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# KINGDOM OF THAILAND



SOIL SURVEY REPORTS  
of the  
LAND DEVELOPMENT DEPARTMENT

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NO. 18 : REPORT ON THE SOIL SURVEY OF THE  
PROPOSED LAND SETTLEMENT AREA AT NAM PHONG  
(KHON KAEN PROVINCE)

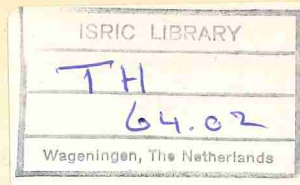
by

Tanit Tongchuta

Soil Survey Division  
Bangkok, March, 1964  
13 pages, 3 maps, 2 figs  
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SOIL SURVEY REPORTS

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No 18. REPORT ON THE SOIL SURVEY OF THE PROPOSED LAND  
SETTLEMENT AREA AT NAM PHONG (KON KHAEN PROVINCE)

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Tanit Tongchuta

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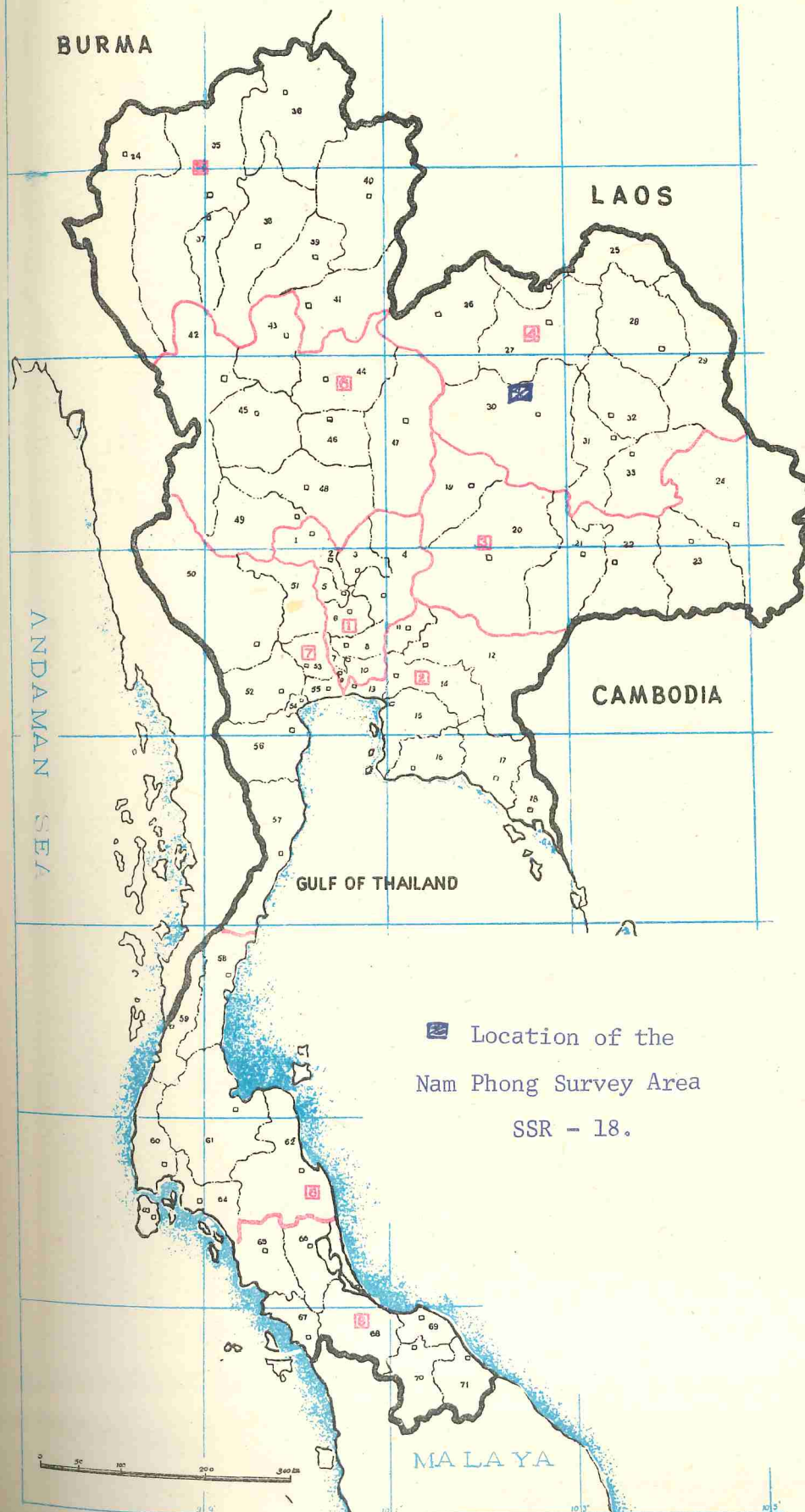
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13 pages, 3 maps, 2 fig.

Report SSR-18-1964.

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# MAP OF THAILAND



Location of the  
Nam Phong Survey Area  
SSR - 18.

- 1 Chai-Nat
- 2 Singh-buri
- 3 Lopburi
- 4 Sara-buri
- 5 Ang-thong
- 6 Ayuthya
- 7 Nonthaburi
- 8 Pathum-thani
- 9 Thonburi
- 10 Phra-nakhorn
- 11 Nakhornayok
- 12 Prachinburi
- 13 Samutprakan
- 14 Cha-choengsao
- 15 Cholburi
- 16 Rayong
- 17 Chant-buri
- 18 Trat
- 19 Chayaphum
- 20 Nakhornratsima
- 21 Buriram
- 22 Surin
- 23 Srisaket
- 24 Ubonratthani
- 25 Nong-kai
- 26 Loei
- 27 Udonthani
- 28 Sakonnakhorn
- 29 Nakhornphanom
- 30 Khon-kaen
- 31 Mahasarakham
- 32 Kalasin
- 33 Roi-et
- 34 Mae-hongsorn
- 35 Chiangmai
- 36 Chiangrai
- 37 Lamphun
- 38 Lampang
- 39 Phrae
- 40 Nan
- 41 Uttaradit
- 42 Tak
- 43 Sukhothai
- 44 Phitsnulok
- 45 Kamphaengphet
- 46 Phichit
- 47 Phetchbun
- 48 Nakhornsawan
- 49 Uthai-thani
- 50 Kanchanaburi
- 51 Suphanburi
- 52 Ratburi
- 53 Nakhornpathom
- 54 Samutsongkhram
- 55 Samutsakhorn
- 56 Phetburi
- 57 Prachuap-khirikhar
- 58 Chumphon
- 59 Ranong
- 60 Phang-nga
- 61 Surat-thani
- 62 Nakhornsrihamrat
- 63 Phuket
- 64 Krabi
- 65 Trang
- 66 Phatalung
- 67 Satun
- 68 Song-khla
- 69 Pattani
- 70 Yala
- 71 Nara-thiwat

REGION

## Page

I	INTRODUCTION	..	..	..	..	..	..	..	1
II	GENERAL DATA	..	..	..	..	..	..	..	1
	1. Topographical description of the area				..	..	..	..	1
	2. Geomorphology and parent materials	..			..	..	..	..	2
	3. Climate	..	..	..	..	..	..	..	4
	4. Vegetation and landuse	..	..	..	..	..	..	..	5
	5. Hydrography	..	..	..	..	..	..	..	5
III	SOILS	..	..	..	..	..	..	..	6
IV	CONCLUSION AND RECOMMENDATIONS				..	..	..	..	11
	1. General evaluation of the area	..			..	..	..	..	11
	2. Existing agriculture	..	..	..	..	..	..	..	12
	3. Possibilities for land development	..			..	..	..	..	13

REPORT ON THE SOIL SURVEY OF THE PROPOSED  
LAND SETTLEMENT AREA AT NAM PHONG (Khon Kaen province)

I INTRODUCTION

The survey of the Nam Phong area, downstreams of the Pong Neeb damsite, was requested by the Secretary General of the National Energy Authority and the Director General of the Department of Public Welfare. The request was made for surveys of terrains, situated both to the north and to the south of the Nam Phong river; this report only covers the first phase of the survey, treating of the area to the south of the Nam Phong river which covers an estimated 120,000 rais (19,200-ha).

The purpose of this survey was to obtain detailed information on the soils and the agricultural potential of the Nam Phong area, chosen as the site for resettling farmers and villagers who have to evacuate their villages and lands situated in the reservoir area behind the Nam Phong dam, now under construction.

The soil survey of the southern land settlement area was carried out from October 1963 to March 1964 by a field party under the direction of Tanit Tongchuta, and consisting of Vichai Boonyawat, Suraphon Charoengphong, Sommart Sriyanong, Boonsong Intasean and Ploy Trongtiang.

The survey is of the semi-detailed type. Soils were studied in borings, profile pits and roadcuts, with an average density of 24 observations per square kilometre. A limited number of soil samples for laboratory analysis were taken. Certain terrain features and soil boundaries were delineated by means of stereoscopic airphoto interpretation.

As a base map for the survey, enlarged airphotos of approximate scale 1:10,000 were used, whereas the final map included in this report was reduced to approximately 1:20,000. The soil units are defined and named in accordance with Miscellaneous Soil Report No 9, "A key to the Soil Survey of Northeastern Thailand", Bangkok 1962.

II GENERAL DATA

1. Topographical description of the area.

The surveyed area comprises one third of the area proposed as a site for land settlement; it is situated between the Huay Hinlat and the Nam Phong river. The eastern boundary is the highway from Khon Kaen to Udorn. The western boundary is the hill range of Pu Pan Kum. The area is crossed by the new road, connecting the highway with the Pong Neeb Dam, which has a length of 24 kilometers. A multitude of tracks and footpaths crosses the area.

The Nam Phong river borders the surveyed area on the north side. Several creeks drain the area towards the Nam Phong, the main ones being the Huay Yang, Huay Hinlat and Huay Jod.

The general topography of the area is undulating with, locally, flat and rolling parts. The highest part, over 200 meters elevation is found along the Pu Pan Kum hillrange in the west. Within the survey area, some spots to the north of Ban Kok Soong, Ban Sra Kut and to the south of Ban Muang Wan also have a high situation. The lowest portion of the area is observed in the valley of the creeks and along the Nam Phong river; the valley of which is situated at approximately 160 meters at Ban Kum Bon.

The higher portions of the terrain present themselves as low ridges with a variable direction (see fig. 2). These ridges are not continuous, but are interrupted by the creeks which cross them from south to north. The slopes along the creeks are fairly strong. The relief of the transition zone between the high and the low parts is rather irregular in spots, with high and low parts alternating at short distance. The most typical of these irregular transition zones can be observed on both sides of the road from the highway to the Pong Neeb Dam. Where the valleys cut through the above mentioned ridges, they have a typical V shape with a very narrow valley bottom. Both upstreams and downstreams, the valley bottoms widen considerably and the whole valley takes a U shape. The topography of the valley along the Huay Yang may serve as an example for this.

The micro - topography in the Nam - Phong valley is classic for the rivers of northeastern Thailand. Along the Nam Phong river, a zone, varying in width, is found, in which higher and lower strips, parallel to the river alternate. Behind, the valley bottom is lower with the lowest parts being occupied by intermittent lakes.

## 2. Geomorphology and parent materials

The general geomorphology of the area is represented schematically in figure 1. Landforms and topography in this particular area are profoundly influenced by the bedrock, consisting of sandstones and conglomerates of the Korat series. The bedrock formations, which in general are not very deep, or even near the surface, show a rather intricate pattern of anticlines (ridges) and synclines (lows). The most obvious one of these ridges is formed by the hillrange of Pu Pan Kum (see fig. 2), which has a regular, NE - SW direction. To the east of this hillrange, the bedrock formation have been folded in a more intricate pattern, as can be seen on fig 2, where the main ridges (synclines) are indicated. Folding in the Nam Phong southern survey area formed a series of more or less concentric ridges around a central monadnock, situated south of km 5 of the road to the Pong Neeb dam.

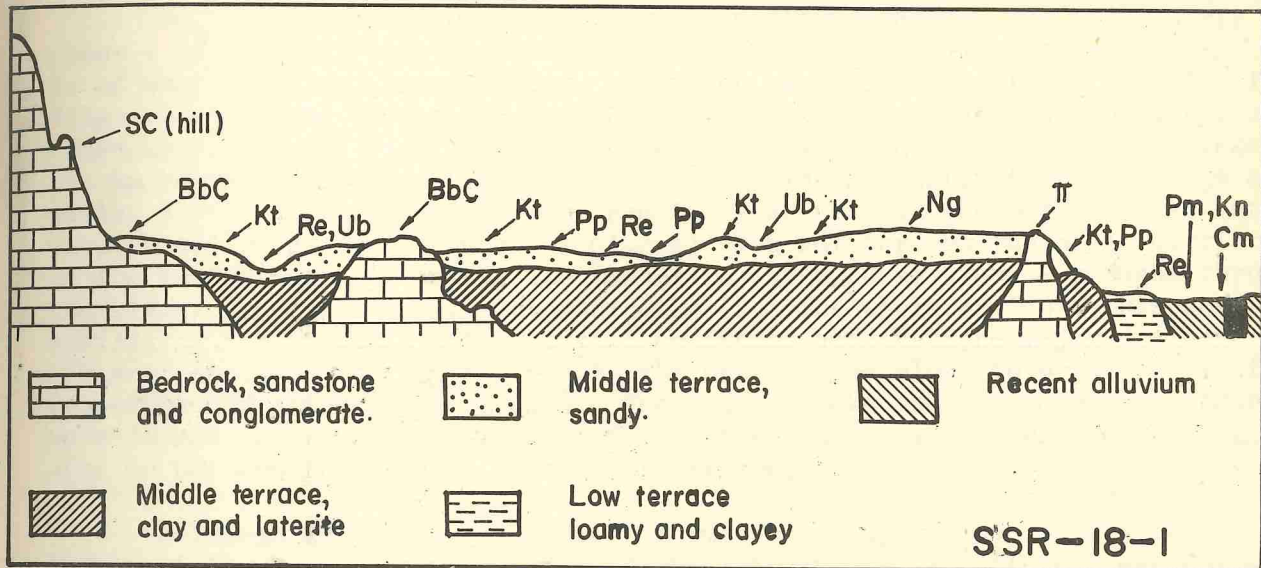


Fig.1 : Schematic SW-NE cross-section of the formations at Nam Phong  
(no scale)

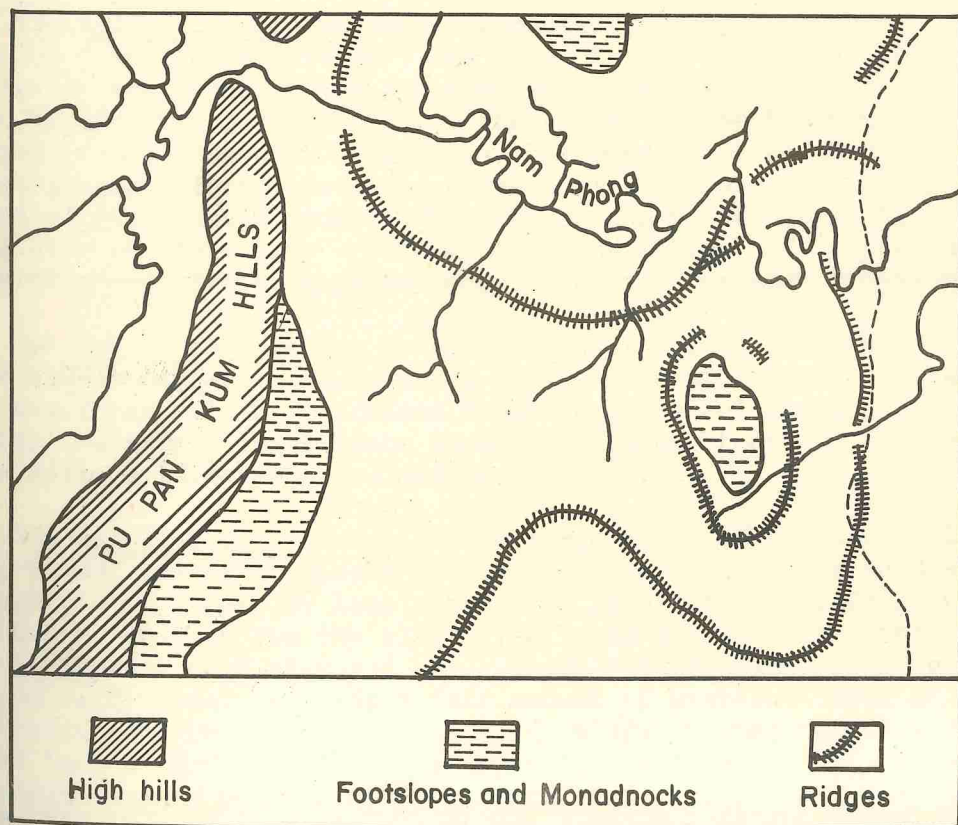


Fig.2 : Main structural bedrock ridges in the Nam Phong area  
SSR-18-2  
Scale 1:250,000

On the ridges and on the monadnock, mentioned above, the sedimentary cover - if any - is very shallow, and rock outcrops of sandstones, but especially of conglomerates, are numerous, as can be seen on the soil map (no 2). The disposition of the ridges has a great influence on topography hydrography, and consequently on the distribution of the soil units (map no 2). Nevertheless, the hydrographic pattern has developed partly independantly from the ridge and valley system of the bedrock. The Nam Phong as well as the major creeks cut through the ridges in a number of places; even cut through the major barrier of the Pu Pan Kum hillrange. The manner in which these brake - troughs through the ridges occurs in the field, indicates that the whole area once was covered entirely and uniformly with alluvial sediments and that the major drainage pattern developed in the time before the bedrock was close to or at the surface (superimposed antecedent streams). The minor creeks and drainage ways, however, were formed later and more or less follow the "way of least resistance" e.g. the lows in between the ridges (subsequent streams).

Although in this area, bedrock formations play an important role, the majority of the area is covered with alluvial sediments of different age which are not directly derived from the bedrock. The alluvial sediments of this area can be subdivided according to the level of sedimentation in sediments of the alluvial plain, of the low terrace and of the middle terrace. It should be observed that high terrace sediments were not found here, although they are known to be present to the north of the Nam Phong river.

The alluvial plain is mainly composed of clayey sediments, which are even being deposited at present. Adjacent to the stream, slightly elevated river levees are found, which are composed of somewhat less clayey material. Because of the frequent shifting of the course of the Nam Phong, a number of abandoned stream cahnnels (oxbows) have formed, each of which is accompanied by river levees. This intricate pattern of highs and lows along the river is surveyed as AC (alluvial complex) on the soil map. Between the river levees and the side of the valley - bottom, the land is low and clayey, and subject to deep flooding with some parts being inundated for most or all of the year.

The low terrace forms, in spots, a narrow zone between the alluvial plain and the middle terrace. Low terrace may be present in some of the creek valleys, but at least part of the sediments found here are colluvial and from a younger date than the normal low terrace formations in Northeastern Thailand. Mostly, the low terrace formations are medium textured.

The middle terrace occupies the large parts of the area. The middle terrace formations are composed of a sandy upper part and a sandy-clay or clayey lower part, with a more or less pronounced layer of lateritic gravel on the boundary between the sand and the clay. The lower layer of the sandy stratum usually contains slightly more clay and has a loamy sand or sandy loam texture. Locally, the upper sandy layer contains a fair amount of gravels. Most of the soils of the surveyed area are formed on the sandy middle terrace material. Where the sand has been eroded away; that is on the lower slopes along the valleys and in the transition zone between the high land and the alluvial plain of the Nam Phong, the lateritic gravels and the clayey lower stratum of the middle terrace occur close to or at the surface. This is shown schematically in figure 1.

According to lithology and geologic origin, following soil forming materials can be distinguished.

#### RESIDUUM

Some weathering products from sandstone and conglomerates are found where the rocky substratum comes close to or at the surface. However, as a soil forming material, residuum is only of minor importance. The residuum has a sandy loam texture and contains varying amounts of pebbles, disintegrating fragments of sandstone as well as some lateritic gravels.

#### TRANSPORTED MATERIALS

A. Recent alluvium. This is found in the valley of the Nam Phong and its tributary creeks. This alluvium is usually clay or heavy clay. In the creeks, the alluvium is generally medium textured (loamy), but both sand and clay layers may occur and part of the material may be colluvium locally derived from the slopes. This material shows, as a rule, little weathering.

B. Old alluvium. The low terrace old alluvium is mainly medium textured, but some sandy loam and clay loam is found. This material is highly weathered.

The texture of the soil forming material in the middle terrace formation varies widely. It is sandy (sand, loamy sand and sometime sandy loam) in its upper layers and clayey (clay loam, sandy clay loam, sandy clay) in its lower layers. Lateritic gravels and rounded pebbles occur on the boundary between the two layers. Locally the sand may contain rounded pebbles over a greater depth, but usually the pebbles are confined to the lower clayey strata. Sometimes, part of the surface materials of the middle terrace formations are composed of more recent colluvium, washed down from the higher parts towards the lower slopes and the narrow valleys. This colluvium, which is mostly sandy, usually cannot be distinguished in the field from the original sandy old alluvium.

#### 3. Climate.

No specific data of rainfall for this area are available. Climate can be estimated intermediate between Udon Tani (1428 mm.) and Khon Kaen (1189 mm.), with an average rainfall of about 1300 mm. annually. The average annual temperature is around 27° C, with a minimum in Dec. - Jan. (22.5°) and a maximum in April - May (27.5°). The period of rainfall starts in late April and lasts to the middle of October, with a first maximum in May (appr. 200 mm.) and a second, more important one in September (appr. 270 mm.).

The variation of the amount of rainfall from year to year is great. In some years, 30 - 50 % more or less than the average rain may fall. The distribution of dry spells during the rainy season also is variable; periods with two or three weeks of dry weather are not exceptional.

The growth and production of agricultural crops mostly takes place in the wet season. In the dry season the growth and production is strongly inhibited due to the lack of water, except in some places where winter crops are planted and other places where the ground water is near or at the surface and where vegetables are grown during this period of the year.

#### 4. Vegetation and landuse.

Landuse of the surveyed area is shown on map, No. 1 which represents landuse conditions in 1954, the year that the airphotos were made.

Most of the area is under forest. On the sandy soils, the forest stand is poor and mainly composed of dipterocarps, often with dwarf growth and no complete ground cover. On the less sandy parts, undergrowth is thicker with a predominance of shrubs, some of which are spiny.

Some spots in the forest were taken for shifting cultivation. Mostly, kenaf was grown, the land being abandoned after two or three years of cultivation.

Some better quality forest and shrub land is found in the valley of the Nam Phong, along the stream (Alluvial Complex and Chiang Mai series). In this valley the low spots usually bear a marshy vegetation without trees.

The remainder of the land is mainly in use for the cultivation of rice, and for gardens in and around the villages.

#### 5. Hydrography.

The Nam Phong river is the main stream of the surveyed area, maintaining a considerable flow all the year around. Its valley is more or less deeply flooded during the rainy season. Some of the major creeks, as Huay Yang also have water all the year, but most smaller creeks are intermittent streams, falling dry in the second part of the dry season. Only in the lower part of their course some water may be found late in the dry season. Usually, the dry season flow in these tributary creeks is a mere trickle, fed by occasional showers. The side - valleys of these creeks, do not usually contain water, unless it is impeded in rice fields. Only during and immediately after the rains, running water is found in these secondary valleys.

In the high parts of the surveyed area the groundwater table is low or even absent because of the presence of waterless bedrock at shallow depth. In the synclines between the ridges, some deeper groundwater may be present, but because of the generally sandy character of the area, the groundwater usually is well below the rooting zone of most plants, a fact which is clearly reflected in the general poor plant growth of the area.

### III SOILS

The following soil units are distinguished on the soil map (No. 2)

#### LOWLAND SOILS (Soils of the alluvial plains, subject to flooding)

Cm : Chiang Mai series. These soils are found on the natural levees of the Nam Phong river, which are mostly under forest. The Cm soils have no distinct genetic soil horizon other than an A<sub>1</sub> or A<sub>p</sub> horizon. Texture of these soils is loam to clay loam or silty clay loam with clay layers occurring frequently. These lands have a rough micro-relief and are subject to recurrent flooding. Some small low sand dunes are found in this area. The Chiang Mai soils are moderately well to well drained. The pH value is around 6.5 and higher in the subsoil. Colours are gray brown to blackish in the surface layers, turning to brown or yellowish brown in the subsoil.

Mostly, these soils are not used for agriculture, but in some places they are used for planting vegetables and field crops after the period of flooding. Their inherent fertility is relatively high.

Pm : Phimai series.

In the lower spots of the Nam Phong valley, at places lower than the level of the Chiang Mai series, Pm soil occur. These soils are clayey throughout, with a black surface soil and a dark gray subsoil. They are very poorly drained; they show mottling throughout the profile. Base saturation is medium high.

Because they are subject to deep flooding, the Pm soils usually are not cultivated.

St : Si Thon series.

Si Thon soils are found in narrow strips in the valleys of creeks such as Huay Yang, Huay Hin Lat and Huay Jod. Some other valleys also show Si Thon soils in the lowest portion, but such areas are usually too small to be indicated on the soil map.

Texture of St soils is variable. Often, a distinct stratification is observed with more sandy and more clayey layers alternating. The pH of these soils is mostly somewhat higher than 5.

The St soils are mostly used for rice growing and give a medium to good yield.

Kn : Kalasin series.

These soils are always found in the lowest parts of the Nam Phong valley. Not all Kn soils are shown on the soil map, because some of them were incorporated in the AC unit. The Kn. soils are marshy and covered with water most of the year. Some spots which are inundated throughout the year are probably included.

These soils are very poorly drained; they are mostly clayey, rich in humus and of black colour. In some cases, the surface material may be mucky or even peaty.

Usually, these soils are not used for agriculture, because of drainage difficulties. On some Kn soils, situated close to the boundary with higher soils; rice is grown. Water vegetables may be grown to a limited extent.

AC : Alluvial complex

Along the Nam Phong river, the terrain shows a complicated soil pattern. Higher and lower parts and strips alternate quickly and soils of the Chiang Mai, Phimai and Kalasin series are found side by side. The different soil series cannot be represented separately on the soil map and are grouped in the AC unit.

The rough microrelief and the periodic flooding prevent the permanent use of these terrain. On this soil complex, a rich forest with dense undergrowth prevails, but the lowest parts are marshy. Apart from the use as productive forest land, these terrains might be reclaimed for establishing highly productive pasture.

#### LOW UPLAND SOILS

(Soils of the low and middle terrace, inundated because of rice cultivation)

Re : Roi Et series

Most of the paddy land in the surveyed area belongs to this series. These soils are situated in the lower parts of the terrain depressions. Some Re soils occupy gentle slopes which have been terraced for use as paddy lands. Also, these soils are found in narrow valleys, often along both sides of creeks.

Texture of the majority of the Re soils in this area is fine sandy loam, with somewhat sandier surface layers and somewhat more clayey subsoils. Some of the Re soils in depressions are more clayey in the surface layers (clay loam to loam) and were indicated on the soil map as a separate phase (e.g. Re-1). The sloping Re soils, mentioned above are distinctly more clayey than the average Re soils of the area; they are also mapped as a separate phase of the Re series (eg Re-h). Both the Re-1 and the Re-h phase are shown in only a few spots on the soil map; smaller areas of these soils occur elsewhere, but such areas could not be indicated separately in view of the scale of mapping.

pH values of these soils are moderately acid to acid with minimum values around 4.5. They show gley (mottling) throughout the profile, because of their use as paddy land which is periodically inundated by impounded rainwater. However, the groundwater table sinks deeply below the surface in the dry season, so that in that period, they are too dry for any cultivation, unless supplementary irrigation water is provided for.

The Re soils are rice-producing soils of medium quality (12-22 tangs per rai). Depending on the water supply, the yield of rice varies strongly. It can be low in dry years, whereas in very wet years, flood damage may occur on Re soils, situated in depressions. The yield of rice could be improved by better water control and fertilizer application but the economic feasibility of such measures is by no means certain at present.

Ub : Ubon series

The Ub soils are found in narrow depressions and on the sloping lower parts of the middle terrace formations. Some of the areas in narrow valleys, indicated as Ub on the soil map, include some soils, belonging to the Phen, Roi Et and Si Thon series, which could not be mapped separately.

Texture of the Ub soils is sandy (sand or loamy sand) for at least 50 cm. Below this depth, the texture may become finer, but often the soils are sandy for more than 100 cm. These soils are slightly acid to acid and have little organic matter in the surface layer; usually less than 1 %. In the surface soil, the Ub profiles are mottled but below, gley phenomena are only weakly developed in the sandy material. These soils are dry for an important part of the year. Only in the middle of the rainy season do they fill up with water so that rice can be planted.

Because of their sandy character, the value of these soils for agriculture is low. Rice yields average from 7 tangs to 10 tangs per rai and failure in dry years often occurs. Because of this intermittent failure, many Ub rice fields are abandoned after having served only a few years for rice cultivation.

Improvement of these soil should be through irrigation, combined with heavy fertilizer application. These measures, however, may prove too costly in most cases when compared to yield increases, which could be obtained this way.

Pn : Phen series.

The Pn series was found only in a few spots, some of which were too small to indicate on the soil map.

The surface soil of the Pn soils is loamy sand to sandy loamy; deeper down, more clayey material, mixed with lateritic concretions is found at a depth of less than 50 cm. These soils are mottled throughout and hence are poorly drained, but in the dry season the ground water is found at great depth only and the profiles then dry out strongly.

These soils are used for rice, giving yields comparable to those observed on Re soils.

#### UPLAND SOILS (Soils of the terraces, not inundated)

Ng : Nam Phong series

The higher parts of the surveyed area are mostly occupied by these soils.

Profiles of the Ng soils are composed for at least 60 cm. of pure sand which is loose when freshly dug and which contains very little clay and minerals other than quartz. Below 60 cm., loamy sand and lateritic gravels are quite often found. In the environment of Ban Kut Nam, a spot of Ng soils, containing a high percentage of rounded pebbles in the sandy material, was found. This area of gravelly Ng soils was indicated separately on the map. Its position indicates that at this place the old Nam Phong river deposited materials, coarser than sand and containing alluvial pebbles.

The humus content of the Ng soils is low, the pH of these soils is around 5 with higher values in the topsoil. No mottling occurs in the surface layers up to a depth of at least 60 cm, these soils never being water saturated, even in the rainy season. For most of the year they are very dry.

From field observations we know that only few areas of Ng soils have ever been cultivated, mostly for planting of kenaf. The results were so poor that these areas were abandoned after one or two years of cultivation only. Usually the Ng. soils are covered with an open dipterocarp forest of little economic value. The undergrowth is poorly developed and more than half the soil surface is bare of any vegetation.

Under the present economic conditions, the Ng soils have little or no economic value for agriculture, including pasturing and commercial forestry. Reclamation of such soils is bound to become a failure, because so little can be grown. Even when fertilizing and irrigation would be applied, agricultural production would be so low as to made the investment of capital a very poor proposition. The poor growth of natural grass indicates that establishing pasture on these soils is bound to become a failure too.

Kt : Korat series.

These soils occupy an intermediate topographical position between the higher Nam Phong series and the low upland or lowland soils. Kt soils in this area can be distinguished into two phases which, however, are not indicated separately on the map. In the northwest of the area the Kt soils are composed of pure sand in their upper layers, which passes to loamy sand or sandy loam at the depth of less than 60 cm., with quite frequently, lateritic concretions in the deeper subsoil. In the middle of the area the Kt soils show loamy sand to sandy loam in the top soil and a more clayey subsoil. The villages of this area are all situated on such finer textured Korat soils, in which lateritic concretions, if present, are mostly encountered at more than 100 cm. depth.

pH values are between 4.5 to 5.5 in the subsoil and higher in the surface soil. Mottling may occur in the subsoil or may altogether be absent in the profile. The organic matter is usually below 1%.

The Korat soils with a sandy surface soil mostly are not used for agriculture. The somewhat finer Korat soils have for an important part been used for shifting cultivation but have by now been mostly abandoned. Only in limited areas in and around the villages, permanent agriculture, as gardens with diverse vegetables and fruits are found. These village soils are somewhat richer, because they have been fertilized with village refuse, bones and the like. Also, they have more humus in the topsoil.

The Korat soils are poor soils, both in respect to physical conditions and to plant nutrient status. When freshly reclaimed, they give fair yields in the first two years or so, after which the fertility goes down so much that the farmers are obliged to abandon the land. Erosion, especially micro erosion due to destruction of the surface structure is rampant when these soils are exposed to heavy rains. A permanent system of agriculture on these soils could only be introduced, if more is known on suitable crop rotations, maintenance of soil structure and of fertility. No conclusive data to this respect are available at present.

Irrigation by sprinkling, combined with liberal fertilizer application would make these soils suitable for permanent agriculture, but the economic aspect of such costly measures is far from bright.

Pp : Phon Pi Say series.

These soils usually border areas of Nam Phong soils, being situated at a slightly lower level. The largest consolidated area was found west of Ban Huay Yang, below the level of the Borabu-complex. Smaller spots of Pp. soils are observed along the flanks of the valleys crossing through the high terrain. Mostly, these soils have an accentuated relief with medium to strong slopes, often crossed by gullies and drainage ways.

The profiles are composed of a sandy to loamy surface soil passing to heavier material such as clay loam or even clay at shallow depth. Lateritic gravel is found at less than 50 cm. depth, usually in great quantities. More often than not, the laterite starts in the surface layers and the soil may be covered by these lateritic gravels. The pH of these soils is low; around 4.5 in the clayey subsoil layer. These soils, because of the presence of clayey material at surface layers are wet in the rainy season, as indicated by showing of mottling in this layer. In the dry season, the upper layers dry out considerably but the yellowish clayey subsoil apparently remains moist.

Although the presence of lateritic gravel may interfere more or less severely with soil management, the Pp soils are not nearly as poor as the soils of the Nam Phong series. The clayey subsoil contains at least some mineral reserves and preserves water, so that these soils are less susceptible to drought than the soils of the Korat and Nam Phong series.

Nevertheless, the Phon Phi Say soils in this area are only rarely cultivated, which is due to their unfavourable topography and to the fact that farmers have no experience in working these finer and gravelly soils. In future, a more intensive agriculture use could be made of these soils, provided that measures are taken to avoid accelerated erosion, for which the Pp soils of this area are extremely susceptible. Establishing permanent grassland may be the most economic solution.

Bb and BbC : Borabu series and Borabu complex.

These soils are found near the Pu Pan Kum hills and in spots in the northern part of the surveyed area. (rock outcrops and surrounding soils). The largest spot of BbC which cover an area of about 4 square kilometers, is found to the south of km 5 on the Pong Neeb road.

The Bb soils in this area are composed of sand to loamy sand in the surface layers and residuum from sandstone in the subsoil. Sometimes, the residuum appears in the surface layers. These soils appear in combination with larger and smaller rock outcrops which are bare of soil cover and of vegetation. The rocks, are sandstones and conglomerates. In some spots, the area is dominantly covered by the rock outcrops. pH values are slightly acid to acid, with a value of 6.5 in the surface soil and less than that in the subsoil.

Besides rocks and soils of the Bb series, inclusions of Nam Phong and Korat soils are found in the areas surveyed as BbComplex.

These soils bear a poor dipterocarp forest of hardly any economic value, without much undergrowth. No cultivation of these soils was observed. They may be considered of no value for any form of agriculture.

#### IV CONCLUSIONS AND RECOMMENDATIONS \*

##### 1. General evaluation of the area

Based on the data of the soil survey, a landclassification map was made (map no 3), which represents a general evaluation of the area in terms of land settlement. In this landclassification, the meaning of the major landclasses is as follows.

Class I land is land that could be settled with very little fear of failure. The soils of this class are good to fair, and should produce satisfactory crops. No particular management problems would be encountered after clearing, and the land is not or little susceptible for accelerated erosion or, if susceptible, erosion control would have to be simple and not expensive. No class I land is found in the Nam Phong area.

\* This chapter was written in collaboration with Dr.F.R.Moormann,FAO Soil Specialist.

Class II land is land that, though of good to moderate quality, has one or several undesirable characteristics which limit its permanent use after reclaiming or which would make additional improvement measures necessary. Limitations are of various nature: infertility of soil, susceptibility for erosion, salinity, acidity, recurrent damaging flooding, etc. No class II land is present in the Nam Phong area.

Class III land is to be considered as marginal, having limitations like those mentioned for the class II land, but to a much more serious degree. Sustained agricultural use of such lands is only possible on condition of costly measures, such as extensive erosion control, irrigation, soil improvement to fertilizing. Often the cost benefit ratio of these improvement measures may prove high or even too high.

Class IV land is unsuitable for settlement, for either one of two reasons

- a the land is too poor, too steep, too stoney, too wet, too saline or any of these factors in combination, and hence its settlement is doomed to failure.
- b the land is under permanent agriculture already, and hence not available for settlement.

In the Nam Phong settlement area, no class I and class II land is available for settlement. Class IV land, both unsuitable and already settled, occupies an important place. The remainder, class III land, with soil, topography and flooding limitations is usually very marginal. Besides, most of this marginal class III land is rather scattered and interrupted by zones of class IV land, making it very difficult to arrive at a consolidated plan for land reclamation and settlement.

It thuswise is obvious that the site, chosen for land settlement in the Nam Phong area is, at its best, of very marginal value and, at its worst, not suited for any large scale land settlement operations.

## 2. Existing agriculture

Only a small part of the area is in agricultural use. Rice fields are found in all depressions, except those that flood too deeply. Even in narrow creek-valleys, rice fields can be found, often only as wide as twenty meter and taking up the entire valley bottom. Rice cultivation in the area is pushed to about its maximal possible extension or is, in several cases overextended on very marginal soils which produce a minimum crop and which frequently have to be abandoned after a few years. Many of the rice lands produce a poor crop; only on the Re soils, a fair crop is obtained.

Permanent upland agriculture is only found in and around the villages, where vegetable and fruit crops are grown with the help of manure, village refuse, etc. Shifting agriculture has been practiced on the finer Kt soils but not on other soils such as Ng or Bb. Most of the land suitable for this type of agriculture, has been used once already and has been left in a more or less depleted stage.

It thus can be concluded that, in terms of present-day agricultural practices, the area is being used already to its maximum capacity or even may show signs of a beginning overpopulation. The best possibilities appear in the direction of establishing improved pasture in the Nam Phong valley and, possibly, on some of the Pp soils and the finer Kt soils. This might result in a more intensive livestock industry.

### 3. Possibilities for land development

It has been concluded that the possibilities for success of a major land settlement operation in the area are dim. Some of the class III land, especially the finer textured Kt soils, however, could be farmed on certain conditions. These conditions include :

- a. Irrigation. Because of the sandy nature and the rather unfavourable topography, sprinkler irrigation is to be considered as the best approach. Gravity irrigation can only be applied in very limited areas.
- b. Fertilizing. The inherent fertility of the soils is low. Hence, for sustained production, fertilizers and manure have to be applied on a liberal scale.
- c. Erosion control. Most of the land, when reclaimed, will be subject to erosion, both major erosion and "micro erosion", due to deterioration of surface structure and loss of humus in the soils when exposed. Thus, suitable crop rotations should be found, aimed at a permanent ground cover. In many cases, stripcropping may be necessary and in some, a certain amount of terracing may have to be applied.

Apart from this, integration of the existing agricultural population in the settlement area appears to be one of the important socio-economic problems to be taken into consideration.