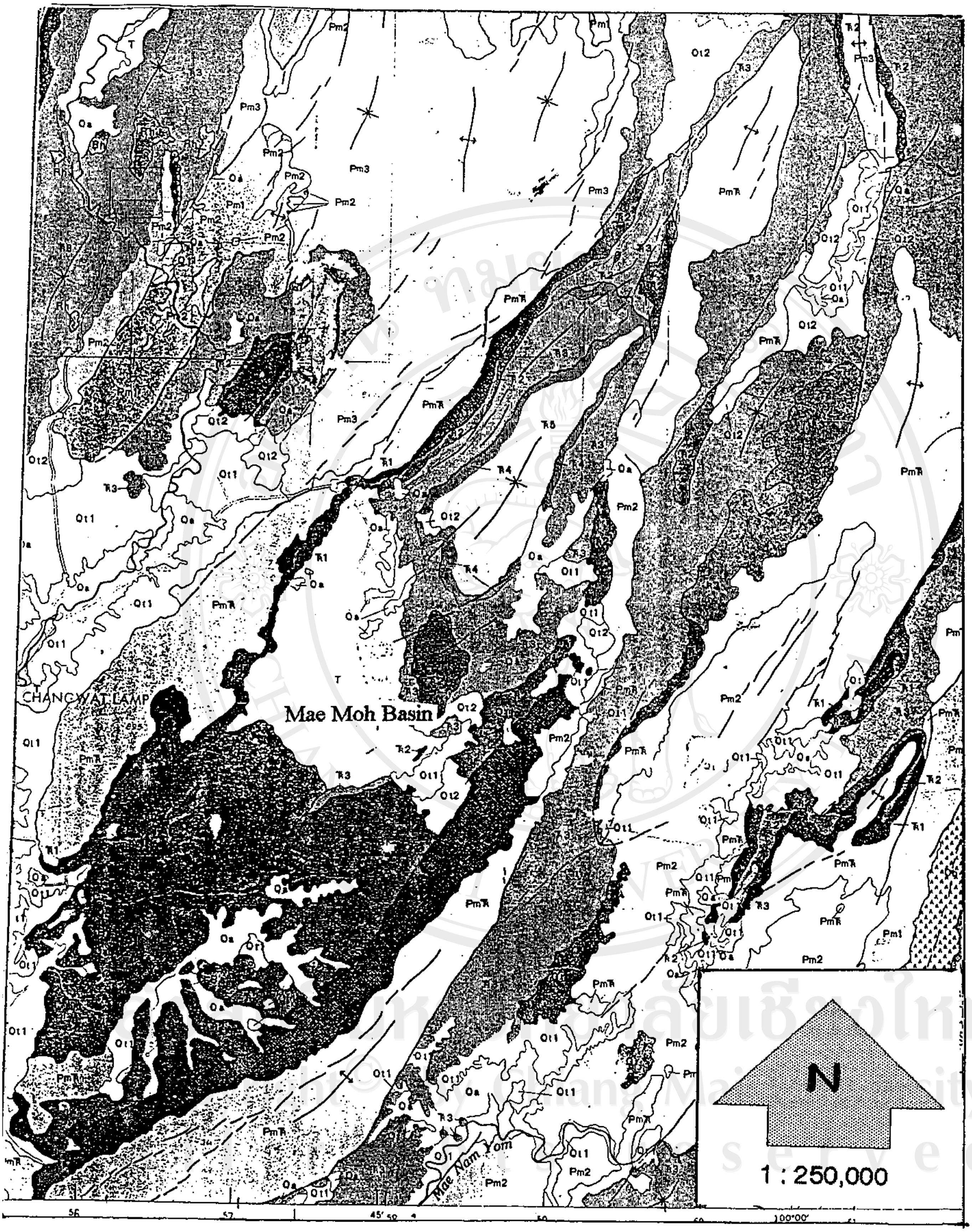

Figure 3.2. Geological map of Mae Moh area

Source: Department of Mineral Resources

Explanation

Qa River gravel, sand, clay and mud

Qt1 Lower terraces, gravel, sand silt, clay

Qt2 Higher terraces, gravel, sand, silt, clay (Mae Taeng Group)

T Fresh-water sandstone, shale, carbonaceous shale, limestone viviparous beds, lignite (Mae Moh Group)

T5 Reddish-brown sandstone, shale, conglomerate, greenish-grey siltstone, shale, sandstone (Pha Daeng Formation, Lampang Group)

T4 Limestone, limestone conglomerate; medium grey to pinkish-grey with fossils of gastropod, brachiopods (Doi Chang Formation, Lampang Group)

T3 Greenish-grey shale, sandstone, tuffaceous sandstone, laminated shale, conglomerate, with fossils of Halobia, Daonella, Posidonia, Trachyceras, Paratrachyceras, Joannites, etc. (Hong Hoi Formation, Lampang Group)

T2 Limestone, massive or banded, dark grey to medium grey; shale, sandstone, calcareous, grey to greyish-brown, well stratified, with fossils of brachiopods, Claraia, Halobia, Daonella, Posidonia, Ammonites, (Pha Kan Formation, Lampang Group)

T1 Basal conglomerate; redish-brown sandstone, shale, agglomerate, tuff

Pm3 Shale, calcareous shale, carbonaceous shale, tuffaceous shale and sandstone, laminated shale with fossils of Dielasma, Leptodus, Orthotichia, Echinochus, Neospirifera, Schizopoira, Aviculopecten, etc. (Huai Thk Formation, Ratburi Group)

Bs basalt; vesicular, Amygdaloidal

3.2. Study sites

Study sites were selected in different directions and distances from the power plant. Figure 3.3 shows a map of study sites and Table 3.1 shows the distance and direction from the power plant to each site. Figure 3.4 shows photo of some study sites

Table 3.1 Study Sites

No.	Site	Distance from the power plant	Direction	Note
1	Mae Chang Res.	10 km	NE	behind the mountain
2	Pumping Station	2 km	NE	near the stacks of power plant
3	Dumping Area	5 km	NE	near ash dumping
4	Ban Na Che	20 km	NE	
5	Ban Huay Luang	25 km	NW	behind mountain
6	Lp-Ngao, km 621	60 km	NE	the farthest site
7	Pratu Pha	40 km	NE	
8	Ban Tha Si	20 km	NE	near mining area
9	Ban Pang Puay	15 km	E	
10	Ban Sop Pat	7 km	E	
11	Ban Sop Moh	5 km	SW	
12	Ban Mae Lu	15 km	S	
13	Fah Mayo Reserv.	20 km	SW	
14	Mae Moh new Town	8 km	W	
15	Main Gate of PP	3 km	S	
16	Mae Tha Reserv.	20 km	SW	
17	Accom.,Centre area	3 km	NW	
18	Inside PP	0.5 km		

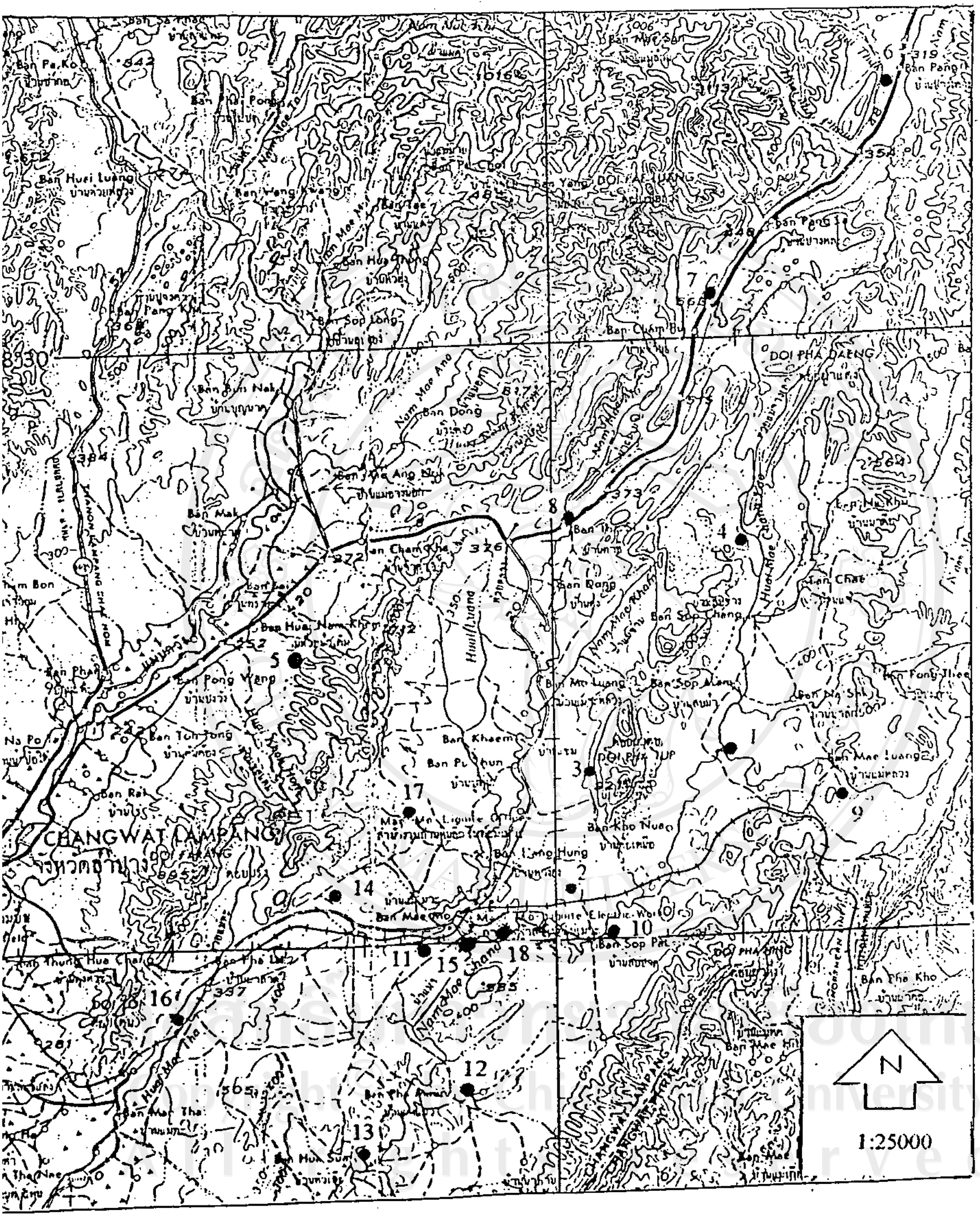

Figure 3.3. Map of study area

Figure 3.4 Photo of some study sites

Figure 3.4 Photo of study sites

3.3. Climate

The climatic of the Mae Moh Basin is typical to the northern Thailand climate. The area is located in a monsoon zone which is influenced by the southwest and the northeast monsoons and secondarily by cyclonic sorm and intertropical fronts. During May to October, the air mass moves from the Indian Ocean and brings moisture creating the rainy season over the basin. Most of the rain falls in August and September, but isolated heavy downpours have also been recorded in May to November, (in 1994, to December). The dry season occurs during mid-October to mid-February with cool and dry weather and normally without rain. The hot and dry season is from mid-February to mid-May. Because of the effect of the monsoons, the duration of the seasons vary. Also, heavy rainfall occurs when a cool air mass from the north meet the southwest monsoon. The cyclonic storms from the Pacific Ocean cause the intense precipitation in the region.

3.3.1 Rainfall

In general, three types of rainfall occur over the area, namely: oragraphic, convective and cyclonic. During the rainy season, oragraphic cyclonic rains prevail while local convective rains of high intensity occur during the hot season. The average monthly rainfall ranges from 0.6 to 235 mm (Figure 3.5). The minimum amount of rainfall occurs during December-February as a result of dry-cool air masses moving to the region from the Arctic. The maximum amount of rainfall usually occurs in August -September due to the southwest monsoon from the Indian Ocean.

3.3.2 Temperature

The temperature of the area is very variable. A maximum temperature of 41^0C is occurs in April and the lowest temperature of 6.8^0C was recorded in January. Figure 3.6 illustrates the variation of temperature recorded at Mae Moh Station .

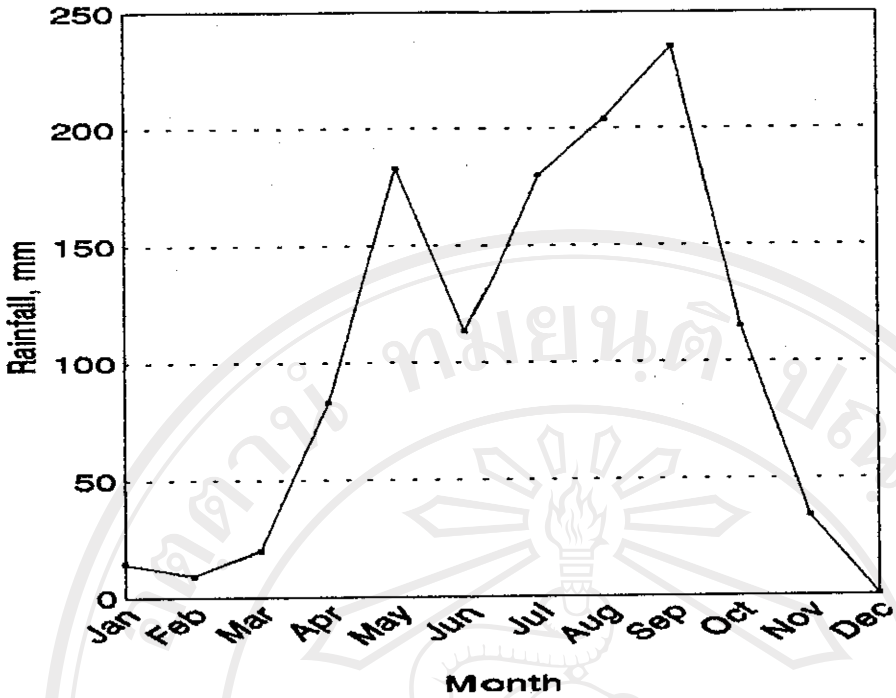

Figure 3.5. Average rainfall in Mae Moh Area
Source: EGAT

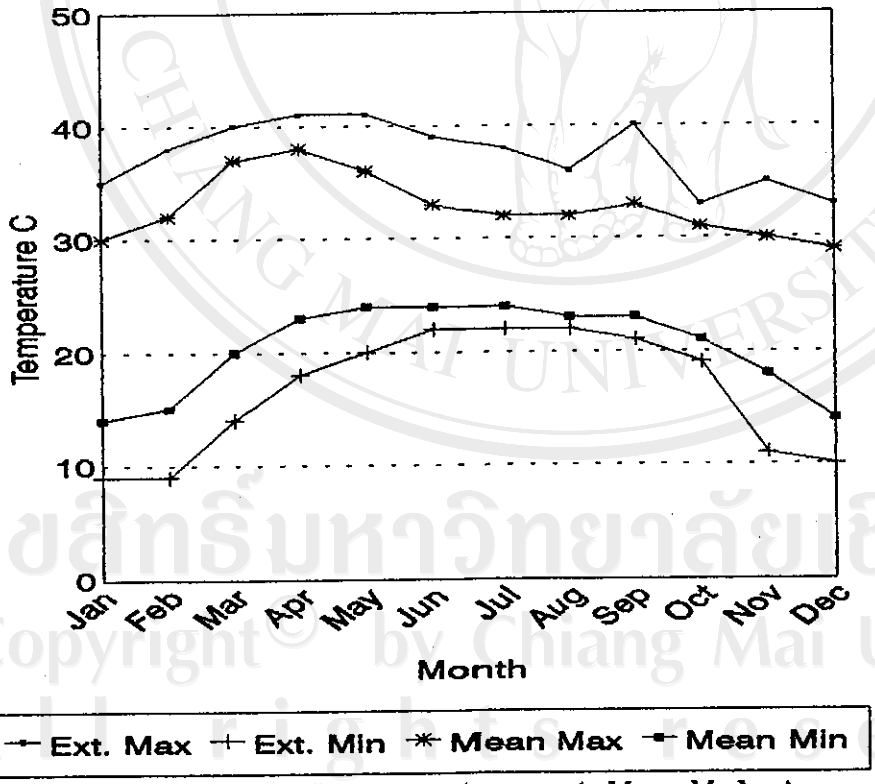

Figure 3.6. Ambient Temperature at Mae Moh Area
Source: EGAT

3.3.3 Wind

Generally, the direction of the prevailing wind changes according to the season. From October to January when the northeast monsoon is prevailing, wind direction is usually due to south. However, the prevailing wind varies in all direction during the transition period of the northeast monsoon to the southwest monsoon. Figure 3.7 shows the wind rose

3.3.4 Thermal inversion

Normally, as the sun rises over the horizon in the morning, the temperature of lower atmosphere is warmest near the ground and drops slightly with elevation. A temperature or thermal inversion is a condition where the temperature actually increases with altitude within a layer in some part of the troposphere. In other words, there is a layer of warm air over cold air. The effect of this is that surface-heated air rises through the lower levels only until it reaches the inversion layer. There the rising air is suddenly cooler (less dense) than the air above or around it and so it stops rising. Convection is thus halted, and the air is effectively trapped, together with any pollutant it carries, as long as the inversion persists. The Mae Moh Power Plant is located in a valley especially prone to dangerous level of pollution when inversions put lids air circulation. Mountain can help create inversions because heat is radiated from the tops of mountains faster than it is from valleys. As air next to cool mountain slope is cooled, it pours down the sides of the mountains and fills the valley with cool air, aggravating and often creating inversion conditions that are favorable to accumulation of air pollution.

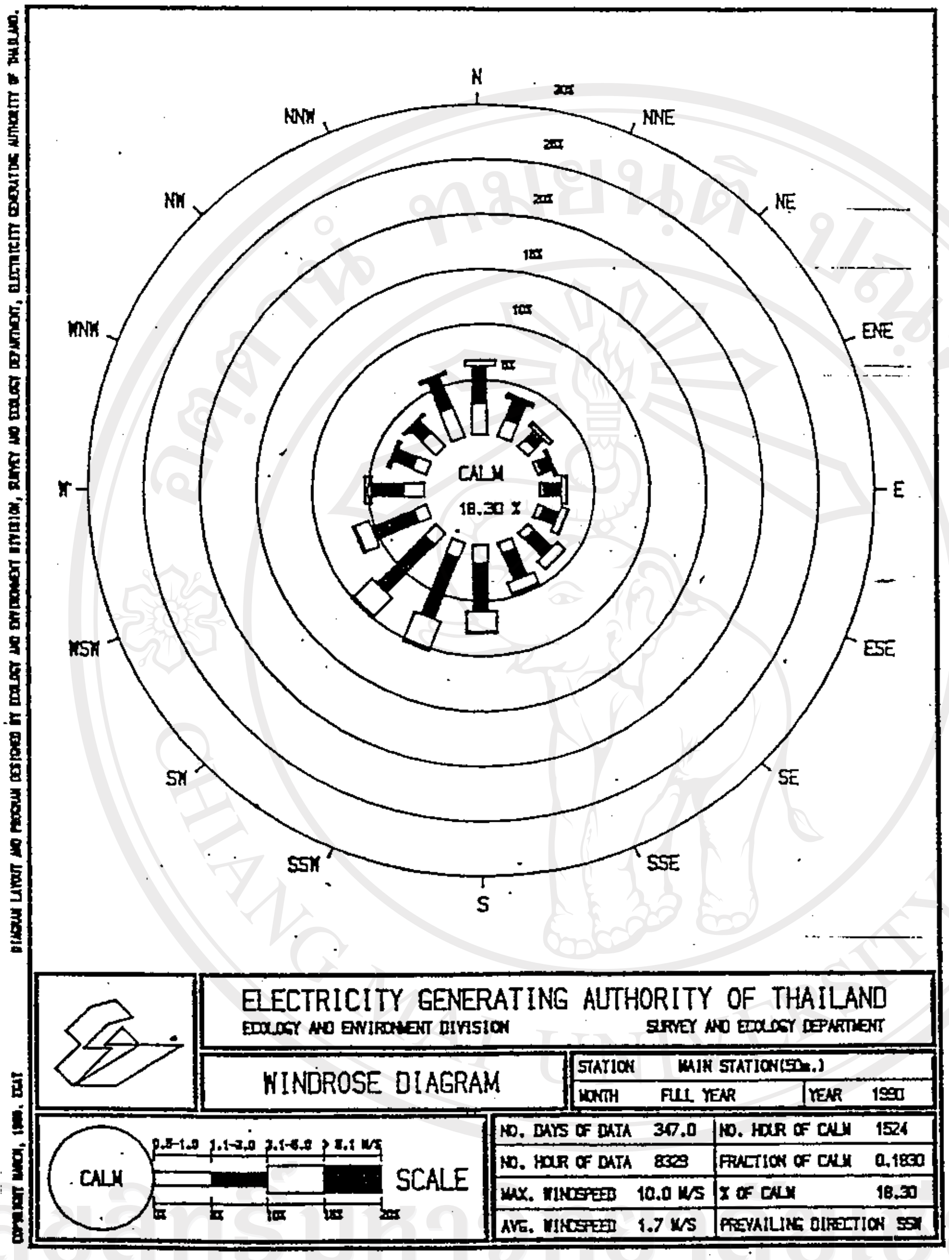

Figure 3.7.a. Windrose diagram. Annual

Source: EGAT

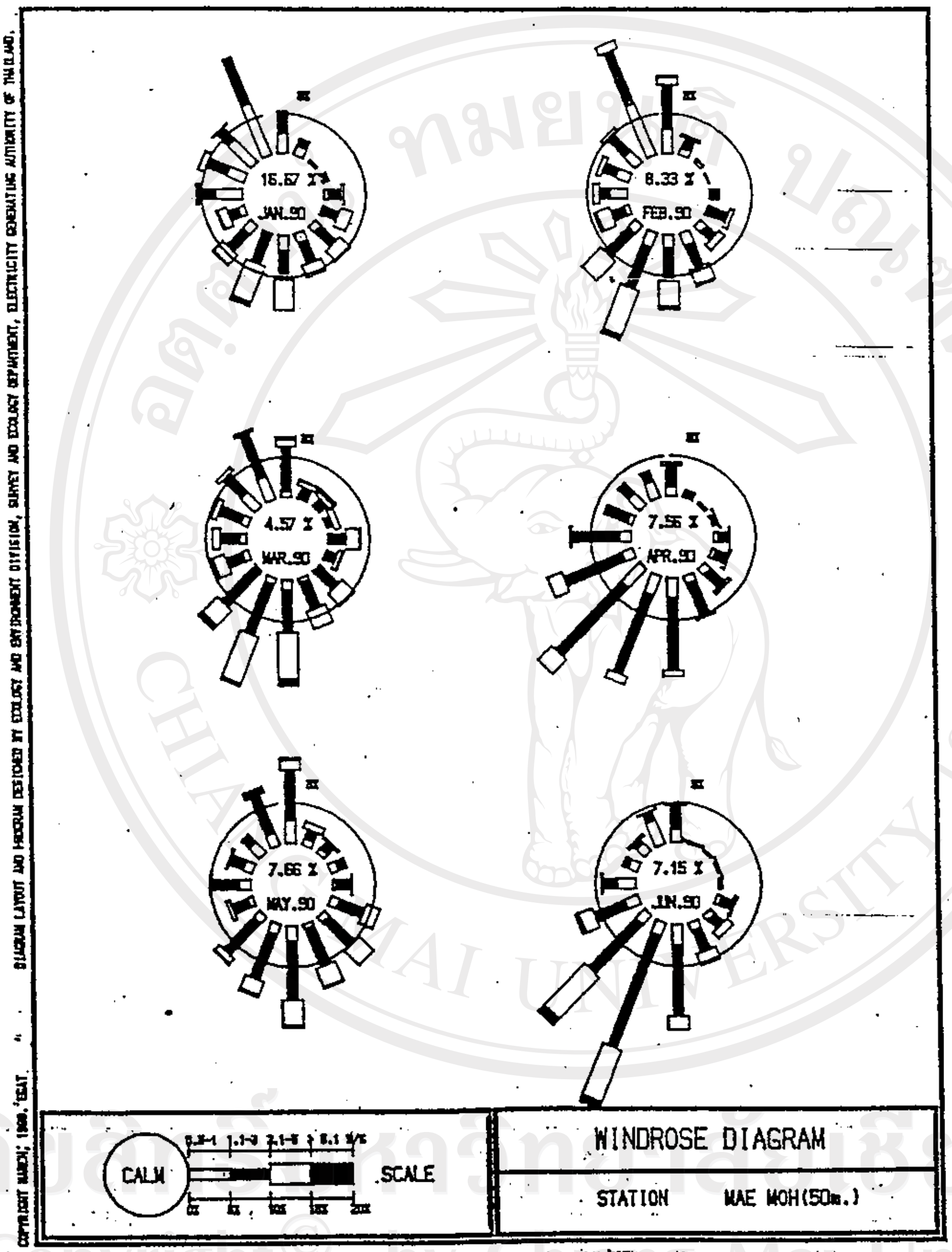

Figure 3.7.b. Windrose diagram, January to June

Source : EGAT

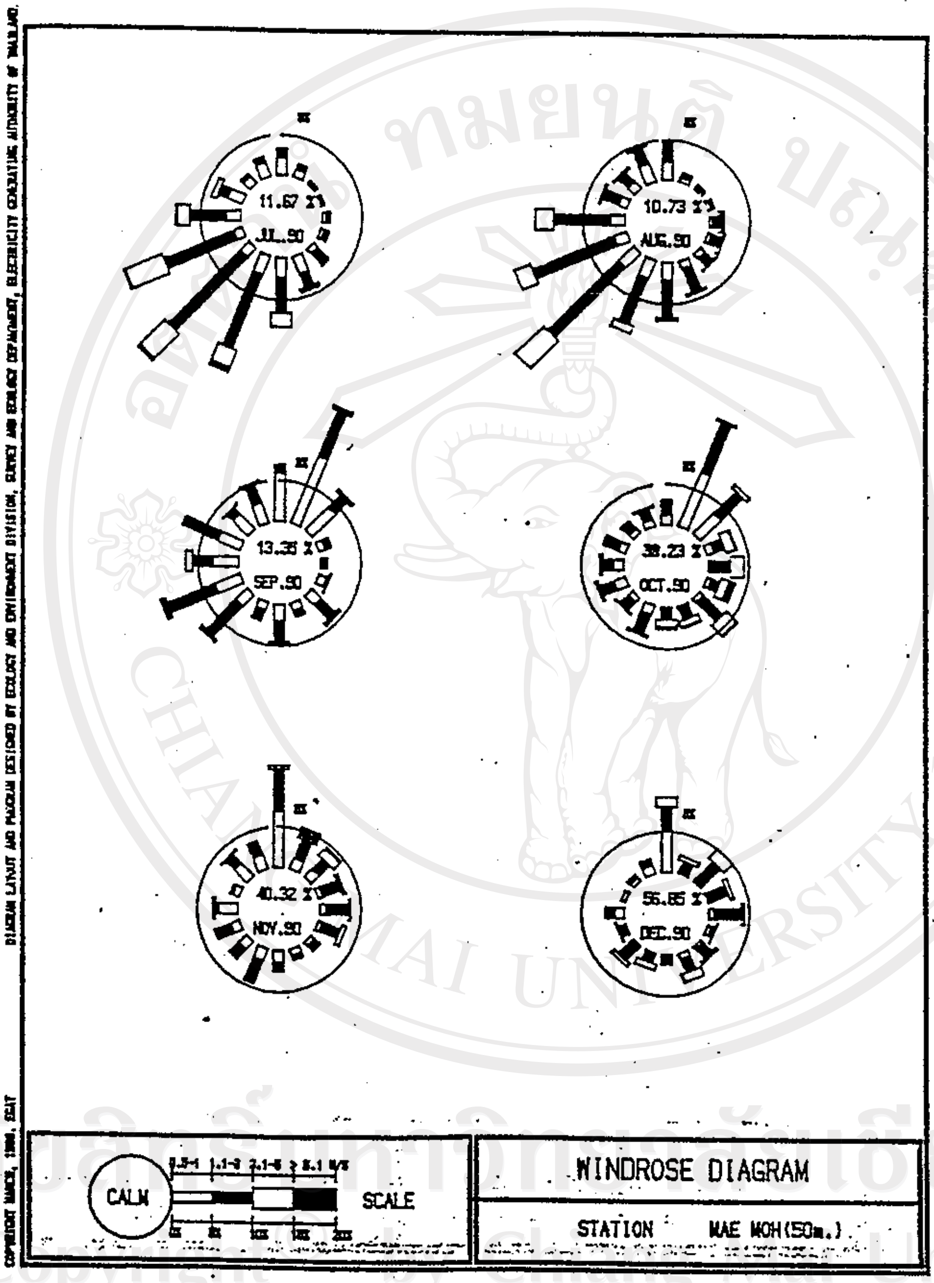

Figure 3.7.c. Windrose diagram. July to December

Source : EGAT

3.4. Vegetation- Forest type

The forest in the area can be classified as degraded deciduous and deciduous dipterocarp-oak forest often with much bamboo and secondary growth. Most common tree species existing in forest including the following species: *Tectona grandis; Xylia xylak kerrii; Shorea obtusa; Dipterocarpus obtusifolius, Dipterocarpus tuberculatus, Dipterocarpus alatus, Terminalia......* Beside above tree species, various kind of bamboo as described below were found distributing over the area: *Dendrocalamus mepavocen, D. nudus, Bambusa tulda, Thyrsostachys siamensis, Oxytenanthera alsociliata, and Ceaphalostachyum pergracile...*

The forest was repeatedly exploited by British logging company and State Railway Department. As for Lampang, about 45-59 percent of the total area was cleared during the years 1973-1977. Human factor was considered the topmost one affecting the forest deterioration. Illegal logging still continues destroy remain forest and forest fires are common. A vegetation analysis for each study site is given in Appendix 1.

3.5. Mae Moh Mine and Power Plant

3.5.1. Background history

The Mae Moh Mine is the largest lignite mine in Thailand with reserve of 1460 million tons. It started operation in 1955 and at present can supply a maximum 30,000 tons of lignite daily. The mining operation is an open pit which is divided into two activities: overburden removal and lignite mining. Overburden removal activities include excavation of top soil and hard material in the mining area. The uncovered lignite is drilled, blasted send and then excavated and loaded into rear dump trucks, which hand it to the crushers. The crushed lignite is then transferred to the lignite stockyard by three sets of conveyor belts.

Mae Moh Power Plant is Thailand's second largest power source providing about 25 percent of the country's total supply. A small lignite-fired power plant with two 6.25 MW generating units started operation in 1960 and lasted until 1978. When the EGAT took over the operation of the Lignite Authority in 1969, lignite exploration has been expanded to locate and exploit potential lignite reserves for power generation.

The first three 75 MW generating units were installed at Mae Moh Power Plant in 1978-1981. In 1980, with advanced technology and high efficiency equipment, further surveys of EGAT revealed the lignite reserve to be over 500 million tons. Therefore, the Mae Moh Lignite Power Plant planned 10 generating units with a total capacity of 1,725 MW. Further exploration in 1987, resulted a lignite reserve of over 1,000 million tons and led to the expansion of the power plan up to 14 units with a total capacity of 2,925 MW. The daily lignite consumption would be 75,800 tons in 1995. This amount of lignite should produce ash at least of 22,740 tons per day (Table 3.2) According to the EGAT power development plan, the ultimate capacity of 4,725 MW of lignite power plant will be reached in the year 2001 with the completion of Lampang units 6 and the lignite production will be increased to approximately 30 million tons annually as required by the power plants.

3.5.2. Calculation of potential movement of some trace and major elements from fly ash

The amount of ash cumulated each year can be calculated based on the amount of lignite consumption. The Mae Moh lignite contains approximately 30 percent ash which after burning generates 80 percent fly ash and 20 percent wet or bottom ash. Assuming that the plant works 365 days per year at full capacity. Tables 3.3 shows the concentration of some elements in fly ash and bottom ash potential movement of the elements in the area around the mine and power plant. The increase in total trace element content of soil arises from the deposition of lignite-fired power plant effluent. These calculation were based upon 2,5 and 10 cm soil depth in the area of 135 km^2 (the Mae Moh valley area), area with a radius of 3, 5 and 10 km from the power plant respectively and the assumption that 1% of fly ash escapes to surrounding area with soil bulk density of 1.5 g/cm3. The data indicates quite a small changes in total concentrations of elements.

Table 3.2. Estimated Lignite Consumption and Ash Production in Mae Moh Power Plant

Year	Units	Capacity MW	Lignite Consumption Daily T [a]	Lignite Consumption Annual T [b]	Ash Production Daily T [a]	Ash Production Annual T [b]
1978	1	75	1500	540000	450	16200
1979 - 1980	2	150	3000	1080000	900	32400
1981 -1983	3	225	4500	1620000	1350	48600
1984	4	375	10900	3924000	3270	1177200
1985	6	675	14100	5076000	4320	1555200
1986 -1988	7	825	17300	6228000	5190	1868400
1989	8	1125	23800	8568000	7140	2570400
1990 -1991	9	1425	30800	11088000	9240	3326400
1992	10	1725	37800	13608000	11340	4082400
1993 -1994	11	2025	44800	16128000	13400	4824000
1995	12-13	2625	75800		22740	

Total ash produced	33559200
Fly Ash	26847360
Bottom Ash	6711840

Source: [a]: Ratanasthien (1991)
[b]: Calculation assuming Plant works on full capacity in 360 days a year

Table 3.3. Estimated Concentration of some elements enriched surface soil

Element	Total amount in fly ash (T)	Concentration insurface soil (Area: 135km^2)			Area around 5 km			Area around 10 km		
		10 cm	5 cm	2 cm	10 cm	5 cm	2 cm	10cm	5 cm	2 cm
Al (%)	2,633,726	0.14	0.28	0.70	0.22	0.44	1.11	0.11	0.22	0.55
Fe	2,955,894	0.16	0.32	0.79	0.25	0.50	1.25	0.12	0.25	0.62
Ca	1,715,546	0.09	0.18	0.45	0.145	0.29	0.73	0.72	015	0.32
Mg (ppm)	319,483	170	340	850	271	542	1355	136	271	660
As	5,718	3.05	6.10	15.2	4.85	9.70	24.2	2.4	4.85	12.1
Co	905	0.48	0.96	2.41	0.76	1.53	3.84	0.38	0.76	1.92
Cr	1,785	0.95	1.90	4.76	1.51	3.03	7.57	0.76	1.51	3.78
Mn	15,625	8.83	16.66	41.67	13.3	26.5	66.3	6.6	13.3	33.1
Mo	534	0.28	0.57	1.42	0.45	0.90	2.26	0.72	0.45	1.13
Ni	1,431	0.76	1.52	3.81	1.24	2.42	6.07	0.62	1.24	0.31
U	167	0.09	0.18	0.44	0.14	0.28	0.70	0.22	0.14	0.35
V	3,517	1.88	3.75	9.38	2.98	5.97	14.9	1.49	2.98	7.4

Source: Calculation