2.2.3 TOURISM RESOURCES AND SPATIAL DEVELOPMENT FRAMEWORK

1. PHYSICAL DEVELOPMENT FRAMEWORK

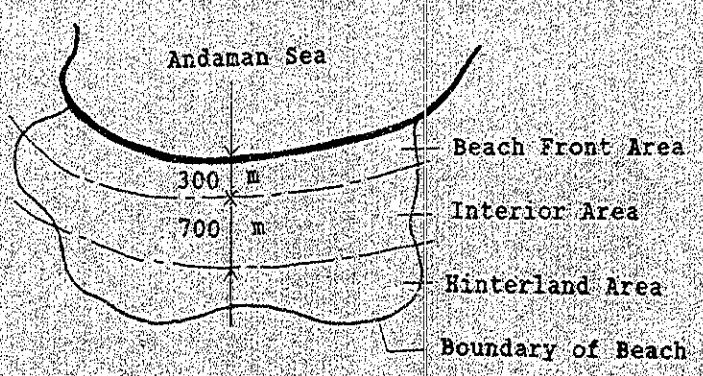
Analysis of Available Land for Tourist Accommodation Sites

1.1 LAND USE OF BEACH AREA

1) CONSIDERATION OF BOUNDARY OF BEACH AREA

The boundary of Beach Area would be fixed to examine the existing land use in beach front area by road, river, or other remarkable change of landscape such as precipice. Furthermore, it could be divided to 3 categories such as Beach Front Area, Interior Area and Hinterland Area. Beach Front Area is a area which faces to the Andaman sea and is 300 m width from beach. Interior Area is a area which locates behind the Beach Front Area with 700 m width and Hinterland Area is behind the Interior Area as below Fig. 2-3 shown.

FIG. 2-3 CONCEPT OF 3 CATEGORIES OF BEACH AREA



2) LAND USE DATA

Landsat data is available to get land use information. Land use pattern is divided to 12 categories in Landsat data, such as;

1)	Mining Land	7)	Swamp Area
2)	Open / Idle land	8)	Management
3)	Mixed Plantation	9)	Water Bodies
4)	Rubber Plantation	10)	Village (Build-up Area)
5)	Paddy Land	11)	Sand Beach
6)	Forest	12)	Others (Unclassified)

Note : - There is a category 'road' in original Landsat data, however, almost of road in Phuket does not identified because most of them are covered by trees and other reasons.
- Available Landsat Data is 18 FEb. 1988.

3) LAND USE OF BEACH AREA

Land Use of Beach Area is shown as below Table 2-10.

TABLE 2-10 TOTAL AREA SUMMARY

No.	NAME OF BEACH	FRONT	INTERIOR	HINTER	TOTAL
1	LAEM KA	2.60	0.00	0.00	2.60
2	RAWAI	70.00	110.80	0.00	180.80
3	NAI HARN	17.50	32.50	0.00	50.00
4	KATA NOI	16.39	0.00	0.00	16.39
5	KATA YAI	43.30	74.20	0.00	117.50
6	KARON	100.60	52.70	0.00	153.30
7	RELAX	5.80	0.00	0.00	5.80
8	PATONG SOUTH	33.40	5.80	0.00	39.20
9	PATONG	130.81	234.20	31.96	396.97
10	KAMALA	110.80	154.20	0.00	265.00
11	SURIN	17.51	31.72	0.00	49.23
12	PANSEA	2.01	0.00	0.00	2.01
	SUBTOTAL	550.72	696.12	31.96	1278.80
13	BAN TAO	183.30	520.00	576.70	1280.00
14	NAI TON	34.20	35.81	0.00	70.01
15	NAI YANG SOUTH	78.79	203.20	5.40	287.39
16	NAI YANG NORTH	211.00	482.49	12.50	705.99
17	CHAT CHAI	213.50	241.50	241.50	696.50
	SUBTOTAL	720.79	1483.00	836.10	3039.89
18	PHANG NGA(1)	66.71	40.80	0.00	107.51
19	PHANG NGA(2)	90.80	168.11	174.91	433.82
20	PHANG NGA(3)	126.89	178.55	556.21	861.65
21	PHANG NGA(4)	95.60	240.00	671.09	1006.69
	SUBTOTAL	380.00	627.46	1402.21	2409.67
22	PHANG NGA(5)	77.50	173.30	375.91	626.71
23	PHANG NGA(6)	117.50	239.20	580.81	937.51
24	PHANG NGA(7)	133.30	302.50	715.51	1151.31
25	PHANG NGA(8)	75.00	189.99	140.00	404.99
	SUBTOTAL	403.30	904.99	1812.23	3120.52
	GRAND TOTAL	2054.81	3711.57	4082.50	9848.88

TABLE 2-11 LENGTH OF BEACH

	FRONT	INTERIOR	HINTERLAND	TOTAL
LENGTH OF BEACH(meter)	43350.00	0.00	0.00	43350.00
0) AREA(ha)	2054.81	3711.57	4082.50	9848.88
LANDUSE(ha)				
1) MINING LAND	57.26	225.32	109.56	392.14
2) OPEN/IDLE LAND	302.84	577.22	411.74	1291.80
3) MIXED PLANTATION	230.71	127.47	154.31	512.49
4) RUBBER PLANTATION	201.57	823.14	2340.40	3365.11
5) PADDY LAND	103.23	493.49	455.50	1052.22
6) FOREST	54.13	35.28	0.00	89.41
7) SWAMP AREA	78.74	149.62	262.12	490.48
8) MANGROVE	18.74	53.35	1.69	73.78
9) WATER BODIES	87.90	114.57	54.48	256.95
10) VILLAGE	135.37	173.93	33.30	342.60
11) SAND BEACH	267.07	0.00	0.00	267.07
12) OTHERS	13.96	10.99	0.00	24.95

1.2 HOTEL ROOM AVAILABLITY

1) AVAILABLE LAND

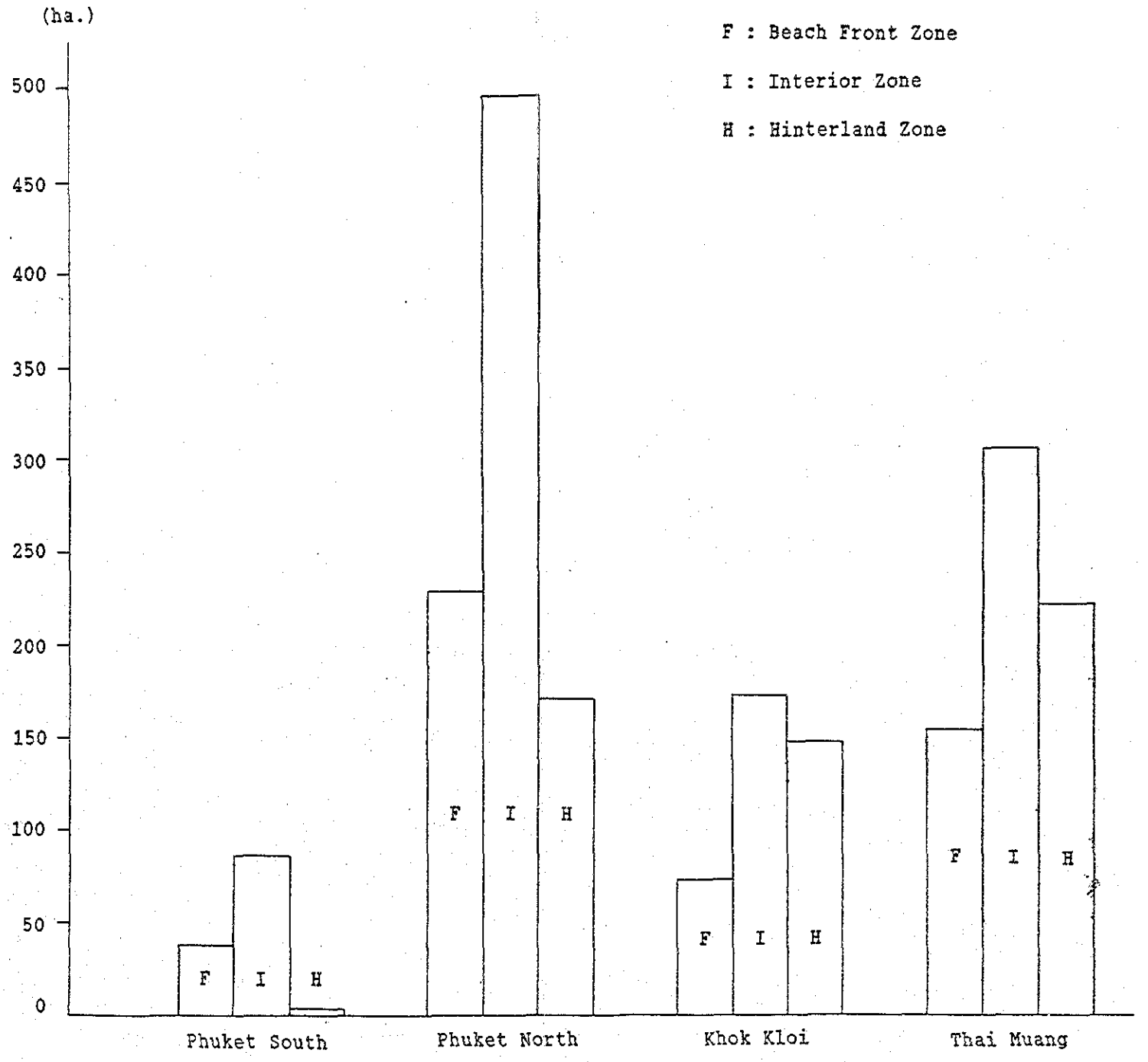
It is suitable to develop open/idle land and mining land for an additional tourist accommodation sites. As mining is now declining in terms of total area as well as its economic denomination, many of mining land operating would be closed gradually. Meanwhile, land for habitat, land for production such as rubber plantation, coconuts plantation, orchard, paddy land, manufacturing must be remained. This is a reason why open/idle land and mining land would be possible to develop as an additional tourist accommodation sites.

Available land, which is open/idle land and mining land, of each beach area is shown of Fig 2-4 and Table 2-12. It is approximate 500 ha, 1,100 ha, 600 ha available in Beach Front Area, Interior Area and Hinterland Area respectively.

TABLE 2-12 AVAILABLE LAND

No.	NAME OF BEACH	FRONT	INTERIOR	HINTER	TOTAL
1	LAEM KA	0.00	0.00	0.00	0.00
2	RAWAI	0.00	0.00	0.00	0.00
3	NAI HAN	0.00	0.00	0.00	0.00
4	KATA NOI	0.00	0.00	0.00	0.00
5	KATA YAI	0.00	0.00	0.00	0.00
6	KARON	17.00	2.00	0.00	19.00
7	RELUX	0.00	0.00	0.00	0.00
8	PATON SOUTH	3.38	0.00	0.00	3.38
9	PATONG	4.53	86.03	4.74	95.30
10	KAMALA	8.77	6.12	0.00	14.89
11	SURIN	0.00	3.09	0.00	3.09
12	PANSEA	0.30	0.00	0.00	0.30
	SUBTOTAL	33.98	97.24	4.74	135.96
13	BANTAO	81.82	222.12	145.63	449.57
14	NAI TON	16.65	10.68	0.00	27.33
15	NAI YANG SOUTH	36.07	56.87	2.16	95.10
16	NAI YANG NORTH	29.49	108.62	5.00	143.11
17	CHAT CHAI	66.72	96.74	19.85	183.31
	SUBTOTAL	230.75	495.03	172.64	898.42
18	PHANG NGA(1)	25.57	14.29	0.00	39.86
19	PHANG NGA(2)	18.10	73.15	38.69	129.94
20	PHANG NGA(3)	3.18	63.02	84.45	150.65
21	PHANG NGA(4)	24.99	23.71	25.28	73.98
	SUBTOTAL	71.84	174.17	148.42	394.43
22	PHANG NGA(5)	33.91	48.95	49.88	132.74
23	PHANG NGA(6)	38.07	60.38	49.18	147.63
24	PHANG NGA(7)	40.66	116.73	84.78	242.17
25	PHANG NGA(8)	43.17	82.27	38.67	164.11
	SUBTOTAL	155.81	308.33	222.51	686.65
	GRANG TOTAL	492.38	1,074.77	548.31	2,115.46

FIG. 2-4 AVAILABLE LAND FOR BEACH RESORT DEVELOPMENT



2) HOTEL ROOM DENSITY

As it is shown the below Table 2-13, High Density development is 65 rooms/ha, Mid Density development is 32.5 rooms/ha and Low Density development is 16.25 rooms/ha.

TABLE 2-13 HOTEL ROOM DENSITY

CASE	NET (rooms/ha)	GROSS (rooms/ha)	
Low Density	25	16.25	Samui
Mid Density	50	32.5	Patong
High Density	100	65	Pattaya

*) Including service facilities area related to accommodation

3) AVAILABLE ROOMS

Available Rooms are calculated as Available land multiplies to Hotel Room Density as mentioned above sections. As it is shown Table 2-14/15/16, approximate 138,000 rooms are available with high density development and approximate 68,000 rooms with mid density development, approximate 34,000 rooms with low density development.

TABLE 2-14 AVAILABLE ROOMS (HIGH DENSITY)

No.	NAME OF BEACH	FRONT	INTERIOR	HINTER	TOTAL
1	LAEM KA	0.00	0.00	0.00	0.00
2	RAWAI	0.00	0.00	0.00	0.00
3	NAI HAN	0.00	0.00	0.00	0.00
4	KATA NOI	0.00	0.00	0.00	0.00
5	KATA YAI	0.00	0.00	0.00	0.00
6	KARON	1,105.00	130.00	0.00	1,235.00
7	RELUX	0.00	0.00	0.00	0.00
8	PATON SOUTH	219.70	0.00	0.00	219.70
9	PATONG	294.45	5,591.95	308.10	6,194.50
10	KAMALA	570.05	397.80	0.00	967.85
11	SURIN	0.00	200.85	0.00	200.85
12	PANSEA	19.50	0.00	0.00	19.50
	SUBTOTAL	2,208.70	6,320.60	308.10	8,837.40
13	BANTAO	5,318.30	14,437.80	9,465.95	29,222.05
14	NAI TON	1,082.25	694.20	0.00	1,776.45
15	NAI YANG SOUTH	2,344.55	3,696.55	140.40	6,181.50
16	NAI YANG NORTH	1,916.85	7,060.30	325.00	9,302.15
17	CHAT CHAI	4,336.80	6,288.10	1,290.25	11,915.15
	SUBTOTAL	14,998.75	32,176.95	11,221.60	58,397.30
18	PHANG NGA(1)	1,662.05	928.85	0.00	2,590.90
19	PHANG NGA(2)	1,176.50	4,754.75	2,514.85	8,446.10
20	PHANG NGA(3)	206.70	4,096.30	5,489.25	9,792.25
21	PHANG NGA(4)	1,624.35	1,541.15	1,643.20	4,808.70
	SUBTOTAL	4,669.60	11,321.05	9,647.30	25,637.95
22	PHANG NGA(5)	2,204.15	3,181.75	3,242.20	8,628.10
23	PHANG NGA(6)	2,474.55	3,924.70	3,196.70	9,595.95
24	PHANG NGA(7)	2,642.90	7,587.45	5,510.70	15,741.05
25	PHANG NGA(8)	2,806.05	5,347.55	2,513.55	10,667.15
	SUBTOTAL	10,127.65	20,041.45	14,463.15	44,632.25
	GRANG TOTAL	32,004.70	69,860.05	35,640.15	137,504.90

TABLE 2-15 AVAILABLE ROOMS (MID DENSITY)

No.	NAME OF BEACH	FRONT	INTERIOR	HINTER	TOTAL
1	LAEM KA	0.00	0.00	0.00	0.00
2	RAWAI	0.00	0.00	0.00	0.00
3	NAI HAN	0.00	0.00	0.00	0.00
4	KATA NOI	0.00	0.00	0.00	0.00
5	KATA YAI	0.00	0.00	0.00	0.00
6	KARON	552.50	65.00	0.00	617.50
7	RELUX	0.00	0.00	0.00	0.00
8	PATON SOUTH	109.85	0.00	0.00	109.85
9	PATONG	147.23	2,795.98	154.05	3,097.25
10	KAMALA	285.03	198.90	0.00	483.93
11	SURIN	0.00	100.43	0.00	100.43
12	PANSEA	9.75	0.00	0.00	9.75
	SUBTOTAL	1,104.35	3,160.30	154.05	4,418.70
13	BANTAO	2,659.15	7,218.90	4,732.98	14,611.03
14	NAI TON	541.13	347.10	0.00	888.23
15	NAI YANG SOUTH	1,172.28	1,848.28	70.20	3,090.75
16	NAI YANG NORTH	958.43	3,530.15	162.50	4,651.08
17	CHAT CHAI	2,168.40	3,144.05	645.13	5,957.58
	SUBTOTAL	7,499.38	16,088.48	5,610.80	29,198.65
18	PHANG NGA(1)	831.03	464.43	0.00	1,295.45
19	PHANG NGA(2)	588.25	2,377.38	1,257.43	4,223.05
20	PHANG NGA(3)	103.35	2,048.15	2,744.63	4,896.13
21	PHANG NGA(4)	812.18	770.58	821.60	2,404.35
	SUBTOTAL	2,334.80	5,660.53	4,823.65	12,818.98
22	PHANG NGA(5)	1,102.07	1,590.88	1,621.10	4,314.05
23	PHANG NGA(6)	1,237.28	1,962.35	1,598.35	4,797.98
24	PHANG NGA(7)	1,321.45	3,793.73	2,755.35	7,870.53
25	PHANG NGA(8)	1,403.03	2,673.78	1,256.78	5,333.58
	SUBTOTAL	5,063.83	10,020.73	7,231.58	22,316.13
	GRANG TOTAL	16,002.35	34,930.03	17,820.07	68,752.45

TABLE 2-16 AVAILABLE ROOMS.(LOW DENSITY)

No.	NAME OF BEACH	FRONT	INTERIOR	HINTER	TOTAL
1	LAEM KA	0.00	0.00	0.00	0.00
2	RAWAI	0.00	0.00	0.00	0.00
3	NAI HAN	0.00	0.00	0.00	0.00
4	KATA NOI	0.00	0.00	0.00	0.00
5	KATA YAI	0.00	0.00	0.00	0.00
6	KARON	276.25	32.50	0.00	308.75
7	RELUX	0.00	0.00	0.00	0.00
8	PATON SOUTH	54.93	0.00	0.00	54.93
9	PATONG	73.61	1,397.99	77.03	1,548.63
10	KAMALA	142.51	99.45	0.00	241.96
11	SURIN	0.00	50.21	0.00	50.21
12	PANSEA	4.88	0.00	0.00	4.88
	SUBTOTAL	552.18	1,580.15	77.03	2,209.35
13	BANTAO	1,329.58	3,609.45	2,366.49	7,305.51
14	NAI TON	270.56	173.55	0.00	444.11
15	NAI YANG SOUTH	586.14	924.14	35.10	1,545.38
16	NAI YANG NORTH	479.21	1,765.08	81.25	2,325.54
17	CHAT CHAI	1,084.20	1,572.03	322.56	2,978.79
	SUBTOTAL	3,749.69	8,044.24	2,805.40	14,599.33
18	PHANG NGA(1)	415.51	232.21	0.00	647.73
19	PHANG NGA(2)	294.13	1,188.69	628.71	2,111.53
20	PHANG NGA(3)	51.68	1,024.08	1,372.31	2,448.06
21	PHANG NGA(4)	406.09	385.29	410.80	1,202.18
	SUBTOTAL	1,167.40	2,830.26	2,411.83	6,409.49
22	PHANG NGA(5)	551.04	795.44	810.55	2,157.03
23	PHANG NGA(6)	618.64	981.18	799.18	2,398.99
24	PHANG NGA(7)	660.73	1,896.86	1,377.68	3,935.26
25	PHANG NGA(8)	701.51	1,336.89	628.39	2,666.79
	SUBTOTAL	2,531.91	5,010.36	3,615.79	11,158.06
	GRANG TOTAL	8,001.18	17,465.01	8,910.04	34,376.23

2. LANDSAT DATA ANALYSIS

2.1 INTRODUCTION

Many projects conducted in Thailand have demonstrated the value of Landsat satellites as an important tool for data gathering. Landsat TM data as well as Landsat MSS have been widely used for land cover classification and coastal mapping. For detail study, image processing becomes very significant and has been employed as a regular method and procedure in several research programs.

The present project "The Study for Potential Tourism Area Development for the Southern Region of Thailand" is one of the efforts in using available Landsat TM and MSS data for the mapping of sedimentation along the west coast of the Phuket and Phang Nga provinces as well as for investigation of the land use in this area. The project is a joint effort between the Remote Sensing Division, National Research Council and the JCP Inc. of Japan. The activities in this project do not involve ground verification due to limited time frame. Therefore other sources of information such as available land use map, topographic map in cooperated with background knowledge of the area are used as a criteria for data analysis.

2.2 OBJECTIVES

1) To classify present land use pattern and measure its acreage in Phang Nga and Phuket by means of computer analysis.
2) To determine sea contamination in terms of turbidity level for the western coast of Phang Nga and Phuket.

2.3 THE STUDY AREA

The study area covers western part of the Phang Nga and Phuket provinces. Being in the southern region, the climate is tropical with monsoon rain. Major activities in this area include rubber plantation and tin mining, not to mention tourism. Recently the dredging of tin mines have contaminated the coastal area of Phang Nga and Phuket with suspended loads transported into the sea by the streams.

2.4 METHODOLOGY

1) MATERIAL USED

a. Landsat TM data in the form of Computer Compatible Tape of 18 Feb. 1988 was used in the analysis of land use pattern and coastal turbidity. The analysis was performed on the Meridian digital image analysis system.

b. Topographic maps at a scale of 1: 50,000 were used to facilitate the registration of the scene to the map projection.

2) PRE-PROCESSING OF SATELLITE DATA

a. Geometric correction: Due to the distortion generated in the satellite data as affected by rotation and the attitude of the satellite, it is necessary to change the geometrical properties of the image to a reference ground coordinates, in order to produce a true cartographic information. Three control points were selected based on the least changeable infrastructures located in the image. With the know coordinates of these points from the maps, the image was spatially warped to a Universal Transverse Mercator map projection.

b. Image enhancement: A Linear Enhancement method was applied to TM band 2, 3, 4 and 5 to produce enhanced image with greater contrast among various features. These images are helpful for preliminary interpretation and analysis.

3) IMAGE ANALYSIS

Sample training sites were selected by outlining polygon on to the image to represent classes of land cover to be identified. A total of twelve categories of sample sites were obtained and utilized for the classification of the whole study area. A maximum likelihood classification method which was based on the evaluation of the mean vector and variance coveriance matrix of brightness values or spectral response of all pixels in each category was employed to classify the individual pixels into an appropriate class. As for the turbidity classification, six water levels could be identified based on the density slicing method.

4) POST CLASSIFICATION

After the classification, the results usually contain a number of isolated pixels. To reduce this effect, a smoothing technique was applied to transform the neighboring pixels that remained unclassified to the appropriate class of the majority neighbor according to their relationship.

2.5 RESULTS

1) TURBIDITY STUDY

Turbidity effects the reflective or emission properties of water along the west coast of Phuket and Phang Nga, and thus can be visually detected. To estimate water quality in the area, it was adequate to simply detect and delineate the area of contamination or turbidity via density slicing method. With this technique, relative turbidity which appears as tonal change can be expressed in terms of different colors each of which represents different levels of turbidity. TM bands particularly band 2 was found most useful for turbidity study.

In the study, water with different tones were sliced into 6 levels and assigned colors according to their spectral response as follows:

SPECTRAL RESPONSE	WATER LEVEL	DESCRIPTION
low	1	Clear water
	2	Moderately clear water
	3	Slightly turbid water
	4	Moderately turbid water
	5	Highly turbid water, shallow water
high	6	Extremely turbid water, very shallow water along shoreline

2) LAND USE CLASSIFICATION

The primary purpose of this task is to study the existing land use pattern in both Phuket island and the area west of Phang Nga province. Four spectral band combinations (2, 3, 4 and 5) were employed for the analysis.

In order to accurately identify or interpret the TM data, supplementary data such as topographic maps and available land use maps produced from conventional method were used. These provided the information and references need to make land use classification decision Based on the above, 12 land use categories could be delineated as follows:

1. Forest
2. Mangroves
3. Rubber plantation
4. Mixed plantation : coconut, orchard
5. Paddy land
6. Open land : clear-cut forest and mangrove area,barren land, fallow land
7. Swamp area : swamp forest, marsh
8. Built-up area : town, village
9. Mining area
10. Sandy beach : coastal zone
11. Water bodies : River, pond
12. Road

The following table illustrates the area of each category in the study area.

TABLE 2-17 LAND USE OF STUDY AREA

No.	Category	sq.kilometers	percent
1.	Forest	419.964	19.19
2.	Mangroves	220.655	10.08
3.	Rubber plantation	1,158.064	52.91
4.	Mixed plantation	18.161	.83
5.	Paddy land	46.977	2.15
6.	Open land	124.292	9.79
7.	Swamp area	5.473	.25
8.	Built-up area	10.785	.49
9.	Mining area	25.565	1.17
10.	Sandy beach	5.933	.27
11.	Water body	15.270	.70
12.	Road	3.765	.17
	Unclassified and cloud area	43.672	2.00
Total area		2,188.557	100.00

2.6 CONCLUSION AND DISCUSSION

Digital data from remote sensing by satellite is an important tool and paves the way for a new technology of mapping. By analyzing turbidity water and outlining the land use activities in the study area, it is possible to take into account not only the bio-physical environment, but also the human uses and transformation which are in interaction with it.

Data selection of the image is important, for they link to the phenomena understudy. Natural vegetation such as rubber will shed their leaves in certain months which makes it difficult to identify from the satellite image. Likewise coastal currents are regulated by the prevailing monsoons. As suspension loads are discharged into the sea, their distribution pattern becomes different from one season to another. Therefore, the prevailing winds and currents must be taken into account in the interpretation. In the South region of Thailand, the main constraints for choosing the image include high cloud coverage. However, the probability of acquiring cloud-free data have been considerably improved with the SPOT satellite with its capability to cover a particular area with repetition rate of less than one week.

The point to stress is that, of vital importance area observations in the field, both for the preparation of data for processing and for verifying the results obtained. Te value of the classification depends on this to a great extent. However with aid of other data sources available, it was possible to pinpoint the area precisely. The output maps proved to be satisfactory even without field observation.