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# Panama

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NATIONAL INTELLIGENCE SURVEY

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Military Geography

28

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*This chapter has been prepared for the NIS by the Defense Intelligence Agency. Research was substantially completed by December 1973.*

# PANAMA

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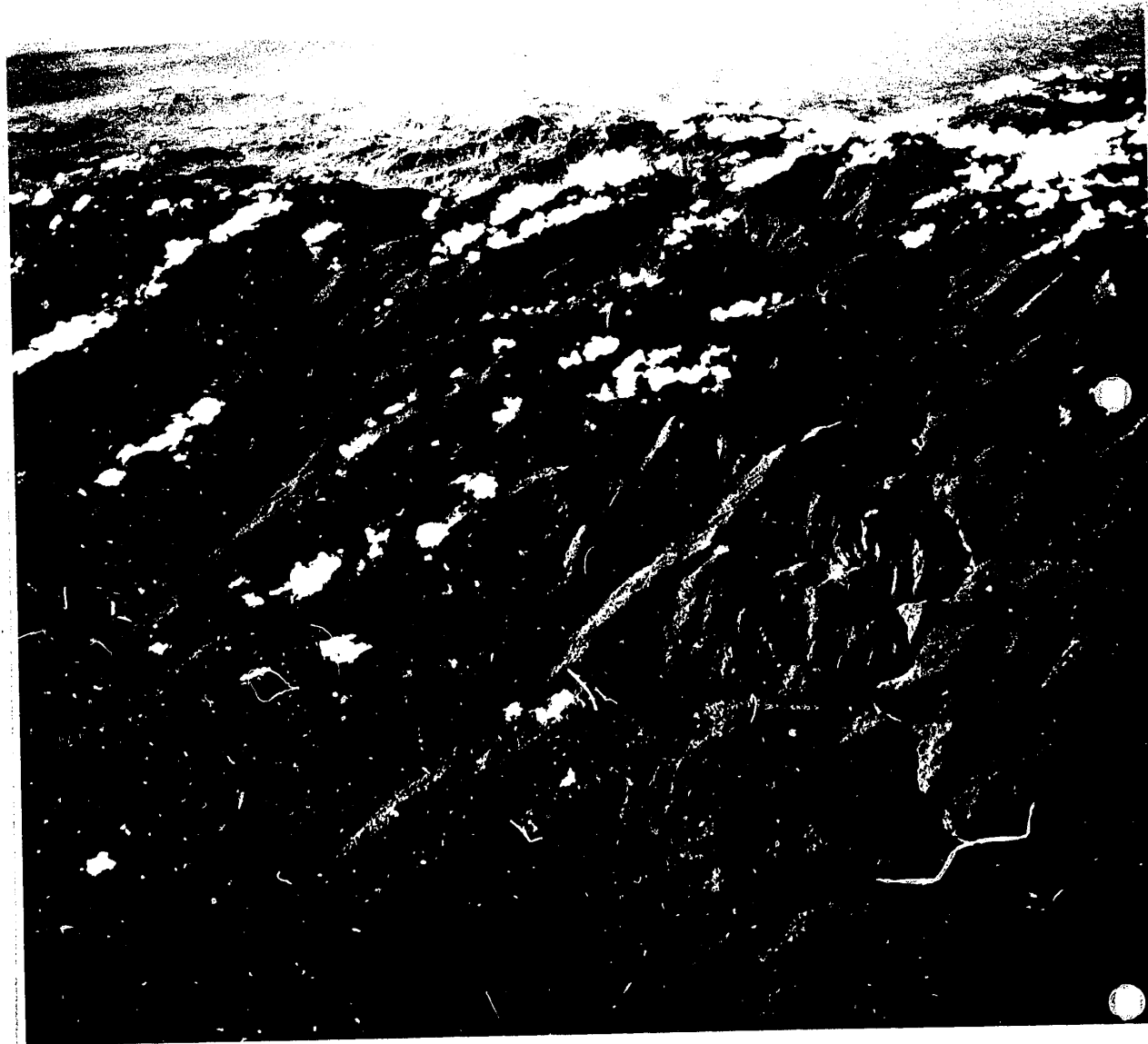
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# Military Geography

## A. Location and description (U/OU)

Panama—including the Republic of Panama and the U.S.-leased Canal Zone—is at the narrowest part of the isthmus connecting North and South America. The Canal Zone is about 500 nautical miles west of the important oilfields in western Venezuela and is within 700 nautical miles of Cuba. Panama's most valuable resource has been its geographic location and the subsequent construction of the Panama Canal, one of the two most significant interocean ship canals of the world. The canal is a vital factor in hemisphere defense and economic considerations, it greatly facilitates movement of naval and commercial vessels between the Atlantic and Pacific Oceans.

The combined area of Panama (29,208 square miles) and the Canal Zone (553 square miles including water areas) is about two-thirds the area of Pennsylvania. The country has a maximum east-west extent of about 400 miles<sup>1</sup> and a maximum north-south extent of 120 miles. The population, 1,640,600 is about one-tenth that of Pennsylvania (Panama, 1,594,000 and Canal Zone, 46,600).

### 1. Topography

Densely forested highlands and plains comprise about three-fourths of the country; the remainder

<sup>1</sup>Distances are in statute miles unless nautical miles are specifically stated.

consists predominantly of cultivated or grass- or scrub-covered lowland plains (Figure 10, map at end of chapter).

East-west trending bands of rugged hills and mountains (Figure 1), generally between 500 and 7,000 feet above sea level, extend almost unbroken from the Costa Rica border to Colombia. Highly dissected hills and mountains rise abruptly from the narrow Caribbean coastal plain and form the drainage divide between the Caribbean and Pacific. In the southwest, a narrow spur of predominantly rugged hills (Figure 2) extends from the divide to the Pacific. The highlands forming the divide are an almost continuous belt of high, rugged, steep-sided mountains and hills characterized by steep, highly dissected slopes, deeply incised, narrow V-shaped valleys, and nearly continuous crests; perpendicular sharp-crested ridges are common in the west. Elevations increase from east to west reaching a maximum elevation of 11,400 feet near the Costa Rica border. In general, elevations range from about 1,650 feet to 6,600 feet in the west to generally less than 1,900 feet in the east. Adjacent to and within the Canal Zone, the divide is bisected by a predominantly rolling plain that has some scattered dissected areas and low hills. South of Santiago, a rugged group of severely dissected, steep-sided hills and mountains (Figure 3) rises steeply from the Pacific coast and reaches a maximum elevation of about 5,000 feet.

FIGURE 1. This maze of steep, deeply dissected mountains is typical of most of the mountainous areas, particularly in the western part of the country. Crestlines are short and randomly aligned; most crests are sharp. Valleys are V-shaped, winding, and deeply incised. The entire mass is blanketed by dense broadleaf evergreen forests. (C)



Plains comprise a large area of eastern Panama on the Pacific side of the highland divide. The plains are predominantly rolling, with large areas of flat surfaces, some areas of dissected surfaces, and a few scattered low hills. Highly dissected, discontinuous hills and mountains fringe the narrow Pacific coastal plain and, in places, extend to the coast.

Dense broadleaf evergreen forests, in places intermixed with broadleaf deciduous forests, cover more than half of western Panama and nearly all of eastern Panama. The trees are commonly closely spaced, are up to 10 feet in diameter, and have a dense continuous canopy. The deciduous trees lose their leaves gradually, and new leaves continually replace those that have fallen; thus the forest canopy is fairly continuous all year. The undergrowth is generally sparse under the forest canopy but is more dense in

clearings and along streams. The forests are interspersed with small, scattered cultivated or grass-covered areas near the coasts and are fringed by cultivated or grass and scrub in the southwest.

Numerous streams drain the highlands and plains. They are generally short and swift, except in the eastern interior plains. In the highlands, they flow through deep valleys less than 150 feet wide and have rocky or gravelly bottoms. Stream levels fluctuate greatly from season to season. Most streams are less than 3.5 feet deep during the low-water period, January through April, but many exceed this level during the high water period, May through December. In the lowlands, streams flow sluggishly through shallow, meandering channels between 150 and 500 feet wide; a few exceed 500 feet in width. They are generally more than 3.5 feet deep; however,

FIGURE 2. Low hills with rounded to rugged summit areas stretch from the central part of the western highlands southward to the Pacific and form the Peninsula de las Palmas. They are moderately dissected, and narrow V-shaped valleys prevail. Most elevations in this hill area are less than 1,400 feet. Broadleaf evergreen brush intermixed with broadleaf evergreen forest cover most of the area. (C)



FIGURE 3. A complex mass of deeply dissected hills and a few small scattered areas of rolling plains compose a large part of the Peninsula de Azuero, south of Santiago. The hills rise steeply from narrow, twisting valleys or adjacent plains to A-shaped crests. Most of the area is less than 2,650 feet above sea level. Broadleaf evergreen forest or broadleaf deciduous scrub cover most of the area. (C)



during the low-water period, sandbars and gravelly bottoms are exposed locally. Stream bottoms are mainly composed of gravel and sand but are silty or muddy near the river mouths. Mangrove swamps (Figure 4) and marshes are extensive, particularly in the southern coastal areas. They vary in extent and depth as river floodwaters encroach on low-lying land and as tidal flooding occurs along the coast. Drainage features in the Canal Zone have been altered so greatly that artificial rather than natural drainage dominates. The outstanding features consist of the canal, which ranges between 300 and 500 feet in width, and two manmade lakes. Flooding does not occur in the Canal Zone because all drainage is controlled.

Flat to rolling plains are in the south-central and southwestern parts of the country. The south-central plains are predominantly rolling, and scattered, roughly dissected plains are adjacent to the highlands. Relatively small, discontinuous flat plains fringe the

coastal margins (Figure 5). In the southwest, extensive flat plains fringe the coast and merge into gently rolling plains in the interior. A relatively large area of dissected plains flanks the adjacent highland in the north. Low, lightly dissected hills are scattered throughout the plains and a small hilly area parallels the Costa Rica border in the southwest. Throughout the plains, elevations range from sea level to about 1,300 feet; however, most of the area is less than 600 feet above sea level. The plains are predominantly covered by a mixture of grassland and scrub, interspersed with cropland. Large areas of the plains in the southwest are under continuous cultivation.

Numerous streams drain the adjacent highlands and flow sluggishly across the south-central and southwestern plains in broad, meandering channels. Most streams are less than 250 feet wide, although a few major streams are as much as 500 feet wide at their mouths. Although depths of most principal streams are

FIGURE 4. Mangrove forest at the mouth of the Rio Chepo. The trees are approximately 100 feet tall and their trunks measure about 1 1/2 feet in diameter; the canopy is dense. Organic ooze is common on the ground. (C)

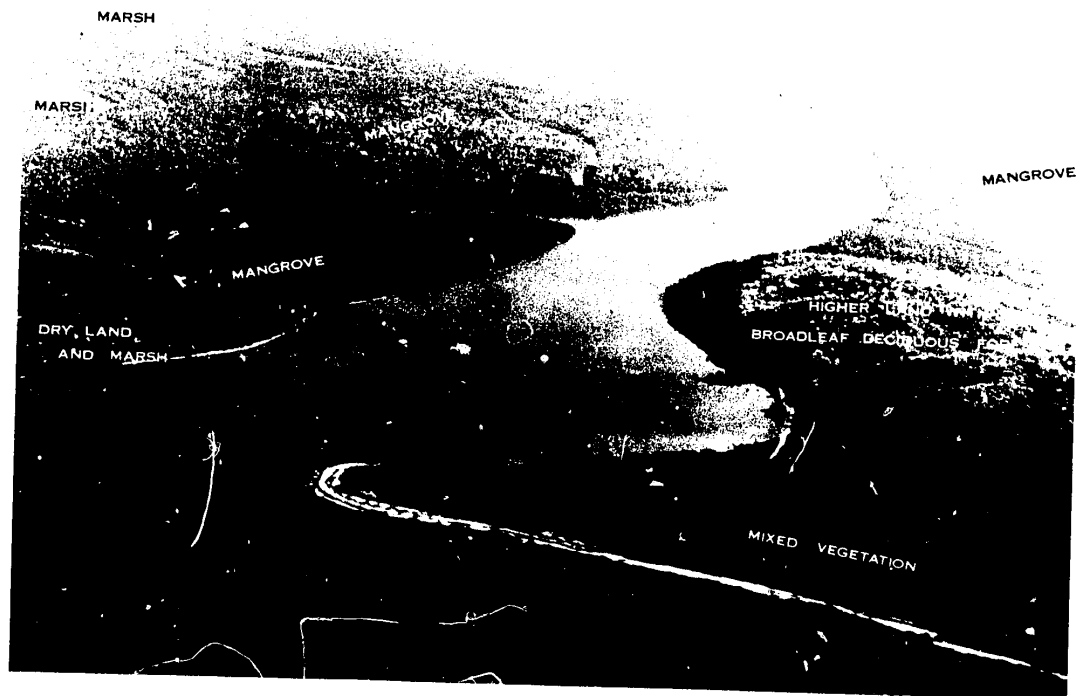




FIGURE 5. Discontinuous areas of flat plains are common along the southern coasts. These plains near Aguadulce are nearly featureless; valley bottoms are less than 35 feet below the broad interfluvies, and most slopes are less than 3%. Grasslands dotted with patches of low evergreen and deciduous forest and deciduous scrub cover the plains. (C)

more than 3.5 feet, sandbars and gravelly bottoms are visible, in places, during the low-water period. Near the highlands, bottoms consist largely of gravel and sand, but downstream they are principally composed of sand, mud, and silt. Swamps, primarily mangrove, and marshes fringe most of the coastal areas and extend inland along the lower courses of many streams. The swamps and marshes increase in extent

and depth during the high water period and during high tide.

Settlements and transportation lines are concentrated in the Canal Zone and its environs and in the southwest; in other parts of the country, settlement is sparse or nonexistent. The larger cities are at the termini of the Panama Canal and provide storage and servicing facilities for its activities. Other urban

communities, located mostly in southwestern Panama, are small and serve primarily as regional agricultural marketing or distribution centers. Generally, in the urban areas, commercial and industrial establishments are so intermingled with dwellings that few purely residential sections exist. The larger cities have a grid street pattern and consist of one- to two-story, closely spaced buildings constructed of concrete, brick, or wood with tile or galvanized-iron roofs. The principal streets are generally surfaced and two lanes wide. In the smaller urban communities, buildings are generally one story and of brick or wood construction and have tile, galvanized-iron, or thatched roofs. Rural dwellings are constructed largely of adobe. Highways, although sparse, comprise the only integrated transportation network in Panama. The Inter-American Highway and a transisthmian road, the Boyd-Roosevelt Highway, which serve the only two significantly populated sections of the country, are surfaced and in generally good condition. However, most of the feeder roads leading into the Inter-American Highway are unsurfaced and become impassable after heavy rains. Single-track 3'0"-gauge rail lines serve small areas in the northwest and southwest, and a single-track 5'0"-gauge rail line augments the transportation facilities in the Canal Zone. Inland waterways, with the exception of the Panama Canal are generally utilized for local movement only and are relatively insignificant.

## 2. Climate

Panama has a tropical climate characterized by a prolonged rainy season, May through December, and a short dry season, January through April (Figure 9, chart at end of chapter). Weather conditions during these seasons are influenced chiefly by the Intertropical Convergence Zone, located near Panama during the rainy season, and by the strength of the northeasterly trade winds, strongest and most pronounced over the area during the dry season. In most of Panama, temperature and relative humidity are uniformly high all year and have only small to moderate diurnal variations. Rainfall is plentiful, averaging between 50 and 150 inches per year over most sections, and occurs mostly as showers.

During the prolonged rainy season, the frequent, often heavy, showery precipitation is the principal cause of restricted visibility. Rainfall occurs on about 15 to 25 days per month, while the frequency of thunderstorm days ranges from more than 20 per month in parts of the interior to mostly 5 to 15 per month elsewhere. A thunderstorm maximum usually occurs in July, August, or September. Cloudiness is

extensive and skies frequently become cloudy to overcast, especially during the afternoon.

The shorter dry season is marked by negligible to light rainfall, which occurs on 10 days per month or less in most sections, and by a reduced number of thunderstorms, generally less than 3 per month. Except for haze aloft and for cloud development along windward slopes, visibility is generally good and skies are clear to partly cloudy.

Northerly or northeasterly surface winds prevail throughout the year except in the mountain sections, where winds are deflected by topographic features, and in the southwest, where winds are quite variable during the rainy season. Wind speeds are generally light, rarely exceeding 25 knots. However, strong gusts occur in some mountain passes and in association with thunderstorms.

## B. Military geographic regions (C)

Differences in terrain afford a basis for dividing the country into four military geographic regions—Forested Panama, Southern Highlands, Southwestern Lowlands, and South-Central Lowlands (Figure 10, map at end of chapter). The combination of environmental conditions within the Forested Panama and Southern Highlands regions would have a relatively uniform effect on military operations, but there would be marked differences between these regions and the Southwestern Lowlands and South-Central Lowlands regions.

### 1. Forested Panama and Southern Highlands

These regions consist of the predominantly forested highlands and plains comprising about 75% of Panama. The broadleaf evergreen and deciduous forests covering most of the regions are extremely dense, continuous, and have an almost complete canopy. Flanking the forested highlands in the southwest and south are hills and mountains predominantly covered by brush, scrub, and grass and having scattered areas of cultivation. Extensive areas of swamp and marsh fringe both the Caribbean and Pacific coasts. Settlements and transportation lines are concentrated in the Canal Zone and its environs. Elsewhere, the regions are extremely sparsely populated, and large areas, especially in eastern Panama, are virtually uninhabited.

Conditions are largely unsuited for large-scale conventional ground operations in these regions. Vehicular cross-country movement and offroad dispersal would be extremely difficult or precluded in most places by dense forest, steep slopes, or swamps

and marshes. The only existing avenues for movement would be the limited road network that serves the Canal Zone and its environs. Several low-capacity bridges and, in places, sharp curves and steep grades would impede onroad movement, and many of the unsurfaced roads become impassable after heavy rains. The construction of roads would be difficult. Heavy grading and blasting and much cut and fill would be required in the highlands, and road alignments would be extremely restricted. Throughout the regions, extensive clearing and grubbing would be necessary and constant maintenance would be required to prevent the regrowth of vegetation. The region is well suited for the construction of underground installations. The rugged hills and mountains provide numerous sites for the construction of tunnel-type installations, and the thick soils covering most of the plains, hills, and lower mountain slopes provide many sites for the construction of bunkers and hasty ground fortifications. Access to most potential construction sites in these regions, however, would be extremely difficult. The dense forests provide excellent concealment from air and ground observation. Additional concealment from ground observation and cover from flat-trajectory fire would be provided by the rugged terrain.

The regions are unsuited for airborne and airmobile operations. Because of the rugged terrain and dense vegetation there are virtually no sites for parachute operations, and sites suitable for helicopter operations are limited to a few areas of low cultivation and grassland. The few existing airfields constitute the best areas for most operations and the only suitable areas for landings of assault-type aircraft. The largest airfields are concentrated in the Canal Zone or within 25 miles east of the Zone; other airfields are mostly small, unpaved facilities that would require constant maintenance. Sites suitable for the construction of large airfields having unrestricted runway orientations and approaches are limited to a few widely scattered flat plains. Elsewhere, excessive slopes preclude the construction of all but the smallest airfields.

The coasts of these regions are poorly suited for amphibious operations. Although there are many firm sandy beaches, nearshore and, along the Caribbean coast, offshore approaches are partly obstructed by reefs, rocks, shoals, sandbars, extensive mudflats, islands, and islets. Many of the beaches on the Pacific coast are usable only at high water. Exits inland would be precluded in most places by swamps, marshes, and densely forested lowlands or hills. The few existing transportation facilities are suitable only for local movement.

Terrain conditions in these regions are excellent for irregular force operations. The dense forests provide excellent concealment from air and ground observation and would permit clandestine movement of small groups of personnel with a minimum chance of detection. The rugged hills and mountains would provide additional concealment from ground observation as well as afford excellent cover from flat-trajectory fire. In most places the only possible means of cross-country movement would be on foot; vehicular movement would be confined almost entirely to the very few roads. The population and transportation lines are concentrated in the Canal Zone and its environs. Elsewhere, the population is extremely sparse and many areas are virtually uninhabited. Food supplies would be difficult to obtain in these sparsely populated areas. The only source of supply would be from small, scattered agricultural areas and the Canal Zone. Fish and edible wild plants are abundant; however, wild game is generally scarce in densely forested areas. Fresh water is generally available from perennial streams. Timber for shelter materials is abundant, but firewood may be scarce in some areas. Irregular force personnel would be subjected to numerous detrimental physiological and psychological aspects in these regions. The tropical climate with heavy rainfall and high temperatures and humidity is both depressing and enervating, slowing physical activity and creating health problems. Diseases and infections develop rapidly, and materiel is subject to rot, mildew, and corrosion. Dangerous plants and animals, insects, and allergenic plants are widespread. The predominantly heavily forested coasts and rugged, forested borders are mostly unpatrolled and could be clandestinely penetrated by small groups with little difficulty.

## **2. Southwestern Lowlands and South-Central Lowlands**

These regions consist of the large, discontinuous coastal plains along the Pacific coast. The plains are predominantly flat to rolling with scattered areas of roughly dissected plains and some low hills. The central plains are mostly scrub- or grass-covered, and there are scattered areas of cultivation. Large areas of the Southwestern Lowlands are under continuous cultivation. Extensive areas of swamp and marsh fringe the coasts. Most of the population, settlements, and transportation lines of Panama, outside of the Canal Zone and its environs, are located in these regions.

In these regions, conditions are, for the most part, suitable for large-scale conventional ground

operations. Onroad movement is possible all year on the Inter-American Highway and on the surfaced roads leading to the highway. However, most roads that intersect this highway are of earth and are impassable after heavy rains. Offroad dispersal and cross-country movement of vehicles would be feasible but would be restricted in direction by numerous streams and severely hindered in the roughly dissected areas. Cross-country vehicular movement would be precluded in the areas of swamps and marshes. In most of the region, the construction of roads would involve only minor construction problems. Road alignments would be generally unrestricted, and only light grading and clearing would be required. Extensive drainage facilities and much fill would be required in the areas of swamp and marsh. There are numerous sites suitable for the construction of bunkers and hasty ground fortifications in the predominantly thick, well-drained soils of the regions. The generally low relief, however, affords few sites for the construction of tunnel-type installations. Opportunities for cover and concealment are limited in these regions. Some cover from flat-trajectory fire and concealment from ground observation would be provided by surface irregularities and steep streambanks. Additional limited cover from flat-trajectory fire and concealment from air and ground observation would be provided by some structures in the scattered towns and villages.

The regions are generally well suited for airborne and airmobile operations. There are numerous good sites suitable for parachute and helicopter operations in the grass and cultivated plains. The regrouping of personnel and retrieval of supplies would be easy, and landings and takeoffs of helicopters would be unrestricted. There are also many suitable sites in the scrub-covered plains; however, the size of most sites would be limited. There are few existing airfields suitable for the landings of assault-type aircraft. The two largest airfields are south of David and northeast of Rio Hato;<sup>2</sup> other airfields are small and unpaved and would require constant maintenance. The construction of airfields would, for the most part, involve only minor construction problems. Runway orientations and air approaches would be generally unrestricted in the flat plains but would be restricted locally in the areas adjacent to the dissected plains and highlands.

These regions are, for the most part, unsuited for amphibious operations. There are many sandy beaches, but nearshore and offshore approaches to

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

large parts of each region are partly obstructed by mudflats, shifting sandbars, rocks, reefs, shoals, islands, and islets. Movement inland would be precluded along most of the coast by extensive areas of marsh and swamp. Elsewhere, muddy soils during the wet season and the general lack of developed transportation facilities leading inland seriously hinder exits from the beaches.

Terrain conditions in these regions are poorly suited for irregular force operations. The limited opportunities for concealment from air and ground observation and cover from flat-trajectory fire would severely restrict clandestine movement of small groups of personnel. In addition, cross-country movement of conventional forces is generally fair and conventional helicopter and parachute operations are possible over wide areas. Food supplies are available from numerous small farms and plantations; however, edible plants, fish, and small game are limited. Plentiful fresh water, although biologically contaminated, is available only during the wet season. During the dry season, freshwater supplies are scarce. Timber for shelter materials and firewood is generally lacking. Irregular force personnel would be subjected to detrimental physiological and psychological aspects in these regions as in the adjacent forested highlands and plains. The climate is only slightly less enervating, and there are only a few dangerous plants and animals. The mostly unpatrolled coasts of these regions are largely fringed by extensive areas of swamp and marsh and could be penetrated by small groups with little difficulty.

### C. Strategic area (C)

The Canal Zone and its environs comprise the only strategic area in the Republic of Panama (Figure 6). The strategic area contains the Panama Canal and the installations necessary for the maintenance and defense of the canal. The part of the strategic area within the Republic contains the political, industrial, commercial, telecommunications, and cultural centers of the country. The two metropolitan areas, Panama City (Figure 7) and Colon (1970 population 442,400 and 70,500, respectively), and the Canal Zone (1970, 46,600) contain 47% of the total population of the country. The Panama Canal is of vital importance to the Republic because the industrial and commercial activities of the strategic area are in large part dependent upon the existence of this waterway. Most of the installations in the strategic area are concentrated near Cristobal (on the Caribbean) and Balboa (on the Pacific), the terminal points of the

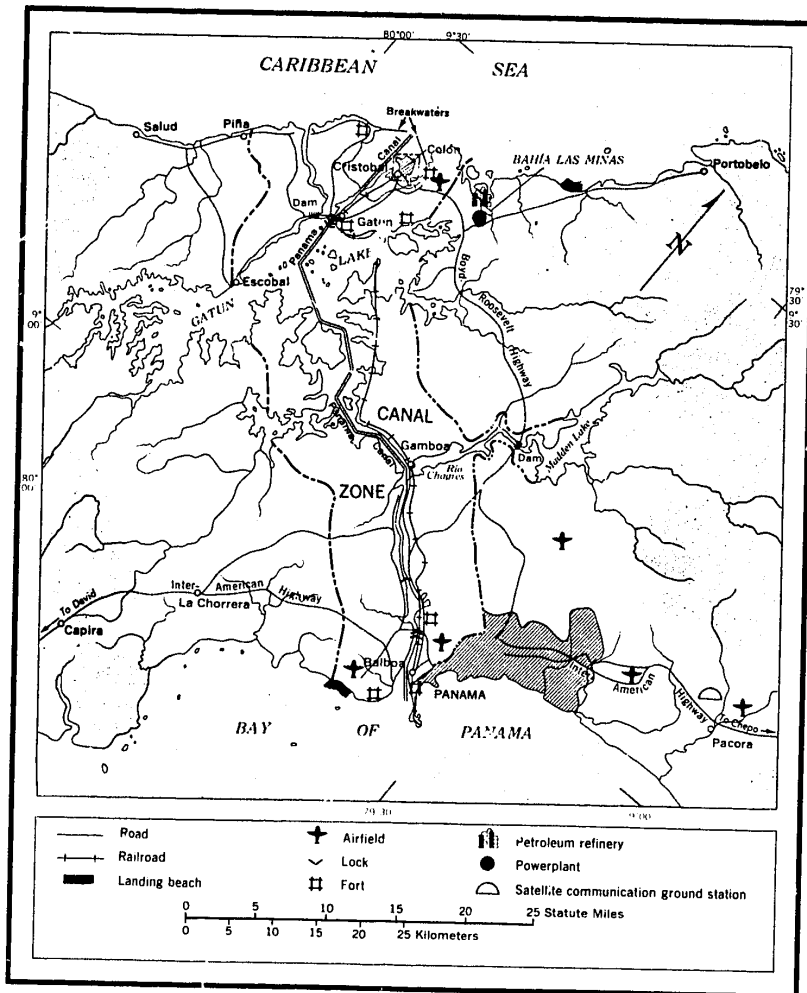


FIGURE 6. Canal Zone strategic area (C)

canal and the largest ports in Central America. The installations include the various facilities for international commercial shipping, as well as U.S. naval facilities, military installations for air and ground defense of the canal, administrative and military headquarters, extensive billeting and storage facilities, and most of the industrial installations in the Republic. Industrial development is limited mainly to food processing and to the manufacture of construction materials. An oil refinery, with a capacity of 75,000 barrels per day, is located near Colon in the Bahia Las Minas area; petroleum storage facilities are

available for about 3,080,000 barrels, of which about 1,070,000 barrels is crude storage. Other significant facilities at seven sites scattered throughout the Canal Zone provide storage for about 5,800,000 barrels of refined products. The largest powerplant in the country (116,000 kilowatts) is also located in the Bahia Las Minas area. The strategic area is the control center for the nationwide wire and radio telecommunications network. International telecommunications traffic is routed through nearby radio communication stations and the satellite ground station about 10 miles northeast of Panama City. An international submarine

cable terminates in the Canal Zone, near Colon. Within Colon is an important 100 acre, enclosed, free-port zone. Of the six most important airfields in the strategic area, three are military airfields in the Canal Zone and three are civil airfields northeast of Panama City. Tocumen International Airfield, one of the civil facilities, handles the largest volume of traffic and is one of two airfields in the country open to international traffic. It has complete overhaul and repair facilities and is to be expanded in the near future.

Other important areas are David and Puerto Armuelles:

NAME	IMPORTANCE
David ..... 8°26'N., 82°26'W.	Transportation and market center. International airfield nearby. Estimated population 43,000. Petroleum storage facilities for 38,900 barrels of refined products.
Puerto Armuelles ... 8°17'N., 82°52'W.	Port on Pacific coast. Terminus of railroad from David. Small airfield nearby. Estimated population 13,000. Petroleum storage facilities for 48,000 barrels, of which 5,000 barrels is crude storage.

#### D. Internal route (C)

The internal route (Figure 10, map at end of chapter) provides the easiest avenue of movement from the land approach southeast of Corredor, Costa Rica, and from the amphibious landing area about 25 miles southwest of the Canal Zone to the strategic area. The route crosses mostly flat to rolling plains, although surfaces are dissected in many places. The plains are covered mainly by grassland or scrub and cropland, but swamps and marshes are extensive in

parts of the route. Transportation facilities consist of a road, part of the Inter-American Highway, and, in the extreme southwest, a railroad. The road is concrete surfaced, two lanes, and in good condition. Landslides, washouts, and many sharp curves and steep grades would hinder onroad movement. The rail line is single track and 3'0" gage. During the dry season, offroad dispersal and cross-country movement generally would be unrestricted in the flat to rolling plains but would be severely hindered or precluded by steep slopes in dissected areas and, in places, by swamps and marshes. During the remainder of the year, muddy ground would preclude offroad dispersal and cross-country movement locally.

#### E. Approaches

The perimeter of the country totals about 1,935 miles. Land boundaries extend approximately 390 miles, mostly across forested hills and mountains. Both land boundaries are demarcated and unfortified. The Canal Zone is a 10-mile-wide strip, dividing the Republic of Panama into two nearly equal parts. A Panamanian enclave, Colon, is on the Caribbean coast of the Canal Zone (Figure 10, map at end of chapter). (U/OU)

The boundary with Costa Rica, about 225 miles, traverses, for the most part, densely forested hills and mountains. In the north, it is across a densely forested plain and in most of the south an open forested or cultivated plain. The Rio Sixaola marks the boundary in the extreme north. The boundary with Colombia is 165 miles long and is mostly across densely forested hills and mountains. (U/OU)

The Caribbean coastline, 545 miles, has few irregularities and is backed by a predominantly rolling

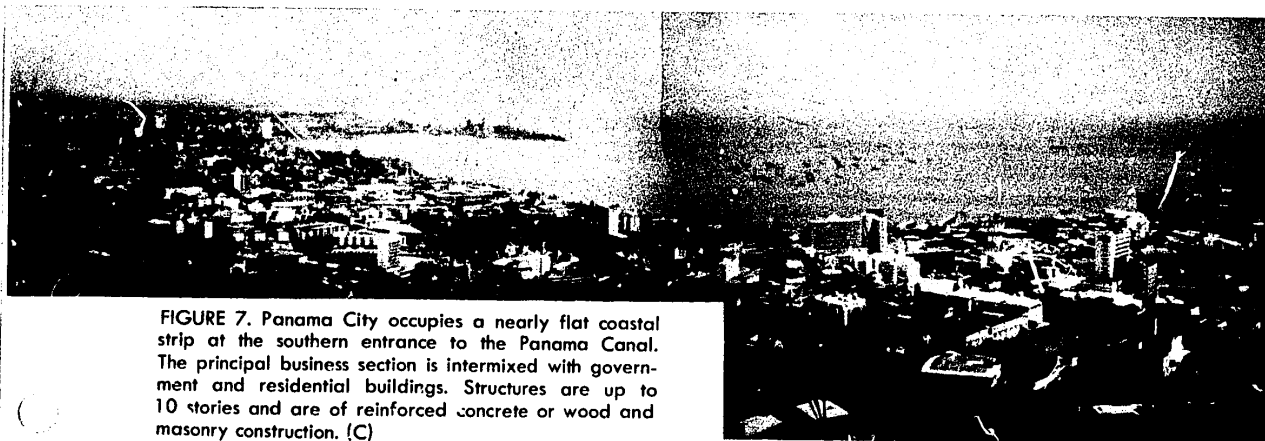


FIGURE 7. Panama City occupies a nearly flat coastal strip at the southern entrance to the Panama Canal. The principal business section is intermixed with government and residential buildings. Structures are up to 10 stories and are of reinforced concrete or wood and masonry construction. (C)



to hilly plain. Extensive areas of fresh-water swamp or marsh fringe the shore in the extreme west. The Pacific coastline, 1,000 miles long, is indented by numerous bays and gulfs. The predominantly low coast is interrupted by hills in the central and extreme eastern sections. Extensive areas of swamp, mostly mangrove or marsh, fringe much of the shore and, in the east, border estuaries that extend far inland. Panama claims territorial jurisdiction over waters within 200 nautical miles of its shores. (U/OU)

### 1. Land (C)

Overland approach to Panama is severely hampered or precluded by the perennially large Rio Sixaola, dense forest, and rugged highlands. Cross-country movement over the borders is virtually impossible. Developed transportation facilities cross only the Costa Rica border. The principal facilities consist of a section of the Inter-American Highway, a rail line in the southwest, and a short rail line in the northwest that lacks connections with other parts of either Costa Rica or Panama. The approach from Costa Rica extends across open to densely forested plains and contains a road that is gravel surfaced and two lanes wide. There are few possibilities for offroad dispersal or cross-country movement.

### 2. Sea (C)

Sea approaches to both the Caribbean and Pacific coasts are partly obstructed. Offshore approaches are mostly deep and clear along the western half of the Caribbean coast but are channelized and partly obstructed by reefs, rocks, shoals, and islets in the eastern half. Nearshore approaches to the entire coast are partly obstructed by rocks, shoals, sandbars, stretches of fringing coral reef, islands, and islets. Nearshore bottom material consists of sand, mud, shell, and coral reef; bottom gradients vary from flat to steep. Tides are diurnal and have a range of about 1 foot. Surf 4 feet or higher occurs infrequently in all months on protected shores and up to 53% of the time, January through March, on exposed shores. There are many beaches consisting mainly of firm sand along the Caribbean coast, but few have feasible exits. Beach gradients are moderate to mild in the low-water to high-water zone, and are generally steep in the high-water zone. Movement inland would be severely hampered or precluded by dissected, densely forested plains that back most of the shore and, in the west, by extensive areas of fresh-water swamp or marsh.

Offshore and nearshore approaches to the Pacific coast are partly obstructed by rocks, reefs, shoals,

islands, and islets. Nearshore approaches are also partly obstructed by fringing reefs, shifting sandbars, and extensive mudflats. Nearshore bottom material is composed of sand, mud, rock, shell, and gravel; flat to mild bottom slopes are common. Tides are semidiurnal and have spring ranges of 9½ to 16 feet. Surf 4 feet or higher can be expected to occur infrequently on protected shores and up to 20% of the time on exposed shores. Beach materials are sand, mud, pebbles, and rocks. Gradients on the beaches are flat to steep in the low-water to high-water zone and are predominantly steep to moderate in the high-water zone. Exit from the beaches would be precluded in most places by mangrove swamps and marshes or densely forested, highly dissected terrain. Transportation facilities leading inland are virtually nonexistent along most of the coast and are generally inadequate where they do exist. The amphibious landing areas shown on Figure 10, map at end of chapter, provide access to the strategic area or to the internal route leading to the strategic area. Detailed information on the amphibious landing areas is presented in Figure 8.

### 3. Air (U/OU)

There are four air approaches<sup>3</sup> to Panama. The northern approach is over the Caribbean Sea, the eastern over Colombia, the southern over the Pacific Ocean, and the northwestern over Costa Rica and southern Nicaragua.

Rugged mountains in the eastern and northwestern approaches are hazards to low-flying aircraft. Crests are generally less than 9,000 feet above sea level; however, several peaks in the northwest are over 10,000 feet, and a few in the east exceed 12,000 feet. The highest is in the eastern approach and rises to nearly 18,000 feet. Weather conditions in general are most favorable over the Pacific and least favorable over land approaches. Over all approaches, weather conditions are usually favorable in December through April, and hazardous conditions occur most often in May through November. Winds aloft are light and easterly throughout the year below 25,000 feet. Above 25,000 feet, winds remain easterly during June through November and westerlies prevail in December through May. Mean speeds are mostly less than 40 knots.

During the period May through November in all approaches, the principal weather hazards are

<sup>3</sup>Discussion zones for air approaches extend approximately 200 nautical miles beyond the borders of Panama.

FIGURE 8. Amphibious landing areas (C)

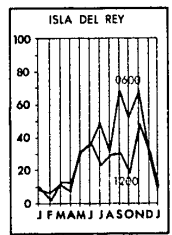
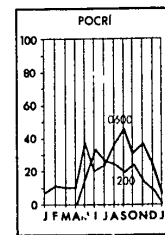
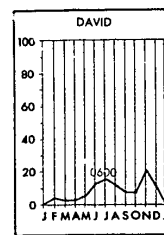
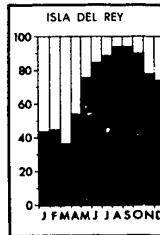
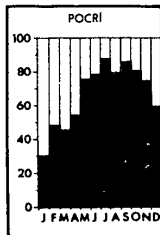
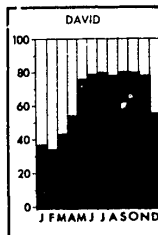
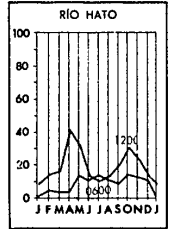
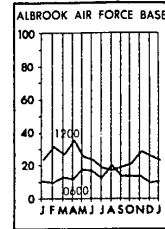
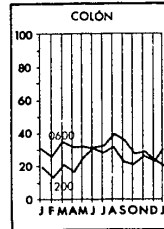
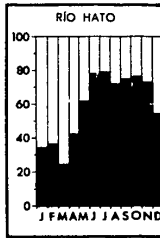
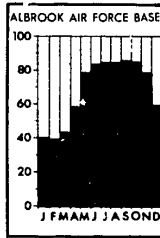
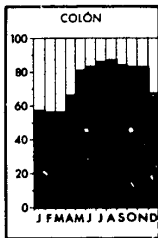
LOCATION	APPROACH	BEACH	TERRAIN BEHIND BEACH AND EXIT
East of Colon.....	Seaward of 5-fathom depth contour clear; shoreward of 5-fathom depth contour partly obstructed by rocks off left third; beach may be separated by stream in center third during heavy runoff. Nearshore bottom sand, mud, and some rock and average gradient 1 on 91; suitable for LST dry-ramp landings near right end of beach; surf 4 ft. or higher expected 40% of time Jan.-Mar., 20% Apr.-June, 10% July-Sept. and 20% Oct.-Dec.; tidal range 1.1 ft., diurnal.	1 1/4 mi. long; all usable; 15 to 45 yd. wide at L.W. (low water) and 1 to 15 yd. at H.W. (high water); average L.W. to H.W. gradient 1 on 38 and H.W. zone gradient 1 on 10; material sand.	Flat plain covered by grass and scattered forest; plain backed by low gentle hills; stream behind left and center third; exits via track, unsurfaced road, or by cross-country movement to loose-surfaced road 25 to 400 yd. inland.
In Canal Zone, southwest of Panama City.	Seaward of 5-fathom depth contour partly obstructed by islands, islets, and rocks; shoreward of 5-fathom depth contour partly obstructed off flanks by islands, islets, and rocks; mudflats exposed at L.W. Nearshore bottom mud and some rock and average gradient 1 on 378; suitable for LST dry-ramp landings at high tide during spring tides; surf 4 ft. or higher expected 10% of time July-Dec. and infrequent during remainder of year; tidal range 16 ft., springs.	670 yd. long; all usable; 400 to 500 yd. wide at L.W. and 10 to 20 yd. at H.W.; average L.W. to H.W. gradient 1 on 79 and H.W. zone gradient unknown, but probably 1 on 15 or steeper; material sand and mud.	Grass and forested flat plain backed by low hills in center third; airfield about 750 yd. inland behind right third; exit via track from right third of beach or by cross-country movement to tracks and unsurfaced roads connecting with surfaced road about 750 yd. inland.
Southwest of Canal Zone....	Seaward of 5-fathom depth contour clear except for scattered shoals; shoreward of 5-fathom depth contour partly obstructed by scattered shoals and rocks. Nearshore bottom sand and mud and average gradient off beaches about 1 on 70; suitable for LST dry-ramp landings at high tide during spring tides; surf 4 ft. or higher infrequent except expected 10% of time July-Dec. on NE. beach; tidal range 15.3 ft., springs.	Area 3 1/2 mi. long; about 1 3/4 mi. usable; includes 3 beaches; NE. beach 560 yd. long; all usable; 50 to 70 yd. wide at L.W. and about 10 yd. at H.W.; average L.W. to H.W. gradient 1 on 10 and H.W. zone gradient unknown, but probably 1 on 10 or steeper; material sand and some mud. Center beach 755 yd. long; all usable; 40 to 105 yd. wide at L.W. and 5 to 60 yd. at H.W.; average L.W. to H.W. gradient 1 on 7 and H.W. zone gradient unknown, but probably 1 on 7 or steeper; material sand and some mud. SW. beach about 1 mi. long; nearly all usable; 60 to 85 yd. wide at L.W. and 10 to 35 yd. at H.W.; average L.W. to H.W. gradient 1 on 9 and H.W. zone gradient unknown, but probably 1 on 9 or steeper; material sand and some mud.	Beaches separated by unusable shores with infeasible exits; NE. beach backed by mostly forested flat plain except left end; plain and left end backed by low bluff fronting rolling plain; town in left third. Center beach backed by brushy low bluffs fronting town backed by rolling plain. SW. beach backed by low bluffs and small valleys fronting partly cultivated rolling plain. Exit from beaches by track, loose-surfaced roads, unsurfaced roads, or by cross-country movement to Inter-American Highway about 2 mi. inland.

## CONFIDENTIAL

extensive convective cloudiness (averaging 70% to 90%) which is accompanied by frequent rain showers, moderate to severe turbulence, and the increased risk of severe icing above 15,000 feet, the mean height of the freezing level. Convective cloudiness and thunderstorm activity tend to be most pronounced during the afternoon over land and at night over water. Thunderstorm activity, another major hazard, is at a maximum at this time of year, occurring on 5 to 15 days per month in all sections and up to 20 days per month in some areas. Thunderstorms are especially severe over and near mountainous regions where vertical development often reaches heights of 50,000 to 60,000 feet. Visibility is generally good but may be restricted for brief periods during rain showers and thunderstorms. Tropical storms infrequently affect the

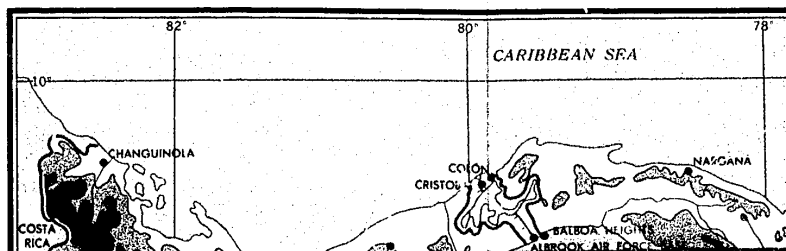
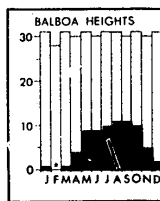
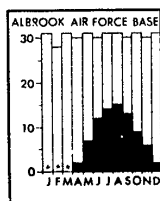
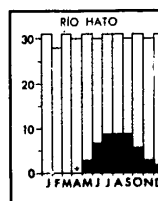
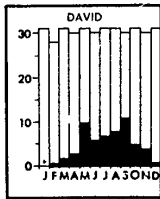
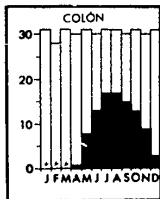
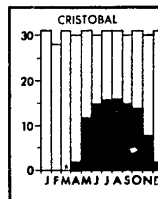
northern approaches and cause widespread, multi-layered cloudiness, strong winds, severe turbulence, and heavy rainfall.

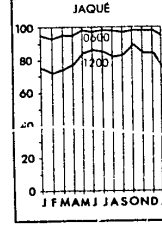
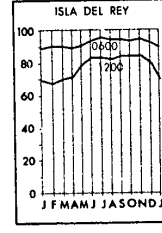
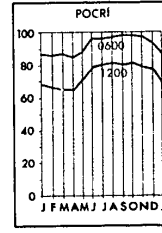
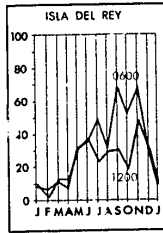
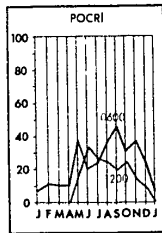
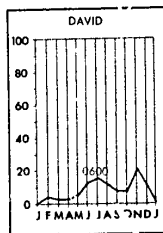
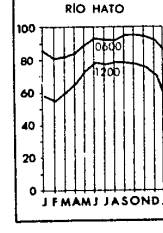
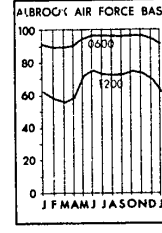
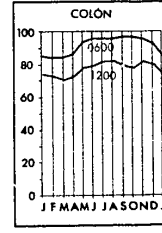
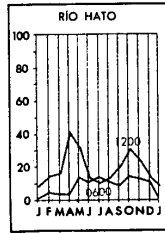
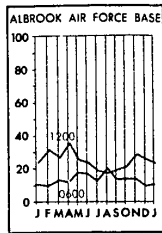
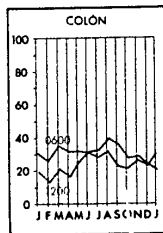
During the period December through April, weather conditions are largely improved by the decrease in convective cloudiness, 30% to 80%, and thunderstorm activity, generally less than 10 per month in all sections and less than 5 per month in some areas. Vertical cloud development is usually limited to 6,000 feet and seldom extends above 20,000 feet, thus reducing the likelihood of severe turbulence and aircraft icing. Shower activity is sporadic and widely scattered, and good visibility prevails most of the time. However, occasional cold fronts penetrate the approaches from the north, causing low ceilings, low visibility, and squally conditions for brief periods.



MEAN CLOUDINESS (%)

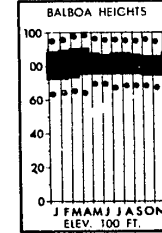
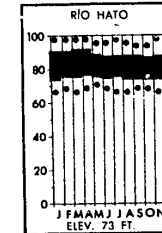
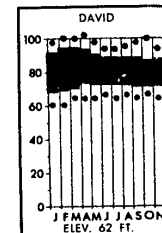
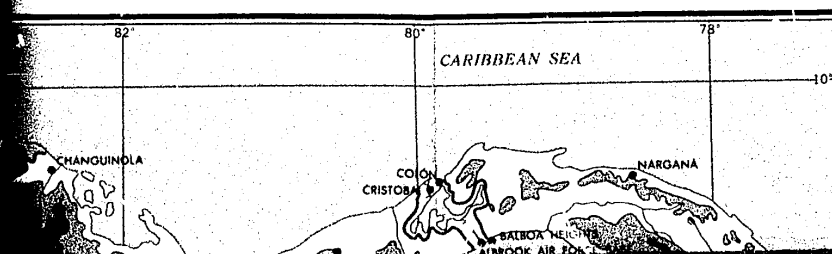
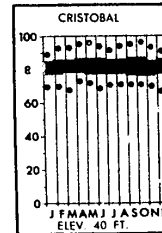
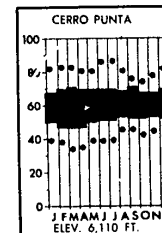
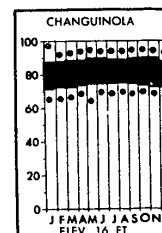
PERCENTAGE FREQUENCY OF CEILING  
< 5,000 FEET AT SPECIFIED HOURS (LST)

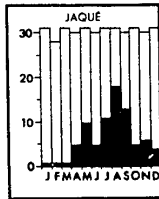
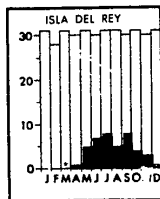
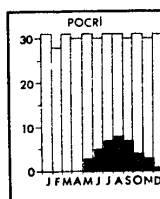




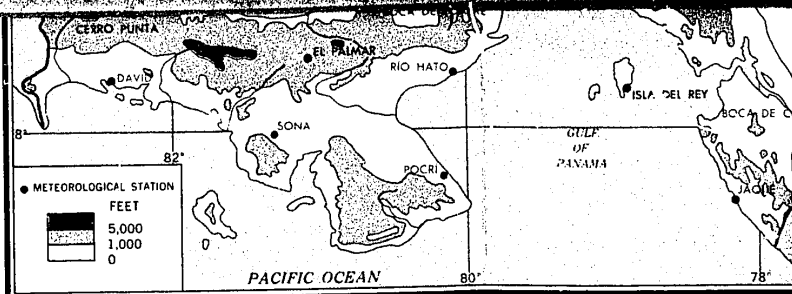
PERCENTAGE FREQUENCY OF CEILING  
< 5,000 FEET AT SPECIFIED HOURS (LST)

MEAN RELATIVE HUMIDITY (%) AT SPECIFIED HOURS (LST)

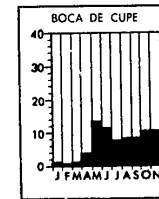
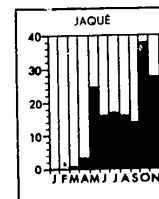
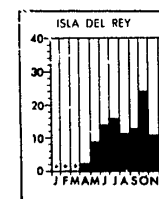
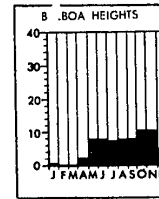
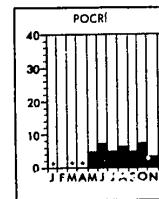
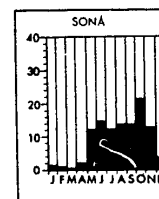
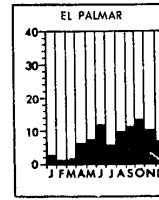
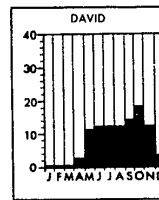
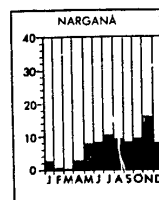
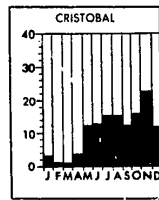
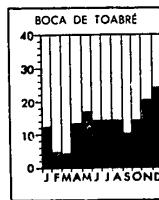
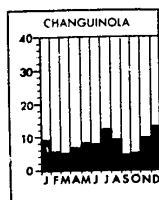




MEAN NUMBER OF DAYS WITH THUNDERSTORMS  
\* < 0.5 DAY



STATION LOCATIONS

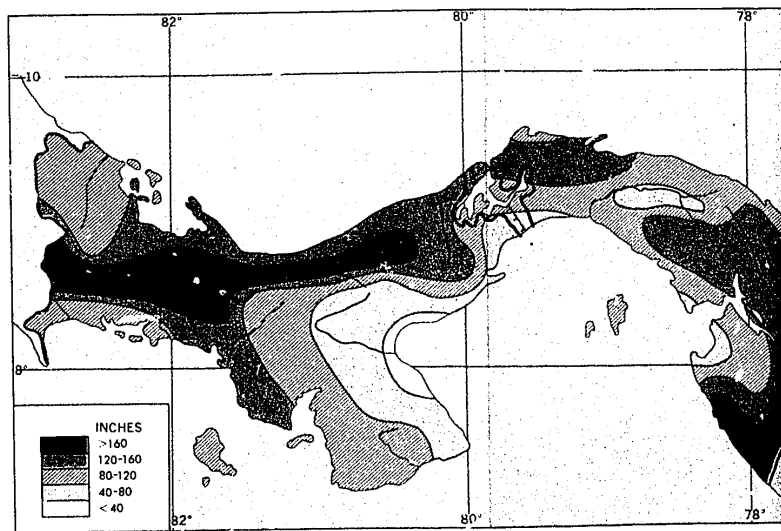


MEAN MONTHLY PRECIPITATION (INCHES)  
\* < 0.25 INCH

LIST OF STATIONS			
STATION	LATITUDE*	LONGITUDE*	ELEV. (FT.)
ALBROOK AIR FORCE BASE	8°58'N	79°34'W	53
BALBOA HEIGHTS	8°58'N	79°33'W	100
BOCA DE CUPE	8°02'N	77°36'W	100**
BOCA DE TOABRE	8°56'N	80°32'W	300**
CERRO PUNTA	8°52'N	82°38'W	6,110
CHANGUINOLA	9°29'N	82°29'W	16
COLON	9°22'N	79°54'W	13
CRISTOBAL	9°21'N	79°55'W	40
DAVID	8°23'N	82°27'W	62
EL PALMAR	8°32'N	81°04'W	1,900**
ISLA DEL REY	8°14'N	78°55'W	15
JAQUE	7°32'N	78°10'W	18
NARGANA	9°29'N	78°31'W	10
POCRI	7°44'N	80°09'W	40
RIO HATO	8°26'N	80°07'W	73
SONA	8°01'N	81°19'W	800**

\*COORDINATES GIVE LOCATION OF WEATHER STATIONS AND DO NOT NECESSARILY CORRESPOND TO THOSE FOR POPULATED PLACES.

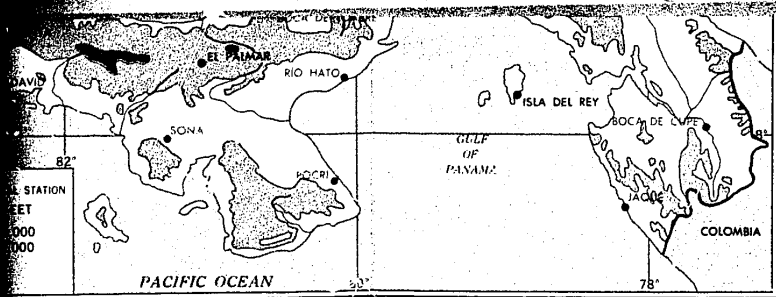
\*\* APPROXIMATE ELEVATION



MEAN ANNUAL PRECIPITATION (INCHES)

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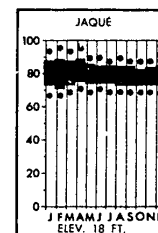
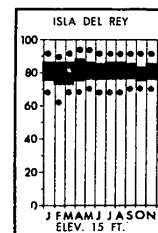
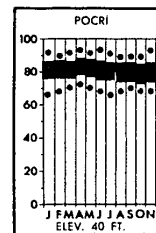
STATION LOCATIONS

LIST OF STATIONS

STATION	LATITUDE*	LONGITUDE*	ELEV. (FT.)
ALBROOK AIR FORCE BASE	8°58'N	79°34'W	53
BALBOA HEIGHTS	8°58'N	79°33'W	100
BOCA DE CUPE	8°02'N	77°36'W	100**
BOCA DE TOABRÉ	8°56'N	80°32'W	300**
CERRO PUNTA	8°52'N	82°38'W	6,110
CHANGUINOLA	9°29'N	82°29'W	16
COLÓN	9°22'N	79°54'W	13
CRISTOBAL	9°21'N	79°55'W	40
DAVID	8°23'N	82°27'W	62
EL PALMAR	8°32'N	81°04'W	1,900**
ISLA DEL REY	8°14'N	78°55'W	15
JAQUE	7°32'N	78°10'W	18
NARGANA	9°29'N	78°31'W	10
POCRI	7°44'N	80°09'W	40
RIO HATO	8°26'N	80°07'W	73
SONA	8°01'N	81°19'W	800**

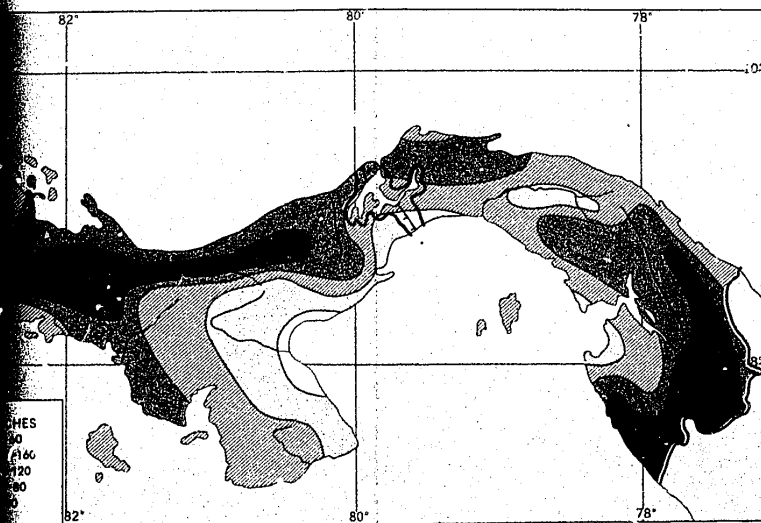
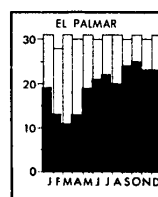
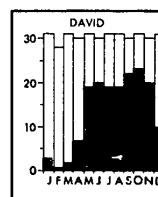
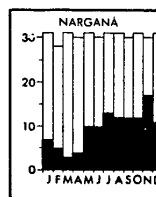
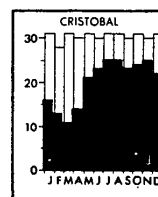
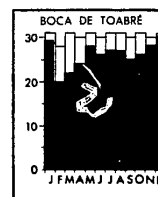
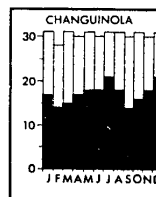
\*COORDINATES GIVE LOCATION OF WEATHER STATIONS AND DO NOT NECESSARILY CORRESPOND TO THOSE FOR POPULATED PLACES.

\*\* APPROXIMATE ELEVATION



TEMPERATURES (°F.)

• ABSOLUTE MAXIMUM  
 ■ MEAN DAILY MAXIMUM  
 ■ MEAN DAILY MINIMUM  
 • ABSOLUTE MINIMUM



MEAN ANNUAL PRECIPITATION (INCHES)

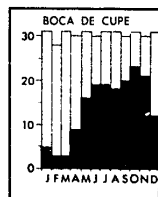
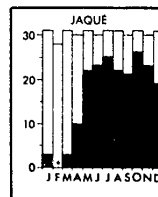
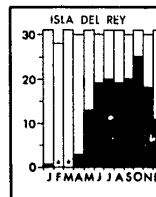
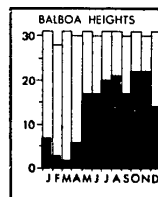
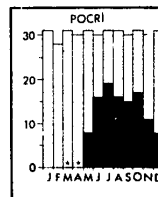
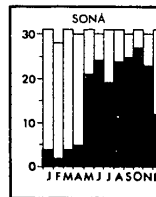
MEAN NUMBER OF DAYS WITH PRECIPITATION  $\geq 0.01$  INCH  
 \* < 0.5 DAY

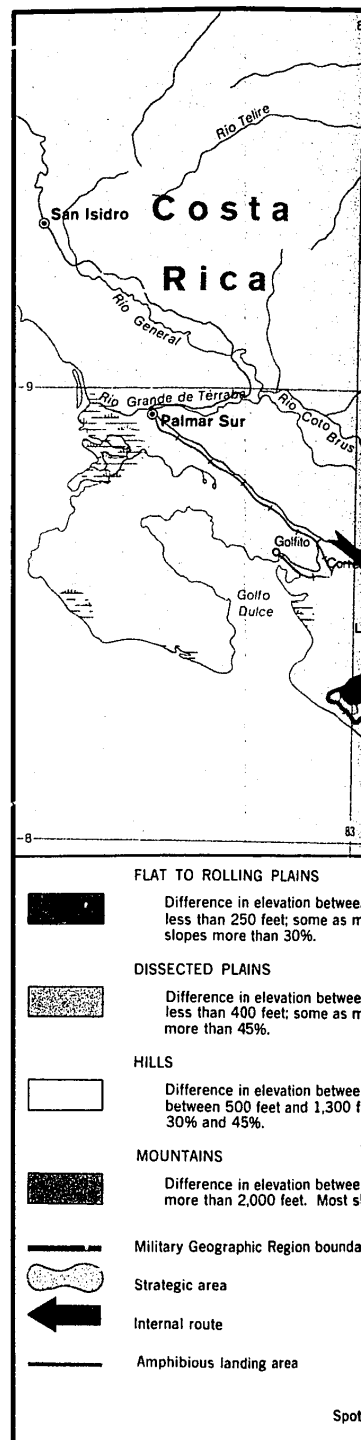
FIGURE MG-1. VARIATIONS OF CLIMATIC ELEMENTS

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Climatic Data Figure 9

## Places and features referred to in this chapter (u/ou)

	COORDINATES			
	°	'N.	°	'W.
Aguadulce.....	8	15	80	33
Azuero, Península de ( <i>pen</i> ).....	7	40	80	35
Bahía Las Minas ( <i>bay</i> ).....	9	24	79	50
Balboa.....	8	57	79	34
Canal Zone ( <i>leased zone</i> ).....	9	10	79	48
Colón.....	9	22	79	54
Corredor, Costa Rica.....	8	39	82	57
Cristobal.....	9	21	79	55
David.....	8	26	82	26
Las Palmas, Península de ( <i>pen</i> ).....	7	50	81	25
Panama Canal ( <i>navigation canal</i> ).....	9	20	79	55
Panama City.....	8	58	79	32
Puerto Armuelles.....	8	17	82	52
Río Chepo ( <i>strm</i> ).....	9	00	79	06
Río Hato.....	8	23	80	10
Río Sixaola ( <i>strm</i> ).....	9	34	82	34
Santiago.....	8	06	80	59
<b>Airfields</b>				
Tocumen International.....	9	05	79	23

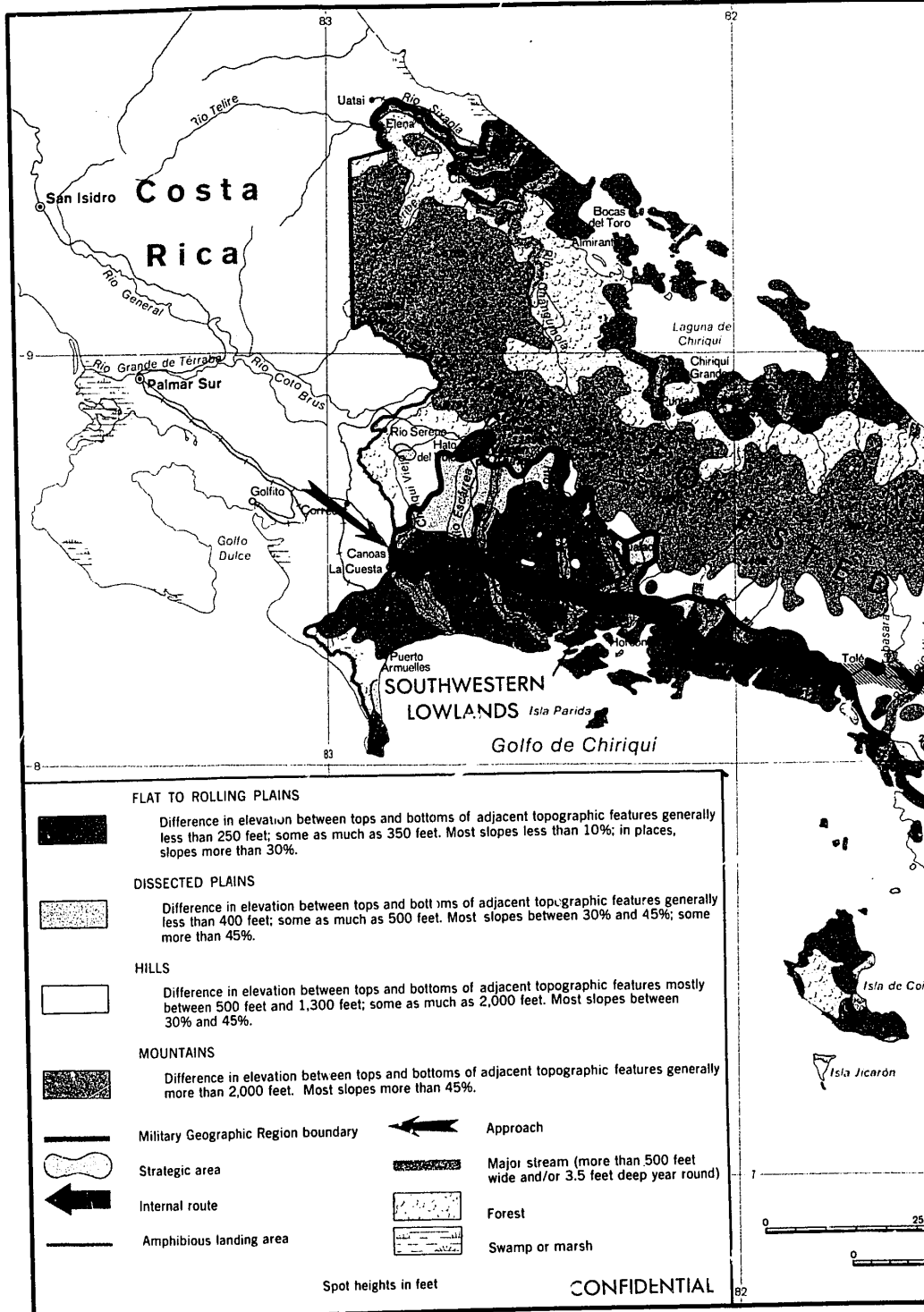


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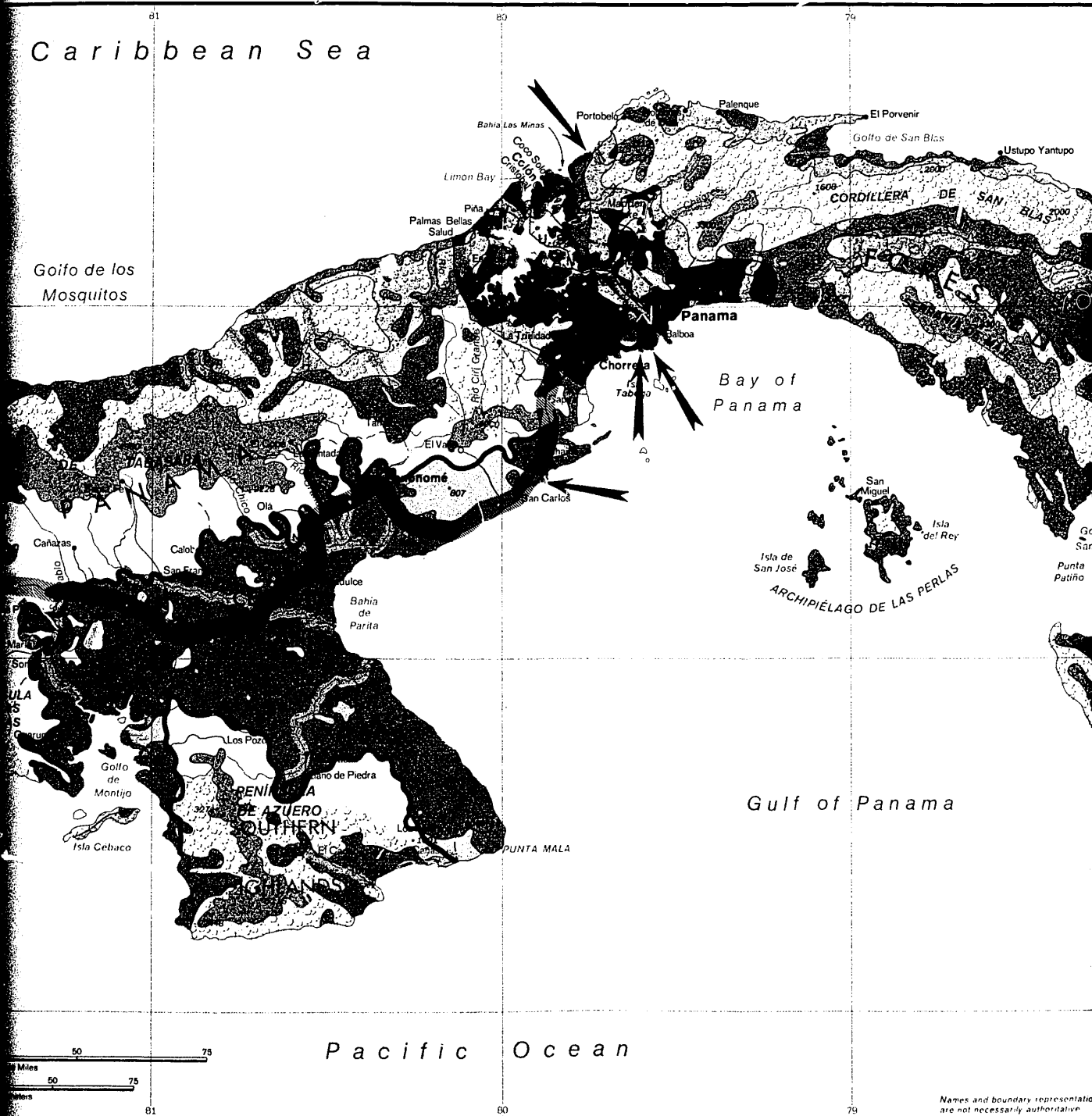


referred to in this chapter (u/ou)

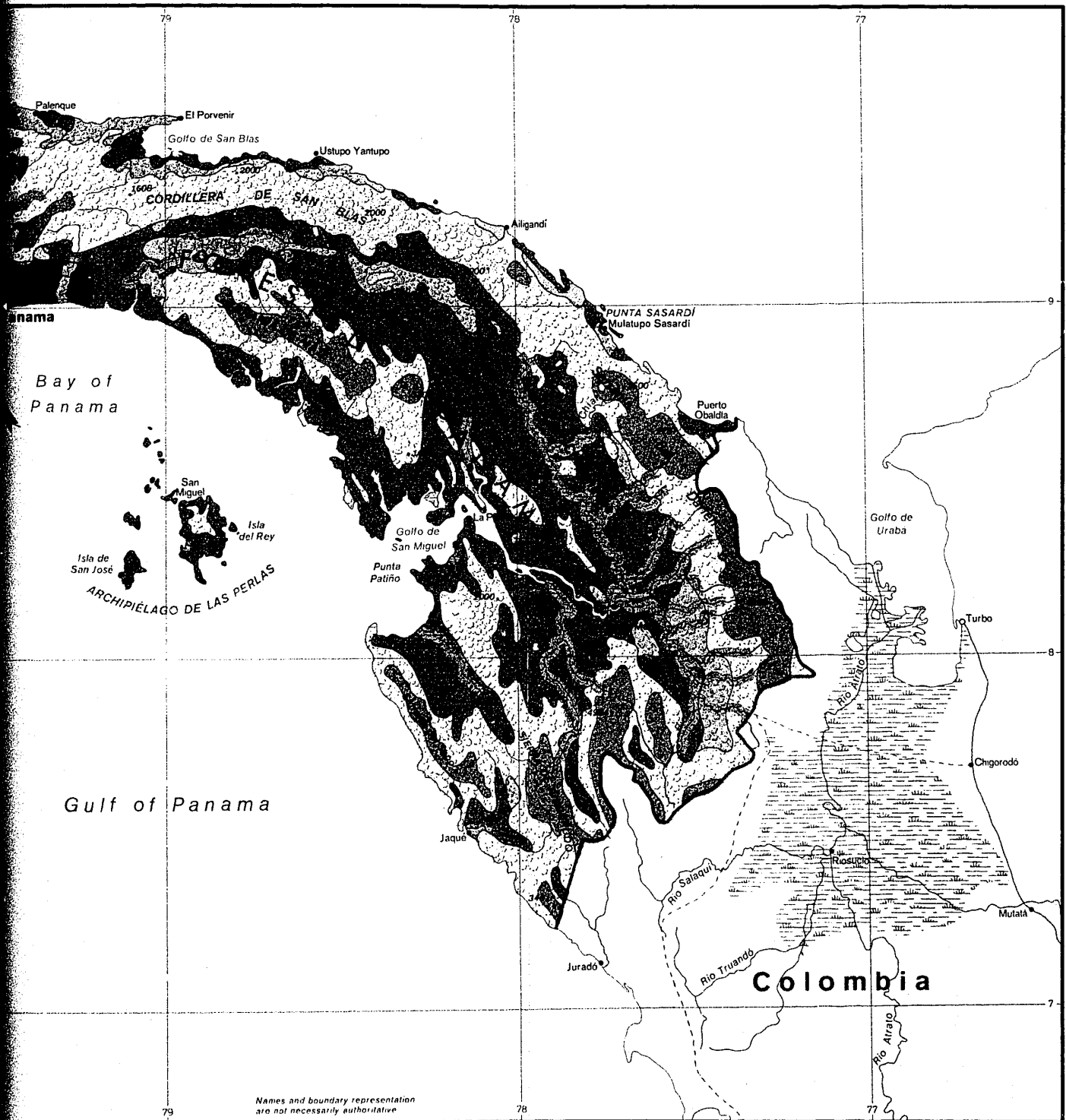
COORDINATES		
	° 'N.	° 'W.
.....	8 15	80 33
en) .....	7 40	80 35
.....	9 24	79 50
.....	8 57	79 34
.....	9 10	79 48
.....	9 22	79 54
.....	8 39	82 57
.....	9 21	79 55
.....	8 26	82 26
le (pen) .....	7 50	81 25
ion canal) .....	9 20	79 55
.....	8 58	79 32
.....	8 17	82 52
.....	9 00	79 06
.....	8 23	80 10
.....	9 34	82 34
.....	8 06	80 59
<b>Airfields</b>		
.....	9 05	79 23



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Military Geographic Factors Figure 10