PSF Subject file : OSS Celebes Sea Area May 1944

OFFICE OF STRATEGIC SERVICES [redacted]
WASHINGTON, D. C.

26 July 1944

Miss Grace Tully,
The White House,
Washington, D. C.

Dear Grace:

Would you be kind enough to place the attached memorandum before the President?

Thank you.

Sincerely,

Bill

William J. Donovan,
Director

REGRADED UNCLASSIFIED

[redacted]

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OFFICE OF STRATEGIC SERVICES
WASHINGTON, D. C.

26 July 1944

MEMORANDUM FOR THE PRESIDENT

I believe you may be interested to receive the attached copy of the JANIS (Joint Army-Navy Intelligence Study) of the Celebes Sea Area which represents the successful combined effort of several governmental agencies.

William J. Donovan
Director

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JANIS 155
Volume No. 1 of 4

~~Confidential~~
Non-registered

JOINT ARMY-NAVY INTELLIGENCE STUDY

OF

Celebes Sea Area

★

JOINT INTELLIGENCE STUDY PUBLISHING BOARD
May · 1944

1034 CONNECTICUT AVE.
Washington 6, D. C.

30 May 1944.

MEMORANDUM

Subject: JANIS No. 155.

1. Joint Army-Navy Intelligence Study of Celebes Sea Area (JANIS No. 155) is promulgated herewith.

2. This is a confidential non-registered publication. It contains information affecting the national defense of the United States within the meaning of the Espionage Act, 50, U.S.C. 31 and 32, as amended. Its transmission or the revelation of its contents to an unauthorized person is prohibited by law.

3. When complete, JANIS No. 155 will comprise Chapters I to XIII, inclusive, and a Plans Pouch containing reference maps.

4. As a means of effecting quick distribution, the various chapters will be issued as they come from the printer, not necessarily in numerical order.

5. At the time of this distribution the following chapters are issued: III, V, IX, X and XI.

6. It is anticipated that the issue will be complete by 30 June 1944. As the several chapters are received, the recipient should arrange them in numerical order in the binders provided, and check-off in the space below.

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JANIS 155
CHAPTER 1

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JOINT ARMY-NAVY INTELLIGENCE STUDY

OF

CELEBES SEA AREA

BRIEF

MAY 1944

List of Effective Pages, Chapter I

Subject Matter	Change in Effect	Page Numbers
Cover Page	Original	unnumbered
List of Effective Pages and Table of Contents, Chapter I (inside front cover)	Original	unnumbered
Text and Figures	Original	pp. I-1 to I-26
Figure (insert, reverse blank)	Original	Figure I-1
Figure (insert, reverse blank)	Original	Figure I-2
Figure (insert, reverse blank)	Original	Figure I-3
Figure (insert, reverse blank)	Original	Figure I-4
Text	Original	pp. I-27 to I-28
Figure (insert, reverse blank)	Original	Figure I-5
Figure (insert, reverse blank)	Original	Figure I-6
Text	Original	pp. I-29 to I-42
Figure (insert, reverse blank)	Original	Figure I-7
Figure (insert, reverse blank)	Original	Figure I-8
Figure (insert, reverse blank)	Original	Figure I-9
Figure (insert, reverse blank)	Original	Figure I-10
Figure (insert, reverse blank)	Original	Figure I-11
Figure (insert, reverse blank)	Original	Figure I-12
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Table of Contents

Note: This Chapter is based on material available in Washington, D. C. on 25 April 1944.

FOREWORD

The purpose of this study is "to make available one publication containing all the necessary detailed information upon which may be based a war plan for military operations" in the Celebes Sea Area.

In order to increase the usefulness of the study, the material has been presented in 2 distinct patterns.

Chapter I, entitled "Brief," is a condensation, and to some degree an interpretation, of the material presented in much greater detail in the succeeding chapters. It is intended as a "quick look," complementing the main body of the study, to which reference can be made where more detailed information is desired.

The material for this study has been contributed by the intelligence agencies authoritative in the various subjects.

For the purpose of convenience, contents have been made up into 4 volumes, the last of which is a Plans Pouch containing plans numbered 1 to 62 inclusive.

JOINT INTELLIGENCE STUDY PUBLISHING BOARD

Map Evaluation

British North Borneo

A. District Road Development Maps, 1:63,360. Surveyor General, Jesselton.

Sandakan District, 1934.
Lahad Datu District, 1934.
Tawau District, 1934.
Kudat District, 1934.

Maps contain general road classification. Topography is shown by sparse hachures. Drainage and cultural detail is sparse. Considered to be of reconnaissance nature and of value for classifications but not for positions of all detail.

B. District Maps, 1:63,360. Surveyor General, Jesselton.

Labuk District (undated).
Simpoena, 1935.
Sandakan (undated).

These maps show very sparse topographic hachures and drainage data. Road classification is detailed. The maps are considered to be sketchy in nature and are fairly reliable.

C. District Plans. Surveyor General, Jesselton.

Jembongan Island, 1 inch = 20 chains (undated) (covers parts of north and south shore).
Tungku, 1:12,232, 1932.
Kudat, 1:15,840, 1936.
Tambisan, 1 inch = 16 chains (undated).
Lahad Datu, 1:12,232 and 1:15,840, 1932-34.
Tawau, 1:12,232, 1941.
Sandakan, 1:12,232 and 1:12,840, 1933-38.

Contains detailed plans of all plantations and roads. Topography is shown by sparse hachures. Considered reliable.

D. Kudat and Marudu Bay, 1:126,720 (undated). Surveyor General, Jesselton.

Topography is sparse and is shown by hachures. Cultural and drainage detail is very sparse. Map is considered to be fairly reliable.

E. Plan of a portion of the East Coast of North Borneo, 1:380,160. Surveyor General, Jesselton, 1940.

Map is partially made from aerial photographs. Detail is very sparse. Map is considered unreliable. Covers NE side of British Borneo, from coast to about 50 miles inland.

F. Geologic Map of Dent Peninsula, 1:200,000. Sarawak Oilfields, Ltd., 1936. Based on aerial photographs. Map is reliable but shows planimetric data only.

G. Geologic Map of Jembongan-Tembelang, 1:50,000. Sarawak Oilfields, Ltd., 1936. Detail is dense. Corrects errors in existing published maps.

Netherlands Borneo

A. Sangkoelirang Area, 1:100,000. NNVPM. 1934.

This is an oil company map made from reconnaissance surveys. No topography is shown. Geologic data is shown. Only the main rivers are shown in detail. All other data is sparse. Map is considered fairly reliable.

B. Tarakan Island, 1:50,000. Topografische Dienst, 1936.

Standard Dutch topographic map. Map is considered reliable.

C. Zuider Costerafdeeling van Borneo, 1:750,000. Topographische Inrichting, 1913.

Four-sheet general map covering all of Eastern Netherlands Borneo. Topography is by hachures. Map is considered fairly reliable.

Celebes

A. Noord en Midden Celebes, 1:500,000. Topographische Inrichting, 1919.

Four-sheet map covering nearly all of Celebes. Topography by hachures. Not considered reliable.

B. Zuidoost Celebes, 1:500,000. Topographische Inrichting, 1924.

Topography shown by shading. Map is considered fairly reliable.

C. Geologische Schetakaart van den Noordaim van Celebes, 1:200,000. Jaarbock van het Mijnwezon in N.I., 1928.

Reconnaissance geologic map with contours. Considered fairly reliable.

D. Netherlands Indies, 1:200,000. Topografische Dienst, 1939-40.

Compiled maps covering Talaud and Sangihe Islands and northern arm of Celebes. Topography by hachures and contours. Considered fairly reliable.

Portion of map covering part of northern arm of Celebes is compiled map. Topography by hachures. Data shown is sparse. Considered unreliable.

E. Atlas Midden Celebes, 1:100,000. E. C. Abendanon, 1916.

Maps of limited coverage along routes of traverse. Topography by contours. Some geologic data shown. Considered reliable.

F. Schetskaart van Midden Celebes, 1:200,000. A. C. Kruijt, 1926.

General compiled map of Middle Celebes. Topography by hachures. Not considered reliable.

G. Meer-Gebeid van Midde Celebes, 1:30,000. Jaarbock v.h. Mijnwezon in N.O.I., 1924.

Sparse data along route of traverse. Topography by contours. Considered reliable.

H. Schetskaart v.h. Cebergte, 1:200,000. Jaarbock v.h. Mijnwegan in N.O.I. 1920.

Compiled map. Topography by form lines. Considered fairly reliable.

I. Costarm van Celebes, 1:500,000. Jaarbock v.h. Mijnwezon in N.I., 1929.

Compiled map. Detail is sparse. Topography by contours. Considered unreliable.

J. Costarm van Celebes on Pelang Eland, 1:100,000. Nederlandsche Pacific Petroeum Mij., 1941.

Sparse planimetric and geologic data along lines of traverse. Considered fairly reliable.

K. Schetakaart v.h. Landschap Boston, 1:250,000. Topographische Inrichting, 1916.

Compiled map. Topography by hachures. Considered unreliable.

L. Geologische Kaart v.h. Eland Boston. 1:200,000. Topografische Dienst, 1936.

Map covers Boston Island only. Planimetric and geologic detail shown. Considered fairly reliable.

M. Tokang Besi Eilanden, 1:250,000. Topographische Inrichting, 1916.

Compiled map. Topography by hachures. Detail sparse. Considered unreliable.

N. Celebes, 1:100,000. Topographische Inrichting. Topografische Dienst, 1919-37.

Covers southwestern arm of Celebes except for gap between 4° and 4° 40′s. Oldest sheets are in the south. Standard Dutch sheets. Sheets south of 4° 40′ do not check with later 1:50,000 sheets. These are not considered reliable. Sheets north of 40° are reliable.

O. Celebes, 1:30,000. Topographische Inrichting, Topografische Dienst, 1923-34.

Standard Dutch topographic sheets. Considered reliable. Covers southwestern arm of Celebes and Salajar.

P. Celebes, 1:25,000. Topographische Inrichting, 1923-27.

Standard Dutch topographic sheets covering area to south and east of Makassar. Considered reliable.

Q. Celebes, 1:125,000. AMS, 1942-43.

Compiled topographic map. Covers area south of 3°. Based on Dutch 1:100,000 and 1:50,000 maps. First edition is not reliable. Second edition is considered reliable.

R. Soola Elanden, 1:250,000. Topographische Inrichting, 1927.

Covers all of the Sulu Group. Topography by shading. Detail sparse. Considered unreliable.

Molukken Islands

A. Halmahera and vicinity, 1:100,000. Topografische Dienst, 1924-36. Standard reconnaissance topographic maps covering Halmahera, Ternate, Tidore, and adjacent islands.

Topography by contours. Maps are considered to be only fairly reliable.

B. Ceram, 1:100,000. Topografische Dienst, 1919.

Topographic maps based on reconnaissance survey. Reliability is fair except for positions which in the area of Pirve Basi are out as much as 2′ 30″.

Mindanao

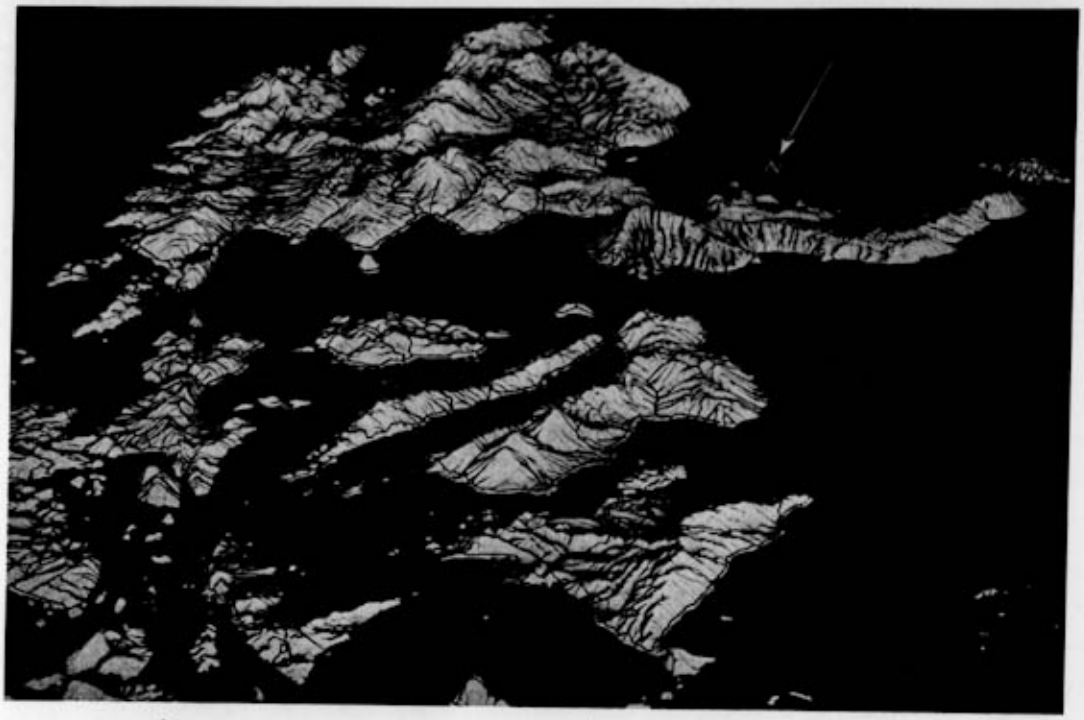
No reliable surveys over Mindanao are available. Numerous reconnaissance maps produced by the Philippine Department, U. S. Army, between 1902 and 1913 are available but each covers only small local areas. Their reliability is poor. Jolo and Tawi-Tawi are covered at 1:80,000 and 1:62,500, respectively, produced by the Philippine Department. Their reliability is fair. At present AMS is producing 1:50,000 scale maps on the Sulu Archipelago and 1:100,000 scale on Mindanao, which will incorporate the data from all available sources plus some corrections from aerial photographs.

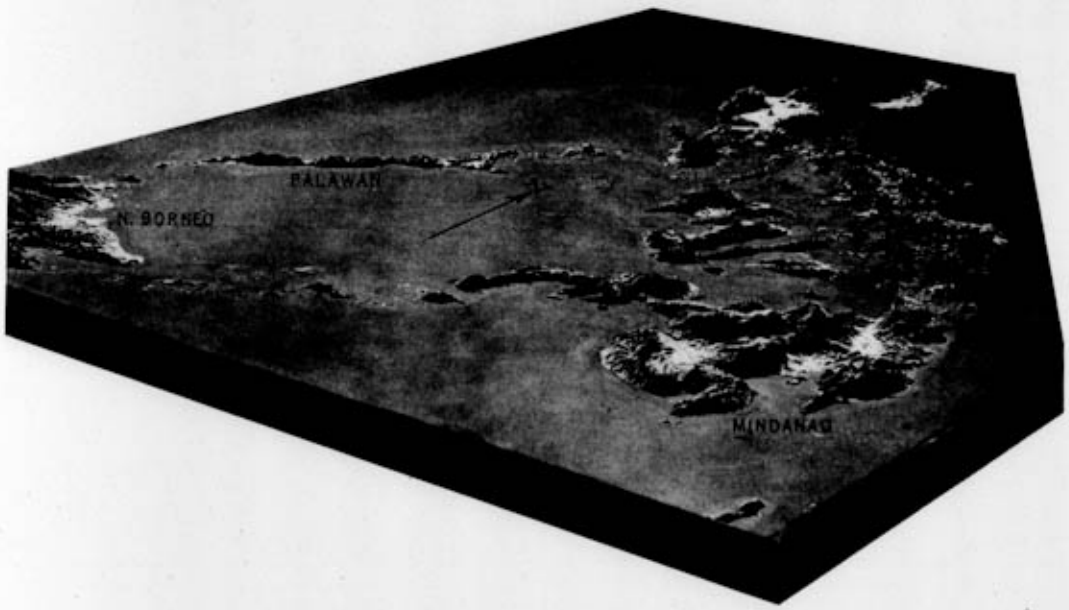
BRIEF

10. Military Geography

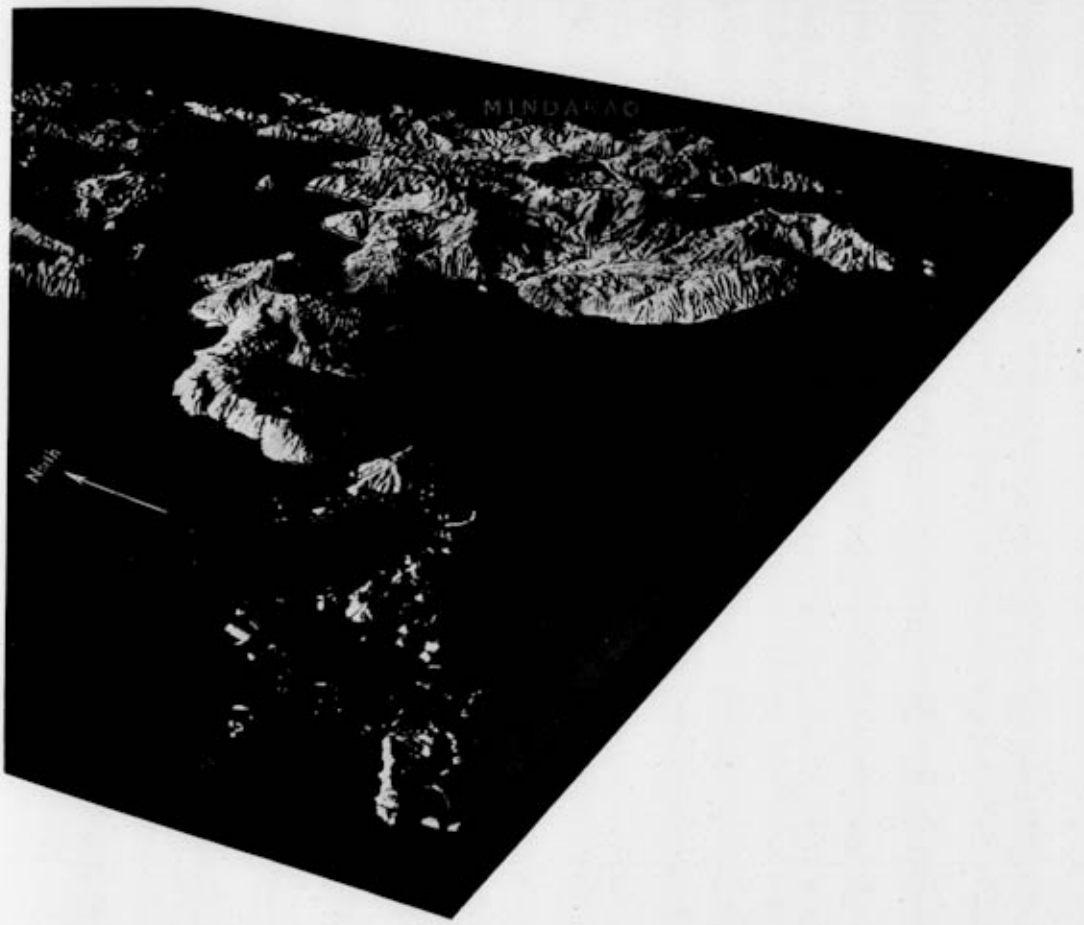
The Celebes Sea lies northwest of Halmahera Island, and is enclosed by the Sangihe-Talaud Islands, Mindanao Island, the Sulu Archipelago, Northeastern Borneo and Northern Celebes. Together with numerous small adjacent islands, these major land segments, and the waters they enclose, comprise the Celebes Sea Area. The maximum dimensions of the area are approximately 1,100 miles east—west and 850 miles north—south. The approximate size of each major island or island portion within the area is shown below:

Island	*Approximate land area in square miles*	*Comparable in size to*
Halmahera Group	10,000	Vermont, Maryland, or Sicily
Mindanao	36,906	Indiana, Maine, or Portugal
Northeastern Borneo	95,000	Wyoming, Great Britain, or Korea
Northern Celebes	14,000	Switzerland, Netherlands, or Salvador





NOTE: On the photographed model, vertical scale to horizontal scale is 5 to 1.


MINDANAO
North

There is a great deal of physical diversity within each island. The area as a whole has unity, however, in that all the major islands have:

1. Rugged interiors which are only partially explored and which are bordered by small discontinuous plains.
2. Interior basins or plains which are limited in size and in most cases are difficult to reach.
3. Moist, warm climate the year round.
4. Heavy cover of tropical vegetation.
5. Adverse soil trafficability conditions during wet seasons.

It is important to note, however, that in several places the local physical conditions are more favorable than indicated above for military operations, and make it feasible to utilize these lands for bases in operations moving westward and northward toward Malaya, the northern Philippines, China, and Japan.

A. Relief (Figures I - 7 and I - 8, Plan 1).

A large portion of the area consists of rough, mountainous terrain, especially in the interior of the islands. Low flat lands are found mainly along the coasts, or on flood plains of the large rivers in Borneo and Mindanao. The coastal plains are usually narrow, and seldom are continuous for long distances.

Cross-country military operations will have to contend with difficult terrain problems throughout the area, with few exceptions. These exceptions are found in the Minahasa Region in the northeastern part of the northern peninsula of Celebes, and in the central portion of Mindanao where there are wide stretches of open, rolling terrain. Elsewhere, the interiors of the islands under consideration are mountainous, covered with dense forests, sparsely inhabited, and accessible only by forest trails. For this reason most military operations probably will be directed against peripheral objectives—primarily airfields, harbors, supply points, and garrison bases along the coasts. Nearly all such objectives are located on comparatively narrow and discontinuous plains.

Because of the peninsular character of the larger island masses included within the area, attention likely will be focussed also upon cross-island routes that will enable troops to cut off relatively large segments of the islands. These routes, with few exceptions, lead through mountain passes, and undoubtedly would cross numerous defensive positions. Very few routes are now utilized by motor roads, and it is doubtful if many are suited for road construction.

The most significant smaller islands within the Celebes Sea Area are those that have enough low flat land to be suitable for airfield development. Several such islands are located off the east coast of Halmahera, and in the southern portion of the Sulu Archipelago.

B. Drainage and water supply.

Poor drainage imposes major barriers to military operations in many parts of the area, but water supply is adequate in most places and at most seasons.

(1) Rivers.

The rivers generally are short and rapid, without broad coastal plains. Their drainage basins are small. The main exception to this rule is in Borneo, particularly in the eastern and northeastern portions. In the interior of this island the broad area of hilly to mountainous terrain, which receives heavy rainfall, gives rise to many large rivers. These rivers have built flood plains at the highland border, and flow in winding courses across these flood plains to the sea. The rivers are deep in their lower courses and are practically the only easy routes of penetration into the interior of this large but little known island. From a military point of view, however, they act more as barriers than routes, since objectives are seldom located in the interior. These rivers are wide, deep, and susceptible to flooding, hence are effective

obstacles on overland routes from one coastal objective to another. Outside Borneo, there are only 2 rivers that would be sufficiently large to act as tactical barriers for large troop units. These are the Agusan and Mindanao-Pulangi Rivers on the island of Mindanao.

(2) Swamps.

Even more effective than the rivers as barriers to cross-country movements are the swamps and marshes. Almost all of the extensive ones are located on the flood plains of the large rivers of Borneo and Mindanao. Small stretches of poorly drained land lie back of the beaches on many of the coastal plains and restrict coastal travel to narrow beach strips, thus limiting the area of flat land available for airfields.

(3) Lakes.

There are few lakes in the Celebes Sea Area, and most of these are either small ponds in volcanic craters or shallow swamp lakes on river flood plains. The only lakes that appear to be suitable for float plane use are Lakes Lanao and Mainit on Mindanao, Galela Lake on Halmahera, and Tondano Lake on Celebes.

(4) Water supply.

Most parts of the area have considerable rainfall. Numerous streams with headwaters in mountainous country afford fresh water at most places and at almost all seasons. On the very small islands, however, particularly those of the low coral or sandy type, the only available fresh water is obtained either by collecting rain water, or from shallow wells.

C. Vegetation (Plan 2).

Wide expanses of unbroken rain forest are characteristic of nearly all the rough mountainous sections, and moss forest covers large highland areas having exceptionally wet conditions. Swamp forests are found on poorly drained lands, both upland and lowland. On the coastal lowlands the type of vegetation is dependent in many cases, upon soil conditions, drainage, and the stage of cultural development of the area. Coastal mud flats in many cases have dense growths of mangrove. Where the land is somewhat higher and less salty, but poorly drained, nipa swamps are found. As a general rule, low sandy coastal plains contain groves of coconut palms. Back from the sandy soil areas, the coastal lowlands are utilized for cultivated crops. The amount of land so used, and the types of crops vary according to locality. In Halmahera, Borneo, and on many of the smaller, sparsely populated islands, the vegetation on such plains is likely to consist of scattered native gardens. Abandoned clearings grown up to tall coarse grass (*kunei* or *cogon*), or dense secondary forest.

In culturally more advanced portions of the area, such as Celebes and Mindanao, open cultivated fields are much more common. Rice and corn are usually important corps. Large plantations are relatively rare outside Mindanao.

Intermediate slopes, or low hilly land, commonly are in either secondary forest or scattered clearings. Mindanao contains the broadest areas of open grasslands. The Bukidnon and Lanao Uplands, in central Mindanao, have hundreds of square miles of grasslands, and the flat interstream areas in these regions require little more than the cutting of the coarse tall grass to make them suitable for emergency airfields.

D. Soil trafficability (Figure I - 9).

Soil trafficability refers to the capacity of soil to support the movement of military vehicles. It applies especially to cross-country movement of vehicles and to traffic on unimproved roads made of local soil, rather than to traffic on improved or surfaced roads. Soil trafficability is determined by the type of soil (textural grade, organic matter content and other profile features), topography, vegetation, and weather factors.

The difference in trafficability between the coarse-, medium-, and fine-textured soils is not so great in the Celebes Sea Area as in higher latitudes. This situation results from the type of rock weathering (lateritic) which is characteristic of the area and which generally produces medium-, and fine-textured soils which are friable, and maintain their structure well, yet allow excess precipitation to drain rapidly. In spite of this ready drainage, the general soil trafficability is moderately unfavorable.

The generally heavy rainfall is unfavorable to the movement of vehicles, and largely offsets the relatively favorable drainage properties of the soils. Furthermore, the large islands have heavily forested mountain regions in their interiors, which restrict movement to discontinuous coastal plains separated by rocky headlands and swampy areas.

The regions exposed to the northeast monsoon generally have higher annual precipitation and a relatively wet season in the northern winter, whereas places exposed to the southwest monsoon tend to have most rain in the northern summer, but receive less annual rainfall. Consequently, conditions for vehicular movements will generally be least favorable on the northeast coasts of the larger islands during the northern winter, and least favorable on the southwest coasts during the northern summer.

Many of the smaller islands have steep, rocky slopes or, where they are of low elevation, have a heavy mangrove cover. The most trafficable soils are those developed on coral atolls, coral islands, and uplifted coral rock along the coasts of the larger islands. These soils are generally trafficable at all times.

No soil surveys of any extent have been made in the Celebes Sea Area. The soil trafficability map is based upon geologic and topographic information which itself is incomplete. The soil trafficability boundaries, therefore, are approximations.

A very common soil-type consists of soils which range from coarse- to medium-texture and include sandy loams, stony loams, and loams. In general, these soils should be trafficable except during and immediately following heavy precipitation. However, where they occur in heavily forested mountain regions, their trafficability will be very poor regardless of weather.

Fine-textured soils also cover large areas, especially on lowlands. These include silty clay loams, clay loams, and clays. These soils are slippery when wet, but they recover rapidly from the effects of precipitation. Their trafficability probably is somewhat less favorable than that of the coarse- and medium-textured soils. Fine-textured soils also occur in mountainous regions where unfavorable topography restricts ground movement.

Intermittently-flooded soils occur at many places along the coasts of the islands, usually at the mouths of streams and rivers, and in the interior river basins of the larger islands. These alluvial soils are frequently non-trafficable during and after rainy periods. During dry weather their trafficability is moderately favorable. Lowlands planted in rice are similarly flooded during growing seasons, and are not completely dry even at harvest time.

There are moderately large swamps and marshes on many parts of the coastal lowlands and along the larger river valleys. The swamps, or *moeras*, are very wet and muddy. Locally in such areas a man may sink to his shoulders. The marshland, or *drasland*, also muddy but less deep, generally has no standing water. At many places mangrove swamps are serious obstacles to landing operations. The small scale of FIGURE I - 9 makes it unfeasible to show the numerous mangrove swamps.

E. Critical areas.

There are 4 areas, each located on 1 of the major islands of the region, that have critical strategic importance. These include the Kaoe Bay Region of Halmahera, the Bukidnon Uplands of Mindanao, the island of Tarakan off the east coast of Borneo, and the Minahasa Region of Northern Celebes. Tarakan Island is important because of its oil, which can be used as fuel oil directly, without being refined. The strategic importance of the other areas is the result of terrain and position.

(1) Kaoe Bay Region, Halmahera.

This region is strategically located about midway between the southern portion of the Philippines and the Vogelkop or westernmost part of New Guinea. Kaoe Bay is a large sheltered anchorage, and can accommodate an entire fleet. There are low, flat plains in the vicinity, where the Japanese have several airfields in use or under construction. The rugged peninsulas on either side of the bay provide good defensive positions.

(2) Bukidnon Uplands, Mindanao.

This region is located in the north central portion of the island, and is the natural fortress of Mindanao. Its numerous airfields and potential airfield sites, its natural defenses, and its road connections to both the northern and southern coastal areas, make it the logical center of defense by ground and air forces.

(3) Tarakan, Borneo.

This island is located just off shore from the swampy delta area at the mouth of the Sesajap River in Northeastern Borneo. It is important for its oil fields. It is not an easy area to attack, as the island is bordered on nearly all sides by dense mangrove swamps, and contains a hilly, heavily wooded central core.

(4) Minahasa Region, Celebes.

There are 2 main objectives for military operations in this area. These are the harbor of Manado, and the airbases near Tondano Lake. The Minahasa Region also has strategic importance because of the general suitability of the terrain for military operations, the relatively good network of roads, and the available local labor supply.

F. Routes to critical areas.

The most important strategic routes are indicated on Plan 1 and on FIGURES I - 7 and I - 10.

(1) Routes to Kaoe Bay Region, Halmahera.

At the present time, there are no motor roads leading to the Kaoe Bay Region from other parts of the island. The only routes, with the exception of the bridle track across the Dodinga Isthmus, are along native footpaths. There are many of these, especially from the west coast, but few of them have potentialities for development into motor supply roads.

(2) Routes to Bukidnon Uplands, Mindanao.

This strategically important area in the central portion of Mindanao has immediate approaches only from the north and south, but there are several points along the periphery of the island from which good routes lead toward these 2 entrances.

The routes from the coastal points toward the Bukidnon Uplands are already utilized by good motor roads, but they are more than just roads, since there is open, low terrain suitable for deployment in most places. There are also a number of foot or pack trails through forested mountain country that lead toward the strategic area from both the east and west.

(3) Routes to and in Northeast Borneo.

There is no approach to Tarakan Island other than by sea. Furthermore, the mainland opposite the island consists of low, swampy, delta country, covered with mangroves and other swamp vegetation. There is almost no access to the rest of Northeastern Borneo except by boat along the coast, or up the rivers to inland trail connections.

(4) Routes in Northern Celebes.

The Minahasa Region and the most critical points within it, the Lake Tondano area and the port of Manado, are accessible from the following points: along the macadamized road from Lombagin to Amoerang; from either end of the Kanado-Kema road; from either end of the Amoerang-Belang road; from Likoepang at the northeastern tip. Access to the interior is restricted by steep slopes to the routes leading inland from the points mentioned above, but once the plateau is reached, there is a fairly good network of roads, and the terrain would permit deployment off the roads in many places.

The Gorontalo-Loeandang route, a considerable distance west of the Minahasa Region, has some strategic significance because it bisects the northern peninsula. A possible potential route also exists from Gorontalo, via the Bone Valley, eastward toward the upper portion of the Ongkag Doemoga basin, from which a motor road leads to Minahasa, via Lombagin. A military road along this route was begun prior to the war, but was never completed. Much of it is through hilly to mountainous terrain.

G. Regional summary.

TABLE I - 1 summarizes the data on relief drainage, vegetation, and water supply.

TABLE I - 1.

MAJOR AREA	TERRAIN REGION	RELIEF	DRAINAGE	VEGETATION	WATER SUPPLY
Halmahera	Southern Halmahera	Narrow coastal plains; hilly to mountainous interior.	Small mountain streams; much swamp on coastal plains.	Rain forest; narrow strips of coconut plantations along the coast.	Wells and streams.

TABLE I - 1 (Continued)

MAJOR AREA	TERRAIN REGION	RELIEF	DRAINAGE	VEGETATION	WATER SUPPLY
	Central Halmahera	Mountainous; few scattered coastal plains; NE Peninsula, the most rugged.	Sangadji River; small mountain streams; narrow swamps.	Rain forest in the interior; cultivation and second growth on coastal strips.	Wells and streams.
	Northern Halmahera (Kaoe-Tobelo Lowlands and Ridges)	Open plains; rolling country; dissected terraces.	Kaoe River; other streams small; swamps in middle Kaoe valley and near Akelamo.	Much second growth; some grasslands in lower Kaoe valley; coconut plantations along the coast.	Wells and streams.
	Northern Halmahera (Lamo-Kaoe Block)	Low mountains; steep NW side.	Lamo River and small mountain streams; swamps on N side of Dodinga Bay.	Rain forest.	Streams.
	Northern Halmahera (Volcanic Range)	High volcanic cones; rough hill country between; flat coastal plains on W.	Mountain streams; swamps at head of Djailolo Bay.	Rain forest in interior; clearings and second growth on coastal plains.	Wells and streams.
	Northern Halmahera (Galela Plain and Tiabo Valley)	Undulating to flat plain; narrow flat valley.	Tiabo River; swamps N of Galela, and in middle portion of Tiabo valley; Galela Lake.	Scattered patches of grassland, gardens, coconut groves and secondary forests on plain; Tiabo valley heavily forested.	Wells and streams.
	Northern Halmahera (NW Mountain Ridge)	Narrow, steep mountain range; narrow, discontinuous coastal plains.	Small mountain streams.	Rain forest; small clearings along coast.	Wells and streams.
	Morotai Island	Rugged interior; widest lowlands along SW coast.	Small mountain streams.	Rain forest; scattered clearings, gardens and second growth.	Wells and streams.
	Western Volcanic Islands	High volcanic cones; narrow coastal plains; fairly gentle, undissected lower slopes.	No permanent streams; small swamps on coastal strips.	Barren mountain tops; brush and forest farther down; gardens and plantations on lower slopes.	Wells and springs.
	Batjan Islands (Kasiroeta Island)	Rough hilly terrain; lowland in S.	Small streams, few have permanent flow; swamps at W end of S lowland.	Rain forest; small plantations and clearings along coast.	Wells and springs.
	Batjan Islands (Batjan Island)	Four mountainous peninsulas, separated by low, flat corridors.	Small streams; swamps east of Laboeha and along Sambaki Strait.	Rain forest; plantations in Laboeha area; scattered clearings and second growth.	Wells and springs.
	Batjan Islands (Obit Island)	Hilly interior; narrow coastal flats on W and S.	No permanent streams.	Coconuts along coast; rain forest in interior.	Wells and springs.
	Batjan Islands (Mandioli Island)	Hilly; narrow coastal plain.	No permanent streams; swampy on S coast.	Coconuts along coast; rain forest in interior.	Wells and springs.
Mindanao	Southern Mountains	Mountainous; Koranadal corridor NW of Sarangani Bay.	Short mountain streams.	Rain forest; grasslands at head of Sarangani Bay and in Koronadal Valley.	Wells, cisterns, and streams.
	Central Mountains	Mountainous; pass between Digos and upper Cotabato Basin.	Swift mountain streams.	Rain forest, moss forest; lower slopes cultivated in south.	Streams and springs.
	Davao Lowlands	Flat to rolling.	Small rivers; swamps at mouths of streams and at head of Davao Gulf.	Coconuts along the coast; extensive abaca plantations; some forest.	Wells, cisterns, and streams.

TABLE I - 1 (Continued)

MAJOR AREA	TERRAIN REGION	RELIEF	DRAINAGE	VEGETATION	WATER SUPPLY
	Eastern Mindanao	Mountainous; isolated coastal plains at heads of bays; rough, hilly peninsulas.	Mountain streams; no large rivers; some swampy areas on coastal plains.	Dense rain forest; scattered clearings on coastal plains.	Wells and streams.
	Agusan Basin	Broad, flat lowland.	Agusan River system; extensive marshes and swamps.	Mostly dense rain forest; scattered clearings along the lower courses of the river.	Wells, cisterns, and streams.
	Bukidnon Uplands	Broad, sweeping slopes, deeply entrenched in the N; included volcanic mountain areas; many level upland areas.	Rapid streams; not navigable; those in north in canyon-like valleys.	Mountain areas in rain forest or moss forest; wide areas of grassland; patchy forest in extreme S.	Wells, cisterns, and springs.
	Lanao Uplands	Diverse terrain; mountains, plateaus, coastal plains, and rolling country; latter dominant.	No large rivers, but some may be obstacles after heavy rains; swamps at head of Iligan Bay.	Much open grassland; scattered cultivation N of Lake Lanao; dense forest E of lake.	Wells, cisterns, and streams.
	Western Mindanao	Mostly mountainous; some hilly country; widest plains on extreme N and S.	Sibuguey River; small, mountain streams; much swamp on coastal plains at mouths of streams.	Rain forest; scattered grass lands on Zamboanga Peninsula; coastal plains on N and S cultivated.	Wells, cisterns, and streams.
	Cotabato Basin	Flat basin bordered on N by low terraces, steep edge on SW; some isolated flat-topped hills.	Mindanao River system; extensive marshy areas in central portion.	Rice cultivation in lower valley; marsh grasses, open grassland, and secondary forest in rest of basin.	Wells, cisterns, and streams.
Sulu Archipelago	Basilan Island	Hilly to mountainous interior; widest lowland on N.	Small streams; swamps along many coastal stretches.	Rain forest; N plain cultivated; some plantations along the coast.	Wells, cisterns or springs.
	Jolo Island	Volcanic hills and peaks separated by wide sweeping slopes; most rugged on W.	Few streams; swamps along low sheltered coasts.	Mostly under cultivation or second growth; forests on peaks.	Wells, springs or cisterns.
	Tawitawi Island	Rough, hilly interior; a few coastal flats.	No permanent streams; a few coastal swamps.	Mostly rain forest; grass and clearings at SW end.	Inadequate supply. Shallow wells and cisterns.
Borneo	British North Borneo	Mountainous interior especially toward W; narrow coastal plains on W interrupted by hills; broad river flood plains on E coast.	Short mountain streams on W coast, except Padas R.; large rivers flow to E coast; extensive swamps SE of Sandakan, and at river mouths.	Rain forest; some grassy clearings, second growth, and cultivation along W coast; swamp forests along E coast, some moss forest.	Wells, springs, and streams.
	Dutch East Borneo	Rough hill land; some interior basins; broad river flood plains; isolated ridges and hills; mountains on W border.	Large river systems: Sembakoeng, Sesajap, Kajan, Beraoe, and Mahakam.	Rain forest; scattered cultivation and secondary forest along streams.	Wells, springs, and streams.
Celebes	Minahasa-Bolaäng-Mongondow	High volcanic cones; plateaus; narrow coastal plains; several passes.	Mountain streams; Lake Tondano.	Forested summits; much cleared and cultivated land (rice, corn), and secondary growth.	Wells, springs, and streams.
	Northern Peninsula	Central mountain range; narrow coastal plains; only one gap in range (Gorontalo-Koeandang).	Mountain streams.	Mountains covered with rain forest; lower slopes scattered second growth and clearings; coastal plain cultivated land, second growth, and swamp forest.	Wells, springs, and streams.

11. Oceanography

A. Tides.

The tides in this area are complex, varying from semidiurnal tides with some inequality between morning and afternoon tides to those that become entirely diurnal (1 tide a day) for certain portions of each month. At some places, the average range at the time of tropic tides exceeds 9 feet.

B. General circulation.

The greatest flow of water into the Celebes Sea is southwesterly through the passage between the southeast coast of Mindanao and the Talaud Islands. Within the Celebes Sea, the water circulates in a counterclockwise direction, and most of it leaves the area through the northeastern part of Molucca Passage. Some water also enters from the Sulu Sea through Sibutu Passage except during the spring and summer when the current is reversed. Similarly, some water leaves the area through Makassar Strait.

Strong tidal currents are to be expected in numerous localities within the area.

C. Sea and swell.

High sea and swell are infrequent in the areas covered by this report. The 4 areas differ slightly in the monthly distribution of the amounts of sea but, in general, the sea is least disturbed during April, May, and June and is roughest during December and January. Sea and swell are predominantly from the northeast from November through April and from the south or southwest during the rest of the year.

D. Sea-water characteristics.

Water temperature at the surface ranges between extremes of 76° and 88° F., and at 300 feet between 60° and 84° F. Temperature gradients are not common just below the surface, but there is an average difference of 9.4° F., with a maximum of 28° F., between the surface and 300 feet.

Extreme salinity values of 30.91 and 36.20 parts per thousand have been recorded at the surface; the average surface salinity is 34.03 parts per thousand. Lower values are to be expected close to shore owing to fresh-water runoff. At a depth of 300 feet, the salinity ranges from 33.20 to 37.74 parts per thousand, with an average of 34.62 parts per thousand.

Density layers are frequently found below 100 feet. Only rarely will submarines be able to balance on these layers, and ballast changes of 2,000 to 19,000 pounds will be required.

Echo-ranging conditions are usually *fair* throughout the year, except when the background noise level is high. Assured echo ranges of 1,500 to 2,000 yards may be expected away from the islands. Screw noises have been recorded at a maximum distance of 10,000 yards and pinging at a distance of 12,000 yards.

Away from land the water is probably relatively clear and blue.

E. Bottom sediments.

The shelves surrounding the islands in the Celebes area are narrow. For the most part, the shallow-water bottoms consist of alternating patches of *sand* and *coral* and some *stone*. In large bays and off the mouths of the rivers of Mindanao and Borneo, the bottom is generally *mud*. *Mud* may also be expected in the more protected bays on the smaller islands.

12. Coasts and Landing Beaches

A. Halmahera sector.

(1) Coasts.

(a) Djailolo Bay and vicinity. Djailolo village can be approached either directly through Djailolo Bay or overland from Sahoe Bay. Sahoe Bay approach is clear to the 18-foot curve which lies about 1,000 feet off the beach. From the shore, a broad plain extends inland around a 3,705-foot mountain to Djailolo, on the north shore of Djailolo Bay. Direct approach through Djailolo Bay is by way of a narrow channel in the fringing drying reef, which extends more than 300 yards from the low shores of the bay. There are several shoals off the coastal reef. Extensive mangrove swamps are intersected by small sandy beaches, which are usually soft but have good exits. There are few good landing sites, the best being at Djailolo wharf.

(b) Dodinga Bay and vicinity. Dodinga is located at the head of Dodinga Bay on the narrow isthmus that separates Dodinga and Kaoe Bays. In Dodinga Bay the 10-fathom curve is close to shore, but there are reefs on both north and south sides of the bay. Southward of the bay the coast is free of dangers and can be approached to within ½ mile. There is good anchorage off Dodinga village. Dodinga can also be approached by trail or cart track, about 2 to 3 miles long, across the isthmus from Kaoe Bay.

(c) Hiri and Ternate Islands. The shore of Ternate Roads is bordered by a coastal reef that narrows southward. The 3-fathom curve lies about 100 yards and the 10-fathom curve about 200 yards beyond the reef. A semidiurnal tide predominates, and a strong current sets through the roads at times. The coasts of Hiri and Ternate Islands are steep-to in places, with alternating beaches. There are narrow coastal reefs but almost none that dry. Approach is clear to the reefs. Landings at high tide by shallow-draft landing craft should be possible in the lee of Ternate Island in all seasons.

(d) Galela Bay. The bottom falls off sharply, with depths of 20 fathoms within 300 yards of the shore. The harbor is not safe during the northwest monsoon. Currents are negligible, with a semidiurnal tide predominating. The western shore is backed by a broad plain through which flows the Tiabo River. An impenetrable marsh at this point cuts the area in two. There is a beach in the northern section and another at Galela itself. Landing is possible, even with the heaviest surf, south of the islet west of Bongo Point. The coast may be approached close to.

(e) Tobelo—Miti. A clear channel runs between the foul ground that fronts the Halmahera shore and the Tobelo Islands. There is little current between the islands and the shore. The coast of Halmahera in this area is mostly low. South of Tobelo the shore is swampy, with mangroves. The Tobelo Islands are low, of coral, well-wooded. Most have fringing reefs. There are numerous beaches on the mainland and the islands, most of them fringed by wide reefs. The best anchorages are at Tobelo and Miti. All shoals in this area discolor well.

(f) Kaoe Bay. Entrance to Kaoe Bay is deep in the fairway but has a 5½-fathom patch on its western side and a 3½-fathom bank on the east. The northwestern shore of Kaoe Bay is in general rather low, with sandy beaches and mangroves around the mouths of the rivers. The southeastern shore is fairly high and steep with some exceptions. At Kaoe Roads, in the northern part of Kaoe Bay, a semidiurnal tide predominates; the 10-fathom curve lies about 20 miles from shore. Westward of

Kaoe is a large bank extending 1⅔ miles offshore. There are beaches at intervals along this part of the coast.

(*g*) *Wasile Bay.* The main channel leading into Kaoe Bay and Wasile Bay is close east of Boebale Island. Depths in Wasile Bay range from 7 fathoms near the shore to 34 at the entrance. The south coast of the bay is rocky. There is a wide mud bank on the east coast. Northward, the shore is sandy and narrower. Wasile Bay is clear.

(*h*) *Morotai Island.* The west coast, between Point Dehegila and Wajaboela, is fronted by numerous shoals, reefs, and islets. Southeastward of Wajaboela Point, where there is a low plain, is a bight forming a harbor protected by 3 drying coral reefs. The bight is fringed by a narrow drying reef and is fronted by numerous shoals and reefs. Northward of Wajaboela the coast is steep-to. Landings during the north monsoon are reported practically impossible except at Berri Berri, Boesoeboesoe, and Sangowo.

(2) Landing beaches.

Scattered beaches, usually associated with a fringing coral reef, occur along all the coasts of Halmahera. The most extensive beaches lie on the west coast between Loloda Bay and Dodinga Bay and on the east coast in Galela Bay, Boeli Bay, and Weda Bay. The beaches are backed generally by a narrow coastal plain leading inland to steep slopes. Numerous small offlying islands obstruct the approach to sections of the coast. Roads or trails affording exit from the beaches are most numerous on the northern peninsula. Beaches on Morotai occur on the east, south, and southwest coasts. The northwest coast is steep and has no beaches.

B. Sangihe-Talaud sector.

(1) Coasts.

Between Mindanao and the northeastern point of Celebes lie the Sangihe and Talaud Islands. The Sangihe Islands are volcanic and rise from very deep water. The Talauds are hilly, but in general, are lower.

Of the Sangihe group, Sangihe Island is the largest, being 26 miles in extreme length and rising to a height of 6,102 feet. The coast has several bays, and is steep and rocky in places, low in others.

There are several landing places as well as probable landing places on Sangihe. Good anchorages may be found all around the island.

Other important but smaller islands in the Sangihe group are: from north to south—Toade Islands, Kalama Island, Kahakitang Island, Mahengetang Island, and Para Island.

Siaoe Island is the southernmost large island of the Sangihe Islands. It has good beaches on the east, west, and south coasts, near the most important settlements. These are connected by a coastal road and by cross-island roads and trails.

South of Siaoe are the islands of Tahoelandang, Roeang, and Biaro. The first 2 are high, steep-sided volcanoes. The last is lower but also hilly.

The 3 main islands of the Talaud group are Karakelong, Salebaboe and Kaboeroeang. They are hilly and heavily wooded for the most part, but in many places on the coast, they are low and swampy.

Karakelong Island, the largest and northernmost island of the group rises to a summit of 2,231 feet near the middle of the island, having steep-to coasts in general, except on the southern side where a bank of soundings joins it to Salebaboe Island. Near the bights on the west coast the hills draw away from the shore. Broad reefs are found there. The north coast is rocky and steep; the east coast is fronted by a drying coastal reef with large rocks in places, while that on the south is fringed by a reef nearly 1 mile in width.

There are several good anchorages off this island, as well as several landing places on the coast. Dangers to navigation are prevalent near Mawawo, Kiama village and in Liroeng Strait.

Salebaboe Island, southwest of Karakelong is about 15 miles long, having a saddle-like formation of densely wooded hills at the middle of the island. There are some sand beaches here and there, varied by large, rocky lumps of coral. The island is surrounded by a very narrow shore reef. The west coast is rocky and steep; the east coast is low and swampy near Moronge village. There are several probable landing beaches on the island, but anchorages are limited.

Kaboeroeang Island, the southernmost of the group, is 8½ miles in length. Its 2 summits are 1,328 and 1,578 feet in height. The coast is rocky, broken by sandy beaches, and fringed by a narrow, steep-to coastal reef. Probable landing beaches can be found in several places, but safe anchorages are not, in general, available off this island.

(2) Landing beaches.

Small beaches occur on all the Sangihe Islands, usually at small villages and generally along the inner edge of a fringing coral reef. The most extensive beach lies along the west shore of Sangihe Island itself, extending westward from Tahoena Bay. The approach to the beaches is obstructed locally by small off-lying islands. Generally the terrain inland rises in steep slopes, except along the east coast of Sangihe Island where there are numerous river valleys. Trails and in a few cases secondary roads generally follow the coast at least part way around most islands.

There is little detailed information on landing beaches on the Talaud Islands, but those best known occur in Beo Bay and Poeloetan on Karakelong Island; at Liroeng on Salebaboe Island; and at Mengarang on Kabaroeang Island. Other probable beaches occur in small bays between rocky headlands and along the open southern coast of Karakelong Island. The beaches are often associated with a fringing coral reef. The offshore approach is generally clear. The beaches are generally backed by a narrow coastal plain, often with narrow river valleys lying between fairly steep wooded hills. A trail or road generally parallels the coast, but with few known connections inland.

C. Mindanao sector.

(1) Coasts.

In the Surigao area the coast between Claver Point and Bilaa Point consists principally of a narrow, wooded plain fringed by mangrove swamps and backed by timbered mountains. A number of mangrove-covered islands occur immediately off the middle of the coast. Between Bilaa Point and Mount Tubay forested mountains rise almost from the water's edge. Anchorage is available off Surigao and Placer. A number of detached dangers occur off the east coast, but none are present from Bilaa Point southward.

In the Cagayan area the eastern and western shores of Macajalar Bay are mountainous, but the head of the bay is bordered

by a narrow coastal plain. A number of anchorages and several off-lying dangers occur in the bay.

In the Misamis area the entire shore line of Iligan Bay consists of a narrow coastal plain backed by wooded mountains. The best anchorages are in Port Misamis, which contains numerous detached dangers.

In the Zamboanga area rugged mountains rise directly from the western coast of the peninsula. There is good anchorage at Port Santa Maria and there are few off-lying dangers. A narrow, wooded coastal plain borders the southern and eastern shores of the peninsula. Anchorage is available east of Zamboanga, and numerous dangers face the eastern coast.

In the Davao Gulf area an extensive, swampy coastal plain lies at the head of the gulf, but the western and eastern shores are predominantly mountainous. The large wooded island of Samal is opposite Davao. There is good anchorage at Malalag Bay and Davao, and at a few points along the east shore of the gulf. The head of the gulf and the southern part of its western shore are practically free of dangers, but detached reefs and shoals face most of the remaining shore line.

(2) Landing beaches.

Beaches are numerous along the coast of Mindanao, both on open coasts and in bays, near all important centers. The most extensive beach areas lie along the northwestern shores of Davao Gulf. Most beaches are associated with fringing coral reefs. The offshore approach is generally clear, except along the northeastern coast and parts of the southern coast, where small off-lying islands occur. Beaches exposed to the northeast and southwest are subject to the heaviest waves and surf during the seasons of onshore winds. A narrow coastal plain backs most of the beaches, and it is commonly succeeded inland by steep wooded slopes. A road or trail is accessible from most of the beaches.

D. Sulu Archipelago and Basilan Island.

(1) Coasts.

Basilan Island lies adjacent to and southwest of the Zamboanga Peninsula of Mindanao. There are several routes of relatively clear approach to this large island, and there are good landing places and beaches near the important coastal settlements and cross-island trails. Much of Basilan Island is mountainous and heavily wooded.

Jolo Island, near the center of the Sulu Archipelago, is 43 miles long east and west, and 3 to 13 miles broad from north to south. It is composed of several groups of volcanic peaks, which have long slopes and wide, intervening valleys. The highest peak is from the west end of the island to 2,665 feet above the sea. In general, the hills have little timber. The lower slopes and the lowlands are intensively cultivated. The coasts are well wooded, clear and steep-to, for the most part, as are also the islets and islands bordering them. The several bays formed by coastal indentation provide good anchorage, especially so at Jolo, the capital, which is situated on the northwestern coast, in a bight about ½ mile eastward from Belan Point. Other good anchorages are at Dalrymple Harbor, Tandu' Batu, Maimbung Bay, Tutu Bay, Capual Channel, and Patotol Bay.

Dangers to navigation are numerous in Capual Channel north of Liangliang, off Bulicutin Island, Panganaa Island, in Maimbung Bay, and off the coasts of Jolo.

(2) Landing beaches.

In general the most extensive beaches along Basilan and Jolo Islands occur along the northern coasts. They are associated with a fringing coral reef, usually with an otherwise clear approach, and in general are subject to heavy surf during the season of the northeast monsoon. Along the southern coasts, the beaches are generally located along the inner edge of a fringing coral reef at small villages. They are separated by extensive stretches of mangrove-lined shore, and in some places have poorer means of exit to the interior than do those along the northern shores.

E. Northeast Borneo.

(1) Coasts.

(a) Jesselton area. Jesselton Harbor, at the south end of Gaya Bay on the west coast of Borneo, is a fairly safe anchorage. It is bounded on the west by Gaya Island and on the east by the mainland. The coastline at Jesselton consists of long, narrow, sandy beaches separated by rocky bluffed headlands, which rise steeply from the sea to altitudes from 150 to 1,000 feet. Behind the beaches there are irregular discontinuous and locally swampy plains which border the coast and extend inland along the major rivers.

(b) Marudu Bay area. Kudat Harbor is situated on the western shore of Marudu Bay between Point Bornugus on the north and Cape Tigasamil on the south. From Aru Point to Melau Island the entire coast is fronted by a shelving reef 200 to 1,400 yards wide. The 5-fathom curve passes just off the outer edge of the reef. In the vicinity of Kudat Harbor, hills 200 to 400 feet high rise steeply from the water or from narrow sandy beaches, except for a low marshy plain extending about 3 miles north and northwest of the town. The harbor offers good anchorage in 6 to 9 fathoms over a mud bottom. There are a few dangers off this part of Marudu Bay, the most prominent being Sandilands Rock at the harbor entrance.

(c) Sandakan Harbor area. Sandakan is located on the northeastern coast of British North Borneo southeast of Labuk Bay. The harbor affords one of the best anchorages in North Borneo. The water off the harbor entrance is free of dangers and is fairly deep, but to the northwest and southeast there are shallow depths containing several small rocky islands and reefs. Sandakan Peninsula between Labuk Bay and Sandakan Harbor is a low plain with a few rolling hills. The northern part of Sandakan Harbor is formed by steep hills. Coalescing deltas of many streams draining the interior form the western and southern parts of the harbor. Near the stream mouths, the deltas are fringed with sandy beaches, elsewhere are soft mud flats. The entrance to Sandakan Harbor is bordered by extensive mud flats which have a maximum depth of 3 fathoms at high water.

(d) Darvel Bay. The northwestern shore of Darvel Bay is indented for about 5 miles by Lahad Datu Harbor. There is generally deep water off the coast between Bagahak Point, to the east of the harbor, and Skertchley Point on the west, except off Darvel Peninsula where a 3-fathom shoal is located. The coastline westward of Bagahak Point is generally lacking in extensive coastal lowlands although isolated mangrove swamps appear at the mouths of streams. The hill and mountain slopes commonly descend to the beach. Low cliffs are reported between Kennedy Bay and the Sebahat River. From Kennedy Bay to Lahad Datu there are low mangrove swamps. To the west, near Silam, steep slopes border the coast. From Silam to Skertchley

Point the coast is lined with mangrove swamps. The best anchorage is Lahad Datu Harbor, although there are others at Silam, Kennedy Bay, southwest of Silam, and Lamak Bay. There are few dangers to navigation off the coast near Lahad Datu except along the western end of Darvel Bay, where there are numerous reefs and shoals.

(*e*) *Sibuco Bay—Tawau area.* Offshore depths, both within and outside Cowie Bay, are everywhere regular, 7 to 16 fathoms prevailing, with few dangers to navigation. The 5-fathom curve lies less than a mile offshore on the north; on the south, the edge of the shallow water is for the most part steep-to, and depths of over 6 fathoms prevail close inshore. From Mount Putri on the north, the coast trends in a general northwest direction and is intersected by numerous small creeks and rivers. The ground is flat or generally undulating with locally small steep-sided hills rising 200 to 500 feet above the plain, which is interrupted by lines of rocky hills, on either side of Tawau. The south side of Cowie Bay is formed by Sebatik Island, about 20 miles long and 7 miles in average width. A range of high densely wooded hills traverses the island throughout its length. There is good anchorage within Cowie Bay.

(*f*) *Tarakan Island area.* Depths are irregular off the Sesajap Delta and for the most part are very shallow to a distance of 15 miles offshore, except in the passages north and south of Tarakan Island, where depths up to 20 fathoms are found. The coast between Ahoes Island on the north, an unnamed point abreast the mouth of Salinbatoe River on the south, is intersected by many rivers of which Sesajap River is by far the largest. The delta of the Sesajap River, contains a large number of small islands, between which 3 main passages give access from the sea; these are subdivided by many of lesser importance. The coast here is low and flat, the only recognizable points from seaward being the islands of Menoeloen, Tarakan, Bunju, and the Senbakung Hill. There is good anchorage in Tarakan Harbor. Three reefs about 15 miles off the coast of Tarakan Island are dangers to navigation.

(2) Landing beaches.

On the northwest coast of Borneo, from Brunei to the northern tip of the island, there are a number of extensive, wide, sand beaches. Coral reefs are generally lacking, and approaches are clear. During part or all of the year, surf may be the critical factor in landing. Some of the beaches are backed by swampy ground, but most of them have good exits to a trail, road, or railroad. On the north, northeast, and east coasts, as far south as the Equator, there is an almost complete lack of landing beaches except in the sections described in detail. Even in these sections the beaches are in general less favorable than those on the northwest coast. Elsewhere, the shore is mostly low, covered with mangrove and fringed by coral reef, and backed by swampy ground without exits.

F. Northern Celebes sector.

(1) Coasts.

In the Gorontalo Bay area rugged, forested mountains rise steeply from deep water, except at the head of the bay, where the mountains are broken by the narrow estuary of the Bolango-Bone Rivers. Locally, short strips of sandy beach, backed by coconut groves, fringe the shore. Anchorage is available along the eastern shore at the head of the bay, and no detached dangers exist.

In the Kema Bay area the waters are shallow for some distance offshore. Except in the bay proper the coast is fringed by a broad coral reef. A narrow coastal plain, mantled by coconut palms with occasional patches of woods and grassland, separates steep, timbered, volcanic slopes from the sea. A few short beaches border the shoreline. Anchorage may be found off Kema. Detached shoals and rocks occur near the entrance points.

In the Manado Bay segment, rolling, wooded foothills, flanked by a very narrow coconut-covered coastal flat, rise from waters which deepen very rapidly offshore. The broad valley of the Manado River leads southward from the head of the bay. The entire shoreline is bordered by a dark sand beach. Anchorage exists off the village of Manado and off-lying dangers are absent with the exception of 2 submerged rocks a short distance south of the harbor.

In the Amoerang Bay segment, the deep waters of the bay are encircled by a narrow, coconut-mantled coastal plain which is separated from the rugged interior mountains by low benches. At several localities sandy beaches or mangrove swamps border the shoreline. Anchorage exists off the town of Amoerang, and a few scattered shoals very near the shore form the only dangers.

In the Koeandang Bay segment the relatively shoal waters of the bay are studded with numerous islands and detached dangers. The coast consists of small coconut-covered flats backed by benches and wooded foothills, and separated by forested spurs extending seaward from the foothill belt. Much of the shoreline is fringed with mangrove and nipa swamps. The waters east of Pajoenga Island afford anchorage.

In the Tolitoli Bay segment the broad, beach-fringed, cultivated plain encompassing the bay is fronted by a wide submarine shelf under moderate depths, on which lie several islands and numerous reefs. A semicircle of forested mountains behind the coastal flat terminates in blunt rocky promontories. The coasts northward and southward from the bay itself consist of mountainous headlands separated by small flats. Anchorage is available off the village of Kampoengbaroe or Tolitoli.

(2) Landing beaches.

Many beaches are found on both the north and south shores of the northern arm of the Celebes; for the most part they are small and separated by numerous mountain spurs which run down to the shore from the interior highlands. The longest and widest beaches line the broad bays on the northwestern shores; these are in many places backed by narrow dune areas. The south shore is generally rockier and the beaches smaller than on the north shore. Areas of coral reef are scattered and discontinuous, and front about half the beach areas. Mangrove swamps in many places lie inland of the reef, with mangrove trees growing out on the reef itself, particularly on the north shore. In general, exit from the beaches is provided by trails paralleling the shore either on the beach or a short distance inland from it.

13. Weather and Climate

The Celebes Sea Area has a humid tropical climate characterized by gentle winds, monotonous heat, extremely high humidity, heavy cloudiness, and frequent intense rain showers.

Due to monsoon influence, wind direction is northeast from December through March and southwest from July through September. From April through June and from October through

November the intertropic front lies within the Celebes Sea region and northeast monsoon and southwest monsoon each dominates part of the area.

The airmasses of both the monsoons have had a long journey over warm tropical seas and are warm and moist by the time they arrive over the Celebes Sea Area. Thus, despite the complete reversal of wind flow from season to season, in most respects the climate is monotonously uniform throughout the year.

With most weather elements, diurnal variation, associated with daily heating and cooling of the earth, is of greater magnitude than the seasonal variation.

Differences in latitude, in altitude, and in exposure to wind and sea cause climatic contrasts among different parts of the region. High mountains rise into a cool zone of persistent cloudbanks, but only the highest peaks have snow. Even minor topographic differences cause large place-to-place contrasts in most weather elements: local differences of exposure or slope commonly give nearby places dissimilar wind and rainfall regimes.

A. Ground operations.

Ground operations would be seriously restricted by extensive and persistent muddy soil conditions and occasional floods. Throughout the area, heavy rains are possible in any season. However, winter rainfall is generally heaviest at places exposed to the north and east, summer rainfall heaviest at places exposed to the south and west. Constant high temperatures and moist air are accompanied by difficult health problems as well as constant trouble with rust and mold.

B. Air operations.

Low-level air operations would encounter few weather restrictions. Turbulence is common, but is usually sufficiently localized to be avoided. Very low ceilings are rare. Visibility is generally good. Heavy cloudiness at medium heights would interfere frequently with high-level operations. Icing occurs only at high levels.

Effective incendiary bombing would be greatly restricted by the prevailing dampness and low wind speeds.

Parachute operations would occasionally be hampered by surface winds. However, low wind speeds predominate in all seasons.

C. Naval and amphibious operations.

Naval and amphibious operations would encounter relatively little interference by wind; strong winds and gales are infrequent. Prevailing low wind velocities are reflected in low frequency of heavy sea and swell. Disturbed sea conditions are possible in any season during a thundersquall, but the prevailing wind velocities are too gentle to cause heavy sea.

Direction of sea and swell corresponds to direction of prevailing wind. On shores exposed to the north and east, sea and surf conditions are least favorable from November through April when winds are northeast. On shores exposed toward the south and west, sea and swell is onshore from June through September. Disturbed sea is most frequent when the prevailing winds are onshore and are intensified by the afternoon sea breeze.

There is little prospect of effective concealment of fleet movements or landings by fog or low cloud. Most suitable conditions for concealment would probably be found during times when the intertropic front lies over the area: April through June, and October through November.

D. Chemical warfare.

Chemical warfare would be greatly restricted by frequent turbulence and unstable air. Constant heat, high humidity, and frequent heavy rains would affect the rate of evaporation and hydrolysis of many chemical agents.

14. Towns and Port Facilities

The Celebes Sea region contains no large cities and relatively few towns, of which not more than half a dozen have more than 10,000 inhabitants. The population of the largest town, Manado, in Northern Celebes, was less than 30,000 in 1930. Nearly all the towns are located along the coasts, and the principal towns were the principal ports as well. Often, long stretches of shoreline have no settlements except small native villages, and the interior regions are still more sparsely populated. The number of white inhabitants is everywhere very small, even in commercial and administrative centers, while the Chinese are comparatively numerous and play an important part in the economic and civic life of all the larger settlements. Native villages throughout the area vary greatly in size and form, but almost all are self-sufficient units.

The Mindanao sector was by far the most developed and had the greatest concentration of both principal and secondary ports, with facilities greatly in excess of those found elsewhere. Zamboanga had a daily cargo clearance capacity of 2,420 short tons, while its nearest rival in other sectors, Sandakan on Borneo, had an estimated capacity of 450 short tons.

For location of ports in the area, see FIGURE I - 11.

A. Halmahera sector.

Most of the settlements on Halmahera and the neighboring islands are primitive native villages on the coast. The areas of heaviest settlement are the islands of Ternate and Tidore and the adjacent areas of Halmahera.

(1) Ternate.

The largest town and principal port in the Halmahera area, Ternate, is on the eastern coast of Ternate Island, across Dodinga Bay from Halmahera. It is accessible by land, sea, and air.

(*a*) *General facilities.* Among facilities that were located at Ternate were: a 120-volt, DC lighting system powered by a diesel prime mover; a water system capable of supplying drinking water to ships at the wharf; a radio station; cable connections with Manado; and a 55-bed civilian hospital and a 13-bed military hospital. Wells provided an adequate supply of drinking water for the town. Billeting facilities might be available in military buildings, hospitals, churches, schools, a prison, a hotel, a sultan's palace, houses, and other town buildings.

(*b*) *Port facilities.* Anchorage is unlimited in the open Ternate Roads, with depths of 15 fathoms about ¼ mile offshore and about 30 fathoms, 800 yards offshore. The roadstead is fairly well-protected, but holding ground is bad, the bank steep and the tidal stream strong. Troublesome rollers occur from December to April and a heavy swell frequently in De-

cember. The southwestern approach through Gamme Lamo Channel has a least depth of 19 fathoms and the approaches from northward and southward are deep and generally clear.

The only commercial pier, Hertog Hendrik Pier, was of timber on metal screw piles, T-head, 198 feet on the face and 430 feet long, with an approach about 18 feet wide. Depth of water at pier face was 13 feet. There were no mechanical cargo-handling facilities. Two narrow-gauge tracks connected the pier head with a coal storage shed about 700 feet inland. A fresh water pipeline, laid onto the pier, could deliver 40 tons per day, pumped from the town wells.

There were 3 other small boat piers: the Japanese fishing boat pier, 40 feet wide at the face and 95 feet long; the Residency Pier for small boat landings, 10 feet wide, 250 feet long and with 2 feet of water at the head; the Sultan's Pier for small boat landings, timber open-pile, 40 feet wide on face, 855 feet long, and with only a few feet of water alongside.

Storage facilities consisted of: a stone and tile cargo shed, 225 feet by 40 feet; a stone and shingle cargo shed, 100 feet by 60 feet; a wood and corrugated iron storage shed, 120 feet by 80 feet; a coal storage shed with adjacent open storage yard; an open storage yard for oil in drums. Most of these were destroyed or damaged by the Dutch but the Japanese have since built a number of structures, believed to be warehouses, in the area adjacent to and southward of the Hertog Hendrik Pier.

About 20 motorboats were based at Ternate.

The only repair facility was a small machine shop for the Japanese fishing boats.

The unloading capacity is estimated to have been 160 short tons.*

(2) Villages.

There are 22 coastal villages in the Halmahera sector which were of some local importance. All of them had minor port facilities or were ports-of-call for the Royal Netherlands Line steamships.

(*a*) *General facilities.* There were radio stations at Djailolo and Tobelo, a hospital at Djailolo, and numerous copra plantations were scattered throughout the area. In October 1943, the Japanese were constructing a landing strip near the village of Galela and another 9 miles south of Tobelo. There were 2 potential landing strip sites near Djailolo and an emergency alighting area for seaplanes near Galela.

(*b*) *Port facilities.* Anchorage for large vessels is, in nearly all cases, in open roadstead, and only small craft and proas can find sheltered anchorage close in.

Small wharves or piers, generally with shallow depths alongside and in most cases capable of handling only shallow-draft vessels or native craft, have been located at the following points (unless otherwise noted, villages are on Halmahera Island): Weda, Gamsoengi, Inggelang (Inggelang Island), Boeli-serani, Lolobata, (aerial photographs indicate 3 new piers), Goeroea (aerial photographs indicate 1 new pier), Bobaneigoe, Kaoe, Tobelo, Galela, Kjiko (Morotai Island), Djailolo, Mare (Mare Island), Ngofakiaha (Makian Island), Batoela, Waisabatang, (Batjan Island), Laboeha (Batjan Island), Penamboean (Batjan Island), Waja (Mandioli Island).

No cargo-handling machinery or repair facilities have been reported for these villages. Storage facilities were limited to small warehouses, usually for copra, at some of the villages.

B. Sangihe-Talaud sector.

There are no major towns nor ports in the sector. Settlements consist of a few small locally important centers and a large number of native villages. Much of the area's administration and trade was handled from Manado, Celebes. There are 9 coastal villages of local importance, all of which had some minor port facilities or were ports-of-call for vessels of the K.P.M. The chief town was Tahoena, an administrative and trading center on Sangihe Island. Hoeloe was the chief center on Siaoe Island, Tahoelandang, on the island of the same name, and Beo was the chief center of the Talaud Islands.

There were radio stations communicating with Manado at Tahoena and Beo, and Tahoena had a 10-bed hospital.

Anchorage for large vessels is in open roadstead, except at Dagho and Behongang, where there is sheltered, deep-water anchorage of limited area. Some villages have sheltered anchorage for shallow-draft vessels close in.

Villages which had piers for small boats, generally with depths between 3 and 6½ feet at the pierhead were: Beo, Talaud Island, 426-foot stone pier; Tahoena, Sangihe Island; Dagho, Sangihe Island, 600-foot stone pier; Behongang, Kahakitang Island; Hoeloe, Siaoe Island, wharf; and Tahoelandang, Tahoelandang Island.

No cargo-handling machinery has been reported. There is no information as to storage facilities but it is probable that the K.P.M., which called at all of these villages, had warehouses at some of them. No repair facilities have been reported although the natives of Tahoelandang are said to be noted as boatbuilders.

C. Mindanao sector.

Settlement in Mindanao was concentrated in the coastal areas and along the few lines of travel which cross the island or penetrate the interior. There were 10 principal towns, 8 of which were also the principal ports. Fifty-six coastal villages had harbors or landing facilities sufficiently significant to be designated as minor ports.

Two of the major ports, Davao and Zamboanga, were stops on important world trade routes and had extensive port facilities. The other major ports as well as many of the minor ports were shipping centers for extensive trade in lumber, logs, copra, coconut products, and hemp. Lumber mill installations were located at many of these points, and several served as shipping centers for nearby plantations or food packing operations, primarily coconut products. The bulk of the trade from these points, however, was in the form of raw materials, or materials which had undergone only initial processing.

Even at the minor ports many of the installations were constructed of reinforced concrete and had storage or cargo-handling facilities superior to those available at points in the southwest Pacific which were designated in an earlier JANIS study as major ports.*

(1) Surigao.

The captal of Surigao Province, Surigao, was the largest and most important town on the northeastern coast of Mindanao, handling much of the trade of eastern Mindanao. It was the cen-

*Unless otherwise noted, the estimates of unloading and discharging capacities of ports discussed in this topic are based on short tons of 2,000 pounds of general cargo handled daily at the vessel berths, assuming an 8-hour day.

*JANIS 157, Netherlands New Guinea.

ter of extensive gold mining operations, and had lumber, corn, and rice mills. Copra was exported in quantity.

(*a*) *General facilities.* The north coastal road connected with Davao, Cotabato, Cagayan and Placer. There was a diesel electric power plant, a radio station, and telegraph connection with Cantilan via Placer and Gigaquit. At Lake Manit, 18 miles southwest and connected by road, was an alighting area for seaplanes and about 16 miles south, also connected by road, was a small emergency airfield. A mill railway ran about 2 miles inland from the beach.

There were 2 maternity hospitals (4 and 8 beds) and 1 dispensary.

Billeting accommodations were available in the schools, hotel, constabulary headquarters, provincial building, and the hospitals.

(*b*) *Port facilities.* Surigao itself is up the river and inaccessible to anything but very small boats. All port facilities were at Bilanbilan, about ⅔ mile southeast.

Anchorage is in Bilanbilan Bay, open to the northward, with depths of 10 to 15 fathoms. A cove in the northwestern corner of the bay forms a natural harbor of limited area with depths of from 4½ to 10 fathoms. Small vessels can find shelter in 9 feet of water behind the harbor point.

The piers and wharves are as follows:

Main wharf, reinforced concrete, 325′ long (face) and 29½′ wide, depth along face, 13 feet to 30 feet. Improvements were under way in 1937.
Ong Hing Lian wharf, wooden, 85′ long (face), 7½ to 18 feet of water along face.
T-head pier, 2 feet of water off head.
T-head pier, no data.
Pier about 100′ long, no other data.

No cargo-handling machinery was reported at any of the piers or wharves.

Storage facilities included a stone and masonry hemp warehouse at Surigao, several other warehouses at Bilanbilan, 2 oil tanks about 20 feet in diameter and 10 to 12 feet high, at Bilanbilan, and an open area of over 10,000 square feet backing the main wharf.

Two short roadways, over 20 feet wide, connected the main wharf with the provincial road, which paralleled the entire waterfront at Bilanbilan and connected with Surigao.

Diesel oil was stored in bulk and piped to the waterfront. A fresh-water pipe was laid to the main wharf.

The only repair facility was a small machine shop.

There were several tugs and a few lighters.

Unloading capacity at the main wharf is estimated to have been 240 short tons.

(2) Cagayan.

The capital of Misamis Province, Cagayan is the only all-weather port on the northern coast of Mindanao and the terminus of the north—south road which crosses central Mindanao to the Cotabato—Davao highway.

(*a*) *General facilities.* Facilities which have been available at Cagayan include: A mountain stream with a capacity of 158,400 gallons per day; a 160-kilowatt diesel electric power plant; 2 radio stations, one 200-watt and the other 100-watt shortwave; and 3 hospitals with a total of 106 beds. The hospitals, churches, a hotel and jail, and other concrete buildings with galvanized iron roofs might be available for billeting purposes.

(*b*) *Port facilities.* The landing place for the town is located about 1¾ miles northeastward from Cagayan with a good road connecting.

The harbor is an open roadstead near the head of the bay. The middle of the bay is deep and clear with anchorage available in 8 to 20 fathoms of water.

The only facility at the port was a reinforced concrete wharf about 380 feet long and 30 feet wide. In 1939 reports indicated a least depth of 20 feet alongside. The wharf was lighted.

Storage facilities included a cargo shed and a number of warehouses near the wharf.

Repair facilities included bus company machine shops and garage, and several small machine shops where minor repairs could be made. Welding equipment, but no foundry facilities, were available.

Unloading capacity is estimated to have been 300 short tons.

(3) Iligan.

Iligan, on the north coast of Mindanao, handled the commerce of the Lake Lanao district. Copra and corn were the chief exports.

(*a*) *General facilities.* The town had a 55-kilowatt diesel engine electric light plant, a telegraph station, and a first-aid station. Only limited billeting facilities existed.

(*b*) *Port facilities.* The harbor is an open roadstead in the southeast corner of Iligan Bay. The anchorage off Iligan is bad; during the northeast monsoon it is untenable. At such times vessels have sought shelter 3 miles northward of Iligan in 20 to 25 fathoms.

The only landing facility at Iligan was a reinforced concrete pier 272 feet long and 39 feet wide, with depths alongside ranging from 12 feet at the inshore end to 36 feet at the head. The pier was equipped with metal bollards and fender piles, and was lighted.

Storage facilities included a cargo shed on the pier and 2 buildings located at the root of the approaching causeway.

No repair facilities have been indicated.

Unloading capacity of the port is estimated to have been 240 short tons. A roadway connects the pier with the town. Fresh water could be secured from a pipe connection at the outer end of the pier.

(4) Misamis.

Misamis, on the northern coastal plain of Mindanao, was the westernmost port of importance on the north coast. It was the business center for the surrounding agricultural area, a base for small motorboats, trans-shipment point for lumber, and a port of export for corn.

(*a*) *General facilities.* A 125-kilowatt electric power plant, operated by a lumber company primarily for its own use, and a telegraph and a radio station constituted the facilities located at Misamis. Adequate water was obtained by catchment and from wells, a few of which were artesian. Three schools, a wooden military barracks, churches, and other town buildings might provide billeting facilities.

(*b*) *Port facilities.* The harbor, a small natural bay open from the southeast but protected from northwest winds, has depths of 4½ fathoms at the entrance decreasing toward the head of the bay.

Two piers were located at Misamis: the government pier, consisting of a dumped rock causeway 235 feet long and 27

feet wide, and a 40-foot square steel sheet-piling head, and a reinforced concrete pier section 187 feet long and 40 feet wide, with reported depths alongside of 20 feet; a privately-owned lumber mill pier consisting of a rock and earth causeway 200 feet long with a pier, probably of timber construction, extending about 250 feet seaward, with reported depths alongside ranging from 13 to 16 feet at low water. The latter pier was lighted, water was piped to it, and industrial tracks on the causeway connected it with a lumber mill.

No special storage or warehousing facilities have been reported.

Machine shops capable of handling minor repairs were available. Unloading capacity of the port is estimated to have been 600 short tons.

(5) Oroquieta.

Located about 1 mile northwest of the town, Loboc Cove, the harbor for Oroquieta, has charted depths of from 3 fathoms at the pier to 6¼ fathoms at the entrance. Anchorage, protected from southerly and westerly winds, with good holding ground, may be found about ¼ mile from shore in 12 fathoms of water over muddy bottom, but during the northeast monsoon this anchorage is untenable.

The only landing facility at Oroquieta consisted of a dumped rock causeway 135 feet long and 20 feet wide with a rock-filled crib head 27 feet long and 33 feet wide, terminating in a reinforced concrete pier, 194 feet long and 30 feet wide, on piling. Depths of 10 feet are reported along the southern face and 27 feet along the northern face.

A large warehouse is reported to have been located in the town.

The unloading capacity of the port is estimated to have been 200 short tons.

(6) Zamboanga.

The only large town in western Mindanao and one of the island's most important ports, Zamboanga exported copra, coconut products, hemp, lumber, and canned fish. Vessels called from many major Pacific ports. A U.S. Army Airfield was located near the town, but there were no road connections with the main part of the island.

(a) General facilities. Among facilities available at Zamboanga were: a 2-diesel engine electric light power plant which served the town via overhead wires; a reservoir and water system that provided pure drinking water; a government telegraph office and radio station at the airfield, a military barracks radio station, and 4 other radio transmitters in the adjacent area; a well-developed telephone system; and an army hospital and 3 civilian hospitals. Several schools, a police barracks, military barracks, churches, 4 hospitals, and municipal buildings might be available for billeting.

(b) Port facilities. The harbor is an open roadstead in Basilan Strait with depths ranging from 10 to 45 fathoms. It is protected on the south but exposed to gales from the west and southeast. However, during the northeast monsoon, it is sheltered and the water is smooth. An inner small boat harbor, with depths ranging from 5 to 20 feet, is formed by a rock jetty and a rock breakwater. The anchorage off Zamboanga is not good. The coast drops off rapidly and outside the 12-fathom contour the bottom is hard and uneven.

The landing facilities consisted of a reinforced concrete T-head wharf, approached by a reinforced concrete pier which extended from a reclaimed area fronted by a concrete bulkhead. A reinforced concrete boat pier extended eastward from the approach pier and parallel to the T-head wharf. These facilities had the following dimensions:

The T-head wharf had an 800-foot face, with depths along the outer side of 25 to 30 feet and along the inner side of 20 feet.

The approach pier was 465 feet long with depths alongside of 15 to 20 feet, but the eastern side was broken into 2 segments by a 178-foot boat pier extending parallel to the shore. Two government wharves running to the east and west of the base of the approach pier extended for 1,180 feet along the waterfront and had depths alongside of 15 feet.

Another government wharf extended for 300 feet to form the small boat basin quay.

A reclaimed area had 1,970 feet of bulkhead, most of which was used as a quay by small boats. The water adjacent to these facilities was dredged to the depths noted.

There were no cranes. All cargo was handled by ships tackle and was hauled to and from the ships side by trucks.

The T-head wharf was lighted and water was available.

Storage facilities included a customs warehouse and at least 5 private warehouses with a capacity of about 5,000 tons. The reclaimed section, probably available for open storage, had an area of about 11 acres. Harbor boats included 4 light towing launches and 2 small sea-going tugs, owned by a commercial towing company, and 6 sea-going and 4 harbor lighters of 50 to 100 tons capacity.

Limited repair facilities existed, including a marine railroad capable of hauling out a vessel of 50 tons. A machine shop for small repair work also was available.

Discharge capacity of the port is estimated to have been 2,420 short tons. Experienced gangs of native stevedores were available. The discharging rate was from 15 to 30 tons per stevedoring gang per hour, depending on the cargo. No bunker coal or fuel oil was available.

(7) Cotabato.

Cotabato, the third largest town on Mindanao, was the center of trade for the Mindanao Valley and surrounding coastal area. Rice, copra, and corn were exported in quantity, and supplies were available in its commercial stores.

(a) General facilities. A municipal pipeline water supply system, an ice plant, a 122-kilowatt electric light plant, a telephone system, a radio station, 2 maternity hospitals with a total of 12 beds, and 1 dispensary were among the facilities of the town. A hotel, a girls' dormitory, constabulary barracks, churches, and municipal buildings might provide billeting facilities. A commercial airport was located near the town.

(b) Port facilities. A river port, Cotabato is located on the banks of the Mindanao River about 5 miles above Cotabato Entrance from Illana Bay. The entrance has a controlling depth of 5 feet over the bar. Large vessels must anchor outside and lighter cargo to the port. Opposite the town the river forms a basin area of about 15 acres with depths of 5 to 18 feet over soft mud. The best anchorage is in Illana Bay, northwest of the entrance, in depths of 5 to 20 fathoms over mud bottom 1 mile from shore. During the heights of the southwest monsoon this anchorage might become uncomfortable. Smaller vessels can anchor closer inshore.

The main landing facility at Cotabato was a concrete and sheet piling quay about 425 feet long running parallel to the river bank with depths alongside ranging from 7 to 14 feet at

low water. In addition, there were 2 small municipal wharves, one with a depth of 14 feet alongside and the other with a depth of 4 feet.

Storage might be possible in a shed, 200 feet by 25 feet, which was located to the rear of the quay. Other town buildings, including a storehouse for explosives, might be available as warehouses. In the vicinity of the quay, there was a 2-acre open space that might be used for storage.

Repair facilities included several machine shops with welding equipment available.

Lighters and tugs were available for the handling of cargo from the anchorage at the river mouth. Trucks had access from the waterfront to the inland road system. Before the war, steamboats connected with other ports in the area and small river steamers made daily trips up the river.

No estimate of unloading capacity is available.

(8) Davao.

With its nearby port Santa Ana, Davao constituted the chief commercial center of Mindanao. It was the world's leading port for the shipment of hemp and also exported copra and lumber. The largest concentration of Japanese in the Philippine Islands was found within a radius of 30 miles of Davao; they controlled most of its commercial activity. Roads connected Davao with the interior; a commercial airport was located nearby.

(*a*) *General facilities.* Facilities located at Davao included: a city water system based on a reservoir drawing supplies from springs; a 515.5-kilowatt diesel electric light plant; 4 radio stations; an urban telephone system and a second system connecting nearby Japanese plantations; and 6 hospitals with a total of 282 beds. A constabulary barracks, hotel, 3 schools, churches, and municipal buildings might provide considerable billeting facilities.

(*b*) *Port facilities.* Within the Davao Harbor limits, port facilities were located at: Santa Ana, which handled the bulk of the Davao traffic and which was linked to Davao—1 mile distant—by 2 good roads; Ipil; Lanang Point, the petroleum terminal; Tibungko, the shipping terminal of a lumber company; and Tambungon.

The harbor at Santa Ana is naturally sheltered from west to north and to some extent from northeast to east. During the southwest monsoon the sea is choppy. The 5-fathom contour is 200 to 400 yards offshore and the approach is clear of dangers. The harbor at Ipil is a small basin and at Lanang Point, an open roadstead. There is anchorage for large vessels off the Santa Ana pier in depths of 12 fathoms over mud bottom. Vessels anchor in 20 fathoms over mud at Tibungko with an anchorage for smaller craft closer to shore. At Tambungon there is anchorage offshore in 10 to 20 fathoms over mud.

The government pier at Santa Ana consisted of a reinforced concrete outer section 75 feet by 326 feet and a solid-fill inner section 75 feet by 238 feet, with steel sheet-piling along one side. Depths at the end of the pier were 25 feet. The pier was lighted and fresh water was piped to it. Locations of other piers were: a small pier at Ipil; two 200 feet wharves, one open timber pile and the other concrete, at Lanang Point; a small timber pier, the terminus of a logging railway, at Tibungko; a 1,300 foot stone pier with a depth of 15 feet at its end at Tambungon, the terminal of a logging railway. One wharf at Lanang Point had a 1-ton crane and pipelines to oil storage tanks.

Warehouses located at Santa Ana, 5 of which had a total estimated gross floor space of 81,000 feet, are believed to have been able to handle 4,000 tons of cargo. One acre of open storage space was also available near the pier. There were 2 warehouses at Ipil and 1 at Lanang Point.

Japanese sources report that a shipbuilding yard for medium-sized vessels has been established at Santa Ana. There was a machine shop available as well as casting and welding equipment and a small private marine railway capable of handling boats up to 40 feet.

The discharging capacity at Santa Ana has been estimated at 450 tons. All cargo was moved by flat rail trucks from wharf to warehouses. Stevedores were available. For general cargo, the discharge rate was 20 tons per gang per hour. Two sea-going tugs, 15 lighters, 11 scows, and a number of fishing boats and launches were based in the Davao Harbor.

(9) Malaybalay.

Located in the interior, Malaybalay, the capital and largest town of Bukidnon Province, is on the central uplands of Mindanao, about 66 miles southeast of Cagayan. There was a commercial airport 2 miles west of the town. Billeting facilities were available in a Catholic girls' dormitory, a government resthouse, and the constabulary barracks, as well as in several schools. Water was obtained from a watershed north of the town. Malaybalay had telegraph, radio, and telephone connections, and a provincial hospital.

(10) Dansalan.

Dansalan, the capital of Lanao Province and the largest interior town, was the nucleus of Moro political and social life in western Mindanao and the site of Camp Keithley, the Philippine Army training camp. It is at the northern end of Lake Lanao. The main road between Iligan and Cotabato passes through Dansalan. The town had limited possible billeting facilities, a waterworks, a radio station (KZPN) at Camp Keithley, telegraph and telephone facilities, and a 105-kilowatt capacity electric plant. Two hospitals with a total of 49 beds were located here.

(11) Villages.

Most of 56 coastal villages that constitute the minor ports of Minandao are located on the river entrances, bays, and other indentations found at almost regular intervals around the island coastline. The remaining villages are located on off-lying small islands. The natural harbors provide sheltered anchorages, good holding ground, adequate depths, and approaches free from danger; but all 4 favorable factors are seldom found in any single harbor.

Generally, the villages served as shipping outlets for hemp, copra, coconut products, or lumber. In many cases they were closely tied in with local logging, sawmill, or coconut processing operations. Utilities, communications facilities, supplies, and general and repair facilities frequently were very meager; where they did exist, they were available only to the degree necessary to take care of local commercial operations. TABLE I - 2 lists port facilities that were available at coastal villages.

TABLE I - 2.

PORT FACILITIES LOCATED AT COASTAL VILLAGES ON MINDANAO AND NEARBY ISLANDS*

VILLAGE	TYPE HARBOR	PORT FACILITIES	DEPTH ALONGSIDE PIER OR WHARF	EXPORTS
Mati	Bay	Reinforced concrete pier with T-head landing 39.5′ wide and 147′ long, extending from 530′ rock and earth causeway.	Low water 20′ at head	Hemp and copra
Hinatuan	River entrance	Small landing along bank.	Charted at 2 fathoms	
Port Lamon	Bay	L-head wharf extending 1,000′ from shore to near 5-fathom curve. Head 150′ long and 15′ wide. Wharf lighted. Minor repair facilities available.	At face, 24′ to 28′	Lumber
Tandag	Small cove	Small boat stone pier. Cargo landed on beach.	At pier, 6′	
Lakando (Masapelid I.)	Open roadstead on side of bay	Mining company timber T-head pier attached to 400′ causeway. Head 80′ long. Two small sheds on causeway and larger building on outer end. Pier lighted. Narrow gauge track ran to end. Pipeline on pier indicated.		
Placer	Cove	Rock and timber pier 20′ wide and 402′ long, extending from 345′ rock causeway.	Controlling depth, 16′ at low tide	Shipping point for mining area
Numancia (Siargao I.)	Channel	Stone pier.	3½ fathoms charted near end of pier	
Dapa (Siargao I.)	Cove	Reinforced concrete pier 30′ wide and 115′ long, extending from 450′ rock causeway. Another smaller pier.	At end main pier, 20′	
Dinagat (Dinagat I.)	Cove	Pier	At end, 3′ to 5′	
Butuan	River port	Main landing platform with timber deck 31′ by 72′ and apron along face. Cargo shed on landing 21′ by 43′. Second small boat landing entirely covered by shed.	Along face main landing controlling depth, 14′	Hemp and copra
Nasipit	Opening between bluff rock headlands	L-head pier 150′ long and 40′ wide at end of 375′ causeway and 100′ extension.	Pier end in deep water	Copra and logs
Odiongan	Open roadstead near bay head	Lumber company T-head pier 350′ face. Company operated 18.6 mi. of railroad and had 3 locomotives. Water piped to pier end.	At face, 30′	Lumber
Gingoog	Open roadstead near bay head	Open timber pile L-head pier with wood deck extended 400′ from shore. Face of L-head about 230′ long. Pier lighted. Tracks on pier. Lumber company had 2.5 mi. of railroad.		Lumber
Balinguan	Bay	Small pier used as ferry landing extended 450′ from shore. Ferry connected with Binone on Camiguin I.	At end, 8′	
Binone (Camiguin I.)	Open roadstead	Small pier for ferry landing.	At end, 6′	
Mambajao (Camaguin I.)	Open roadstead	1,000′ stone causeway and timber pier extension 30′ wide at outer 115′. Small cargo shed on mid-pier. Open storage space also available. Water piped to end.	At end, 14′ Alongside, 6′ to 15′	Hemp and copra
Bugo	Open roadstead near bay head	Rock causeway with timber T-head wharf face 200′ long. Railroad tracks connect packing plant with face of pier. Pier lighted.	At face, 30′	
Kolambugan	Open roadstead in bay	Lumber company wharf, 1,950′ long made of wood piling with wood decking. Tracks on pier. Wharf lighted. Machine shop at mill.	At end, 25′	Lumber
Jiminez	Open roadstead	Rock and earth causeway with reinforced concrete pier, 39.5′ wide and 275′ long, at seaward extremity. Warehouse available.	At head, 20′	
Plaridel	Bay	Two wooden landings, each 20′ wide and 65′ long. Reinforced concrete pier 30′ wide and 65′ long added to 1 landing.	At head concrete pier, 13′. At timber wharf, 16′	
Baliangao	Bay	Dumped rock causeway 20′ wide and 120′ long, with reinforced concrete pier at end 29.5′ wide and 165′ long. Also small boat stone pier.	At head, 10′	
Port Puluan	Open roadstead on bay side	Dumped rock causeway, 200′ long and 20′ wide, with steel sheet-piling 32′ long and 30′ wide, ending in concrete pier 130′ long and 30′ wide.	At head, 27′	Copra, corn, hemp, lumber.

TABLE I - 2 (Continued)

VILLAGE	TYPE HARBOR	PORT FACILITIES	DEPTH ALONGSIDE PIER OR WHARF	EXPORTS
Port Santa Maria	Practically landlocked	Timber pier 150′ long and 100′ wide. Several sheds and mill buildings. Tracks from wharf to mill.	At end, 11′ to 15′	Lumber
Caldera Bay	Bay	Coconut company had 2 small timber wharves. Sheds, warehouses, tanks on shore. Pipeline to wharf. Small marine railway but no machinery.	At ends of wharves, 28′ and 14′	Coconut products
Kabasalan	River port	Timber wharf.	10′	
Lumarao	Bay	Timber pile bulkhead inaccessible to boats having draft more than 10′. Wharf lighted. Railway tracks connect wharf and lumber mill. Small tug and several lighters were available. Number of sheds and mill buildings. Minor repair facilities.		Lumber
Naga-Naga	Open roadstead at bay entrance	Open pile and timber T-head pier 390′ across face and 50′ wide. Tracks on pier connecting with mill. Water piped to pier. Pier lighted.	At T-head, 19′ to 24′	Lumber
Malangai	Bay	Reinforced concrete T-head pier, 160′ long and 40′ wide, at extremity 200′ causeway. Belt conveyor for direct coal loading. Small warehouse and sheds. Radio station and diesel generator.	At face, 27′ low water	Coal
Margosatubig	Bay	Lumber company pier, T-head, 180′ long and 30′ wide, with approach 60′ long and 30′ wide. Municipal wharf with T-head 40′ long and 20′ wide. Motor launches available. Water on municipal wharf. Logging railroad 7.1 miles long.	At face lumber pier, 20′. At face municipal pier 10′.	Lumber
Flecha Point	Small bight	Timber T-head wharf. Water piped to pier.	At face, 13′ to 35′	Lumber
Pagadian	Bay	Rock and earth mole 6′ wide timber landing at end. Also small stone landing.	No water at end of mole at low tide	
Malabang	Open roadstead in bay	Small boat landing. Shed.		Copra
Parang	Natural harbor	L-shaped pier with 564′ causeway approach and reinforced concrete pierhead 39′ wide and 300′ long.	At face, 4′ to 30′	
Makar	Cove	Small boat landing, 50′ long and 20′ wide.		
Glan	Cove	Reinforced concrete pier-head, 82′ long and 29½′ wide, connected to causeway.	At face, 12′ to 18′	Copra and hemp
Lawa	Open roadstead on gulf	Open pile and timber pier, 300′ long.	At end, 3′	
Malita	Open roadstead on gulf	Open pile timber pier 250′ long and 30′ wide. Plantation warehouses and open storage space.	At end, 9′	Hemp and copra
Lacaron	Open roadstead on gulf	Small launch landing.		
Daliao	Open roadstead on gulf	Timber pier 600′ long. Railway served pier. Water piped to mid-pier. Travelling 15-ton motor operated crane was available. 3 large warehouses and open storage. Minor repairs.	At end, 14′	
Talomo	Bay	Open-pile timber pier 350′ long. Outer end widened. Large warehouses and open storage.	At end, 13′ to 18′	
Madaum	River port	Pier 20′ wide and less than 100′ long.		
Monserat	Cove	Small concrete pier.	At face, 13′	

*The ports of Basilan Island are shown in Table I - 3.

D. Sulu Archipelago.

The greater part of the population in the Sulu Archipelago is concentrated on Jolo and three or four of the small islands immediately south of it. Jolo was the most important port and administrative and commercial center of the island. Malaria, dengue fever, and dysentery were prevalent.

(1) Jolo.

The capital of the Sulu Province, Jolo was the headquarters for detachments of the Philippine Army, the hub of Moro culture, and the home of the Sultan of Sulu, the political and religious leader of the Moros.

(a) General facilities. A water system, a 240-kilowatt diesel electric power plant, a commercial radio station and an army station, a manual telephone system, a 46-bed hospital, and a 40-bed treatment station were among the facilities at Jolo. A school, military headquarters, hospital, sultan's palace, church,

and several other buildings might be used for billeting. Seaplanes could land and take off in Jolo Harbor; an emergency airplane landing field was located near the city.

(*b*) *Port facilities.* At least 5 first-class berths were available in 73 to 84 feet of water. The entrance channel is clear and the port is sheltered from the southwest, but fairly open in other directions.

There were 2 piers: the principal one, a concrete structure at the end of a stone causeway, had a seaward face of 280 feet and a depth alongside of 30 feet; and the Chinese pier, a wooden structure. The bottom dries alongside the latter at low water. There were no cargo handling facilities. Fresh water was piped to the pier.

A cargo shed on the main pier and warehouses in the town had a capacity of 30,000 tons of cargo.

A small marine railway capable of handling launches up to 50 feet and 2 small machine shops for minor repairs were available.

Privately owned gasoline launches and native boats, but no tugs or lighters, were located at Jolo.

(2) Villages.

The 9 coastal villages of the sector were minor ports used as shipping points for lumber, copra, and rubber companies.

(*a*) *General facilities.* There were small radio stations at Siasi, Bangao, and Cagayan de Sulu, a telephone system on Basilan Island and a few small hospitals and dispensaries were scattered throughout the sector. Siasi had a small electric power plant and a fair seaplane anchorage. Billeting facilities were limited.

(*b*) *Port facilities.* TABLE I - 3 lists facilities available at the 9 villages.

E. Northeast Borneo.

The few towns in this sector were commercial and administrative centers and, with the exception of Beaufort, were ports. Most of the natives live in villages or *kampongs,* generally located along the rivers on the seacoast.

(1) Jesselton.

With a population of 4,594 (1931), Jesselton was the chief port on the west coast of British North Borneo and the northern terminus of the State Railway. It was the focal point of the best road system in Borneo and a center of agriculture and rubber-growing.

(*a*) *General facilities.* Among the facilities at Jesselton were the following:

A public water supply system with a reservoir which supplied 34,350,600 gallons in 1939.
A radio station.
A diesel-powered electric power plant AC and DC, 366KW, 230 volts.
An automatic telephone system within the town, connecting with long distance lines to many interior points.
Overland telegraph lines to Beaufort, Tenom, and Mempakul.
A well-equipped 66-bed hospital.
An ice plant.
Two garages and the State Railway locomotive repair shop.
Ample billeting and warehouse facilities.

TABLE I - 3.

PORT FACILITIES OF MINOR PORTS OF THE SULU ARCHIPELAGO

VILLAGE	HARBOR	PIER OR WHARF	DEPTH ALONGSIDE PIER OR WHARF	EXPORTS	HANDLING CAPACITIES
Isabela	Room for 2nd class vessels, protected except NE	Wharf with 200′ berthing space Fresh water Small pier	18′ to 29′ 12′	Lumber General	70,000 feet of lumber per hatch per 24-hour day No estimate
Port Holland	Well-sheltered but size permits only small vessels	Wharf 513′ long. Fresh water piped but capacity small Wharf 55′ long	17′ to 29′ 6′	Lumber General	500,000 feet of lumber per 24 hours No estimate
Kulibato Point (Lamitan)	Exposed to N, NE, and E	Pier 40′ long	21′	General	No estimate
Tandu Bato	Fair shelter, 11′ to 32′ depths	Stone mole	6′	General	No estimate
Siasi	Mid-channel, in depths 36′ to 60′	Government wharf 47′ long. Fresh water piped.	20′	General	No estimate
Bangao	Excellent shelter but limited space. 22′ to 42′ depths.	Wooden pier 50′ long.	18′	General	No estimate
Si Tangkay	Open	Concrete wharf, 98′ long, 65′ wide	18′	General	No estimate
New Batu Batu	Batu Batu Bay. 36′ to 60′ depths close in.	Small pier, in poor repair in 1937	16′	General	No estimate
Cagayan de Sulu	Small land-locked harbor. Anchorage outside in 54′-66′ depths.	Pier with 131′ of berthing space	13′	Copra	No estimate

Small quantities of provisions could be obtained at Isabela, Port Holland, Lamitan, Siasi, Sitankai, New Batu Batu, and Cayagan. Isabela, Port Holland, and Lamitan maintained small stores of gasoline and diesel oil. The lumber company at Port Holland had a large machine shop which could make minor marine repairs.

(*b*) *Port facilities.* The harbor, partly open to the north and about 2,400 feet wide off pier end, can accommodate vessels up to 7,000 tons. Dredging is necessary to maintain depths. Fairly secure anchorage for 30 or 40 vessels can be had in nearby waters.

The only pier was a reinforced concrete, L-shaped structure, providing berthing space of 328 feet, with depths of 18 to 26 feet alongside. The pier was electrically lighted and there were several cranes with capacities up to 20 tons. Railway tracks ran to the pier. There were also several small docks, dry alongside at low water.

Three warehouses at the pier had a total floor area of 67,500 square feet.

Boiler water was piped to the pier with connections at each berth. Maximum flow was 15 tons per hour.

Fresh provisions were plentiful. Deck and engineering supplies were available in limited quantities. About 7,000 gallons of gasoline were kept on hand in drums and tins.

There were no ships' repair facilities but the railway shop was available.

Discharge capacity is estimated to have been about 340 short tons per day.

(2) Sandakan.

The largest town (1931 population, 13,723) and chief port, Sandakan was also the capital of British North Borneo. It provides a good emergency seaplane alighting area and anchorage.

(*a*) *General facilities.* The important facilities were as follows:

A radio-telegraph station of 2½ KW.
A steam electric power plant, 3 phase, 60-cycle, 700 KW at 110-220 volts.
An automatic telephone system with 200 subscribers.
A waterworks system supplying a daily minimum of 180,000 gallons of filtered and sterilized water.
An ice and aerated water plant.
A closed sewerage system.
A well-equipped 90-bed hospital.
Extensive billeting facilities.
Two warehouses for storage, totalling about 12,000 square feet of area.
A small foundry and machine shop.

(*b*) *Port facilities.* The harbor gives excellent shelter and has room for about 40 first-class berths in depths of 30 to 54 feet. A bar across the entrance has limiting depths from 8 to 30 feet at low water.

There was only 1 important wharf, the property of the government. It was substantially built, 450 feet long, 44 feet wide for a length of 225 feet, and had a depth alongside of 19 feet at low water. The wharf had electricity, a water hydrant, and a small narrow-gauge railway nearby. Twenty-foot wide asphalt roads connected with points several miles around, and 1 road ran for 17 miles into the interior. A narrow-gauge railway for timber ran 8 miles into the jungle.

A second pier had a depth of 11 feet at the head and was equipped with a 15-ton fixed hand crane.

In addition, there were 4 small jetties, privately owned.

There was a patent slip belonging to the British Borneo Timber Company, 400 feet long, with a cradle 150 feet long, draft on keel blocks of 5.6 feet forward and 10.6 aft, and having a lifting power of 500 tons.

A small shipyard and foundry could build lighters up to 100 tons displacement.

Food supplies could be obtained in small quantities. Engineering and deck supplies were obtainable. A stock of 160,000 gallons of gasoline was maintained.

Twenty-six lighters with a total capacity of 8,000 tons were available for loading ships anchored in the stream.

The discharge capacity is estimated to have been about 450 short tons per day.

(3) Lingkas (Tarakan).

This was the port for exporting the petroleum product at 2 nearby fields. The 1930 population of the town was 11,589; of the district, 13,398. Food was almost wholly imported. There was an airfield and a seaplane alighting area.

(*a*) *General facilities.* Most of the facilities in the Lingkas area were owned by the oil company. Among them were:

A radio station.
A telephone system connecting various parts of the oil fields.
A modern hospital of 120 beds.
Two electric power plants.
A machine and repair shop at the Pamoesian oil field.
A pumping station which provided water from a stream for purposes other than drinking. Drinking water was obtained by rain catchment.
An ice plant and distillery.
A narrow-gauge railroad connected Lingkas with the Pamoesian oil field.
Good roads connected with the airfield and with the oil fields.
Billeting facilities were very limited.

(*b*) *Port facilities.* The harbor was secure in all weather. There were reported to be 12 to 15 berths (1,800 feet) in 42 feet of water and many berths in 24 to 30 feet. An anchorage north of Lingkas could accommodate a large number of destroyers or submarines.

There are 2 piers, as follows:

1. T-head pier, 1,050 feet long with low-water depth at head of 30 feet. Pier was 6 feet above water at high tide. Water was piped on with a 3-inch connection. Two 6-inch and one 4-inch fuel oil lines with standard fittings connected with the oil field. A good road, 5 miles long, led to the oil fields.
2. T-head pier, 1,362 feet long with a low water depth of 33 feet along face. Pier was 6 feet above water at high tide. Water was piped on with a 3-inch connection. Two 10-inch and one 6-inch fuel oil lines with standard fittings connected with the oil fields. A narrow-gauge railroad, laid onto the pier, led to the oil fields. A 10-ton crane was mounted on tracks. Boat hoisting gear was capable of lifting a 50-foot launch.

A floating crane of 15-ton capacity was moored between the 2 piers.

There was an oil tank farm close to the shore and a warehouse, 60 feet long, was built at the end of the north pier.

A pump house on the north pier could supply salt water for fire fighting.

No gasoline was produced at Tarakan. The maximum discharge rate for fuel oil at both piers, working simultaneously, was 7,200 pounds per hour. The south pier alone could discharge 4,800 pounds per hour. Discharge was by gravity, forced feed, or both.

Food was available in small quantities.

The only repair facilities available were at the oil field machine shop.

The discharge capacity for general cargo is estimated to have been about 225 short tons per day.

(4) Villages.

There were 9 coastal villages of local importance and 1 inland town, Beaufort, was an administrative headquarters and the center of a rubber and sago-producing area. All of the coastal villages had some minor port facilities, including 1 or more small piers.

Kudat, a livestock center, had a radio station, telephone and telegraph systems, a submarine cable to Singapore, a water supply system, and a 28-bed hospital.

Tanjong Batu was connected by a railroad 3 miles long with a manganese mine.

Lahad Datu, a tobacco and copra shipping point, had telephone and telegraph connection with Sandakan, and a 10-mile long light railway led to a tobacco plantation.

Tawau, the center of a large trade in rubber, coconuts, livestock, and timber, was also the headquarters of a large-scale tuna-fishing industry. There was a radio station, a telephone system, and a civil hospital.

Tanjong Selor, Tanjong Redeb, and Benoa Baru had radio stations.

F. Northern Celebes sector.

The Minahasa region around Manado is densely populated with numerous villages and several large towns. The remainder of the sector is largely unexplored wilderness with no towns and a few primitive widely scattered villages.

(1) Manado.

The largest town in the Celebes Sea area (1930 population, 27,544), Manado was the commercial hub for the Celebes, Sangihe, and Talaud Islands, and part of the Moluccas. Although 486 vessels with a total tonnage of 1,875,000 visited the port in 1939, there were no docking facilities and the vessels were serviced by praus. Motor roads connected with important places in the surrounding area. There was a landing strip, connected by road, 32 miles south, and another was under construction by the Dutch, 7 miles east. There was a seaplane stop on the K.N.I.L.M. route at Lake Tondano.

(*a*) *General facilities.* Among the important facilities were the following:

A radio station, call letters PKY.
Submarine cable to Balikpapan and Java.
Telegraph line to Ternate, Gorontalo, and Kema.
A local telephone system.
An electric power plant with 3 diesel engines of 300 horsepower each, lighting 10 miles of streets.
A municipal water system with 14 miles of pipe, serving 1,491 private consumers, 113 services and plants, and 40 public hydrants. The total distribution in 1939 was 37,000 cubic meters.
A modern, European-staffed hospital of 124 beds. A military hospital of 8 beds. A mission hospital, and a leper asylum.
Billeting facilities were extensive.

(*b*) *Port facilities.* From December to February the anchorage in the open roadstead was unsafe and Kima, to the north, and Kema, to the south, were used instead. A basin for praus, with a 210-foot wharf, was used by unloading craft drawing no more than 6½ feet. The basin was served by a 1-ton crane.

There were 2 small shipbuilding and repair concerns. One had 3 slipways for 200-, 100-, and 50-ton vessels, a repair yard workshop, a carpenter shop, and a smithery. The other had a 200-ton slipway, a fitting and turning shop, a carpenter shop, and a smithery.

The government maintained a small wrecking tug. There were also 24 lighters of 4 to 15 tons capacity and a steam waterboat of 18 tons capacity.

Warehouse storage space totalled 40,000 square feet.

Storage areas for gasoline had a total capacity of 450,000 barrels, and for diesel oil, 2,100 barrels (1936). No pumps were available, but a portable pipeline was used.

(2) Gorontalo.

The second largest town of northern Celebes (1930 population, 15,603), Gorontalo was the trade center for the Gulf of Tomini area. Although 483 vessels of a total tonnage of 594,000 visited the port in 1939, port facilities were poor. Lake Limboto was a seaplane stop of the K.N.I.L.M. and the Dutch had planned a landing strip which may have been built by the Japanese. Good roads connected with localities as far away as 25 miles.

(*a*) *General facilities.* Facilities at Gorontalo included the following:

A radio station.
A local telephone system.
Telegraphic cable to Kema.
An overland telegraphic connection with Koeandang.
An electric power plant with a 400 horsepower diesel engine.
A government hospital with 44 beds.

(*b*) *Port facilities.* Anchorage in Gorontalo Bay is poor because of great depths, confined space, and strong currents. The river is navigable only by the smallest craft. Large vessels tied up to mooring buoys in the bay and were serviced by lighters which unloaded at the small wharves on the west shore.

Lighters were available, but no tugboats.

Minor motor repairs could be done at an automobile repair shop which had welding equipment and a lathe.

Storage facilities consisted of several warehouses of the steamship company and oil and gasoline storage installations of the Shell Oil Company. Capacities are not reported.

(3) Tondano.

The chief inland town in Minahasa (1930 population, 15,007), Tondano was the center of an intensely cultivated region and was used as a health resort by Europeans. Two motor roads connect with Manado by different routes. Facilities included a radio station (PKL, PNL), a government hospital, a mission hospital with 36 beds, a school, and a hotel.

(4) Villages.

Villages of local importance include the following:

Tolitoli, a minor port, had a radio station, a small water system and an emergency landing place for seaplanes.

Koeandang (Kwandang), a minor port, had road connection and reported telegraph and telephone connection with Gorontalo. The Manado-Balikpapan cable landed here.

Amoerang, a minor port, has a seaplane alighting area and had road connections with Manado and with Lake Tondano.

Tomohon, an interior village, had a modern 130-bed hospital.

Kakas, on Lake Tondano, was the site of the Dutch Air Line seaplane base and the Dutch naval seaplane base was nearby. A landing strip was 5 miles southwest. Good roads led to the landing strip and to Tondano.

Talise (Talisei), a minor port, was a small coaling station. Lighters could supply 200 tons per day. There was an emergency

seaplane alighting area and small stores of aviation gasoline were maintained.

Kema, a minor port, was used as an alternate port for Manado, 30 miles distant, during the northwest monsoon, December to February. A motor road connects the 2 ports. There is an emergency seaplane alighting area 5 miles northeast.

Tomini, Toeladenggi (Tuladenggi), Tilamoeta (Tilamuta), Kotaboena (Kotabuna), Totokrata (Totok), Soematata (Sumalata), Tang, Boeol, Kampoengbaroe, and Stadang were minor ports and ports of call of the K.P.M.

15. *Transportation and Communications*

No portion of the Celebes Sea region has a well-developed system of transportation or communications. The areas best served are the Philippines, British North Borneo, and portions of Northern Celebes; Mindanao and the Minahasa district of Northern Celebes have good road systems, and 125 miles of railroad exist in British North Borneo. In general, however, land routes are undeveloped, and water is by far the more important means of transportation.

The 60 radio stations in the region, concentrated largely in Mindanao, Sulu, and British North Borneo, constituted the principal means of rapid communication. Rudimentary telegraph and telephone systems in Mindanao, British North Borneo, and Northern Celebes connected the chief cities with their hinterlands. Five submarine cables linked parts of the region with neighboring areas. (FIGURES I - 1 to I - 4)

A. Transportation.

(1) Railroads.

The State Railway of British North Borneo is the only common carrier railroad in the Celebes Sea region. It has a total track length of 125 miles, is of meter gauge, and runs from Jesselton to Tenom via Beaufort, with branches from Tenom to Melalap and from Beaufort to Weston. All other roads in the region are light railways, including the short marine railways at the major ports, numerous logging railways, an abandoned coal mine line, and a Decauville railway serving the Tarakan oil fields.

(2) Roads and trails.

The stage of development of the land routes varies from sector to sector within the region. Mindanao has the best system, with 2,176 miles of improved roads, of which the best are on the north coast, in the Bukidnon and Cotabato valleys, and in the Davao region. Halmahera has no roads, but many footpaths and some bridle paths and cart tracks. The Sangihe and Talaud Islands are well supplied with roads, which the Dutch classified as "secondary." In the Sulu Archipelago, Basilan Island, Tawitawi Island, and Cagayan Sulu Island have 1 road each; Jolo Island has an extensive network of gravelled, macadam, and coral rock-surfaced roads. All the islands have numerous trails. British North Borneo had 340 miles of roads and 640 miles of bridle paths in 1941; the west coast was much better supplied than the east coast. The only roads in Dutch Borneo were on Tarakan Island; footpaths were the only means of land transport on the mainland. Northern Celebes is comparatively well supplied with roads and footpaths, with the main roads concentrated in the Minahasa region around Manado. A second important road system centers on Gorontalo.

(3) Water transport.

Vessels of the Koninklijke Paketvaart Maatschappij (Royal Packet Navigation Co.) paid regular calls at ports in Halmahera, the Sangihe and Talaud Islands, Dutch Borneo, and Northern Celebes. Ocean-going vessels called at Zamboanga and Davao in Mindanao; the bulk of the island's trade, however, was carried by interisland steamers, which made irregular stops at a number of other smaller ports. Much of the coastal trade was carried on by launch-towed barges and praus. The Sulu ports were connected by steamer with Mindanao and Singapore. The 7 major ports of British North Borneo were served by the Straits Steamship Company and the Sabah Steamship Company, as well as by others.

Inland water transport was not extensive in Halmahera or the Sangihe and Talaud Islands, where bars at the river mouths and swift currents made navigation difficult for all but small praus. In Mindanao, however, the 2 large river systems (the Agusan and the Mindanao) are used extensively for inland transport. The rivers on the islands of the Sulu Archipelago are short, but used wherever possible because of the scarcity of roads. The rivers of Borneo were the region's main routes of travel and trade. Travel by inland waterways is relatively unimportant in Northern Celebes, except in the lakes of the interior.

B. Communications.

(1) Radio.

There were about 60 radio stations in the Celebes Sea region, constituting the chief means of rapid communication. The stations in the Netherlands East Indies portion were owned and operated by the government, with headquarters in Java. Only the Tondano station may have been of the broadcast type. The stations in Mindanao and Sulu were almost all operated or controlled by the Bureau of Posts to supplement the telegraphic communications. None of them was of the broadcast type. North Borneo had 6 radio-telegraph stations; the 1 at Sandakan was a broadcast station, communicating with Hong Kong and Japan.

(2) Telegraph, telephone, and submarine cable.

The only telegraph and telephone networks in the Dutch portion of the Celebes Sea region were in the Minahasa District of Northern Celebes. Submarine cables connected Ternate with Kema and Menado with Balikpapan. The northern coastal towns of Mindanao, from Gingoog, Misamis Oriental, to Katipunan, Zamboanga, were connected by telegraph. Another line extended southward through Dansalan and Malabang to Cotabato. The system was supplemented by radio-telegraph and telephone. Mindanao had no overall telephone system, but a number of provincial lines and local systems supplemented the radio and telegraph facilities. The only telephone lines in the Sulu Archipelago were on Basilan and Jolo Islands. The 2 submarine cables in Mindanao connected Misamis with Titunod and Baliangan with the island of Negros. British North Borneo had 700 miles of telegraph lines making up 1 main line and a number of branches. A cable connected at Labuan with the Eastern Telegraph Company submarine cable to Singapore. There were also 12 telephone exchanges, 2 of which, at Sandakan and Jesselton, were automatic.

16. Resources and Trade

(FIGURES I - 1 to I - 4)

A. Food resources.

No surpluses of food exist in the Celebes Sea area, which produces quantities barely sufficient to feed the local population and has been obliged to import food from other parts of southern Asia. The staples of the native diet are rice, corn, sago, tubertables, and nuts, some of which grow wild. Food crops were ous roots, and fish, supplemented by many tropical fruits, vegegrown on small plots of land; the few large plantations in the area were devoted to crops for export. A moderate amount of livestock was available throughout the area. Most cattle were used as beasts of burden. Goats were common in Mohammedan villages and pigs in non-Mohammedan ones. The carabao was used both for food and as a beast of burden in Mindanao. Fish were plentiful and a more important source of food than meat, ranking after rice, corn, and sago as a staple. There were ice factories on Jolo Island in the Sulu Archipelago and in northern Celebes, British Borneo, and Mindanao. British Borneo had several rice mills. Mindanao had the largest food processing facilities, including a Japanese tunafish cannery, a pineapple cannery at Bugo, and several small plants for making desiccated coconut. Another Japanese fish cannery was at Manado.

B. Water supply.

The Celebes Sea Area has, in general, fairly abundant water supply, owing to the heavy and evenly distributed rainfall and the numerous rivers and streams. In the eastern part of the Jolo Island group of the Sulu Archipelago the supply is sometimes inadequate. Mindanao and Sulu have a number of artesian wells. The surface wells are generally open and unprotected, and should be considered polluted. Natives obtain their water from shallow wells, springs, streams, lakes, and rainwater catchment basins. In some places the natives pipe water to their houses from the nearest spring through a split bamboo aqueduct. There are a few public supplies in the area and before the war, water from these could be consumed without additional treatment, but it is doubted whether the Japanese have continued adequate supervision. Reservoirs, rain water catchments, storage tanks, etc., most frequently are used. All water in the area, regardless of source, should be boiled or chemically purified. Stream water should be taken from a point near the headwaters.

C. Construction materials.

Wood for construction is generally available throughout the Celebes Sea area; excellent supplies exist on Halmahera and Mindanao. Rattan and the leaves of various palms can be used for roofing native huts. The Japanese have recently claimed to be constructing a cement factory in northern Celebes. Coral from the shores of the entire area and basalt rock from the interior of Mindanao and the Sulus can be used to build roads and airfields.

D. Industrial raw materials and primary processing.

(1) Minerals.

Relatively small amounts of a few important industrial raw materials were mined in the Celebes Sea area before the war. Large parts of the area had not been adequately surveyed for mineral deposits, and deposits in other sections had not been exploited. Japanese propaganda has emphasized the discovery and development of a variety of minerals, particularly in Borneo. One large unexploited deposit of iron ore was in the northern tip of Surigao Province, Mindanao. Much smaller deposits were reported in British Borneo. A small amount of chromite has been mined on Dinagat Island off Mindanao. Mindanao had important gold mines; silver was mined as a by-product. These metals were mined primitively and on a small scale in northern Celebes, where some sulphur was also produced.

(2) Fuels.

Ample wood for fuel exists throughout the area. Bituminous coal was mined in British Borneo, Dutch East Borneo, and Mindanao; the production in Dutch Borneo (300,000 tons annually) far exceeded that in the other 2 regions. The chief source of petroleum was Tarakan Island, off Dutch East Borneo, which produced about 4,000,000 barrels of crude oil annually before the war. The oil, which can be used as under-boiler fuel without refining, could be piped directly to ships lying at the piers. The Japanese have restored the field and are using it.

One oil seepage has been found at Banasilan, in eastern Cotabato Province on Mindanao, and others have been noted in British North Borneo. Coconut oil is used for cooking and lighting by natives in Halmahera, Sangihe, and Talaud.

(3) Agricultural and marine materials.

Timber is one of the area's principal resources. Extensive logging of numerous hard and soft woods has been carried on in Mindanao and Borneo. Gums and resins were collected in significant quantities from the forests in British and Dutch Borneo, the Sulus, Mindanao, and Halmahera. Rubber was an important export from Borneo, although international restrictive agreements kept production far below capacity. Small amounts were also grown on Mindanao and Basilan Island. Coconuts were grown for local use and export (as copra and coconut oil) on small native farms throughout the area. Large amounts of excellent hemp were grown on plantations in Davao Province, Mindanao, in other parts of Mindanao, and in the Sulus. One experimental cinchona plantation existed in Mindanao.

E. Manufacturing plants.

The only manufacturing plants in the Celebes Sea area were small installations connected with the primary processing of foods and agricultural and mineral products for export. Some of the larger towns in Mindanao, Celebes, and North Borneo had small machine repair shops.

F. Electric power.

Information on power plants in the Celebes Sea area is incomplete. Mindanao had 20 public plants and numerous small private plants connected with mines and sawmills. The Sulus had 1 very small power plant at Jolo; there was another on Ternate Island, off Halmahera. At least 2 others existed in northern Celebes, at Manado and Gorontalo.

G. Commerce.

The chief imports to all parts of the Celebes Sea area were cotton goods, small iron and steel manufactures, medicines, and some canned goods. The chief exports included: petroleum, coal, and timber from Dutch Borneo; rubber, timber, and copra from British Borneo; Manila hemp, copra, and gold from Mindanao;

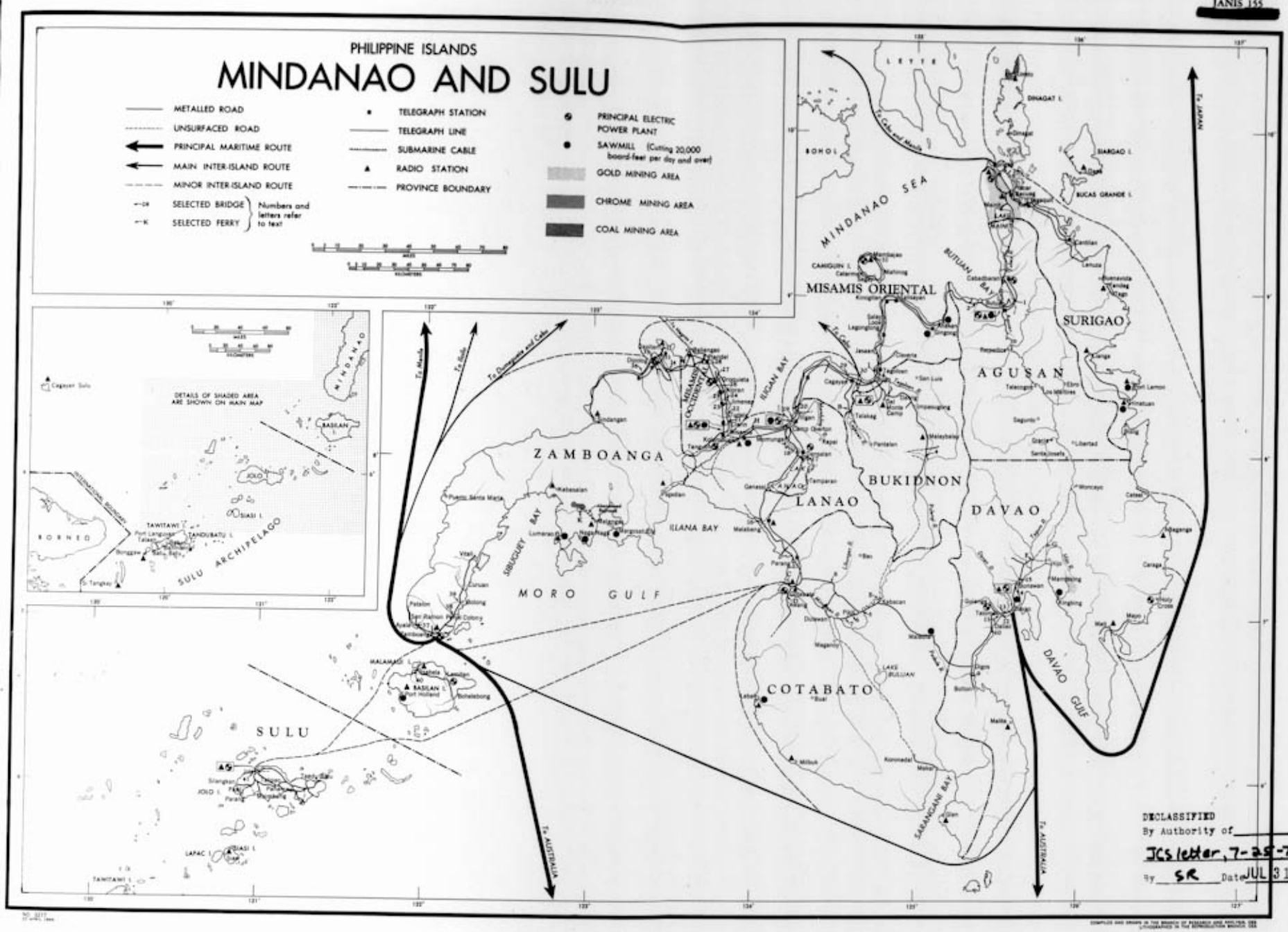


FIGURE I - 1. *Mindanao and Sulu—Transportation, Communications, Industrial Facilities.*

FIGURE 1 - 2
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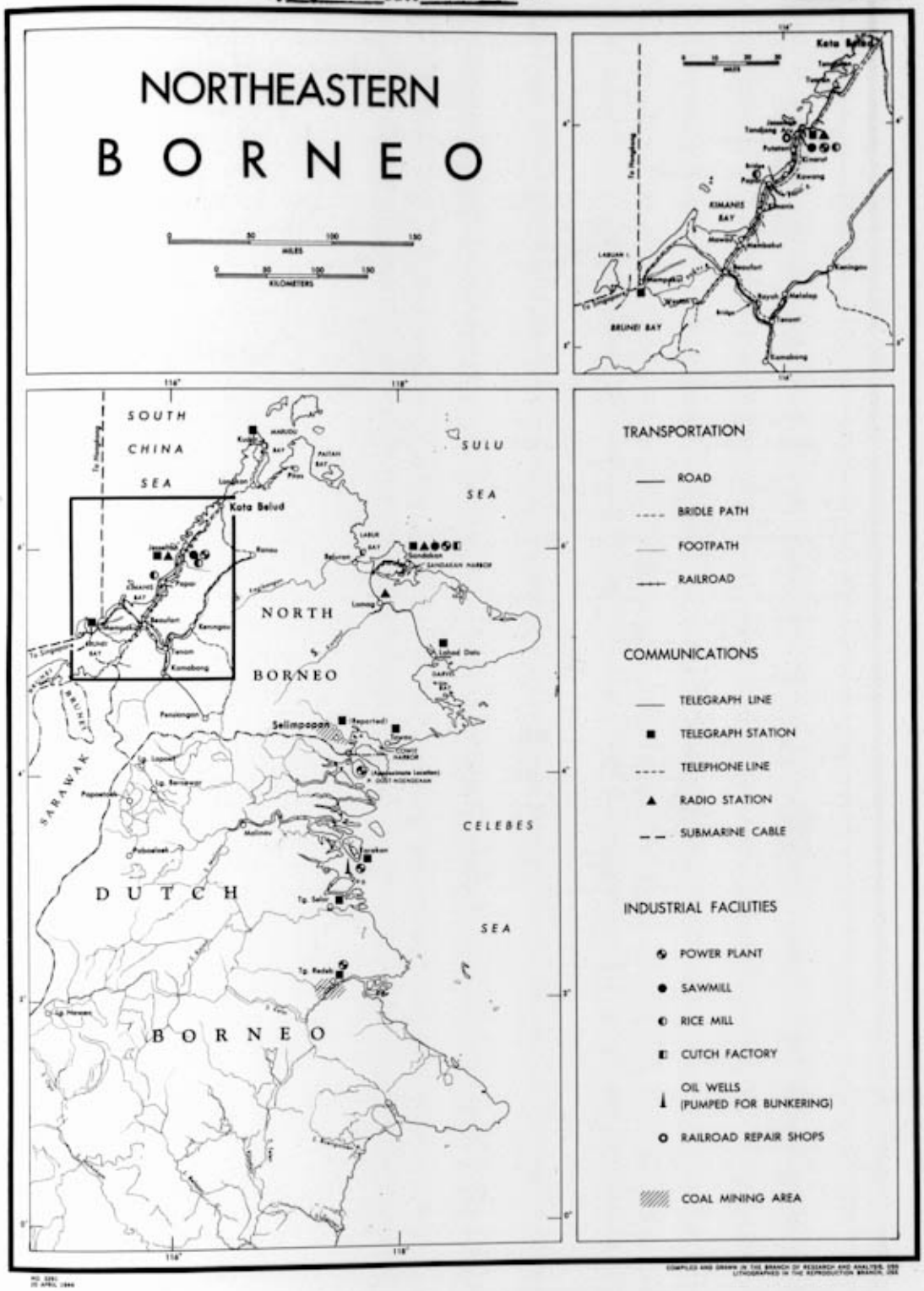

FIGURE 1 - 2. *Northern Borneo—Transportation, Communications, Industrial Facilities.*

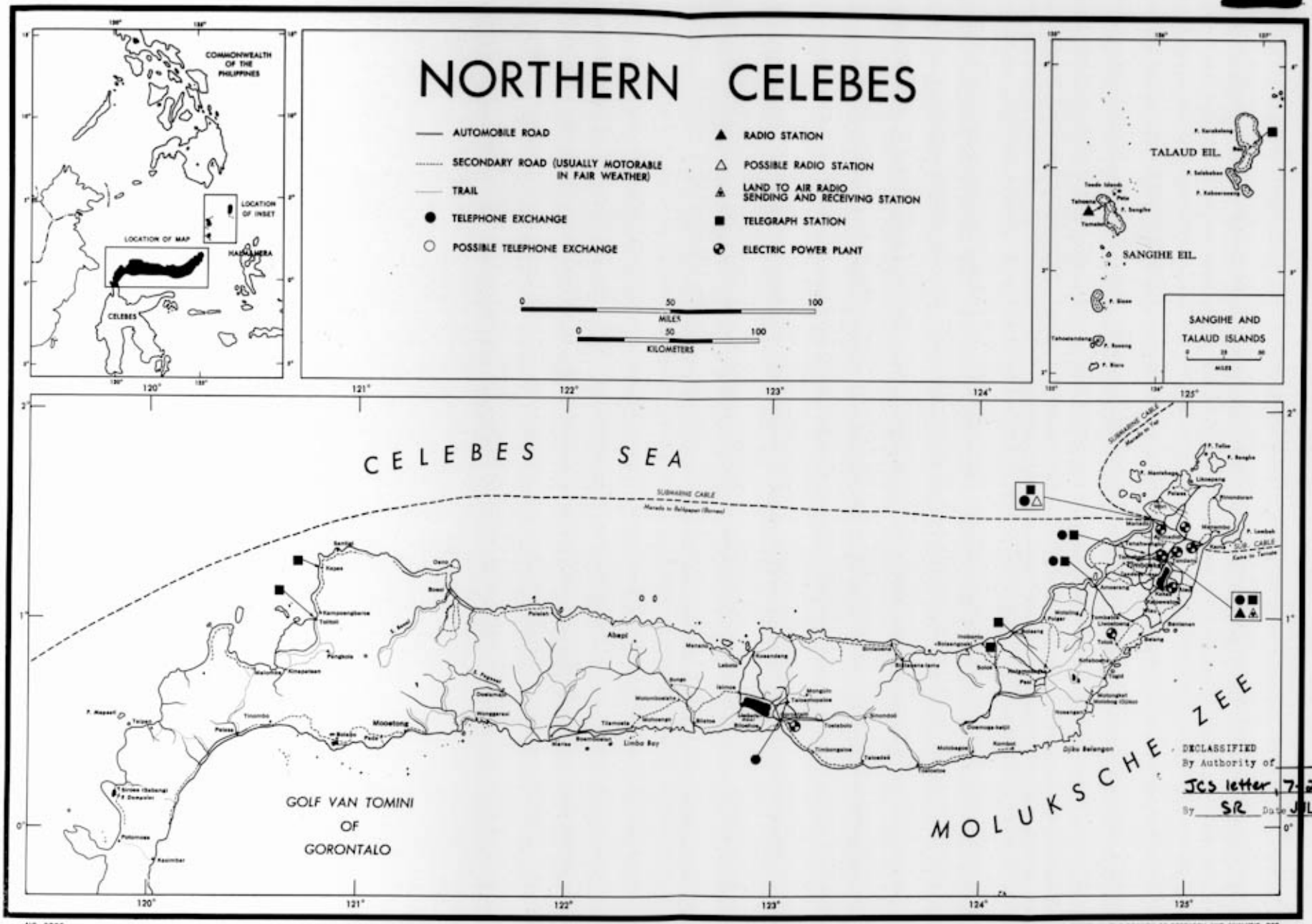

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FIGURE 1 - 3. *Northern Celebes—Communications.*

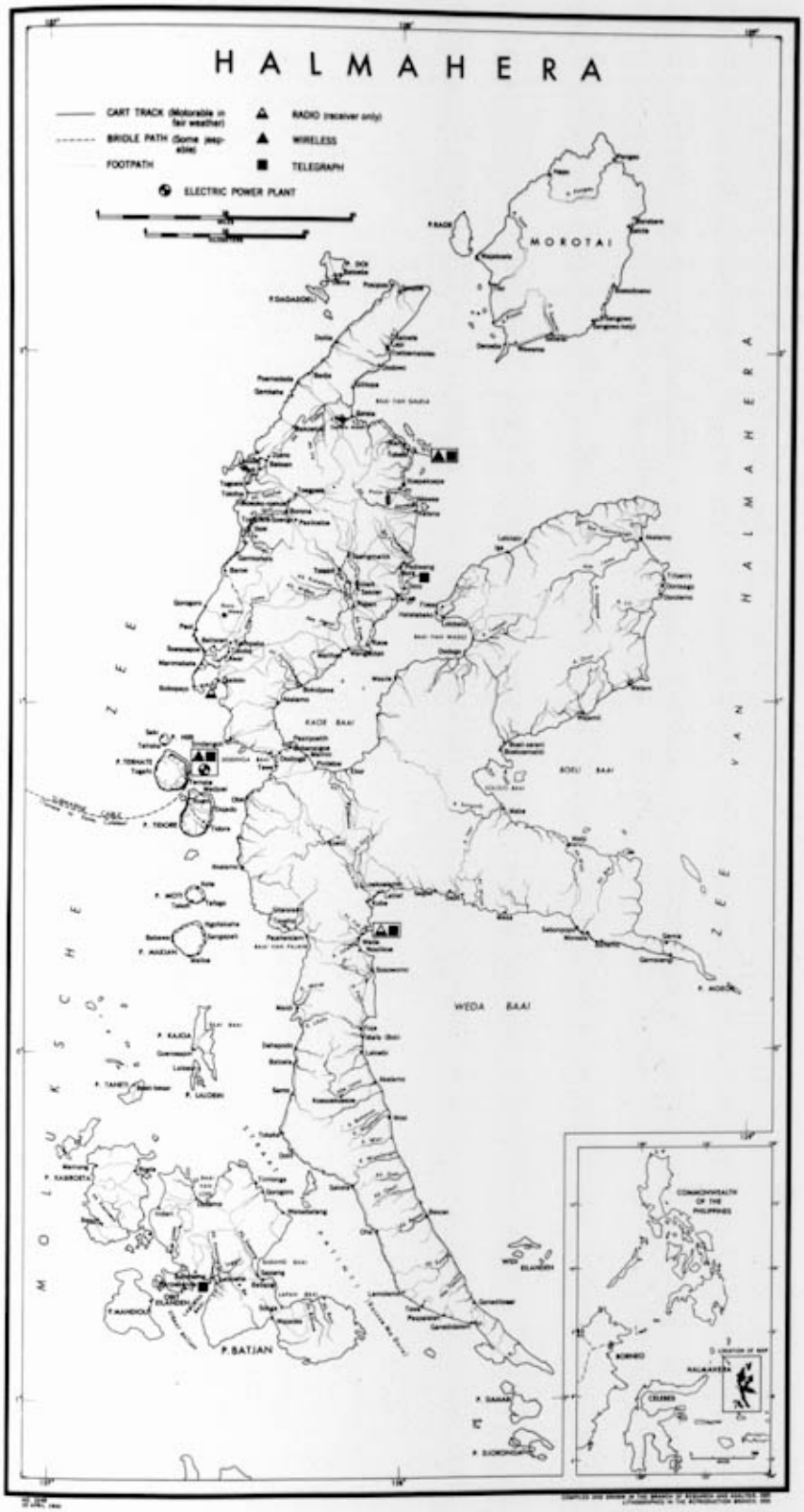

FIGURE 1 - 4. *Halmahera—Communications.*

copra and small amounts of coffee and rubber from northern Celebes; copra and hemp from the Sulus; and copra and spices from Halmahera, Sangihe, and Talaud.

H. Finance.

Barter is a common form of trade throughout the area. The Japanese have introduced scrip, using the names of the pre-war currencies of the occupied territories, and have tried to enforce its use for all transaction. The people, however, are probably hoarding the pre-war Philippine pesos and Netherlands Indies guilders.

17. *People and Government*

A. Halmahera sector. (FIGURE I - 5)

Portugal, the first European power to control the Moluccas, was driven out of Tidore in 1605 by the Dutch, who obtained a monopoly for the entire spice trade. In recent years, the great prosperity of Halmahera diminished with the decline of the spice trade.

The natives of northern Halmahera, Morotai, Ternate, Tidore, and Makian Islands are all of substantially identical stock; they are Alfoer tribes, the result of a mixture of Malays and Papua-Melanesians. The natives of southern Halmahera and of the Batjan group resemble the Papuans of New Guinea. The population of Halmahera is about 56,000; that of the off-lying islands is about 47,000. The northern Halmaherans speak at least 13 mutually unintelligible languages of non-Malayan stock; the 7 or more languages spoken throughout the rest of the island are of Malayan stock. Ternatean is used as a *lingua franca.* Malay is known only in the harbor towns of Halmahera, but is fairly widespread throughout the off-lying islands.

Most of the Halmaherans are pagan, but Christianity and Mohammedanism have made some advances in the coastal regions. Mohammedanism is predominant in most of the off-lying islands, except in Morotai, where the pagans are by far the largest group.

The natives of this sector are inclined to be surly, irritable, and lazy. All villages can supply male carriers; some expert boatbuilders are available in the coastal areas.

Administration of Halmahera and the off-lying islands was vested in the Assistant Resident at Ternate, who was responsible to the Resident of the Moluccas at Amboina, and ultimately to the Governor of the Great East at Makassar. The territory of the North Moluccas was divided into 2 areas, 1 under the direct rule of the Netherlands Government, and the other under the nominal rule of the Sultans, who coöperated with the Netherlands Government. *Controleurs* and *Gezaghebbers* were administrative officers of subdivisions in the territories under direct rule. The natives' attitude toward both the Dutch and Japanese is probably passive, although the old nobility of Ternate may resent Dutch usurpation of their power.

B. Sangihe—Talaud sector. (FIGURE I - 5)

The natives of Sangihe resemble those of Minahasa in Celebes; the Talauders show some physical differences. The people of the islands, which are overcrowded, are timid and inoffensive, and reluctant to serve as hired labor. They live by agriculture and fishing. About 70% of the population were classified as Christians in 1935.

The Sangihe and Talaud Islands form a division under the Residency of Manado, which is in turn under the Government of the Great East.

C. Mindanao sector and Sulu Archipelago. (FIGURE I - 6)

There are at least 20 different ethnic groups in the Mindanao-Sulu area, of which 13 are pagan, 6 Mohammedan, and 1 Christian. The groups are chiefly Indonesian and Malayan; a few are Negritos or are intermixed with Megritos. The pagan groups show little cultural or political unity; the Moros, on the other hand, have many close cultural bonds stemming from their religion, although they lack a national consciousness. The Christian Visayas form part of the general Visaya group of the central Philippines, which is the largest and most powerful cultural and political group in the Islands.

Most of the natives near the coasts have had contact with foreigners, and many of them have been employed as ordinary laborers on plantations. The Bagobos, Bilaans, Bukidnons, Lanaos, Samals, Subanos, Sulus, and Visayas are all potential sources of labor; the Visayas on the north and east coasts will probably furnish the best laborers. Many workers are indifferent and unreliable, while the religious beliefs of the Moros sometimes interfere with their doing certain types of work or working at set hours. Consultation with the headman of a tribe, the town mayor, or members of municipal governments should serve to provide sufficient labor.

The large Japanese population around the city of Davao, in Davao province, which the Japanese now claim to total 30,000, was strongly disliked by the natives of Davao, who massacred many groups of settlers.

The 10 provinces of Mindanao are classed as regular (Misamis Occidental, Misamis Oriental, and Surigao) and "special" (Agusan, Bukidnon, Cotabato, Davao, Lanao, Sulu, and Zamboanga). "Special" provinces are much more subject to the close and direct scrutiny of the central government than the regular provinces, and less entitled to the suffrage and to the election of their own officers. The ultimate aim is to transform all provinces into regular provinces. The Secretary of the Interior in the Philippine Cabinet is responsible for the supervision of all provincial and local governments in the Philippines.

Internal dissension in Mindanao and Sulu has stemmed largely from the fact that the Filipino groups, chief of which are the Visaya and Tagalogs, have held most of the important official posts in the government, to the exclusion of the Moros. The Moros lack sufficient education to be able to play an important part in the government, and suffer from profound splits within their own groups.

D. Northeast Borneo. (FIGURE I - 5)

The Dutch and English established footholds in Borneo in the seventeenth century, and extended their influence in the course of the eighteenth century. Borneo remains one of the least developed parts of the East Indies. The inhabitants fall into 3 main groups: the Klamantan, in British North Borneo; the Bahau, in central and east Dutch Borneo; and the Punan, in the mountains and deep forest of central Borneo. Of the 530,000 people in Northeastern Borneo, about 84% (450,000) are natives, 11% Chinese, and 5% other Asiatics and Europeans.

The business language in the coastal towns is Malay, which is

also the chief language taught in schools. The tribes continue to speak their own tongues.

The majority of the natives are pagan. The most important Christian missionary work has been the establishment of schools.

It has been necessary to import Chinese and Javanese laborers for work on rubber and tobacco plantations; of the 15,500 laborers in 1939, 7,000 were natives, 6,000 Chinese, and 2,300 Javanese. Natives were employed as unskilled laborers on rubber estates, oil fields, and at cutting timber. Other natives were engaged in small-scale agriculture. The Dusun are considered good workers, although not so steady or reliable as the Chinese. About 30,000 males were available in the South and East Divisions residency in 1939. The natives stay close to tribal centers and are unwilling to remain away from their homes for more than 6 months at a time.

British North Borneo was administered by the British North Borneo Company. A Governor of the island acted under the authority of a Court of Directors in London, assisted by a Government Secretary and a Civil Service staff of 60 men. Dutch Borneo was one of the Outer Territories in the Netherlands East Indies governmental organization. Three of the 8 subdivisions included in this study were native-ruled, although the capital of each subdivision was ruled directly by the Dutch. The Japanese have tended to retain the old boundaries. Natives courts coexist with British and Dutch courts in Borneo.

E. Northern Celebes sector. (FIGURE I - 5)

A confederation of the 4 largest tribes of the northeastern peninsula of Celebes, the Tombulus, Tonseas, Tontemboans, and Tondanos, was created in the seventeenth century for mutual protection. The Minahasans requested Dutch aid against the Spanish in 1679, and have ever since remained friendly toward the Netherlands.

The entire sector is inhabited by peoples of mixed ancestry. The Minahasans, the largest group, are distinct from the other tribes, and are said to have a strain of Javanese and a fair amount of European blood. The total number of inhabitants in the area is believed to be under 700,000. The coasts are fairly well populated; there are relatively few interior villages.

Malay is generally comprehensible throughout the Celebes sector. Natives who have attended high school know some Dutch, and a few probably know English.

Christianity is the most important religion in Minahasa, where 266,000 of 292,000 natives were Christians in 1935. There were less than 5,000 Mohammedans. A very small number are pagan.

The best laborers in the area are the Boeginese and South Makassarese. They are usually obtained at Makassar. Many Minahasan boys become clerks or join the army.

Northern Celebes falls within the Territory of the Great East, whose capital is at Makassar. Manado Residency is one of 6 within the Territory; the Residency contains 5 divisions and 12 subdivisions. A large part of the Residency is under indirect rule of the Netherlands Government. The sector probably contains many pro-Japanese, as well as pro-Dutch, natives.

18. Health and Sanitation

A. Diseases.

Mosquitoes capable of transmitting malaria, filariasis, dengue, and yellow fever are widely distributed in the territories bordering on the Celebes Sea. Consequently, malaria is the principal health problem and the first of the diseases of special military importance. The disease is extremely prevalent throughout Halmahera, Sangihe, and Talaud, but no details are available. Malaria in the Philippines is a disease of the foothills and is transmitted neither in the coastal plains nor in the mountains. Efforts have been made in Mindanao and Sulu to control the disease, but since the malarial mosquitoes here are stream breeders, oiling has proved ineffective. Malaria control in Borneo and Celebes has been simplified somewhat by the fact that the vectors are ground breeders and do not deposit their larvae in plants, coconut shells, or small artificial containers. Blackwater fever occurs in Mindanao and Sulu but is known to be rare. The next important diseases are typhoid fever and other intestinal diseases. Bacillary and amebic dysentery are common in Halmahera, as well as in North Borneo, Dutch Borneo, and Celebes. Acute outbreaks of amebiasis were reported from Tobelo and from Djailolo at the end of 1937. Dysentery is said to be common on Sangihe and Talaud. Typhoid fever is prevalent throughout the Philippine Islands, but few cases are reported from North Borneo. In Dutch Borneo and Celebes the disease is definitely common. This is largely due to inadequacies in the drinking water supplies and sewage systems. Paratyphoid fever and many varieties of salmonella infections have been reported from many areas in the Netherlands Indies. Bacillary dysentery is by far the most important enteric infection in the Philippines. It is said that the cases are largely sporadic but unsafe water and food supplies augment the possibility of outbreaks. Amebic dysenteries occur much less frequently but cause much illness. The third group of disease of special military importance are the venereal diseases. Only in Halmahera are syphilis and gonorrhea infrequent. In the Philippines, gonorrhea is the most prevalent venereal disease and will prove to be a serious problem for military forces there. In Borneo gonorrhea rates as high as 80% have been reported in some areas. Syphilis is fairly new but is spreading rapidly. Occasional cases of chancroid and granuloma inquinale are encountered. In cities the rates are higher than in rural areas.

Rickettsial diseases constitute the fourth group, though little information is available on its occurrence in any sector. The only definite knowledge is that flea-borne murine typhus and tick-borne scrub typhus do occur in the Philippines. Although there are no specific data or scrub typhus in the area, its presence should be strongly suspected. The current army typhus vaccine does not protect against it. Another disease, dengue, occurs abundantly in all parts of the area. It produces a low mortality rate but a high non-effective rate and readily disables an entire army. Also, the respiratory infections are an important source of trouble throughout the islands. Influenza, bronchitis, bronchopneumonia, and lobar pneumonia are all quite prominent. Lobar pneumonia is one of the most frequent causes of death in the Netherlands Indies. Careful hygienic measures have not been able to stamp out the dangers of pneumonia on the large plantations.

In this area, as in other tropical countries, skin diseases are a major affliction. Scabies, Dhobie itch, and common fungus infections are prevalent. Impetigo is often seen in Halmahera. Tinea albigena is frequent and is localized in the palms and on the soles. Epidermophytoris occurs and is highly communicable. Prickly heat often bothers newcomers more than natives. Red

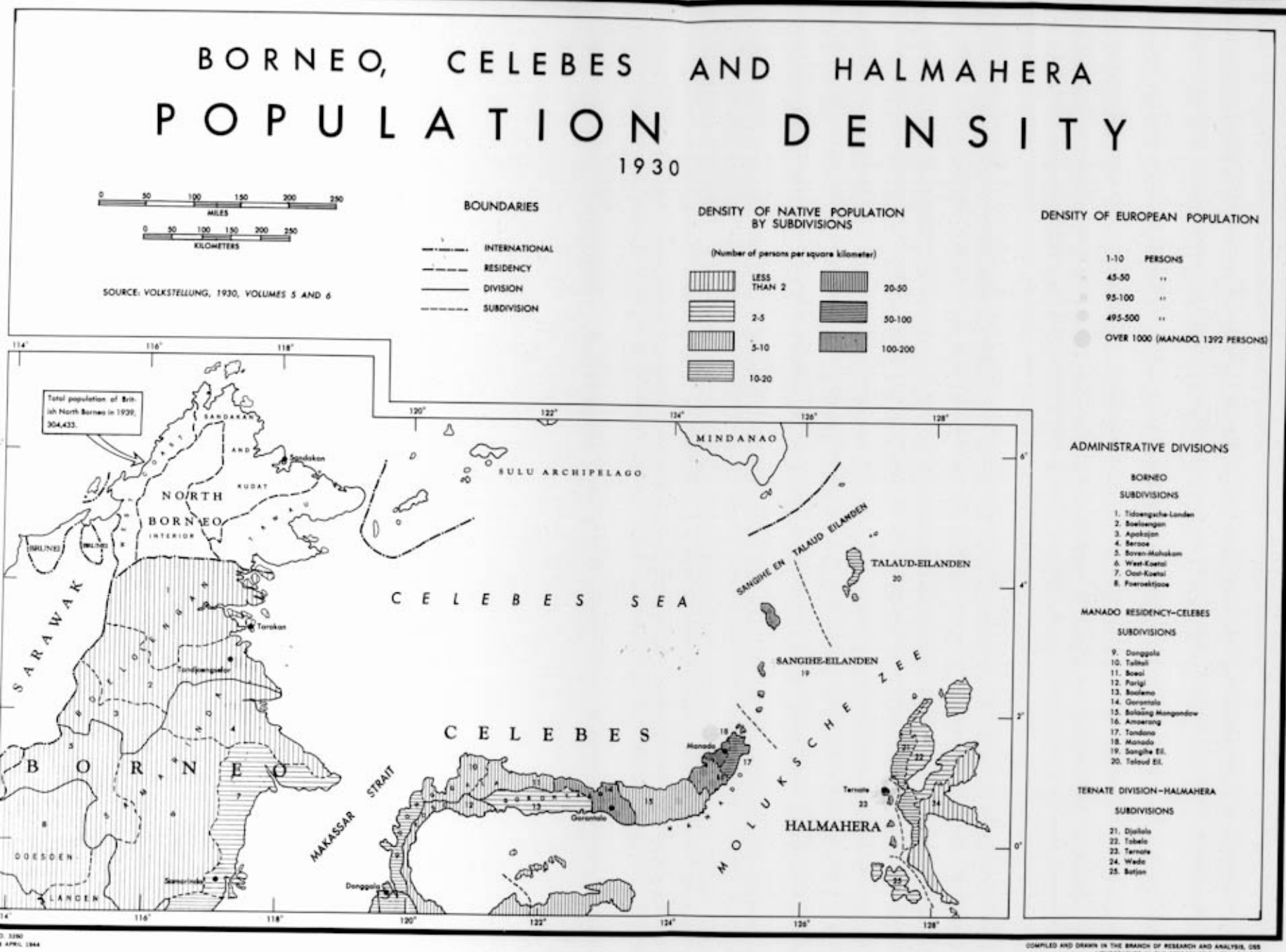

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FIGURE I - 5. *Borneo, Celebes and Halmahera—Population Density.*

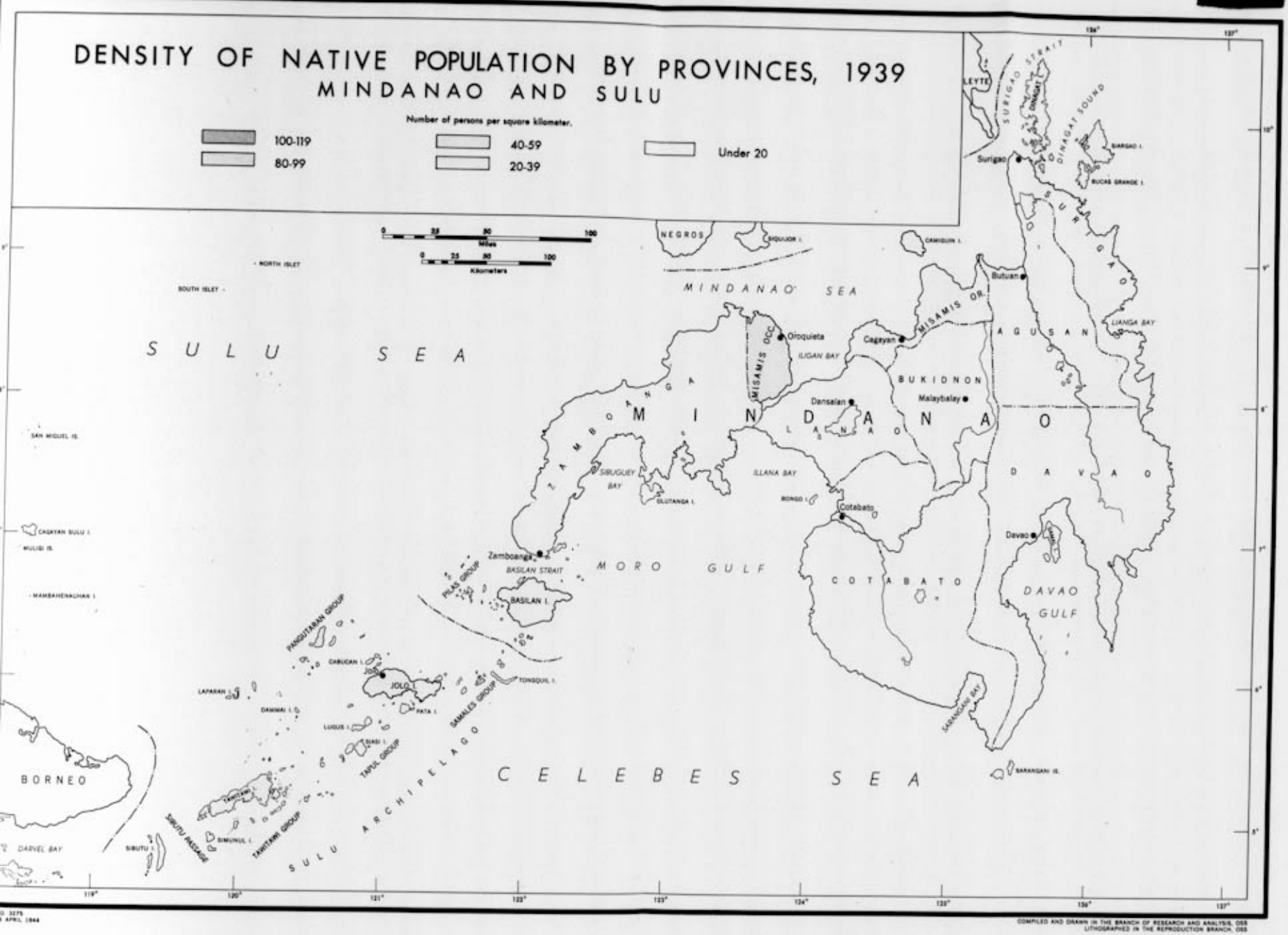

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FIGURE 1 - 6. *Density of Native Population by Provinces.*

bug dermititis if often an intolerable annoyance. Cutaneous myiasis is common.

There are other diseases which might become military problems though they have not been encountered in the area. In recent years there have been no cases of cholera or plague reported. Yellow fever has never occurred in any of this territory, although the vector of the disease, aedes aegypti, is found throughout.

There are other diseases, not of particular military importance but likely to affect small numbers of troops. The first of these is tuberculosis which is prevalent in the area in all forms, and ranks as the single greatest cause of death. It is not believed that this disease will be of great military significance for well selected white personnel. Also, worm infections are extremely common throughout the Philippines, ascariasis and trichuriasia being the most prevalent forms. Hookworm disease is endemic. The combination of hookworm and malaria is dreaded especially because of the resultant severe anemia. Filariasis has been observed in the Philippine Islands, North Borneo, Sangihe and Talaud, and Halmahera. *Schistosomiasis* due to *Schistosoma japonicum* occurs in Northern Mindanao. Yaws is prevalent throughout the area, though it is more common in lowland than in mountain districts. Eye diseases are also commonly prevalent in the area. It is estimated that in Celebes alone there are at least 10,000 persons who are blind or nearly so. The loss of vision is tue to trachoma, gonococcal ophthalmia, and syphilitic uveitis. Leprosy is extremely common. Other miscellaneous diseases are smallpox, diphtheria and tetanus, common in Borneo and Celebes, and measles. Malnutrition and beriberi are common because of the great poverty of the natives.

B. Water.

In general there is an adequate supply of water available in all parts of this area except the eastern part of the Jolo Island group of the Sulu Archipelago when the supply is sometimes inadequate. All water should be regarded as potentially dangerous and should be boiled or chlorinated before use. Containers should be kept clean, and ice made from local water supplies should not be used for drinks.

C. Sanitation.

In most of the area, excreta are disposed of directly to a stream, to the ocean, or to the soil. In parts of the Sulu Archipelago, houses are built on stilts and all waste materials are dropped through holes to the ground below. In the Philippines a campaign was carried out for the provision of bored hole latrines and in 1937 it was estimated that there was 1 such latrine for every 8 persons. No reliance should be placed on the availability of any sewage disposal facilities. Because of the prevalence of enteric diseases, special attention must be paid to the careful disposal of sewage by approved methods in order to safeguard against pollution of water and soil and access by flies.

D. Public health.

It is impossible to consider the public health organization of the entire area, since each sector is only a small part of a larger organization. The Philippine Government has made many efforts to improve health conditions and its success has been remarkable. At the end of 1938 there were 16 government hospitals on Mindanao and the Sulu Archipelago and 2 semi-government hospitals supervised by the Bureau of Health. A large part of the curative medical work was undertaken by mission hospitals and industrial hospitals in cooperation with the Bureau of Health. The Bureau maintained 4 travelling X-ray units for use in tuberculosis control work. A Malaria Control Field Laboratory had headquarters in Bulacon Province, Luzon, and Malaria Control units were located in the provinces of Laguna, Pangasinan, and Isabela with subunits in other provinces. The medical facilities and the public health program of North Borneo were inadequate. This was due in part to limited funds and personnel, to the difficulties of transportation, and to the ignorance of the natives. A small amount of malaria control had been carried out at Jesselton, Tawau, Sandakan, Tenom, and Keningau. The work undertaken by the Dutch Government in the Netherlands Indies has led to important results in many fields. This is surprising since the number of physicians is very small. The small body of medical pioneers was able to improve sanitary conditions to a point where life offered few special health dangers for foreigners.

E. Hospitals and medical personnel.

At the end of 1938 there were 25 hospitals in Mindanao and in Sulu Province, exclusive of United States military and naval hospitals. In general the hospitals were fairly well equipped and able to offer a variety of services. Public health laboratories were maintained in the provinces with their facilities available free of charge. In every instance the hospitals, laboratories, and clinics were utilized fully and increased capacity was a constant need. Almost all medical supplies were imported. The only medicinal product available locally was totaquinine, a new quinine preparation which was supposed to be very effective. In North Borneo in 1939 there were 4 general hospitals under government direction. These were at Sandakan, Jesselton, Beaufort, and Tawau. The medical department maintained a system of dispensaries operated by native dressers which were scattered throughout the rural areas. A special clinic for the treatment of venereal diseases was established at Sandakan. In 1940 there was a total of 63 hospitals on the Celebes Islands, 28 in the Government of Celebes, and 34 in the Government of Manado. The larger of these were fully equipped with X-ray apparatus, surgical instruments, and laboratory facilities. The 5 hospitals on Halmahera were poorly organized, poorly built, and inadequately equipped. In some cases even the sanitary conditions were unsatisfactory. No information as to hospital facilities on Sangihe and Talaud is available.

There were 4,909 licensed physicians in the Philippines as of 1 January 1940. About 90% of these physicians were Filipinos, and a great majority were graduates of the 4 local medical colleges. No reports are available for North Borneo after 1937, but at that time the medical staff consisted of 6 European medical officers, and an auxiliary staff of nurses, midwives, and male dressers. In Celebes there were 41 physicians; in Halmahera 3 public health physicians and Indonesian nurses.

F. Food.

In general, the natives in this area are fairly well nourished, although they also suffer from the effects of inadequate nutrition, due either to poverty or to ignorance. The native diet is made up of fish, rice, leafy vegetables, and fruit. As a general rule, Americans and Europeans used imported foods, since locally grown vegetables must be considered unsafe when cooked. In the Netherlands Indies there are some chickens, but they lay

very small eggs. Ducks are available in large numbers. There is little surplus milk and in every instance it should be boiled before consumption. Local cattle are often tubercular, and meat should be carefully inspected if it is used. The food supplies should, as a general rule, be imported entirely.

G. Insects and animals.

Mosquitoes capable of transmitting malaria, filariasis, dengue, and yellow fever are widely distributed throughout the territories surrounding the Celebes Sea. The 3 main species present are the *Anopheles, Aedes,* and *Culex*. Lice are common, particularly in Borneo, Celebes, and Halmahera. Flies are found in large numbers and act as vectors of enteric diseases. Sandflies, ticks, and mites are present, though they do not act as vectors. The oriental rat flea is the principal vector of plague and is present throughout the area. Rats are numerous and act as a reservoir of plague. Poisonous spiders must be guarded against constantly. The spectacled cobra, the king cobra, and the Philippine cobra are found in Mindanao and Sulu. The king cobra may be found in dense jungles near streams and sometimes in trees. The spectacled cobra is the most deadly, and frequently enters houses in search of rats on which it feeds. Kraits are common throughout the Philippines. Other poisonous snakes are found but they seldom attack man. On Halmahera poisonous snakes are rare. Crocodiles are found throughout the area and jungle animals are found on Borneo. Some fish are poisonous and should not be eaten. Pests are everywhere present and will be great nuisances if men aren't supplied with protective clothing.

19. *Naval and Air Facilities*

The Celebes Sea Area is one of the most important Japanese defense zones. Loss of the area would make Japanese shipping lanes south and southwest of Hong Kong and Formosa vulnerable to Allied sea and air attacks and would cut off sources of material essential to the Japanese conduct of the war. The numerous airfields on the islands bordering the Celebes Sea Area are vital to its defense and are important in strategic plans for defense of Greater East Asia. A concentrated effort to strengthen and further develop both naval and air installations in the area may be expected.

A. History and development.

The Japanese advance into Netherlands East Indies early in 1942 proceeded so rapidly that no particular effort was made to develop naval facilities in Northeast Borneo, Northern Celebes, Mindanao, and Halmahera. Capture of the Singapore and Sourabaya naval bases in February and March of 1942 fulfilled Japanese needs for advanced naval bases and the development of other installations was confined to the most forward areas.

Until allied progress in New Guinea, in the Solomon Islands, and in the Marshalls coupled with increasing attacks on the Carolines and Mariannas, became a serious threat, the Japanese maintained only very small forces in the Celebes Sea area. Since January, 1944, constructive activity in connection with both naval and air facilities has become intensive at various points in the area.

B. Organization.

(1) Administration.

The Celebes Sea Area is under the Southwest Area Fleet with headquarters at Singapore. This fleet is subdivided into 4 Southern Expeditionary Fleets each covering a defined area within the Philippines-Indies-Malaysia region. The Thirteenth Air Fleet is the Naval Air Arm of the Southwest Area Fleet.

Sector E, Northeast Borneo as defined in this study, is under the jurisdiction of the Twenty-second Base Force with headquarters at Balikpapan, which is a subdivision of the Second Southern Expeditionary Force. The Third Southern Expeditionary Force, covering the Philippines, is based at Manila. Under it, the Thirty-second Base Force, with headquarters at Davao, has jurisdiction over sectors C and D, Mindanao, and the Sulu Archipelago, respectively. The recently organized Fourth Southern Expeditionary Fleet has as 1 of its subdivisions the Twenty-sixth Base Force with headquarters at Kaoe. The Twenty-sixth Base Force has jurisdiction over Sector A, Halmahera, Sector B, Sangihe-Talaud Islands, and Sector F, Northern Celebes.

It is believed that administrative control of the Japanese Army Air Service emanates from Manila. Specific details are not available.

(2) Tactical.

The Japanese Army Air Service is responsible for support of ground forces, bombing of forward allied bases, and local air defense. Its employment is controlled by the senior Japanese field commander in the area. At present in the Philippines and Netherlands East Indies, excluding Sumatra, the Fourth Air Army is estimated to be exercising command over probably 2 air divisions, 2 air brigades, approximately 5 air regiments, and possibly 5 independent air squadrons.

The Naval Air Service executes long range reconnaissance, submarine patrol, shipping escort, attacks on Allied surface vessels, and local air defense under direction of the senior fleet commander in the area. It is believed that the Thirteenth Air Fleet now commands 1 air flotilla and approximately 7 or 8 air groups in the Philippines and Netherlands East Indies excluding Sumatra.

(3) Disposition of forces.

The normal strength of the naval base forces in the area is weak. Small naval garrisons are stationed at shore installations and sea forces include only a few patrol and mine craft and miscellaneous small coastal vessels. It is difficult to arrive at figures on naval air strength owing to the mobility of the Japanese air forces and the continuing development of air facilities. Estimates for the Philippines and Netherlands East Indies excluding Sumatra, for the first quarter of 1944, fluctuated between a high of 498 and a low of 270 aircraft.

C. Supply and maintenance.

(1) Depots.

Principal naval supply depots for fuel, munitions, and materiel in general are at Davao and Kaoe. Only minor repair facilities are available throughout the area. No information is available on the location of aircraft supply and maintenance depots.

(2) Supply routes.

Principal supply routes to and within the area are shown on the accompanying map. (FIGURE XII - 1)

The air ferry route from Japan leads southwest by way of Formosa and the northern Philippines to Del Monte and Davao on Mindanao Island, thence to Menado on Celebes Island and from there to delivery points in the Netherlands Indies.

D. Naval facilities.

Within the Celebes Sea area there are no naval bases or stations which may be properly so-called. Kaoe and Davao are headquarters of Japanese base forces but facilities at those points are limited. Several bays and harbors are regarded as potential naval bases possible of extensive development. These include the Wasile-Kaoe Bay on Halmahera Island; Dumanquilas Bay, Polloc Harbor, and Davao Gulf on Mindanao Island; West Tawitawi Bay and Tutu Bay in the Sulu Archipelago.

E. Air facilities.

The Celebes Sea Area as a whole is eminently suited to seaplane operations. Most of the islands in and surrounding it are suitable for construction of airfields and landing grounds and many such facilities have been developed, formerly by commercial airline companies and, since the occupation, by the Japanese. The following tables list seaplane facilities, airfields, landing grounds, and possible airfield sites in the area.

TABLE I - 4

SEAPLANE FACILITIES

Sector A: Halmahera

NAME AND COORDINATES	CLASSIFICATION	LOCATION	DIMENSIONS	REMARKS
1. Ternate 0° 46′ N, 127° 23′ E	S.A.A.	Just east of Ternate I. off west coast of Halmahera.	Unlimited runs north to south and northeast to southwest.	Fair shelter and anchorage; 4 mooring buoys and a slipway reported; dispersal for 20 aircraft; other facilities.
2. Berri Berri 2° 23′ N, 128° 40′ E	E.S.A.A.	Off northeast coast of Morotai I.	No data.	Sheltered by reefs and Tabailengi Island.
3. Bobane Bay 0° 52′ N, 127° 41′ E	E.S.A.A.	At the head of Kaoe Bay.	No data.	Sheltered anchorage for several seaplanes.
4. Bori Island 0° 35′ N, 127° 36′ E	E.S.A.A.	Between a small island and the mainland of Batjan Island.	No data.	Reported as a good concealment area.
5. Galela Lake 1° 49′ N, 127° 49′ E	E.S.A.A.	Near town of Galela on northern peninsula of Halmahera Island.	No data.	Invisible from sea. Best anchorage on east side of lake. Use of buoys is advised.
6. Groot Geelmulden Atoll 1° 04′ S, 128° 15′ E	E.S.A.A.	Across Obi Strait, 35½ miles northeast of Obi Major.	No data.	Anchorage at north end of atoll.
7. Labohea 0° 39′ N, 127° 28′ E	E.S.A.A.	In Awanggo Bay, at head of Laboeha Bay, just southwest of the town.	No data.	No details.
8. Lebessan Island 3° 29′ N, 125° 39′ E	E.S.A.A.	In a small bay off the east coast of Sangihe Island, 128 miles north-northeast of the northeast tip of Celebes Island.	No data.	No details.
9. Moeilijk 0° 34′ N, 128° 22′ E	E.S.A.A.	Atoll, 15 miles east of Halmahera Island.	No data.	A hiding place on west side of Moeilijk Atoll.
10. Sololo Bay 0° 48′ N, 128° 13′ E	E.S.A.A.	At head of Boeli Bay.	No data.	Reported hiding place.
11. Tahoena 3° 36′ N, 125° 29′ E	E.S.A.A.	Off west coast of Sangihe Island.	No data.	Open to northwest monsoon. Pier and radio station available.
12. Talawide 2° 41′ N, 125° 24′ E	E.S.A.A.	Reported in a lake on Siaoe Island at center of Sangihe Islands.	No data.	No details.

TABLE I - 4 (Continued)

NAME AND COORDINATES	CLASSIFICATION	LOCATION	DIMENSIONS	REMARKS
13. Tifore Island 0° 58′ N, 126° 09′ E	E.S.A.A.	In Laboehan Bay on east coast of Tifore Island.	No data.	Maneuvering in bay not possible. Planes can be beached.
14. Tobelo 1° 44′ N, 128° 01′ E	E.S.A.A.	Just north-northeast of Tobelo; between Tobelo Island and Halmahera Island.	No data.	Two landing stages. Planes can be beached.
15. Wasile Bay 1° 12′ N, 128° 08′ E	E.S.A.A.	In northern part of Kaoe Bay, on northeast peninsula of Halmahera Island.	No data.	Mooring area adjacent to north or south shore according to prevailing monsoon.
16. Weda Bay 0° 19′ N, 127° 52′ E	E.S.A.A.	Just south of Weda at head of Weda Bay.	No data.	No details.
		Sector C: Mindanao		
17. Malalag Bay 6° 36′ N, 125° 25′ E.	S.A.A.	In southwest part of Davao Gulf, 2 miles north of Baculing Hills, 58 miles northwest of Cape Agustin.	Four miles long, northwest to southeast; 1½ miles wide.	Bolton reef at middle of entrance to bay an obstruction; depths 6 to 30 feet; mooring for 4 PBYs; several sandy beaches suitable for hauling out.
18. Zamboanga Harbor 6° 54′ N, 122° 05′ E	S.A.A.	Just south of town of Zamboanga at southwest tip of Mindanao Island.	No data.	Sheltered from northeast monsoons; depths 6 to 30 feet; good anchorage near wharf in 28 feet; minor repairs and accommodations at Zamboanga.
19. Bugo 8° 30′ N, 124° 45′ E	E.S.A.A.	In Macajalar Bay.	No data.	Small craft available.
20. Davao Gulf 7° 06′ N, 125° 39′ E	E.S.A.A.	In Davao Gulf, 4 miles east of Samal Island.	Runs of 5¾ miles in any direction.	Limited shelter; minor repairs and fuel.
21. Dapitan Bay 8° 39′ N, 123° 24′ E	E.S.A.A.	West of Dapitan town in the bay off north end of west peninsula of Mindanao Island.	Runs of 2¼ miles in any direction.	No details.
22. Hinatuan Bay 8° 21′ N, 126° 21′ E	E.S.A.A.	In the bay west of Hinatuan Village on west side of Mindanao Island.	Two and one-half miles east to west; 1½ miles north to south.	No other details.
23. Igat Bay 7° 35′ N, 123° 10′ E	E.S.A.A.	On south side of west peninsula of Mindanao; on east arm of Dumanquilas Bay.	Three miles north to south; 3 miles east to west.	No details.
24. Isabela 6° 42′ N, 121° 58′ E	E.S.A.A.	In Isabela Channel between Malamaui and Basilan Islands.	No data.	No details.
25. Lake Buluan 6° 41′ N, 124° 48′ E	E.S.A.A.	About 38 miles west of Davao Gulf and 45 miles north of Sarangani Bay.	No data.	No details.
26. Lake Lanao 7° 59′ N, 124° 21′ E	E.S.A.A.	Near the center of Mindanao Island.	Runs of over 5 miles in any direction.	No other details.
27. Masinloc Anchorage 6° 55′ N, 122° 10′ E	E.S.A.A.	In the channel between Sacol and Mindanao Islands.	Run of 3 miles northeast to southwest.	No other details.
28. Murcielagos Bay 8° 35′ N, 123° 34′ E	E.S.A.A.	In Casul Bay, the south arm of Murcielagos Bay, off the north tip of the west peninsula of Mindanao.	Runs 12,000 feet north to south; 8,000 feet north-northeast to south-southwest.	No other details.
29. Nasipit Harbor 8° 59′ N, 125° 20′ E	E.S.A.A.	In Nasipit Harbor west and southwest of Nasipit town, 10 miles southeast of Diuata Point.	One mile north to south; 3,000 feet northeast to southwest.	No other details.
30. Polloc Harbor 7° 22′ N, 124° 14′ E	E.S.A.A.	On the west side of Mindanao Island, just west of Parang.	Two miles north to south, 3 miles east to west.	No other details.

TABLE I - 4 (Continued)

NAME AND COORDINATES	CLASSIFICATION	LOCATION	DIMENSIONS	REMARKS
31. Port Banga 7° 32′ N, 122° 27′ E	E.S.A.A.	On east side of the southwest peninsula of Mindanao Island; separated from Sibuguey Bay by Linguisan Point.	Three miles northeast to southwest.	No other details.
32. Port Holland 6° 33′ N, 121° 52′ E	E.S.A.A.	Just northeast of Port Holland in Malusu Bay, 4 miles southeast of Pangasahan Hill, 929 feet elevation.	Long runs available.	No other details.
33. Port Lamon 8° 28′ N, 126° 23′ E	E.S.A.A.	West of the wharf on north side of the bay.	Two miles east to west.	No other details.
34. Port Lebak 6° 32′ N, 124° 03′ E	E.S.A.A.	In Port Lebak on southwest part of Mindanao Island.	Over 1 mile east to west and north to south.	No other details.
35. Port Misamis 8° 08′ N, 123° 50′ E	E.S.A.A.	In Port Misamis on north central part of Mindanao, 12 miles southeast of Mount Malindang, elevation 8,950 feet.	No data.	No details.
36. Port Santa Maria 7° 46′ N, 122° 06′ E	E.S.A.A.	On west coast of Zamboanga Peninsula, northeast of Mount Santa Maria, elevation 646 feet.	No data.	No details.
37. Port Sibulan 7° 31′ N, 122° 55′ E	E.S.A.A.	In Tantalang Bay at the head of Port Sibulan, east of Naga Naga, on south side of the west peninsula of Mindanao Island.	Three miles east to west and north to south.	No other details.
38. Taba Bay 7° 32′ N, 122° 49′ E	E.S.A.A.	In Taba Bay north of Lumaro, about 2 miles southwest of Mount Sibuguey, elevation 1,050 feet.	One mile northeast to southwest; 2½ miles northwest to southeast.	No details.
		Sector D: Sulu Archipelago		
39. Banaran Island 5° 01′ N, 120° 08′ E	E.S.A.A.	Off northeast side of island which is in Tawitawi group.	No data.	Good shelter from nearly all weather.
40. Batu Batu Bay 5° 04′ N, 119° 53′ E	E.S.A.A.	Off the south coast of Tawitawi Island on east side of bay at New Batu Batu.	No data.	No details.
41. Capual Channel 6° 01′ N, 121° 24′ E	E.S.A.A.	In Capual Channel north of Liangliang on Jolo Island.	Three miles east-southeast to west-northwest.	Open to the southwest.
42. Jolo Harbor 6° 04′ N, 121° 00′ E	E.S.A.A.	Near the wharf in Jolo Harbor on the northwest coast of Jolo Island.	Three thousand feet in all directions.	Facilities for minor repairs.
43. Luuk Sula Bay 5° 03′ N, 119° 52′ E	E.S.A.A.	At the head of Luuk Sula Bay on south coast of Tawitawi Island, about 1 mile north of Patong Point.	One mile east to west and 1 mile east-northeast to west-southwest.	No other details.
44. Maraning Bay 5° 15′ N, 120° 02′ E	E.S.A.A.	Off northwest coast of Tawitawi Island, 3¼ miles southwest of Languyan Point.	No data.	No details.
45. Port Bongao 5° 02′ N, 119° 46′ E	E.S.A.A.	North of Bongao Island, south of Sanga Sanga Island, west of Papahag Island.	One mile east-northeast to west-southwest.	Run could extend 2 miles into Chongos Bay. Radio station at Bongao.
46. Port Languyan 5° 16′ N, 120° 04′ E	E.S.A.A.	In Port Languyan on the central northwest coast of Tawitawi Island.	No data.	Reported an excellent alighting area; bordered by a mangrove swamp, with some beach frontage.
47. Sibutu Island 4° 48′ N, 119° 22′ E	E.S.A.A.	In the north lagoon of the island.	No data.	Ample room for landings and take-offs reported.

TABLE I - 4 (Continued)

NAME AND COORDINATES	CLASSIFICATION	LOCATION	DIMENSIONS	REMARKS
48. Tataan Pass 5° 11′ N, 119° 55′ E	E.S.A.A.	Between Tataan Island and Tawitawi Island.	Two miles north to south, 3 miles northeast to southwest.	There are two reefs in the pass about ⅛ mile offshore.
		Sector E: Northeast Borneo		
49. Abai River 6° 22′ N, 116° 21′ E	E.S.A.A.	On the Abai River about 1½ miles inland and about 5 miles west-northwest of Kota Belud, on north side of east-west reach.	No data.	No details.
50. Ambong Bay 6° 19′ N, 116° 18′ E	E.S.A.A.	Five miles southwest of the Abai River on northwest coast of British North Borneo.	No data.	Well-sheltered.
51. Balambangan Island 7° 17′ N, 117° 01′ E	E.S.A.A.	In Lung Bay on east coast of island which is west of Banguey Island.	No data.	No details.
52. Balung River 4° 18′ N, 118° 11′ E	E.S.A.A.	Nineteen miles east of Tawao, 15 miles due west of Cowie Harbor.	Two reaches 1¼ miles by 600 feet lying east to west and north to south.	No details.
53. Boeaja 1° 26′ N, 118° 27′ E	E.S.A.A.	Off the northeast coast of a large headland on the east coast of Borneo.	No data.	No details.
54. Cowie Harbor 4° 15′ N, 117° 50′ E	E.S.A.A.	In Coal Mine Reach, on east coast of Borneo.	Area unlimited.	Well-sheltered.
55. Jesselton 5° 59′ N, 116° 05′ E	E.S.A.A.	Between Gaya Island and Jesselton Harbor on northwest coast of British North Borneo.	No data.	Some repair facilities, a pier, and a crane. Occasionally used by both civil and military aircraft prior to Japanese invasion.
56. Kinabatagen River 5° 37′ N, 118° 35′ E	E.S.A.A.	Thirty-six miles east of Sandakan and 2½ miles southwest of Driftwood Point.	No data.	No details.
57. Kudat 6° 53′ N, 116° 51′ E	E.S.A.A.	About ½ mile west of Kudat wharf on west side of an inlet on north end of the west arm of North Borneo.	No data.	Two mooring buoys. No evidence of use by Japanese since occupation in January 1942.
58. Kalumpang River 4° 20′ N, 118° 21′ E	E.S.A.A.	Thirty-two miles east of Tawau, 1 mile north of Kalumpang and in the river east of Mangrove Island where the stream divides.	No data.	No details.
59. Labuan 5° 17′ N, 115° 15′ E	E.S.A.A.	In Victoria Harbor on southeast coast of Labuan Island.	Approximately 6,000 feet in all directions.	Two moorings, 1 pier. Fuel and oil storage facilities. RAF flying boats operated from here. No evidence of Japanese use or development.
60. Lahad Datu 5° 02′ N, 118° 20′ E	E.S.A.A.	West of Jetty at Lahad Datu in Darvel Bay on southeast coast of North Borneo.	No data.	Good anchorage.
61. Maruap River 5° 25′ N, 118° 16′ E	E.S.A.A.	Northwest of Evans Island off extreme northeast coast of Borneo.	Described as ample alighting area.	No details.
62. Mitford Harbor 7° 08′ N, 117° 07′ E	E.S.A.A.	Near south coast of Banggi Island off the north coast of Borneo. Exact location unknown.	No data.	No details.
63. Papar 5° 45′ N, 115° 55′ E	E.S.A.A.	In the lower reach of Papar River, about 20 miles south-southwest of Jesselton on the northwest coast of Borneo. Near the Jesselton-Linkungan Railroad.	No data.	No details.

TABLE I - 4 (Continued)

NAME AND COORDINATES	CLASSIFICATION	LOCATION	DIMENSIONS	REMARKS
64. Sandakan 5° 49′ N, 118° 07′ E	E.S.A.A.	In the harbor ¾ mile west-southwest of the government pier.	No data.	No moorings. Limited repair facilities. Slipway available but unsuitable for large aircraft. Fuel and oil available but location of storage unknown.
65. Tarakan 3° 16′ N, 117° 36′ E	E.S.A.A.	Off the southwest coast of Tarakan Island just east of the town.	No data.	Sheltered. Gasoline and oil available. Facilities for minor repairs.
66. Timbu Nata 4° 34′ N, 118° 32′ E	E.S.A.A.	Off the south coast of Timbu Mata Island just south of Darvel Bay.	No data.	No details.
		Sector F: Northern Celebes		
67. Amoerang Bay 1° 12′ N, 124° 34′ E	E.S.A.A.	In southwest part of Amoerang Bay, just north of Amoerang on the northeast coast of Celebes Island.	Three and one-half miles in any direction.	No other details.
68. Bangka Strait 1° 41′ N, 125° 03′ E	E.S.A.A.	In southwest part of Bangka Strait, just north of Likoepang.	Reported unlimited.	Well-sheltered.
69. Belang Harbor 0° 57′ N, 124° 47′ E	E.S.A.A.	In Belang Harbor just northeast of Belang.	No data.	Sheltered anchorage.
70. Dampelas Lake 0° 11′ N, 119° 52′ E	E.S.A.A.	In Dampelas Lake on Dampelas Cape, southeast of Makassar Strait, just southeast of Sabang village.	No data.	No details.
71. Danau Lake 0° 46′ N, 124° 28′ E	E.S.A.A.	In southwest corner of Danau Lake, just south of Kotamobagoe.	No data.	Surrounded by mountains.
72. Gorontalo Bay 0° 28′ N, 123° 03′ E	E.S.A.A.	In Gorontalo Bay just south of Gorontalo on the south coast of Menado Peninsula.	No data.	No details.
73. Kakas 1° 11′ N, 124° 53′ E	E.S.A.A.	In the southwest corner of Lake Tondano, 4 miles northeast of Langoan.	No data.	Fuel and oil available. Mooring buoys believed present.
74. Koeandang Bay 0° 51′ N, 122° 54′ E	E.S.A.A.	On the east side of Koeandang Bay on the north shore of Manado Residency.	No data.	No details.
75. Lembeh Strait 1° 26′ N, 125° 11′ E	E.S.A.A.	In the south part of Lembeh Strait between the northeast coast of Celebes and Lembeh Island.	Three miles northeast to southwest and ¼ to ¾ mile wide.	No details.
76. Limboto Lake 0° 35′ N, 122° 58′ E	E.S.A.A.	On the south side of Limboto Lake on the south central part of the north peninsula of Celebes Island.	No data.	No details.
77. Manado Bay 1° 30′ N, 124° 50′ E	E.S.A.A.	In Manado Bay just north of Manado.	No data.	Four mooring buoys. Unprotected.
78. Santigi Bay 1° 20′ N, 120° 55′ E	E.S.A.A.	In Santigi Bay on north coast of Celebes.	No data.	Alighting area is east to west.
79. Talise Island 1° 52′ N, 125° 05′ E	E.S.A.A.	Reported at Talise Island, 10 miles north of north tip of Celebes Island.	No data.	No details.
80. Tasoeka 1° 11′ N, 124° 54′ E	E.S.A.A.	Also in southwest corner of Lake Tondano.	No data.	Fuel and oil available. Moorings believed present.

TABLE I - 4 (Continued)

NAME AND COORDINATES	CLASSIFICATION	LOCATION	DIMENSIONS	REMARKS
81. Telok Pagalongian 0° 50′ N, 120° 34′ E	E.S.A.A.	On the south side of Dondo Bay about 2 miles north of Boeloetong.	No data.	No details.
82. Tolitoli Bay 1° 03′ N, 120° 48′ E	E.S.A.A.	Just north of Kampoengbaroe town, northeast of Dondo Bay.	No data.	Small jetty, beaching facilities, 3 mooring buoys, and a radio station formerly available.
83. Tondano Lake 1° 17′ N, 124° 55′ E	E.S.A.A.	On Tondano Lake which lies near the tip of Manado peninsula.	No data.	Anchorages at Tasoeka, Kakas, and Tondano.

TABLE I - 5

AIRFIELDS AND LANDING GROUNDS

Sector A: Halmahera

NAME AND COORDINATES	CLASSIFICATION	LOCATION	DIMENSIONS	REMARKS
1. Galela 1° 52′ N, 127° 49′ E	MAD	On Galela Plain, 3¾ miles northwest of Galela on northern peninsula of Halmahera Island.	No. 1 runway, 4,500 by 250 feet northeast to southwest. No. 2 runway 4,700 by 290 feet, northeast to southwest.	Extensive dispersal system. Capacity, 158 bombers, 100 fighters. Field still under construction. Buildings nearby. Extensible.
2. Lolobata 1° 17′ N, 128° 06′ E	MAD	On the north coast of Lolobata Cape on west side of northeast peninsula of Halmahera I., 2½ miles northwest of Lolobata.	Runway 4,600 by 500 feet north-northeast to south-southwest.	Ample dispersal. Capacity, 34 bombers, 10 fighters. Field reported in excellent condition.
3. Miti 1° 34′ N, 128° 04′ E	MAD	On the northwest side of Miti Island close off the east coast of the north peninsula of Halmahera Island.	Runway 4,600 by 350 feet north to south.	Capacity, 95 bombers, 40 fighters. Thirty-five unprotected bomber dispersal points. Reported serviceable in all weather.
4. Kaoe 1° 11′ N, 127° 53′ E	FLG	One and one-half miles west of Kaoe, just east of Kaoe River, on the north coast of Kaoe Bay.	Runway No. 1, 4,500 feet north to south; No. 2, 3,600 by 300 feet north to south, 4,000 feet northeast of No. 1.	Capacity, 50 bombers, 80 fighters. Field tends to become water-logged, landings possible only on runways. Several buildings near runway.
5. Laboeha 0° 38′ S, 127° 29′ E	ELG	Approximately 1 mile east-southeast of Laboeha on Batjan Island, west of the south end of the south peninsula of Halmahera Island.	Length of runway, northeast to southwest, unknown.	Estimated capacity reported as 25 bombers, 25 fighters. Site may offer possibilities of expansion and further development.
6. Oba 0° 45′ N, 127° 34′ E	FLG	Just east of Sofifi on west central coast of Halmahera Island.	Runway 3,400 feet northwest to southwest with no flight gaps.	Estimated capacity, 10 bombers, 15 fighters. Ample room for construction of dispersal facilities. Runway extensible to possibly 6,000 feet.
7. Pitoe (Doroeba) 2° 03′ N, 128° 18′ E	MLG	Just east of Doroeba on southernmost tip of Morotai Island, 10 miles east of north end of the northern peninsula of Halmahera Island.	Approximately 5,000 feet northeast to southwest.	Reported still under construction. Dispersal for 5 bombers, 5 fighters observed.

Sector C: Mindanao

8. Davao 7° 07′ N, 125° 39′ E	FAD	Six miles north of Davao, 7 miles south of Bunawan on west side of Davao-Bunawan highway.	Runways 3,346 by 164 feet north to south; 2,624 feet northeast to southwest.	North-south runway paved. Serviceable in all-weather. One hangar reported. Ample area and cover for dispersal.
9. Davao-Cabaguio 7° 06′ N, 125° 37′ E	FAD	Three miles north-northeast of Davao, on south side of the Davao to Bunawan highway.	Runway 2,850 feet north to south.	Ample cover for dispersal; 1 hangar. Strip 2,640 by 66 feet reported paved.
10. Alah River 6° 16′ N, 124° 44′ E (approx.)	ELG	Just south of Sapali Barrio on east bank of Alah River. Estimated elevation 1,200 feet.	Runway approximately 1,250 by 125 feet, extensible.	Good cover nearby. No other details.

TABLE I - 5 (Continued)

NAME AND COORDINATES	CLASSIFICATION	LOCATION	DIMENSIONS	REMARKS
11. Barobo 8° 32′ N, 126° 05′ E	FLG	Four miles west of Barobo barrio; 7½ miles south of Lianga near southwest shore of Lianga Bay.	Runway 3,328 by 197 feet east to west.	Field soft after rains but drainage good. Near road from Barobo to Tambis. Accommodations at Tambis Mining Company.
12. Bassa Point 7° 10′ N, 125° 44′ E (approx.)	ELG	Near Bassa Point on north tip of Samal Island in Davao Gulf.	Approximately 2,000 by 500 feet.	No details.
13. Bual 6° 04′ N, 125° 08′ E (approx.)	ELG	Two and one-half miles south of Makar River mouth near west shore of Sarangani Bay.	Estimated 750 by 50 feet.	Some cover nearby. No other details.
14. Buenavista (San Jose de Buenavista) 8° 56′ N, 125° 23′ E	MLG	At Risal barrio 2½ miles south of Buenavista on Butuan Bay; 10 miles west of Butuan.	Reported 5,249 by 328 feet north-northeast to south-southwest.	Field has clay surface with a central gravelled strip 2 inches thick and 75 feet wide. Drainage poor. Soft in wet weather.
15. Buluan 6° 42′ N, 124° 47′ E	HLG	At east edge of town of Buluan just northwest of Lake Buluan.	Reported 5,249 by 328 feet east to west.	Field sodded, sandy loam, all-weather. Cover available. Camouflage nets and pens built in 1942. Philippine Constabulary barracks nearby.
16. Butuan 8° 57′ N, 125° 31′ E	ELG	On west edge of town of Butuan in Agusan Province near west bank of Agusan River.	North to south 1,950 by 195 feet.	Surface is sodded clay loam. Possibly extensible. Ample cover. Access by road and waterway. Telephone and telegraph in town.
17. Butuan-Bancase 8° 57′ N, 125° 28′ E	FLG	Three miles south of Butuan Bay at barrio of Bancase, 4 miles west of Butuan.	Reported 2,427 by 98 feet northwest to southeast.	Reported paved. Access by road and waterway. Barracks at adjacent Philippine military reservation.
18. Cagayan 8° 29′ N, 124° 38′ E	MLG	Two miles west of Cagayan on the Cagayan to El Salvador highway, 2½ miles south of Macajalar Bay.	Runways 4,265 by 328 northwest to southeast, 3,-609 by 328 feet north to south.	Considered an all-weather field for fighter aircraft. Abundant cover nearby. Road transportation to dock at Cagayan. Buildings available.
19. Cotabato 7° 12′ N, 124° 14′ E	FLG	At barrio of Kakar 2 miles south of Cotabato.	Runway 2,625 by 164 feet northwest to southeast.	Reported enlarged and in active use. Sodded hard ground, slightly rolling. Reported all-weather. Ample cover nearby. Buildings available.
20. Dadiañgas 6° 08′ N, 125° 10′ E	ELG	At barrio of Dadiañgas between Silvay and Makar river mouths, 1 mile north of Sarangani Bay.	Reported 1,969 by 164 feet northwest to southeast.	Level and sandy, all-weather. Two new runways, each 3,281 by 328 feet, were under construction in 1941.
21. Davao-Ipil 7° 06′ N, 125° 38′ E	ELG	Three miles northeast of Davao at the south entrance to Pakiputan Strait.	Reported 1,626 by 189′ north to south.	Grass surface. Ample cover nearby.
22. Del Monte No. 1 8° 21′ N, 124° 49′ E (approx.)	HLG	Fifteen miles southeast of Cagayan, on west bank near headquarters of second south tributary to Tagoloan River.	Reported 7,000 by 600 feet northeast to southwest. Elevation estimated 1,500 feet.	All-weather, suitable for all types of aircraft. Ample area for dispersal but with little cover.
23. Del Monte No. 2 8° 20′ N, 124° 47′ E	FLG	At Del Monte Club 2 miles west of Tankulan, 2 miles southwest of Del Monte No. 1. Eleveation 1,200 feet.	Runways 3,300 by 300 feet north to south, 2,200 by 300 feet east to west.	Sodded hard ground. All-weather. Ample dispersal area with limited cover.
24. Del Monte No. 3 8° 20′ N, 124° 54′ E (approx.)	HLG	One-half mile west of Daling Barrio, 8 miles east of Del Monte No. 1. Elevation estimated 1,500 feet.	Reported 6,000 by 200 feet north to south.	Surface of sod, all-weather for all types. Slope to south. Good cover for small aircraft.
25. Del Monte No. 4 8° 16′ N, 124° 59′ E (approx.)	HLG	Near Impasugong barrio, 15 miles southeast of Del Monte No. 1. Estimated elevation 1,800 feet.	Reported 6,200 by 300 feet north to south.	Sodded. Suitable in all-weather for all types of aircraft. Limited cover for dispersal.
26. Del Monte No. 5 (Palais) 8° 21′ N, 124° 49′ E (approx.)	MLG	On west bank near headwaters of second south tributary to Tagoloan River, 1 mile south of Del Monte No. 1.	Two east to west runways, adjacent, each 5,000 by 300 feet.	Good cover available for dispersal. No other information.

TABLE I - 5 (Continued)

NAME AND COORDINATES	CLASSIFICATION	LOCATION	DIMENSIONS	REMARKS
27. Del Monte No. 6 (Tigiptip) 8° 21′ N, 124° 47′ E (approx.)	MLG	Near Del Monte Club, 2½ miles southwest of Del Monte No. 1. Estimated elevation 1,500 feet.	Reported 5,000 by 300 feet north to south.	Turf, all-weather. Good cover for dispersal.
28. Del Monte No. 7 8° 21′ N, 124° 49′ E (approx.)	HLG	One mile south of Del Monte No. 1. Estimated elevation 1,500 feet.	Reported 6,200 by 300 feet northeast to southwest.	Turf, all-weather, for all types of aircraft. At least 1 bombproof hangar in mountain at south end of field.
29. Del Monte No. 8 8° 21′ N, 124° 54′ E (approx.)	FLG	One mile northeast of Dalirig near Agusan-Impasugong Road; 8 miles east of Del Monte No. 1.	Reported 4,000 by 300 feet north to south.	Grassy sod, all-weather, drainage presumably good. Good cover for fighter aircraft nearby. Road and telephone communication.
30. Dipolog 8° 36′ N, 123° 21′ E	HLG	One mile north of Dipolog; 9 miles south-southwest of Tagolo Point.	Reported 6,562 by 197 feet northeast to southwest.	Sodded, all-weather for all types of aircraft. Good drainage. Dispersal for 9 heavy bombers, 25 fighters. Paved road to Puluan port.
31. Gingoog 8° 49′ N, 125° 06′ E	FLG	Three and one-half miles south of Gingoog on Gingoog Bay on north coast of Mindanao Island.	Runway 3,400 by 150 feet northeast to southwest.	Sodded ground, soft after rain. Dispersal for 25 fighter aircraft. Standard gauge railroad to deep water port at Anakan.
32. Iligan 8° 15′ N, 124° 15′ E	FLG	About 1,000 feet north of Mandulug River mouth on Iligan Bay, 1 mile north of Iligan.	Runway 4,000 by 300 feet east to west.	Grass surface, soft in wet weather. Ample cover nearby.
33. Kabacan 7° 09′ N, 124° 49′ E (approx.)	ELG	One and one-half miles south of Pulangi and Kabacan River junctions near Kabacan.	Approximately 750 by 150 feet.	Believed wet and dangerous. Ample cover nearby.
34. Kibawe 7° 30′ N, 124° 59′ E	ELG	At Kibawe, 51 miles southeast of Lake Lanao, 52 miles northwest of Davao.	Runway 2,624 by 246 feet north to south.	Sodded clay loam, all-weather. Ample cover nearby.
35. Labo 8° 11′ N, 123° 49′ E (approx.)	MLG	Near Labo barrio, 4 miles northwest of Misamis at the southwest end of Iligan Bay.	Reported 4,642 by 328 feet.	Grass sod on sandy loam. All-weather. Suitable for all types of aircraft. Ample cover. Paved road to Port Misamis.
36. Dansalan-Maguire 8° 01′ N, 124° 17′ E	FLG	At Camp Keithley, ½ mile northwest of Lake Lanao, 2 miles west of Dansalan. Elevation 2,455 feet.	Runways 2,297 by 180 feet north to south; 2,297 by 164 feet northwest to southeast.	Sodded, all-weather, good drainage, 2.2% down-grade to south. Military barracks and other buildings at Camp Keithley.
37. Makar 6° 06′ N, 125° 09′ E	ELG	On west shore near north end of Sarangani Bay, near Makar River mouth and Makar Barrio.	Reported 1,950 by 651 feet.	Smooth, sandy turf. Limited cover nearby.
38. Malabang 7° 38′ N, 124° 04′ E	HLG	Three miles north of Malabang on north shore of Illana Bay in south Mindanao Island.	Runways 7,500 by 300 feet east to west, 4,500 by 300 feet north to south.	Smooth sand, all-weather. Also reported as grass on coral base. Extensive natural cover.
39. Malangas 7° 36′ N, 123° 02′ E (approx.)	ELG	Near Malangas barrio in Zamboanga Province, on west shore of Dumanquilas Bay.	Approximately 1,500 by 200 feet.	Sodded, possibly extensible. Ample cover nearby. Waterway and roads to Zamboanga. Radio and telegraph in Malangas.
40. Malaybalay 8° 02′ N, 125° 06′ E	FLG	At Mamala barrio, 2 miles west of Malaybalay; elevation 2,050 feet.	Runways, 2,370 by 300 feet northwest to southeast; 3,400 by 300 feet northeast to southwest.	Sodded loam, all-weather, excellent drainage. Suitable for light aircraft. Near road to Davao, Del Monte, and Cagayan.
41. Maramag No. 1 7° 44′ N, 125° 00′ E	FLG	Just south of Maramag, 53 miles east-southeast of Maguire Field on Lake Lanao. Elevation 1,550 feet.	Reported 3,000 by 300 feet east to west.	Grass surface, soft after heavy rain but drainage good. Used in 1942 by P-40s and B-25s.
42. Maramag No. 2 7° 44′ N, 125° 00′ E (approx.)	MLG	Near Maramag about 500 feet east of Maramag No. 1.	Reported 5,000 by 250 feet north-northwest to south-southeast.	Grass surface, soft after heavy rain but drainage good. Used in 1942 by P-40s and B-25s.

TABLE I - 5 (Continued)

NAME AND COORDINATES	CLASSIFICATION	LOCATION	DIMENSIONS	REMARKS
43. Maramag No. 3 7° 43′ N, 125° 01′ E (approx.)	HLG	Two miles south of Maramag No. 1.	Runways 6,000 by 500 feet east-northeast, 4,000 by 500 feet north to south.	During April, 1943, a 3-inch gravel surface was being laid on the north to south runway.
44. Maraut River (Pantukan) 7° 19′ N, 125° 57′ E	ELG	In wooded canyon on bank of Maraut River near Pantukan, 20 miles northeast of Bassa Point on Samal Island in Davao Gulf.	Reported 3,000 by 197 feet east to west.	Area limited by canyon. Upgrade to east, landings from west and take-offs from east only. Sodded clay loam. Good cover.
45. Midsayap 7° 10′ N, 124° 32′ E (approx.)	FLG	Three miles south of Midsayap, 5 miles southeast of Lake Labas. Estimated elevation 200 feet.	Reported 5,249 by 328 feet east to west.	Drainage poor. Good cover available.
46. Mount Matutum 6° 26′ N, 124° 58′ E (approx.)	MLG	Seven miles northwest of Mount Matutum in Cotabato Province, 18 miles southeast of Lake Buluan. Estimated elevation 1,500 feet.	Reported 4,921 by 262 feet north to south.	Level and rolled with gravel. Soft when wet. Hills to south. Best approach from north. Only cover at north end of field.
47. Pikit 7° 04′ N, 124° 40′ E (approx.)	ELG	One mile north of Pikit-Pagalungan barrio, 35 miles east-southeast of the mouth of Mindanao River.	Approximately 700 by 200 feet north to south.	Possibly extensible. Limited cover.
48. Placer-Badas 9° 38′ N, 125° 33′ E	ELG	Near barrio of Basas, 2½ miles west of Plaur, 7 miles north of Mainit Lake.	Runways, 2,625 by 164 feet east to west, 2,297 by 98 feet northeast to southwest.	All-weather. Northeast to southwest runway paved, east to west runway soft when wet. Ample cover. Buildings. Access by road and waterway.
49. Santa Cruz 6° 56′ N, 125° 25′ E	ELG	Eight miles north-northeast of Santa Cruz, 14 miles southwest of Davao.	Reported 2,600 by 650 feet.	Limited cover nearby. No other details.
50. Valencia No. 1. 7° 50′ N, 125° 05′ E, (Based on AAF chart 855 AI)	MLG	Two miles north of Valencia Barrio, 14 miles south of Malaybalay. Elevation 1,032 feet.	Reported 5,280 by 900 feet north to south.	Sodded clay loam. Serviceable in all-weather. Good cover nearby.
51. Valencia No. 2 7° 53′ N, 125° 06′ E (approx.)	MLG	Near Mailag, 4 miles north of Valencia on east side of Valencia-Malaybalay highway. Estimated elevation 1,850 feet.	Reported 5,249 by 328 feet northeast to southwest.	Cogon grass turf. Good drainage. Serviceable in all-weather for all types of aircraft.
52. Wolfe Field 6° 56′ N, 122° 02′ E	FLG	At Calarian barrio 4 miles west of Zamboanga on southwest tip of Mindanao Island.	Runway 2,296 by 197 feet.	Sodded ground, serviceable in all-weather. Good cover nearby.
53. Zamboanga 6° 55′ N, 122° 07′ E	HLG	Just east of the town of Zamboanga on southwest tip of Mindanao Island.	Three strips reported 7,000 by 400 feet, 7,000 by 400 feet, 4,000 by 400 feet.	The existence of this new large landing ground has not been confirmed.
Sector D: Sulu Archipelago				
54. Zettel Field (Jolo) 6° 03′ N, 121° 01′ E	FLG	On northwest coast of Jolo Island, 1 mile east of town of Jolo.	Reported 3,960 by 459 feet east to west.	Sodded clay loam. Serviceable in all-weather. Cover nearby.
Sector E: Northeast Borneo				
55. Jesselton 5° 57′ N, 116° 04′ E	HLG	On northwest coast of North Borneo, 3 miles west of Jesselton.	Various reports. May not be actually constructed. Also two 7,000 foot runways reported.	Fuel, oil, water and some repair facilities available. Radio station and accommodations at Jesselton.
56. Kenigau 5° 21′ N, 116° 12′ E (town)	ELG	Exact location unknown; reported to lie between 2 spurs of low hills.	Reported 3,300 feet square, exact dimensions unknown.	Sandy soil covered with alang (heavy grass). No other details.
57. Kudat 6° 56′ N, 116° 50′ E	ELG	Three and one-half miles north of Kudat on the northwest coast of Marudu Bay at north end of west arm of North Borneo.	Unknown.	Details unknown. Reported a military field and considered operational.

TABLE I - 5 (Continued)

NAME AND COORDINATES	CLASSIFICATION	LOCATION	DIMENSIONS	REMARKS
58. Labuan Island 5° 20′ N, 115° 13′ E (approx.)	FLG	Reported on Labuan Island which lies off the west coast of British North Borneo.	Varying reports of 2 runways, longest 6,000 feet; also that both are 6,000 feet.	Two aircraft observed here according to recent intelligence. No other details.
59. Lahad Datu 5° 02′ N, 118° 20′ E (town)	ELG	Reported at Lahad Datu in west corner of northernmost reach of Darvel Bay on the Southeast coast of Borneo.	Unknown.	No other details but field is considered operational.
60. Ranau 5° 58′ N, 116° 42′ E (town)	ELG	Exact location unknown. Ranau is reported in West Coast Residency 1 mile east of confluence of Ligwau and Berambang Rivers.	Unknown.	Reported that development was unlikely. Also reported that it is now considered operational.
61. Sandakan 5° 51′ N, 118° 07′ E (town)	ELG	Reported at Sandakan on the west side of the entrance to Sandakan Harbor on the northeast coast of Borneo.	Unknown.	Details unknown; development into a major base expected; considered operational.
62. Tarakan 3° 20′ N, 117° 34′ E	ELG	In central part of southwest coast of Tarakan Island, 5 miles north-northwest of Tarakan.	Runways 2,850 ft. northeast to southwest, 2,520 feet east to west, 2,430 feet northwest to southeast, 2,310 feet north to south.	Firm earth and grass usually serviceable; fuel and oil available; facilities for minor repairs. Dutch had 4 fighter and 4 bomber revetments here.
63. Tawau 4° 15′ N, 117° 53′ E (town)	ELG	Reported at Tawau on north shore of entrance to Cowie Harbor on the southeast coast of North Borneo.	Unknown.	Details unknown but it is considered now to be used for operational purposes.
Sector F: Northern Celebes				
64. Langoan 1° 09′ N, 124° 50′ E	FAD	One mile east-northeast of Langoan, 3 miles west-southwest of Kokas at the south end of Lake Tondano.	Reported 4,200 by 300 feet north-northeast to south-southwest.	Surface coral or limestone, probably all-weather. Extensible. Dispersal for 40 fighters, 30 bombers. Buildings nearby. Mountains in area.
65. Mapanget 1° 31′ N, 124° 54′ E	FLG	One and three-fourths miles west of Mapanget, just north of Mapanget River and south of Kima River, 6 miles east-southeast of Manado.	Information varied, (Topic 124, F, (3), (b))	Grass surface. Reported capacity 20 fighters, 40 bombers.

TABLE I - 6

POSSIBLE AIRFIELD SITES

Sector A. Halmahera

NAME	APPROXIMATE COORDINATES	REMARKS
1. Akelamo	1° 28′ N. 128° 40′ E.	Small coconut plantation, 62 acres near Akelamo; ground flat and dry; soil, sandy.
2. Belangbelang I.	1° 19′ S. 127° 24′ E.	Possible site a mile long northwest to southeast on northeast side of the island.
3. Bisa I.	1° 15′ S. 127° 28′ E.	Possible strip reported at southwest end of Bisa Island, which is 13 miles north of west end of Obi Major Island.
4. Boeli-Serani	0° 52′ N. 128° 17′ E.	Clearing for possible strip reported inland from Boeli-Serani, north coast of Boeli Bay.
5. Djailolo North	1° 09′ N. 127° 28′ E.	Five miles north-northeast of Djailolo; cleared for 1650 feet by the Dutch in 1941; not developed; extension possible in all directions; a good deal of levelling required on this strip.
6. Djailolo South	1° 07′ N. 127° 28′ E.	Three and one-fourth miles north-northeast of Djailolo; cleared for 5280 feet by the Dutch in 1941; not developed; extension possible east-west.
7. Galela East	1° 48′ N. 127° 53′ E.	Possible clearing for strip reported 7 miles east-southeast of Galela medium bomber airfield, 3 miles east-southeast of Galela; unconfirmed.
8. Morotai I.	2° 06′ N. 128° 31′ E.	Possible strip reported on southeast end of Morotai Island; unconfirmed.
9. Sidangoli	0° 54′ N. 127° 31′ E.	Possible site, runway limited to 4000 feet (approximately) northeast-southwest; near Sidangoli at northwest end of Dodinga Bay.

TABLE I - 6 (Continued)

NAME	APPROXIMATE COORDINATES	REMARKS
10. Sofifi	0° 44′ N. 127° 33′ E. (town)	Clearing for strip reported but not confirmed, 1 mile south of Sofifi.
11. Tilope	0° 13′ N. 127° 55′ E.	Possible site on coastal plain near Tilope village, on the east coast of south arm of Halmahera Island. Land is flat, dry, and sandy near the shore.
12. Tobelo	1° 39′ N. 128° 00′ E.	Possible site on coastal plain 5 miles south of Tobelo, 15 miles southeast of Galela, on east coast of Halmahera Island. Ground reported flat, firm, and well drained.
13. Wajaoea	0° 45′ S. 127° 39′ E.	Possible site about 1 mile northeast of Wajaoea village, on south side of isthmus on Batjan Island.
14. Wasile	1° 04′ N. 127° 59′ E. (town)	Probably just north of Wasile town, on northeast coast of Kaoe Bay; "serviceable strip" reported but not confirmed.
		Sector B. Sangihe-Taland
15. Karakelong I.	4° 00′ - 4° 35′ N. 126° 33′ - 126° 55′ E.	A few flat areas along the coast; no detailed information.
16. Tamako	3° 28′ N. 125° 30′ E.	Possible sites reported near Tamako on the southwest coast of Sangihe Island.
		Sector C. Mindanao
17. Camp Overton	8° 12′ N. 124° 12′ E. (town)	Possible site reported at Camp Overton at the head of Iligan Bay; flat, cleared area on the coast.
18. Dalwangan	8° 06′ N. 125° 04′ E.	Possible site reported at Dalwangan; outside of town parallel to a road.
19. Davao (Japanese Colony)	7° 17′ N. 125° 41′ E.	Approximately 15 miles north-northeast of Davao in the midst of a Japanese Colony, a natural landing field 6000 feet by 7000 feet.
20. Davao Gulf	6° 30′ N. 126° 07′ E.	Any amount of flat land which could be cleared and used as a landing ground; on the east coast of Davao Gulf, in the general vicinity of Madruka Point.
21. Dapitan	8° 39′ N. 123° 26′ E. (town)	Potential site just in front of the church at Dapitan, on the north end of Mindanao Island, about 1200 feet by 1500 feet, running down to the water, could be made into a small field.
22. Dayana Point	7° 39′ N. 123° 08′ E.	Potential site reported on Dayana Point on the south central coast of Mindanao; on the northeast coast of Dumanquilas Bay; the land slopes gently back from the end of the point for a distance of about 1 mile.
23. Dumanquilas Bay	7° 04′ N. 123° 01′ E.	Potential site just northwest of Bacao, just southwest of Boton; 3000 feet by 1500 feet nearly level but needs clearing; good approaches.
24. Igai Point	7° 38′ N. 123° 03′ E.	Potential site reported on Igai Point on west side of Dumanquilas Bay on south side of Mindanao Island; on a 100 foot plateau which tops the point; reasonably flat, needs clearing; drainage considered excellent.
25. Malalag	6° 36′ N. 125° 23′ E.	Flat area to the southwest of Malalag which is on the southwest coast of Malalag Bay, east of Davao Gulf; needs to be cleared.
26. Malamaui I.	6° 43′ N. 121° 58′ E.	Potential site reported on Malamaui Island, just northwest of Basilan Island; landing field could be cleared at a neighboring rubber plantation but would entail considerable work.
27. Murcielagos Bay	8° 35′ N. 123° 34′ E.	Sites are located in the vicinity of the cultivated areas on Diuyu River; at the South end of Murcielagos Bay.
28. Nasipit Harbor	8° 59′ N. 125° 26′ E. (town)	Potential site reported at Nasipit Harbor on the northwest coast of Mindanao Island; sufficient level ground to permit clearing and levelling for a landing ground.
29. Polloc Harbor	7° 23′ N. 124° 16′ E. (town)	Small emergency landing ground could be made from the parade ground at the constabulary post at Parang by removing the radio poles; on the central east coast of Polloc Harbor.
30. Port Holland	6° 33′ N. 121° 52′ E.	Potential site reported at Port Holland in a large area filled and packed with sawdust; on the west coast of Basilan Island.
31. Port Misamis	8° 10′ N. 123° 51′ E.	Two excellent sites about ½ to 2 miles in area reported on the road between Misamis and Clarin; at the southwest end of Iligan Bay.
32. Port Sibulan	7° 33′ N. 122° 54′ E.	Potential site reported at the head of Port Sibulan on the south coast of Mindanao Island; could be prepared at considerable cost by clearing the necessary land.

TABLE I - 6 (Continued)

NAME	APPROXIMATE COORDINATES	REMARKS
33. Sapali	6° 18′ N. 124° 43′ E. (town)	Possible site reported at Sapali which is ½ mile northeast of Alah River; 6 miles northwest of Lake Sultan; about 23 miles south-southwest of Lake Buluan.
34. Sindangan	8° 14′ N. 123° 00′ E. (town)	Potential landing field reported at Sindangan; in the northeast corner of Sindangan Bay; 1½ miles north of mouth of Sindangan River.
35. Sumilao	8° 17′ N. 124° 56′ E. (town)	Potential site reported at Sumilao which is 20 miles southwest of the head of Macajalar Bay.
		Sector D. Sulu Archipelago
36. Banaran I.	5° 01′ N. 120° 08′ E.	Area is well cleared and could be prepared easily on Banaran Island in the Tawitawi Island Group.
37. Bubuan I.	5° 25′ N. 125° 35′ E.	Potential site on Bubuan Island in Tawitawi Group; best cleared areas are on the north side of the island.
38. Carmen Point	5° 05′ N. 119° 50′ E.	One mile east of Carmen Point, on the west coast of Tawitawi Island, an area which could be levelled. Reported as the best spot in the Tawitawi Islands for building and maintaining a landing field.
39. Manalik Channel	5° 05′ N. 119° 50′ E.	A landing ground could possibly be constructed on the east side of Manalik Channel between Carmen Point and Lapidlapid; area only 75% cleared.
40. Papahag I.	5° 02′ N. 119° 48′ E.	Potential site reported in the center of Papahag Island, at the south end of the Tawitawi Group; area is flat and could easily be cleared.
41. Sanga Sanga I.	5° 04′ N. 119° 48′ E.	North of Malasa Point, site about 1 mile square may be prepared in less time than any other point in the Tawitawi Group; Sanga Sanga Island is one of the southernmost in the Tawitawi Group.
42. Secubun I.	5° 06′ N. 120° 18′ E.	The east central side of the island can easily be cleared to form a landing field 1 mile by ½ to ¾ mile. The soil is coarse loam with chalky sub-soil at about 18 inches. Secubun Island is 4½ miles southeast of Tawitawi Island.
43. Simunul I.	4° 53′ N. 119° 51′ E.	Cleared spaces are available on both east and west sides of the island which is 9 miles south of Tawitawi Island. In 1929 a naval reconnaissance estimated that in three weeks with local Simunul labor a large-sized landing field could be cleared.
44. South Ubian I.	5° 10′ N. 120° 30′ E.	Potential site which could be levelled in a reasonably short time, rich loam soil with a tendency to fine coral and sand toward the shore. Cleared spaces are firm. About 17 miles east of Tawitawi Island.
45. Tabawan I.	5° 13′ N. 120° 35′ E.	Reported probably the flattest island in the Tawitawi Group, areas on both north and south shores where a small plane could take off.
		Sector F. Northern Celebes
46. Amoerang	1° 11′ N. 124° 33′ E. (town)	Possible site reported around Amoerang Bay to the west and along the coast from Amoerang.
47. Belang	0° 56′ N. 124° 47′ E.	Possible site reported at Belang on the south side of the north arm of the Celebes; coconut plantations along the shore.
48. Bongo	0° 42′ N. 122° 30′ E.	Possible sites reported in low flat areas along the coast; in valley of Pagoejaman River near Bongo.
49. Dondo Bay	0° 52′ N. 120° 22′ E.	Possible site on a low flat shore covered with mangroves and coconut plantations on south side of inlet on west side of Dondo Bay.
50. Gorontalo	0° 30′ N. 123° 03′ E.	Possible site in Pagoejaman valley about 30-40 miles from Gorontalo.
51. Kema	1° 22′ N. 125° 05′ E. (town)	Possible site reported at Kema on east side of north tip of the Celebes; on a low plain covered with coconut plantations and scattered mangrove.
52. Kotaboena	0° 48′ N. 124° 39′ E. (town)	May be same as Kotaboenan (coordinates given); low ground with protected anchorage behind islands.
53. Limba	0° 29′ N. 122° 32′ E.	Existence doubtful, unconfirmed.
54. Leok (Bilang Bay)	1° 09′ N. 121° 25′ E.	Possible site about 3 miles southeast of Leok on southwest side of Bilang Bay; flat shore but area is rather marshy.
55. Tamboe Gulf	0° 01′ N. 119° 54′ E.	Low sandy shores planted with coconuts on Tamboe Gulf.
56. Toeladenggi	0° 45′ N. 121° 52′ E.	West in the direction of Cape Santigi some flat stretches of coast line with scattered jungle of coconut plantations.

FIGURE I - 7
JANIS 155

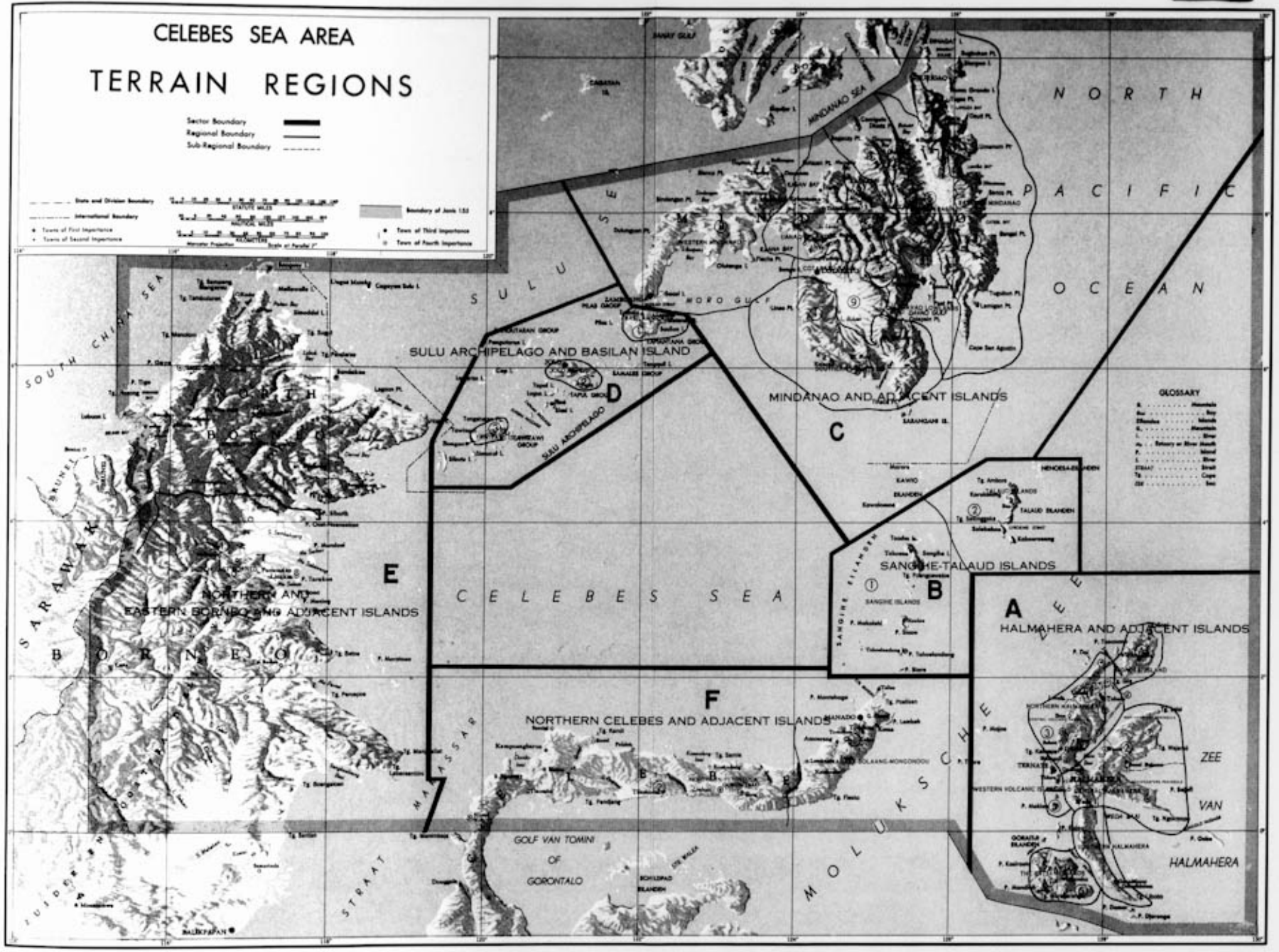
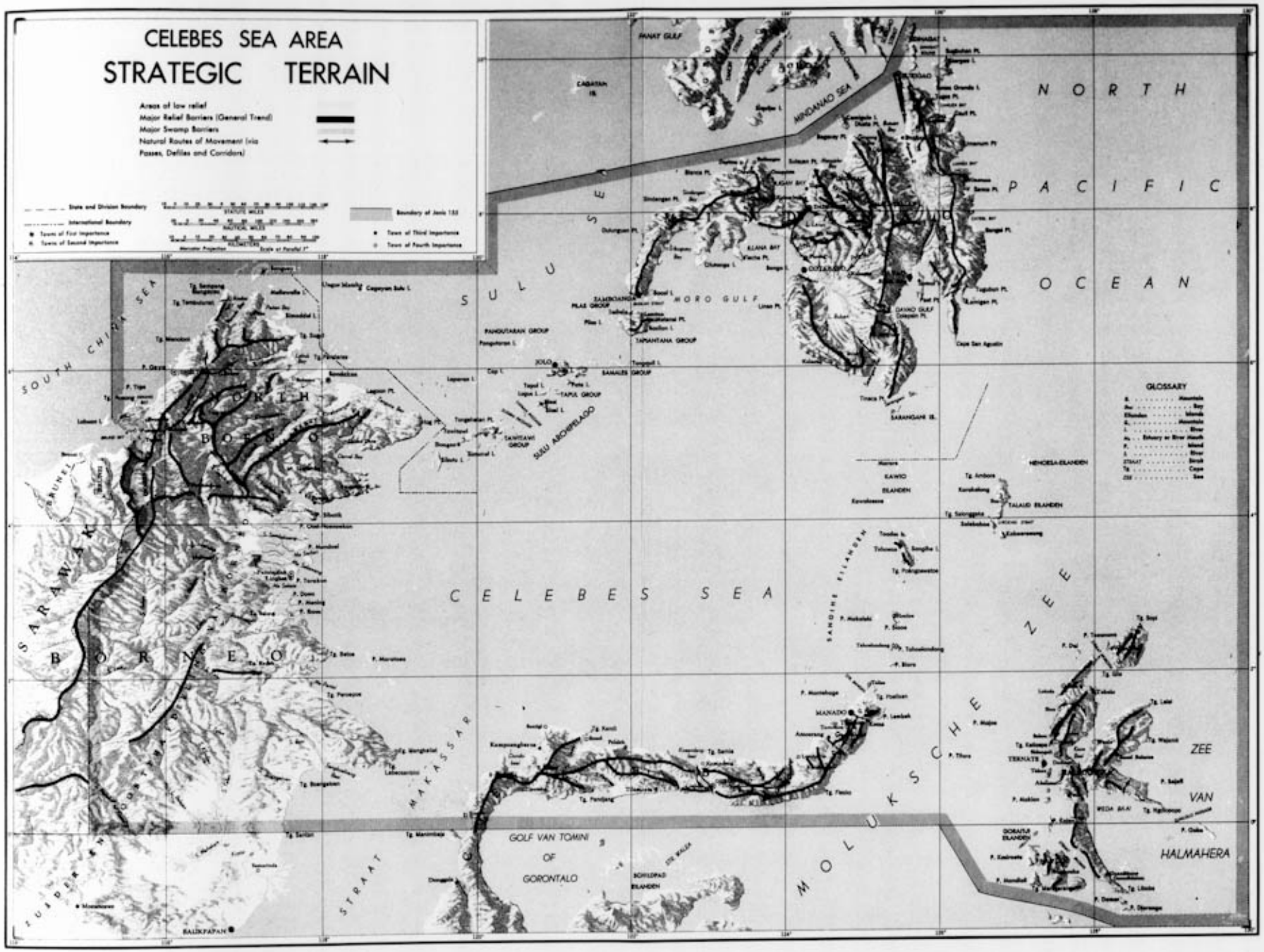


FIGURE 1 - 8
JANIS 155



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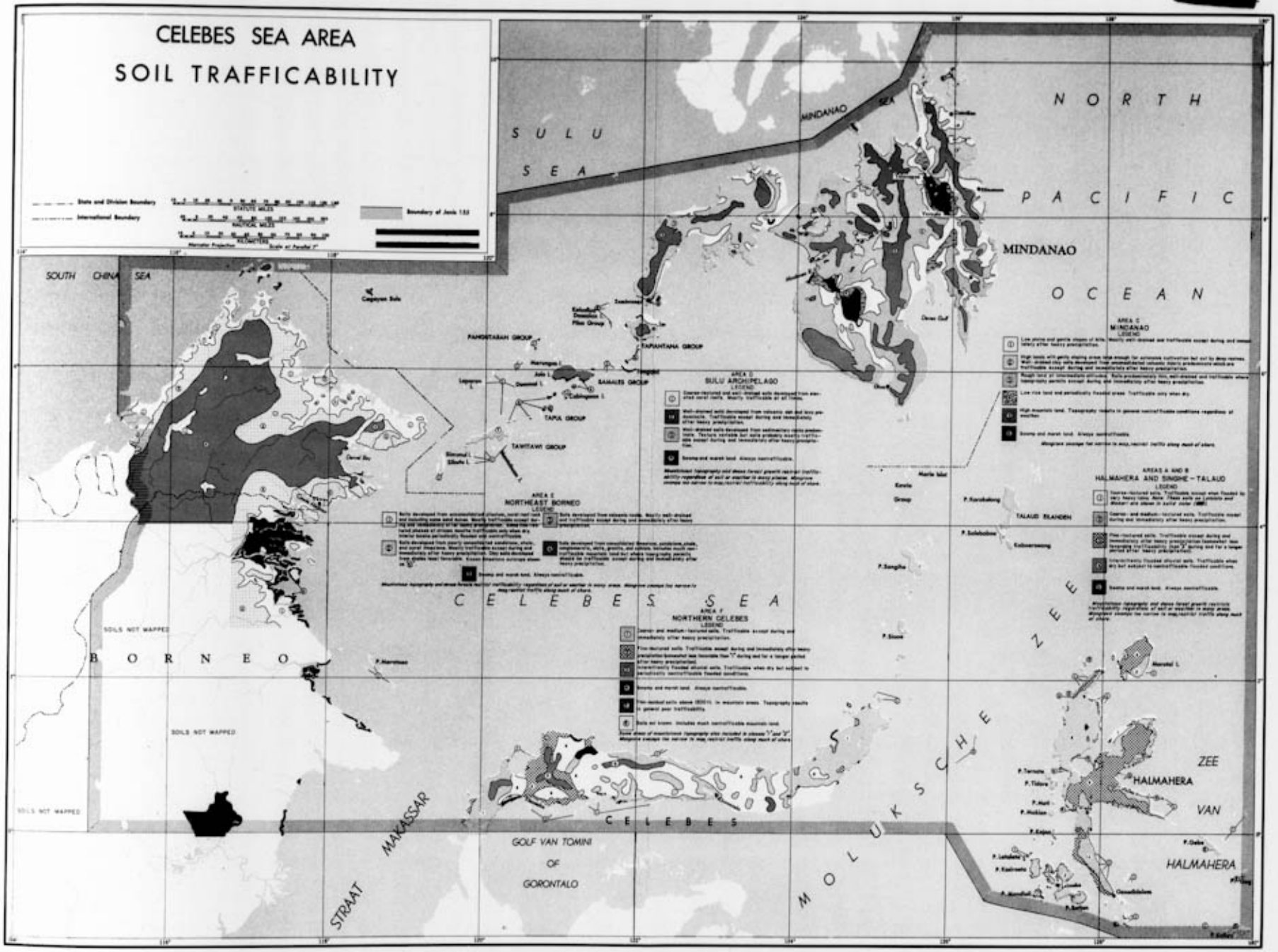

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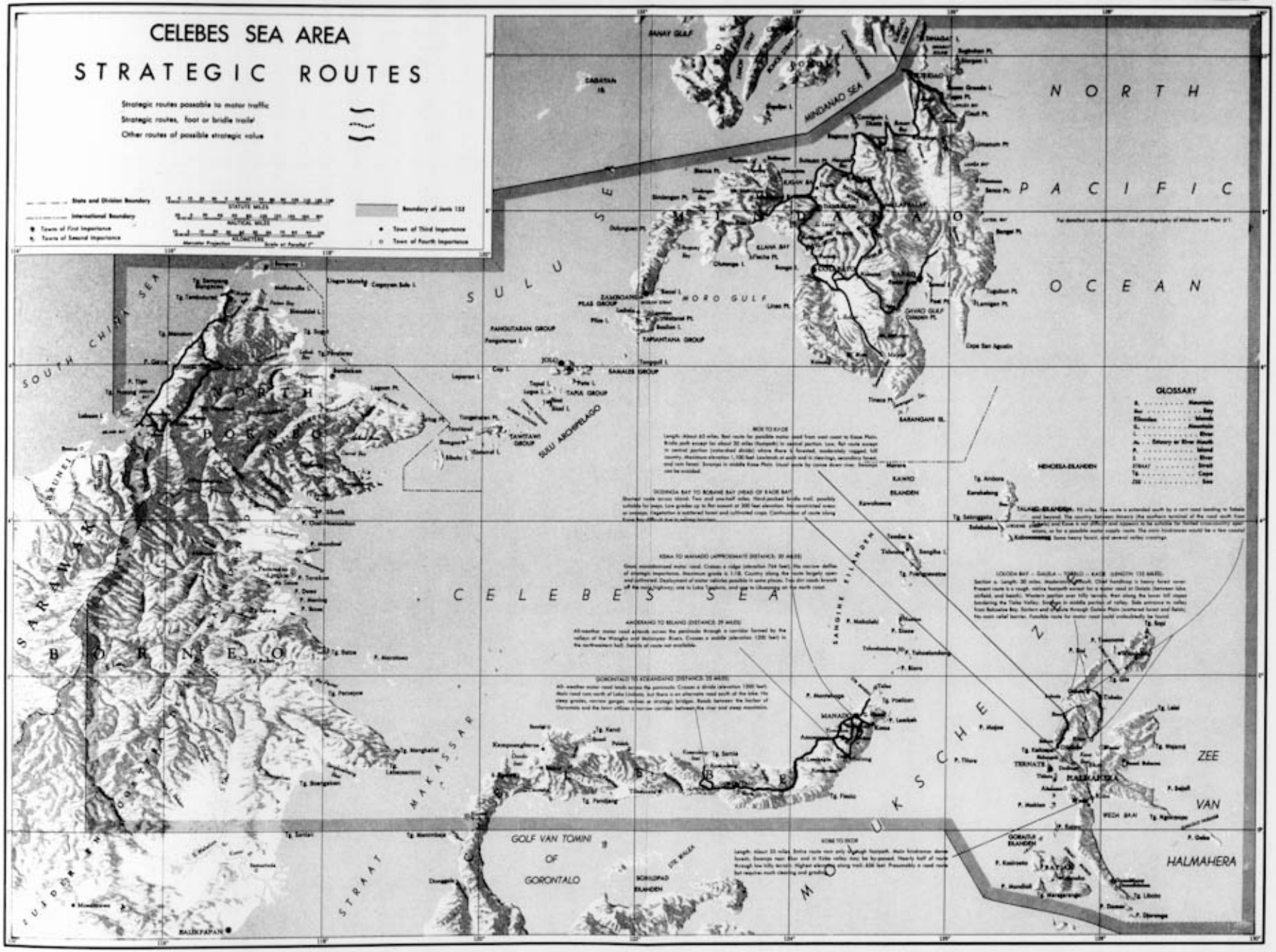

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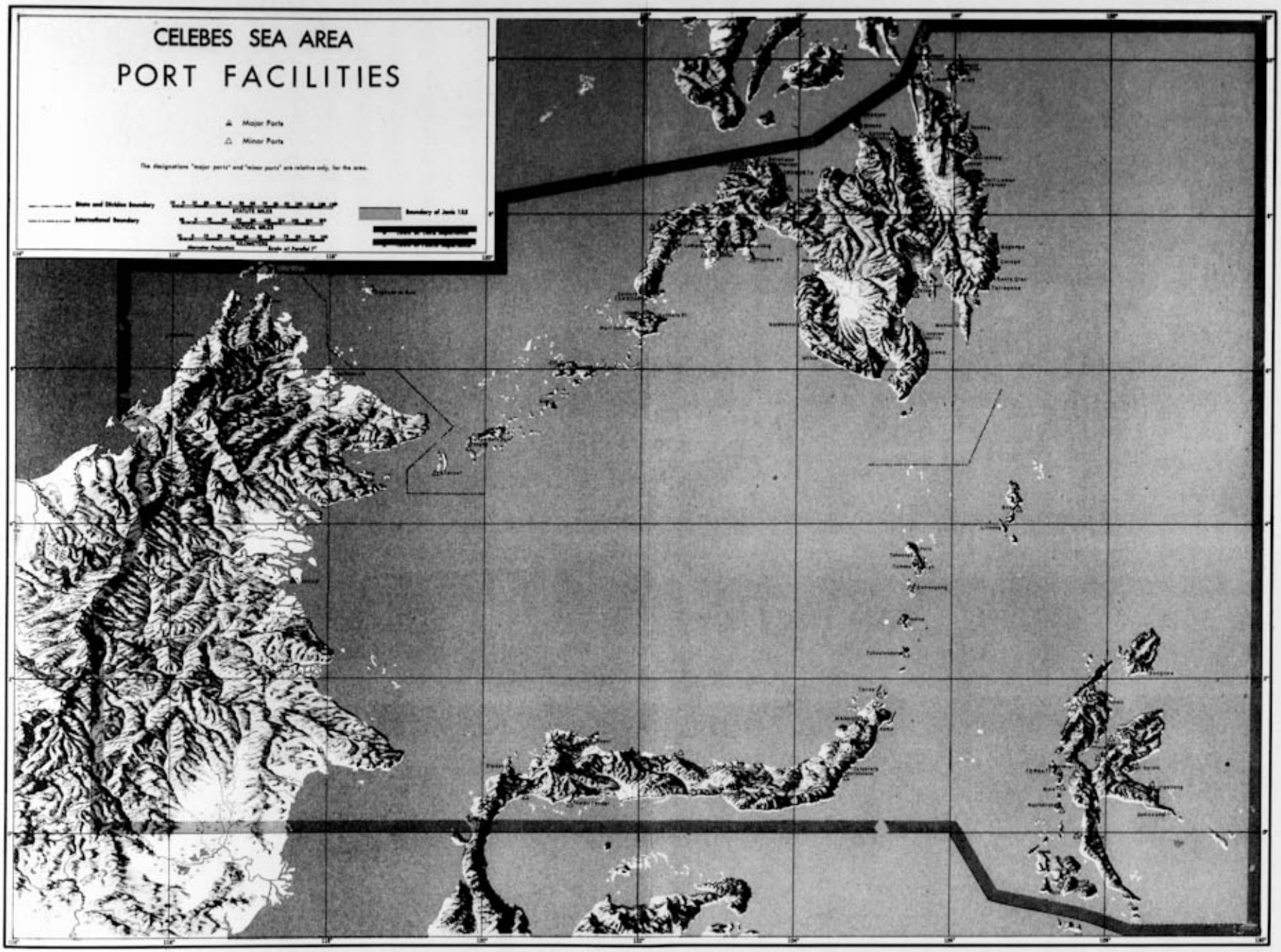

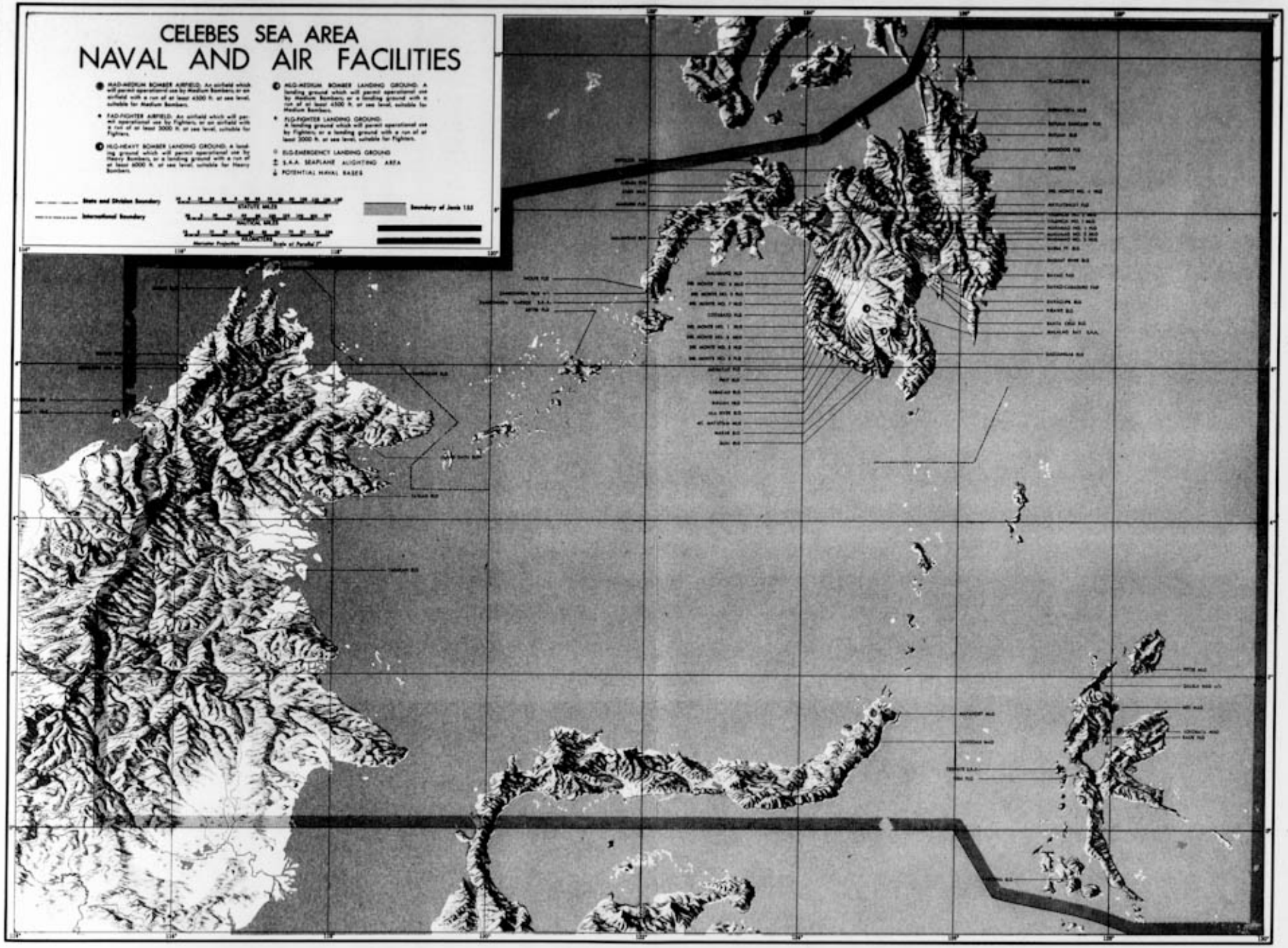
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State and Division Boundary
International Boundary
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JANIS 155
CHAPTER II

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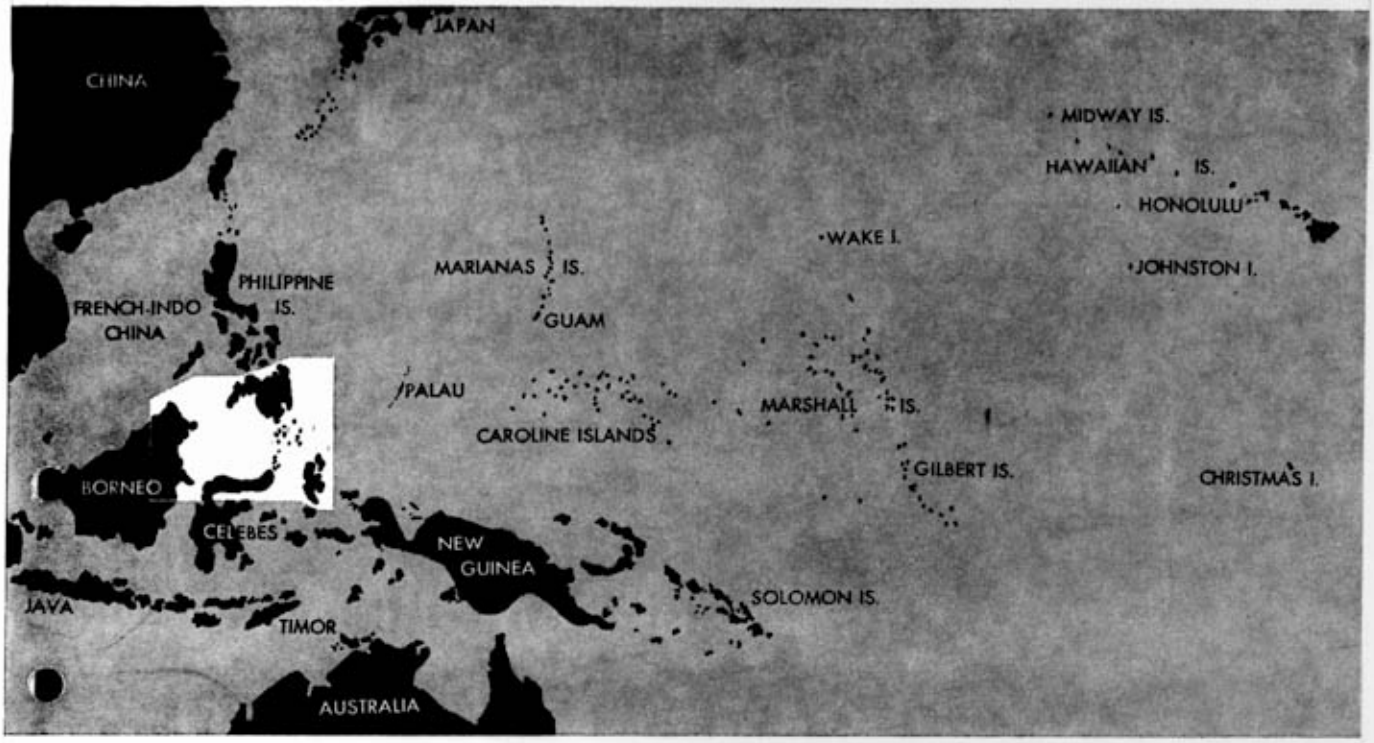

JOINT ARMY-NAVY INTELLIGENCE STUDY

OF

CELEBES SEA AREA

MILITARY GEOGRAPHY

MAY 1944

List of Effective Pages, Chapter II

Subject Matter	Change in Effect	Page Numbers
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List of Effective Pages and Table of Contents, Chapter II (inside front cover)	Original	unnumbered
Text and Figures	Original	pp. II-1 to II-40
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Figure (insert, reverse blank)	Original	Figure II-43
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Note: This chapter is based on material available in Washington, D. C., on 25 April 1944.

(Continued inside back cover)

MILITARY GEOGRAPHY

20. *General Description of the Area*

A. Relief.

(FIGURES II - 42 and II - 43).

Most of the land in the Celebes Sea area consists of rough, mountainous terrain, especially in the interior of the islands. Areas of low flat land are found mainly along the coasts or on flood plains of the larger rivers in Borneo and Mindanao. The coastal plains are usually narrow, and seldom are continuous for long distances. Cross-country military operations will have to contend with difficult terrain problems throughout the area, with few exceptions. These exceptions are in the Minahasa Region of Celebes (the northeastern tip of the northern peninsula), and the central portion of Mindanao where there are wide stretches of open, rolling terrain. Elsewhere, the interiors of the islands under consideration are mountainous, covered with dense forests, sparsely inhabited by native populations, and accessible only by forest trails. For this reason, most military operations will be directed against peripheral objectives, primarily against airfields, harbors, supply points, and garrison bases along the coasts. Nearly all such objectives are located on comparatively narrow and discontinuous coastal plains without good exits inland. In a few cases, particularly in northeastern Borneo, there are extensive river flood plains extending inland from the coast, but these are likely to be swampy, heavily forested, and not suitable for large scale operations. Because of the peninsular character of the larger island masses included within the area, attention also will likely be focussed upon cross-island routes, control of which will enable troops to cut off relatively large segments of the islands. These routes, with few exceptions, follow mountain passes, and undoubtedly have numerous associated defensive phase lines. Very few of these passes are now utilized by motor roads, and it is doubtful if many are suited for road construction.

Although there are hundreds of smaller islands within the area, relatively few are militarily significant—chiefly those that are low, flat, and suitable for airfield development or for minor land bases. Several such islands are located off the east coast of Halmahera, and in the southern portion of the Sulu Archipelago.

B. Drainage and water supply.

(1) Rivers.

The rivers generally are short and rapid, because of their small drainage basins and the absence of broad lowland plains. The main exception to this is in Borneo, particularly in the eastern and northeastern portions, where a broad area of hilly to mountainous terrain in the interior receives heavy rainfall, and is the source region of many large rivers. In their lower reaches these rivers are deep and follow winding courses across their flood plains to the sea. They are practically the only easy routes of penetration into the interior of this large but little known island. From a military point of view, however, they act more as barriers than routes, since objectives are seldom located in the interior. The great width and depth of these rivers, along with their susceptibility to flooding, make them effective obstacles to overland routes from one coastal objective to another. Outside Borneo, there are only two rivers that would be sufficiently large to act as defensive phase lines for large-scale operations; these are the Agusan and Mindanao-Pulangi rivers on the island of Mindanao.

(2) Swamps.

Even more effective than the rivers as barriers to cross-country movement are the swamps and marshes. Practically all the extensive ones are located on the flood plains of the large rivers of Borneo and Mindanao, but often no less significant are the small stretches of poorly drained land that lie back of the beaches on many of the coastal plains. They restrict coastal travel to narrow beach strips, and effectively limit the area of flat land suitable for airfields.

(3) Lakes.

There are few lakes in the area, and most of these are either small ponds in volcanic craters or shallow swamp lakes on river flood plains. The only ones that appear to be suitable for float plane use are Lakes Lanao and Mainit on Mindanao, Galela Lake on Halmahera, and Tondano on Celebes.

(4) Water supply.

Since all of the area has a considerable rainfall, and because there are innumerable streams that have their headwaters in mountainous country, fresh water is almost always available. The main exception to this is found on the very small islands, particularly those of the low coral or sandy type. Usually on such islands the only available fresh water is obtained either from the collection of rain water or from shallow wells.

C. Vegetation.

Wide expanses of unbroken forest are characteristic of nearly all of the rough mountainous sections. On the coastal lowlands, however, the type of vegetation is dependent largely on soil conditions and on the stage of cultural development of the area. As a general rule, low, sandy coastal plains contain groves of coconut palms. Back from these sandy soil areas, the coastal lowlands contain variable amounts and types of cultivated land. On Halmahera, Borneo, and many of the smaller islands sparsely populated with native peoples, the lowland plains vegetation is likely to consist of scattered native gardens, abandoned clearings grown up to tall coarse grass (*"kunai"* or *"cogon"*), dense secondary forest, or patches of sago (particularly in the swamps). In culturally more advanced portions of the area (Celebes and Mindanao), open fields are much more common, and are used mainly for rice and corn. Large plantations are relatively rare outside of Mindanao. Intermediate slopes, or low, hilly lands, commonly are in either secondary forest or scattered clearings. Mindanao contains the only broad areas of open grasslands. The Bukidnon and Lanao uplands in central Mindanao have hundreds of square miles of grasslands, and the flat, interstream areas in these regions require little more than the cutting of the coarse tall grass to make them suitable for airfields.

21. Relief

The major relief regions and their characteristics are indicated on FIGURES II - 42 and II - 43, which should be studied concurrently with the text material below. Topographic maps of many sectors will be found in the plans pouch.

A. Halmahera and adjacent islands.

Halmahera and its neighboring islands are mostly hilly to mountainous (PLANS 2, 3, and 4). Areas of flat to undulating land are small and discontinuous, and are found along the coast, primarily near the mouths of the principal streams. The three lowland areas (The Galela, Kaoe, and Djailolo-Soesoepoe plains) are located on the northern peninsula of the main island. The only easy cross-island route is at the narrow isthmus between Dodinga Bay and Kaoe Bay. The central portions of the peninsulas have mountainous backbones, and trail crossings are usually of low utility. Large-scale military operations would be exceedingly difficult, and probably impracticable away from a few coastal areas, because of rugged terrain and dense forest cover in the interior. For purposes of convenience in describing the relief of Halmahera it is divided into 3 regions: a southern region, a central region, including the 2 eastern peninsulas and the central part of the island; a northern region consisting of the northern peninsula. These are sub-divided into terrain subregions. The volcanic islands west of Halmahera, Morotai, and the Batjan Group will be treated in separate paragraphs.

(1) Southern Halmahera.

This region includes the southern peninsula of the island. A long mountain ridge extends along the western side. The southern end of the peninsula is composed largely of uplifted coral reefs with rough surfaces. In a few places, such as west of Weda, and east of Saketa and Ganedidalem, streams have cut gaps into the ridge, providing relatively easy crossings. The highest and most rugged section is directly opposite the northeast corner of Batjan Island. Mount Oewattjain rises here to an elevation of 4,100 feet. The top of the ridge is generally between 2,000 and 3,000 feet in elevation. Since the drainage divide is near the west coast, the coastal plain on the west side is very narrow or is nonexistent. Wider coastal plains with associated coral terraces border the east coast. Extensive swamps cover large segments of the plains in the vicinity of Foja and Weda on the east coast, and Maidi on the west coast.

(2) Central Halmahera.

Central Halmahera consists of several terrain subregions which are similar in general but have sufficient individual diversity to merit individual description.

(a) Southeastern Peninsula. The northwestern portion of this region consists of rough hill country. Toward the southwest, the hill country narrows to a long, narrow ridge that continues to the end of the peninsula, Ngolopopo Point. The largest valley in the region is that of the Sangadji River, whose middle course opens out to form a broad interior basin. This basin is relatively inaccessible. The lower portion of the valley is almost a continuous swamp during the wet season. The coastal plains on the northern side of the peninsula are somewhat wider than those on the south side, although they are generally only a mile or so in width. Except for a few places where there are rocky sea cliffs, such as a short distance westward of Ngolopopo, eastward of Remdi Point, and westward of Sagea village, the coastal flats are continuous around the entire peninsula. The best crossing of the peninsula is south from the middle portion of the Sangadji valley to the valley that reaches the coast of Weda Bay at the village of Sepo. The maximum elevation along this trail is only 1,424 feet.

(b) Central Subregion. This subregion is located at the junction of the four peninsulas. In general relief structure, it is somewhat similar to the mountain block between the Kaoe and Lamo valley (Paragraph (3)(b) below.). The western escarpment, however, is much more deeply dissected, and there are several outlying remnants of the block rising from surrounding lowlands, particularly in the southwestern portion. East of the summit the land surface is not as dissected as in the district west of the Kaoe valley, and there are a few rather wide upland areas of low relief. The coastal plains generally are narrow, except near the mouths of some of the larger streams, i.e., that at the head of the Bay of Pajahi, the southeastern side of Dodinga Bay, the Kobe valley extending inland from the head of Weda Bay, and the plain of Ekor, on the south side of Kaoe Bay. The lowlands generally contain a considerable proportion of swamps or marshes, particularly those along the southwestern coast of this region. None of these lowlands has good natural exits to other parts of the island except, in a few cases, laterally along the coast. The most feasible and probably the only possible strategic cross-country route lies between the plain of Ekor on Kaoe Bay, and the northern portion of the Kobe Plain. Only a crude native path now follows this route, but presumably it would not be difficult to improve. The maximum elevation along this trail is only about 700 feet. A notable characteristic of the coastal plains is their uniform flatness. Airfield construction on them generally would have serious drainage problems.

(c) Northeastern Peninsula. The mountain area that comprises most of this peninsula is not very high (generally between 2,000 and 3,000 feet), but it is a confused mass of ridges and valleys of irregular shape, trending in every direction. The interior is unpopulated and would be very difficult to cross. West of Boeli-Serani is an extremely rugged mountain area about 30 miles long from north to south, and 10 miles wide (in its northern portion). It constitutes an effective barrier to any cross-country travel northwestward from Boeli Bay. As in other parts of the island, the coastal plains vary in width. The principal ones are at the head of Wasile Bay, the Akelamo and Onat River valleys, and the plain of Boeli-Serani. There are no good exits to the rest of the island, hence the military significance of these plains lies mainly in their suitability for airfield construction.

(3) Northern Halmahera.

From the standpoint of relief, the northern peninsula of Halmahera is the best suited for military operations, because despite the preponderance of rough, mountainous terrain, it also contains the largest areas of low slopes on the island. The major alignment of the relief features is in a northeast-southwest direction. The northern peninsula can be divided into 5 subregions of relief: the Kaoe-Tobelo Lowlands and Ridges, the Lamo-Kaoe Block, the Central Volcanic Range, the Galela Plains and Tiabo Valley, and the Northwestern Mountain Ridge.

(a) Kaoe-Tobelo Lowlands and Ridges. The southeast-

ern side of the northern peninsula of Halmahera is a region of open flat plains, rolling hill country, and dissected coastal benches or terraces. The most extensive area of plains on the entire island lies within this region, in the drainage basin of the Kaoe River. The Kaoe plains can be divided into 3 segments: a wide, well-drained lowland lying back of the village of Kaoe, and extending inland for about 8 miles to a point near Popan where the valley is constricted; a middle portion, 11 miles long and 4 to 5 miles wide, much of the southern part of which is swampy; and in the north, an area of flat plateau country lying directly south of the volcanic range at an elevation of about 1,000 feet, and separated from the lower plains by a belt of hilly terrain. Immediately east of and facing westward toward the Kaoe plains is a steep escarpment. From the top of the escarpment, the land surface breaks away toward the east in a series of long sweeping slopes broken by numerous stream valleys. The gradient of these slopes decreases gradually toward the coast. Along the eastern coast, from opposite Miti Island southward to the entrance to Kaoe Bay, the coast is backed by extensive terraces between 100 and 300 feet in elevation. They are deeply dissected by streams. From Miti Island northward to Tobelo and beyond, there is a continuous coastal plain which, at its widest point, is only about 2 miles wide. It is well drained and has a comparatively large native population. The narrow coastal strip between the Tobelo coastal plain and the Galela plain is broken by a series of lava flows from Mount Mamoeja. These flows, on several occasions, have blocked the coastal road between Galela and Tobelo.

(*b*) *Lamo-Kaoe Block.* West of the Kaoe plains and extending southwestward almost to Dodinga Bay, is a belt of low mountainous country that forms a fairly effective terrain barrier. The west side of this mountainous area is formed by a steep escarpment which rises from 1,500 to 2,000 feet above the Lama valley, which in turn separates this region from the volcanic range to the northwest. Only short, swift streams have indented this escarpment. East of the escarpment crest, which forms the highest part of the area, the land surface is very broken, with long, irregular ridges and valleys trending roughly eastward. One of the more important cross-island trails passes up the Lamo valley, and leads across a belt of hill country to the upper Kaoe valley. An area of fairly rough hill country extends southward from the southern end of the mountain belt to the Dodinga Isthmus. The narrow Dodinga Isthmus itself is easily crossed, as is evidenced by the fact that natives often drag their boats across it from Dodinga Bay to Bobane Bay in order to avoid the long route around the southern end of the island. On the northwestern side of Kaoe Bay, extending northeastward from Akelamo, is a coastal plain about 4 miles wide at its widest point. Except for a narrow beach strip along the shore, this area appears to have little military significance because of the extensive swamps that cover most of the plains.

(*c*) *Central Volcanic Range.* The central part of the northern peninsula lies along a line of former extensive volcanic activity. This line trends from northeast to southwest. Along it is a string of volcanic peaks, from Djailolo on the southeast to the rugged Tobelo Mountains on the south side of Galela Bay. Some of these volcanic peaks exceed 4,000 feet in elevation. The sides of the volcanoes are entrenched by numerous steep-sided ravines. Although the volcanoes do not constitute an unbroken mountain barrier, the entire area is wild and rugged. Between the main axis of the volcanic area and the Tiabo valley to the north, is a belt of rough country, interrupted by the Iboe plains which extend inland from the west coast for about 5 miles. A considerable part of this lowland is under native cultivation. The lowland at the head of Loloda Bay is mostly swampy. The southwestern end of the region is formed by Djailolo Peak, a volcanic cone 3,706 feet high. It is separated from the rest of the range by a belt of low, level terrain, the Djailolo-Soesoepoe Plain (FIGURE II - 1). This plain is fertile and well-populated, and the Dutch, prior to the war, had partially completed 2 emergency airplane landing strips on it, about 3 miles north of Djailolo.

(*d*) *Galela Plains and Tiabo Valley.* The Tiabo River has its headwaters not far from Loloda Bay on the west coast. It flows for most of its course through a narrow, flat-bottomed valley that is swampy in many places. Its lower reaches open out into the Galela plain, one of the largest and most continuous areas of flat land on the island. This lowland is approximately 8 miles long from north to south, and 5 miles wide at its widest point. Two volcanic cones (965 and 685 feet in elevation) rise abruptly from the lowland immediately northeast of Galela Lake, and dominate the eastern approaches to the plain. Most of the plain is cleared and either under cultivation or in patchy grassland, but there are rather extensive marshes near the mouth of the Tiabo River that are reported to be almost impenetrable. The military significance of this subregion is due to 2 relief conditions; first, the suitability of the Galela plain for airfield development (a new Japanese strip is under construction between Galela Lake and the Tiabo River), and second, the Tiabo valley forms a corridor providing access to the west coast at 2 points (Bakoeloe Bay and Loloda Bay). The upper reaches of the river run through low, hilly country where the main hindrance to cross-country travel is the dense forest cover.

(*e*) *Northwest Mountain Ridge.* At the northern tip of the island, a steep mountain ridge rises directly out of the sea and trends southwestward to Loloda Bay. Average elevations along the crest of this ridge are between 1,500 and 2,500 feet. The only notable break in its continuity lies directly behind the small bay of Bakoeloe, where a low pass at only 300 feet elevation leads across to the Tiabo valley. The coastal plains on the eastern side of the ridge are somewhat wider than those on the west side, but still are narrow, usually being less than a mile in width.

(4) Morotai Island.

The interior of Morotai is mountainous, and, although few details are available on interior terrain conditions, there appear to be 2 low mountain ranges trending from southwest to northeast, with a depression between them. The western range, maximum elevation 3,333 feet, closely parallels the coast, rising abruptly from rocky headlands or narrow coastal flats. The eastern ridge (Sabatai Mountains) has a maximum elevation of 4,100 feet, and lies somewhat farther from the coast, being separated from it by a narrow interior lowland, a belt of low coastal hills, and a narrow strip of coastal plain. This eastern coastal plain, despite its narrowness, contains a relatively dense native population.

The largest area of lowland is on the southwestern side of the island. An isolated belt of hills divides this lowland into a northern and a southern portion. There are rather extensive sago swamps on the southwestern plain, particularly back of the narrow, sandy, beach ridges along the west coast.

FIGURE II - 1. *Northern Halmahera.*
Djailolo-Soesoepoe plain, near the road crossing of the Lamo River. 1944. Typical vegetation pattern—scattered clearings and secondary growth.

(5) Western Volcanic Islands.

West of Halmahera is a string of 7 volcanic islands extending from north to south for a distance of about 50 miles. They include, from north to south: Hiri, Ternate, Maitara, Tidore, Mare, Moti and Makian Islands. They have considerable importance from an administrative and commercial standpoint. For this reason and because of their location, these islands merit consideration in strategic plans for operations in this sector, despite the fact that they are little more than ash cones rising out of the sea. The lower slopes of the cones are fairly gentle and concave, and the richness of the soil attracted cultivation and settlement from the earliest days. Flat coastal plains are rare, and, where found, are usually swampy, hence unsuited to airfield development. The majority of the cones are still active, and their flanks are not deeply dissected.

(6) Batjan Islands.

The Batjan Islands form an important group immediately southwest of Halmahera.

(a) Kasiroeta. This island lying west of Batjan Island, does not have as rugged a land surface as Batjan (below), although it contains little actually flat land. The steepest slopes

face the west coast and are a short distance back of it. A lowland crosses from west to east between Kasiroeta Bay and Imboe-imboe Bay near the southern end of the island. Much of the western portion of this lowland is sago swamp. Much of the coast of Kasiroeta Island consists of rocky headlands, and coastal plains are limited mostly to small strips at the heads of bays or coves.

(*b*) *Batjan Island.* Batjan, the largest island of this group, lies southwest of Halmahera, and is divided into 4 separate blocks of rugged mountainous terrain. Separating them are 3 lowland areas; the Laboeha plain, the Wajaoea plain, and the Sajoang valley. The first 2 have a large proportion of swamp. The 3 lowlands form corridors across the island. Within the mountain blocks, the ridges and valleys have little alignment with each other, and cross-country travel is difficult in any direction. The northwestern and southeastern blocks are not quite as rugged as the other two. Maximum elevations vary from 2,500 feet to 6,925 feet (Mount Sibela). The plains, other than the 3 lowlands mentioned above, border the coast and are narrow and discontinuous. The west coast, bordering Sambaki Strait, is almost a continuous marshland about 10 miles long.

(*c*) *Obit.* This island is located between Mandioli and Batjan. Most of the central and northeastern parts of the island are hilly with a maximum elevation of 630 feet. There are narrow flats along the western and southern coasts.

(*d*) *Mandioli.* Mandioli Island is the third largest in the group and lies south of Kasiroeta. It is hilly in the interior, but considerably lower in elevation than the 2 larger islands in the group. It reaches a maximum of 1,986 feet. A narrow coastal plain about ½ mile wide borders most of the coastline. The portion along the south coast is swampy.

(7) Lesser islands.

Although there are 120 islands adjacent to Halmahera which exceed ½ mile in diameter, the largest of these is only 11 miles long. Fewer than 30 exceed 2 miles in length. These islands vary considerably in shape, elevation, vegetative cover, coastal characteristics, and military value.

B. Sangihe-Talaud Islands.

These 2 groups of islands lie between the northeastern tip of Celebes and the southernmost tip of Mindanao.

(1) Sangihe Islands.

The Sangihe group consists of volcanic cones or groups of cones, some of which are active. They have little military importance, since there are no large sheltered harbors, and flat land suitable for airfield construction is notably absent. Coastal plains are narrow and discontinuous, and in the wider portions (not exceeding 1 or 1½ miles) generally are swampy. Sangihe Island is the largest of the group. In a few cases, such as on Sangihe and Siaoe, there are good cross-island routes, located in the gaps between the volcanic cones (FIGURE II - 2). The islands are made up largely of loose volcanic detritus, although there are several areas of solidified lava and terraces of coral limestone. The latter are common along some of the coastal lowlands.

(2) Talaud Islands.

The Talaud group are chiefly of sedimentary origin, hence differ from the volcanic Sangihe Islands. The Talaud Islands are considerably lower, the highest elevation, on Karakelong, being 2,222 feet, and common elevations in the interior being between 1,000 and 1,500 feet. The bulk of the island masses consists of limestone. Most land surfaces are exceedingly rough despite the moderate relief. The largest areas of flat plains are located along the southeastern coasts of Salebaboe and Kaboeroeang. Because of the roughness of the interior portions of the islands, there are few good cross-country routes, travel between different parts of the same island generally being along good coastal trails. A good route crosses the central portion of Karakelong, however, from Beo on the west coast, to Rainis on the east coast.

C. Mindanao and adjacent islands.
(PLAN 1).

In contrast to the other larger islands treated in this report, Mindanao has relatively large areas in the interior where both relief and vegetation are suited to large scale military opera-

FIGURE II - 2. *Sangihe Islands.*
Siaoe Islands, Hoeloe village, looking W. 1939. A motor road utilizes the pass between the two volcanoes and leads to Ondong village on the west side of the island.

tions, particularly in a north-south direction. There are a number of high mountain ranges, most of which have volcanic peaks rising well above 7,000 feet, but some of these ranges are broken by natural corridors or defiles. There are 3 main corridors across the island from north to south. These are, from west to east: the isthmus between Illana and Iligan Bays; the Bukidnon Uplands (FIGURE II - 3) with their grassy plains, lying between Macajalar Bay and the Cotabato Basin; and the Agusan Valley, including the low hilly terrain that separates it from the lowland at the head of Davao Gulf. This latter corridor is largely unusable as a route for troop movements because of large areas of swamp and marsh. The most continuous terrain barriers are the mountain ranges that lie to the east and west of the Agusan basin, and the belt of rugged terrain that runs the length of Zamboanga Peninsula. The only easy east-west corridor leads northwestward from the west side of Davao Gulf to the Cotabato Basin. Routes within the Agusan and Cotabato Basins are restricted, owing to extensive marshes.

The arrangement of the mountains, plateaus and lowlands permits a logical compartmentation of the island into relief regions. These various regions will be described separately in the following paragraphs, beginning in the south and progressing around the island in a counter-clockwise direction.

FIGURE II - 3. *Mindanao.*
Bukidnon Uplands. Looking WNW toward Pangantocan. 1939. Typical undulating open grassy terrain in southern Bukidnon.

(1) Southern Mountain Region.

This region includes the mountainous district in the south central part of the island. Its northeastern boundary is formed by the pass that is followed by the Cotabato-Davao highway. On the north is the broad Cotabato Basin. The peninsula east of Sarangani Bay is almost entirely mountainous (FIGURE II - 4). West and northwest of Sarangani Bay, there are 2 rugged areas of volcanic peaks. Separating these areas is a low corridor extending from the northwestern corner of Sarangani Bay to the southeastern corner of the Cotabato Basin. This corridor (the Koronadal Valley) has recently been the scene of considerable colonial activity, and is traversed by a highway completed just prior to the war. The mountains continue to the northwest without a break to a point northeast of Linao Bay. At this point the mountains become lower in elevation and continue as a low range of hills to Tapian Point. The entire northwestern portion of the region, with the exception of the range of hills just mentioned, is a dissected plateau of limestone and other sedimentary rocks. Its highest portion (2,000-2,500 feet) is on the northern and northeastern side, where there is an abrupt slope down to the Cotabato Basin. This plateau rises directly from the sea from Linao Bay northwards to the mouth of the Mindanao-Pulangi River, except for a few small bays or coves where there are stream mouths. In general, the streams in the limestone area have their sources in the range of hills that rise above the plateau near its northern edge. They flow southwestward in narrow, deep ravines. Except for the Koronadal valley route, the entire region would be extremely difficult to cross. There are a few narrow coastal plains along the southwestern coast, such as at Linao Bay, Port Lebak, and Kling.

(2) Central Mountain Region.

This long north-south mountain range, extends from the Mount Apo district, which is southwest of Davao, northward to the north coast. It is perhaps the most effective terrain barrier on the island (FIGURE II - 5). It is high and rugged throughout its length and there are no easy routes across it. Routes from eastern Mindanao to the western portion of the island either skirt the northern end of the range, closely following the coast, or pass through the Cotabato-Davao corridor that separates the southern end of the range from the Southern Mountain Region. The highest elevations are found in the group of volcanic peaks southwest of Davao, of which Mount Apo is the highest (9,690 feet). There has been an appreciable spread of cultivation from the Davao coastal plains up the long lower slopes of the peaks.

(3) Davao Lowlands.

These lowlands extend northward from Malalag Bay (on the west side of Davao Gulf) around the head of Davao Gulf (FIGURE II - 6). The terrain is flat to rolling. The narrowest portion is near the village of Santa Cruz, where the mountain slopes come within a few hundred yards of the coast. Elsewhere the mountains are 3 to 25 miles from the coast. The flat plains are limited to fairly narrow coastal strips and alluvial flats along the lower stream courses. The largest of these are in the Padada-Digos Valley, the area northwest of Daliao, and at the head of Davao Gulf. The most important terrain features are the remnants of old gravel terraces that rise above the general level in the inter-stream areas and command the plain and sea approaches. They have been dissected by streams until they appear as low hills. Many of them are cleared for abaca fields and could be climbed by tracked vehicles; others are steeper and covered with trees. The belt of gravel terraces becomes much wider toward the head of Davao Gulf and continues almost to the Agusan Basin to the north. On the east side of the gulf, the coastal plains vary considerably in width, and in many places the mountain foothills come out to the coast (FIGURE II - 7). In contrast to conditions on the western side, there is little cultivated land on this side of the gulf.

(4) Eastern Mindanao Region.

This region includes all of the easternmost part of Mindanao, east of the Agusan Basin and the Davao Lowlands, and extends from Bilaa Point on the north to Cape San Agustin on the south. It is largely an area of mountainous terrain, with discontinuous coastal plains bordering the bays. The northern portion is formed by the Diuata Range. The mountain belt is almost a continuous barrier 20 to 40 miles wide, having average elevations of about 3,800 feet in the north and 2,700 feet in the south. Individual peaks rise to 6,000 and 8,000 feet. The only breaks in its continuity are the Lake Mainit-Surigao corridor near the northern end, and the Lupon-Mati corridor that cuts

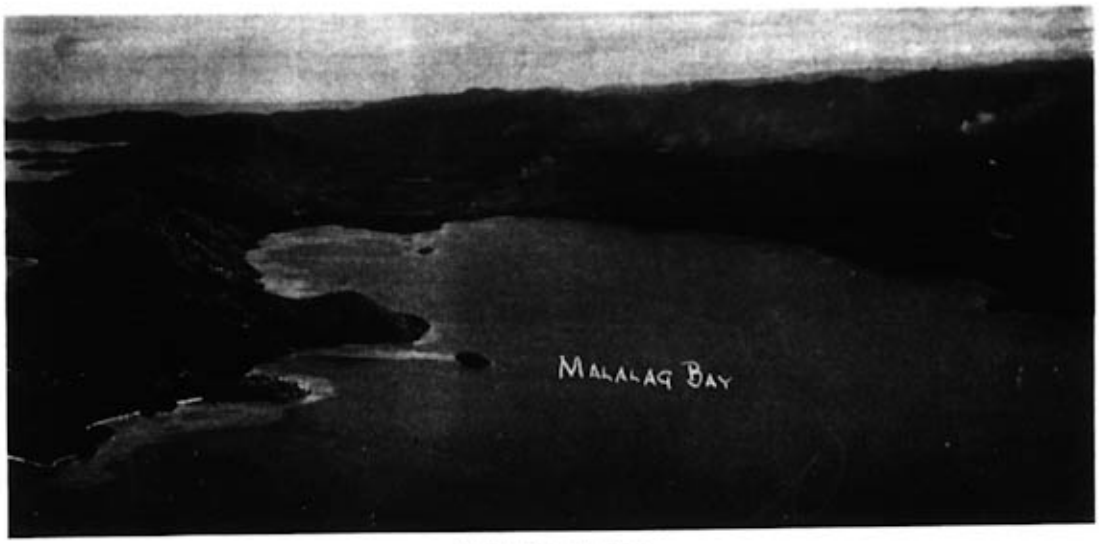

FIGURE II - 4. *Mindanao.*
Malalag Bay, Davao Gulf. Looking SE. 1935. Forested mountainous terrain typical of the Southern Mountain Region.

FIGURE II - 5. *Mindanao.*
Central Mountain Region. Looking SE. Malaybalay village in foreground. 1935. Western front of the Central Mountain Region, at the eastern edge of the Bukidnon Uplands.

across the narrow neck of the peninsula east of Davao Gulf. West of Hinatuan Bay, the mountain belt is narrow (only about 10 miles wide); and this was selected as the best location for a road connecting the east coast with the central portion of the Agusan Basin. There is much limestone that has been elevated to heights of from 500 to 1,000 feet along the east coast. Such areas are difficult to cross because of the rough surfaces, steep-sided ravines, and vertical cliffs facing the sea (FIGURE II - 8). Remnants of such plateau areas stand out as isolated hills on many of the coastal plains. The plains bordering the east coast are isolated from each other and from the rest of the island (FIGURE II - 9). The largest of these plains are found bordering the larger bays, such as Mayo, Cateel, Bislig, Hinatuan, Lianga, Lanuza, Carrascal, and Becebos. The maximum width of these coastal lowlands is about 7 miles.

(5) Agusan Basin.

This large valley extends nearly the entire north-south length of eastern Mindanao. The Agusan River which drains this basin is 130 miles long. Its source is in the mountain district east of Davao Gulf. The basin proper begins near Moncayo, at the northern edge of the low hilly zone that separates it from the lowland at the head of Davao Gulf. From Moncayo northward, there is a broad, flat trough all the way to the north coast. There are no broad areas of foothills bordering the plain, and mountains rise abruptly from the plain along much of the eastern side. An important feature of the basin is the marsh and lake

FIGURE II - 6. *Mindanao.*
Davao Lowlands. Daliao plain. Looking NW from a point about 8 miles NE of Astorga. 1935. Narrow strip of coconut palms near coast. Extensive abaca plantations in Sirawan valley in rear. Plantations and second growth woodland in middle distance. Highland border on horizon.

FIGURE II - 7. *Mindanao.*
East side of Davao Gulf. Looking NE toward Piso Point. 1935. Mountainous topography. Dense tropical rain forest growth. Coastal lowlands absent.

FIGURE II - 8. *Mindanao.*
Entrance to Lamon anchorage. Steep-walled, densely forested coast, typical of east coast peninsulas on Mindanao.

FIGURE II - 9. *Mindanao.*
Cateel River. 1942.
Obstacles to overland travel: steep cliffs, thick vegetation cover, and boulder-strewn river.

district in the central portion. This is a serious barrier to cross-country movement. The highest and best drained portions of the flat plain are along the banks of the river, or along the old banks of abandoned stream channels (FIGURE II - 10).

FIGURE II - 10. *Mindanao.*
Agusan Basin. Looking SE over Talacogon village. 1939. Wooded and cultivated areas on slightly higher ground next to river. Marsh grass on lower land farther back from river.

(6) Bukidnon Uplands.

This region, located in the central part of the island, is characterized by wide, sweeping, grass-covered valleys and slopes, surmounted by more or less isolated groups of volcanic mountains. The northern end of the uplands lies only a mile or two from the head of Macajalar Bay, and rises abruptly from the narrow coastal plain. On the south, the uplands slope gently southward, merging with the gravel terraces and low hills that border the northern side of the Cotabato Basin. As a rule, the surfaces of the valleys and slopes lie at elevations of between 1,500 and 3,000 feet, and slope away gradually from the groups of mountains.

The largest mountain groups are the Katanglad and Kalatungan Mountains (FIGURE II - 11). There are also a few isolated volcanic cones rising above the general level of the up-

FIGURE II - 11. *Mindanao.*
Bukidnon Uplands. Looking NW over Maramag village toward southeastern end of Kalatungan Mountains. 1935. Typical distribution of grasslands and forests.

land plains. In the northern part of the region, the streams that radiate outward from the Katanglad Range have cut deep, steep-sided trenches into the gently sloping deposits of volcanic material that constitute much of the region. Farther south, along the middle course of the Pulangi River, the slopes are less dissected, and the country has the appearance of gently undulating prairies.

From a military standpoint, the most important factors in the geography of the region are: the numerous airfield sites (many of which require little more than cutting or burning the tough, tall *"cogon"* grass to make them usable as emergency landing fields); the general suitability of the terrain for large scale military operations; the central position on the island; and the natural approaches from the south and north.

The most logical approach from the south is up the Pulangi River valley, along the Sayre Highway. There are few points where hilly terrain constricts the southern approach, but there are possible defensive positions near Kibawe. The Maridagao valley is a poor route of approach from the south because of the rough terrain along much of its lower course. The Central Mountain Region forms an effective barrier along the eastern side of the Bukidnon Uplands. The mountains rise abruptly (FIGURE II - 5), and only poor foot trails lead across from the Agusan Basin.

The most logical defensive position against approaches from the north (Macajalar Bay) is the escarpment that borders the narrow coastal plain (FIGURE II - 12). This escarpment is cut by innumerable steep-sided ravines. Supporting this defensive line are flanking positions for secondary defense that can be established along the larger canyon-like trenches that are cut into the plateau, particularly the trenches of the Cagayan and Tagoloan Rivers and their tributaries (FIGURE II - 13). Near the headwaters of the Maridagao River there is a pass that gives access southeastward from the Iligan Bay-Lake Lanao district (FIGURE II - 14), but the dense forest west of the pass would be a handicap to overland travel there.

(7) Lanao Uplands.

West of the Bukidnon Uplands, and extending toward the narrow isthmus between Iligan and Illana Bays, is an area of diverse terrain features. The southeastern part is formed by a range of high volcanic peaks trending almost east-west, including Mount Piapayungan (9,233 feet), Mount Ragang, and Mount Latukan (7,598 feet). The lower slopes of this range are long and sweeping, similar to those in the Mount Apo district. In the northeastern part of the area, extending northwestward from the Bukidnon Uplands Region, and forming the peninsula between Iligan and Macajalar Bays, is an area of hilly terrain, not particularly high (average elevation 800 to 2,000 feet), but exceedingly rough.

The coastal plain bordering Mindanao Sea is narrow, except at the head of Panguil Bay (the narrow extension of Iligan

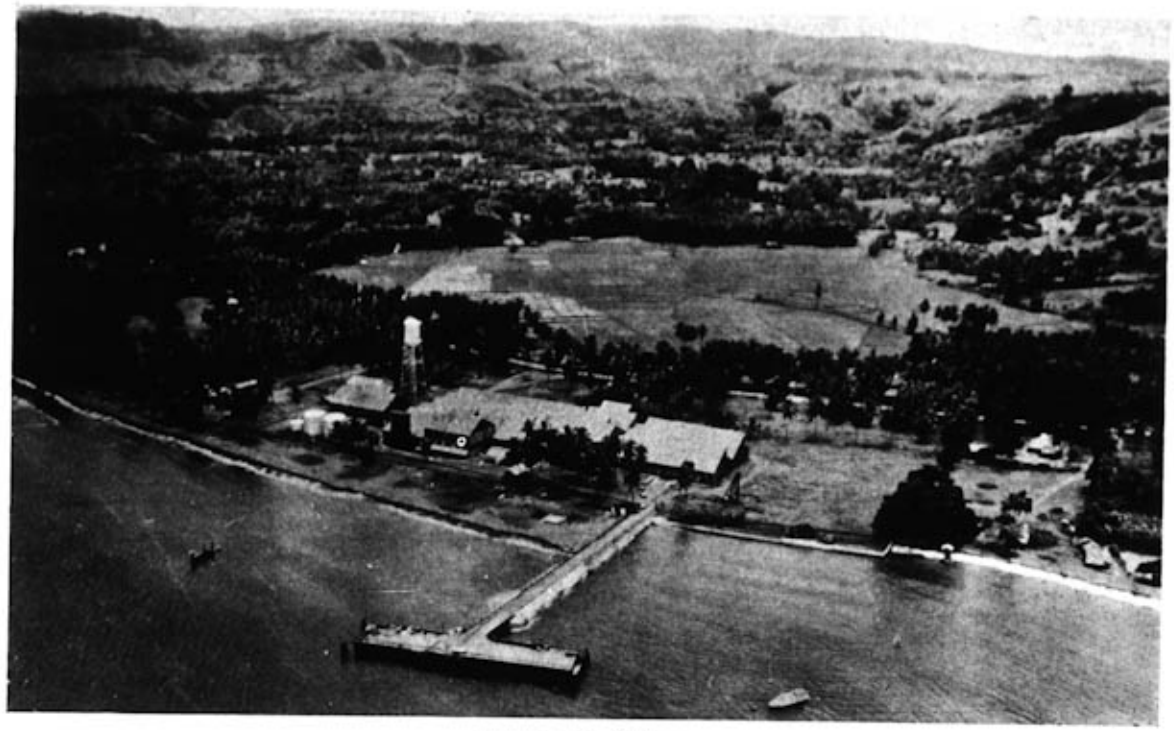

FIGURE II - 12. *Mindanao.*
Northern edge of Bukidnon Uplands. Looking S from Bugo on Macajalar Bay. 1936. The dissected escarpment seen in the middle distance offers good natural defenses. (See also Figures IV - 70 and IV - 71).

FIGURE II - 13. *Mindanao.*
Bukidnon Uplands. Mangima Canyon, at crossing point of Sayre (Malaybalay-Cagayan) Highway. Looking N toward Tagoloan Canyon. 1939. Characteristic gorge-dissected terrain of northern Bukidnon Region.

FIGURE II - 14. *Mindanao.*
Bukidnon Uplands. Kidanguin River near its junction with the Maridagao. Looking N toward lower slopes of Kalatungan Mountains. 1939. The pass between the upper Maridagao valley and the Lake Lanao area is in the far left rear.

Bay), where there are great expanses of mangrove swamps. The major part of the region consists of an undulating to rolling land surface that rises gradually from Iligan Bay to Lake Lanao (FIGURE II - 15), and continues eastward on the east side of the lake toward the pass leading to the Bukidnon Region.

On the west side of the lake, and paralleling it, is the Gurain (Gurayan) Mountain Range. This range swings westward near the southwestern end of the lake, and widens southward as far as the coast of Illana Bay, forming a belt of rough terrain that blocks land communications between the eastern and northern portions of Illana Bay. At the western end of the region, there

is only a belt of low hills separating the coastal plains at the heads of Illana and Iligan Bays. This isthmus has considerable strategic significance because it affords the easiest crossing of Mindanao from south to north. Within the region, there are 3 points toward which land communications focus in the Lanao Upland Region. These are the gap between Illana and Iligan Bays (mentioned above); the pass at the southwestern end of Lake Lanao, between the southern end of the Gurain Range and the northwestern end of the volcanic region lying south of the lake (FIGURE II - 16); and the gap at the northern end of Lake Lanao (near Dansalan) between the Gurain Range and the northwestern extension of the Kalatungan Mountains.

FIGURE II - 15. *Mindanao.*
Lanao Uplands, near Dansalan. Looking NW from north end of Lake Lanao, across Saguiaran valley toward Illigan Bay. 1943. Characteristic undulating terrain.

(8) Western Mindanao.

The western end of Mindanao, including Zamboanga and Misamis Occidental Provinces, is essentially an area of rough mountainous terrain and isolated segments of coastal plains. The greater portion of the rugged terrain lies at elevations of from 2,000 to 4,000 feet, but Mount Malindang in the center of Misamis Oriental Province (west of Iligan Bay) rises to 7,956 feet. The interior of Western Mindanao is difficult of access (FIGURE II - 17), and is little known. The longest and widest coastal plains are found at the southern end of Zamboanga Peninsula (FIGURE II - 18), and along the western side of Iligan Bay. Even here, however, the width of the plains does not exceed 5 miles. Another fairly large lowland extends up the Sibuguey River for about 20 miles, from the northeastern head of Sibuguey Bay. One of the few cross-country routes in the region lies between the lower part of this valley and the small port of Malangas, on the west side of Dumanquilas Bay. The only good land exit from the region is the coastal road that skirts the north coast. The western terminus of this road is Sindangan, on Sindangan Bay. Foot or pack trails afford the only means of cross-country movement across Zamboanga Peninsula. Movement along routes paralleling the southern coast is hindered by hill spurs that form rocky peninsulas, by rough coral terraces, and by swampy stream mouths.

(9) Cotabato Basin.

This large lowland covers 1,800 square miles. It opens westward to the east side of Moro Gulf. It is approximately 60 miles long, from northwest to southeast, and 30 miles wide (FIGURE II - 19). It is similar to the Agusan Basin in that it contains large areas of poorly drained land, such as the Libungan and Liguasan marshes (FIGURE II - 20), and a dense network of sluggish, winding streams. The northern portion of the region is bordered by a zone of low, gravel and limestone terraces. The eastern portion merges with the long slopes of the volcanoes in the Mount Apo area, and the southern border is formed by the steep northern front of the Southern Mountain Region. At several places, isolated, low, flat-topped hills of soft limestone rise above the flat surface of the plain, such as the Cotabato airfield, Reina Regente, and Pikit (Fort Pikit).

Entrances to the region, except by sea, have already been treated in the descriptions of adjacent regions. These entrances include: the Koronadal corridor from Sarangani Bay; the pass from the west side of Davao Bay; the Bukidnon Upland route via the Pulangi valley; and the Lake Lanao-Illana Bay route, via the Malabang coastal plain and the Balut Lake district (FIGURE II - 21). The highways of the area generally avoid the poorly drained sections, keeping to the slightly higher terraces along the northern side of the basin. Approaches from the seaward side would be hindered by the Distributaries of the Mindanao River.

(10) Adjacent islands.

There are 88 islands exceeding ½ mile in diameter which are adjacent to Mindanao. They vary greatly in physical character and military importance. One of these, Samal Island (FIGURE II - 22), has particular significance because it is large and lies near the head of Davao Gulf and opposite the city of Davao.

FIGURE II - 16. *Mindanao.*
Lanao Uplands. Looking S along west side of Lake Lanao. Gurian Mountains to right. Ganassi Peaks in distance to left. The gap between is utilized by the Dansalan-Cotabato highway.

FIGURE II - 17. *Mindanao.*
Zamboanga Province. Looking NW on west side of Dumanquilas Bay. 1931. Typical hilly terrain. Dense forests in interior.

D. Sulu Archipelago and Basilan Island.

All of the larger islands in the chain that extends from the southwestern tip of Mindanao to northeastern Borneo are rugged and forested. Of these, only Jolo and Tapul contain appreciable areas of flat to rolling land, with adequate cross-island routes for military operations. Many of the smaller islands in the archipelago, however, are low and flat, and appear to have suitable sites for airfield development.

(1) Basilan Island.

The large island lying south of Zamboanga Peninsula (Mindanao) is Basilan. It is 35 miles long from east to west, and 23 miles wide. Most of the interior is hilly to mountainous, the highest peak, Basilan Peak, rising to an elevation of 3,317 feet. There is a series of mountain peaks encircling the interior of the island 5 or 6 miles inland from the coast. Within this circle the terrain is less high, consisting of rolling upland country. The largest lowland area is along the northern coast in the vicinity of Lamitan, the largest settlement on the island. The lowland along the southwestern coast is flat and swampy.

(2) Jolo Island.

Jolo Island is 38 miles long from west to east, and 3 to 14 miles wide. Several volcanic peaks and hills rise singly from gently rising slopes (FIGURE II - 23). The highest and most rugged part of the island is in the west, where more than 10 peaks rise above 1,000 feet elevation, with 6 of these surpassing 2,000 feet. Some of these volcanic peaks have craters at their summits. Between some of the peaks are wide passes or valleys followed by roads that serve the island exceptionally well. Most of the useable gaps trend from north to south. Many gullies and ravines dissect the steeper hill slopes. The mountain peaks and hills are only local barriers to cross-country travel, and as a general rule, such travel would not be difficult, as there are wide areas of open grasslands and cultivated fields. Swampy areas would hinder deployment of troops in some of the coastal flats such as in the vicinity of the town of Jolo and along the shores of Tutu and Maimbung Bays.

(3) Tawitawi Island.

This large island, located near the southwestern end of the Sulu Archipelago, is 32 miles long from southwest to northeast, and is from 5 to 16 miles wide. Most of the interior is rough, hilly terrain (FIGURE II - 24). The highest point is Mount Sibankat (1,803 feet). There are only a few fairly large areas of low, level land, such as at the extreme southwestern end of the island (FIGURE II - 25), and near the northwestern end, between the Dungun River and Kula Kula Channel. The half of the island southeastward from Mount Sibankat is composed of sedimentary rocks which have been dissected without a regular pattern of valleys and ridge lines. The northwestern half, on the other hand, is composed of a different type of rock, and there is formed a more or less continuous central ridge, trending northeast-southwest. Several airfield sites are reported in the small islands that lie off the southwestern part of Tawitawi.

(4) Lesser islands.

There are 165 islands in the Sulu Archipelago which have a diameter exceeding ½ mile. Most of these are small, but some have potential military value and should be studied in detail. FIGURES II - 26 and II - 27 show characteristic terrain for some of the lower islands.

E. Northern and Eastern Borneo.

Few details are known about terrain conditions in the interior part of this region. The coastal districts, on the other hand, are

fairly well known, particularly along the west coast. The interior consists almost entirely of highlands, most of which are composed of rough terrain. High mountain ranges do not constitute a large percentage of the land area except in the northwestern portion of the region, where a series of ranges, trending from northeast to southwest forms a barrier to east-west, cross-country travel. The highest of these ranges is the Crocker Range, which culminates in Mount Kinabalu, elevation 13,498 feet (FIGURE II - 28). There are several places in the interior where stream valleys widen to form flat to rolling, basin-like depressions, such as in the Pegalan valley southeast of Jesselton, and along some of the upper tributaries of the Koetai, Kajan, Sembakoeng, and Sugut Rivers. With the exception of the Pegalan valley, these basins are isolated, and of little military importance.

Coastal lowlands are wider along the east coast than on the west, because the largest rivers in the region flow out to the eastern or northeastern coasts, building extensive alluvial plains and deltas near their mouths. A characteristic of nearly all of the coastal areas is the presence of isolated hills or groups of hills that rise steeply from the surrounding lowlands without any regular pattern of distribution or alignment (FIGURE II - 29).

There are no well-developed cross-island routes. The almost continuous covering of forest, the hilly to mountainous terrain, and the lack of settlements in the interior have effectively discouraged the construction of roads between the eastern and western coasts. Most travel in the interior is either by boat along the larger rivers, or by foot over native trails. The best potential route for cross-island road development leads westward from Sandakan to the basin in the upper Sugut valley east of Mount Kinabalu, and joins the Kota Belud-Pegalan valley-Beaufort route at Ranau.

Instead of dividing Borneo into terrain regions as was done in the descriptions of Halmahera and Mindanao, only 2 divisions (corresponding to the areas under Dutch and British control prior to the war) will be described.

(1) Dutch Borneo (north of the Equator).

This part of the region is essentially an area of rough, hilly terrain, fringed on the west by a low mountain range, and on the east and south by wide, flat, poorly drained, alluvial plains. The largest area of such river plains is in the southeast, in the basin of the Koetai River. Another area of low, marshy river plains is found in the multiple deltas of the Kajan, Sesajap, and Sembakoeng Rivers. The Sangkoelirang and Beraoe

FIGURE II - 18. *Mindanao.*
Zamboanga coastal plain, looking NW from Caldera Bay, 8 miles west of Zamboanga. 1925. Cultivated lowlands, forested highland interior.

FIGURE II - 19. *Mindanao.*
Cotabato Basin. Looking NW from Pikit toward highlands at basin edge. 1935.

Rivers also have broad lowlands near their mouths. A large portion of the interior consists of dissected plateau country. Stream valleys are deep and narrow. The underlying rock is principally sedimentary, including much sandstone. Cross-country travel is hindered more by stream gorges and dense vegetation than by mountain barriers. The highest chain is the Muller Range, between 3,000 and 4,000 feet in elevation, which forms the extreme southwestern corner of the region. The northern extension of this range, the Iran Mountains, is lower. Still farther north, the mountains increase in elevation, and the range splits into several off-shoots which form the rugged mountain chains of British North Borneo. If it were necessary, potential routes for motor roads could undoubtedly be found that would connect Dutch East Borneo with Sarawak, Brunei, or British North Borneo. To develop any such routes, however, would require an immense amount of labor, primarily in clearing the forest, grading and filling, and constructing bridges.

(2) British North Borneo.

This part of Borneo is much more rugged than the Dutch portion previously described. Along the west coast is a lowland that is widest in the delta area of the Padas River. Hills that rise steeply from the plain are scattered near the coast, but are grouped into a belt of foothills a few miles inland. In general, the coastal lowlands become narrower toward the north, and are displaced entirely by hilly terrain in several places north of Tuaran. The Crocker Range forms almost a continuous wall facing the west coast, about 10-15 miles inland. It is broken by only one major pass—the gorge of the Padas River, southeast of Beaufort. Another pass that is much more difficult is located along the southwestern flanks of Mount Kinabalu, and connects the Ranau plain with the upper Tempasuk River that flows out to the west coast northwest of Kota Belud. Northeast of Mount Kinabalu, the Crocker Range divides, one branch extending north and forming the mountainous backbone of the peninsula west of Marudu Bay, and the other bending eastward to be joined by other ranges from the south.

The largest interior depression is the Pegalan valley that forms a trough from northeast to southwest on the east side of the Crocker Range. It varies in width, but at 2 points (near Keningau and Tambunan) it is a flat, grassy basin several miles in width. The exit southward from this valley is via the Padas gorge, and that northward is over a fairly low divide into the Ranau plain, a partially dissected plateau lying east of the base of Mount Kinabalu.

East of the major drainage divide, in northern Borneo, the general features of the terrain are similar to those in the Dutch territory farther south. The drainage basins are larger than those

FIGURE II - 20. *Mindanao.*
Cotabato Basin. Liguasan Marsh, showing floating islands. 1936.

FIGURE II - 21. *Mindanao.*
Cotabato Basin. Looking NE toward Lanao Uplands. 1939. Typical terrain in the Balut Lake district along the route from the Malabang coastal plain to the Cotobato Basin.

west of the divide, the streams are larger, there are broad swampy areas near the river mouths, and there is less mountainous terrain. Land travel parallel to the coast would be greatly hindered by the swamp and marsh lands and also by the belts of heavily forested hills that occasionally rise above the lowlands in the inter-stream areas.

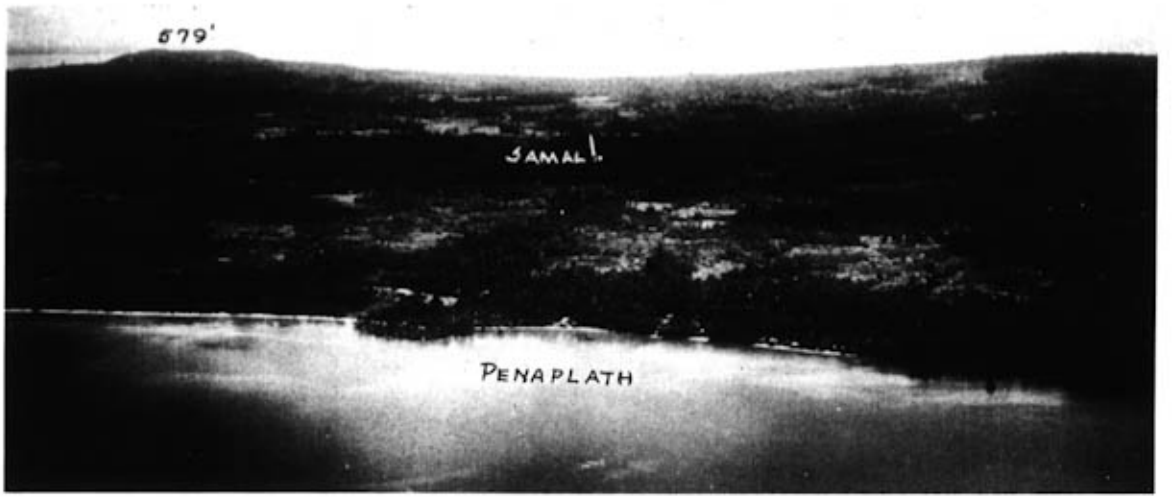

FIGURE II - 22. *Mindanao.*
Davao Gulf. Samal Island, looking N toward head of gulf. 1935. Characteristic terrain on west side of island.
(See also Chapter IV, Topic 43, R).

FIGURE II - 23. *Sulu Archipelago.*
Jolo Island. Looking W. 1936. Typical terrain in vicinity of Seit.

FIGURE II - 24. *Sulu Archipelago.*
Tawitawi Island. Looking S. 1937. Hilly terrain typical of most sections of the high islands in southern portion of the Sulu Archipelago.

FIGURE II - 25. *Sulu Archipelago.*
Tawitawi Island. Looking SW at southwestern corner. 1935. One of the few possible airfield sites on the island.

FIGURE II - 26. *Sulu Archipelago.*
Western shore of Tapul Island. Looking NE. 1935. Cultivated terrain typical of lowlands of islands of the Tapal group.

(3) Adjacent islands.

There are 72 islands whose maximum diameter exceeds ½ mile which are adjacent to Northern and Eastern Borneo. These differ greatly in physical character and military value, but should be studied in detail. Tarakan Island is discussed under topic 26, Critical Areas.

F. Northern Celebes and adjacent islands.

Except for the extreme northeastern or Minahasa end of Celebes, the area north of the Equator has a comparatively simple framework of relief. In the interior is a central mountain backbone, which in a few places sends out tributary spurs *"en echelon"* to the coast. The mountains comprise an unbroken rampart between the Celebes Sea and the Gulf of Tomini, except near Gorontalo and in the Minahasa Region.

The coastal plains for the most part are narrow, although fairly continuous. Not all coastal lowlands of Northern Celebes are universally favorable for military operations. This is due to swampy terrain which commonly is found immediately behind the sandy beach ridges and near the mouths of the larger streams.

In the Minahasa Region, the relief pattern is quite different. Here are found broad, upland flats and rolling country, surmounted by several tall, volcanic cones. The approaches to these upland areas, particularly those from the southwest, are restricted because of the deep, gorge-like valleys that cut into the plateau edge.

For purposes of more detailed description, Northern Celebes has been sub-divided into two regions: an eastern region including the Minahasa and Bolaäng-Mongondow Provinces, and a western region, hereafter called the Northern Peninsula, including all of the peninsula west of the Ongkag-Doemoga River.

(1) Minahasa-Bolaäng-Mongondow Region.

From a military point of view, this region is much more significant than the rest of Northern Celebes. This is because of the availability of several cross-island routes and a fair network of motor roads, the presence of several well-drained, cleared areas of flat land suitable for airfields, and a comparatively numerous native population.

There are 2 main corridors across the island: the Belang-Amoerang passage on the west, and the Manado-Kema valley farther east. Of these, the latter is by far the easier, the highest point on the route being only 764 feet in elevation. The former requires an ascent of about 1,200 feet to the plateau level. Connecting these two routes is a lateral corridor, the Tondano plateau, which includes the flat terrain in the vicinity of Lake Tondano. Routes connecting the interior basins and plateaus with the coast are more frequent along the northwest coast than the southeast coast. A possible route from the west into the interior is from Gorontalo eastward up the Bone valley thence across a hilly divide to the plateau country near the headwaters

FIGURE II - 27. *Sulu Archipelago.*
Tawitawi Group. Simunul Island, looking E. 1935. Terrain and vegetation typical of the low islands in the Tawitawi group.

FIGURE II - 28. *British North Borneo.*
Mount Kinabalu (elevation 13,498 feet). Direction and date of view unknown.

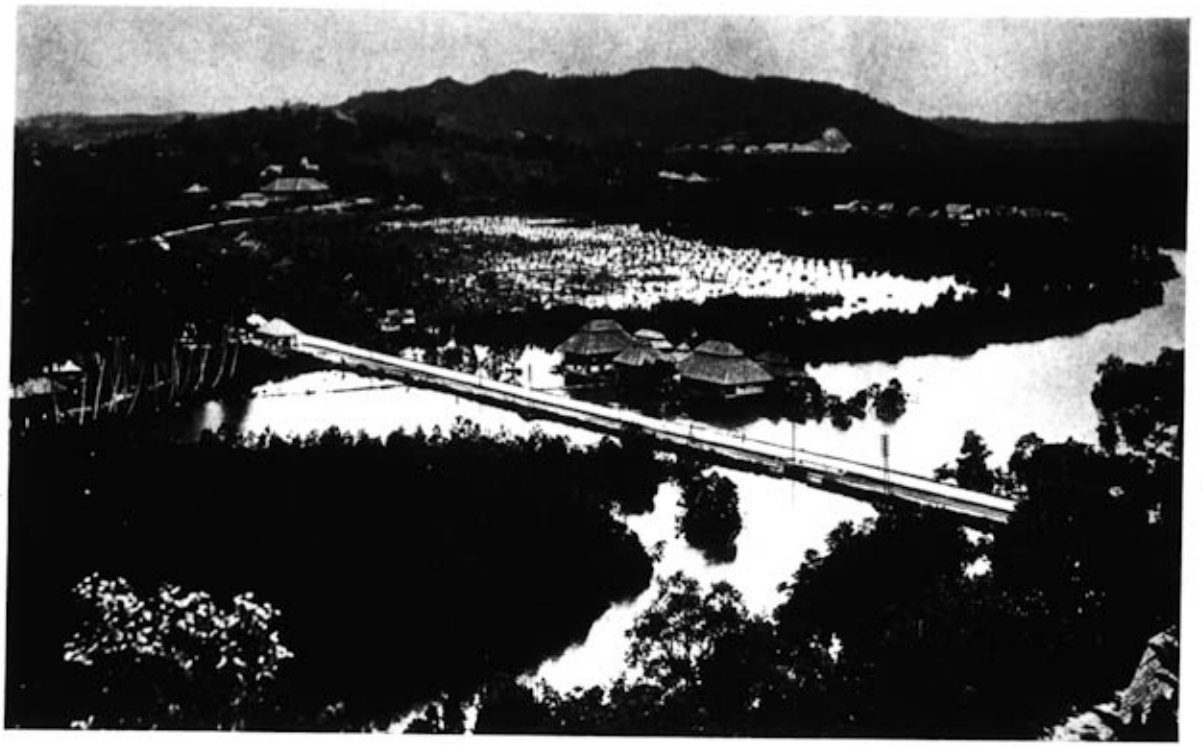

FIGURE II - 29. *British North Borneo.*
Northwestern coast. View near Jesselton. Direction and date unknown. Characteristic lowland scene during the wet season. Isolated hills rise above the plain.

of the Ongkag-Doemoga River. A military road was planned along this route, but was never completed. This route would join with the main entrance to the Mongondow country (the Lombagin-Kotamobagoe-Doemoga-ketjil road).

The coastal plains on the northwest are wider than those on the southeast. Included among those on the northwestern coast are the Amoerang and Manado lowlands, which extend inland for about 3 miles up the Ranorapo and Manado Rivers respectively. The plateau surfaces become smaller and more isolated toward the southwest, in the Mongondow area. The largest is in the vicinity of Kotamobagoe. The region has many volcanic peaks. These rise to elevations considerably greater than those of the plateaus, lowlands, and corridors which they dominate. The highest volcanoes are Kalabat (6,590 feet), flanking the northeast side of the Manado-Kema corridor (FIGURE II - 30); Lokon (5,210 feet), lying southwest of Manado; and Soepoetan (6,000 feet), southwest of Lake Tondano.

Cross-country operations in the interior of the region would not be particularly difficult. The main obstacles would be the narrow ravines cut into the flanks of the volcanic peaks. Between the ravines, the land surface usually is gently rolling, with many open, cultivated fields and tree plantations. Wet rice paddies (*sawahs*) are found mainly on the flats surrounding Tondano Lake.

(2) Northern Peninsula.

The western portion of northern Celebes differs from the northeastern tip of the peninsula in that it is generally lacking in interior plateaus, basins, and cross-island corridors. An exception to this is in the Gorontalo district where a good cross-island route leads northward from Gorontalo to Koeandang, and a discontinuous interior basin, consisting of the Bone River, Lake Limboto, and Pagoejaman valleys, trends roughly east-west (FIGURE II - 31). The lowlands are situated along the coast, and while fairly continuous laterally, they do not penetrate far into the interior. The mountain backbone is almost uniform in its sharpness and in its elevation (generally between 6,000 and 7,000 feet). It is an effective barrier to cross-country travel, and only in a few places is it crossed by native foot trails. For the most part, it is a single ridge, although in a few places it is bent, broken, and paralleled by one or more accessory ridges.

The coastal plains along the southern side of the peninsula, facing the Gulf of Tomini, are more nearly continuous than the plains along the north coast, where there are a number of high rugged peninsulas. The head of the Gulf of Tomini is bordered by a continuous coastal plain never more than about ½ mile wide. The widest coastal plains along the south coast from west to east are the Oja-Ongka plain, the Bolano-Moöetong plain, and the Marisa plain. These plains average about 8 to 10 miles in width.

On the opposite side of the peninsula, the principal coastal plains form a series from the Bay of Tamboe (Bocht van Tamboe) on the southwest, to Lombagin on the east in the following order:

1. Pambero plain,
2. Moente-Siboa plain,
3. Lendjoe-Pepe plain,
4. Maradja River lowland,
5. Kampoeng Baroe (or Tolitoli) plain,
6. Boeal-Matinan plain,
7. Paleleh plain, and
8. Koeandang plain.

FIGURE II - 30. *Celebes.*
Minahasa Region. Mount Kalabat. Looking E from Manado-Tomohon Road. 1937.

FIGURE II - 31. *Celebes.*
Northern Peninsula. Lake Limboto, near Gorontalo. Date and direction of view unknown. Low marshy shores in foreground. Highlands back of opposite shores.

These coastal lowlands would not be suitable for the deployment of mechanized forces except locally, because of swamps, and it is doubtful if there are many places suitable for airfield development. Exits from the plains are only lateral (parallel to the coast), and none of them provides access to the strategic Minahasa Region at the northeastern end of the peninsula.

The only district that appears to have strategic importance from a terrain standpoint is the Gorontalo district. Here is a lowland, the Limboto plain, lying inland from the coast, with one narrow gap in the coastal range as its only southern approach (FIGURE II - 32). A pass leading from Limboto plain northward across the peninsula to Koeandang has a maximum elevation of only 1,384 feet, and a potential route leads eastward, via the upper Bone valley, to the Bolaäng-Mongondow plateau with its road connections to the Minahasa Region.

(3) Adjacent islands.

There are 29 islands a mile or more in diameter which are adjacent to Northern Celebes. The largest island is 12 miles long. Most of the islands are less than 2 miles long. Some of these islands have military significance in that they flank the approaches to critical areas in Northern Celebes.

22. *Drainage and Water Supply*

The drainage and water supply of each of the major sectors of the Celebes Sea Area are discussed individually in the following paragraphs.

A. Halmahera and adjacent islands.

Drainage conditions in many parts of Halmahera are unfavorable for military operations, but water supply is generally adequate for large forces.

(1) Rivers.

The rivers in Halmahera, without exception, are navigable only for native canoes (*prahoes*). Sandbars block the mouths of rivers preventing the entry of larger craft. Most of the streams are short and swift. Almost all are fordable, however, except after heavy rains. The largest stream on the island is the Kaoe River, and it is the only one which is navigable by large prahoes of 3 to 4 foot draft for any considerable distance. The sandbar at the mouth of Kaoe River is awash at low tide. This river is a barrier to military advance. Other streams that would be minor barriers to cross-country travel in their lower courses are the Tiabo (north of Galela), the Mede (between Galela and Tobelo), the Akelamo (near the end of the northeast peninsula), the Sangadji (on the southwest side of Boeli Bay), the Lamo

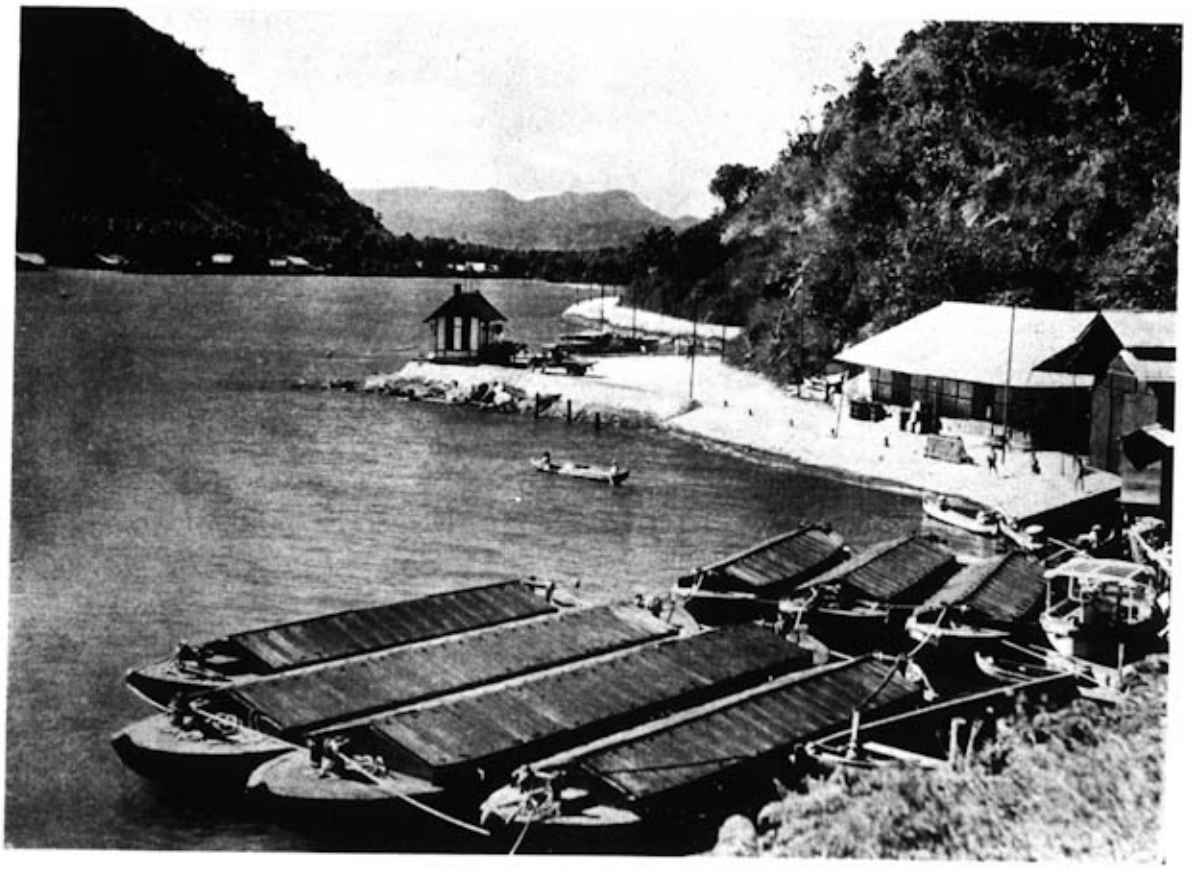

FIGURE II - 32. *Celebes.*
Northern Peninsula. Looking N. and inland through gap in coastal range toward Gorontalo and east-west valley.

(on the Soesoepoe Plain), and the Iboe (mid-way on the west coast of the northern peninsula).

(2) Lakes.

The only lake of any significance on Halmahera is Galela Lake, located several miles inland from the head of Galela Bay. It is about 2.6 miles long from east to west, and about 1 mile at its greatest width. It is reported to be suitable for a seaplane anchorage.

(3) Swamps.

Swamps and marshes constitute one of the greatest obstacles to military operations on the island. Their most common location is near the mouths of the larger streams and paralleling the shoreline behind the beaches, although in a few cases they may continue for several miles inland along the stream courses. The swamps are poorly drained areas that are periodically flooded by fairly shallow water and tend to have a forest vegetation, while the grassy marsh areas develop where there is deeper flooding. As a general rule, the marshes are even more difficult to cross on foot than the dense palm forests of the swamps. Mangrove swamps are commonly found along the muddy shores of sheltered bays, such as in Loloda, Djailolo and Dodinga bays, and at river mouths. Listed below are the largest areas of poorly drained land on the island, given by terrain regions. (No distinction is made between swamps and marshes.)

(a) Southern Halmahera.

East coast
- Northwest of Foja
- Northwest of Weda
- Along the lower course of the Kobe River

West coast
- North of Lifofa
- West and northwest of Pajaheislam

(b) Central Halmahera.

East coast
- Central portion of the south coast of Boeli Bay
- The lower portion of the Sangadji River valley
- South side of Kaoe Bay

West coast
- Between Cape Dobegasi and Akelamo
- Along the mainland coast opposite the Woda Islands

(c) Northern Halmahera.

East coast
- Northeast of Akelamo on the northwest side of Kaoe Bay
- Middle portion of Kaoe River Valley
- North of Galela

West coast
- East side of Loloda Bay
- South of the mouth of the Iboe River
- The head of Djailolo Bay
- The north side of Dodinga Bay

(d) Morotai.

Southeast of Wajaboela on the west coast.

(e) Batjan Island.

East of Laboeha

East side of Sambaki Strait on the west coast.

(4) Water supply.

Nowhere in the area, does the difficulty of obtaining drinking water arise. Nearly all villages obtain their drinking water from wells, generally only sufficient for village requirements. The water supply can be increased in any locality by digging additional wells, or by utilizing the water in streams. Inland, mountain streams are available everywhere. It is advisable, however, to boil or treat all drinking water to remove possible contamination.

B. Sangihe-Talaud Islands.

These islands are well drained for the most part.

There are no navigable rivers, and none of the streams is sufficiently large to be an obstacle to overland travel. There are no lakes of sufficient size to be of any military significance. There are a few small swamps located on the flat coastal plains, particularly near the mouths of the small valleys. They are not of sufficient size, however, to be effective barriers. Although little accurate information is available, it appears that water supply would not present serious problems, except for unusually large military operations. Since there are no rivers or streams with a permanent flow, the normal fresh water supply is obtained from wells.

C. Mindanao and adjacent islands.

In addition to the text material following, a great deal of information about drainage and water supply will be found in the regional relief descriptions in Topic 21.

(1) Rivers.

Despite the large size of Mindanao, there are only 2 rivers that can be used for water transportation. These are the Agusan and Mindanao-Pulangi Rivers.

(a) Agusan River. This river has the following depths at its western entrance: 9 to 10 feet at low water, 12 to 14 feet at high water over the bar. Above Butuan, it is usually navigable for about 12 miles by vessels of 8-foot draft or less. At this point there is a rocky obstruction over which boats of 6-foot draft can pass. The river is navigable in all seasons by boats of 5-foot draft as far as Esperanza, and in all but the driest weather as far as Lake Lumao, almost 60 miles from the mouth. In the wet season, launches with a 5-foot draft may go upstream as far as Bunawan and Veruela. While the Agusan is fairly deep and wide (from 400 to 800 feet), the channels constantly shift, and it is advisable to use local guides wherever possible. The entire river basin, for 15 to 20 miles on either side of the river, is low and traversed by a network of interlocking water courses. The highest ground is found along the stream banks.

(b) Mindanao-Pulangi River. The bar at the mouth of the Cotabato entrance to the Mindanao River has only about 5 feet of water over it at low tide. The south entrance is used only by small native craft. The lower part of the river is navigable to launches of 5- to 7-foot draft as far as Paidu-Pulangi at low water, and to Pikit at high water. Small launches can go up to Kabacan at low water, and to the Lumatan River at high water. There are only a few stretches of firm ground along the lower course of the river for good boat or barge landings or for bridge approaches. The current is fairly strong. The lower valley is covered largely by rice paddies (FIGURE II - 33), and the numerous water courses that form a network over the valley floor would be a handicap to military operations.

(c) Other rivers. The other rivers are not navigable by river launches except for very short distances (usually less than 2 miles) near their mouths. As a general rule, they are obstacles to movement only on the flat, narrow coastal plains, where they commonly have tidal characteristics, or in the mountains, where they become raging torrents following heavy rains.

(2) Lakes.

There are many large lakes on Mindanao, but most of them are located in the marsh and swamp country in the Agusan and Cotabato Basins, and have poor shores or are difficult of access. Lake Mainit south of Surigao, and Lake Lanao, northeast of Illana Bay, however, have potentialities as seaplane anchorages.

FIGURE II - 35. *Mindanao.*
Western Cotabato Basin. Flooded rice fields. Looking NE from a point a few miles east of Cotobato. 1939.

(*a*) *Lake Mainit.* This egg-shaped lake is about 15 miles long from north to south, and 4 to 9 miles wide, the widest portion being near the northern end. It is relatively clear of obstructions, and there are several sections of shoreline suitable for beaching seaplanes.

(*b*) *Lake Lanao.* This is the largest lake on the island, and is located on the Lanao Plateau at an elevation of 2,297 feet. It is clear and deep. Its use by seaplanes is handicapped mainly by the frequent squalls which arise suddenly, particularly in the late afternoon.

(3) Swamps.

The 2 great swamp and marsh areas of the Cotabato and Agusan Basins already have been mentioned under the description of terrain. They are significant barriers to any cross-country troop movement at any season of the year. They contain innumerable interlocking watercourses, lakes, and ponds. The coastal plains on the island all contain some more or less poorly drained land, the amount being roughly proportional to the extent of the flat land. The larger areas of coastal plain swamps are at the head of Davao Gulf; near the mouth of the Agusan River; at the head of Panguil Bay (the innermost section of Iligan Bay); at the extreme southeastern tip of Zamboanga Peninsula; and at the mouths of streams flowing into Sibuguey and Dumanquilas Bays.

(4) Water supply.

There is no problem of an adequate fresh water supply in Mindanao. Streams, lakes, springs, and wells could supply an unlimited number of troops. The only possible exception to this condition is in some of the porous limestone areas, such as between Linao Bay and the Cotabato Basin, and on some of the adjacent islands. These areas, however, are small. A large portion of the domestic drinking water on Mindanao is obtained by collecting rain water. This is not because of a lack of fresh water, but rather to avoid contamination. All surface and ground water should be boiled or treated chemically before being used for drinking purposes.

D. Sulu Archipelago.

None of the streams of this group of islands is large enough to be of any value for water transportation. A few have swampy tidal estuaries that would be troublesome to cross-country movements. There are no lakes of military importance in the archipelago. There are 2 general locations for swamps on these islands. One location is along low, muddy, sheltered coasts, where mangrove is almost universally present. The other location is along the lower courses of the streams, where they cross flat coastal plains.

Fresh water is difficult to obtain in the Sulu Archipelago, especially from December to May. No difficulty will be encountered on Basilan or Jolo Islands, but elsewhere water is at a premium, since there are few permanent streams, springs, wells, or other all-year sources. Shallow wells are dug, from which limited quantities of brackish water are obtained, and cisterns for collecting rainwater are fairly common. If traveling south through the archipelago, large supplies of fresh water should be stocked at Jolo and Siasi in preparation for water shortages farther south. During the dry months, water is the chief concern of the native population in many parts of the southern islands, and they are reluctant to give or sell water.

E. Borneo and adjacent islands.

Drainage conditions are of primary military significance in many parts of Borneo.

(1) Rivers.

Within the portion of Borneo treated in this study, there is a great contrast between the rivers that flow toward the west coast and those flowing toward the east coast. The former are commonly short and swift, and are of use for water transportation only for short distances. The main exception is the Padas River, which is navigable by large launches for a considerable distance inland. In their lowest courses, where they lie on flat coastal plains (FIGURE II - 29), the west-flowing rivers may often be unfordable during the wet season, thus hindering overland travel laterally along the coast. The rivers flowing toward the east are large, and form the main routes of access into the interior. They are also major barriers to overland travel at right angles to their courses, since fords and good bridge sites are rare, particularly along the lower courses. In their lower reaches these rivers wind back and forth across flat, periodically flooded river plains. Usually there is a chaotic maze of drainage channels (*"pintasans"* or *"antasans"*) and abandoned river bends that have ponded water (*"danaus"*) in them on these plains. Winding ridges of slightly higher ground border the present main river channels, as well as the sites of previous river courses. The river bottom along the lower reach is almost always muddy. On the Beraoe River (the lower Kelai and Segah Rivers) the first firm gravel bank in the stream is not reached until 50 miles above Redeb Point.

General statements as to the navigability of these rivers can be misleading. Some of the reasons for this are:

Wide fluctuations in volume. A difference in depth of 33 feet has been observed at one point, and a rise of 16 feet in a single hour was recorded on one of the mountain streams in the central part of the island.

Changing stream courses. A deep channel may be partially filled, split, or shifted in a short period of time.

Temporary obstructions, particularly log jams—owing to the common practice of dumping trees into the rivers following clearing for cultivation.

Sections with falls or rapids. Many of the rivers have narrow gorges along their middle courses, yet have long stretches of navigable water farther upstream. Use of rivers by large ocean going vessels is hindered by bars at the river mouths, but several rivers, such as the Kinabatangan, Sesajab, Kajan, Berauc, and Mahakam, have been entered by vessels having less than 15-foot draft.

(2) Lakes.

There are no lakes of any military significance in this portion of Borneo.

(3) Swamps.

Swamps and marshes are a common feature of the terrain on the broad, flooded, river plains. They include both forested swamps and grassy marshes, depending on the depth of flooding. Although found along the lower courses of all of the larger rivers, the swamps are most extensive, and are very significant terrain barriers in three broad areas:

The Mahakam basin (the northern portion of which lies north of the equator and within the boundaries of this study).

The multiple-delta region between the mouths of the Kajan and Sesajab Rivers.

The area between the Kinabatangan River and Sandakan Bay.

(4) Water supply.

There is no lack of fresh water in any portion of the main island, owing to the heavy rainfall and numerous rivers and springs. Some of the smaller islands, however, particularly the low coral islands to the northeast, have a water supply problem.

F. Celebes and adjacent islands.

Drainage conditions are diverse in Celebes but water supply is adequate almost everywhere.

(1) Rivers.

There are no large rivers in Northern Celebes. A few streams are navigable to small boats of shallow draft (3 to 4 feet) but only for short distances. The rivers of Celebes usually have characteristics typical of mountain streams along most of their courses, but where they cross the narrow coastal plains they are generally unfordable and wind across swampy flats.

(2) Lakes.

There are several lakes in Northern Celebes, only 2 of which appear to be suitable for possible seaplane anchorages. The largest is Lake Tondano, which has a greatest length of 7¾ miles, and a maximum width of 3¼ miles. It lies on the Tondano plateau, in the central portion of the Minahasa Region at an elevation of 2,269 feet. Mountains lie near the northwestern and southeastern sides of the lake, but there are clear approaches by air from either the northeast or southwest end of the lake. Lake Danau also appears to be large enough for a seaplane landing, but it is almost surrounded by high volcanic peaks. It is $3\frac{1}{16}$ miles long and 1 mile wide. The lake is located in Bolaäng-Mongondow Province, and is the source of the Poigar River.

A third lake, Limboto, is located just west of the town of Gorontalo. It has the shape of a rough rectangle, is about 7 miles long from east to west, and 4 miles wide. It is very shallow, however, and may be dangerous for float plane use. It is bordered by considerable stretches of marshy ground (FIGURE II - 31).

(3) Swamps.

Swamps and marshes are found on nearly all of the coastal plains, especially near the mouths of streams. Most of the fresh water swamps contain much sago. The swamps are difficult to cross on foot, particularly during the wet season. The coastal trails usually keep inland away from the swamps, or follow the narrow sandy beaches.

(4) Water supply.

The supply of fresh water throughout the region is adequate for normal military requirements.

23. *Soil Trafficability*

(FIGURE II - 44).

Soil trafficability refers to the capacity of soil to support the movement of military vehicles. It refers especially to cross-country movement of vehicles and to traffic on unimproved roads made of local soil, rather than to traffic on improved or surfaced roads.

A. General factors affecting soil trafficability.

The difference in trafficability between the coarse-, medium-, and fine-textured soils is not as great in the Celebes Sea Area as in higher latitudes. This results from the type of weathering (lateritic) which is characteristic of the area and which generally produces medium-, and fine-textured soils which are friable and allow excess precipitation to drain rapidly. In spite of this, the general soil trafficability is moderately unfavorable.

Whenever seasons are referred to in this section, they are those of the Northern Hemisphere, in keeping with the treatment of climate and meteorology in Chapter V.

The frequent rainfall is cumulative in its adverse effect upon trafficability since there is little time for the soil to dry thoroughly between rains. The rainfall is also generally heaviest in the afternoon or evening, and this tends to prolong further the nontrafficable period, since much of the time between rains occurs at night or in the morning when there are unfavorable conditions for the soil to dry.

The weather factors are generally unfavorable to the movement of vehicles, and largely offset the generally favorable drainage properties of the soils. Furthermore, the larger islands have heavily forested mountain regions in their interiors, which restrict movement to discontinuous coastal plains separated by rocky headlands and swampy areas. Many of the smaller islands have steep, rocky slopes or, where they are of low elevation, have a heavy mangrove cover. The most favorable soils for trafficability are those developed on coral atolls, coral islands, and uplifted coral rock along the coasts of the larger islands. These soils are generally trafficable at all times.

No soil surveys of any extent have been made in this area. However, written descriptions and geologic information have been used to map the general soil trafficability where possible. Since geologic and topographic information is, itself, incomplete, the soil trafficability boundaries are approximations. With these considerations understood, the accompanying map (FIGURE II - 44) and the general areal descriptions following should be of use in determining routes of movement, and soil trafficability conditions to be encountered over chosen routes under different weather conditions.

B. Soil trafficability in Halmahera.

On Halmahera and some of the larger islands, such as Morotai, Batjan, Mandioli, Kasiroeta, Latalata, and Kajoa, coarse-textured soils occur in rather narrow, discontinuous coastal strips. They are derived from layers of conglomerate, volcanic ash, uplifted limestone, clay, and marl, interbedded in varying combinations. These soils are trafficable except when flooded by very heavy rains. Access to them is made difficult in many places, however, by mangrove swamps. On some of the smaller islands, such as those of the Widi group off the southeast coast of Halmahera, the coarse-textured soils are derived entirely from uplifted coral rock, drain very rapidly, and should be trafficable at all times.

The most common soils in the Halmahera group of islands are those which range in texture from coarse to medium. They include sandy loams, stony loams, and loams. These are developed from a variety of rock types, including old consolidated volcanic debris, more recent volcanic flows and ejected volcanic debris, sandstone, conglomerate, coarse- and medium-textured alluvium, schists, and granite. They extend entirely across the islands in some places, such as the northern peninsula of Halmahera, and the southern peninsula of Halmahera in the vicinity of Weda; also on Ternate, Tidore, Moti, Makian, Gebe, Gag, and Kofiau. At other places in the islands these soils are separated from the coast soils which are usually coarse-textured, as in southeastern Morotai and on Kasiroeta, Batjan and Mandioli. Taken as a group, these soils should be trafficable except during and immediately following heavy precipitation. However, where they occur in heavily forested mountain regions, their trafficability will be very poor regardless of weather.

Fine-textured soils also cover large areas on Morotai and Halmahera. These include silty clay loams, clay loams, and clays that are developed from dark-colored igneous rocks, limestone, marl, and fine-textured alluvium. These soils are friable; although slippery when wet, they recover rapidly from the effects of precipitation. They may be considered somewhat less trafficable than the coarse- and medium-textured soils. These soils also occur in mountainous regions where unfavorable topography restricts ground movement.

Intermittently flooded soils occur at many places along the coasts of the islands, usually at the mouths of streams and rivers. These soils are alluvial types and are frequently flooded and nontrafficable during and after rainy periods. During dry weather, however, they are moderately trafficable.

The swamps and marshes in the Halmahera group do not usually cover large areas in the interior. The larger ones, which are on Halmahera itself, have been mapped and should be considered nontrafficable at all times unless ground reconnaissance reveals feasible routes not now noted on available maps. There are fairly large areas of swamps and marshland on many of the coastal lowlands and along the larger river valleys. The swamps (*moeras*) are very wet and muddy with standing water. Locally in such areas, a man may sink to his shoulders. The marshland (*drasland*) is also muddy but less deep, and generally there is no standing water. No attempt has been made to map the narrow coastal mangrove swamps. These are serious obstacles to landing operations at many places (Chapter IV and accompanying Plans).

The most favorable season for ground movement is fall, while the least favorable is spring. Trafficability should generally be better on the southeastern coasts of the larger islands throughout the area, especially during the summer and fall.

C. Sangihe-Talaud Islands.

Almost all of the islands of this area have coarse- and medium-textured soils developed from volcanic ash and lava. These soils are trafficable except during and immediately after heavy rainfall. Some of the islands such as Siaoe and Sangihe have active volcanoes. Most of the islands have rugged topography and steep coastal cliffs, but the larger islands such as Sangihe, Karakelong, Salebaboe, and Kaboeroeang have some low coastal areas, parts of which are swampy and always nontrafficable. Marie Islet in the Kawio group is low and sandy and should be trafficable at all times. Average rainfall in these islands is about 135 inches and shows no significant seasonal variation, so that throughout the year there will be periods of nontrafficable conditions.

D. Mindanao.

Because of lack of complete information on the soils and geology of this area, the trafficability map has been adapted from Pendleton's agricultural topography map. This divides the area into convenient units, based on topography and land use, which also reflect to a useful degree the type of soil and trafficability.

The low plains and gentle slopes of hills, not more than several hundred feet above sea level, have mostly arable, well-drained soils except in marsh and swamp districts. Most land of this type occurs along low parts of the coast and marginal strips of the main river valleys. The soils are in large part developed from poorly consolidated alluvial and littoral sedimentary deposits, tertiary sediments, and both extrusive and intrusive igneous rocks. The soils developed are mostly trafficable except during and immediately after heavy rainfall.

Another group of readily trafficable soils consists of those developed on high land with gently sloping areas large enough for extensive cultivation. Usually these are friable and well-drained clay soils from unconsolidated volcanic debris, although some alluvial soils are included. They are mostly trafficable except during and immediately after heavy precipitation. The gentle slopes on which they occur are those flanking large volcanic peaks. Movement is relatively unhindered parallel to the slopes, but since there are numerous deep ravines and valleys radiating from the peaks, continuous movement at right angles to the slopes is practically impossible.

The most common type of land in Mindanao is rough land at intermediate altitudes. The soils in these areas are thin, well-drained, and trafficable where topography permits except during and immediately after heavy rainfall. They are developed on a variety of rocks including poorly consolidated alluvial and littoral deposits, recent unconsolidated volcanic debris, tertiary sediments, and older lavas and intrusive rocks. These soils extend from high mountain areas to the coast in many parts of the islands. Topography is a more serious obstacle to movement over this type of land than soil or weather conditions, except in the valleys.

Land having periodically unfavorable trafficability is that shown on the map as low rice land or periodically flooded land. Such areas are confined to the valleys of the Agusan and Mindanao Rivers, to those valleys entering Davao Gulf from the north, and to a small area near Zamboanga. This type of land is usually found between the permanent swamp and marsh areas of the central part of the valleys and the better-drained land on the lower hill slopes. Where cultivated, these lands are

usually flooded and nontrafficable from September through December in the northeastern part of Mindanao, and from February through May in southeastern Mindanao. At other times, these soils are trafficable when dry, but require a longer time to regain trafficability after periods of rain than the soil types already mentioned.

High mountain land is common in the interior of Mindanao and in the central parts of its peninsulas. The rugged topography and dense forests in most of these areas are the chief hindrances to vehicular movement.

The swamp and marsh lands of permanent poor trafficability on Mindanao cover large areas, in the upper Mindanao and Agusan River valleys, where they usually surround the numerous lakes. In addition, there are some smaller areas of swamps and marshes along the coasts of Mindanao and the smaller islands off its shores. Since steep slopes extend to the shores at many places on Mindanao, coastal shallow water and mangrove swamps are limited except in some of the bays. The more important coastal obstacles are discussed and mapped in CHAPTER IV.

There is considerable variation in annual rainfall and its seasonal distribution in northern Mindanao. The most favorable trafficability conditions occur during the summer, while the worst conditions occur during the winter.

In the central part of Mindanao, the precipitation is generally less at the lowland stations than in the northeast. Although there is considerable variation from place to place, trafficability in Veruela is generally best during the winter, and least favorable during summer and fall.

Along the southern coasts, and particularly the southwestern coasts, weather conditions are more conducive to good trafficability than they are elsewhere. Glan has an average annual rainfall of 58 inches, and Zamboanga receives only 42 inches. In this area, the most favorable season is winter while the least favorable conditions occur during summer and fall.

E. Sulu Archipelago.

The soils of this area are of 3 general types, when considered on the basis of their trafficability.

The first type consists chiefly of sandy soils, developed on uplifted coral reefs, and found on most of the low islands on either side of the central arc. These islands include the Pangutaran group and those to the southwest including Laparan, Dammai, Sibutu and its adjacent islands, as well as Simunul and the low islands of the Tawitawi, Samales, Tapiantana, and Pilas groups. Many of these islands, including Tongquil and those islands between Tongquil and Jolo in the Samales group, Kaludlud and Dassalan in the Pilas group, Mantabuan and adjacent islands in the Tawitawi group, Cabingaan island in the Tapal group, and practically all of the islands in the Pangutaran group, are largely covered with impassable mangrove swamps. Where mangroves are not present the coarse-textured soils are trafficable at all times.

Among the second type soils some are derived from sediments. These soils occur on the larger islands—such as Tawitawi—in the central part of the arc, and on the high islands of the Pilas, Tapiantana, and Samales groups also on Marungas, a small island just north of Jolo. Soils derived from recent volcanic rock and unconsolidated volcanic ash occur on the larger islands of the Tapul group, Jolo, on the high islands in the Pilas, Tapiantana, and Samales groups, and the separate island of Cagayan Sulu. The soils from both the sediments and volcanics are similarly trafficable where topography permits, except during and immediately following heavy rainfall. Steep slopes and narrow valleys restrict movement of vehicles in many of the islands on which these soils occur.

The third type of soil is that which occurs in permanently nontrafficable swamp and marsh areas. The largest of these areas are indicated on the map. The narrow mangrove coastal strips have not been mapped in all cases but are very common especially around the small low coral islands.

The average annual rainfall in the Sulu Archipelago is about 70 inches and on Cagayan Sulu, 83 inches. In the Sulu Archipelgo, the most favorable time for vehicular movement is winter, but conditions become steadily unfavorable as the seasons progress into summer. On Cagayan Sulu trafficability conditions are best during spring and least favorable during fall and winter, which reflects the island's exposed position to the northeast monsoons.

F. Northern Borneo.

Soil trafficability information of only general nature is available for Northeast Borneo. Four major bedrock units are outlined on FIGURE II - 44: the generally unconsolidated quaternary sediments of the coastal lowlands and interior basins, the poorly consolidated tertiary sediments lying between the interior mountains and coastal lowlands, the volcanic rocks of the Darvel Bay and Cowie Harbor regions, and the consolidated pre-tertiary rocks of the interior mountain country. The soils developed through lateritic weathering from all of these rocks should be friable, permit rapid drainage of excess water, and be trafficable except during and immediately after heavy precipitation. Those derived from rocks such as shales, with fine-textured clay components predominating, have less favorable drainage properties, are probably very slippery when wet, and require more time to regain trafficability after periods of rain.

Soil information is not available for the southern part of the Borneo sector of the Celebes Sea Area. The limited geologic information concerning that region indicates that the soils occurring there are probably of similar trafficability to those mapped in the northern part of Borneo.

The unconsolidated alluvium of the coastal areas is least trafficable near the mouths of the rivers and between the natural levees and the better-drained hill slopes. The interior basins are floored with interbedded silt, sand, and coarse gravel, and although trafficable when dry are periodically flooded and nontrafficable. Heavy forest and rough mountain topography provide serious obstacles to vehicular movement in the interior regions.

Extensive swamps and marshes occurring at the mouths of the major rivers and along parts of the coastal lowlands should be considered nontrafficable at all times unless found by ground reconnaissance to be usable. There are some low coral islands off the eastern coast, such as Maratoea, which have trafficable soils at all times. Most of the islands, however, other than those at the mouths of the major streams, have rough topography which precludes rapid movement of vehicles. Most of the islands just south of Darvel Bay are of this type.

The annual rainfall in Northeastern Borneo averages about 100 inches but is variable and probably higher on the exposed mountain slopes. South of Tawau, the most favorable season for movement of vehicles is summer, but north of Tawau this con-

dition is less apparent and there is little consistency in the seasonal precipitation records from station to station.

G. Northern Celebes.

From what is known of the soils of the northern peninsula of Celebes, it appears that they are similar to those of Halmahera. Because of incomplete information, much of this area cannot be mapped as to soil type. Furthermore, the coarse- and medium-textured soils have not been separated. These coarse- and medium-textured soils cover large areas especially in the eastern part of the northern peninsula of Celebes. They are derived from consolidated and unconsolidated volcanic ash, from granite and granite-like rocks, from miscellaneous consolidated sediments including sandstone, shale, conglomerate and limestone and from coarse- and medium-textured alluvium. They probably extend from one coast to the other in some places and are found also on many of the off-lying islands, particularly those along the north coast. As a group they should be trafficable where topography permits except during and immediately after heavy precipitation.

Much of the interior of Celebes is mountainous and heavily forested and therefore nontrafficable, regardless of weather. There are numerous small coral islets along the coast of northern Celebes, particularly in the Gulf of Tomini, which have coarse-textured soils which are trafficable at all times.

So far as is known, fine-textured soils cover large areas only near the western end of the northern peninsula of Celebes. These soils are derived from micaceous rocks, soft-sheared basic metamorphic rocks, limestone, and fine-textured alluvium. Where topography is favorable, these soils should be trafficable except during and after heavy precipitation. Slippery when wet, they require somewhat longer to dry out and regain trafficability after precipitation, than do the coarse- and medium-textured soils.

Soils of less favorable trafficability occur at the mouths of the major streams. These soils are trafficable when dry, but are frequently flooded and impassable during periods of heavy precipitation.

As in the Halmahera Sector, there are fairly large areas of swamps and marsh land at places along the coastal lowlands. These areas are always nontrafficable. In addition, narrow coastal strips of mangrove swamps occur at many places.

Thin residual soils predominate in the mountain areas of Celebes. Although some of these areas between 1,200 and 4,500 feet have been mapped, many of the unmapped areas are also mountainous. In such areas, vehicular movement is impeded more by the rough topography than by soil or weather conditions.

The average annual rainfall in northern Celebes is about 90 inches. It is highest in the northern part where it averages 101 inches, and lowest in the southern part where it averages 78 inches. Lowest average annual rainfall occurs on the southern coast at Gorontalo, where it is 48 inches, and at Tinombo where it is 50 inches. Trafficability conditions are most favorable during summer, less favorable during fall and spring and least favorable during winter.

24. Vegetation

Vegetation distribution in the Celebes Sea Area is shown on Plan 2, which should be studied concurrently with the text material given below:

A. Natural vegetation.

Certain general vegetation types are common to all the islands of the region, but the distribution and the relative amount of area covered by each type vary greatly, depending upon population density, rainfall, drainage, and soil. There is also considerable variation within the types themselves, dependent upon the same factors. The main vegetation cover types are briefly described in the following paragraphs.

(1) Rain forest.

This is the original type of forest cover on most of the island areas, but it has been greatly reduced in many places by human activities. It still covers most of the rough, uninhabited terrain.

Particularly characteristic is the very dense overhead canopy, 100 to 140 feet in height, which shuts out almost all sunlight and renders the floor of the forest dark and damp. Species of trees are numerous and varied, and with few exceptions, the trees are broad-leafed. There also are numerous species of vines (lianas), creepers, and ferns. The trees stand close together, and the trunks are free of branches to a considerable height. Many trees send out roots at some distance above the ground which spread to a radius of several yards. The trees are often dripping with moisture.

Two types of rain forest may be recognized:

(a) Rain forest with sparse undergrowth. (FIGURE II - 34). There is an absence of thick undergrowth due to the small amount of light which reaches the floor of the forest. Visibility is poor, due to close spacing of trees and dim light. The undergrowth offers little obstruction to free movement of men on foot, except for small detours to avoid lianas, fallen trees and thorny palms. The close stand of the trees, together with fallen trees, prohibits movement of motor vehicles. Often too, the ground is very wet and soggy.

FIGURE II - 34. *New Guinea.*
Rain forest with comparatively sparse undergrowth. Characteristic also of rain forests in Celebes Sea Area.

(b) Rain forest with undergrowth. (FIGURE II - 35). Where sufficient light penetrates the overhead canopy, there is thick undergrowth. Such areas are found marginal to the rain forests or occur on steep slopes and along streams. The floor of the forest is covered with a jungle of vines, bushes, palms, bamboos, and other undergrowth. Movement is extremely difficult and slow due to the necessity of hacking a way through the tangled vegetation. The overhead cover is quite as complete as in the more open rain forest. Horizontal visibility is usually restricted to a few feet.

FIGURE II - 35. *New Guinea.*
Rain forest bordering river where light penetrating under trees encourages heavy undergrowth. Similar conditions are found along forest edges and on steep slopes in Borneo, Mindanao, and other parts of Celebes Sea Area.

(2) Second growth. (FIGURE II - 1).

This type of forest occupies areas once cultivated, on which the forest has again taken possession but has not reached maturity. Vegetation of greatly varying height and density may be found within the same local areas, depending upon the age of growth. Within the cut-over forest, patches are cleared for cultivation each year, then abandoned after two or three years. Seen from above, small areas of growth of varying height give a spotted appearance. Such forests predominate in northern Borneo and in considerable areas in Halmahera. Early stage second growth consists of thickets of tangled bush, brambles, and creepers, which may be interspersed with large trees and stumps. Movement may be as difficult as in rain forest with undergrowth. Cover is complete for men, but it may be difficult to conceal motor vehicles completely in areas of relatively young second growth. Bamboo thickets are common as second growth, especially in Halmahera and Mindanao.

(3) Moss forest. (FIGURE II - 36).

This type occurs in the higher altitudes, above 6,000 feet near the Equator, but extends to lower altitudes as one goes from the Equator. In northeastern Mindanao and in some parts of Borneo its lowest occurrence is at about 3,500 feet. This forest occupies areas in which evaporation is practically nil, and generally conforms to the zone of greatest cloudiness. It is dripping wet, and the atmosphere is gloomy, cold and depressing. A layer of moss and decayed vegetation covers the ground, to a thickness of several feet, covering fallen trunks and branches. The trees are also covered with lichens and festoons of moss. As a rule, the forest consists of a thick undergrowth of slender unbranched trees. Sometimes the trees are dwarfed. The forest is silent due to nearly complete absence of bird, animal, and insect life, and to the absorption of sound by the moss. Movement is very difficult and sometimes dangerous, due to concealed obstructions or rock fissures. Cover is as complete as in the rain forest and visibility is usually restricted to a few yards.

FIGURE II - 36. *New Guinea.*
Moss forest. Typical also of large parts of forested areas in Mindanao, Borneo, and other lands of Celebes Sea Area.

(4) Mangrove swamp.

Mangrove trees grow thickest along protected coasts with low, muddy, flat lands, especially about the mouths of streams or along their lower courses. The trees are of fairly even height, commonly 20 to 40 feet or more. They are close-set and send out a tangle of prop-roots growing from the trunks at a wide angle, as much as 10 feet above the ground. Underneath, the ground is likely to be thick, slippery mud, which may be covered with water at high tide. A network of narrow, fairly deep water courses is likely to interlace the swamp area. The swamps are very difficult to penetrate, both because of the tangle of prop-roots and because of mud or water.

(5) Nipa swamp.

Nipa palms occupy the drier and less salty areas beyond mangrove swamps. Patches of them may be distributed like islands within the larger mangrove areas, particularly in deltas. The fronds of the trunkless palms (10 to 15 feet high) grow straight out of the ground, which is usually thick mud or even shallow water. The palms grow very close together with the stiff and tough leaves against each other or interlaced. The palms are lighter in color than the mangroves. Movement is extremely difficult due to the dense growth and the lack of solid footing. Concealment is usually complete, and visibility is limited to a few feet.

(6) Swamp forest. (FIGURE II - 37).

Swamp forest is commonly found in conjunction with sago palm swamps in those areas where accumulation of mud or silt has been sufficient to leave these areas comparatively dry during the dry season, although covered with water during the wet season. Trees with prop roots or roots which extend from the base of the trees in large slab-like projections are especially characteristic. Individual trees may be 100 feet or more in height. The swamp forest may resemble somewhat a rain forest with a fairly thick undergrowth of smaller trees and shrubs. Thin stands of sago palms may be included. Except for vines, palms, and some bushy undergrowth, movement in the swamp forest during the dry season may be as easy as in the rain forest with sparse undergrowth. In some parts of Halmahera the

swamp forest is composed of almost pure stands of sago palms. Sago is also fairly abundant in the swamp forests of northern Celebes.

FIGURE II - 37. *New Guinea.*
Swamp forest. Typical also in Celebes Sea Area.

(7) Marsh grass, sedge, and wild cane.

Large areas of floating grasses and sedges are found in the interior of Mindanao (FIGURE II - 20). Wild cane, called *"pit pit"* in New Guinea, resembles tall reeds and grows densely to a height of 12 feet (FIGURE II - 38). It frequently fringes the banks of rivers, but does not cover large areas. Floating grass areas have no footing, and can be crossed only by canoe where narrow waterways have been opened. Wild cane may grow in several feet of water.

(8) Open grassland. (FIGURES II - 3 and II - 39).

Extensive natural grasslands are found in Mindanao in the areas of lesser rainfall. On other islands grasslands are limited in area, developing generally after cultivation. The common type of grass is known as *"cogon"* in the Philippines and elsewhere as *"alang alang"* or *"kunai."* It is very coarse and dense, growing usually to a height of 4 to 6 feet, but occasionally up to 12 feet. The blades are about ½ inch wide and have serrated edges. The natives burn off large areas in the dry season, but the grass quickly grows back to maturity. Travel on foot in *cogon* is difficult but not impossible. The heat may be almost unbearable, due to lack of breeze and shade. Motor vehicles can move through the grass without great difficulty. Planes can make emergency landings with wheels up in tall grass. Troops can find cover from ground view, and fair cover from air view. Visibility varies from excellent in short grass to a couple of feet in the tallest and densest grass.

(9) Special types of vegetation.

There are several types of plant growth which are found in relatively small areas, and are of only local significance. They include: (a) the casuarina forest, a sparse growth of low trees with needle-like foliage, found on sandy ridges along the beaches and easily penetrable by troops; (b) scrub and dwarf forests at high altitudes, limited to a few mountain summits, with trees growing densely to heights of 10 to 20 feet; (c) alpine vegetation of scrub and grass on the highest summit areas, as on Mount Kinabalu in northern Borneo.

B. Cultivated lands.

The total area of land actually under cultivation is relatively small. The island of Mindanao includes much the greater part. Two distinct types of cultivation should be noted:

FIGURE II - 38. *Mindanao.*
Wild cane at crossing on upper Agusan River, near Compostella. This growth is characteristic of low muddy stream banks.

FIGURE II - 39. *Mindanao.*
Cotabato Basin. Buldun. Looking NE. 1939. Tpyical open stand of *cogon* grass.

(1) Plantations.

These are found chiefly on the better drained sandy lands of the coastal plains, although in Mindanao there is much scattered cultivation of the plantation type in inland valleys and plains. Coconut plantations are by far the most common. They are located on or near the coasts. Next in importance are abaca (hemp) plantations in Mindanao, and rubber in northeast Borneo. Of minor importance are tobacco and coffee plantations in North Borneo, and pineapples in Mindanao. Plantation vegetation generally permits free movement on foot or by motor vehicle, except in neglected coconut groves where young coconuts and other undergrowth have come up. Well-kept plantations have networks of roadways. The coconut trees usually are planted in rows far enough apart (ordinarily about 30 feet) to permit movement of motor vehicles between. Abaca plantations often are traversed by roads, and the plants, although 10 to 18 feet high, have shallow roots and are easily pushed over by tanks and trucks (FIGURES II - 6 and II - 40).

(2) Cultivated fields.

The most common practice of the natives is to make small clearings which are cultivated for 2 or 3 years and then abandoned for new sites. Grass and second growth forest then take possession. In a few local, more densely populated areas in Mindanao, Minahasa, and northwest Borneo, cultivated fields and abandoned open grassy patches are more or less continuous. Rice paddies, common along the stream valleys of Borneo, Celebes, and some parts of Mindanao, are cultivated from year to year (FIGURE II - 33). Corn is the chief crop in the shifting clearings. Some yams, bananas, taro, sugar cane, and vegetables, are also grown. In areas of shifting clearings the cultivation is spotted amid second growth in various stages.

C. Distribution of vegetation in Halmahera.

The island is almost entirely covered with rain forests in which it is difficult to make progress due to vines. Coconut palms or plantations extend along much of the coast. Back from the coast, a belt of plains, hills, and valleys includes native clearings, local grass areas and considerable second growth. The grass, here called *"alang alang,"* corresponds to the *"cogon"* of the Philippines and the *"kunai"* of New Guinea.

(1) Southern Halmahera.

Most of the coast is bordered by coconut trees and groves. Inland, the country is uninhabited and covered with dense rain forests, which extend to the coast of the southern extremity and some parts of the east coast. On the west coast there are scattered small coconut plantations between Semo and Lifofa, and native clearings and second growth in a narrow belt back of the coast. On the northeast coast, around Weda and Foja, and in the river valleys between, a pattern of coconut plantations, native clearings, grass areas and second growth extends some miles inland. Mangrove swamps are found at the mouths and along the lower courses of the larger streams on the east coast, north of Foja. The coast north of Maidi is swampy, and swamp land extends inland between Maidi and Lifofa. Damar Island is entirely covered with rain forest.

(2) Central Halmahera.

Mangrove swamps extend along much of the west coast be-

tween Pajaheislam and Akelamo and for a few miles north of Akelama, as well as along stretches of coast on the southeastern peninsula. Coconut groves are found along most of the west coast, also along the coast of the southeastern peninsula and some stretches of coast on the northeastern peninsula. Most of the streams have mangrove swamps at their mouths and along their lower courses. Farther inland there are grassy areas along the bottoms of the main stream valleys. There are occasional grassy marshes. Native clearings and second growth occur on the coastal lands of the southeastern peninsula and along the south coasts of the northeastern peninsula. All the interior is covered with dense rain forest. Much of that near the coasts has heavy undergrowth.

(3) Northern Halmahera.

The interior is densely covered with rain forest, but there is relatively more cultivation and grassland than in other parts of Halmahera. North of Djailolo is an area of well-kept coconut plantations, scattered fields, and areas of abandoned cultivation which have gone into grass or have reverted to various stages of second growth (FIGURE II - 1). On the east side of the peninsula, the plain of the lower Kaoe River has considerable areas in grass. There are also many scattered cultivated spots. Coconut groves extend along the coast from Malifoet north to Tobelo. A belt of grassland parallels much of this coast. The country around Tobelo and Galela is also a mixture of coconut plantations, native clearings, second growth, and grassland. Grasslands extend northward over the Galela Plain. On the west side of the peninsula there are plantations around Baroe on the coast and extending inland around Iboe. There are mangrove swamps at the heads of Galela and Djailolo Bays.

(4) Morotai Island.

Coconut palms fringe all of the south and east coasts. There are also considerable areas of marsh land, especially at the river mouths on the southwest coast. Grasslands or bamboo thickets extend in narrow bands inland along the streams. All of the rest of the island is dense rain forest.

(5) Western Volcanic Islands.

Ternate has a considerable amount of cultivated land. Many villages and fields dot the coastal region though they are more isolated inland. All of the southern slopes of the mountain are dotted with gardens. Rain forest with undergrowth and second growth cover the rest of the mountain sides. The top of the volcanic cone is barren or covered with grass and brush. There are a number of coconut plantations around Kajoa. The other islands have scattered clearings and second growth along the coast, grading into rain forests in the interior. Mangrove swamps are common along the east coasts of Tidore, Kajoa, and Laloein.

(6) Batjan Islands.

Coconut groves fringe most of the coasts. Plantations are fairly continuous on Batian Island south of Laboeha. Inland from Laboeha, sago swamps extend toward Babang Bay. There are a few small areas of grassland and bamboo in the interior valleys. Most of the area of the islands is covered with rain forests. Mangrove swamps extend along the south coast of Mandioli and along Sambaki Strait.

FIGURE II - 40. *Mindanao.*
Lanao Uplands. Alubijid west of Cagayan. 1939. Abaca plants.

D. Vegetation distribution in the Sangihe-Talaud Islands.

All of the intermediate mountain slopes of the larger islands are covered with forests. Coconut groves are continuous along the sandy coasts and on well-drained coastal plains. Native clearings, gardens, and second growth extend up the lower slopes of the mountains. The higher volcanic slopes are barren, or covered with dense low brush. Occasional mangrove swamps are found on sheltered low coasts. Some of the smallest islands are almost entirely covered with coconut palms.

E. Vegetation distribution in Mandanao.

The greater part of the rough terrain on the island is forested. The forests are most nearly continuous in the eastern part of the island, on the western peninsula, and in the Southern Mountain Region. There are extensive grasslands, however, throughout the central part, and some grasslands in the west coastal regions. Districts where cultivation is shifted frequently and in which considerable areas of second growth occur, are widely distributed. The better drained lowlands have abaca plantations or permanently cultivated fields of rice, corn, sugar cane, and other crops.

(1) Southern Mountain Region.

This region is an almost unbroken forest. A belt of moss forest covers the higher mountain ranges, paralleling the coast inland and west of Sarangani Bay. There are several small areas of moss forest east of the bay also, on the range paralleling the Pacific Coast. Open grass country extends inland from the north coast of Sarangani Bay. At the western end of the region, north of Linao Bay, there is a smaller area of mixed grassland and forests, and all along the coast a narrow belt of scattered fields, occasional coconut plantations and much second growth.

(2) Central Mountain Region.

Except near the north coast, this region is covered by almost continuous rain forest. There are two small areas of moss forest in the mountains east of Macajalar Bay. On the east coast of Macajalar Bay there is a belt of villages, scattered fields and grasslands, and farther inland an area of mixed grassland and

forest. Bordering the streams, the forests have dense undergrowth, but inland they are comparatively open.

(3) Davao Lowlands.

Cultivation is more extensive in this region than elsewhere in Mindanao. There are extensive plantations of abaca extending back from the coast, especially up the Davao, *Talomo* and *Daliao River* valleys. (FIGURE II - 6). There is a network of private roads through these plantations. Many coconut plantations border the coast. Mangrove swamps fringe much of the coast north of Davao and around the head of the bay. These swamps are most extensive at the mouths of the rivers, especially the Hijo, Tuganay, and Padada rivers. Sporadic native cultivation with second growth is characteristic of the lower east and south slopes of Mount Apo, and the river valleys extending inland from the northern part of Davao Gulf.

(4) Eastern Mindanao.

Dense forests cover all of the region except for small cultivated areas along or near the coasts. Most of the forest has comparatively sparse undergrowth, but on the narrow coastal plain there is considerable dense second growth in areas formerly cultivated. Mangrove swamps are not common on the east coast except for about 10 miles of coast southeastward from Surigao and a small area at the head of Lianga Bay. Along the coast there are scattered, small, settled areas where the natives grow rice, hemp, and coconuts. Cultivation is most extensive in the north, between Surigao and Lake Mainit. Extending inland from the coast, north of Carrascal for about 15 miles, there is a large area of red soil, barren of vegetation. There are 2 fairly large areas of moss forest; one in the mountains east of Davao Gulf, and the other in the Diuata Mountains. In the latter area the moss forest extends downward as low as 3,500 feet and in the southern mountains down to about 4,000 feet. The forests of this region are the wettest in Mindanao.

(5) Agusan Basin.

Rain forests cover most of the Agusan Valley. There are mangrove and nipa swamps at the mouth of the Agusan River which extend up the river about 2 miles. Beyond this, both banks are covered with coconut trees. The east bank of the river is generally lower and swampier than the west bank and has considerable wild cane and swamp forest. Swamp areas extend along the east side south of Butuan for several miles. Between Butuan and Esperanza there is low-lying farm land. Upstream from Talacogon there is an extensive area of marsh, with floating grasses and sedges, and with strips of swamp bordering the river. The swampy area extends for 15 to 20 miles back from the main channel, on both sides.

(6) Bukidnon Uplands.

Cogon grass (*kunai*) covers all of the northern and eastern parts, in the drainage basins of the Pulangi, Cagayan, and Tagoloan Rivers (FIGURE II - 3). The grass is exceptionally high between Bugo and Alae in the northern part. The grasslands are broken by scattered fields, especially near the coast of Macajalar Bay and along the road south of Cotabato. Corn and upland rice are important crops. The Katanglad and Kalatungan Mountains, in the western part, are forest-covered. The higher areas are in moss forest. The Del Monte pineapple plantation extends for about 7 miles northward from near the base of the Katanglad Mountains.

(7) Lanao Uplands.

Around Lake Lanao, and northward to Iligan Bay, the country is open and grassy, with much of it under cultivation, rice being the chief crop. East of Lake Lanao, the long slopes leading to the drainage divide are covered with dense wet forests. Some moss forest is found on the mountain slopes southeast of the lake. South of the lake the country is forested, but nearer the coast the forest is only scattered. In the vicinity of Malabang on Illana Bay, the coastal region is open grass with considerable scattered cultivation and extensive coconut plantations.

(8) Western Mindanao.

Rain forests cover much of the area and are particularly dense on the slopes of the mountains to the north and east. A considerable mountain area west of Iligan Bay is covered with moss forest. The coastal regions tributary to Sibuguey Bay, and on the opposite north coast, are mostly in *cogon* grass. Grass also covers much of the uplands to the north, and open, partly cultivated country extends up the Sibuguey Valley. There is also a stretch of grass country between Dumanquilas and Illana Bays, but Baganian Peninsula is forested. The coastal region west of Iligan Bay is quite densely populated and has coconut groves on the low ground back of the beach. Mangrove swamps fringe much of this coast. They are quite extensive around the head of Panguil Bay and on the deltas of the Sibuguey and Kumalarang rivers. Mangrove swamps also fringe much of the coast to the east and northeast of Zamboanga. Coconut groves extend along the coast at the south end of the Zamboanga Peninsula (FIGURE II - 18). The Goodyear rubber plantation is located at Kabasalan, 3 miles inland and north of Sibuguey Bay. The coastal lands sloping toward Dumanquilas and Pagadian Bays have much second growth interspersed with cultivated patches (FIGURE II -17).

(9) Cotabato Basin.

Four types of country are included: grasslands, mixed grass and forest, swamp, and cultivated lands. Mangrove swamps cover much of the delta lands of the Pulangi-Mindanao River. Upstream from the delta, the flat lands bordering the lower Pulangi-Mindanao river are mostly in rice fields, especially around Cotabato (FIGURE II - 33). Grasslands extend from the coast southeastward over the plains of the Alah and Bunga rivers. Scattered forest and grass cover the northern part of the Cotabato Basin. The Libungan and Liguasan marshes cover extensive areas through the central part. They are mostly covered with floating grasses (FIGURE II - 20) or reeds, merging into forest on the slightly higher natural levees along the rivers (FIGURE II - 10). At Kusiong, on the coast south of the delta, there is an abaca and a coconut plantation. Inland, there is a rubber plantation at Kabacan. Bongo Island, off the coast, is mostly covered with patches of coconut trees.

F. Vegetation distribution in Sulu Archipelago and Basilan Island.

Many of these islands (particularly those in the central portion) are extensively cultivated by the natives. The fields are well laid out and cultivation is continuous. Areas of second growth are subordinate, but increase in proportion inland, giving way to rain forests on the steeper slopes. The more rugged islands are almost entirely covered with forests with little or no cultivation. Mangrove and nipa swamps border the sheltered

coasts of the larger island, and completely cover some of the small low islands.

(1) Basilan Island.

More than half of the island is forested. Native cultivation is extensive, and there are several small rubber plantations in the northern and eastern parts of the island between Isabela, Lamitan, and Bohelebong. There are also scattered patches of cultivated land and much second growth along the south coast. Mangrove swamps extend along much of the southwest and southeast coasts.

(2) Jolo Island.

The island is very largely under cultivation or in grassland which was formerly cultivated. The fields are contiguous, moderately large, well laid out, and separated only by lines of brush or local patches of second growth. The most intensively cultivated areas are around Jolo, Maimbung, Parang, and Seit (FIGURE II - 23), adjacent to the coast, and around Talipaw in the interior. Most of the fields are open, but many groves of tropical fruit trees are included. Only a few minor areas of mountain or hill country remain in forest. There are mangrove swamps along parts of the south coast. The larger islands of the Tapul group (including Pata, Tapul, Lugus, Lapac, and Siasi Islands), south of Jolo Island, are similarly largely under cultivation, but include areas of second growth and forest (FIGURE II - 26).

(3) Tawitawi Island.

In the southwestern part of the island open cultivated fields, grassy patches, and second growth cover the landscape (FIGURE II - 25). In the eastern part of the island, patches under cultivation are widely scattered amid second growth which grades inland to rain forest with dense undergrowth. On other parts of the island there are only narrow coastal strips having cultivated patches and second growth. The interior of the island is covered with rain forest. The neighboring small islands off the northeast coast of Tawitawi are mostly in rain forest and second growth, with only isolated clearings. There are coconut plantations on the southwestern tip of Sanga Sanga Island. On Simunul, south of Tawitawi, there are coconut groves along the coast and scattered clearings and second growth farther inland (FIGURE II - 27). Manuk Manka Island is covered with second growth and rain forest having dense undergrowth. Broad areas of mangrove and nipa swamps are almost universal along the eastern coast of Tawitawi and along the shores of the numerous, small neighboring islands.

G. Vegetation distribution in Northern and Eastern Borneo.

More than 80% of the area is forested. Primary rain forests with sparse undergrowth extend over the ridge summits, but on the lower slopes and plains the forests have heavy undergrowth, becoming thinner inland. They include occasional clearings and areas of second growth. Along the stream valleys the land is almost entirely in scattered fields, grass, and second growth. Casuarina forests border much of the coast which is not in swamp.

(1) Dutch Borneo (north of the Equator).

Rain forest covers much the greater part of the region. Many of these forests are utilized or worked by the natives for both commercial products and for their own sustenance. These forests tend to have considerable undergrowth except where it has been cut. Native clearings and also spots of second growth are sparsely scattered through most of the forested regions. Nearly all the trees are broad-leafed. Along the main valley bottoms there is relatively much more cultivated land. Practically all the rest of the land has been under cultivation fairly recently and has gone to second growth or tall grass (*"alang"*). Casuarina forests are characteristic along the coast. Mangrove swamps border the coast line, especially at the mouths of the rivers where they are bordered inland by nipa palm swamps.

(2) British North Borneo.

Except for the relatively small areas of cultivated lands and grasslands, North Borneo is forest-covered. Primary rain forest with sparse undergrowth are found mainly over the summits of the ridges or mountains, above 3,500 to 4,000 feet elevation. The lower forests are all cut-over, having been partly cleared by the natives for their products. Beginning near the coast the forests, therefore, have dense undergrowth which becomes more sparse until the primary undisturbed forest is reached. The forests include more than 500 species of trees, nearly all of them broad-leafed. In the Crocker Range, in the western part, most forests occur at elevation above 5,000 or 6,000 feet. On Mount Kinabalu, dwarf forests and scrub cover the slopes above the moss forest.

The flat lands along the coast are grasslands for the most part, within which there are cultivated areas, mostly in rice. The hill lands near the coast are largely covered with second growth. The hill or mountain zone comes much closer to the west coast than to the east, and forested mountain spurs extend to the coastline. The valley bottoms include many open areas of tall grass, as well as second growth, rice fields, and rubber plantations. Coconut plantations are distributed along the coast. Minor plantation crops are tobacco, coffee, tea, abaca, and sugar cane. The system of shifting cultivation has produced large areas of second growth on the western side of the major drainage divide. Mangrove and nipa swamps occur at the mouths of the rivers, and on the east side, where the rivers have less current, the swamps extend up stream, giving way inland to fresh water swamp forests.

H. Vegetation distribution in Celebes (north of the Equator).

Rain forests cover the mountains, which comprise the major portions of the region. Some parts of the coastal plains tend to be swampy. At the eastern extremity of the peninsula the population is fairly dense and much of the area is in cultivation. The well drained portions of the coastal plain are almost entirely under cultivation, with coconuts, rice, and corn as the principal crops.

(1) Minahasa-Bolaäng-Mongondow.

Rain forests with sparse undergrowth cover the mountains, especially toward the west side. Toward the east coast the forests are comparatively dry and there are local valleys with almost arid vegetation including masses of cacti. In most places, the coastal plain and also the foothills are covered with tall grass, called *"alang alang,"* (*cogon* or *kunai*). Grassy areas with native clearings (*"ladangs"*) and plantations extend also up the lower slopes of the volcanic mountains (FIGURE II - 41). Considerable flat land is under cultivation with native fields of

FIGURE II - 41. *Celebes.*
Minahasa Region. Exact locality and date unknown. Native clearings ("ladangs") with upland rice and some palms. Rain forest in background.

rice and corn and plantations of coconuts, rubber, some tobacco and coffee. Wet rice paddy fields (*"sawahs"*) surround Tondano Lake. Nipa and mangrove swamps are common at the mouths of the larger streams and behind the sandy beaches.

(2) Northern Peninsula.

This region is almost completely covered with rain forests. The coastal plains include limited areas of cultivation and second growth. The swamps on the coastal plains include mangrove and nipa near the shores, and, farther inland, considerable sago. The largest area of swamps is on the delta of the Randangan River on the south side of the peninsula. Coconuts are universally present along sandy shore lines.

25. *Regional Summary*

The relief, drainage, vegetation, and water supply of the Celebes Sea Area are summarized by terrain regions in TABLE II - 1 below:

TABLE II - 1

MAJOR AREA	TERRAIN REGION	RELIEF	DRAINAGE	VEGETATION	WATER SUPPLY
Halmahera	Southern Halmahera	Narrow coastal plains; hilly to mountainous interior.	Small mountain streams; much swamp on coastal plains.	Rain forest; narrow strips of coconut plantations along the coast.	Wells and streams.
	Central Halmahera	Mountainous; few scattered coastal plains; NE Peninsula, the most rugged.	Sangadji River; small mountain streams; narrow swamps.	Rain forest in the interior; cultivation and second growth on coastal strips.	Wells and streams.
	Northern Halmahera (Kaoe-Tobelo Lowlands and Ridges)	Open plains; rolling country; dissected terraces.	Kaoe River; other streams small; swamps in middle Kaoe valley and near Akelamo.	Much second growth; some grasslands in lower Kaoe valley; coconut plantations along the coast.	Wells and streams.
	Northern Halmahera	Low mountains; steep	Lamo River and	Rain forest.	Streams.