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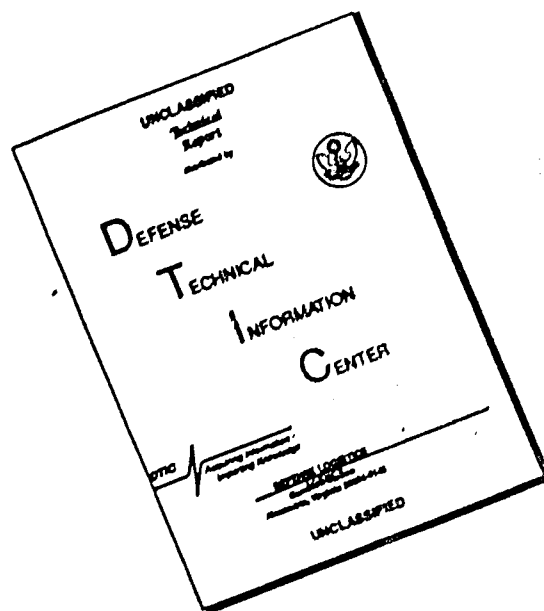
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SPECIAL REPORT

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EARTH SCIENCES DIVISION

**Special Report
S-1**

**NOTES ON SOME ENVIRONMENTAL CONDITIONS AFFECTING
MILITARY LOGISTICS IN THAILAND**

**Project Reference:
7X83-01-008**

Jun.

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QUARTERMASTER RESEARCH & ENGINEERING COMMAND, US ARMY
Quartermaster Research & Engineering Center
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**Special Report
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FOREWORD

In accordance with a request by Army Research Office, Office of the Chief, R&D, the Earth Sciences Division, QM R&E Command, has put into usable form and brought together in this brief preliminary report, a selection from its available material on certain environmental conditions that might affect military logistics in Thailand. A complete study of all aspects of the environment has not been attempted. Material from studies of this Division already completed or in progress particularly dealing with climatology, along with current available literature, has been used.

Maps are included showing conditions for sample months, representing the two great contrasting seasons that dominate the climate in Thailand: the wet season, when movement is confronted by deep mud and green, leafy landscapes, and the dry season, with its clouds of dust and brown, dry countryside. Some continuity for the entire yearly cycle is provided by the 12-month graphs of climatic elements for Bangkok, a station fairly representative of Thailand climates (Figs. 18-20). Figure 20 suggests the extent to which the climates of the different parts of Thailand resemble those of the rest of Southeast Asia.

The report is designed to provide some insight into the character of the environment and its relation to human activity in an important part of Southeast Asia. Insects and other animal life are dealt with as a part of the environment of special concern to people moving into the area. Food geography is closely related to natural geographic factors, is an element of considerable practical importance logistically to any American forces in the area, and is of concern in relations with the regular residents.

This report was prepared by the members of the Desert and Tropic Section of the Regional Environments Branch, and the Logistics Applications Section of the General Environments Branch, Earth Sciences Division. The cartographic work was accomplished by the members of the Cartographic Branch. Individual acknowledgements are made in Section 5.

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Earth Sciences Division

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ABSTRACT

Thailand's climate is characterized by a rainy and a dry season, except for small areas of year-long wet conditions. Shortage of potable water is a problem in much of the country especially during the dry season. The amount and color of the foliage and the problems associated with mud or dust, change greatly with the seasons. Average annual rainfall varies from 40" to 180"; differences in intensity and in dates of beginning and end of the rainy season, fluctuate strikingly from year to year and place to place. Temperatures are relatively high throughout the year, with maxima above 90 F possible in any month. Cold weather is rare, but an occasional reading as low as 40 F is reported in December or January. Compared to the climate elsewhere in southeast Asia, the climate of most of Thailand is most analogous to that of Burma to the west, and Laos, Cambodia, and Vietnam to the east. Only the southern part of Thailand, in the Kra Peninsula, has a climate with heavy rain throughout the year such as prevails in most of the Indonesian Islands on the south.

The dietary structure of the Thai people reflects a crucial dependence on rice for all meals. Of secondary importance are fish, vegetables, and fruit. Too great a dependence on a single food type, coupled with long-practiced dietary habits and taboos that depress the consumption of available foods, such as eggs, creates a problem of malnutrition in the form of deficiency diseases. Nevertheless, Thailand is a food-surplus nation.

Mosquitoes, flies, biting gnats, midges, mites, lice, ticks, spiders, scorpions, and leeches are common pests in Thailand. Insects and similar pests, because of their presence, bites, and stings, can lower the morale of even well-seasoned troops. Insect-borne diseases remain a problem even with military personnel possessing innoculative immunity. It is necessary to maintain preventive measures for disease control in Thailand. Anti-venom should be available for all field personnel.

NOTES ON SOME ENVIRONMENTAL CONDITIONS AFFECTING MILITARY LOGISTICS
IN THAILAND

1. Climate

Thailand has a modified tropical climate, largely a product of its peninsular location on the warm southeast side of the Eurasian land mass. The entire Indochinese peninsula, of which Thailand is a part, lies south of the Tropic of Cancer and extends almost to the equator. It is bordered on three sides by warm seas in such a manner that no part of Thailand is more than 350 miles from a maritime water body. The country is joined on the north to the vast reaches of interior Asia, the region of origin for the colder air masses of the winter season that occasionally make their presence felt as far south in Thailand as Bangkok (Figs. 1 and 2).

The greatest seasonal contrasts in the climate of Thailand involve the alternation of wet and dry seasons. The rainy season is the season of the southwest monsoon, lasting from the latter part of April or early May to late October or early November in most of Thailand. The dry season is generally considered to extend from the end of one rainy season to the beginning of the next the following year, to include the period of the northeast or winter monsoon (November through February) and the hot season (March and April). On this basis, Thailand's climate has been described as monsoonal by Pendleton and others¹⁰, though it differs slightly from the classic monsoonal climate. Variability of rainfall, both areally and from one year to the next, is a problem of foremost military and economic importance in Thailand. The length and intensity of the rainy season has a direct bearing on rice productivity, with the rice crop being flooded out by too much rain some years, and by desiccation of soil in others when rain is deficient. The length of the dry season, therefore, as indicated by the number of dry months, becomes a significant climatic index to regional environmental characteristics (Fig. 20).

The pattern of climate changes but slightly from one section of Thailand to another. Except for a slight cooling toward the north, the latitudinal effect on temperature is negligible. The most marked temperature change is that induced by the height of the major mountain ranges of the country. This trend for decreasing temperatures with increasing elevation is the chief cause for mean temperatures of the coldest month to fall below 18 C (64.4 F) in the western and northern mountains, a region set apart as too cool for tropical analogy on the Climatic Analogs Map (Fig. 20). The temperature limit of tropical climate is reached at elevations of 1,000 feet or below in the valleys of North Thailand and adjoining portions of Burma, Laos, and Vietnam,

whereas in peninsular Thailand to the south, tropical temperatures extend up the mountains to 3,000 or more feet of elevation. Shown also in Figure 21 is the general increase in the number of dry months from 0 to 1 at many peninsular locations to more than 6 months in the north. Compared to the climate of the rest of southeast Asia, the climate of most of Thailand is most analogous to that of Burma to the west, and Laos, Cambodia, and Vietnam to the east. The climate of the Indonesian islands to the south is mostly too wet and lacking in a dry season, to resemble any part of Thailand except the southern part of the Kra Peninsula.

a. Temperature

Both the hottest and coldest weather ever experienced in Thailand occurred during the dry season (Figs. 3 through 9). This paradox of temperature extremes results from the relatively dry air that prevails during the early part of the year, which creates conditions conducive to rapid radiational heating and cooling. Radiational cooling reaches its peak on clear, cool nights during December and January, a period dominated by moderately cool, dry air brought into the region from the north by the northeast monsoon; night-time temperatures frequently drop to the 40 to 45 F range during this period. In contrast, daily maxima are highest in March and April, just before the onset of the rainy season, with afternoon temperatures usually exceeding 100 F and sometimes 105 F.

There is a close correlation between temperature seasonality and the presence or absence of a cloud cover. This helps explain the occurrence of the warmest weather near the end of the dry season (March and April)--a period, too, when incoming solar radiation is at its maximum for the year. When the rains begin (generally in May), the skies become overcast and temperatures undergo a sharp decline--a direct response to the shielding-out effect of cloud cover on solar radiation, as well as to the cooling from the rain itself. During the rainy season, temperatures often seem higher than they actually are because of the high moisture content of the air, particularly during the brief periods of bright, sunny weather that sometimes follow in the wake of thunder showers.

In the Kra Plain and neighboring mountains, temperatures are relatively uniform throughout the year because of low latitude, nearness to the sea, and less distinct wet and dry seasons. Here, moderately high temperatures persist throughout the year, though some temperature changes can be sensed due to seasonal differences in relative humidity.

Temperatures throughout the Central Valley are remarkably uniform and fairly stable from season to season (Figs. 18 and 19). At Bangkok, for example, mean monthly temperatures vary from a low of 77 F in

December and January to a high of 86 F in May. Though January and February are the coldest months, the days are hot; daily maxima exceed 90 F on some afternoons. Beginning in February temperatures rise rapidly, and in April and May daily maxima exceed 90 F almost every day. The highest temperature recorded for Bangkok is 108 F (April and May), and the lowest 40 F (December).

Because of the greater distance from the sea and the increased elevation of the interior valleys and mountains which cut off much of the wind, the range of temperatures is much greater in northern Thailand. In the northern mountains and valleys, temperatures during the wet season are only slightly lower than those in the Central Valley (Fig. 2) due to an almost continuous cloud cover over both regions. When the rainy season ends in November temperatures drop rapidly in the north, influenced by the cold winter monsoon from the interior of the Asiatic continent. Dews during this season are remarkably heavy. Frost, however, has been reported only in the highest mountains.

During the dry season the Korat Plateau experiences higher daytime temperatures than the Central Valley, but nights are cooler. This is the season of the cool northeast monsoon. Skys are cloudless. The relative humidity is so low that intensive evaporation thoroughly dries the surface soils, and sand and dust storms are common. During this season, dense palls of smoke caused by numerous grass fires frequently hang in the air.

b. Precipitation

Annual rainfall in Thailand varies from an average of less than 40 inches in some of the "rain-shadow" valleys of the western mountains to more than 180 inches on certain of the wet, western slopes of peninsular Thailand (Fig. 14). For the country as a whole, more than 80% of the rain falls from mid-April to October, the season of the principal or southwest monsoon. The Kra Plain, however, and three other small areas, experience two distinct seasons of rainfall peaks, with some rain in all months. In these areas the southwest monsoon causes a primary season of rains from mid-April to mid-August, and the northeast, or retreating monsoon, a secondary maximum from September to December.

The Central Valley is relatively dry, averaging between 40 and 60 inches of rain annually (Fig. 18). Most rains fall in the form of brief, heavy thunderstorms, originating over the hills and mountains to the southwest. Rainfall decreases inland, with amounts and distribution largely reflecting the degree of protection from monsoonal influences afforded by the bordering mountains. In winter, the ranges to the west block or divert all but the most severe of cyclonic storms that occasionally invade the area. Those that do reach the valley proper are considerably weakened, producing little or no rain.

Like the Central Valley, the Korat Plateau reflects a high degree of "rain-shadow" effect and is relatively dry (50-60 inches annually). On the west, the plateau is shielded by the Dong Paya Mountains, and on the east by the Annam Range. Because of the protection provided by the Annam Range, typhoons that occasionally strike the neighboring coasts of Vietnam from the South China Sea, seldom extend their influence in the form of heavy rains as far inland as the Korat Plateau.

For all Thailand but the Kra Plain, winter is the dry season and summer the wet. Every month from December to April is dry, usually with not more than one rainy day, and with total rainfall averaging less than an inch. In late April or early May, heavy rains begin abruptly and continue until early or mid-November. The time of beginning and ending of the rainy season (Figs. 10 and 11) is extremely unpredictable, varying as much as 30 days from one year to the next. At Bangkok the shortest rainy season on record was 174 days, and the longest 236 days. Monthly rainfall intensities vary from place to place depending upon exposure and elevation. For example, southeastern Thailand and nearly all of the mountain areas receive 10 to 16 inches of rain in July, the wettest month, while the Central Valley and Korat Plateau receive but 5 to 8 inches.

In the Central Valley, there is usually a conspicuous recession of the rains in August caused by the southwest passage of the inter-tropical convergence zone. At this time, partly cloudy skies, bright sunshine, and high humidity dominate the weather. If this "little dry season" lasts for more than a few days, rice fields may become dry, but unsurfaced roads also dry out and become temporarily usable.

The relatively low and unreliable rainfall of interior Thailand seriously affects river navigation and irrigation of crops. The rivers serve both as sewers and all-purpose sources for water. Some primary and most secondary streams are relatively short, and in some years flow only during the wet season. Water levels consequently fluctuate widely. All rivers and streams carry an abnormally heavy load of silt at the onset of the wet season due to the ease with which the initial rains scour the dry, dusty surface of the ground. The seasonally fluctuating water discharge causes the rivers to build mud flats and sandbars across their mouths.

Nearly all the Central Valley is in flood during the wet season. The flow of the district's principal river, the Chao Praya (Mekong), increases from scarcely 4,000 cu. ft. sec² during the dry season, to 54,000 cu. ft. sec² during the wet season at a point approximately 100 miles north of Bangkok. By late autumn the annual flood characteristically reaches depths of 10 to 12 feet over considerable areas of the

central lowlands. This necessitates the planting of floating rice, particularly along the western margin of the valley opposite Bangkok. At Bangkok the flood discharge is approximately 95,000 cu. ft. sec². The rise begins rapidly in May and continues to the end of October, after which it falls gradually to a minimum in April. For fifty miles inland the distributaries of the Chao Praya are subject to tidal influence, particularly during the dry season. The lower reaches of the river are therefore brackish and cannot be used as a source for drinking or other potable water purposes. The mouth of the Chao Praya is kept open for navigation by regular dredging. Other streams are unsuited for navigation even at their mouths. The Mekong, bordering the northern and eastern edge of the Korat Plateau, is made unsuitable by many rapids. The smaller streams usually dry out during March and April, a period when water is in short supply everywhere in Thailand outside the main river valleys.

The dry season leaves its imprint on the physical landscape in the form of an overtone of tan. By January, the drought is at its peak, particularly in the north where skies are typically clear, visibilities unrestricted, and rainfall a rarity, occurring on the average of less than one day per month (Fig. 12) and in amounts measuring but fractions of an inch. The loose, fine-textured soils, which by now are thoroughly dried out, create favorable conditions for the development of atmospheric dust whenever they are disturbed by such factors as wind or vehicular passage. All unpaved roads become a primary source for heavy dust clouds, whenever agitated by heavy traffic such as Army convoys, etc. All deciduous trees of the broadleaf variety have shed their leaves and the natural grasslands are dried out and dormant. Croplands are either being harvested or are in state of fallow, so that the landscape is characteristically light tan or brown in color. Since there is a strong correlation between the lowlands (or lower mountain slopes) and the light-colored vegetation types during January, there is a camouflage requirement for standard Army tan throughout most of Thailand (Fig. 16). Evergreen forests predominate on the upper slopes (generally above 3,000 feet), however, so that standard Army green is recommended for the uplands even during the dry season.

The wet season is a period of special logistical significance to the military. By September, the wettest month, flooding has reached a maximum for the year, with all low-lying districts (Central Valley, etc.) subject to inundation that reaches depths of 10 to 12 feet in some districts. Vehicular traffic is generally confined to the few paved roads of the country, and cross-country travel is unthinkable. Water is frequently made unsafe for drinking through contamination during this period, and is therefore in general short supply. Flying weather is generally poor because of the extensive cloud cover and frequent rains

(Fig. 13) which limit air-to-ground support capabilities severely. The vegetative cover, including both natural and agricultural types, is generally at the height of its growth stage and therefore lush green in color. Consequently, standard Army green is recommended throughout the country for camouflage purposes (Fig. 15).

2. Food Geography

Thailand is a food-rich nation where malnutrition flourishes in the presence of an over-abundance of basic food types. This anomaly of want in the midst of plenty stems from cultural rather than economic causes, with long-established feeding habits providing the stimulus for the growth and support of a uniquely unbalanced dietary structure.

Traditionally, the diet of the working class Thai consists almost entirely of rice seasoned with spices and supplemented by small quantities of fish or meat. Such a diet satisfies energy requirements moderately well, but provides lower amounts of vitamins, minerals, and proteins than are generally considered adequate for maintaining good health.

a. Food Productivity

The cultivated lands of Thailand total some 23 million acres, or a little less than 1/5 the total area of the country. Rice is the predominating crop type (Fig. 17) with 78 per cent of the total harvested area given over to paddy rice (Table I). Forty-five per cent of the gross national product is derived from agriculture, and of the total working population, 85 per cent is engaged in either farming or fishing. As a food-surplus nation, Thailand exports more than a million tons of rice each year (since 1954) which brings an average annual income of about 140 million dollars. Other food exports include peanuts, mung-beans, soya beans, tapioca flour, and salt. Imports include sugar and milk products.

(1) Rice

Thailand's rice production is characterized by large annual variations in both acreage and tonnage due to fluctuations in rainfall amounts. During 1956, for example, 14.5 million acres were planted to rice, as compared with 12.2 million acres in 1957. Nevertheless, a crop totalling between 4.5 and 5.5 million tons (before milling) is produced in most years.

Records show that production of rice declines when: (a) rainfall is below average during the plowing and sowing season in April and May; (b) heavy early monsoon rains cause prematurely early floods and a large

TABLE I

Thailand: Area, Yield and Production of Selected Crops,
1934-1938 and 1948-1952 Averages and 1953-1957

Period	Paddy Rice	Maize	Soya beans	Peanuts	Sugar cane	Tobacco	Cotton	Rubber
1934-38 av.	3,370	8	3	10	6	...
1948-52 av.	5,211	34	17	63	58	33	34	251
1953	5,931	47	24	72	83	53	40	275
1954	4,524	52	22	79	96	54	34	282
1955	5,356	55	21	78	103	56	32	291
1956	5,762	82	24	81	121	56	39	272
1957	4,576	95	25	95	127	61	41	...

Yield per hectare (Index: 1934-38 or 1948-52 = 100)

1934-38 av.	100	100	100	100	100	...
1948-52 av.	102	149	63	100	100	95	71	100
1953	108	177	71	114	129	107	75	86
1954	98	195	76	123	146	111	79	103
1955	106	200	74	127	150	115	93	111
1956	111	230	72	132	135	120	100	122
1957	97	234	85	132	137	125	98	...

Production (Index: 1934-38 or 1948-52 = 100)

1934-38 av.	100	100	100	...	100	100	100	100
1948-52 av.	157	620	350	100	379	299	350	323
1953	189	1,020	502	130	697	547	450	306
1954	151	1,240	550	153	934	578	400	373
1955	168	1,340	500	156	1,034	614	400	415
1956	190	2,296	550	168	1,467	640	550	426
1957	131	2,736	688	197	1,589	733	550	434

Source: My, Jacques M., The Ecology of Malnutrition in the Far & Near East

initial rise of the Chao Praya (Menam) river; or (c) rainfall in July and August is below average. A study of rainfall records for the past 124 years indicates that rainfall distribution was favorable in 60 of these years, and that in the remaining 64, rainfall was either too much, thereby flooding out crops, or so little that the ground dried out before the crops reached maturity.

Because of the instability of the rainfall regime, the government decided that a more dependable water supply system was necessary, and began construction of several irrigation projects. The most important of these, the Chainat Project, was completed in 1960 and serves more than 3 million acres of rice fields or "paddies" in central Thailand. This district, frequently described as the "rice-bowl" of Thailand, is nearly synonymous in area with the Central Valley shown on the Physical Regions Map (Fig. 2). Other irrigation projects are being developed in the north and northeast (Northern Hills and Valleys and Korat Plateau) which will bring another million or so acres under irrigation when complete.

Since World War II, the production of rice has increased. The output, given in Table II, shows, for example, that in 1957 rice production was 90 per cent above the prewar average; exports have increased, but not nearly so much, with 1957 showing a 13 per cent increase over prewar levels. The relatively small increase in rice export as compared to production indicates a much higher domestic rate of rice consumption. According to the Thai Ministry of Agriculture, the rate of rice consumption within the country increased by an average percentage of 3.7 each year from 1947 to 1956.

(2) Corn

Since World War II, the production of corn (maize) has shown a decided upswing, both in acreage and yield. As compared to a production index of 100 for 1938, for example, the 1957 index was 234. Though acreage planted to corn increased by about 12 times from 1938 to 1957, it still totalled only about 2 per cent of that planted to rice. Corn is not a popular food locally and is seldom included in the daily fare of the average Thai; rather, it is produced principally as an export crop.

(3) Other Crops

Other crops of agricultural significance in Thailand include tubers, pulses (soy beans, mungbeans), peanuts, sugar cane, coconuts, fruit (principally mangoes, durians, bananas, and oranges), vegetables (principally chilies, spices, onion, garlic, cucumbers, cabbages,

TABLE II

Thailand: Population and Rice Production, Consumption and Exports,
1934-1938 Average and 1947-1957

	Population Mid-year (1,000)	Production (1,000 metric tons, milled rice equivalent)	Domestic Consumption	Export
	(a)			
1934-1938, average	14,492	2,832	...	1,388
1947	17,478	2,887	2,598	385
1948	17,808	3,579	2,674	812
1949	18,145	4,443	2,767	1,215
1950	18,488	4,345	2,876	1,508
1951	18,837	4,408	2,959	1,612
1952	19,193	4,761	3,035	1,413
1953	19,556	4,291	3,265	1,342
1954	19,925	5,355	3,471	1,018
1955	20,302	3,711	3,377	1,228
1956	20,686	4,769	3,445(b)	1,239
1957	21,076	5,393	...	1,571
1958		7,128		

(a) 1937.

(b) Preliminary.

Source: May, Jacques M., The Ecology of Malnutrition in the Far & Near East.

lettuce, tomatoes, bamboo shoots, and green peas), cotton, and rubber. Separately, each contributes but a tiny fraction to the gross national product, but collectively they are important to the economy of Thailand either for cash return or for consumption locally. Those grown principally for internal consumption include the fruits, vegetables, sugar cane, and coconuts.

(4) Meat and Fish

Fish is the principal source of animal protein for the average Thai. Fishing is important to the economy of the country as (a) a source for essential food, (b) a livelihood for an unusually large segment of the population, and (c) a source for government revenue through license fees.

Most of the catch is consumed locally and is made up principally of fresh-water carp and catfish caught in the numerous rivers and canals. Various other fresh-water species are represented in the overall catch but are of far less importance to the local economy. The many species of salt-water fish caught in the bordering seas are also of relatively minor importance.

Domestic animals provide only a small percentage of the animal proteins consumed by the Thai. Cattle and water buffalo are both well represented in Thailand, with nearly 6 million head each scattered throughout the countryside, but they are used principally as draft animals. Consequently, the livestock industry is not at all oriented toward meat producing purposes. The government is hopeful of developing meat production for export.

b. Diet Types

In Thailand as elsewhere, what actually reaches the table in the form of a meal, is controlled by many factors, both economic and social, with the result that certain groups or classes of people eat better than others. These privileged well-to-do are not truly representative of the people as a whole either in number or in dietary custom, which frequently is dictated by inclination rather than need. The middle and working class groups of any society, which in Thailand corresponds closely to the rural population, best represent the total population, both in number and customs. The diets discussed here, therefore, relate principally to the rural or farm population.

In the farm areas of Thailand, the dietary structure reflects a seasonal pattern of change that correlates nicely with the annual cycle of farm activities.

The harvest season for rice begins in November and ends in early February. During this period, the work-day begins before sunrise, continues through the day, and generally terminates after dark, with threshing frequently continuing well into the night. The harvest season coincides with the best fishing of the year, so that each family usually divides its adult labor between harvesting and fishing, while young children stay home to care for the babies and toddlers.

The post-harvest hot-dry season is a period of family and religious festivities which terminate about the time of the onset of the spring rains. In April and May, the cycle begins anew with the preparation of the fields for the next rice planting.

During the busiest parts of the year (sowing, harvest seasons) food is customarily cooked once a day in sufficient quantities to supply all needs for that day. Meals are either served in the home or taken to the fields. If the latter, fish and sweets must be protected from ants, and rice must be made secure from dogs.

During the least busy time of the year (post-harvest season) food is cooked twice a day, with rice the principal ingredient of all meals. Nearly everyone, including children from six years in age, knows how to cook rice. Breakfast usually consists of rice and coconut milk, flavored with curry, served about 6 o'clock in the morning. For lunch and dinner, several additional dishes are served, all seasoned with fish sauces. These dishes include vegetables, occasionally eggs, and roasted or boiled fish. Fruits are seldom included as part of the main meal, but are eaten as in-between snacks.

A typical daily menu is given in Table III. It is based on an actual survey of the food consumption for a family of five adults and three children of the Minburi district of Pranakara province, about 40 kilometers from Bangkok. From this it might be concluded that the average diet of the people of Minburi is deficient in quality, proteins, fats, and B vitamins. More eggs, fish, beans, vegetables, and fruit would help balance this diet.

c. Food Inadequacies

Because rice so thoroughly dominates the dietary structure of the Thai, the nutritive value of this basic food must be kept at or above a minimum level for the general good health of the people. This requirement is not always met however, particularly in those parts of the country where the rice is polished and milled mechanically. The processing removes much of the thiamin-rich hull from the rice kernel, thereby reducing its nutrient content significantly. Because of the

TABLE III

Typical Daily Menu for a
Family of 5 Adults and 3 Children (14 yrs., 12 yrs., 9 yrs.)

Number of Cookings Daily		Quantities Consumed in Grams	Carbohy- drates in Grams	Proteins in Grams	Fat in Grams	Calories
<u>First</u>	Cooked rice	3880	1224.32	51.58	16.30	5456.44
	Green bean pungent soup with fish	3940	162.33	151.69	124.90	2378.18
	Fried fish (Trichopodus pectoralis)	100	-	32.02	21.93	325.40
	Boiled duck's egg	50	0.25	7.12	8.0	105.0
	Ripe banana	990	295.20	10.40	2.77	1128.60
<u>Second</u>	Cooked rice	2640	846.64	52.48	11.08	3712.64
	Roasted fish (Clarius batrachus)	160	0.14	29.26	7.60	122.14
	Fried sweet and salted fish	120	18.0	39.60	28.80	423.60
	Total daily quantities		2566.88	396.23	221.38	13652.0

The following values are based on an adult person coefficient of 7.2 for the 8 member family listed above.

Calorie value per person: 1896
Protein value per person: 55.03 grams
Fat value per person: 30.75 grams
Carbohydrate value per person: 356.51 grams

Source: May, Jacques H., The Ecology of Malnutrition in the Far & Near East.

savings in time and labor, most Thai farmers have the family rice supply processed at the local rice mill. Unfortunately, this practice has resulted in an upturn of beriberi, particularly in the densely populated Menam delta, the heart of the "rice bowl." Only in a few isolated areas is rice still hulled at home by wooden pestle and mortar. Where home hulling persists, the incidence of beriberi remains low.

The swing toward mechanically hulled rice has created the problem of how to re-establish a safe 0.18 or higher thiamin-to-calorie ratio. Recommendations aimed at correcting this deficiency include the rather obvious one of reverting to hand pounding methods. The savings in labor by milling, however, are too great a temptation to be resisted, with the result that hand-hulling is gradually becoming a lost art.

One of the most practical solutions to the thiamin deficiency problem would be to parboil all rice intended for home consumption. This procedure yields a product very similar in appearance to white rice. It is less acceptable to the people, however, because the flavor of the parboiled rice is slightly different from that to which they are accustomed.

Enrichment of rice offers another easy way to attain the desired effect. This involves the addition of small quantities of thiamin-impregnated rice grains to the bulk rice as it is being milled. However, it is difficult to induce the village miller to purchase this specially treated rice and mix it carefully with each family lot as it is being milled.

Still another method is to control the amount of hull removed from the rice kernel. This, however, involves a break with convention, since the people are accustomed to the traditional fine-textured product produced by the mills.

Diversification of the present rice-dominated diet, to include adoption of dishes rich in protective nutrients, affords another practical way to lessen the dangers of thiamin deficiency. Fresh vegetables and fish are excellent sources for the needed vitamins and minerals, but are sometimes in short supply, particularly in the more inaccessible districts of the northern hills and plateaus. Pulses, which could easily be produced in sufficient quantities to supply the needed protection, are eaten only as special festival dishes, and not as part of the day-to-day menu. Similarly, eggs, which are rich in animal protein, are consumed locally in insignificant numbers only. In the rural districts, egg production could easily be increased to meet even the most extraordinary demands for local consumption; instead, most eggs are sold for cash return.

Summarizing, it appears that the Thai neglect certain native foods that are high in nutrient value either because of inadequate knowledge about sound dietary practices or because eating habits have become so firmly entrenched that a change of menu is an intolerable thought. Either way, the government recognizes the need for re-educating the people to accept better balanced menus. Children and pregnant women in particular, are badly in need of the nutrition supplied by such foods as eggs in order to assure good health and well being.

3. Insects and Similar Pests

Natural factors and cultural practices of the inhabitants combine to foster the development of large insect populations in Thailand. As in other tropical areas where temperature and moisture conditions are favorable, most insect groups are active through most months of the year, especially in the lower parts of the country. Among the insects and similar pests that directly affect the comfort and health of man, mosquitoes and flies are represented by the greatest number of individual species in Thailand. No part of the country is without flies and mosquitoes. Many rivers and streams and the widespread use of irrigation, with a high percentage of the cropped land in wet rice fields for several months of the year, provide breeding habitats for mosquitoes. Sanitary conditions, primitive by western standards, particularly in the villages and rural areas, promote the development of large fly populations. Among these two groups of insects are some of the most important vectors (carriers) of insect-borne diseases.

Mortality rates for disease in which insects play an important role are still impressive, although the incidence of these diseases has been significantly reduced in recent years by public health measures undertaken by the government and other organizations. The Annual Epidemiological and Vital Statistics Reports for the year 1958, published by the World Health Organization in 1961, lists the rates for diseases in which insects or related species play a role (Table IV).

Although no cases of cholera were reported for 1957, this disease appears as an epidemic from time to time. In 1958, for example, 11,582 cases and 1,747 deaths were reported. During some years there have also been sporadic outbreaks of plague, though no cases were reported in 1957.

The malaria-transmitting Anopheline mosquitoes are widely distributed throughout the country. More than a dozen species of Anopheles, breeding in a variety of environmental conditions from low rice fields to mountain streams and each capable of transmitting malaria, have been reported from Thailand. Among the more dangerous species are A. aconitus, A. culicifacies, A. fluviatilis, A. hyrcanus nigerrimus, and A. minimus. Other species of Anopheles may also transmit malaria or be important only as pests; some of these are abundant throughout the country.

TABLE IV
Mortality Rates for Most Important Arthropod-Borne Diseases in Thailand

<u>Disease</u>	<u>Death Rates per 100,000 Population</u>	
	<u>Year 1940</u>	<u>Year 1957</u>
Malaria	272.2	49.6
*Dysentery (all forms)	96.6	14.4
*Typhoid Fever	4.8	7.3
*Cholera	1.	0
*Plague	.2	0

*Occurrence of disease not solely dependent upon insects or other arthropods as vectors.

More than twenty species of Aedes mosquitoes have been reported; species of this group occur in all the major geographical regions of Thailand. Their disease relationships have not been extensively investigated in Thailand, but they are known to carry disease. Although yellow fever is not reported from this country, Aedes aegypti, the vector of this disease in other areas of the world, has been found in the Bangkok area and in several other provinces. It is also a vector of dengue, a disease attended with fever, eruptions, and severe pains. This disease occurs chiefly in the central and southern portions of the country. Aedes albopictus, reported from Bangkok, Koh Chang and Krabi, is also a possible vector of dengue.

At least twenty-five different species of Culex mosquitoes occur in Thailand. Often found around human habitations and inside homes and other buildings, these mosquitoes are widely distributed geographically. Most species are troublesome only as pests, but Culex pepiens fatigans, a common vector of filariasis (a pathological condition caused by the presence of threadlike nematodes in the blood and tissues), is reported from several provinces.

In addition to the above, several genera of other mosquitoes are represented by species which are only pests.

Among the many types of flies which find favorable breeding habitats in Thailand are species capable of transmitting diseases and causing discomfort by biting or depositing their eggs in wounds. The common house fly, Musca domestica, is the most widely distributed and is important in the spread of intestinal (typhoid fever, dysentery, cholera), skin, and eye diseases.

Numerous other flies, varying in distribution by species, are present. Among these are species of the genera Chrysops, Culicoides, Haematopota, Sarcophaga, Simulium, and Tabanus, which include the commonly known blood-sucking deer and horse flies, eye flies, blow flies, and biting gnats and midges. In addition, several species of sand flies (Phlebotomus), have been identified. Certain species of these, capable of transmitting sand-fly fever and leishmaniasis, occur.

Although it is known that ticks are abundant and widely distributed in Thailand, very few studies on them have been conducted. A dog tick and a few other species have been identified. Available information indicates that no tick-borne diseases have been reported in this country.

Because of favorable environments and the presence of large numbers of rodents and similar animals, it is assumed that mites may be common in certain areas of the country, particularly in open forests and along streams. Reports of mite typhus fever from Thailand also indicate the presence of mites, though apparently no studies on them are available.

Head, body, and pubic lice occur throughout the country. The body louse, perhaps the most common, is capable of transmitting epidemic typhus fever and one form of relapsing fever. Neither of these diseases is at present common in Thailand, the latter only being reported occasionally.

Several species of fleas are common. Among these are species able to transmit plague, but the incidence of this disease is very low, and in some years no cases are reported.

Other pests found in Thailand are cockroaches, scorpions, spiders, and bed bugs. These are not important in the transmission of human diseases, but they may be a considerable nuisance temporarily in certain areas until proper control measures are established. Scorpion stings and spider bites, although painful, are not generally dangerous.

Land leeches are common in the lowland jungle areas, especially during the wet season. Found on grasses and plants along paths and near water holes, they attach quickly to passing individuals. Their bites, which bleed freely, and itch, may become infected.

Military personnel, disciplined to field conditions and possessing inoculative immunity to the common endemic diseases, are not subject to the same health hazards as civilians in an area. but insect-borne diseases remain an important problem, especially in warm countries such as Thailand. Moreover, insects and similar pests, because of their presence,

bites, and stings, can lower morale of even well-seasoned field troops. It is necessary to maintain preventive measures for disease control and to have protective anti-insect equipment and repellents immediately available for issue in Thailand.

4. Snakes and Other Dangerous Animals

Species of several snake families are common in Thailand; the presence of individual species varies somewhat with the environment. Since a few of these species are dangerous, personnel should be able to distinguish them and be familiar with first-aid measures. Antivenom should be quickly available to field personnel.

The common Indian cobra (Naja naja) and the king cobra (Naja hannah) are fairly abundant. The former, rarely more than 5 feet in length, distinctly brown in color, with the characteristic "spectacles" on the back of its head, is usually found in the jungle and open field. The king cobra, brownish in color and shiny, up to 12 to 15 feet long, with a small hood, may be encountered in the forest or jungle. The venom of both these snakes is neurotoxic, and that of the king cobra is especially dangerous because of its quantity and extreme toxicity.

The poisonous pit vipers are found chiefly in areas of sandy soil or along the coast. There are three common species of this family in Thailand. One is recognized by a pair of large dark brown spots along its back, which is grayish or reddish brown. The common tree or bamboo viper usually has a dark green back, but it may also be olive or yellow. The third species has large spots on its back. The hematoxic venom of these snakes causes pain and swelling, but it is not normally fatal to man. One very dangerous viper (Russell's Viper) inhabits eastern and central Thailand. The hematoxic venom of this fawn or sand-colored snake, with a heart-shaped head, is thought to cause more deaths in Asia than any other snake.

At least three species of kraits inhabit the country. These smooth-headed snakes are banded or striped, and one species is identified by its yellow head. They readily enter houses or tents and sleeping bags. Their very poisonous venom is neurotoxic, but these snakes cause very few deaths because of their reluctance to strike.

In addition to the above snakes, the small spotted coral, the white-striped coral, and the belted coral are sometimes found in Thailand. These snakes do not often bite man.

Other possibly dangerous animals in Thailand are bears, boars, leopards, tigers, wild elephants and cows, and wild dogs. Seldom encountered, these animals present little menace to military personnel.

5. Acknowledgements:

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7. List of Maps and Graphs

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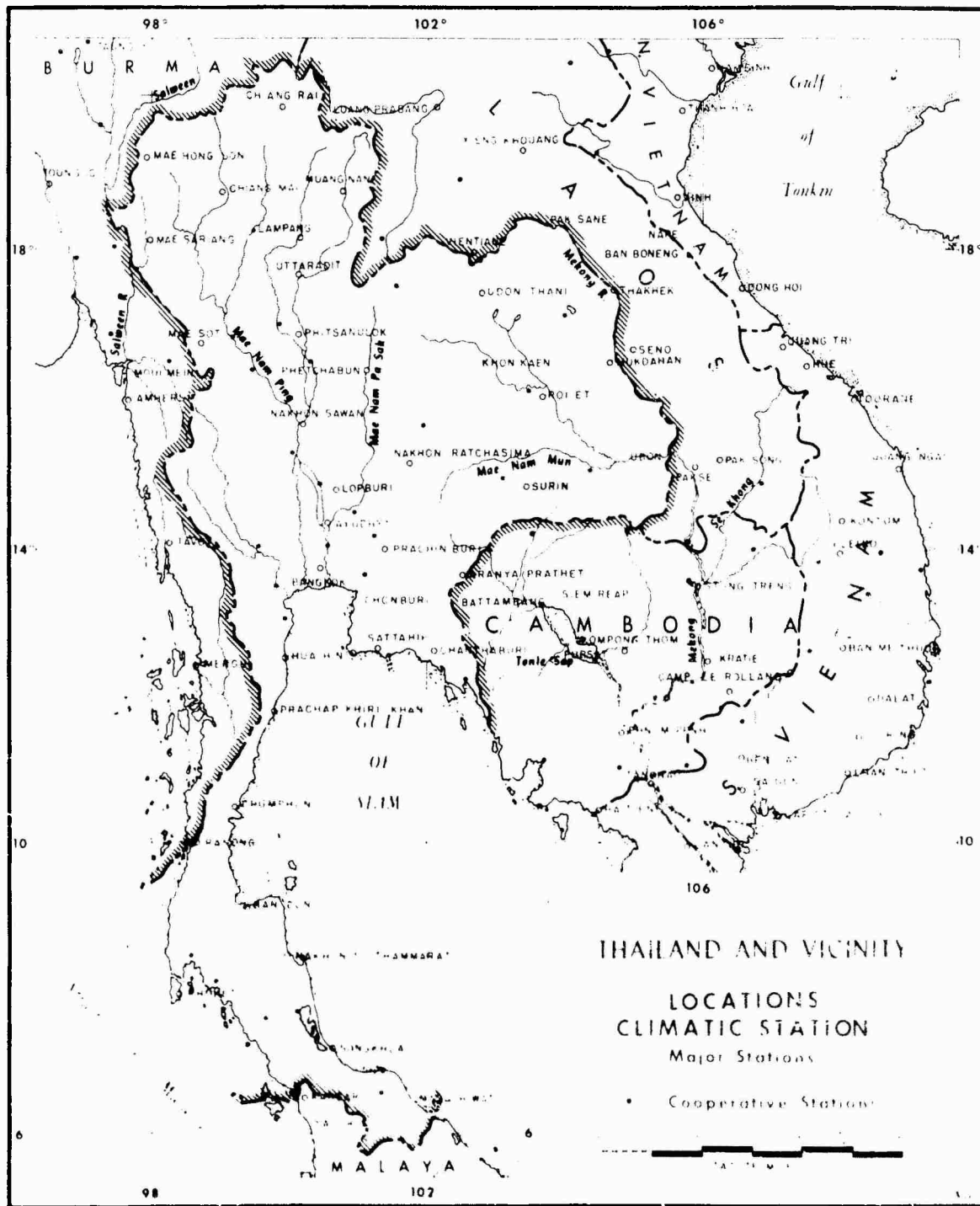


Fig. 1: Climatic Station Locations

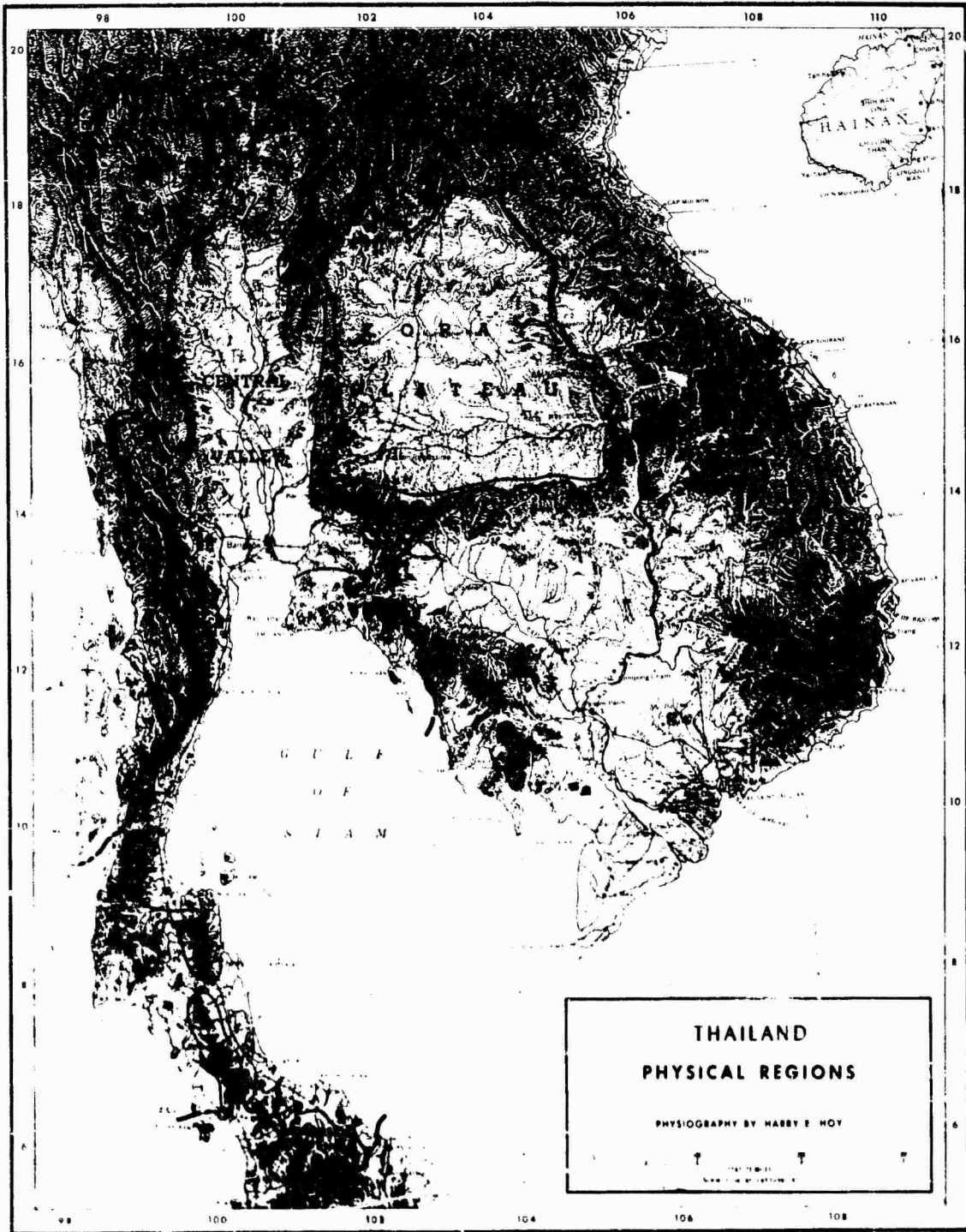


Fig. 2: Physical Regions

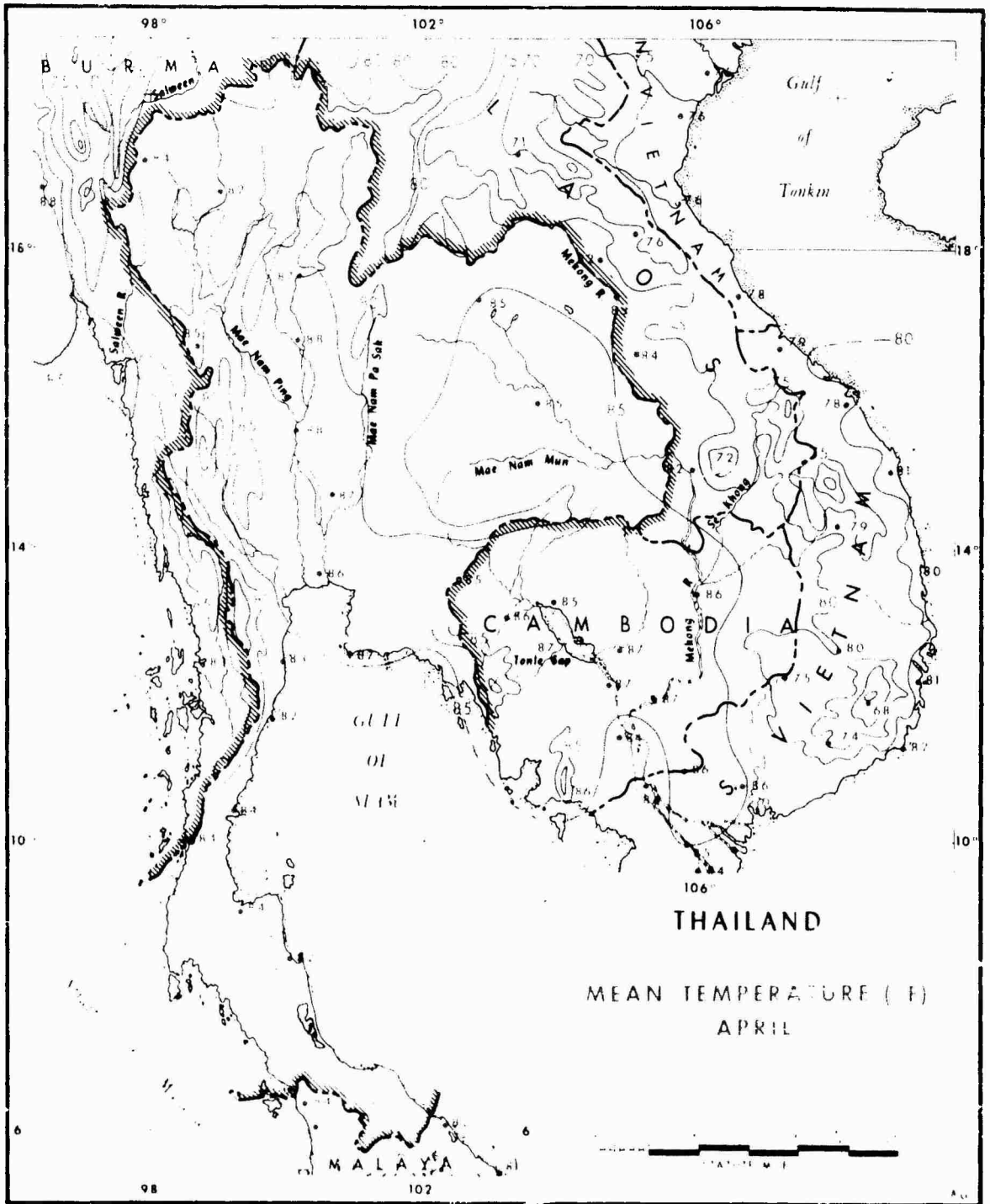


Fig. 3: High average monthly temperatures indicate needs for light-weight clothing, supplemental liquids in master menus, and air conditioning equipment for hospitals.

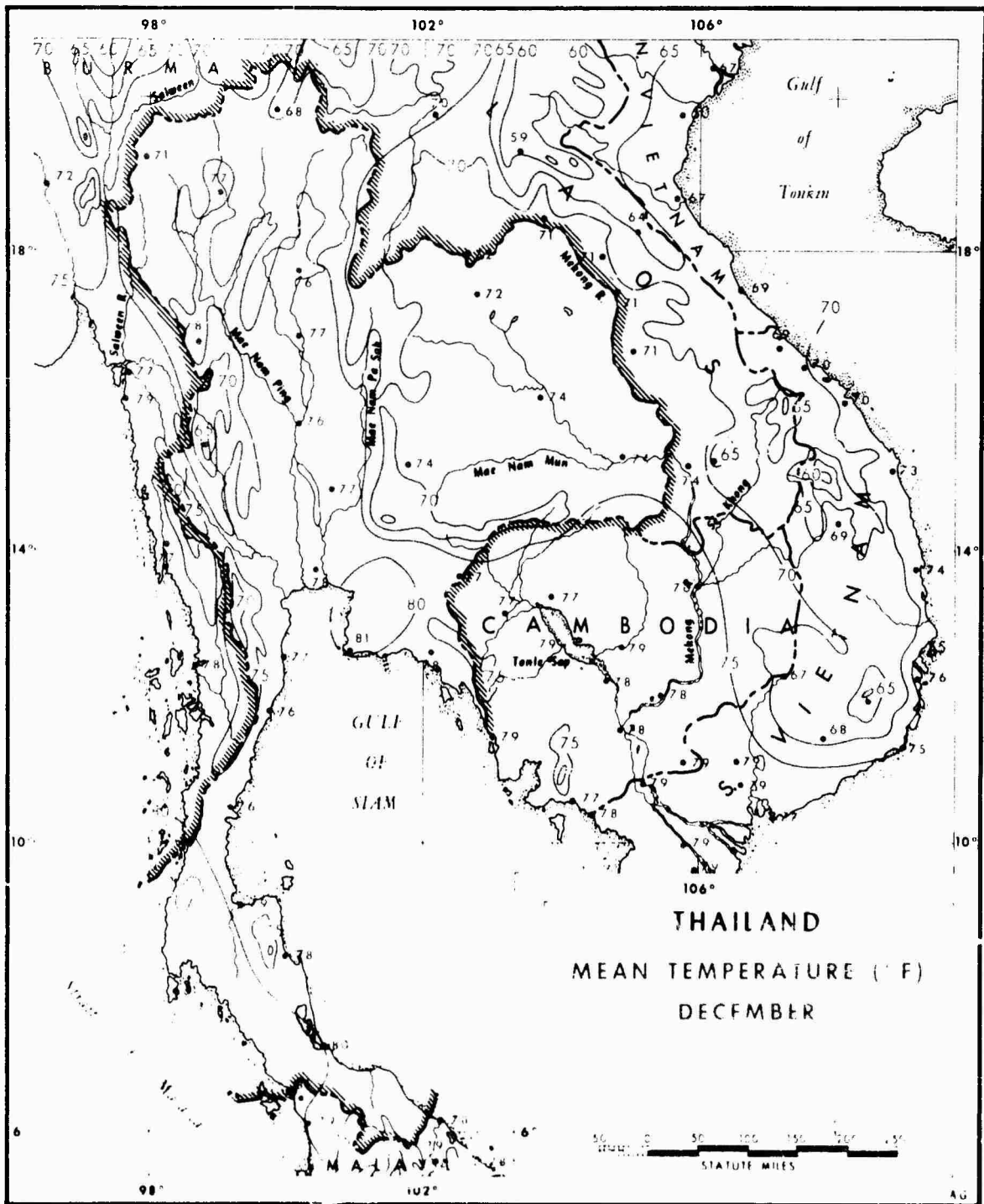


Fig. 4: Mean December temperatures range between 70 and 80 F throughout Thailand except in the mountainous areas located on the Burma-Thailand border. Requirements for special cold-weather clothing are not indicated by these temperatures. A period of acclimatization, however, will be necessary for visitors arriving from temperate countries.

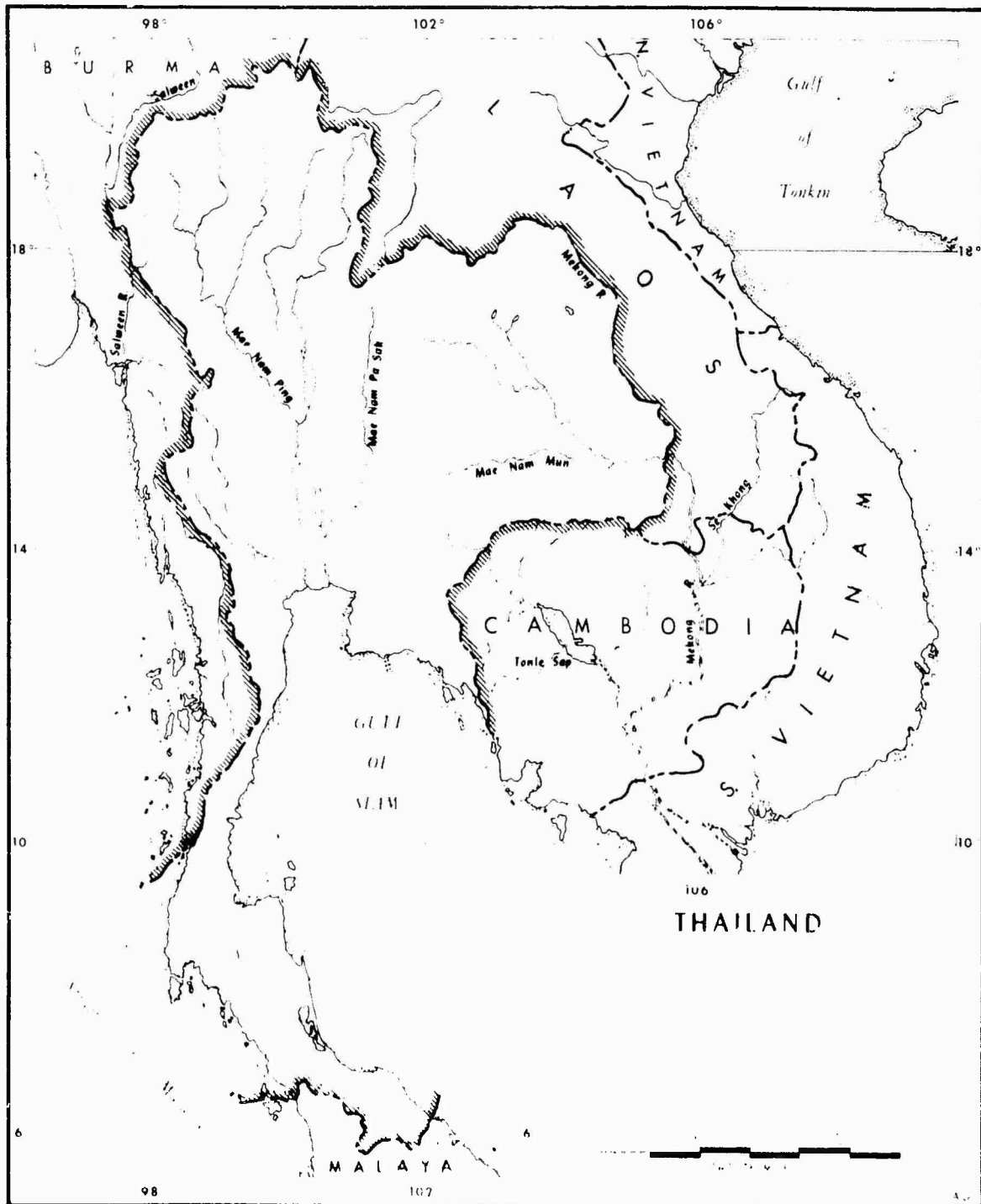


Fig. 5: April mean minimum temperatures are in the 70's throughout the country except for the mountains. These temperatures may be considered to approximate mean dew-point temperatures. (See comparison of mean dew-point temperatures and mean minimum temperature for Bangkok, Fig. 18.) These high minimum temperatures and high dew-points are conducive to deterioration of materials due to mildew and fungus growth.

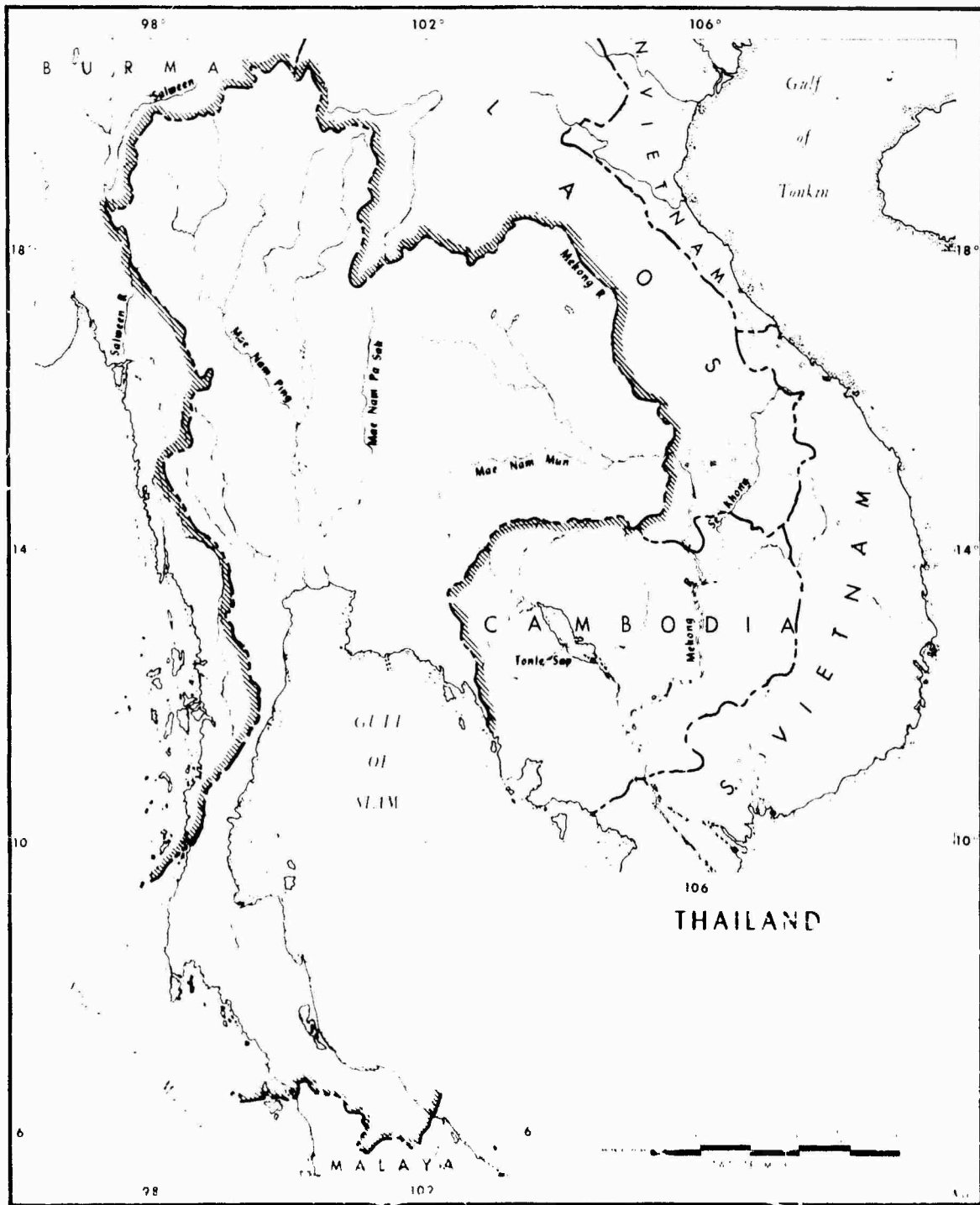


Fig. 6: December mean minimum temperatures range from 60 F in the north to the low 70's on the southern coast and the Kra peninsular region of Thailand. These high minimum temperatures for the coldest month indicate little or no need for cold-weather clothing or equipment except in the highest mountains.

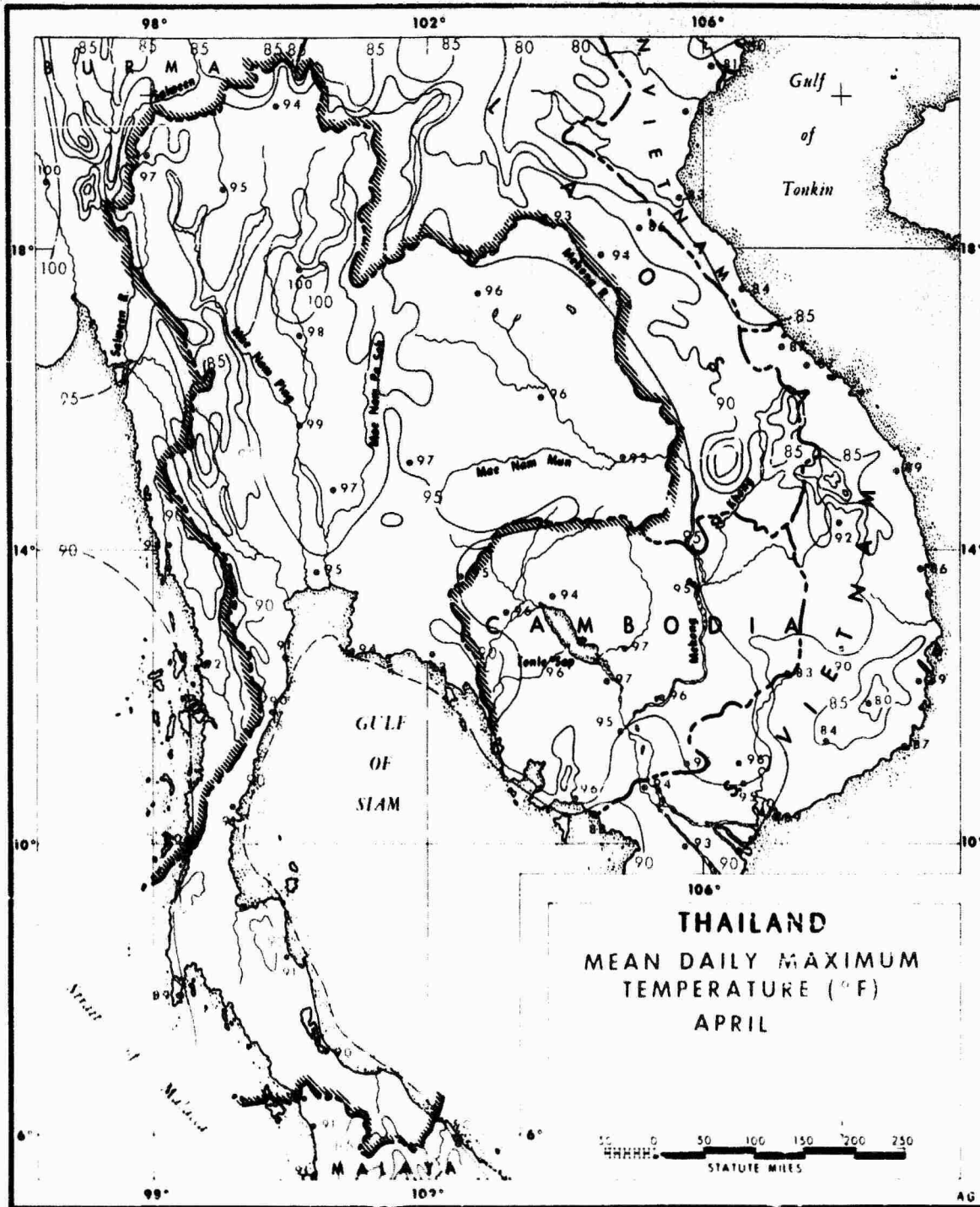


Fig 7: Average daily maximum temperatures for April, the hottest month, are mostly in the mid to high 90's for southeast Asia. The only exceptions are the cooler coasts and eastern highlands where the maxima average in the 80's, and two hot-spots, both with average maxima of 100 F, one near Uttaradit, Thailand, and the other near Toungoo, Burma. When occurring in conjunction with high humidity, such temperatures produce a temperature-humidity index sufficiently high to cause heat strain in active men.

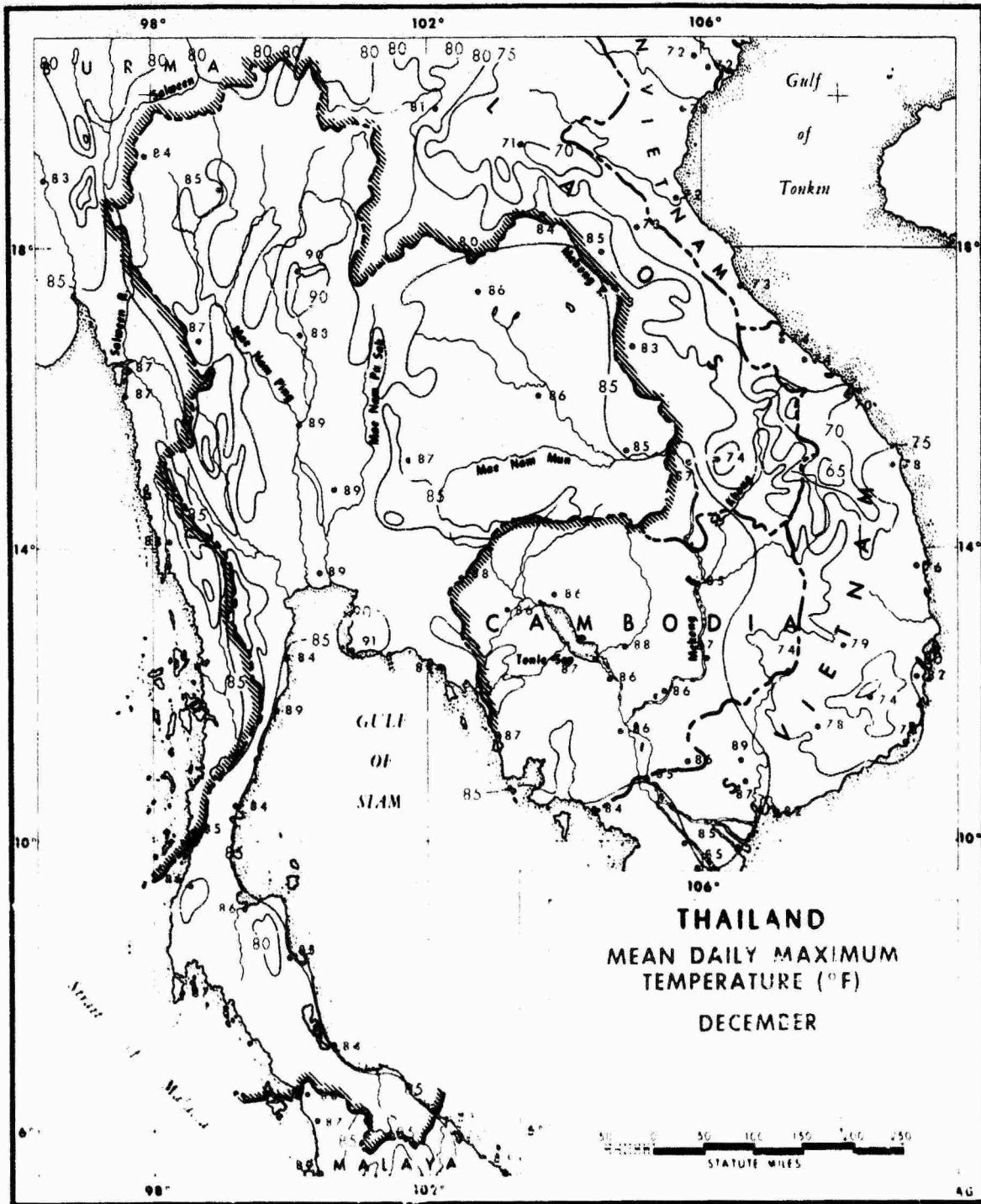


Fig. 8: The average daily maximum temperatures in December, the coldest month, are in the mid to high 80's for southeast Asia, except in the eastern highlands and coastal areas. The latter areas are usually in the 70's, which are not enough lower to cause any cold-weather problems. During this time of year no great heat stress should be encountered.

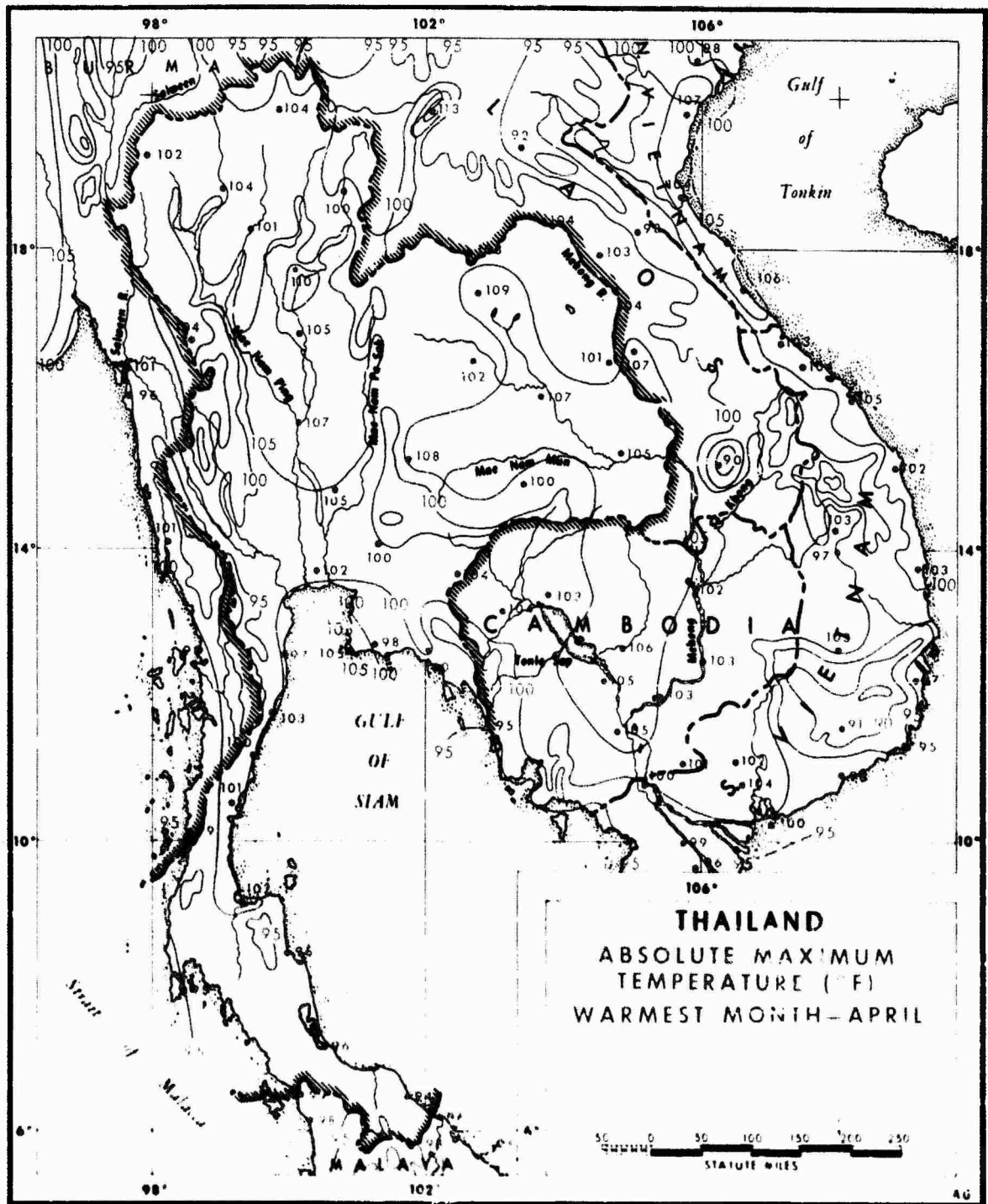


Fig. 9: Absolute maximum temperatures indicate weather hotter than is likely to be met during any given year. The heat center for Thailand is located in the interior lowlands, some distance removed from maritime influence. Occurrence of air temperatures in excess of the 125 F limit adopted by the Army for design criteria purposes is highly improbable, even in the areas of greatest heat stress.

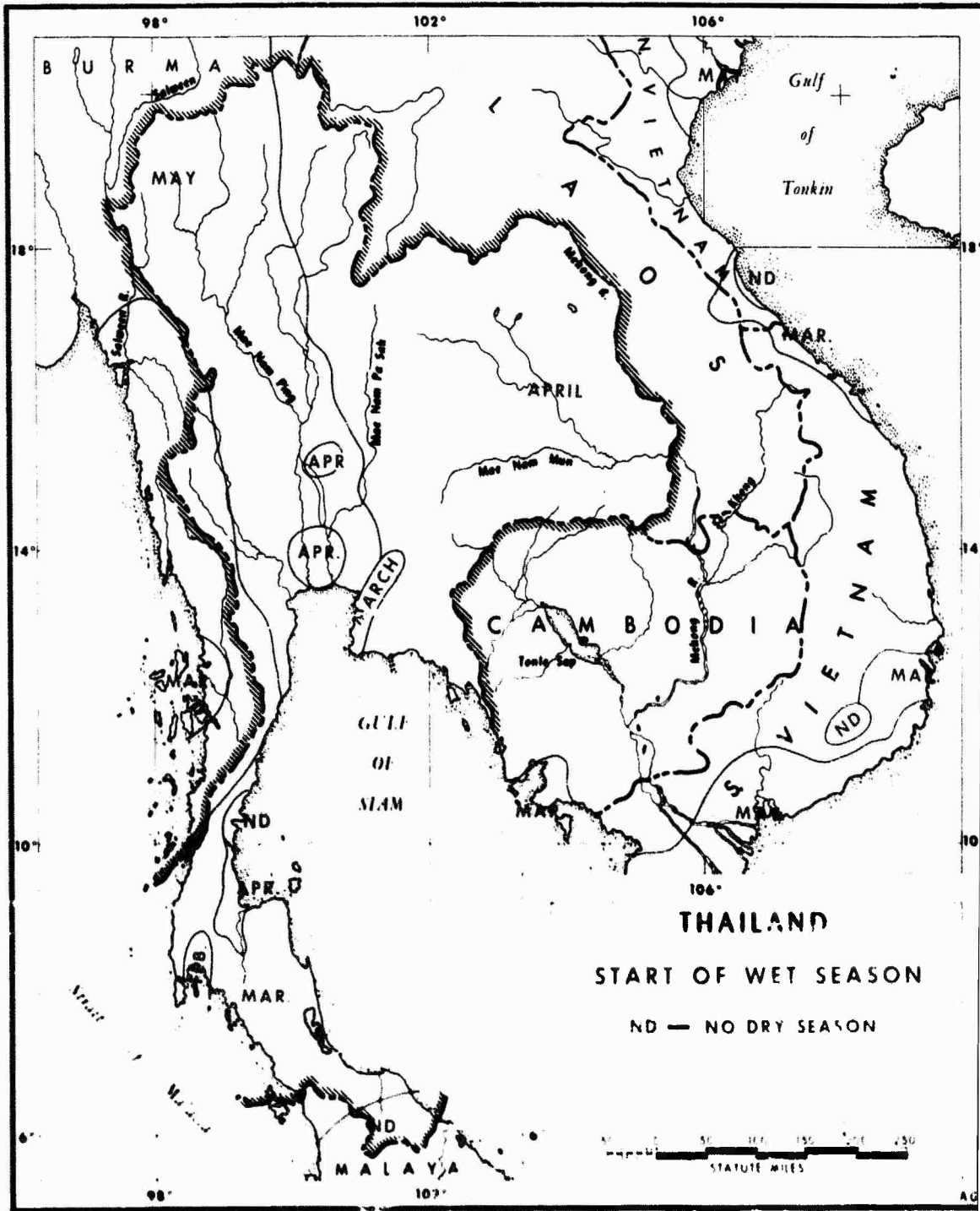


Fig. 10: As the wet season progresses through Thailand, it is accompanied by floods, increased restrictions to vehicular mobility due to mud, and increased problems in water potability. This map shows only the average starting month of the rainy season. In a given year the season may start a month earlier or be delayed for a month.

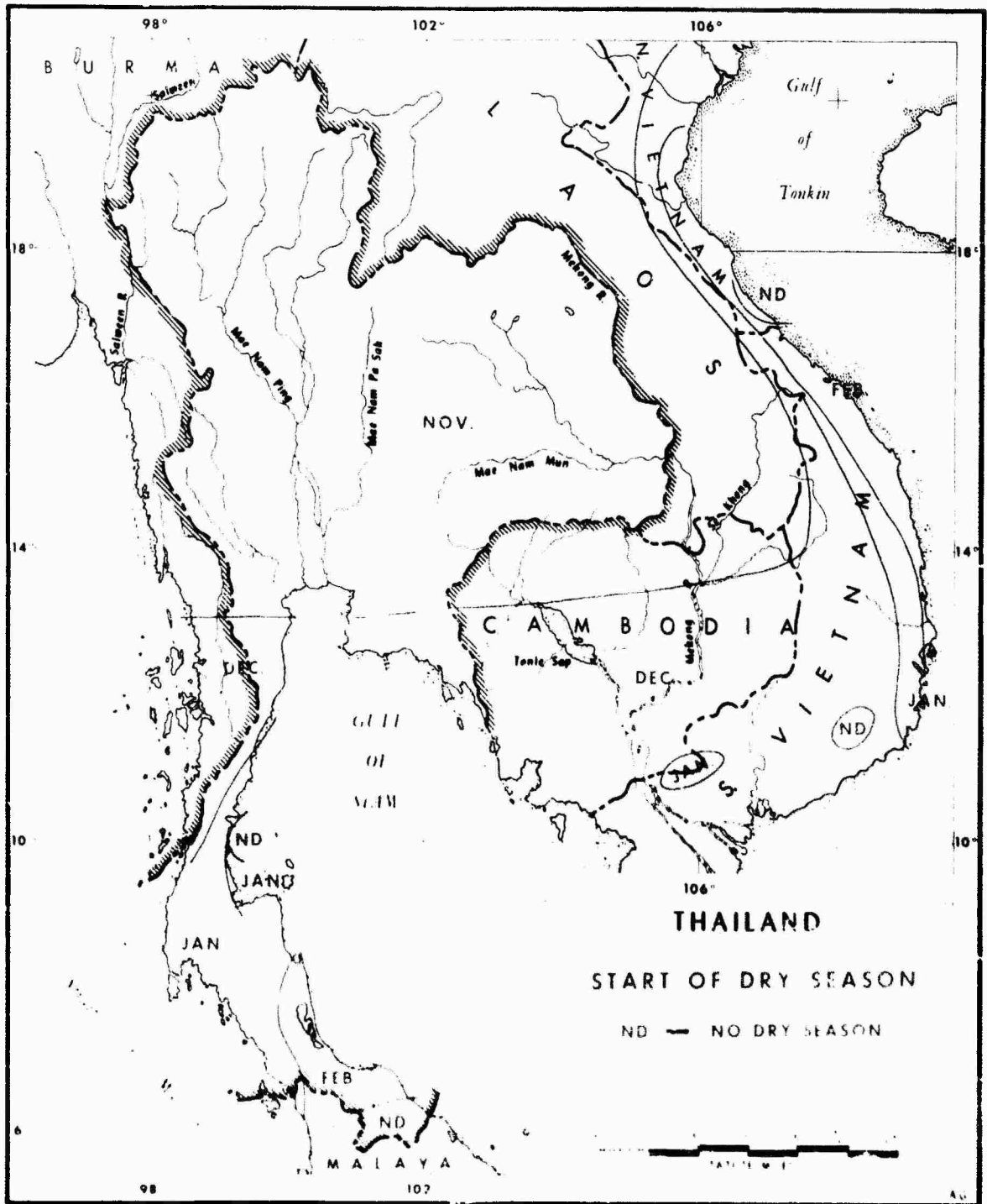


Fig. 11: During the dry season clouds of dust characterize heavily-traveled unpaved roads and, unless carried away by winds, seriously slow truck convoys. Respirators and goggles should be provided for drivers during this season.

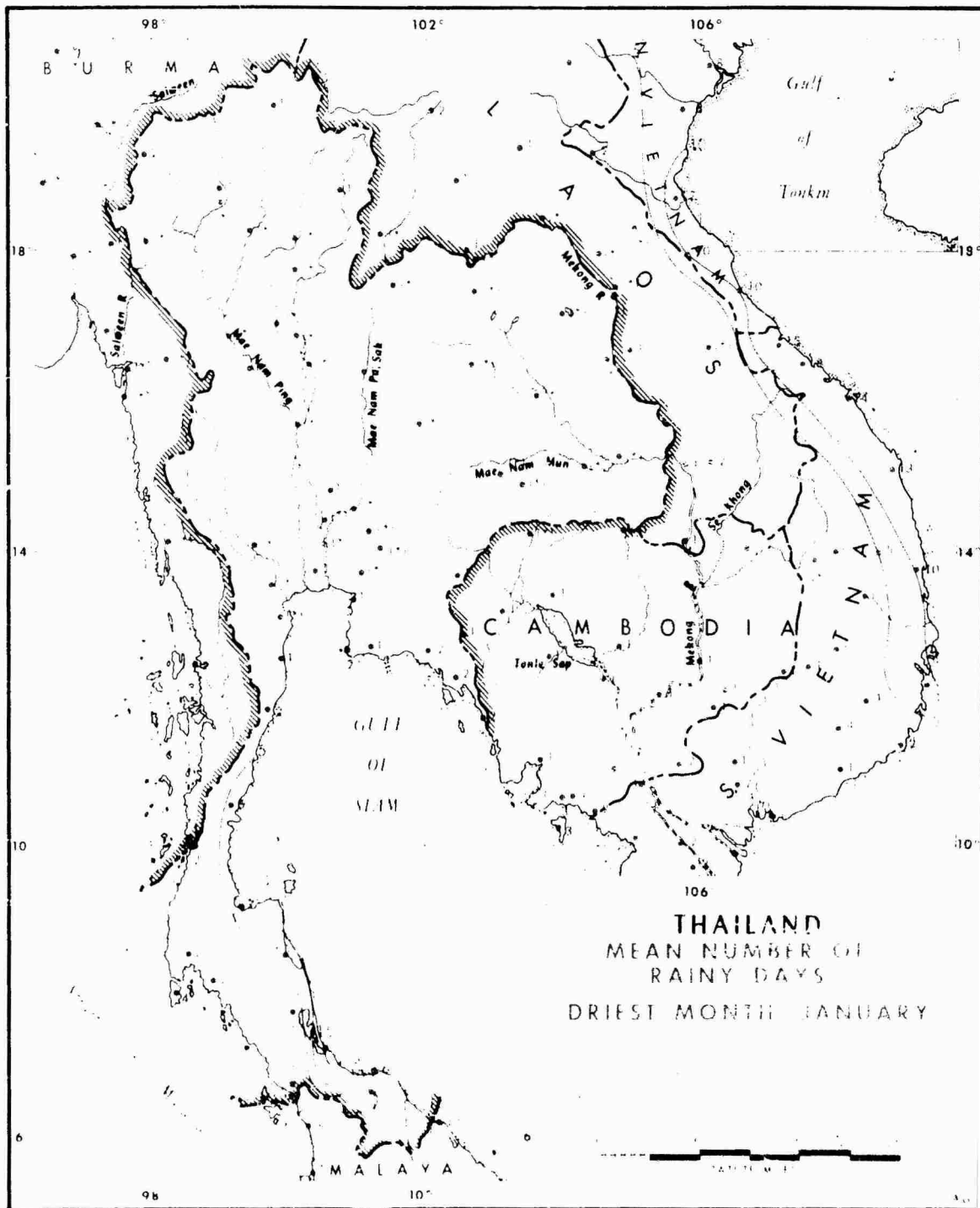


Fig. 12: In January, the driest month, there is usually less than one day with rain over an extensive area in the north. The clear skies and good visibilities provide excellent conditions for aerial delivery operations. In the northeastern coastal areas and in southern Thailand near the Malayan border, the increased number of rainy days limits the number of hours of contact-flying and cloudiness may conceal ground movements.

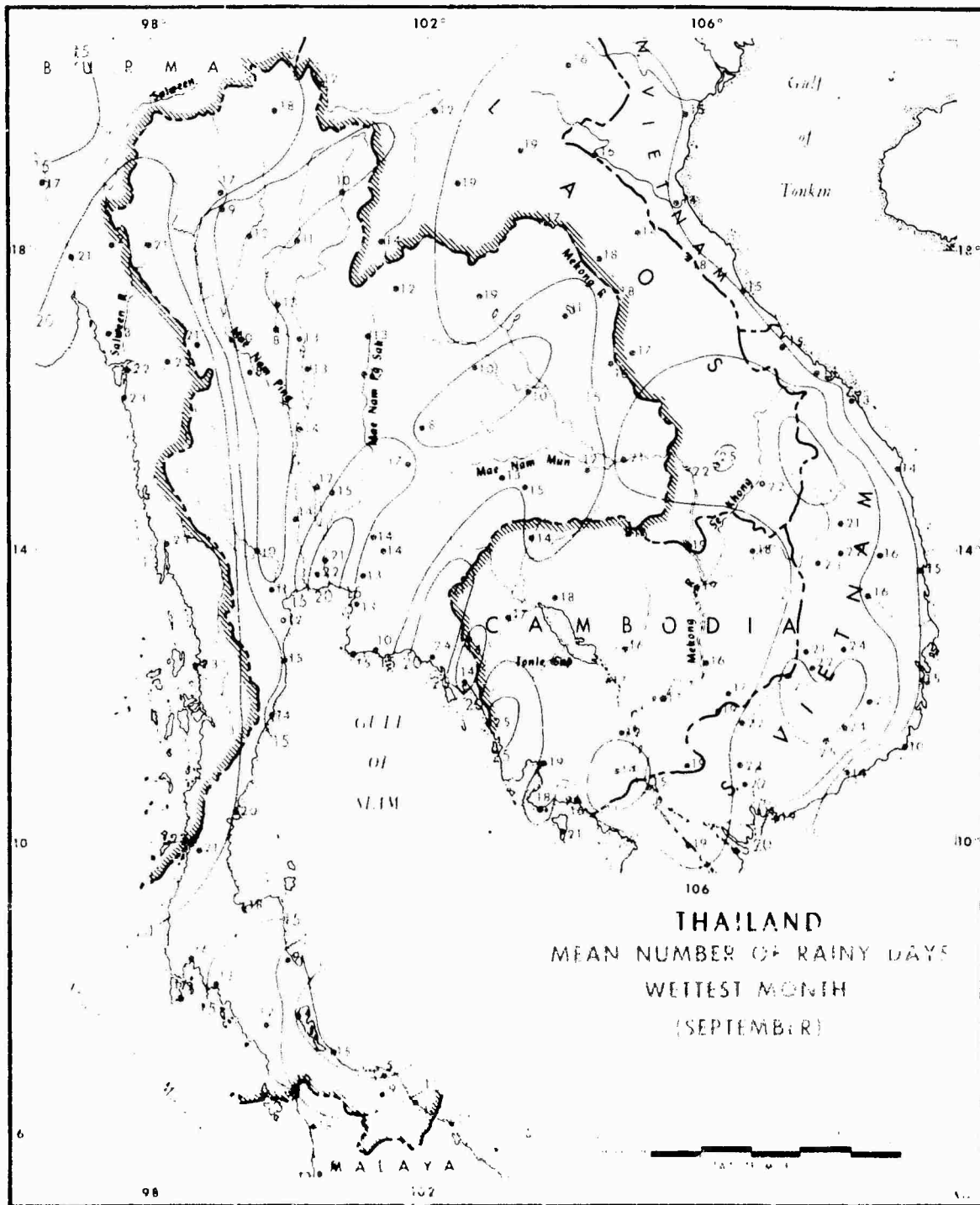


Fig. 13: In September, the wettest month, the number of rainy days increases from about 10 in the rain shadow of the mountains along the Burma-Thailand border to between 20 and 25 days along the south coast. Flooding of lowland areas reaches its maximum extent at this time. Weather suitable for flying air support missions is generally confined to only a few hours a day.

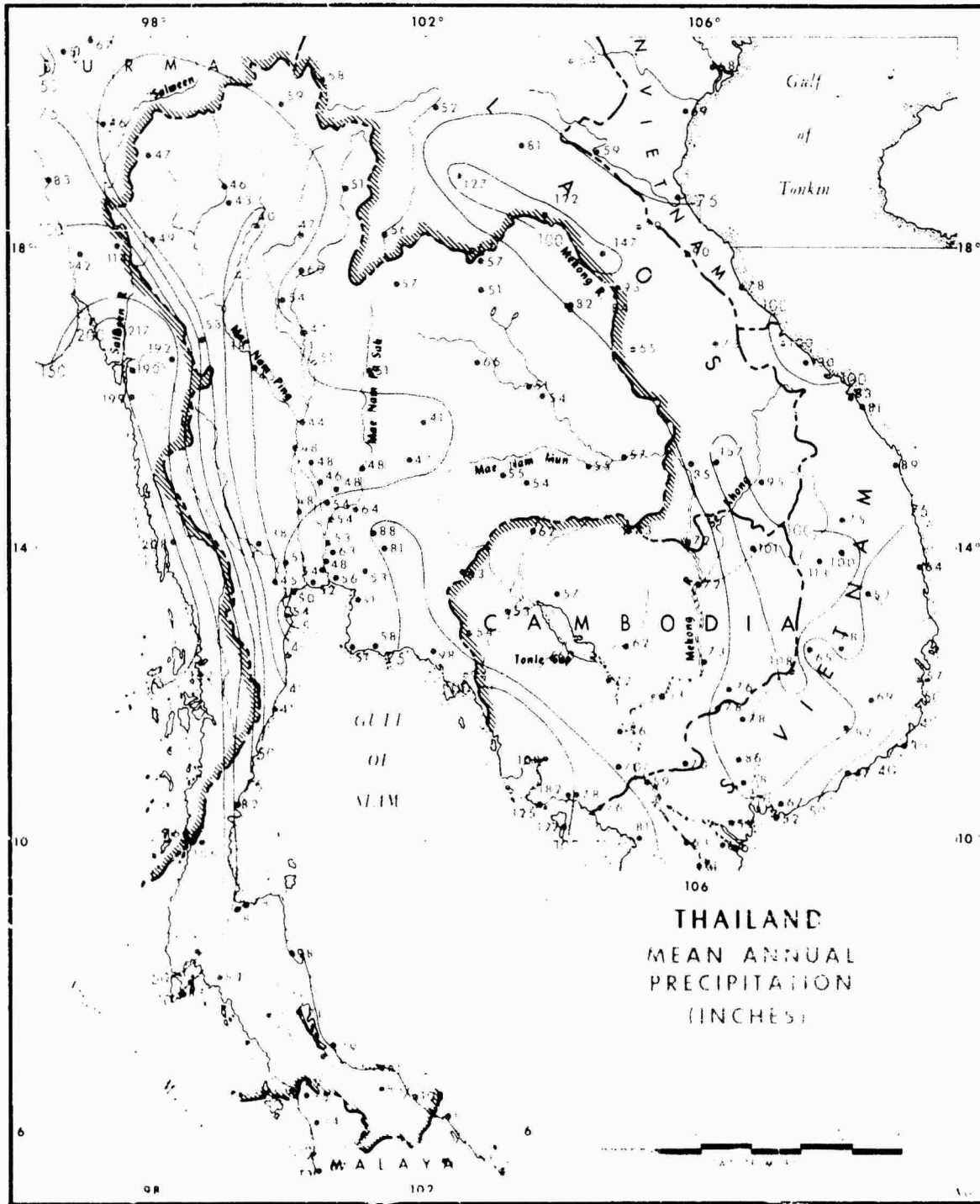


Fig. 14: Mean Annual Precipitation gives a rough estimate of water availability in various parts of the country. Where rainfall is low, water supply problems are acute, particularly in areas distant from the main streams where well-water only is available for use. Activities requiring water in quantity, such as bathing, showering, or laundering must be carefully regulated. In areas of high rainfall, flooding may be a problem.

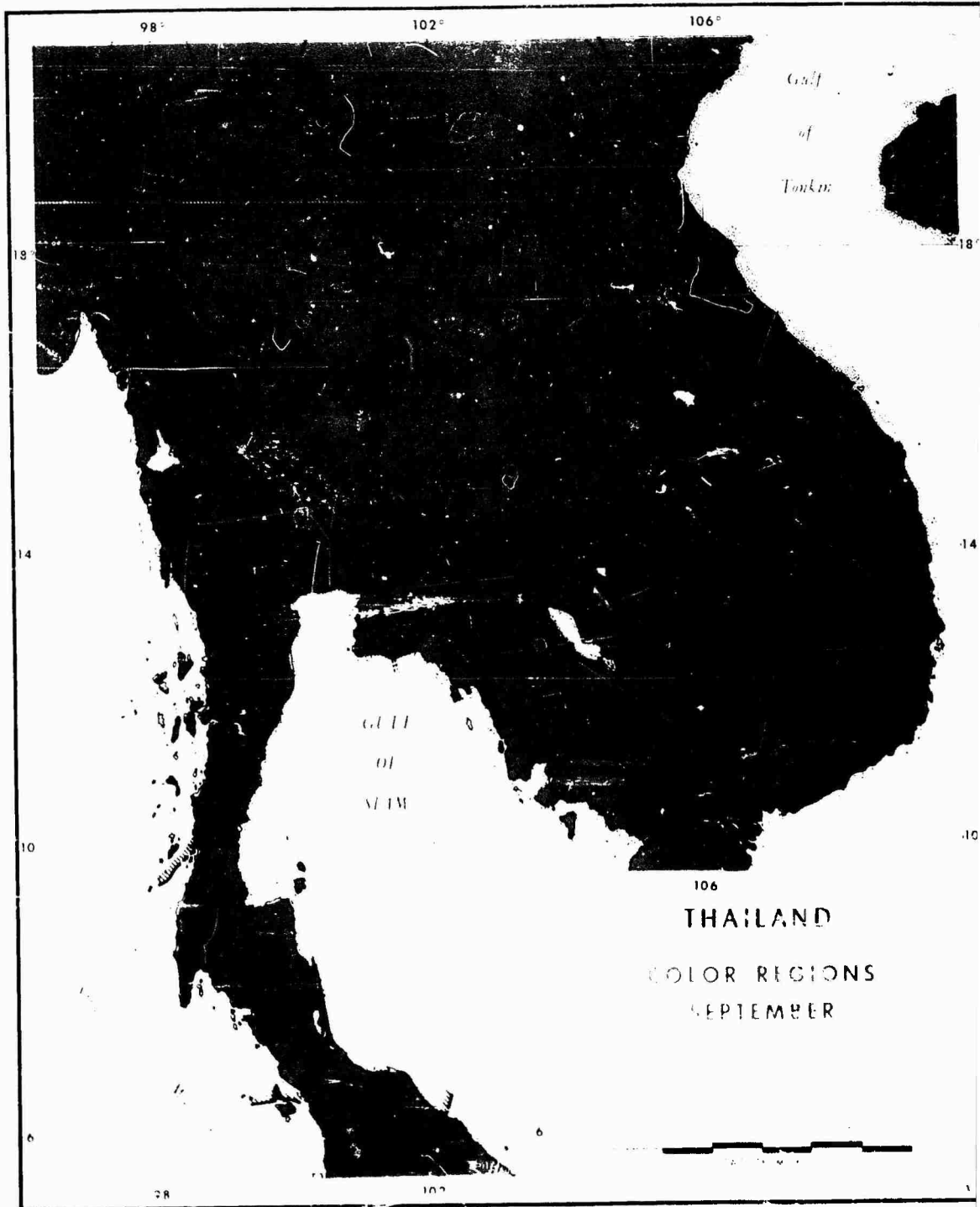


Fig. 15: The September color map shows a near total dependence on standard green for general camouflage use. This color represents broadleaf evergreen trees and, during the growing season, cultivated crops, grasses, and other herbaceous plants, and broadleaf deciduous trees. The Munsell color nomenclature should approximate 5GY 4/5.

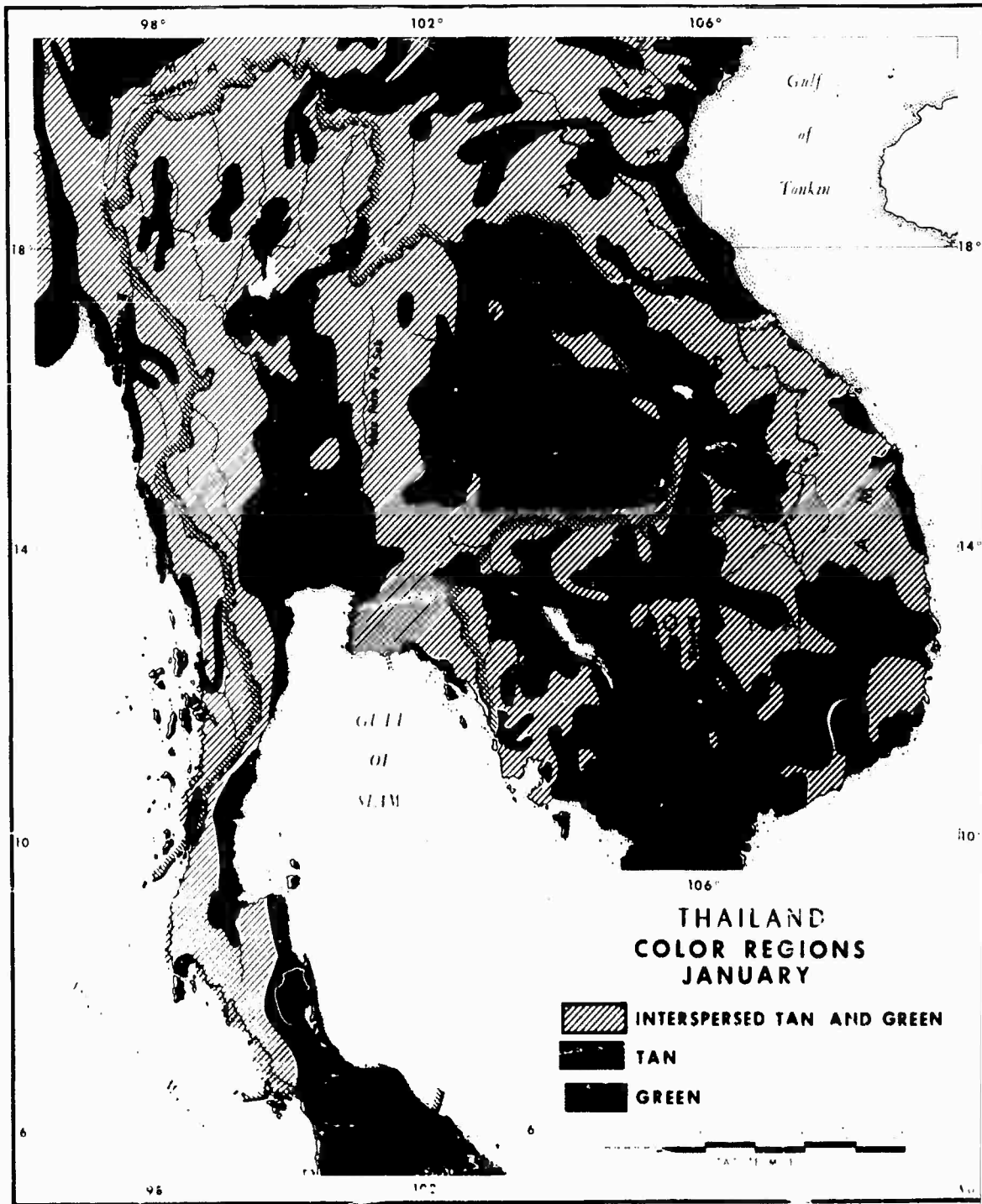


Fig. 16: The January color map shows areal camouflage requirements for two standard Army colors, tan and green. Tan represents areas of sand or thin mountain soils, harvested cropland, and broadleaf deciduous trees during the dormant season. Green represents broadleaf evergreen trees and deciduous trees during the rainy season. Munsell 7.5 YR 6/6 is the approximate color nomenclature for tan, and 5 GY 4/5, for green. In parts of the mountainous regions areas of evergreens alternate with those of leaf-shedders.

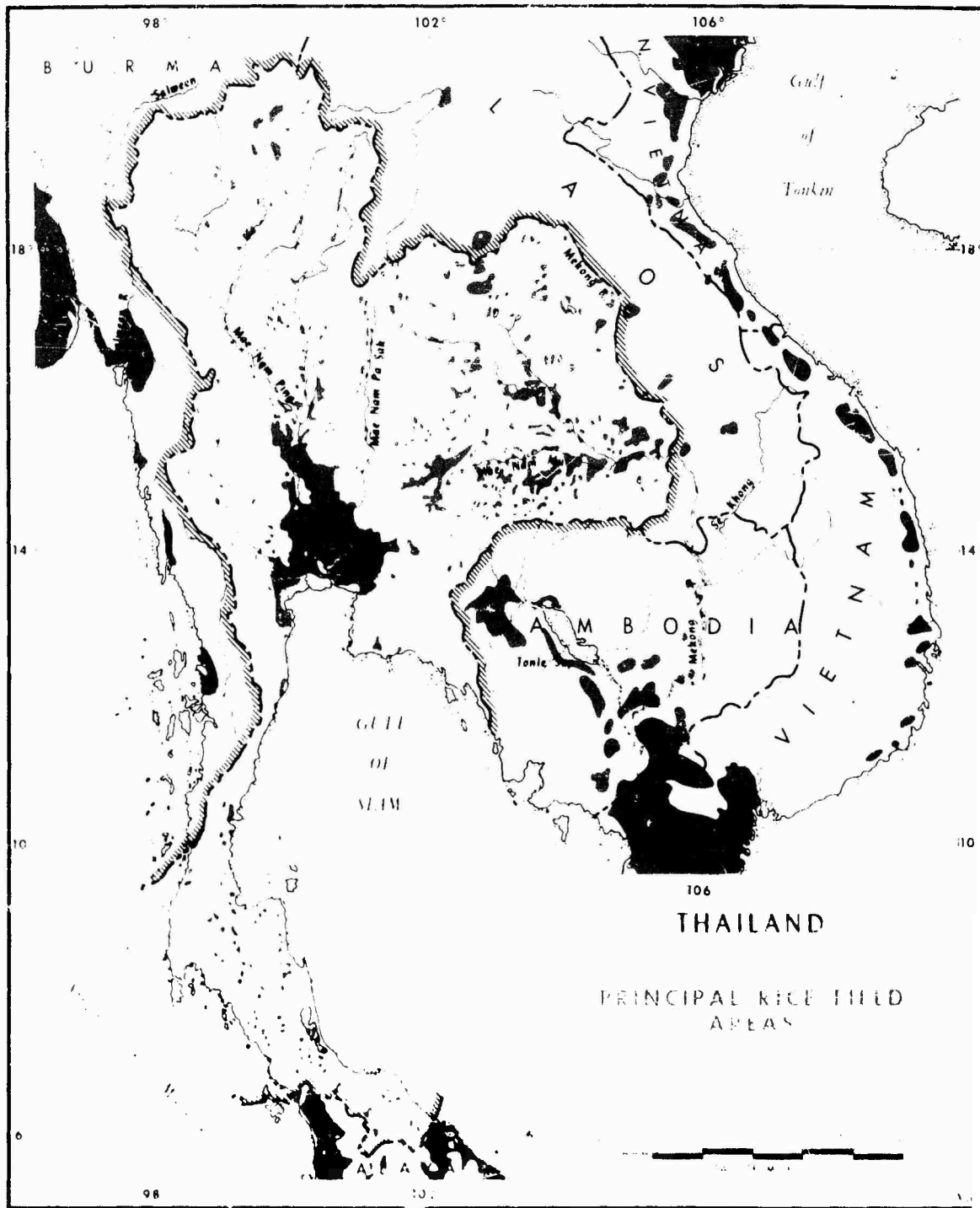


Fig. 17: Much of the rice grown is of the "wet" variety that develops and matures best in a thoroughly flooded field or "paddy." During the flood season, particularly in the Central Valley, the rice-growing districts are sometimes under 10 to 12 feet of water. Motor travel along unpaved roads is made extremely difficult by ponding during the flood season, and cross-country movement through the network of flooded paddies is impracticable.

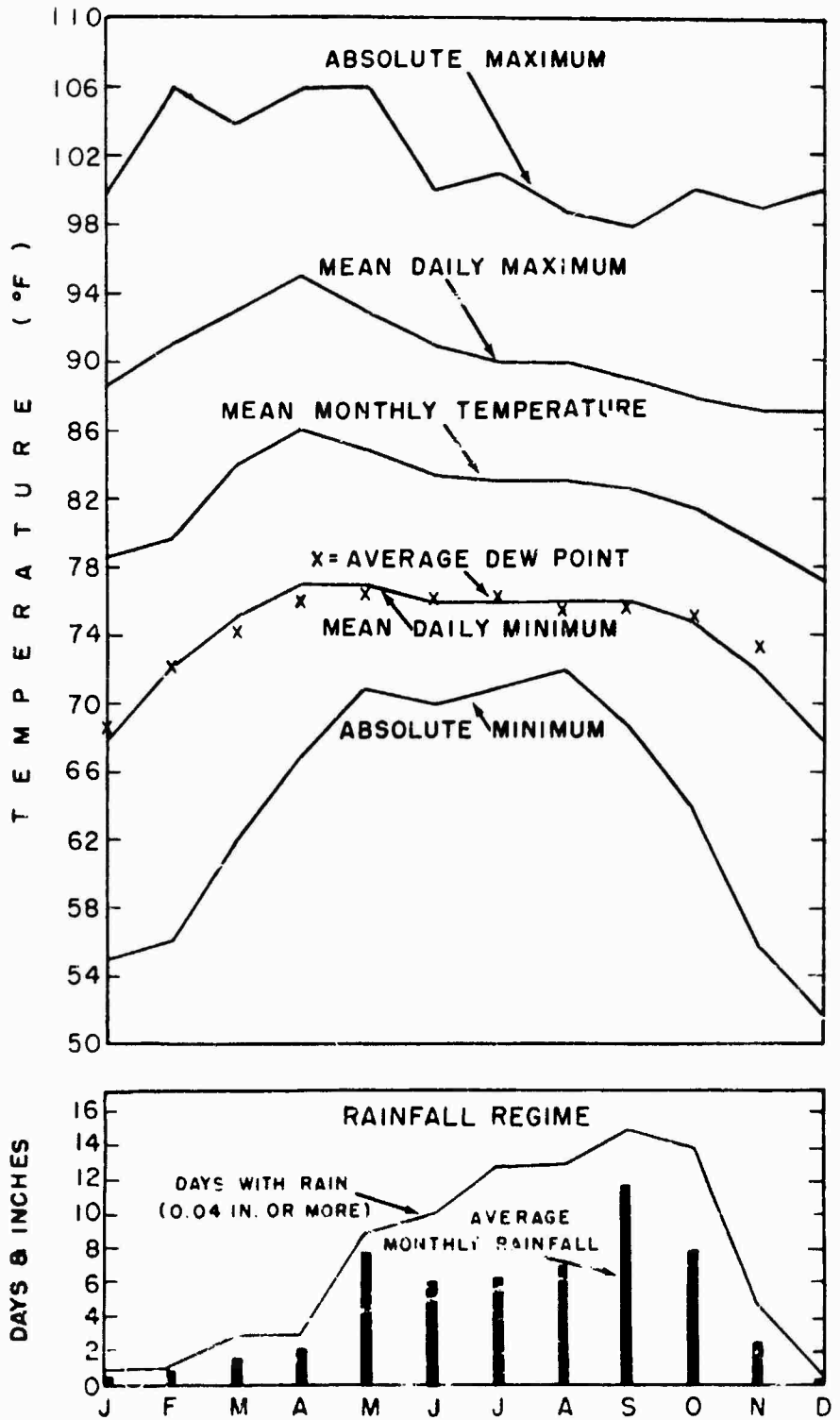


Fig. 18: Climate of Bangkok.

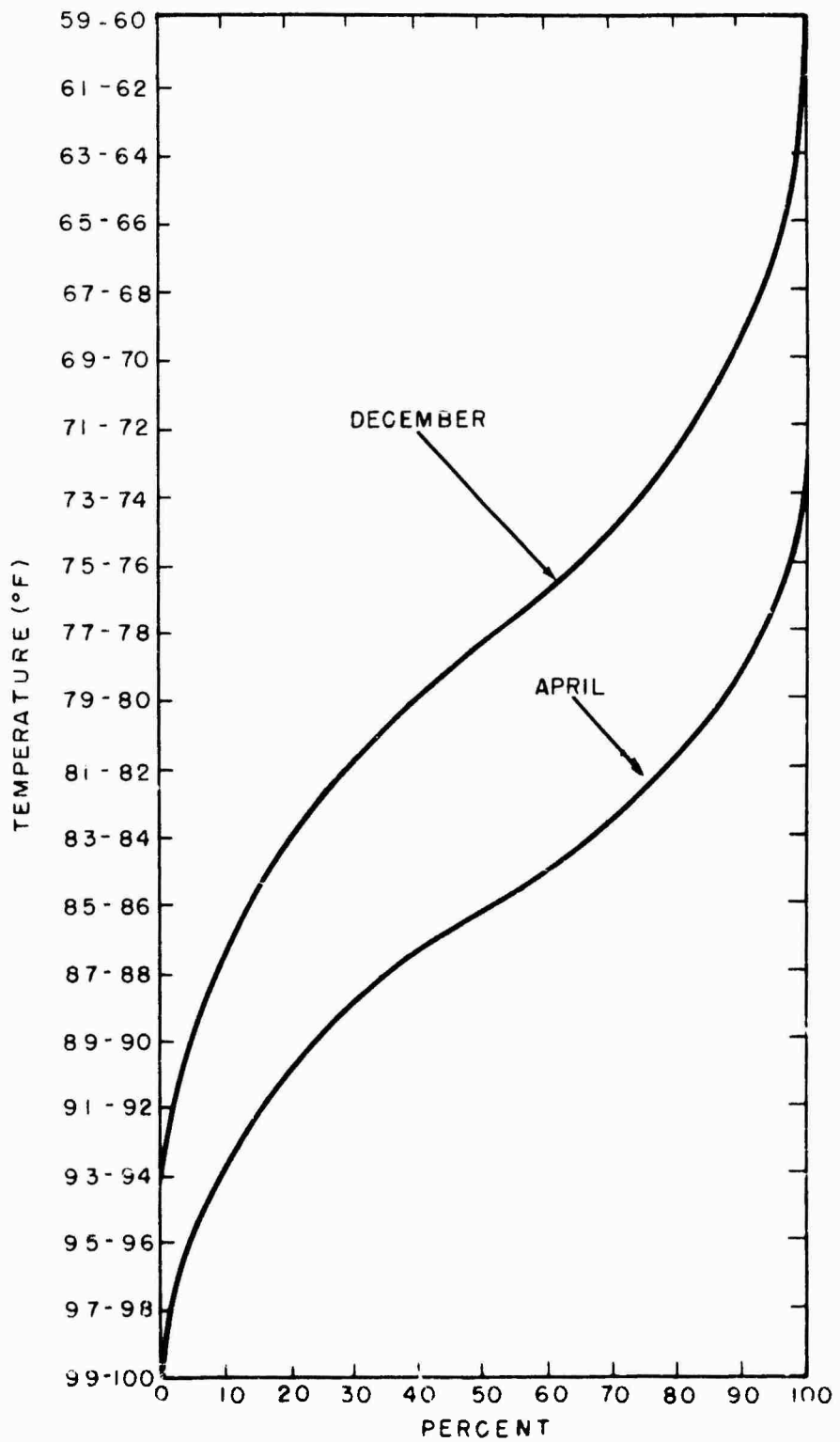


Fig. 19: Cumulative frequencies of temperatures, Bangkok, based upon observations at 0700, 1300, and 1900 hours.

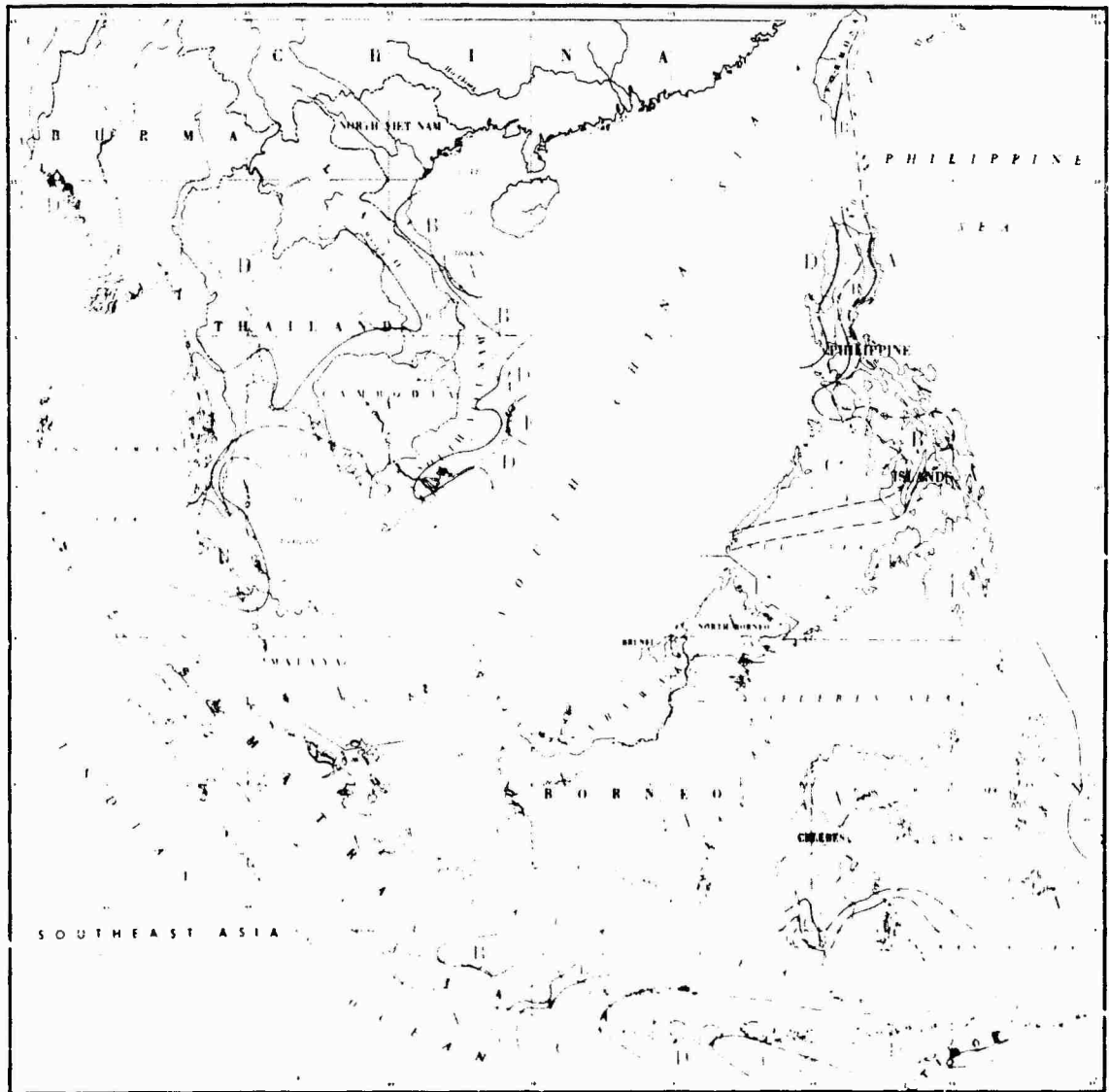


Fig. 20: The climate of central Thailand, with a long dry season, is most analogous to that of Burma on the west, and Laos, Cambodia, and Vietnam on the east. The climate is quite different in most of the Malay Peninsula and the large islands of Indonesia, where heavy rains prevail in all or nearly all months throughout the year. In Thailand, this type of tropical rainy climate occurs only in small areas in the Kra Peninsula, in the south.