AD 275 476

UNCLASSIFIED

04231-1-F

THE UNIVERSITY OF MICHIGAN

COLLEGE OF LITERATURE, SCIENCE, AND THE ARTS
DEPARTMENT OF GEOGRAPHY

Final Report

Analysis of Geographic and Climatic Factors in Coastal Southeast Asia

Under Contract With:

Quartermaster Research and Development Command
Environmental Protection Research Division
Contract No. DA-19-129-QM-1655
Natick, Massachusetts

Administered through: *March 1962*

OFFICE OF RESEARCH ADMINISTRATION · ANN ARBOR

AD Accession No. UNCLASSIFIED

The University of Michigan, Office of Research Administration, Ann Arbor
ANALYSIS OF GEOGRAPHIC AND CLIMATIC FACTORS IN COASTAL SOUTHEAST ASIA
Report No. 04231-1-F, March 62, 178 pp incl. 31 illus., and 30 tables
(Contract DA-19-129-QM-1655)
Unclassified Report

Description of a fifty mile wide strip around the coast of Southeast Asia from Pakistan to China. The topics included are: offshore water depths;
(over)

UNCLASSIFIED

AD Accession No. UNCLASSIFIED

The University of Michigan, Office of Research Administration, Ann Arbor
ANALYSIS OF GEOGRAPHIC AND CLIMATIC FACTORS IN COASTAL SOUTHEAST ASIA
Report No. 04231-1-F, March 62, 178 pp incl. 31 illus., and 30 tables
(Contract DA-19-129-QM-1655)
Unclassified Report

Description of a fifty mile wide strip around the coast of Southeast Asia from Pakistan to China. The topics included are: offshore water depths;
(over)

UNCLASSIFIED

UNCLASSIFIED

coastal analysis; land surface with separate studies of relative relief and slope angles; climate and weather with detailed statistics of some weather stations; vegetative cover with a special study of trafficability of rice paddies in Malaya; soils, described by separate countries; a quantified study of the road system with an interesting new technique for appraisal; and native animals and diseases of importance to military operations.

UNCLASSIFIED

UNCLASSIFIED

coastal analysis; land surface with separate studies of relative relief and slope angles; climate and weather with detailed statistics of some weather stations; vegetative cover with a special study of trafficability of rice paddies in Malaya; soils, described by separate countries; a quantified study of the road system with an interesting new technique for appraisal; and native animals and diseases of importance to military operations.

UNCLASSIFIED

AD Accession No. UNCLASSIFIED

The University of Michigan, Office of Research Administration, Ann Arbor
ANALYSIS OF GEOGRAPHIC AND CLIMATIC FACTORS IN COASTAL SOUTHEAST ASIA
Report No. 04231-1-F, March 62, 178 pp incl. 31 illus., and 30 tables
(Contract DA-19-129-QM-1655)
Unclassified Report

Description of a fifty mile wide strip around the coast of Southeast Asia from Pakistan to China. The topics included are: offshore water depths; (over)

UNCLASSIFIED

UNCLASSIFIED

coastal analysis; land surface with separate studies of relative relief and slope angles; climate and weather with detailed statistics of some weather stations; vegetative cover with a special study of trafficability of rice paddies in Malaya; soils, described by separate countries; a quantified study of the road system with an interesting new technique for appraisal; and native animals and diseases of importance to military operations.

UNCLASSIFIED

AD Accession No. UNCLASSIFIED

The University of Michigan, Office of Research Administration, Ann Arbor
ANALYSIS OF GEOGRAPHIC AND CLIMATIC FACTORS IN COASTAL SOUTHEAST ASIA
Report No. 04231-1-F, March 62, 178 pp incl. 31 illus., and 30 tables
(Contract DA-19-129-QM-1655)
Unclassified Report

Description of a fifty mile wide strip around the coast of Southeast Asia from Pakistan to China. The topics included are: offshore water depths; (over)

UNCLASSIFIED

UNCLASSIFIED

coastal analysis; land surface with separate studies of relative relief and slope angles; climate and weather with detailed statistics of some weather stations; vegetative cover with a special study of trafficability of rice paddies in Malaya; soils, described by separate countries; a quantified study of the road system with an interesting new technique for appraisal; and native animals and diseases of importance to military operations.

UNCLASSIFIED

AD Accession No. UNCLASSIFED

The University of Michigan, Office of Research Administration, Ann Arbor
ANALYSIS OF GEOGRAPHIC AND CLIMATIC FACTORS IN COASTAL SOUTHEAST ASIA
Report No. 04231-1-F, March 62, 178 pp incl. 31 illus., and 30 tables
(Contract DA-19-129-QM-1655)
Unclassified Report

Description of a fifty mile wide strip around the coast of Southeast Asia from Pakistan to China. The topics included are: offshore water depths;
(over)

UNCLASSIFIED

UNCLASSIFIED

coastal analysis; land surface with separate studies of relative relief and slope angles; climate and weather with detailed statistics of some weather stations; vegetative cover with a special study of trafficability of rice paddies in Malaya; soils, described by separate countries; a quantified study of the road system with an interesting new technique for appraisal; and native animals and diseases of importance to military operations.

UNCLASSIFIED

AD Accession No. UNCLASSIFIED

The University of Michigan, Office of Research Administration, Ann Arbor
ANALYSIS OF GEOGRAPHIC AND CLIMATIC FACTORS IN COASTAL SOUTHEAST ASIA
Report No. 04231-1-F, March 62, 178 pp incl. 31 illus., and 30 tables
(Contract DA-19-129-QM-1655)
Unclassified Report

Description of a fifty mile wide strip around the coast of Southeast Asia from Pakistan to China. The topics included are: offshore water depths;
(over)

UNCLASSIFIED

UNCLASSIFIED

coastal analysis; land surface with separate studies of relative relief and slope angles; climate and weather with detailed statistics of some weather stations; vegetative cover with a special study of trafficability of rice paddies in Malaya; soils, described by separate countries; a quantified study of the road system with an interesting new technique for appraisal; and native animals and diseases of importance to military operations.

UNCLASSIFIED

AD Accession No. UNCLASSIFED

The University of Michigan, Office of Research Administration, Ann Arbor
ANALYSIS OF GEOGRAPHIC AND CLIMATIC FACTORS IN COASTAL SOUTHEAST ASIA
Report No. 04231-1-F, March 62, 178 pp incl. 31 illus., and 30 tables
(Contract DA-19-129-QM-1655)
Unclassified Report

Description of a fifty mile wide strip around the coast of Southeast Asia from Pakistan to China. The topics included are: offshore water depths; (over)

UNCLASSIFIED

UNCLASSIFIED

coastal analysis; land surface with separate studies of relative relief and slope angles; climate and weather with detailed statistics of some weather stations; vegetative cover with a special study of trafficability of rice paddies in Malaya; soils, described by separate countries; a quantified study of the road system with an interesting new technique for appraisal; and native animals and diseases of importance to military operations.

UNCLASSIFIED

AD Accession No. UNCLASSIFIED

The University of Michigan, Office of Research Administration, Ann Arbor
ANALYSIS OF GEOGRAPHIC AND CLIMATIC FACTORS IN COASTAL SOUTHEAST ASIA
Report No. 04231-1-F, March 62, 178 pp incl. 31 illus., and 30 tables
(Contract DA-19-129-QM-1655)
Unclassified Report

Description of a fifty mile wide strip around the coast of Southeast Asia from Pakistan to China. The topics included are: offshore water depths; (over)

UNCLASSIFIED

UNCLASSIFIED

coastal analysis; land surface with separate studies of relative relief and slope angles; climate and weather with detailed statistics of some weather stations; vegetative cover with a special study of trafficability of rice paddies in Malaya; soils, described by separate countries; a quantified study of the road system with an interesting new technique for appraisal; and native animals and diseases of importance to military operations.

UNCLASSIFIED

THE UNIVERSITY OF MICHIGAN
COLLEGE OF LITERATURE, SCIENCE AND THE ARTS
Department of Geography

Final Report

ANALYSIS OF GEOGRAPHIC AND CLIMATIC FACTORS IN COASTAL SOUTHEAST ASIA

ORA Project 04231

under contract with:

QUARTERMASTER RESEARCH AND DEVELOPMENT COMMAND
ENVIRONMENTAL PROTECTION RESEARCH DIVISION
CONTRACT NO. DA-19-129-QM-1655
NATICK, MASSACHUSETTS

administered through:

OFFICE OF RESEARCH ADMINISTRATION ANN ARBOR

March 1962

TABLE OF CONTENTS

TABLE OF CONTENTS (Concluded)

LIST OF TABLES

LIST OF TABLES (Concluded)

LIST OF FIGURES

LIST OF MAPS

LIST OF MAPS (Concluded)

I. INTRODUCTION

Directive

Contract No. DA 19-129-QM-1655 between the Headquarters of Quartermaster Research and Engineering Command, U.S. Army Quartermaster Research and Engineering Center, Natick, Massachusetts, and the Department of Geography, The University of Michigan, directs that the contractor "shall exert his best efforts with a view toward:

"1. Determining the environmental elements (e.g., weather and climate, landforms, soils, vegetation, native animals, diseases, and the physical works of man) in the coastal areas of Southeast Asia (Burma, Thailand, and Malay Peninsula, and the countries of former French Indo-China) which should be considered in the design and operation of all types of military equipment."

Assumptions

Certain assumptions were made by the contractor within the broad framework of the directive to limit and guide the research work. These were:

A. The "coastal area" was considered to be an area extending inland for an arbitrary distance of fifty miles and included the offshore water.

B. That "operation" implied military operation by a commander who would need to know the environmental character of whatever part of the coastal area in which his operations were being conducted.

C. That basic information about all of the elements listed in the directive would not be available in the same degree of detail for all of the area, so that the several sections of the report should not be confined to any given degree of detail and that each one should be relatively complete in itself.

D. That the report would be used for both of the purposes (design and operation) mentioned in the directive and should be easily understood by persons without extensive geographic knowledge and vocabulary.

Presentation

The environmental elements are presented in topical form with regionalization, when applicable, made on the basis of the individual element. Qualitative descriptions are supplemented by quantitative analyses in those parts of the report where the data lend themselves to quantification.

Basic Map Coverage

In several of the tables, maps are referred to by numbers 1 to 85. These represent the numbers given to the maps of several series on the 1:250,000 and similar scales, arranged in series around the Project Area from northwest to northeast. For purposes of identification the exact designations of these numbered maps follows:

Number	Series and Index Number		Scale
1	U542	NF 46-10	1:250,000
2	U542	NF 46-14	1:250,000
3	U542	NF 46-15	1:250,000
4	U542	NE 46-3	1:250,000
5	U542	NE 46-7	1:250,000
6	U542	NE 46-8	1:250,000
7	U542	NE 46-12	1:250,000
8	U542	NE 46-15	1:250,000
9	U542	NE 46-16	1:250,000
10	U542	ND 46-4	1:250,000
11	U542	NE 47-13	1:250,000
12	U542	NE 47-9	1:250,000
13	L509	NE 47-14	1:250,000
14	U542	NE 47-14	1:250,000
15	U542	ND 47-2	1:250,000
16	U542	ND 47-6	1:250,000
17	U542	ND 47-10	1:250,000
18	U542	ND 47-14	1:250,000
19	U542	NC 47-2	1:250,000
20	U542	ND 47-6	1:250,000
21	L508	C 470	1:253,440
22	L508	C-47V	1:253,440
23	L508	B-47C	1:253,440
24	L508	B-47D	1:253,440
25	L508	B-47J	1:253,440

Number	Series and Index Number	Scale
26	L501 B-47K	1:253,440
27	L501 2I	1:253,440
28	GS GS 4218 13-47R	1:253,440
29	L501 B-47W	1:253,440
30	L501 B-47X	1:253,440
31	L501 3A	1:253,440
32	L501 313	1:253,440
33	L501 A-47L	1:253,440
34	L501 A-47G & part A-48M	1:253,440
35	L501 3L	1:253,440
36	L501 A-48 0	1:253,440
37	GS GS 4218 A-481	1:253,440
38	GS GS 4218 A-48H	1:253,440
40	L501 C3	1:253,440
41	GS GS 4218 B-48T	1:253,440
42	GS GS 4218 B-48S	1:253,440
43	GS GS 4218 B-48N	1:253,440
44	GS GS 4218 B-48M	1:253,440
45	GS GS 4218 B-48G	1:253,440
46	L501 13-47L	1:253,440
47	L508 B-47E	1:253,440
48	L508 C-47W	1:253,440
49	L508 C-47V	1:253,440
50	L508 C-47P & C-47Q	1:253,440
51	L509 NC 47-7	1:250,000
52	L509 NC 47-3	1:250,000
53	L509 ND 47-15	1:250,000
54	L509 ND 47-11	1:250,000
55	L509 ND 47-12	1:250,000
56	L509 ND 48-9	1:250,000
57	L509 ND 47-16	1:250,000
58	L509 ND 48-13	1:250,000
59	L509 NC 48-1	1:250,000
60	L509 NC 48-2	1:250,000
61	L509 NC 48-5	1:250,000
62	L509 NC 48-6	1:250,000
63	L509 NC 48-10	1:250,000
64	L509 NC 48-15	1:250,000
65	L509 NC 48-11	1:250,000
66	L509 NC 48-7	1:250,000
67	L509 NC 48-8	1:250,000
68	L509 NC 48-4	1:250,000
69	L509 NC 49-1	1:250,000
70	L509 ND 49-13	1:250,000
71	L509 ND 49-9	1:250,000
72	L509 ND 49-5	1:250,000

Number	Series and Index Number		Scale
73	L509	ND 48-4	1:250,000
74	L509	ND 49-1	1:250,000
75	L509	NE 49-13	1:250,000
76	L509	NE 48-16	1:250,000
77	L509	NE 48-15	1:250,000
78	L509	NE 48-12	1:250,000
79	L509	NE 48-11	1:250,000
80	L509	NE 48-7	1:250,000
81	L509	NE 48-3	1:250,000
82	L509	NF 48-15	1:250,000
83	L509	NF 48-16	1:250,000
84	L509	NF 48-11	1:250,000
85	L509	NF 48-12	1:250,000

Personnel connected with the research and preparation of this report are:

Project Director: Charles M. Davis

Research Associates: L. A. Peter Gosling, David L. Jones, Ian M. Matley, John D. Nystuen, Waldo R. Tobler, Paul Vander Meer

Research Assistants: Alberta A. Bellaire, Donald J. Lenick, Anne Lindgren, Susan H. Perham, Ann Peterson, Jean P. Ponchie, William Rogell, Helen Thompson.

II. APPROACHES TO THE COAST

It seems a reasonable assumption that any military operations in Southeast Asia will involve landing of personnel and equipment on the shore. It is also probable in any widespread operations that several such landings would be made because the capacity and extent of the road and railroad system would not permit long supply lines. During World War II the Japanese forces used coastwise amphibious movements to circumvent defense lines across the Malay Peninsula.

For these reasons it seemed useful to analyze the coastal conditions of the area. This analysis has been done in two parts: first, a study of the offshore water depths; second, an analysis of the nature of coastal structure and cover which might affect amphibious landings. The offshore water depth study is complete for the entire coastline but the coastal type analysis had to be limited to the areas for which large scale map coverage was available. For both studies the raw material data is presented with some summaries and generalizations.

The data of the analyses indicate that approximately 30% of the examined coast is easily approachable; that about the same percentage is inaccessible, mostly because of mangrove growth; and that the remainder presents problems either in the approach itself or on the immediate shore. The inaccessible areas as well as the problem areas are interspersed with accessible areas so that amphibious landings would be possible within almost any considerable strip of the coast.

Offshore Water Depths

There is a common but not universal relationship between the offshore depths and the coastal geomorphology. This may be stated: deep water is closer onshore along hilly and mountainous coastlines and farther offshore on flat alluvial coasts and deltas; on bay-and-headland coasts the deep water approaches most closely onshore at the headlands and is most distant offshore in the bay bottoms. Considering the whole of the coastline of Southeast Asia and medians of measured samples, the five fathom contour will usually be located from one to two miles offshore and the ten fathom contour two to five miles offshore.

MEASUREMENTS

The 1:250,000 coverage was used for measurement because the HO charts were on smaller scales and the fragmentary coverage of larger scales (1:50,000 and 1:63,360) did not always include hydrographic information and also the sheets seldom extended far enough offshore for the purposes of this analysis.

The five and ten fathom contours were used in the analysis because they were available on the 1:250,000 coverage and also because it was probable that transports and larger vessels could approach the shore landward of the ten fathom contour but not beyond the five fathom contour.

One or more measurements were made on each of the 85 maps of the area coverage except those with no shoreline. For summary purposes the data has been divided into distributional areas in terms of location from Burma around to the China border. The data itself does not show any regionality except for the association with geomorphology mentioned above. The accompanying map (Map 1) shows the locations of the samples; two of the same number means two samples from the same map. The names of the locational areas are also shown on the map.

Coastal Type Analysis

A survey of incomplete map coverage indicates that about 30% of the coastline is open to easy access by any kind of landing craft and about 13% presents some but probably not serious offshore obstacles such as rocks, coral, or sandbanks. About 25% has onshore conditions that present difficulties and some 31% is inaccessible, almost entirely because of mangrove growth. The poorest coastal conditions were found along the west coast of Thailand and South Burma and the best conditions, as judged from incomplete coverage occur along the South China Sea Coast and the southern part of the Gulf of Tonkin.

A survey of coastal types was made from the available large-scale map coverage to determine the frequency and geographical distribution of the types. The objective was to ascertain the availability of coastal areas on which landings could be made.

AVAILABLE MAP COVERAGE

After some experimentation it was decided that the information shown on the 1:250,000 and similar scales was not useful for the purposes of the objective. The 1:25,000 gave the best and most detailed information but the area covered at this scale was confined to one part of the coast and therefore did not make a good sample. The 1:63,360 coverage was available for most of the west coast area and 1:50,000 for approximately one-half of the Indo-China Coast. An attempt was made to generalize the missing parts from the 1:250,000 maps but the results of trial checks were not comparable.

TABLE 1

OFFSHORE LOCATIONS OF THE FIVE- AND THE TEN-FATHOM CONTOURS

(Arranged by distributional areas in terms of increasing distances from shore)

VC - very close, computed as 0.0 in figuring averages.
OM - off map, commonly distances of ten miles or more (where OM readings occur the average distances are not computed).
Measurements in miles perpendicular to shore direction.

BAY OF BENGAL (9 samples)

	5 Fathoms	10 Fathoms
	VC 0.0	1.0
	0.5	1.0
	0.5	2.0
	1.0	2.0
	1.0	2.0
	1.0	6.0
	2.0	12.0
	2.0	13.0
	3.5	13.0
Average	1.27	5.77
Median	1.0	2.0

GULF OF MARTABAN (4 samples)

	5 Fathoms	10 Fathoms
	1.0	3.0
	2.0	OM
	2.0	OM
	20.0	OM
Average	6.25	--
Median	2.0	--

ANDAMAN COAST (9 samples)

	5 Fathoms	10 Fathoms
	VC 0.0	0.25
	VC 0.0	0.50
	VC 0.0	1.25
	0.75	2.0
	1.0	2.0
	2.5	4.0
	4.0	4.5
	5.0	7.0
	5.0	7.0
Average	2.0 (1.9722)	3.166
Median	1.0	2.0

MALACCA STRAIT (11 samples)

	5 Fathoms	10 Fathoms
	VC	0.5
	0.75	1.0
	1.0	1.25
	1.0	1.50
	1.0	2.0
	1.5	3.0
	1.75	3.0
	3.0	5.0
	3.0	6.5
	5.0	8.0
	6.0	16.0
Average	2.1818	4.3409
Median	1.5	3.0

MALAYA EAST COAST (8 samples)

	5 Fathoms	10 Fathoms
	VC 0.0	1.5
	VC 0.0	2.0
	0.25	2.0
	0.5	2.5
	0.75	3.5
	1.5	5.0
	3.0	5.0
	3.0	6.0
Average	1.1250	3.4375
Median	0.5	2.5

GULF OF SIAM (16 samples)

	5 Fathoms	10 Fathoms
	VC 0.0	0.5
	VC 0.0	0.75
	0.5	2.0
	1.0	2.5
	1.0	2.5
	1.0	4.0
	1.5	5.0
	1.5	5.5
	1.5	6.0
	2.0	7.0
	2.0	9.0
	2.5	10.0
	3.0	10.0
	4.0	13.0
	7.0	14.0
	19.0	OM
Average	2.9687	--
Median	1.5	5.5

SOUTH CHINA SEA COAST (11 samples)

	5 Fathoms	10 Fathoms
	VC	0.25
	VC	0.5
	VC	0.5
	0.25	0.75
	0.25	0.75
	0.25	1.0
	0.25	1.0
	0.5	1.0
	0.5	1.5
	0.75	4.0
	5.0	7.5
Average	0.7045	1.7045
Median	0.25	1.0

GULF OF TONKIN (5 samples)

	5 Fathoms	10 Fathoms
	VC	0.5
	0.5	7.0
	1.5	8.0
	3.0	13.0
	14.0	24.0
Average	3.8	10.5
Median	1.5	8.0

TABLE 2

EXACT LOCATIONS BY PLACE NAME, LATITUDE, LONGITUDE, AND MAP NUMBER OF SAMPLED AREAS WITH OFFSHORE DISTANCES OF FIVE- AND TEN-FATHOM CONTOURS

Map No.	Location		5-Fathom Line, miles	10-Fathom Line, miles
	Country: BURMA			
(1) NF 46-10	Out of territory			
(2) NF 46-14	Thavinchaung	20°25' N 92°35' E	2	12
(2) NF 46-14	Dahaing	20°10' N 92°50' E	3-1/2	13
(3) NF 46-15	No coastline			
(4) NE 46-3	*Kyunzon Taung (an island)	19°47' N 93°02' E	1/2	1
(4) NE 46-3	West Point (an island named Ramree)	19°20' N 93°26' N	1	2
(5) NE 46-7	Thandougzu	18°50' N 93°55' E	Close off shore	13
(5) NE 46-7	Agat Eaung	18°16' N 94°20' E	1	2
(6) & (7)	Sheets off coast			
(8) NE 46-15	Tazin	16°52' N 94°22' E	1/2	1
(8) NE 46-15	Alegon	16°33' N 94°45' E	1	2
(9)	Sheet off coast			
(10) ND 46-4	Purian Point	15°50' N 94°22' E	2	6
	Both following are in Gulf of Martaban:			
(11) NE 47-13	Tawpalwe	16°15' N 96°00' E	20	Cannot be found on map
(11) NE 47-13	Padaukkon	16°30' N 97°22' E	2	Cannot be found on map
(12), (13), & (14)	Off coast			
(15) ND 47-2	Rocky Ledge	15°16' N 97°42' E	2	3
(15) ND 47-2	Pagoda	15°55' N 97°35' E	1	Indefinite
(16) ND 47-6	White Point	14°52' N 97°47' E	Extremely close to shore	2
(16) ND 47-6	S. of Pagoda Point	14°12' N 98°03' E	1	2
(17) ND 47-10	Than Maw	13°32' N	Extremely close	1/2
(18) ND 47-14	North of Mergui	12°29' N 98°35' E	4	4-1/2

TABLE 2 (Continued)

Map No.	Location		5-Fathom Line, miles	10-Fathom Line, miles
	Country: BURMA (Concluded)			
(19) NC 47-2	Alyne	11°10' N 98°44' E	5	7
(20) NC 47-6	Tutkabo Maw	10°36' N 99°29' E	2-1/2	4
	Country: THAILAND			
(21) C-47 O	Laem Pho	9°38' N 98°28' E	3	7
(22) C-47 U	Laimtam Chak	8°32' N 98°13' E	3/4	1-1/4
(22) C-47 U	Laem Son	8°02' N 98°15' E	Extremely close	1/2
(23) B-47 C	Laem Mum Nai	7°47' N 98°16' E	Extremely close	1/4
(24) B-47 D	B Ta Pe	7°21' N 99°78' E	6	8
(25) B-47 J	B Bau Ched Luk	6°52' N 99°40' E	5	16
	Country: MALAYA			
(26) B-47 K	Kg Kubang	6°07' N 100°16' E	3	5
(27) Sheet 21	Yen	50°47' N 100°22' E	3	6-1/2
(28)	No shoreline			
(29) B-47 W	Bt Batu Tiga	4°10' N 100°37' E	3/4	1
(30) B-47 Y	No shoreline			
(31) Sheet 3A	Tajong Sauk	3°47' N 100°49' E	1-3/4	3
(32) Sheet 3B	West of K Selangor Fort	3°22' N 101°10' E	1-1/2	3
(33) A-47 L	Port Dickson	2°32' N 101°47' E	Extremely close	1/2
(34) A-48 G	Tg Klinz	2°14' N 102°07' E	1	1-1/2
(34) A-48 G	Kg Jawa	1°52' N 102°40' E	1	1-1/4
(35) Sheet 3-L	Tg Piai (Bules)	1°15 N 103°30' E	1	2
(36) A-48 O	Kg Telok Bemunia	1°17' N 104°15' E	Extremely close	2

TABLE 2 (Continued)

Map No.		Location		5-Fathom Line, miles	10-Fathom Line, miles
		Country: MALAYA (Concluded)			
(37)		Very little shoreline			
(38)	A-48 H	Tg Penyabony	2°38' N 103°47' E	1-1/2	5
(39)	A-48 B	Kg K Pahang	3°32' N 103°27' E	3	6
(40)		No shoreline			
(41)	B-48 T	Kg Telok Kalong	4°17' N 103°27' E	1/4	2
(42)		No shoreline			
(43)	B-48 N	Bt Chenering	5°16' N 103°10' E	Very close	3-1/2
(44)	B-48 M	Kg Merang	5°32' N 102°52' E	1/2	2-1/2
(45)	B-48 G	Kg Sabak	6°10' N 102°20' E	3	5
(46)	B-47 L	Kg Tauk Ha	6°50' N 101°32' E	3/4	1-1/2
		Country: THAILAND			
(47)	B-47 E	Songkhla	7°13' N 100°10' E	2-1/2	14
(48)	C-47 W	Laem Lum Phuk	8°30' N 100°10' E	3	10
(49)	C-47 V	Sichon	9°00' N 99°55' E	1	
(50)	C-47 P	Pak Khlong	9°07' N 99°53' E	1-1/2	9
(51)	NC 47-7	North of Kowiang Island	10°50' N 99°32' E	Very close	1/2
(52)	NC 47-3	Khao Mae Ramphung	11°13' N 99°33' E	1/2	2
(53)	ND 47-15	Ban Khung Tanot	12°10' N 100°02' E	1-1/2	2-1/2
(54)	ND 47-11	Hat Pak Khlong	13°00' N 100°05' E	2	7
(55)	ND 47-12	Laem Chabang	13°05' N 100°52' E	1	5-1/2
(56)		No coastline			
(57)	ND 47-16	Laem Pu Chao	12°40' N 100°52' E	Very close	3/4
(58)	ND 48-13	Ban Thammochat Lang	12°10' N 102°17' E	2	6

TABLE 2 (Continued)

Map No.	Location		5-Fathom Line, miles	10-Fathom Line, miles
	Country: CAMBODIA			
(59) NC 48-1	Pointe Kah Kussat	11°05' N 103°05' E	1	4
(60)	No shoreline			
(61) NC 48-5	A point SE of Ream	10°30' N 103°38' E	1-1/2	2-1/2
	Country: VIETNAM			
(62) NC 48-6	Mui Ong Thoa	10°08' N 104°38' E	19	Extremely far
(63) NC 48-10	Point South of Les Mamelles	9°02' N 104°48' E	7	13
(64) NC 48-15	Kam Mui	8°38' N 104°43' E	4	5
(65) NC 48-11	Ap Kam Thanh	9°40' N 106°40' E	5	7-1/2
(66) NC 48-7	Cap Saint Jacques	10°20 N 107°15' E	Very close	4
(67) NC 48-8	Pointe de Ke Ga	10°40' N 108°00' E	1/4	1
(68)	No shoreline			
(69) NC 49-1	Mui Sung Truu	11°18' N 109°00' E	Very close	1/2
(70) ND 49-13	Dam Van	12°25' N 109°20' E	Very close	1/4
(71) ND 49-9	Phu Oc	13°18' N 109°18' E	3/4	1
(72) ND 49-5	Vinh Tuy	14°40' N 109°05' E	1/4	3/4
(73)	No shoreline			
(74) ND 49-1	Cap Nam Tram	15°25' N 108°50' E	1/2	3/4
(75) NE 49-13	Cap Chon May (east)	16°20' N 108°02' E	1/4	1/2
(76) NE 48-16	Vinh Tri	16°40' N 107°35' E	1/4	1-1/2
(77)	No shoreline			
(78) NE 48-12	Cap Lay	17°05' N 107°05' E	1/2	1
(79)	No shoreline			
(80) NE 48-7	Cap Mui Ron Ma	18°08' N 106°28' E	Very close	1/2

TABLE 2 (Concluded)

Map No.	Location		5-Fathom Line, miles	10-Fathom Line, miles
	Country: VIETNAM (Concluded)			
(81) NE 48-3	Cap Talus	19°20' N 105°48' E	1/2	7
(81) NE 48-3	Cap Chao	19°42' N 105°52' E	1-1/2	13-1/2
(82)	No appreciable shoreline			
(83) NF 48-16	Point nearHon Dau Sight	20°42' N 106°48' E	3	8
(84)	No shoreline			
(85) NF 48-12	Nui Cat	21°20' N 107°37' E	14	24

Complete coverage was obtainable for the Burma Coast (see Coastal Regions, below) the Gulf of Martaban, and for most of the Andaman Sea Coast and Malacca Straits. For these areas meaningful generalizations can be made. The coverage for the East Malay Coast is all in one section representing more than half of the coast. There is so little coverage in the Gulf of Siam as to be useless but that on the South China Sea Coast represents a good sample. In the Gulf of Tonkin the parts representing the Red River delta are missing but the rest is complete.

TABLE 3

AREAS COVERED BY COASTAL TYPE ANALYSIS

Region	No. of Maps	Estimated % Covered	Estimated % Missing	Miles Covered	Estimated Miles Missing
Burma Coast 1:63,360	24	100	0	500	0
Gulf of Martaban 1:63,360	19	100	0	388	0
Andaman Sea Coast 1:63,360	21	74	26	452	158
Malacca Straits 1:63,360	36	78	22	603	169
Malaya East Coast 1:63,360	10	58	42	186	134
Gulf of Siam 1:50,000	8	5	95	95	1805
South China Sea Coast 1:50,000	29	51	49	533	522
Gulf of Tonkin 1:50,000	16	55	45	206	171
Totals	163			2963	2959

VARIABILITY OF MAP DATA AND NOMENCLATURE

In this part of the survey, we are compelled to rely upon maps which vary from series to series, possibly from map to map, in the criteria and the names used to identify coastal conditions. As examples, the designation "Sand Bank" occurs on only one map and "Mud Bank" on only eight. The entire areas of the South China Sea Coast and the Gulf of Tonkin, represented by 99 maps do not show such designations. On the same 99 maps there is no designation "Tidal Flats" which must be common in most places. On the 58% coverage of the Malay East Coast there is no designation "Mangrove" although some 21% of the covered coast is designated "Swampy." Because of these and many other inconsistencies, the raw material of the survey is presented and implications and assumptions must be understood as being subject to the limitations implied above.

COASTAL REGIONS AND GEOMORPHOLOGY

For purposes of convenience in analysis, the coastal area has been separated into eight sections. Some of these have recognizable geomorphological differences, but these differences are those of inland structure and are not statistically recognizable in coastal types. The eight sections described below are delineated on Map 1.

Burma Coast (15 to 21° north latitude). Much flat plain north of 20°; Arakan Range, 17 to 20° but fronted with wide plains; tidal and swampy flats around Ramree Island; narrow plains south of 15° latitude.

Gulf of Martaban (15 to 17° north latitude and 94 to 97° east longitude). Mostly wide plains and the delta fringe of the Irrawaddy.

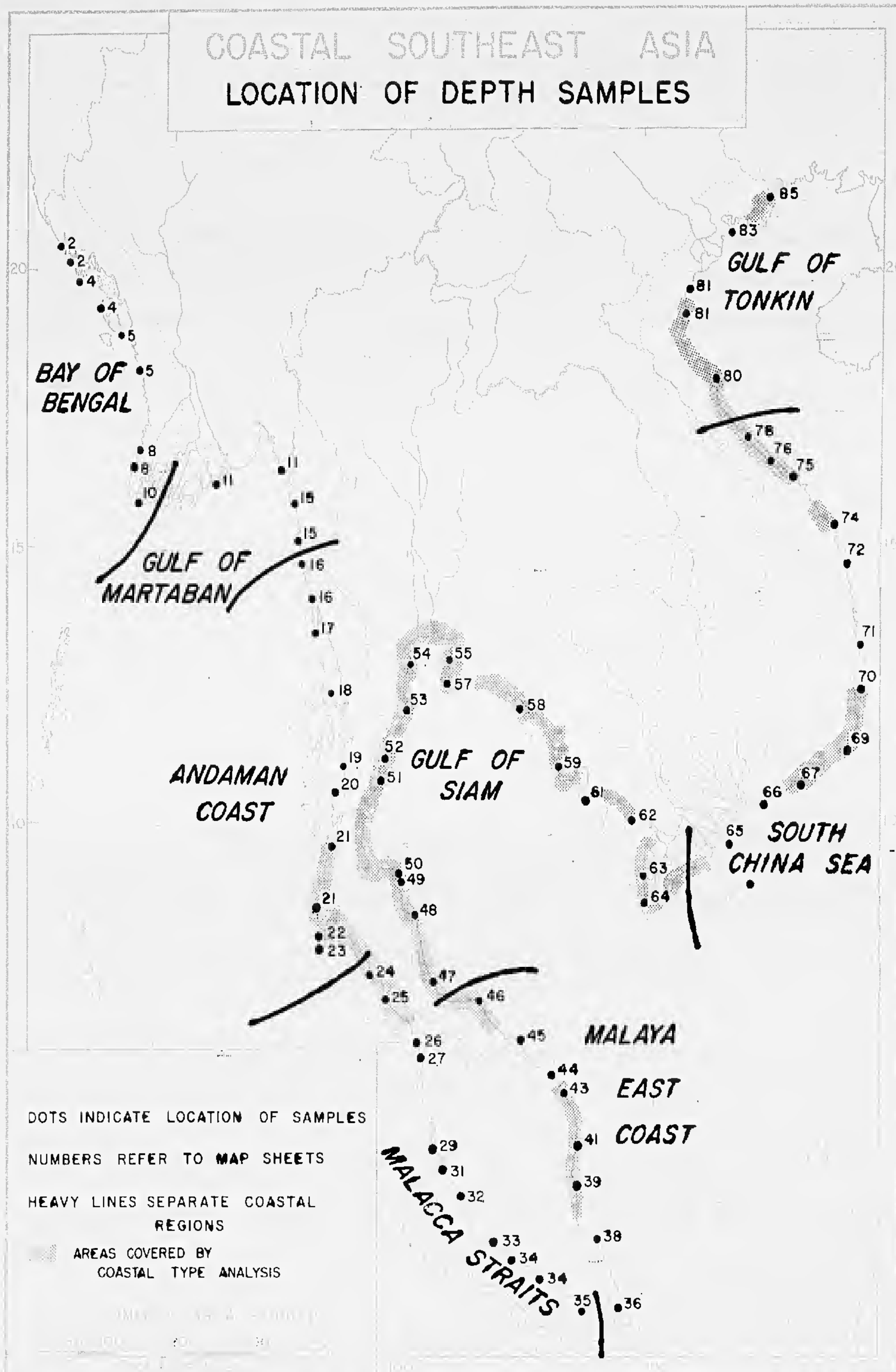
Andaman Sea Coast (8 to 15° north latitude). Mostly hilly fronted with narrow coastal plains. Islands of the Merugi Archipelago fringe the central part of the coastal stretch.

Malacca Straits (2 to 8° north latitude). Mostly broad plains, some alluvial; protected to south by Sumatra.

East Malay Coast (2 to 7° north latitude). Wide coastal plains with a few hilly spurs.

Gulf of Siam (7° north latitude and 101° east longitude to 8° north latitude and 105° east longitude). Wide alluvial plains and delta coasts of the Chao Phraya. Hilly on the east coast between 10 and 13° north latitude.

South China Sea Coast (8 to 18° north latitude). Wide delta plains at mouths of the Mekong (to about 11° north latitude) north of this the coastal zone is hilly with relatively narrow plains with hilly spurs projecting as headlands. Many beaches are covered with blown sand or moving sand dunes in parallel rows.



Map 1. Location of Depth Samples and Areas Covered by Coastal Type Analysis.

Gulf of Tonkin (18 to 22° north latitude). Narrow coastal plains in south with delta of the Red River in north. A small hilly area near the Chinese border (about 21° north).

Coastal Types

From map analysis of the available coverage the following coastal types were identified and measured for each map.

Accessible Types

Flat Foreshore. Flat beach area, usually several hundred yards or more in width, not identified as sandy, marshy, or tidal in character; commonly the coastal feature of alluvial plains.

Sandy Foreshore. Same as flat foreshore except that maps indicate sand by symbol or name but do not indicate dunes. Probably some dune area included because of differing symbolization on different map sets. In a few places sandy foreshores include lagoons immediately inland from the sandy shoreline (Map 2).

Types with Onshore Terrain Problems

Hilly Foreshore. Hills as identified by contours reach to the coast; with or without narrow strand areas between the actual slopes and the shore; limited beach area for assembly or supply functions (Map 3).

Sand Dunes. Single or multiple sand ridges high enough to be indicated by contours or specifically so labeled on maps. Especially abundant along the South China Sea Coast and southern Gulf of Tonkin (Map 4).

Swampy. Fresh or brackish water commonly inland of a beach ridge and other kinds of indicated swampy land. Probably includes mangroves in some places (Maps 5 and 6).

Tidal Flats. Marshy areas especially in estuaries and along other low coastal types; grassy vegetation where indicated on maps. Probably much overlap with the "swampy" category above (Map 7).

Types that Present Difficulties in Approach

Rocky Offshore. Rocks in shallow water adjacent to the actual coastline (Map 8).

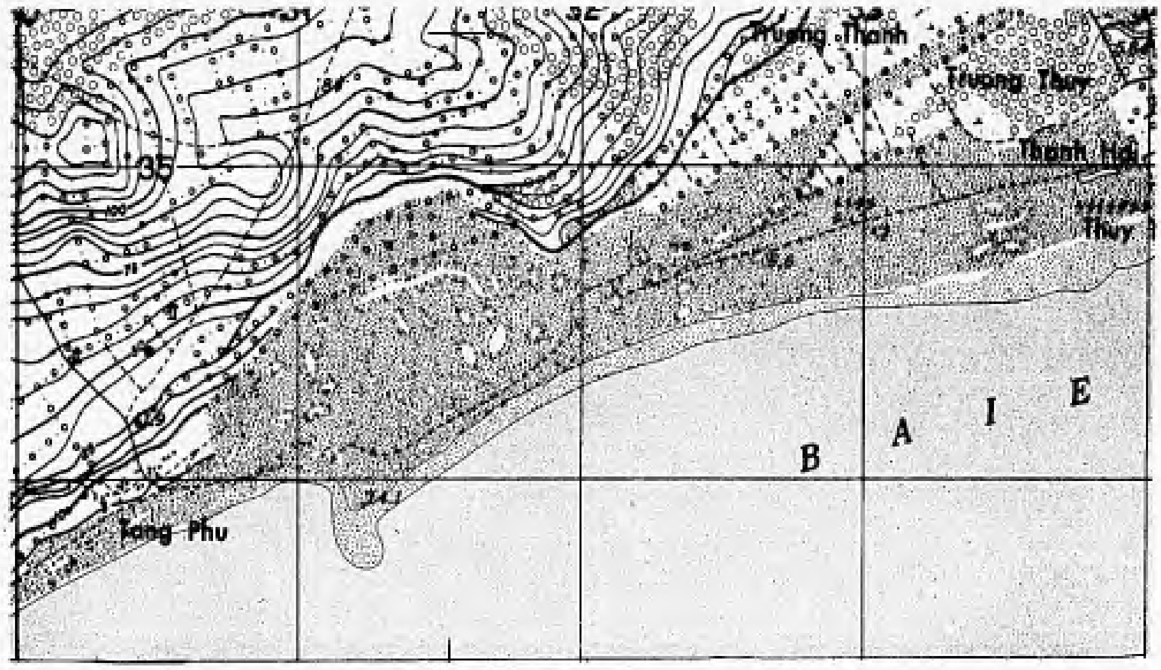
Sand Banks or Mud Banks. In shallow water offshore probably much more

TABLE 4

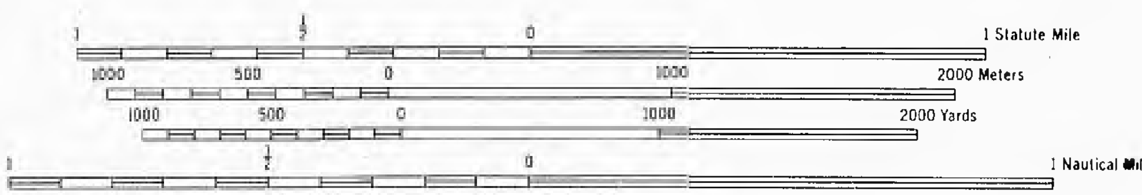
SUMMARY OF COASTAL TYPE ANALYSIS

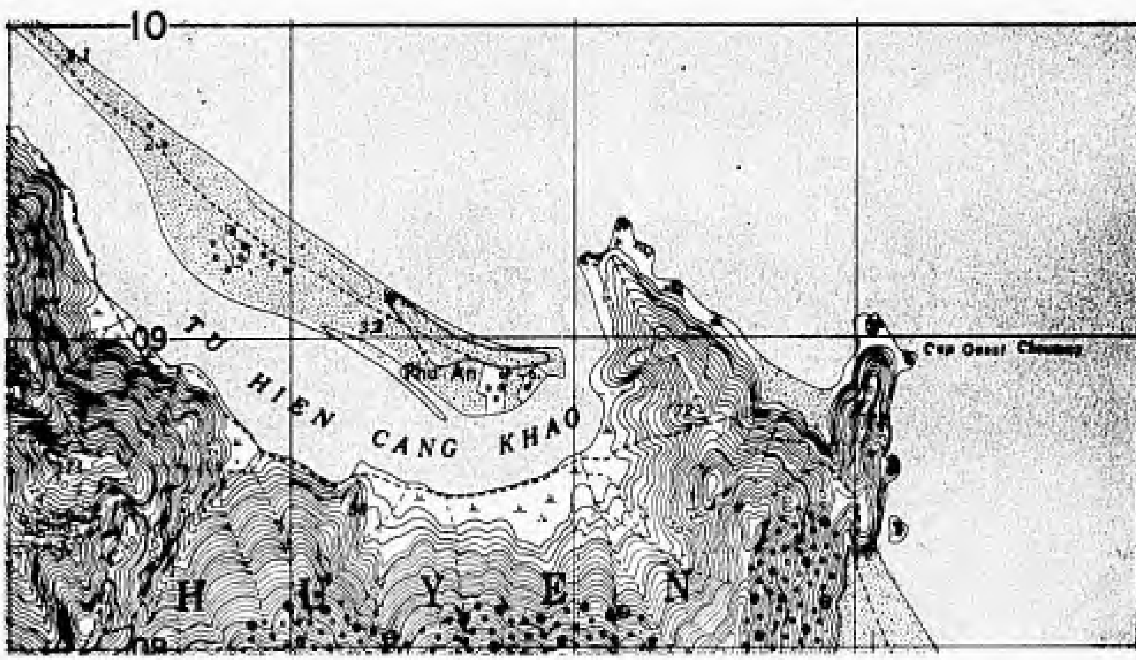
(Coastal Regions by Miles and Percentages)

		Flat	Sandy	Hilly	Rocky Offshore	Cliffs	Sand Dunes	Mangrove	Swamp	Mud Banks	Sand Banks	Tidal Flats	Coral Reefs	Totals
Burma Coast	Mi	136	30	61	123			107	7	5		7	24	500
	%	27.3	6.0	12.0	24.7			21.4	1.4	1.0		1.4	4.8	100
Gulf of Martaban	Mi	105	12	9	8			151	41	29	9	24		388
	%	27.1	3.1	2.3	2.0			38.9	10.6	7.5	2.3	6.2		100
Andaman Sea Coast	Mi	25		81	64			241	4	17		20		452
	%	5.5		17.8	14.2			53.5	1.0	3.8		4.4		100
Malacca Straits	Mi	155		14	19	5		222	188					603
	%	25.7		2.2	3.1	.8		37.0	31.2					100
Malay East Coast	Mi	89	16	3	39				39					186
	%	41.8	8.6	1.6	21.0				21.0					100
Gulf of Siam	Mi	25	5	17				47	1					95
	%	26.3	5.3	27.8				49.5	1.1					100
South China Sea Coast	Mi	36	78	64	50	26	144	118	6				11	533
	%	6.8	14.8	12.0	9.4	4.9	27.0	22.1	1.1				2.1	100
Gulf of Tonkin	Mi	43	129	6	5	1		11	11					206
	%	20.9	62.6	2.8	2.4	.5		5.3	5.3					100
Totals	Mi	614	270	255	308	32	144	897	297	51	9	51	35	2963
	%	20.7	9.1	8.6	10.4	1.1	4.9	30.3	10.0	1.7	.3	1.7	1.2	100

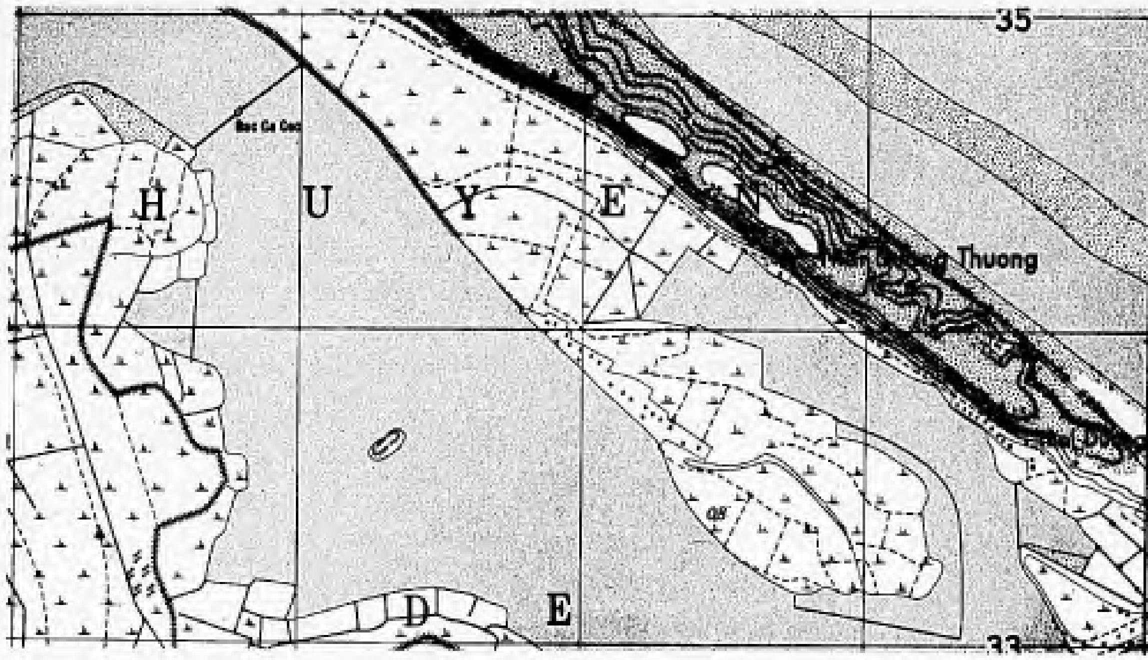


Map 2. Sandy Coast. From Series L 805, No. 213 77E.

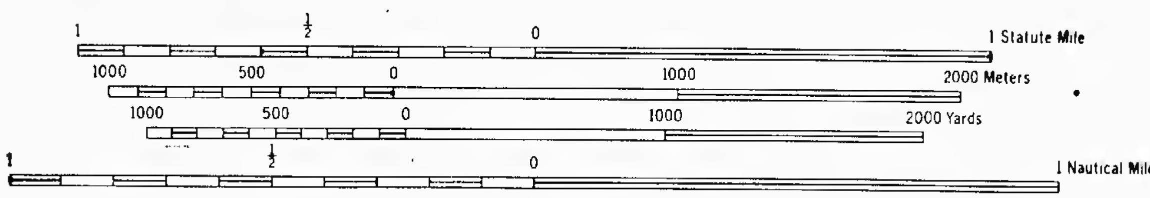


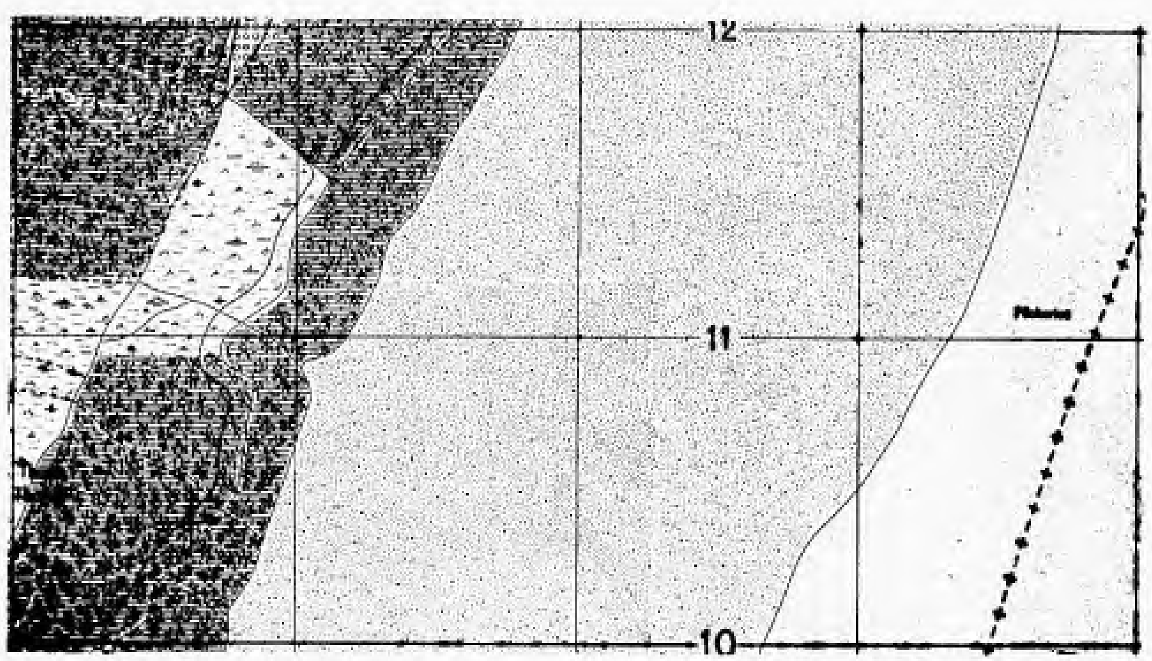


Map 3. Hilly Coast. From Series L 805, No. 125 35E.

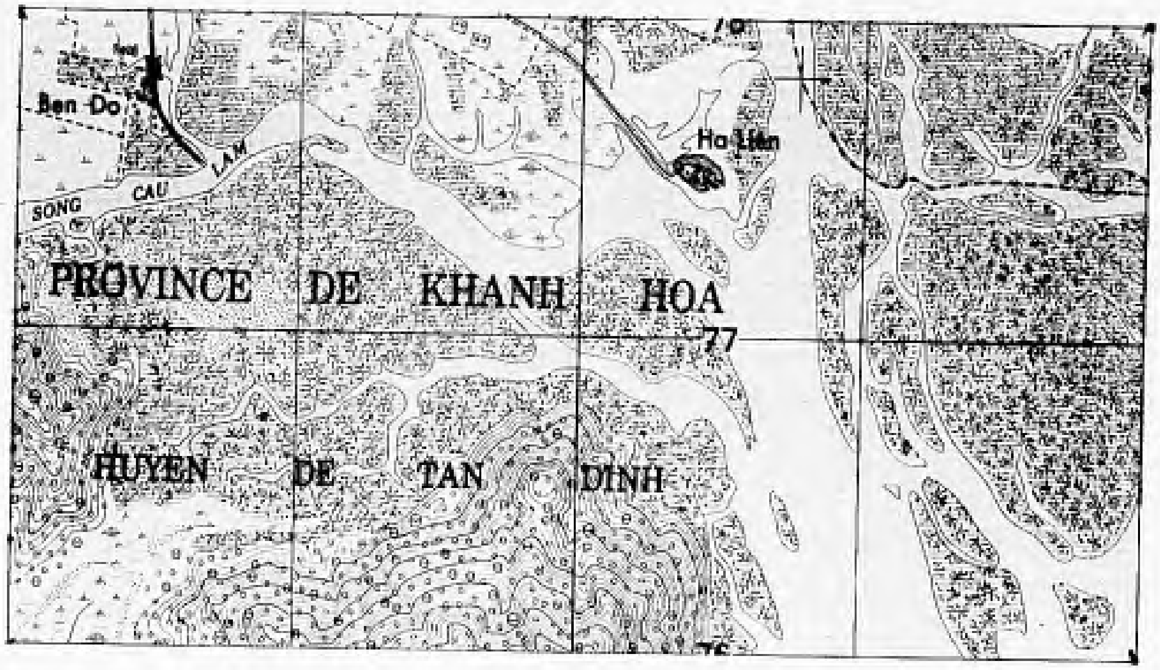


Map 4. Sand Dunes and Lagoon Coast. From Series L 805, No. 125 29E.

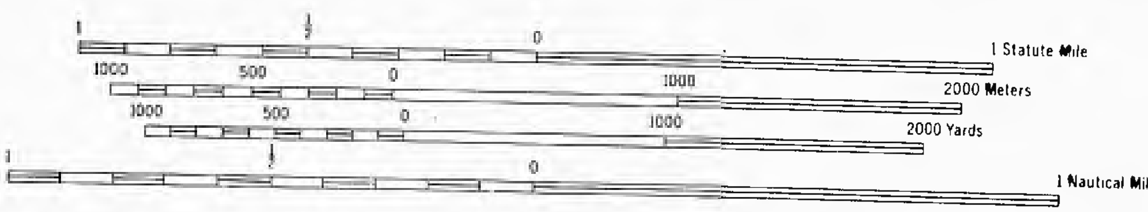


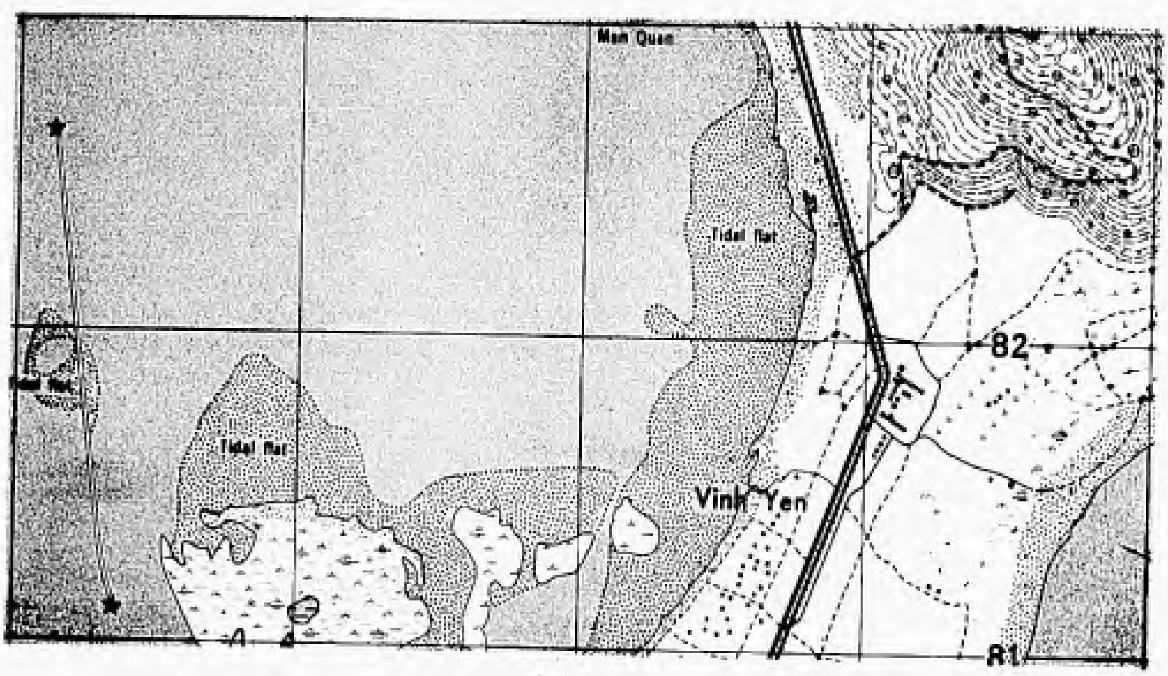


Map 5. Swamp and Mangrove Coast. From Series L 805, No. 236 9E.

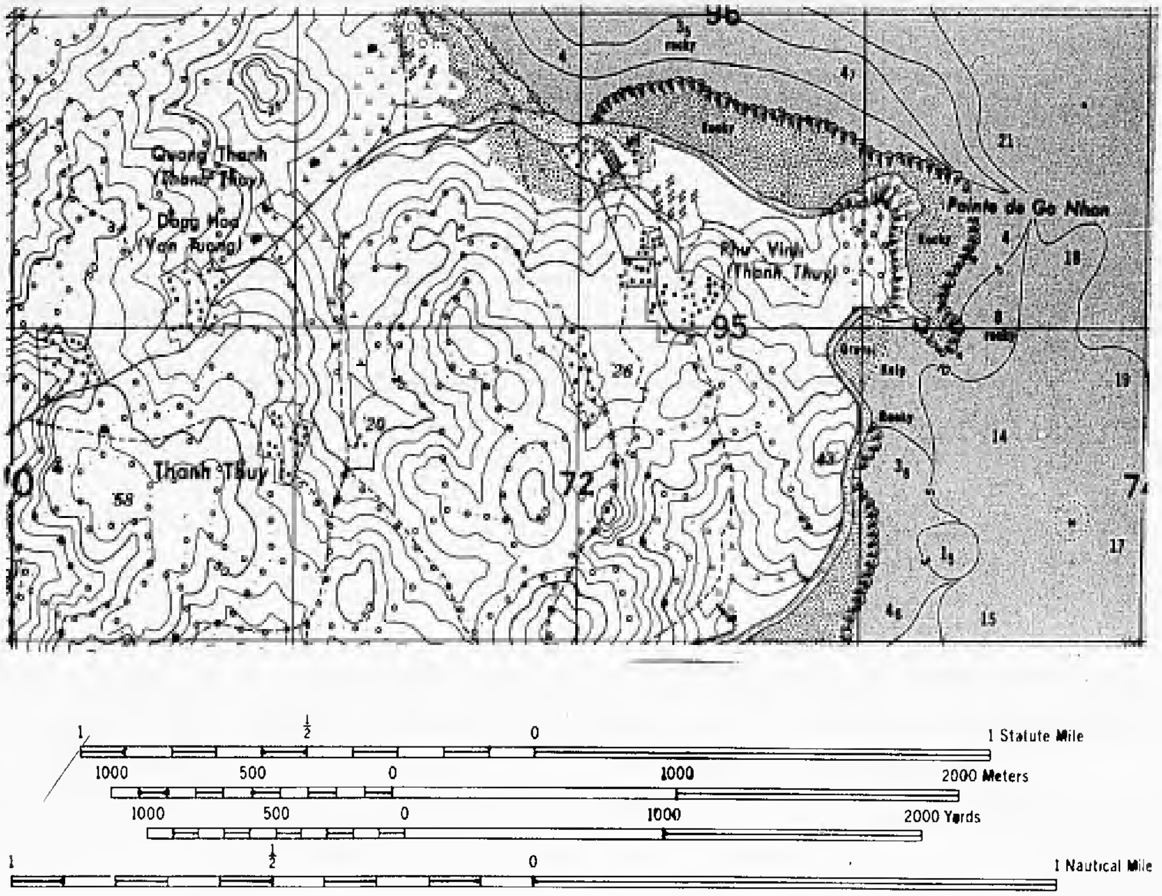


Map 6. Mangroove Coast. From Series L 805, No. 194 70Ter.





Map. 7 Tidal Flats. From Series L 805, No. 132 36W.



Map 8. Rocky Offshore. From Series L 805, No. 138 50E.

common than indicated. Absent on maps east of Gulf of Martaban (Map 3).

Coral. Coral barrier in shallow water offshore; uncommon in muddy situations along delta coasts.

Inaccessible Types

Cliffs. Precipitous slopes actually reaching shore, so designated on maps. Probably wave beaten in storms or high water (Map 3).

Mangroves. Tree covered tidal shallows presenting a barrier to landing (Map 6).

Raw Inventory Data. Because of the incomplete coverage and the inconsistencies of data mentioned earlier in this section the raw data sheets of the coastal inventory are included for their specific locality value. The analyses and summaries must be interpreted in terms of these limitations.

Coastal Types Analyzed by Accessibility. The following table summarizes the complete mileage inventoried. It is not a statistical sample because of the missing coverage but does present the categories as proportions of the available whole. In terms of accessibility it shows the following:

TABLE 5

COASTAL TYPES ANALYZED BY ACCESSIBILITY

	Miles	Percent of Total
Easily Accessible Coast		29.8
Flat	614	20.7
Sandy	270	9.1
Approachable with Difficulty		13.6
Rocky	308	10.4
Sand or Mud Banks	60	2.0
Coral Fringe	35	1.2
Inaccessible		31.4
Mangrove	897	30.3
Cliffs	32	1.1
Onshore Problems		25.2
Hilly	255	8.6
Sand Dunes	144	4.9
Swampy	297	10.0
Tidal Flats	51	1.7
	2963	100.0

Implications. Within the limitations of the data it may be inferred that there is about as much readily accessible coast as inaccessible coast and that these two categories compose some 60% of the coastal miles. Another 13% (hilly and sand dunes) may not present serious problems to getting onshore or establishing a foothold.

Relationship of Accessibility of Geomorphological Structure. Table 6 presents a percentage analysis of the areas in which continuous coverage is available. It indicates some obvious facts.

1. A larger percentage of wet plain coast is inaccessible than dry plains. This comes from the mangrove growth on the wet coasts.

2. All types of coast have enough available areas of ready access for military operations.

3. All types of coast have a surprising percentage of inaccessible mileage. This comes from mangrove growth.

Distribution of Inaccessibility and Lack of Easy Accessibility. An analysis of the complete coverage along the west coast between 10 and 21° N. lati-

TABLE 6

DISTRIBUTION OF COASTAL TYPES BY GEOMORPHOLOGICAL AREAS

(Percentages of Total Mileage)

Map Nos. Location	Flat	Sandy	Hilly	Rocky Offshore	Cliffs	Sand Dunes	Mangrove	Swamp	Mud or Sand Banks	Tidal	Coral	Easy Access (A)	Difficulties Onshore (B)	Difficult Access (C)	Inaccessible (D)
Burma Coast															
1-8 20°-21° N. lat. Wide dry plains	41.8	22.4	8.2	1.5			20.9			5.2		64.2	13.4	1.5	20.9
9-12 18:30°-20° N. lat. Low, wet islands off shore	13.2		7.5	28.3			50.9					13.2	7.5	28.3	50.9
13-24 16°-18:30° N. lat. Wide dry plains	23.5		14.8	34.2			16.8	1.3	1.6		7.7	23.5	16.1	43.5	16.8
Gulf of Martaban															
25-43 95°-97:30° E. long. Wide alluvial and delta plains	27.1	3.1	2.3	2.1			38.9	10.6	2.3	7.5	6.2	30.2	20.4	10.6	38.9
Andaman Sea Coast															
44-64 10°-16° N. lat. Narrow wet plains	5.5		17.9	14.2			53.3	0.9	3.8	4.4		5.5	23.2	18.0	53.3
6°-10° N. lat.	Coverage missing														
Malacca Straits															
65-100 2°-6° N. lat. Wide wet plains	25.7		2.3	3.2	0.8		36.8	31.2				27.5	33.5	3.2	37.6

(A) Flat or Sandy
(B) Hilly, Sand Dunes, Swamps, Tidal Flats
(C) Rocky, Sand or Mud Banks, Coral
(D) Cliffs and Mangrove

TABLE 7

COASTAL ANALYSIS

(Raw Data)

Map No.*	Index No.	Location	Flat	Sandy	Hilly	Rocky Offshore	Cliffs	Sand Dunes	Mangrove	Swamp	Mud Banks	Sand Banks	Tidal Flats	Coral Reefs	Totals
								Burma Coast							
1	84 C/3	21-15N 92-15 E	7	10	5										22
2	84 C/4	21-00N 92-15 E		20											20
3	84 D/5&1	20-45N 92-15 E	14						5						19
4	84 D/6	20-30N 92-15 E	5						9						14
5	84 D/10	20-30N 92-45 E	11												11
6	84 D/11	20-15N 92-45 E	16							3					19
7	84 H/4	20-00N 93-15 E	3		4								5		12
8	84 H/8	20-00N 93-30 E			2	2			14				2		20
9	85 E/5	19-45N 93-30 E			3	13			4						20
10	85 J/1	18-45N 94-15 E							16						16
11	85 J/2	18-30N 94-15 E	4						7						11
12	85 J/6	18-30N 94-30 E	3		1	2									6
13	85 J/7	18-15N 94-30 E	2		4	15			7					12	40
14	85 J/8	18-00N 94-30 E	4		3	8			9						24
15	85 K9&5	17-45N 94-45 E	5		3	9			3						20
16	85 K10	17-30N 94-34 E	4		9	10			2					7	32
17	85 K11&7	17-15N 94-45 E	1		6	12			9					2	30
18	85 K12	17-00N 94-45 E			1	4			2					1	8
19	85 L5	16-45N 94-30 E	10		2	9			1						22
20	85 L6&L2	16-30N 94-30 E	9		6	8			6						29
21	85 L7&L3	16-15N 94-30 E	3		3	9			3						18
22	85 L8	16-00N 94-30 E	14			2			10		5				31
23	85 L4	16-00N 94-15 E	5		5	9								2	21
24	86 I5&1	15-45N 94-30 E	16		4	11				4					35
	Miles of Coast		136	30	61	123			107	7	5		7	24	500
	Percentage		27.3	6.0	12.0	24.7			21.4	1.4	1.0		1.4	4.8	100

*These numbers refer to this table only for the 1:63,360 and 1:50,000 coverage. They should not be confused with the numbers of the general coverage mentioned in the Introduction.

TABLE 7 (Continued)

Map No.*	Index No.	Location	Flat	Sandy	Hilly	Rocky Offshore	Cliffs	Sand Dunes	Mangrove	Swamp	Mud Banks	Sand Banks	Tidal Flats	Coral Reefs	Totals
		Gulf of Martaban													
25	86 I9	15-45N 94-45 E	4						18						22
26	86 I13&14	15-45N 95-00 E							3	10	3				16
27	86 M 1&2	15-45N 95-15 E	2						10	4	1				17
28	86 M5	15-45N 95-30 E	2	1					4						7
29	86 M6	15-30N 45-30 E							15						15
30	86 M9	15-45N 95-45 E	5						12	5					22
31	85 P12	16-00N 95-45 E							12		1				13
32	85 P16	16-00N 96-00 E	5								5	9			19
33	94 D/3&4	16-15N 96-15 E	19								19				38
34	94 D/7	16-15N 96-30 E	6						11						17
35	94 D/10&11	16-30N 96-45 E							21						21
36	94 D/13	16-45N 97-00 E							19						19
37	94 C/16	17-00N 97-00 E								18					18
38	94 G4	17-00N 97-15 E	10		3					4					17
39	94 H1	16-45N 97-15 E	5						23						28
40	94 H6&2	16-30N 97-30 E	20												20
41	94 H7&8	16-15N 97-30 E	9	11											20
42	95 E9	15-45N 97-45 E	12		6	5							23		46
43	95 E10	15-30N 97-45 E	6			3			3				1		13
	Miles of Coast		105	12	9	8			151	41	29	9	24		388
	Percentages		27.1	3.1	2.3	2.0			38.9	10.6	7.5	2.3	6.2		100
		Andaman Sea Coast													
44	95 E15&11	15-15N 98-00 E	6		2	9			5		5		15		42
45	95 E16&12	15-00N 98-00 E	6		7	6				4					23
46	95 F13	14-45N 98-00 E	2		16				3						21
47	95 F14	14-30N 98-00 E			3	7			14						24
48	95 F15	14-15N 98-00 E			13	1			1						15
49	95 J4	14-00N 98-15 E	1		3	5			9						18
50	95 K1	13-45N 98-15 E			6	15			4						25
51	95 K6	13-30N 98-30 E	6		8	3			6						23
52	95 K7	13-15N 98-30 E	3		3	3			9						18
53	95 K12	13-00N 98-45 E			4	4			11						19

TABLE 7 (Continued)

Map No.*	Index No.	Location	Flat	Sandy	Hilly	Rocky Offshore	Cliffs	Sand Dunes	Mangrove	Swamp	Mud Banks	Sand Banks	Tidal Flats	Coral Reefs	Totals
		Andaman Sea Coast (Concluded)													
54	95 L9	12-45N 98-45 E				2			17				1		20
55	95 L12	12-00N 98-45 E							25				4		29
56	96 I9	11-45N 98-45 E							20		12				32
57	96 I14	11-30N 99-00 E							6						6
58	96 I11	11-15N 98-45 E	1						18						19
59	96 I/12&8	11-00N 98-45 E							27						27
60	96 J/9	10-45N 98-45 E							28						28
61	96 J/10	10-30N 98-45 E							6						6
62	96 J11&7	10-15N 98-45 E			9	3			10						22
63	96 J12&8	10-00N 98-45 E			5	4			11						20
64	96 I10	11-30N 98-45 E			2	2			11						15
	Miles of Coast		25		81	64			241	4	17		20		452
	Percentages		5.5		17.8	14.2			53.5	1.0	3.8		4.4		100
		Malacca Strait													
65	2 E/9	6-15N 100-15 E	2							10					12
66	2 E/13	6-00N 100-15 E								5					5
67	2 E/14	6-00N 100-30 E							15						15
68	2 I/2	5-45N 100-30 E	1							16					17
69	2 I/6	5-30N 100-30 E	4				5			12					21
70	2 I/9&10	5-15N 100-30 E	14							3					17
71	2 I/14	5-00N 100-30 E	21												21
72	2 M/2	4-45N 100-30 E							10						10
73	2 M/3	4-45N 100-45 E								12					12
74	2 M/7	4-30N 100-45 E							24						24
75	2 M/11	4-15N 100-45 E	1		7					12					20
76	2 M/15	4-00N 100-45 E	3			5				10					18
77	2 M/16	4-00N 101-00 E							8						8
78	3 α/3&4	3-45N 101-00 E							21						21
79	3 A/8	3-30N 101-00 E							11						11
80	3 B/5	3-30N 101-15 E								13					13
81	3 B/9	3-15N 101-15 E							17						17
82	3 B/10	3-15N 101-30 E	1							9					10

TABLE 7 (Continued)

Map No.*	Index No.	Location	Flat	Sandy	Hilly	Rocky Offshore	Cliffs	Sand Dunes	Mangrove	Swamp	Mud Banks	Sand Banks	Tidal Flats	Coral Reefs	Totals
						Malacca Strait (Concluded)									
83	3 B/13&14	3-00N 101-30 E	3							19					21
84	3 F/1&2	2-45N 101-30 E	2						27						29
85	3 F/6	2-36N 101-30 E	6												6
86	3 F/7	2-20N 101-45 E	6						13						19
87	3 F/8	2-30N 102-00 E	5						7						12
88	3 F/12	2-15N 102-00 E	17		1	2									20
89	3 G/9	2-15N 102-15 E	14												14
90	3 G/13	2-00N 102-15 E	10												10
91	3 G/14	2-00N 102-30 E	3								15				18
92	3 G/15	2-00N 102-45 E							10						10
93	3 K/3	1-45N 102-45 E	2						12						14
94	3 K/4&8	1-45N 103-00 E	1		1					21					23
95	3 L/5	1-30N 103-15 E	4						15	2					21
96	3 L/6	1-30N 103-30 E	1						11						12
97	3 L/10&11	1-15N 103-37-47 E	6							27					33
98	3 L/12	1-12N 104-00 E	12		3	12				3					30
99	4 I/9	1-15N 104-15 E	16		1				10						27
100	4 I/10	1-15N 104-30 E			1				11						12
	Miles of Coast		155		14	19	5		222	188					603
	Percentages		25.7		2.2	3.1	.8		37.0	31.2					100
						East Malaya Strait									
101	4 I/5&6	1-45N 104-00 E	8			6				4					18
102	4 I/1	2-00N 104-00 E	2			9				10					21
103	3 H/16	2-15N 103-45 E	14			4									18
104	3 H/12	2-30N 103-45 E	11			9				3					23
105	3 H/8	2-45N 103-45 E	7			7				2					16
106	3 H/7	2-45N 103-30 E	17			1									18
107	3 D/6	3-45N 103-15 E	5							12					17
108	3 D/2	4-00N 103-15 E	13			3				8					24
109	2 P/14	4-15N 103-15 E	2	16	3										21
110	2 K/2	6-00N 102-15 E	10												10
	Miles of Coast		89	16	3	39				39					186
	Percentages		47.8	8.6	1.6	21.0				21.0					100

TABLE 7 (Continued)

Map No.*	Index No.	Location	Flat	Sandy	Hilly	Rocky Offshore	Cliffs	Sand Dunes	Mangrove	Swamp	Mud Banks	Sand Banks	Tidal Flats	Coral Reefs	Totals
		Indo-China - Gulf of Siam													
111	5842/2	10-20N 104-30 E	8	5	2				7	1					23
112	5942/3	10-20N 104-45 E	2						7						9
113	5941/4	10-10N 104-45 E	6		7										13
114	5941/3	10-00N 104-45 E	2		6										8
115	5941/1	10-10N 105-00 E	2						4						6
116	5941/2	10-00N 105-00 E	2						12						14
117	6041/3	10-00N 105-15 E	1		2				5						8
118	6040/4	9-50N 105-15 E	2						12						14
		Miles of Coast	25	5	17				47	1					95
		Percentages	26.3	5.3	17.8				49.5	1.1					100
		Indo-China - South China Sea Coast													
119	6239/1	9-40N 106-15 E							21						21
120	6339/4	9-40N 106-30 E						3	7						10
121	6340/3	9-50N 106-30 E	2		3			7	7						19
122	6340/4	10-10N 106-30 E			6				20						26
123	6341/3	10-10N 106-30 E	2	1					15						18
124	6341/4	10-20N 106-30 E	7						7						14
125	6342/3	10-30N 106-30 E							2						2
126	6342/2	10-30N 106-45 E	9						5						14
127	6442/3	10-30N 107-00 E	6		7			5	25						43
128	6643/4	11-00N 108-00 E	2	11				5							18
129	6845/4	11-40N 109-00 E		3	2			6						11	22
130	6846/3	11-50N 109-00 E	1	2	11	2	6		1						23
131	6846/4	12-00N 109-00 E	6		2	7	16	11	8	2					52
132	6852/3	13-50N 109-00 E	1	3	1	2	2			4					13
133	6852/2	13-50N 109-15 E			10	2		1							13
134	6852/1	14-00N 109-15 E			6			5							11
135	6852/4	14-00N 109-00E						2							2
136	6853/3	14-10N 109-00 E			5			8							13
137	6756/1	15-20N 108-45 E		4	2	7	2								15
138	6756/2	15-10N 108-45 E		5				7							12
139	6658/2	15-50N 108-15 E						13							13

TABLE 7 (Concluded)

Map No.*	Index No.	Location	Flat	Sandy	Hilly	Rocky Offshore	Cliffs	Sand Dunes	Mangrove	Swamp	Mud Banks	Sand Banks	Tidal Flats	Coral Reefs	Totals
		Indo-China - South China Sea Coast (Concluded)													
140	6658/1	16-00N 108-15 E						16							16
141	6659/2	16-10N 108-15 E			5	7		7							19
142	6659/3	16-10N 108-00 E		16	1	8									25
143	6659/4	16-20-30N 108-00 E		9	2	15									26
144	6560/2	16-30N 107-45 E		4	1			13							18
145	6560/4	16-40N 107-30 E		4				16							20
146	6461/2	16-50N 107-15 E						19							19
147	6461/4	17-00N 107-00 E		16											16
		Miles of Coast	36	78	64	50	26	144	118	6				11	533
		Percentages	6.8	14.6	12.0	9.4	4.9	27.0	22.1	1.1				2.1	100
		Indo-China - Gulf of Tonkin													
148	6166/2	18-30N 105-45 E		15	2										17
149	6166/1	18-40N 105-45 E		11	2										13
150	6167/2	18-50N 105-45 E		10											10
151	6167/3	18-50N 105-30 E	2	5											7
152	6167/4	19-00N 105-30 E		11		5									16
153	6169/1	19-40N 105-45 E		12											12
154	6170/2	19-50N 105-45 E	4	8			1			1					16
155	6170/1	20-00N 105-45 E	4	7						1					12
156	6270/4	20-00N 106-00 E		10						4					14
157	6271/3	20-10N 106-00 E	2	2											4
158	6271/2	20-20N 106-15 E		11											11
159	6271/1	20-20N 106-15 E	1	9					5						15
160	6371/4	20-20N 106-30 E	6							4					10
161	6372/3	20-30N 106-30 E	11	7						1					19
162	6372/4	20-40N 106-30 E	11	10					1						22
163	6373/3	20-50N 106-30 E	2	1					5						8
		Miles of Coast	43	129	6	5	1		11	11					206
		Percentages	20.9	62.6	3.0	2.4	.5		5.3	5.3					100

tude covering 1340 miles of coastline indicated that short stretches of inaccessibility were scattered through the whole of the coast and that the longest continual stretch of inaccessibility was 146 miles along the wet narrow plains of the Andaman Sea. The areas of lack of easy accessibility followed the same pattern, the longest stretch was 236 miles also along the wet narrow Andaman coastal plain.

III. SURFACE QUALITY

In coastal Southeast Asia as a military environment the two most important factors in terms of operations are the surface quality and the nature of the climate.

In this part of the report the nature of the land surface is presented, first by qualitative description of its components, next by its regional pattern, and finally by quantitative analyses of its roughness and its slopes.

The analysis of roughness shows that about 45% of the project area is in plains surface; with less than 600 feet of relative relief; some 35% is in hills with relative relief between 600 and 2000 feet, and the remainder is rough enough to be called mountainous although much of it does not bear typical mountainous landforms.

Analysis of the slopes by comprehensive random sampling shows that, within the hill-mountain part of the project area, 19% of the slopes are slight; (3 to 15%) 56% are moderate; (16-30%) and 25% are steep. (31-50%).

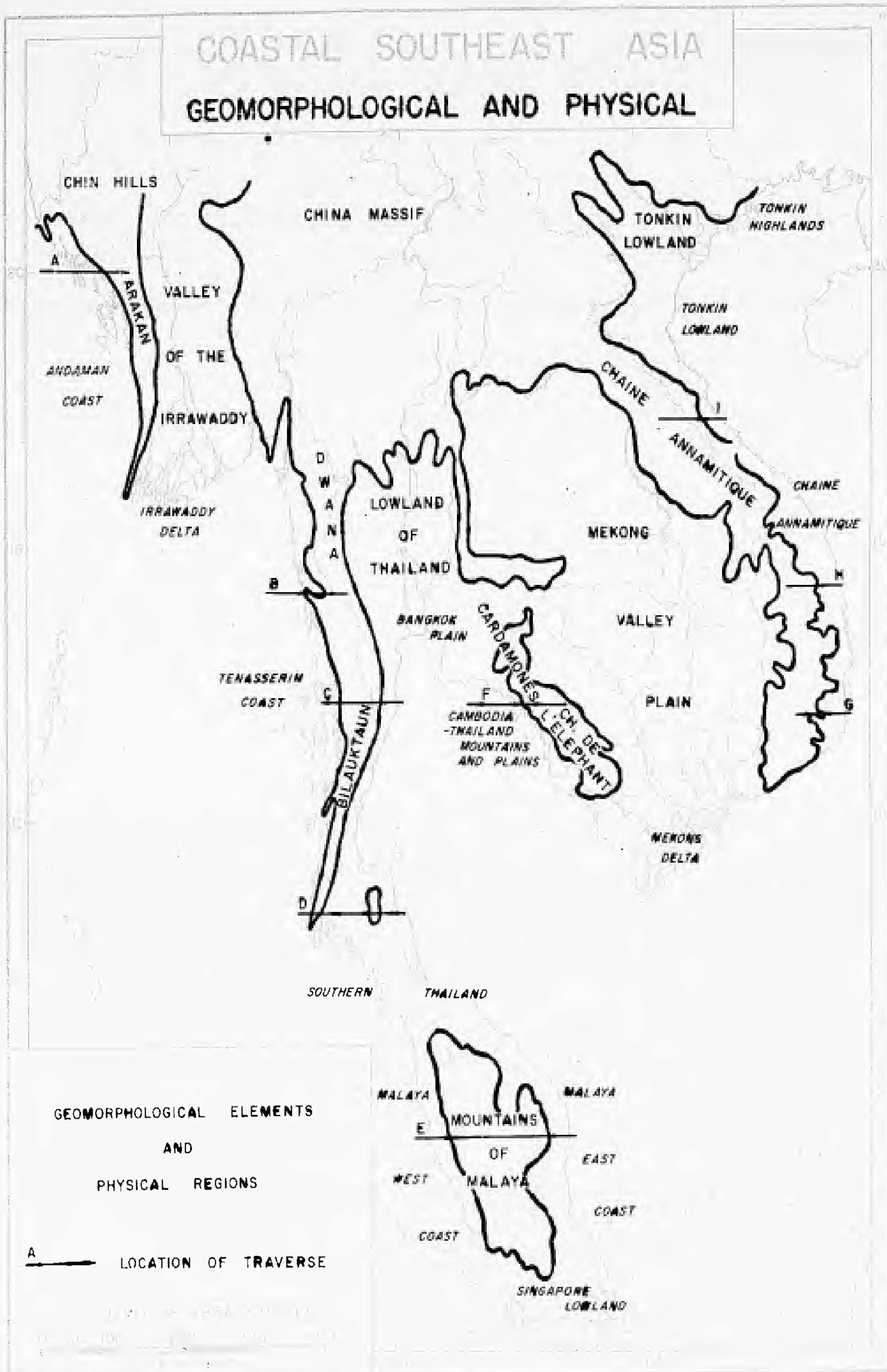
The surface conditions of coastal strip are most easily understood in terms of the general geomorphology of Southeastern Asia for which purpose a short description of the principal elements of the structure is necessary.

Geomorphological Elements

From the land mass of South China four chains of mountainous uplands extend southward to form the skeleton of Southeast Asia. Between these uplands stretch the plains and deltas of the four great rivers. The ocean margin of this complex is rimmed with a generally narrow fringe of coastal plain. The eight principal elements, four uplands and four plains, are briefly described hereafter and their distribution shown on Map 9.

1. The coastal mountains of North Burma between the Bay of Bengal and the Irrawaddy vally are composed of the narrow dissected ridge of the Arakan Range which diminishes in both width and altitude from the Chin Hill country of the north to its termination at Cape Negris west of the Irrawaddy delta.

2. The valley of the Irrawaddy together with that of the Sittang on the east compose a lowland some 150 miles in breadth extending from the north and terminating in the flat and poorly drained delta area.



Map. 9. Geomorphological and Physical Areas.

3. The hill country of northern Burma separates the drainage of the Irrawaddy and Sittang from that of the Thailand rivers. This upland extends to the south over the Malay Peninsula almost to the equator and terminates in the mountains of Malaya. The northern part is formed by the Dawna and the Bilauktaung ranges. To the south through the Kra Isthmus it is a discontinuous series of hilly strips.

4. The lowland of Thailand is separated into the watershed of the Chao Phraya on the west and that of the Mekong on the east by a low, hilly water-divide. The western part of the lowland is the valley of the Chao Phraya, some 150 miles wide which terminates in the Bangkok plain formed of the deltas of the Chao Phraya and the Tachin.

5. The low water-divide mentioned above is the central portion of the third narrow upland which depends to the south from the China massif. Its northern part is rugged as is also its southern extension which, through coastal Cambodia, is composed of the Cardamomes and the high (4000 ft) Chaine de l'Elephant that reaches the coast and forms the western margin of the Mekong Valley.

6. The Mekong Valley: a broad lowland, up to 200 miles wide, extending through eastern Thailand and terminating in the river delta in South VietNam.

7. The fourth upland belt is the widest. This is the Chaine Annamitique, from 50 to 150 miles in breadth extending in a broad arc paralleling the South China Sea Coast between the Tonkin and Mekong Deltas. It is a succession of eroded plateaus bearing high peaks and has relatively steep slopes toward the eastern coast.

8. The most easterly lowland is that of Tonkin, formed by the valleys and deltas of the Red River and its neighbors, the Ma, the Chu, and the Ca. It lies between the Chaine Annamitique on the south and the China massif on the north.

These eight elements are narrow in proportion to their lengths and extend generally in north-south directions. They give a "grain" to Southeast Asia formed by the alternation of broad flat riverine lowlands with narrower, rugged and dissected strips of hilly uplands.

The 50-mile wide strip of coastal country which comprises the area of this study contains only the edges of these major geomorphological elements: the flanks and foothills of the upland surfaces, the seaward margins of the deltas, but it does include almost all of the fringing coastal plain.

Land Types

The landforms of the area may be grouped into four associations, called the Land Types. Three of these are lowland types characterized by plains and the fourth is composed of the rougher upland surfaces. They are: delta plains, alluvial coastal plains, complex plains, and complex hills.

Delta Plains are the most uniform of the land types. They are level alluvial surfaces on which elevations are rare and the most conspicuous surface forms other than the plains themselves are man-made dikes and barriers constructed to prevent flooding. Gradients inland from the coast are almost impreceptable, usually less than 1 in./mile. The most important facts of military environment in delta country are those of drainage and water-logged soils. The gradual slope toward the sea produces an indefinite coast line including a broad shallow tidal zone which may be a mangrove swamp extending several miles inland from lowtide water.

Alluvial Coastal Plains have one character in common with deltas: basically they are flat alluvial surfaces. The difference is found in the presence of several kinds of minor landforms which are absent in deltas. These include beach ridges, sand dunes, coastal lagoons, offshore rocks, and also in many places, tidal mangrove fringes.

Complex Plains are in a way transitional between the purely alluvial types and the hill country. They are associations of various flat or subdued landforms such as recent alluvial coastal and riverine plains, older, upraised and dissected alluvium (diluvium), river terraces, and degraded or structurally flat surfaces. Their common characteristic is that their component landforms are all relatively low and that such erosion slopes as are present are short even though they may be steep. The complex plains offer more variety, less waterlogging and less poor drainage than either the deltas of the coastal alluvial plains and therefore would be better passageways from the coast to the interior of the country.

Complex Hills. All of the rougher and higher surface, that is, all of the area not classified as plains, has been grouped into a single category, complex hills. It includes areas with such landforms as elevated but smooth plateau surfaces, rolling foothill land, stream-cut uplands, low rounded mountains, residual blocks, limestone erosion forms (karst topography) and such parts of truly mountainous areas as come within the 50-mile strip of the Project Area.

This is not a homogeneous category because it covers a wide range of relative relief as well as of structure and erosional stages. An early attempt was made to separate the areas with high relative relief (over 2000 ft) and make categories for low mountains and rugged mountains. This produced small and patchy distributions resulting principally from area with deep stream cutting rather than of mountainous forms such as ridges. In a statistical sense it is possible to separate these rougher areas. The study of relative relief which follows in this chapter indicates that the complex hills category which occupies 55% of the area is composed of:

Hills (relative relief from 600 to 2000 ft), 54%
Low mountains (relative relief from 2000 to 3000 ft), 32%
Rugged mountains (relative relief over 3000 ft), 14%.

The common characteristic of the complex hills category is that of steep slopes which form considerable local relief. On a few of the smoother upland plateau area (such as that of eastern Thailand) this characteristic is subdued. The operational problems of the hilly country would be those of slopes which would limit movement and observation, in contrast to those of the plains types in which drainage and bearing strength of the soil would be of greatest importance.

Physical Regions

For purposes of description and analysis the Project Area has been divided into eleven physical regions from the northwest around to the northeast. These are not homogeneous regions but in each of them the associations of the land types and their landforms differ from those in adjoining regions. The four delta areas are generally similar but each has some individually in its structure. The eleven regions, shown on Map 9, are:

1. Arakan
2. Irrawaddy Delta
3. Tenasserim Coast
4. South Thailand
5. Malaya
6. Bangkok Plain
7. Mountains and Plateaus of Western Cambodia and Eastern Thailand
8. Mekong Delta
9. Chaine Annamitique
10. Tonkin Delta
11. East Tonkin Highlands.

1. The Arakan Coast of North Burma extends southward from the Pakistan border to Cape Negris between the crest of the Arakan Range and the sea coast. The northern part is some 50 miles in width but the area tapers to the south where the range borders on the Andaman Sea. It consists of three differing sections:

a. The Northern Section is composed of the narrow, parallel north-south belts of complex hills which are the outlyers of the Arakan Range.

Between these ridges there extends from the south, strips of the alluvial plain of the Kaladan, Mayu, and Lempo Rivers. North of Akyab there is only a narrow, sandy coastal plain between the seas and the Mayu Range. The ridges rise sharply above the alluvial lowland to heights of 500 to 1800 ft. The Arakan Range which is the eastern boundary of the area reaches heights of 4500 ft. It contains local relief of 1500 to 2000 ft and slope angles of 25 to 30%.

The local relief stated in the remainder of this description is measured by the differences between the highest and lowest contours within the squares of the 10,000 yard or 10,000 meter grid of the L501, L508, L509, and U542 and GSGS 4218 series, an area of approximately 30 square miles.

Slope angles are taken from the study which is a later part of this chapter.

Cross-section A, Fig. 1, shows a profile of the area on a line just south of Akyab. This section and others used in the descriptions have been made from the map series mentioned above with considerable vertical exageration to emphasize the surface roughness. The local relief shown by the figures, in feet, above each section on these profiles is taken along the profile line itself by 5-mile intervals. The section shows the lowland of the Kaladin and other rivers and the low hilly strips of the outlyers of the Arakan Range.

b. The Central Section extends southward from Akyab to Sandoway. Throughout most of its length offshore islands protect the mainland coast from heavy surf and permit a wide belt of mangrove growth between the sea and the inland foothills. The low, swampy coast is additionally described in the section on soils. The hilly chain is some 50 miles in width and drops off sharply on the east into the Irrawaddy Valley. The local relief and slope angles are about the same as those in the northern section.

c. The Southern Section. South of Sandoway the range decreases in altitude and width and its foothills lie directly on the coast. At Cape Negris it terminates in the low hilly peninsula between the Irrawaddy Delta and the sea. The coastal fringe is a narrow and swampy plain commonly fringed with mangrove growth. In the southern hills the local relief has decreased to 600 to 800 ft and the slopes from 17 to 20%.

2. The Irrawaddy Delta. At Cape Negris the coastline turns eastward for some 50 miles along the Gulf of Martaban and northward to the mouth of the Sittang River. The country inland is a flat delta lowland intricately divided by the distributaries, inlets, and offshore islands of the Irrawaddy. There

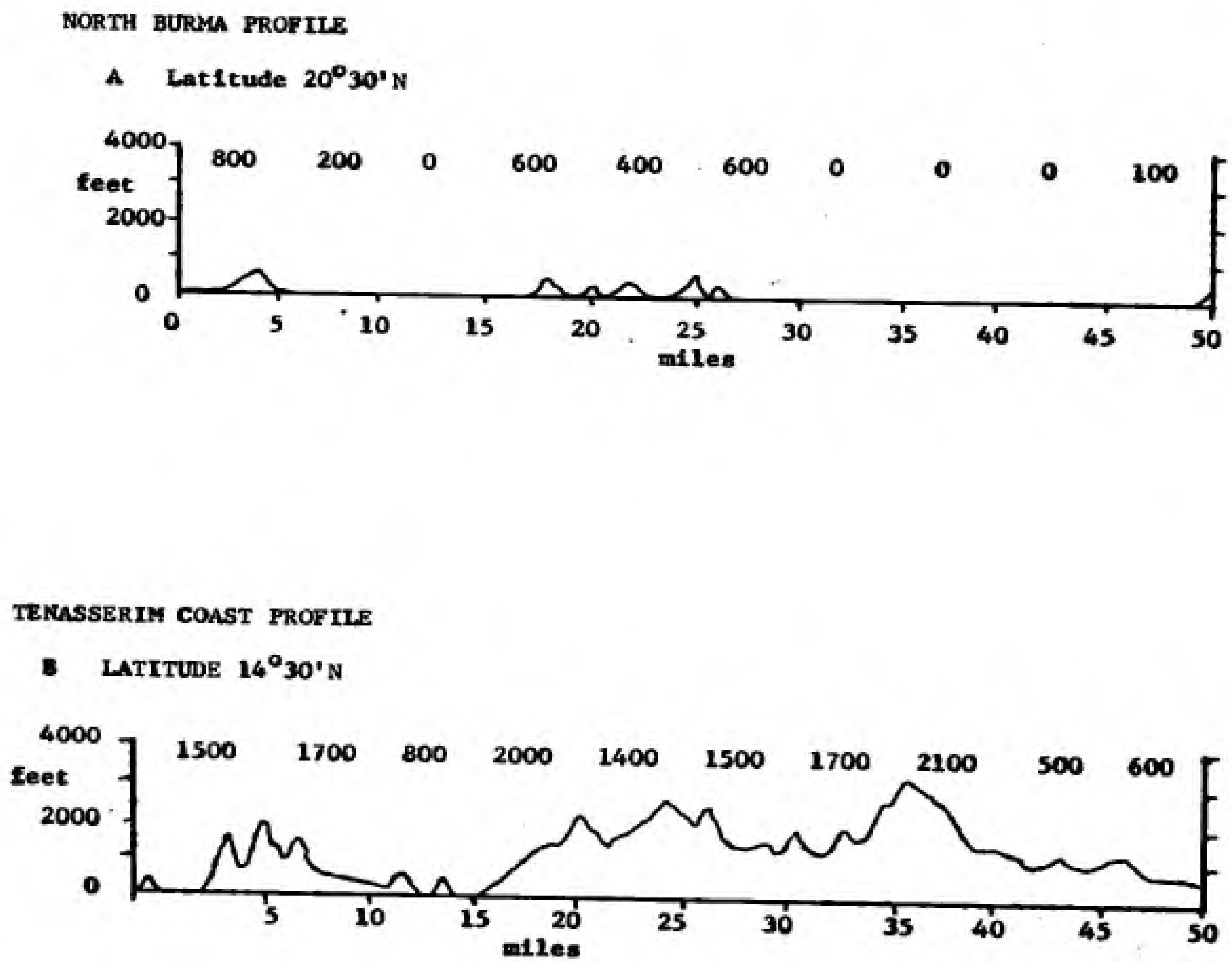


Fig. 1. Cross Section A and B.

are no conspicuous landforms except in the extreme northern part (of the 50-mile strip of the Project Area) where the southern extremities of the Pegu Range form belts of hill country. In general the delta is low, flat, and wet. It is described in some detail in the section on soils.

3. The Tenasserim Coast extends southward from the Irrawaddy Delta to the southern end of the mountain country at about latitude 8 north and includes part of southern Thailand. South of latitude 13, and to the border of Malaya, it includes the entire width of the Maylay Peninsula. In structure and appearance it resembles the Arakan Coast and is composed of two sections.

a. The Northern Section is the area between the crest of the Dwana Range and the ocean. It encloses the broad alluvial plain of the Salween and other rivers between the mountains and the low coastal hills. Cross-section B, Fig. 1, shows the coastal hills, Tavoy River Valley, and inland mountains.

b. The Southern Section, between latitudes 8 and 13 north, includes the width of the peninsula and the coasts of both the Andaman Sea and the Gulf of Siam. The western or Andaman Coast, protected by the islands of the Mergui Archipelago, is low and wet and covered, nearly to the foothills of the Belauktaun Range with mangrove forests. The eastern coast is also narrow and in places outlyers of the range reach the gulf coast. This plain, however, is generally dry and its margins bear sand and sand dune strips. The Belauktaun Range which forms the boundary between Burma and Thailand is narrow, and generally below 5000 ft in altitude. Within the range local relief varies from 1000 to 2000 ft and slopes from 25 to 37%. Cross-section C, Fig. 2, shows a profile of the area from the Andaman Sea to the Gulf of Siam.

4. South Thailand is the low, central part of the Malay Peninsula, some 100 miles in width lying between the latitudes of 6 and 8° north. Within it the hilly chains are present only as isolated hills and mountain masses which rise above the general level of the rolling lowland. The eastern coastal plains along the Gulf of Siam are alluvial in nature and some of them extend inland for many miles. They commonly bear coastal fringes of sand or sand dunes. The western plains are complex in nature formed of undulating surfaces cut by shallow stream erosion. Cross-section D, Fig. 3, shows the generally level nature of the area with the individual hills and one of the isolated mountain masses.

5. Malaya is described in three parts because the most of the central upland is outside the 50-mile strip of the Project Area. The parts are: the west coast, the Singapore Lowland, and the east coast.

a. The West Coast consists of a coastal plain generally about 15 to 20 miles wide backed by mountains reaching elevations of 5000 to 6000 ft. The plain is generally of alluvium and broken in a few places by mountain

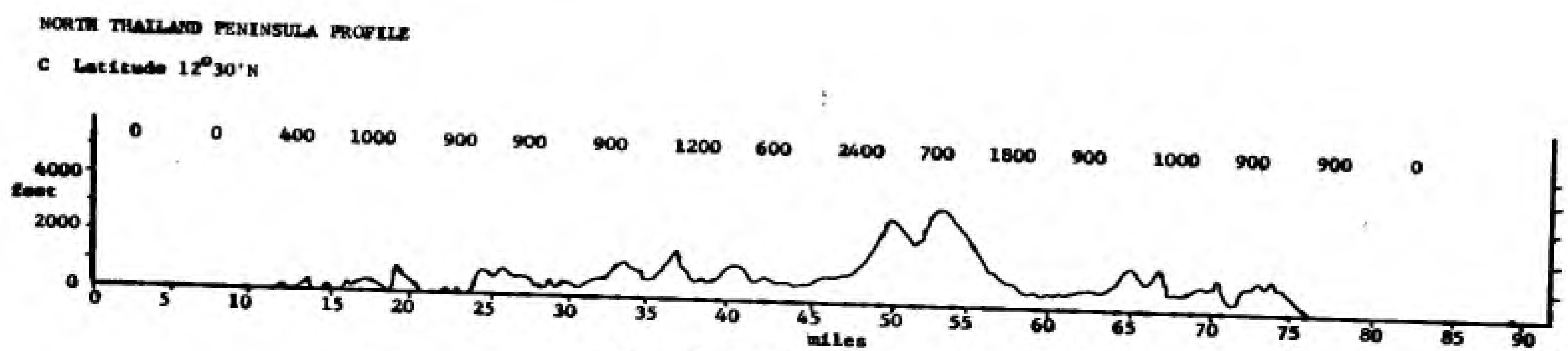


Fig. 2. Cross Section C.

KRA ISTHMUS PROFILE

D Latitude 8°30'N

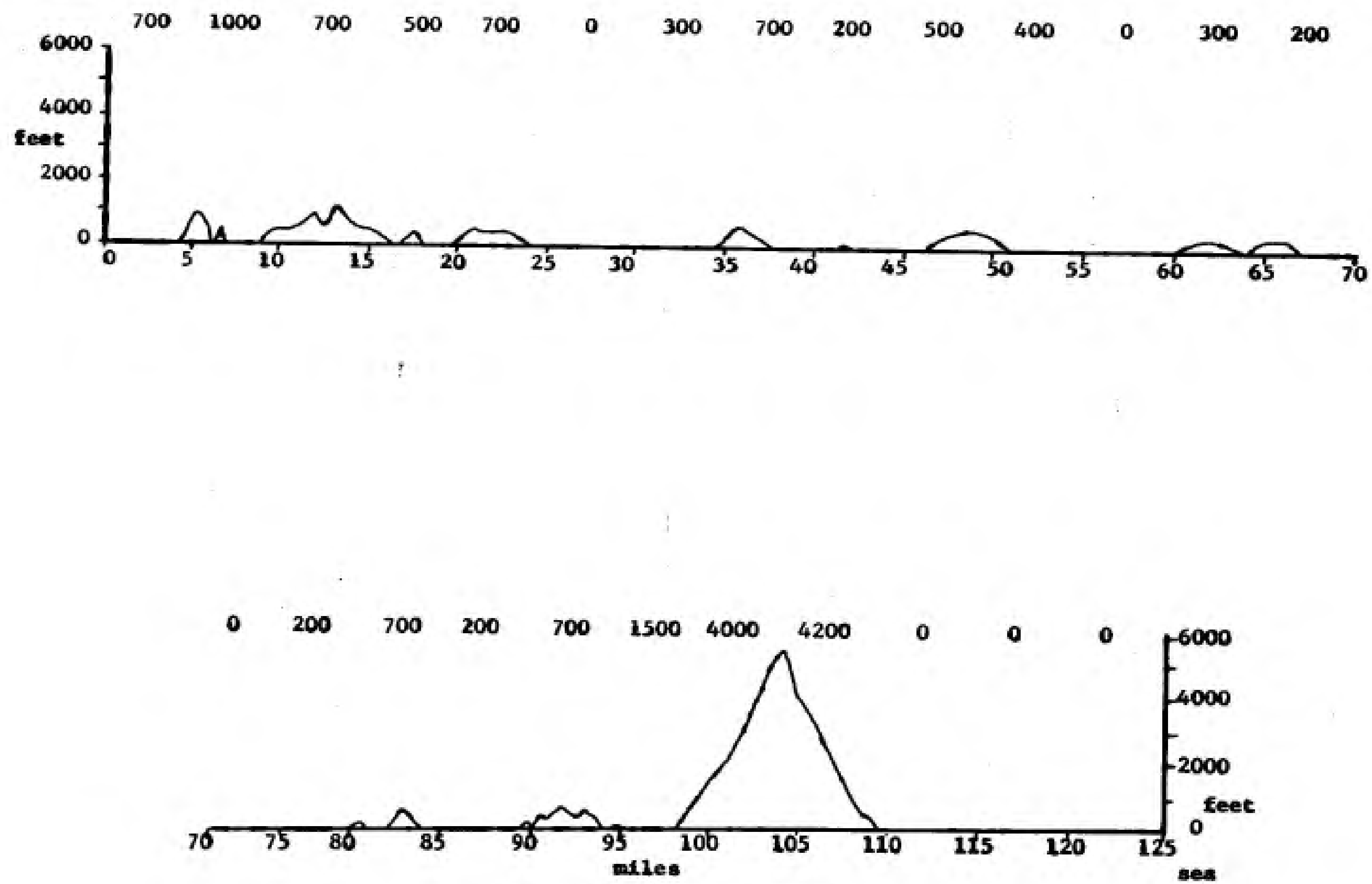


Fig. 3. Cross Section D.

spurs or outlyers which make parts of it of complex character. It contains an extensive swampy area extending between latitudes 3°30' and 4°30'. The coastline is marked by a narrow sandy strand, commonly wet, and in many places covered with a mangrove fringe. The mountains rise sharply from the coastal plain. Local relief increases from north where it will average 1500 ft to the south where it reaches 5000 ft. Slopes vary between 21 and 31%.

b. Singapore Lowland. The mountains extend as ranges to about latitude 2°30' where they break up into discontinuous and individual hilly masses. The general upland surface is a composite of wet lowlands of negligible elevations and somwhat higher but flattish areas of complex plain with altitudes of 100 to 300 ft. Along the east side of this lowland is a large area of freshwater swamp extending from the coastal sand dunes to the margins of a large isolated hilly mass. Singapore island and the city itself at the extremity of the Malay Peninsula are a center for the communications lines; roads and railroads from the peninsula.

East Coast is formed by an alluvial plain some 20 miles in width which is consistently swampy immediately inland from the strand. The coast itself is sandy and probably bears low dunes which are not high enough to show within the contour interval of the maps (250 ft) but are indicated by presence of short streams parallel to the coast. Mangrove is uncommon except in the river estuaries. The northern part of the plain is of complex character and holds small individual rounded hills which rise sharply from the level surface to heights of 600 to 1000 ft.

The country behind the coastal plain is a hilly upland cut by stream erosion. The summits are between 2000 and 3500 ft in elevation with local relief near the coastal plain of 1500 to 2000 ft and inland up to 3000 ft. Slopes average from 19 to 26%. Cross-section E, Fig. 4, covers the entire width of the peninsula. The difference between the high mountains of the west and the hill country and plains of the east is apparent.

6. The Bangkok Plain. The flat alluvial lowland formed by the delta of the Chao Phraya, and three other rivers, is a plain about 100 miles in breadth along the ocean. The coast is fringed with a narrow tidal strip of mangrove. The surface is relatively well drained by agricultural canals and contains no extensive swampy areas. It is entirely under paddy cultivation and has a road and railroad system centering on Bangkok.

7. Mountains and Plateaus of Western Cambodia and Eastern Thailand. Between the Bangkok Plain and the Mekong Delta extends an area of uplands composed of plateau and mountainous surface which approaches the coast closely throughout most of its extent. In the western, or Thailand, part of this is an undulating surface, 700 to 1000 ft in altitude, with tabular mountains and ranges rising to 2000 ft. The coastal alluvial strip is only two to three

MALAYA PROFILE

E Latitude 4°30'N

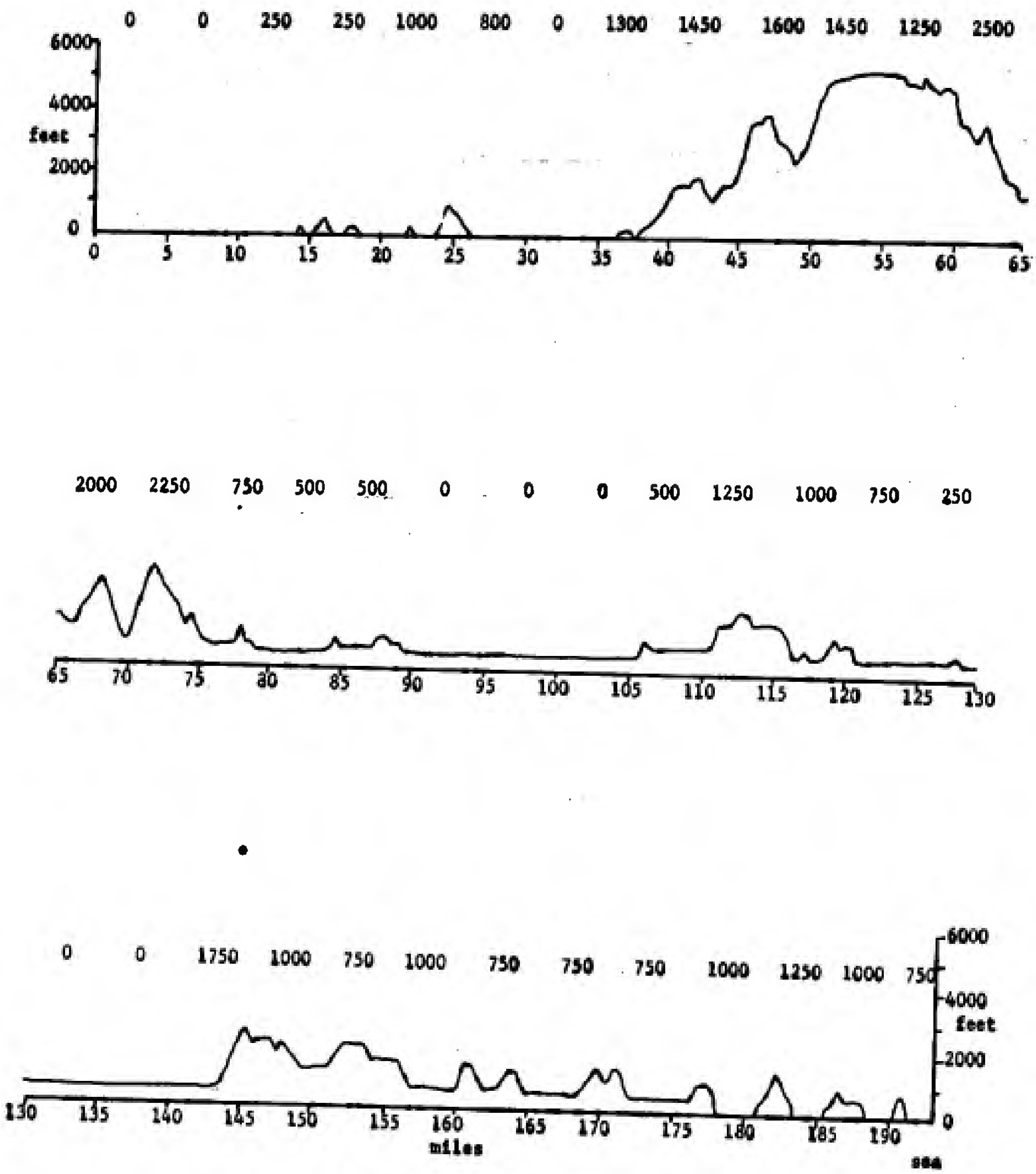


Fig. 4. Cross Section E.

miles wide but extends farther inland along rivers and the bays. Local relief in the foothill and coastal areas is from 300 to 600 ft but reaches 2000 ft in the isolated mountain ranges. Slope samples in the area average from 16 to 18%.

The eastern or Cambodian side, somewhat higher and rougher, is formed by the Chaine des Cardamones and the Chaine de l'Elephant with summit elevations within the 50-mile zone reaching 3000 ft. The mountains extend to the coast as headlands and the discontinuous coastal strips are very narrow. Local relief in the coastal foothill areas is from 900 to 1200 ft but in the mountain spurs is as high as 2400. Slopes in the coastal zone average 16 to 18% but are as steep as 34% in the mountains.

Cross-section F, Fig. 5, is drawn across the Thailand-Cambodia border. It shows the low plateau and the isolated hill group of the Thailand (western) side and the Cardamones on the eastern interior.

8. The Mekong Delta extends southward from the end of the Cambodian mountains for about 100 miles to Point de Camau (Cape Cambodia), the southern extremity of the Indo-China Peninsula, and thence northeastward along the South China Sea. It reaches inland for 400 miles or more. This is a level, featureless lowland intricately patterned by drainage ditches and the distributaries of the Mekong. Much of the western part for 15 or 20 miles inland is permanently flooded and covered with wet forest. The northeast-southwest (eastern) coast bears a mangrove fringe two or more miles wide along most of its extent. Most of this lowland is subject to disastrous floods. It would be a difficult area for cross country movement but does have a relatively good system of roads.

9. Chaine Annamitique is the extensive area of hills and mountains which stretches for 600 miles along the coast of the South China Sea between the delta of the Mekong and the Tonkin Lowland. It extends inland somewhat beyond the limits of the 50-mile Project Area and on the west drops onto the Mekong drainage basin.

The chain is a succession of eroded plateaus with a general elevation of 1000 ft or higher and capped by erosional remnants of individual mountains and ranges reaching elevations of 5000 to 6000 ft. Spurs of the upland reach the sea and cut the coastal plain into separate segments. The upland has been strongly dissected into a hill and valley surface.

The southern end of the chain, for about 100 to 150 miles north of the Mekong Lowland is an undulating upland about 50 miles in width between the coast and the Mekong drainage to the west. It has surface elevations of about 300 to 600 ft with individual mountains reaching to 2400 ft. Local relief on the undulating surface is from 150 to 300 ft and slopes are of about 3 to 4%. The isolated mountains contain local relief of 2500 ft and slopes of 27 to 28%.

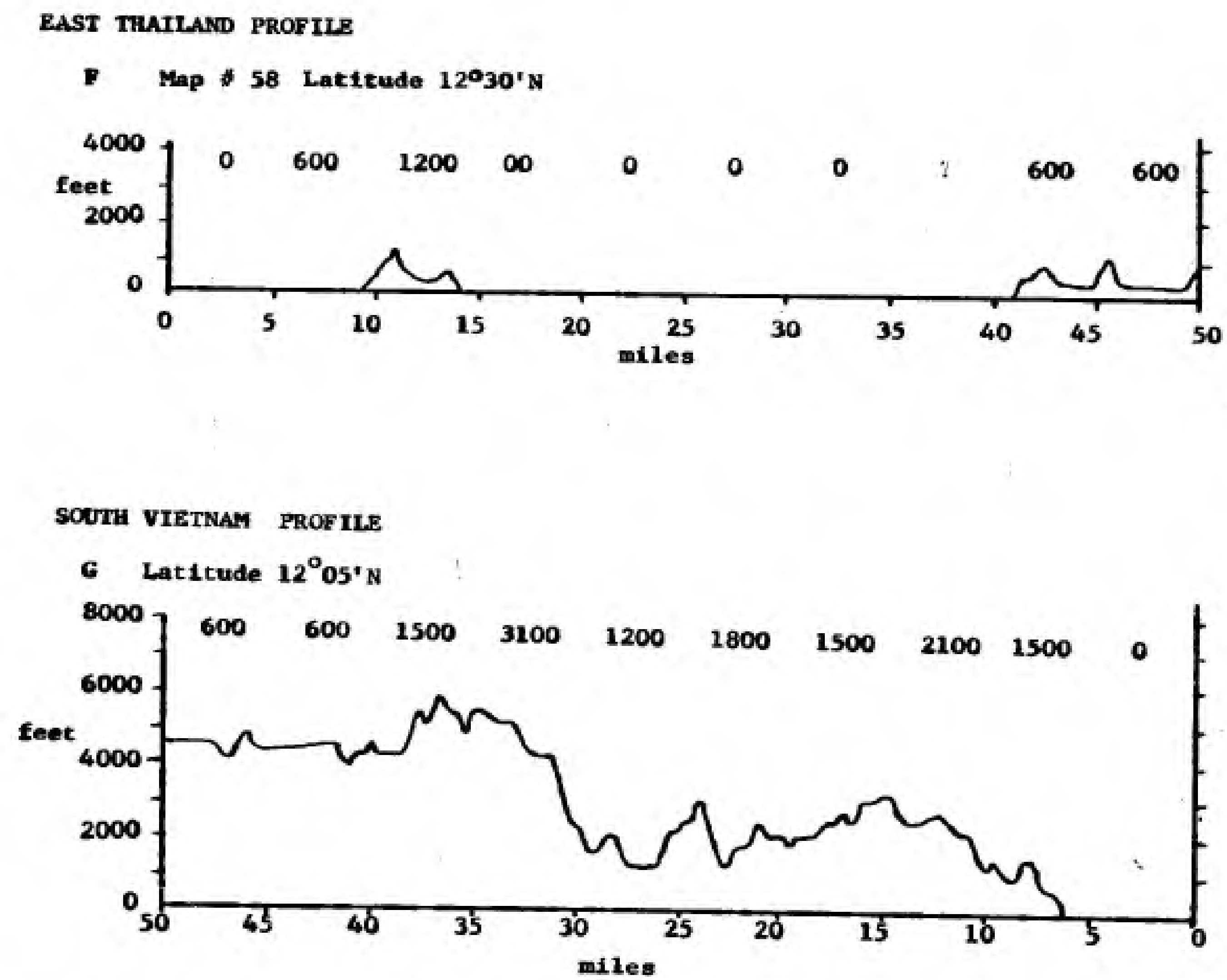


Fig. 5. Cross Sections F and G.

From about latitude 13 to the beginning of the Tonkin Lowland the chain is a rough dissected upland into which the short streams flowing into the South China Sea have cut deep valleys. In the rougher, middle parts of the chain local relief between the valley bottoms and the higher crests reaches 2500 to 3000 ft with slopes as steep as 35 to 50%.

The coastal strip along the chain is broken into nine segments by headlands. These alluvial areas are usually ten miles or less in width but extend much farther into the hill country along the valleys of the larger streams. On their seaward fringes they are characterized by sand dune ridges, lagoons, and offshore sand bars. Inland of the dunes the lowlands are commonly in paddy cultivation. North of latitude 18° the coastal strip becomes wider and merges with the Tonkin Lowland.

Cross-section G, Fig. 5, shows the ruggedness of the terrain of the Chaine Annamitique, the large local relief and narrow coastal plains. Sections H and I, Fig. 6, indicate the same general character as well as the sharp drop into the Tonkin Lowland on the east.

10. The Tonkin Lowland is the alluvial plain formed in the north by the delta of the Red River and its distributaries and in the south by the wide coastal lowlands and narrow delta deposits of the Ma, the Ca, and the Chu Rivers. It is a flat, featureless area which is only 2 or 3 ft above the sea along the coast and more than half of its entire area is below the elevation of 10 ft. An intricate pattern of ditches and low dykes provide drainage and protection for the densely settled and intensively cultivated low ground. Its coastal extent is about 200 miles.

The lowland is divided approximately in half by a ridge of limestone hills which reach within ten miles of the coast at latitude 20°. (See Fig. 7.) The northern part, the delta of the Red River, extends inland for 150 miles, constantly narrowing in width. The coast of this part consists generally of sand or mud banks with much mangrove swamp. The southern half is narrower, some 25 to 35 miles in width and is broken into two sections by a hilly upland which reaches the coast at latitude 19°15'. Its coastal fringe is sandy with some dunes, but generally open and smooth.

11. Highlands of Northeast Tonkin. Between the Tonkin Lowland and the Chinese border is a rough hilly area formed by the southern extension of the massif of China. It is a dissected plateau with short ranges extending generally at right angles with the coastline. The highest elevations, 5000 ft, and the steepest slopes, 26%, are in the extreme northeast adjoining the Chinese border. Over most of the hilly area the local relief is between 1200 and 2000 ft. Figures 8 and 9 drawn from photographs show the nature of the hill and valley terrain close to the Chinese border and near the Tonkin Delta.

The coast of the northern half of the upland is an alluvial strip some five miles wide, bordered by sand and mud flats and protected by a chain of islands lying two to three miles offshore.

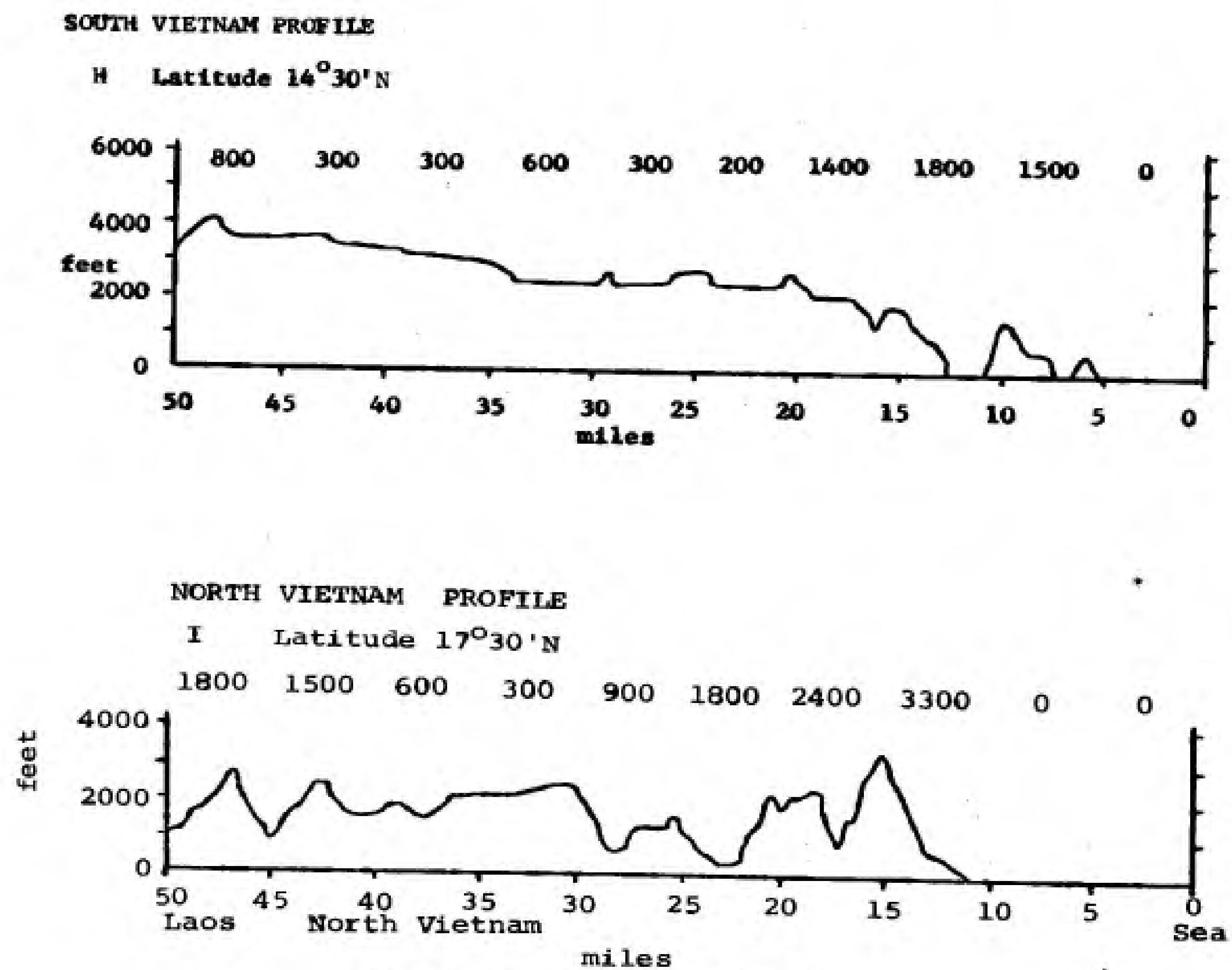
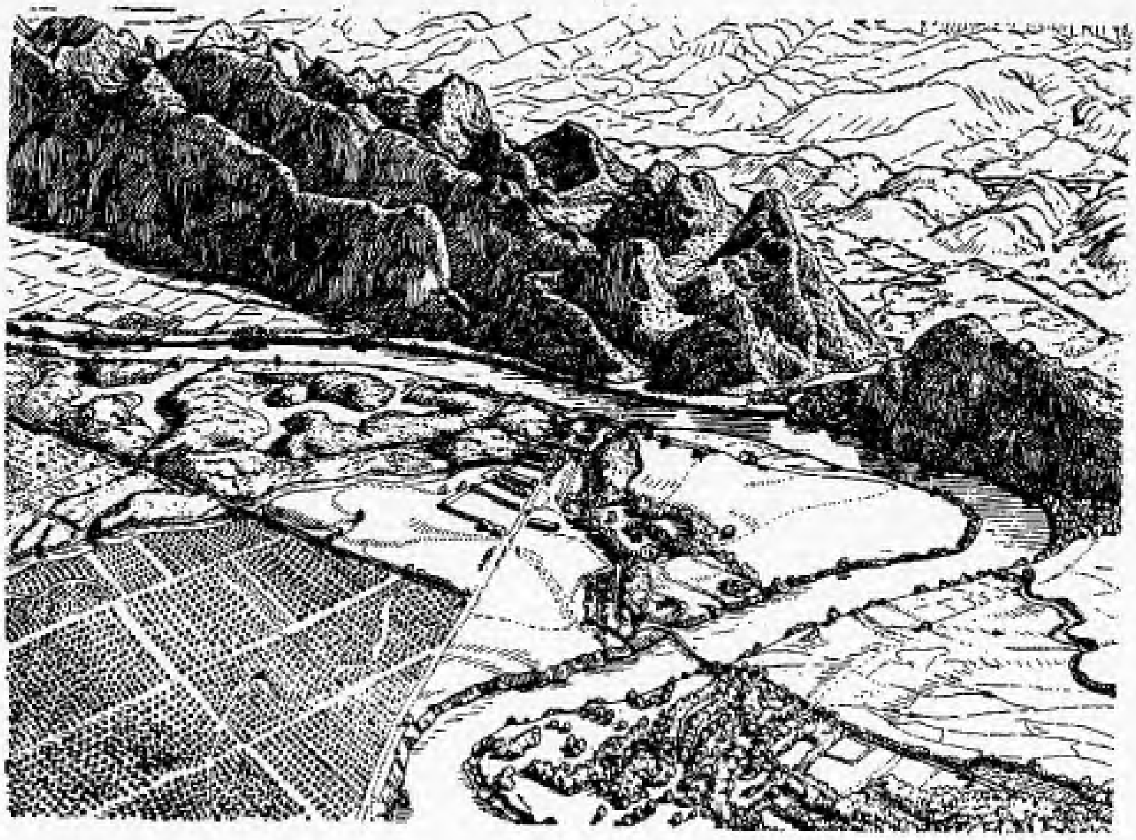


Fig. 6. Cross Sections H and I.



The hills rise abruptly from the flat lowland of the delta and are covered with forest to their summits. In the left foreground there is a coffee plantation and large modern farm buildings.
Source: P. Gourou, *Les Paysans du Delta tonkinois*, plate 5 (Paris, 1936).

Fig. 7 Limestone Hills on the Tonkin Delta.

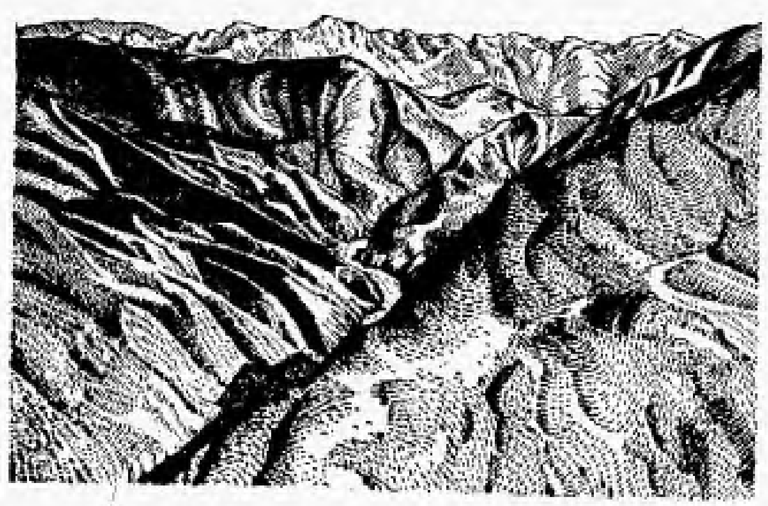


Fig. 8 The highlands of northeastern Tonkin.

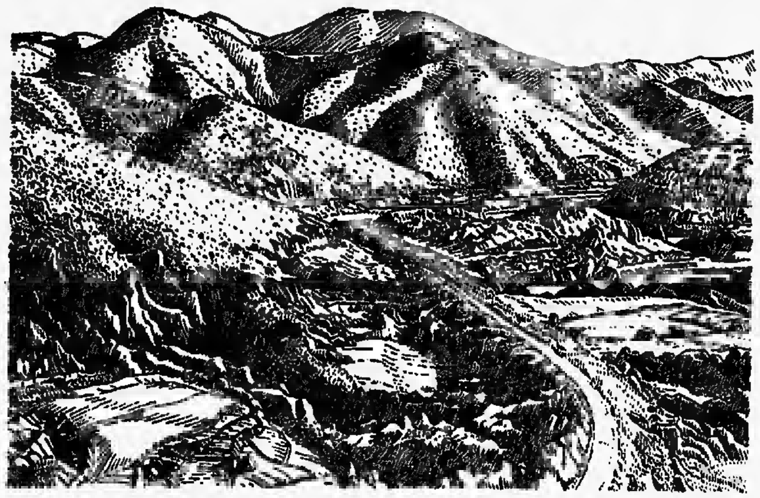


Fig. 9. Country at Margin Between Highlands and Tonkin Delta. From: Geographical Handbook Series, B.R. 510, Naval Intelligence Division, London.

Analysis of Relative Relief

Relative relief is a measure of local roughness. It is obtained by measuring the difference between the highest and the lowest elevation within a limited area. It is one of the elements of the environment of importance in calculating the difficulty of off-road movement.

METHOD USED IN THIS STUDY

The military grid squares, 10,000 yards on a side (or 10,000 meters on some maps) was used as the basic area. Within each square the difference in elevation was calculated for the parts of each map within the Project Area. The maps used were the 1:250,000 and similar scale of the U542, L509, L508, and L501 series. The difference in area between the 10,000 yard and the 10,000 meter squares was not considered significant. The contour interval varied from one map series to another. Those used in the analysis were 100 ft, 200 ft. 250 ft, 100 meters, and 500 ft (for one map only). A total of 6372 squares were counted. These have been divided into the Physical Region categories used previously in this section on Land Surface and are presented in Table 8. The division of the findings of relative relief into the simple categories, plains, hills, and mountains follows in the main categories by the Army Map Service for the same maps but calculated by the AMS on 5,000

TABLE 8

RELATIVE RELIEF BY PHYSICAL REGIONS

Physical Region	Map No.	Plains 0	100	200	400	600	Hills 800	1000	1200	1400	1600	1800	2000	Low Mountains 2200	2400	2600	2800	3000
Arakan (north)	1-3	34	--	20	26	17	15	23	9	16	12	12	30	6	30	4	3	15
Arakan (central)	4	11	3	18	27	15	7	13	8	11	10	--	11	4	7	4	2	2
Arakan (south)	5-10	291	37	35	43	43	13	18	14	12	13	12	18	7	14	9	14	14
Irrawaddy	11-14	170	39	44	38	31	13	20	7	9	14	6	11	8	9	4	1	4
Tenasserim (N)	15-17	4	5	9	6	5	8	19	17	10	14	26	26	22	22	17	18	11
Tenasserim (S)	18-20	3	--	10	13	10	16	18	16	22	16	14	19	13	7	2	--	1
[illegible] (west)	26-33	118	1	44	50	--	50	39	35	27	--	26	22	25	21	--	14	6
[illegible]	34-39	69	9	93	45	--	35	25	16	14	--	13	13	7	6	--	3	8
[illegible] (east)	40-47	74	--	24	54	--	38	35	43	30	--	38	23	23	14	--	20	15
N. Thail. (west)	48-53	68	1	27	40	28	38	45	8	34	37	5	28	4	28	18	5	14
S. Thail. (west)	21-25	23	--	11	47	28	19	38	17	39	10	14	20	14	12	1	3	6
[illegible]	54-55	123	--	4	14	21	--	28	--	8	12	--	10	--	14	12	--	6
[illegible] Mts.	56-61	35	--	13	42	42	--	38	--	30	38	--	36	--	28	17	--	16
[illegible]	62-66	342	--	7	12	17	--	13	--	8	3	--	2	--	1	--	--	--
Ch. Annam (north)	67-69	3	--	6	19	23	--	16	--	13	14	--	12	--	17	16	--	10
Ch. Annam (centrl)	70-77	31	--	--	18	27	--	34	--	33	45	--	51	--	53	41	--	41
Tonkin Delta	78-81	20	--	--	22	30	--	39	--	32	25	--	18	--	19	19	--	20
E. Tonk. Highlds.	82-85	91	--	--	16	11	--	25	--	19	24	--	17	--	6	9	--	6
Totals		1502	80	387	547	344	246	488	190	367	287	160	367	133	294	193	83	195
Percent		23.97	24.83	30.99	39.17	44.57	48.43	56.09	59.07	64.83	69.33	71.85	77.60	79.69	84.31	87.33	88.64	91.70

Physical Region	Rugged Mountains 3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200	6400	6600
Arakan (north)	2	5	2	4	3	--	--	--	--	1	--	--	--	--	--	--	--	--
Arakan (central)	3	5	2	3	--	--	2	1	--	--	--	--	--	--	--	--	--	--
Arakan (south)	5	3	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Irrawaddy	--	1	3	1	3	3	1	2	1	2	--	--	1	--	--	--	--	--
Tenasserim (N)	5	10	5	5	4	1	--	1	1	1	--	--	--	--	--	--	--	--
Tenasserim (S)	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
[illegible] (west)	11	16	--	10	5	6	4	--	6	2	1	1	--	1	--	--	--	--
[illegible]	3	2	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
[illegible] (east)	18	8	--	8	2	1	2	--	6	--	1	--	--	--	--	--	--	--
N. Thail. (west)	--	10	3	2	4	6	3	1	--	2	1	--	--	2	--	--	--	--
S. Thail. (west)	3	2	--	1	2	1	1	--	--	--	--	--	--	--	--	--	--	--
[illegible]	--	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
[illegible] Mts.	--	13	6	--	5	1	--	--	--	1	--	--	--	--	--	--	--	--
[illegible]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ch. Annam (north)	--	18	6	--	6	4	--	1	--	2	--	--	--	--	--	--	--	--
Ch. Annam (centrl)	--	45	26	--	19	21	--	13	--	13	1	--	2	--	3	--	--	1
Tonkin Delta	--	22	8	--	7	7	--	3	--	6	--	--	1	--	1	--	--	1
E. Tonk. Highlds.	--	4	--	--	1	3	--	--	--	1	--	--	--	--	--	--	--	--
Totals	50	169	61	34	63	54	13	20	14	31	4	1	4	3	4	--	--	2
Percent	92.48	95.13	96.09	96.63	97.61	98.46	98.67	99.01	99.23	99.72	99.78	99.80	99.86	99.91	99.97	--	--	100

Physical Region	Percent: Total	Plains	Hills	Low Mts.	Rugged Mts.
Arakan (north)	279	34.0	42.0	17.2	6.8
Arakan (central)	164	40.2	38.4	11.6	9.8
Arakan (south)	463	72.8	16.3	9.4	1.5
Irrawaddy	438	71.3	18.7	5.9	4.1
Tenasserim (N)	278	10.6	44.1	33.0	12.3
Tenasserim (S)	181	19.9	60.8	18.8	0.5
[illegible] (west)	539	38.5	37.3	12.4	11.8
[illegible]	382	48.0	38.4	6.3	1.3*
[illegible] (east)	473	38.6	40.5	15.2	9.7
N. Thail. (west)	496	36.0	41.5	15.1	7.4
S. Thail. (west)	306	33.5	51.4	11.8	3.3
[illegible]	238	62.0	22.5	13.2	1.5
[illegible] Mts.	385	37.1	40.0	15.6	7.3
[illegible]	405	93.4	6.4	0.2	--
Ch. Annam (north)	186	27.5	29.5	23.1	19.9
Ch. Annam (centrl)	538	14.3	30.3	28.9	26.5
Tonkin Delta	388	24.0	38.0	19.4	18.6
E. Tonk. Highlds.	233	50.6	36.4	9.0	3.9
Totals	6372				

Summary of Relative Relief analysis

Chart shows number of grid squares (10,000 yards or 10,000 meters) which have elevation differences in feet in each category, 0 to 6600. Physical Regions are those described in text.

yard squares. The AMS classification is:

> Plains: under 600 ft of relative relief
> Hills: 600 to 2000 ft of relative relief
> Mountains: over 2000 ft of relative relief.

For the purposes of this project, the area of the mountain category was included within our general category "complex hills." Our original map analysis, made by counting these same 6372 squares for vegetation and geomorphological nature showed that 45% of the area was in plains of one or another character and 55% in complex hills.

The relative relief analysis shows that exactly 45% of the squares have relative relief of 600 ft or under, so that we have taken this figure which is the same as that used by AMS as the limit of "plains." The AMS limit of 2000 ft or under for "hills" includes (together with plains) 79% of the surface and that of 3000 ft or under, 94% of the surface. Because we have no geomorphological data to separate hills from mountains we have taken the AMS limit of more than 2000 ft of relative relief as the hill-mountain boundary. We have also subdivided the mountains into two categories: low mountains with relative relief between 2000 and 3000 ft; and rugged mountains with relative relief over 3000 ft. On this basis the categories of relative relief presented in Table 9 are:

> Plains: under 600 ft of relative relief
> Hills: 600 to 2000 ft of relative relief
> Low mountains: 2000 to 3000 ft of relative relief
> Rugged mountains: over 3000 ft of relative relief.

The physical regions presented above may be described in terms of their relative relief from the study summarized in Table 9. In reading these figures it should be considered that the flat areas such as the Tonkin Delta include also their surrounding mountains to the boundaries of the Project Area.

TABLE 9

PERCENTAGES OF PROJECT AREA IN CATEGORIES OF RELATIVE RELIEF BY PHYSICAL REGIONS

Physical Region	Plains	Hilly	Low Mountains	Rugged Mountains
Arakan Cst. N.	34.8	42.0	17.2	6.0
Arakan Cst. Cent.	42.2	36.4	11.6	9.8
Arakan Cst. South	78.8	16.3	9.4	1.5
Irrawaddy	71.3	18.7	5.9	4.1
Tenasserim (N)	10.6	44.1	33.0	12.3
Tenasserim (S)	19.9	66.8	12.8	0.5
Malaya (West)	38.5	37.3	12.4	11.8
Singapore	62.0	30.4	6.3	1.3
Malaya (East)	33.6	42.5	15.2	9.7
S. Thailand East	36.0	41.5	15.1	7.4
S. Thailand West	33.5	51.4	11.8	3.3
Bangkok	62.8	22.5	13.2	1.5
Camb. Thail. Mts.	37.1	40.0	15.6	7.3
Mekong	93.4	6.4	0.2	--
Ch. Annam (South)	27.5	29.5	23.1	19.9
Ch. Annam (Cent.)	14.3	30.3	28.9	26.5
Tonkin Delta	24.0	38.0	19.4	18.6
E. Tonkin Highlands	50.6	36.4	9.0	3.8

Analysis of Slope

Of the two general geomorphologic divisions with in area of the study, plains and complex hills, the former presents few problems in terms of slope angles. Impediments to trafficability on the plains stem from low soil strength for which we have no measurable data, from poorly drained areas, and from paddies.

In the complex hills, one of the factors of trafficability is the slope angle. Envinal points out that vehicles "seldom bog down on steep slopes although they may not be able to climb them"; therefore, we assume that the slope angle is the controlling condition although soil strength may be a factor in valley bottoms.

An analysis was made from 75 samples, each selected at random from the 1:250,000 maps which in linear sequence cover the coastal area from the Pakistan border to the China border, using Wentworth's formula for a circle with a ten mile radius and counting along six or less radii. Each observation is, therefore, an average of a sample of some 300 square miles. The quantitative distribution of these samples is shown in three magnitudes of category in Fig. 10, and the actual readings and computations in Tables 10 and 11.

When arranged by the categories used in Envinal the following distribution is found:

3-15% (slight)	14 samples	19% of samples
16-30% (moderate)	42 samples	56% of samples
31-50% (steep)	19 samples	25% of samples

There is no recognizable, or at least measurable, geographical distribution of the categories as can be seen by running down the columns for numbers of contours, as well as percent or degree of slope in Tables 10 and 11.

IMPLICATIONS

It is recognized that vehicles do not climb "average" slopes but are limited by the steepest slopes. However vehicles are not usually forced to travel "across the grain" of a surface and may select the easiest way, commonly along the valleys rather than up the hills. By this reasoning, the average slope of a sample may be a pretty good indication of its trafficability in terms of slope alone. Envinal gives the following capabilities (disregarding the factor of soil strength).

0-15% (slight)	All wheel-drive trucks, trailed vehicles, heavy tanks.
15-30% (moderate)	Medium tanks, tractors with high contact pressures, trucks with low contact pressures.
30-45% (steep)	Tractors with average contact pressures, tanks with low contact pressures.

Under these criteria almost all of the area should be trafficable for light tanks. It should be stated however, that such conclusions are directly opposed to those of a military reconnaissance party which reported that in the steeper parts of the country (somewhat inland from the area under analysis) cross country movements except by foot parties were impractical.

Method of Slope Analysis

To give some indication of the character of slope in the complex hills regions this analysis employed a method described in the Headquarters Quartermaster Research and Engineering Command, U.S. Army, Technical Report EP-124, "A Quantitative System for Classifying Landforms," issued by the Quartermaster Research and Engineering Center, Environmental Protection Research Division, Natick, Massachusetts, February 1960, page 7, was used.

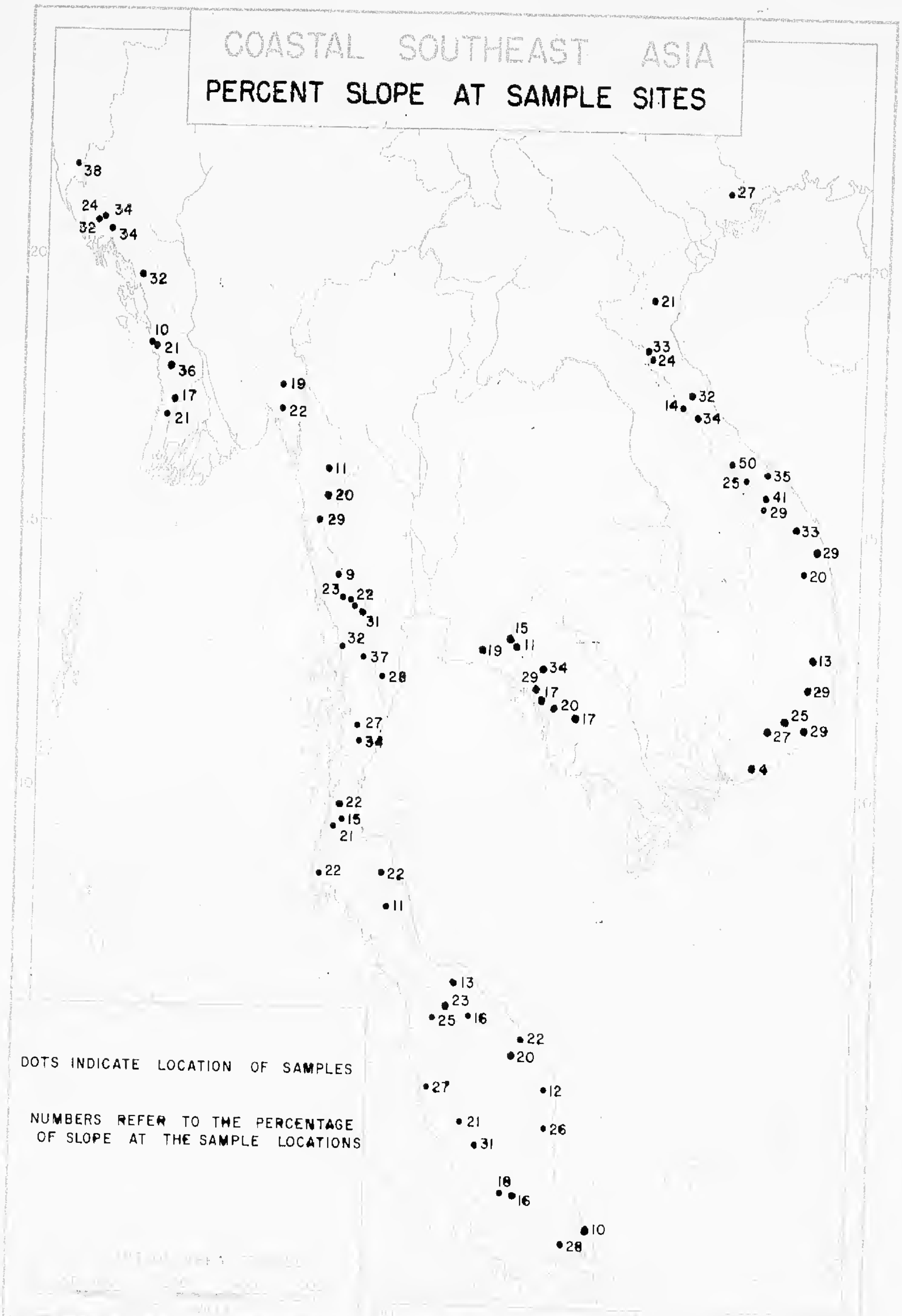
"(5) Average slope - As yet, no quick method has been devised for obtaining the data needed to describe the statistical and spatial distribution of slopes within an area. Therefore the only indication of the angle at which the surface departs from the horizontal is the average slope.

"A measure for average slope is obtained by drawing traverses across the area in several directions, counting the number of contours which cross these traverses, and computing the slope tangent by the Wentworth equation (5): S tan = I x M/3361, where S tan is the slope tangent; I is the contour interval in feet; and M is the number of contours crossed per mile of random traverse."

After selecting 75 random locations (Map 10) a count of contours was made along six (north, northeast, southeast, south, southwest, northwest) ten mile traverses from the random spots. To preserve the maps however no lines were drawn directly on the maps. Instead the traverse lines were drawn as radii on transparent plastic as illustrated and the count of contours made along the inked lines. Since most of our working maps are at a scale of 1:250,000 the star was constructed with a ten mile radius at that scale. No adjustments were made for those maps whose scale was 1:253,440, inasmuch as the difference is negligible. (Data enclosed.)

Knowing the contour interval and having counted the number of contour crossings per mile the data were readily applied to the Wentworth equation. The procedural and concluding figures are attached as Tables 10 and 11. The final solumns of the Table 11 show the slope in percentage and degree respectively.

Three different histograms (Fig. 10) constructed from findings show the mean and median figures and to some extent the deviation.



Map 10. Percent Slope at Sample Points.

TABLE 10

MEASUREMENTS OF SLOPE DETERMINATION IN COMPLEX HILLS

Stratified random sample - 15 regions   n, number of observations = 75

Observation	Map No.	Contour Interval	1st		2nd		3rd		Total	
			Miles	No. of Contours	Miles	No. of Contours	Miles	No. of Contours	Miles	No. of Contours
1	1	500 ft	10	28	10	26	10	23	30	77
2	3	200 ft	10	38	10	42	10	44	30	124
3	3	200 ft	10	62	10	51	10	60	30	173
4	3	200 ft	10	56	10	58	10	56	30	170
5	4	200 ft	10	43	10	38	10	49	30	160
6	5	200 ft	9	14	10	19	10	16	29	49
7	5	200 ft	10	44	10	33	10	31	30	108
8	6	200 ft	10	69	10	55	10	57	30	181
9	7	200 ft	10	22	10	32	10	34	30	88
10	7	200 ft	10	27	10	40	10	40	30	107
11	12	200 ft	10	32	10	32	10	33	30	97
12	12	200 ft	10	48	10	18	10	44	30	110
13	14	200 ft	10	22	10	7	10	24	30	53
14	15	200 ft	10	50	10	49	10	49	30	148
15	15	200 ft	10	29	10	32	10	41	30	102
16	16	200 ft	10	23	10	10	10	14	30	47
17	17	200 ft	10	41	10	36	10	33	30	110
18	17	200 ft	10	41	10	38	10	38	30	117
19	17	200 ft	10	57	10	47	10	55	30	159
20	18	200 ft	10	48	10	31	10	42	30	161
21	21	250 ft	10	37	10	31	10	21	30	89
22	21	250 ft	10	26	10	31	10	29	30	86
23	21	250 ft	10	20	10	20	10	20	30	60
24	22	250 ft	10	25	10	37	10	25	30	87
25	24	328.1 ft	10	11	10	11	5	7	25	29
26	27	250 ft	10	40	10	30	10	29	30	99
27	28	250 ft	10	24	10	18	10	24	30	66
28	29	250 ft	10	34	10	34	10	39	30	107

TABLE 10 (Continued)

Observation	Map No.	Contour Interval	1st		2nd		3rd		Total	
			Miles	No. of Contours	Miles	No. of Contours	Miles	No of Contours	Miles	No. of Contours
29	32	250 ft	10	50	10	36	10	40	30	126
30	32	250 ft	10	24	10	31	10	31	30	86
31	34	250 ft	10	25	10	25	10	14	30	64
32	34	250 ft	10	33	10	16	8	18	28	67
33	35	250 ft	7	22	5	21	5	21	17	64
34	36	100 ft (form lines)	5	12	10	15	10	11	25	38 (form lines)
35	39	250 ft	10	37	10	35	10	33	30	105
36	41	250 ft	10	12	10	19	10	19	30	50
37	44	250 ft	10	23	10	30	10	27	30	80
38	44	250 ft	10	28	10	26	10	36	30	90
39	46	250 ft	10	17	10	12	10	22	30	51
40	46	250 ft	10	45	10	23	10	25	30	93
41	49	250 ft	10	34	10	29	10	28	30	91
42	52	100 m	10	28	10	34	10	20	30	82
43	52	100 m	10	35	10	29	10	41	30	105
44	53	100 m	10	35	10	28	10	23	30	86
45	53	100 m	10	29	10	41	10	45	30	115
46	54	100 m	10	29	10	30	10	37	30	96
47	56	100 m	10	15	10	7	10	23	30	45
48	57	100 m	10	26	10	11	5	11	25	48
49	58	100 m	10	28	10	28	10	32	30	88
50	58	100 m	10	30	10	47	10	28	30	105
51	58	100 m	10	13	10	9	10	11	30	33
52	59	100 m	10	21	10	13	10	17	30	51
53	59	100 m	10	24	10	21	10	18	30	63
54	60	100 m	10	22	10	20	10	11	30	53
55	67	100 m	10	6	10	6	10	2	30	14
56	68	100 m	10	35	10	21	10	27	30	83
57	69	100 m	10	30	10	30	10	29	30	89
58	69	100 m	10	24	10	28	10	25	30	77

TABLE 10 (Concluded)

Observation	Map No.	Contour Interval	1st		2nd		3rd		Total	
			Miles	No. of Contours	Miles	No. of Contours	Miles	No. of Contours	Miles	No. of Contours
59	70	100 m	10	19	10	15	10	8	30	42
60	70	100 m	10	32	10	36	10	20	30	88
61	72	100 m	10	28	10	16	10	18	30	62
62	72	100 m	10	33	10	26	10	30	30	89
63	73	100 m	10	35	10	26	10	29	30	90
64	73	100 m	10	45	10	38	10	42	30	125
65	74	100 m	10	31	10	34	10	37	30	102
66	76	100 m	10	55	10	50	10	49	30	154
67	76	100 m	10	32	10	19	10	27	30	78
68	76	100 m	10	35	10	35	10	39	30	109
69	79	100 m	10	40	10	29	10	30	30	99
70	79	100 m	10	35	10	38	10	33	30	106
71	79	100 m	10	14	10	16	10	14	30	44
72	80	100 m	10	43	10	29	10	29	30	101
73	80	100 m	10	18	10	28	10	29	30	75
74	81	100 m	10	22	10	21	10	23	30	66
75	85	100 m	10	27	10	30	10	25	30	82

TABLE 11

COMPUTATIONS OF SLOPE DETERMINATION IN COMPLEX HILLS

Wentworth formula:

$$\text{slope} = \frac{I \times M}{3361}$$

M = contour crossings per mile
I = contour interval in feet

Observation	Map No.	I, ft	M	I x M	$\frac{I \times M}{3361}$	% of Slope	Degree (approx)
1	1	500	2.566	1283.0	.3817	38.17	20°53'
2	3	200	4.133	826.60	.2459	24.59	13°49'
3	3	200	5.766	1153.2	.3431	34.31	18°56'
4	3	200	5.666	1133.2	.3372	33.72	18°38'
5	4	200	5.332	1066.4	.3173	31.73	17°36'
6	5	200	1.690	338.0	.1006	10.06	5°45'
7	5	200	3.560	712.0	.2118	21.18	11°58'
8	6	200	6.033	1206.6	.3590	35.90	19°45'
9	7	200	2.933	586.6	.1745	17.45	9°54'
10	7	200	3.566	713.2	.2122	21.22	11°59'
11	12	200	3.233	646.6	.1924	19.24	10°54'
12	12	200	3.666	733.2	.2181	21.81	12°18'
13	14	200	1.766	353.2	.1051	10.51	6°00'
14	15	200	4.933	986.6	.2935	29.35	16°22'
15	15	200	3.340	668.0	.1988	19.88	11°15'
16	16	200	1.567	313.4	.0932	9.32	5.20'
17	17	200	3.666	733.2	.2181	21.81	12°18'
18	17	200	3.900	780.0	.2321	23.21	13°04'
19	17	200	5.299	1059.8	.3153	31.53	17°30'
20	18	200	5.366	1073.2	.3193	31.93	17°43'
21	21	250	2.966	741.50	.2206	22.06	12°27'
22	21	250	2.866	716.5	.2132	21.32	12°02'
23	21	250	2.000	500.0	.1488	14.88	8°10'
24	22	250	2.900	725.0	.2157	21.57	12°10'
25	24	328.1	1.160	380.596	.1132	11.32	6°28'
26	27	250	3.300	825.0	.2455	24.55	13°48'

TABLE 11 (Continued)

Observation	Map No.	I, ft	M	I x M	$\frac{I \times M}{3361}$	% of Slope	Degree (approx)
27	28	250	2.200	550.0	.1636	16.36	9°18'
28	29	250	3.566	891.5	.2652	26.52	14°51'
29	32	250	4.200	1050.0	.3124	31.24	17°21'
30	32	250	2.866	716.5	.2132	21.32	12°02'
31	34	250	2.133	533.25	.1586	15.86	9°01'
32	34	250	2.393	598.25	.1780	17.80	10°06'
33	35	250	3.765	941.25	.2801	28.01	15°39'
34	36	100	6.633	331.50	.0986	9.86	5°38'
35	39	250	3.500	875.0	.2603	26.03	14°36'
36	41	250	1.667	416.75	.1240	12.40	7°04'
37	44	250	2.666	666.5	.1983	19.83	11°13'
38	44	250	3.000	750.0	.2231	22.31	12°35'
39	46	250	1.700	425.0	.1265	12.65	7°13'
40	46	250	3.100	775.0	.2306	23.06	12°59'
41	49	250	3.033	758.25	.2256	22.56	12°43'
42	52	328.1	2.733	896.6973	.2668	26.68	14°56'
43	52	328.1	3.500	1148.35	.3417	34.17	18°52'
44	53	328.1	2.866	940.3346	.2798	27.98	15°38'
45	53	328.1	3.833	1257.6073	.3742	37.42	20°31'
46	54	328.1	3.200	1049.92	.3124	31.24	17°21'
47	56	328.1	1.500	492.15	.1464	14.64	8°20'
48	57	328.1	1.920	629.952	.1874	18.74	10°34'
49	58	328.1	2.933	962.3173	.2863	28.63	15°59'
50	58	328.1	3.500	1148.35	.3417	34.17	18°52'
51	58	328.1	1.100	360.91	.1074	10.74	6°08'
52	59	328.1	1.700	557.77	.1660	16.60	9°26'
53	59	328.1	2.100	689.01	.2025	20.25	11°35'
54	60	328.1	1.766	579.4246	.1724	17.24	9°47'
55	67	328.1	1.63	133.66	.0398	3.98	2°17'
56	68	328.1	2.766	907.5246	.2700	27.00	15°07'
57	69	328.1	2.966	973.1446	.2895	28.95	16°09'
58	69	328.1	2.566	841.9046	.2505	25.05	14°04'
59	70	328.1	1.400	459.34	.1367	13.67	7°47'

TABLE 11 (Concluded)

Observation	Map No.	I, ft	M	I x M	$\frac{I \times M}{3361}$	% of Slope	Degree (approx)
60	70	328.1	2.933	962.3173	.2863	28.63	15°59'
61	72	328.1	2.066	677.8546	.2017	20.17	11°24'
62	72	328.1	2.966	973.1446	.2895	28.95	16°09'
63	73	328.1	3.000	984.3	.2929	29.29	16°20'
64	73	328.1	4.166	1366.8646	.4067	40.67	22°08'
65	74	328.1	3.400	1115.54	.3319	33.19	18°22'
66	76	328.1	5.133	1684.1373	.5011	50.11	26°37'
67	76	328.1	2.560	839.936	.2500	25.00	14°03'
68	76	328.1	3.633	1191.9873	.3547	35.47	19°32'
69	79	328.1	3.300	1082.73	.3221	32.21	17°51'
70	79	328.1	3.533	1159.1773	.3449	34.49	19°02'
71	79	328.1	1.467	481.3227	.1432	14.32	8°09'
72	80	328.1	3.366	1104.3846	.3286	32.86	18°12'
73	80	328.1	2.500	820.25	.2441	24.41	13°43'
74	81	328.1	2.200	721.82	.2148	21.48	12°08'
75	85	328.1	2.73333	896.6973	.2668	26.68	14°56'

Mean = 24.05013333 or 13°32'

Standard Deviation

$\sum x^2 = 4.88873912$

$\sum (xi-\bar{x})^2 = \sum x^2 - \frac{(\sum x)^2}{n}$

$s^2 = \frac{\sum (xi-\bar{x})^2}{n-1}$

$s^2 = .00744152$ variance

$s = .08626 = 4°55'\ (5°)$

$\bar{x} = \frac{18.0376}{75}$

$\bar{x} = .240501333$ or 13°32'

DISTRIBUTION OF SLOPE FREQUENCIES

Slopes calculated in percentages by the Wentworth method from ten mile traverses intersecting at each sample point. Based on 75 Random Samples

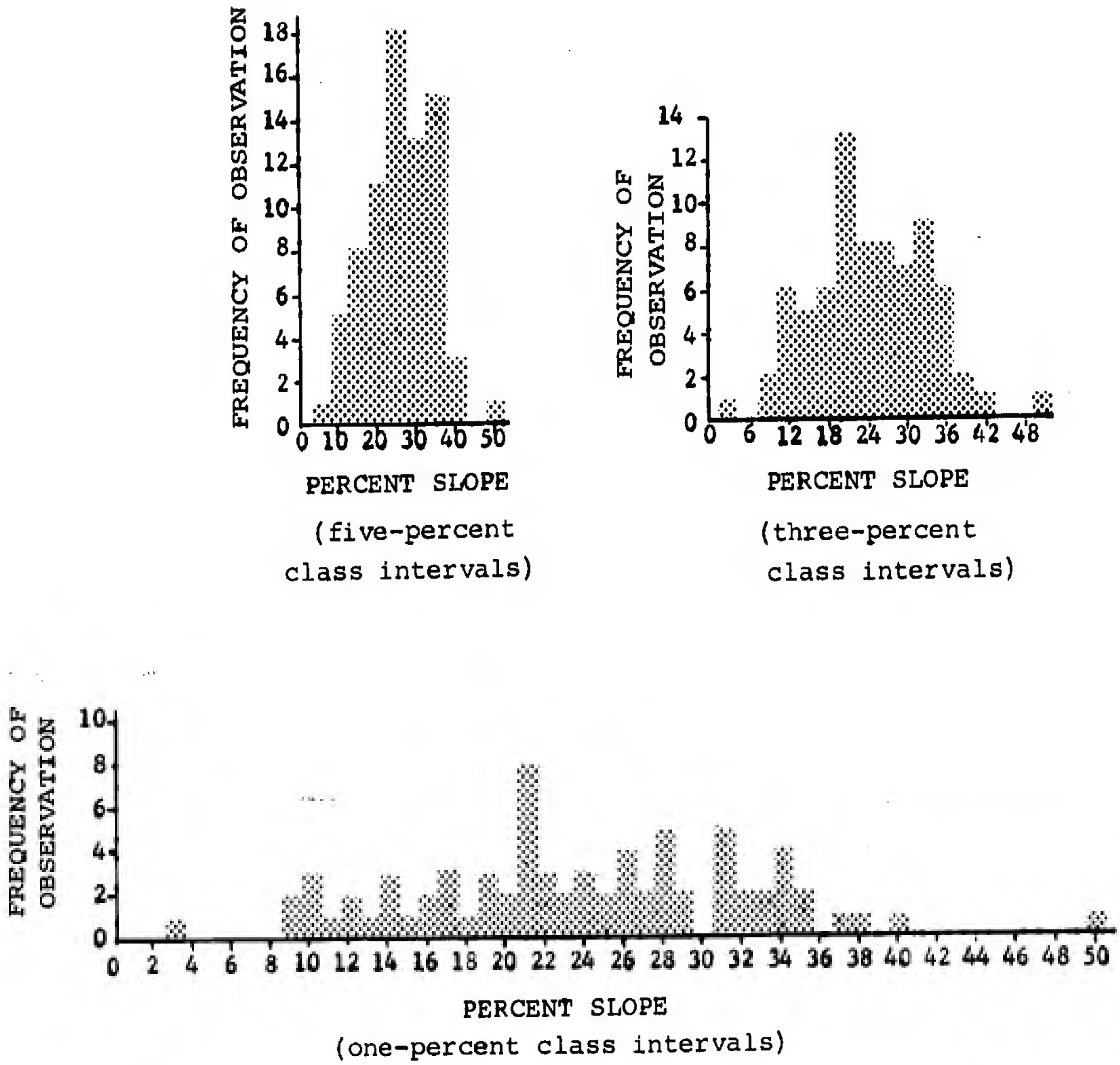


Fig. 10. Distribution of Categories of Slope Frequencies.

IV. CLIMATE AND WEATHER

The climate of Southeast Asia may be described as tropical and monsoonal. The temperatures are constantly warm and their variation from season to season is small by midlatitude standards. The annual alternation of the monsoon winds produces in most places a wet season and a dry season and a relatively large amount of annual precipitation. The rainfall in its quantitative and distributional aspects is the most important fact which will affect military operations in the climatic environment.

The rains of the wet season produce soft and boggy lowlands, flooded river valleys, and slippery surfaces even on gentle slopes. Together with inadequate and indifferent roads and lack of bridges, these conditions will strictly limit the operation of heavy equipment.

Climatic Controls

The climatic character of any part or any place in the coastal strip may be explained in the combinations of the following three factors: latitude, altitude, and exposure to wind and nature of local topography. The functions of each of these are briefly described as preliminary to the general climatic description.

Latitude. The position of a place in latitude determines in a broad way its temperature. All of the Southeast Asian coasts lie between the equator and the Tropic of Cancer in the zone where there are few cool and no cold monthly temperatures and seasonal variation of about five to twenty degrees between the warmest and the coolest months.

Altitude. Temperatures decline roughly three degrees per 1000 ft increase in altitude. In coastal Southeast Asia about 45% of the area is low plain and 55% is hilly, the highest elevations of which are around 5,000 ft. Comparison of the temperatures in degrees of the following two stations within about 50 miles of each other will illustrate the altitude factor.

	J	F	M	A	M	J	J	A	S	O	N	D	Yr.
Nahtrang Alt 20 ft	75	76	78	81	83	83	83	84	82	80	78	66	80
Dalat Alt 4921 ft	62	63	65	67	68	68	67	67	66	65	64	61	65

Exposure to Winds. All of Southeast Asia lies under the regimen of the monsoonal system which in combination with local topography is the principal factor in the amount and distribution of rainfall. The monsoons alternate their directions with the seasons. In summer they blow into Asia from the south and southwest and in winter blow out of Asia from the north and east as illustrated on Maps 11 and 12. The southwest winds bring heavy summer rainfall to the coasts that face their directions. The northeast monsoons are dry winds except where they pass over the South China Sea and bring rain to east-facing coasts. As a generalization the rainfall regimens may be expressed thus:

For west-facing coasts, summer rains and winter droughts; for east facing coasts, winter rains and summer droughts; for peninsular extremities affected by the monsoons of both seasons, double-maximum patterns with peaks of precipitation in spring and autumn.

Climatic Elements

TEMPERATURE

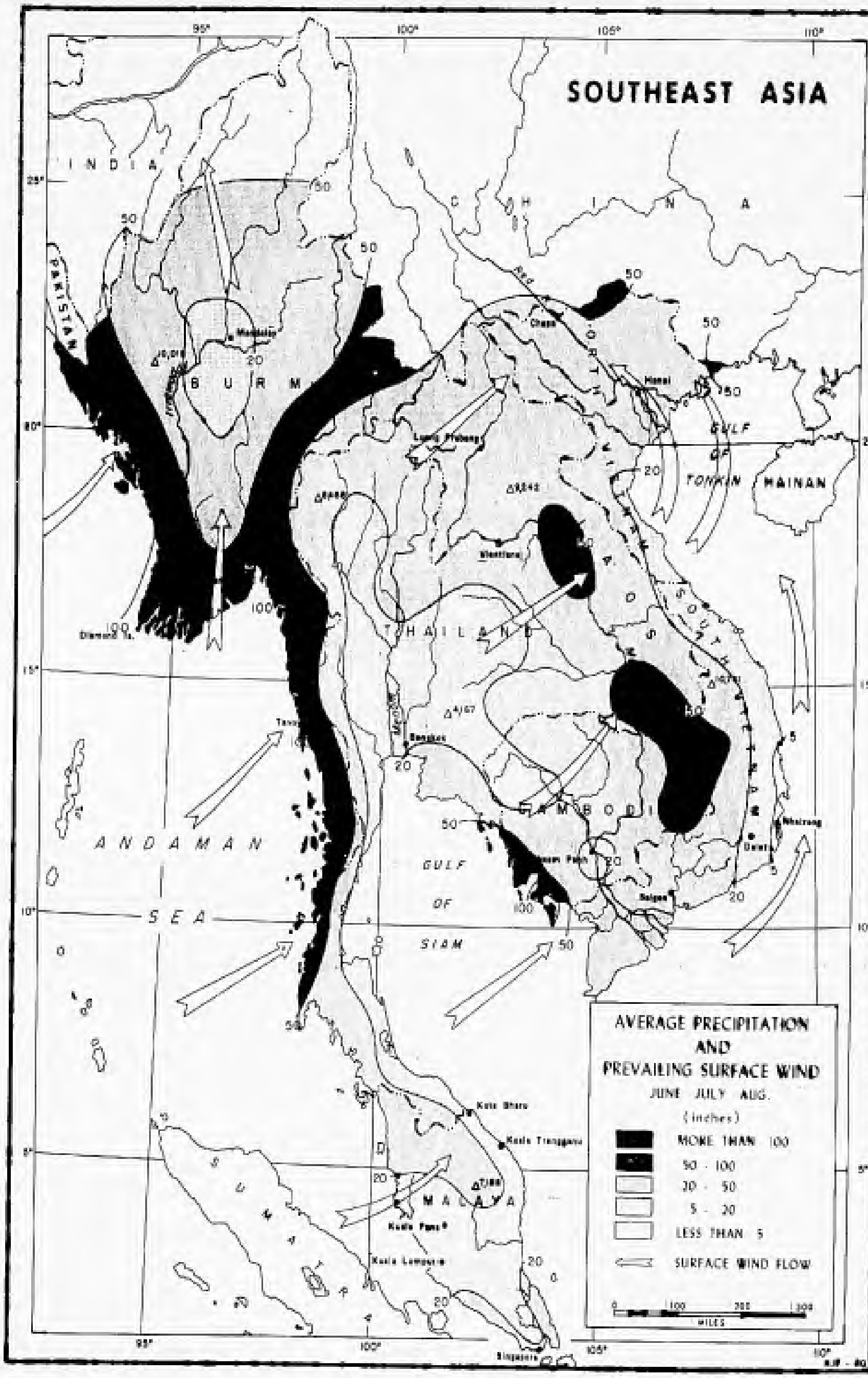
As the area lies wholly within the tropics, almost all weather stations except those of the highlands and the extreme northeast corner (Tonkin) show normal monthly mean temperature above 70°. The range of temperatures between the warmest and the coldest months is low by midlatitude standards, varying from about two degrees at Singapore near the equator to 22° at Hanoi near the Chinese border in North VietNam. The maximum temperatures lie some 10° to 15° above the means and vary within a range of approximately 10°. The mean maximum temperatures (see monthly analysis charts) range from the low 80's to the mid 90's with the seasons and the extreme maxima from the 90's to slightly above 100° (Fig. 11).

Temperature Regimens. Four types of temperature regimens may be recognized in the area. These are:

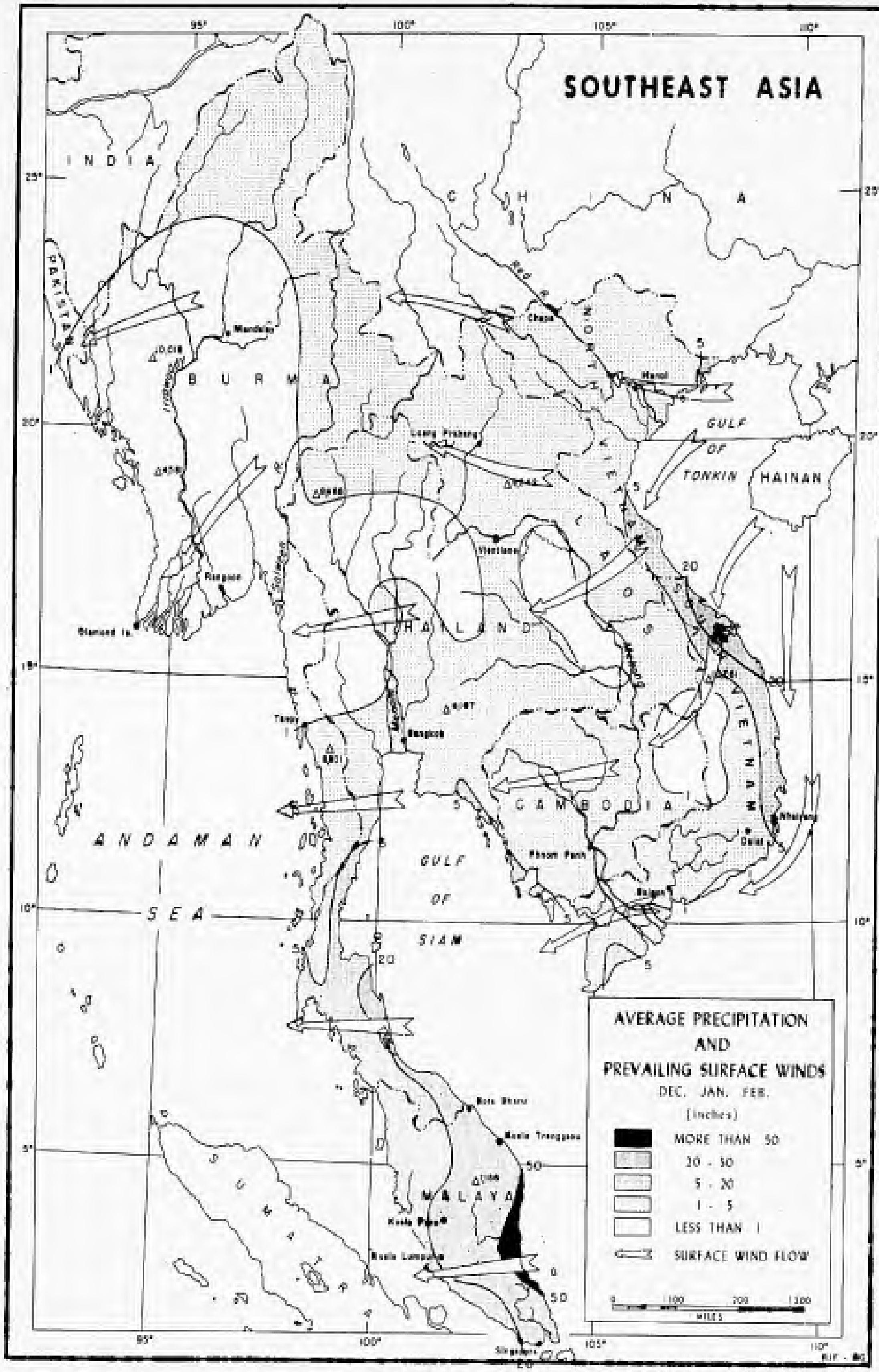
1. Low range-high average temperatures. These occur in the equatorial and subequatorial stations protected from or outside of the full monsoonal alternation. Monthly temperatures are high, above and below 80°, with a low annual range of less than ten degrees. Such a regimen occurs around Singapore and the Malacca Straits area and around Saigon.

2. Summer maximum temperatures, warm. This is the normal pattern for the coastal lowlands. Low month temperatures in the 70's: high month temperatures in the 80's.

3. Highland regimen. This corresponds with the usual summer maximum warm type except that the temperatures for all months are lowered as a function



Map 11. Average Precipitation and Prevailing Surface Winds During June, July, and August. From: "An Environmental Comparison of Southeast Asia and the Island of Hawaii," by J. V. Chambers. QMR&E Command Research Study RER-38 (1961).



Map 12. Average Precipitation and Prevailing Surface Winds During December, January, and February. From: "An Environmental Comparison of Southeast Asia and the Island of Hawaii," by J. V. Chambers. QMR&E Command Research Study RER-38 (1961).

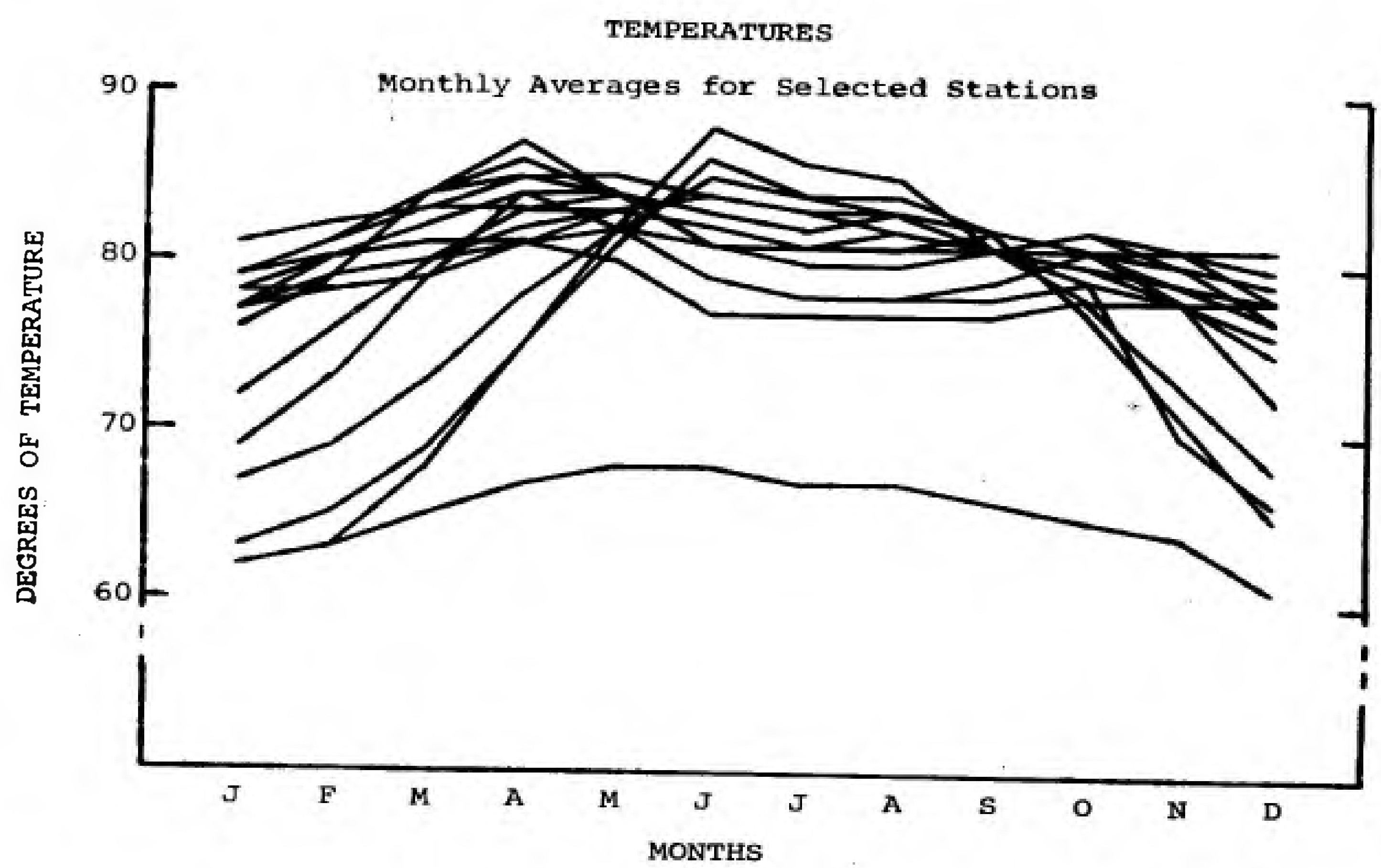


Fig. 11. Temperature Graphs.

of elevation. The figures given above for Nahtrang and Dalat will serve as an example.

4. The Tonkin regimen. The northeastern extremity of the Project Area differs in temperature characteristics from the other types because of its higher latitude as well as the effects of winter weather conditions on the Chinese mainland. The Tonkin area has the coldest winter months, in the low 60's; the highest annual ranges of temperature, up to 22°; and the greatest diurnal ranges, with variation as much as 30° in a winter day.

Significance of Temperature Regimens. By themselves the temperatures and their regimens are not of critical importance in military operations. Few of the monthly average temperature-humidity combinations at various hours (see the sheets of monthly analysis) lie near the Envinal thermal strain value of 30 at which performances deteriorate. It is probable that individual days produce more severe strain conditions but it is doubtful if these would persist very long.

PRECIPITATION

Precipitation occurs almost entirely in the form of rain. Snow is absent except for some of the highest elevations in the northeast; hail and fog, while present are not common and furnish a negligible amount of the total precipitation.

Rainfall is derived from the streams of oceanic air which constitute the monsoonal flow. It occurs in greatest amounts at times when the boundaries of the opposing airflows of the monsoonal system pass over coasts where highland margins induce a lift of the humid air. The most intense rains occur, therefore, at the "break" of the wet monsoon along the mountain-flanked coast of northern Burma where they produce the accentuated rainy maximum described in Type II regimen.

Rainfall Intensity in a Single Day. From statistics of indifferent reliability, individual 24 hr periods on the northern Burma coast seem to receive up to 30 in. of rain during the June or July break of the monsoons. Cherrapunji, to the north in India, has an official record of 40.79 in. in 24 hr. From a study of Malayan rainfall between 1931 and 1940, the maximum precipitation for any day in most of the 47 stations was between two and eight inches. The greatest falls recorded during this study period were:

Pekan	19.18 in.
Penang	14.29 in.
Kuala Krai	12.15 in.
Port Dickson	12.72 in.
Kuantan	11.05 in.

The absolute maximum daily rainfall reported for the fourteen "N" type stations appears on Tables 12 a to 12 1. Over a period of ten years in almost all cases, the occurence of very high daily rainfall, for the approximately 1680 (14 x 12 x 10) observed months was

19 in.	2 months
13 in.	1 month
12 in.	2 months
11 in.	2 months
10 in.	4 months
9 in.	3 months
8 in.	1 month

A total of 15 months out of 1680 recorded have received the very heavy rainfall of 8 in. or more in a 24-hr period.

Diurnal Distribution of Rainfall. It is a generalization that precipitation over land is more frequent in the afternoon and over seas in the early morning. This is somewhat modified for coastal stations which may be affected by the seaward rainfall.

The graphs on Fig. 12 are taken from a manuscript study of diurnal variation of precipitation in Malaya. They are made by plotting the hours of day against the percentage of days of the month in which rain falls during the hour. For the inland station, Temerloh, the generalization of afternoon rains is apparent. For the coastal stations the pattern is complicated by exposure. Westfacing coasts (Sitiawan), exposed to the southwest monsoon have a preponderance of rain in the afternoon during the dry season. During the rainy season the daily distribution is more even. On east-facing coasts with rainfall maxima in fall and early winter, (Kota Bharu) the "inter-monsoon" months, February-April, show fairly even daily distribution; during the summer monsoon, which brings little rain to such-located stations, the afternoon maxima appear; during the rainy months mid-October to January, there are no very rainless hours of the day.

Rainfall Regimens. For the purposes of analysis, records of rainfall were obtained for some available stations. The data are not strictly comparable in the sense of covering similar periods and some are from very old sources. They do however serve the purpose of establishing patterns of rainfall for the area (Map 13).

Five precipitation regimens can be recognized, one in the hill country and four on the coastal lowlands. Each of the lowland regimens appears in two separate places to form precipitations regions shown on Map 14.

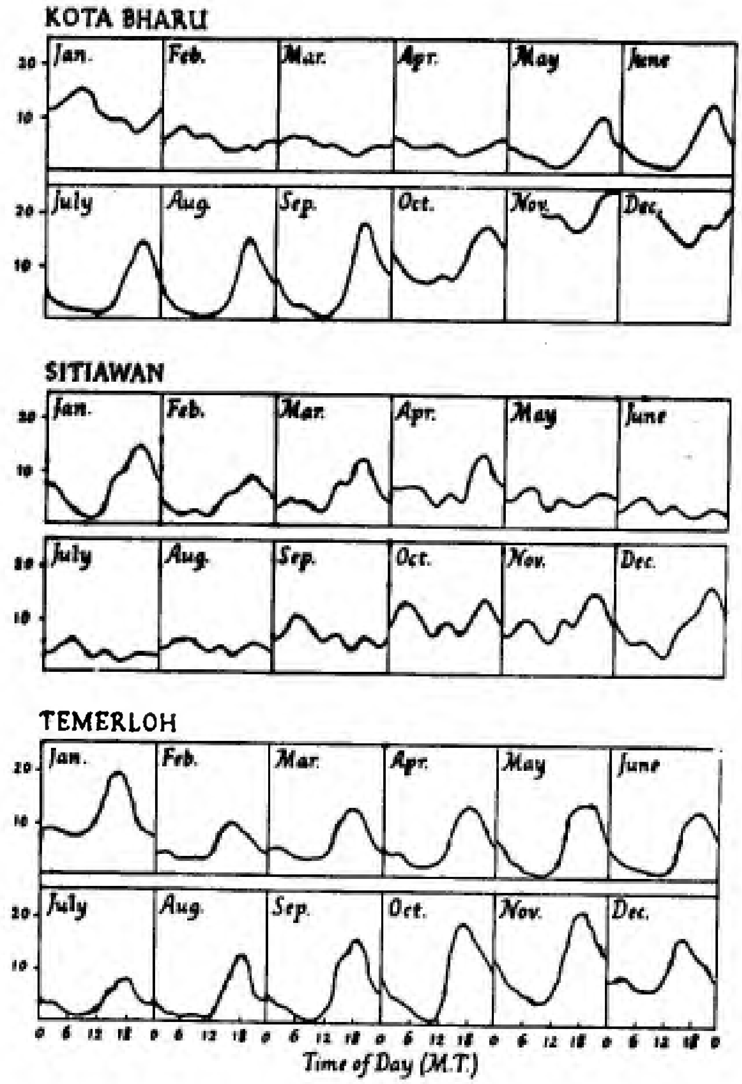
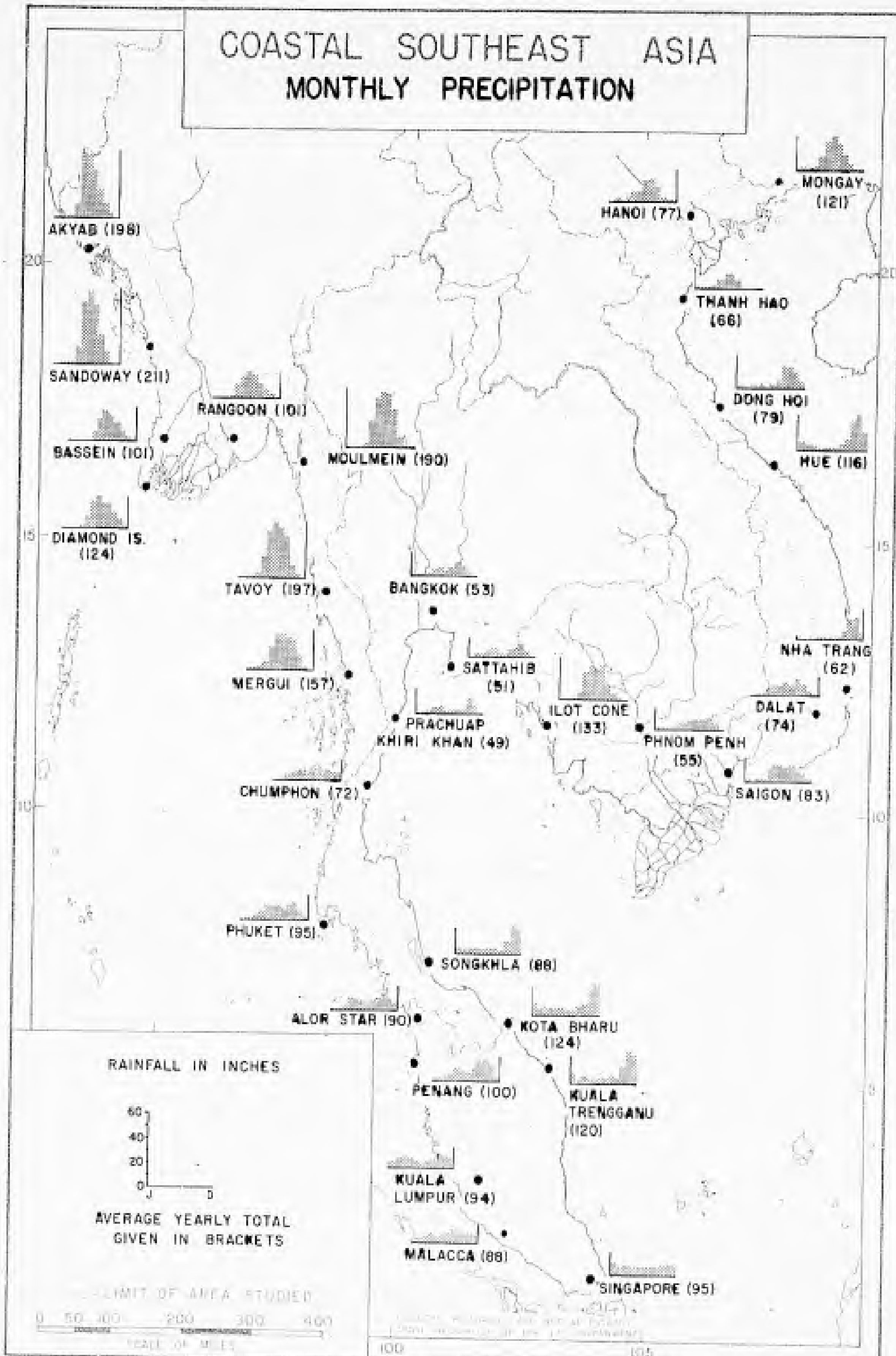


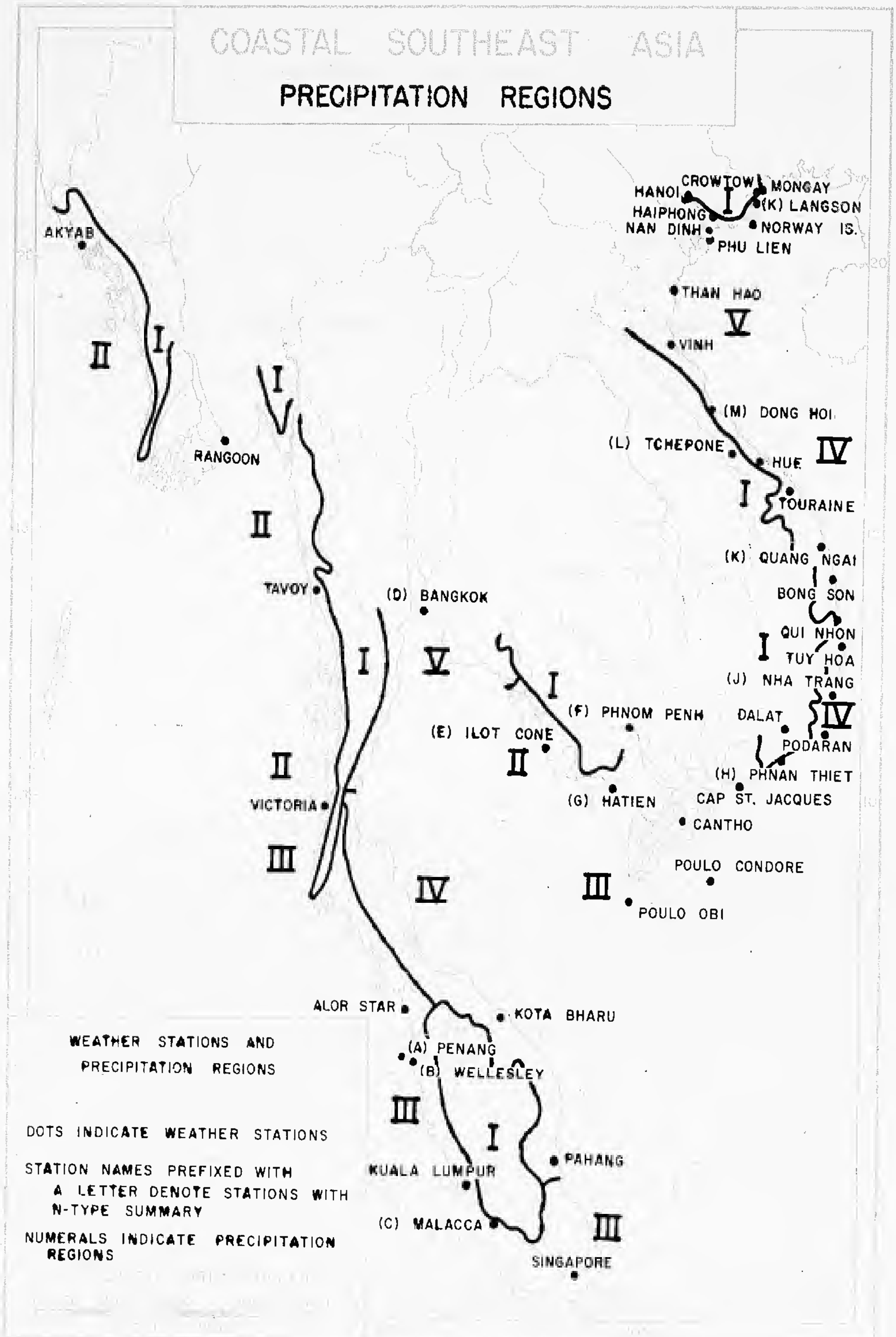
Fig. 12. Diurnal Distribution of Precipitation in Malaya. After Lea, C. A. "Diurnal Variation in Rainfall Over Malaya" (unpublished), cited in Watts, L.E.M., Equatorial Weather, University of London Press, 1955.

Type I. Hill Country, Summer Rain-Winter Drought

Only a few stations are available within the relatively narrow zone of hill country included in the project area but these do not seem to differ significantly in their precipitation regimens from other upland stations more distant from the coast. The hill stations present a remarkably uniform regimen of rainy summer months (April-May to September-October) and dry winter months (November-March). This pattern is a result of the seasonal alternation of a summer air flow of warm, moist, maritime air with a winter flow of cooler,



Map 13. Monthly Precipitation.



Map 14. Precipitation Regions and Weather Stations

more dry, air of continental origin; a circulation uncomplicated by facts of coastal exposure. The differences between lowland and upland precipitation regimens may be illustrated by again citing the two stations, Nahtrang and Dalat, in South VietNam of about the same latitude and within 50 miles of each other:

	J	F	M	A	M	J	J	A	S	O	N	D	Yr
Nahtrang Alt 20 ft	2.3	0.9	1.7	0.9	2.6	1.8	1.8	2.0	6.7	13.4	15.1	7.4	56.6
Dalat Alt 4921 ft	0.4	1.0	2.2	6.5	8.5	7.3	9.6	8.3	12.1	10.0	3.9	1.1	71.0

Significance. Traffic through the hill country is difficult at any season and off-road movement is probably impossible during the wet season. In places where the lowland precipitation regimens correspond in season with those of the adjoining Hill Country regimen, the winter months from November to April are best for operations. However where there is a discordance of season, such as along the South China Sea Coast (from which the two examples above are taken) the common dry months for uplands and lowlands are only those from January to March.

The Lowland Precipitation Regimens which occur along the coasts from Pakistan around to China are differentiated by the factors of exposure and latitude into four patterns:

1. Accentuated Summer Maximum with Dry Winters (Type II).
2. Normal Summer Maximum (Type III).
3. Accentuated Autumn and Early Winter Maximum (Type IV).
4. Double Maximum, Transition Type (Type V).

Each of these types is distributed in terms of exposure and protection and each occurs in two separate areas within the strip of the coastal lowlands.

Type II. Accentuated Summer Maximum with Dry Winters

From November to April the rainfall is relatively light, the monthly mean varying from less than one inch to less than five. With the onset of the southwest monsoon the monthly precipitation increased sharply to the wettest month (June or July) which receives from twenty-five to fifty or more inches. The total yearly precipitation is usually in excess of 100 in., half or more of which is concentrated in the months of June, July, and August.

Distribution. The type is located on unprotected west-facing coasts with hilly backgrounds in two areas:

a. The Burma-Thailand West Coast from the Pakistan border to 8° north latitude. This coast is open to the full force of the summer monsoon which begins in May and the wettest months, June or July, may receive as much as 60 in. of rain. The winter months are very dry; in the northern three-quarters of this coastal strip, the three winter months, December, January, and February together receive less than one inch of rain.

b. Thailand and Cambodia Coast, facing west on the Gulf of Siam from the eastern point of the Bight of Bangkok (Cape Liant) to Isle de Phu Quoc (10° north latitude). In this area the rainy summer months receive somewhat less precipitation, 30 to 40 in., and the dry winter months somewhat more than those of the Burma coast.

Significance. In this type the occurence of three or more months in which 30 to 60 in. of rain fall on coastal lowlands with indifferent drainage suggests that military operations would be difficult during this period.

Type III. Normal Summer Maximum

The precipitation regimen in these two areas resembles that of the Hill Country (Type I). From November to March the dry season months receive rainfall of only a few inches. During the wet summer months, June, July, and August, some 40 to 50 in. will be received, which amount represents about one-half of the total annual. These areas lack the accentuation occurring in the rainy months of Type I; the winter months although much drier than those of the summer, are rainy when compared to the nearly absolute drought of those in Type I.

Distribution. This type occurs in situations protected from the direct force of both the southwest and the northeast monsoons. Two such protected areas are located along the coastal zone:

a. The shores of the Bight of Bangkok and extending southward along the west coast of the Gulf of Siam to about the Kra Isthmus (10° north latitude). The winter months are relatively warm and dry, the summers are hot and wet.

b. Coasts of the Tonkin Delta in the Gulf of Tonkin and the adjoining coastal lowland south to about 19° north latitude. This area is protected by the configuration of the Gulf of Tonkin and Hai-Nan Island. Because of its proximity to the Asiatic mainland as well as its latitude, the winters are quite cool, in the low 60's, and the seasonal ranges (22° at Hanoi) are highest of any part of the coastal strip. Winter precipitation to the amount of one or two inches per month occurs in the form of drizzles, called "crachin," possibly caused by mainland cyclonic passages.

Significance. The absence of an accentuated maximum of precipitation make the summer period somewhat more acceptable for operations. Winters in the Tonkin lowland would be less favorable than those in the Bangkok area because of lower temperatures and poorer visability.

Type IV. Accentuated Autumn and Early Winter Maximum

This type is marked by an accentuated rainy period occurring from September to December with the remainder of the year receiving only light rainfall in the magnitude of three or four inches per month. This regimen is the result of exposure of east-facing coasts to the force of the northeast monsoon after it has passed across the waters of the South China Sea. The total rainfall is considerably less than that in the accentuated summer maximum type (Type II).

Distribution. This type occurs in two places where east-facing coasts with hilly backgrounds are exposed to the force of the northeast monsoon.

a. Malaya and Thailand east coast, unsheltered by Indo-China extending south from the Kra Isthmus (10° north latitude) to the lowlands around Singapore. With the onset of northeast monsoon in November and lasting through December the coast and a strip extending inland for about 30 miles receive heavy rains in the amount of 20 to 25 in. per month. From February through September the monthly means are below eight inches.

b. The VietNam east Coast extending from about Cape Padaran (10° north latitude) northward to the Tonkin Delta (19° north latitude) where the coast comes under the shelter of Hai-Nan Island. The rainfall pattern is similar to that of eastern Malaya with heavy rain from September through December and dry months of 3 to 6 in. from February through August.

Significance. This distribution while it covers considerable latitude is confined to the coastal lowlands; the hill country which lies behind these distributions has the regular summer rain pattern. For the east-facing coasts, lowlands and hills together, the only common dry period is from January to March.

Type V. Double Maximum, Transitional Type

This is characterized by a double maximum of precipitation in spring and autumn, April-May and September-October respectively. The summer maximum and Type II is replaced by somewhat drier months which receive from 5 to 10 in. of rainfall per month. The type is transitional both in character and distribution between the two accentuated maximum types (II and IV).

Distribution. The two occurrences within the coastal strip are somewhat different in their characteristics.

a. Malacca Straits Coast from about 8° north latitude to and including the lowland at the Southern extremity of the Malay Peninsula around Singapore. This area is protected from the southwest monsoons by Sumatra and from the effects of the northeast winds by the hilly country of southern Malaya. The summer maximum of the accentuated type II is replaced by a drier period leaving the spring and fall rainfall to form two maxima. The wettest months of these periods have less than 15 in. and the drier summer months have considerable rain, 10 in. or so. The November to March period shows the characteristic monsoonal dry months of one to four inches. In the vicinity of Singapore the protection of the hill country is lost but in this equatorial latitude the force of the monsoon is somewhat attenuated and the pattern of precipitation smooths out to a fairly constant monthly mean.

b. The Saigon Area in the lowland extremity at the south of the Indo-China land mass from about Isle de Phu Quoc (10° north latitude) on the western side to Cape Padaran (11° north latitude) on the eastern coast. This is an area of heavy summer rain with a drier but not very dry period in July and August. The resulting pattern shows double maxima with that in the autumn and early winter being the most pronounced. From December to April the months are quite dry.

Significance. The absence of accentuated maxima in either summer or fall is probably of small significance because all of the summer is wet. The best operating period is during the dry winter months from December through March.

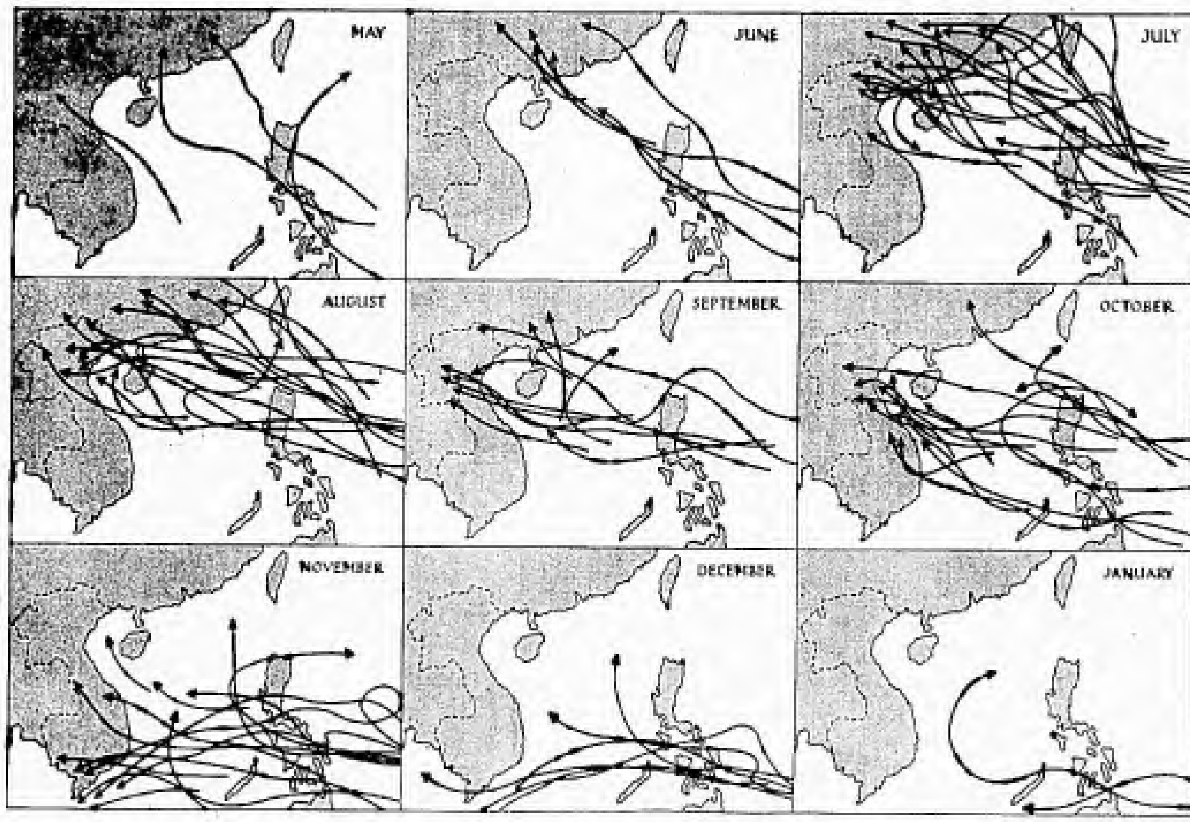
Storms

Thunderstorms are much more common in the tropics than in the midlatitudes. In inland areas they occur mainly in the afternoon, along the coast this afternoon maximum is supplemented by morning occurrences from offshore conditions. Thunderstorms not only bring heavy local rains but are also of importance to air operations because of the up and down drafts in their convections.

Typhoons. Typhoons are circulations of winds around intense low pressure spots. Their high winds, 70 miles per hour or faster, cause destruction to installations and the waves they generate make landing operations impossible and sweep sea water far inland over lowlands. Typhoons form over tropical oceans north of 10° latitude and move slowly, 10 to 15 miles per hour, toward the west. They curve to the north and northeast and lose their force on entering the midlatitudes.

In the Bay of Bengal an average of 13 such storms per year are formed. These occur about one each month from May to July with two in August. Few occur from January through March. In April-May and November-December the storms pass onto the coast north of Rangoon. During other months and south of Rangoon, the typhoon menace is slight.

About 20 typhoons are generated each year in the South China Sea and approximately half of these affect the east-facing coast of Indo-China. They are most common from July to October and negligible from January to April. Figure 13 shows the typhoon tracks in this area during the years 1911-1929.



Source: E. Bruzon and P. Carton, *Le Climat de l'Indochine et les Typhons de la Mer de Chine*, following p. 274 (Hanoi, 1930).

Fig. 13. Typhoon Tracks in Indo-China and the South China Sea. From: Indo-China, Geographical Handbook Series, B.R. 510, Naval Intelligence Division, London.

Monthly Analysis of Weather Stations

For 41 weather station records, selected values have been abstracted and set down on monthly tables (Table 12). For 14 of the stations "N" type summaries were available at the National Weather Records Center, Ashville, N. C. These are designated by letters, A through N and their distribution is shown on Map 14. Selected items fro these 14 stations are displayed graphically on Figs. 14 through 27.

The data on the monthly charts present:

1. The average number of dry days and dry spells of various duration for the month.

2. The average number of wet days in three categories, the absolute maximum of rain during a single day in the record period, and average number of wet spells of varying durations.

3. The mean, mean maximum, and mean minimum rainfall for the month.

4. The mean maximum and extreme maximum temperatures for the month and the average number of cool, warm and hot days.

5. The average relative humidity and temperature at two times during the day.

6. The average number of days suitable for contact flying at two times during the day.

The values used in the items are defined as:

Location: Taken from maps. It should be noted that there are few upland stations for which detailed data are available.

Period of Record. As stated on the source material.

Dry Days and Rainy Days. Dry days are those without trace of precipitation. Rainy days are those with a trace or more.

Dry Spells and Rainy Spells are derived from the number of occurrences during the record period divided by the number of years of the record. It should be noted that these are average occurrences (not days) for the month over the record period.

Light, Heavy, and Very Heavy Rainy Days are the mean number for the month over the period of the record.

Cool, Warm, and Hot Days are daily averages for the months of the record period.

Days Suitable for Contact Flight (at various hours) defined as: Ceiling must be equal to or greater than 1000 feet with visibility equal to or greater than 2-1/2 miles.

TABLE 12

SELECTED WEATHER ELEMENTS FOR WEATHER STATIONS

(January—December)

MONTH: JANUARY

STATION	LOCATION	YEARS RECORD	DRY DAYS	SHORT DRY SPELLS 1-3 DAYS	LONG DRY SPELLS 4 DAYS	RAINY DAYS	SHORT RAINY SPELLS 1-3 DAYS	LONG RAINY SPELLS 4 DAYS	LIGHT RAINY DAYS TRACE TO 0.49"	HEAVY RAINY DAYS .50 to 1.99"	VERY HEAVY RAINY DAYS OVER 2.00"	ABSOLUTE MAXIMUM OVER RECORD PERIOD	MEAN RAINFALL FOR MONTH	GREATEST MONTHLY RAINFALL	LEAST MONTHLY RAINFALL	MEAN MAXIMUM TEMPERATURE	EXTREME MAXIMUM TEMPERATURE	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 0600 HRS	MONTHLY AVERAGE: TEMPERATURE AT 0600 HRS	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 1300 HRS	MONTHLY AVERAGE: TEMPERATURE AT 1300 HRS	COOL DAYS UNDER 70° F	WARM DAYS 70-90° F	HOT DAYS OVER 90° F	DAYS SUITABLE FOR CONTACT FLIGHT AT 0600	DAYS SUITABLE FOR CONTACT FLIGHT AT 1300
AKYAB	COASTAL															82	92	79.6	67.0[4]	70.4	73.3[5]	-	30.4	0.6	31.8[2]	31.0[3]
	10 MILES																									
RANGOON	INLAND															88	93	72.4	72.4[4]	53.4	83.0[5]	-	13.5	17.5	30.5[2]	30.3[3]
TAVOY	COASTAL																									
VICTORIA	COASTAL															87	96	72.4	79.5[4]	72.1	79.9[5]	-	28.6	2.4	30.2[2]	30.1[3]
ALOR STAR	COASTAL															90	96	92.9	72.4	57.7	87.9	-	11.3	19.7	30.7[1]	31.0
PENANG (A)*	COASTAL	10	24.1	3.0	0.4	6.9	1.7	2.2	5.4	1.3	0.2	2.70	2.68	6.15	0.92	90	94	76.0	81.0[2]	64.3	87.4[6]	-	12.7	18.3		
WELLESLEY (B)	COASTAL	10	20.9	4.2	0.5	10.1	2.6	1.8	6.1	3.2	0.8	3.50	6.02	17.81	1.8	92	97	73.9	81.6[2]	63.2	88.2[6]	-	6.5	24.5		
	25 MILES																									
KUALA LUMPUR	INLAND															89	96	96.4	73.2	59.8	87.1	-	12.7	18.3	23.1[1]	30.3
MALACCA (C)	COASTAL	10	22.9	4.0	.4	8.1	1.9	2.5	5.9	2.0	0.2	2.20	3.38	5.37	0.86	88	93	90.7	74.2	66.8	84.4	-	18.5	12.5	31.0[1]	28.3
SINGAPORE	COASTAL															86	92	94.3	75.1	71.7	83.7	-	26.2	4.8	29.7[1]	30.3
KUALA PAHANG	COASTAL																									
KOTA BHARU	COASTAL															84	87	91.7	74.9	72.6	82.4	-	31.0	-	28.3[1]	29.3
	20 MILES																									
BANGKOK (D)	INLAND	5	29.0	.6	-	2.0	-	.8	1.7	0.4	-	0.84	0.36	1.35	Trace	90	98	90.7	69.3	51.3	88.7				-	-
ILOT-CONE (E)	COASTAL	2	31.0	-	-	-	-	-	-	-	-	-	0.00	0.00	0.00	-	-	86.6	72.3	60.6	84.4				27.8	31.0
	60 MILES																									
PHNOM PENH (F)	INLAND	10	27.2	.1	.8	3.8	1.1	-	3.7	0.1		0.71	0.33	1.14	0.00	86	93	86.7	71.2	52.0	85.7				29.2	30.9
HA TIEN (G)	COASTAL	10	29.7	.2	7	1.3	1.3	-	1.1	0.2	-	1.62	0.39	2.09	0.00	-	-	91.0	72.0	66.7	83.2				30.6	30.7
POULO OBI	ISLAND																	93.2	71.7	82.5	76.8				27.9	30.5
POULO CONDORE	ISLAND																	84.9	74.5	76.2	78.9				28.8	29.6
	50 MILES																									
CAN THO	INLAND	10	27.2	.4	1.3	3.8	2.1	-	3.6	0.2	-	1.89	0.66	2.15	0.02	-	-	88.4	73.6	58.8	86.7				26.3	31.0
CAP ST JACQUES	COASTAL	10	28.5	.3	-	2.5	.8	-	2.5	-	-	0.42	0.10	0.45	0.00	82	91	87.3	72.2	70.1	80.4				30.4	31.0
	30 MILES																									
SAIGON	INLAND	9+	25.4	-	-	5.6	-	-	5.4	0.2	-	0.95	0.39	1.03	0.00	89	98	92.7	70.9	51.5	85.9				16.8	29.3
PHAN THIET (H)	COASTAL	5	29.5	1.2	.4	1.5	1.6	-	1.5	-	-	0.20	0.10	0.57	0.00	-	-	91.3	69.6	62.8	82.9				25.9	31.0
PADARAN	COASTAL	10	26.1	.2	1.5	4.9	1.7	.1	4.5	0.4	-	0.94	0.58	1.38	0.13	77	88	82.1	71.4	73.7	77.7				30.6	30.8
	50 MILES																									
DALAT (I)	INLAND	9+	25.6	.2	1.5	5.4	1.5	.1	5.3	0.1	-	0.56	0.40	1.58	0.00	75	85	88.4	54.4	46.6	73.1				23.1	31.0
NHA TRANG (J)	COASTAL	10	16.8	2.1	1.7	14.2	2.8	.9	12.8	1.1	0.2	3.02	2.54	5.42	0.21	82	89	89.1	69.8	64.4	81.1				29.5	30.2
TUY HOA	COASTAL																	90.9	70.7	72.6	77.0				27.5	28.2
QUI NHON	COASTAL	10	12.2	3.3	1.7	18.8	3.7	1.1	18.1	0.7		1.10	1.83	2.65	0.56	78	91	88.5	70.3	72.4	77.7				27.9	30.2
BONG SON	COASTAL																	90.4	67.9	60.5	78.1				21.1	30.4
QUANG NGAI (K)	COASTAL	10	17.6	2.6	1.5	13.4	3.0	1.2	10.0	2.9	0.5	2.92	5.74	10.12	2.42	78	91	94.8	67.3	74.3	76.6				17.4	27.4
TOURANE	COASTAL																	92.5	67.4	73.9	74.7				25.8	28.4
HUE	COASTAL																	95.5	65.2	81.7	73.2				21.0	28.2
	50 MILES																									
TCHEPONE (L)	INLAND	10	29.1	-	.2	1.9	.2	-	0.1	0.1	-	1.67	0.17	1.67	0.00	-	-	92.5	59.4	-	76.4				26.4	29.5
DONG HOI (M)	COASTAL	10	15.2	1.5	1.9	15.8	3.4	1.2	14.1	1.7	-	1.95	2.90	3.86	1.52	72	94	89.8	65.5	69.4	72.8	8.9	22.0	-	18.1	26.9
VINH	COASTAL	10	14.8	2.1	2.5	16.2	3.2	1.2	15.3	0.9	-	1.61	2.09	4.09	1.06	71	95	95.4	62.8	74.7	69.0				9.0	22.9
THANH HAO	COASTAL	10	17.7	1.7	1.5	13.3	2.0	1.2	12.7	0.6	-	1.50	1.49	5.61	0.00	71	91	93.1	61.5	72.9	68.0				13.9	24.6
	20 MILES																									
NAMDINH	INLAND															73	88	83.6	63.2	67.4	70.3	11.3	19.6	-	7.4[1]	18.4
PHU LIEN	COASTAL	10	13.2	2.5	1.6	17.8	3.4	.8	16.9	0.9	-	1.77	1.53	3.38	0.20	-	-	88.8	60.2	72.5	67.5				20.0	26.7
NORWAY IS.	ISLAND															66	72	85.7	62.5	70.7	65.6	13.3	17.7		27.3[1]	29.1
LANGSON (N)	COASTAL	10	19.0	1.6	1.6	12.0	3.0	.4	11.5	0.5	-	0.83	1.09	2.01	0.00	65	89	81.3	57.2	59.6	68.9	13.8	17.2	-	18.0	23.2
HAIPHONG	COASTAL															70	84	85.0	61.6	67.8	68.2	13.0	18.0	-	22.6[1]	28.4
	50 MILES																									
HANOI	INLAND	10	18.3	-	-	12.7	-	-	12.5	0.2	-	1.00	0.81	1.96	0.00	69	92	92.5	59.6	69.0	67.5	10.3	20.6	-	13.9	26.3
GONTON	COASTAL																	83.2	62.0	71.4	65.8				16.5[1]	24.8
MONCAY	COASTAL	10	18.9	1.8	1.8	12.1	2.1	1.3	11.2	0.9	-	1.14	1.92	3.0	0.27	68	82	79.1	61.0	68.4	67.6	-	31.0	-	23.7	28.5

*Letters indicate stations with complete records.

1 --- 700 HR

2 --- 900 HR

3 --- 1800 HR

4 --- 300 HR

5 --- 1200 HR

6 --- 1500 HR

TABLE 12 (Continued)

STATION	LOCATION	YEARS RECORD	DRY DAYS	SHORT DRY SPELLS 1-3 DAYS	LONG DRY SPELLS 4 DAYS	RAINY DAYS	SHORT RAINY SPELLS 1-3 DAYS	LONG RAINY SPELLS 4 DAYS	LIGHT RAINY DAYS TRACE TO 0.49"	HEAVY RAINY DAYS .50 to 1.99"	VERY HEAVY RAINY DAYS OVER 2.00"	ABSOLUTE MAXIMUM OVER RECORD PERIOD	MEAN RAINFALL FOR MONTH	GREATEST MONTHLY RAINFALL	LEAST MONTHLY RAINFALL	MEAN MAXIMUM TEMPERATURE	EXTREME MAXIMUM TEMPERATURE	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 0600 HRS	MONTHLY AVERAGE: TEMPERATURE AT 0600 HRS	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 1300 HRS	MONTHLY AVERAGE: TEMPERATURE AT 1300 HRS	COOL DAYS UNDER 70° F	WARM DAYS 70-90° F	HOT DAYS OVER 90° F	DAYS SUITABLE FOR CONTACT FLIGHT AT 0600	DAYS SUITABLE FOR CONTACT FLIGHT AT 1300
AKYAB	COASTAL															84	89	79.9	69.7[4]	70.2	76.1[5]	-	28.0	-	26.4[2]	27.0[3]
RANGOON	30 MILES INLAND															93	98	71.9	74.9[4]	47.2	86.5[5]	-	2.2	25.8	25.2[2]	26.9[3]
TAVOY	COASTAL																									
VICTORIA	COASTAL															89	93	75.3	81.4[4]	69.9	83.1[5]	-	13.1	14.9	26.9[2]	28.0[3]
ALOR STAR	COASTAL															91	96	94.6	72.5[2]	56.0	89.1[6]	-	11.3	13.7	27.0[1]	28.0
PENANG (A)*	COASTAL	10	28.1	2.8	0.4	5.9	1.7	1.3	4.3	1.5	0.1	4.25	2.70	5.34	0.01	91	96	75.6	81.5[2]	62.1	88.6[6]	-	5.5	22.5		
WELLESLEY (B)	COASTAL	10	19.6	2.5	0.8	8.4	1.5	1.8	4.8	2.8	0.8	5.02	6.25	19.15	0.92	93	101	75.5	82.2[2]	61.3	89.1[6]	-	3.2	24.8		
KUALA LUMPUR	25 MILES INLAND															90	95	97.1	73.3	59.5	87.6	-	11.1	16.9	19.9[1]	28.0
MALACCA (C)	COASTAL	10	21.5	2.7	0.3	6.5	1.7	1.6	4.6	1.9	0.0	[illegible].98	3.00	8.53	0.74	89	94	93.1	74.1	69.3	84.2	-	15.3	12.7	27.7[1]	26.0
SINGAPORE	COASTAL															87	93	94.7	75.2	70.3	84.6	-	21.0	6.9	27.0[1]	27.3
KUALA PAHANG	COASTAL																									
KOTA BHARU	COASTAL															85	89	95.2	74.4	71.7	83.6	-	27.9	-	24.0[1]	27.3
BANGKOK (D)	20 MILES INLAND	5	23.4	2.0	0.2	4.6	.4	1.6	4.2	0.4	-	1.40	0.65	1.56	0.09	92	103	93.0	74.3	55.3	90.7				-	-
ILOT-CONE (E)	COASTAL	2	25.4	-	1.5	2.6	1.5	-	1.9	0.7	-	0.60	0.87	1.34	0.00	-	-	89.5	74.7	63.0	84.2				24.8	28.0
PHNOM PENH (F)	60 MILES INLAND	10	26.5	0.1	0.5	1.5	0.5	-	1.4	0.1	-	1.48	0.27	1.85	0.00	88	94	88.5	73.1	51.0	88.7				24.9	28.0
HA TIEN (G)	COASTAL	10	27.1	0.1	1.0	0.9	0.8	-	0.5	0.4	-	1.26	0.56	2.76	0.00	-	-	90.2	74.8	69.0	84.5				27.5	27.7
POULO OBI	ISLAND																	92.4	72.1	83.8	78.4				26.8	27.3
POULO CONDORE	ISLAND																	85.7	74.8	70.4	81.5				26.7	26.0
CAN THO	50 MILES INLAND	10	27.1	0.4	1.3	1.1	2.1	-	1.0	-	0.1	2.24	0.26	2.62	0.00	-	-	87.2	74.2	53.8	87.2				24.2	28.0
CAP ST JACQUES	COASTAL	10	27.0	0.3	1.1	1.0	0.1	0.3	1.0	-	-	0.08	0.01	0.08	0.00	83	93	86.0	74.0	72.7	80.7				27.9	27.6
SAIGON	30 MILES INLAND	9+	26.3			1.7			1.7	-	-	0.07	0.03	0.10	0.00	91	102	90.2	72.3	48.8	88.2				18.9	27.3
PHAN THIET (H)	COASTAL	5	26.7	0.6	0.6	1.3	1.4	-	1.3	-	-	0.21	0.09	0.56	0.00	-	-	87.9	69.6	63.5	82.3				22.3	28.0
PADARAN	COASTAL	10	26.6	0.6	-	1.4	0.8	-	1.4	-	-	0.18	0.07	0.24	0.00	80	91	80.7	72.5	73.4	79.2				27.4	27.6
DALAT (I)	50 MILES INLAND	9+	23.7	0.3	1.4	4.3	1.5	0.1	3.7	0.5	0.1	2.12	0.83	3.28	0.00	78	86	86.1	56.3	51.4	73.8				20.0	24.2
NHA TRANG (J)	COASTAL	10	18.8	0.6	2.1	9.2	2.3	0.1	8.7	0.5	-	1.24	0.80	2.03	0.05	84	91	90.1	77.9	66.4	82.3				27.8	28.0
TUY HOA	COASTAL																	91.2	71.1	68.9	79.2				25.6	27.4
QUI NHON	COASTAL	10	15.6	0.9	1.6	12.4	2.2	0.3	12.1	0.3	-	0.80	0.62	2.28	0.05	79	96	89.5	71.7	69.8	79.6				27.1	27.7
BONG SON	COASTAL																	91.0	68.4	59.9	79.2				21.1	27.5
QUANG NGAI (K)	COASTAL	10	21.0	1.3	1.9	7.0	2.9	0.4	5.9	0.9	0.2	3.57	1.97	7.35	0.26	80	92	95.8	68.3	71.7	79.8				16.8	27.3
TOURANE	COASTAL																	92.4	69.3	73.7	76.5				28.0	27.3
HUE	COASTAL																	95.4	66.7	79.9	74.7				31.0	24.9
TCHEPONE (L)	50 MILES INLAND	10	26.3	0.2	0.6	1.5	0.6	0.1	1.1	0.4	-	1.83	0.54	4.12	0.00	-	-	89.9	62.4	-	78.5				25.5	28.0
DONG HOI (M)	COASTAL	10	14.7	2.4	2.0	13.1	3.8	0.3	12.5	0.6	-	1.72	1.56	4.38	0.54	73	97	85.4	66.0	73.7	72.5	4.8	21.9	1.4	15.5	23.9
VINH	COASTAL	10	11.6	2.7	1.8	16.4	3.8	0.7	15.8	0.6	-	1.87	1.56	4.24	0.17	76	96	96.2	64.6	81.8	68.6				10.9	18.0
THANH HAO	COASTAL	10	10.1	2.1	2.0	17.9	3.8	1.1	17.2	0.7	-	1.27	1.72	4.11	0.33	70	96	94.3	63.1	79.6	67.5				11.5	21.6
SAMDINH	30 MILES INLAND															70	95	82.7	62.8	68.4	67.9	11.5	15.8	.7	7.0[1]	15.1
PHU LIEN	COASTAL	10	7.9	2.2	1.5	20.1	1.5	1.5	19.1	1.0	-	1.46	2.19	5.33	0.56	-	-	91.6	62.2	81.0	66.0				17.9[1]	22.1
NORWAY IS.	ISLAND															68	84	86.5	62.4	75.8	65.4	16.5	11.5	-	21.1[1]	20.0
LANGSON (N)	COASTAL	10	15.5	1.9	1.5	12.7	2.2	1.1	11.6	0.7	0.2	3.07	2.53	6.84	0.85	65	98	76.8	58.6	58.4	65.6	15.6	10.9	1.6	16.0[1]	19.2
HAIPHONG	COASTAL															71	91	84.3	63.1	65.0	68.0	11.0	15.8	1.2	20.6[1]	22.6
HANOI	50 MILES INLAND	10	11.9	-	-	16.1	-	-	15.1	1.0	-	1.00	.81	1.96	0.00	68	93	94.2	61.0	79.0	66.6	12.5	19.5		9.9	24.5
CONTON	COASTAL																	88.5	59.0	77.7	64.3				14.0[1]	21.0
MONCAY	COASTAL	10	14.6	1.8	1.8	13.4	2.1	1.3	11.6	1.4	0.4	3.46	3.40	6.54	0.91	66	83	82.2	59.4	67.1	66.9	14.0	14.5	1.0	18.7	25.5

MONTH

February

*Letters indicate stations with complete records.

1 --- 700 HR

2 --- 900 HR

3 --- 1800 HR

4 --- 300 HR

5 --- 1200 HR

6 --- 1500 HR

TABLE 12 (Continued)

STATION	LOCATION	YEARS RECORD	DRY DAYS	SHORT DRY SPELLS 1-3 DAYS	LONG DRY SPELLS 4 DAYS	RAINY DAYS	SHORT RAINY SPELLS 1-3 DAYS	LONG RAINY SPELLS 4 DAYS	LIGHT RAINY DAYS TRACE TO 0.49"	HEAVY RAINY DAYS .50 to 1.99"	VERY HEAVY RAINY DAYS OVER 2.00"	ABSOLUTE MAXIMUM OVER RECORD PERIOD	MEAN RAINFALL FOR MONTH	GREATEST MONTHLY RAINFALL	LEAST MONTHLY RAINFALL	MEAN MAXIMUM TEMPERATURE	EXTREME MAXIMUM TEMPERATURE	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 0600 HRS	MONTHLY AVERAGE: TEMPERATURE AT 0600 HRS	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 1300 HRS	MONTHLY AVERAGE: TEMPERATURE AT 1300 HRS	COOL DAYS UNDER 70° F	WARM DAYS 70-90° F	HOT DAYS OVER 90° F	DAYS SUITABLE FOR CONTACT FLIGHT AT 0600	DAYS SUITABLE FOR CONTACT FLIGHT AT 1300
AKYAB	COASTAL															89	99	73.2	76.9[4]	68.6	81.7[5]	-	18.3	12.7	30.0[2]	30.4[3]
RANGOON	30 MILES INLAND															97	102	69.4	80.7[4]	54.2	89.3[5]	-	1.4	29.6	26.3[2]	30.5[3]
TAVOY	COASTAL																									
VICTORIA	COASTAL															90	98	76.4	82.4[4]	70.2	83.6[5]	-	12.9	18.1	30.1[2]	30.2[3]
ALOR STAR	COASTAL															91	96	95.6	73.3[2]	55.1	90.4[6]	-	6.0	24.0	30.0[1]	30.7
PENANG (A)*	COASTAL	10	19.5	5.0	0.8	11.5	4.1	1.6	7.5	3.9	0.1	2.28	4.93	9.28	2.21	92	97	77.3	83.1[2]	65.5	88.9[6]	-	2.7	28.3		
WELLESLEY (B)	COASTAL	10	16.4	5.6	1.0	14.6	5.1	1.2	7.8	5.2	1.6	4.30	11.32	27.66	2.61	93	101	76.2	83.7[2]	64.8	88.9[6]	-	2.9	28.1		
KUALA LUMPUR	25 MILES INLAND															92	96	96.6	74.1	57.3	89.0	-	4.4	26.6	25.1[1]	31.0
MALACCA (C)	COASTAL	10	20.6	5.4	0.5	10.4	3.9	1.5	7.1	3.0	0.3	3.80	5.13	9.31	2.51	89	95	93.1	75.3	71.0	85.2	-	13.6	17.4	30.7[1]	29.3
SINGAPORE	COASTAL															89	94	94.3	76.3	70.5	85.9	-	20.4	10.6	30.3[1]	31.0
KUALA PAHANG	COASTAL																									
KOTA BHARU	COASTAL															88	92	97.0	74.3	66.4	86.1	-	26.5	4.5	28.3[1]	31.0
BANGKOK (D)	30 MILES INLAND	5	24.5	1.6	-	6.5	0.8	-	4.7	1.8	-	1.49	1.56	3.11	Trace	95	101	92.2	76.8	53.9	93.1					
ILOT-CONE (E)	COASTAL	2	30.0	-	1.5	1.0	1.5	-	-	1.0	-	1.57	1.51	4.53	0.00	-	-	89.7	76.1	68.4	87.4				27.9	28.3
PHNOM PENH (F)	60 MILES INLAND	10	26.2	0.8	1.8	4.8	2.3	0.2	3.7	0.8	0.3	5.63	2.26	7.16	0.00	91	98	90.6	75.9	50.6	91.2				24.9	30.7
HA TIEN (G)	COASTAL	10	26.6	1.0	1.5	4.4	2.3	0.1	2.8	1.4	0.2	9.21	3.15	16.56	0.00	-	-	92.1	76.9	73.3	85.7				27.1	30.8
POULO OBI	ISLAND																	91.3	74.4	75.0	82.0				30.1	30.7
POULO CONDORE	ISLAND																	86.7	75.5	68.0	85.5				28.8	29.3
CAN THO	50 MILES INLAND	10	27.7	0.2	1.2	3.3	1.3	0.1	2.4	0.9	-	1.61	0.98	3.35	0.00	-	-	90.2	76.5	55.7	90.0				19.3	31.0
CAP ST JACQUES	COASTAL	10	29.0	0.3	0.1	2.0	0.3	-	1.9	0.1	-	0.54	0.17	1.60	0.00	85	99	85.6	76.7	72.1	83.3				30.8	31.0
SAIGON	30 MILES INLAND	9+	25.3	-	-	5.7	-	-	5.2	0.4	0.1	4.06	1.16	5.07	0.00	93	103	90.0	76.0	51.3	90.5				19.9	30.6
PHAN THIET (H)	COASTAL	5	30.8	-	0.4	0.2	0.2	-	0.2	-	-	0.01	Trace	0.01	0.00	-	-	86.6	74.0	66.9	84.5				28.6	31.0
PADARAN	COASTAL	10	26.5	0.5	1.2	4.5	1.4	0.2	3.5	0.8	0.2	3.38	1.35	8.35	0.00	83	92	81.8	76.1	70.9	83.0				30.3	31.0
DALAT (I)	50 MILES INLAND	9+	22.4	1.8	1.7	8.6	2.9	0.3	7.2	1.4	-	1.78	1.86	4.43	0.02	79	89	89.1	57.6	49.6	75.5				21.1	26.9
NHA TRANG (J)	COASTAL	10	21.3	0.8	1.6	9.7	2.3	0.4	7.8	1.5	0.4	4.87	3.76	12.02	0.00	86	94	91.4	72.8	69.5	85.4				30.8	31.0
TUY HOA	COASTAL																	93.1	73.4	66.9	83.3				28.9	30.2
QUI NHON	COASTAL	10	20.5	0.7	1.6	10.5	1.9	0.2	9.0	1.4	0.1	2.60	2.01	5.21	0.01	82	101	89.9	74.1	72.0	82.6				30.1	30.6
BONG SON	COASTAL																	91.8	71.6	57.4	85.6				25.0	30.8
QUANG NGAI (K)	COASTAL	10	24.7	1.1	1.5	6.3	2.4	0.3	4.7	1.3	0.3	4.96	2.87	9.07	0.08	84	96	95.5	71.8	70.3	83.2				19.2	30.7
TOURANE	COASTAL																	91.9	72.7	74.8	80.0				25.8	30.1
HUE	COASTAL																	94.2	70.7	79.2	79.3				25.1	28.4
TCHEPONE (L)	50 MILES INLAND	10	28.4	0.2	1.2	2.6	1.5	-	1.6	0.9	0.1	2.08	1.17	3.05	0.00	-	-	92.7	67.4	-	84.9				24.1	29.9
DONG HOI (M)	COASTAL	10	16.4	2.8	2.1	14.6	4.0	0.9	13.3	1.0	0.3	3.62	2.85	10.20	0.11	77	102	87.5	69.1	77.6	76.1	3.9	24.8	2.3	16.5	25.4
VINH	COASTAL	10	16.3	1.5	2.3	14.7	3.2	0.7	13.7	1.0	-	1.12	1.80	3.28	0.22	75	102	95.9	67.8	80.9	74.2				9.6	23.2
THANH HAO	COASTAL	10	14.3	4.0	1.5	16.7	4.5	1.0	16.1	0.6	-	1.28	1.63	3.42	0.65	74	102	94.5	66.6	79.4	72.5				10.7	24.0
NAM DINH	20 MILES INLAND															72	91	85.3	65.7	76.2	71.7	10.1	20.3	.6	8.2[1]	17.8
PHU LIEN	COASTAL	10	8.7	3.1	1.4	22.3	3.0	1.4	21.7	0.6	-	1.20	1.69	[illegible].26	0.33	-	-	93.7	65.4	83.1	70.5				16.1[1]	23.6
NORWAY IS.	ISLAND															67	75	87.2	64.2	79.7	67.1	16.2	14.9	-	22.7[1]	24.8
LANGSON (N)	COASTAL	10	16.6	2.0	1.9	14.4	3.0	0.6	13.1	1.3	-	1.78	1.98	4.37	0.05	71	98	74.6	61.6	78.3	68.4	13.1	16.6	1.2	18.4	25.8
HAIPHONG	COASTAL															74	93	79.8	67.1	73.1	71.9	6.8	23.8	.3	20.9[1]	25.0
HANOI	50 MILES INLAND	10	13.3	-	-	17.7	-	-	17.1	0.6	-	1.24	1.58	2.92	0.14	74	98	95.1	65.7	75.7	72.8	8.0	22.0	1.0	9.1[1]	27.5
CANTON	COASTAL																	83.4	61.9	79.0	66.7				24.3[1]	25.4
MONCAY	COASTAL	10	15.9	3.0	1.8	15.1	3.6	1.3	13.5	1.5	0.1	2.20	2.61	5.39	0.31	71	95	85.7	62.5	69.5	69.6	20.7	10.3	-	20.7	27.0

MONTH

March

*Letters indicate stations with complete records.

1 --- 700 HR

2 --- 900 HR

3 --- 1800 HR

4 --- 300 HR

5 --- 1200 HR

6 --- 1500 HR

TABLE 12 (Continued)

MONTH: April

STATION	LOCATION	YEARS RECORD	DRY DAYS	SHORT DRY SPELLS 1-3 DAYS	LONG DRY SPELLS 4 DAYS	RAINY DAYS	SHORT RAINY SPELLS 1-3 DAYS	LONG RAINY SPELLS 4 DAYS	LIGHT RAINY DAYS TRACE TO 0.49"	HEAVY RAINY DAYS .50 to 1.99"	VERY HEAVY RAINY DAYS OVER 2.00"	ABSOLUTE MAXIMUM OVER RECORD PERIOD	MEAN RAINFALL FOR MONTH	GREATEST MONTHLY RAINFALL	LEAST MONTHLY RAINFALL	MEAN MAXIMUM TEMPERATURE	EXTREME MAXIMUM TEMPERATURE	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 0600 HRS	MONTHLY AVERAGE: TEMPERATURE AT 0600 HRS	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 1300 HRS	MONTHLY AVERAGE: TEMPERATURE AT 1300 HRS	COOL DAYS UNDER 70° F	WARM DAYS 70-90° F	HOT DAYS OVER 90° F	DAYS SUITABLE FOR CONTACT FLIGHT AT 0600	DAYS SUITABLE FOR CONTACT FLIGHT AT 1300
AKYAB	COASTAL															90	101	73.4	83.3[4]	70.9	83.8[5]	-	15.6	14.4	30.0[2]	30.0[3]
RANGOON	30 MILES INLAND															93	98	71.8	84.1[4]	66.8	87.9[5]		2.2	25.8	28.4[2]	28.6[3]
TAVOY	COASTAL																									
VICTORIA	COASTAL															89	97	72.7	83.1[4]	79.3	82.0[5]	-	18.7	11.3	29.3[2]	26.7[3]
ALOR STAR	COASTAL															91	96	96.1	75.5	63.3	89.4	-	6.0	24.0	28.7[1]	30.0
PENANG (A)*	COASTAL	10	17.5	9.6	0.6	12.5	4.6	1.6	9.1	3.1	0.3	3.35	5.51	9.11	1.43	91	95	79.1	83.8	69.4	88.1	-	3.7	26.3		
WELLESLEY (B)	COASTAL	10	13.4	4.1	1.5	15.6	4.4	1.3	8.9	6.4	1.3	4.17	11.12	13.95	6.49	93	100	77.3	84.2[2]	68.6	88.1	-	3.8	26.2		
KUALA LUMPUR	25 MILES INLAND															91	94	96.7	75.2	62.6	88.5	-	6.4	23.6	21.4[1]	30.0
MALACCA (C)	COASTAL	10	17.5	4.0	1.1	12.5	3.5	1.7	6.5	5.0	1.0	4.00	8.65	13.81	3.20	89	95	94.0	76.0	75.5	84.6	-	14.9	15.1	30.0[1]	27.0
SINGAPORE	COASTAL															88	94	92.6	77.7	72.8	85.3	-	22.4	7.6	29.0[1]	29.7
KUALA PAHANG	COASTAL																									
KOTA BHARU	COASTAL															90	94	95.5	76.1	64.6	88.1	-	12.1	18.0	29.7[1]	30.0
BANGKOK (D)	30 MILES INLAND	5	20.8	2.8	0.4	9.2	1.4	1.8	7.2	1.4	0.6	3.17	3.81	6.06	Trace	96.4	113.7	88.5	80.0	56.8	93.6					
ILOT-COME (E)	COASTAL	2	25.7	0.5	4.5	4.3	3.5	-	1.3	1.7	1.3	3.11	5.46	11.86	1.38	-	-	88.6	78.5	67.6	88.5				28.2	28.8
PHNOM PENH (F)	60 MILES INLAND	10	20.8	2.5	2.2	9.2	4.0	0.4	7.0	1.8	0.4	4.09	4.39	14.14	0.93	93	109	92.0	78.1	54.3	91.7				24.5	28.4
HA TIEN (G)	COASTAL	10	21.7	3.0	1.6	8.3	4.2	0.5	3.8	3.8	0.7	3.95	6.61	13.41	2.60	88	90	90.8	79.2	72.4	87.0				27.5	29.8
POULO OBI	ISLAND																	90.6	77.3	74.2	84.7				29.1	29.2
POULO CONDORE	ISLAND																	83.7	79.1	66.4	87.1				29.5	29.2
CAN THO	30 MILES INLAND	10	24.5	1.0	2.2	5.5	2.8	0.2	4.2	1.1	0.2	2.13	2.01	6.28	0.00	-	-	88.9	78.0	58.3	90.3				22.2	29.2
CAP ST JACQUES	COASTAL	10	25.7	0.9	0.9	4.3	1.8	0.2	3.7	0.6	-	1.93	1.12	6.22	0.00	89	100	89.4	79.0	70.7	85.7				28.9	29.8
SAIGON	30 MILES INLAND	9+	22.0	-	-	8.0	-	-	7.0	0.6	0.4	3.50	2.20	5.51	0.06	95	104	88.5	79.0	53.7	90.7				21.0	28.7
PHAN THIET (H)	COASTAL	5	27.5	1.2	0.8	2.5	2.0	-	1.9	0.3	0.3	2.30	1.11	5.59	0.00	-	-	84.8	77.7	66.7	86.9				23.7	28.6
PADARAN	COASTAL	10	25.6	0.3	1.8	4.4	1.0	-	3.8	0.5	0.1	3.47	1.09	3.64	0.11	87	99	93.3	78.3	71.6	85.2				29.1	29.3
DALAT (I)	30 MILES INLAND	9+	12.9	3.2	1.3	17.1	3.6	1.0	12.5	4.2	0.4	3.46	6.49	14.17	2.92	80	88	92.5	62.1	57.9	75.2				17.7	25.7
NHA TRANG (J)	COASTAL	10	23.9	1.0	1.7	6.1	2.5	0.1	5.7	0.3	0.1	2.26	0.94	3.69	0.00	89	97	90.2	76.0	70.4	86.6				29.3	29.7
TUY HOA	COASTAL																	91.5	76.4	67.0	85.7				28.2	29.6
QUI NHON	COASTAL	10	23.0	0.6	1.6	7.0	2.2	0.2	6.0	1.0	-	1.19	1.08	3.04	0.16	86	97	88.0	77.1	71.5	85.2				29.7	29.9
BONG SON	COASTAL																	90.2	74.7	54.1	88.1				27.4	29.0
QUANG NGAI (K)	COASTAL	10	25.6	1.0	1.4	4.4	2.3	0.1	3.2	1.0	0.2	3.44	1.84	6.85	0.00	89	102	94.1	74.8	68.0	86.3				24.3	29.3
TOURANE	COASTAL																	89.5	75.2	72.9	82.9				28.1	29.6
HUE	COASTAL																	92.7	74.3	77.7	82.6				26.1	29.3
TCHEPONE (L)	30 MILES INLAND	10	25.5	0.8	2.0	4.5	2.0	0.3	2.2	1.5	0.8	3.62	4.03	5.77	0.11	-	-	93.3	72.5	-	86.7				22.1	30.0
DONG HOI (M)	COASTAL	10	18.7	1.6	2.3	11.3	3.2	0.5	10.2	0.8	0.3	2.80	2.40	7.85	0.26	84	106	86.2	72.9	70.6	79.7	0.5	25.2	4.3	19.9	26.9
VINH	COASTAL	10	17.5	2.0	2.6	12.5	4.0	0.2	11.1	1.2	0.2	2.15	2.35	4.81	0.44	83	103	94.8	72.2	75.8	80.2				14.7	27.1
THANH HOA	COASTAL	10	14.5	3.5	2.0	15.5	4.5	1.2	13.9	1.5	0.1	2.29	2.54	5.28	0.98	82	107	93.0	71.5	74.2	78.6				17.0	26.7
NAMDINH	30 MILES INLAND															81	99	79.9	71.5	69.6	78.4	2.9	22.7	4.4	8.5[1]	18.6
PHU LIEN	COASTAL	10	9.5	4.4	1.5	20.5	4.8	0.9	18.9	1.5	0.1	2.12	3.07	4.68	1.09			86.7	75.2	77.4	76.8				28.1[1]	25.8
NORWAY IS.	ISLAND															76	88	83.5	68.4	78.1	73.5	9.1	21.0	-	17.9[1]	28.0
LANGSON (N)	COASTAL	10	16.9	2.6	2.0	13.1	4.0	0.8	11.6	1.5	-	1.59	2.23	5.34	0.62	79	101	75.2	69.9	64.5	76.6	8.6	12.8	8.6	21.7	26.3
HAIPHONG	COASTAL															79	99	82.2	71.7	75.6	76.4	2.2	27.2	.6	20.9[1]	25.4
HANOI	30 MILES INLAND	10	11.9	-	-	18.1	-	-	16.0	1.8	0.3	2.97	3.69	7.55	1.42	81	101	94.3	70.3	70.2	78.7	2.3	23.1	4.6	13.1[1]	27.5
CANTON	COASTAL																	83.6	69.4	69.0	73.3				19.3[1]	23.3
MONCAY	COASTAL	10	16.2	3.7	1.5	13.8	4.0	1.2	10.7	2.8	0.3	2.99	4.90	13.86	0.79	79	93	80.8	69.9	74.0	76.6	2.1	25.7	2.1	21.2	27.6

*Letters indicate stations with complete records.

1 --- 700 HR

2 --- 900 HR

3 --- 1800 HR

4 --- 300 HR

5 --- 1200 HR

6 --- 1500 HR

TABLE 12 (Continued)

STATION	YEARS LOCATION	YEARS RECORD	DRY DAYS	SHORT DRY SPELLS 1-3 DAYS	LONG DRY SPELLS 4 DAYS	RAINY DAYS	SHORT RAINY SPELLS 1-3 DAYS	LONG RAINY SPELLS 4 DAYS	LIGHT RAINY DAYS TRACE TO 0.49"	HEAVY RAINY DAYS .50 to 1.99"	VERY HEAVY RAINY DAYS OVER 2.00"	ABSOLUTE MAXIMUM OVER RECORD PERIOD	MEAN RAINFALL FOR MONTH	GREATEST MONTHLY RAINFALL	LEAST MONTHLY RAINFALL	MEAN MAXIMUM TEMPERATURE	EXTREME MAXIMUM TEMPERATURE	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 0600 HRS	MONTHLY AVERAGE: TEMPERATURE AT 0600 HRS	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 1300 HRS	MONTHLY AVERAGE: TEMPERATURE AT 1300 HRS	COOL DAYS UNDER 70° F	WARM DAYS 70-90° F	HOT DAYS OVER 90° F	DAYS SUITABLE FOR CONTACT FLIGHT AT 0600	DAYS SUITABLE FOR CONTACT FLIGHT AT 1300
AKYAB	COASTAL															86	96	79.7	83.7^4	75.0	84.0^5	0.7	22.4	7.9	27.0^2	28.9^3
	30 MILES																									
RANGOON	INLAND															91	99	78.4	83.1^4	79.2	82.8^5	-	10.3	20.7	27.9^2	28.4^3
TAVOY	COASTAL																									
VICTORIA	COASTAL															88	119	79.2	82.4^4	77.6	82.3^5	-	23.7	7.3	28.0^2	29.6^3
ALOR STAR	COASTAL															89	93	95.7	76.4	70.8	86.8	-	17.3	13.8	30.3^1	31.0
PENANG (A)*	COASTAL	10	15.4	5.2	1.3	15.6	4.7	1.5	9.6	4.9	1.1	3.83	10.31	16.14	3.11	90	98	81.2	83.3^2	72.3	87.1^6	-	8.1	22.9		
WELLESLEY (B)	COASTAL	10	16.4	5.4	1.0	14.6	4.5	1.9	8.1	5.1	1.4	5.20	11.42	28.29	4.65	92	99	76.6	84.7^2	68.5	88.1^6	-	9.4	21.6		
	25 MILES																									
KUALA LUMPUR	INLAND															90	98	96.3	75.6	65.5	37.2	-	9.4	21.6	22.7^1	30.3
MALACCA (C)	COASTAL	10	18.7	5.7	0.6	12.3	4.4	2.0	7.4	4.5	0.4	3.95	6.44	11.39	1.99	89	98	93.7	76.5	76.8	84.1	-	20.2	10.8	31.0^1	28.3
SINGAPORE	COASTAL															88	91	91.6	78.4	73.2	85.4	-	27.0	4.0	30.3^1	31.0
KUALA PAHANG	COASTAL																									
KOTA BHARU	COASTAL															90	99	94.5	76.4	66.3	87.9	-	14.5	16.5	31.0^1	31.0
	20 MILES																									
BANGKOK (D)	INLAND	5	12.3	5.2	1.0	18.7	5.0	1.2	14.3	3.8	0.6	3.19	6.12	9.23	3.30	94	103	91.2	79.3	62.3	92.0				-	-
ILOT-CONE (E)	COASTAL	2	16.3	4.5	2.0	14.7	5.5	2.5	-	10.4	4.3	3.94	23.83	32.40	15.91	-	-	89.4	78.7	76.8	84.5				25.4	27.6
	60 MILES																									
PHNOM PENH (F)	INLAND	10	13.6	4.2	1.8	17.4	4.8	1.0	14.2	3.0	0.2	2.91	5.31	8.43	1.99	92	100	93.1	78.7	62.0	89.8				27.3	29.5
HA TIEN (G)	COASTAL	10	15.5	4.3	1.1	15.5	4.5	1.1	9.1	5.3	1.1	4.04	10.98	19.85	4.55	88	91	90.2	79.8	78.3	86.5				28.7	30.4
POULO OBI	ISLAND																	90.6	78.3	81.4	83.1				28.3	27.8
POULO CONDORE	ISLAND																	85.9	79.2	75.0	85.8				27.7	26.3
	50 MILES																									
CAN THO	INLAND	10	14.1	4.6	1.5	16.9	4.6	1.1	12.4	4.0	0.5	3.11	7.04	11.35	2.72	-	-	93.2	78.2	72.5	86.5				21.9	27.7
CAP ST JACQUES	COASTAL	10	13.3	4.0	1.2	17.7	4.1	1.1	12.5	4.9	0.3	3.07	7.64	15.01	2.80	90	101	87.6	79.1	76.2	85.1				30.4	30.5
	30 MILES																									
SAIGON	INLAND	9	12.6	-	-	18.4	-	-	12.4	5.4	0.6	4.10	9.28	22.07	3.25	92	102	91.4	79.2	66.1	88.3				25.7	29.3
PHAN THIET (H)	COASTAL	5	21.0	3.2	2.6	10.0	4.2	1.0	6.5	3.3	0.2	2.32	4.81	6.67	2.29	-	-	88.3	78.7	67.5	87.3				26.5	30.0
PADARAN	COASTAL	10	21.1	3.0	2.0	9.9	4.4	0.3	8.2	1.6	0.1	2.28	2.81	4.88	0.67	88	97	82.6	80.3	72.2	86.5				30.6	30.1
	50 MILES																									
DALAT (I)	INLAND	9	9.7	3.0	1.0	21.3	2.1	1.9	16.1	5.1	0.11	2.10	7.50	12.53	3.84	79	87	90.9	65.0	62.2	74.9				24.9	27.9
NHA TRANG (J)	COASTAL	10	21.4	1.8	2.1	9.6	3.7	0.1	8.6	1.0	-	1.54	1.31	3.45	0.00	91	101	88.8	78.0	73.3	89.4				31.0	31.0
TUY HOA	COASTAL																	88.7	78.7	66.2	89.2				30.8	30.8
QUI NHON	COASTAL	10	24.0	1.4	1.8	7.0	2.9	0.1	6.1	0.9	-	1.99	1.69	6.20	0.11	90	103	86.9	80.1	71.4	88.0				31.0	30.6
BONG SON	COASTAL																	86.8	78.1	56.9	89.8				30.3	30.8
QUANG NGAI (K)	COASTAL	10	26.1	1.2	1.7	4.9	2.3	0.1	3.9	0.8	0.2	2.80	1.72	7.25	0.00	93	102	92.4	78.1	65.1	90.7				30.7	30.5
TOURANE	COASTAL																	86.3	78.4	70.0	87.1				30.4	30.4
HUE	COASTAL																	88.8	78.4	71.5	88.0				30.8	30.7
	50 MILES																									
TCHEPONE (L)	INLAND	10	21.2	3.0	2.0	9.8	4.8	0.2	5.4	3.8	0.6	3.92	6.81	15.15	2.11	-	-	92.9	74.4	-	86.4				22.0	28.3
DONG HOI (M)	COASTAL	10	21.3	1.9	2.3	9.7	4.3	0.1	7.8	1.6	0.3	5.61	3.48	12.86	0.71	91	108	81.6	80.7	68.8	88.6	-	8.6	22.3	28.5	30.2
VINH	COASTAL	10	19.3	2.3	2.5	11.7	4.4	0.3	9.4	1.8	0.5	2.93	3.75	6.70	0.81	91	106	92.4	77.5	71.0	84.0				22.3	28.4
THANH HAO	COASTAL	10	18.5	3.3	2.1	12.5	4.7	0.4	8.6	3.1	0.8	6.82	7.21	11.01	3.22	91	107	92.1	77.2	74.2	85.0				24.7	30.5
	20 MILES																									
NAMDINH	INLAND															89	99	79.9	71.5	69.9	87.7	-	13.1	17.8	21.0^1	28.6
PHU LIEN	COASTAL	10	10.9	4.3	1.5	20.1	4.6	1.1	15.5	3.5	1.1	5.89	7.44	16.83	1.05	-	-	91.3	72.4	79.0	83.8				26.7	29.7
NORWAY IS.	ISLAND															81	90	89.2	77.9	86.9	80.4	-	29.1	1.9	28.4^1	27.4
LANGSON (N)	COASTAL	10	15.7	5.0	1.2	15.3	5.0	0.9	10.7	3.5	1.1	4.87	7.07	12.84	2.49	87	104	75.5	75.7	59.8	83.7	-	13.8	17.2	26.5	29.1
HAIPHONG	COASTAL															86	97	90.5	79.4	75.4	84.7	.7	18.8	11.4	25.1^1	29.3
	50 MILES																									
HANOI	INLAND	10	13.3	-	-	17.7	-	-	12.8	3.8	1.1	4.46	8.77	15.54	2.51	89	109	93.3	76.7	64.8	86.1	-	11.0	20.1	23.5	30.1
CANTON	COASTAL																	90.1	77.7	76.9	86.0				20.7^1	29.2
MONCAY	COASTAL	10	14.9	4.2	1.4	16.1	4.6	1.5	10.1	4.7	1.3	11.65	11.70	20.63	2.32	87	100	87.6	77.7	78.1	83.6	-	27.2	3.9	27.5	31.0

MONTH

May

*Letters indicte stations with complete records.

1 --- 700 HR

2 --- 900 HR

3 --- 1800 HR

4 --- 300 HR

5 --- 1200 HR

6 --- 1500 HR

TABLE 12 (Continued)

STATION	LOCATION	YEARS RECORD	DRY DAYS	SHORT DRY SPELLS 1-3 DAYS	LONG DRY SPELLS 4 DAYS	RAINY DAYS	SHORT RAINY SPELLS 1-3 DAYS	LONG RAINY SPELLS 4 DAYS	LIGHT RAINY DAYS TRACE TO 0.49"	HEAVY RAINY DAYS .50 to 1.99"	VERY HEAVY RAINY DAYS OVER 2.00"	ABSOLUTE MAXIMUM OVER RECORD PERIOD	MEAN RAINFALL FOR MONTH	GREATEST MONTHLY RAINFALL	LEAST MONTHLY RAINFALL	MEAN MAXIMUM TEMPERATURE	EXTREME MAXIMUM TEMPERATURE	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 0600 HRS	MONTHLY AVERAGE: TEMPERATURE AT 0600 HRS	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 1300 HRS	MONTHLY AVERAGE: TEMPERATURE AT 1300 HRS	COOL DAYS UNDER 70° F	WARM DAYS 70-90° F	HOT DAYS OVER 90° F	DAYS SUITABLE FOR CONTACT FLIGHT AT 0600	DAYS SUITABLE FOR CONTACT FLIGHT AT 1300
AKYAB	COASTAL															86	99	88.3	81.1[4]	81.8	82.2[5]	-	26.3	3.7	18.5[2]	22.5[3]
	30 MILES																									
RANGOON	INLAND															86	93	86.8	80.6[4]	84.7	80.5[5]	-	26.0	4.0	25.8[2]	22.4[3]
TAVOY	COASTAL																									
VICTORIA	COASTAL															85	100	85.0	80.2[4]	82.7	80.8[5]	-	26.7	3.3	25.3[2]	26.9[3]
ALOR STAR	COASTAL															89	94	95.3	75.9[2]	67.2	87.4[6]	-	15.0	15.0	30.0[1]	30.0
PENANG (A)*	COASTAL	10	17.8	4.6	0.9	12.2	3.9	1.7	7.2	4.2	0.8	5.65	7.62	14.67	3.13	90	95	79.7	83.1[2]	72.0	87.0[6]	-	9.8	20.2		
WELLESLEY (B)	COASTAL	10	18.5	5.2	0.6	11.5	3.9	1.8	6.7	3.5	1.3	4.40	8.57	20.13	2.49	92	99	76.8	84.1[2]	66.3	88.7[6]	-	4.3	25.7		
	25 MILES																									
KUALA LUMPUR	INLAND															90	94	95.5	74.6	61.1	88.0	-	9.0	21.0	25.9[1]	29.7
MALACCA (C)	COASTAL	10	16.3	4.7	0.9	13.7	3.9	1.6	9.2	3.8	0.7	4.39	7.53	12.49	0.61	88	99	91.9	76.1	74.4	84.7	-	21.4	8.6	30.0[1]	26.6
SINGAPORE	COASTAL															88	92	89.1	79.4	71.0	86.2	-	22.0	8.0	29.3[1]	30.0
KUALA PAHANG	COASTAL																									
KOTA BHARU	COASTAL															89	94	94.5	76.2	65.0	88.0	-	15.5	14.5	30.0[1]	30.0
	20 MILES																									
BANGKOK (D)	INLAND	5	9.2	4.0	1.4	20.8	4.0	1.4	16.6	3.8	0.4	2.63	6.57	8.59	5.15	91.6	98.1	91.4	78.1	66.6	89.5				-	-
ILOT-COME (E)	COASTAL	2	14.3	3.5	1.5	15.7	1.5	3.0	1.0	8.0	6.7	3.54	27.62	40.04	11.97	-	-	92.2	77.9	83.0	87.9				20.2	22.3
	60 MILES																									
PHNOM PENH (F)	INLAND	10	9.2	4.9	0.8	20.8	4.6	1.4	17.2	3.2	0.4	3.49	6.70	15.46	3.35	90	101	92.2	78.3	67.1	88.5				28.5	28.9
HA TIEN (G)	COASTAL	10	15.4	2.7	1.8	14.6	2.8	1.6	7.8	5.8	1.0	4.04	10.37	16.32	6.26	87	91	89.1	79.5	81.5	84.6				27.3	28.1
POULO OBI	ISLAND																	93.1	77.1	87.6	80.6				27.3	25.8
POULO CONDORE	ISLAND																	86.6	78.6	80.7	82.4				26.3	27.0
	30 MILES																									
CAN THO	INLAND	10	11.5	6.4	0.7	18.5	5.9	1.3	13.6	4.7	0.2	2.34	7.25	11.81	4.14	84	93	93.7	77.8	74.9	85.6				28.9	28.1
CAP ST JACQUES	COASTAL	10	7.6	4.0	0.6	22.4	3.0	2.0	16.3	5.4	0.7	3.07	8.94	15.92	3.94	87	96	89.6	77.8	78.6	83.5				28.7	29.3
	30 MILES																									
SAIGON	INLAND	9+	5.8	-	-	24.2	-	-	15.8	7.0	1.4	5.41	13.76	20.55	8.11	89	100	93.4	78.4	69.9	87.0				23.5	28.7
PHAN THIET (H)	COASTAL	5	18.5	4.2	1.8	11.5	5.2	1.4	5.8	5.0	0.7	5.20	8.02	12.50	3.37	-	-	86.7	78.1	68.7	87.1				23.8	28.8
PADARAN	COASTAL	10	21.4	1.6	2.1	8.6	3.5	0.2	7.5	1.0	0.1	2.99	1.65	3.59	0.50	85	97	81.8	79.5	75.8	83.2				29.3	29.3
	50 MILES																									
DALAT (I)	INLAND	9+	6.0	2.8	0.8	24.0	2.1	1.4	20.1	3.7	0.2	2.79	6.80	11.30	3.42	76	85	90.3	65.1	67.4	74.8				23.5	29.4
NHA TRANG (J)	COASTAL	10	18.4	1.3	2.4	11.6	3.4	0.4	10.2	1.4	-	1.83	1.73	3.46	0.12	92	103	86.7	78.3	70.9	89.1				30.0	29.4
TUY HOA	COASTAL																	80.1	80.4	60.7	90.5				29.2	29.6
QUI NHON	COASTAL	10	21.2	1.0	1.6	8.8	2.3	0.2	7.6	1.0	0.2	2.22	2.02	6.24	0.50	92	106	76.9	82.0	62.8	90.7				29.4	29.5
BONG SON	COASTAL																	79.5	80.5	54.0	92.4				28.3	29.5
QUANG NGAI (K)	COASTAL	10	22.1	1.5	2.1	7.9	3.5	0.3	5.7	1.9	0.3	2.91	3.52	6.14	1.39	94	104	89.3	79.5	63.6	91.8				30.0	29.1
TOURANE	COASTAL																	81.4	80.6	65.1	90.0				29.0	29.7
HUE	COASTAL																	84.4	80.7	67.7	90.9				29.8	29.5
	50 MILES																									
TCHEPONE (L)	INLAND	10	18.5	3.5	1.7	11.5	4.6	0.7	5.6	4.5	1.4	5.88	11.20	28.44	3.31	-	-	93.4	75.7	-	83.2				14.4	27.3
DONG HOI (M)	COASTAL	10	19.7	1.1	2.0	10.3	2.7	0.6	9.2	0.9	0.2	3.90	2.35	6.70	0.34	94	107	77.5	82.3	64.3	89.8	-	8.00	22.0	28.7	29.4
VINH	COASTAL	10	20.9	1.0	2.1	9.1	3.0	1.1	6.4	2.1	0.6	6.12	5.04	12.26	0.14	94	108	86.3	80.7	63.0	89.8			-	27.6	29.6
THANH HOA	COASTAL	10	16.9	2.4	2.1	13.1	3.2	1.2	8.4	3.5	1.2	6.76	8.88	16.57	3.93	94	106	89.1	80.1	69.8	89.4				26.8	29.8
	20 MILES																									
NAMDINH	INLAND															92	104	88.8	79.2	69.4	89.3	-	7.0	23.0	25.6[1]	27.6
PHU LIEN	COASTAL	10	11.2	4.2	1.5	18.8	4.1	1.1	11.8	5.8	1.2	6.25	11.28	23.38	5.39	-	-	93.3	79.5	78.2	86.4				26.5	28.5
NORWAY IS.	ISLAND															85	93	88.7	81.8	81.4	84.9	1.6	23.7	4.7	30.0[1]	28.5
LANGSON (N)	COASTAL	10	13.0	4.7	1.7	17.0	4.7	1.4	11.7	4.3	1.0	5.69	9.69	20.38	5.14	88	97	82.4	78.6	78.9	81.5		12.9	17.1	24.6	28.2
HAIPHONG	COASTAL															87	102	88.5	82.0	75.3	87.9	.5	16.6	12.5	27.5[1]	28.4
	50 MILES																									
HANOI	INLAND	10	12.4	-	-	17.6	-	-	11.7	4.0	1.9	7.98	12.65	23.52	4.33	91	104	92.9	79.4	68.5	88.7	-	8.4	21.6	25.8	28.7
COUTON	COASTAL																	92.2	82.3	81.3	86.2				27.1[1]	29.2
MONCAY	COASTAL	10	9.9	4.5	0.7	20.1	2.7	2.1	10.3	5.3	4.5	9.68	23.29	31.34	12.95	89	97	91.5	80.4	80.2	85.6	-	22.6	7.5	25.5	29.3

MONTH: June

*Letters indicate stations with complete records.

1 --- 700 HR

2 --- 900 HR

3 --- 1800 HR

4 --- 300 HR

5 --- 1200 HR

6 --- 1500 HR

TABLE 12 (Continued)

MONTH: July

STATION	LOCATION	YEARS RECORD	DRY DAYS	SHORT DRY SPELLS 1-3 DAYS	LONG DRY SPELLS 4 DAYS	RAINY DAYS	SHORT RAINY SPELLS 1-3 DAYS	LONG RAINY SPELLS 4 DAYS	LIGHT RAINY DAYS TRACE TO 0.49"	HEAVY RAINY DAYS .50 to 1.99"	VERY HEAVY RAINY DAYS OVER 2.00"	ABSOLUTE MAXIMUM OVER RECORD PERIOD	MEAN RAINFALL FOR MONTH	GREATEST MONTHLY RAINFALL	LEAST MONTHLY RAINFALL	MEAN MAXIMUM TEMPERATURE	EXTREME MAXIMUM TEMPERATURE	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 0600 HRS	MONTHLY AVERAGE: TEMPERATURE AT 0600 (HRS)	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 1300 HRS	MONTHLY AVERAGE: TEMPERATURE AT 1300 HRS	COOL DAYS UNDER 70° F	WARM DAYS 70-90° F	HOT DAYS OVER 90° F	DAYS SUITABLE FOR CONTACT FLIGHT AT 0600	DAYS SUITABLE FOR CONTACT FLIGHT AT 1300
AKYAB	COASTAL															84	97	88.7	80.5[4]	88.7	80.3[5]	-	30.6	0.4	21.3[2]	22.1[3]
RANGOON	30 MILES INLAND															85	94	85.4	80.3[4]	85.7	79.6[5]	-	29.7	1.3	21.6[2]	18.3[3]
TAVOY	COASTAL																									
VICTORIA	COASTAL															84	95	85.3	79.3[4]	83.9	79.6[3]	-	29.3	1.7	28.5[2]	29.6[3]
ALOR STAR	COASTAL															88	93	95.8	74.8	69.9	85.7	-	23.8	7.2	30.7[1]	31.0
PENANG (A)*	COASTAL	10	18.9	4.9	0.8	12.1	4.1	1.8	8.2	3.1	0.8	4.90	6.80	16.25	2.98	90	93	80.8	82.8[2]	73.2	86.3[6]	-	11.9	19.1		
WELLESLEY (B)	COASTAL	10	21.5	4.9	0.4	9.5	3.5	2.1	5.2	3.4	0.9	5.10	7.04	16.89	1.43	92	98	76.0	83.7[2]	66.2	88.2[6]	-	5.0	26.0		
KUALA LUMPUR	25 MILES INLAND															89	94	94.9	73.7	63.1	86.7	-	15.4	15.6	29.2[1]	31.0
MALACCA (C)	COASTAL	10	17.5	4.6	1.3	13.5	4.2	1.6	7.6	5.0	0.9	4.60	9.07	17.98	3.18	88	99	93.3	75.2	75.7	83.4	-	25.3	5.7	30.7[1]	29.6
SINGAPORE	COASTAL															87	90	88.6	78.5	73.1	84.4	-	29.4	1.6	28.6[1]	30.7
KUALA PAHANG	COASTAL																									
KOTA BHARU	COASTAL															89	92	94.6	75.1	64.3	87.0		20.5	10.5	31.0[1]	31.0
BANGKOK (D)	20 MILES INLAND	5	7.2	6.2	1.4	23.8	7.0	0.6	21.2	2.6	-	1.31	4.29	6.80	2.65	90.7	95.7	91.2	78.0	64.5	89.0				-	-
ILOT-CONE (E)	COASTAL	2	14.7	2.5	2.0	16.3	2.5	2.0	0.7	11.0	4.6	3.27	26.13	48.62	12.65	-	-	90.6	78.1	81.1	81.7				22.2	25.1
PHNOM PENH (F)	60 MILES INLAND	10	10.0	5.0	1.3	21.0	4.7	1.5	17.5	3.1	0.4	3.03	6.19	10.19	2.15	88	95	91.9	77.4	66.4	88.4				30.2	29.7
HA TIEN (G)	COASTAL	10	14.1	2.6	1.2	16.9	2.6	1.4	7.7	7.7	1.5	7.27	14.54	24.14	4.94	86	90	89.2	79.1	78.9	84.0				28.3	29.1
POULO OBI	ISLAND																	93.1	76.2	84.8	79.2				27.7	27.4
POULO CONDORE	ISLAND																	86.4	78.3	78.8	82.6				25.9	28.0
CAN THO	50 MILES INLAND	10	8.9	5.4	0.6	22.1	4.3	2.0	16.1	5.5	.5	3.33	9.24	13.07	6.07	87	92	93.2	77.7	72.3	86.1				26.9	29.1
CAP ST JACQUES	COASTAL	10	7.7	4.7	0.6	23.3	3.7	1.5	17.4	5.7	0.2	5.59	8.89	16.59	5.59	85	93	90.3	77.2	81.5	82.0				30.0	29.6
SAIGON	30 MILES INLAND	9+	5.9	-	-	25.1	-	-	16.1	8.2	0.8	5.89	13.67	22.97	10.64	88	94	93.4	77.7	71.6	85.3				23.3	29.7
PHAN THIET (H)	COASTAL	5	18.3	5.8	1.0	12.7	5.8	0.6	6.3	6.4	-	1.91	7.91	11.11	5.66	-	-	88.2	77.7	69.8	85.5				26.9	28.0
PADARAN	COASTAL	10	19.2	2.9	2.2	11.8	4.9	0.1	11.2	0.5	0.1	3.38	1.42	3.08	0.12	84	96	81.1	78.7	80.0	82.0				30.5	30.8
DALAT (I)	50 MILES INLAND	9+	3.0	1.8	0.4	28.0	1.0	1.5	19.6	7.8	0.6	2.83	11.48	16.74	6.67	74	83	91.5	63.6	80.9	70.8				21.6	28.1
NHA TRANG (J)	COASTAL	10	16.9	1.8	2.2	14.1	3.7	0.4	13.2	0.9	-	1.57	1.62	2.74	0.26	91	102	85.6	78.6	67.8	89.0				30.8	31.0
TUY HOA	COASTAL																	77.1	80.3	57.9	90.4				30.5	30.6
QUI NHON	COASTAL	10	18.5	1.1	1.6	12.5	2.7	0.2	11.5	0.9	0.1	4.10	1.81	4.99	0.39	92	108	73.1	82.4	56.7	91.6				30.7	30.7
BONG SON	COASTAL																	77.4	80.1	49.7	92.7				28.5	30.3
QUANG NGAI (K)	COASTAL	10	24.5	1.9	1.8	6.5	3.3	0.3	5.2	1.2	0.1	3.84	2.17	5.02	0.35	94	103	86.6	79.8	57.4	93.3				31.0	30.8
TOURANE	COASTAL																	77.1	81.1	60.4	91.3				30.6	31.0
HUE	COASTAL																	78.6	80.6	60.6	91.6				30.7	30.5
TCHEPONE (L)	50 MILES INLAND	10	15.1	3.9	1.4	15.9	4.2	1.1	7.2	6.9	1.8	9.04	17.23	54.58	7.20	-	-	94.1	75.4	-	81.6				13.6	24.9
DONG HOI (M)	COASTAL	10	20.6	1.2	2.3	10.4	2.8	0.6	8.5	1.8	0.1	10.38	3.39	13.43	0.87	94	106	76.2	82.6	60.6	91.6	-	5.9	25.1	29.9	30.4
VINH	COASTAL	10	19.9	2.1	2.1	11.1	3.8	0.1	9.3	1.3	0.5	5.83	4.41	8.35	1.46	94	106	83.0	81.4	54.6	91.0				30.1	30.7
THANH HAO	COASTAL	10	16.7	2.4	2.1	14.3	3.2	1.2	8.0	4.8	1.5	4.09	10.32	19.72	4.03	93	108	89.3	80.3	69.9	88.9				28.8	29.2
NAMDINH	20 MILES INLAND															92	100	87.7	82.2	68.7	90.1	-	5.6	25.4	26.8[1]	29.4
PHU LIEN	COASTAL	10	10.4	3.7	1.4	20.6	4.1	1.5	14.2	4.1	2.3	6.04	12.63	20.87	5.29	-	-	92.1	81.1	76.2	86.4				26.7[1]	28.9
NORWAY IS.	ISLAND															87	90	85.5	83.5	78.7	85.6	-	26.9	4.1	29.9[1]	28.8
LANGSON (N)	COASTAL	10	12.5	3.3	1.4	18.5	3.4	1.6	10.7	6.1	1.7	6.85	13.74	20.89	7.17	88	99	81.3	80.2	67.7	85.6	-	10.3	20.6	24.3[1]	27.9
HAIPHONG	COASTAL															90	100	89.7	83.2	75.6	89.1	-	10.1	20.9	29.6[1]	29.4
HANOI	50 MILES INLAND	10	12.0			19.0			10.7	6.1	2.2	6.76	15.12	22.19	9.34	91	104	93.3	80.0	71.0	87.8	-	4.8	26.2	26.7[1]	29.3
CANTON	COASTAL																	88.4	83.2	78.4	87.8				31.0[1]	29.5
MONCAY	COASTAL	10	9.8	2.9	0.8	21.2	1.9	2.3	10	6.9	4.3	9.13	27.21	34.72	6.50	90	101	89.6	81.7	79.3	86.6	-	20.7	10.3	28.6	30.5

*Letters indicate stations with complete records.

1 --- 700 HR

2 --- 900 HR

3 --- 1800 HR

4 --- 300 HR

5 --- 1200 HR

6 --- 1500 HR

TABLE 12 (Continued)

MONTH: August

STATION	TERRAIN LOCATION	YEARS RECORD	DRY DAYS	SHORT DRY SPELLS 1-3 DAYS	LONG DRY SPELLS 4 DAYS	RAINY DAYS	SHORT RAINY SPELLS 1-3 DAYS	LONG RAINY SPELLS 4 DAYS	LIGHT RAINY DAYS TRACE TO 0.49"	HEAVY RAINY DAYS .50 to 1.99"	VERY HEAVY RAINY DAYS OVER 2.00"	ABSOLUTE MAXIMUM OVER RECORD PERIOD	MEAN RAINFALL FOR MONTH	GREATEST MONTHLY RAINFALL	LEAST MONTHLY RAINFALL	MEAN MAXIMUM TEMPERATURE	EXTREME MAXIMUM TEMPERATURE	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 0400 MB	MONTHLY AVERAGE: TEMPERATURE AT 0400 MB	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 1300 MB	MONTHLY AVERAGE: TEMPERATURE AT 1300 MB	COOL DAYS UNDER 70° F	WARM DAYS 70-90° F	HOT DAYS OVER 90° F	DAYS SUITABLE FOR CONTACT FLIGHT AT 0400	DAYS SUITABLE FOR CONTACT FLIGHT AT 1300
AKYAB	COASTAL															84	96	91.2	79.5[4]	90.3	80.6[5]	-	30.0	1.0	19.8[2]	25.6[3]
RANGOON	30 MILES INLAND															85	93	87.6	79.5[4]	87.1	79.4[5]	-	27.7	3.3	16.3[2]	15.0[3]
TAVOY	COASTAL																									
VICTORIA	COASTAL															86	87	88.7	79.0[4]	88.2	79.6[5]	-	31.0	-	25.2[2]	26.2[3]
ALOR STAR	COASTAL															88	91	96.0	75.3[2]	69.5	86.2[6]	-	23.0	8.0	31.0[1]	31.0
PENANG (A)*	COASTAL	10	18.1	5.4	1.1	12.9	5.0	1.2	7.0	4.3	1.6	6.61	10.75	18.96	2.65	89	96	82.8	81.6[2]	75.4	89.5[6]	-	17.8	13.2		
WELLESLEY (B)	COASTAL	10	18.4	5.3	1.0	12.6	4.5	1.3	7.5	2.8	2.3	6.37	11.38	27.53	1.74	92	98	76.1	83.0[2]	66.8	87.6[6]	-	6.2	24.8		
KUALA LUMPUR	25 MILES INLAND															90	95	94.6	73.8	60.6	87.0	-	11.2	19.9	29.3[1]	30.3
MALACCA (C)	COASTAL	10	16.7	5.5	0.9	14.3	5.5	1.1	6.9	5.9	1.5	4.46	12.03	16.15	5.66	88	94	92.4	75.3	75.0	83.5	-	26.1	4.9	31.0[1]	31.0
SINGAPORE	COASTAL															87	91	89.6	78.3	72.8	84.6	-	28.6	2.4	26.0[1]	30.7
KUALA PAHANG	COASTAL																									
KOTA BHARU	COASTAL															89	94	94.9	75.0	69.9	87.1	-	18.5	12.5	30.7[1]	30.7
BANGKOK (D)	20 MILES INLAND	5	8.2	4.8	1.2	22.8	5.2	1.0	19.6	2.6	0.6	3.16	6.46	10.22	2.55	91.0	96.3	92.1	77.9	65.2	88.9	-			-	-
ILOT-CONE (E)	COASTAL	2	13.3	5.0	1.0	17.7	3.5	2.5	-	13.3	4.4	3.54	28.21	49.76	12.99	-	-	90.9	77.8	80.8	82.9				19.2	24.0
PNOM PENH (F)	60 MILES INLAND	10	10.7	4.4	1.6	20.3	4.2	1.8	16.7	3.0	0.6	3.19	6.47	11.75	2.59	88	97	91.5	77.6	67.5	88.1				30.6	30.6
HA TIEN (G)	COASTAL	10	14.6	3.8	1.3	16.4	3.6	1.2	10.1	5.3	1.0	5.07	10.35	19.95	2.99	86	90	89.5	78.9	78.4	84.0				27.9	29.2
POULO OBI	ISLAND																	91.7	76.2	86.8	79.9				28.1	27.3
POULO CONDORE	ISLAND																	86.7	78.3	77.6	82.4				26.6	28.7
CAN THO	30 MILES INLAND	10	10.9	5.1	1.2	20.1	4.8	1.3	14.8	5.0	0.3	2.84	7.14	11.54	5.07	86	89	93.3	77.6	73.1	85.8				27.6	28.9
CAP ST JACQUES	COASTAL	10	9.3	5.1	1.1	21.7	4.3	1.7	16.1	5.4	0.2	2.61	6.99	9.17	3.95	85	92	91.3	77.1	81.4	82.5				28.2	28.6
SAIGON	30 MILES INLAND	9+	6.3	-	-	24.7	-	-	18.0	5.6	1.1	6.95	11.88	18.94	6.64	88	93	94.0	77.6	74.6	85.4				24.3	28.2
PHAN THIET (H)	COASTAL	5	20.3	4.2	2.0	10.7	5.6	0.6	4.5	5.8	0.4	3.84	7.51	10.89	5.08	-	-	89.7	77.1	68.5	86.6				23.4	28.5
PADARAN	COASTAL	10	23.0	1.6	1.9	8.0	3.7	0.1	7.2	0.7	0.1	2.37	1.40	3.35	0.15	84	95	82.9	78.3	77.6	82.1				30.2	30.4
DALAT (I)	50 MILES INLAND	9+	5.6	3.4	0.3	25.4	2.3	1.2	19.5	5.8	0.1	2.09	8.29	12.59	3.03	74	85	93.3	63.6	79.4	71.1				23.8	26.3
NHA TRANG (J)	COASTAL	10	16.1	1.0	2.8	14.7	4.3	0.1	13.1	1.0	0.6	1.73	2.55	4.29	1.14	92	101	87.4	77.7	69.2	88.8				30.6	30.7
TUY HOA	COASTAL																	80.6	79.6	59.5	90.4				30.7	30.4
QUI NHON	COASTAL	10	18.6	0.9	1.6	12.4	2.0	0.4	10.8	1.4	0.2	3.56	2.70	8.01	0.00	94	106	77.7	81.5	58.9	91.2				30.7	30.7
BONG SON	COASTAL																	80.5	79.7	51.8	91.9				29.4	30.4
QUANG NGAI (K)	COASTAL	10	21.9	2.1	1.7	9.1	3.2	0.8	5.4	3.2	0.5	2.60	5.03	11.50	0.73	95	104	81.8	78.2	62.8	92.1				30.3	30.5
TOURANE	COASTAL																	85.2	79.1	63.4	78.2				30.5	30.7
HUE	COASTAL																	87.4	79.0	66.0	91.1				30.2	30.7
TCHEPONE (L)	30 MILES INLAND	10	14.6	2.7	1.5	16.4	2.6	1.5	6.3	7.8	2.3	5.28	17.89	24.47	8.25	-	-	94.0	74.3	-	82.5				14.4	29.0
DONG HOI (M)	COASTAL	10	18.2	2.9	2.0	12.8	3.9	1.0	10.0	2.3	0.5	6.04	5.29	11.39	1.71	94	107	80.5	81.0	65.2	90.0				29.4	30.2
VINH	COASTAL	10	18.4	1.9	1.8	12.6	3.6	0.5	9.3	2.8	0.5	6.06	5.26	10.01	0.72	93	103	91.2	78.9	63.9	87.8	-	4.1	26.9	27.1	28.4
THANH HOA	COASTAL	10	14.5	4.0	1.6	16.5	4.2	1.2	10.5	4.4	1.6	6.61	11.49	16.66	3.44	92	107	93.1	78.9	73.1	86.4				25.8	29.2
NAMDINH	30 MILES INLAND															90	97	89.6	82.7	74.9	88.0	-	8.7	22.3	24.8[1]	26.3
PHU LIEN	COASTAL	10	10.5	4.0	1.5	20.5	3.9	1.6	12.8	5.7	2.0	7.47	14.56	38.67	6.39	-	-	94.2	78.1	81.4	84.2				25.5[1]	28.3
NORWAY IS.	ISLAND															87	90	87.1	81.9	79.2	85.1	-	17.7	13.3	29.6[1]	30.1
LANGSON (N)	COASTAL	10	10.4	3.9	1.1	20.6	3.1	2.0	12.8	6.7	1.1	5.67	11.90	28.91	6.82	88	98	89.2	76.9	73.6	84.7	-	19.4	11.6	17.9[1]	27.2
HAIPHONG	COASTAL															89	95	93.2	81.0	79.7	86.6	-	14.4	16.6	29.5[1]	30.3
HANOI	30 MILES INLAND	10	12.1	-	-	18.9	-	-	9.9	5.9	3.1	7.09	17.41	35.61	8.20	90	101	95.1	78.9	74.2	84.0	-	12.0	19.0	25.9	28.7
CONTON	COASTAL																	87.1	81.8	79.5	86.3				27.6[1]	28.2
MONCAY	COASTAL	10	11.5	4.2	0.9	19.5	2.2	2.6	9.5	6.5	3.5	8.11	22.70	47.00	4.06	90	99	92.8	79.4	80.6	86.4	-	10.3	20.7	28.9	30.4

*Letters indicate stations with complete records.

1 --- 700 MB

2 --- 900 MB

3 --- 1800 MB

4 --- 300 MB

5 --- 1200 MB

6 --- 1500 MB

TABLE 12 (Continued)

September

STATION	LOCATION	YEARS RECORD	DRY DAYS	SHORT DRY SPELLS 1-3 DAYS	LONG DRY SPELLS 4 DAYS	RAINY DAYS	SHORT RAINY SPELLS 1-3 DAYS	LONG RAINY SPELLS 4 DAYS	LIGHT RAINY DAYS TRACE TO 0.49"	HEAVY RAINY DAYS .50 to 1.99"	VERY HEAVY RAINY DAYS OVER 2.00"	ABSOLUTE MAXIMUM OVER RECORD PERIOD	MEAN RAINFALL FOR MONTH	GREATEST MONTHLY RAINFALL	LEAST MONTHLY RAINFALL	MEAN MAXIMUM TEMPERATURE	EXTREME MAXIMUM TEMPERATURE	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 0400 HRS	MONTHLY AVERAGE: TEMPERATURE AT 0400 HRS	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 1300 HRS	MONTHLY AVERAGE: TEMPERATURE AT 1300 HRS	COOL DAYS UNDER 70°F	WARM DAYS 70-90°F	HOT DAYS OVER 90°F	DAYS SUITABLE FOR CONTACT FLIGHT AT 0400	DAYS SUITABLE FOR CONTACT FLIGHT AT 1300
AKYAB	COASTAL															86	98	87.3	80.6^4	85.4	81.7^5	-	28.1	1.9	22.4^2	26.3^3
RANGOON	30 MILES INLAND															86	94	86.5	80.5^4	84.4	80.5^5	-	27.2	2.8	17.9^2	20.7^3
TAVOY	COASTAL																									
VICTORIA	COASTAL															84	85	90.4	77.9^4	88.0	77.3^5	-	30.0	-	26.7^2	27.2^3
ALOR STAR	COASTAL															87	91	96.6	74.9^2	72.6	84.9^6	-	26.8	3.3	29.3^1	29.7
PENANG (A)*	COASTAL	10	12.1	2.9	1.9	17.9	4.0	1.1	9.7	5.7	2.5	8.50	15.08	26.57	3.83	88	93	84.1	81.5^2	76.9	85.0^6	-	22.1	7.9		
WELLESLEY (B)	COASTAL	10	14.0	3.6	1.3	16.0	4.3	1.0	8.8	5.3	1.9	13.80	15.05	30.21	3.30	91	98	76.6	82.9^2	68.5	86.8^6	-	9.2	20.8		
KUALA LUMPUR	25 MILES INLAND															90	94	95.3	74.0	62.8	86.7	-	12.8	17.2	25.1^1	29.7
MALACCA (C)	COASTAL	10	15.7	5.9	0.8	14.3	5.1	1.4	9.8	4.4	0.7	4.15	8.74	15.43	3.08	88	99	92.9	73.2	74.7	83.3		27.6	2.4	29.7^1	29.7
SINGAPORE	COASTAL															87	91	90.0	78.0	71.7	84.7	-	27.8	2.2	27.2^1	30.0
KUALA PAHANG	COASTAL															88	93	95.1	75.1	66.1	86.6	-	23.0	7.0	29.7^1	30.0
KOTA BHARU	COASTAL																									
BANGKOK (D)	20 MILES INLAND	5	7.4	2.8	2.2	22.6	4.2	1.0	15.2	6.4	1.0	3.91	10.73	16.70	6.06	90.1	95.4	94.3	77.4	67.9	87.8				-	-
ILOT-CONE (E)	COASTAL	2	18.3	5.0	1.0	11.7	4.3	2.0	9.6	6.1	-	2.40	12.63	27.91	4.08	-	-	93.1	76.7	80.8	82.9				18.5	24.8
PHNOM PENH (F)	60 MILES INLAND	10	6.9	5.5	0.4	23.1	4.0	1.9	16.9	5.6	0.6	2.63	8.91	13.07	5.89	87	92	91.9	78.0	71.9	86.9				29.0	28.9
HA TIEN (G)	COASTAL	10	15.9	3.1	1.4	14.1	3.3	1.3	6.8	5.7	1.6	4.12	14.72	49.26	3.11	85	89	90.1	78.3	79.5	84.1				27.8	27.9
POULO OBI	ISLAND																	93.2	75.9	87.9	78.7				27.7	27.1
POULO CONDORE	ISLAND																	87.2	77.8	79.9	81.8				25.3	26.1
CAN THO	50 MILES INLAND	10	7.8	4.9	0.6	22.2	3.6	2.1	15.3	5.8	1.1	3.25	10.51	13.64	4.35	86	90	94.3	77.7	76.0	84.4				27.0	28.8
CAP ST JACQUES	COASTAL	10	9.8	4.8	1.2	20.2	5.0	1.2	15.4	4.4	0.4	2.36	7.10	10.83	4.66	85	93	91.1	76.6	79.8	82.4				27.0	28.5
SAIGON	30 MILES INLAND	9	5.9	-	-	24.1	-	-	16.1	6.9	1.1	5.22	12.92	18.66	8.02	88	96	94.9	77.2	75.0	84.5				19.8	29.3
PHAN THIET (H)	COASTAL	5	20.7	4.2	2.2	9.3	5.8	0.6	5.0	4.1	0.2	6.38	5.72	10.36	1.67	-	-	91.1	75.9	70.6	85.7				19.7	28.3
PADARAN	COASTAL	10	17.2	3.3	1.9	12.8	4.2	0.6	10.5	2.3	-	1.59	3.15	6.67	1.05	85	93	84.3	78.0	77.6	83.8				28.6	28.8
DALAT (I)	50 MILES INLAND	9	2.3	2.3	0.2	27.7	1.1	1.4	17.2	9.9	0.6	3.72	13.99	20.72	8.88	76	84	93.9	63.1	79.0	71.8				25.3	27.2
NHA TRANG (J)	COASTAL	10	13.1	3.8	1.2	16.9	3.8	1.2	13.0	3.5	0.4	3.21	6.24	11.04	0.16	90	101	91.3	76.5	69.8	87.8				29.9	29.6
TUY HOA	COASTAL																	88.7	77.4	65.9	87.4				28.5	29.3
QUI NHON	COASTAL	10	9.2	4.7	1.5	20.8	5.1	1.1	16.3	3.6	0.9	4.28	8.16	14.61	1.05	89	102	86.9	78.3	67.2	87.4				28.4	28.9
BONG SON	COASTAL																	90.8	76.6	62.0	87.3				26.7	28.2
QUANG NGAI (K)	COASTAL	10	16.8	2.8	2.0	13.2	3.6	1.0	8.6	4.2	0.4	3.44	6.49	12.58	3.61	90	102	84.2	76.5	71.4	87.8				25.7	29.0
TOURANE	COASTAL																	92.8	76.6	71.3	85.9				27.5	28.3
HUE	COASTAL																	92.1	76.9	74.8	87.0				28.1	28.9
TCHEPONE (L)	30 MILES INLAND	10	21.9	1.7	1.9	8.1	3.1	0.5	3.1	3.1	1.9	5.82	10.90	24.42	1.33	90	98	86.4	73.4	-	83.4				13.1	26.1
DONG HOI (M)	COASTAL	10	12.5	3.8	1.8	17.5	3.7	1.6	10.5	4.4	2.6	10.31	17.26	44.28	6.30	89	106	87.6	77.8	74.1	86.5	-	12.3	17.7	26.3	28.1
VINH	COASTAL	10	14.2	2.5	1.8	15.8	3.2	1.4	9.6	3.9	2.3	6.32	11.78	18.76	3.79	88	103	84.4	77.1	72.2	85.0				23.9	27.1
THANH HOA	COASTAL	10	14.8	3.6	1.5	15.2	3.8	1.2	8.9	4.8	1.5	2.71	11.47	19.46	2.71	89	101	93.8	77.0	75.9	85.0				23.7	26.9
NAMDINH	20 MILES INLAND															87	93	88.2	79.0	73.7	84.6	-	17.7	12.2	23.4^1	26.3
PHU LIEN	COASTAL	10	12.1	3.4	1.3	17.9	3.5	1.3	11.7	5.0	1.2	19.31	12.92	46.98	2.36	-	-	93.1	76.7	79.4	84.4				26.1	28.1
NORWAY IS.	ISLAND															86	93	77.3	79.9	64.5	83.6	-	20.0	10.0	25.7^1	27.9
LANGSON (N)	COASTAL	10	18.3	2.6	1.8	11.7	3.9	0.7	8.9	2.1	0.7	6.26	5.90	15.00	0.87	86	97	88.9	72.8	70.3	81.0	-	19.4	10.6	20.6	26.8
HAIPHONG	COASTAL															86	93	90.5	78.5	78.3	84.9	-	22.8	7.2	27.5^1	27.8
HANOI	50 MILES INLAND	10	16.5	-	-	13.5	-	-	8.2	3.9	1.4	5.39	9.84	17.04	2.10	88	99	84.5	77.1	73.0	85.0	-	18.0	11.9	24.3	29.0
[illegible]	COASTAL																	90.9	78.7	78.0	83.4				25.7^1	27.9
MONCAY	COASTAL	10	17.9	3.0	1.7	12.1	3.4	1.1	6.0	4.2	1.9	10.8	13.87	27.07	4.29	89	102	88.9	78.4	69.0	84.9	-	26.6	3.3	28.3	29.9

*Letters indicate stations with complete records.

1 --- 700 HR

2 --- 900 HR

3 --- 1800 HR

4 --- 300 HR

5 --- 1200 HR

6 --- 1500 HR

TABLE 12 (Continued)

MONTH: October

STATION	TERRAIN LOCATION	YEARS RECORD	DRY DAYS	SHORT DRY SPELLS 1-3 DAYS	LONG DRY SPELLS 4 DAYS	RAINY DAYS	SHORT RAINY SPELLS 1-3 DAYS	LONG RAINY SPELLS 4 DAYS	LIGHT RAINY DAYS TRACE TO 0.49"	HEAVY RAINY DAYS .50 TO 1.99"	VERY HEAVY RAINY DAYS OVER 2.00"	ABSOLUTE MAXIMUM OVER RECORD PERIOD	MEAN RAINFALL FOR MONTH	GREATEST MONTHLY RAINFALL	LEAST MONTHLY RAINFALL	MEAN MAXIMUM TEMPERATURE	EXTREME MAXIMUM TEMPERATURE	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 0600 HRS	MONTHLY AVERAGE: TEMPERATURE AT 0600 HRS	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 1300 HRS	MONTHLY AVERAGE: TEMPERATURE AT 1300 HRS	COOL DAYS UNDER 70° F	WARM DAYS 70-90° F	HOT DAYS OVER 90° F	DAYS SUITABLE FOR CONTACT FLIGHT AT 0600	DAYS SUITABLE FOR CONTACT FLIGHT AT 1300
AKYAB	COASTAL															86	90	83.4	79.3[4]	81.9	80.7[5]	-	28.5	2.5	25.0[2]	29.0[3]
RANGOON	30 MILES INLAND															89	98	79.8	82.7[4]	76.3	83.4[5]	-	15.2	15.8	29.2[2]	29.4[3]
TAVOY	COASTAL																									
VICTORIA	COASTAL															84	84	85.8	79.8[4]	88.1	78.0[5]	-	31	-	28.6[2]	30.0[3]
ALOR STAR	COASTAL															87	92	96.6	74.9[2]	74.4	84.5[6]	-	27.6	3.4	29.7[1]	31.0
PENANG (A)*	COASTAL	10	9.4	2.7	2.5	21.6	4.0	0.9	11.9	7.9	1.8	6.91	16.38	32.11	10.17	88	92	82.5	81.5[2]	74.6	85.2[6]	-	22.9	8.1		
WELLESLEY (B)	COASTAL	10	9.0	3.5	1.7	22.0	4.4	0.7	11.9	6.5	3.6	5.50	20.10	32.08	9.16	90	98	78.2	82.5[2]	71.8	85.8[6]	-	12.3	18.7		
KUALA LUMPUR	25 MILES INLAND															89	96	95.5	74.5	65.2	86.0	-	16.2	14.8	27.6[1]	30.7
MALACCA (C)	COASTAL	10	15.0	4.3	1.6	16.0	5.1	0.9	10.3	5.0	0.7	3.34	8.73	16.51	1.15	88	92	92.4	75.5	74.2	83.4	-	27.3	3.7	31.0[1]	30.7
SINGAPORE	COASTAL															87	91	91.5	77.3	71.5	84.9		28.6	2.4	29.7[1]	31.0
KUALA PAHANG	COASTAL																									
KOTA BHARU	COASTAL															87	92	95.5	75.2	69.6	85.3	-	28.2	2.8	30.7[1]	31.0
BANGKOK (D)	20 MILES INLAND	5	14.5	2.4	1.2	16.5	2.0	0.8	10.9	4.5	1.1	3.79	8.47	14.82	4.28	89.6	95.2	93.1	77.1	68.6	87.0				-	-
ILOT-CONE (E)	COASTAL	2	25.3	1.0	2.0	5.7	3.5	0.0	2.0	3.7	-	1.97	5.61	13.11	0.00	-	-	91.8	75.6	75.1	82.9				26.8	29.5
PHNOM PENH (F)	60 MILES INLAND	10	11.7	4.9	0.9	19.3	4.2	1.5	13.7	4.9	0.7	3.92	8.95	17.31	4.41	86	91	92.0	77.7	70.2	85.8				28.9	30.0
HA TIEN (G)	COASTAL	10	15.8	3.6	1.7	15.2	4.0	0.9	7.6	6.8	0.8	3.08	10.06	7.02	6.05	84	87	91.6	77.4	76.8	83.9				28.8	29.0
POULO OBI	ISLAND																	93.9	75.4	86.7	79.3				26.5	28.6
POULO CONDORE	ISLAND																	88.1	77.7	79.9	82.5				26.2	29.3
CAN THO	30 MILES INLAND	10	12.2	6.5	1.4	18.8	5.8	1.4	11.3	6.8	0.7	3.60	10.42	19.22	5.76	85	89	91.5	78.5	71.8	85.5				29.6	30.1
CAP ST JACQUES	COASTAL	10	14.2	3.7	1.4	16.8	3.4	1.4	12.7	3.3	0.8	5.91	7.39	16.61	2.02	84	92	90.9	76.0	78.8	81.7				28.7	29.5
SAIGON	30 MILES INLAND	9+	8.9	-	-	22.1	-	-	15.5	5.6	1.0	3.63	9.97	15.33	3.58	88	94	94.6	76.4	71.9	84.8				24.1	30.1
PHAN THIET (H)	COASTAL	5	24.3	2.2	1.2	6.7	3.4	0.6	3.3	2.9	0.5	4.65	5.47	13.17	1.39	-	-	93.1	75.4	73.1	84.6				20.1	27.9
PADARAN	COASTAL	10	16.2	3.3	1.7	14.8	4.0	1.0	11.5	2.8	0.6	3.81	5.30	9.81	0.49	83	92	86.2	76.2	76.3	82.3				28.2	29.0
DALAT (I)	50 MILES INLAND	9+	10.7	2.7	0.7	20.3	2.5	1.5	13.7	5.7	0.9	3.60	9.90	18.94	2.82	75	82	91.4	61.9	78.5	72.8				29.0	29.0
NHA TRANG (J)	COASTAL	10	10.5	3.9	1.2	20.5	4.2	1.1	12.7	5.4	2.4	7.25	16.73	35.52	3.51	86	95	91.4	75.4	71.7	85.5				29.3	30.5
TUY HOA	COASTAL																	93.4	76.1	73.5	82.7				25.6	27.5
QUI NHON	COASTAL	10	7.8	2.7	1.3	23.2	2.2	1.7	15.2	5.2	2.8	7.25	17.74	28.97	6.74	84	99	89.7	76.7	73.7	83.8				27.6	28.1
BONG SON	COASTAL																	90.6	74.8	64.9	84.0				25.2	28.3
QUANG NGAI (K)	COASTAL	10	14.3	3.3	1.3	16.7	3.2	1.5	8.0	5.9	2.8	19.30	22.16	35.97	5.06	85	94	94.7	75.1	73.7	83.2				24.4	27.0
TOURANE	COASTAL																	91.2	75.4	75.2	82.2				26.7	27.2
HUE	COASTAL																	93.4	74.5	76.6	82.5				28.2	28.2
TCHEPONE (L)	30 MILES INLAND	10	26.6	0.6	1.0	4.4	2.0	0.1	2.3	1.2	0.9	6.55	6.03	18.13	0.00	84	91	94.6	70.8	-	82.9				23.5	29.9
DONG HOI (M)	COASTAL	10	13.5	2.4	1.6	17.5	2.6	1.9	10.2	4.4	2.9	9.04	17.51	29.73	5.90	83	99	85.0	75.5	74.6	82.7	-	23.7	7.3	26.1	27.5
VINH	COASTAL	10	17.3	2.5	2.1	13.7	3.6	1.5	8.7	3.1	1.9	6.33	11.54	18.16	1.93	83	99	93.5	73.6	64.3	81.8				21.8	28.0
THANH HAO	COASTAL	10	21.8	1.8	2.0	9.2	3.0	0.6	6.7	1.5	1.0	12.18	6.50	19.52	2.40	85	99	92.5	72.8	63.1	82.3				24.3	28.3
NAMDINH	20 MILES INLAND															84	91	84.4	75.3	61.2	82.0	1.2	24.8	5.0	23.0[1]	26.3
PHU LIEN	COASTAL	10	17.9	1.5	1.6	13.1	2.7	0.5	11.2	1.6	0.3	5.13	3.30	10.90	0.72	-	-	80.7	72.7	66.3	82.0				27.5	28.5
NORWAY IS.	ISLAND															82	88	75.2	78.3	67.7	81.6	-	31.0	-	31.0[1]	30.4
LANGSON (N)	COASTAL	10	22.7	1.9	2.3	8.3	3.5	0.3	6.4	1.8	0.1	2.40	2.64	6.44	0.82	81	94	77.6	68.7	58.0	79.2	-	31.0	-	20.8	28.0
HAIPHONG	COASTAL															85	91	85.9	75.2	65.7	82.6	-	27.2	3.8	29.3[1]	29.6
HANOI	30 MILES INLAND	10	21.0	-	-	10.0	-	-	7.9	1.7	0.4	4.77	3.82	7.55	0.19	84	96	93.9	72.8	59.3	82.7	-	26.0	5.6	22.6[1]	30.1
CAMPHA	COASTAL																	80.8	75.5	66.2	82.1				27.3[1]	29.9
MONCAY	COASTAL	10	22.0	1.5	2.0	9.0	2.8	0.7	6.1	2.3	0.6	6.99	6.00	19.06	0.55	85	98	76.8	73.3	67.2	81.4	-	15.7	10.3	28.6	30.6

*Letters indicate stations with complete records.

1 --- 700 HR

2 --- 900 HR

3 --- 1800 HR

4 --- 300 HR

5 --- 1200 HR

6 --- 1500 HR

STATION	LOCATION	YEARS RECORD	DRY DAYS	SHORT DRY SPELLS 1-3 DAYS	LONG DRY SPELLS 4 DAYS	RAINY DAYS	SHORT RAINY SPELLS 1-3 DAYS	LONG RAINY SPELLS 4 DAYS	LIGHT RAINY DAYS TRACE TO 0.49"	HEAVY RAINY DAYS .50 to 1.99"	VERY HEAVY RAINY DAYS OVER 2.00"	ABSOLUTE MAXIMUM OVER RECORD PERIOD	MEAN RAINFALL FOR MONTH	GREATEST MONTHLY RAINFALL	LEAST MONTHLY RAINFALL	MEAN MAXIMUM TEMPERATURE	EXTREME MAXIMUM TEMPERATURE	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 0600 HRS	MONTHLY AVERAGE: TEMPERATURE AT 0600 HRS	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 1300 HRS	MONTHLY AVERAGE: TEMPERATURE AT 1300 HRS	COOL DAYS UNDER 70° F	WARM DAYS 70-90° F	HOT DAYS OVER 90° F	DAYS SUITABLE FOR CONTACT FLIGHT AT 0600	DAYS SUITABLE FOR CONTACT FLIGHT AT 1300
AKYAB	COASTAL															85	91	81.2	75.5[4]	79.0	77.9[5]		28.1	0.9	27.7[2]	29.6[3]
	30 MILES																									
RANGOON	INLAND															90	100	75.6	79.4[4]	69.2	82.2[5]		15.0	15.0	29.3[2]	26.1[3]
TAVOY	COASTAL																									
VICTORIA	COASTAL															84	86	79.7	78.8[4]	79.3	77.7[5]	-	30.0	-	29.3[2]	29.1[3]
ALOR STAR	COASTAL															87	92	97.0	74.3[2]	71.6	85.4[6]	-	24.6	5.4	28.0[1]	29.7
PENANG (A)*	COASTAL	10	10.4	4.0	1.3	19.6	4.8	0.8	12.2	6.1	1.3	7.03	12.91	20.22	4.23	87	92	82.9	81.4[2]	76.6	84.3[6]	-	24.6	5.4		
WELLESLEY (B)	COASTAL	10	10.4	3.5	1.9	19.6	4.3	1.0	10.4	6.8	2.4	6.20	17.37	33.75	3.78	89	96	79.5	81.9[2]	73.3	85.2[6]	-	14.5	15.5		
	25 MILES																									
KUALA LUMPUR	INLAND															89	94	96.3	74.1	65.8	86.0	-	17.0	13.0	25.3[1]	29.3
MALACCA (C)	COASTAL	10	12.7	5.0	1.2	17.3	5.1	1.1	10.8	6.2	0.3	2.34	8.54	11.51	4.31	87	93	93.5	75.2	73.5	83.6	-	26.1	3.9	30.0[1]	29.3
SINGAPORE	COASTAL															87	92	92.3	76.7	72.4	84.9	-	26.0	4.0	27.7[1]	30.0
KUALA PAHANG	COASTAL																									
KOTA BHARU	COASTAL															84	90	96.6	75.1	77.9	82.4	-	29.8	0.2	29.0[1]	28.3
	20 MILES																									
BANGKOK (D)	INLAND	5	21.0	3.4	0.4	9.0	1.8	2.2	6.2	2.8	-	1.63	3.23	5.72	1.31	88.2	95.9	91.5	75.7	65.9	86.6				-	-
ILOT-COME (E)	COASTAL	2	29.3	1.0	2.0	0.7	3.5	-	0.3	0.4	-	0.59	0.33	0.98	0.00	-	-	89.4	75.7	69.7	85.3				28.9	27.8
	60 MILES																									
PHNOM PENH (F)	INLAND	10	18.9	2.3	1.1	11.1	2.9	0.7	8.2	2.6	0.3	2.22	4.45	11.56	1.18	85	93	89.1	76.6	68.2	85.9				29.0	29.0
HA TIEN (G)	COASTAL	10	19.7	2.5	1.0	10.3	3.0	1.1	6.2	3.1	1.0	5.12	7.12	14.57	0.00	85	88	92.7	76.2	75.0	83.0				29.1	29.3
POULO OBI	ISLAND																	93.8	74.6	85.9	79.4				25.1	25.5
POULO CONDORE	ISLAND																	88.8	77.0	78.7	81.2				28.7	28.0
	50 MILES																									
CAN THO	INLAND	10	17.8	3.1	2.0	12.2	4.7	0.7	8.2	3.3	0.7	7.79	7.62	18.46	3.20	85	88	90.4	77.6	69.3	86.1				26.8	29.1
CAP ST JACQUES	COASTAL	10	19.9	2.3	1.4	10.1	2.6	1.0	8.9	1.1	0.1	2.05	2.16	4.58	0.00	83	92	90.5	75.6	77.0	82.0				29.3	29.9
	30 MILES																									
SAIGON	INLAND	9+	14.8	-	-	15.2	-	-	11.5	3.2	0.5	5.16	6.45	10.12	3.28	87	95	93.8	75.4	67.6	85.9				23.4	29.7
PHAN THIET (H)	COASTAL	5	28.3	2.0	1.2	1.7	1.8	-	1.2	0.4	0.1	4.96	1.35	6.57	0.00	-	-	92.3	74.5	68.4	85.5				20.9	28.9
PADARAN	COASTAL	10	17.3	3.8	0.5	12.7	2.1	2.0	9.3	2.6	0.8	5.91	6.70	15.27	0.76	81	91	87.4	75.7	79.6	79.6				27.4	28.8
	50 MILES																									
DALAT (I)	INLAND	9+	16.6	1.8	1.2	13.4	1.9	0.9	10.3	2.7	0.4	2.56	4.58	8.27	0.02	74	84	88.3	62.2	72.0	71.8				27.0	27.9
NHA TRANG (J)	COASTAL	10	11.2	2.4	1.5	18.8	2.2	1.6	11.4	4.5	2.9	9.00	17.14	28.71	3.99	84	92	91.7	74.7	78.6	82.7				27.9	28.8
TUY HOA	COASTAL																	92.1	75.7	80.8	80.3				24.7	24.7
QUI NHON	COASTAL	10	6.8	3.2	1.2	23.2	2.2	2.1	15.8	3.9	3.5	12.17	20.00	66.33	4.04	81	91	88.7	76.0	79.6	81.0				25.1	27.0
NONG SON	COASTAL																	89.9	74.4	72.8	81.3				20.1	25.4
QUANG NGAI (K)	COASTAL	10	10.5	2.9	1.1	19.5	1.8	2.2	8.8	5.4	5.3	11.69	31.24	59.77	7.99	81	93	93.9	73.6	81.2	80.3				20.1	24.4
TOURANE	COASTAL																	91.3	73.5	82.1	78.5				24.2	24.2
HUE	COASTAL																	93.9	72.1	84.5	77.7				24.7	25.9
	50 MILES																									
TCHEPONE (L)	INLAND	10	28.8	-	0.6	1.2	0.5	-	0.6	0.5	0.1	2.08	0.63	2.16	0.00	81	93	91.3	69.5	-	78.5				24.7	28.0
DONG HOI (M)	COASTAL	10	10.5	4.1	0.9	19.5	2.9	1.8	12.0	5.6	1.9	6.98	13.87	27.54	7.10	78	90	77.6	71.0	73.3	77.3	2.0	27.9	-	23.0	24.1
VINH	COASTAL	10	15.3	2.3	2.3	14.7	3.0	1.1	11.3	2.7	0.7	4.21	6.18	18.15	0.71	77	92	92.5	69.0	74.5	74.4				19.4	23.1
THANH HAO	COASTAL	10	19.5	2.3	2.0	10.5	3.8	0.5	9.7	0.7	0.1	4.09	1.58	6.81	0.37	78	91	90.6	67.8	68.0	76.1				20.2	27.3
	20 MILES																									
NAMDINH	INLAND															80	86	80.3	69.7	65.2	75.8	1.6	28.4	-	18.7[1]	24.5
PHU LIEN	COASTAL	10	19.6	1.5	1.8	10.4	2.7	0.5	9.7	0.5	0.2	3.78	1.72	4.66	0.03	-	-	86.7	67.0	67.4	75.4				26.9[1]	28.8
NORWAY IS.	ISLAND															77	82	69.9	71.8	66.4	75.4	2.7	27.2	-	29.4[1]	30.0
LANGSON (N)	COASTAL	10	23.2	0.7	2.1	6.8	2.3	0.1	6.3	0.4	0.1	2.83	0.97	4.35	0.10	74	91	77.1	60.3	58.6	71.1	12.9	17.2	-	18.1	26.8
HAIPHONG	COASTAL															80	88	73.8	69.9	60.3	77.5	2.4	27.6	-	27.7[1]	28.7
	50 MILES																									
HANOI	INLAND	10	20.8	-	-	9.2	-	-	8.8	0.4	-	0.94	0.86	1.57	0.07	76	97	91.9	67.1	62.3	76.3	2.3	27.8	-	20.3[1]	28.8
CANTON	COASTAL																	70.3	70.3	71.3	75.3				28.2[1]	27.9
MONCAY	COASTAL	10	24.4	2.0	0.4	5.6	0.7	2.2	4.6	0.8	0.2	6.49	2.21	8.98	0.00	78	90	77.9	66.2	62.7	75.5	No data			27.2	29.0

MONTH
November

*Letters indicate stations with complete records.

1 --- 700 HR

2 --- 900 HR

3 --- 1800 HR

4 --- 300 HR

5 --- 1200 HR

6 --- 1500 HR

TABLE 12 (Concluded)

MONTH: December

STATION	TERRAIN LOCATION	YEARS RECORD	DRY DAYS	SHORT DRY SPELLS 1-3 DAYS	LONG DRY SPELLS 4 DAYS	RAINY DAYS	SHORT RAINY SPELLS 1-3 DAYS	LONG RAINY SPELLS 4 DAYS	LIGHT RAINY DAYS TRACE TO 0.49"	HEAVY RAINY DAYS .50 to 1.99"	VERY HEAVY RAINY DAYS OVER 2.00"	ABSOLUTE MAXIMUM OVER RECORD PERIOD	MEAN RAINFALL FOR MONTH	GREATEST MONTHLY RAINFALL	LEAST MONTHLY RAINFALL	MEAN MAXIMUM TEMPERATURE	EXTREME MAXIMUM TEMPERATURE	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 0600 HRS	MONTHLY AVERAGE: TEMPERATURE AT 0600 [HRS]	MONTHLY AVERAGE: RELATIVE HUMIDITY AT 1300 HRS	MONTHLY AVERAGE: TEMPERATURE AT 1300 HRS	COOL DAYS UNDER 70° F	WARM DAYS 70-90° F	HOT DAYS OVER 90° F	DAYS SUITABLE FOR CONTACT FLIGHT AT 0600	DAYS SUITABLE FOR CONTACT FLIGHT AT 1300
AKYAB	COASTAL															82	89	84.9	69.2[4]	75.8	73.6[5]	-	31.0	-	28.0[2]	30.2[3]
RANGOON	30 MILES INLAND															90	94	71.7	77.0[4]	62.5	82.9[5]	-	11.7	19.3	30.3[2]	28.6[3]
TAVOY	COASTAL																									
VICTORIA	COASTAL															88	88	78.6	79.4[4]	76.6	79.1[5]	-	31.0	-	30.4[2]	30.1[3]
ALOR STAR	COASTAL															88	92	96.0	72.5	65.1	86.4	-	23.6	7.4	31.0[1]	30.7
PENANG (A)*	COASTAL	10	20.9	5.4	0.5	10.1	3.9	1.9	7.3	2.6	0.2	2.65	4.00	7.42	1.38	88	93	79.4	81.2[2]	71.6	85.4[6]	-	24.5	6.5		
WELLESLEY (B)	COASTAL	10	18.1	5.0	0.7	12.9	3.9	2.3	8.5	3.3	1.1	8.65	8.32	25.95	2.48	90	97	78.7	81.2[2]	69.5	86.2[6]	-	13.0	18.0		
KUALA LUMPUR	25 MILES INLAND															89	95	97.0	73.4	61.5	86.7	-	16.9	14.1	23.8[1]	31.0
MALACCA (C)	COASTAL	10	16.6	4.9	1.4	14.4	4.9	1.5	10.1	3.4	0.9	3.33	6.93	12.31	2.74	87	91	93.2	74.6	70.8	84.0	-	27.2	3.8	31.0[1]	31.0
SINGAPORE	COASTAL															87	92	93.7	75.7	70.8	84.7	-	25.8	5.2	30.7[1]	31.0
KUALA PAHANG	COASTAL																									
KOTA BHARU	COASTAL															83	87	94.8	74.6	77.2	81.5	-	31.0	-	30.3[1]	29.7
BANGKOK (D)	20 MILES INLAND	5	26.8	1.4	0.0	4.2	0.4	0.8	3.6	0.6	-	1.15	0.83	2.77	0.01	87.3	95.2	90.5	70.1	58.0	85.6				-	-
ILOT-CONE (E)	COASTAL	2	30.0	-	0.5	1.0	-	-	0.3	0.7	-	1.38	1.18	3.54	0.00	-	-	86.1	72.5	64.8	82.6				30.1	31.0
PHNOM PENH (F)	60 MILES INLAND	10	25.8	0.4	1.5	5.2	1.7	0.2	3.8	1.2	0.2	2.52	2.16	6.94	0.00	85	92	86.1	72.0	57.8	84.0				29.8	30.7
HA TIEN (G)	COASTAL	10	28.0	0.7	1.2	3.0	1.6	0.1	1.6	1.2	0.2	3.54	1.85	10.26	0.00	85	88	90.8	72.6	67.7	82.1				30.6	30.6
POULO OBI	ISLAND																	91.4	71.4	83.7	76.7				28.9	29.7
POULO CONDORE	ISLAND																	84.3	75.4	74.4	80.0				29.9	30.5
CAN THO	30 MILES INLAND	10	25.3	1.3	1.8	5.7	3.1	-	4.2	1.1	0.4	1.48	1.20	3.14	0.00	84	88	89.0	74.5	64.3	84.8				27.8	30.7
CAP ST JACQUES	COASTAL	10	24.6	0.9	1.7	6.4	2.2	0.4	6.1	0.3	-	0.59	0.58	1.32	0.01	82	91	89.1	72.9	74.2	80.0				29.9	30.0
SAIGON	30 MILES INLAND	9+	22.2	-	-	8.8	-	-	8.0	0.7	0.1	2.79	1.47	2.85	0.53	87	97	93.1	71.7	59.7	84.6				20.5	29.3
PHAN THIET (H)	COASTAL	5	29.2	0.2	0.6	1.8	0.6	-	1.5	0.3	-	0.82	0.35	0.82	0.00	-	-	93.3	70.6	63.8	82.8				24.0	30.4
PADARAN	COASTAL	10	21.5	1.3	1.6	9.5	2.7	0.3	7.7	1.4	0.4	4.33	2.98	12.86	0.00	78	87	82.8	72.7	75.4	77.8				29.7	29.3
DALAT (I)	50 MILES INLAND	9+	23.8	1.2	1.4	7.2	2.1	0.2	6.3	0.7	0.2	2.20	1.37	4.98	0.03	73	85	88.1	58.5	67.3	69.2				27.9	30.5
NHA TRANG (J)	COASTAL	10	12.3	2.9	1.4	18.7	3.7	0.9	14.8	3.5	0.4	5.22	6.36	20.75	0.05	82	91	88.0	71.4	68.5	80.7				29.2	30.6
TUY HOA	COASTAL																	90.7	71.7	76.9	77.2				24.4	27.2
QUI NHON	COASTAL	10	8.0	3.9	1.3	23.0	3.3	1.7	20.5	1.9	0.6	4.00	5.18	17.06	0.72	78	87	87.6	71.7	75.7	77.4				27.3	29.0
BONG SON	COASTAL																	87.7	69.9	65.3	76.8				22.6	29.4
QUANG NGAI (K)	COASTAL	10	12.7	3.6	1.5	18.3	3.1	1.8	12.2	4.9	1.2	11.48	11.13	29.13	1.64	78	88	93.9	68.9	77.3	76.1				20.4	26.1
TOURANE	COASTAL																	89.8	68.5	77.3	74.1				25.9	28.5
HUE	COASTAL																	93.9	66.1	83.6	73.0				23.7	27.8
TCHEPONE (L)	30 MILES INLAND	10	30.9	-	0.1	0.1	0.1	-	0.1	-	-	0.15	0.02	0.15	0.00	83	95	89.7	62.1	-	74.8				27.6	30.6
DONG HOI (M)	COASTAL	10	14.0	2.9	1.7	17.0	2.9	1.6	13.0	3.7	0.3	4.47	6.18	10.96	0.76	73	85	80.2	64.2	70.3	71.4	5.0	25.0	1.0	24.6	25.7
VINH	COASTAL	10	16.2	2.6	2.0	14.8	4.1	0.8	12.3	2.5	-	1.55	3.28	7.06	0.14	72	89	93.9	63.0	69.0	69.9				14.9	23.4
THANH HAO	COASTAL	10	20.6	1.7	2.0	10.4	3.4	0.3	9.5	0.9	-	1.03	1.24	2.22	0.05	73	89	91.0	61.6	64.9	70.8				18.2	26.2
NAMDINH	20 MILES INLAND															71	84	80.5	62.0	59.4	70.2	12.4	18.6	-	12.4[1]	24.4
PHU LIEN	COASTAL	10	18.2			12.8			11.9	0.9	-	1.44	1.41	3.38	0.08	-	-	84.0	60.6	63.3	69.7				26.3	29.4
NORWAY IS.	ISLAND															70	81	71.4	63.4	67.5	65.8	18.6	12.4	-	28.5[1]	29.3
LANGSON (N)	COASTAL	10	23.0	1.0	1.5	8.0	2.6	0.2	7.6	0.4	-	1.75	1.13	2.50	0.14	68	88	88.6	59.0	82.5	62.5	24.1	6.9	-	19.2	24.3
HAIPHONG	COASTAL															70	84	80.0	61.9	63.8	68.8	11.8	19.2		24.2[1]	29.0
HANOI	50 MILES INLAND	10	21.4	-	-	9.6	-	-	8.7	0.9	-	1.83	1.32	1.39	0.13	72	89	91.6	59.5			13.0	18.0		24.8[1]	25.7
CANTON	COASTAL																	78.6	60.2	67.3	65.3				18.5	28.0
MONCAY	COASTAL	10	21.7	2.1	2.6	9.3	3.1	0.8	8.4	0.9	-	1.77	1.91	3.50	0.24	71	88	80.5	59.2	61.5	67.7	No data			24.6	29.5

*Letters indicate stations with complete records.

1 --- 700 HR

2 --- 900 HR

3 --- 1800 HR

4 --- 300 HR

5 --- 1200 HR

6 --- 1500 HR

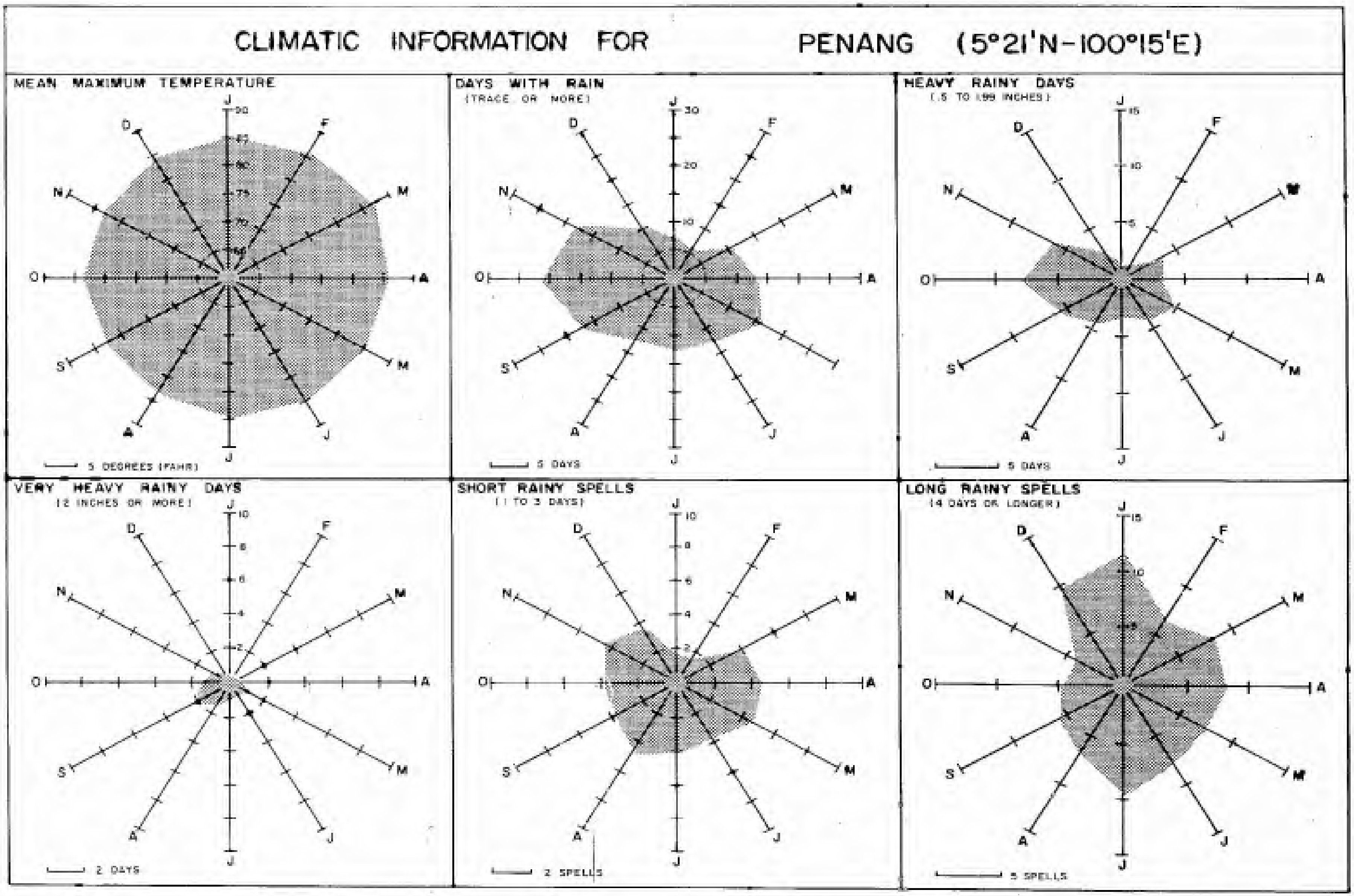


Fig. 14. Climatic Information—Penang.

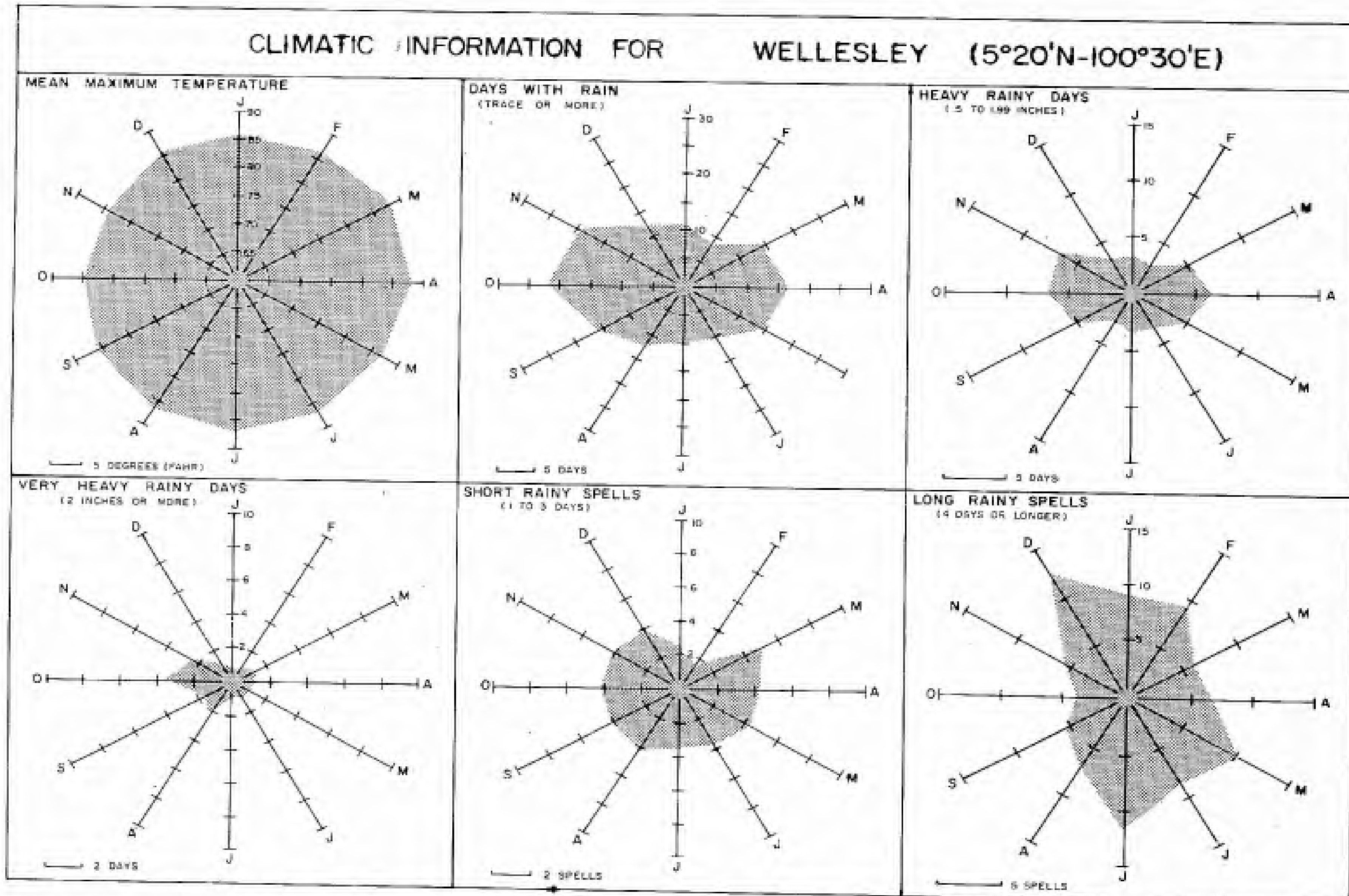


Fig. 15. Climatic Information—Wellesley.

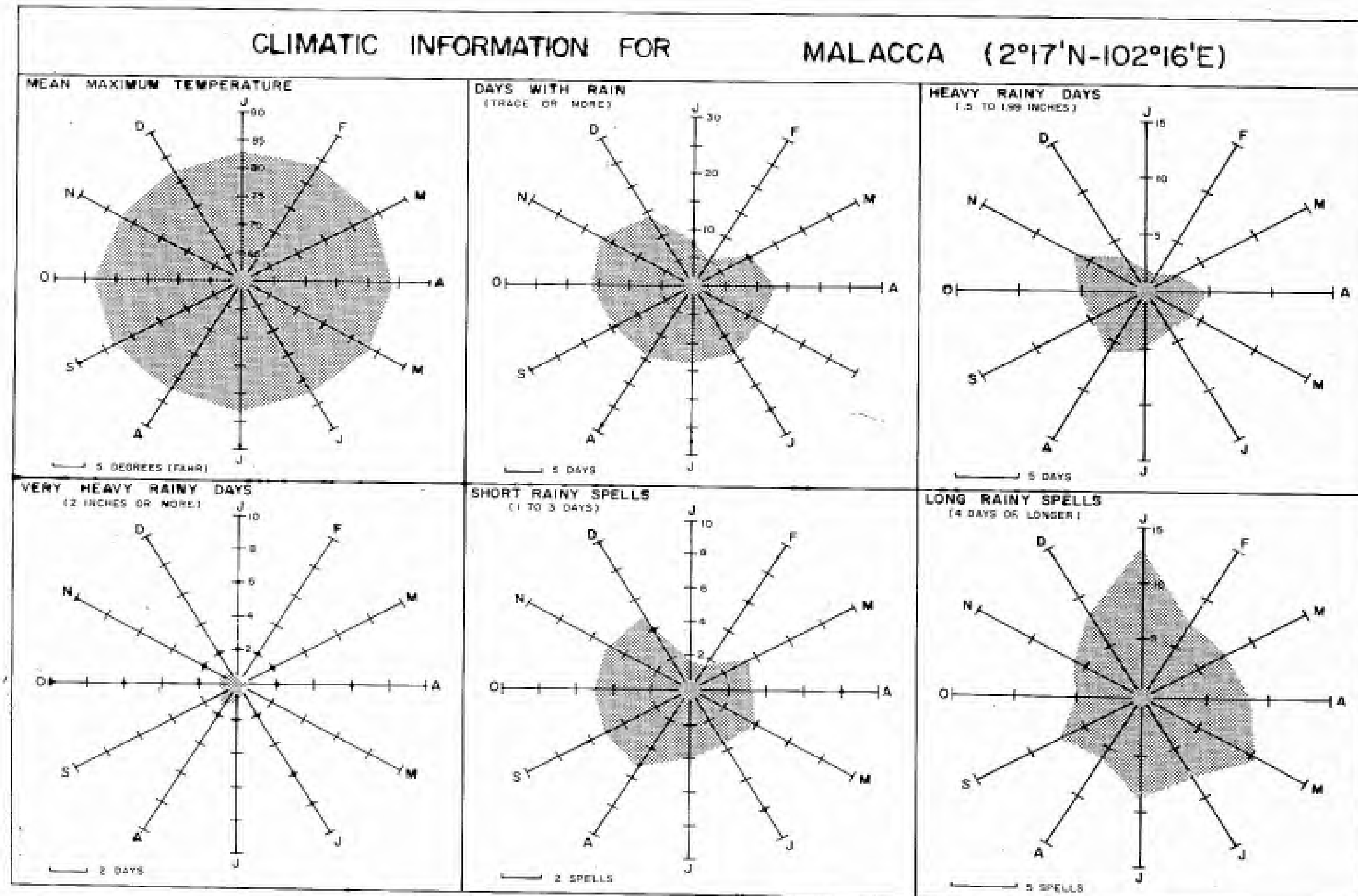


Fig. 16. Climatic Information—Malacca.

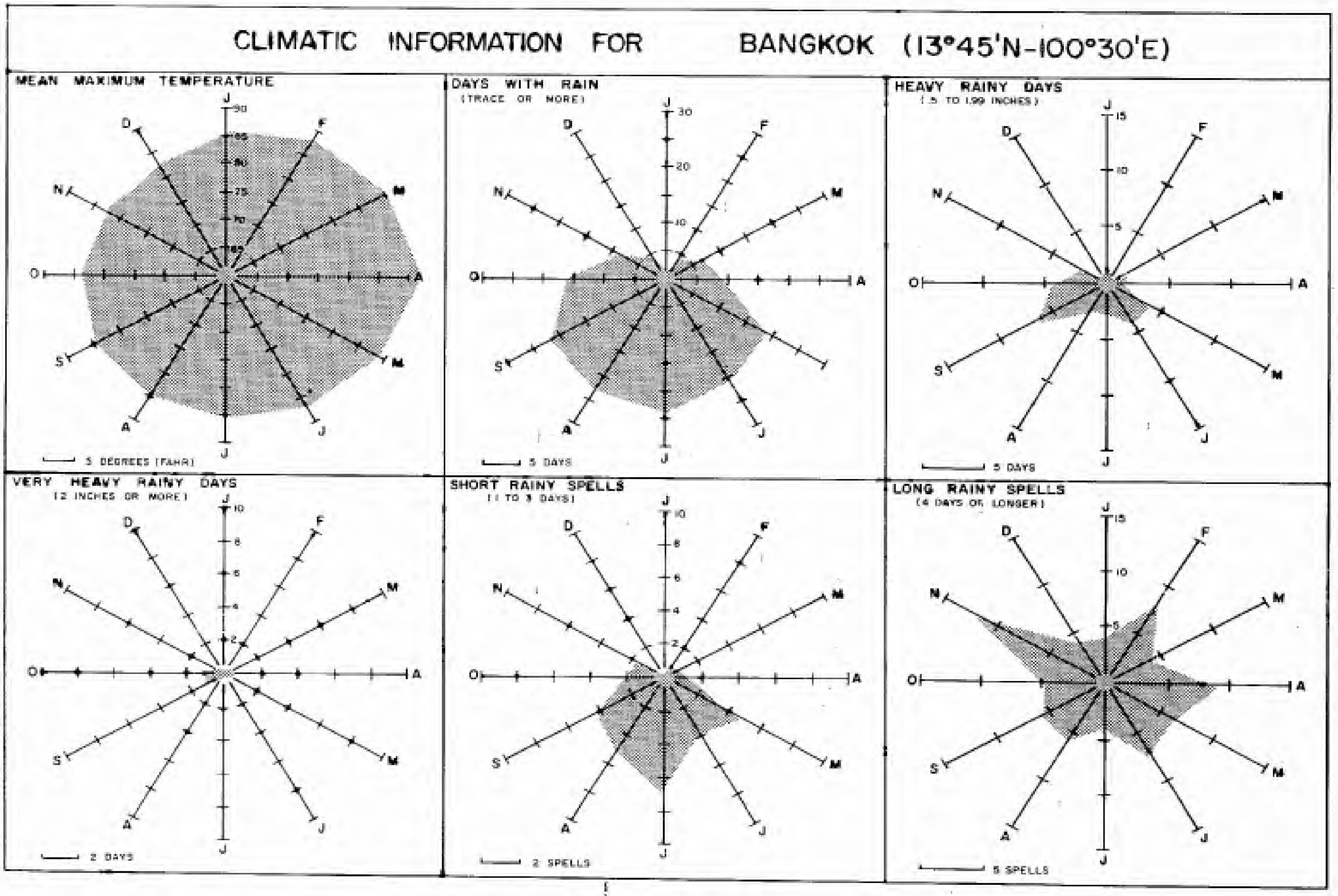


Fig. 17. Climatic Information—Bangkok.

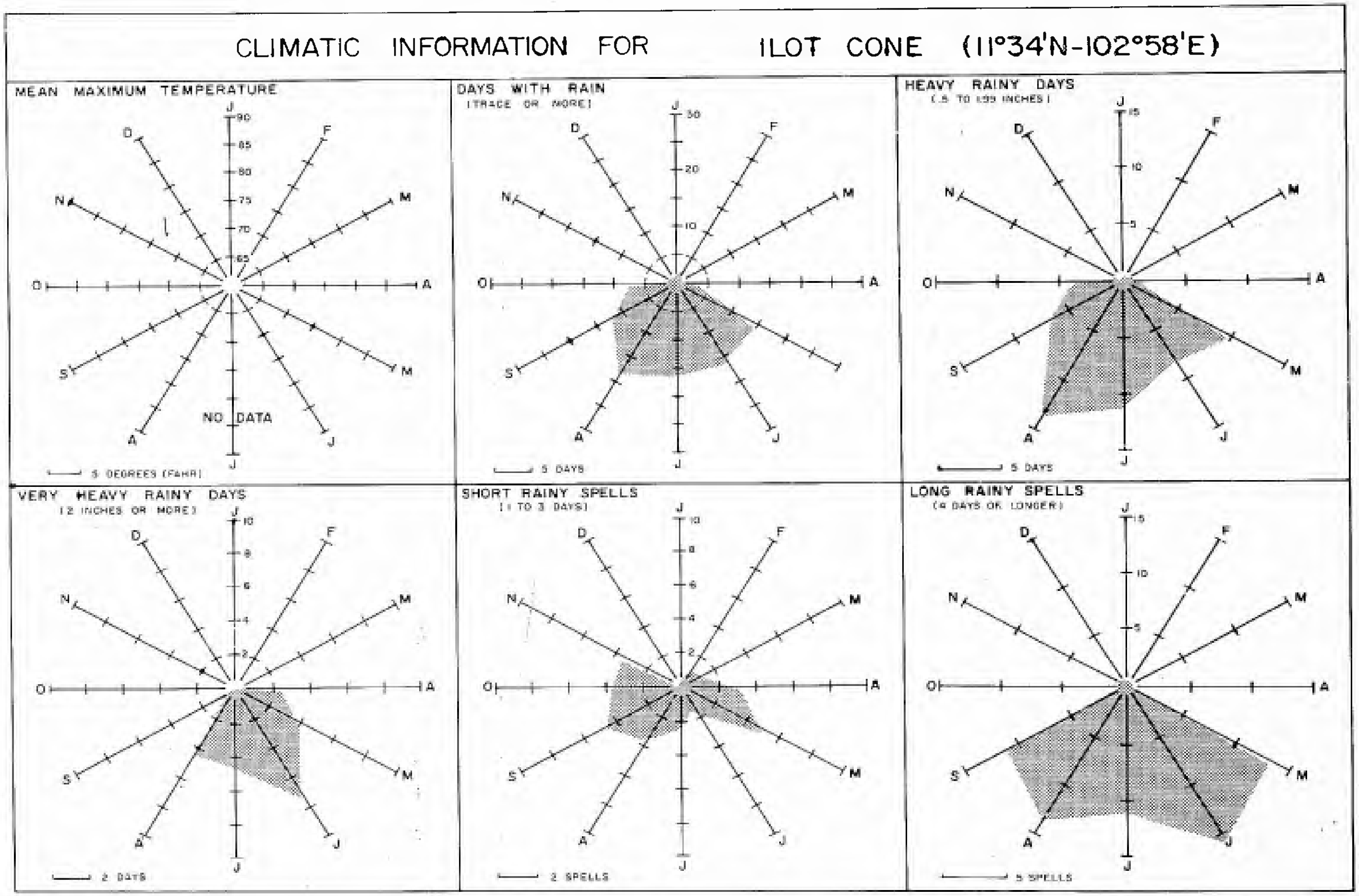


Fig. 18. Climatic Information—Ilot Cone.

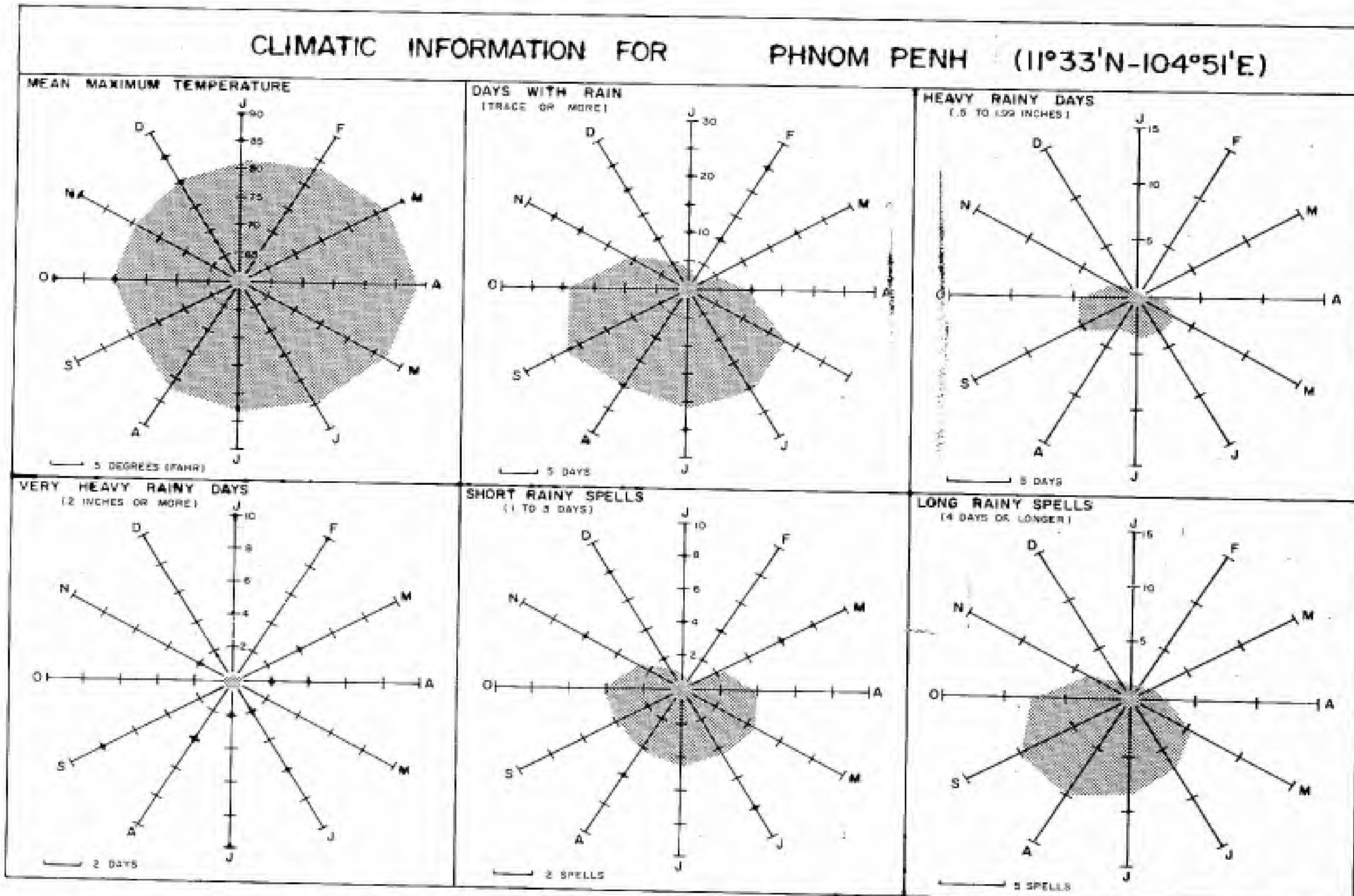


Fig. 19. Climatic Information—Phnom Pehn.

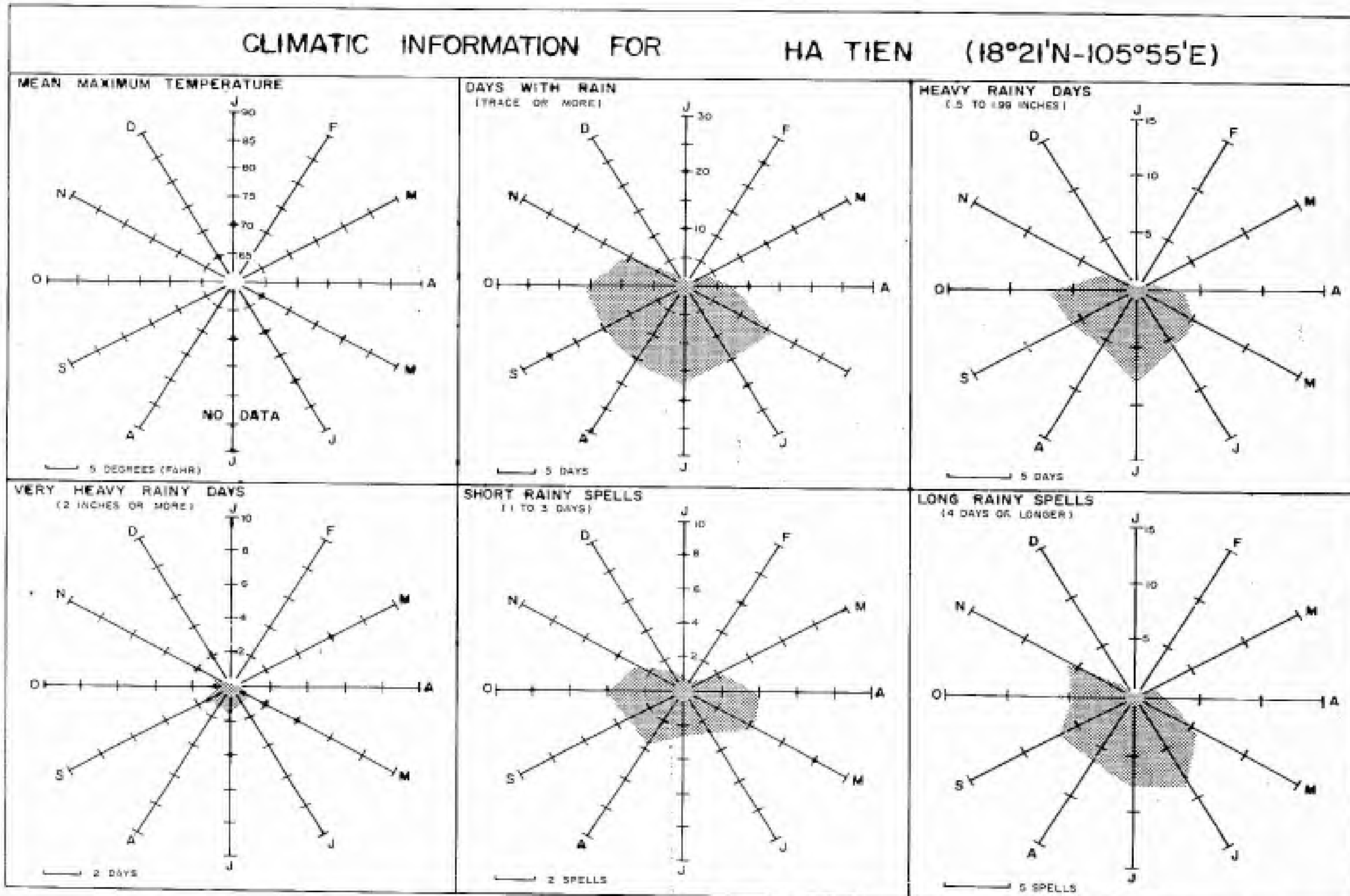


Fig. 20. Climatic Information—Ha Tien.

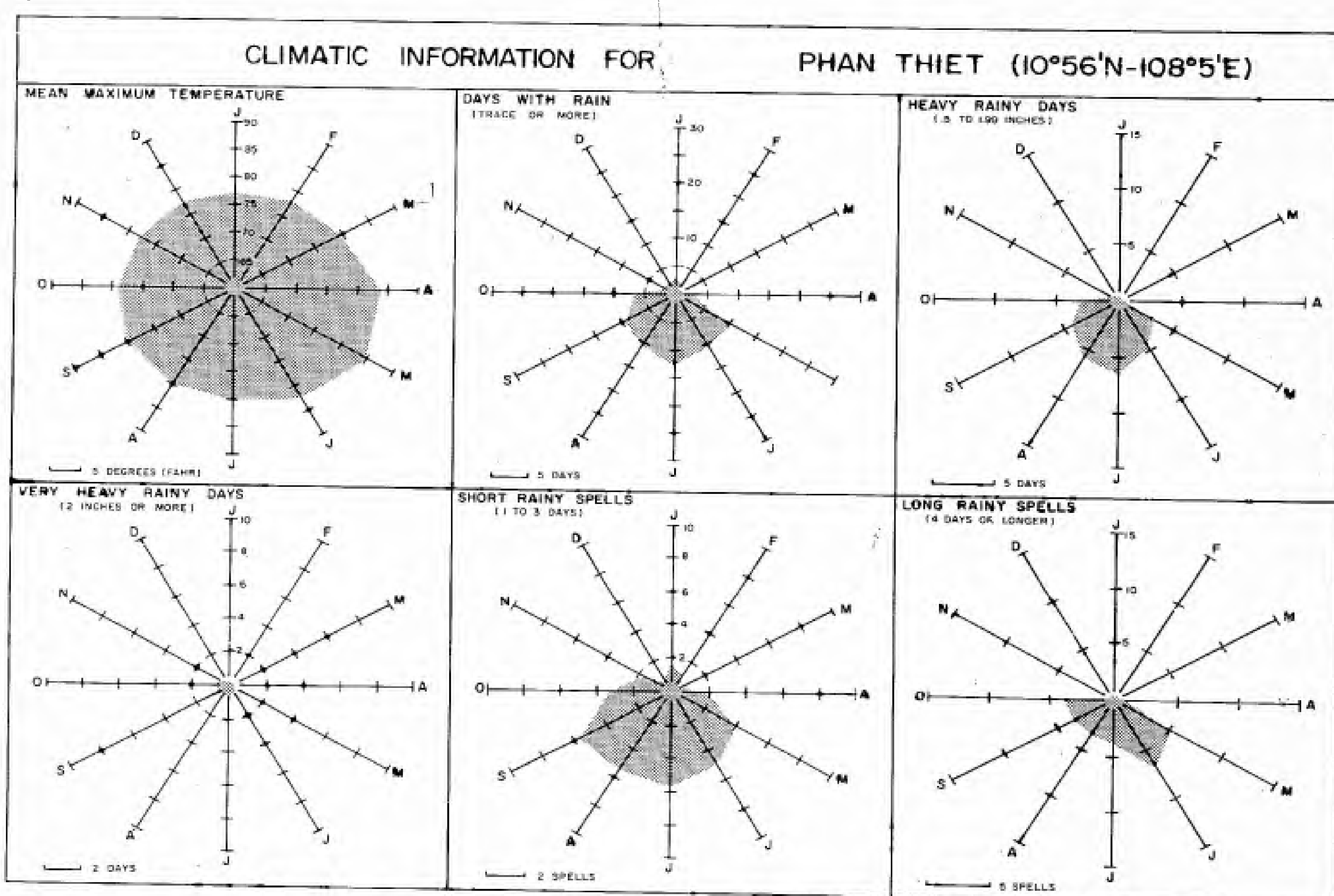


Fig. 21. Climatic Information—Phan Thiet.

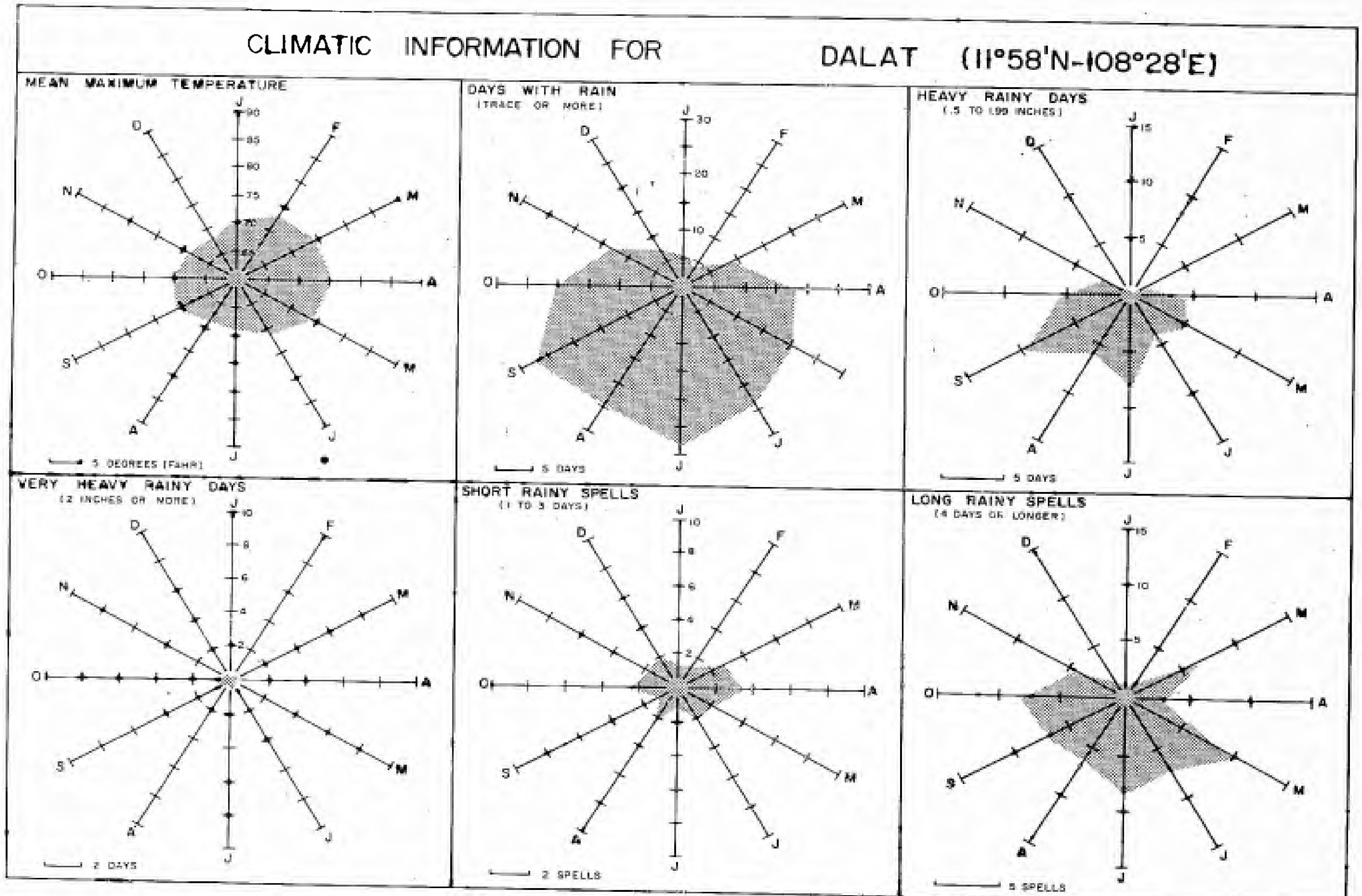


Fig. 22. Climatic Information—Dalat.

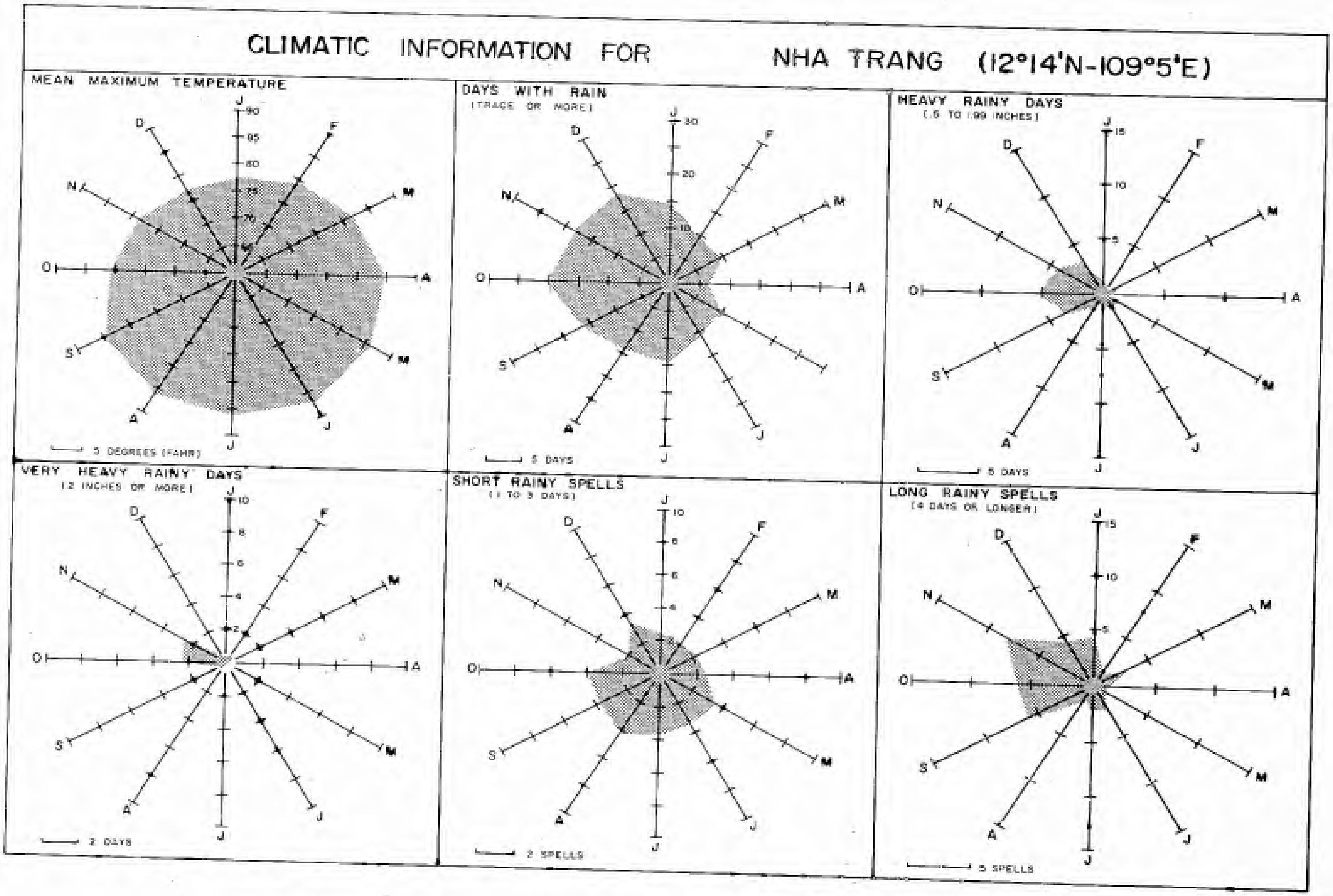


Fig. 23. Climatic Information—Nha Trang.

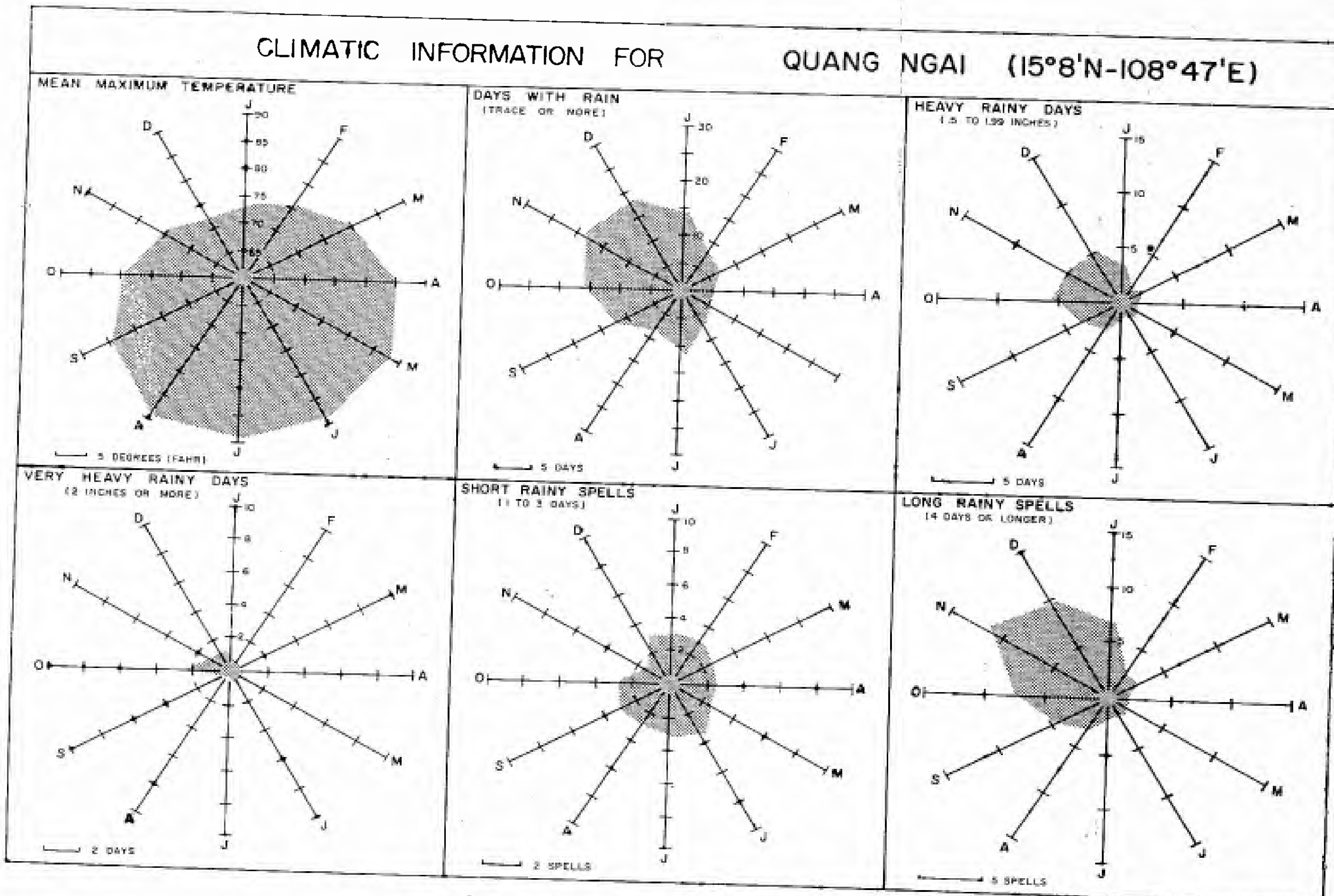


Fig. 24. Climatic Information—Quang Ngai.

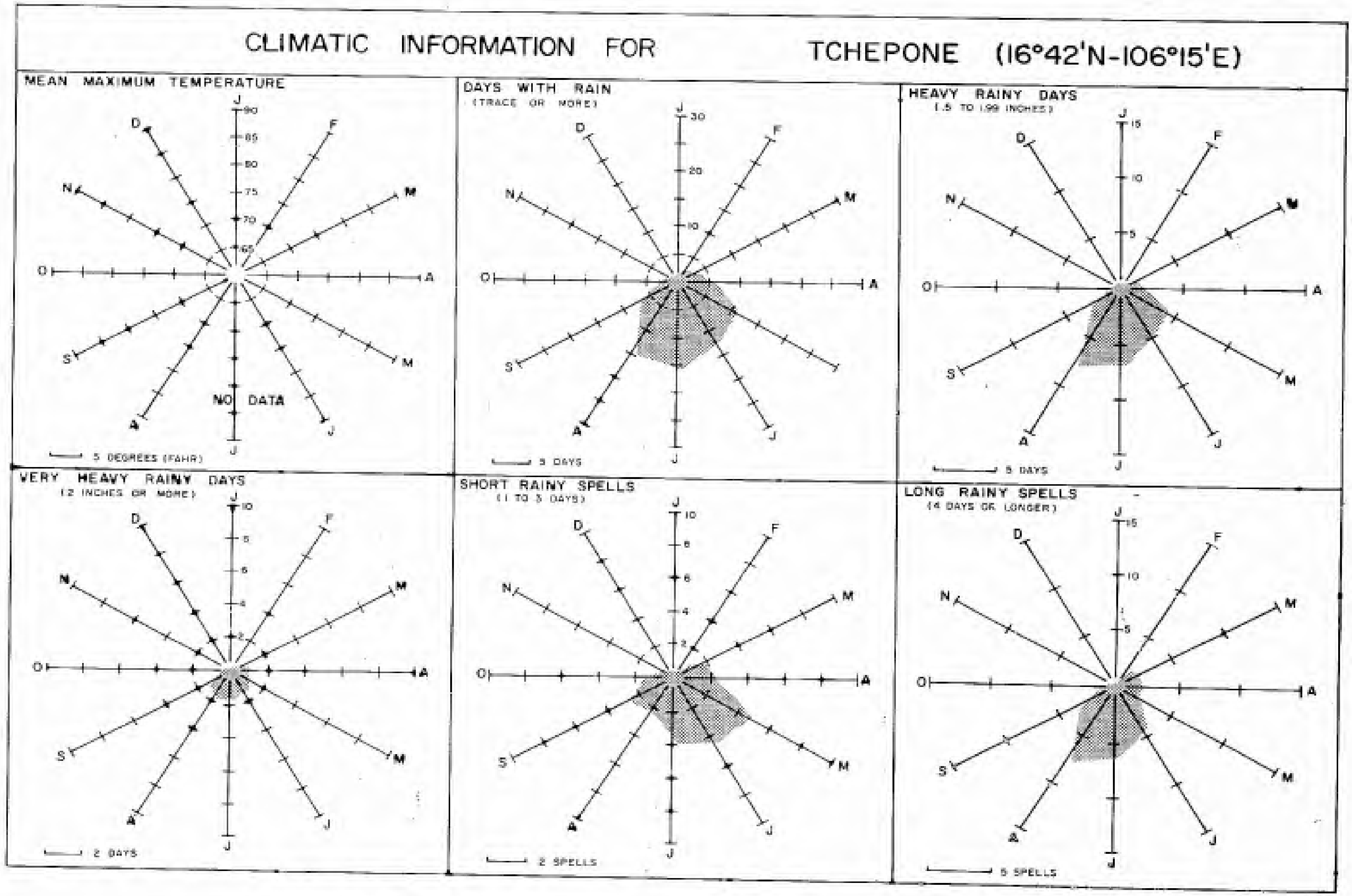


Fig. 25. Climatic Information—Tchepone.

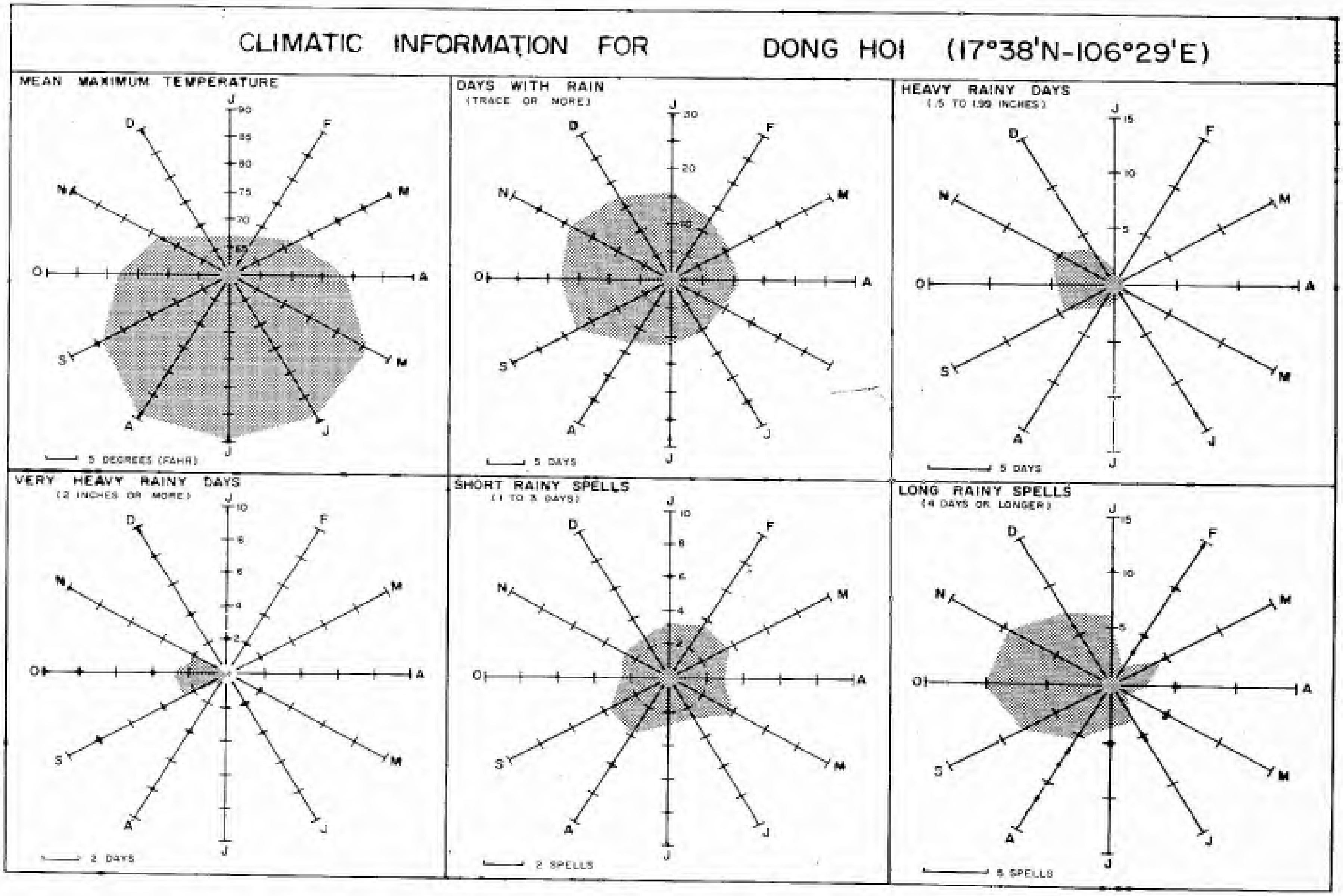


Fig. 26. Climatic Information—Dong Hai.

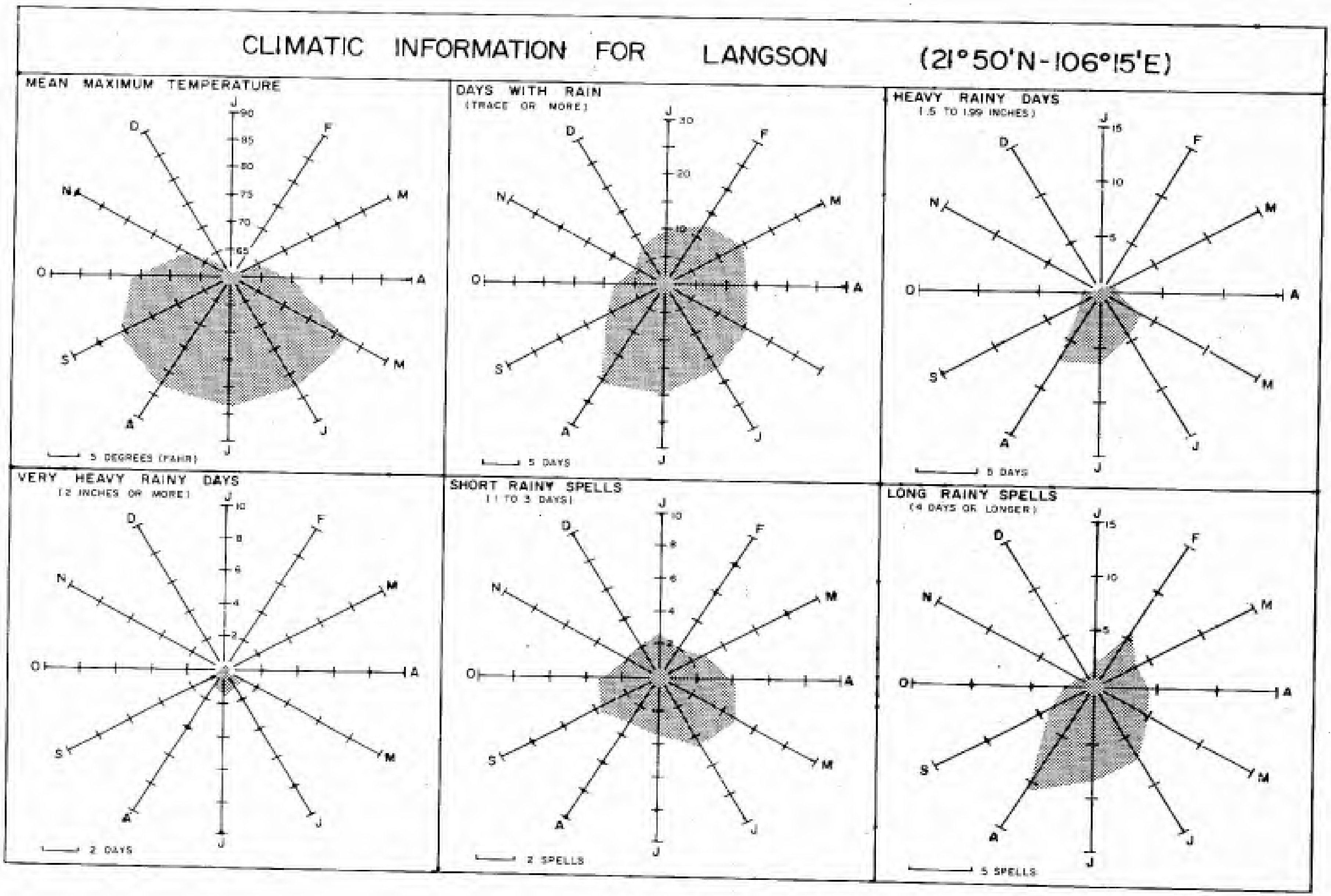


Fig. 27. Climatic Information—Langson.

V. NATURAL VEGETATION AND LAND COVER

About two-thirds of the project area, including almost all of the hill-mountain country and 20% of the plain surface is covered with one or another kind of forest growth. Most of the remainder of the identifiable cover on the plains is rice paddy fields.

Because of the concealment it offers, the forest growth is an important part of the military environment as demonstrated by the current guerrilla fighting in the area.

Broad areas of rice paddies present a special kind of military environment in which, during the wet season at least, heavy equipment cannot be used to advantage.

The character of this cover together with the facts of surface and climate which have been presented earlier point toward an assumption that military operations in this area are likely to be done by relatively small bodies of troops, with hand weapons, and will require strong air support for communication and supply.

The land cover of the coastal strip of Southeast Asia may be separated into the following broad categories:

1. Littoral Forests

2. Tropical Rain Forests—primary and secondary

3. Tropical Dry Deciduous forests

4. Savanna Grasslands with thin forests and brush

5. Freshwater Swamps—coastal and riverine

6. Cultivated Land—tree plantations and rice paddy

Each of the natural categories is a composition of associations of vegetation varying in species and density as well as in changes resulting from centuries of human occupation. None of them are homogeneous types and all have great interspersion and differences resulting from edaphic drainage, and exposure in their local environments. The following generalized descriptions are composites from those obtained in the United States as well as locally in Southeast Asia.

Littoral Forests. These are those found actually on the sea coast or within a few hundred yards of it and extending inland in some places along river estuaries.

Mangrove. This is a term applied to forest growth of a variety of trees which have a common habit of growth. They occur in the shallow water of muddy coasts which are protected against strong waves and heavy surf. Mangroves form a relatively thick growth consisting of trees of two characters: one bears "stilt" roots which support the main trunk from the sides and form "knees" that make an impassable tangle at low tide; they are about awash at high tide; the other is supported by a wide lateral root system and is therefore somewhat more easy to traverse than the former. The available maps do not differentiate these two kinds of mangrove growth. The barrier effect of mangroves occurs partly from the density of the stand and partly from the mud in which they grow. On the landward side this may be only a foot or more in depth but on the seaward side is deeper so that it is impossible to wade ashore through and over the slippery stilt roots.

Other Littoral Cover. On fairly stable sand dunes and sandy coasts there is a sparce cover of herbaceous plants and small trees which presents no problems of penetration. On waterlogged coastal soils, in places inland of the mangrove fringe, there may be a relatively dense forest growth of thin-stemmed trees—"tram" in the Indo-China parts—together with heavy brush. Some is of swampy nature in which "visibility at eye level is seldom more than ten yards." This cover is known from description but is not identified as a separate type on the available maps; probably it is a kind of fresh water swamp.

Tropical Rain Forest. This is a dense, storied forest, the typical growth of those parts of the area where the distribution and amount of precipitation is such that there is no effective dry season in the soil. It is of evergreen-broadleaf character and is composed of an intimate mixture of many species. The rain forest occurs in two different aspects, its primary form and its secondary form.

Primary Rain Forest. Is an association of tall trees with interlocking crowns which form a closed canopy over the ground. A few tall trees thrust their crowns up through the canopy, and on the forest floor there is a clumpy growth of shade-tolerant brush and seedlings. It is not difficult to traverse the tropical rain forest because of the open nature of the ground but many of the trees are supported by buttress roots that extend out from the tree trunks narrowing the space between. There is an abundance of epiphytes and lianas. The closed canopy probably would cut down radio communication. Fig. 28 is a generalized drawing of this forest.

It is our belief that little primary rain forest occurs within the coastal strip under description because of the centuries of occupation by shifting cultivators. Most of that indicated on the general map is probably secondary forest of somewhat different character. Map 16 shows the interspersion of primary and secondary forest along the VietNam coast.

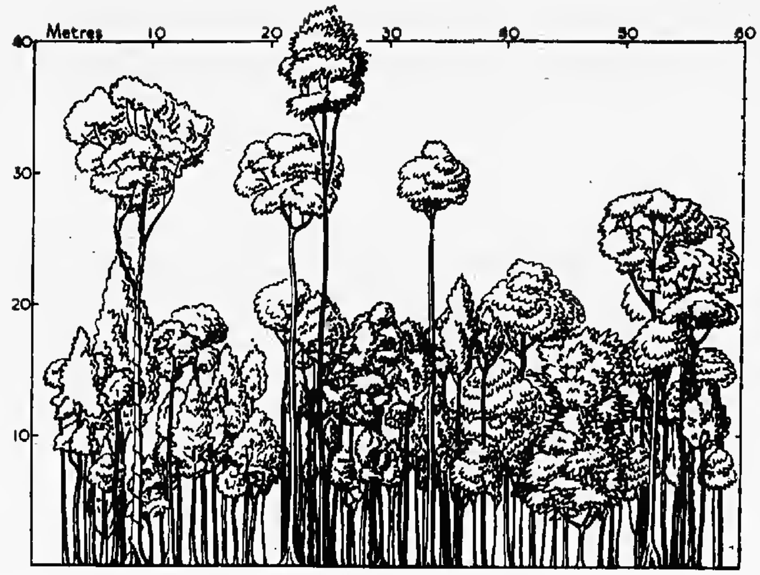


Fig. 28. Profile of a Rain Forest. From: Indo-China, Geographical Handbook Series, B.R. 510, Naval Intelligence Division, London.

Secondary Rain Forest. For some centuries the rain forest has been used by shifting cultivators who girdle trees to let in light for crops. Within a few years the resulting jungle growth prohibits cultivation and the site is abandoned. It is estimated that several hundred years are required for the rain forest to regain its climax condition. The secondary forests are, therefore, any stage between abandonment and climax development. Clearings are first invaded by heavy grass growth which survives under repeated burnings that destroy some of the other immature vegetation. The forest floor develops a heavy brushy growth containing numerous small trees with lianas and climbers to form jungle thickets so dense as to require cutting for penetration. However this thicket growth occurs in clumps and may be circumvented. Tree reproduction in secondary forests consists of a dense growth of saplings. small and close together. For these reasons the secondary forest is not so readily traversable as the primary type but probably is much better for radio communication.

Subtropical Mountain Forest. Above altitudes of 2500 ft this replaces the rain forest. It is a broadleaf-evergreen forest commonly not with a dense, closed canopy; somewhat similar in appearance to a midlatitude open forest. In wet situations there is a heavy brushy growth on the forest floor; in dry places this may consist of a low cover of bracken fern or herbaceous plants. In the coastal area under description this occurs only in one narrow distribution on the flanks of the mountains of northern Burma.

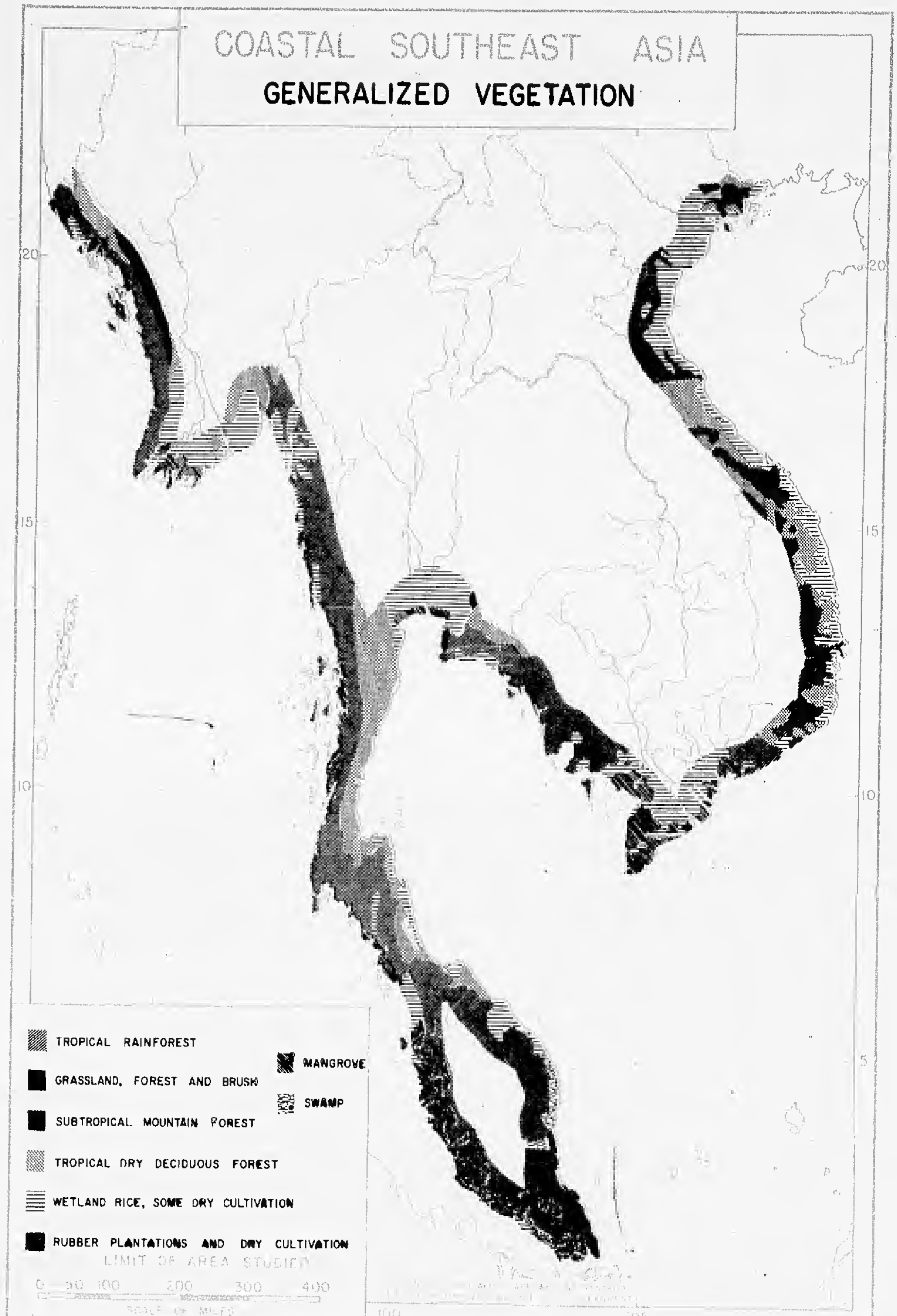
Tropical Dry Deciduous Forest. Are found in situations where there is an effective dry season in the climate that causes the trees to shed all or some of their leaves. It consists of a relatively open forest with patches of dense brush, especially along streams. It is also called "monsoon Forest" from its climatic association. In terms of its trafficability, the dry deciduous forest resembles secondary rain forest but because of the rarity of lianas and brushy patches is much more easy to traverse. During the dry season most of the trees are bare so that visibility and radio communication probably are good. The fallen leaves burn readily and the forest may be subject to repeated firings.

Grassland, Forest, and Brush. This category appears in four places on the general vegetation map but probably is not a climax type in itself. Grass and brush have been described as components of both the secondary rain forests and the dry deciduous forests and the map distributions may be considered as somewhat more extensive areas of these components. The grassy savanna areas occur in climatic situations where deciduous forests would be expected and possibly represent poorer soils where tree generation is slow or which have been repeatedly burned.

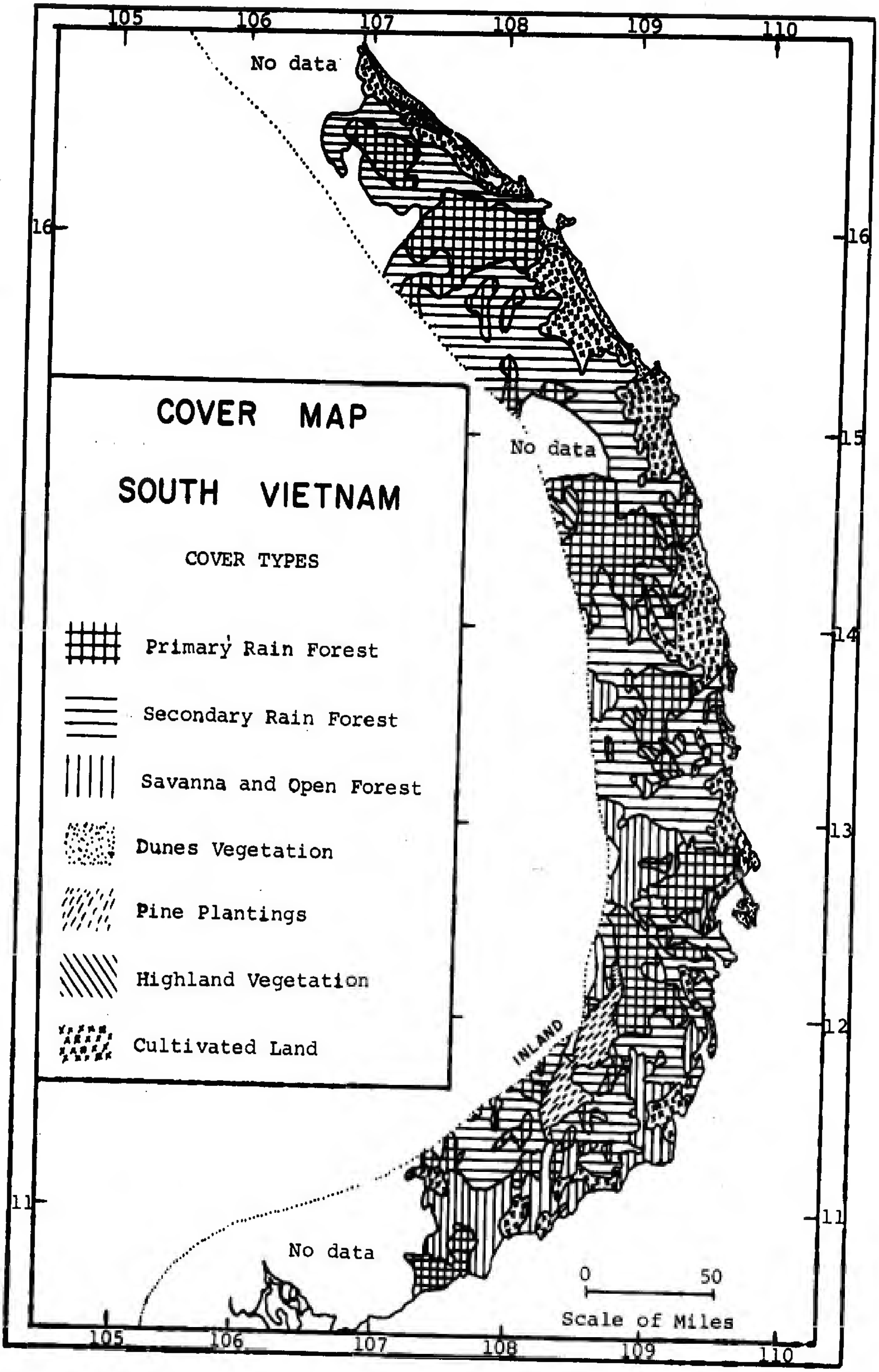
Swamps. The area of fresh-water swamp is less than 6% of the total plains area probably because much of it has been converted to rice paddy. The remaining parts occur characteristically in strips along river courses, around lakes, on flat delta plains, or on coasts inland from the area subject to salt water invasion. The general map of vegetation cannot show these small patches but there are extensive area long the southwestern and the southeastern coast of Malaya where even now soil surveys are in progress to determine their suitability for paddy development. Swamps are commonly inundated during the period of heavy rains and retain high water tables throughout the remainder of the year. The character of the cover varies widely with soil differences, the duration of flooding, and human utilization. Some swamps are covered with tropical forest and support considerable undergrowth; others bear a thick growth of small trees. Some are repeatedly burned so that the vegetative cover consists largely of tall grass. In almost all situations the swamps would constitute barriers to easy movement of vehicles but only in a few places are they extensive enough to constitute a special environment for military movement. The upper Mekong and the country around the Tonle Sap, outside the area under description, is an example of such environment wherein the military operations of August, 1961, utilized landing craft in ditches and creeks (Time Magazine--August 25, 1961).

Distribution of Cover Types

The general surface configuration of coastal southeast Asia consists of a wider or narrower coastal plain backed by hill country and interrupted by river plains and broad deltas. Wherever the coast opposes the course of the summer (southwest) monsoon relatively heavy rainfall occurs and the resultant



Map 15. Generalized Vegetation.



Map 16. Cover of Part of South VietNam.

vegetation in the non-swampy plains and hills to elevations of 2500 ft is tropical rain forest. Such conditions with local exceptions mark the entire western coastline from Pakistan to Singapore (Map 15). Most delta plains and some riverine plains have been cleared as rice areas and in western Malaya there is a large area of tree plantations and other dry cropping. The east coast of the Gulf of Siam is similarly situated and covered in general by tropical rain forest and strips of rice cultivation.

On coasts protected from the direct force of the southwest monsoon there are areas where not enough moisture is received to support the rain forest, these are covered by dry deciduous forest. A stretch of such coast occurs along the west side of the Gulf of Siam and spotty distributions appear in parts of eastern Malaya and North and South VietNam. The minor vegetation types, grasslands, mangroves, and swamps are incidental to this major distribution pattern. It should be understood that these broad distributions are not of homogeneous cover types but are based upon dominance of the indicated cover. In particular the difference between primary rain forest and secondary rain forest is not indicated on the general map and is of considerable importance in terms of trafficability and radio communication. The patchy interspersion of cover types is well illustrated by Map 16 which shows a section of the South VietNam coast northward from Saigon.

Cover Type—Analysis from Map Coverage

A cover survey was made by an analysis of the 87 maps forming the 1:250,000 and similar coverage of the area, recording the indicated cover for each grid square in terms of its geomorphological character. This provided about ten thousand samples; not all squares could be identified and the coverage in Thailand did not commonly carry cover overprints so that estimates had to be made from such vegetation maps as were available. The summary by square miles follows as Table 13.

Vegetation of Plains. If the alluvial, delta, and complex plains are combined, they form 74,732 square miles or 45% of the area under description. From the map survey, their cover types are as follows:

Type	Square Miles	Percentage
Forest	19,622	20.72
Paddy	41,032	43.25
Tree Plantation	5,147	5.43
Mangrove	4,525	5.32
Swamp	6,393	6.74
Sandy Shore	744	0.78
Not Identified	16,851	17.76

TABLE 13

MAP ANALYSIS OF NATURAL AND CULTIVATED VEGETATION BY GEOMORPHOLOGICAL TYPES

(By grid squares from 1:250,000 (approximate) maps in square miles)

	Alluvial Plain	Delta Plain	Complex Plain	Complex Hills	Total	Notes
			Burma			
Forests	3200	569		35286	39055	
Paddy	3852	4697			8549	Concentrated in Irrawaddy Delta
Tree Plantation	58				58	
Mangrove	1819	930			2749	
Inland Swamp	78	344			422	
Sandy Shore						
Not Identified	4712	1221		97	6030	No symbol on maps
Totals	13719	7761		35383	56863	
			Malaya			
Forests	2528		354	12599	15481	
Paddy	1537			64	1601	
Tree Plantation	5011			526	5537	All on west coast
Mangrove	591		150		741	
Inland Swamp	3780		11	176	3967	
Sandy Shore	81		62	9	152	
Not Identified	4339		1207	6530	12076	No symbol on maps
Totals	17867		1786	19904	39555	
			Cambodia			
Forests	2555			6960	9515	
Paddy	1095				1095	
Tree Plantation						
Mangrove	50				50	
Inland Swamp	98				98	
Sandy Shore	5				5	
Not identified	667			78	745	No symbol on maps
Totals	4470			7038	11508	
			VietNam			
Forests	921	1680	2213	26229	31043	
Paddy	2309	11317	2585	200	16411	
Tree Plantation	10	58	10	81	159	
Mangrove	40	935	10		985	
Inland Swamp	59	1741		20	1820	
Sandy Shore	99	4	493	5	601	
Not Identified	1804	1725	1118	7205	11852	No symbol on maps
Totals	5242	17460	6429	33740	62871	
			Thailand			
Forests		5642		20630	26272	Only a few of maps carry vegetation overprints. Calculations of forest and paddy made from planimeter of general vegetation maps.
Paddy		13640			13640	
Tree Plantation						
Mangrove	521				521	
Inland Swamp	282			59	341	
Sandy Shore						
Not Identified	58				58	
Totals		20143		20689	40832	

The percentage of each cover for the three types of plains is illustrated graphically in Figure 29.

Vegetation of the Hill Country. The hilly country is almost entirely in forest of one or another type. The map analysis by square miles shows:

Type	Square Miles	Percentage
Forest area	101,699	87%
Not Identified	13,910	12%
Other	1,144	1%

It seems probable that most of the unidentified area is actually forest.

Cultivated Land

Almost half of the plains country is under cultivation. This cover consists of rice paddy, 43.25% and tree plantations and dry agriculture 5.43%. The hill area is almost entirely in forest and the scattered plantations within it are unimportant in reference to the general forest cover. On the plains, the tree plantation areas are almost entirely confined to a single area in western Malaya (Map 17).

Tree Plantations in Malaya. In a belt some 20 to 40 miles wide extending along the entire Malayan west coast, tree plantations are the principal land cover. There are several paddy rice districts (descriptions below) that have been reclaimed from swampy areas. These occupy perhaps one-quarter of the land. The principal crop is rubber with minor areas of coconut palms especially along the immediate coast in Malacca Strait. -

Tree plantation areas in contrast to rice paddies are easy to reach and traverse. They are situated mostly on well drained ground and are serviced by good roads which connect them with the principal highways or railroads. Plantation headquarters are nodes of settlement and communication. In plantations the native vegetation had been almost entirely removed and replaced by the crop trees. These have been planted precisely so that there will be no shading of one by another with the result that the space between the trunks is wide enough for ordinary vehicular passage. The absence of undergrowth makes good visability. Although tree crowns touch to form an almost complete canopy, this is not thick enough to shut out all sunlight from the ground and is much more permeable to light and presumably to radio waves than is that of the dense and storied tropical rain forest.

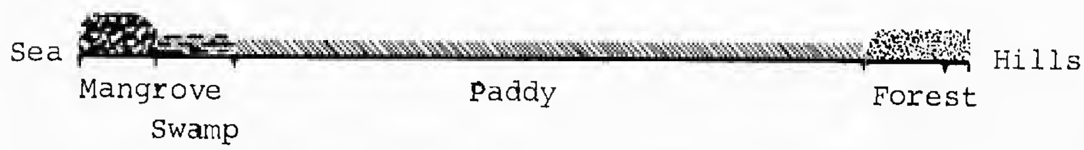
The plantation areas are by no means solidly in crop trees. There is

COVER ON THE PLAINS

Diagrammatic Representation of Identifiable Types

ALLUVIAL PLAINS

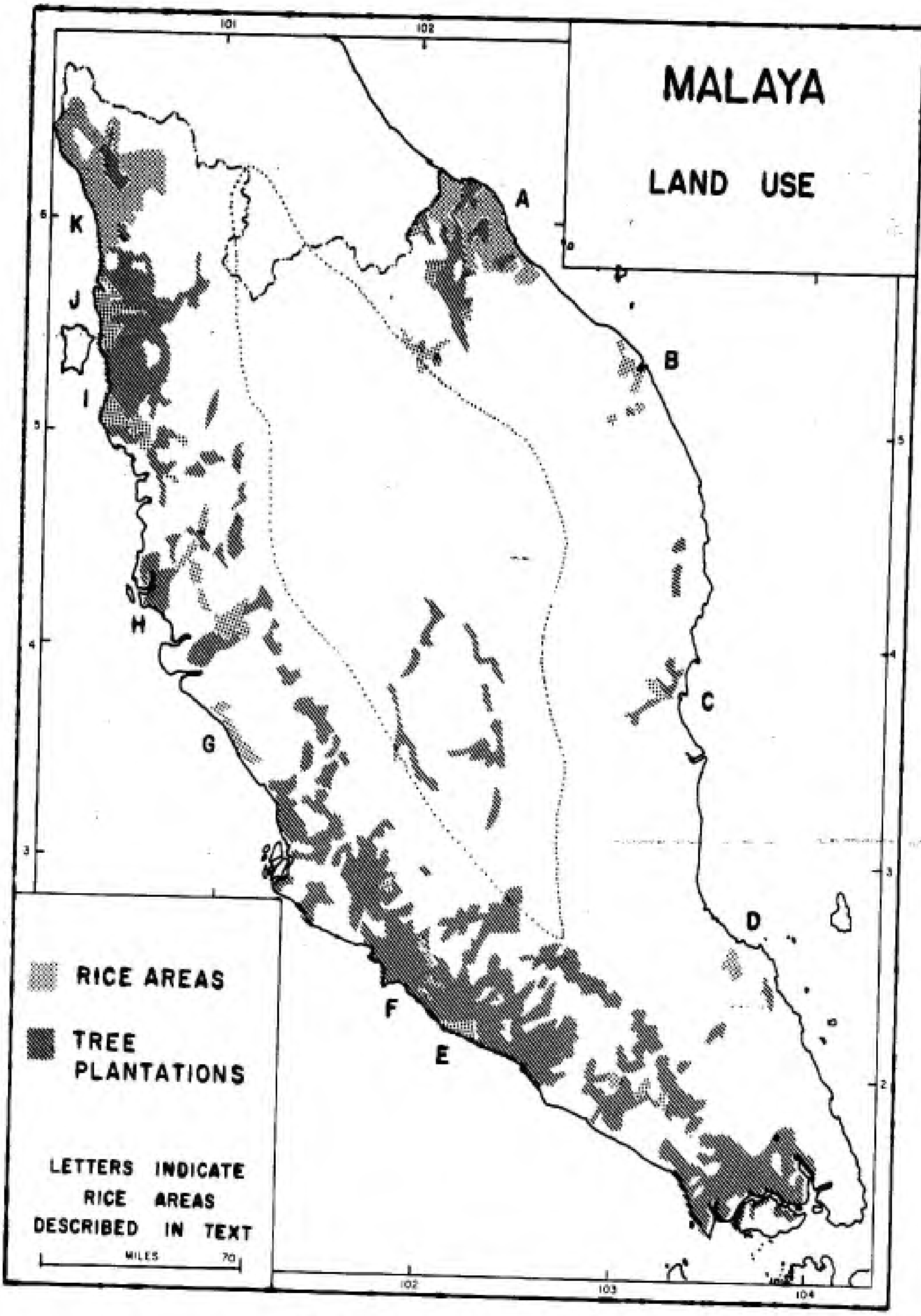
DELTA PLAINS



COMPLEX PLAINS

scaled in percentages observed

Fig. 29. Percent of Cover on Plains.



Map 17. Malaya—Land Use.

much undeveloped forest land within the actual limit of any plantation and more between plantations. The wetter parts along streams are in heavy brushy jungle growth. However the plantations present few problems to trafficability because of their open character and the presence of the road network which serves them.

Rice Lands. Rice is an aquatic food plant which grows in fields constructed to hold some water during the growing season. Most rice areas are developed from swamp lands by drainage and accompanying irrigation systems and are divided into small fields, usually by solid dikes which give some individual control of water height, or in new areas with common water systems by landmarking soft dikes of raked vegetation.

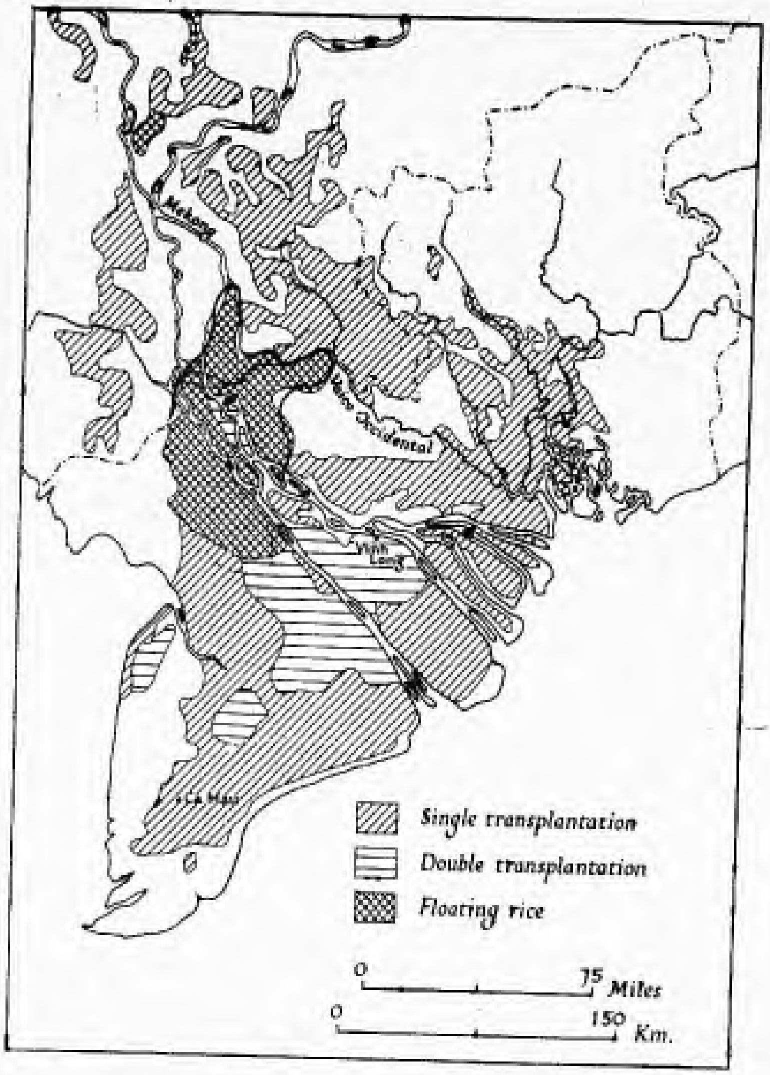
The dual requirement of level land and a plentiful water supply confines paddy cultivation to plains areas. The delta plains with their smooth surface and abundant water are the best sites and 71% of the delta plain surface is used for rice cultivation. The coastal alluvial plains are 29% covered with rice paddies, somewhat less than their forest cover and the complex plains, most of which is river flood plain, are 42% in paddy rice.

Rice cultivation consists of four periods. The rice seedlings are grown in beds; they are transplanted into flooded fields; they mature and ripen as the water supply dwindles into the dry season; the crop is harvested in relatively dry fields. After harvest there is a period of two to five months when the fields are dry until the next planting season.

Variations of this cycle occur in places where the water supply permits two crops to be raised in a single season extending the wet period to ten months as some fields are harvested while others are being planted. In a few places, particularly on the Mekong, deeply flooded paddies produce "floating" rice, which is planted in dry land, then deeply flooded and harvested from boats (Map 18).

The rhythm of rice operations would be an important factor in military operations because of the barrier character of flooded paddies (see the study of Malaya rice areas). No sound generalization can be made concerning specific dry seasons for the whole area. In most places winter months bring northerly winds, dry weather, and trafficable rice paddies (Table 14), but on protected coasts with north-south extent the dry paddy time may be through the summer months. If river water is available from irrigation works two or even three overlapping crops may keep some paddies flooded throughout the year.

Rice Areas as Military Environments. In areas where rice paddies are interspersed with other cover types such as the paddy strips along river valleys, they represent only another type of locality in which movement is limited by the cover. However the broad continuous paddy areas such as those of the deltas of the Irrawaddy, Chao Phraya, the Mekong, and the Red Rivers, represent a unique environment for military operations. Some of the



Source: Exposition Coloniale Internationale, Paris, 1931. *Riziculture en Indochine*, following p. 44 (Hanoi, 1931).

Map 18. Types of Rice Cultivation in Indo-China. From: Indo-China. Geographical Handbook Series B.R. 510. Naval Intelligence Division, London.

elements of this environment are:

1. During flooded periods or in wet places there would be great difficulties in deployment, lateral movements, circumvention of road-blocks, etc.

2. Area would be open to constant air observation because of the absence of concealing cover.

3. Operations would be completely dependent on roads.

4. Any off-road operations would be carried out with hand weapons and the advantage of mechanization and armour would be negligible.

5. Extensive paddy areas are densely populated.

Rice Paddy Areas and Trafficability in Malaya

So little information could be obtained about the nature of paddy areas in terms of trafficability that a special report was obtained covering eleven rice producing areas in Malaya. The questions asked were these:

1. What are the usual field sizes?

2. How high and wide are the dikes:

3. What is the trafficability of the rice area and adjoining ground in various seasons for wheeled vehicles such as jeeps?

The eleven areas are located on Map 17.

A. Kelantan Delta. The fields are very small; few of them are as large as one-half acre. They are separated by field dikes about 2 ft high and some 18 in. wide at the top. The fields dry out about the first of March and remain dry under ordinary weather conditions until the middle of July or the first of August. During this time vehicles could be driven across them because the water table is far below the surface. During the remainder of the year they are wet; the monsoon period from October to February spreads water over the whole area.

Trafficability would be good during the dry season. At other times there is a good system of Kampong roads that do not show on our maps that are passable some of the time. The structure of the delta with old beach ridges and levees is such that there are dry ridges between wet sloughs that hold some water at all times except at the height of the dry season. These are arranged parallel to the coast so that inland movement would have to pass over the wet sloughs and lagoons between the ridges which, themselves, are passable at all times.

There is one local place, the Salor area in the great bend of the Kelantan, where an irrigation scheme allows dry season flooding from pumped water. This area could be circumvented or the pumping stopped. It is not a very large area anyway.

B. Trengganu Delta. Conditions are almost the same as those in Kelantan (A) including a pumping operation near Bukit Basar which can flood a small area during the dry season for double cropping practices.

C. The Pahang River. All the way upstream to Kuala Lipis there are small, scattered paddy areas known as "Paya Paddy" or swamp paddy. These are in old river channels, Oxbow meander scars, lagoons, and similar low spots behind the river levees. They are usually wet throughout the year although some of them dry up during July. By September they are all wet again. Wheeled movement could go along the high levees any time except in rare years when the levees are flooded in late December. The paddies are long strips with few dikes and little water control and therefore difficult to cross at right angles. However they are small and discontinuous and crossing is possible where they end in high ground.

The paddy areas themselves would not be a serious barrier to movement because they do not form a continuous broad expanse of wet land; it would always be possible to get through or around area. In this district there are distributions of swamp forest which would probably be more serious barriers than the paddy land.

D. North Jahore. The area is included in the paddy summary although most of it is not yet under paddy but is part of the planned reclamation, now alienated and under development. However the development is slow.

The general conditions are about the same as in Kelantan (A) but with a shorter dry season. Only in April and May would the well drained areas support wheeled traffic. In this newly developed area there would be fewer dikes and larger field sizes, some several acres in extent. Drainage canals are being dug which, as they increase in number, would be all-season barriers to traffic.

E. Malacca. The wettest period is from July through October and the dry period from February through June. Many of the lower fields will be wet even in the dry season. During April, May, and June most of the area would be passable for wheeled vehicles.

The field size is small and fields are separated by 2-ft dikes. The paddy areas are not so continuous as in Kelantan and commonly separated by strips of rubber plantation upland, easily passable at any time. During the dry season the fields near the town of Malacca are planted to vegetables by their Chinese owners in heaped-up beds which might bog down jeep traffic. Field dikes are not wide enough for jeep travel but there is a good network of Kampong roads passable in all but the height of the rainy season.

F. Negri-Sembilan. In this area paddy is commonly confined to the stream flood plains. The ribbons of rice land on either side of the streams is usually flanked on the higher ground with rubber plantings and villages. The rice land is divided into small plots with many dikes, few of which would bear jeep traffic. Most of the villages are joined to the main highways by short lateral Kampong roads that are passable in all but the most rainy part of the season. The fields are wet from March to November but most of them dry out by January. Those nearest the stream stay wet throughout most of the year but the higher ones would be passable from January to April.

G. Kuala Selangor. This is a new paddy area recently reclaimed from swamp forest and because much of the land is low, near the coast, and not yet well drained, the dry period of the fields is short, December through March. Near the town of Kuala Selangor there is much double cropping in fields that can be flooded from the river. The cropped areas nearest the sea are never dry enough for wheeled vehicles and in addition, this part of the area is cut up by drainage canals which would be additional barriers to transportation.

The fields are large and continuous; some consist of several hundred acres owned by many people with the ownerships separated only by strips of uncut vegetation that do not now provide trafficable roads. Vehicular traffic off main roads would be difficult in this area at any time and probably impossible during the rainy season.

H. Telok Anson (Sangei Manik) and the Perak River. This is much like Kuala Selangor (G) except that there is no double-cropped areas. The fields are somewhat smaller but still several acres in extent. The dikes are low, small, weak, and discontinuous. The area is wet throughout most of the year and should be considered passable only by tracked vehicles with great difficulty, except during the months of March and April. The Perak River is bordered by strips of paddy which are discontinuous along either bank. The fields are small and separated by firm dikes. The paddy strips are subject to deep flood during the rainy season but dry out to a greater extent than do the larger areas near Telok Anson. Travel is possible at all seasons along the high ground of the river levees.

I. Krian District. This area is wet throughout the year. It is somewhat like Kuala Selangor (G) and Telok Anson (H) but even more wet. Most of it is deep ex-swamp and probably impassable at any time. The inland margins might be passable during February and March but this is not certain. The fields are smaller than either of the two preceding areas because this has been established longer. Field dikes have been built up from vegetation and are not firm enough for passage of wheeled vehicles at any time.

J. Province Wellesley. This is the largest double cropping area in Malaya and the fields are wet throughout the year except a week or two in late October and again in March; these dates vary a little with the growing season. The normal climatic dry period is in January and February.

Field sizes are small, few are more than an acre in extent. Most of the dikes are firm and solid but some are of raked vegetation so the whole system may not be trusted for passage. There are good roads following the north-south beach ridges; these provide access into the area but it would be difficult to move across it with jeeps.

K. North Kedah-Perlis Plain. This is the most extensive area of paddy in Malaya. It dries out from January through May. There is much variation in soil moisture from the coast inland. The coastal areas are generally much wetter and do not dry out thoroughly at any time.

Near the coast the fields are large, over an acre in extent but become smaller inland. The dikes are high and firm away from the coast but usually not wide enough for jeep travel. The area is cut up by drainage canals that carry some water even through the four-month dry season. The inland parts probably are passable during the February or March period and then only with difficulty.

An analysis of this report is presented by Table 14. It indicates clearly the differences between the dry periods on the side that faces the southwest monsoon (G through K) and those which are on the lee, eastern, side of the peninsula (A through D) and also Negri Sembilan (F) protected by Sumatra. In the former group the rains come earlier and probably in greater amounts so that the land is wet by April or May and does not dry out until December or January. On the other side the paddies are not flooded until August and remain wet until March or April.

In addition to this field study for Malaya, the Agricultural Calendar of South VietNam (Table 15) shows the conditions on another east coast. Here the rice areas would appear to be flooded by May or June and not dry until December. It should be noted that where irrigation water is available local areas will produce two crops (Map 18) and therefore fields will be wet during the otherwise dry season. Because of water supply and probably also from market conditions the rice harvest within a single area (Map 19) may occur at two or more times during the year. Trafficability predictions should therefore be made in terms of specific studies, such as that presented for Malaya, rather than upon general dry season climatic assumptions.

Sources: Vegetation

Coi, Jin-Bee, "The Nature and Distribution of Natural Vegetation in Malaya," Pacific Viewpoint, 1:2 (1960) pp. 183-204.

Morehead, F. T., Forests of Burma. Burma Pamphlets No. 5, Longmans, Green and Co. Ltd., London, 1944.

Wyatt-Smith, J., "A Note on the Freshwater Swamp, Lowland and Hill Forest Types of Malaya." The Malayan Forester, 24:2 (1960) pp. 110-121.

TABLE 14

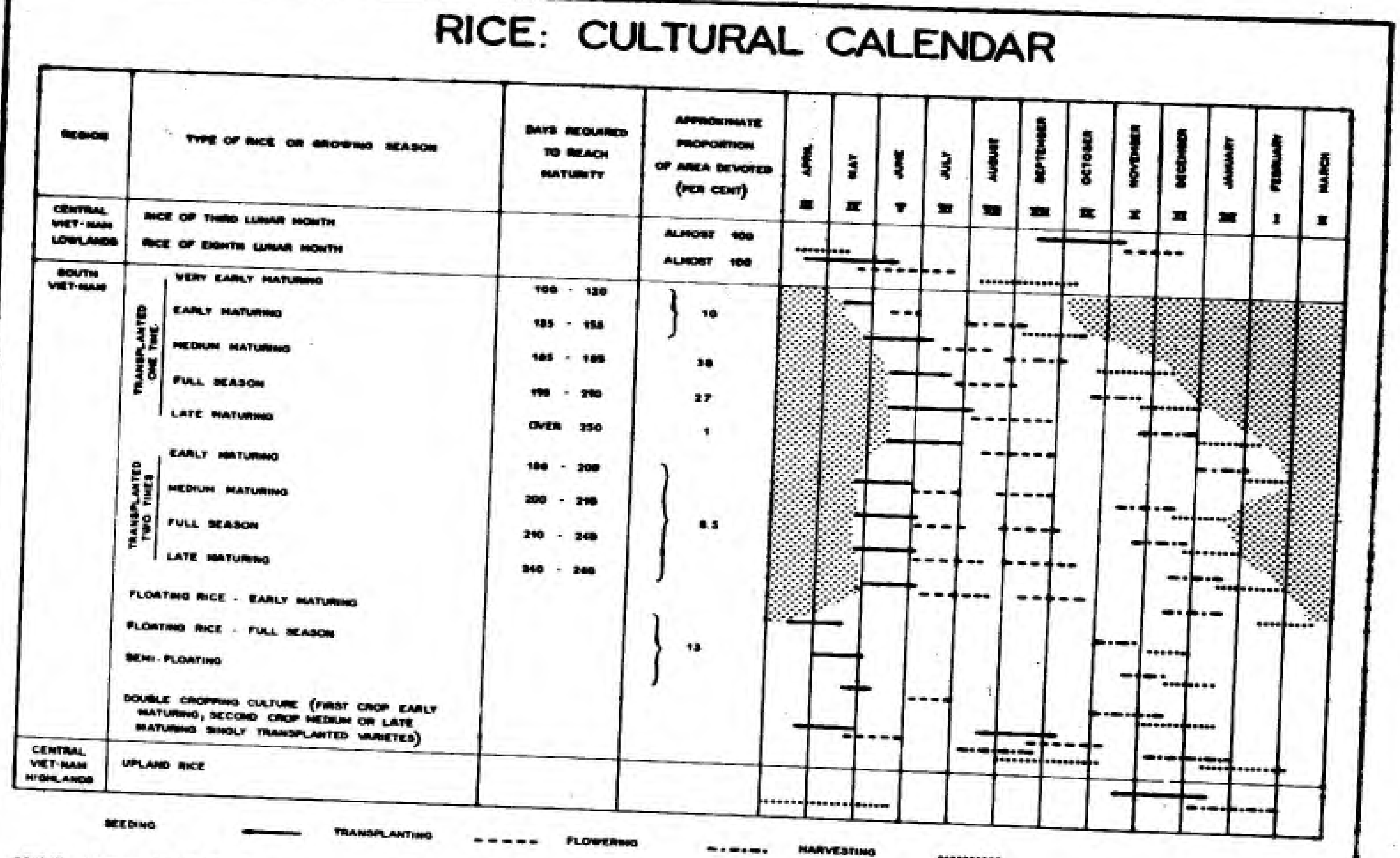
PERIOD OF POSSIBLE TRAFFICABILITY OF RICE AREAS OF MALAYA

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
A) Kelantan			x	x	x	x	x					
B) Trengganu			x	x	x	x	x					
C) Pahang River							?	?				
D) North Jahore				x	x							
E) Malacca				x	x	x						
F) Negri Sembilan	x	x	x									
G) Kuala Selangor	x	x	x									
H) Telok Anson	x	x	x									
I) Krian		?	?									
J) Wellesley			?									
K) North Kedah-Perlis	x	x	x	x	x						?	

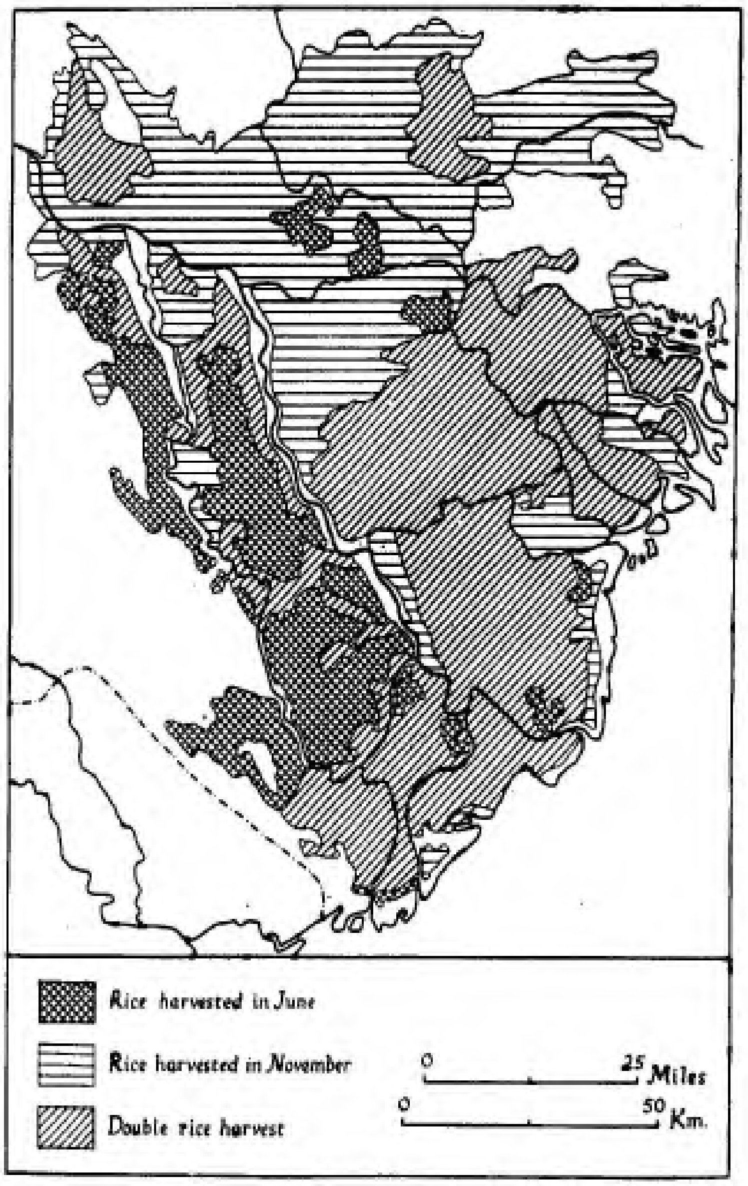
x = probably passable
? = possibly passable

TABLE 15

AGRICULTURAL CALENDAR FOR SOUTH VIETNAM



SOURCE: Y. COYAUD, LE RIZ (SAIGON: L'OFFICE INDOCHINOIS DU RIZ, 1950)



Source: P. Gourou, *Les Paysans du Delta tonkinois*, p. 396 (Paris, 1936).

Map 19. Times of Rice Harvest in the Tonkin Delta. From: Indo-China. Geographical Handbook Series B.R. 510. Naval Intelligence Division, London.

Davis, John H., The Forests of Burma. 23 pp. The University of Florida (1960).

McKinley, T. W., Forests of Free VietNam. 152 pp. USOM, Saigon (1957).

Dempsey, J. M., Agricultural Calendar of VietNam. USOM, Saigon (1961).

Gittinger, J. P., Vietnamese Agricultural Calendar, USOM, Saigon (1959).

"La Foret Cambodgienne" in Cambodge d'Aujourd'hui Duexieme Anne No. 1 (1959).

Nguyen, Van Chi, "Les Forets Indonees au VietNam," in Causeries sur le Developpment des Ressources Naturelles au VietNam. Le Secretariat d'etat d' l'Agriculture (1960) pp. 23-66.

Maps

Dia Do-Phan Loai Rung-VietNam (Vegetation of VietNam) manuscript, 1:1,000,000. Probably from the South VietNam Forest Agency.

Land Utilization Map of Malaya, Surveyor General of Malaya 1:760,320 (1953).

IndoChine Forestiere, Institut des Recherches Agronomiques de l' Indo-China 1:2,000,000, not dated (probably before 1954).

VI. SOILS

It is only during the last decade that systematic work has been done on the soils of Southeast Asia. At the present time surveys are being carried out in a few countries but the results have not yet been generally distributed. So little information could be obtained in the United States that it was necessary for this report to secure the material directly from the soil services of the countries. In Burma the survey is conducted with the assistance of a technical group of advisors from the USSR and its preliminary maps are difficult to obtain. All of the soil information for North VietNam comes through Russian sources.

Soil descriptions from the various surveys cannot readily be correlated in detail. In some cases they are collected for agricultural purposes with emphasis on productivity rather than genetic classification. There is the difference between actual soil mapping and soil sampling with boundaries run out on imperfect geological maps. For these reasons the descriptions are presented separately for each country. The map of major soil distributions has been made from such information as could be obtained and in itself is a generalization of that presented by countries.

From a military point of view the principal deficiency of the material lies in the absence of data on which trafficability and bearing-strength estimates can be made. No such information could be obtained; if it has been collected by the Russian technical groups in Burma and North VietNam it is understandably not available for general distribution.

Generalized Pattern of Soils

The geomorphological pattern of coastal Southeast Asia is composed of three general entities: the relatively steep slopes of mountains, dissected plateaus, and footlands composed of igneous and hard sedimentary rocks; the intermediate slopes, mostly on sedimentary rocks, and the alluvial coastal, riverine and delta plains of recent deposition. The soils of each of these entities vary widely in texture and structure but they form board groupings of recognizable characteristics.

1. Mountain, Hill-Country, Dissected Plateaus with Steep Slopes. As a group the soils of these areas are immature, shallow, and commonly well drained. Some slopes have little soil and are areas of crushed stone surface from which the finer materials have been removed by strong sheet erosion. The valley soils are generally lateritic red-yellow and red-brown earths of heavy texture which may have stony profiles.

2. Intermediate Slopes. The gently to strongly sloping surfaces between the mountain-hill land and the alluvial plains are covered by residual soils mostly derived from sedimentary rocks. In almost all situations these are red-brown or red-yellow forest soils or latosoils although some of the older alluviums in VietNam are podsolized. The lateritic process develops clays rather than sands so the soils are generally heavy with high water-holding capacities and probably slippery when wet.

3. Alluvial Soils are those of the coastal, riverine and delta plains, in some places fringed by mangrove or sand strips. In general the alluvial soils are soft, water-logged during the rainy season, and have a high water table. The study of the Malayan rice lands indicates that they are passable with great difficulty during the wet season. The alluvial soils may be grouped into three subcategories.

a. Water-logged, muddy and sandy soils bearing mangrove forests.

b. Intrazonal meadow soils of the broad river valleys and fresh-water swamps. These are of heavy texture and dark color, some are of gley (sticky, compact, structureless) nature. Included in the group are the soils of the deltas of the great rivers.

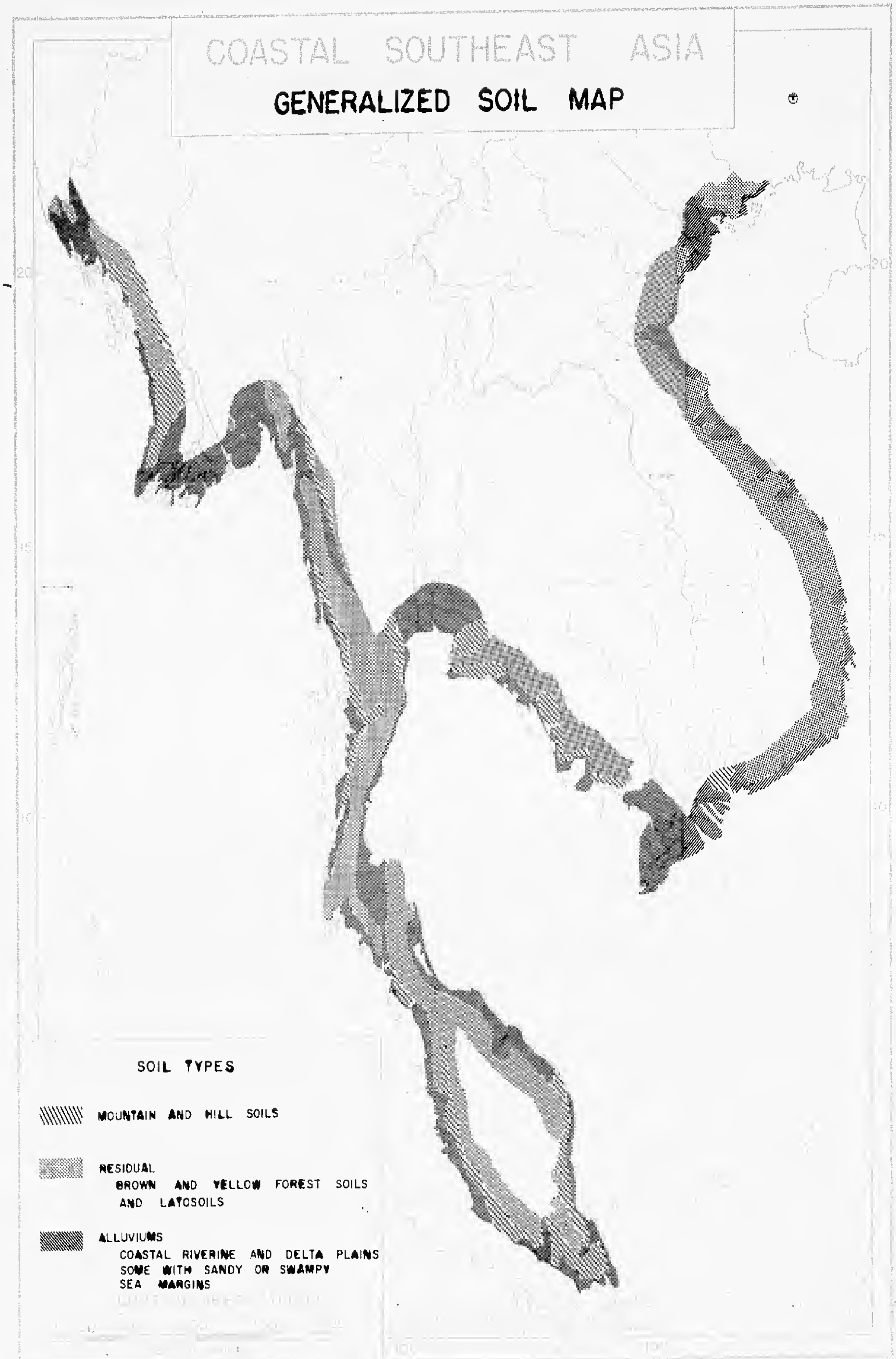
b. Sandy Coastal Soils. These are most common along the east facing coasts of Indo-China and Malaya where they form bands some few miles in width. Probably they originate from fossil sand dunes. It should be noted that the coastal survey presented earlier shows many more miles of coast line with narrow sandy strips than is indicated by the sandy category on the soil maps because coast lines of other classifications may bear narrow sandy strands along the tidal zone.

The distribution of these classes is fairly regular as may be seen on May 20. The hilly core-land is fringed by alluvial soils which penetrate into the interior along river valleys and over the great deltas. On the flanks of the hills lie residual latosoils but not in all places. Along the VietNam coast where the hills approach the coast closely and in places actually reach the lateritic belt is very narrow or absent although it occurs on the inland side of the mountains.

Such detail as could be obtained is presented in the discussions of the soils of the several countries. This political organization is necessitated by the differences in extent and character of the soil investigations done on national bases.

The Soils of Burma

The soil survey of Burma, with the assistance of a technical mission



Map 20. **Generalized** Soil **Map.**

from the USSR has progressed since 1956. In 1959 some 42% of the total area had been covered by mapping on approximately 1:250,000 field scale. The following descriptions make extensive use of such parts of this mapping as could be secured.

The Burmese coast may be separated into three parts: the northern or Arakan coast strip, the Irrawaddy Delta, and the Southern or Tennasserim coast. The first two of these are the best covered by soil surveys.

ARAKAN COAST

On the northern section, from the Pakistan border to Akyab, the mountains lie principally inland beyond the arbitrary 50-mile limit of this study. Their long parallel outlying ridges give a northwest-southeast grain to the area. The soils of the ridges have not been mapped in detail but probably are Mountainous Red Earths of shallow depths and stony composition.

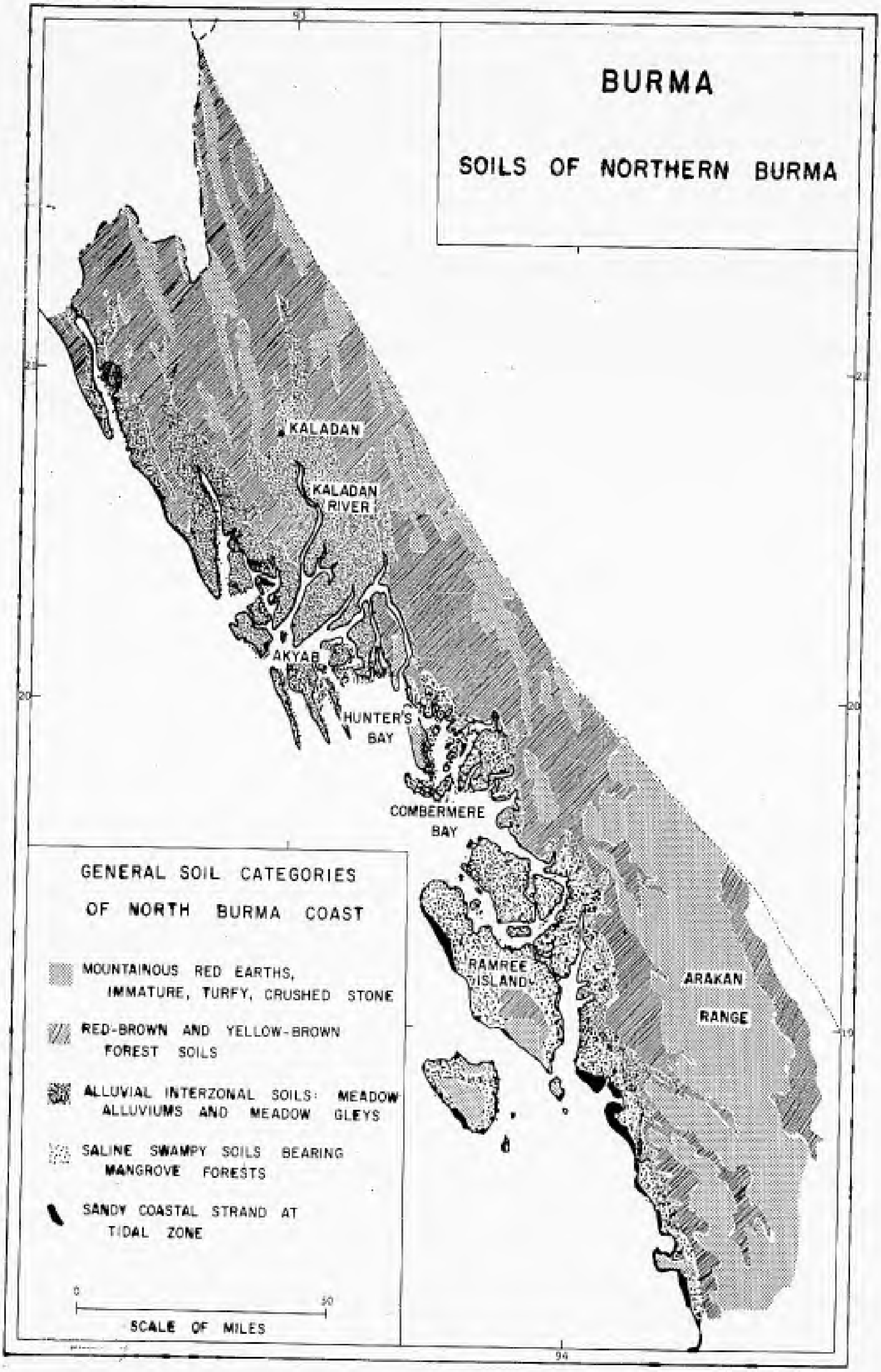
The valleys between the ridges and the lower hill slopes are covered with red-yellow forest soils between the elevations of 300 and 1500 ft. Red-brown forest soils occur above these elevations up to 4000 ft. These two soil categories are similar; both are residuals developed by lateritic leaching. The higher, red-browns, occur where there is heavy rainfall, 80 to 200 in./yr and have no dry period in the soil. They bear heavy tropical evergreen forests. The red-yellows are in areas of lower rainfall with seasonal soil drought, and bear deciduous or semideciduous forests.

The red-brown soils are shallow on the steeper hills but 5 to 7 ft in depth on level ground. They are usually heavy loams with some stoniness in the lower parts of the surface layer. They contain little humus and are previous in the upper layers.

The red-yellow soils are intermediate between the coastal alluviums and the red-browns. They are light in texture, 3 to 6 ft deep with a heavy layer which would hold up water in the rainy season.

South of Ramwee Island the main mass of the Arakan Range approaches to within 5 to 10 miles of the coast. In this area the strip of the residual forest soils is much more narrow than in the north.

The alluvial soils of the North Burma coast are of two general categories: the meadow soils and the mangrove soils. The lowland formed by the basin of the Kaladin River together with the Lempo and the Mayu extends inland to the north for some 60 miles. It is covered by alluvium which forms intrazonal meadow soils of heavy texture, high humus content, and large water-holding capacity. The water table is close to the surface even during the dry season and probably at the surface during the wet season. Some of the soils are gleyey, i.e., sticky, compact, and structureless. The lower, tidal parts of



Map 21. Soils of North Burma.

the river banks are swampy and bordered with mangrove forest. Much of the plain is in paddy.

From Akyab wouthward in the areas of Hunter's and Combermere Bays, the coast, sheltered from heavy surf action, is covered with swampy saline soils bearing mangrove forests which reach inland along the tidal streams for distances up to 25 miles. In the lower parts of this area, affected by daily tides, the soil is deep mud, certainly impassable at any time. The higher ground, flooded only at seasonal high tides is much more firm and the mangrove forest less dense.

The seaward coast of Ramree Island and the mainland coast to the south bears a discontinuous narrow sandy strand strip.

IRRAWADDY DELTA

The alluvial delta plain of the Irrawaddy is some 100 miles wide at the coast and extends as an entity for about the same distance inland. It is continued northward along the river valley for another 100 or more miles. The following report on the soils includes also the area between the delta and the Sittang River. The material presented is taken principally from the unpublished maps of the Burmese Soil Survey covering the Districts of Hanthawaddy, Insein, Toungoo, Pyapon, Tharrawaddy, Henzada, and Ma-ubin. For simplification several of the original mapped categories have been combined. These are:

Meadow Soils: in which have been placed meadow soils, meadow loams, meadow alluviums, alluvial soils and meadow light brown.

Meadow Swampy Soils: meadow swampy, swampy gley, swampy soils.

Saline Soils: meadow saline, solonchoks.

Saline Mangrove Soils: salty-muddy, saline gley-mangrove.

Latosoils: lateritic brown and yellow, dark brown, forest soils, cinnamon soils, light and heavy loams (nonsedimentary).

Hilly-Mountainous: red mountainous earths, crushed stone, turfy.

The soils of the area may be separated into four general groups, similar in nature to those described for North Burma. These are: coastal soils, intrazonal alluviums, latosoils, and hilly-mountainous soils.

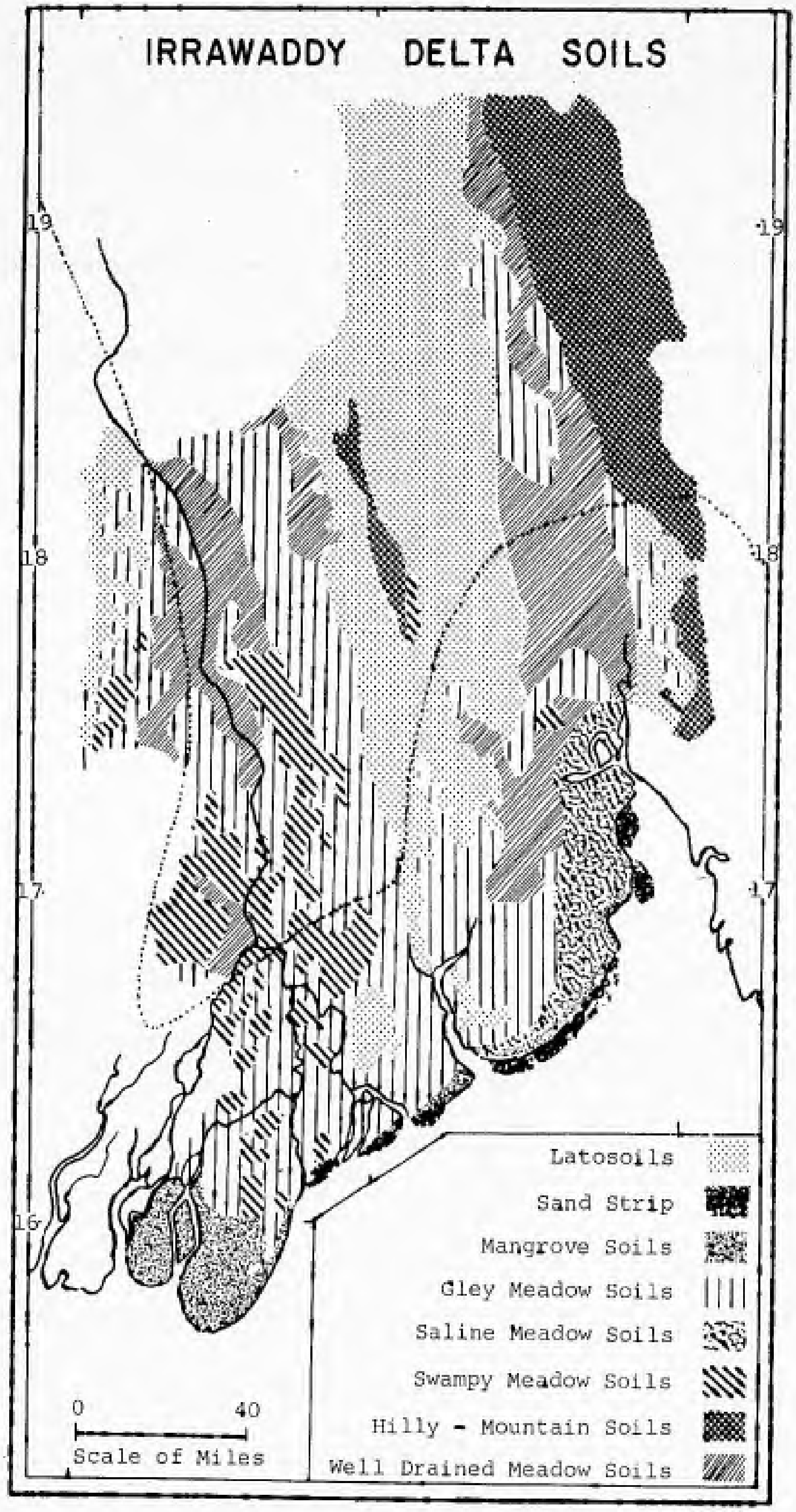
The Coastal Soils occupy a narrow band along the tidal fringe of the delta coast and the larger river mouths. There is a strip of mangrove, five miles or less in width, bordering directly on the ocean on the west side of the delta but fronted with a wet sandy tidal strand of about equal width on the east. The meadow soils behind this eastern part are also saline, probably inundated at seasonally high tides.

Meadow Soils. The delta plain and the northern valleys into which it extends are covered with a group of intrazonal alluvium originating from river detritus. This parent material has been separated into 12 soil groups by the Burmese mappers. It seems probable from the maps alone (these are preliminary manuscript maps for which no textual material is available) that more than one of the cateogires may apply to the same soil grouping and that such broad ones as "alluviums" are themselves inclusive of others. For the intended purposes of this report it is convenient to regroup these meadow soil categories in terms of drainage into the following:

Meadow Soils: generally good drainage
Meadow Gley Soils: sticky, heavy, with poorer drainage
Swampy Meadow Soils: poor drainage, probably wet at all seasons
Meadow Saline Soils: subject to seasonal high tides.

The pattern of distribution of these meadow soils is delineated on Map 22. Few generalizations about distribution can be made because the drainage seems to be related to the complexities of the pattern of the distributaries of the Irrawaddy as well as to centuries of agricultural use whereby drainage conditions have been changed. The saline meadow soils are located just inland from the coastal soils along the estuary of the Sittang where the tidal bore characteristics of this estuary or the force of the southwest monsoon winds cause seasonal flooding by sea water. The swampy soils are usually in areas of small extent, partly or wholly surrounded by better drained soils. This suggests that they may be remnants of much larger areas now drained artificially. The significance of this distribution pattern lies in the probability that the well drained and the gley meadow soils are trafficable during the dry season and that the smaller areas of swamp may be circumvented. There are no continuous east-west all-weather roads or railroads across the lower delta but the waterways formed by the distributaries could be utilized.

Hill-Mountain and Latosoil Areas of the North. Finger-like projections of the hill country extend southward west of the Irrawaddy, east of the Sittang, and in the area between these rivers. The soils of these steep areas are described as shallow, turfy, of crushed stone, and lateritic in nature. It seems probable that they are similar to the red-brown mountainous soils described for the hilly mountainous area of North Burma in view of the fact that the western area is a continuation of the Arakan Range of North Burma. Along the footlands of these southward-extending ridges are broad belts of forest soils and latosoils. Like those of northern Burma, they are on gently to strongly sloping terrain and are usually covered with forest or jungle growth.



Map 22. Soils of Irrawaddy Delta.

Soils of Malaya

The Department of Agriculture of Malaya has assembled a map of soils made from all useful information available extended along lines of geological reconnaissance. It is in manuscript form and is intended by the Department for early publication. From this map the distributional information which follows is taken and the map of Malaya soils (Map 23) of this report is generalized from it by combining the original fertility categories of the latosoils and disregarding the separation of the alluvial soils into categories based on the amount of organic matter and the completeness of the drainage. The blank spaces on the map represent unknown soil areas.

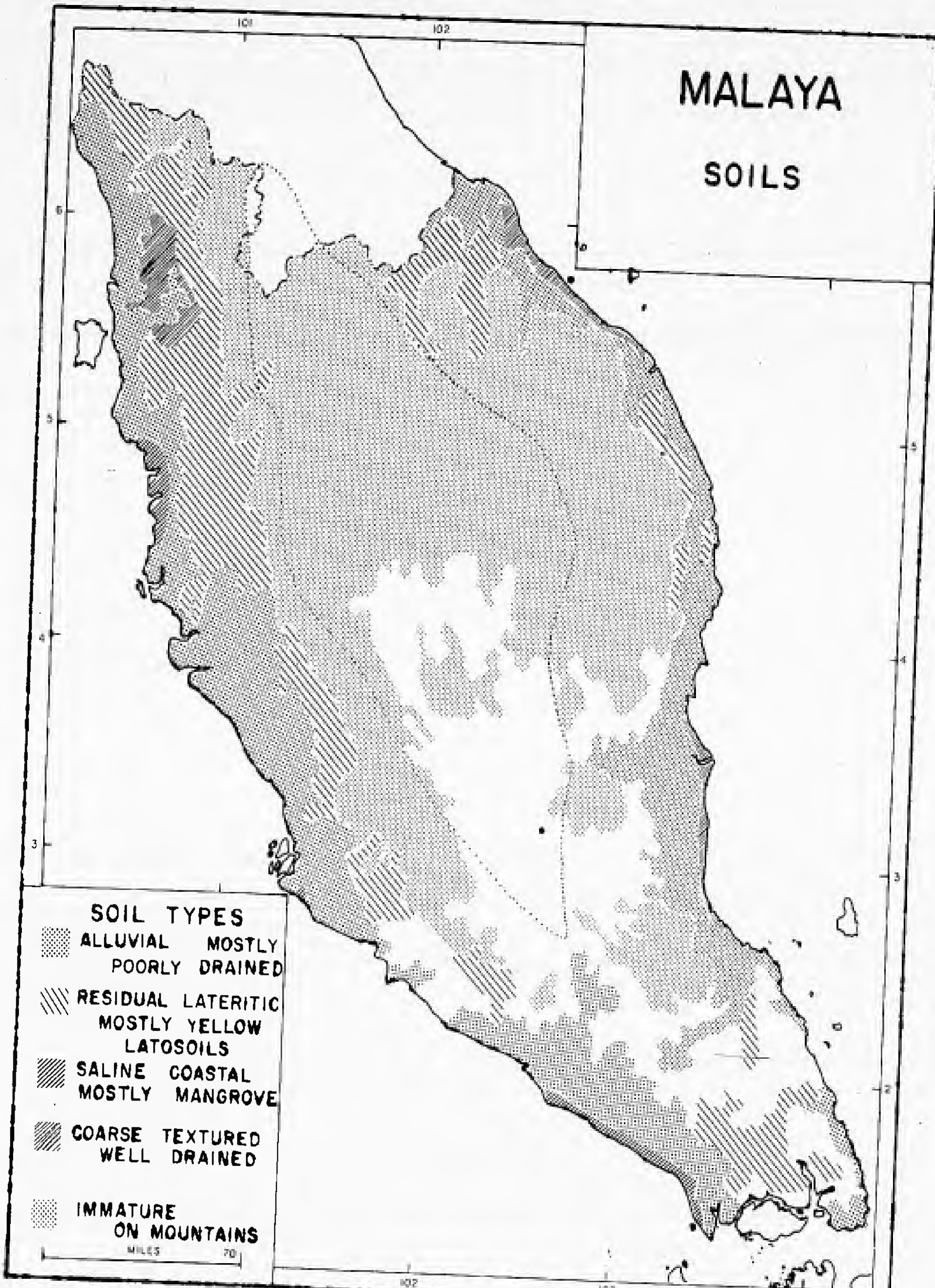
The pattern of distribution is fairly regular; the soils are distributed in concentric bands around the central hilly-mountainous core in the following sequence toward the sea: immature hilly-mountainous soils, lateritic residual soils, lowland alluviums, and coastal fringe soils.

The hilly-mountainous soils are poorly known. They are stony and shallow except in the valleys. The texture characteristics seem to be a function in the amount of quartz contained in the parent material. Where this is abundant the soils are light-colored and coarse textured. Where quartz is scarce the soils are heavier and darker, probably similar to the Mountainous Red Earths.

The latosoils belt is formed by residual soils developed almost entirely on sedimentary rocks of gently to strongly sloping surfaces. They are mostly yellow latosoils which correspond in situation to the red-yellow forest soils of Burma. The belt of residuals in the northwest at altitudes above 2000 ft, is probably bears of red-brown latosoils. The soils of the blank, unsurveyed area on the map, from what is known about its geological character, probably also are mainly yellow latosoils.

Alluvial soils cover the broad river basins and the coastal plains in a belt of some 20 miles or less in width. The riverine and inland alluviums are better drained than those near the coast and are relatively firm for wheeled passage. There is much broad swamp area in the river basins, where the soils are heavy enough to be classed as organic (peats and mucks).

The western coastal fringe bears strips of saline mangrove soil which are neither so broad or so continuous as those of the Burma coast. On the east are relatively wide sandy strands similar to those of the VietNam coast, in some places there are clay strips between the sandy ridges.



Map 23. Soils of Malaya.

Soils of Thailand

The soils of Thailand are less well known than those of either Burma or Malaya. The best source of distributional information is an article and accompanying provisional map by Pendleton and Montrakun, "The Soils of Thailand," reprinted from the Proceedings of the Ninth Pacific Science Congress (1960) by the Department of Agriculture of Thailand. It presents 21 categories based on agricultural utility. These are grouped into three divisions, lowland soils, soils of flat to gently sloping land, and soils of steep uplands. The geomorphological association of these three divisions is obvious.

Coastal Thailand can be conveniently divided into three entities: the Bangkok Lowland, the peninsular west coast, and the short east coast between the lowland and Cambodia.

The Bangkok Lowland is formed by the alluvial deposits of the Naman Chao Phya and neighboring rivers. The soils are described as dark, heavy, poorly drained clays and are differentiated into subcategories for which distribution is not shown on the map. The soils are permanently saturated at depths of 6 ft or less. This delta does not have the complex pattern of distributaries that occurs on the Irrawaddy Plain and much less swamp area inland from the ocean. It is probable that these lowland soils are passable during the dry months but no specific information to that effect is available. The delta is fringed along the ocean by a belt some 5 miles of saline mangrove mud and tidal marshes.

Peninsular Thailand. The narrow strip of Thailand that extends southward along the Malay Peninsula consists principally of hilly land that reaches the coast in several places. This hill country bears shallow and generally sandy soils derived from quartzite sandstone. The lower slopes contain coarse sandy loams of about the same nature. Strips of recent alluvium extend along the coast and into the valleys and lowlands between the hills. Little is stated about their composition. Close to the Malaya border the coast contains the alternating sand and clay complex previously described for eastern Malaya.

East Coast. Between the Bight of Bangkok and the Cambodia border the coastline is formed by fine sandy loams of lateritic character located on the plateau surface. These are penetrated by short and discontinuous intrusions of alluvial soils in the valleys of streams arising in the mountainous country some 40 miles inland.

Soils of Cambodia

The 200 mile stretch of Cambodian coastline contained within the limits of this description is formed by the plateaus, mountains, and hills of the rough country of the Cardomones and the Chaine de l'Elephant mountains which approach near the coast. The soils of these areas are unknown but probably are of well drained, stony nature similar to those of the Chaine Annamitique of South VietNam. The very narrow coastal strip is sandy and a few alluvial penetrations of the upland occur along the streams. At the west extremity of the coast, near the Mekong Delta, there is a saline mangrove fringe.

Soils of South VietNam

Material on the soils of South VietNam is derived from a map entitled "General Soil Map of the Republic of South VietNam" published in 1961 by the National Geographic Service (Dalat). It was surveyed and compiled by Dr. F. R. Moorman, with technical and financial support of the FAO (United Nations) and the ICA (U.S.A.). It shows 25 categories of which nine are not present or not important within the 50-mile belt of the coastal area. The remaining 16 fall into three general divisions:

1. Alluvial soils of the Makong Delta.

2. The complex of red and yellow podsols and lithosols which occur in the plateau and mountainous country.

3. The discontinuous coastal complex of sands and alluviums which cover the generally narrow belt between the coast and the hills.

Mekong Delta. This is an area of low, level, alluvial land cut up by the several distributaries of the Mekong and the lateral drainage ditches which connect them. The map lists six classes of alluviums differentiated principally on their acidity (agricultural value). For about 10 miles inland from the delta margins the soils are tidal and saline muds supporting mangrove forests. Along the west side of the delta coast is a rather extensive area of mixed peat and mud, presumably swampy, which supports mangrove and forest growth. The delta soils as a group are soft, dark in color, level and generally wet. The eastern half of plain is thickly settled and extensively cultivated. It is subject to severe flooding (such as that in 1961) and would be a difficult area for operations except during the dry months, December to March.

North of Saigon there is a transitional zone of about 100 miles between the low delta country and the higher and rougher plateau surface. This is an area of flat to rolling topography bearing soils which are in part podsolized alluviums, now uplifted, and in part reddish latosoils on various kinds of sedimentary and basaltic rocks. No additional soil information is available but, in terms of its soils and slopes this transitional area would offer few impediments to traffic.

Chaine Annamitique. Beginning at about 11° north latitude, most of the width of the 50-mile coastal area is occupied by the Chaine Annamitique, a succession of eroded plateaus which present a relatively steep slope to the east and in several places actually reaching the coast as hilly or cliff headlands. All of the soils of the uplands of this chain are grouped into an inclusive category entitled "complex of mountainous soils"; mostly red and yellow podolic soils and lithosoils. This same structure extends into North VietNam where the Russian soil mappers classify the soils as "mountain lateritic." The genetic difference is probably unimportant for operational purposes. From title alone the soils of the hilly areas would seem to be shallow, sandy or rocky, and well drained.

Coastal Complex. The uplands reach to the sea in places and cut the coastal complex into a number of discontinuous strips which have a characteristic composition. The immediate coast is marked by an area of sand or of sand dunes extending inland for a few miles, in places up to ten miles. The soils are white or yellow dune sands. When these do not reach to the base of the plateau slopes, the intervening area is covered with strips of alluvium, recent or older which extend up the valleys into the plateau country in places for as much as 50 miles. Some of this older inland alluvium is podsolized and apparently not subject to annual flooding.

Soils of North VietNam

Information on the soils of North VietNam comes from material obtained through the FAO (United Nations) in Rome. It consists of a Russian map with legend translated into English. This is from a publication "The Nature of North VietNam" by V. M. Fridland, Scientific-Popularized Series, published by the USSR Academy of Sciences, 1961. The Table of Contents was also obtained, but not the text. Presumably the soil mapping represented was done by or with the assistance of a technical mission from the USSR because the soil classification follows closely that used by the Russian mission in Burma.

From the South VietNam border north to the beginning of the lowland of Tonkin, the geomorphology and the soils are similar to those described for the adjoining area in South VietNam. The plateau bears lateritic soils (analagous to those classed as "podsolic" in South VietNam) and a coastal complex of sand dune strips and alluvium extending up the valleys.

Lowland of Tonkin and Northern Annam. This is formed by the delta deposits of the Red River and its neighbors the Ma, Ca, and the Chu. It is a flat, alluvial area narrowing inland for about 50 miles. The soils are separated into categories which include gleyey, and those "receiving annual fresh deposits" among other subclassifications. Presumably they are like those of the other river deltas of Southeast Asia: dark colored, heavy, and bearing high water tables. No areas of inland swampy soils are shown. The coastal fringe of the delta is bordered by a narrow strip of sand, sand dunes, and mangrove mud.

Highlands of East Tonkin. This is the upland between the Tonkin and the Chinese border. The plateau or hilly country approaches within 20 miles of the coast; its soils are the same as those of the plateau belt south of the Tonkin Lowland. The immediate coast is fringed with sandy and mangrove mud soils and the area between this coastal strip and the hills is composed of old lateritic alluvium.

Sources: Soils

Moore, E.C.J. and Van Baren, F. A. Tropical Soils. Interscience Publishers, London, 1954.

Bramad, D. L. and Dudal, R. Tropical Soils. (Manuscript), F.A.O. Rome, 1957.

Dudal, R. "Les Sols du Bassin du Mekong Inferieur et leur Utilization." Pedology, 10: (1960), pp. 24-47.

Compy, E.Z.W. (Soils Advisor USOM), End of Tour Report, Project No. 442-12-054 (1960), Cambodia. (Manuscript.)

Coulter, J. K., McMaster, A. R., and Arnott, G. W. "Trans Perak Swamp." (Malaya), Soil Survey Report No. 3. Ministry of Agriculture, Malaya.

Moorman, F. Note Explicative de la Carte General des Sols, VietNam. Mimeographed, F.A.O. Rome (1960), 50 pp.

Panton, W. P. Reconnaissance Soil Survey of Trengganu. Ministry of Agriculture (Malaya), Bull. 105 Kuala Lumpur (1958).

Rozanov, Boris G. (Soviet Soil Expert), Explanatory Note to the Soils Map of Burma. (Typewritten English translation), 22 pp. (1959).

Pendelton, R. L., Sarat, Montrakan. "Soils of Thailand." Department of Agriculture, Ministry of Agriculture, Bangkok (1960). Reprinted from the Proceedings of the Ninth Pacific Science Congress, 33 pp.

Pendleton, R. L. Notes of Soils and Land Utilization in Southeastern Siam with some Comments upon the Improvement of the Agriculture of the Area. Tech. Bull. 4 (1950), 123 pp. Thailand Department of Agriculture.

Note also the maps and information contained in the soil presentations under the separate countries.

VII. ROADS AND COMMUNICATIONS

The importance of roads in conducting operations in an area such as the one under description needs no elaboration. The nature of the land surface, the vegetation, and the drainage inhibits vehicular travel away from roads. It is obvious from Map 24 that the communication network is thin, consisting for the most part of long tentacle roads designed for communications between parts rather than within parts.

It did not seem useful to delineate the transportation system because this exists on the general map coverage as well as in the usual road maps issued for the several countries by gasoline producers. In place of this we attempted an analysis, by quantitative methods, of the effectiveness of the road system. By sampling methods we sought the answers to these four questions:

1. How accessible is any point within the Project Area to the transportation network?

2. What is the quality of the surface and construction of the roads, especially their seasonal quality?

3. Is the coastal transportation system trend inland or laterally along the coast?

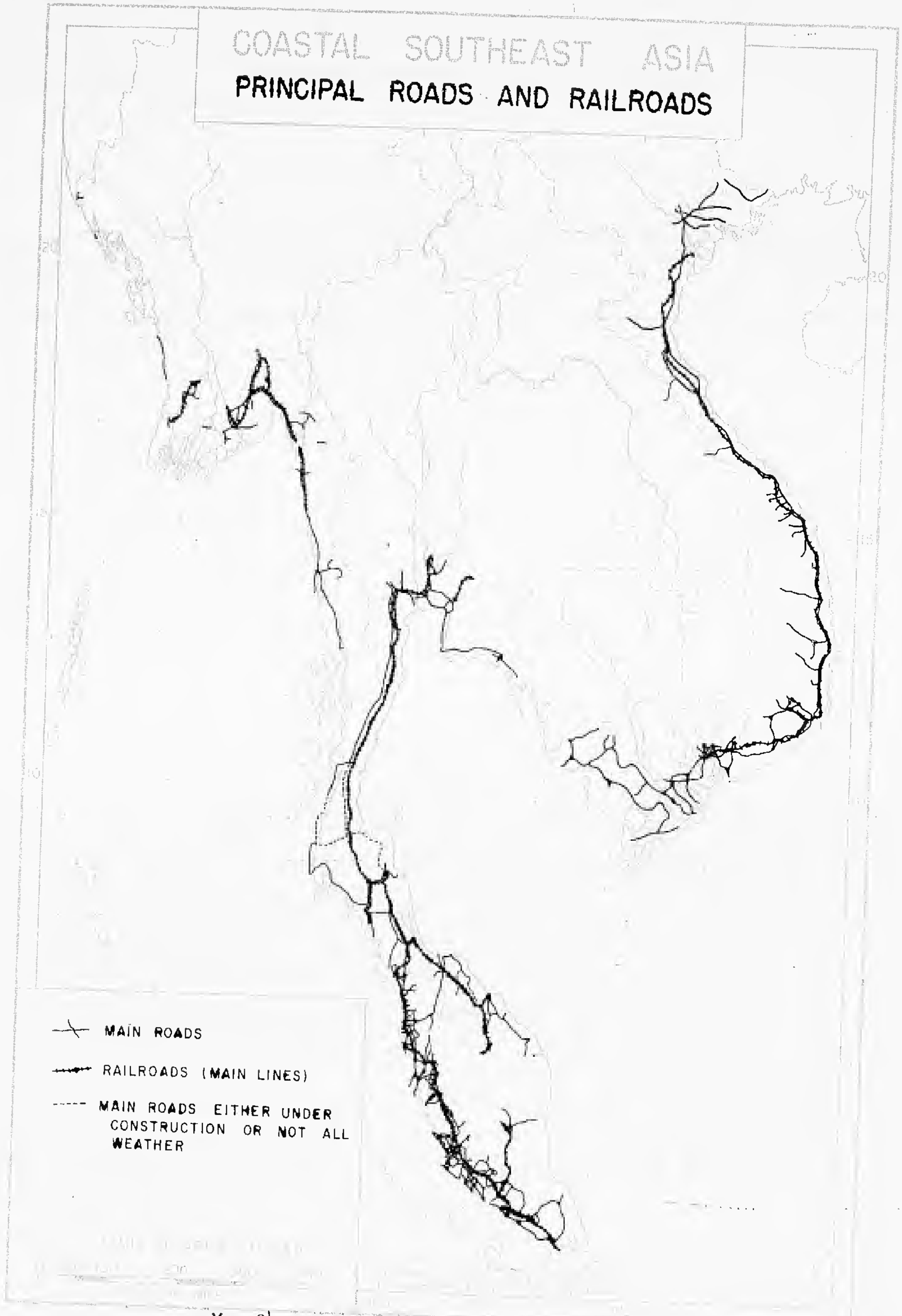
4. How well is the transportation network connected?

These questions needed answers for the two general types of surface within the area: plains, and hills and mountains.

An analytical method was devised and 221 samples taken. These are analyzed in the following pages. Much useful information is contained in the several analyses for the areas covered by the samples.

It was our expectation that the findings of the samples would hold true for the Project Area as a whole or at least for the several areas into which it was divided for the purposes of road analysis. Some characteristics of the road network vary over wide ranges, and as a result there are large deviations between the actually measured miles of various kinds of roads and the prediction from the sampled areas. This occurs, we think, because the actual mileage of road is a very small quantity in relation to the very large size of sample areas, and the roads are quite unevenly distributed.

This attempt to reduce a road net to measurable numbers is based on map analysis alone. We do not know just how much and in what ways the measured



Map 24. Principal Roads and Railroads.

qualities will affect military operations. But when experience has demonstrated what these road net qualities mean in operations in one area, we can predict in some measure at least, what they will mean in other areas.

Analysis of the Transportation Network

This section presents a description of the transportation network in the Project Area. Important properties of the network are identified and measured by statistical samples. For some properties a complete enumeration is made. The adequacy of the sampling of these same properties is suggested by comparison of the actual with the sample estimate. The transportation network is defined as all roads and railroads, but not including tracks and paths. The entire analysis is based on information obtained from Army Map Service 1:250,000 and similar scale maps. (See list in Introduction.) Minor adjustments and interpretations were made on the basis of other information sources—particularly first-hand accounts.

The first part of this section describes the properties of a transportation network and defines methods for measuring these properties. The second part describes the sampling procedure and methods of analysis. The last section presents the results of the analysis and a general impression of the transportation network in various parts of the study area.

THE PROPERTIES OF A TRANSPORTATION NETWORK

A road network has several characteristics which are quite independent of one another. A complete description of the network thus requires several kinds of measures. For example, one characteristic of the network is the relation of road to area. The density of the network defined as miles of road per square mile is one measure of this characteristic. But two networks with identical density may look entirely different. Figure 30a shows a grid pattern network and Fig. 30b a dendritic lattice. The density of the road network is the same for both diagrams. In fact the diagrams have the same number of boundary points, road segments and intersections respectively. The difference between the diagram is in the number of endpoints and in the number of road segments radiating from the intersections.

In Figs. 30c and 30d all of the above variables are constant, but the spacings between roads vary. The standard deviation of the distances to the nearest road from a set of randomly chosen points would reflect this difference in spacing.

Figures 30e and 30f show orientation or directional trend in the road network with respect to the coastline. Whether the network tends to be con-

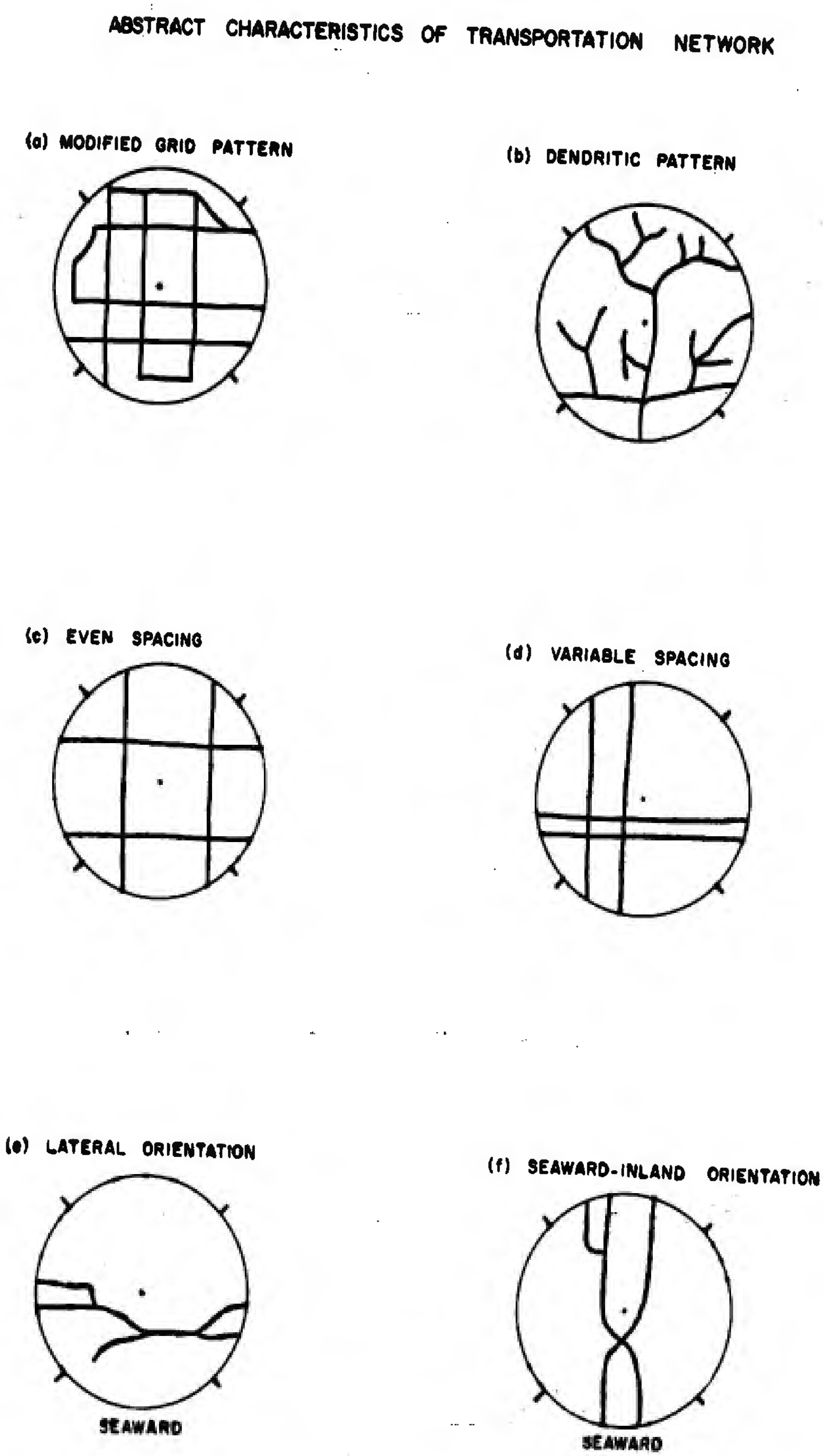


Fig. 30. Abstract Characteristics of Transportation Network.

nected, on the average, more in an inland-seaward direction than laterally is of interest. This may be observed by counting boundary crossings of the sample area in four quadrants with one direction oriented seaward, or by resolving the road mileage into orthogonal components with one component oriented seaward.

We recognize four general characteristics of the transportation network. In the following analysis we attempt to obtain one or more adequate measures of each of them. The characteristics are:

1. network to area relations;

2. quality of construction and surface material of roads and rail roads;

3. orientation or directional tendency; and

4. connectiveness or extent of strategic points and alternate routes.

These characteristics were singled out in an attempt to throw some light on answers to the following questions:

1. How accessible is the study area or any point in the study area to the transportation network?

2. What is the quality of surface and construction of rail and road in the area especially with respect to seasonal weather conditions?

3. Is the coastal region transportation network trend inland-seaward or is the trend laterally along the coast?

4. How connected is the transportation network? Are there strategic points and how often do they appear? To what degree are alternate routes available?

The measures described below attempt to answer these questions.

SAMPLE DESIGN AND MEASUREMENTS

The transportation network analyzed is that shown on the Army Map Service at 1:250,000 and 1:253,440. These maps are based on British, French, and American sources. They are believed to be the most reliable and current coverage of the area. The reliability varies from survey to survey and from sheet to sheet. Most sheets include a reliability diagram. Most sheets were compiled or revised by air reconnaissance in the period 1950-1958 and printed by the Army Map Service in the period 1954-1960.

The study region is a coastal strip extending 50 miles inland and including major adjacent islands (islands appearing on the sheets showing coastline). The region includes all the coastal areas of Burma, Malaya, Thailand, Cambodia, South VietNam, and North VietNam.

Three landform types were defined: (1) mountains and complex hills (called upland); (2) complex and alluvial plains (plains); and (3) delta plains (delta). Total square miles of each landform type was computed. The sample was stratified by proportion of area in each landform type because the transportation network varied considerably by landform type.

SAMPLE AREAS AND SAMPLE OBSERVATIONS

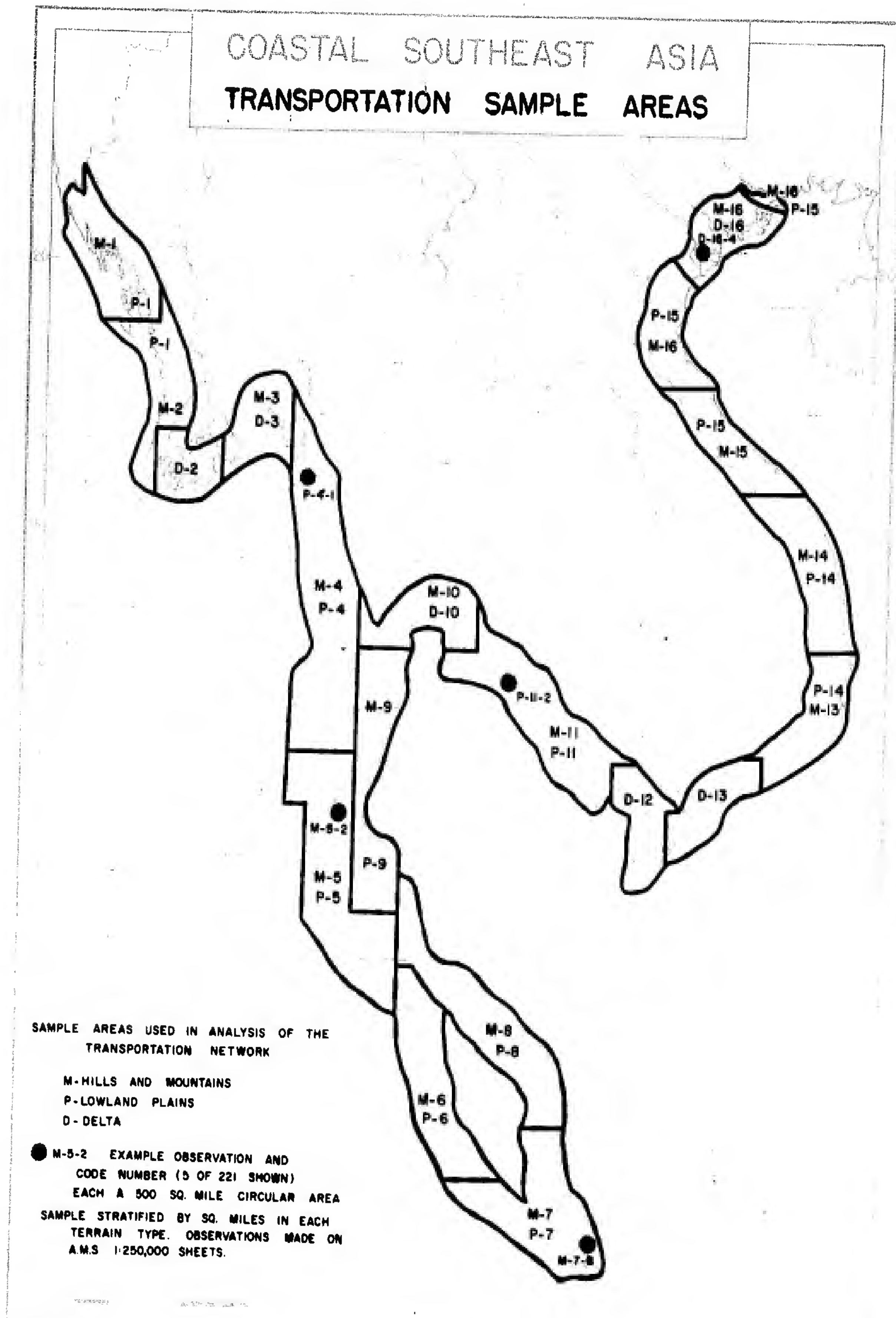
The 221 sample observations were grouped into sample areas containing from 3 to 12 observations, depending upon how many square miles of each landform type were represented. Sixteen of the sample areas were designated as the upland sample. These areas have an M in their code number. Ten sample areas represent plains and six represent delta. Their code numbers carry a P and D respectively. All 32 areas are shown in Map 25.

TABLE 16

SQUARE MILES OF AREA AND NUMBER OF SAMPLE OBSERVATIONS BY LANDFORM TYPE

	Total in Sq Miles	%	No. of Observations	%
Upland	119,731	55	120	54
Plains	68,353	32	68	31
Delta	27,990	13	33	15
Total	216,074	100	221	100

Sample observations were chosen at random for each area in the following manner. A square mile grid template was placed on the maps of each sample area on which the physiographic boundaries had been marked. The total square miles of each landform type was counted and a table of random numbers was used to pick the appropriate number of sample observations in that sample area. The center of the square mile chosen was used as the center of the sample observation. This rather involved procedure was an attempt to insure equal opportunity for every square mile to be included in the sample. The physiographic regions sampled were very irregular in shape and deeply interlaced with one another and with water surfaces. The method allowed narrow valleys, isolated hummocks and/or islands to be in the sample.



Map 25. **Transportation—Sample Areas.**

Five-Hundred Square Mile Sample Observations. Each sample observation serves as the source of several types of information regarding the transportation network, such as density of network, type of roads, number of intersections, endpoints, and direction trends. A circular area of 500 square miles, with the randomly sampled point as the center, was chosen in order to obtain sufficient observations of these varied elements in a region where the transportation network is generally rather light and simple. The 500 square mile size was arbitrarily chosen and used throughout the study. The circular shape was considered necessary to avoid bias in the directional measurements.

Figure 31 and Table 17 give five examples of the sample observations. The measurements and counts made for each of these observations were systematically recorded in the form given in Table 17. Most of the subsequent analysis is based on these observations. One exception is the analysis of the quality of the roads. The quality varied so greatly from area to area that the sample was an inadequate measure of quality. A total network enumeration was taken, measuring the miles of rail or road in each route classification. This total count also provided a check on the method of estimating density using the sample observation. With the total count available it was possible to compare actual road mileage with estimated mileage.

CHARACTERISTICS OF THE TRANSPORTATION NETWORK

In the section below each of the four general properties of a transportation network is measured for the coastal Southeast Asia study area.

Network to Area Relations. Three measures characterize accessibility of the land area to the transportation network. They are the density, the average distance to the nearest road from randomly chosen points in the area, and the standard deviation of the distribution of the distances to the nearest road.

Density of the Network. The method of counting boundary crossings of an arbitrary circle to determine density of the network is not appropriate here because of the interlacing of upland, plains, and water in most of the 500 square mile circles used as sample observations. Road and railroad mileage are measured in each landform area and, using a square mile template, the number of square miles in each of these areas is also measured. The density of the network is estimated for plains and upland by dividing the road mileage by total square miles in the appropriate landform areas.

The density for the entire area has little meaning because of the large differences in density in the two landform types. However, the separate density estimates may be used to estimate the road and railroad mileage in the entire area simply by making separate estimates for each landform type and summing. Before this is done successfully an adjustment must be made to take into account the heavy density of road network in urban areas.

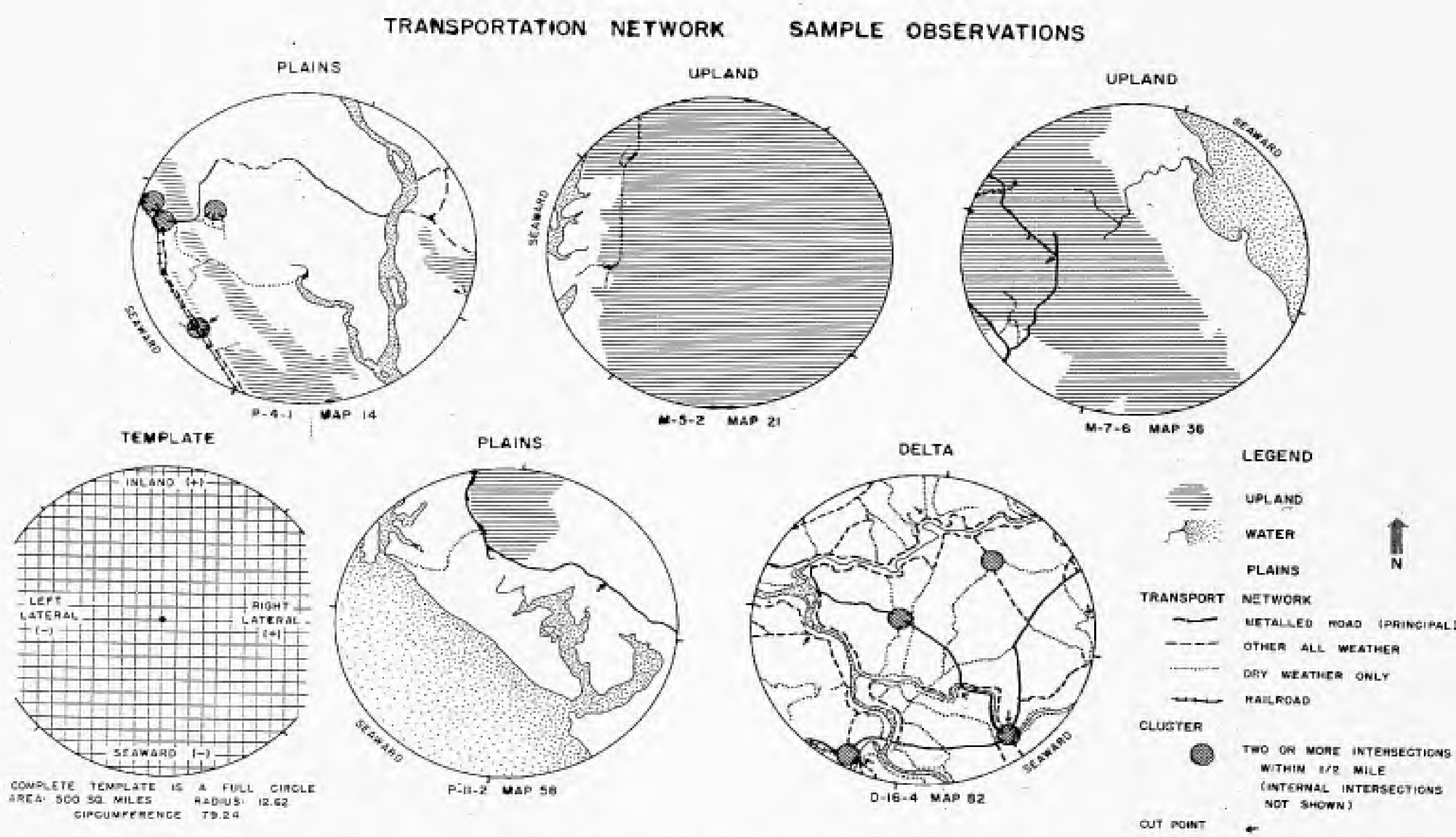


Fig. 31. Transportation Network—Sample Observations.

TABLE 17

TRANSPORTATION NETWORK SAMPLE OBSERVATIONS

(5 of 221 shown)

observation number map number	P-4-1 14 plains	 upland	 total	M-5-2 21 plains	 upland	 total	M-7-6 36 plains	 upland	 total	P-11-2 58 plains	 upland	 total	D-16-4 82 plains	 upland	 total
Road to Area Relations															
Distance to nearest road from center of sample area (miles)			2.5			7.0			5.5			5.0			0.0
Square miles in water			22			11			70			240			12
plains	415		415	44		44	152		152	227		227	488		488
upland		63	63		445	445		278	278		33	33		0	0
Total miles of road and railroad	100	4	104	5	16	21	13	30	43	33	1	34	350	-	350
Quality of Road and Rail Network															
miles: metalled (principal)	23	0	23	0	0	0	6	24	30	23	1	24	58	-	58
miles: other all weather	32	1	33	5	16	21	0	0	0	0	0	0	130	-	130
miles: dry weather only	28	3	31	0	0	0	3	6	9	0	10	10	157	-	157
miles: railroad (all classes)	17	0	17	0	0	0	4	0	4	0	0	0	5	-	5
Connectiveness of Network															
components			4			1			1			1			9
intersections	12	0	12	1	1	2	3	4	7	2	0	2	57	-	57
sum of degrees	30	-	30	3	3	6	9	13	22	6	-	6	182	-	182
clusters	4	0	4	0	0	0	0	0	0	0	0	0	4	-	4
sum of degrees	18	-	18	-	-	-	-	-	-	-	-	-	24	-	24
internal intersections	14	-	14	-	-	-	-	-	-	-	-	-	10	-	10
segments			38			5			14			5			118
endpoints			11			3			4			2			17
cutpoints			2			0			1			1			6
Orientation of Network															
boundary points															
inland (+)			1			0			2			1			9
seaward (-)			2			0			0			1			6
right lateral (+)			3			0			2			0			11
left lateral (-)			2			1			0			1			12
directional mileage															
inland			42			0			17			12			98
seaward			26			5			0			3			114
right lateral			18			3			18			9			97
left lateral			28			13			8			17			93

A Cluster on the Transportation Network. The urban areas represent a density of settlement much higher than the average. This difference is probably even greater than the differences between upland and plains. These large variances in density make accuracy of sampling estimates poor. Furthermore, the maps do not show the urban areas with any consistency. An adjustment to eliminate the effects of these urban areas is made. Because the analysis is of the transportation network, these built-up areas are defined in terms of the network itself. We define a cluster as being a portion of the transportation network in which an intersection is within one-half mile of at least one other intersection. This definition corresponds rather too broadly to settlements with improved road systems. A more restrictive definition might perhaps have served better but the above definition was employed throughout.

Clusters were delimited in each sample observation using the above definition. The amount of road mileage within the cluster was then deleted from the total mileage in the sample observation and replaced with the sum of two dimensions of the area in clusters. The dimensions used are the longest length and the width at right angles to the direction of that length. This procedure is simply an attempt to replace the close network of an urban-like settlement, whose primary function is internal connection, with a rough estimate of cluster's contribution to regional transportation.

Results of Network Density Measures. Table 18 displays the results of the analysis described above along with the actual mileage determined by a complete measurement of the network in the coastal region under study. The table indicates a total of 25,372 miles estimated compared with 24,076 miles in the complete inventory. This represents a 5% overestimate. Individual sample areas show much greater discrepancies. Four areas have over +25% error, two of which have over +50% error. All of these large overestimates are in areas of very low network density in Burma and Thailand.

The average density of the plains and delta regions is 20.38 miles per 100 square miles compared with 3.71 miles per 100 square miles in the uplands. Notice this density in the plains corresponds to approximately an average of two roads crossing a ten mile square. The 3.71 miles per 100 square miles in the uplands corresponds to a single road extending 1/3 of the way across a ten mile square. Only in Malaya is the road network in the hills comparable with that in the plains. However, the heaviest network is in the Tonkin Delta of North VietNam, followed by the Mekong Delta near Saigon, and then both plains and uplands of the west coast of Malaya and the plains on the east coast of Malaya.

The sample results compared to the complete inventory of road mileage suggests the reliability of the sample is low and adequate estimates will result only if care is taken to separate areas of greatly differing densities. Road network densities vary considerably in a region such as the one under study, and this inherent variability will necessarily result in rather loose estimates of true density.

TABLE 18

TOTAL NETWORK MILEAGE BASED ON ESTIMATED DENSITY OF NETWORK IN PLAINS AND UPLANDS COMPARED WITH ACTUAL MILEAGE BY SAMPLE AREAS

	1	2	3	4	5	6	7	8
		Plains and Deltas		Uplands				
	Sample Area Code Number	total square miles in plains (square miles) x	estimated network density (miles/100 sq. miles) +	total square miles in uplands (square miles) x	estimated network density (miles/100 sq. miles) =	estimated total network mileage (miles)	actual total network mileage (miles)	% error
Burma	1	3139	10.25	7922	0.42			
				6936	1.88	691	771	+ 10
	2	3856	3.98			236	152	+ 36
(Rangoon)	3	4781	17.80	3600	1.91	916	796	+ 15
	4	5119	11.10	13619	1.17	737	986	- 26
Thailand	5	4459	6.81	7670	1.47	417	351	+ 19
Malaya (Georgetown) (Kuala Lumpur)	6	7260	23.42	8540	10.39	2587	2483	+ 4
(Singapore)	7	8677	18.53	7813	28.99	3873	3200	+ 21
	8	7103	20.08	6781	3.31	1649	1346	+ 23
Thailand	9	5896	17.43	9495	*	1110	705	+ 57
(Bangkok)	10	5587	12.70	4719	*	750	900	- 17
Cambodia	11	5016	14.30	8988	0.86	794	566	+ 40
South Viet-Nam	12	7771	17.72	663	**	1377	1168	+ 18
(Saigon)	13	7839	39.88	0		3111	2916	+ 7
	14	5323	32.31	7909	8.30			
				9706	2.06	2652	2892	- 8
	15	5876	24.70	7103	0.89	1514	1647	- 8
North Viet-Nam	16	4619	57.25	8467	3.06	2970	3219	- 8
	TOTAL	98321	20.38	119731	3.71	25372	24076	+ 5

Notes

* No roads were in sample observations. Upland road density was estimated using area N-11 estimate of density — 0.86 miles/100 sq. miles.

** No sample observations were made in this small area.

The Distance to Nearest Road. Choosing a set of random locations in the study area and measuring the shortest distance to the nearest road gives some information about the spacing of the road network. The center of the sample observations is used as the point from which this measurement is made. The nearest road is used regardless of which landform type in which it is located.

Table 19 presents the results of this tabulation for each sample area. Notice from Thailand north and east to North VietNam the distance to nearest roads in upland areas is from three to eight times farther than in the plains for the same area. This is also true of Burma where the coastal plains are narrow (areas 1 and 4). The average ratio for the entire coastal region is 2.5. Only in area 7 is the distance to the nearest road significantly greater in the lowland than in the upland. This may be understood by the fact that Singapore is in this area and is located on an island classified primarily as complex hills (uplands). This same area, on the other hand, has considerable area in inaccessible mangrove swamps in the plains sample area. In other areas of Malaya distances to the road in upland and plains are about the same within 50 miles from the coast.

The shortest distances to the road are in the delta regions of North and South VietNam. Approximately the same short distances are also found in the narrow coastal plains of South VietNam. The areas classified as delta around Rangoon and Bangkok have some of the longest distances to roads, reflecting the rather low and uneven road densities in these areas.

Variations in Distances to Nearest Road. The variation in distances to nearest road is extreme. This fact is shown in Table 19 by the large standard deviations compared with the average values for each sample area. The distribution of the distances tends to be skewed to the right although both tails of the distribution are sometimes large. The flatter the distribution, the more uneven is the transportation network.

The standard deviation seems roughly proportional to the means. This fact suggests the distances to the nearest road from a randomly chosen point may be described as a Poisson population in certain circumstances. We suspect the distribution of distances to the nearest road is a Poisson distribution for the ideal case of a perfectly even transportation network. No analysis was attempted to prove this statement but we consider it a very fruitful avenue of research. If this measure could be related to the Poisson curve, the degree to which a network varied from an even distribution could be established by comparison with the Poisson distribution.

Differences in the Variation of Distances to Nearest Road. The plains and delta of North and South VietNam again display least variation in transport network spacing. The deltas and plains around Rangoon and Bangkok show great variation in spacing (areas D-2, D-3, and D-10). Malaya has a medium variation in spacing except for great unevenness in the southern tip of the peninsula in the vicinity of Singapore where, as noted above, mangrove swamp and urban road densities are adjacent.

TABLE 19

DISTANCES TO NEAREST ROAD FROM RANDOMLY CHOSEN POINTS IN UPLANDS, PLAINS, AND DELTA

Sample Area Code Number	Average Number of Miles from Random Point to Nearest Road			Standard Deviations of Miles to the Nearest Road		
	Plains & Delta	Uplands	Ratio of Plains & Delta to Uplands	Plains & Delta	Uplands	Ratio of Plains & Delta to Uplands
1	5.9	16.6 16.9	2.8 2.8	4.7	10.6 13.2	2.3 2.8
2	9.7			8.8		
3	6.8	7.0	1.0	11.4	2.3	0.2
4	2.5	20.0	8.0	1.5	12.0	8.0
5	13.6	13.1	1.0	12.9	7.3	0.6
6	2.7	5.8	2.1	2.2	4.9	2.2
7	11.1	3.3	0.3	12.0	10.3	0.8
8	4.8	8.6	1.8	6.1	8.0	1.3
9	4.1	21.9	5.3	2.7	9.4	3.4
10	9.3	30.8	3.3	11.7	5.0	0.4
11	4.2	18.7	4.4	9.4	13.6	1.4
12	5.1			7.8		
13	1.5			1.0		
14	1.8	5.8 9.1	3.2 5.1	1.4	7.3 9.9	5.2 7.1
15	1.7	11.6	6.8	1.0	9.1	9.1
16	1.2	9.9	8.2	1.4	9.0	6.4
Landform Area Average	5.3	13.1	2.5	7.5	11.7	1.6

Entire Area: mean 9.5 miles, standard deviation 10.7 miles.

The variation of the distances to nearest roads is greater in the uplands than in the plains for most areas, but this difference is not as pronounced as the difference in average miles to the nearest road. The standard deviation of the distances is 10.7 for the entire region. The standard deviations for the upland areas of Burma, Thailand, and Cambodia are near this value, but have large average distances to the nearest road. This implies a very light road network, but with average variation in spacing in these areas.

QUALITY OF SURFACE AND CONSTRUCTION OF TRANSPORTATION NETWORK

The capacity of a transportation network depends upon the quality of the surface and construction of the roadway. We distinguished three classes of roads plus one class of railroad. It is difficult to be consistent because of differing classifications of roads on different map series. The British maps had at least two classifications and the American maps still another. Some British maps (group 1) classify roads as:

1. Road, all weather motorable with milestones and bridge
2. Road, fair weather motorable
3. Road, unclassified
4. Pack-track
5. Foot-path

Another British classification (group 2) is:

1. Road, 1st class, metalled (unrestricted), with milestone and bridge
2. Road, 2nd class, metalled or gravel
3. Road, indifferent
4. Cart or jeep-track
5. Foot-path

The American classification for maps compiled from either American or French sources is:

Roads

1. All weather, hard surface, two or more lanes wide
2. All weather, hard surface, one lane wide
3. All weather, loose or light surface, principal
4. All weather, loose or light surface, other
5. Fair or dry weather, loose surface, principal
6. Fair or dry weather, loose surface, other
7. Cart-track
8. Footpath-trail

Railroads were classified as normal guage (3.3'), narrow gauge; single or multiple track; light, milestone and bridge, or simply railroad.

The classification adopted in this study to combine these classifications is:

<u>All Weather Routes</u>

1. Railroad (all classes)
2. Metalled (principal) roads

   British group 1-1
   British group 2-1
   American 1,2

3. Other all weather roads

   British group 2-2
   American 3,4

<u>Dry Weather Routes</u>

4. Dry weather roads only

   British group 1-2, 3
   British group 2-3
   American 5,6.

Cart, jeep-track, pack-track, foot-path, and trail were not included in the study. Persons with experience in the area claim the British 2nd class road in Malaya is indeed an all year metalled road. The cart-track and trail are normally unreliable for motor vehicles. Bridges and ferries for larger streams are available on all the metalled (principal) roads. Fords are not uncommon on the other all weather roads and dry weather roads only. The railroads have bridges, and (normally) displayed cuts, fills, and tunnels. Construction (embankments, slopes, etc.) of the railroads are considered at least as good as those of the metalled roads.

<u>Distribution of Routes by Type</u>. There is a total of slightly over 24,000 miles of all classes of road and railroad in the study area, 19,700 miles (82%) in the plains and delta and 4300 miles in upland regions. Of this total 9445 miles or nearly 40% of the network consists of dry weather roads only. Forty-three percent of the network in the uplands is dry weather roads only while 38% of the network on the plains is dry weather road. Recall that these totals excluded the network within large cities except for the diameter of the cities. There is probably an additional 500 miles of road and railway in the cities but mapping is so inconsistent that no measure was attempted.

Table 20 is the breakdown by class of routes for the entire coastal region by landform type. In addition, by looking at Table 4 vertically we calculated the proportion of each route class by landform type. Thus the uplands have 16% of the railroads, 23% of the metalled roads, 8% of the other all weather roads, and 20% of the dry weather roads only.

TABLE 20

TOTAL MILEAGE AND PROPORTIONS BY CLASS OF ROUTE FOR TRANSPORTATION NETWORKS OF COASTAL SOUTHEAST ASIA

	All Weather Routes						Dry Weather Routes		Total	
	Railroads		Metalled Roads (Principal)		Other all Weather Roads		Dry Weather Roads Only			
	Miles	%	Miles	%	Miles	%	Miles	%	Miles	%
Plains & Delta	3101	16	5368	27	3692	19	7602	38	19,763	100
Upland	576	13	1572	36	322	7	1834	43	4,313	100
Total	3677	15	6940	29	4014	17	9445	39	24,076	100

The reciprocal of these values gives the proportion of each route class in plains and delta areas. Table 21 (a and b) is similar to Table 20, being a detailed breakdown by class of road for each sample area. This Table shows that the quality of the transportation network varies considerably from area to area.

The variation in quality of route is very large. This variation is summarized in Table 22 for sample areas by listing the median proportion in each class of route and the range, i.e., the largest and smallest proportions.

The variability makes it difficult to make any statements about expected quality of the road. That no mileage was classified as "other all weather road" in Malaya probably means the classification system is faulty—not that this is an actual characteristic of the routes in that region.

Certain patterns can be seen in Table 21. Burma has a higher proportion of dry weather roads than the rest of the region. In Burmas something like 75% of all routes are dry weather roads only, whereas this lowest class of road accounts for approximately one-third of the total mileage in other areas. North VietNam also has a higher proportion of poorer roads. Close to one-half of its roads are dry weather roads only.

TABLE 21

TRANSPORTATION NETWORK MILEAGE AND PROPORTIONS BY QUALITY OF SURFACE AND CONSTRUCTION

	Sample Area Code Number		all weather routes: railroads miles	railroads percent	metalled roads (principal) miles	metalled roads (principal) percent	other all weather roads miles	other all weather roads percent	dry weather routes: dry weather roads only miles	dry weather roads only percent	Totals: by land form type miles	Totals: combined sample area miles
	1	plains	64	12	62	11	28	5	398	72	552	
Burma		upland	0	0	7	16	0	0	36	84	43	
		upland	0	0	0	0	10	6	166	94	176	
		total	64	8	69	9	38	5	600	78		771
	2	delta	28	18	0	0	12	8	112	74	152	152
(Rangoon)	3	delta	262	35	163	22	182	25	135	18	742	
		upland	2	4	24	44	8	15	20	37	54	
		total	264	33	187	23	190	24	155	19		796
	4	plains	122	16	102	13	180	23	368	48	772	
		upland	14	7	8	4	22	12	148	77	192	
		total	136	14	110	11	202	21	516	54		964
Thailand (west coast)	5	plains	46	15	58	18	8	3	205	65	317	
		upland	0	0	6	18	8	24	20	59	34	
		total	46	13	64	18	16	5	225	64		351
Malaya (Georgetown)	6	plains	343	20	946	55	0	0	437	25	1726	
(Kuala Lumpur)		upland	118	16	493	65	0	0	146	19	757	
		total	461	19	1439	58			583	23		2483
(Singapore)	7	plains	266	13	1026	52	0	0	692	35	1984	
		upland	112	9	606	50	0	0	498	41	1216	
		total	378	12	1632	51			1190	37		3200
	8	plains	262	23	444	39	0	0	422	37	1128	
		upland	76	35	30	14	0	0	112	51	218	
Thailand		total	338	25	474	35			534	40		1346

TABLE 21 (Concluded)

	Sample Area Code Number		all weather routes: railroads miles	railroads percent	metalled roads (principal) miles	metalled roads (principal) percent	other weather miles	all roads percent	dry weather routes: dry weather roads only miles	dry weather roads only percent	Totals: by land form type miles	combined sample area miles
	9	plains	370	59	78	13	48	8	128	21	624	
Thailand		upland	45	56	8	10	0	0	28	35	81	
		total	415	59	86	12	48	7	156	22		705
(Bangkok)	10	delta	268	31	264	30	56	6	288	33	876	
		upland	20	83	4	17	0	0	0	0	24	
		total	288	32	268	30	56	6	288	32		900
	11	plains	0	0	220	46	134	28	130	27	484	
Cambodia		upland	0	0	16	20	20	24	46	56	82	
		total			236	42	154	27	176	31		566
	12	delta	0	0	364	36	316	31	334	33	1014	
		upland	24	16	50	33	20	13	60	39	154	
South VietNam		total	24	1	414	35	336	29	394	34		1168
(Saigon)	13	delta	92	3	324	11	1500	51	1000	34	2916	2916
	14	plains	405	21	676	34	372	19	519	26	1972	
		upland	124	21	156	26	124	21	190	32	594	
		upland	22	7	60	18	62	19	182	56	326	
		total	551	19	892	31	558	19	891	31		2892
	15	plains	393	26	260	17	174	11	708	46	1535	
		upland	13	12	44	39	2	2	53	47	112	
		total	406	25	304	18	176	11	761	46		1647
North VietNam	16	delta	180	6	381	13	682	23	1726	58	2969	
		upland	6	2	60	24	46	18	138	55	250	
		total	186	6	441	14	728	23	1864	58		3219

TABLE 22

MEDIANS AND RANGES IN PROPORTION OF TRANSPORTATION NETWORK IN EACH CLASS OF ROUTE BY LANDFORM TYPES

Class of Route	Plains and Delta		Uplands		Total	
	Median	Range	Median	Range	Median	Range
Railroad	17%	0-59%	8%	0-83%	17%	0-59%
Metalled Roads	20%	0-55%	19%	0-65%	27%	9-58%
Other all Weather Roads	10%	0-51%	13%	0-24%	9%	0-29%
Dry Weather Only	35%	18-74%	49%	0-94%	36%	19-78%

Note also that there is no coastal rail connection between Thailand and Cambodia, although one exists at greater than 50 miles inland. Also there is no rail connection between Thailand and Burma.

DIRECTIONAL TRENDS IN THE TRANSPORTATION NETWORK

A natural orientation or direction suggested in a coastal study is the coastline. Directions parallel and perpendicular to the coastline may be used as a basis for establishing directional tendencies in the transportation network. This orientation is defined in the sample observations by establishing a line from the center of the sample area to the nearest open seacoast. The direction of this line is called the inland-seaward direction. A line perpendicular to it will be parallel to the coast and is called the lateral direction. It is convenient to establish a right and left lateral direction by viewing the sample area from seaward towards the inland direction. A grid coordinate system so oriented with the origin at the center of the observation area divides the area into the familiar positive and negative coordinates where inland and right lateral are positive values and seaward and left lateral are negative values. The sample observations in diagram display these directions.

A circular observation area was chosen to avoid a bias in measuring directional mileage, boundary crossings, etc. Intuitively we know what direction means and can conceive of a transportation network that tends to be better connected in one direction than another. However, some difficulty is encountered in trying to define an operational definition for directional bias. In a map projection, directional distortion is usually defined around a single point; that is, if angles are the same in all directions from any point on a map, no angular deformation exists in the transformation of a coordinate system from a sphere to a plane and the projection is conformal. Many projections have angular deformation present and Tissot's indicatrix provides one method of measuring this deformation. See for example, Arthur H. Robinson, Elements of Cartography, New York: John Wiley, 2nd edition, 1960, p. 59ff.

We can think of a road network as deforming the accessibility in different directions from any given point, but some radius of observation is required to measure it. The radius of observation may be made infinitely small in a map transformation because of the continuous nature of the transformation. The road network is a discrete rather than a continuous phenomena over space and Tissot's indicatrix is not appropriate. The problem is to choose a meaningful radius of observation. If the radius is too large the measure will reflect "in the large" influences such as the shape of the study region—the Southeast Asia coastal region under study here being an example of an extremely odd-shaped region. If the radius is too small, the observations will lack data because of the discrete nature of roads. A 500 square mile area was chosen rather arbitrarily after indications from a pre-test that most samples of this size would contain examples of the road net in the study region.

More study is needed on an appropriate radius of observation. Given a network with a certain bias, we suspect sample measures designed to reveal that bias would have large variances if the radius of observation was small compared to the average spacing of the network and that the variance in sampling would decline to some minimum value as the radius of observation was broadened. When "in the large" effects set in, the sample variance would increase again. This implies some best radius to estimate directional trends exists. Proof of these assertions require further research. In this report, a 500 square mile area is used, which means that directional measures refer to the transportation network in a circle of just over 12 miles radius around the sample points. As noted below this did not work well in areas of extremely sparse road networks.

Directional Trend in Number of Boundary Points. Using the seaward line to orient the sample observations, the circumference of the circle is divided into four arcs, each centered on one axis of the coordinate system. A count is made of the number of times a road or railroad crosses each arc. The intersections are boundary points and their sum by direction is a measure of directional trend. The absolute sum of the right and left lateral boundary points divided by the absolute sum of the inland-seaward boundary points yields a ratio which has the value 1.0 if no directional trend is present. The value will be less-than-one when the trend is inland-seward and greater-than-one when the trend is lateral to the sea. Table 23 shows these calculations for the sample areas.

TABLE 23

DIRECTIONAL TRENDS BY RATIO OF BOUNDARY POINTS

Sample Area Code Number	Plains and Delta			Uplands		
	Boundary Points		Ratio	Boundary Points		Ratio
	Sum Inland-Seaward	Sum Right-Left Lateral	Lateral to Inland-Seaward	Sum Inland-Seaward	Sum Right-Left Lateral	Lateral to Inland-Seaward
1	6	17	2.8	1 4	4 4	4.0 1.0
2	4	3	0.8			
3	4	18	4.5	2	2	1.0
4	8	9	1.1	2	5	2.5
5	1	4	4.0	4	5	1.3
6	38	53	1.4	43	40	0.9
7	19	38	2.0	45	63	1.4
8	29	29	1.0	9	13	1.4
9	9	13	1.4	3	5	1.7
10	10	13	1.3	*		
11	7	10	1.4	1	5	5.0
12	19	12	0.6			
13	92	82	0.9			
14	15	29	1.9	27 6	22 11	0.8 1.8
15	10	21	2.1	4	19	4.8
16	53	55	1.0	22	16	0.7
Entire coastal region	327	406	1.2	173	214	1.2

*No roads in observation area.

A predominance of lateral trends is characteristic of both uplands and plains. Four plains and delta areas are nearly balanced including the Mekong and Red River Deltas and the east coast of Malaya. Five areas have over a 2:1 ratio in favor of a lateral orientation. These areas include Rangoon and Singapore zones and certain narrow coastal areas such as in Burma and North VietNam. The narrow coastal valley of South VietNam (area 14) almost reaches a 2:1 ratio in the plains sample—1.9:1. The other areas with narrow coastal valley do not seem to have an unusually high lateral orientation, e. g., area 4, 1.1:1; area 11, 1.4:1. The most extreme lateral orientation in the uplands is in areas adjacent to the narrow coastal valleys (areas, 4, 11, and 15). A large portion of the upland roads in these areas is in fact, connecting lowland areas along the coast rather than penetrating inland from the sea. The rest of the upland areas seem rather evenly balanced with some tendency for lateral orientation. An expected inland-seaward orientation did not materialize.

Directional Mileage. It is possible to divide a road crossing diagonally to the inland-seaward direction into components of inland-seaward mileage and lateral mileage. Of course, this procedure yields more mileage than a direct measure of the road yields. This is of no consequence, because the objective is again to form a ratio of the sum of the lateral mileage to the sum of inland-seward mileage. The measurements were accomplished with a square-mile grid template covering the area. To establish the sum of the lateral road mileage, simply count the number of miles (grid lines) the road crosses in the lateral direction regardless of how far it extends inland-seaward. If a road waves back and forth within a mile in a lateral direction while extending a long distance inland-seaward, to facilitate the count, no lateral mileage is counted. Lateral mileage is counted only when it crosses entirely between grid lines. This procedure tends to underestimate the component mileage, but one might argue that one is getting nowhere on a road that waves back and forth within a mile width anyway. If the road extends several miles laterally and then doubles back the total lateral mileage is counted. In this sense the road represents two routes for lateral movement.

Table 24 is the result of the analysis of directional mileage of the network. The entire coastal region again shows a slight lateral orientation to the transportation network. Although the magnitudes of the directional trends are somewhat dampened by using directional mileage as the index compared to the boundary point index, roughly comparable ranks are found. The rank-correlation coefficient for the two indices is .76 for the plains area. This is a significant correlation.

On the other hand the rank correlation of the two indices for the upland area is only .05, which is not significant. This low correlation resulted from such changes between the indices as area 11 going from the most laterally trending in the boundary count to the most inland-seaward trending in the directional mileage count. Very small mileage is involved in the calculation

TABLE 24

RATIO OF DIRECTIONAL MILEAGE OF TRANSPORTATION NETWORK BY SAMPLE AREAS

Sample Area Code Number	Plains and Delta			Uplands		
	Directional Mileage		Ratio	Directional Mileage		Ratio
	Inland-Seaward	Right-Left Lateral	Lateral to Inland-Seaward	Inland-Seaward	Right-Left Lateral	Lateral to Inland-Seaward
1	101	173	1.7	17 34	48 76	2.8 2.2
2	71	64	0.9			
3	148	216	1.5	17	14	0.8
4	117	110	0.9	44	67	1.5
5	22	34	1.5	30	42	1.4
6	518	528	1.0	364	485	1.3
7	433	453	1.0	809	761	0.9
8	250	321	1.3	162	168	1.0
9	96	202	2.1	38	62	1.6
10	150	180	1.2			
11	91	94	1.0	39	24	0.6
12	270	208	0.8			
13	1065	1002	0.9			
14	255	325	1.3	155 59	311 118	2.0 2.0
15	167	296	1.8	82	161	2.0
16	668	637	1.0	134	242	1.8
Entire coastal region	4422	4843	1.1	1954	2579	1.3

for these areas, apparently too small to be of any significance in the analysis of directional trends. Thus in upland sample areas 1 through 5 and 9 through 12 there are too few roads upon which to make any generalizations about directional trends. This is an area of 62,770 square miles of upland with (by actual count) a total of 686 miles of road and railroad combined—slightly over 1 mile of road per 100 square miles of area. From map inspection no directional trend is apparent for this mileage. Sometimes it is a single lateral connector between coastal valleys and sometimes a single spur heading inland.

CONNECTIVENESS OF THE TRANSPORTATION NETWORK

The road and rail network of the Project Area is now investigated to establish the prevalence of strategic points or alternate routes in the system. These elements depend upon the connectiveness of the network. To measure this property the frequency of events such as intersections, deadends, and sample observation boundary crossings is counted. The relative proportions of deadends to branching, or deadends to connections beyond the sample observation (boundary crossings) are important variables for describing the connectiveness of the network.

The number of lines (road segments) incident with intersections is another variable. That is, intersections may be three-way, four-way, or larger. The number of road segments radiating from an intersection is defined as the degree of the intersection. The larger the average degree of the network, the more alternate routes there are and, most likely, the more interconnected is the network. This is not necessarily true however, and a better measure of interconnection is the ratio of road segments to intersections—here called the line density.

The matter of the size of the sample observation area is again a problem. There may be a snarl of roads and intersections locally. Two examples of such areas are on a plantation and in a built-up urban area. In these areas, local manuverability is great but at the same time there may be but a single connector to the outside—or perhaps no outside links at all. Local connectiveness may be compared to external connection by noting the proportion of boundary points, internal connections, and end-points. In using these measures, the size of the sample area is critical, for it defines a "neighborhood" or local area. The question of what a meaningful neighborhood is has not been answered here. The same 500 square mile circular area with a 12.6 mile radius used throughout the study is chosen as the "local area."

A set of intersections, any one of which is within one-half miles of another, is defined as a cluster. Clusters may often be strategic locations. Example, from a military point of view, it would be fairly simple to control two or more intersections within one-half mile of one another. Also clusters normally have higher degrees than intersections giving them greater strategic value in the network.

In summary, the list of the "events" defined in the network is: clusters, intersections, endpoints, and boundary points.

Analysis of the connectiveness of the network did not extend into the upland regions where the roads are so sparse that extremely few observations of branching, endpoints, etc., are possible. Identification of these excluded regions is given in Table 25.

TABLE 25

AREA OF VERY SPARSE TRANSPORTATION NETWORK

Country	Sample Area Code No.	Upland in Square Miles	Total Route Miles	Route Miles in Sample Observations
Burma and west coast of Thailand	M-1 through M-5	39,567	499	197
Thailand and Cambodia	M-9 through M-11	29,983	187	41
Total		69,550	686	238

These areas not included in the analysis of route connectiveness. These regions contain 58% of the upland area and 15% of the upland routes (3% of all routes).

Frequency of Network Events. Table 26 summarizes the events per 100 miles of route. Two groups are distinguished in addition to the regions of very sparse networks. The heaviest networks are in the lowlands of Malaya and the uplands in the Singapore region and the deltas near Rangoon, Saigon, and in North VietNam. In these areas there is, on the average, an intersection, a cluster, or an endpoint just over every two miles. Surprisingly enough, there is only a small correlation between the density of the network in miles per square mile and the number of events per 100 miles of roads. The highest network effect is in Malaya where many short plantation roads from a complicated network, but with less total route mileage than the delta areas display. The delta areas, on the other hand, have a fairly high density of road to area, but the network is rather disconnected with endpoints more common. This is due, no doubt, to the emphasis on canal transportation in the delta area. If the canal network is connected, then the road network in the area is broken up into separate components because bridges are not common. The variation in the number of components is shown in Table 26 where a component is defined as a connected portion of the network found in the sample observations.

TABLE 26

NETWORK EVENTS PER 100 MILES OF ROUTE

location	sample area code number	landform type	Total miles of route (adjusted for urban areas)	Total events per 100 miles	Network events: clusters	Network events: inter-sections	Network events: end points	Network events: boundary points	average number of components
Over 30 events per 100 miles									
Burma	D-2		95	32.7	4.2	7.4	13.7	7.4	2
(Rangoon)	D-3	delta	296	49.6	9.8	11.5	20.9	7.4	3
Malaya (Kuala Lumpur)	P-6	plains	854	47.0	5.3	18.0	13.0	10.7	2
(Singapore)	P-7	plains	843	47.3	5.3	22.3	12.9	6.8	3
(east coast)	M-7	upland	819	53.3	7.7	24.1	14.5	7.0	3
Thailand	P-8	plains	510	39.6	2.5	18.2	7.5	11.4	2
(eastern coastal plains)	P-11	plains	173	35.4	1.2	8.1	11.6	14.5	2
South VietNam (Saigon)	D-13	delta	1729	45.3	3.4	21.0	11.1	10.1	5
North VietNam (Tonkin delta)	D-16	delta	1060	33.3	2.6	14.3	6.2	10.2	5
		average		42.6	4.7	16.1	12.4	9.5	
Less than 30 events per 100 miles									
Burma (coastal plains)	P-1	plains	215	23.3	1.9	5.1	5.6	10.7	2
Malaya	P-4	plains	192	26.6	2.1	7.3	8.3	8.9	2
	M-6	uplands	320	27.7	1.9	13.4	3.8	8.6	3
	M-8	uplands	101	27.7	4.0	7.9	7.9	7.9	1
Thailand (Bangkok)	P-9	plains	270	21.4	2.6	6.3	4.4	8.1	1
South VietNam	D-10	delta	276	20.3	1.1	5.1	5.8	8.3	2
	D-12	delta	425	26.5	1.6	8.7	8.9	7.3	4
	P-14	plains	484	25.0	2.3	8.5	4.5	9.7	2
	M-13	upland	308	17.8	0.3	2.9	6.8	7.8	2
North VietNam	M-14	upland	102	14.8	1.0	2.0	5.9	5.9	1
	M-16	upland	143	20.3	1.4	3.5	4.2	11.2	1
		average		22.9	1.8	6.4	6.0	8.6	

Very sparse network

Very sparse network in uplands of Burma, Thailand, and Cambodia -- sample areas M-1 through M-5, M-9 through M-11, M-15 and the lowlands of west coast Thailand (area P-15).

The regions with an average of 22 events per 100 miles (an event every 4.5 miles) are primarily the long coastal plains throughout the Project Area and the delta area around Bangkok. The road network in the Bangkok region is considerably less dense and complicated than the network in the vicinity of the other large cities in the area. The region must depend very heavily on canal traffic.

The Proportion of Internal and External Connections and Endpoints. How often a traveler willbe faced with a deadend rather than a choice of routes or an opportunity to leave a neighborhood is indicated by the relative frequency of enpoints, internal connections, and boundary points. Table 27 is a summary of these values for the sample areas arranged in order of decreasing percentage of internal connections. In all of Malaya and the deltas, excepting that around Bangkok, over 40% of all route events are internal branching. The proportion of boundary points is generally inversely related to percentage of internal connections. The highest proportion of boundary points is in the coastal plains and uplands where simple networks cross the observation area without much branching. The percent of endpoints is not significantly correlated with either of these two events. Endpoints are slightly more common in the narrow coastal valleys and upland than elsewhere. The exception to this observation is the delta region near Rangoon, where 42% of the road segments lead to deadends.

The Line Density of the Network. The number of line segments in a network is equal to one-half the sum of the degrees of the route events. Let q be the number of line segments and p be the number of points. Define d_i as the degree of the ith point. Then, the above statement may be expressed as:

$$q = \frac{1}{2}\sum_{i=1}^{p} d_i; \quad i = 1. \tag{1}$$

The line density of a network is the ratio of number of line to one-half the number of points. The number of points is divided by one-half because it takes two points to establish each line. Call the line density ρ, then:

$$\rho = \frac{q}{\frac{p}{2}}. \tag{2}$$

In a network of p points there are two sources of lines—internal connections between the p points and connection from the points to the outside. It would be desirable to establish the proportion of line density contributed by internal and external connections. It would also be desirable to compare the line densities of an observed network with some standard network.

The theory of graphs, a mathematics of relations, suggests certain standards. A graph is defined as a set of points and lines in which each line is

TABLE 27

INTERNAL AND EXTERNAL CONNECTIONS AND ENDPOINTS AS A PERCENTAGE OF TOTAL NETWORK EVENTS

	sample area code number	Percentage of total events on routes: internal connection (clusters and intersections)	external connections (boundary points)	endpoints
Malaya, Singapore, lowland	P-7	60	13	27
Malaya, Singapore, upland	M-7	58	14	27
Malaya, Kuala Lumpur, upland	M-6	55	31	13
South VietNam, Saigon, delta	D-13	54	22	25
Malaya, east coast lowland	P-8	52	29	19
North VietNam, Tonkin delta	D-16	51	31	19
Malaya, Kuala Lumpur, lowland	P-6	50	23	28
Burma, Rangoon, delta	D-3	43	15	42
Malaya, east coast upland	M-8	43	29	29
South VietN am, coastal plain	P-14	43	39	18
Thailand, coastal plain	P-9	42	38	21
South VietNam, delta	D-12	39	28	34
Burma, delta	D-2	35	23	42
Burma, coastal plain	P-4	35	33	31
South VietNam, coastal plain	P-15	35	45	19
Thailand, Bangkok, delta	D-10	31	41	29
Burma, coastal plain	P-1	30	46	24
Eastern Thailand, Cambodia, coastal plain	P-11	26	41	33
North VietNam, coastal upland	M-16	24	55	21
South VietNam, coastal upland	M-14	20	40	40
South VietNam, coastal upland	M-13	18	44	38

defined as a segment connecting two, and only two, points. Each point, on the other hand, may have any number of lines incident to it. A planar graph is a graph with points on a plane and pairs of points joined by lines also in that plane such that no two lines intersect except at defined points. The transportation network, as we have defined it, is a model of a planar graph in which the above definitions hold as well as the condition that every point has at least one line incident to it.

The minimum connected graph is one standard to which a real network may be compared. A connected graph is one in which there is a path (a sequency of points and lines) between every pair of points. The number of lines in a minimum connected graph is:

$$q_{min} = p - 1. \qquad (3)$$

Partition the points p of a graph of the transportation network in the sample observations into two sets p_o = (set of internal points) and p_b = (set of boundary points). Notice that each point in p_b has degree 1. If the number of boundary points is b, then the number of line segments connected to the outside is also b. The density of the internal connections of a network is:

$$\rho_o = \frac{q-b}{\frac{p_o}{2}} = \frac{2(q-b)}{p_o} . \qquad (4)$$

The density of the minimum connected graph of internal connections is:

$$\rho_{omin} = \frac{2(q_{omin})}{p_o} = \frac{2(p_o-1)}{p_o} . \qquad (5)$$

An index of internal density of a network relative to the standard minimum connected graph of the network is then,

$$D_o = \frac{\rho_o}{\rho_{omin}} = \frac{q-b}{p_o-1} . \qquad (6)$$

Consider the set of boundary points p_b as a single point, that is, if a route crosses the boundary of the observation area it is simply considered to be connected to a point designated as "the outside." An index for the total network is now derived.

$$\rho_t = \frac{2q}{p_o+1} . \qquad (7)$$

The density of the minimum connected graph with the boundary considered a single point is:

$$\rho_{tmin} = \frac{(p_o+1)-1}{\frac{p_o+1}{2}} = \frac{2p_o}{p_o+1} . \qquad (8)$$

The <u>index of total connectiveness</u> is, then,

$$D_t = \frac{\rho_t}{\rho_{tmin}} = \frac{q}{p_o} . \qquad (9)$$

The indices (6) and (9) are easily calculated for each observation area given a count of the points and their degrees. Table 28 is a summary of these calculations. The indices of line densities may be read as percentage comparisons with the density of the minimum connected graph with the same number of internal points. Networks with indices at 100% are just equal in line density to a graph with a single line from each point. Less than 100% values indicate a system is broken into component parts.

An upper limit on the density index is suggested by the maximum planar graph, that is, the graph with not more than one line between any pair of points and with no lines intercepting except at defined points. The maximum number of line q in a planar graph of p points is:

$$q_{max} = 3(p-2) \text{ for } p > 2. \qquad (10)$$

Given this fact, it is easy to show that the index of maximum density to minimum density connected graph is:

$$D_{max} = \frac{\rho_{max}}{\rho_{min}} = \frac{3p_o}{p_o+1} . \qquad (11)$$

These values are shown in the last column of Table 28. These values are useful for gauging the extent of connectiveness in the network. The maximum planar graph is not an absolute limit of density on a road network because more than one route may connect a pair of points.

Table 28 is ordered by decreasing values of internal connections. This value is correlated with size of the network and slightly inversely related to external connections. Again the Bangkok area is distinguished by resembling the poorly connected uplands and narrow coastal valley areas more than the area with the other large cities. The former rely more on external contacts to exceed the minimum connected density then do the later, which achieve greater internal completeness.

TABLE 28

INTERNAL AND BOUNDARY POINTS, LINE SEGMENTS AND PERCENTAGES OF LINE DENSITIES TO LINE DENSITY OF MINIMUM CONNECTED NETWORKS

	sample area code number	clusters and intersections	endpoints	total internal points P_o	boundary points b	line segments q	percentage line density to minimum connected line density: internal D_o	external D_b	total D_t	percentage maximum line density to minimum line density $D_{max-min}$
Malaya, Singapore	P-7	233	109	342	57	494	128	16	144	299
Kuala Lumpur	M-7	261	119	380	57	536	126	15	141	299
Burma, Rangoon	P-6	196	111	307	91	477	126	29	155	299
North VietNam, Tonkin delta	D-3	63	62	125	22	178	126	16	142	298
Thailand, coastal plain	D-16	180	66	246	108	406	122	43	165	299
Malaya, eastern coastal plain	P-9	24	12	36	22	64	120	58	178	292
South VietNam, Saigon	P-8	106	38	144	58	225	117	39	156	298
Malaya, east coastal upland	D-13	421	192	613	174	885	116	28	144	300
South VietNam, coastal	M-8	12	8	20	8	30	116	34	150	285
South VietNam, coastal	P-14	52	22	74	47	129	112	59	174	295
South VietNam, coastal	M-13	30	21	51	24	80	112	45	157	294
Burma, coastal plain	P-15	24	13	37	31	67	100	81	181	292
South VietNam, delta	P-1	15	12	27	23	48	96	82	178	289
Burma, coastal plain	D-12	44	38	82	31	106	93	36	129	296
Burma, delta	P-4	18	16	34	17	44	82	47	129	291
Thailand, Bangkok	D-2	11	13	24	7	24	74	26	100	288
Thailand, east coastal	D-10	17	16	33	23	46	72	67	139	291
North VietNam, upland	P-11	16	20	36	25	48	67	66	133	300
South VietNam, upland	M-16	7	6	13	16	24	67	118	185	277
Malaya, upland	M-14	3	6	9	6	11	63	59	122	267
	M-6	49	12	61	28	61	55	45	100	295

SUMMARY OF TRANSPORTATION NETWORK ANALYSIS

The attempt has been made in this section to define and devise measures for a sufficient number of properties of a transportation network to establish all of its important characteristics. Network-to-area relations, quality of surface, orientation and connectiveness have been considered. Although the nature of the transportation network in the Project Area has become apparent in the discussion, the value of this section is more in specifying characteristics likely to be important in any type of transportation network analysis. Further steps are required to make the measures presented more immediately useful.

One such step is to combine these various measures using factor analysis or some similar technique to establish transportation network types. If the material presented here yielded to a grouping analysis several useful results might become available. Of course, areas could be classified by their transportation network type. We were thinking more of correlating transportation network types with other features and events, physical and cultural. For example, the Army is collecting detailed tactical battle histories, eventually for analysis of factors in success or failure of battles. The degree of connectiveness or orientation of the road network could possibly be an influence in such events. Or for another example, population densities and the road density are very likely highly correlated. An investigation might be made to determine if one could be estimated from the other.

The measures presented here were not particularly satisfying. Large variances in the network density make statistical estimates of road-to-area relations difficult. Lack of consistent sources of data and great variation in quality of the surface and construction make capacity estimates difficult. What is needed here is good information on the capacities of roads under different weather conditions. The number of lanes and at least grades of surface are minimum requirements for capacity estimates.

The measures of orientation and connectiveness are new. They require further development and demonstration of usefulness. For example, some definition of a "local area" is required because both orientation and connectiveness change with the radius of observation.

<u>The Project Area</u>. One type of transportation route—waterways, did not receive attention. Lack of data prevented any significant comments. It is impossible to tell from the maps available whether a stream or canal is navigable or not. Nevertheless this omission is probably serious for all the delta areas in the study. Some of the same measures suggested here could be used to analyze a canal network if definitional problems could be resolved.

VIII. NATIVE ANIMALS AND DISEASES OF IMPORTANCE TO MILITARY OPERATIONS

Native Animals

The larger carnivors, leopard and tiger, are present in the coastal areas of Southeast Asia particularly in the wooded, brushy, and sparcely populated parts. The estuarian Crocodile inhabits the tidewater parts of the lower rivers. Although these animals can harm men, none are serious menaces to military personnel and except for the exercise of "common sense" precautions, they may be disregarded.

Poisonous snakes are common throughout the area both on the plains and in the hill country; however, the danger they present to military personnel is much less than their numbers might indicate. They do not "lie-in-wait" for passers by; most are timid, few are aggressive, and many are nocturnal. In the tropics snakes do not bask in the sun as they do in colder climates. Ordinary service clothing which covers legs offers considerable protection against the Elapidae (cobras and kraits) but less against the Vipers. Although the danger from poisonous snakes is small, it should not be disregarded. Someone in cross-country foot parties should be able to recognize the difference between the two groups mentioned above, because the first-aid measures required are different.

Invertebrate pests are present and may cause annoyance but not casualties. Large spiders, scorpions, and centipedes can give painful bites but are not at all common. The worst pests are land leeches which are found almost everywhere in jungle, forest, or long grass situations, especially during the rainy periods. Leech-bites are painless but continue to bleed after the animal is removed because of the anticoagulent injected. The bite is not poisonous but readily becomes infected. Clothing constructed to prevent entrance and impregnated with leech repellant greatly reduces the incidence of attachment.

Diseases

The native population of southeast Asia, particularly in the rural areas is in poor health condition by United States standards. This condition is a result of many factors, chief among which are: poor diets, lack of hygienic knowledge and practices, inadequate sanitation, ~~lack of~~ and indifference to medical treatment, and constant exposure to food and water contamination. Although United States military personnel would be within the same environment they would not be subject to any of the above factors. In addition, they would have innoculative immunity to some of the common diseases and would come into the environment in excellent health condition. The medical problem in relation to disease, therefore, would be preventive rather than curative in the main.

The infectious diseases of southeast Asia are spread by three methods:

(1) By insects: malaria, typhus, filiarisi, plague, dysentery, dengue fever, relapsing fever, and encephalitis.

(2) By contaminated food, water or soil: bacillary dysentery, amebiasis, typhoid, schistosomiasis, cholera, Aneylostomiasis, Taenia Solum or Saginata, and Ascariasis (infection with hook-worm, tapeworm, and roundworm, respectively).

(3) By social contact: tuberculosis, smallpox, syphilis, yaws, leprosy, trachoma, and diphtheria.

Under disciplined conditions of field service it should be possible to protect personnel to a large degree from disease bearing insects, contaminated water and food, and contact with natives. No measures will absolutely be certain and no very effective ones exist against the enteric diseases but experience in this and similar environments in World War II do not indicate that health problems will incapacitate military forces that contain modern medical facilities.

Sources: Native Animals and Diseases

Simmons, J., Global Epidemiology, Vol. 1., London (1945).

Schwardt, H., List of Arthropods of Medical Importance. Ithaca, N. Y., (1957).

Harrison, Audy, and Traub, "Further Tests of Repellants and Poisons Against Leeches." Med. Journ. of Malaya, 9:1 (1954) pp. 61-71.

Walton, Traub, and Newson, "Efficacy of Clothing Impregnants N-2065 and N2066 against Terrestrial Leeches in North Borneo." Amer. Journ. of Trop. Medicine and Hygiene, 5:1 (1956) pp. 190-196.

U.S. Army, Walter Reed Army Institute of Research, Health Data Publications, Washington.
No. 2a Cambodia
No. 5 Republic of VietNam (South VietNam)
No. 6 Thailand
No. 9 Kingdom of Laos.

TABLE 29

A SELECTED LIST OF INSECTS AND OTHER ANIMALS OF IMPORTANCE IN THE TRANSMISSION OF DISEASE OR AS PESTS IN THE COUNTRIES OF SOUTHEAST ASIA

Distribution within country is not regionalized because of lack of necessary information. Principally from, Simmons, J., Global Epidemiology, Vol. 1, London, 1945, and Schwardt, H., List of Arthropods of Medical Importance, Ithaca, N.Y., 1957.

Distributional symbols taken from references but lack of symbol does not mean lack of species. Probable presence (?) from logical assumption of other distributions.

Distributional Legend:

R	rare	VC	very common or abundant
C	common	?	probably present

		Burma	Cambodia	Malaya	Thailand	VietNam
Mosquitos (1)		VC	VC	VC	VC	VC
Culex species	non-malarial	C	C(2)	C	C	C
Anopheles minimus (3)	malarial	VC	VC	C	VC	C(4)
A. Maculatus (5)	malarial	C		C	C	C
A. fluviatilis (6)	malarial	C	?	?	C	C
A. hyrcanus sinensis (7)	malarial	C	C	C	C	C
A. sundaicus (8)	malarial	C	VC(9)	C	C	C(9)
Lice						
Pediculus capitis	on natives	C	C	C	C	C
P. corporis	on natives	C	C	C	C	C
Phthirus pubis	on natives	C	C	C	C	C
Flies						
Chrysomyia vesia	blowfly	?	?	C(10)	C(11)	?
Musca domestica	housefly	VC	VC(12)	VC	C	C
Flies of family Tabinidae	horseflies & deer flies	C(13)	VC(13)	C(13)	C(13)	C(13)
Culicoides various species	Midge flies	?	?	C(14)	C(14)	?
Gnats						
Siphunculina funi cola signata			?	C(15)	?	?
Ticks		VC	(16)			
Typhus tick		C				
Rhipicephalus sanguineus	dog tick	C	C	C	C	C
Mites						
Trombicula		C	C(17)	C(17)	C	C(17)
Fleas						
Xenopsylla cheopis	rat flea	C(18)	C(18)	C(19)	C(18)	C(19)
X. astia	rat flea	C(20)	C	C	C	C
Ctenocephalis canis	dog flea	VC	?	VC	VC	VC
Rodents						
Mus musculus	mouse	C	?	?	?	?
Rattus concolor	domestic rat	VC		C	C	?
R. norvegicus	brown rat	C	C(21)	C	C	C(21)
R. rattus	black rat	C	VC		C	C
Thizomys	"bamboo rat"	C	C	?	?	C
Snakes dangerous to man		VC	VC	VC	VC	VC
Pit Vipers (22)	several species	C	C	C	C	C
Kraits (23)	several species	C	C	C	C	C
Naja naja (24)	common cobra	C	C	C	C	C
N. hannah (25)	king cobra	R	R	R	R	R
Vipera russellii (26)	Russell's viper	C	R	C	R	R
Hydrophinae (27)	sea (marine) snakes	C	C	C	C	C
Pests						
Haemadipsa zeylanica Leeches (28)	land leeches	C	C	C	C	C
Cockroaches (29)		VC	VC	VC	VC	VC
Scorpions (30)		C	C	C	C	C
Spiders Pelenocosmia	hairy spider	?	C	?	C	C
Centipedes (31)		?	R	?	R	R

Other Animals of Significance (not distributed)
Tigers, Leopards, Estuarian Crocodile, Sharks, Poisonous Fish, Reticulated Python.

NOTES

Mosquitos

(1) Culex species are non-malarial but transmit other disease. There are fifty or more species of Anopheles a few of which carry malaria between persons. All breed in water but of differing characteristics so that the species are distributed in terms of the breeding conditions required. However there are malarial Anopheles in all environments and protection is required everywhere.

(2) Culex fathgans is the vector for filariasis.

(3) Anopheles minimus live in fresh running water, seldom in rice paddies or ponds; also found in clear unpolluted pits and tanks. Presumed to be the most important vector of malaria in altitudes of 1500 feet and under. Very common in foothills.

(4) Found below altitudes of 1500 feet.

(5) Found in water, pools of fast streams. Mostly nocturnal but will bite in daytime if disturbed.

(6) Habitat and habits about the same as (5).

(7) Found in still or slow water, occasionally in brackish or in rice paddies. Enters houses by day; most active at night.

(8) Usually near coast in any kind of water; bites day and night.

(9) Particularly abundant during dry season.

Lice

The three forms, headlice, body lice, and crab lice, are common among natives in crowded and filthy conditions, especially in cities. Typhus is transmitted from person to person by human lice which do not live on other animals.

Flies are found everywhere and transmit disease by carrying filth borne diseases mechanically. All fresh provisions need protection.

(10) Blowflies cause myiasis of skin wounds and carry yaws, intestinal diseases, and eye infections.

(11) Same as (10) above.

(12) Particularly plentiful and annoying in rainy season.

(13) Horse flies inhabit jungle cover especially in rainy season. Bites are painful and enough of them may cause incapicitation.

(14) Very small and may get through ordinary screening or netting. They bite visciously. Annoying at night when there is little wind.

(15) Are mechanical vectors of diseases of the eyes, also possibly of yaws.

(16) Ticks are known to be present in the countries of Southeast Asia but no tick-borne diseases have been reported.

(17) Transmit scrub typhus.

(18) Rat flea is the vector of plague.

(19) Rat flea in these countries also is a vector of tropical typhus.

(20) Found in most of the port cities.

Rodents are common through the area: squirrels, flying squirrels, and mice will be encountered everywhere. The "bamboo rat" is a large burrowing form which appears periodically in great numbers and damages crops. The most important military consideration is the association of rats with plague which is endemic in some parts.

(21) Found around ports.

Snakes are abundant but are seldom seen because of their nocturnal habits. During the day they hide away. Only a few species are dangerous and very few are aggressive. The reticulated python is the world's largest snake but is not considered dangerous to man. However there are poisonous snakes and some of these certainly will be encountered by military personnel. There are three groups of poisonous snakes: the Crotalidae, or pit vipers, some of which are arboreal. These have arrow or heart-shaped heads and small pits between the eyes and nostrils. Their poison is hemotoxic much like that of rattlesnakes, copperheads, and water mocassins. Their bites cause swelling and incapacitate victims but is not commonly fatal. Elapidae, cobras, kraits, and coral snakes, are smooth or narrow-headed, usually dark-colored. Their poison is neurotoxic and relatively much more deadly than that of the pit vipers. The cobras are very dangerous, the kraits are timid and bite only if physically hurt such as being stepped upon. Coral snakes are usually small and timid and do not represent much of a hazard. The Viperidae or true vipers include Russell's Viper which is especially prevalent in Burma. Very dangerous snake reported to cause more deaths than any other in Asia (although listed third in India) a fawn or sand-colored snake with heart-shaped head. Venom is hemolytic. Sea snakes are common along the coasts and can inflict deadly bites but do not attack men in the water. The only known fatalities occur when they are brought up in nets or caught on hooks by fishermen. They are easily identified by their flattened paddlelike tails.

TABLE 29 (Concluded)

Deaths from snake bite are small in proportion to those bitten. The Pastuer Institute in Bangkok treated 2218 persons for snake bite in 1952 whereas the deaths from bites of venomous animals for the entire country averaged 200 between 1946 and 1950. If military personnel have available intelligent first aid and antivenons, the mortality from snakes should be infinitesimal. The Pastuer Institute in Bangkok produces antivenins for specific snakes and also polyvalent antivenin for the poisonous species of Thailand. Antivenon should be available quickly to military parties in the field.

(22) Mainly in the coastal districts or on sandy soils. Some are aboreal, heart-shaped head. Usually not aggressive; venom causes pain and swelling but is not fatal to men.

(23) Smooth-headed snakes, commonly banded or striped. Very poisonous but cause few deaths because of inoffensive disposition and reluctance to strike even when abused. Readily come into houses or tents, even into sleeping bangs.

(24) Smooth dark-colored snakes which flatten neck into a "hood" when annoyed. Some types spit venom which is injurious to the eyes. The neurotoxic venom is deadly but statistics show that 40% of those bitten recover without any treatment, probably because the snake did not get in a good bite.

(25) The king cobra, world's largest poisonous snake, may be 10 to 14 feet long. Lives mostly in open jungle and is relatively rare. To strike will rear up so that head is six feet or so above the ground. Large amount of neurotoxic venom makes this snake probably the world's most deadly; has been known to attack without provocation. Best defense—a shotgun.

(26) Very common in Burma and probably also in the inland parts of the other countries. Hemolytic venom is very dangerous. It is said without statistical evidence that Russell's Viper bites more people and causes more deaths than any other snake in Asia.

(27) Are abundant along the coasts, in inlets and bays. May be disregarded as a hazard.

(28) Leeches are perhaps the worst pest and most feared annoyance of the jungles and forests. They are especially prevalent during the rainy season along trails on the ground or vegetation, awaiting opportunity to attach themselves to passing animals. The bite is painless but bleeds profusely and may become infected. Leeches can reach the body through difficult passages such as shoelace eyelets, trouser flaps, under belts. Some work has been done on leech repellents for impregnating clothing; if effective it would be very useful to troops in the area.

(29) Common everyhwere. Supplies need to be protected.

(30) Common and may be found in large groups. Stings painful but not deadly.

(31) Often found in warehouses in ports. May be four or five inches long. Bites are painful but not serious.

TABLE 30

PRINCIPAL CONTAGIOUS DISEASES OF SOUTHEAST ASIA

Key to Characters:

U - Unknown or not reported	WS - Wet season	Cs - Cold season
R - Rare	Wb - Wet season beginning	VL - Varies greatly with locality
RC - Rather common	We - Wet season ending	Ep - Epidemic form
C - Common	Db - Dry season beginning	End - Endemic form
VC - Very common	De - Dry season end	

	Burma	Cambodia	Malaya	Thailand	VietNam
Enteric Diseases (Diseases spread chiefly through the intestinal tract)	VC	VC	C	VC	VC
Dysentery and Diarrhea	VC	VC	C	VC	VC
Amebic Dysentery	C, WS	C, WS	C	C, WS	WS
Bacillary Dysentary	WS	C	C	VL, WS	C
Typhoid Fever	C	VL, WS	C	DS	WS
Cholera	End, De, Wb	R, Ep	R	C, Ep	R, Ep, WS
Helminthic Diseases (all diseases due to worms - in intestinal tract, blood, or internal organs)	VC	VC	VC	VC	VC
Aneylostomiasis (infection with hookworm)	VC	VC	VC	VC, VL	VC
Ascariasis (infection with common roundworm)	VC	VC	VC	VC, VL	VC
Enterobiasis (infection with pinworm)	RC, VL	VC, VL	RC, VL	RC, VL	RC, VL
Strongyloidiasis (infection with the nematode Strongyloides Stercoralis - Thread worm)	C, End	C	C, End	C, VL	VC, VL
Tainiasis saginata (infection with beef tapeworm	C	RC	R	VC	RC
Tainiasis solium (infection with pork tapeworm)	R	R	R	C	C
Trichuriasis (infection with whipworm)	RC, VL	VC, VL	RC, VL	VC, VL	VC, VL
Fluke Diseases	RC	RC	R	C	RC
Opisthorchiasis	RC	C	RC	End, VL, C	RC
Schistosomiasis	RC, VC	R	R	R	U
Diseases Spread Chiefly Through the Respiratory Tract					
Influenza	Ep, CS	Ep	C	Ep, Cs	Ep
Bronchitis Pneumonia	VC	VC, Cs	VC	VC	RC, Ds
Smallpox	C, VL	End, RC	R	RC, Ep	Ep, RC
Tuberculosis	VC, VL	VC	VC	VC, VL	VC
Viral Infections	C	RC	R	C	RC
Diseases Spread Chiefly by Contact					
Diseases of the skin	VC	VC	VC	VC	VC
Scabies	VC	C	C	VC	VC
Fungus Infections	VC	C	C	C	VC
Tropical Ulcers	C	C	C	C	VC
Gnathostomiasis	RC	RC	C	VC, VL, End	RC
Leprosy	C, VL	RC	C	C, VL	RC
Leptospirosis (Weil's Disease, or infectious hepatitis)	C	R	RC	RC, End, WS	R
Rabies	C	C	C	VC	VC
Tetanus	RC	RC	RC	C	RC
Trachoma	C, VL	End, VC	VC	C, VL	VC, VL
Venereal Diseases	VC	C	C	VC	VC
Chancroid	C	C	C	C	C
Gonorrhea	C	C	C	C	VC
Granoloma Inguinale	RC	RC	C	RC	RC
Lymphogranuloma Venereum	RC	RC	C	RC	RC
Syphilis	C	C	C	C	C
Yaws	RC, VL	VC	RC, VL	RC, VL	R
Diseases Spread by Arthropods					
Dengue fever	C, VL	VC	Ep	C, VL	C, VL
Filariaris (sequel: elephantiasis)	RC, VL	R	C	C, End, VL	R
Malaria	V, VL, (Dec), WS	VC, VL, Wb, We	C	VC, VL	VC, VL, Ws
Plague	RC, End	R, VL	R	V	R, VL
Relapsing Fever	R	R	U	R	R
Typhus Fever					
Epidemic (louse-borne)	R	R	U	R	R
Murme (endemic	R	R	R	R	R
Scrub (mite-borne)	R	R (un-diagnosed)	R	R, Ep (with-out confirm-ation)	R (un-diagnosed)
Yellow Fever	U	U	U	U	U

UNCLASSIFIED

UNCLASSIFIED