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Malagasy Republic

August 1973

NATIONAL INTELLIGENCE SURVEY

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Military Geography

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*This chapter was prepared for the NIS by the
Defense Intelligence Agency. Research was sub-
stantially completed by April 1973.*

Malagasy Republic

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APPROVED FOR RELEASE: 2009/06/16: CIA-RDP01-00707R000200080041-2

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Military Geography

A. Location and description (U/OU)

The Malagasy Republic consists of the rugged island of Madagascar and several small islands lying close to the coast (see Military Geographic Factors map at the end of the chapter). Madagascar is situated in the Indian Ocean about 215 nautical miles across the Mozambique Channel from the southeastern coast of Africa. The fourth largest island in the world, Madagascar has an area of 230,000 square miles. If superimposed on the eastern part of the United States, Madagascar would extend from Buffalo, New York, to Tallahassee, Florida, and from near Washington D.C., to Cincinnati, Ohio. Maximum distances are about 1,000 miles¹ northeast-southwest and 375 miles east-west. The population was estimated to be 7,141,000 in January 1973.

¹Distances are in statute miles unless nautical miles are specifically stated.

1. Topography

Most of the country consists of hills and rugged mountains (Figure 14) ranging from 2,000 to 6,000 feet above sea level, although scattered mountain peaks have elevations from 8,000 to slightly more than 10,000 feet. The highlands are characterized by sharp-crested ridges (Figure 1)—trending roughly north-south—numerous V-shaped valleys, and short escarpments (Figure 2). Slopes are predominantly 10% to 30% in the hills and 30% to more than 100% in the mountains. Most hill crests are 500 to 1,000 feet above adjacent streams or valley floors, but in some northern and central areas of Madagascar they are 1,000 to 2,000 feet. In the mountains, crests are mainly 2,000 to 3,500 feet above adjacent valley floors. Plains, located mainly in the west and south, are rolling or moderately dissected with slopes of 3% to 10%; interstream areas rise 150 to 500 feet above adjacent valley floors. In the

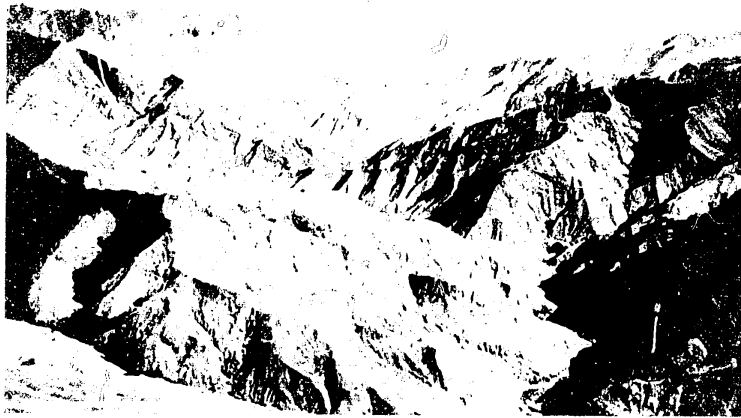


FIGURE 1. The Massif de Tsaratanana, one of the most rugged areas on Madagascar, has sharp, sinuous crests; steep, deeply dissected slopes; and an intricate pattern of winding V-shaped valleys. The crests are as much as 3,000 feet above the narrow valley floors. Most ridges are rocky, but other parts of the mountains are covered by savanna or broadleaf evergreen forest. (C)

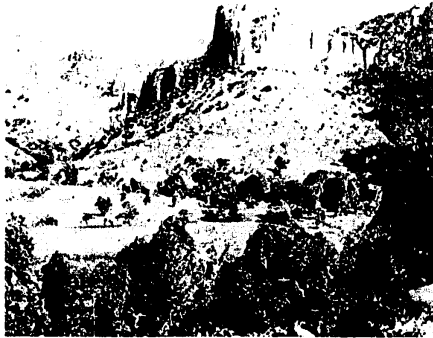


FIGURE 2. Discontinuous escarpments are common throughout Madagascar but are particularly numerous in the highlands. Those shown here are in the Andringitra and have typical rocky, vertical faces and bouldery debris near the base of the slopes. In this area, the escarpments rise as much as 2,000 feet above adjacent valleys. (U/OU)

plains, hillocks and short escarpments are common. In places on the narrow plains along the eastern coast of Madagascar, there are narrow beach ridges separated by lagoons and marshy areas. Small areas of karst plains are severely dissected northwest of the Hauts Plateaux de l'Anjafy; another rough area is along the southwestern coast, where numerous depressions are enclosed by stationary sand dunes. A narrow belt of plains along and near the western and southern coasts, however, is flat to gently rolling, with slopes less than 3% and broad interstream areas less than 150 feet above intervening streams or broad valley floors. In the interior, scattered areas of flat to rolling or moderately dissected plains are enclosed by hills and mountains. Elevations are generally less than 1,200 feet above sea level except in some interior basins where they are nearly 3,000 feet.

The plains and highlands are covered chiefly by savanna (Figure 3), consisting of grass and scattered trees and shrubs; narrow bands of dense forest parallel the streams. Along the eastern coast, some areas of savanna plain contain patches of dense secondary woody growth (*savoka*) commonly 5 to 10 feet tall (Figure 4). Broadleaf evergreen forests (Figure 5) occur mainly on hills and mountains in the east and north. Dense deciduous forests and grassy openings cover plains and low hills in the west and southwest; the trees are generally leafless during August through October. Some areas of plain in the south are covered



FIGURE 3. Savanna vegetation of grass and scattered deciduous trees and shrubs covers most of Madagascar. In this plains area near Tulear, in the southern part of the island, the grass is less than 3 feet high and is highly susceptible to fires during the dry season, early May through November. (U/OU)

by dense thorn scrub (Figure 6). Vegetation in the wet areas consists of scattered marsh grass, mainly along the coasts; mangrove along the west coast; and wetland rice. Wetland rice is grown in many river valleys and around lakes in the interior basins; except for the extensive paddies (Figure 7) around Tamana-rive, most are small.

In most places, streams flow in narrow valleys between high, steep banks in the hills and mountains and meander in broad valleys between low, gently sloping banks in the plains. Several of the large rivers are over 500 feet wide (Figure 8) and are over 3 1/2 feet



FIGURE 4. Patches of dense regenerative woody growth (*savoka*) are common in the savanna along the eastern coast. The area shown here is near Tamatave. (C)



FIGURE 5. Dense broadleaf evergreen forest covers the hills and mountains in eastern Madagascar. This view east of Fianarantsoa is typical of such forests; canopies are multistoried and dense, and the trees have straight trunks and range from about 15 feet high in the lower story to more than 100 feet high in the upper story. Undergrowth consists of shrubs, herbs, and waxes; vines. (U/OU)



FIGURE 6. The dense thorn scrub that covers the plains and lower slopes of the hills in the southern part of Madagascar consists mostly of twisted and gnarled trees 10 to 20 feet high and less than 8 inches in trunk diameter. The trees are leafless August through October. Thickets of shrubs are interspersed among the trees. The vegetation is highly susceptible to fires during the dry season. (U/OU)

deep; during high water, early December through May, nearly all watercourses are over 3½ feet deep and are swift. At times during low water, June through November, some of the large rivers and most of the small streams are shallow or nearly dry. In the south, the streams are generally dry or shallow much of the time.

The principal culture features—urban areas and rural settlements—are located mainly in the central part of Madagascar and along the eastern coast. The few large urban centers contain one or more old, densely built-up sections as well as newer, sparsely built-up sections. Most buildings, both old and new, are one to two stories of brick with clay-tile roofs. The oldest parts of towns consist mostly of single-story structures constructed of mud or wood, with thatch or scrap metal roofs, and the newer sections of the larger towns contain many masonry structures (Figure 9). Streets in most towns, particularly in the older sections, are narrow and winding; those in the newer sections are bituminous- and stone-surfaced and two lanes or more wide. Rural settlements, generally more than 10 miles apart, are mostly haphazard groups of mud or wood huts with thatch roofs. Some rural settlements, however, consist of several 2- or 3-story dwellings constructed of laterite blocks, with steep thatch or metal roofs, and some are partly surrounded

by old laterite-block walls 5 to 10 feet high. Most rural settlements are connected by numerous trails, tracks, and a sparse network of mostly unsurfaced roads in very poor condition; principal cities, however, are linked by a few roads with crushed-stone, gravel, and bituminous-treated surfaces in fair to good condition. Most roads have few bridges, and the streams are crossed by fords, some of which are constructed of



FIGURE 7. Wetland rice is grown in irregular-shaped paddies and is commonly planted in November and harvested in late April or early May. Most fields are fallow the remainder of the year. When mature, the crop is 1 to 3 feet high. The paddies shown here are in a hill basin south of Tananarive. (C)

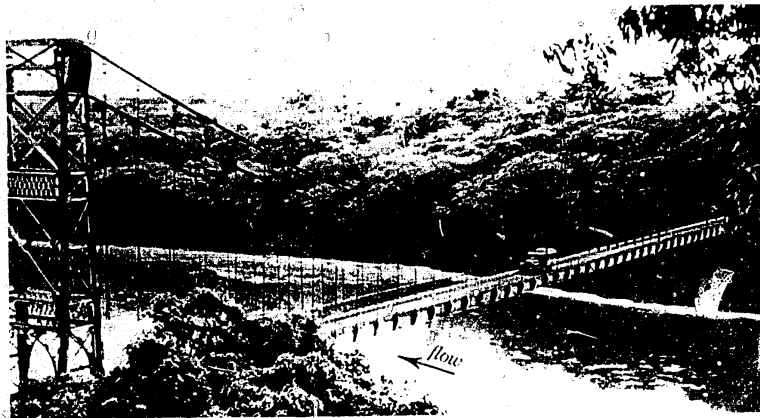


FIGURE 8. The Mahavavy river, among the largest in the country, is more than 500 feet wide and 3.5 feet deep for most of its course. In this stretch, the river flows through a rolling plain covered by dense deciduous forests. (C)

concrete, and by a few low-capacity ferries. In the hills and mountains, sharp curves and steep grades are common. Single-track 3'3³/₈'-gauge railroads in fair condition connect Tananarive with Tamatave and Antsirabe, Moramanga and Ambatosoratra, and another line connects Fianarantsoa and Manakara. Airfields, mostly less than 6,000 feet long and unsurfaced, are scattered throughout the country. However, surfaced airfields over 6,000 feet long are near Tananarive, Majunga, Tamatave, Diego-Suarez,² and on Nosy Be (island).

2. Climate

Madagascar has a tropical monsoon climate, characterized in most regions by a long wet period, usually during November through March, and an equally long dry period, usually May through September (Figure 10). April and October are most often transitional months. The major exception is the central east coast, which is wet all year. The main climatic controls are the tropical latitudes, the easterly trade winds, the surrounding ocean, and the rugged terrain of the interior.

Seasonal variations in temperature are small, but areal variations are pronounced, principally because of large differences in elevation. On the coastal plains, mean daily temperatures fluctuate between afternoon maximums mostly in the 80's (°F.) or low 90's and

²For diacritics on place names see the list of names on the apron of the Military Geographic Factors map and the map itself.

early morning minimums mostly in the 60's or low 70's. Mean daily maximums and minimums in the highlands are about 10 to 20 Fahrenheit degrees cooler. Relative humidity is high all year on the east coast, with afternoon values seldom lower than 70%; this, along with the high temperatures, creates oppressive conditions. Elsewhere, similarly oppressive conditions occur during the wet period, but it is much more comfortable during the dry season, when afternoon humidities drop to percentages ranging in the 40's and 50's at most places.

Rainfall varies considerably across the island. The greatest amounts fall on the east coast, where rain is heavy most of the year; annual accumulations average more than 100 inches in some sections. Annual rainfall decreases both westward and southward; average amounts are smallest in the southwest sections, where some places receive less than 15 inches per year. Except on the east coast most of the annual precipitation occurs during the wet period, when monthly amounts range between 5 and 20 inches, falling mainly as showers. Dry-period precipitation is light and infrequent, and monthly amounts are generally less than one inch. Mean cloudiness follows much the same pattern as precipitation, both areally and seasonally. In general, cloud cover is great on the east coast all year and elsewhere is greater during the wet period than during the dry period. Maximum thunderstorm activity occurs during the wet period, when frequencies range mostly between 10 and 20 thunderstorm days per month, and during the



FIGURE 9. Tananarive is built on a series of steep hills and ridges that rise abruptly from the Betsimitatatra plain. Retaining walls and narrow, winding streets are typical of the older residential sections which occupy the hill slopes. The newer sections, located on relatively flat land at the base of the hills, contain most of the industrial, administrative, and commercial installations. (U/OU)

transitional months of April and October, when they occur on 5 to 10 days. Thunderstorms are infrequent during the dry period.

Visibility usually is good all year; the greatest restrictions occur during the periods of heavy showers and thundershowers. Light, primarily easterly trade winds prevail on the east coast, while calms and variable winds dominate the highlands and leeward inland sections. Land and sea breezes dominate the west coast. The strongest winds usually accompany the four or five tropical cyclones of varying intensities which affect the island each year, chiefly in December through March. The east coast is most susceptible to storms; here, winds on occasion approach or exceed 100 knots, and the thick, widespread cloudiness releases torrential rainfall.

B. Military geographic region (C)

Madagascar is a single military geographic region, a highland region (Figure 14), where the combination of

environmental conditions would have a relatively uniform effect on military operations. Predominant features affecting military operations are steep slopes, dense forest and thorn scrub, scattered wet areas, a scarcity of water supplies in the south, periods of adverse weather, and a sparse transportation network. There are many unusual disease problems; although there are no poisonous snakes on the islands, poisonous scorpions and spiders are prevalent, and crocodiles are common in all inland water bodies.

Terrain conditions are generally unfavorable for conventional ground forces. Cross-country movement of tracked and wheeled vehicles would be precluded by steep slopes in the dissected plains, hills, and mountains, by closely spaced trees in the densely forested plains, by soft ground all or much of the time in the wet areas, and by numerous depressions in the plains along the southwest coast. The lagoons and marshy areas between the beach ridges along the eastern coast would confine movement to ridge crests.

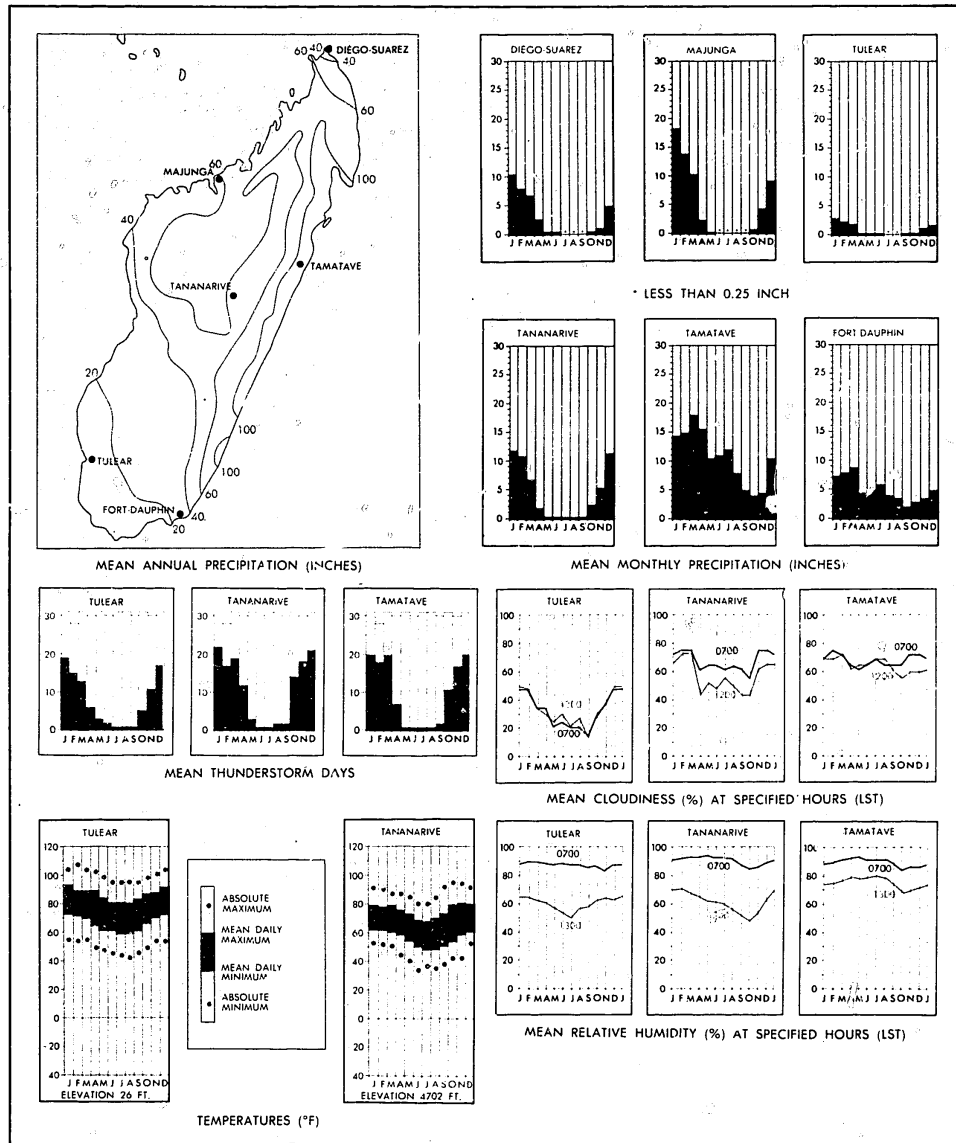


FIGURE 10. Precipitation, thunderstorm days, cloudiness, temperatures, and relative humidity (U/OU)

although here movement of wheeled vehicles would be hindered by patches of *savoka* vegetation. Movement of tracked vehicles would be feasible in the south on plains covered with thorn scrub, although wheeled vehicles would be precluded. In the scattered areas of rolling or moderately dissected plains covered with savanna, chiefly in the west and south, movement would be feasible but locally restricted in direction by short escarpments, hillocks, and other surface irregularities. Only in small, scattered areas of flat to gently rolling plains covered with savanna, primarily near the western coast, would vehicular cross-country movement be easy; from about mid-November to mid-April, however, soft soils in the valleys would restrict movement to the broad interfluvies much of the time. In most places, movement on foot would be hampered or precluded by steep slopes, dense thorn scrub and *savoka*, and generally soft ground in scattered wet areas and between beach ridges. On-road movement would be limited to the sparse network of mostly earth roads and tracks, which are nearly impassable during mid-November to mid-April because of soft surfaces and numerous washouts. Although movement would be feasible on the few surfaced roads linking the major cities, traffic would be slowed in many places by sharp curves and steep grades. During December through May, movement would be halted at numerous fords by swift streams more than 3½ feet deep, and the few ferries are generally inoperative during this period.

Construction of additional roads would be difficult in most places because of the requirements for much grading, drilling, and blasting; also, there is a need for protection from landslides, and numerous bridges and culverts, some with raised approaches, would be needed. In the scattered areas of plains covered with deciduous forest, thorn scrub, and *savoka*, mainly along or near the coasts, extensive clearing would be a problem. Construction in the scattered wet areas would be extremely difficult because of poor foundations and drainage problems. Only in the small areas of flat to gently rolling plains covered with savanna can roads be built with few alignment problems and little clearing. In the scattered areas of rolling or moderately dissected savanna plains, alignments would be locally restricted by hillocks, short escarpments, and other surface irregularities. In the south, the scarcity or lack of water most of the year would be a major construction problem. The hard and mixed hard and soft rocks, which are extensive, generally are suitable for crushing, aggregate, and riprap; the thick soils covering scattered areas of plains in the west and south are suitable for fill material.

Concealment from air observation would be limited largely to the areas of dense broadleaf evergreen forest in the east and north, scattered areas of deciduous forest in the west, and areas of thorn scrub in the south. In the areas of deciduous forest and scrub, however, concealment possibilities are greatly reduced during August through October, when the trees are generally leafless. In most places, concealment from ground observation would be afforded by tall grass and, in areas in the east, by *savoka*. Cover from flat-trajectory fire would be afforded by steep slopes. Tunnel-type installations could be constructed in the hills and mountains; in many places short entries and 100 feet or more of protective cover in hard, massive rock would be possible. In the plains in western Madagascar and in scattered interior basins, bunkers could be dug with handtools in soils over 20 feet deep, but shoring generally would be required to prevent slumping.

Conditions are predominantly unfavorable for airborne and airmobile operations because of extensive steep slopes and scattered forests and wet areas. Only in the small areas of flat to gently rolling plains covered with savanna, mainly along or near the western coast, are there many suitable sites for parachute drops and helicopter landings. In the scattered areas of rolling or moderately dissected plains covered with savanna, chiefly in the west and south, there are many suitable sites, but approaches would be locally restricted by hillocks and escarpments, and movement from some sites would be hampered by surface irregularities. Assault-type aircraft could land easily at the airfields with hard surfaced runways over 6,000 feet long near Tananarive, Majunga, and Diego-Suarez, and at several scattered airfields with surfaced and unsurfaced runways less than 6,000 feet long. Construction of new airfields would be difficult because of restricted approaches; the need for much grading, drilling, and blasting in the hills and mountains; grading and filling in the severely dissected plains; extensive clearing in the scattered areas of plains covered with deciduous forest, thorn scrub, and *savoka*, mainly along or near the coasts; and poor foundations and drainage in the scattered wet areas. Only in the small areas of flat to gently rolling plains covered with savanna are there many suitable sites for airfields over 6,000 feet long; in these areas approaches would be restricted, although little grading, clearing, and subgrade improvement would be necessary. In the scattered areas of rolling or moderately dissected plains there are many suitable sites for airfields over 6,000 feet long, but approaches

would be locally restricted by hillocks and escarpments, and moderate amounts of grading and excavating would be needed in many places. In addition, long hauls to water points would be necessary from about early June to December in the west and most of the time in the south.

Conditions are fair for irregular force operations. There is a predominance of rugged relief and fairly large areas of dense forest, and the road network is sparse. Small units of foot troops would be able to move almost everywhere in the hills, mountains, and dissected plains which characterize the relief of most of the country. The extensive surface irregularities provide good cover and concealment from ground observation, and the dense forests provide excellent concealment from air observation and good concealment from ground observation. Conditions for irregular force operations, however, are poor in the scattered areas of rolling or moderately dissected savanna plains, chiefly in the west and south, where concealment from air observation generally would be lacking and in small areas of flat to gently rolling savanna plains, mainly along or near the western coast, where concealment from air observation generally would be lacking and cover would be severely limited. Operations by irregular forces in the scattered marshes and mangrove swamps along the west coast would be precluded because of soft ground and the lack of freshwater supplies; also, some marshes and lagoons in a narrow strip along much of the eastern coast are unsuited because generally the surface water is saline. In the south, operations would be extremely difficult because surface water is scarce or lacking and movement on foot would be severely slowed by thorn scrub. Natural shelter materials are scarce. Widely scattered cultivated fields, mainly rice, corn, and manioc, would provide considerable food supplies. Abundant quantities of wild berries, nuts, fruits, and fish would afford additional sources of food. Supply would be possible by airdrops and landings of aircraft at widely scattered airfields and by landing of craft at scattered beaches.

Conditions are unfavorable for large-scale amphibious operations because of restricted offshore and nearshore approaches, periods of heavy sea and swell, periods of adverse weather, large tidal ranges at many locations, and, in places, flat nearshore gradients. In addition, beaches suitable for dry-ramp landings are widely spaced, short, and backed in places by wet areas, beach ridges, and, along the southeastern coast, by rough plains consisting of stabilized sand dunes, numerous depressions, and short escarpments. Exits are primarily by cross-country

movement, to tracks and widely spaced roads, mostly unsurfaced, which lead to the interior. Along parts of the northwestern coast, exits and cross-country movement inland would be precluded by steep slopes of hills.

C. Strategic area (C)

The strategic area is Tananarive and its environs (Figures 11 and 14). Tananarive, the capital and largest city (population 403,000 including suburbs), is the chief commercial, industrial, transportation, and cultural center of the country. Major installations include two motor vehicle assembly plants, a railroad repair shop, a radio and TV assembly plant, the country's only battery plant, and factories producing

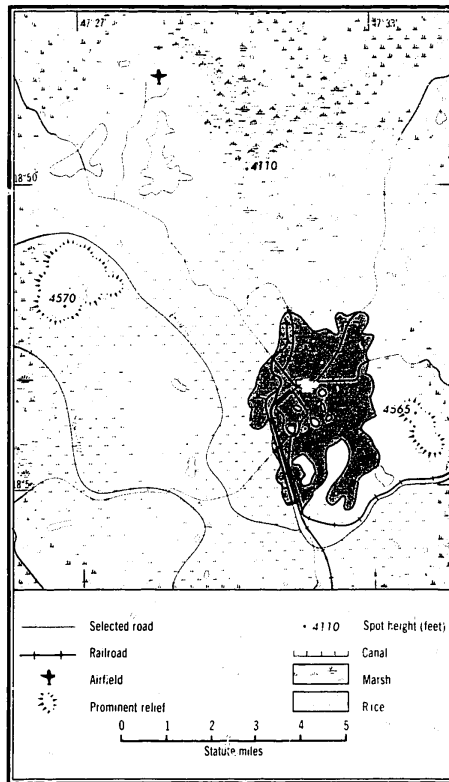


FIGURE 11. Tananarive strategic area (C)

agricultural equipment, oxygen and acetylene, chemicals, pharmaceuticals, and shoes. There are also several printing plants, several brickworks, and numerous small factories engaged in the processing of agricultural products. The Pasteur Institute, a major medical research center, produces vaccines and medicines. The University of Madagascar, the only university in the country, is located just east of the city. Considerable covered storage space is available in several warehouses, two large army camps, and the railroad freight station. A POL (petroleum fuels, oils, and lubricants) depot at the northern edge of the city has a storage capacity of about 32,500 barrels of refined products. Tananarive/Ivato airfield, a joint civil/military facility located about 7 miles northwest of the city, is the largest airfield in the country.

Other important areas are Tamatave, Diego-Suarez, Majunga, Fianarantsoa, and Antsirabe. Tamatave is the chief port and second largest city (population 61,000) and an important commercial, industrial, and transportation center. It is the terminus of the railroad line from Tananarive. Tamatave has the only petroleum refinery in the country, which has a daily throughput capacity of 14,000 barrels, and storage facilities for 476,500 barrels of crude oil and one million barrels of refined products. Other important industrial installations include a steel drum and tin can factory, railroad and ship repair yards, and a vegetable oil and soap works. Extensive open, covered, and cold storage facilities are available in the port area. An airfield is about 3 miles northwest of the city.

Diego-Suarez (population 48,000) contains a large French naval base and is the second-ranking ocean port and principal shipbuilding and repair center in the country. Other industrial installations include an oxygen and acetylene plant, a saltworks, meat packing plant, rice mills, a vegetable oil and soap works, and a sawmill. The POL storage depot has a capacity of about 136,000 barrels of refined products. There is a French Navy airfield 2 miles northwest of the city and a civil airfield 4½ miles south of the city.

Majunga is an important ocean port and the principal river post and third largest city (population 54,000) in the country. It is the principal commercial, transportation, and telecommunications center for the west coast of Madagascar. Important industrial installations include the country's only cement plant, a textile factory, paper mill, metal container plant, a small boatworks, and several rice mills. The POL storage depot has a capacity of about 59,000 barrels of refined products. An airfield is 4 miles northwest of the city.

Fianarantsoa (population 48,000) is a principal marketing and distribution center for southern

Madagascar. It is the terminus of the railroad from the minor port of Manakara. The city contains the Malagasy Army Noncommissioned Officers Academy. Industrial installations include a railroad repair shop, brick and tile works, and several plants engaged in the processing of agricultural products. An airfield is about 2 miles south of the city.

Antsirabe (population 34,000) is the terminus of the railroad from Tananarive and contains the Malagasy Army Military Academy. Industrial installations include a textile plant, tobacco processing plant, brewery, peanut oil refinery, a brick and tile works, and several rice mills. The airfield serving the city lies 2 miles to the northeast.

D. Internal routes (C)

The internal routes (Figure 14) provide the easiest avenues of movement from the best amphibious landing areas to Tananarive. Data on individual routes are presented in Figure 12.

E. Approaches

The coastline of Madagascar, including a few offshore islands, is approximately 3,000 miles. The country claims 12 nautical miles as territorial waters. (U/OU)

1. Sea (C)

Offshore approaches are encumbered by numerous islands, reefs, shoals, rocks, banks, and, along the southern two-thirds of the eastern coast, by a nearly continuous barrier reef. Nearshore approaches are restricted in places to bays and channels and partly obstructed by rocks, reefs, shoals, wrecks, and breakwaters. Heavy sea and swell are encountered in most offshore areas during April through September except in the southeast, where the maximum occurrences are probably over 30% of the time during July through March. Tropical cyclones occur seasonally, mainly along the eastern coast during December through March. Although surf 4 feet or higher can occur at anytime, it occurs more than 30% of the time during October through March along the eastern and southern coasts. Tides are mixed along the eastern coast, and spring tides range from 2 to 6½ feet; elsewhere they are mostly semidiurnal, with spring ranges up to 18½ feet. Nearshore bottom materials are chiefly sand, and slopes are predominantly flat along the western coast and gentle to flat elsewhere. Beaches are widely separated; usable stretches generally are less than 1 mile long and most are less than 100 yards wide. Most beaches consist of sand, have moderate to steep gradients, and are

FIGURE 12. Internal routes (C)

ROUTE	ROAD	RAILROAD	OFFROAD DISPERSAL AND CROSS-COUNTRY MOVEMENT
Links landing area at Majunga with Tananarive. From Majunga to slightly south of Ambalanjanakomby, extends across savanna-covered plains and some hills, some small areas of densely forested plains and hills; remainder across hills and rugged mountains covered by savanna except near Tananarive, where plains are covered by marsh and numerous wetland ricefields.	One to 2 lanes, bituminous, in good condition. Sharp curves and steep grades common. Some partly submerged concrete fords potential bottlenecks.	None	Precluded in most places by steep slopes, dense forests, or wet ground in marshes and wetland ricefields. Easy in most plains near coast.
Connects landing area at Tamatave with Tananarive. Traverses hills covered by savanna except from Tamatave to Brickaville, where mostly plains covered by <i>saroka</i> vegetation. Small areas of densely forested plains east of Moramanga and savanna-covered plains west of town.	From Tamatave to Moramanga, 1 to 2 lanes, crushed stone or gravel, in poor to fair condition, except for 25-mile segments south of Tamatave and east of Moramanga where bituminous, 1 to 2 lanes, and in good condition. Sharp curves and steep grades in many places. Some concrete fords potential bottlenecks. From Moramanga to Tananarive, 2 lanes, bituminous, and in good condition.	Single-track 3 ³ / ₈ '-gauge line closely parallels road in most places between Brickaville and Tananarive. In good condition.	Precluded in most places by steep slopes; between Tamatave and Brickaville, wheeled vehicles precluded by <i>saroka</i> , but movement of tracked vehicles feasible.
Links landing area at Morondava with Tananarive. Crosses hills and mountains covered by savanna; in west, however, flat to rolling or moderately dissected plains with small areas of dense forest.	From Morondava to Ivato, 1 to 2 lanes with stone or gravel surface in fair condition except from Morondava to Mahabo, where 2 lanes, bituminous, and in good condition. From Ivato to Tananarive, 1 to 2 lanes, with bituminous surface in fair to good condition. Sharp curves and steep grades common. Some concrete fords potential bottlenecks.	Single-track 3 ³ / ₈ '-gauge line closely parallels road from Antsirabe to Tananarive. In good condition.	Precluded in most places by steep slopes.

backed by low plains containing scattered areas of marsh, lagoons, and in many places along the western coast, mangrove swamps. Along parts of the eastern coast, beach ridges separated by narrow lagoons and marshes back the beaches. The plains along the coasts are backed by extensive hills and mountains. Exits from the beaches are by cross-country movement or by tracks, trails, and a sparse network of mostly unsurfaced roads leading into the interior. Figure 13 provides data on individual landing areas.

2. Air (U/OU)

Air approaches³ to Madagascar are over water and, in places, over small, widely separated islands. Most of

³The discussion zone for air approaches extends approximately 250 nautical miles beyond the coasts of the Malagasy Republic.

the hazardous flying weather within the air approaches is associated with tropical cyclones and thunderstorms. The highest frequency of thunderstorms in the approach area is probably over the Mozambique Channel and near the western coastline of Madagascar, where thunderstorms occur on an average of 5 to 20 days per month in October through April. Tropical cyclones are normally confined to the period December through March and present the greatest danger in the eastern approaches. Unfavorable weather conditions are also associated with the intertropical convergence zone, which effects the northern approaches during December through February. Cloudiness is usually greatest along the north and northeast coast most of the year, but it generally averages 40% to 70% in most of the approaches except over the Mozambique Channel, where only 10% to 40% occurs in June through

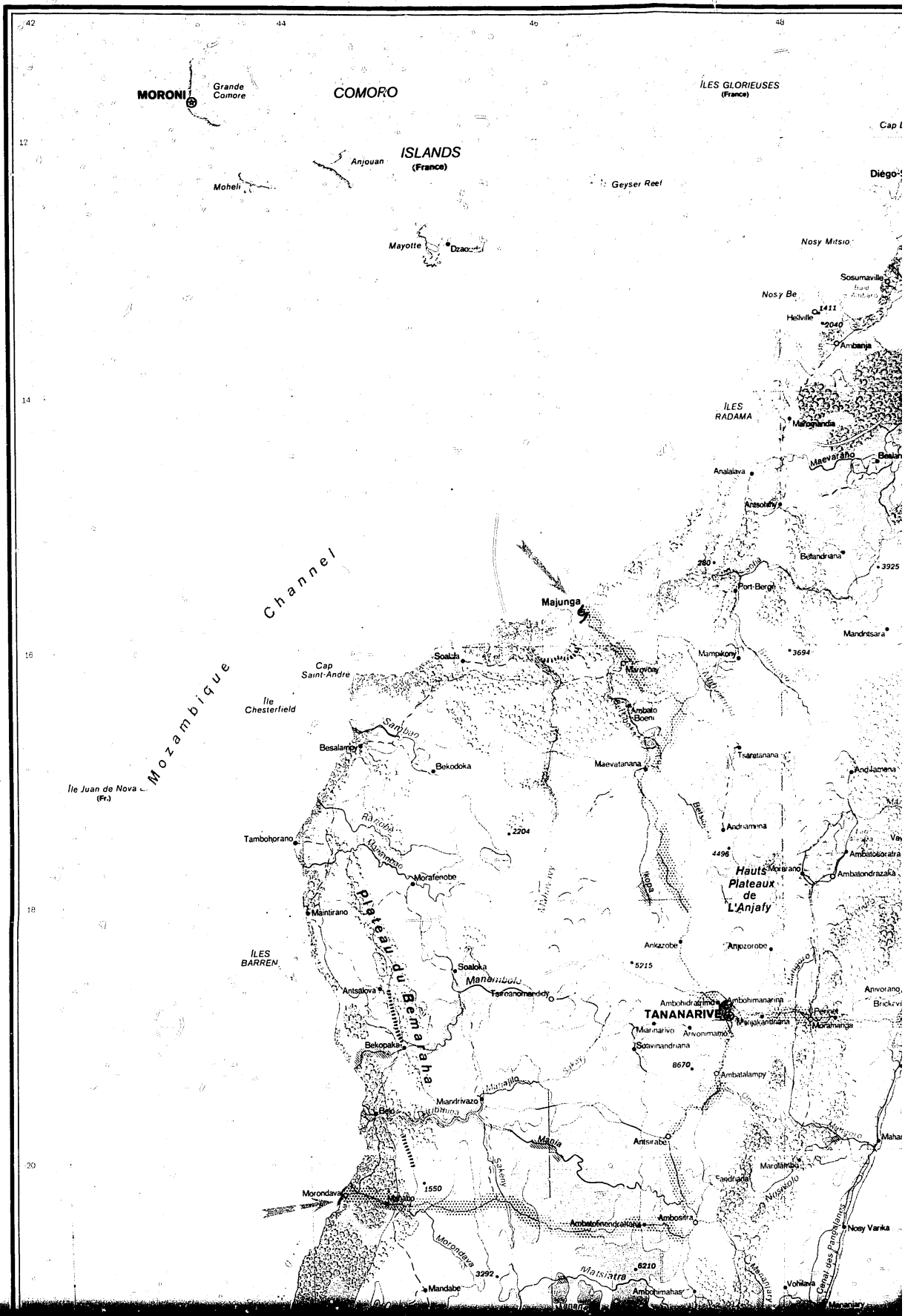
FIGURE 13. Amphibious landing areas (C)

LOCATION	APPROACH	BEACH	TERRAIN BEHIND BEACH AND EXIT
Morondava....	Seaward of 5-fathom curve partly obstructed by shoals and banks up to 20 nautical mi. offshore; shoreward, partly obstructed by jetties and breakwaters. Nearshore bottom sand and mud; gradient 1 on 175 to 1 on 220; most places unsuitable for dry-ramp LST landings. Minimum occurrence of surf 4 ft. or higher, probably 5% of time or less, Apr.-Sept.; maximum occurrence, probably less than 20% of time, Oct.-Mar. Tidal range 11½ ft., springs.	1½ mi. long; all usable; recommended for use at high tide stages only; estimated 50 to 150 yd. wide at L.W. and 25 to 50 yd. wide at H.W.; gradient estimated 1 on 25 L.W. to H.W., and 1 on 15 or steeper in H.W. zone; material sand.	Beach backed by low, sandy strip; in turn backed by mangrove swamps and tidal mud flats extending to partly cultivated and forested plain 2 to 10 mi. inland; Morondava behind most of beach. Exit by tracks, trails, streets, loose-surfaced roads or cross country.
Majunga.....	Seaward of 5-fathom curve, restricted to channels and partly obstructed by shoals and banks up to 24 nautical mi. offshore; shoreward, restricted to channels and partly obstructed by shoals and banks, with least depths of 9 ft. up to 6 nautical mi. offshore, and by scattered rocks near L.W. line. Nearshore bottom sand and mud; gradient 1 on 70 to 1 on 370; few places suitable for dry-ramp LST landings. Minimum occurrence of surf 4 ft. or higher probably 5% of time or less, Apr.-Sept.; maximum occurrence, probably more than 20% of time, Oct.-Mar. Tidal range 13 ft., springs.	Contains 2 beaches; recommended for use at higher tide stages only. Beach extending 1,200 yd. northeast from Majunga breakwater, all usable; estimated 15 to 65 yd. wide; gradient estimated 1 on 15 to 1 on 25, L.W. to H.W., and 1 on 15 or steeper in H.W. zone; material sand. Beach centered 5 mi. northeast of Majunga, 2½ mi. long; nearly all usable; estimated 10 to 50 yd. wide; gradient estimated 1 on 10 to 1 on 25, L.W. to H.W., and 1 on 10 or steeper in H.W. zone; material sand.	Most parts of beaches backed by low dunes which, in turn, are backed by gently rolling, partly cultivated plain with scattered marsh areas, dissected by several streams and extending over 20 mi. inland. Majunga backs southwestern part. Exits by tracks, trails, streets, loose-surfaced roads, and cross country to hard-surfaced road leading inland from Majunga.
Tamatave....	Seaward of 5-fathom curve, restricted to channels and partly obstructed by rocks, reefs, and shoals, shoreward, partly obstructed by rocks, wrecks, and breakwaters along L.W. line. Nearshore bottom sand and rock; gradient 1 on 10 to 1 on 60; many places suitable for dry-ramp LST landings. Minimum occurrence of surf 4 ft. or higher, probably less than 5% of time Apr.-Sept.; maximum occurrence, probably more than 30% of time, Oct.-Mar. Tidal range 2 ft., springs.	Contains 2 beaches. Beach extending north from Tamatave, 3¾ mi. long; 3½ mi. usable; estimated 50 to 75 yd. wide at L.W. and 30 to 50 yd. wide at H.W.; gradient estimated 1 on 15 to 1 on 30, L.W. to H.W., and 1 on 10 or steeper in H.W. zone; material sand. Beach centered 2 mi. southwest of Tamatave, 3½ mi. long; all usable; estimated 75 to 100 yd. wide at L.W. and 50 to 75 yd. wide at H.W.; gradient estimated 1 on 15 to 1 on 30, L.W. to H.W. zone, and 1 on 15 or steeper in H.W. zone; material sand.	Most parts of beaches backed by narrow, partly forested sandy strip, interspersed and largely backed by marsh areas and lagoon belt crisscrossed by several canals and streams; all in turn backed by rolling, partly cultivated and forested plain extending over 20 mi. inland; Tamatave behind central part. Exit by tracks, trails, streets, hard- and loose-surfaced roads, or cross country.

October and about 30% to 60% during the remainder of the year. Turbulence is generally light to moderate in cumulus clouds and near the high-level jet streams. Severe turbulence is associated almost entirely with thunderstorms. Normally, hazardous icing conditions are not present except in cumulonimbus clouds. The height of the freezing level ranges from about 12,000 to 15,000 feet. Prevailing upper winds are east to

southeast below 5,000 feet in the south throughout the year but increase in depth northward to approximately 25,000 feet in summer and to 55,000 feet in winter in the extreme north. Westerlies prevail above these levels. Wind speeds are generally strongest south of 25°S. latitude and reach a maximum during June through August, when they average 50 to 85 knots near 45,000 feet.

2

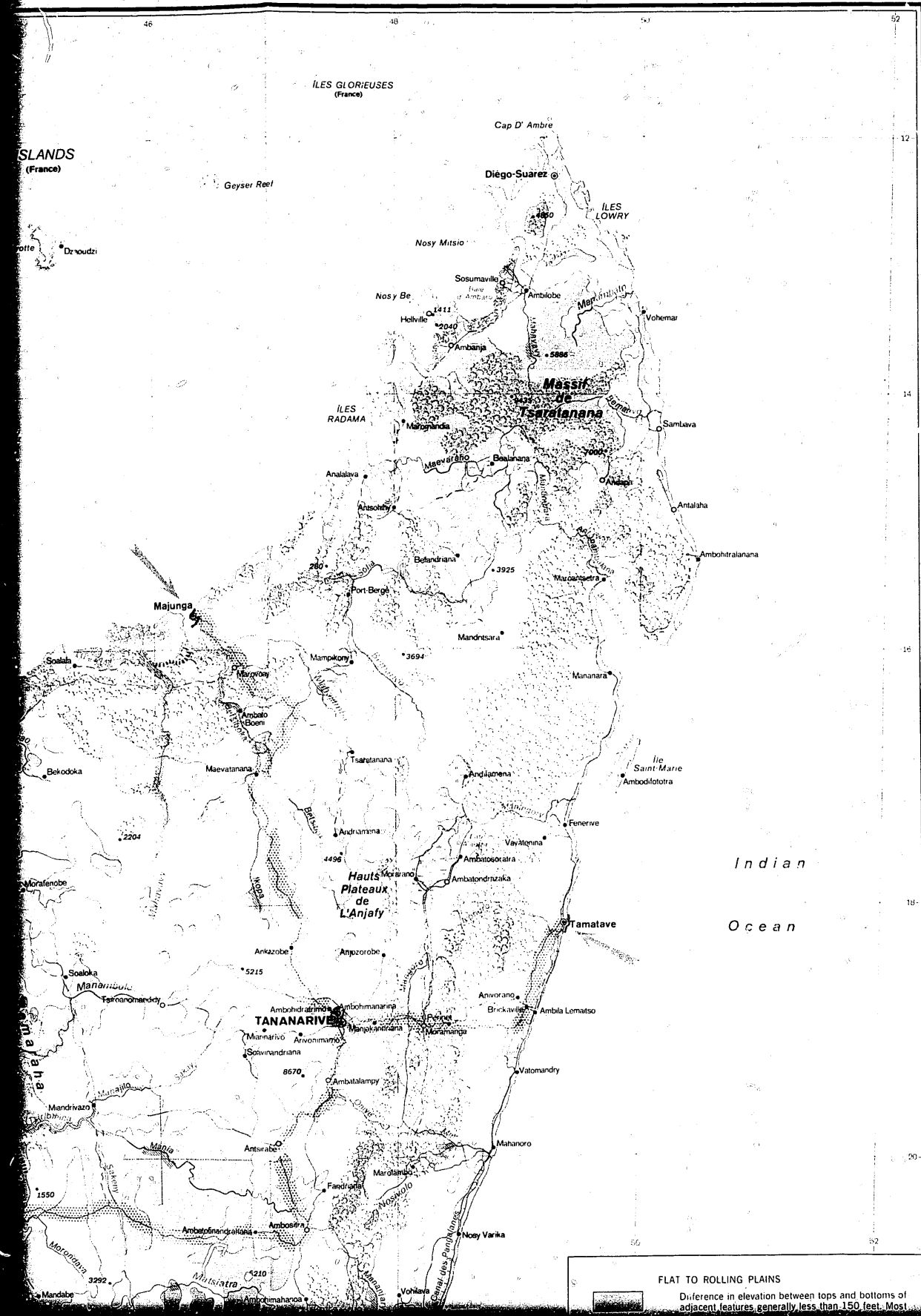


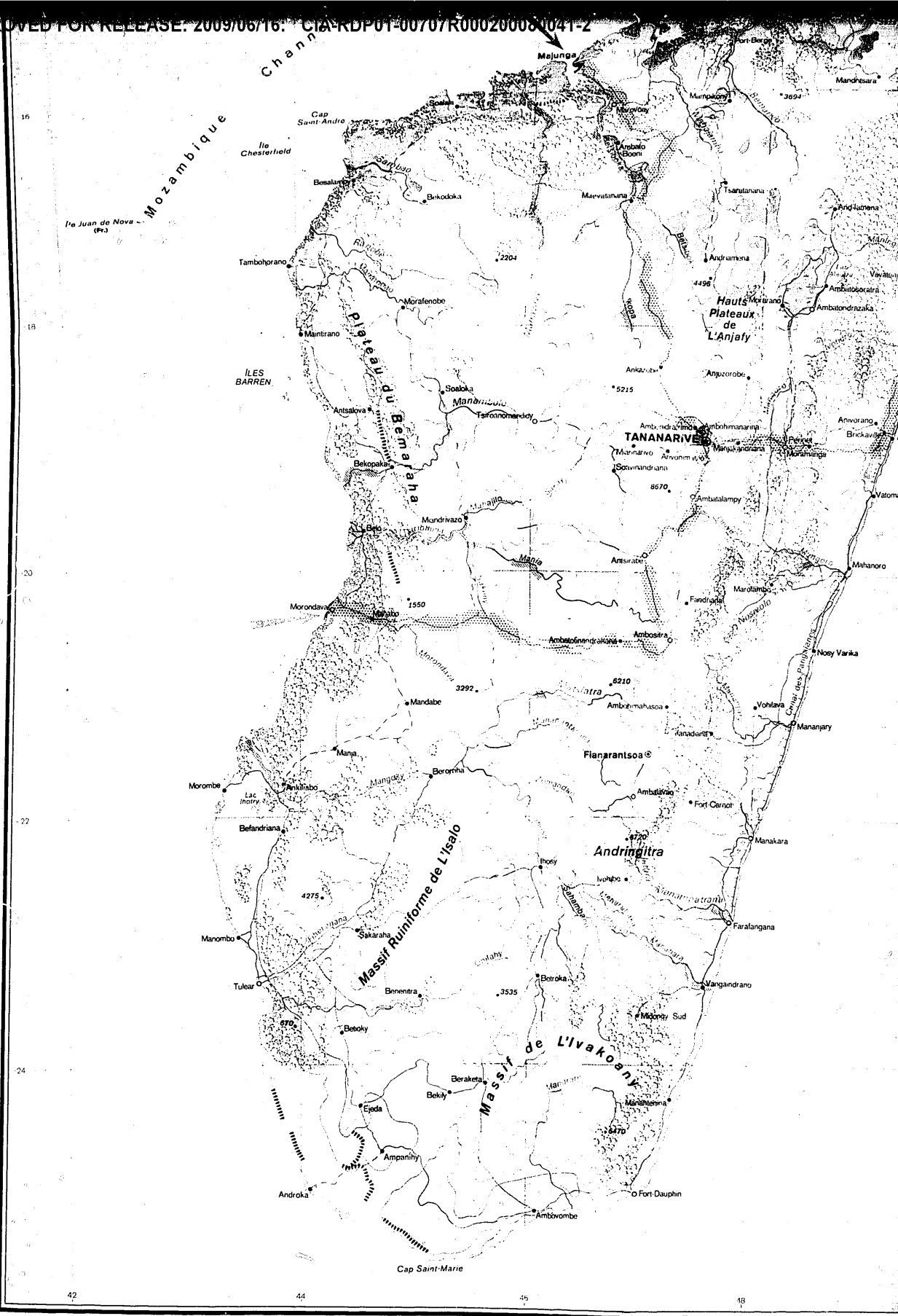
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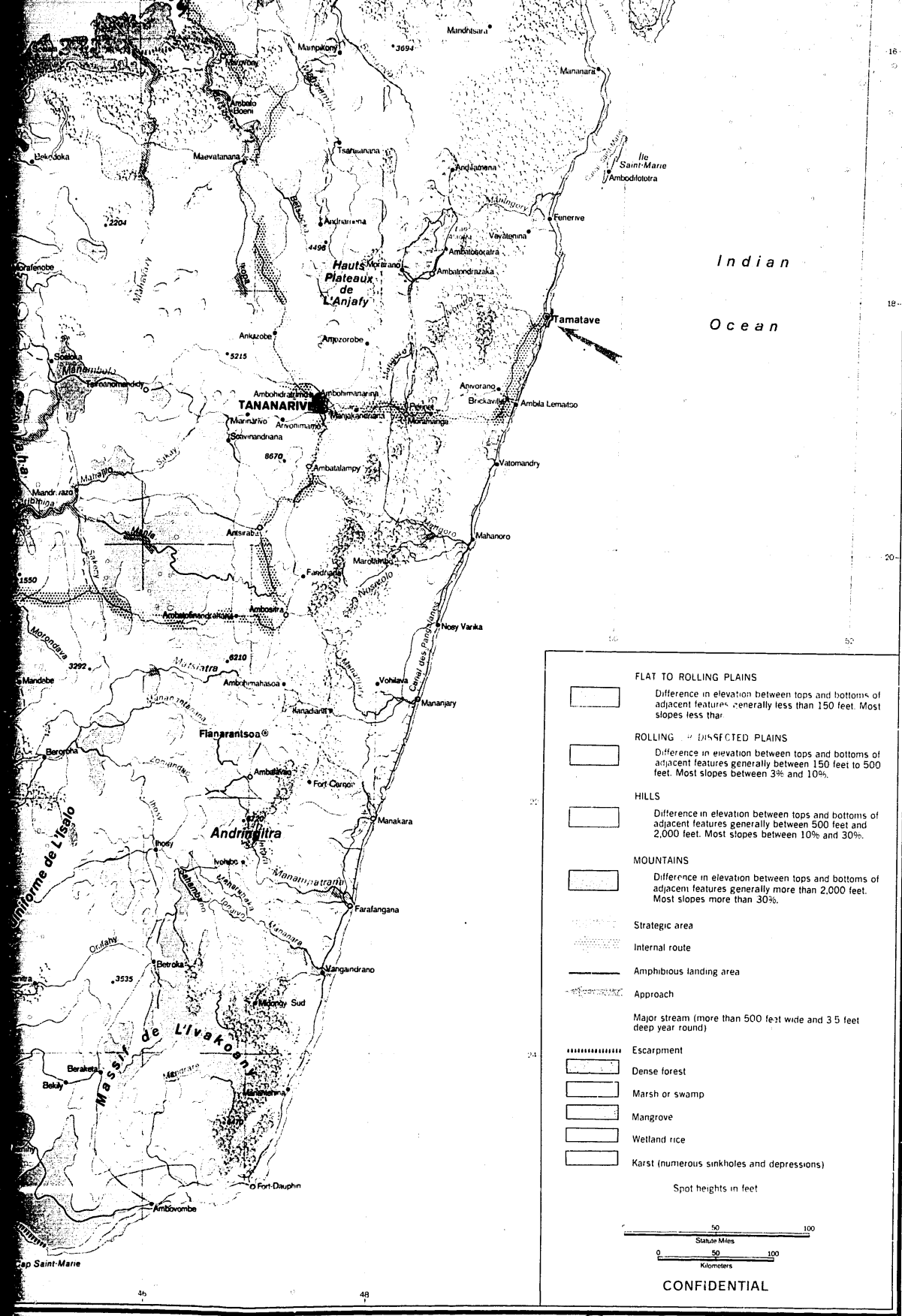
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4



5 Military Geographic Factors Figure 14