# CHAPTER IV

# ENVIRONMENTAL GEOLOGY OF CHANGWAT BURIRAM

## 4.1 Natural Resources

Determination of resources potential means the assessment of the present condition of the resources and the opportunity for incremental development and optimizing the utilization, bearing in mind the need for rehabilitation and conservation of the deteriorating environment.

The major problem in natural resources of Changwat Buriram is a lack of water during dry season. Thus, all information concerning the surface water and groundwater potential is a necessary requirement. In the first part of this chapter, the analyses of water resources are performed particularly to investigate the surface water potential and the latter part will be focused on groundwater potential.

### 4.1.1 Water resources of Changwat Buriram



#### 4.1.1.1 Surface Water



Water quality is essential in planning the development and management of water resources within a river basin system. The uses of water and water quality are considerably shown in Table 4.1

Most of activities in Changwat Buriram is concerning with water, for example, irrigation, fishing and potable water supply, which are likely to be the basis for water pollution control in the region as well. However, the magnitude of any change will depend on the degree of the water use and the effect of that use on water quality.

The Lam Nam Mun Basin is extensive and contains many centers of population, the site for industry and irrigated agricultural land. All these activities will seemingly change the quality of the surface water. However, minimum flow conditions in the streams will give rise to the worst quality conditions but will not affect the major water uses unless large quantities of pollutants are released after water use in cities, industry or agriculture. At the present time, very little data are available on the type of industry and sizes of industrial plants in the basins. It is understood that population centers do not have central wastewater treatment plants and it can be assumed that much of the small-scale industry is located in or near cities. Therefore, it is likely that the points where stream water quality is degraded most will be immediately downstream of the largest cities in the basin.

If surface water is used without treatment for drinking and washing purpose, the upstream waste discharges should be carefully controlled, particularly from the point of view of pathogens and toxic materials.



#### 4.1.1.1.1 Water Quality for Irrigation

Irrigation is the largest water use in this region. When water is applied to cultivation land, some of it may be lost as surface flow or by direct surface evaporation, while the remainder infiltrates into the soil for subsequent evapotranspiration. The major water quality for irrigation is salinity. The salinity of irrigation water is expressed in terms of the total dissolved solids (TDS).

**4.1.1.1.2 Water Quality Analysis**

Naturally, the pure water is uncommon. Water, basically, will probably contain some substances that derived from the natural environment and from the waste products of man's activities. These constituents are basic criteria in the determination of water quality to satisfy the requirements of water uses. Unfortunately in this study, there are data available to determine the fluctuation of the water quality in a year round.

The attention was made here to make rough estimates of the water condition and to obtain the basic information on water quality in these river basins. As a result, there is generally no toxic substance and serious problem in water pollution. The salinity is low and will be decreased during the flooding period. The other qualities are not greater than the steam quality standard for fishing, irrigation and potable water. However, the management the water quality in the future will be necessary to analyse the information on the following:



- Present quality conditions in the river system at low flows.
- Location of individual industrial plants and municipal waste discharges.
- Classification of industrial plants into types of processing and magnitude of waste discharge.

- Location of agricultural operation likely to cause pollution and their evaluation.
- Water resources and uses throughout the basin.

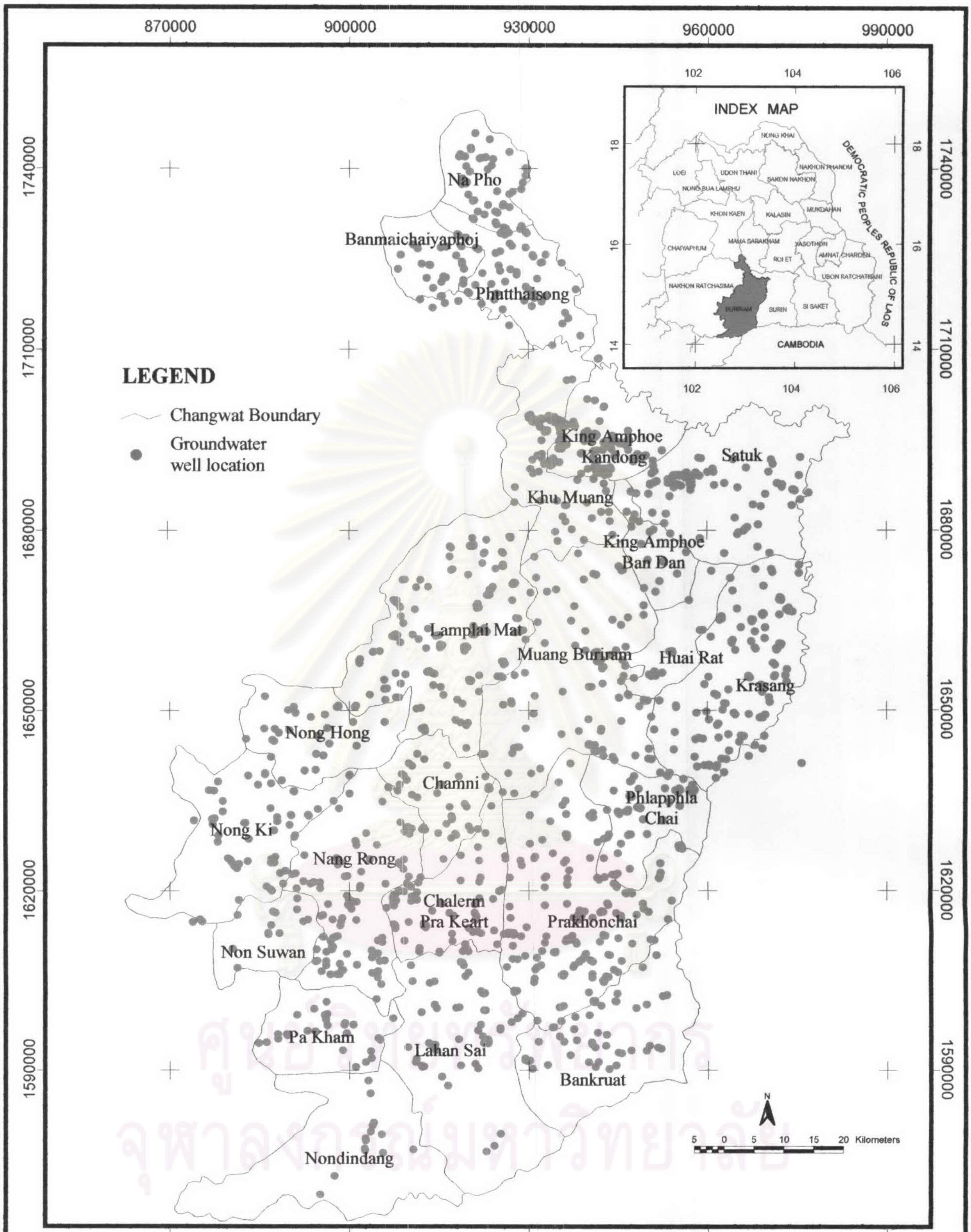
#### 4.1.1.2 Groundwater

The 1,500 water wells, obtained from the DMR selected to reveal the groundwater condition in the study area are shown in Figure 4.1.

#### 4.1.1.2.1 Groundwater Potential Analysis

**a. Water Quality -** The water quality analysis has been conducted by Groundwater Division, DMR, from collected water sample during 1988-1989 and 1998-1999. The parametres of water quality analyzed in the study area consist of total iron (Fe), chloride ($Cl^-$), nitrate ($NO_3^-$), total dissolved solids (TDS), total hardness as CaCO3, and the power of hydrogen ions (pH). They were extensively studied in order to determine the acceptable limits for standard potable water for drinking (GROUNDWATER ACTS B.E. 1977; Table 4.1). However, in case that the chemical content of groundwater is extremely higher than the standard, the new classification needs to be established.

**I The Power of Hydrogen Ion (pH) -** Groundwater quality map of pH is shown in Figures 4.2 and 4.3. The map shows the value of pH within the suitable limit of drinking water standard (pH: 6.5-9.2) in major portion of the whole study area during 1988-1989. But in 1998-1999, the water samples were collected particularly in king




# ENVIRONMENTAL GEOLOGY OF CHANGWAT BURIRAM

Figure 4.1 Groundwater well location of Changwat Buriram
(Source: 1. Groundwater Division, DMR, nodate)

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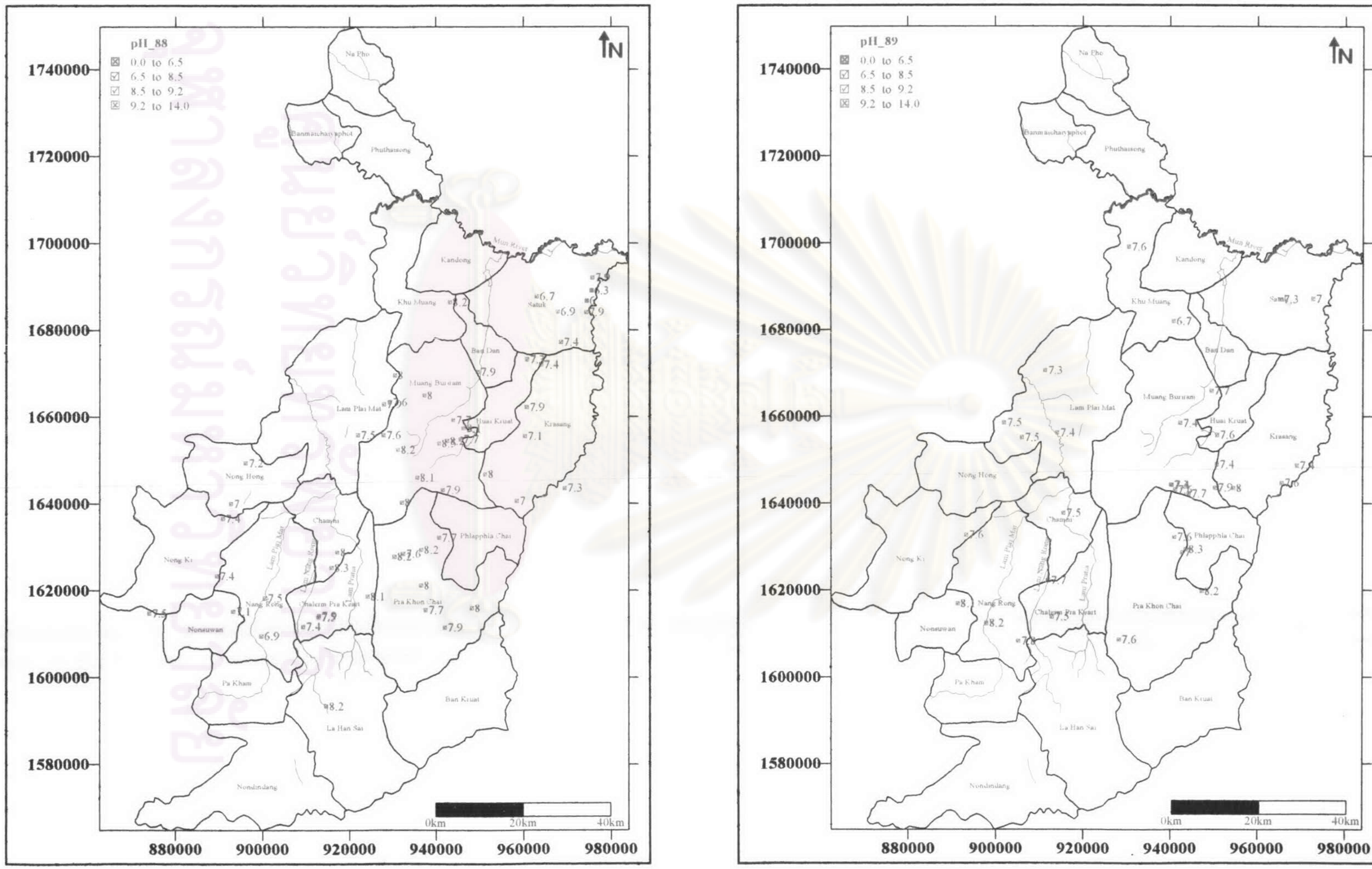


Figure 4.2 pH Value in Groundwater of Changwat Buriram in 1988-1989

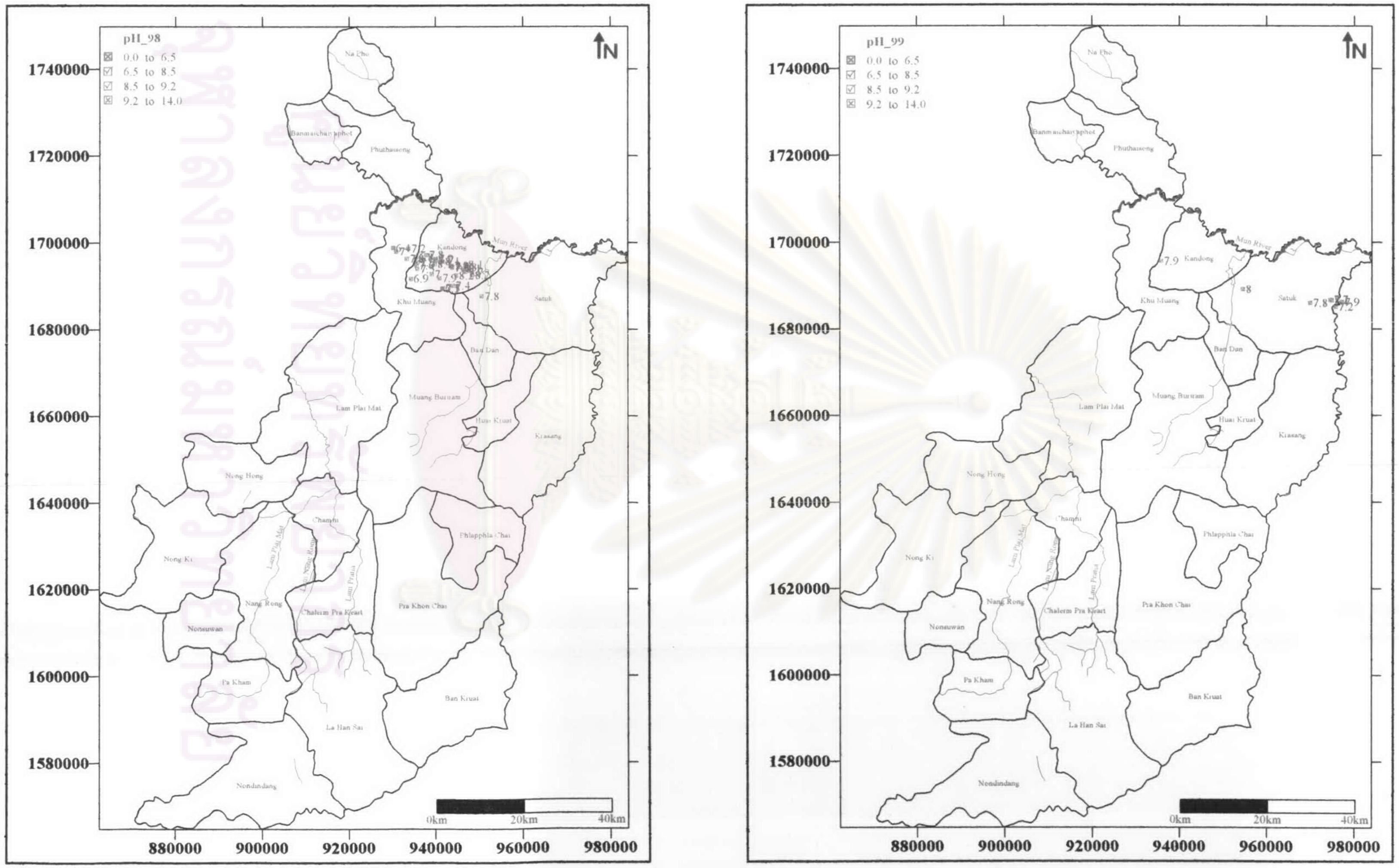


Figure 4.3 pH Value in Groundwater of Changwat Buriram in 1998-1999

amphoe Kandong and amphoe Satuk. In conclusion, these pH values show within the suitable limit of drinking water standard.

Table 4.1 Standard of groundwater quality, GROUNDWATER ACTS B.E. (1977).

| **Physical Characteristics** | | |
|---|---|---|
| **Criterion** | **Maximum Acceptable Limit** | **Maximum Allowable Limit** |
| Color | 5 (Platinum-cobalt) | 50 (Platinum-cobalt) |
| Turbidity | 5 (Units) | 20 (Units) |
| PH | 7.0-8.5 | 6.5-9.2 |
| **Chemical Characteristics** | | |
| **Criterion** | **Maximum Acceptable Limit (ppm.)** | **Maximum Allowable Limit (ppm.)** |
| Iron (Fe) | 0.5 | 1.0 |
| Mangnanese (Mn) | 0.3 | 0.5 |
| Copper (Cu) | 1.0 | 1.5 |
| Zinc (Zn) | 5.0 | 15.0 |
| Sulphate ($SO_4$) | 200 | 250 |
| Chloride (Cl) | 200 | 600 |
| Fluoride (F) | 1.0 | 1.5 |
| Nitrate ($NO_3$) | 45 | 45 |
| Total hardness as $CaCO_3$ | 300 | 500 |
| Non-carbonate hardness as $CaCO_3$ | 200 | 250 |
| Total solids | 750 | 1,500 |
| **Toxic Characteristics** | | |
| **Criterion** | **Maximum Acceptable Limit (ppm.)** | **Maximum Allowable Limit (ppm.)** |
| Arsenic (As) | - | 0.05 |
| Cyanide (CN) | - | 0.2 |
| Lead (Pb) | - | 0.05 |
| Mercury (Hg) | - | 0.001 |
| Cadmium (Cd) | - | 0.01 |
| Selenium (Se) | - | 0.01 |

| **Biological Characteristics** | |
|---|---|
| **Criterion** | **Maximum Acceptable Limit** |
| Standard plate count | Not more than 500 colonies per cubic centimeters |
| Most probable number of coliform organism (MPN) | Less than 2.2 per 100 cubic centimeters |
| E. coli | - |

**II Chloride** - Since the chloride content within groundwater in the study area is very high, comparing to the standard, thus, the chloride analysis in this study is classified into 4 levels upon the standard of drinking water of Groundwater Acts B.E (1977).

| | | | |
|---|---|---|---|
| Level I | 0-200 | ppm. | Low chloride content |
| Level II | 200-600 | ppm. | Moderate chloride content |
| Level III | 600-1,000 | ppm. | High chloride content |
| Level IV | 1,000-5,000 | ppm. | Very high chloride content |

Figures 4.4 and 4.5 display the chloride concentration in groundwater within the study area. The chloride concentration varies within the range of 5-3,600 ppm. The area where the chloride content less than the suitable quality (less than 200 ppm.) and not exceed the maximum quality allowed (600 ppm.) is located in the lower part of the study area. High and very high chloride content are concentrated in central part further to the north in 1988-1989 (amphoe Lam Plai Mat, amphoe Krasang, amphoe Satuk and king amphoe Kandong). Based on data during 1998-1999, it can be concluded that the chloride concentration in king amphoe Kandong and amphoe Satuk is a suitable limit of drinking water standard.

**III Total Iron (Fe)** The new classification for iron content was carried out as follow:

| | | | |
|---|---|---|---|
| Level I | 0.0-0.5 | ppm. | Low total iron content |
| Level II | 0.5-1.0 | ppm. | Moderate total iron content |
| Level III | 1.0-10.0 | ppm. | High total iron content |
| Level IV | 10.0-100.0 | ppm. | Very high total iron content |

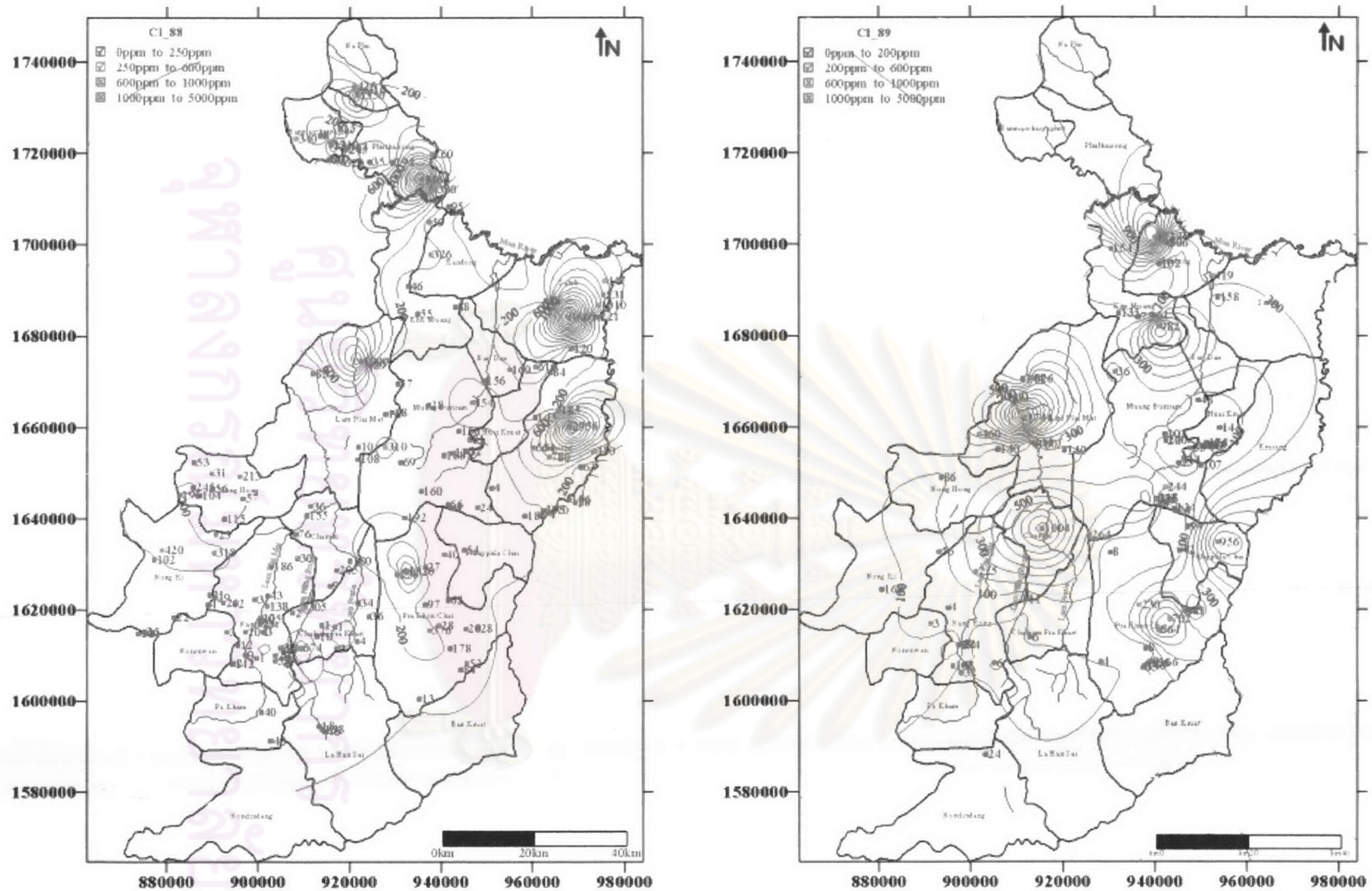


Figure 4.4 Chloride concentration in groundwater of Changwat Buriram in 1988-1989

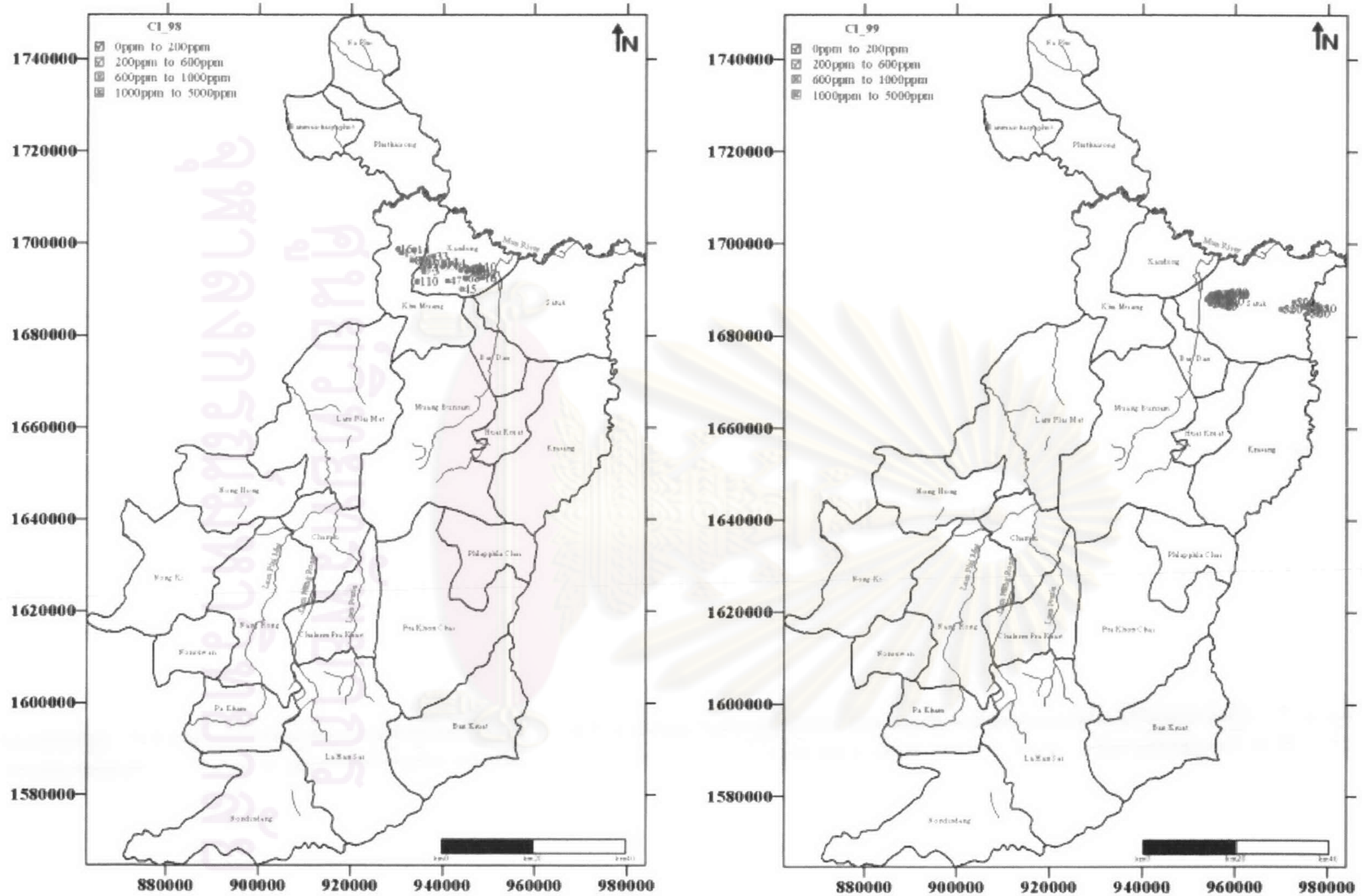


Figure 4.5 Chloride concentration in groundwater of Changwat Buriram in 1998-1999

Figures 4.6 and 4.7 display the total iron concentration of groundwater in the study area. Generally, the total iron concentration ranges from 0-70 ppm. The less suitable quality zone (less than 0.5 ppm.) and not exceed the maximum allowable limit (1.0 ppm.) is located in the central and southern parts of the study area. High and very high total iron content are concentrated in the western (amphoe Nong Ki, amphoe Nang Rong, amphoe Nong Hong, and amphoe Nonsuwan), eastern (amphoe Prakhonchai, amphoe Krasang and amphoe Phlapphlachai) parts further to the north (king amphoe Kandong and amphoe Banmaichaiyaphoj). It is interesting to note that the presence of total iron concentration appears to be related to the chloride content in the groundwater. Therefore, the zone that high chloride concentration was found will be the area where the total iron is high as well. It should also be remarked here that volcanic rocks, basalt in particular, provide the high total iron concentration in this area.

**IV Nitrate ($NO3^-$) -** The nitrate concentration maps are shown in Figures 4.8 and 4.9. The concentration of nitrate varies from 0 to 50 ppm. The whole study area shows the low concentrations of nitrate that is under the standard drinking water (not exceed 45 ppm). Most nitrates in natural water come from organic sources or probably from industrial and agricultural chemicals. Common nitrate concentrations in water range from 0.1 to 0.3 in rainwater to as much as 600 ppm in groundwater from areas influenced by excessive applications of nitrate fertilizer or runoff from barnyards. Normal groundwater contains only from 0.1 to 10.0 ppm (Davis and De Wiest, 1966).

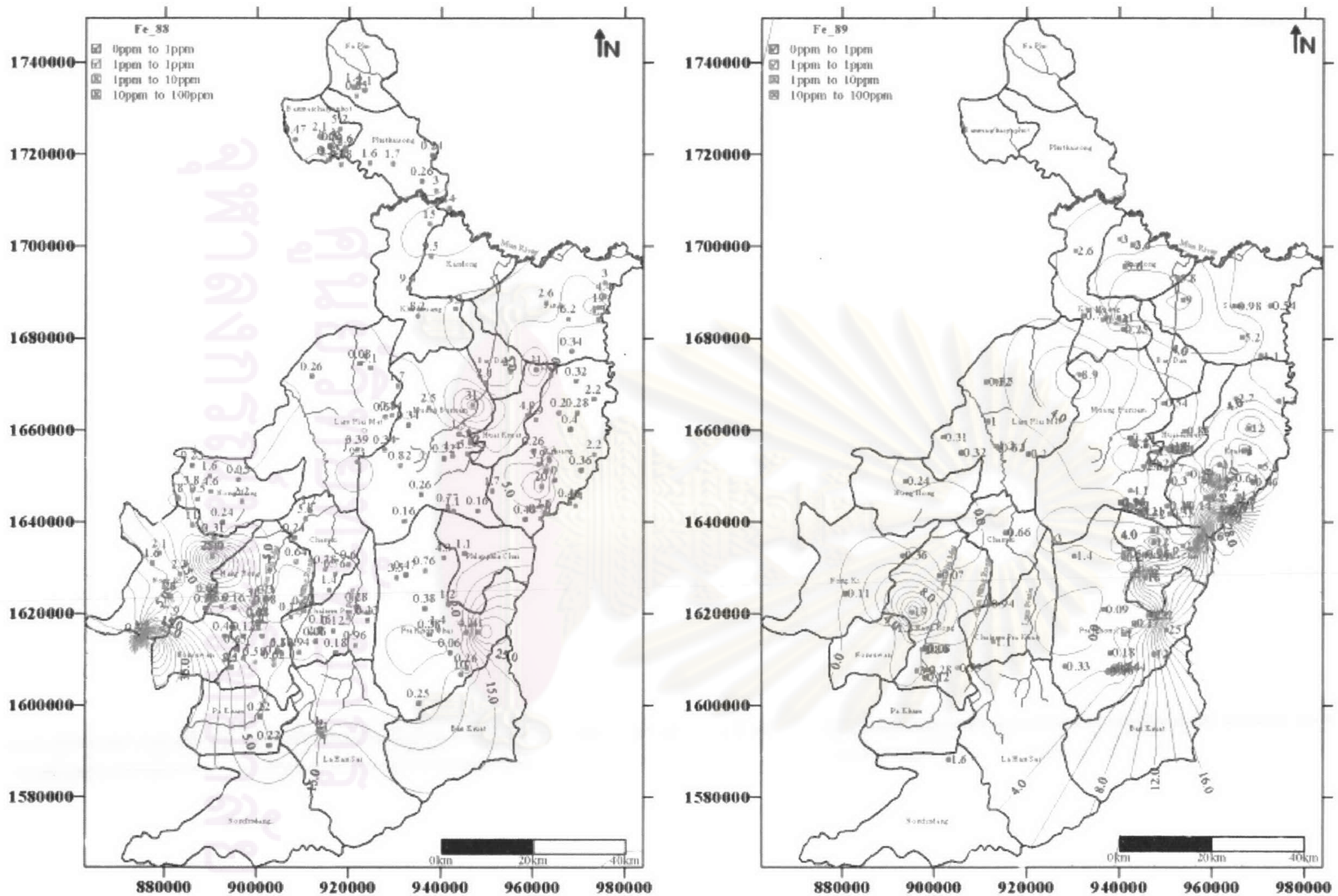


Figure 4.6 Total Iron concentration in groundwater of Changwat Buriram in 1988-1989

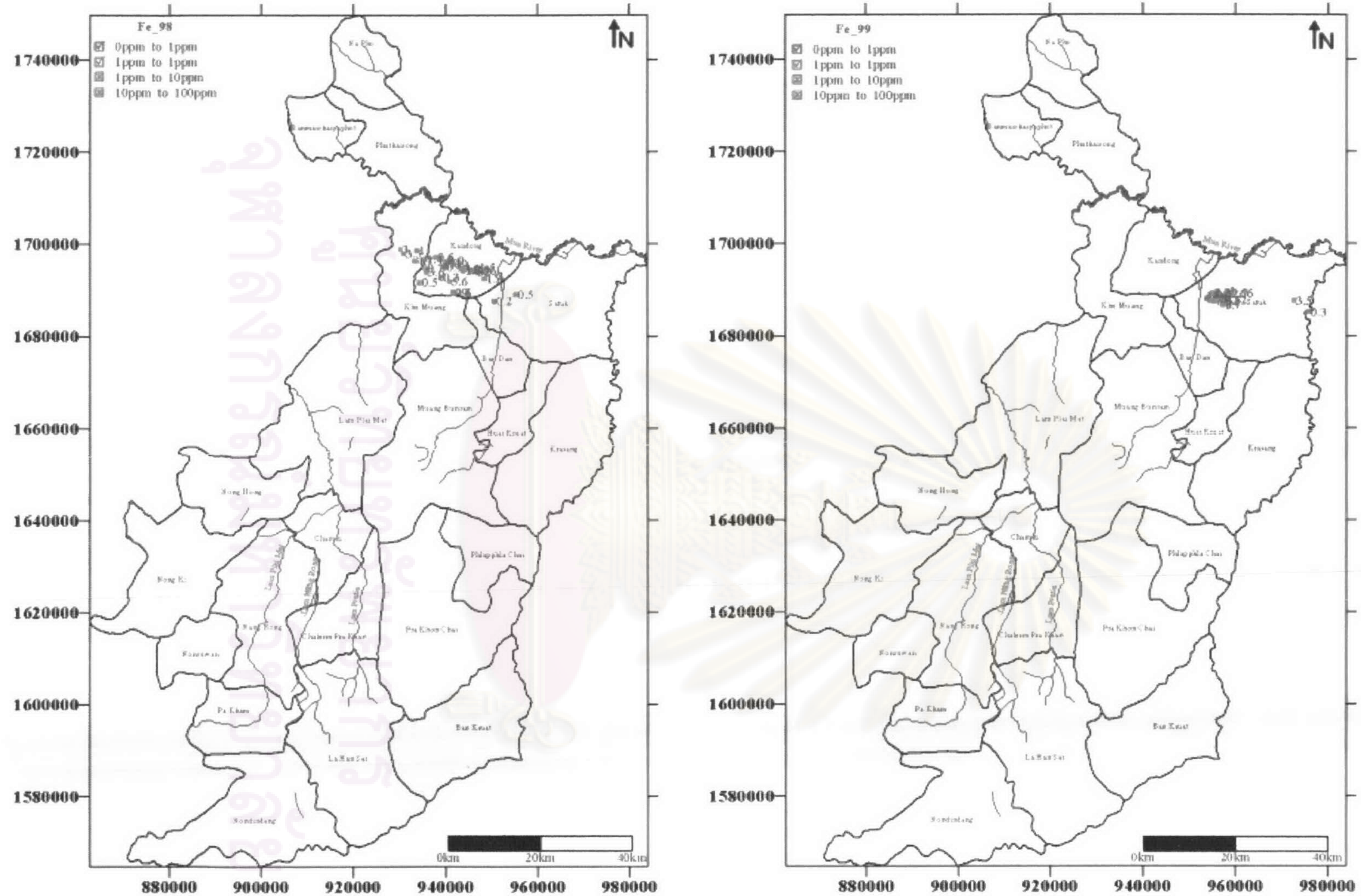


Figure 4.7 Total Iron concentration in groundwater of Changwat Buriram in 1998-1999

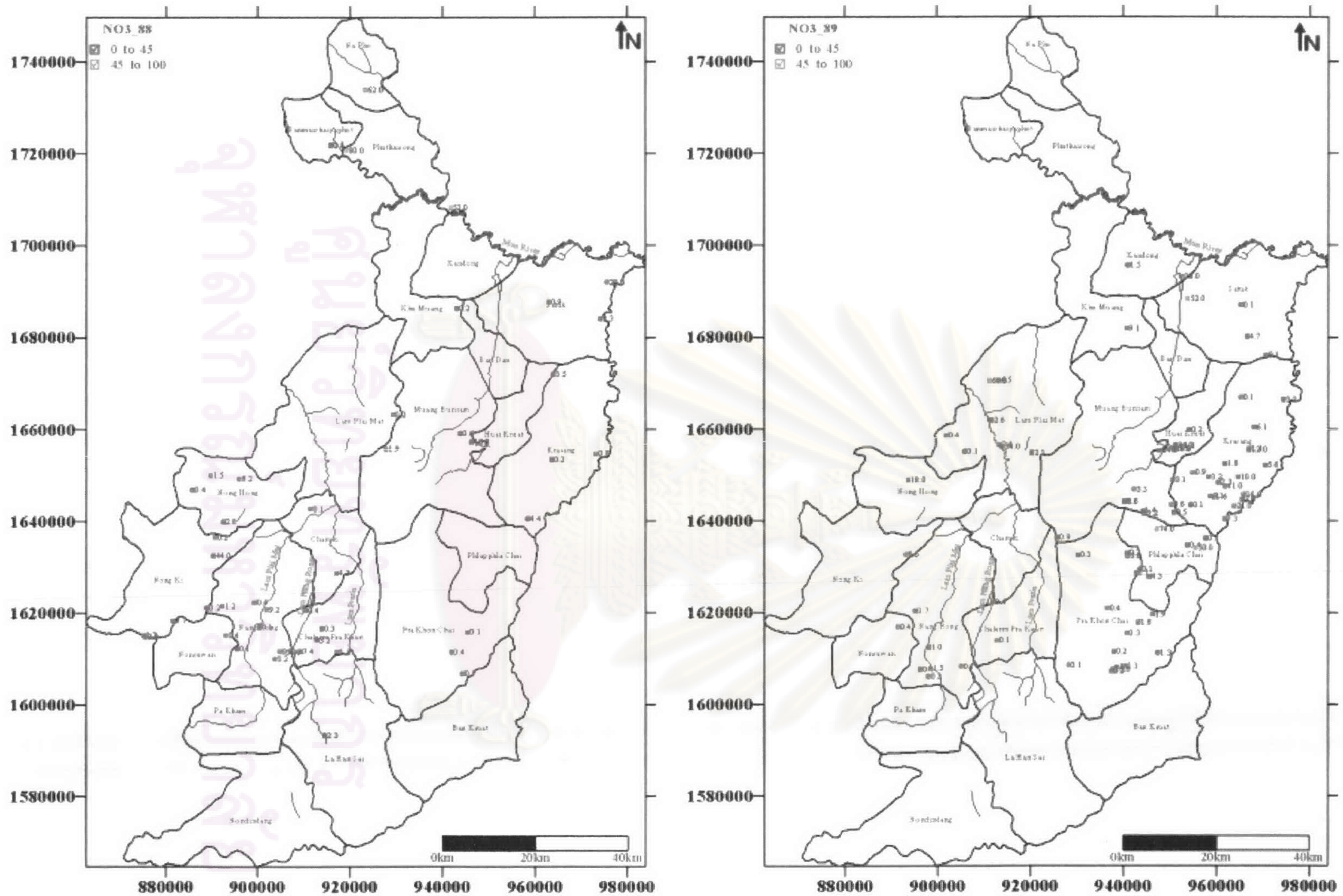


Figure 4.8 Nitrate concentration in groundwater of Changwat Buriram in 1988-1989

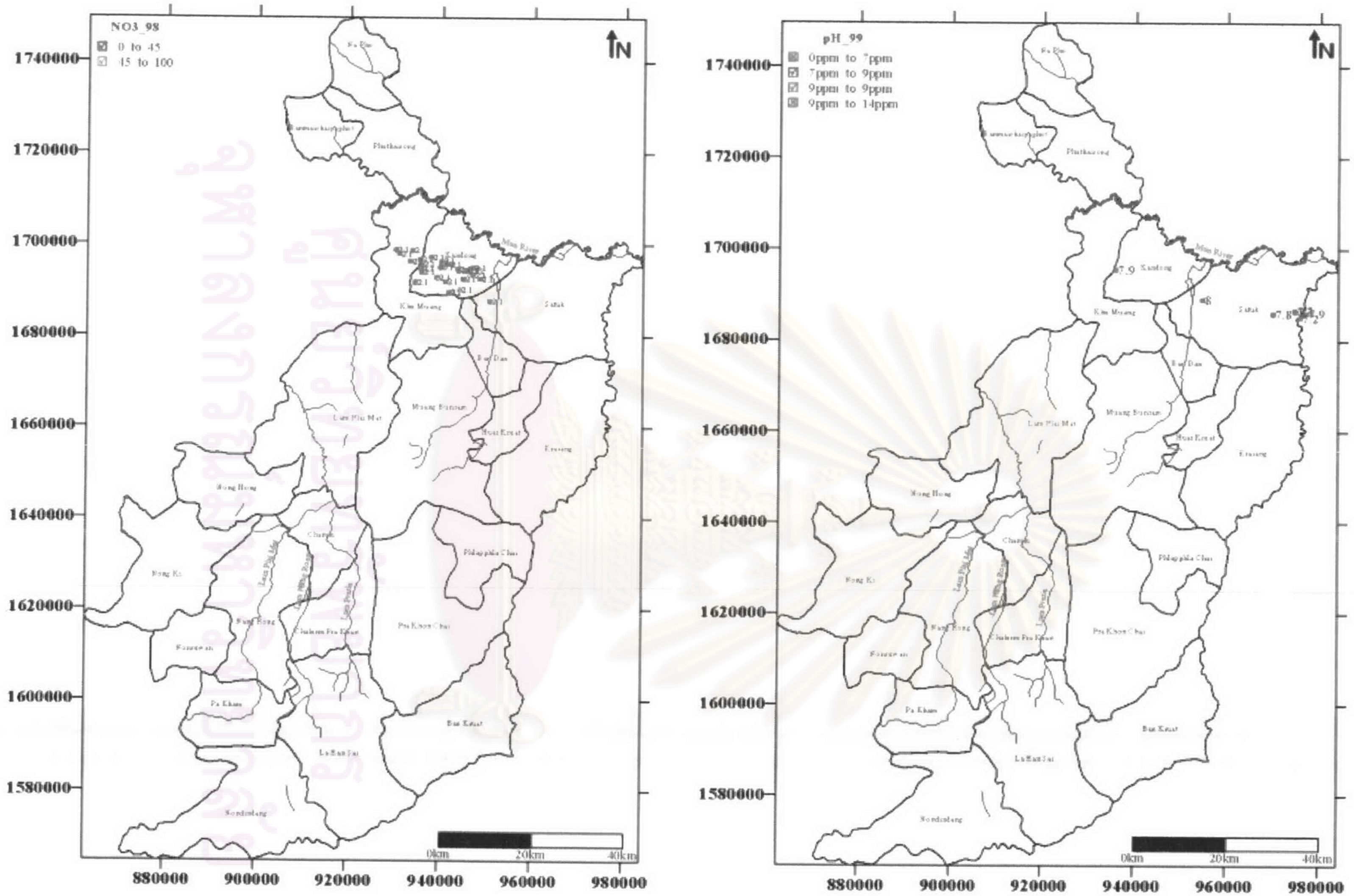


Figure 4.9 Nitrate concentration in groundwater of Changwat Buriram in 1998-1999

**V Total Dissolved Solids, TDS.** The classification of the TDS is also established. There are four levels as follow:

| | | | |
|---|---|---|---|
| Level I | 0-750 | ppm. | Low TDS content |
| Level II | 750-1,500 | ppm. | Moderate TDS content |
| Level III | 1,500-5,000 | ppm. | High TDS content |
| Level IV | 5,000-30,000 | ppm. | Very high TDS content |

Figures 4.10 and 4.11 display the TDS concentration of groundwater in the study area. The TDS varies within the range of 30 to 4,500 ppm. Under the standard drinking water for the suitable quality, the TDS concentration is less than 750 ppm. and not exceeds 1,500 ppm. for the maximum allowable limit. The acceptable limit for potable (< 1,500 ppm.) is located in the upper and lower parts except the central part of the area. High and very high TDS content are concentrated in the central part a bit further to the eastern part of the area (amphoe Lamplai Mat and king amphoe Ban Dan).

**VI Total Hardness.** The classification of the total hardness is also provided. There are four levels as follow:

| | | | |
|---|---|---|---|
| Level I | 0-300 | ppm. | Low total hardness content |
| Level II | 300-500 | ppm. | Moderate total hardness content |
| Level III | 500-1,000 | ppm. | High total hardness content |
| Level IV | 1,000-5,000 | ppm. | Very high total hardness content |

Figures 4.12 and 4.13 show the total hardness concentration of groundwater within the study area. The total hardness concentration falls with the range of 10 to 1,400 ppm. The concentration of total hardness under the standard drinking water is less than 300 ppm. for suitable quality and not exceeds 500 ppm. for the maximum amount allowed. The areas that total hardness is suitable are located in the central part further to the southern part of the study area (amphoe Pa Kham, amphoe Lahan Sai, amphoe Ban Kruat and amphoe Nonsuwan). The total hardness concentration appears to be low and is under the acceptable limits. The zones of over acceptable limits for drinking water are in the western part and eastern part further to the north of the study area. However, the degree of hardness (Table 4.2) is considered to be soft to moderately hard water and is located in the central further to the southern part of the area, whereas, the zone of hard and very hard water occurs in the western part and eastern part further to the north. It is interesting to note that the zone of high to very high of the total hardness content is also conformed to the areas excessive quantities of the TDS and chloride concentrations.

Table 4.2 Hardness classification of water (Sawyer and McCarty, 1967)

| **Hardness, mg/l as $CaCO_3$** | **Water Class** |
|---|---|
| 0-75 | Soft |
| 75-150 | Moderately hard |
| 150-300 | Hard |
| Over 300 | Very hard |

The tendency of these critical parametres concentration cannot be provided due to the lack of continuing collected data.

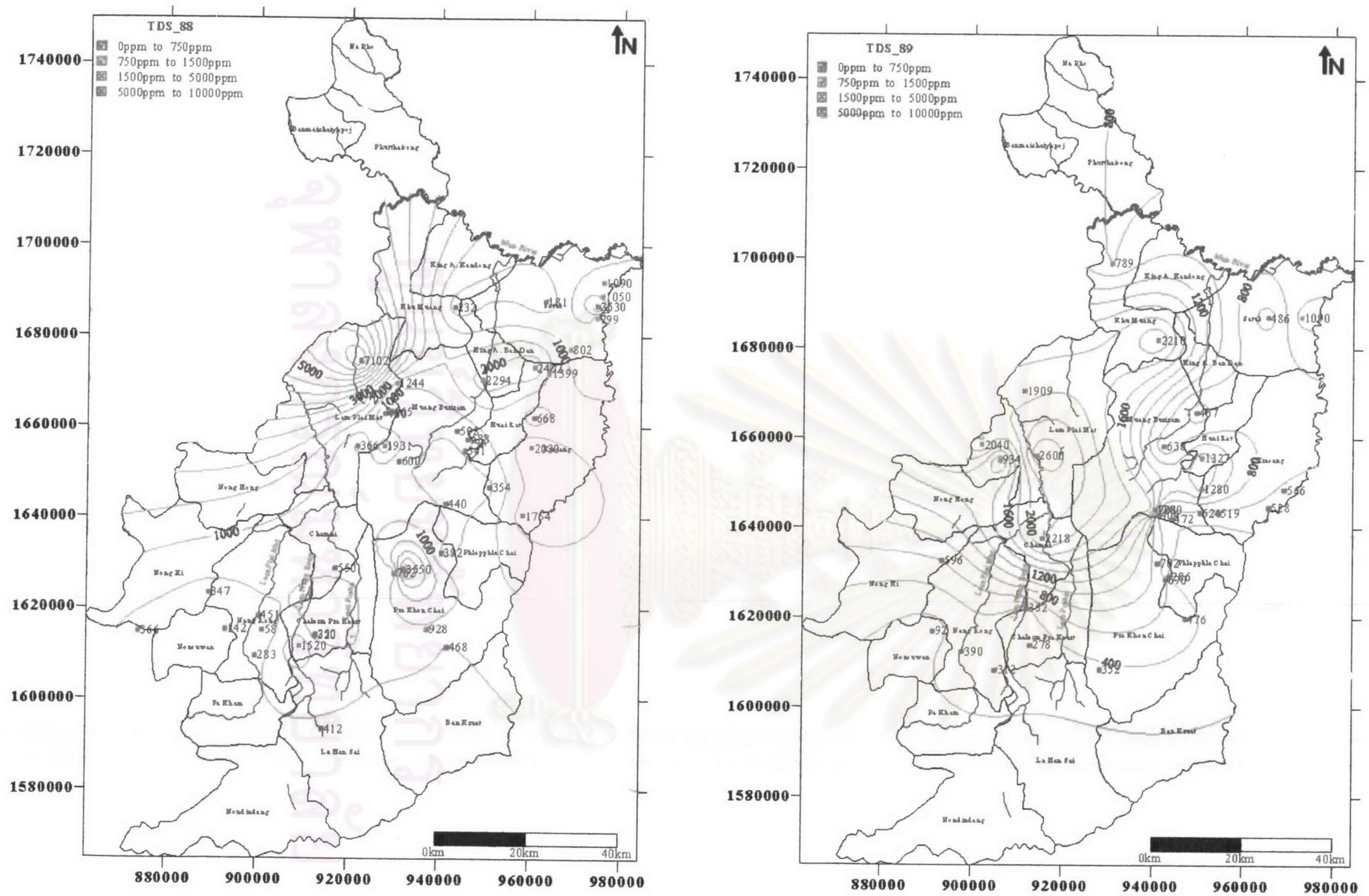


Figure 4.10 Total Dissolved Solids concentration in groundwater of Changwat Buriram in 1988-1989

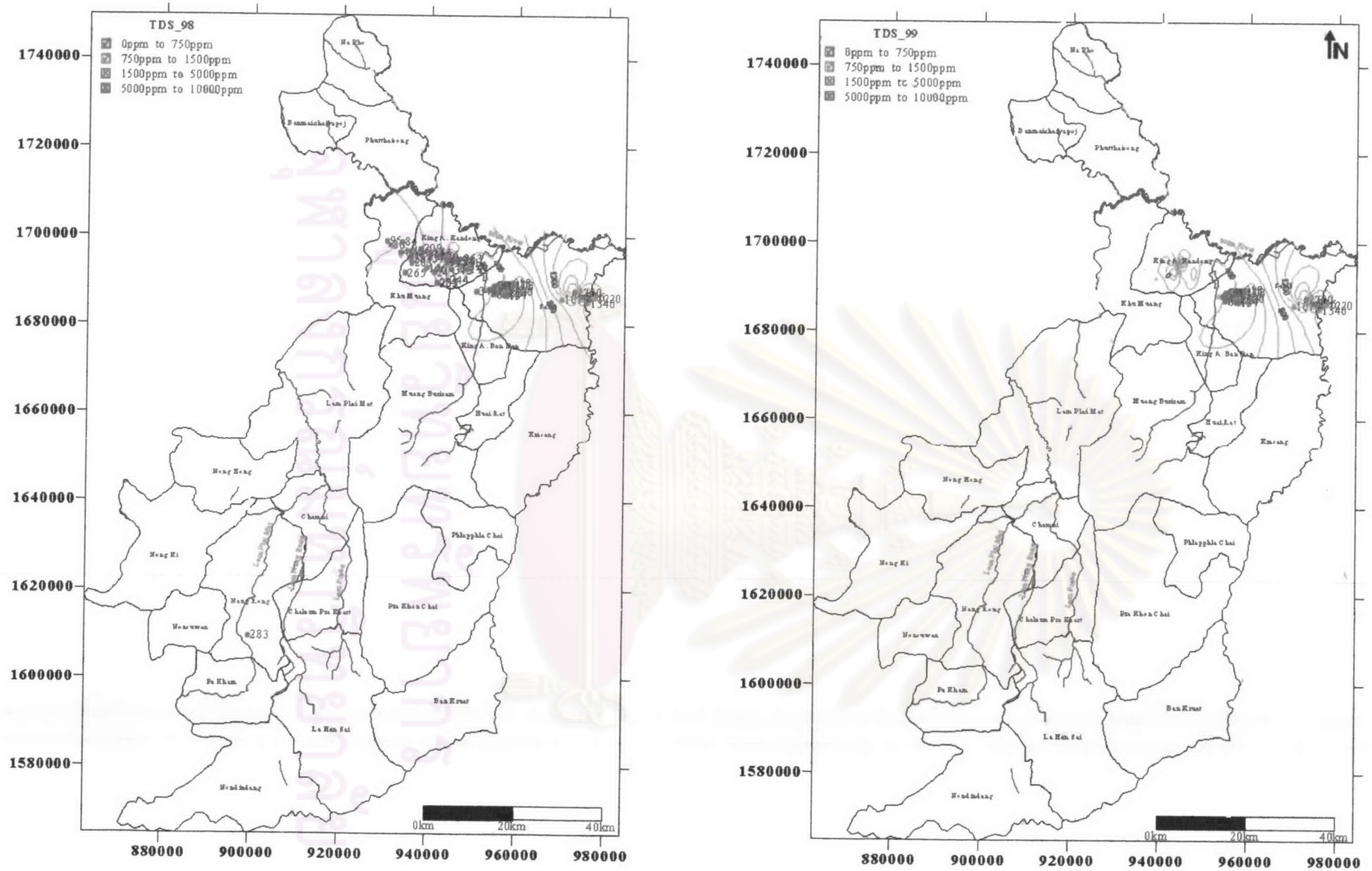


Figure 4.11 Total Dissolved Solids concentration in groundwater of Changwat Buriram in 1998-1999

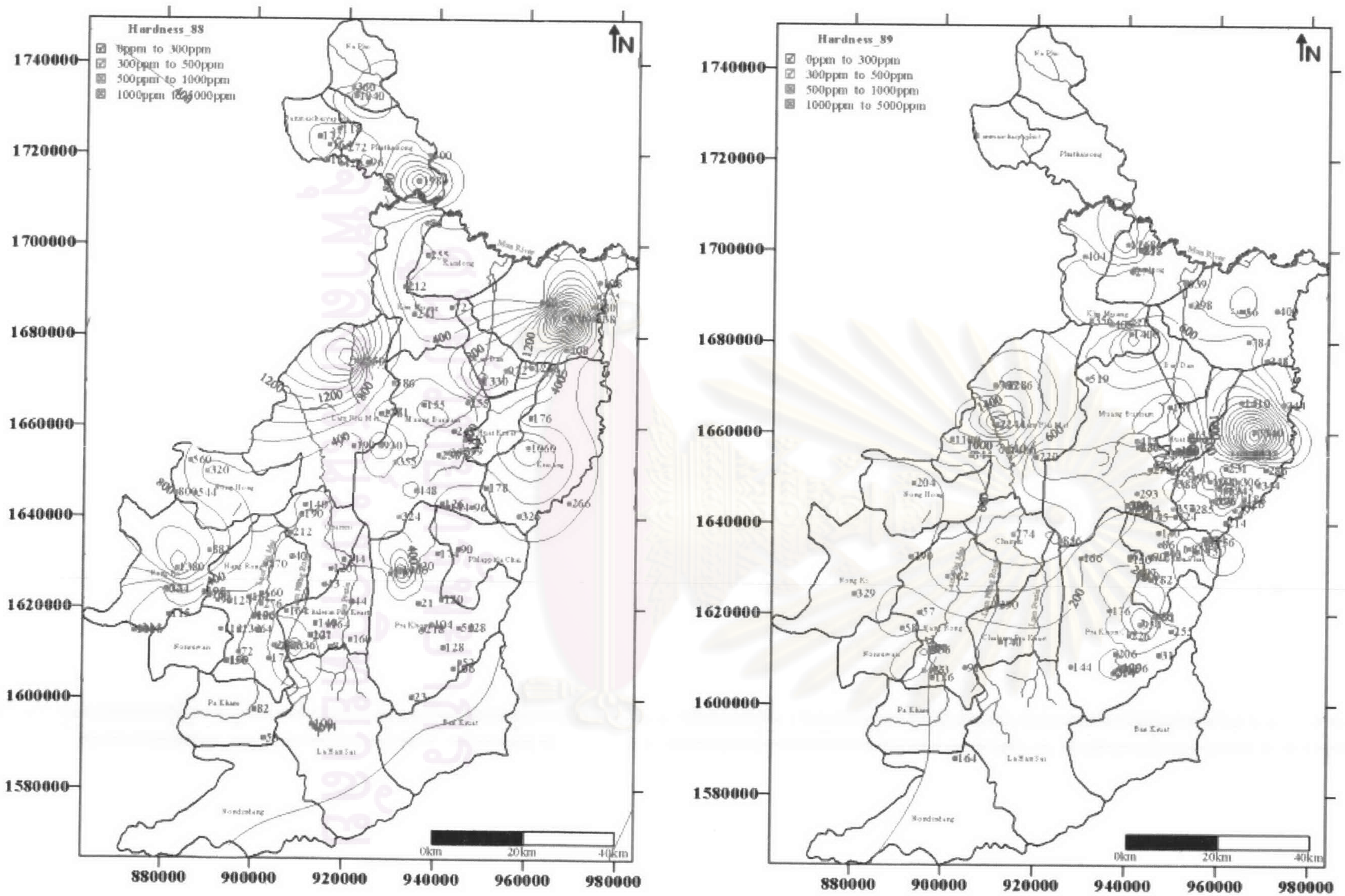


Figure 4.12 Total Hardness concentration in groundwater of Changwat Buriram in 1988-1989

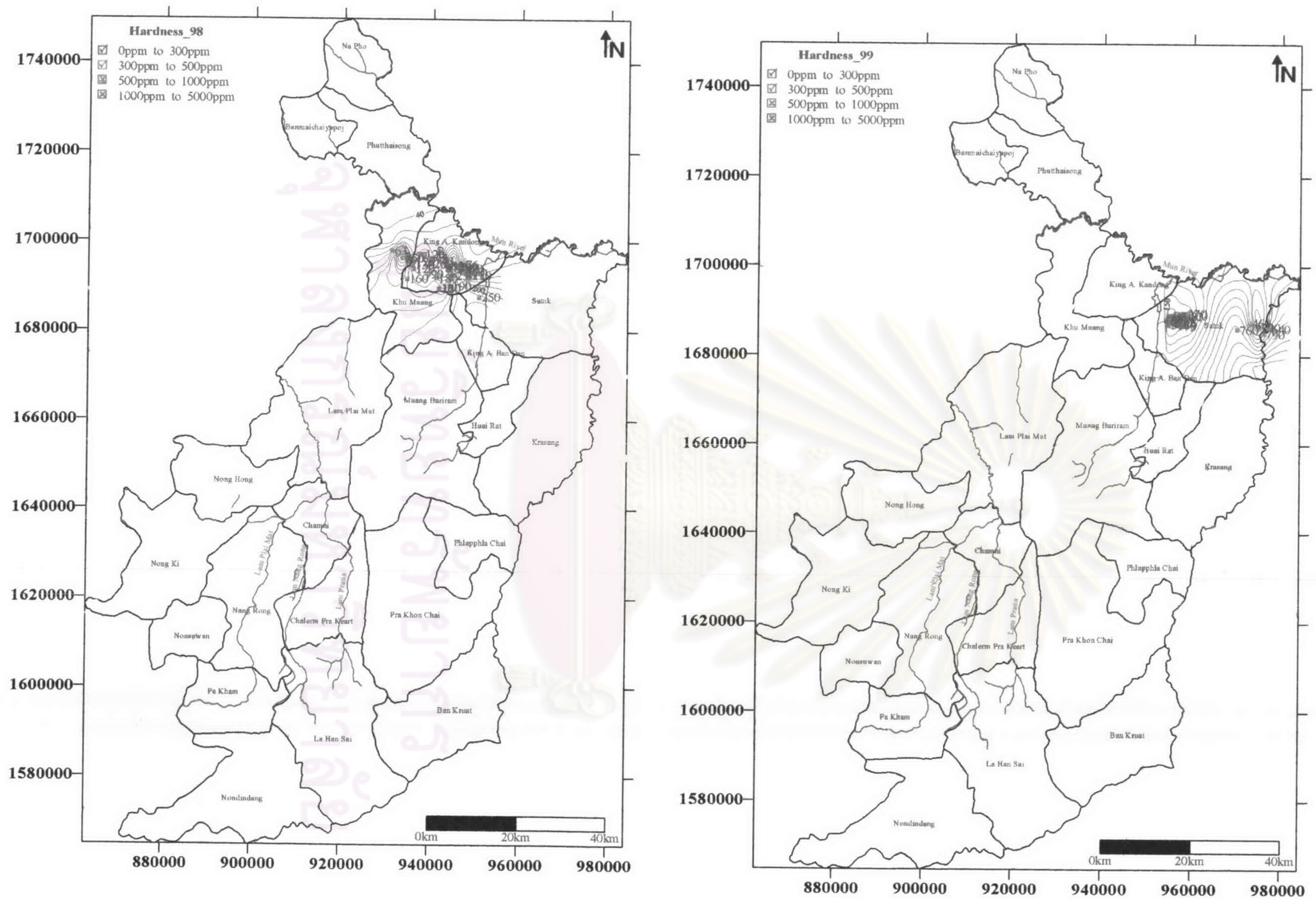


Figure 4.13 Total Hardness concentration in groundwater of Changwat Buriram in 1998-1999

**b. Hydraulic Property**

Due to a lack of data of field pumping test, the transmissivity and storativity cannot be calculated, thus, the hydraulic property, which presented in this study, is the specific capacity values only.

**Specific Capacity**

The specific capacity represents the ratio of pumping rate to the drawdown estimated during well development. The specific capacity is most useful in deciding the relative values of transmissivity, where no other information existed. The specific capacity values are varied, which depend on the type of screen, screening section, and completeness of the development (Chaungcham, 2001).

According to the result of pumping test of each well, specific capacity of well yield can be calculated by using following formula.

$$SC = \frac{Q}{DD} \quad \ldots\ldots 4.1$$

Where

SC = Specific capacity of well yield in $m^3$/day per m. of drawdown

Q = Water discharge in $m^3$/day

DD = Drawdown in m.

The specific capacity varies from 0.1 to 10 $m^3$/hr/m with the time of the pumping period, longer pumping time, and the smaller of specific capacity. That means, in one hand, the drawdown increases, on the other hand, the discharge rate decreases. Moreover, the maximum specific capacity attained relies directly on the percent of aquifer screened (Ramnarong, 1976).

As a result, analysis of specific data shows a lot of variations, thus, the specific capacity can be classified into 2 levels:

| Level | Specific Capacity ($m^3$/hr/m) |
|---|---|
| I | 0-5 |
| II | 5-50 |

The specific capacity values are displayed in Figure 4.14. The level I represents the area of adequate water for domestic wells or other low-yield uses, whereas, the level II represents the appropriate area for industrial, municipal, or irrigation purposes (assume the level as the transmissivity level from Driscoll, 1986). The level I concentrates in all the area, whereas, the level II is found a little north of the area.

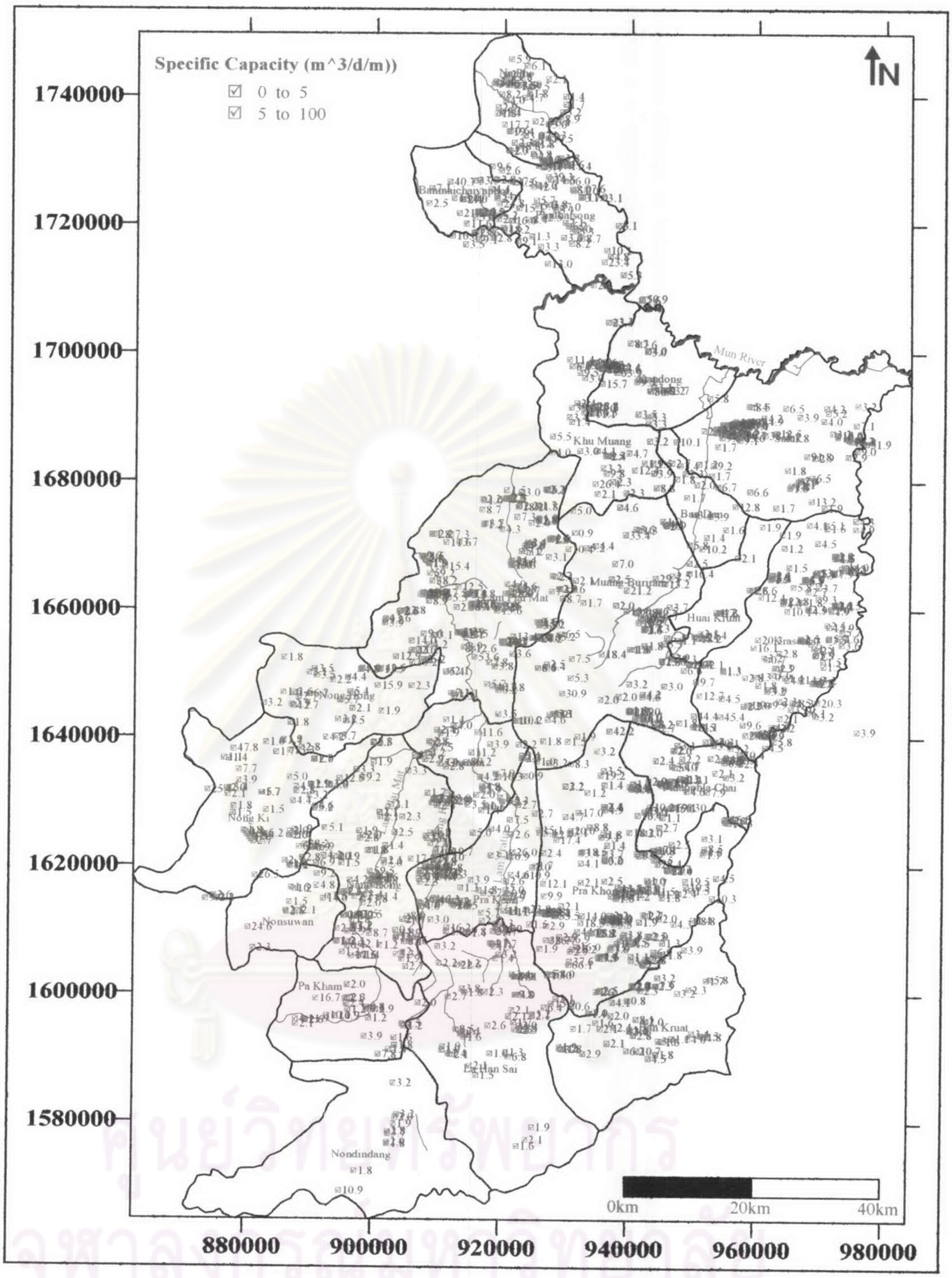




Figure 4.14 The Specific capacity from the pumping test of Changwat Buriram in 1988-1989

#### 4.1.1.2.2 Groundwater Management

Groundwater quality in Changwat Buriram has been analysed regarding, pH, chloride content, total iron content, nitrate concentration, total dissolved solids content and total hardness. As a result, these chemical parametres in groundwater vary in many places.

In general, pH values in almost areas of Changwat Buriram are suitable for drinking water. However, in 1988 and 1998, some water wells in amphoe Satuk and amphoe Khu Muang indicated that the pH values were not adequate for drinking water.

In 1988-1989, chloride concentration in groundwater of Changwat Buriram, were unsuitable for drinking water indicated by data from some water wells, particularly in amphoe Satuk, amphoe Krasang, amphoe Huai Rat, amphoe Phutthaisong, amphoe Na Pho amphoe Banmaichaiyapoj, amphoe Lamplai Mat, amphoe Chalerm Pra Keart, amphoe Prakhonchai, king amphoe Kandong, amphoe Khu Muang, amphoe Lamplai Mat, amphoe Prakhonchai, amphoe Chamni, and amphoe Phlapphla Chai. In 1998-1999, the groundwater quality data were suitable for use as drinking water only from amphoe Khu Muang and king amphoe Kandong and from amphoe Satuk.

Total iron concentration of groundwater in many places of Changwat Buriram in the year 1988-1989, was higher than suitable drinking water standard. In 1998-

1999, high to very high total iron content was recorded only from amphoe Khu Muang, king amphoe Kandong, and amphoe Satuk.

Nitrate concentration in groundwater during 1988-1989 indicates high nitrate content in amphoe Na Pho, amphoe Phutthaisong, amphoe Satuk, amphoe Phlapphla Chai, and amphoe Lamplai Mat. In 1998-1999, the concentration of nitrate from amphoe Khu Muang, king amphoe Kandong, and amphoe Satuk was suitable for using standard drinking water.

Analysis of total dissolved solids concentration in groundwater of Changwat Buriram during the year 1988-1989, revealed that high to very high total dissolved solids concentration was recorded in amphoe Satuk, amphoe Huai Rat, amphoe Muang Buriram, amphoe Krasang, amphoe Prakhonchai, amphoe Chalerm Pra Keart, amphoe Chamni, and amphoe Lamplai Mat. However in 1998-1999, total dissolved solids concentration from amphoe Khu Muang, king amphoe Kandong, and amphoe Satuk was, in turn, recorded to be appropriate for standard drinking water used.

Total hardness concentration in groundwater of Changwat Buriram in 1988-1989, showed high to very high in some water wells from amphoe Satuk, amphoe Krasang, amphoe Lamplai Mat, amphoe Huai Rat, amphoe Prakhonchai, amphoe Muang Buriram, amphoe Chalerm Pra Keart, amphoe Nong Hong, amphoe Nong Ki, amphoe Chamni, amphoe Nang Rong, and king amphoe Ban Dan. However in 1998-1999, there were some locations, such as, amphoe Khu Muang, king amphoe Kandong, and amphoe Satuk that the total hardness concentration was almost suitable for drink.

However, groundwater quality in Changwat Buriram is not appropriate to use in some places, for example, amphoe Satuk, amphoe Huai Rat and amphoe Krasang. Thus, surface water is recommended by building a reservoir.

**4.1.1.2.3 Groundwater Treatment**

Basically, there are some methods that might be able to treat the groundwater quality to get the level for standard drinking water. Hereinafter are some recommendations.

1. Chloride treatment can be done into 2 ways, distillation and ion exchange processes. Ion exchange means the change in cation and anion. Cation can use to extract Ca, Mg, Na, Fe, Mn, whereas, anion will be able to extract $HCO_3$, $SO_4$, Cl, $NO_3$. However, chloride treatment is uncommon because the cost of treatment is too expensive.

2. TDS treatment can be done by distillation, electro dialysis, and reverse osmosis processes.

3. Total hardness can be treated by water softening process. Soft water can be treated by boilable and alum swaying, whereas, hard water can be treated by adding CaO and/or $Na_2CO_3$.

4. Iron treatment can be treated by aeration and ion exchange.

5. Arsenic acid that may derive from the factory can be treated by coagulation process (adding ferricsulphate).

### 4.1.2 Waste Disposal Potential Areas

Waste disposal area is always a problem in most of cities in Thailand and the problem has only limited in recognition. In order to get better understanding on waste disposal management, it is common practice to overlook the consequences of waste disposal programs from individual site. Within the study area, the biggest waste-disposal site is recently situated at amphoe Muang and amphoe Nang Rong. The waste is basically separated into wet and dry wastes. The wet soil wastes are composed mainly of organic matters from domestic kitchens, industrial processes, farms, and restaurants. They are commonly dumped into the depression landfill and covered by the soil layer on the top. Naturally, they will be decomposed by the aerobic organisms. As a result, the end products are sometimes useful as soil conditioners or soil fertilizers.

In case of dry solid-wastes, reused materials such as glass, plastic tools, metal parts, and other renewable materials are picked up. They can then be reprocessed to use for many products of the same usage or converted into other exploitations. The combustible materials will be incinerated, which greatly reduce gas, ash, and/or changes the material to inorganic matters.

In this research, waste disposal areas are evaluated based upon the environment factors, including topography, infrastructure, existing land use and land cover, groundwater protection, forest land, and historical preservation and natural view, which are summarised and presented in Table 4.3. As a result by using the parametres in Table 4.3, the waste disposal potential areas are mostly located in amphoe Krasang (Figure 4.15). The methodology to evaluate the suitable waste disposal potential area is presented in the flow chart procedure (Figure 4.16).

Table 4.3 Environmental factors using for evaluating waste disposal potential area in Changwat Buriram (modified after Pokaew, 1999)

| **Environmental geology factor** | **Subclass** | **Limitation** |
|---|---|---|
| 1. Topography | | |
| 1.1 Slope | 20% | Buffer zone |
| 1.2 Drainage | Stream | Buffer zone 300 meters for control pollution |
| | Reservoir, pond | Buffer zone 300 meters for control pollution |
| 1.3 Flood-risk area | Possibility of flood-risk area | High to very high zone |
| | Swamp | Buffer zone 300 meters for control pollution |
| 2. Forest land | Forest-conservation | Buffer Zone |
| 3. Existing land use | Agricultural land | Agricultural area |
| | Urban land | Buffer zone 5 kilometers for control pollution |
| 4. Infrastructure | Highway | Buffer zone 300 meters for control pollution |
| 5. Historical preservation | Heritage cultural | Buffer zone 500 meters for control pollution |
| 6. Natural view | Scenic place and recreation area | Buffer zone 500 meters for control pollution |
| 7. Groundwater conditions | Yield and total dissolved solids | Yield > 2 $m^3$/ hr, TDS < 1500 mg/l |

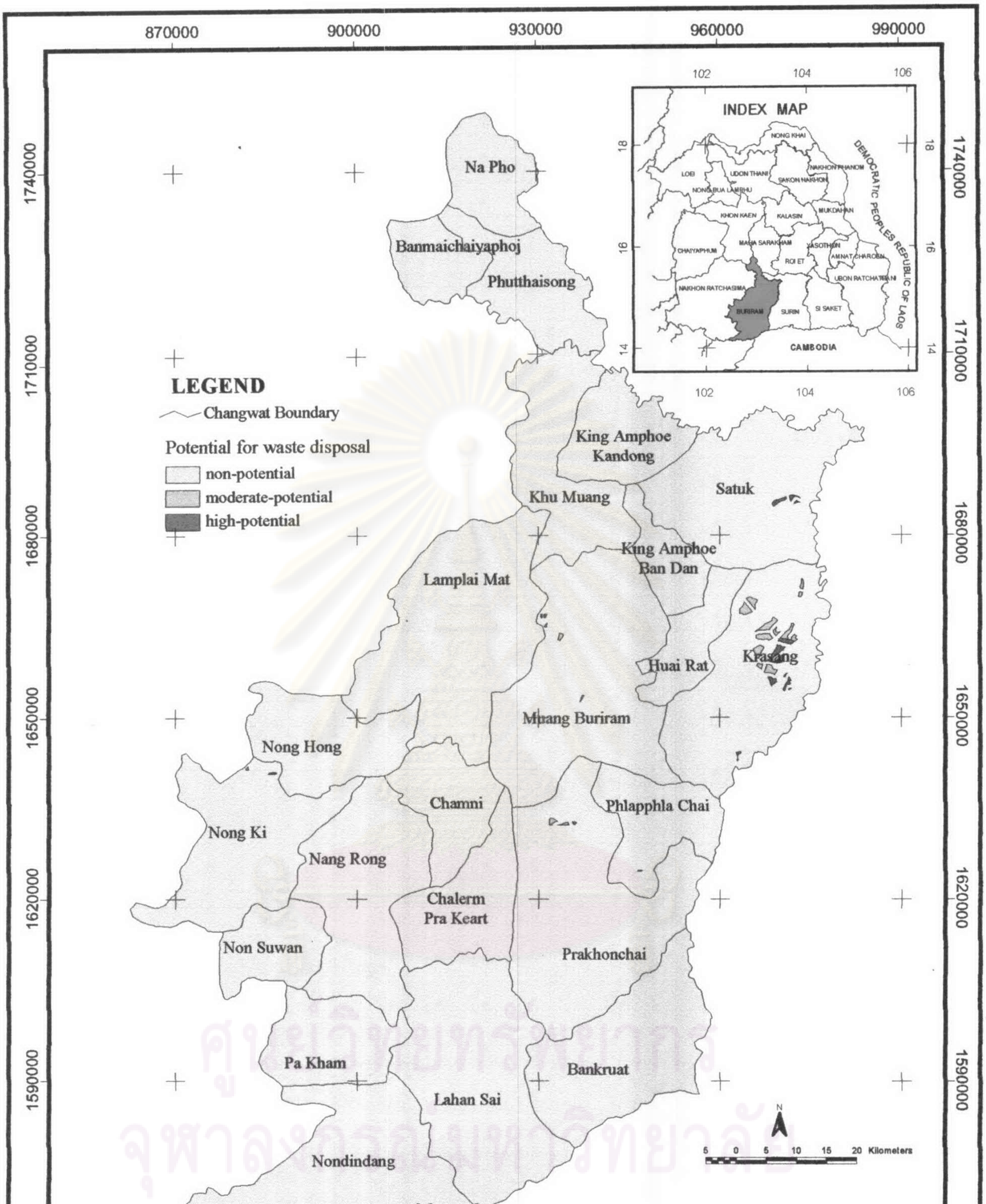


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Figure 4.15 Potential areas for waste disposal of Changwat Buriram

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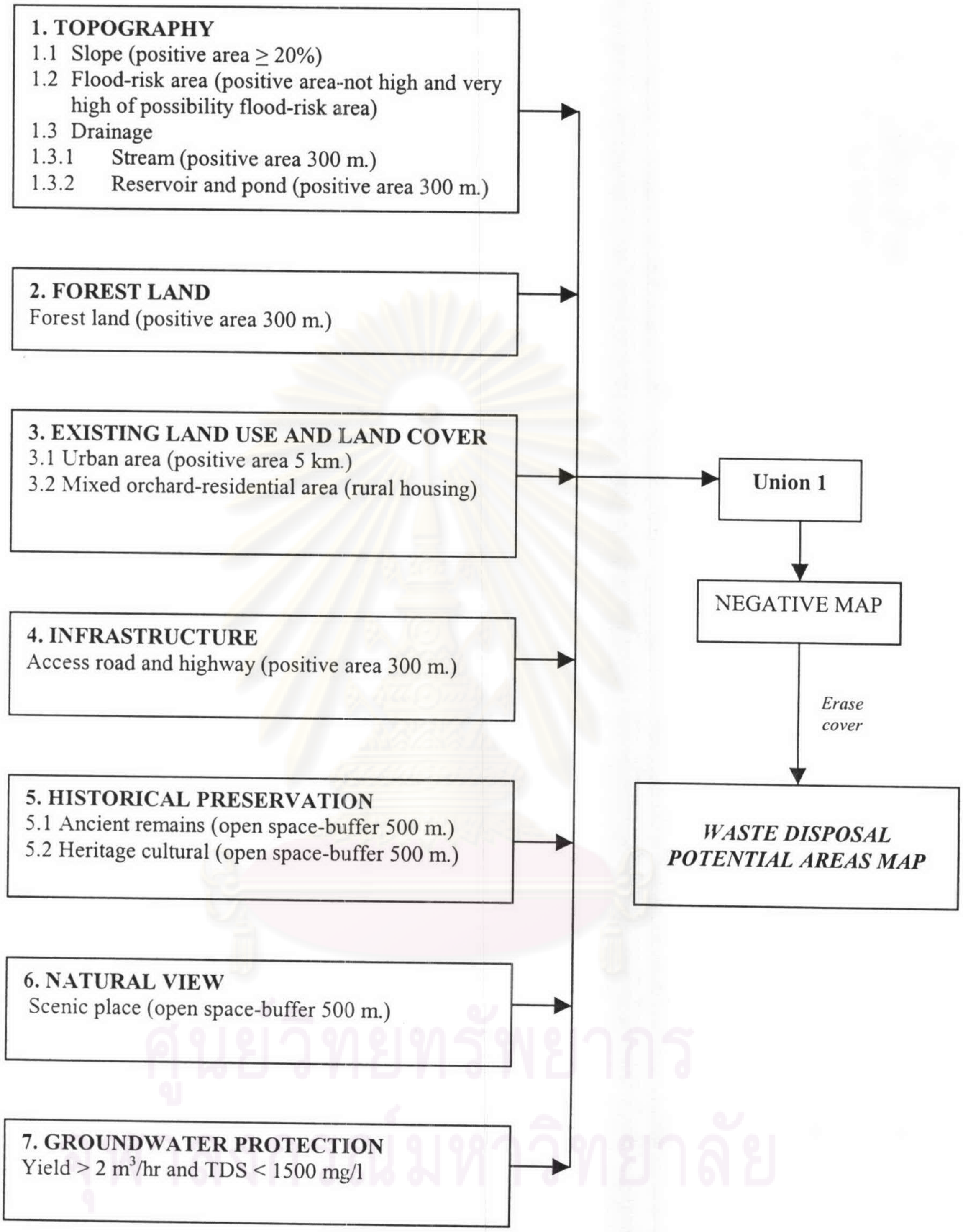


Figure 4.16 The process of evaluating waste disposal potential areas using GIS in Changwat Buriram (modified after Pokaew, 1999)