PHYSICAL ASPECTS AND NATURAL RESOURCES OF THE PHILIPPINES

BY

TELESFORO W. LUNA, JR.

The 7,100 islands and rocks which form the Philippines constitute a portion of the long line of island arcs that lie on the southeastern and eastern margins of Asia. The fragmented shape of the country is both an asset and a liability. The various islands, in particular the major ones, can be easily linked by an inexpensive system of water transportation. On the other hand, the lack of an efficient and adequate water transportation makes economic integration difficult.

Thirty-one islands with areas of 100 square miles or more account for 96 per cent of the total land area of 115,600 square miles. Most of the other islands are high, barren masses of rocks and uninhabited. Luzon with 40,420 square miles and Mindanao with 36,527 square miles are the two major islands. Nine other islands have areas between 1,000 and 6,000 square miles. These, in order of size, are Samar, Negros, Palawan, Panay, Mindoro, Leyte, Cebu, Bohol and Masbate.

TOPOGRAPHIC FEATURES

The principal topographic features are north-south trending mountain ranges. There are also several distinctive structural lines found in the southern and central islands which merge in southern Luzon.

Luzon — The island of Luzon consists of three north-south trending ranges with two intermediate lowland belts. From west to east, the ranges are the Western Cordillera, the Central Cordillera and the Sierra Madre Mountains, and the lowland areas are the Central Plain and the Cagayan Valley.

The Western Cordillera is characterized by steep slopes, deep ravines and peaks up to 6,500 feet or higher. Hills and tablelands border it in the north, irregular belts of rolling foothills and ridges in the east merging with the Central Plain, a narrow coastal plain in the west and rough hills that extend to the Bataan Peninsula in the south.

The Central Cordillera is a rugged, irregular pattern of ridges, canyons and peaks above 8,000 feet in elevation. It has a north-south trend and extends from about the center of Luzon northward for 170 miles. Intermontane valleys and uplands are formed within the range; the best known being the Trinidad Valley and the Baguio Upland region. A narrow coastal plain is also found along its northwestern margin.

The Sierra Madre Mountains with peaks ranging from 4-5,000 feet is almost unbroken by corridors or low passes throughout its entire length of 350 miles. The southernmost extension of the range is the Bondoc Peninsula where the hills are low and rolling. Along its eastern portion are narrow, rocky beaches and plains a few hundred yards in width.

An almost level plain rising only a few feet above sea level, the Central Plain extends from Manila Bay northward to Lingayen Gulf. A low divide near Tarlac, Tarlac with an elevation of 150 feet diverts the drainage northward and southward. Several peaks rise abruptly from the plain; the most prominent is Mt. Arayat, 3,367 feet high.

The Cagayan Valley is a structural depression whose western side is bordered by a fault. The floor of the valley is extensively covered by alluvium deposited by the floods of the Cagayan River. The northern end of the valley opens up to the sea while the southern end merges with the Caraballo Mountains which links the Central Cordillera and the Sierra Madre Mountains.

Other prominent features of Luzon are the Southwest Volcanic Upland and the Bicol Peninsula.

The Southwest Volcanic Upland consists essentially of a tuff covered plain from which arise a series of volcanic peaks. The more important are Mt. Maquiling (3,775 feet), Mt. Banahao (6,210 feet), Mt. San Cristobal (4,946 feet) and Mt. Banahao de Lucban (6,019 feet). Taal Volcano which is only 1,000 feet above sea level is formed at the center of Taal Lake, a crater lake of a formerly much larger volcano. Smaller crater lakes and cinder cones are scattered throughout the area.

The Bicol Peninsula consists of a main synclinal basin trending northwest. It separates a series of active and extinct volcanoes in the northeast and east from a belt of hills in the southwest. The synclinal basin is divided by a low divide into a northern section, the Naga Plain and a southern section, the Legaspi Plain. The line of volcanoes that makes up the irregular northeast and east ranges includes from south to north Mt. Mayon (7,989 feet), Mt. Iriga (3,946 feet), and Mt. Isarog (6,530 feet). Mt. Mayon, a symmetrical cone of lava and agglomerate, is periodically active emitting ash, cinder and lava.

Visayas — Many of the islands in the Visayas are the eroded crests of anticlines which appear above the water and the straits between the islands are occupying synclines. Mountainous cores bordered by narrow coastal plains are characteristic of several of the islands. Others have a central lowland area rimmed by highlands on two or three sides. The mountains in all of the islands are generally rough and commonly very steep and deeply dissected. Extinct and active volcanoes are scattered throughout; some rise above dissected mountain ranges while others are set on coastal plains.

Panay shows three distinct topographic divisions. These are the Western Cordillera, the Central Lowlands and the Eastern Uplands. The Western Cordillera runs parallel to the west coast for about 80 miles in a north-south direction. It is about 15 miles wide at the center but narrows northwards and southwards. The maximum elevation is reached in Mt. Nangtud (6,722 feet). Bordering the range on the west is a narrow coastal plain which attains its widest area around San Jose, Antique. The Central Lowlands is a belt of rolling land 15-20 miles wide stretching through the center of the island. To the southeast it broadens into the Iloilo Basin while it merges into small coastal plains to the north. The Eastern Uplands, with a northeast-southwest direction, extends for about 35 miles. At certain points the range approaches close to the coast while at other points small coastal plains like the Sara Basin separate it from the sea.

The main range in Negros found along the east coast is deeply dissected and eroded. It is flanked on the west side by a high chain of recent volcanoes from which volcanic ash and other materials covering the west plain have been ejected. The quantity of volcanic materials diminishes toward the southern part of the plain. This section is covered by alluvium brought down from the central range. The southern part of Negros is made up of a chain of volcanic peaks and the Tablas plateau region. The highest peak is Cuernos de Negros (6,245 feet). The plateau ranges from 2,000 to 3,000 feet in elevation. The Western Plain extends northward from the edge of the Tablas Plateau along the west and north coasts for 100 miles and inland for 10-30 miles. It is widest at Bacolod where the plain is densely settled and intensively cultivated. On the north coast the plain becomes swampy. Mt. Canlaon (8,088 ft.), the highest peak in Negros, is found in the main range known as the Northern Highlands which lies close to and parallels the east coast for about 90 miles.

Cebu is an elongated island trending in a northeast-southwest direction. The principal topographic feature is a mountainous backbone that extends from one end of the island to the other. It is divided into two parts by a low pass near Carcar. The northern section is some-

what wider than the southern portion with maximum elevations of about 3,325 feet. The southern part is much lower; elevation reaches up to only 2,900 feet. The central range is steep and quite rugged. Surrounding uplands intermediate in elevation to the central range and the coastal plains are less steep and rugged. The largest of the coastal lowlands is found around Medellin at the northern end of the island. On the east coast, the most extensive lowlands are found around Cebu City and Carcar. There are no large rivers in Cebu. All of them are short with steep slopes except in the areas where they cross the coastal plains.

The central part of Bohol is relatively flat. On the west and east coasts, northeast-southwest trending ranges with elevations up to 2,640 feet drop off steeply to the coasts. Bohol is essentially a broad southward dipping syncline with major anticlines developed on the eastern and western borders.

Leyte has a rugged mountainous backbone. This range is almost continuous from north to south except for a low pass found at the island's narrow waist. East of the mountainous center is a lowland area that extends from Carigara Bay in the north to Leyte Gulf in the south. West of the central range the lowland areas are much more limited in extent. Elevation of the peaks on the central range averages 2,310 to 3,630 feet.

Samar, the easternmost island of the Visayan group, is more of a hilly country than a mountainous one. There are no major lowland areas and even the coastal plains are very much limited in extent. Slopes, however, are not too steep as to prevent their being used for cultivation purposes.

Masbate marks the junction of two prominent structural trends. The two arms of the island are roughly linear ranges of low but rugged mountains. The maximum elevation of the western range is about 1,980 feet and the northeastern range, 2,310 feet. Broad plains and rolling hills are found in the southeastern part of the island as well as in the northeast.

Mindoro is a broad anticline with relatively extensive lowlands along the east and northeast coasts. The central part is made up of rugged mountains which extend over the entire length of the island. Mount Baco at the center rises up to 8,200 feet while Mt. Halcon in the north reaches up to 8,260 feet.

Palawan forms a chain of islands resting on a great reef strewn bank along the northwest margin of the Sulu Sea. It constitutes an interrupted land bridge about 450 miles long from North Borneo to

Mindoro. Palawan Island proper is mountainous and hilly throughout its entire length with narrow coastal plains. Rivers are short and generally flow in deep, narrow valleys with small flood plains.

Mindanao — In Mindanao, major topographic features consist of high, rugged mountain ranges, isolated volcanic peaks, plateau areas of moderate elevations and low swampy valley areas.

There are several major mountain ranges which are complex structural mountains, volcanic mountains or a combination of both. The complex structural mountains are: (1) the Diwata Mountains which stretch along the eastern parts of Surigao, Agusan and Davao, (2) the Central Range which extends throughout the length of Mindanao from Diwata Point in the north to Tinaca Point in the south, and (3) the mountain ranges which form the backbone of Zamboanga Peninsula. These ranges have an average elevation ranging from 2,200 to 3,300 feet, although some peaks attain heights of 6,000 feet.

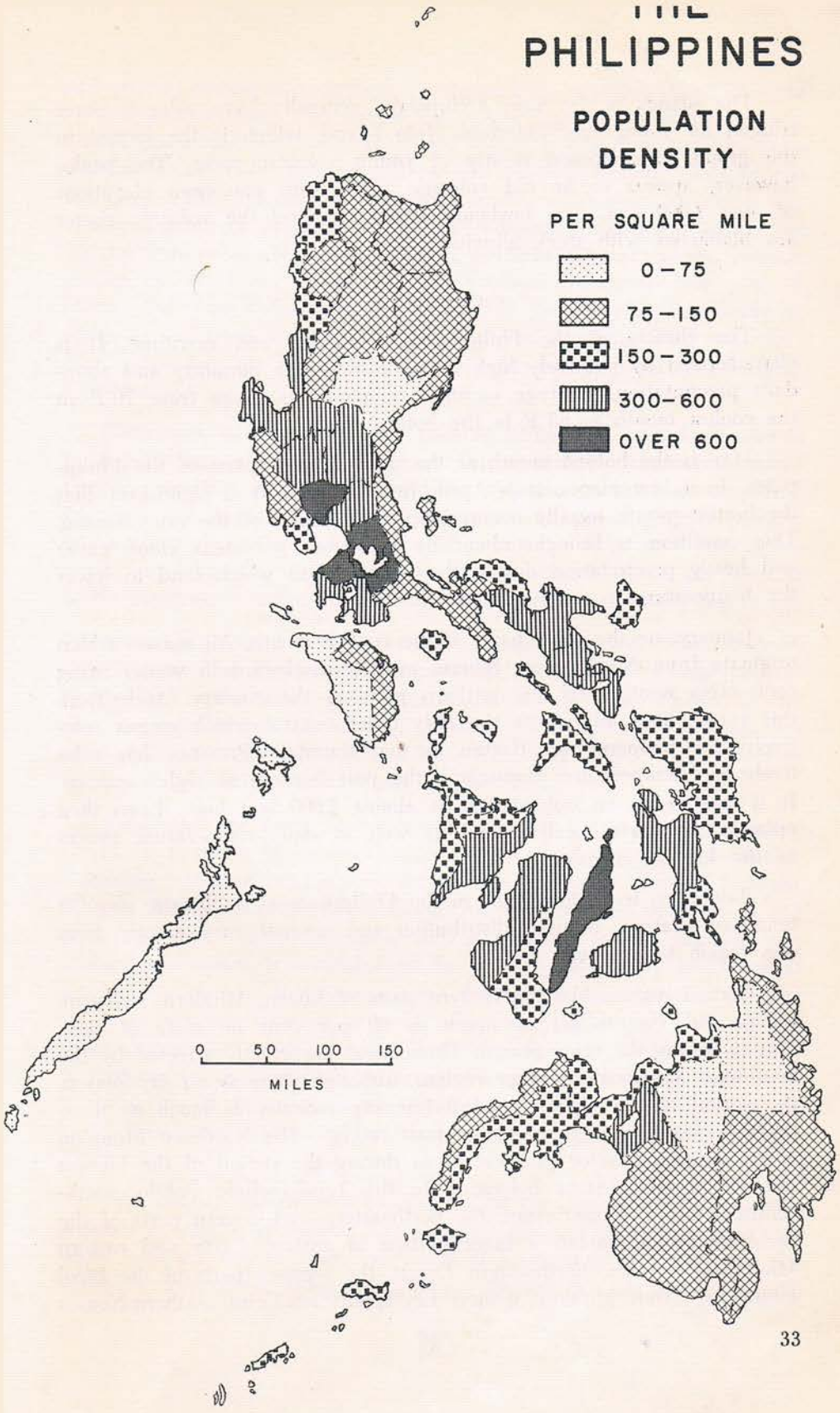
The volcanic mountains have no distinct trends. They occur in clusters or groups or as individual peaks and are fairly distributed throughout Mindanao. In some places, they are closely associated with structural mountains. Mt. Apo, nearly 10,000 feet high, is found in the southern part of the Central range where the northern part is structural. Mt. Apo, an active volcano, is the highest peak in the Philippines.

Plateaus form another prominent topographic feature. The best known is the plateau region found in northern Bukidnon and Lanao del Norte. Generally rolling with elevations ranging from 1,980 to 2,300 feet, it is formed by basaltic lava flows interbedded with ash and tuff deposits as well as water deposited sandstone and conglomerate.

There are two major lowlands areas in Mindanao. The Agusan Valley in the east lies between the Central Range and the Diwata Mountains. It is a broad syncline, wide and swampy extending throughout Agusan. The other is the Cotabato Valley drained by the Mindanao River and its tributaries in southwest Mindanao. The north central part of the valley, like the Agusan Valley, is swampy.

Lake Lanao which drains most of Lanao is one of the largest lakes in the Philippines. It covers an area of approximately 350 square miles and has an elevation of 2,200 feet.

Basilan Island off the southern tip of Zamboanga Peninsula is composed mostly of young volcanics, notably basalt. The numerous peaks on the island are visible as volcanic cones with Basilan Peak (3,317 feet) as the highest. Undulating to rolling lowlands covered with alluvium of fine silt and numerous basaltic boulders surround the volcanic core.


THE
PHILIPPINES
POPULATION
DENSITY
PER SQUARE MILE
0 – 75
75 – 150
150 – 300
300 – 600
OVER 600
0 50 100 150
MILES

The islands in the Sulu Archipelago generally have volcanic cores fringed by young reef limestone. Jolo Island, which is the largest in the group, is composed mostly of young volcanic rocks. The peaks, however, appear to be old volcanic cones with maximum elevations of over 2,000 feet. The lowlands which surround the volcanic center are blanketed with thick alluvium.

CLIMATE

The climate of the Philippines is tropical and maritime. It is characterized by relatively high temperatures, high humidity and abundant precipitation. Average monthly temperatures range from 70°F in the coolest month to 85°F in the hottest month.

May is the hottest month of the year in most parts of the Philippines. In a few places, it is April, June or July. It is significant that the hottest month usually occurs before the height of the rainy season. This condition is brought about by the more persistent cloud cover and heavy precipitation during the rainy season which tend to lower the temperature.

January, on the other hand, is the coolest month. Air masses which originate from Northeastern Siberia moving southward in winter bring cool, crisp weather to the northern parts of the country. Aside from this event, high altitude is the only other control which causes relatively low temperatures. Baguio in the Mountain Province has relatively cool temperatures throughout the year because of high elevation. It is located on an upland that is almost 5,000 feet high. Even then uplands also have small annual as well as daily temperature ranges as the lowland regions.

Rainfall is more important in the Philippines as a climatic element than temperature. Rainfall distribution and amount vary greatly from one region to another.

Certain regions like the western parts of Luzon, Mindoro, Palawan, Panay and Negros get as much as 90 per cent or more of their rainfall during the rainy season. These areas are greatly affected by the Southwest Monsoon. In other regions, although there is no dry season, the period of the highest rainfall intensity receives as much as three times or more than the period of least rainfall. The Northeast Monsoon is an important factor in these areas during the period of the highest rainfall intensity. Areas belonging to this type include Polillo, south-central Quezon, Catanduanes, the northeastern and eastern parts of the Bicol Peninsula, Samar, a large portion of eastern Leyte and eastern Mindanao. Batanes, northeastern Luzon, the western parts of the Bicol Peninsula, eastern Mindoro, western Leyte, northern Cebu, northern Negros

and central, eastern and southern Mindanao have no pronounced seasonal rainfall concentration. The rest of the country experience no pronounced rainfall maximum but has a short dry season lasting from one to three months. Areas under this rainfall pattern are the western parts of the Cagayan Valley (Cagayan through Isabela to Nueva Vizcaya), the eastern portion of Mountain Province, southern Quezon (including the Bondoc Peninsula), Masbate, Romblon, northeast Panay, eastern Negros, central and southern Cebu, parts of Northern Mindanao and most of eastern Palawan. These areas are affected in part only by the Northeast Monsoon and trade winds because of sheltered locations. They are, however, exposed to the full effects of the Southwest Monsoon and frequent typhoons.

Variations in the rainfall pattern arise principally from local causes. In the Philippines the orientation of the mountain ranges and coastlines is important. During the Northeast Monsoon in the low-sun period (winter), the areas on the east coast have heavy orographic precipitation although in the high-sun period (summer) these areas are by no means dry. On the west coasts, very high rainfall totals are brought by the Southwest Monsoon in summer but the winter half of the year is dry.

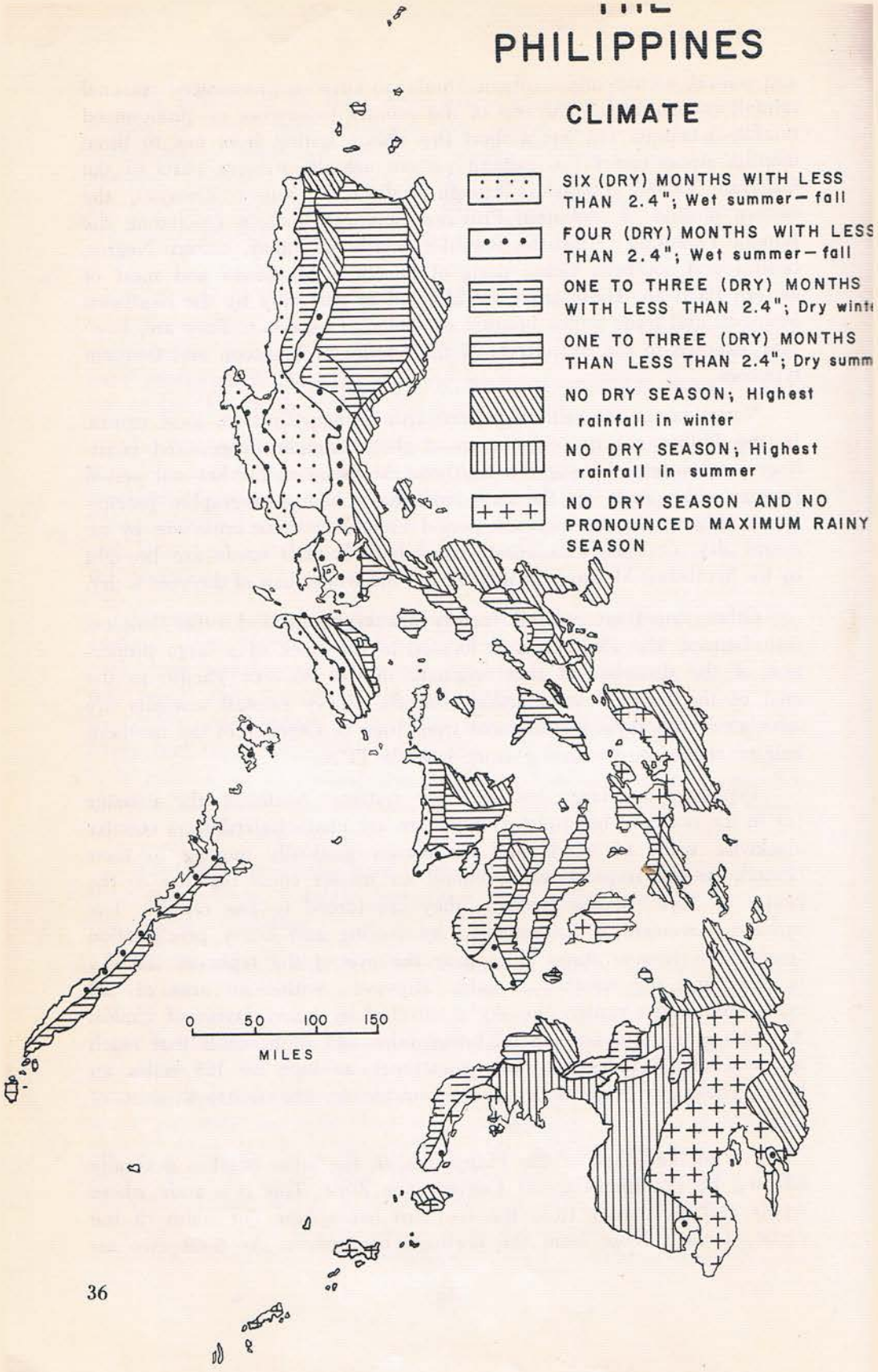
Other important rainfall factors are typhoons and other tropical disturbances. The Philippines is located in the track of a large proportion of the disturbances that originate in the Western Pacific in the area of the Caroline or Marshall Islands. Heavy rainfall amounts are associated with these disturbances from June to October in the northern half of the country starting from latitude 11°N.

Typhoons are large low pressure systems. North of the equator (or in the northern hemisphere) typhoons are characterized by a counter clockwise whirl of winds and air masses gradually moving to their centers. As the tropical warm, humid air masses come together to the center or "eye" of the typhoon, they are forced to rise rapidly. The upward movement is accompanied by cooling and heavy precipitation results. For two or three miles near the eye of the typhoon, the sky is clear and the weather is calm. However, within an area of 300 miles around the center, the sky is covered by heavy layers of clouds. A typhoon is, thus, marked by heavy rains and high winds that reach a speed of 75 miles or more, sometimes as high as 125 miles an hour. These two conditions are responsible for the destructiveness of typhoons.

The southern half of the Philippines on the other hand is generally affected by the Inter-tropical Convergence Zone. This is a zone where winds and air masses from the southern hemisphere (or south of the equator) meet those from the northern hemisphere. As these two air

THE PHILIPPINES

CLIMATE



masses which are unstable come together, they are forced to rise. As they rise, they cool and heavy rains, usually accompanied by lightning and thunder, result. Local convections, small cells of rapidly rising air masses caused by constant heating of the land surface as a result of the position of the sun overhead together with local topography also give rise to precipitation pockets that vary from the regional rainfall pattern.

SOILS

The soils in the Philippines may be classified into four different soil groups. These are: (1) Latosols and associated soils developed in mountainous and steeply sloping regions; (2) Latosols and associated soils on lowlands and hills; (3) Alluvial soils; and (4) Grumusols.

Latosols predominate in the tropics as a result of abundant rainfall and high temperatures which greatly facilitate the work of the forces of weathering. Latosols are found on steep slopes as well as in the lowland belts.

Alluvial soils which are deposited by streams arising from upland regions are found exclusively in the lowland areas. These usually form the most important agricultural soils in the Philippines. As a group they are quite fertile and are used more intensively than any other soil group.

Grumusols are usually found on plains and hills in the western and southern parts of the country. These soils are generally difficult to manage due to their heavy texture and tendency toward excessive wetness or dryness.

Philippine soils are generally moderate in fertility. Although climatic conditions tend to promote rapid leaching or removal of plant nutrients from the top soil, the volcanic origin of most soil materials somewhat balances the effects of this process. Volcanic material having been ejected by volcanoes during periods of eruption or simply issued forth quietly as mud or lava flows from the earth's interior are not yet exposed to very long periods of leaching. Hence, soils derived from volcanic materials, compared with other soil groups, are generally more fertile.

VEGETATION

The principal type of vegetation in the Philippines is that of the forest. The forest vegetation consists of mangrove swamps along the coast, tropical rainforests (primary and second growth) in lowlands and lower mountain slopes, pine forests in higher mountain ranges, and mossy forests on the slopes of some of the highest mountains. Trees grow in great variety in the tropical forests. Thus, one usually finds quite a number of different tree species within a certain area

though small it may be. The ground underneath of the tropical rainforests are generally clear of small trees or shrubs since the tangled branches of the trees make it almost impossible for the sun's rays to reach the ground. In secondary forests where the growth is not very heavy and in higher elevations, small trees and shrubs, sometimes mosses, cover the ground. Pine forests are found in Mountain Province and Mindoro. The stands are open and scattered.

A significant part of the Philippines is still covered by tropical rainforests or primary forests. These forests are found in the northern parts of Mountain Province, eastern part of Cagayan, Isabela, Nueva Vizcaya, Quezon, central part of Zambales, Bataan, Camarines Norte and the island of Catanduanes. The central part of Mindoro, the whole of Palawan, parts of Samar, Leyte and Negros are also still covered by these forests. In Mindanao, the mountain range of the peninsula of Zamboanga, northeastern and southeastern Cotabato, northern Davao, Agusan and Surigao del Sur have their share of primary forest growth.

Second growth forests, the result of man's activities, are found in many parts of the Philippines. Whenever the primary forest is cut down, second growth forests result. Properly managed, most of the second growth forests may again provide commercial merchantable timber.

Mangroves, mostly made up of trees with entangling branches and interlacing root systems, occupy a small area. They are found on tidal flats near the mouth of rivers and on muddy shores of protected bays or inlets. Inland mangrove swamps like the Candaba swamps in Central Luzon or the Agusan swamps in Mindanao are also found.

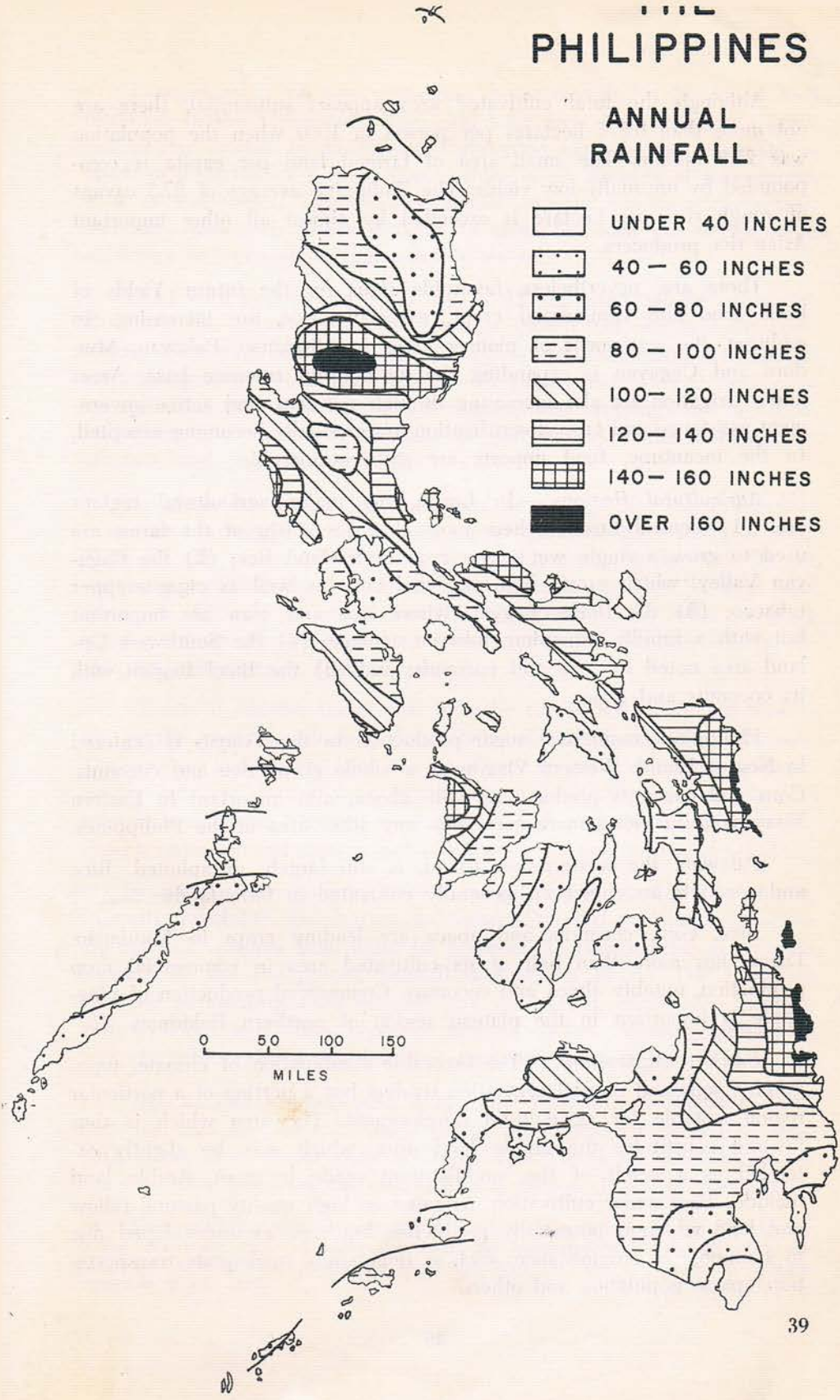
Grasslands called "cogonales" are largely the results of the practice of kaingin or the "cut and burn" method of shifting cultivation. This practice involves the cutting down of trees and brush early in the dry season and then burning them later on. The cleared land is then used for one or two seasons, later abandoned for a new clearing. Since this practice is repeated over and over within a relatively limited area, the grass becomes dominant and permanent.

The soil cover of the Philippines as of now is as follows: commercial or primary forest, 31.35 per cent of the total land area; non-commercial or generally second forest growth, 12.92 per cent; brushland, 6.98 per cent; open land (mostly grass land), 11.44 per cent; marshes and swamps, 2.41 per cent; cultivated land and others, 34.88 per cent.

LAND RESOURCES

Land suitable for agriculture amounts to more than half of the total land surface. At present, approximately 25 per cent is under cultivation including a relatively small area in pastures.

THE PHILIPPINES



Although the total cultivated area appears substantial, there are not more than 0.276 hectares per person in 1960 when the population was 27.5 million. The small area of farmed land per capita is compounded by unusually low yields. The Philippine average of 27.5 cavans of rough rice per hectare is exceeded by almost all other important Asian rice producers.

There are, nevertheless, favorable signs for the future. Yields of basic food and commercial crops, especially rice, are increasing. In addition, the settlement of pioneer areas in Mindanao, Palawan, Mindoro and Cagayan is expanding the agricultural resource base. Areas under irrigation are also increasing through self-help, and active government assistance and crop diversification are gradually becoming accepted. In the meantime, food imports are still considerable.

Agricultural Regions. — In Luzon, the major agricultural regions are: (1) Central Luzon, where more than four-fifths of the farms are used to grow a single wet-season crop of lowland rice; (2) the Cagayan Valley, which grows both rice and corn as well as cigar-wrapper tobacco; (3) the Ilocos Region, where rice and corn are important but with a rapidly expanding tobacco acreage; (4) the Southwest Upland area noted for rice and coconuts; and (5) the Bicol Region with its coconuts and abaca.

Philippine commercial sugar production in the Visayas is centered in Negros Island. Western Visayas as a whole grows rice and coconuts. Corn and coconuts predominate with abaca, also important in Eastern Visayas. Cebu grows more corn than any other area in the Philippines.

Palawan, the westernmost island, is still largely unexploited. Rice and coconuts are, however, generally cultivated in farm lands.

Rice, corn, coconuts and abaca are leading crops in Mindanao. Davao has more than half of its cultivated area in commercial crop production, notably abaca and coconuts. Commercial production of pineapple is important in the plateau region of northern Bukidnon.

Basis of Agriculture. — The favorable combination of climate, topography, soils and natural vegetation renders but a portion of a particular region suitable for agricultural development. The area which is thus favored constitutes the arable land area, which may be slightly extended as a result of the modifications made by man. Arable land includes land under cultivation, irrigated or high quality pasture, fallow and land which is potentially productive but remains undeveloped due to a number of circumstances such as remoteness, inadequate transportation, sparse population and others.

Topography is the most important factor that limits the use of land resources in the Philippines. The total land area with desirable surface contours is limited by landforms. Cultivation can only be extended so much in a particular region. Slope, which is an element of topography, is a critical factor. Steep slopes almost entirely eliminate cultivation. Not only are steep slopes difficult to farm but also the development of severe soil erosion is unnecessarily risked.

Land with slopes from 0 per cent to 12 per cent* can be cultivated. However, the upper slope limits require special soil management techniques. Terracing, contouring, strip cropping are recommended as special soil management procedures. Land with slopes over 12 per cent must be cultivated only if adequate soil management programs are provided. Otherwise, the natural cover must be left intact as the susceptibility of such land to erosion is high.

Based on the above limits imposed by topography, the Philippines is neither too rugged nor is it made up of extensive level tracts of land. Thus, of the total land area of the Philippines, a little over 50 per cent may constitute land of agricultural or arable quality. If level land which is difficult to drain and highly porous areas with resulting rapid permeability are added to steeply sloping land, the land available for cultivation is further reduced.

Climate is another factor that must be considered in the determination of the extent to which land can be used and capable of production. Temperature and precipitation are significant elements of climate. Temperature, however, is not very significant in the Philippines as there is very little variation between the coldest month and the warmest month. Frost is unknown and even in high elevation it is a rare occurrence, if at all.

In comparison to temperature, rainfall is of greater importance. Intensity, reliability, distribution and seasonality, and total annual amount are rainfall features that must be considered. Due to the geographic location of the Philippines, rainfall intensity is heavy. The processes involved in creating such intensity are convection, orographic barriers, and typhoons and other types of tropical storms. These processes in turn also affect rainfall distribution, seasonality, and total annual amounts.

High rainfall intensity and steep slope conditions combine to limit the area that can be cultivated. Under heavy rainfall conditions land with slopes from 0 per cent to 3 per cent (level to undulating) are not altogether free from the effects of soil erosion. However, soil erosion

* Slope conditions can be expressed either in degree or in per cent. The former is the calculated angle of inclination from the horizontal while the latter is the calculated difference in height for each one hundred feet of measured distance expressed in per cent.

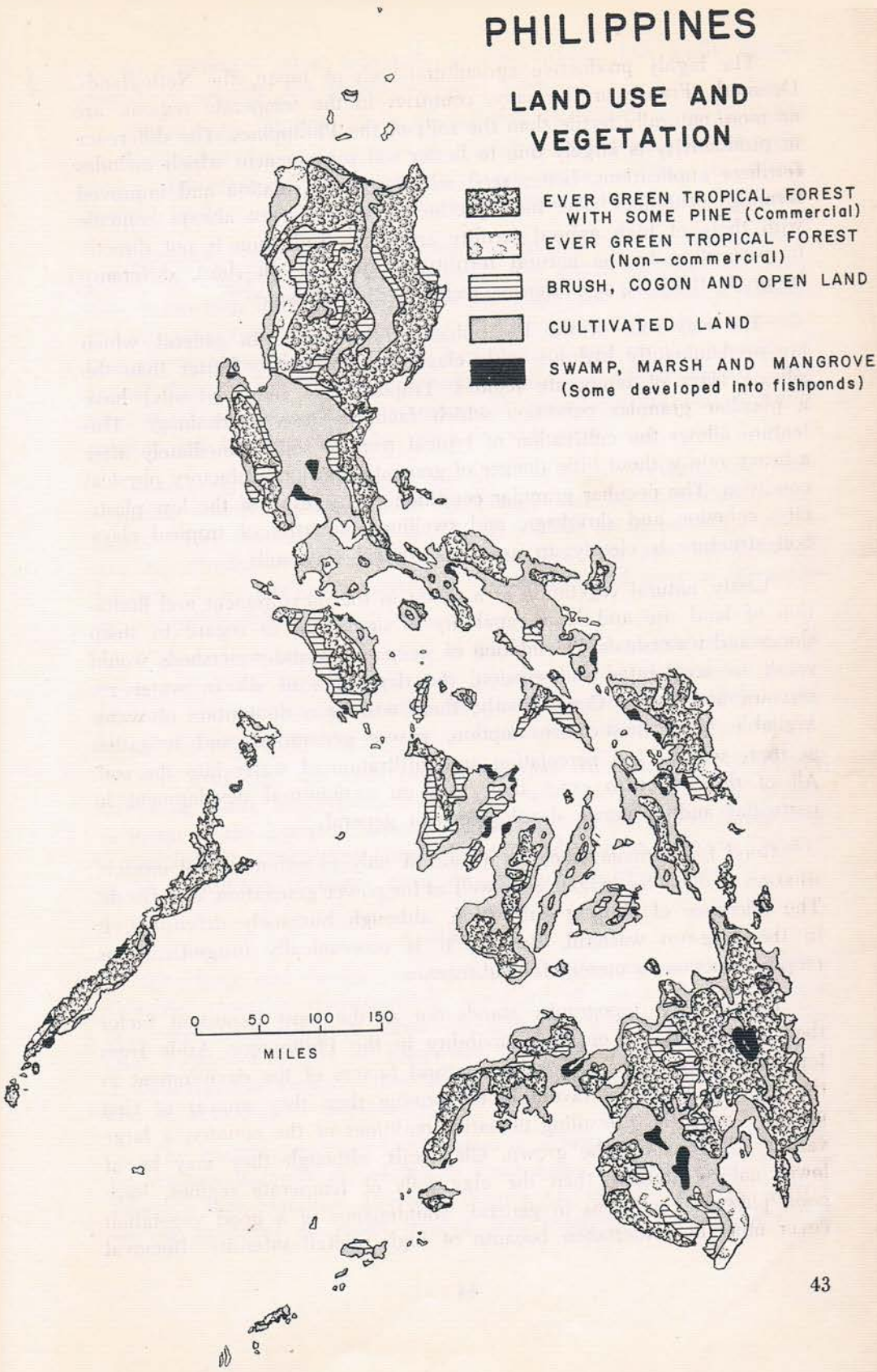
is much more marked in areas with slopes of 12 per cent or more where precautionary measures such as terracing, contouring, and strip cropping are not provided for. In the Philippines where soil management programs are inadequate or lacking, soil erosion is significant. The areas of sufficient slope (12 per cent or over) which have been, one way or the other, subjected to shifting cultivation with resulting badland topography or barren slopes are grim reminders of the lack of good soil management.

Occasionally rainfall may be delayed or there may be too little for a given year. However, no part of the Philippines is rendered unavailable for agricultural development due to scanty rainfall. An analysis of rainfall data shows that rainfall varies only by 12 to 15 per cent above or below the calculated average from year to year; the western parts of Luzon, Mindanao, West Visayas, and Palawan are experiencing a greater rainfall variation than the rest of the country.

Distribution and seasonality of rainfall are essential. In the Philippines, the rainfall maximum occurs during the warmest months. Such an occurrence is generally in accord with the processes of precipitation. Furthermore, maximum precipitation occurring during the warmest months of the year makes up also for the increased loss of water through evapotranspiration. Increased evapo-transpiration during this period is the result of high temperatures and transpiration by plants as it is also the cropping season.

In a further analysis of land use or land capability, soil as a limiting factor must be studied from the point of view of natural fertility, depth, texture, structure, water holding capacity and drainage. Not a few persons are inclined to believe that tropical soils are poor. Poor in natural fertility? Perhaps. Poor in structure? Least likely. The basis of the common argument in regard to the poverty of tropical soils is supposedly the marked development of leaching brought about by high temperatures and high precipitation amounts.

Leaching of the soil is accomplished only during the wet season when precipitation is at its peak. In the part of the Philippines where there is a distinct wet and dry season, leaching is not a continuous process. Moreover, loss of valuable plant nutrients is not only caused by leaching but also as a result of intensive and constant cropping. Crops utilize minerals for growth and development. Thus, constant cropping without mineral replenishment through the application of chemical fertilizers and organic matter poses more as a problem in the impoverishment of the soil as well as in the deterioration of the soil structure, texture, water holding capacity and drainage.


PHILIPPINES
LAND USE AND VEGETATION
EVER GREEN TROPICAL FOREST WITH SOME PINE (Commercial)
EVER GREEN TROPICAL FOREST (Non-commercial)
BRUSH, COGON AND OPEN LAND
CULTIVATED LAND
SWAMP, MARSH AND MANGROVE (Some developed into fishponds)
0 50 100 150
MILES

The highly productive agricultural soils of Japan, the Netherlands, Denmark, France or Germany, countries in the temperate regions, are no more naturally fertile than the soils of the Philippines. The difference in productivity is largely due to better soil management which includes fertilizer applications, better seed selection, crop rotation and improved farming techniques. The most productive soils do not always coincide with those of high natural fertility and that production is not directly in proportion to the natural fertility of the soil. In short, difference in productivity is a matter of technological efficiency.

The clay soils of the Philippines or the tropics in general, which are predominantly hydrous oxide clays, are structurally better than the silicate clays of temperate regions. Tropical clay soils (latosols) have a peculiar granular condition which facilitate internal drainage. This feature allows the cultivation of typical tropical soils immediately after a heavy rain without little danger of generating an unsatisfactory physical condition. The peculiar granular condition is the result of the low plasticity, cohesion and shrinkage, and swelling properties of tropical clays. Soil structure is clearly an asset of tropical clay soils.

Lastly, natural vegetation as a factor in the measurement and limitation of land use and land capability is significant in regard to steep slopes and watersheds. Denudation of steep slopes and watersheds would result in accelerated soil erosion, the deposition of silt in water reservoirs, and floods. Consequently, there will be a diminution of water available for domestic consumption, power generation, and irrigation as there will be less percolation and infiltration of water into the soil. All of these in turn exact their tolls on agricultural development in particular and economic development in general.

Good forest management is a must if only to minimize soil erosion, siltation of dams for irrigation as well as for power generation, and floods. The tolerance of shifting cultivation, although humanely defensible, is in the long-run wasteful. Besides, it is economically insignificant as crop production is merely for subsistence.

In summary, topography stands out as the most important factor that limits land use or land capability in the Philippines. Aside from topography, the other physical or natural factors of the environment in the country are more favorable to farming than they appear at first glance. Under the prevailing climatic conditions of the country, a large variety of crops can be grown. Clay soils, although they may be of lower natural fertility than the clay soils of temperate regions, have good physical conditions in general. Maintenance of a good vegetation cover must be undertaken because of high rainfall intensity. Removal

of the vegetation cover especially in steep slopes can easily induce severe soil erosion and floods in lower areas.

Productivity, however, is not altogether the result of a favorable combination of the physical factors but also due to an efficient technology and management program. But one thing is clear, the extent to which land can be used is still very much influenced by the environment.

Livestock Production. — The raising of livestock is not an important activity in the Philippines except for a few cattle ranches and some dairy farms near the larger urban centers. There are, however, a number of factors that favor the development of a much larger livestock industry. Climatic conditions in the Philippines do not require the storage of animal food unlike countries where there is a winter period. The relatively high and uniform temperatures throughout the year make it possible for breeding to take place at any time.

Natural grasslands, though, are not nutritious. Nevertheless, with adequate water resources, these grasslands can be scientifically improved. More nutritious grasses with high feeding or supporting capacity can be introduced. Grasslands constitute 18.42 per cent or 6,080,000 hectares of the total land surface of the country and most of these can be reasonably improved.

Climate can also be a liability or handicap. Insect pests and diseases thrive well under high temperatures, high humidity and abundant precipitation. Also without an extensive refrigeration system, meat spoils easily. These problems, however, can be controlled or at least minimized.

The inadequacy of meat supply, together with rising prices due to increasing meat imports, should provide enough incentive for people to invest in the livestock industry. Meat consumption in the Philippines is very low. It is far below nutritional standards and, in order to improve health conditions, a larger meat intake must be encouraged.

FORESTRY

The large and diverse forests of the Philippines constitute another valuable resources. Approximately one-third of the total land surface is covered by commercial forest stands from which timber is cut. The most important stands of hardwood are those which belong to the dipterocarpaceae family. Trees belonging to the molave forest type are also of considerable importance.

The leading provinces in the logging industry are Negros Occidental, Agusan, Zamboanga del Norte, Zamboanga del Sur, Davao, Quezon Province and Mountain Province. Negros Occidental has long been a leading producer of rough lumber and finished wood products due

to the location of good stands of "Philippine Mahogany" in the area. Agusan is important as an exporter of logs although a number of sawmills and plywood and veneer factories are also located in the province. The Zamboanga provinces have large timber areas, most of which are near the coast. Davao probably has the largest timber resources in the country. Quezon Province also has considerable timber reserves. Most of the timber are transported to Manila or locally processed into plywood and veneer. Some of the logs are also exported direct from several parts in the province. Mountain Province is different from the other provinces in that most of its commercial forest reserves are soft woods — pine — rather than hardwoods.

In addition to the extent of forest land, other physical factors that need to be considered are type of forest, growth capability and accessibility.

The tropical forests of the Philippines are dominated by broadleaf evergreens. These forests have developed under conditions of continuous warmth and large amounts of moisture. However, of the 3,000 tree species known in the country, only 60 are commercially important. Thus, the 9,329,280 hectares of commercial forest land which make up 31.37 per cent of the total land area of the Philippines may not be as highly productive as expected.

Due to the high temperatures and high amounts of precipitation, forest growth in the tropics is characteristically rapid. While it may take 60 years or more for a tree to grow to merchantable size in the middle latitudes, it takes less than that period in the tropics. Climate is, thus, an asset in the Philippines in regard to the more rapid growth of its tropical forests.

The fragmentation of the Philippines into more than 7,000 islands provides good accessibility to many forested areas. The many islands offer good conditions for logging because the forest where it is available is likely to be close to the sea. The inland forested parts of Luzon and Mindanao require, nevertheless, extensive land transportation facilities.

If the present forests now under exploitation can be kept and maintained in the condition they should be, the Philippines can expect to have a continuous supply of lumber and related products for some time to come. However, many people think that there will always be forests to exploit even without adequate provisions for forest conservation. Certain people even think that forests are detrimental to a more rapid agricultural development in the country. These people overlook the fact that much of the area now covered with forests is not suitable for agricultural purposes and such can be rendered more pro-

ductive by using it permanently for the growing of timber. Clearly, the people need to be educated and informed on the proper utilization of forest resources.

RESOURCES FOR HEAVY INDUSTRY

The common sources of power for industry are the mineral fuels — coal, oil, and natural gas — and water. Nuclear energy minerals — uranium, radium, thorium, and lithium — have also become prominent in recent years because, as widely dispersed minerals, they represent a source of huge potential energy.

The Philippines has problems with regard to fuel resources. Coal reserves are small, scattered and low grade, generally of the non-coking variety. Oil and natural gas in commercial quantity have yet to be discovered. Water, however, as a source of power seems to hold more promise. Mountain topography and high annual precipitation totals make hydroelectric power development feasible.

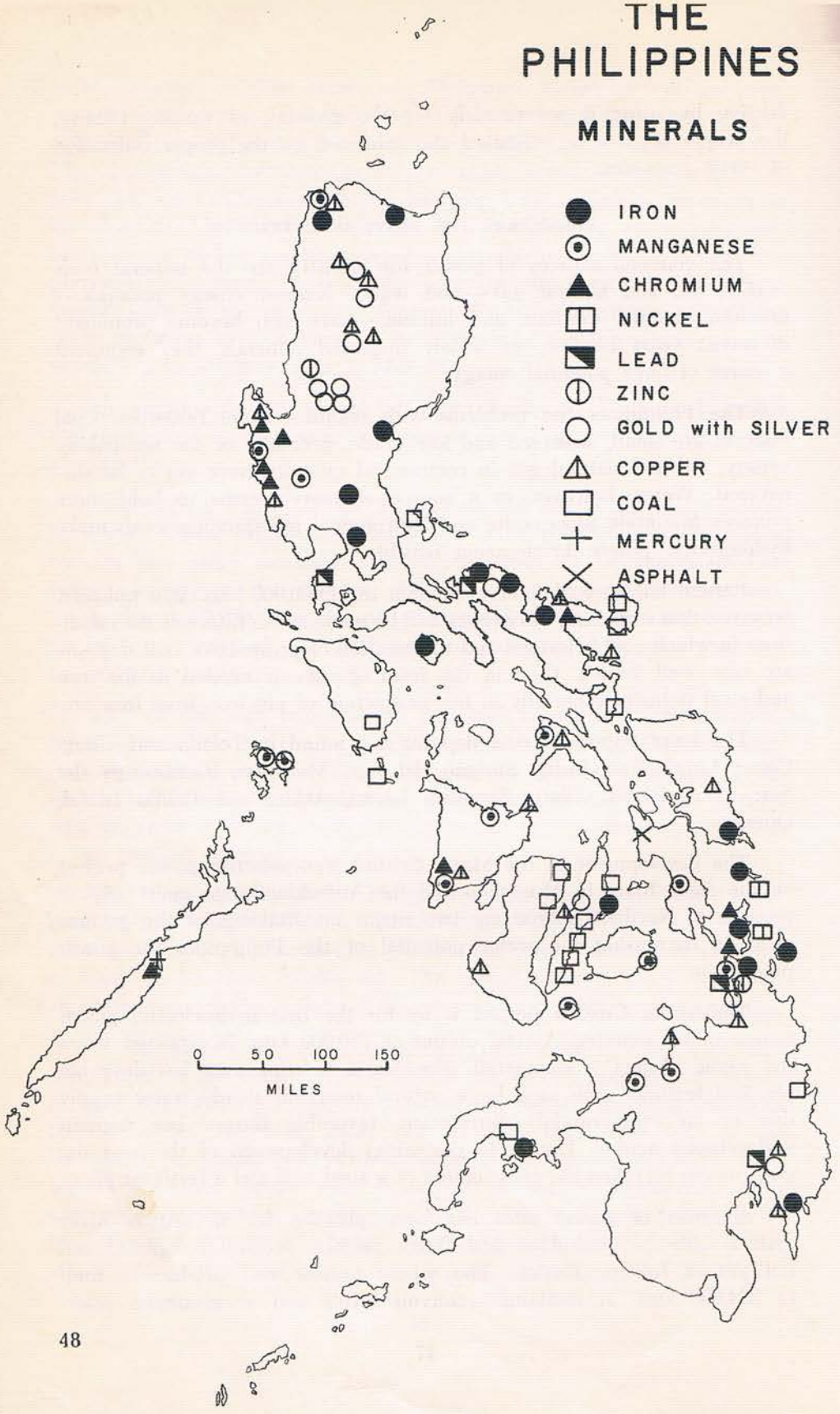
Present known coal reserves amount to 67,000,000 tons. It is unlikely, however, that surprising discoveries will be made in the future as the conditions in which coal is formed and the location of prospective coal deposits are now well known. Coal in the form of coke is needed in the iron and steel industry especially in the production of pig iron from iron ore.

The more important coal deposits are found in Toledo and Uling, Cebu; Lingig and Bislig, Surigao del Sur; Malangas, Zamboanga del Sur; Batan Island, Albay; Semirara Island, Aklan; and Polillo Island, Quezon.

The development of the Maria Cristina hydroelectric power project on the Agus River in Mindanao and the Ambuklao-Binga multi-purpose projects in Northern Luzon are two major undertakings of the government in harnessing the water potential of the Philippines for power production.

The Maria Cristina project is by far the best hydroelectric power source in the country. A total output of 750,000 kws. is expected when the whole project is completed. The Maria Cristina area has desirable physical features such as a large natural reservoir, steady water supply due to an even rainfall distribution, favorable terrain but without a developed market. Hence, in the initial development of the area the government included the construction of a steel mill and a fertilizer plant.

A series of power sites has been planned for the Agno River system with the Ambuklao and Binga projects already completed but not yet in full production. The whole project will produce a total of 324,000 kws. at minimum reservoir levels and at maximum reser-


THE PHILIPPINES
MINERALS
IRON
MANGANESE
CHROMIUM
NICKEL
LEAD
ZINC
GOLD with SILVER
COPPER
COAL
MERCURY
ASPHALT
0 50 100 150
MILES

voir levels, a production of 430,000 kws. is expected. The variation in expected power output is due to the great rainfall fluctuations in the Ambuklao area where reservoir sites are poor and topography unfavorable. These physical features made the construction of an earth-filled dam in Ambuklao necessary. The presence of a nearby market is, nevertheless, a desired and distinct advantage.

Still to be developed are the Angat and Marikina River systems of moderate potentials located in central and south central Luzon, respectively. The Lumot-Caliyara project in southwestern Luzon with an output of 38,000 kws. which was constructed before World War II but had to be rebuilt after the war represents the first hydro-electric power project developed by the government.

In addition to the use of water for the generation of power, it is also used for industrial processing, air conditioning and as a raw material.

Among the metals for industry, deposits of iron ore seem to be adequate and satisfactory. Reserves of magnetite and hematite ores are placed at over 100 million metric tons and lateritic ores at four billion metric tons. The magnetite and hematite ore deposits contain from 54 to 66 per cent metallic iron while the lateritic ore deposits average 47 per cent. Although the latter are extensive, they are not at present mined because of extra metallurgical needs. Nevertheless, they constitute an important reserve for the future. The magnetite and hematite deposits, which are fairly widespread, are actively mined.

The more important magnetite and hematite iron ore deposits are found in Calambayogong Island and Larap Peninsula both in Camarines Norte; Southern Samar; Mopog, Marinduque; Angat and San Miguel, Bulacan; Camalaniugan, Cagayan; Sta. Ines in Talisay, Rizal; and Sibuguey Peninsula, Zamboanga del Sur. The lateritic iron ore deposits are located in the mainland and offshore islands — Dinagat, Nonoc, etc. — of Surigao del Norte and Pujada Peninsula, Davao. So far the important producing regions are those of the Larap Peninsula, Camarines Norte; Marinduque; Subuguey Peninsula, Zamboanga del Sur; and Mati, Davao.

Chromite, manganese, nickel and cobalt, the ferroalloys minerals, are found in the Philippines. A fifth, molybdenum, is mined recently.

Chromite is actively mined in Zambales where the major deposits are located. Minor deposits are found in several areas in the Bicol Peninsula and in northern Mindanao. There are two ore types of chromite that are being mined. These are: 1) the ore type that is mixed with iron to produce a special quality steel (metallurgical chromite) and 2) the ore type that is used to line the interior of furnaces to reduce the loss of heat (refractory chromite).

The major manganese ore deposits are found in Busuanga Island, Palawan; Siquijor Island, Negros Oriental; and Guindulman, Bohol. These are also producing areas. Manganese is used as a cleansing (fluxing) material in the iron industry and at the same time it is mixed with iron to produce a special quality steel that is used for the manufacture of mining and roadbuilding equipment. Manganese reserves in the Philippines may undoubtedly be large based on the number of prospective areas which are yet to be surveyed.

Nickel is found in Surigao del Norte in the form of nickel-lateritic deposits. Due to the limited distribution of nickel, presence of nickel deposits in the Philippines if proven to be substantial is significant. Nickel is important to the steel industry because of the special properties of toughness, strength and ductility imparted to the finished product. In combination with chromium and vanadium (another ferroalloy), a harder and tougher steel is produced than if these ferroalloys are used singly.

Cobalt is found in the same areas where nickel is found. Cobalt deposits at present do not appear to be extensive as details of geological investigations with regard to this mineral are still limited.

Molybdenum occurs with copper and is mined at Sipalay, Negros Occidental. Molybdenum is also found with copper, gold and uranium at certain mining areas in Larap Peninsula.

Among the non-ferrous minerals, copper is the most important. Copper ore reserves are based on three sources — from operating mines, prospects from gold mines. Reserves from these sources amount to a little over 163,000,000 tons with an average metallic copper content of 0.87 per cent. The more important places where copper is found and mined are: Lepanto at Mankayan, Mountain Province; Toledo, Cebu; Sipalay, Negros Occidental; Lobo, Batangas. The Toledo Copper Mine is today the leading producer. The Mankayan copper mining region is now only in number two position although it used to be first up to 1955.

Detailed surveys of copper deposits are still going on in areas where copper is suspected to exist as well as in areas where copper is already found or mined at present. The Philippines' total copper ore may not seem very assuring since the average metallic content of the typical ore deposit is low.

Full information concerning reserves of lead and zinc is not available. The present low prices for lead and zinc in the world market act as a depressant in an otherwise more active production of these two metals. Prospective lead and zinc deposits, therefore, remain undeveloped.

The mining of lead and zinc is usually associated with gold production. Hence, gold mining areas like Paracale, Camarines Norte, Baguio, Davao and Surigao. The only exception is the deposit in Nasugbu, Batangas where lead alone is found.

Mercury is also found in the Philippines. It is now mined around the Puerto Princesa district — Tagburos — in Palawan. The known deposit, moderate in size and the ease with which the ores are treated, makes mining profitable.

A variety of non-metallic minerals essential for basic industries is also found. Of these, limestone is quite significant. Deposits are found extensively all over the country and reserves are outstanding. Limestone is used as a raw material for cement production, as liming elements in agriculture and a flux in the iron and steel industry.

Sulfur is also widely distributed. It occurs as iron pyrites which constitute the largest bulk of sulfur reserves, as elemental sulfur in sulfataric areas and fumaroles, or as sulfides in other metals. The main use of sulfur is for the production of sulfuric acid, a chemical which is indispensable in heavy chemical industries that its output is sometimes used as an index of manufacturing activity. More specifically, sulfuric acid is used in oil refining, rubber manufacture, textile processing, steel pickling, fertilizers, pigments and several others.

Other outstanding metals mined, though not industrially important, are gold and silver. The major area which produced 75 per cent of the nation's gold is in the Mountain Province in Baguio, Mankayan-Suyoc and Lubuagan. The Paracale area in Camarines Sur is also important. Gold is usually associated with silver, copper, lead and zinc. Gold production in the Philippines is of commercial significance. In fact, it occupies the most important position in the mining industry in the country.

The possession of a sizable and diversified mineral resource base is a major advantage to any country embarking on a program of industrialization. The Philippines, however, lacks a diversified resource base but the possession of even only a few of the minerals needed in industrialization in substantial amounts is more important than the presence of varied minerals none of which is available in large reserves.

FISHING

With 7,100 islands, the archipelago has an extensive coastline of 11,000 miles with numerous protected anchorages. However, the continental shelf or the underwater extension of the land around the several islands is narrow.

Philippine marine areas are not very highly productive. As with the case of other tropical areas, this country possesses a wide variety of fish but with limited quantities. This is due to the physical geography of the Philippines.

The richest fishing grounds in the world are found in areas where the continental shelf is wide and shallow — not more than 600 feet deep. In addition, cold and warm ocean currents must also meet within the area. This condition promotes the growth of fish food called plankton as mild temperatures limit the rapid growth of bacteria. Rich fishing areas are also characterized by many large fresh water streams emptying into the sea. These rivers which originate in the continents supply substances on which the plankton will in turn derive their nourishment. An example of a rich fishing area is the North Sea region off the coast of Northwestern Europe.

Such factors as the above do not exist in Philippine waters. The surface water temperature is almost the same throughout the year: approximately 85°F. These temperature conditions are responsible for the widespread but thin distribution of fish. The continental shelf is narrow and a large portion is covered with corals and rocks that fishing is limited in such areas.

Man-made factors also limit the productivity of Philippine waters, especially inland and coastal areas. Among these are over-fishing; the use of destructive methods of catching fish such as dynamites, poisons, and fine mesh nets; deforestations which cause floods and deposition of eroded materials on the rivers making them shallow or non-permanent; and the use of some rivers in the disposal of industrial waste laden with substances harmful to water life.

Despite the above-mentioned natural disadvantages, opportunity for the development of off-shore fisheries is fairly good with the use of advanced technology developed locally and abroad. Off-shore or deep-sea fishing is, however, relatively new in the Philippines. There are still very few large deep-water fishing crafts owned by Filipinos.

Inland fishing development is far more favorable. There are 716,000 hectares of swamps and marshes in the Philippines which await development. In addition, there are also extensive tidal flats, lagoons and shallow bays and inlets many of which are good sites for fish culture projects. If all the unutilized waters can be developed for fish production, a sufficient supply of protein food can undoubtedly be obtained for the entire population.

In view of the need for greater self-sufficiency in food, a need fostered by a rapidly growing population, the presence of large areas

of undeveloped or poorly developed swamplands and shallow coastal areas provides a promising possibility for overcoming the present serious shortage of protein foods. Swampy and marshy areas for fishpond development are found throughout the country with the Agusan and Cotabato valleys as the more important regions.