CHAPTER III

GEOLOGICAL AND PHYSIOGRAPHICAL SETTING

3.1 Geological Setting

Thailand shows a great variety topographically there are, in general, three land-form types : the highlands, the plain of alluvium over bedrock and the low-lying alluvial plains. Based upon these land-form types Thailand may be divided into five physiographical provinces, which also coincide with a classification based upon other physical and cultural features such as climate, land-use and ethnology. These provinces are (Figure 3.1 a, 3.1 b):

1) the Continental Highlands, sub-divided into the Northern Hills and Valleys and the Western Mountains;

2) the Central Valley, sub-divided into the Upper Plain, the Bangkok Plain and the Marginal Plain;

3) the Korat Plateau;

4) the Chantaburi Plateau; and

5) the Thai-Malay Peninsula.

The Chao Phraya Basin occupies most of the Northern Hills and Valleys (Northern Thailand) and the Central Valley and extends from the

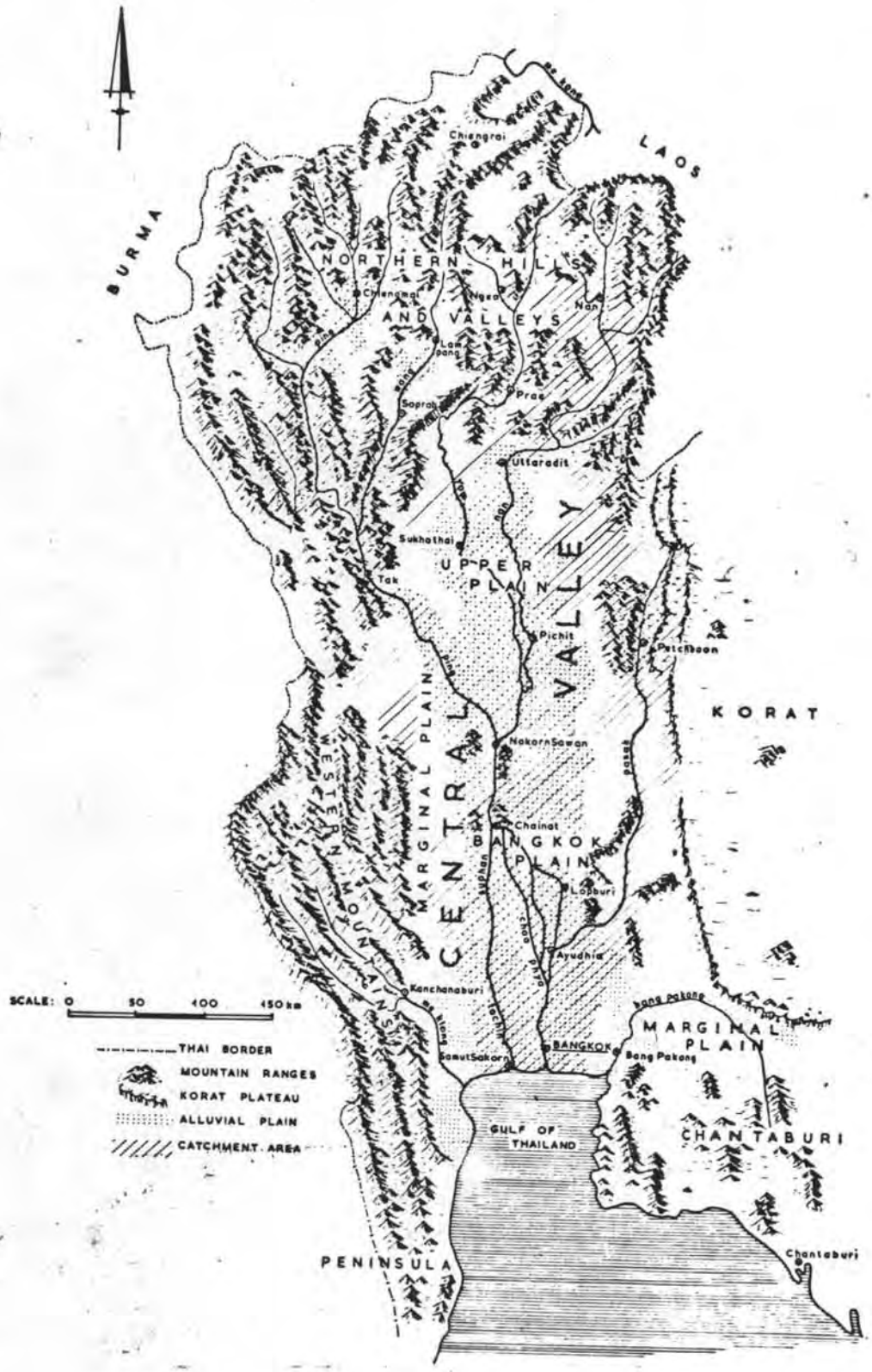

Figure 3.1 a Illustrating the physiography of the Central Plain of Thailand (after NEDECO, 1965).

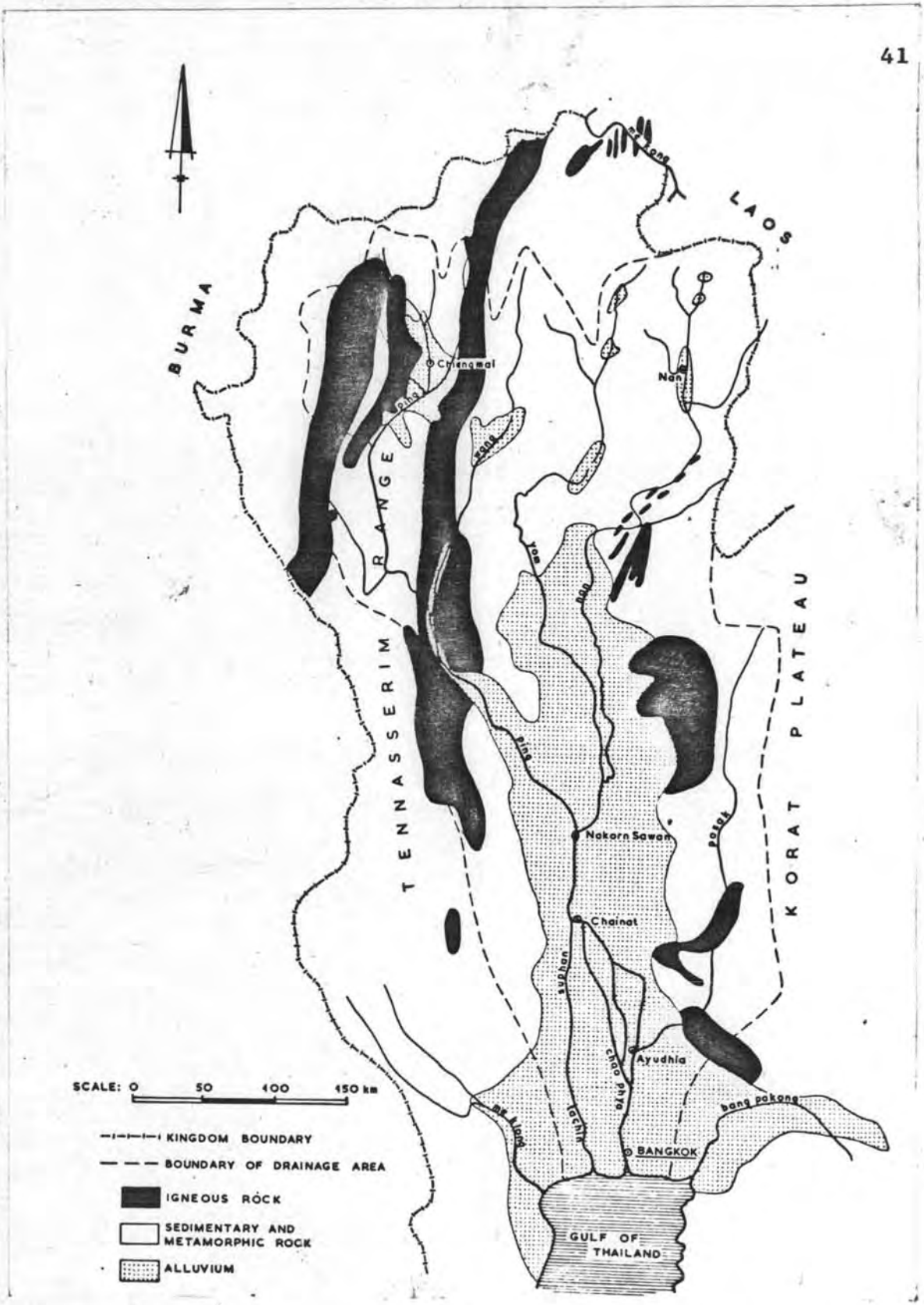

Figure 3.1 b Illustrating the geological setting of the Central Plain and neighbouring areas of Thailand (after NEDECO, 1965).

Thai-Burma in the north to the Gulf of Thailand in the south.

The Tanon Tong Chai and Tennasserim Ranges, a southern extension of the Himalayas, form the western watershed of the basin while to the east it is bounded by the rim of mildly undulating tableland in the north-east, the Korat Plateau. The basin has a length of roughly 750 km, while its width gradually decreases from 300 km in the north to 230 km near Chinat and to 75 km at the coast of the Gulf of Thailand. The area of the basin amounts to roughly 60,200 km^2, or about 31% of the total area of Thailand.

Northern Thailand is characterized by series of hills and mountain ranges which run approximately north-south parallel to each other, dividing the region into the four individual catchment areas of the northern tributaries of the Tha Chin and Chao Phraya rivers. The rivers and streams of the highlands flow for the greater part through narrow, deeply incised valleys, of which the often steep slopes are generally covered with a dense forest vegetation. Occasionally these narrow valleys widen out into flat flood-plains and infilled intermontana plains, formed by riverian deposits, and lying at different elevations. Important plains include Nan basin, Yom basin, Wang Basin and the large and important plain in the Ping basin.

Above Tak the Wang river debouches into the Ping which with the Yom and Nan rivers, leaves the Northern Hills and enters a large common alluvial plain, the so-called Upper Plain, which forms the northern part of the Central Valley.

The Upper Plain, where the lower parts of the relief have been filled with sediments, still shows low outcrops of rock and foothill lands, while isolated mountain or mountain-groups stand out clearly; the towering masses of recrytallized limestones, with their almost vertical slopes, form sharp contrasts with the surrounding flat plains.

In the Upper Plain the Yom and Nan rivers follow more or less parallel courses before meeting about 35 km above Nakorn Sawan; from here on the Nan continues its southerly course towards Paknampo, 2 km above Nakorn Sawan, where the Ping, coming from the northwest, and the Nan join to form the Chao Phraya river.

The southern part of the Central Valley, named the Bangkok Plain, is for the greater part of the true delta of the Chao Phraya river. Geologically the Central Valley is considered to be a deep syncline between the mountain chains on both sides. Through innumerable years this huge trough has been filled with sediments, which by now are supposed to have reached a thickness of several thousand meters in the middle of the trough. To the east and west this sediment layer becomes thinner, while ultimately along the borders of the plain lower hills appear, which culminate in the steep mountains of the Tennasserim Range in the west and in the Korat Plateau in the east. To the south the Chao Phraya Delta ends in the Gulf of Thailand, proceeding under the surface of the sea as a deposit of mud along the northern coast of the Gulf.

The apex of the Chao Phraya River Delta lies approximately at Chinat, where the river starts to bifurcate and throws out several effluents, amongst others the Suphan river. This river, which further

downstream is called the Tha Chin, follows its own course south till it enters the Gulf of Thailand at Samut Sakorn.

The overall slope of the Chao Phraya Delta is very flat. As its apex near Chainat, approximately 200 km from the Gulf, the elevation is only 15 m above Mean Sea Level. Yet the Bangkok Plain is not completely without relief. The whole of the Plain has been built up by river deposits which during floods overflow the main river and its tributaries and distributaries. The coarser particles of the sediment load have been deposited near the river banks on both sides, thus forming ridges, the so-called "natural levees". These ridges generally lie at the elevation of normal flood-level. Behind the natural levees the remaining part of the sediment load of the flood-water gradually settles down as velocities become lower and lower. In this way there is a lateral sorting out of the sediments according to grain-size. Places at a great distance from the rivers may even be flooded by practically clean water, containing only the finest sediment-grades. In such places the sedimentation rate is low, while on the other hand the compaction of these finest deposits, though being a slow process, attain greater values than in the coarser layers closer to the rivers. This complex mechanism causes the creation of lower areas or depression behinds the natural levees.

In the Chao Phraya Delta the differences in elevation between the levees and the lowest depressions is from 3 to 4 m. During flood stages the delta area will be completely inundated; in this huge flood-plain the rivers and their branches are then clearly outlined by the buildings and trees which, because the soils of the ridges are high and

usually well drained, are concentrated on the natural levees.

In Central Thailand the late Tertiary structural movements resulted in the depression of the Chao Phraya Region. At that time a cycle of alluvation began which has continued to this day. At first the northern shore of the Gulf of Thailand may have lain as far north as Uttaradit, but the sediment loads of the streams accumulating in the depression gradually have been moving the shore southward.

The Chao Phraya Depression occupies an area of about 60,200 sq. kms. (140 km wide and 430 m long) and consists of thick Tertiary-Quaternary alluvium and deltaic sediments over irregular basement. The Chao Phraya, Tha Chin, Mae Klong, and Bang Pakong are the main rivers that transport sediment to fill the Gulf as indicated by prograding of delta averaging 4 - 5 meter per year.

3.2 Geomorphology

The study of onshore physiography of the area under the present investigation is primarily based on photo interpretation combined with limited field observations. However, an attempt has been made to subdivide the alluvial and coastal plain area into 7 zones based on their genesis, land-cover, and land-use. These zones are designated as alluvial plain, nipa plain, coastal grassland, mangrove, supratidal salt flat, open intertidal mud flat and urban areas. Besides, the comparative study regarding this matter has been carried out using the information from topographic map surveyed in the 1969 and the aerial photographs taken in 1977 (Figure 3.2 a, 3.2 b).

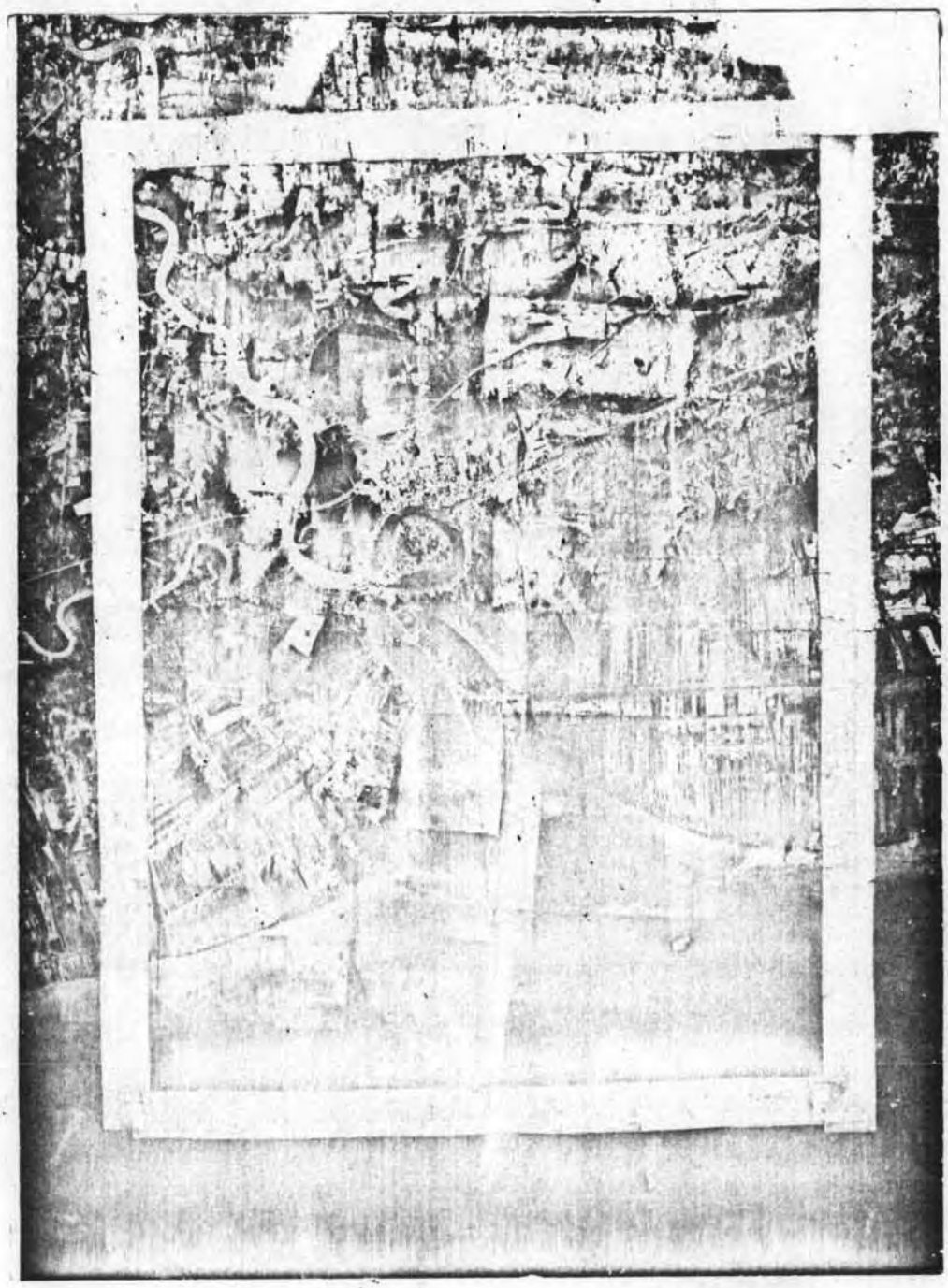

Figure 3.2 Aerial photomosiac,scale1:125,000 , of the area under present investigation taken in 1977.

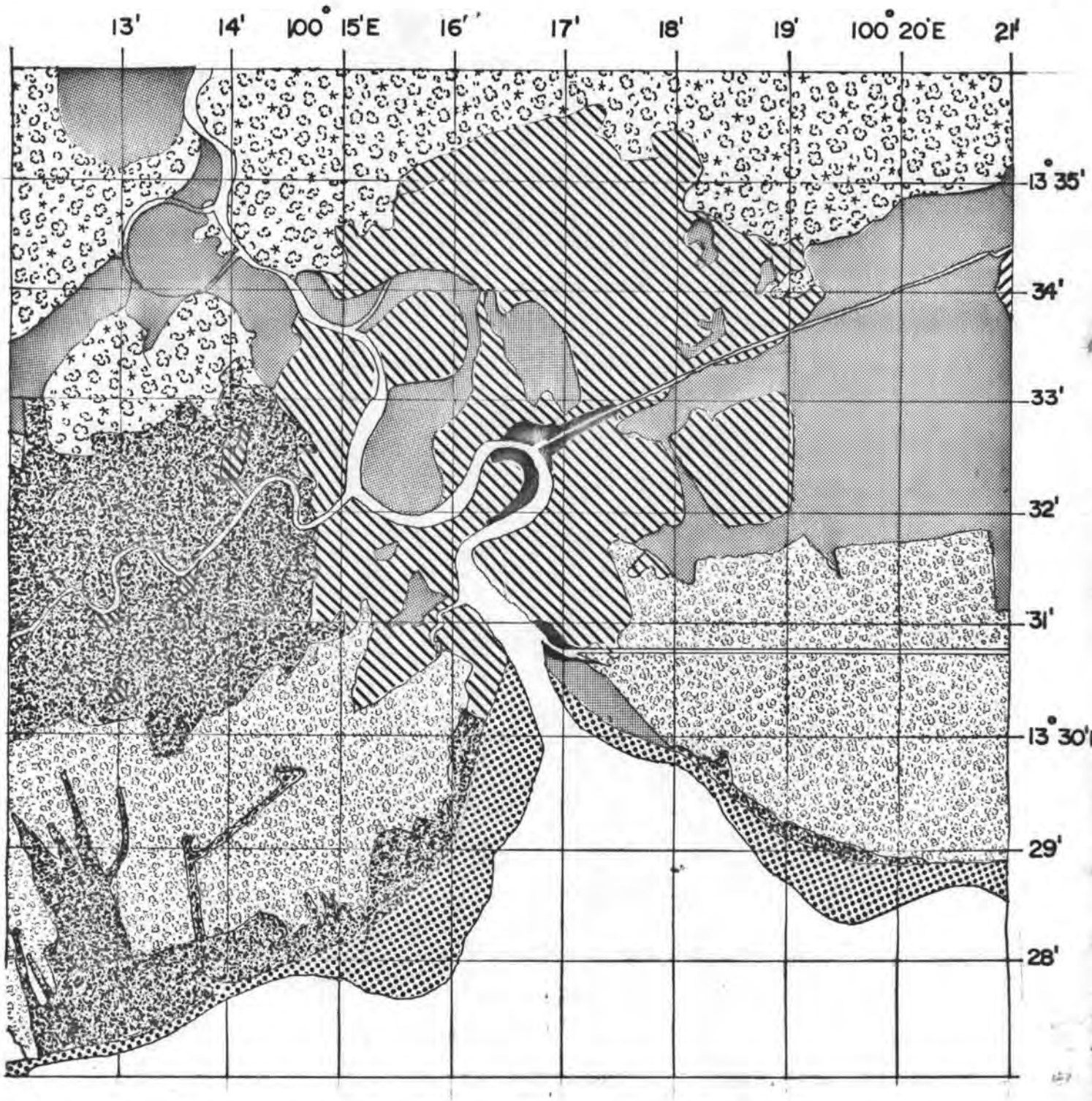

Figure 3.2 a Illustrating different zones of the area studied base on information in 1969.

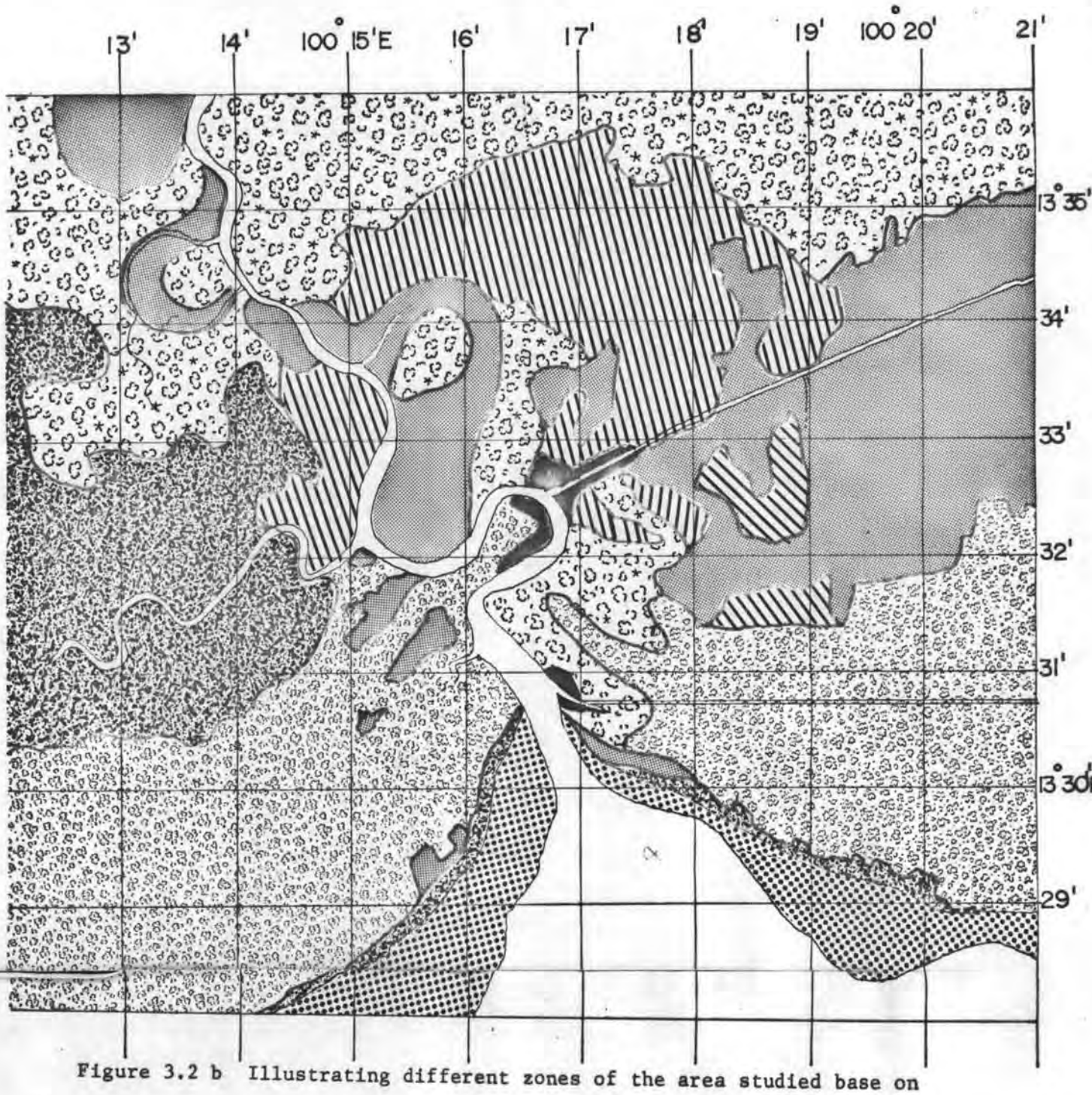

Figure 3.2 b Illustrating different zones of the area studied base on information in 1977.

3.2.1 Alluvial Plain

In the northern part of the area under the present investigation, low-relief alluvial plain of the Tha Chin river which is a part of the Central Plain of Thailand is recognized. These deposits are mainly fine sand, silt, mud and clay of variable thickness. They are unconsolidated and essentially laid down by mixed fluvial load. A well-developed meandering drainage pattern of Tha Chin river with active and cut-off including silting-up meander belts or oxbow lakes are superimposed on the alluvial plain in some areas. It is interesting to note that the aerial extent of the alluvial plain in the area under the present study has increased from 37.02 square kilometers in 1969 to 44.87 square kilometers in 1977 or approximately 21% increase.

These alluvial plain deposits are probably the oldest unconsolidated sediments. These deposits could be Late Pleistocene or Holocene in age. Vegetated natural levees on both sides of the rivers are noted. Alluvial deposits also flank the larger water courses; some are fairly extensive. Sediments underlying the alluvial plain is inner sublittoral deposits. Raising of sea level to the present standstill probably began in Late Pliocene-Pleistocene time where the Gulf was extended as far north as Ayuthya. Afterthat rivers in the lower Central Plain built their fluvial deltaic plain to their present positions (Achalabhuti, 1975).

Table 3.2.1 Some characteristics of Tha Chin drainage basin.

Description of parameters	Diemension
Drainage area	6,300 km^2 (NEDECO, 1965)
Basin length	225 km
Length of stream channel (CL)	295 km
Shortest distance between mouth and source of stream (Air)	225 km
Form Factor (F) = $\frac{\text{drainage area}}{\text{basin length}}$ (Horton)	.1244
Index of Total Sinuosity (CI) = $\frac{CL}{Air}$ (Mueller)	1.31
Basin Elongation (E) = $\frac{\text{diameter of circle with same area as basin}}{\text{basin length}}$ (Schumm)	0.398

3.2.2 Coastal Plain

The seaward or southern part of the Tha Chin alluvial plain is bordered by the coastal plain. Basically the sub-aerial part of the coastal plain may be subdivided into 2 sub-units, the nipa/grasslands and the mangrove/supra-tidal salt flat.

The nipa/grasslands occur immediately seaward of the alluvial plain. The grasslands are believed to be the deforested old nipa plains. The nipa/grasslands are partially reached by marine influences, and the plain is interpreted to be most developed sub-unit of coastal plain. In response to the depositional progradation of the intertidal-supratidal deposits. Topographic feature of the nipa/grasslands is slightly rolling to featureless.

The mangrove/supra-tidal salt flat plains are subaerially exposed for most of the time and extend most seaward. The deposits of this mangrove/supra-tidal salt flat are essentially mud and clay. Generally the mangrove swamp environment extends from the upper part of the inter-tidal zone into the supra tidal zone. However, the most extensive developments occur on both sides of Klong Sunak Hon and bordering both sides of Tha Chin river mouth. A dominant feature of mangrove swamp and mangrove channel environment is the dense vegetation which traps and binds the sediment. Associated with this mangrove is the supra-tidal salt flat which represents the deforested mangrove area. After deforestation, the area has been used for the salt evaporator and shrimp farm.

In addition, it is noted that all sub-units of the coastal plains show a significant change in their aerial extent similar to the alluvial plain. Data obtained from 1969 and 1977 reveal this change which has been summarized in Table 3.2.2. Some of the changes in aerial extent of these sub-units are due to natural causes, the others are man-made. The increase in area of the alluvial plain observed in 1969 and 1977 is certainly of natural cause, while areas of nipa and mangrove decrease slightly during the same period due to human destruction. However, the area of nipa/grasslands show a decrease of 33.15% whereas the area of mangrove/supra-tidal salt flat show an increase of 5.85%.

3.2.3 Intertidal and Off-shore Areas.

The open intertidal deposits are represented by muds as a narrow band generally not more than 2 kilometers wide on both sides of the river mouth. The muds of this area is adjacent to the muds of the mangrove swamp environment. The progradational deposition of open intertidal mud flat is active. Observations made in 1969 and 1977 reveal an increase in the aerial extent of this zone approximately 23%. However, the rate of growth of this zone on the eastern side of the river mouth is more evident at approximately 20 metres/year. The different in the area of open intertidal mud flat during 1969 and 1977 is summarized in Table 3.2.2.

Further seaward from the open intertidal mud flat is the off-shore area. The Upper Gulf of Thailand has an average depth of 15 meters and its total area of about 100 X 100 sq. km. (See Fig. 3.2.2). From the shallow northern coast the bottom slopes gradually downward to a mean

Table 3.2.2 Comparison between each subenvironment of Tha Chin estuary based on information in 1969 and 1977.

Environment	1969 (area in sq.km.)	1977 (area in sq.km.)	Remarks
Alluvial plain	37.02	44.87	21.23 percent increase
Coastal plain			
Coastal grassland	43.25	22.25	48.57 percent decrease
Nipa	38.96	32.72	16.03 percent decrease
Mangrove	29.46	21.66	26.34 percent decrease
Supra-tidal salt flat	49.09	61.40	25.08 percent increase
Open intertidal mud flat	9.32	11.05	23.48 percent increase

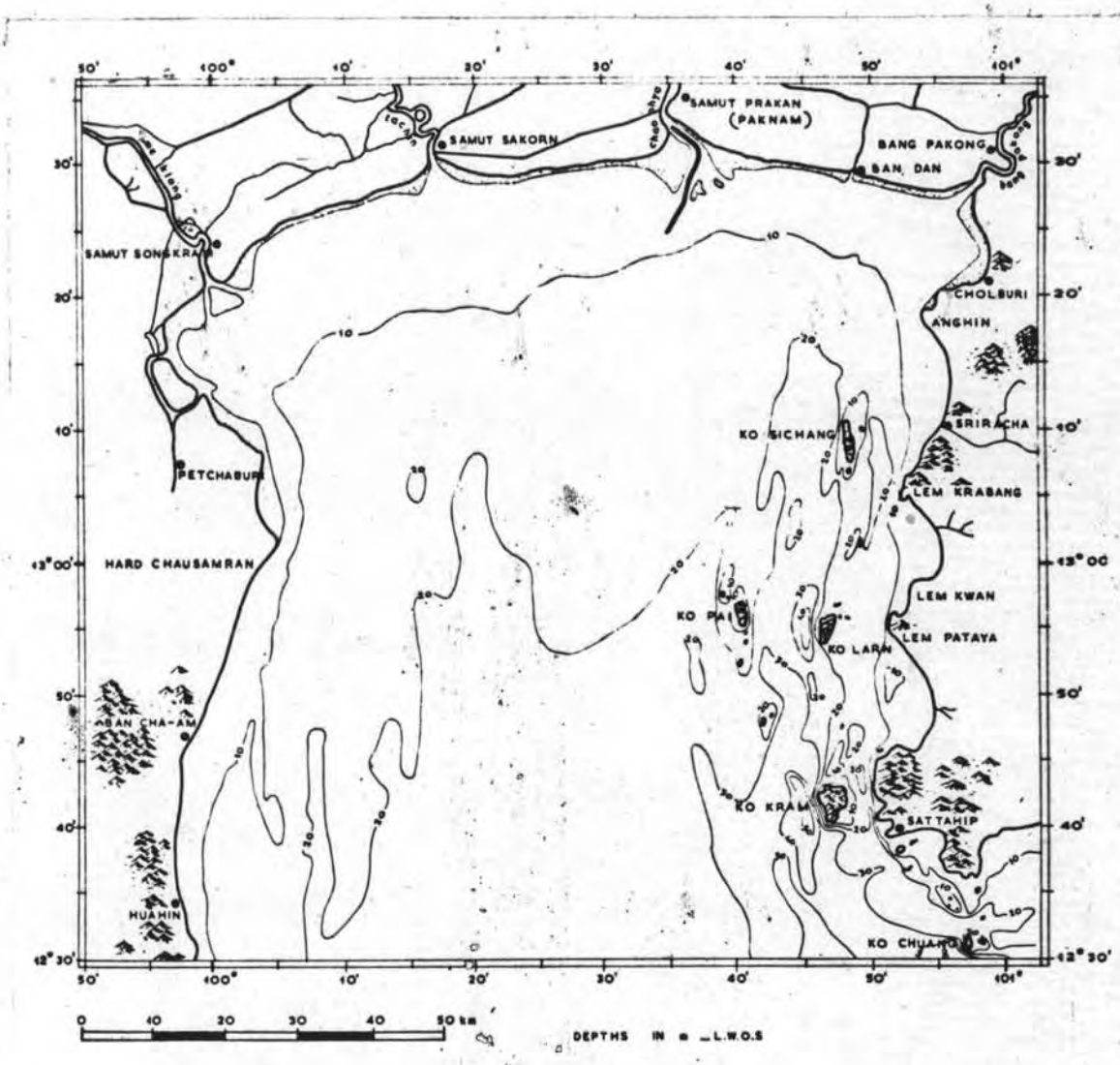

Figure 3.2.2 Bottom topography of the Upper Gulf of Thailand (after NEDECO, 1965).

depth of 24 meters in its mouth between Sattahip and Hua Hin. The eastern part, with its rocky offshore islands, is slightly deeper than the western half. Its northern boundary is the coast of the Central Plain which through this vast Central Plain, the Chao Phraya and its western branch the Tha Chin enter the upper Gulf.

Geologically the western part of the Gulf is a continuation of the syncline of the Central Plain in which the Chao Phraya, Tha Chin and its tributaries have deposited their sediments in layers up to 3,000 meters in thickness. Even at present the rivers build their delta southward into the Gulf with an average accretion of about 5 meters per year (NEDECO, 1965). At northern coast of the Gulf, the bottom censists mainly of mud with particles of 0.001 - 0.004 mm in diameter (NEDECO, 1965). From the center of the Gulf towards the coasts the size of the particles gradually increases, indicating a supply from these coasts. In a few patches near the coast the bottom is rocky.

The environment of depositions of the Tha Chin estuary are summarized and presented in Figure 3.2.3.

3.3 Soil Characteristics.

Tha Chin river is the lower end of Suphan river which enters to the Upper Gulf of Thailand at Samut Sakorn province. Samut Sakorn is situated in the Central Valley. The area of this alluvial plain is 162,860 rai which has some important characteristics as follows: (Appendix I)

a) Upland crops capability This province is classified as a subgroup class u-v (Soil Survey Division, 1972) which soils having little

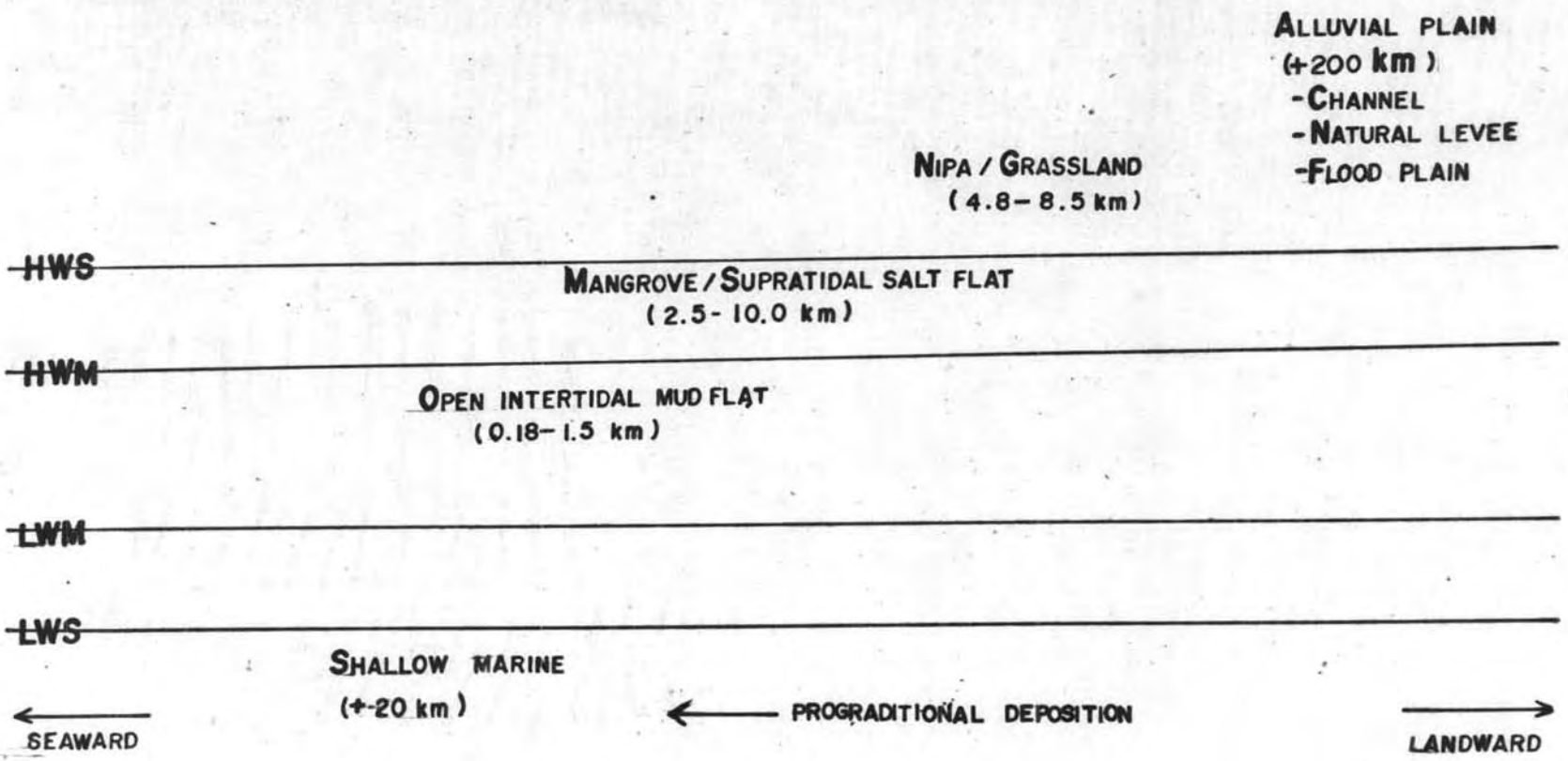

Figure 3.2.3 Schematic representation of the depositional environments of Tha Chin estuary..

or no erosion hazard, but having other limitations that are impractical to remove, making them unsuited for upland crops. The major limitation is salinity or alkalinity.

b) Soil suitability grouping for paddy (wetland) rice Samut Sakorn is classified as a subgroup class P-V (Soil Survey Division, 1972) which soils generally not suited for paddy land and having very serve salinity and alkalinity limitations that preclude their use for rice production with ordinary methods.

c) Soil characteristics Soils in this province is classified as (Typic) Hydraquents (USDA, 1970) or Alluvial soils (Dudal & Moormann, 1964) which has very deep effective soil depth and stratified (silty clay or clay throughout with thin sandy clay layers) textural profile. Its colour profile is brown with dark gray mottles over dark greenish gray. The structure of upper layer is weak to moderate medium and coarse blocky and structureless (unripe) at subsoil layer. This type of soil is very poorly drained and has rapid permeability that results in slow surface runoff and long period of water saturation at soil surface and subsurface. This soil has high organic matter content and very high potassium and phosphorus content. The soil's pH is between 6.5 - 8.0.

From satellite imagery shows that Samut Sakorn provine does not have foresty area (Unpublished data from Foresty Department). But in total area 840 km^2 of Samut Sakorn it still has some mangrove forest.