[1] *Lands and Climates*

Broadly considered, Latin America's geography is not friendly to human occupation, or favorable to people's activities. The struggle to live and thrive on the land has produced over the past 5,000 years or more some astonishingly ingenious human adaptations. But even today, with an unprecedented arsenal of technology at their disposal, people are far from overcoming the challenges posed by geography. Mountains still present a forbidding barrier to movement, transport, and economic development; rivers are, with the exception of the Amazon and the Paraná-Paraguay in South America, less easily navigated than the map might suggest, and mostly lead to places where rather few people want to go; in various countries excessive rainfall or, at the other extreme, aridity, seriously reduce the area available for growing food.

Enough variety can doubtless be found in most large regions of the world for the label "land of contrasts" to be aptly applied to them. But Middle America (Mexico and the seven small nations of Central America) and South America can surely lay a peculiarly strong claim to the title. In them, variations of terrain, climate, vegetation, and resources are often packed together very closely. From the fully tropical, warm, and wet city of Veracruz on the Gulf coast of Mexico it is only 120 kilometers to the permanent snows crowning the Pico de Orizaba (a volcano which, at 5,747 meters, is the highest peak in Mexico). An even more striking shift takes place in north-eastern Colombia, where the Sierra Nevada de Santa Marta rises to snowy heights exceeding 5,500 meters within 50 kilometers of the luxuriantly vegetated Caribbean coast. Rapid changes also happen without any vertical movement. Particularly remarkable is the transition from wet tropical forest to sand desert, with a small intervening zone of savanna and scrub, that takes place over about 400 kilometers of the southern Ecuadorian and north Peruvian coasts. Many other examples of swift change exist. Among the obvious are the passage from high, cool semi-desert around the Bolivian capital of La Paz, over the snows of the eastern Cordillera Real of the Andes, and down into the humid, semi-tropical valleys called the *yungas* in the interior slopes of the mountains; or the rapid shift in

Paraguay from the fertile, watered lands lying east of the Paraguay river to the thorny scrub of the Gran Chaco west of it; or the move from the cool, deciduous rainforests of southern Chile eastward over the Andes to the chill aridity of Patagonia, in the rain shadow of the mountains.

Physical Geography

As some of the examples just given suggest, the physical form of the land is a powerful influence on climate, land use, and living conditions in much of Middle and South America. The structure can be imagined simply as a mountainous spine (the western Sierra in Mexico, the Central American ranges, and the Andes in South America) running down the western side of the entire area; and, east of this spine, a trunk consisting of lesser ranges and massifs, plains, and, in the Caribbean, large and small islands. But, for a sense of the influence of geography on Latin America's history, a closer view of the landforms is needed.

Middle America and the Caribbean

Broadly speaking, the geology and surface formations of North America continue down into northern and central Mexico.[1] The largest feature here is the *altiplano* (high plain), which has an altitude of some 1,200 meters at the border with the United States at the Rio Grande. From there it rises gradually southward to reach about 2,400 meters in central Mexico. The plain is flanked on each side by mountains. The Sierra Madre Occidental, to the west, has peaks in excess of 3,000 meters.[2] The eastern range, the Sierra Madre Oriental, is generally a little lower. The Sierras do not reach the coasts. Low plains run from their feet to the sea.

The *altiplano* and its flanking ranges are abruptly cut off, at about 20°N, by Mexico's most imposing physical feature. This is a line of volcanoes (the "volcanic axis"), running from the Pacific to the Gulf shore. Some of the volcanoes still bear their Nahuatl names. Particularly renowned are Popocatépetl (Smoking Mountain, 5,452 meters) and Ixtaccíhuatl (White Lady, 5,273 meters) which overlook from the south-east the broad valley in which Mexico City lies. It is said that on exceptionally smog-free days their snow-covered peaks, once one of the glories of the capital's site, can still be seen from the city. Some of the volcanoes along the axis continue to be active. And in 1943 their number grew when emerging lava split open the earth 300 kilometers west of Mexico City in the state of Michoacán, and a new cone, named Paricutín, began to rise.

South of the volcanic axis lies a large area of old crystalline rock. Although the maximum heights here barely exceed 3,300 meters, long and heavy erosion has made these Southern Highlands one of the most rugged sections of Mexico's surface. To the east of the Highlands lies a region geologically very different from them and from the rest of Mexico: the Yucatán peninsula, which is a large, almost flat, area of limestone projecting northward into the Caribbean.

Because limestone is porous, Yucatan, especially in its northern half, has few surface streams. Water flows in underground channels, and can be reached only where the roofs of underground caverns have collapsed, leaving sinkholes, known locally as *cenotes*.[3] Yucatan provides the largest area of lowland plain in Mexico, but it is less useful than might be supposed because of the lack of accessible water and the poor quality of soil that weathered limestone typically yields. More fertile is the Gulf coast lowland further north in eastern Mexico, which is a continuation of the coastal plain of Texas in the southern United States. Its greatest width, near the border in the north, is some 200 kilometers. By contrast the coastal shelf in western Mexico is rarely more than 100 kilometers wide, and on the southern coast far less than that.

South of Mexico, the Pacific coast ranges in five of the Central American countries – Guatemala, El Salvador, Nicaragua, Costa Rica, and Panama – continue the mountainous western spine of the Americas to the Andes in northern South America. A second link between Middle and South America exists in the islands of the Greater and Lesser Antilles. The first consist of Cuba, Jamaica, Hispaniola (the island now divided between Haiti and the Dominican Republic), and Puerto Rico; the second comprise the many small islands of the Windward and Leeward Islands. The geological structure producing the Lesser Antilles meets the spur of the Andes that extends eastwards from Colombia to form the coastal ranges of Venezuela.[4] In both Central America and the Lesser Antilles occasionally active volcanoes are to be found.

South America

The Andes

Thus the westward and eastward rims of the Caribbean converge in the northern Andes. These great mountains then run southwards for almost 8,000 kilometers to Tierra del Fuego at the tip of South America, forming the longest continuous series of ranges on the face of the earth. The Andes are not a single chain but many, more or less closely connected. Added to this structural diversity is variety in formation. Over most of their length, the Andean ranges are the product of folding and faulting of the earth's surface. But in three regions – southern Colombia and Ecuador, central and southern Peru together with the border zone of Bolivia and Chile, and south-central Chile (with nearby areas of western Argentina) – volcanic activity has added other peaks to the landscape. The highest mountain anywhere in the Andes (and in the Americas), Aconcagua (6,959 meters) in western Argentina, is volcanic. So are many of the highest summits in Ecuador (for example, Cotopaxi at 5,897 meters, and Chimborazo at 6,267); in southern Peru (Misti at 5,822 meters); and in north-western Bolivia (Sajama at 6,520 meters). Many volcanoes are still active, though eruptions may come only at long and unpredictable intervals. The effects of the volcanoes' eruptions generally extend far from the peaks themselves, leaving lava-covered plateaux and thick layers of ash and tuff, often deeply incised by erosion.[5]

Though enormously long, the Andes are narrow, rarely exceeding 350 kilometers in width except in the center of their course, in Bolivia, where the distance across the ranges grows to almost 700 kilometers. Their narrowness is small consolation, however, to anyone trying to cross them; extreme ruggedness and steep slopes make for slow and difficult progress. East–west passes below 3,000 meters are very few (in contrast with passes across the western ranges of North America, which are rarely higher than 2,000 meters). The deep valleys, generally running parallel with the coast, that separate ranges often make east–west movement a still more daunting challenge of multiple climbs and descents. The problem is particularly severe in Colombia, where the Andes split into three distinct cordilleras, with the valleys of the Cauca and Magdalena rivers between them. Less forbidding, but still challenging, is the physical structure of southern Peru and the entire highland zone of Bolivia. Here the traveler to the interior faces first a high coastal range, then a wide plateau (called *altiplano*, like the plateau of northern Mexico), and finally an inland Cordillera Real ("Royal Range") that is as high as the first range, and drops only gradually through chaotically broken terrain towards the central lowlands of South America.

Though rocks and faulting from many geological periods are found in the Andes, the main uplifting and folding that produced the present mountains took place in very recent geological time, between 4 and 15 million years ago.[6] Those same disturbances were accompanied by the volcanic activity that created, for example, the western range of southern Peru and Bolivia. One reason for the great height and brokenness of the Andes is precisely that, in geological terms, they are young. Erosion has not yet greatly worn them down or softened their outlines. Where volcanoes are active, in fact, peaks are still being built up. This is so not only in parts of the Andes, but also in Central America and, to a lesser degree, in Mexico.

The reason for the commonness of volcanoes is that the mountainous western spine of Middle and South America is part of the geologically unstable "ring of fire" around the Pacific. And the existence of that ring results from the fact that the Pacific shores generally mark the lines of meeting of great tectonic plates in the earth's crust. Where the edges of these plates come together, and move against each other, volcanoes, and also earthquakes, are most likely to occur. The western Mexican and Central American coasts mark the boundary between the Cocos plate, offshore, and the North American and Caribbean plates. Almost the entire western coast of South America corresponds with the meeting of the Nazca plate, underlying the Pacific, and the South American plate – a large slab of the earth's crust that forms not only the land mass of South America, but also the seabed eastwards to the mid-Atlantic ridge in the South Atlantic.[7]

Lesser highlands of South America

In contrast with the Andes, the rest of South America is geologically ancient, and, thanks to its distance from grinding and jolting tectonic joints, seismically

stable. Again, when set against the Andes, roughly three-quarters of the rest of the continent can be described as a series of plains that are quite smooth and low (under 500 meters). Only two large highland areas rise above the general levels: the Guiana Highlands, almost all of which lie in southern Venezuela, and the Brazilian Highlands, which are inland from the Atlantic in central and southern Brazil. But neither matches the Andes in extent or as a problematic physical feature. The maximum altitudes in these two areas give a sense of the difference: 3,014 meters at the Pico de Neblina at the extreme south of the Guiana Highlands, 1,000 kilometers south of Caracas on the Venezuelan–Brazilian border; and 2,890 meters at the Pico da Bandeira at the eastern edge of the Brazilian Highlands, 300 kilometers or so north-east of Rio de Janeiro. The Brazilian Highlands were a hindrance to inward movement from the settled coast of Brazil in colonial times, though far from an insurmountable barrier. Today they are well populated in many areas, partly because over large areas rain has decomposed their old underlying crystalline rock into good, deep soil. The Guiana Highlands, by contrast, are so remote from other large human occupation in northern South America that they are barely inhabited to this day.

South American plains

More than a half of South America's lowland plain lies in the inland area drained by the Amazon and its tributary rivers. At the western boundary of Brazil with Bolivia, Peru, Ecuador, and Colombia, the Amazon basin extends some 1,400 kilometers north to south; but it narrows eastwards, so that as the great river nears its multiple mouths, it flows through a gap of barely 250 kilometers between the Guiana and Brazilian Highlands. The total area of the Amazon basin (including the Andean and other highland areas where the rivers originate, as well as the plains over which they flow) has been estimated as 6,133,000 square kilometers. It is remarkable how far west the Amazonian drainage area stretches: the headwaters of the Marañón, a major tributary, rise in the Peruvian Andes only 115 kilometers from the Pacific. The Amazon basin's flatness is also impressive. At Iquitos in Peru, 2,700 kilometers west of the river's mouths, the land is only 200 meters above sea level. Modern ocean-going ships drawing up to 4.25 meters can reach Iquitos from the Atlantic. Few of the Amazon's tributaries, however, can be used by ships far from the main stream, because of falls or rapids where they cross formations of crystalline rock. Many of the tributaries are, nonetheless, enormous rivers by standards elsewhere in the world. They contribute to the Amazon's being by far the largest river, in volume, anywhere on earth. Its flow as it enters the Atlantic amounts to about 11 percent of all the water draining from the earth's continents into the oceans.

Amazonia, as the Amazon basin is known, is also the earth's largest area of rainforest. The constant moisture that much of it receives from year-round rain, together with tropical warmth, encourages the growth of tall, closely spaced, trees. The forest itself, until the advent of powerful modern machinery,

constituted a strong barrier to travel. In colonial times it was barely settled by Spaniards and Portuguese. Another large disincentive to settlement was the generally low fertility of the forest soils; the constant heavy rains leach soluble minerals out of them, so that when trees are cleared, the ground will normally yield good crops for only a year or two.

North of Amazonia, beyond the Guiana Highlands, lies another lowland region: the plains, or *llanos*, of the Orinoco basin. The Orinoco river rises on the south-west slopes of the Highlands, and wraps around them northward before flowing east through Venezuela to enter the sea through a delta facing the island of Trinidad. The *llanos*, a savanna of mixed grassland and trees, are a plain almost 1,000 kilometers long by 325 kilometers from north to south; but, despite these impressive dimensions, they are of a lesser order of size than the Amazon lowlands.

The third lowland area of the interior, however, is far more Amazonian in scale, and, considered as a scene of human and economic activity over the past several centuries, outranks Amazonia in importance. This is the basin drained by the rivers – the Paraguay, Paraná, and Uruguay are the main streams – that join to form the Río de la Plata (a name that properly belongs only to the estuary through which the three rivers' combined waters enter the South Atlantic). The basin includes the Chaco of western Paraguay and north-western Argentina, and also the fertile lowland plains, known as *pampas*, of southern Uruguay and central Argentina. In colonial times these grassy plains became home to vast numbers of wild cattle and horses. More recently, raising of grains has been added to their function as the richest large pasture lands in South America. Some 400 kilometers south of Buenos Aires the *pampas* come to an end as the land rises into Patagonia, the dry and cold southern third of Argentina.

In addition to its interior lowlands, South America has a perimeter of coastal plains, though these are extensive only in the few places where major rivers, such as the Orinoco, Amazon, and those of the Río de la Plata system, cut through ranges and massifs to reach the sea. There are regions in which the plain disappears altogether. This happens, for example, in the southern quarter of Chile, where mountains run down into the sea, forming an archipelago of hundreds of islands. Elsewhere, some of the more or less narrow coastal plains have had notable historical parts to play. One of these is the thin strip of coastal Peru between the Andes and the Pacific, in some places only a few hundred meters wide, though with deeper valleys running back into the Andean foothills. In those valleys some of the most sophisticated cultures of pre-Columbian Peru developed. Today many of Peru's major towns stand in the same places. On the other side of South America, the Atlantic-facing coastal plain of Brazil, with a maximum width of 170 kilometers, offered in colonial times conditions so favorable for living and farming that it was from the start the heartland of Portuguese America. Once the plain's light tropical forest was cleared, its well-watered soils proved ideal for producing sugar from cane, making the colony Europe's prime, and rich, supplier of that previously rare sweetener.

ILLUSTRATION 1.1 The Bolivian *altiplano* (*c.*4,000 meters) near La Paz, looking east to the peaks of the Cordillera Real of the Andes. Cloud indicates moisture rising westward from the Amazon basin.

ILLUSTRATION 1.2 An Andean volcano: Misti (*c.*5,800 meters) in southern Peru, with the town of Arequipa in the foreground. Owing to the aridity of this region, snow is visible only at the tip of the volcano. Arequipa receives water from streams.

ILLUSTRATION 1.3 The Cerro Rico (Rich Hill) of Potosí (Bolivia), seen from a square in an Indian quarter of the town. Tailings from centuries of mining are heaped on the upper slopes of the Cerro.

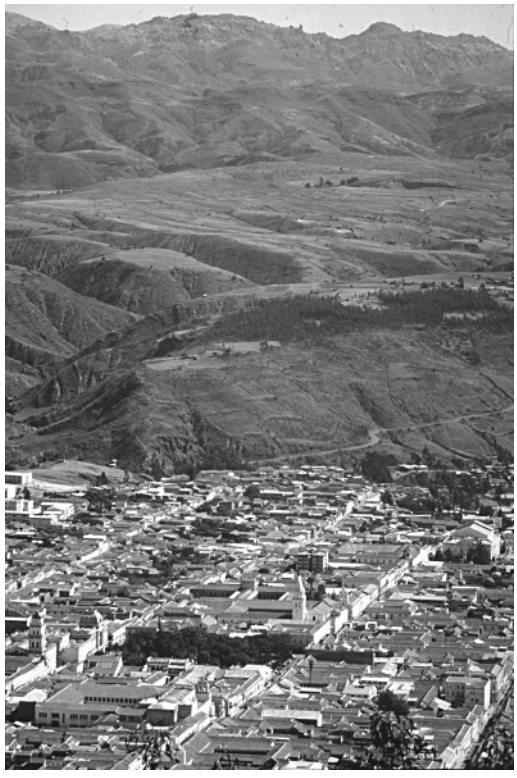

ILLUSTRATION 1.4 Sucre, capital of Bolivia until the end of the nineteenth century, and before that, as La Plata, seat of the *audiencia* of Charcas. The town retains much of its colonial air and form, not least in its straight streets and division into rectangular blocks.

ILLUSTRATION 1.5 An Andean *hacienda*: Cayara, in a high valley near Potosí (Bolivia). Note the terracing, now abandoned, on the surrounding slopes. Spanish farm buildings have been on this site since the 1560s.

ILLUSTRATION 1.6 Interior ranges of the Sierra Madre Occidental, Mexico: the valley of the Bolaños river (state of Jalisco).

ILLUSTRATION 1.7 The volcano Popocatépetl seen from the roofs of Puebla, in central Mexico. The volcano is covered in cloud, not smoke.

ENVIRONMENTS

FAVORABLE ZONES

The east coast of Brazil is, in fact, a rare example in Latin America of a low, tropical area that is generally comfortable for human habitation. It is so because of the temperature-moderating effect of the sea and of the winds that blow over it on to the land.

Much of the rest of tropical Latin America, however, is hot and humid to a degree that makes for disagreeable living conditions. And "tropical Latin America" is, in fact, *most* of Latin America. The northern tropic line (the Tropic of Cancer) passes across Mexico some 450 kilometers north of Mexico City, and the southern line (the Tropic of Capricorn) crosses South America at a latitude just south of Rio de Janeiro. Thus roughly half of Mexico, all of Central America, all the Latin American islands of the Caribbean, and two-thirds of South America lie in the tropics.

What above all else provides relief from heat and humidity in substantial parts of that enormous area is height. The mountain ranges and high plateaux that have so often been barriers to movement and development at least offer reductions in temperature. Air temperatures in the earth's lower atmosphere fall on average by about 6.5° Celsius per 1,000-meter rise in altitude. Thus a quite short journey from a tropical coast or forest up into nearby mountains can produce a change from sweltering heat to pleasant warmth.

Highland central Mexico provides an excellent and important example of that sort of shift in temperature. There, Mexico City, at a height of 2,250 meters, has an average temperature of 12.2° in January, and 16.1° in July. (As in all tropical areas, the change in temperature between winter and summer is quite small.) It is far cooler than places on the same latitude on either the Pacific or the Gulf coast of Mexico. A large area that surrounds the city enjoys the same advantage. Mexico is, in fact, blessed with a central strip of high land, limited to the south by the volcanic axis, and extending into the *altiplano* perhaps 300 kilometers north of that line of peaks, that has long offered marvelously benign conditions for human living. In this zone many of the high cultures of pre-Spanish Mexico developed and thrived: Teotihuacán, the first of the mature, "classic," cultures of central Mexico, *c.*AD 0–750; after that, the Toltecs; the Tarascans, to the west in Michoacán; and the Aztecs, the last major culture before the Europeans came. And, in this same favored zone, many of the major towns of modern Mexico lie: from east to west, Puebla, Mexico City, Toluca, Querétaro, Morelia, León, and Guadalajara, to name only the largest.

It is not just moderate temperatures that make highland central Mexico so agreeable for living. Isolation from the sea by coastal escarpments and ranges protects the region from excessive rain; but the barriers of distance and altitude are not so great as to keep out all moisture-bearing air, so that enough rain for successful farming usually falls in the summer months. Add to these benevolent climatic conditions a remarkable fertility of soil, owed first to long-weathered deposits of volcanic ash (contributing minerals), and second to the presence of large areas of now dry lake beds (contributing organic matter), and it is easy to see why this geographical center of Mexico has always been the demographic and cultural center also.

That fertile heartland of Mexico is by far the largest area in tropical Latin America in which the temperature-moderating effect of height produces agreeable living conditions for human beings. But there are many other smaller such areas. The mountain ranges of Central America, for example, have high valleys that are attractively cool relative to nearby coasts and plains. Outside Mexico, however, it is in the northern and central Andes that high places have been most important in favoring growth of population and economic activity.

In the north of South America, for example, are the high basins of the eastern range, or Cordillera Oriental, of Colombia. In one of these is the colonial and present capital of the country, Bogotá, at an altitude of 2,640 meters, and with an average year-round temperature of 14.5° C (a figure that varies, owing to the city's low latitude, only 1° C between the coldest and warmest months). Taking advantage of the farming potential of these basins, the Chibcha culture, the most advanced in the northern Andes, developed in them in pre-conquest times. The Spaniards brought in cattle, and added their own familiar wheat and barley to maize, the staple native grain.[8]

Further south, in Ecuador, the ten basins lying between the two parallel cordilleras that form the Andes were similarly the home of sedentary, agricultural peoples before the Europeans arrived. They continue to support much of the country's peasant population today. The basin partly occupied

by Quito, the national capital, is the most heavily settled now. The city, lying only 35 kilometers or so south of the equator, perches on the basin's eastern rim at 2,850 meters. At that altitude wheat, barley, and potatoes grow well. Down below, on the valley floor at about 2,300 meters, maize and pasture-grasses for cattle flourish. The second most populous Andean basin in Ecuador is the southern valley of Cuenca, where, at some 2,500 meters, maize and dairy cattle again thrive.[9] In both cases altitude makes middle-latitude farming possible almost on the equator.

South of Ecuador in the Andes many of the mountain valleys and basins are so high that the cooling effect of altitude becomes more of a problem than a blessing. In these places (still within the tropics, it should be remembered) humans have had to make use of specifically local conditions in order to thrive. The outstanding example is the land surrounding Lake Titicaca, part of which lies in Peru and part in Bolivia. The lake's surface is at slightly above 3,800 meters. Its maximum depth is 280 meters. It is 180 kilometers long and averages some 50 kilometers in width. Titicaca is by far the largest body of water at extreme altitude in the world. Its great volume has a moderating effect on the climate of the immediate surroundings, reducing the chill of great height and so benefiting agriculture. This is one reason for the region's long having been a focus of dense and culturally advanced settlement in the central Andes.

Much smaller areas in the heights of the Peruvian Andes have also been home to dense and sophisticated populations. In them people have over the centuries learned to take advantage of very specific geographical conditions: small areas of fertile alluvial soil laid down in valley bottoms by rivers, and protected from cold winds by the steep slopes of the mountains; or slopes oriented northward (here in the southern hemisphere) to the sun, and covered with terracing to maximize the warmed cultivable area. Such areas are said to have "microclimates," and there are great numbers of them in highland Peru. None has had more historical significance than the valley of Cuzco, in the center-south of the Peruvian Andes. This narrow depression of barely 30 square kilometers, but in which height, latitude, aspect, water, and soil combine favorably for living and farming, became the heart of the Inca empire, the largest and most finely organized of all American native states. The valley, some 3,400 meters above sea level, had been occupied for many centuries before the Incas entered it as a small, migrant tribe about 1200 AD. They set their home community, Cuzco, at the head of the valley. From the 1430s the town grew rapidly in size and splendor, concurrently with an exterior expansion of Inca power up and down the Andes that by 1520 had carried the tribe's and the city's political authority as far away as present northern Ecuador in one direction, and central Chile in the other.

As the Incas began to extend their rule, they took in other similar valleys close to Cuzco, such as those of Yucay and Ollantaytambo. The inhabitants of these valleys had long grown food on their alluvial floors and on irrigated terracing built into the nearby mountainsides. But a particularly interesting part of the history of the southern sierra in Peru, the highest part of the central Andes, is the use made by the Incas and their predecessors of cultivable areas at a variety of other heights. The ranges of the southern sierra indeed offer the

widest choice of local environments to be found in the Andes – the most extensive and complex "altitudinal zonation," as it has been called.[10] The highland communities took advantage of this to set up small "colonies" at different heights, using each small area so settled to grow particular foods. So, for example, at the height and latitude of the Cuzco valley, potatoes and other root crops could be grown. But maize, beans, and squash did better in lower, warmer places. And coca and fruits were best grown lower still. Conversely, above the level of Cuzco and other communities sited in high valleys, llamas and alpacas could be grazed on rough grasses.[11] *Puna* is the name given in Peru to the shallow slopes and occasional high plains between the mountains at altitudes running up from roughly 4,000 meters to the snowline at 5,000.[12] This zone has been termed "high-altitude tundra."[13] It has a natural vegetation of *ichu*, a grass so coarse that only the native Andean camelids (llamas and their relatives) have the digestive apparatus needed to benefit from it.

The Incas are the best-known practitioners of the technique of ecological colonization, and used it also for political purposes. So, for example, in the late fifteenth century they sent *mitimaes* (a Quechua term for colonists) from the imperial center to the valleys around Cochabamba in the eastern ranges of what are now the Bolivian Andes. There, at 2,500 meters, maize grew well, and the Cochabamba valleys became one the main granaries of the Inca state.[14] At the same time, however, the colonists served the political purposes of the empire: they contributed to the spread of the "state" language, Quechua; they acted as models in behavior and farming practices for the conquered local people; and they were a constant reminder of Inca power.

The latitude of Cochabamba (the center of present-day Bolivia) is roughly the southern limit of vertical colonization by pre-conquest communities. This is in large part because, with increasing latitude southwards, there is general cooling even at low altitude; hence the range of useful micro-environments at different heights diminishes. An additional difficulty is that in southern Bolivia, northern Chile, and north-western Argentina, the extreme aridity of the coastal plateau reaches far up into the mountains. Almost the only moisture to be found is in the snowcaps of the highest volcanic peaks. In these conditions of high, cold desert, human habitation is hard pressed, although it has long been present to some small, if primitive, degree in the southern *altiplano* of Bolivia, for example. And a little further south, on the *puna* of the Argentine–Chilean border, under the volcanic summits, a pre-Inca Atacaman culture once existed.[15] In slightly less arid conditions a little to the east, where some moisture from the Atlantic penetrates, the Humahuaca and Diaguita (or Calchaquí) farming cultures, again both pre-Inca, flourished in the high basins of north-western and north-central Argentina respectively.[16]

West-coast South America

More or less extreme dryness also affects almost half of the west coast – from northern Peru to central Chile – of South America. The contrast with regions

further north (the coasts of Colombia and Ecuador) and further south (lower Chile) is striking. Both of these are remarkably wet. The first receives in places more than 5 meters of rain annually from onshore winds that have absorbed moisture from the warm tropical seas over which they have passed; the second is almost as wet, as a result of fierce high-latitude storms. But over a rapid transition of only 4° of latitude from southern Ecuador to northern Peru, rainfall declines abruptly. And there begins an arid coastal plain that continues southward for 3,200 kilometers, to a point a little short of Santiago, the capital of Chile.[17] In northern Chile this zone is known as the Atacama desert, in parts of which rains never falls.

What accounts for this dryness is a combination of high atmospheric pressure offshore and cold ocean water. From the south Pacific high-pressure cell, which is centered year-round some 1,600 kilometers off the coast of northern Chile, a little below the Tropic of Capricorn, cool and stable air moves towards the land. As it does so, it crosses two distinct cold currents. The first is the Peru Oceanic Current (until recently known as the Humboldt Current), flowing up from the south; and the second, closer to the shore, is the yet cooler Peruvian Coastal Current, also moving north, and the product of the upwelling of cold bottom-water to the surface. The already cool air from the high-pressure cell is further chilled as it flows over these two currents towards the coastline, and arrives there as a dense, dank, meteorologically inactive mass. An almost permanent temperature inversion exists, indeed, along the coast, preventing vertical development of rain-producing clouds. Cloud, though, is certainly abundant in the winter months (June to October) along the Peruvian shore, presenting a puzzling, almost contradictory, spectacle: lowering, heavy masses of water vapor sliding onshore over a sand desert. A downpour constantly seems imminent, but hardly ever comes. Frequently during the winter, though, a thick, wet mist known as *garúa* covers parts of the coast; it is mainly this heavy, dismal drizzle that produces Lima's average annual precipitation of 41 mm.

In summer the sun is strong enough to dissolve the cloud cover, and the weather turns warm, though still humid. But the temperature inversion generally stays in place, preventing warm air from rising and developing into rain-clouds. The only circumstance in which this atmospheric stability breaks down (and this shows the immense influence on the coastal climate of the chilly waters offshore) arises when the cold upwelling weakens, and warmer water moves down from the north. Then instability in the air mass above the coast becomes possible, clouds form, and heavy, sometimes torrential, rains fall. The result can be disastrous, since the coastal land, being adapted to aridity, has no protection against the power of cloudbursts and heavy masses of surface water. Floods and erosion are the outcome. These changes in offshore flows and onshore rain are the phenomenon known in Peru as El Niño (The Child), since they often happen around Christmas, in midsummer. El Niño affects, however, only the northern half of the Peruvian coast. Further south the changes in currents that lead to warming of the sea do not happen.

Given that the Peruvian coast is (apart from the occasional downpours of El Niño) without rain, it is remarkable that many of the highest cultures of

ancient Peru developed there, and that to this day many of the country's largest towns are found along it. What makes flourishing human settlement possible on this coast is the presence of small rivers dropping down from the Andes. Where these streams cross the desert plain to the sea, vegetation naturally springs up along them in isolated patches of greenery. About forty such "oases" exist up and down the coast. They are larger in the north, where the plain is at its widest, and the rivers bigger and more constant in flow than in the center and south. For thousands of years past humans have maximized the benefit of the westward downflow of water from the Andes through irrigation. The crops grown with the help of this skilful channeling of water sustained such major coastal Peruvian cultures as Paracas (*c.*800–200 BC), Nazca (*c.*100 BC–AD 600), Moche (*c.*0–AD 750), and the immediately pre-Inca, and extensive, kingdom of Chimor (*c.*AD 1050–1500). The towns that the Spaniards built in these coastal oases in colonial times have developed into major current Peruvian centers such as (from north to south) Lambayeque, Trujillo, Lima, and Ica.

Latin America outside the tropics

In the minority of Latin America that is outside the tropics (the northern half of Mexico and the southern third of South America) modern examples of ingenious human adaptations to adverse living conditions can also be found. In parts of the semi-desert *altiplano* of northern Mexico, for instance, are small areas of intensive farming, made possible by irrigation. In the far south of Argentina, deep into chilly Patagonia, Welsh immigrants in the nineteenth century found it possible to raise sheep and grain in the river valleys of Chubut province. In the twentieth century the farming continued, and population grew also in response to oil and gas discoveries in the south of the province.[18]

But outside the tropics most of the population clusters in the temperate, fertile, more welcoming areas. These are strikingly few, and not large in comparison with the total area. Even to the north and south of the tropic lines the terrain and climates of Latin America pose great difficulties. Northern Mexico is mostly arid; where it is not, it is mountainous. A large part of northern Argentina falls within the hot scrub and thorn forest of the Gran Chaco. Much of southern Argentina consists of high, dry, cold Patagonia. Across the Andes from Patagonia, southern Chile is rugged, cool (to cold), and wet.

The sole truly large area hospitable to humans and farming in non-tropical Latin America is, then, the vast grassy plain that starts in southernmost Brazil and continues into Uruguay and central Argentina as the Pampas. In the nineteenth century the cattle (and, in some areas, sheep) raised on these plains were the source of great economic growth and prosperity, with accompanying human settlement. But in colonial times, with the exception of southern Brazil, where ranchers raised cattle for sale, the plains were barely settled. Countless numbers of wild cattle on the *pampas* provided food and hides for hunting and

gathering native people; but very few others lived on the grasslands of Argentina and Uruguay before the nineteenth century.

By contrast, the directly westwards across the Andes in central Chile lay a far smaller, but still substantial, non-tropical area that drew and held a colonial population from the 1540s onward. At about 30° south the overwhelming aridity of the Atacama begins to shade off into a region with a Mediterranean climate of mild, wet winters and dry, sunny summers. This zone, "Middle Chile," extending southwards for some 700 kilometers, is the country's heartland.[19] And, lying behind the coastal ranges, is the heart of the heartland, the Central Valley, containing Santiago, the capital founded in 1541, and other large towns. From the sixteenth century on, colonial Spaniards were drawn to Middle Chile by its highly favorable conditions for living and agriculture. The region had a particular allure in its suitability for growing wheat and grapes, and so providing the white bread and the wine at the centre of the Spanish diet.

Middle Chile is, however, the only sizeable area on the west coast of South America that is truly favorable to living and farming – and it is a narrow, though long, strip. Almost everywhere else is dense forest or sand desert, too hot or too cold, too wet or too dry. The tendency to geographical extremes is all too typical of Latin America. In the late 1960s, 71 percent of the total area of Middle and South America (just over 20 million square kilometers) was ranked as non-agricultural – that is, not under annual or perennial crops, or used as permanent pasture. Forest, desert, and mountain made up most of this non-agricultural area. In the USA the corresponding figure was 57 percent. It is possible, of course, that some of the unfarmed land might have been unused because of lack of demand for its potential products. And some of it has certainly been brought into production since then, particularly through the clearing of rainforests in Amazonia. Nonetheless, the fact that almost three-quarters of Middle and South America's surface was not cultivated in the mid twentieth century, by which time demand for farm products from growing populations was mounting, certainly reflects in part how hard it was, and is, to bring land into production. The sources of the difficulty were as they had always been: unfriendly climate (especially aridity); poor soils (typical of both excessively dry and excessively wet areas); and problems of access (caused above all by mountain barriers). Throughout the history and pre-history of Middle and South America, these conditions have worked powerfully to influence people's decisions about where to live. The result has been that certain atypically favored regions have long held, and continue to hold, the bulk of the populations: the transverse strip of central Mexico immediately north of the volcanoes; the eastern coast of Brazil; the high basins of the Andes from Colombia to Bolivia; the central valley of Mediterranean Chile. True, in some apparently unpromising regions human ingenuity managed to overcome Nature's lack of charity, so that striking concentrations of population, as well as impressive culture, appeared. The Yucatan of the Maya is one such example; though even the Maya declined in the ninth and tenth centuries AD after several hundred years of remarkable florescence – in part, it would seem, because the poverty

of their limestone land at last wore them down. A more enduring instance is that of the oases in Peru's coastal desert. They have produced and sustained some of the most highly cultured and densest populations in South America as far back as can be seen; and they still are the sites of Peru's largest and most modern towns. Still, these are exceptions that test the rule. Generally speaking, in comparison with most other great land masses on the globe, Middle and South America give meager provision of territory offering comfortable living and easy conduct of productive activities. Great wealth and ease can be had; but, as the Spanish and Portuguese found, only with a struggle. The native cultures that it was part of that struggle to overcome could have told them as much.